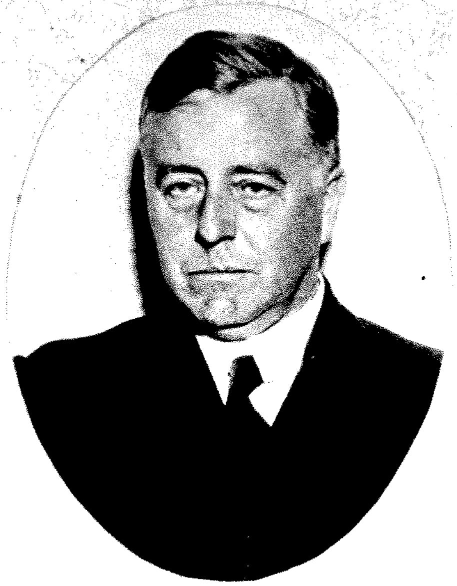

Sir James H. Jeans
Distinguished Scientist
and
Writer

Sir Arthur Eddington
Plumian Professor of Astronomy
in the
University of Cambridge

Alfred N. Whitehead
Professor of Philosophy
in
Harvard University

Robert A. Millikan
Director of the Norman Bridge
Laboratory of Physics
in the
California Institute
of
Technology

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The Religious Implications

of

Modern Astrophysical Thought

(With Special Reference to Eddington,
Jeans, Millikan and Whitehead)

by

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A THESIS

Submitted in Partial Fulfilment
of the Requirements for the
Degree of Doctor of Theology
in the
Biblical Seminary in New York

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"And verily many thinkers of this age,
Aye, many Christian teachers, half in heaven,
Are wrong in just my sense, who understand
Our natural world too insularly, as if
No spiritual counterpart completed it,
Consummating its meaning, rounding all
To justice and perfection, line by line,
Form by form, nothing single or alone,
The great below clenched by the great above."

Elizabeth Barrett Browning

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THE MODERN ASTROPHYSICAL VIEW OF GOD

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Chapter I

INTRODUCTION

A. The Motivation of This Study

1. Spiritually

"Fellowship with great ideas amplifies the soul." Thus did a great divine of the last generation begin a charming essay on the life of Oliver Cromwell. There is something akin to genius in this brief remark, but the writer said further by way of illustration: "The study of a sunset or a mountain or the sea exalts him who studies."[1] To that list of worthy subjects for contemplation might fittingly be added the one which forms the title of this thesis. It deals with things "high and lifted up" that make one the richer for having wrestled with them. Like Kepler when he turned his telescope toward the heavens, the investigator upon this new path is sure to declare that he is going to think God's thoughts after Him, as well as those of man. Impelled by this study to consider the vast expanse of sky studded with innumerable stars, some of which, at such great distances as stagger thought, are believed each to represent material enough to make a star-city composed of thousands of millions of stars,[2] the reverent scholar

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1. Quayle, The Poet's Poet, p. 39
2. Cf. Jeans, The Stars in Their Courses, Explanation at foot of plate XLI opposite page 114.

is certain that by the aid of modern knowledge it will be possible to say even more meaningfully than did the ancient Psalmist:

> "The heavens declare the glory of God; [1]
> And the firmament showeth his handiwork."

2. Intellectually

But not alone under the aegis of this spiritual impulse is this task approached. There is an intellectual exhilaration in the contemplation of such a a piece of work that acts as a stimulus to one's best efforts. Here windows will open through which the mind can view the infinitely great and the infinitesimally small. Horizons will be broadened to take in the farthest star, but through this widening process attention will be made to swing towards the opposite end of the universe. Vision will range from man to "heaven's distant lamps", then from these huge celestial fires to the tiny pieces of fuel that feed them. "For", as one has well expressed it, "the road to a knowledge of the stars leads through the atom; and important knowledge of the atom has been reached through the stars."[2] Interest will not end there, however, but rather will it then be focused on the great question as to how these vastly disparate objects

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1. Psalm 19:1
2. Eddington, Stars and Atoms, p. 10

came into being and are now sustained and as to what the present relation of man and of God is to the picture which they represent. In short, the journey will be from stars to atoms, from atoms to man, from man to God, for, as the poet has said:

> "We find great things are made of little things,
> And little things go lessening, till at last
> Comes God behind them."[1]

Everything along the way which is relevant to this theme will be examined, questioned and studied. There will, of course, be opportunity to indulge in something like Lilliputian fancies in seeking to comprehend the vastness and intricacy of this mighty structure of the universe, and to exercise the greatest powers of intellect nigh unto the breaking-point in trying to fit the various parts of the picture into one grand mosaic.

B. The Problem and Purpose of the Thesis

1. The Problem Stated

a) To Report What Modern Astrophysical Thought Is

Such a problem, however, as that involved in this alluring undertaking cannot even be attacked until it has been carefully stated and the steps in its solution have been noted. The first stage of progress will be the work involved in reporting clearly and accurately what modern astrophysical thought really is. A precise

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1. Browning, Robert, Mr. Sludge, "The Medium"

acquaintance with its views will be fundamental to the success of any further inquiry into the subject.

b) To Report What Its Religious Implications Are

The second stage of progress will be a minute inspection of these views for the purpose of discovering and recording their religious implications which in themselves are a part of the fruits sought in this investigation. They will be permitted first to make their own impression upon the mind before they are dealt with in any way.

c) Critically to Evaluate These Implications

The completion of the task implied in this problem will be the critical evaluation which is given to these religious implications. An effort will be made to point out any noticeable disagreements between reputed scientists themselves. When it seems justifiable alternate implications to those hinted at by scientists will also be advanced. In short, in keeping with the very nature of the problem as here expressed, an earnest attempt will be put forth to examine all proferred solutions that upon the basis of their individual merits sound conclusions may be drawn.

2. The Purpose Defined

a) Immediate

(1) To Orientate Ourselves in the Modern Astrophysical Thought of its Leading Exponents

At the very beginning of this study it is well also to have clearly in mind what its specific purpose is. No great progress can well be made if one does not know what and where the goal posts are. In this thesis, therefore, two aims have been projected, the one immediate and the other more remote. The first of these branches off in two directions. To get anywhere at all there must be at the outset an earnest endeavor to discover what modern astrophysical science is thinking and teaching. To facilitate this attempt only those interpreters will be chosen who are most widely acclaimed to-day as best fitted to open the eyes of the understanding both to things visible and things invisible in the universe about us. Nothing short of the most competent guides will suffice for this journey through the world of symbols and of shadows back to the portals of the spiritual realm. These will tell their own story that out of their mouths the truth may be established and the inquirer may learn at first hand what those who deal in such commodities have to say about their wares.

(2) To Indicate and Examine Critically the Religious Implications of That Thought

As these wonders are observed, however, the place will be approached where only a thin veil seems to separate appearance from the underlying reality. Here the trustworthy guides themselves will be seen standing, at first, in awe and amazement before the great mystery and then dropping their scientific measuring-rods to look at the meaning of the universe through the eyes of the soul. At this point science will so impinge upon the domain of religion that the religious investigator can then feel himself as much at home as those who guide him. In the meantime, too, the aim of this thesis will have branched into a new direction; the religious implications of the things seen will now occupy the centre of attention. The scientist who has turned philosopher will bein to question the universe with regard to the meaning of her hidden secrets. As he records some of the answers and patiently waits for others, the discerning mind would weigh the results already brought forth, always reserving the right to revert anew to the facts and make from them its own deductions.

b) More Remote

(1) To Rationalize the Religious Experience

Besides this aim another will be kept more remotely in view. It also has two sides. By the help of these findings an attempt will be made to rationalize the religious experience and give to it a more comfortable setting in the midst of present day scientific thought. This does not imply that religion must be made subservient to every dictum of science or that every pronouncement of the scientist is to be regarded as though it were spoken in <u>ex cathedra</u> fashion. But it does indicate a purpose to show how science in many of its accepted results lends support to the religious beliefs and practices of men and makes them tenable without doing violence to the reason.

(2) To Furnish a New Apologetic for the Religious Life, so far as Justified by Science

This will lead to the final intention of furnishing a new apologetic for the religious life, so far as this is justified from the scientific viewpoint. It is well to be reminded again that this does not signify blind approbation of all that science says in its own realm and out of it; it simply means that recognition will be given to science as an ally of religion whenever this reasonably can be done, and that an honest effort will be put forth to show how from its end of the tunnel science is facing questions that are answered only by that which religion, working from the opposite end, has to offer. In other words, the aim will be to show both directly and indirectly that religious beliefs are an indispensable necessity to the scientist in his attempt to understand his world.

C. The Justification for Such a Study

1. The Fascination of This Subject

The justification for such a work as this aims to be is many-sided. If mention were to be made of not the most important but the most compelling reason first, it would be the fascination of this whole field of investigation. A noted preacher of the present day, in counseling men who were preparing to be the religious leaders of the future, recommended the reading of science which he declared to be "the modern Aladdin's Lamp."[1] Eddington likens the study of modern science to the thrilling interest of a mystery story.[2] Jeans declares that astronomy, with which this thesis has largely to deal, is the most poetical of all the sciences. He would have men rejoice because they live on a planet with a clear atmosphere which enables them to see the beauty and poetry of the night sky and offers the intellectual excitement and joy of trying to decipher the meaning of this vast panorama of lights scattered throughout the spangled heavens as if placed there by the shaking of a pepper-box.[3] So exciting is the entire subject that any portion lends confirmation to the statement by Eddington in regard to the study of the stars in which he says:

> "In these problems where our thought fluctuates continually from the excessively great to the excessively small, from the star to the atom and back to the star, the story of progress is rich in variety; if it has not lost too much in the telling, it should convey in full measure the delights--and the troubles--of scientific investigation in all its phases."[4]

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1. Buttrick, Jesus Came Preaching, p. 150
2. Cf. Eddington, The Expanding Universe, p. vi
3. Cf. Jeans, The Stars in Their Courses, p. v and p. 1
4. Eddington, Stars and Atoms, pp. 5-6

Indeed to roam through the whole province filled with the breathless activities of the astronomer and the physicist is to feel oneself on enchanted ground which it is difficult to leave. There are romance and adventure enough in this prospect to outdo an Arabian Nights' tale.

2. Its Importance

a) Scientifically

On the other hand, the genuine importance of the subject cannot be overlooked in a consideration of the grounds which justify this procedure. Aside from its enticing features, this thesis is of vital interest because of its intrinsic nature. It is wedded to the patient and thoughtful research and findings of modern science and cannot be divorced from them. These in themselves lend dignity to the study, for they are of a most startling character. When these new discoveries are faced one can hardly believe his own eyes, yet it must be remembered that the world is in the midst of a revolution in scientific thought that is altogether Copernican in scope and motive.[1] The science of to-day

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1. From the purely scientific standpoint this statement may need to be qualified. Millikan maintains that the progress of exact science is always evolutionary and not revolutionary, the future advance incorporating the solid achievements of the past. Cf. next chapter for further elucidation of this point. To the untrained observer, however, the sweeping changes of recent years have looked more like the result of an upheaval in thought than the result of organic growth. Even

would command respect from the fact alone that the present is a period of astonishing activity, but it has even greater reasons for a claim upon man's attention. More significantly than at the threshold of the present age of science can it be said:

> "Progress is a thing of months and weeks, almost of days. The long line of isolated ripples of past discovery seem blending into a mighty wave, on the crest of which one begins to discern some oncoming magnificent generalization. The suspense is becoming feverish, at times almost painful."[1]

Truly science has arrived at new frontiers, and astronomy, because of its close relations with so many of the other branches of physical science, has quite evidently become the queen of them all.[2] At least she has become their popular spokesman. The latest pronouncements in this field are to-day eagerly awaited by the multitudes with something akin to reverence. They are anxious to hear what new thing the latest scanning of the heavens has to

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Millikan himself does not hesitate to apply this descriptive term to the present age of science. (Cf. his Evolution in Science and Religion, p. 11) Eddington also says, "The epithet 'revolutionary' is usually reserved for two great modern developments--the Relativity Theory and the Quantum Theory." (The Nature of the Physical World, p. 4) Both of these discoveries fall within this period.

1. Quoted from Sir Oliver Lodge on the authority of Heyl, New Frontiers of Physics, p. 2
2. Kirk, in Stars, Atoms and God, p. viii, gives chief place to physics, but this can be done only in a derived sense. The real stimulus to recent phenomenal advances in physics came primarily from astronomical studies.

bring them. Consequently those who would be abreast of the age cannot overlook the importance of this message with its attendant influence in other fields of science.

b) Religiously

(1) As Estimated by the Scientist

But there is a more practical reason for laying emphasis on the importance of the subject as a justification of this effort. The new knowledge is not the common property of the scientist alone; it has become the possession of the theologian, the minister, the religious teacher and the average man in the Church and out of it, and, accordingly, it is exerting its influence in reshaping each one's views. How true this is of the latter may be gleaned from the statement of a present-day scientist who, in writing chiefly to religious folk, said:

> "it is probably though regretfully true that in the case of the absolutely thoughtless and indifferent, it is the writings of men like Eddington and Jeans, John Arthur Thomson and Lodge, more than those of any theologian, that have pulled them up, and made them realize that there is something in this matter of Religion and a God, with which they have to come to terms."[1]

In the face of this assertion by a scientist, whether it be true or not, there is nothing for one to do but to recognize the influence of this revolutionary thought in the sphere of religion and to put one's self on familiar

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1. Simpson, Review Article on Scientific Theory and Religion, The British Weekly, May 25, 1933.

terms with it in some such way as this thesis proposes to do. "For", if it is true, as Millikan has said, that "mankind's fundamental beliefs about the nature of the world and his place in it are in the last analysis the great moving forces behind all his activities"[1], it must then be admitted that these modern scientists are exercising a powerful influence, whether for weal or woe, in shaping these activities.

(2) As Seen by the Religious Specialist

It has not been the scientist alone who has asserted the importance of his knowledge in the religious realm. If that were so, one might look upon his statements as an undisguised attempt to find a new market for his own goods. But some of the best assessors of the significance of these doctrines, whether agreeing or disagreeing with them, are not men of the scientist's particular calling, but rather specialists in the field of religion who see the weighty influence that these views are having on the public mind. In a recent article in which the author enters the lists in favor of the establishment of a new chair in theological institutions in Scotland to acquaint the students with both the destructive and constructive views of modern science and to relate those views to the facts of religion, he

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1. Millikan, Science and The New Civilization, p. 34

says: "The books which are being read to-day and which are disturbing men's minds are almost purely scientific--Jeans, Eddington, Whitehead, Millikan, and others."[1] Numerous expressions of a similar character in recent years and months have called attention repeatedly to the importance of becoming acquainted with a subject that has the power to agitate religious thinking in such a fashion. Another of the distinguished leaders of religious thought has caught up this common feeling of present need on the part of religionists in these words of dispassionate advice:

> "Granted . . . that religious faith has an intimate authority of its own, still an intelligent man would like to know how the postulates of religion are related to the prevailing world view; and inasmuch as the present conception is largely determined by science, he cannot remain indifferent to the relations of the two domains."[2]

A scientist, who is both a philosopher and a religionist, corroborates this statement when he says:

> "Religion will not regain its old power until it can face change in the same spirit as does science. Its principles may be eternal, but the expressions of those principles requires continual development....The great point to be kept in mind is that normally an advance in science will show that statements of various religious beliefs require some sort of modification. It may be that they have to be expanded or explained, or indeed entirely restated. If the religion is a sound ex-

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1. Black, James, A Warning to the General Assembly, The British Weekly, May 18, 1933.
2. Kirk, Current Thought, Record of Christian Work, September, 1932.

pression of truth, this modification will only exhibit more adequately the exact point which is of importance. This process is a gain."[1]

No one, therefore, wishing to know the currents of thought that are traversing the religious world of the present, needs further proof of the timeliness of this endeavor.

"New occasions teach new duties,
Time makes ancient good uncouth,
He must upward still and onward
Who would keep abreast of truth."[2]

3. The Scientists' Encouragement

a) Induced Partly by the Popular Appeal

Strange as it may seem science itself lends encouragement to this undertaking. There is little doubt that it has often been urged on to state its own conclusions and their implications by the pressing demand of the hungering multitude for further knowledge concerning the border-land mysteries of life. They would learn, if they can, what lies beyond the distant rim. Jeans has keenly sensed this fact when he says:

"many have begun to suspect that the astronomy of to-day, like that of Galilee, may have something to say on the enthralling question of the relation of human life to the universe in which it is placed, and on the beginnings, meaning and destiny of the human race."[3]

In a more recent work of this author than the one just quoted this same awareness has not faded but is evidenced

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1. Whitehead, Science and the Modern World, pp.263-264
2. Lowell, The Present Crisis
3. Jeans, The Universe Around Us, p. 7

even more strongly by the following statement:

> "There is a widespread conviction that the new teachings of astronomy and physical science are destined to produce an immense change on our outlook on the universe as a whole, and on our views as to the significance of human life."[1]

b) The Scientists' Seeming Hostility to This Appeal Only Professional

Science, however, does not appear at first to take kindly to this friendly overture from the religious seeker after truth. Its governing spirit is expressed in the following quotation from one of its recognized masters who said:

> "I would not venture to say that those who are eager to sanctify, as it were, the revelations of science by accepting them as new insight into the divine power are wrong. But this attitude is liable to grate a little on the scientific mind, forcing its free spirit of inquiry into one predetermined mode of expression; . . . I think it is not irreligion but a tidiness of mind, which rebels against the idea of permeating scientific research with a religious implication."[2]

This spirit emanates from a desire of the scientist to be regarded essentially as one who deals only with hard facts and not with intangible realities. As descriptive of this identical frame of mind the same author says:

> "The religious seeker who pursues significances and values is often compared unfavourably with the scientist who pursues atoms and electrons. The plain matter-of-fact person is disposed to think that the former is wandering amid shadow and illusion, whilst

. . . .

1. Jeans, The Mysterious Universe, p. vii
2. Eddington, Science and the Unseen World, pp. 23-25

the latter is coming to grips with reality."[1]

In language that spells exclusiveness the astronomer has defined the duty of every true scientist in terms of his own duty when he said:

> "The message of astronomy is of obvious concern to philosophy, to religion and to humanity in general, but it is not the business of the astronomer to decode it. The observing astronomer watches and records the dots and dashes of the needle which delivers the message, the theoretical astronomer translates these into words--and according as they are found to form known consistent words or not, it is known whether he has done his job, well or ill--but it is for others to try to understand and explain the ultimate decoded meaning of the words he writes down."[2]

Very humbly would he seem to leave the further task to those working outside his sphere. It would not appear from these statements that the expectation of scientific leadership in man's endeavor to integrate his world was justifiable.

c) Their Open Recognition of the Value of Significances

But the great authorities with regard to things material do not always speak so professionally, for it must be remembered that after all they are men of common clay and are subject to the same desires and impulses as the rest of mankind. Because it is hard for them to live their lives all in one compartment of their nature, the tendency to talk at times much as others would who

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1. Eddington, Science and the Unseen World, pp. 62-63
2. Jeans, The Universe Around Us, p. 327

approach these things from a different angle is obvious in their utterances. Listen to them in their less strictly scientific moments as they admit "our interest in science is not merely a desire to hear the latest facts added to the collection; we like to discuss our hopes and fears, probabilities and expectations."[1] In another section in which this same scientist is trying to justify the excursions of his own science--astronomy--into regions not yet explored and beyond the range of vision where it must deal with questions connected with the extension of the galactic systems, he says:

> "At first sight it seems a reasonable programme for science to tidy up the region of space and time of which we have some experience and not to theorise about what lies beyond; but the danger of such a limitation is that the tidying up may consist in taking the difficulties and inexplicabilities and dumping them over the border instead of really straightening them out."[2]

It is just this spirit carried beyond the confines of his own kingdom which makes him say further:

> "Truth and untruth belong to the realm of significance and values. I am not able to agree entirely with the assertion commonly made by scientific philosophers that science, being solely concerned with correct and colourless description, has nothing to do with significances and values."[3]

In harmony with this remark can be found an illustration, following the preceding comparison between the religious

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1. Eddington, Stars and Atoms, p. 53
2. Eddington, The Expanding Universe, p. 40
3. Eddington, Science and the Unseen World, p. 61

seeker and the scientist, in which he proceeds to "show that unless we pay attention to significances as well as to physical entities we may miss the essential part of experience."[1] Jeans has stated succinctly this new tendency in science, which makes imperative the task here undertaken, when he says:

> "We may well admit that science cannot at present hope to say anything final on the question of human existence and human destiny, but this is no justification for not becoming acquainted with the best that it has to offer."[2]

d) Summary

The thought meant to be conveyed by the aid of these quotations amounts to this: the scientist like others is a born philosopher and cannot help trying to piece together the parts of the picture which he has found. Because of this inherent tendency he justifies his own attempt to bring order out of chaos and remains persistent in his efforts. After admitting the fact that the scientist of the last century, whether he knew it or not, employed of necessity a philosophical creed which will not fit the present facts, Jeans declares for the same reason that the twentieth-century physicist is at work forging a new working philosophy for himself.[3] Proceeding, therefore, in his most recent book to depict the situation

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1. Eddington, Science and the Unseen World, p. 63
2. Jeans, The Universe Around Us, p. 8
3. Cf. Jeans, The New Background of Science, p. 2

in present-day physical knowledge, he frankly says:

> "I have drawn my picture against a roughly sketched background of rudimentary philosophy--the philosophy of a scientist, not a metaphysician--because I believe, in common with most scientific workers, that without a background of this kind we can neither see our new knowledge as a consistent whole, nor appreciate its significance to the full."[1]

This spokesman in behalf of the other members of his profession is quite right in the position he has taken. In remarks even more to the point another distinguished scientist of the presnt day makes this confession:

> "However incompetent any one of us may be to handle the relations of these great fields, every one of us must of necessity attempt to do so for himself if he is a reflectively moral being; for every such person must integrate his experiences into some sort of philosophy and some sort of religion."[2]

In a somewhat similar mood this same writer says:

> "The world is of course 'incurably religious'. Why? Because everyone who reflects at all <u>must have</u> conceptions about the world which go beyond the field of science, that is, beyond the present range of intellectual knowledge."[3]

There is more truth than fiction, then, in these summarizing words:

> "The great scientific minds are doing what they can to aid us to comprehend what is going on; for even they need a world view, if for no other reason than to become reconciled to the mysteries that have recently invaded their domain; and some have become philosphers and theologians in spite of themselves. Such is the inescapable trend toward a unified conception of things."[4]

. . . .

1. Jeans, The New Background of Science, p. vii
2. Millikan, Evolution in Science and Religion, p. 4
3. Ibid, p. 86
4. Kirk, Stars, Atoms and God, p. ix

4. The Universal Philosophical Instinct Within Us

Even if the scientist did not give the slightest bit of incentive to forge ahead with such a purpose as this, there could be no refraining for any great length of time from such an undertaking. For the truth of the matter is that within all men, whether highly learned or not, there is an instinctive urge to unify the world as understood. The philosophical impulse to integrate all true knowledge that comes within one's ken is universal beyond all doubt. Time was when man seemed satisfied to keep himself confined within the border-lands of the Mediterranean Sea and cared little about what existed outside his small world. On the back of old Spanish coins that carried a picture of the Pillars of Hercules there were inscribed the words, "Ne Plus Ultra", meaning "Nothing More Beyond". With that denial some thought the matter was ended, but it did not satisfy Columbus concerning whom it was said that "the instinct of a new continent burned within his soul". Disregarding these man-made prohibitions, the intrepid adventurer set out to explore the world further and ended by adding a new continent to the geographical map which also, in consequence of this, had to be revamped. As Columbus went beyond, so man to-day is compelled to travel beyond his past boundaries and take in new discoveries that may necessitate a re-alignment of his present views. He has nothing to fear from new truth any more than Columbus did when he caught sight of a new world. It cannot do otherwise than beckon him on to a new comprehension of the great diversity in the unity of the world and of the unity in the midst of the great diversity. Man's fearlessness in facing the hard facts of patient investigation should be as well-reasoned as that of the great Capernicus who, it is said, saw

> "that the foundations of real religion are not laid where scientific discoveries of any kind can disturb them, and who therefore keeps his mind open at all times to truth from whatever angle it tries to enter".[1]

D. The Mode of Procedure

1. In the Preparation of the Material

a) In the Initial Stage

In the preparation of the material for this thesis the course followed has been a simple one. It has seemed best in the beginning to study carefully at first hand in this field the works of the accepted masters whose names have been designated on the title-page of this study. Other names might readily occur to the student of this subject, which, it would seem, ought to be included among this list. But the works of such men are few and the strictly scientific character of such treatises as do exist all but preclude their mention in this group. These men have been chosen for their ability to popularize

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1. Millikan, Science and Life, p. 6

present-day scientific thought and for the hold they have upon the reading public. Only those books and articles of each author which upon examination gave evidence of containing material relevant to the investigation have been included in this study. A careful tabulation of such references in those writings as were considered pertinent to the subject has been kept for the purpose of precise quotation. This has been done because it was felt that, in a subject of this character, greater authority and emphasis could be given to the new discoveries and the criticisms based upon them if the writers were permitted to speak in most cases for themselves rather than if an attempt was made by too much paraphrasing to speak for them. This process has involved the rigid application of the inductive method of analysis to every piece of source material in order to procure the evidence with which to build the synthesis attempted in the body of this work.

b) In the More Advanced Work

After a working knowledge of these writers has been obtained, the plan has been to invesitage reputable secondary sources in the sciences for further light upon disputed or difficult points. From these studies the investigation has proceeded to an examination of the best available material dealing with the relation between scientific theory and religion. In other words, the method adhered to has been one that operates from center towards circumference. Whenever work has not been conducted at the center, sedulous care has been exercised in checking all references which have been made in the secondary material to the recognized sources. This has been done in the interest of accuracy, dependahlness and exact scholarship. Sp

2. In the Presentation of the Findings

a) Considered Generally

Generally speaking, the course pursued in setting down the results has been that which one would follow in constructing any piece of research work. First of all, there is an indication of the thing proposed with the reasons for doing it; in the next place, an endeavor to carry out the plan which was settled upon is exhibited; and lastly, the results of this study are gathered together and viewed summarily and critically that the permanent deposit left by the investigation might not be lost. This is the natural way.

b) Explained Specifically

But, more specifically, the presentation of these findings has perforce followed a sternly logical, as well as practical, course. Science has been allowed to take the witness stand first and bear testimony to its new viewpoints and discoveries which have been working such revolutionary changes in man's views of the world, of himself, and of God. There has been a rigid determination throughout the study to listen sympathetically, yet discerningly, to the whole of this testimony, and to heed the good advice of former President Elliot of Harvard by observing exactly what science says and describing correctly what is seen and heard. This testimony has then been organized for presentation in the most cogent manner possible for the purpose of agreeing or disagreeing with it, according as reason, understanding and religious experience dictated the course. At the close a summary of the results of our investigation has been given, together with an appraisal of the present situation as these findings reveal it. The spirit in which this work was begun and in which the final harvest of these studies has been garnered is expressed in those well-known lines:

> "Let knowledge grow from more to more,
> But more of reverence in us dwell;
> That mind and soul, according well,
> May make one music as before,
> But vaster".[1]

1. Tennyson, In Memoriam

PART I

THE MODERN ASTROPHYSICAL VIEW OF THE WORLD

Chapter II

A BRIEF INTRODUCTORY SURVEY OF PHYSICAL SCIENCE SINCE 1900

A. Explanatory Remarks

1. The Scope of Concern in This Chapter

Before approaching the heart of this subject it seems best to spend some time at the threshold of the investigation making a general acquaintance with the spirit, method, purpose and result of modern astrophysical thought. There is no intention in this survey to cover the whole field of modern science, by going back to Darwin or those before him, since that would involve more than it is possible to cover within the compass of one chapter, and since much of the discussion would be unrelated to the problem of this thesis. A very definite and important piece of work has been suggested in the subject which does not require this excursion into broader fields of science; it limits this outline to the advances of astronomy and physics which, interestingly enough, were the first and latest sciences in their respective order to make astounding progress in method and discoveries. One has well expressed this point by saying, "The earliest triumphs of scientific method were in astronomy. Its most noteworthy triumphs in quite recent times have been in atomic physics."[1] But even in the case of these two sciences the whole of their modern history will not be touched. A very definite line of demarcation in their development seems to divide the greater part of the nineteenth century from the twentieth and the last few years of the former. Modern astrophysical progress can be said to have begun in the closing years of the last century, or, roughly speaking, at the beginning of the new. It is this new era, therefore, which this survey purports to cover.

2. Scientific Justification for This Limitation

That there is no arbitrariness in the selection for review of this distinctive period, dating from near the close of the nineteenth century, for the purpose of creating an atmosphere, is abundantly proved from the statements of scientists themselves. Looking over the last century from the standpoint of progress, Millikan says that

> "the changes that occurred within the past one hundred years, not only in the external conditions under which the average man, at least in this western world, passes his life on earth, but in his superstitions, such as the taboo on the number thirteen or on Friday-sailings, in his fundamental beliefs, in his philosophy, in his conception of religion, in his whole world outlook, are probably greater than those that occurred during the preceding four thousand years all put together."[2]

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1. Russell, The Scientific Outlook, p. 40
2. Millikan, Time, Matter, and Values, p. 69

But the same noted scientist undoubtedly gives the greater part of the credit for this changed outlook to the last thirty years. Referring to the scientific view at the end of the nineteenth century, he says:

> "Nobody at that time dreamed . . . what an amazing number of new phenomena would come to light within the next thirty years, or how revolutionary, or, better, how incomprehensible in terms of nineteenth century modes of thought, some of them would be."[1]

A similar statement that determines precisely this author's views on the definite boundaries of the new era is as follows:

> "In many fields no past time has known and no future time can know so sudden and so complete a transformation, for the whole gamut of possibilities has been run through by our single generation."[2]

That this is the accepted belief of most scientists, is confirmed in a recent history of science by one who is himself a scientist. In a chapter entitled "The New Era in Physics" the writer locates the great change in this field in the last decade of the old century.[3] Ample justification, therefore, can be found for confining this review of the sciences involved to the period of the past generation.

B. The Importance of This Survey

1. In Promoting a Better Understanding of the New Positions of Science

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1. Millikan, Evolution in Science and Religion, p. 11
2. Millikan, Science and the New Civilization, p. 73
3. Cf. Dampier, A History of Science, p. 382

Such rapid strides have been made in the field of this thesis during the present century that it is pertinent to the purpose of this investigation to point out the great importance of becoming thoroughly familiar with the remarkable advance in scientific thought and achievement as a preparation for intelligently appreciating the newest positions of the present. The attempt to do this is a good mental exercise which is calculated to develop that kind of acumen necessary for tackling the great problems and questions of to-day. To catch the drift of scientific thought through these years enables one to see whither it is pointing and to evaluate more accurately the significance of its current pronouncements. But more especially is it important in following this advance to note the intrinsic nature of the thought itself, for a new viewpoint with regard to the very nature of the scientific idea has recently taken the field. This changed conception of physical knowledge is clearly pictured by Eddington when he says:

> "I shall have to emphasise elsewhere that the whole of our physical knowledge is based on measure and that the physical world consists, so to speak, of measure-groups resting on a shadowy background that lies outside the scope of physics."[1]

Inherent in this view are many limitations that must not be overlooked when new views are being considered. More

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1. Eddington, The Nature of the Physical World, p. 152

weight should not be given, in consequence, to the new theories than the field of their applications permits. The same authority just quoted recognizes this when he says in another place:

> "The measure-numbers[1], which are all that we glean from a physical survey of the world, cannot be the whole world; they may not even be so much of it as to constitute a self-governing unit."[2]

2. In Facilitating an Intellectual Grasp of the Religious Implications of These Positions

A study of these new concepts, as can readily be seen from the quotations just given, gives one a more discerning insight into their religious implications than could otherwise be possible. The limited province over which authority is claimed for these ideas very nearly excludes the consideration of some problems which, freighted with religious implications, would otherwise come within the scope of the territory commonly believed to be the domain of science. That same limitation of the field of science necessitates the postulation of a background of science over which it can have no control.

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1. Measure-numbers are the mathematical formulas employed in science to fill in the big gaps in man's knowledge of the world. Though unknown as to exact character, these formulas are nevertheless necessary to a consistent mental picture of the working of the cosmos. They are used to represent things we know nothing about, but whose existence must be postulated in an attempt at a rational construction of the universe. They are to be found in any study of relativity or of quanta.
2. Eddington, The Nature of the Physical World, p. 210

Here, there is room for the unfolding of the religious implications of things not clearly understood in physics and astronomy. This privilege Eddington grants to the religionist when he says:

> "The whole trend of modern scientific views is to break down the separate categories of 'things', 'influences', 'forms', etc., and to substitute a common background of all experience. Whether we are studying a material object, a magnetic field, a geometrical figure, or a duration of time, our scientific information is summed up in measures . . . We feel it necessary to concede some background to the measures—an external world; but the attributes of this world, except in so far as they are reflected in the measures, are outside scientific scrutiny."[1]

But even in that restricted area where physical science reigns there is need for discriminating thought upon present physical views that contain religious implications. A survey such as the present reveals that those concepts are ever changing and have not arrived at their final form. It becomes increasingly clear as one follows the history of recent years of physical science that the last word has not yet been said, and that many changes in view are likely to take place as the advance of investigation continues. The religious seeker is aware, therefore, that he must proceed with caution when he explores this region. And he is counseled to do so by the scientist. Referring to the active, growing condition of physical science, Eddington gives this bit

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1. Eddington, The Nature of the Physical World, p. xi

of good advice and warning:

> "These revolutions of thought as to the final picture do not cause the scientist to lose faith in his handiwork, for he is aware that the completed portion is growing steadily. Those who look over his shoulder and use the present partially developed picture for purposes outside science, do so at their own risk."[1]

C. The Emancipation of Science from Bondage to the Past

1. The Character of the Bondage

Modern physical science has traveled a long way from the positions which were held to be almost invincible in the latter half of the nineteenth century. It has done so by breaking the fetters of that age of thought which hindered it in its forward progress. Its genuine accomplishment in this undertaking can best be seen by noting the hard and fast character of that iron-clad system from which it shook itself loose. The system began its development in the seventeenth century with the establishment of the law of causation as the fundamental principle of nature. Explaining apparitions in the sky by the universal law of optics, and interpreting comets, which were formerly regarded as ill-omens for empires and kings, by the universal law of gravitation, the movement continued its progress until Newton himself expressed the wish that all the phenomena of nature could be deduced

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1. Eddington, The Nature of the Physical World, p. 353

from mechanical principles in a similar manner.[1] The continued history of this development to near the end of the last century can only be briefly related; Jeans has well summarized it when he said:

> "Out of this resulted a movement to interpret the whole material universe as a machine, a movement which steadily gained force until its culmination in the latter half of the nineteenth century. It was then that Helmholtz declared that 'the final aim of all natural science is to resolve itself into mechanics', and Lord Kelvin confessed that he could understand nothing of which he could not make a mechanical model."[2]

Not even did human life escape being brought under the influence of this rigid mechanistic philosophy. With each extension of the law of causation and each new successful application of the mechanical principle, man began to question more and more the exemption of human life from this scheme of things. Finally, when, in the early years of the nineteenth century, it was discovered that living cells were formed of chemical atoms in the same manner as non-living matter, man concluded that all life, including that of man, was governed by the same natural laws as those operating in inanimate nature.[3] The success of the mechanical principle was now complete. As a result the whole of nature during most of the last century was subject to a strict determinism, and mechanistic principles were believed to explain everything.

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1. Cf. Jeans, The Mysterious Universe, pp. 18-19
2. Ibid., p. 19
3. Cf. Ibid., pp. 20-21

2. The Historical Cause of the Emancipation

a) Generally Considered

Events, however, were destined to disturb the smooth-running of this machine. Disruptive forces began to work just before the new century dawned that were certain to bring about a great change in the prevailing mode of thought and a vast advance in physical discovery and knowledge. How this emancipation from the domination of the old physics took place is shown in a general way by the following quotation:

> "Throughout the mechanical age of science, scientists had proceeded on the same general lines as the child and the unreflective savage. Out of the impressions registered through their senses, they had built an inferential world of objects which they believed to be real, and affected by events of much the same kind as occurred in their everyday experience. They described this as the 'common-sense' view of science; and defined science as 'organised common-sense'. Any scientific theory which could not be explained in terms of the familiar concepts of everyday life was said to be contrary to common-sense, and could hope for but a cold and unsympathetic reception, either from laymen or scientists. Then new refinements of experimental technique brought new observational knowledge, which shewed that the workings of nature could not be explained in terms of the familiar concepts of everyday life. New and familiar concepts were found to be necessary; the age of common-sense science had passed."[1]

Touching this transition period from the standpoint of two of its fundamental discoveries, the same author in another passage traces the steps leading to the new age in science. So beautifully has he done this that his words are quoted

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1. Jeans, The New Background of Science, pp. 41-42

at length:

> "At the end of the nineteenth century it first became possible to study the behaviour of single molecules, atoms and electrons. The century had lasted just long enough for science to discover that certain phenomena, radiation and gravitation in particular, defied all attempts at a purely mechanical explanation. While philosophers were still debating whether a machine could be constructed to reproduce the thoughts of Newton, the emotions of Bach or the inspiration of Michelangelo, the average man of science was rapidly becoming convinced that no machine could be constructed to reproduce the light of a candle or the fall of an apple. Then, in the closing months of the century, Professor Max Planck of Berlin brought forward a tentative explanation of certain phenomena of radiation which had so far completely defied interpretation. Not only was his explanation non-mechanical in its nature; it seemed impossible to connect it up with any mechanical line of thought. Largely for this reason, it was criticised, attacked and even ridiculed. But it proved brilliantly successful, and ultimately developed into the modern 'quantum theory', which forms one of the great dominating principles of modern physics. Also, although this was not apparent at the time, it marked the end of the mechanical age in science, and the opening of a new era."[1]

b) Viewed with Regard to Personalities

When the new developments in physical science are studied with reference to the personalities who have been most directly responsible for them, there is one name which, by common consent, is associated with the border line between the two periods. Dampier says on this point:

> "The new physics may be said to have begun in 1895 with the discovery of X-rays by Professor Wilhelm Konrad Röntgen of Munich (1845-1923). Before that date many experiments had been made on electric discharge through gases, especially by Faraday, Hittorf, Geissler, Goldstein, Crookes, and later by J.J. Thomson, now Sir Joseph Thomson, Master of Trinity College, Cambridge.

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1. Jeans, The Mysterious Universe, pp. 22-23

> But these experiments seemed of importance only to those with exceptional insight, and it was Röntgen's work which first focussed on them the chief attention of physicists."[1]

A further quotation from this historian of science shows how this initial work of Röntgen inaugurated a new series of developments which distinguish this era from the past. In speaking of this the author says:

> "Röntgen's discovery led . . . to another field of research—that of radio-activity. X-rays produce marked effects on phosphorescent substances, and it was natural to enquire if these or any other natural bodies produce X-rays in turn. In this search, the first success fell to Henri Becquerel, who, in February 1896, found that the double sulphate of potassium and uranium, and later that uranium itself and all its compounds, emit rays which effect a photographic plate through black paper and other substances opaque to light.
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> The next year, 1897, was marked by the great discovery of ultra-atomic corpuscles, particles far lighter than the atoms of any chemical element. The new era in physics had begun."[2]

That radioactivity, which was discovered as a direct result of Röntgen's researches, proves the correctness of placing this name in the forefront of modern physical science, is ably witnessed to by the remarks of Millikan in regard to the significance of this discovery. He says:

> "In a word, radioactivity not only revealed for the first time a world changing, transforming itself continually even in its chemical elements, but it began to show the futility of the mechanical pictures upon which we had set such store in the nineteenth century."[3]

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1. Dampier, A History of Science, p. 382
2. Ibid., p. 384
3. Millikan, Evolution in Science and Religion, p. 15

Again, in referring to the same discovery on another occasion he says even more emphatically that:

> "In that discovery even the physical world changed in our thinking overnight in its fundamental elements from a fixed, changeless, static, dead thing to a changing, evolving, dynamic, living organism."[1]

So far in this consideration of the personalities involved in the liberation of physical science from the deadening restraints of the last century attention has been confined to those close to the beginning of the change. Eddington in his brief survey of this period follows up the names already mentioned with others that cannot be left out in any recital of only the barest facts in the case. And so he reminds us of the following:

> "Between 1905 and 1908 Einstein and Minkowski introduced fundamental changes in our ideas of time and space. In 1911 Rutherford introduced the greatest change in our idea of matter since the time of Democritus . . . When we compare the universe as it is now supposed to be with the universe as we had ordinarily preconceived it, the most arresting change is not the rearrangement of space and time by Einstein but the dissolution of all that we regard as most solid into tiny specks floating in void. That gives an abrupt jar to those who think that things are more or less what they seem. The revelation by modern physics of the void within the atom is more disturbing than the revelation by astronomy of the immense void of interstellar space."[2]

Regarding the results of Rutherford's researches he says further:

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1. Millikan, Evolution in Science and Religion, p. 46
2. Eddington, The Nature of the Physical World, p. 1

"Thus for the first time the main volume of the atom was entirely evacuated, and a 'solar system' type of atom was substituted for a substantial 'billiard-ball'. Two years later Niels Bohr developed his famous theory on the basis of the Rutherford atom, and since then rapid progress has been made. Whatever further changes of view are in prospect, a reversion to the old substantial atoms is unthinkable."[1]

With these names and the discoveries associated with them the more recent history of scientific progress shows that the phenomenal change which characterizes the present was well launched. Only one further bit of work needs to be mentioned which accomplished the severance of the new in spirit and outlook from the past. Rutherford's discoveries, which eventuated in the belief that the "atom is as porous as the solar system",[2] had blown to shreds the old concepts associated with a gross materialism. It yet remained for someone to break completely the spell of the law of causation which still was influential in holding science to a mechanistic interpretation of things. This Einstein succeeded in doing. The story of this new triumph is recorded by Jeans as follows:

"In its earliest form, Planck's theory hardly went beyond suggesting that the course of nature proceeded by tiny jumps and jerks, like the hands of a clock. Yet, although it does not advance continuously, a clock is purely mechanical in its ultimate nature, and follows the law of causation absolutely. Einstein shewed in 1917 that the theory founded by Planck

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1. Eddington, The Nature of the Physical World, pp. 2-3
2. Ibid., p. 1

> appeared, at first sight at least, to entail consequences far more revolutionary than mere discontinuity. It appeared to dethrone the law of causation from the position it had heretofore held as guiding the course of the natural world."[1]

From this time forward the separation between the old scientific philosophy and the new has been complete. Each new investigation into the unknown of this field makes the breach wider. Instead of being tied to a static past, as was the old science, modern physics, whether right or wrong, is dissatisfied with following the beaten track of an old philosophy and is resolved on freedom.

3. The Philosophical Character of This Emancipation

The break of the new age with the past has not occurred strictly in the field of science itself. The line of cleavage between the two periods has been drawn by the revolutionary differences in the philosophical thought which is linked to the purely scientific activity of each era. Every age of science, including the present one, is attached to some background of philosophical opinion. The divergence in viewpoint, therefore, between the two periods in question refers to this background. It is the interpretative positions which are different. This has been clearly observed by Eddington when discussing the contrast between the new and the old.

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1. Jeans, The Mysterious Universe, p. 23

He says in part:

> "There was a time when the whole combination of self and environment which makes up experience seemed likely to pass under the dominion of a physics much more iron-bound than it is now. That overweening phase, when it was almost necessary to ask the permission of physics to call one's soul one's own, is past. The change gives rise to thoughts which ought to be developed. Even if we cannot attain to much clarity of constructive thought we can discern that certain assumptions, expectations or fears are no longer applicable."[1]

Giving attention to the philosophical necessities of modern physics, Millikan likewise points out the insufficiency of the old views and shows how the change in the present is one of underlying ideas when he says: "The childish mechanical conceptions of the nineteenth century are now grotesquely inadequate."[2] That is just another way of expressing the conviction that the shift in the present is one of background and not of belief in exact science. Recent science itself therefore unequivocally acknowledges and teaches that the distinguishing feature of its latest proclamations is the philosophical character of the new dress required to make them presentable to the public.

Professor Niels Bohr, speaking as a specialist in this field, made this fact abundantly plain in an address which he delivered a short time ago before the American

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1. Eddington, The Nature of the Physical World, p. 344
2. Millikan, Evolution in Science and Religion, p. 27

Association for the Advancement of Science at the Chicago Exposition. He directed special attention to the fact that recently acquired knowledge of atoms and molecules demanded fundamental changes in the general philosophical outlook, and declared, in consequence of this, that all concepts of classical physics, and even the ideas common to everyday life, such as those of time and space, must be modified.[1] Sir James Jeans' latest work[2] is also a weighty pronouncement upon this subject. Both the title and the entire contents of the book are sufficiently confirmatory of the present statement about the philosophical character of the revolt in modern physics as to make further elucidation of this point unnecessary. That this observation is true seems to be the concerted belief of scientists and laymen alike.

4. The Preservation of Scientific Continuity throughout the Process of Change

Reference has already been made in the preceding chapter to what some have called the revolutionary character of modern astrophysical thought. By way of explanation of the use of that term, attention was called to the fact that in strictly scientific language this qualifying word could not apply. When all has been said that can be

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1. Cf. New York Times, June 23, 1933
2. The New Background of Science

with regard to the great upheaval of the present in science, the fact still remains that throughout the process of change from the old order to the new a scientific continuity in the chain of events has been preserved which challenges anyone to find a missing link. In showing how society may profit by taking a page from the notebook of science, Millikan pauses to say:

> "One of the greatest contributions of science to life is the discovery that progress is in general made by the evolutionary process. Einstein does not replace Newton; he merely supplements him. There are no revolutions in science. In so far as Newtonian mechanics was a body of experimental facts it is eternally true. The whole of Newton is incorporated in Einstein. Let the revolutionary reformer ponder well that fact."[1]

This eminent scientist enlarges upon this statement in words like these which lend emphasis to this point:

> "For", says he, "the exact and obvious truth is that no discovery of the twentieth century has thus far subtracted, nor can it ever substract, one whit from the great body of experimental facts brought to light in the nineteenth century. These facts, some of them of incalculable importance, too, are henceforth the permanent heritage of the race. In them eternal Truth has been discovered, truth that will forever guide the race in its effort to live in better accord with, better understanding of, better control over, nature. In other words, experimental science never has and never can take a backward step. It moves only forward in ever-expanding circles."[2]

In a remarkable series of Gifford lectures just recently published, the author touches upon this subject and discusses it with discerning insight and illuminating comment.

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1. Millikan, Science and Life, p. 70
2. Millikan, Evolution in Science and Religion, p. 50

After saying that we have no right to use skepticism in support of superstition, he says further:

> "Similarly we have no right to take refuge in the obscurantism which, because our knowledge of Nature is progressive, alleges that 'the scientific theories of one generation are repudiated by the next'. The man of science builds upon the labours of his predecessors. He seldom, if ever, entirely rejects their conclusions when these are the result of scientific method; that is to say, when they result from careful observation and experiment. He usually finds that such conclusions are, as it were, first approximations to the truth. They become, in the development of his research, rough outlines of theories to which he gives more accurate form. Sometimes he can make a higher synthesis, as when the laws of conservation of mass and conservation of energy are combined into a single law in consequence of the discovery that energy has inertia and therefore weight. But to fancy that the main development of any great branch of modern scientific theory may ultimately be proved to be valueless is absurd."[1]

Instead of looking, therefore, upon modern physical science as out of step with the march of progress in science through the ages, one is forced to see this new movement in physics as just another earnest attempt, in the long series of efforts, to approximate the truth and to see its related parts in a more comprehensive and satisfying way. Kirk is duly justified, it would seem, in making the following summarizing observation about the present:

> "The changes in physical theory have been so swift and revolutionary that all positions are tentative: yet they bear this mark, that they are true, and so may be taken as evidence of a growing consensus in respect to the main trends."[2]

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1. Barnes, Scientific Theory and Religion, p. 4
2. Kirk, Stars, Atoms and God, pp. viii-ix

D. The New Approach in Physics

1. More Refined Instruments of Investigation

a) The Improved Tools of Investigation

Such brilliant achievements as the last generation has been enabled to accomplish in physical research might easily create the impression that they were due chiefly to the greater instruments of precision with which the investigator is now able to equip himself. But while this is partly the case, it is not true to the extent that the casual observer might think. Heyl says that the "chief experimental tools of the nineteenth century are still in daily use."[1] Then he startles us further in saying that the distinctive new tools are few, and that of those of the first magnitude we can name only two—the electron tube and the molecular air pump.[2] But this assertion need not frighten one when the great importance of even these two inventions is taken into consideration. Let this same scientist describe their uses. With regard to the former he says:

> "The electron tube is probably the most widely diffused and familiar of the physical inventions of the twentieth century. Upon it the whole modern system of radio communication depends. . .
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> But not only in its public and popular capacity is the electron tube useful; it has become, as well, an indispensable laboratory tool. As a source of rapidly oscillating currents it affords flexibility

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1. Heyl, New Frontiers of Physics, p. 136
2. Cf. Ibid., p. 137

> without inertia and breadth of range without a competitor. As an amplifying relay, no device involving moving parts can compare with it in precision, certainty and magnifying power. The electron tube is a sort of electrical telescope and microscope in one."[1]

No less amazing than the almost miraculous uses to which this tube has been put are the manifold services of the molecular air pump which has also been mentioned as a discovery of first-rate importance. Again the scientist can best speak for himself in this matter. Here are his words:

> "Nearly all of the experimental work with X-rays and electrons requires the use of tubes exhausted to a high vacuum. For the production of such tubes we are much indebted to the modern type of air pump, known variously as the molecular, diffusion, or condensation pump. However different the forms which these pumps may assume, they all possess one characteristic feature in common, which distinguishes them from the older types: their operation depends on properties of gases which do not appear until the pressure has been considerably reduced. For this reason they all require an auxiliary pump of the older type to reduce the pressure to a point where the diffusion pump will take hold. But once the diffusion pump begins to operate, the exhaustion proceeds rapidly, producing in a few minutes a vacuum which would formerly have required as many hours.
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> Had it been necessary of (?) recent years to spend the time and labor in the production of high vacua that were required by the facilities of twenty or even fifteen years ago, it is doubtful whether a tithe of the work of this nature would have been accomplished."[2]

These two inventions have to do chiefly with the microscopic work of physical science in the realm of the atom and the electron. But great improvement has also

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1. Heyl, New Frontiers of Physics,pp. 138-139
2. Ibid., p. 138

been made in the instruments with which the heavens are studied. Gigantic telescopes have been constructed throughout various parts of the world in the last hundred years, but none which is yet completed compares with the superb 100-inch reflector, constructed at Mount Wilson Observatory entirely within the new era, and revealing, it is said, a number of stars estimated conservatively at one hundred million.[1] Reports now emanating almost daily from this source and circulating through the press would seem to indicate that the penetration of this enormous instrument is much greater than was supposed when this estimate was given (1928), and that vast numbers of celestial bodies, heretofore unknown because of their almost inconceivable distances from us, have been brought within the notice of man. Even as late as 1930 it would seem that science had not yet accurately reckoned the full powers of this colossal telescope. Reporting the figures for that time of one who used this powerful mechanism to survey the heavens, Jeans says:

> "Hubble estimates that the most distant of the 2,000,000 nebulae revealed by the 100-inch telescope must be about 140 million light-years away from us. This is the greatest distance which the human eye has so far seen into space."[2]

Now these figures have been increased by Dr. Hubble himself.

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1. Cf. Dampier, A History of Science, p. 429
2. Jeans, The Universe Around Us, p. 70

Speaking from Mount Wilson in the present year, he declared that probably 75,000,000 nebulae, star-systems like the Milky Way, are within the range of the giant reflector, and that some of them are as much as 300,000,000 light-years away from the earth.[1] Truly progress in the study of these remote regions of the universe has been made much easier by man's newest devices designed for this work.

Physical science has been busy, therefore, during this new period of intense activity, forging instruments that will assist man in his search for knowledge at both the large and the small ends of the world. After careful thought on this subject one can concur, without fear of exaggerating, with the following statement of one of the great thinkers of the present:

> "The reason why we are on a higher imaginative level is not because we have finer imagination, but because we have better instruments. In science, the most important thing that has happened during the last forty years is the advance in instrumental design. This advance is partly due to a few men of genius such as Michelson and the German opticians. It is also due to the progress of technological processes of manufacture, particularly in the region of metallurgy. The designer has now at his disposal a variety of material of differing physical properties. He can thus depend upon obtaining the material he desiresp and it can be ground to the shapes he desires, within very narrow limits of tolerance. These instruments have put thought onto a new level. A fresh instrument serves the same purpose as foreign travel; it shows things in unusual combinations. The gain is more than a mere addition; it is a transformation."[2]

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1. Cf. New York Times, January 13, 1934
2. Whitehead, Science and the Modern World, pp. 161-162

b) The New Experimental Material

Not only in new apparatus, as the preceding discussion indicated, but also in new materials upon which to work, has the present new era been especially fortunate. In fact, the latter prove to be more abundant than the former. And Heyl adds that the "progress in physics during the past thirty years has been due more to new material to work upon than to new tools to work with."[1] This new material, it is said, has been chiefly the result of three discoveries: X-rays, radio-active substances, and photo-electricity.[2] The utility of these discoveries in furnishing science with much new material upon which to work has been exhibited by this same writer in such clear and concise language that his words are quoted in full:

> "The quantum theory owes much to the phenomena of scattering and diffraction of X-rays, and quite recently the same phenomena have furnished us an experimental confirmation of the hypothesis of wave atoms. The debt of modern physics to the X-rays is by no means insignificant.
>
> But still more are we indebted to the discovery of radio-active bodies and of photo-electricity. By a study of the phenomena which they present we have learned that the atom may be subdivided into electrons and protons, a long step in advance over the ideas current in the last century, as the etymology of the word 'atom' itself signifies. We have had placed at our disposal charged particles moving with speeds comparable to that of light, by means of which we have learned to regard matter as an electrical phenomenon. Some of these particles are of enormous energy content for their size, and by their impacts we have been able to break up molecules into new and surprising forms.

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1. Heyl, New Frontiers of Physics, p. 136
2. Cf. Ibid., loc. cit.

Upon the phenomena of radio-active bodies chiefly was rooted the Bohr atom with its immense growth of theoretical foliage; and upon the behavior of electrons such as are emitted either spontaneously or under the action of light has been founded the modern theory of wave atoms."[1]

The advantages of this more refined material for an age of vigorous thought that seeks to blaze a new trail into the unknown world are incalculable when compared with those associated with the coarser material of the past age. Indeed, they are responsible for many of the new conceptions held to-day. So the scientists themselves assent. Heisenberg makes this obvious when he says that the "experimental material resulting from modern refinements in experimental technique necessitated the revision of old ideas and the acquirement of new ones."[2] A further summarizing word on this point is sufficiently convincing to warrant no additional comment. Jeans puts it in this satisfying way:

"An almost kaleidoscopic re-arrangement of scientific thought came with the change of century. The early scientists were only able to study matter in chunks large enough to be directly apprehended by the unaided senses; the tiniest piece of matter with which they could experiment contained millions of millions of molecules. Pieces of this size undoubtably behaved in a mechanical way, but this provided no guarantee that single molecules would behave in the same way; everyone knows the vast difference between the behaviour of a crowd and that of the individuals that compose it."[3]

c) The Future Outlook In This Field

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1. Heyl, New Frontiers of Physics, pp. 137-138
2. Heisenberg, The Physical Principles of the Quantum Theory, p. 62
3. Jeans, The Mysterious Universe, pp. 21-22

The present discussion has been an attempt to show in a brief way how the modern weapons of physical science have made possible the great advance in discovery and in the speculations which have accompanied actual progress in scientific knowledge. They have given man more to work with and upon and have stimulated thought in every direction. But the present advance is only a beginning in the progress which can be looked for in the near future. The existing instruments employed in the new approach of physics and astronomy seem crude compared to what is in the offing. Indications as to what one can expect in this field are given in the latest announcements regarding new refinements of mechanism and the possibilities for the immediate future. Only a few of these many new inventions that are almost uncanny in their powers can be mentioned here. Attention will be called first to just two in the realm of physics which may unlock many hidden secrets of the present which have thus far defied detection.

A new miracle worker of science, called the most powerful cannon yet found for releasing the enormous stores of energy locked up in the heart of the atom, was described last summer before the American Association for the Advancement of Science when it met in Chicago. The new "atom-gun" is known as the "Deuton", the name also given to the nucleus of the heavyweight hydrogen, which is called "hydrogen two". It is claimed that the new instrument will whirl these deutons by means of one of the most powerful magnets in the world, until they attain an electric charge of 1,330,000 volts, at which time they are hurled into the heart of an atom of lithium. Only about one in a million thus far has been made to strike its target, but that one, when it does strike, liberates about ten times the energy put into it by breaking down one of the many walls which guard the energy stored up within the atom and releasing alpha particles, or helium nuclei, having an electric charge ten times as great as the deuton itself. While this process, when perfected, may reveal great possibilities in unlocking what Eddington has called "the cosmic cupboard of energy", it also indicates a decided advance in the search of science for greater knowledge about the minute constitution of the world and may in time help to make possible some astounding discoveries in this sphere.[1]

Word has come recently that the 10,000,000 volt direct current generator, built by Dr. R. J. Van de Graff of Princeton for the Massachusetts Institute of Technology, has been tested at the Institute's field station at Round Hill. This machine is powerful and pretentious and undoubtedly can be expected to do much. It is designed to shatter atoms after the manner successfully

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1. Cf. New York Times, June 20, 1933

employed on a much smaller scale by Drs. Cockcroft and Walton of Cambridge in driving helium out of the nuclei of lithium atoms. The technical construction of the machine is difficult and involved and cannot, of course, be described here.[1] The great instrument is merely mentioned to indicate what good prospect there is of hearing of marvelous discoveries in the near future in this infinitesimally small world of the atom. Matter may be forced to yield many of her secrets in this age that surpasses all others before it in its scientific ingenuity.

Those whose business it is to watch the skies have not failed to manifest foresight in their work. Rapid strides in spectroscopic analysis and stellar photography, little known to the uninformed and less understood by them, have been made in recent years and are continuing to be made. A more efficient technique in these fields is netting great results and augurs well well for the future.[2] Then, too, there is the telescope. Mention has already been made of the 100-inch reflector that dominates Mount Wilson, and, in fact, the astronomical world. Scientists look with envy upon it when they are studying the stars in their courses. But a greater cause for envy is the much-heralded

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1. Cf. New York Times, May 8, 1932, December 18, 1933
2. Cf. Kirk, Stars, Atoms and God, p. 10

new telescope now in process of construction for some five years at an approximate cost of $12,000,000,[1] which will undoubtedly be located on a mountain top somewhere in Southern California in the vicinity of Mount Wilson. Its lens, which will be double the size of the present largest one, and which is regarded as the maximum possible in mirror construction, will be 200 inches in width.[2] Since the one now in use at this observatory seems capable of reaching such great depths of space, it is impossible to predict what the new instrument will do. Its possibilities seem incalculable.[3]

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1. A grant of $6,000,000 was originally made by the International Education Board for the construction of the telescope, (cf. New York Times, February 26, 1934) but the actual cost has been estimated by the figures appearing here in the text. (Cf. New York Times, December 30, 1933)
2. Reports from the Corning Glass Works, Corning, New York, where the new "ribbed" mirror is being constructed, indicate that the mold, in which 100 tons of molten glass composed of pyrex boro-silicate are to be poured, is now completed. The construction of the mirror, thus far advanced, has all along been the great problem of the new telescope. Experimentation for three years with fused quartz as the material for use in the lens, proved unsuccessful. More recent trial of a special glass in the construction of a 120-inch reflector has proved satisfactory and has brought the construction of the larger lens to the present stage. When the glass is finally poured, it will require another ten months for cooling, according to the accepted results of special scientific studies in this problem, in an electrically heated annealing box. Upon this slow cooling depends the success of the mirror. When completed its concave curve must be exact to a point within one-tenth of the wave-length of light. (Cf. New York Times, February 26, 1934
3. Scientists are expecting the new telescope to be power-

More startling, however, than the awaited disclosures of this new instrument, is the recent announcement of an entirely new principle of construction in this field. At the latest meeting of the American Association for the Advancement of Science, Dr. Francois Henroteau of the Dominion Observatory, Ottawa, Canada, announced the invention of an "electronic telescope" whose design has in it possibilities for the building of an instrument equivalent to a 2,000-inch lens or mirror. The electro-telescope follows the principle of television. By a new process for covering a thin mica plate with 25,000,000 dots of pure silver to the square inch, as compared with 160,000 dots, which is the best possible until now, and then for scanning it with beams from photo-electric cells, it is possible to transform the starlight falling upon the plate into electrical energy, which the electronic tube will amplify millions of times. This electric energy, as in television, can then be retransformed into light energy, thus magnifying the stars to a size which is the possible equivalent of that produced by a 2,000-inch reflecting mirror. The inventor himself declares that he sees no real obstacles to un-

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ful enough to reveal objects which are as much as one billion light-years away. This would reveal more than three times the penetration of the present largest telescope upon the most extreme estimate thus far made. Cf. loc. cit.)

precedented results from the use of such a telescope in the future. Objections, however, from other sources have already been raised to such an instrument, and doubtless more will arise, which only the scientist is capable of handling.[1] Nevertheless the fact is not altered in the least that man is thinking how he may improve his methods of studying distant worlds, and should such a telescope as this one described be fashioned, or some other one differently constructed, to meet all possible objections, the time may come when all the heavenly host, including galaxies and super-galaxies, will be brought to the back door of this little planet called earth. What may happen in this new era with such prospects in sight, one cannot say. It is being moderate to say that the end is not yet.

2. The New Method

a) An Avowed Attempt to Eliminate the Subjective

Modern science claims to have learned much from a study of the mistakes and failures of the past age of materialism and mechanism. It avows that its purpose is not to approach the old problems of nature in the same way, but to attack them from a new angle. Jeans has contrasted the two methods in a striking manner as follows:

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1. Cf. New York Times, December 30, 1933; January 8, 1934, for description of the telescope and subsequent objections to its construction.

"It was left for twentieth-century physics under the lead of Einstein, Bohr and Heisenberg to discover how large a subjective tinge entered into the nineteenth-century description of nature; recognising this, it tries to discard our human spectacles and study the objective reality that lies beyond. Only in this way has it proved possible to give a consistent description of nature. Thus the history of physical science in the twentieth century is one of a progressive emancipation from the purely human angle of vision."[1]

The emphasis in the present, according to this account, is clearly on the objective character of present scientific research. It may be that the same author is only making concessions to the inability of present science to reach this ideal when, farther on in this same work, he writes what seems like contradictory words. He says:

"We can still only explore nature by stamping it with our own footprints and raising clouds of dust, so that our present pictures of nature shew our human stamp over it all. In time we shall perhaps learn how to remove our own footprints from the picture and shall then see that nature has a real existence, as much outside ourselves and independent of ourselves as the Sahara."[2]

b) The Apparent Confusion of the Old Philosophy with the New

Other statements, however, make it abundantly plain that there is some confusion of thought upon the part of this gifted spokesman for science in his attempt to define the new attitude. It is not the purpose of this section to discuss here at length this seeming discrepancy, since there will be occasion to refer to it again in connection

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1. Jeans, The New Background of Science, p. 5
2. Ibid., p. 67

with the religious implications involved in the studies of the later chapters. Two of these utterances which seem to admit of a different interpretation from the preceding,— especially the former, are here quoted. In the first instance Jeans says:

> "science, mainly under the guidance of Poincaré, Einstein and Heisenberg, came to recognise that its primary, and possibly its only proper, objects of study were the sensations that the objects of the external universe produced in our minds; before we could study objective nature, we must study the relation between nature and ourselves."[1]

The most confusing, however, is the following in which he states:

> "Yet the essence of the present situation in physics is not that something mental has come into the new picture of nature, so much as that nothing non-mental has survived from the old picture. As we have watched the gradual metamorphosis of the old picture into the new, we have not seen the addition of mind to matter so much as the complete disappearance of matter, at least of the kind out of which the older physics constructed its objective universe."[2]

That this affirmation comes close to answering to Whitehead's description of the subjectivist position as employed freely to-day for explanatory purposes, is apparent after we have seen it in the same frame. Whitehead says:

> "The subjectivist position has been popular among those who have been engaged in giving a philosophical interpretation to the recent theories of relativity in physical science. The dependence of the world of

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1. Jeans, The New Background of Science, p. 42
2. Ibid., p. 282

> sense on the individual percipient seems an easy mode of expressing the meanings involved."[1]

The author, however, does not agree with this common view. He says further:

> "I do not understand how a common world of thought can be established in the absense of a common world of sense. I will not argue this point in detail; but in the absense of a transcendence of thought, or a transcendence of the world of sense, it is difficult to see how the subjectivist is to divest himself of his solitariness."[2]

It may be, then, that Jeans would escape the dilemma into which his statements appear to lead him, by postulating behind them some such transcendence as that suggested in this quotation. Speaking for science, he is clearly and empahtically committed to a position that is opposed to the old philosophy of the past. It cannot hastily be said, then, that he, having cast out at the front door the old speculations as woefully inadequate, wishes now to take them back again at the rear entrance.[3] To think this without good evidence would be derogatory to Jeans as a thinker, and to the high esteem in which scientific thought, of which he is an able exponent, is held by many able minds. These statements, therefore, need to be studied separately and together, and to be kept continually

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1. Whitehead, Science and the Modern World, p. 126
2. Ibid., pp. 126-127
3. Cf. Inge, God and the Astronomers, p. 36, for a similar suggestion which was found after this had been written.

in mind as this investigation proceeds. They will help to throw much light on many moot questions which follow.

c) An Employment of a New Technique

The Victorian period in physics not only had a distinct philosophy of its own which underlay the empirical results, but it also had its peculiar technique. The efficient engineer was more in demand than any other worker in the field; in fact, he seemed to be the only one present. To-day science employs a different technique because of the change which has come in the new purpose of scientific endeavor. Now the mathematician is wanted to employ his symbols in constructing an orderly world. Eddington explains the reason for this shift in technique in language that leaves nothing further to be said. He writes as follows:

> "One of the greatest changes in physics between the nineteenth century and the present day has been the change in our ideal of scientific explanation. It was the boast of the Victorian physicist that he would not claim to understand a thing until he could make a model of it . . . Nowadays we do not encourage the engineer to build the world for us out of his material, but we turn to the mathematician to build it out of his material . . . We are dealing in physics with a symbolic world, and we can scarcely avoid employing the mathematician who is the professional wielder of symbols. . ."[1]

Jeans confirms this explanation of the modern way in similar terms. He says:

"And what we are finding, in a whole torrent of sur-

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1. Eddington, The Nature of the Physical World, p. 209

> prising new knowledge, is that the way which explains them more clearly, more fully and more naturally than any other is the mathematical way, the explanation in terms of mathematical concepts. It is true, in a sense somewhat different from that intended by Galileo, that 'Nature's great book is written in mathematical language.'"[1]

What one needs to handle well in order to be an intelligent physicist of the present, is the tools of the mind more than the tools of the hand.

3. The New Objective

a) Its Importance

A significant change in the attitude of modern physics is the new interest which is manifested in a re-examination of the fundamental purpose of the science and of the nature of its basic concepts. The science itself has begun to assess its limitations and to set forth a new objective in its work that promises to bring about a decided change in approach to its enormous problems. Bridgman has made this clear in the following extract:

> "One of the most noteworthy movements in recent physics is a change of attitude toward what may be called the interpretative aspect of physics. It is being increasingly recognized, both in the writings and the conversation of physicists, that the world of experiment is not understandable without some examination of the purpose of physics, and of the nature of its fundamental concepts."[2]

It is well to keep this fact in mind when making an appraisal of the new findings.

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1. Jeans, The Mysterious Universe, p. 151
2. Bridgman, The Logic of Modern Physics, p. vii

b) Its Chief Concern

(1) Not Ultimate Reality

There was a tendency in science in the past to be occupied in experimentation with a desire to know the ultimate constitution of things. Recent physics, however, at least in its assertions of its purpose, has become more humble. It has begun to recognize the definite boundaries of its peculiar province. Says Jeans on this subject: "And indeed many specifically maintain that the phenomena and their laws constitute the whole province of science—science, in brief, is concerned with what happens, not with what is."[1] These words prove that the present research in this region, when it is strictly scientific, is directing the energies to a study of phenomena and not to what lies beyond them in the unknown sphere.[1] In other words, its purpose is to remain scientific and not to turn philosophic.

(2) Not Ultimate Cause

Not only is the new age of physics not concerned

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1. Jeans, The New Background of Science, p. 57
2. Planck in his book, <u>Where is Science Going?</u>, does not accept this aim of science so completely even in theory as do Jeans and Eddington. Referring to the undeniable fact that the unknown in science ever recedes as science advances, he says that we must not try to remove it by restricting the scope of science to a mere description of sensory experience. The other great scientists of to-day, including those dealt with specially in this thesis, have also pursued this aim, as will be seen later in the investigation, but they have not declared their purpose so precisely.

primarily with the essence of things, it also pays no regard, in its most exact experiments, to ultimate causes, Jeans reports for science on this point as follows:

> "It is now a full quarter of a century since physical science . . . left off trying to explain phenomena and resigned itself merely to describing them in the simplest way possible."[1]

Even more definite are the words of Millikan who says:

> "science has little to say about ultimate causes. Its concern is the observation of phenomena, and the fitting of them together into as comprehensive a theory, or theories, as it can find, primarily for the sake of predicting new facts, to be in their turn subjected to the test of new experiments."[2]

In commenting on these pronouncements of science, only one word need be said. Science, when it is true to itself, is more concerned with description than it is with explanation.

(3) To Present a Picture of the Behavior of Phenomena

The objective of the new physics, therefore, is to picture accurately what it sees when observing phenomena. Referring to the well-known simile of Plato, Jeans says: "At present the only task immediately before science is to study these shadows, to classify them and explain them in the simplest possible way."[3] From the viewpoint of mathematics which he, like the other savants of to-day,

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1. Jeans, The Universe Around Us, p. 325
2. Millikan, Evolution in Science and Religion, p. 53
3. Jeans, The Mysterious Universe, p. 151

finds most adapted to describing the picture, Jeans makes these remarks about the purpose and result of the prevailing physics:

> "In brief, a mathematical formula can never tell us what a thing is, but only how it behaves; it can only specify an object through its properties. And these are unlikely to coincide _in toto_ with the properties of any single macroscopic object of our everyday life."[1]

These quotations do not leave one in doubt as to what science has in mind when it issues its reports about its latest findings. Its objective is definite and the results are consistently couched in mathematical symbols that puzzle and perplex the uninitiated.

(4) The Prevailing Temper

Such changes as those referred to in the new approach to nature and its problems, have necessarily produced astounding results not only in new knowledge but also in the way in which the scientist now looks out upon the world and his tasks which are definitely related to the secrets still locked up within the world. What one writer has said with regard to recent astronomy and its effect upon man's mind might well be applied to modern physics with slight alterations in wording to suit the case, and with due consideration for its rhetorical form. His hyperbolic statement seems appropriate when he says:

> "Within the last few years it has made astounding discoveries and expanded the universe into spaces, magni-

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1. Jeans, The Mysterious Universe, p. 177

> tudes and speeds beyond any former dreams. Once the astronomers saw things which frightened us: now they see things which frighten them. They turn from their telescopes and spectroscopes with blanched faces to tell us of what they have witnessed."[1]

In a somewhat more restrained way Whitehead has forecefully expressed this same idea:

> "The note of the present epoch is that so many complexities have developed regarding material, space, time, and energy, that the simple security of the old orthodox assumptions has vanished . . . The new situation in the thought of to-day arises from the fact that scientific theory is outrunning common sense . . . The eighteenth century opened with the quiet confidence that at last nonsense had been got rid of. To-day we are at the opposite pole of thought. Heaven knows what seeming nonsense may not to-morrow be demonstrated truth."[2]

In other words, the prevailing temper created by this fresh approach in science and its consequent results is such that the scientist is prepared to expect almost anything and yet is fearful as to what those discoveries may involve. He is sometimes slow to believe the eyes which invention has given him lest he be called upon to face things too wonderful for him to explain in any satisfying way by his own methods and terms.[3]

E. Fundamental Achievements of the New Age

1. The Discovery of New Physical Laws Necessitating a

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1. Snowden, Old Faith and New Knowledge, pp. 223-224
2. Whitehead, Science and the Modern World, p. 161
3. Cf., for example, Russell, The Scientific Outlook, pp. 88-94, in which he makes a desperate attempt to reject on scientific grounds what so many scientists now firmly believe is established fact with regard to the phenomena of quanta.

Reinterpretation of the Old

a) The Discoveries Necessitating Readjustments

In the center of the stupendous progress which the new era in physics has made can be found the discovery of some revolutionary laws and the complete revamping of others. Not even are the principles with which science works immune from this change. Referring to the complete readjustment which the discoveries of the past thirty years have necessitated, Millikan gives the following summary:

> "To appreciate how stupendous a change these discoveries have already wrought in human thought, it is only necessary to reflect that of the six basic principles which at the end of the nineteenth century acted as the police officers to keep the physical world running in orderly fashion, namely:
> 1. The principle of the conservation of the chemical elements,
> 2. The principle of the conservation of mass,
> 3. The principle of the conservation of energy,
> 4. The principle of the conservation of momentum,
> 5. The principle underlying Maxwell's electrodynamics,
> 6. The principle of entrophy or the second law of thermodynamics,
>
> there is not one the universal validity of which has not been questioned recently by competent physicists, while most of them have been definitely proved to be subject to exceptions."[1]

The chief cause of the disturbance which has upset belief in the universal validity of some of these principles has been the discovery of two new phenomena of nature which have been compelling sweeping alterations in our former theories to accomodate them to existing facts. Jeans reports these discoveries in these words:

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1. Millikan, Science and the New Civilization, pp. 115-116

"A century which has run less than a third of its course has already witnessed two great upheavals in physical science. These are associated with the words Relativity and Quanta, and have forced the physicist of to-day to view nature against a background of ideas which is very different from that of his nineteenth-century predecessor."[1]

In enumerating some of the changes which have been effected as a result of their introduction into physics he says that they have, "in effect, amounted to the dismissal of three concepts from the scheme of science—absolute space, absolute time and the luminiferous ether."[2]

b) The Resultant Confusion

What confusion has resulted in many cases because of this necessary change is evident to any careful reader of science. Take, for example, the sphere of atomic structure. Here the old classical laws have broken down most emphatically and the scientist is forced to accept the new ideas of relativity and quanta. The result has been confusion worse confounded by an illogical adherence to both sets of laws. Says Dampier, quoting Sir William Bragg at first:

"we use the classical theories on Mondays, Wednesdays and Fridays, and the quantum theory on Tuesdays, Thursdays and Saturdays. For the time, at all events, consistency has gone by the board, and we take either set of ideas to get results, according to the subject in hand. This discrepancy probably always appears to some extent when a great intellectual revolution is being made, as for example when the ideas of Aristotle and

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1. Jeans, The New Background of Science, p. 1
2. Ibid., p. 171

Galileo strove for the mastery, but the present instance seems to illustrate the tendency in an extreme form. It may possibly even allow us to hold a third set of ideas on Sundays, for which Bragg omitted to provide a theory."[1]

An aeroplane survey of present-day science justifies, it would seem, the following picture of the realities in the case:

"The progress of science has now reached a turning point. The stable foundations of physics have broken up . . . The old foundations of scientific thought are becoming unintelligible. Time, space, matter, material, ether, electricity, mechanism, organism, configuration, structure, pattern, function, all require reinterpretation. What is the sense of talking about a mechanical explanation when you do not know what you mean by mechanics?"[2]

Old laws are in the melting pot. Some have been recast and others will undoubtedly need to be. The period of readjustment may just be in its infancy. At any rate, there is sure to be a greater change in views as the new achievements develop.

2. A Confirmation of the New Method

Of all the results accruing from the strenuous efforts of the new physics to demonstrate the effectiveness of its changed methods, there is possibly none which can be more satisfying than the confirmation which the abundant results achieved in such a short time, lend to the efficiency of the process. That science is satisfied with this new teaching and method when interpreted

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1. Dampier, A History of Science, p. 485
2. Whitehead, Science and the Modern World, p. 23

in terms of its results, as compared with those of any equivalent period of the past, is evident from Jeans' remarks. He says:

> "Our remote ancestors tried to interpret nature in terms of anthropomorphic concepts of their own creation and failed. The efforts of our nearer ancestors to interpret nature on engineering lines proved equally inadequate. Nature refused to accommodate herself to either of these man-made moulds. On the other hand, our efforts to interpret nature in terms of the concepts of pure mathematics have, so far, proved brilliantly successful. It would now seem to be beyond dispute that in some way nature is more closely allied to the concepts of pure mathematics than to those of biology or of engineering, and even if the mathematical interpretation is only a third man-made mould, it at least fits objective nature incomparably better than the two previously tried."[1]

There is reason to think from this statement that the new way is here to stay until something better is found which will in turn produce proportionately greater results. It has been weighed in the balance and not found wanting in its power to assist man in his progress.

3. A New Realization of the Basic Limitations of Science

a) Testimony of Jeans

One who has made an excursion to the frontiers of modern physical science and has watched the developments which are taking place there can well appreciate the feeling expressed in a choice passage of Kirk in which he says:

> "If there be a sensation akin to that of a devotee watching a priest performing esoteric rites before the

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1. Jeans, The Mysterious Universe, p. 158

shrine of an unknown god, it is the feeling one has when trying to understand the mysteries of modern physical science."[1]

But this is not true of the laymen only. Every honest scientist must have similar emotions, for his studies continually bring him face to face with the unknown. It is in this region that the great scientists to-day are forced to admit the woeful inadequacy of their ability to penetrate far into the dark with the aid of even the most delicate instruments or the finest minds. Nature appears to have laid a veil over herself behind which man cannot look. Jeans comes back from these frontiers with bewildering statements like these:

"we can know nothing of the external world <u>for certain</u>. At best we can only deal in probabilities."[2]

Man receives his knowledge of the external world chiefly through his senses. The reports which come to him are always fragmentary. From these he must try to piece together a consistent picture of the whole. There are bound to be dark spots in the picture in the very nature of the case.[3]

"To speak in terms of Plato's well-known simile, we are still imprisoned in our cave, with our backs to the light, and can only watch the shadows on the wall."[4]

"When we try to discover the nature of the reality behind the shadows, we are confronted with the fact that all discussion of the ultimate nature of things must necessarily be barren unless we have some extraneous

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1. Kirk, Stars, Atoms, and God, p. viii
2. Jeans, The New Background of Science, p. 57
3. Cf. Ibid., pp. 8-9 This paragraph, with the exception of the last sentence, is an abridgment of Jeans' thought, as far as possible, in his own terminology for the purpose of keeping it true to the author's spirit and meaning.
4. Jeans, The Mysterious Universe, p. 151

standards against which to compare them. For this reason, to borrow Locke's phrase, 'the real essence of substances' is forever unknowable. We can only progress by discussing the laws which govern the changes of substances, and so produce the phenomena of the external world. These we can compare with the abstract creations of our own minds."[1]

Speaking of the descriptive character of science, he says further:

"This does not imply any lowering of the standards or ideals of science; it implies merely a growing conviction that the ultimate realities of the universe are at present quite beyond the reach of science, and may be—and probably are—forever beyond the comprehension of the human mind."[2]

b) Testimony of Barnes

Barnes in his recent series of Gifford Lectures would not claim too much for science. He points out the inadequacy of science in always freeing us from possible errors of perception. Geometry, which is much used in the new approach, he shows, proceeds on the basis of assumptions which are true only so far as our observations are free from error.[3] With regard to physics, which he concedes to be the most fully developed science of the present, he says that it

"merely allows us to investigate certain measurable properties of things; but we must never forget, in contemplating the very extensive conquests made by this science, that there are possibly vast regions of the phenomenal world to which its methods, so far as they have been developed, do not apply."[4]

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1. Jeans, The Mysterious Universe, p. 155
   Cf. also Ibid., pp. 59,60,64,65
2. Jeans, The Universe Around Us, p. 326
3. Cf. Barnes, Scientific Theory and Religion, p. 10
4. Ibid., p. 11

c) Testimony of Eddington

Eddington likewise has no doubts about the limited possibilities of a purely physical approach to the problem of reality. He sees with clearness the closed circle within which the methods of present science have drawn the investigator. In speaking, therefore, of the avenues of approach to an understanding of nature, he says that the

> "supposed approach through the physical world leads only into the cycle of physics, where we run round and round like a kitten chasing its tail and never reach the world-stuff at all."[1]

The frankness with which the impotency of science to tell man about the essence of things is acknowledged in these words is amazing. There is no tendency here to exalt physical knowledge above its rightful place.

d) Reported Testimony of Einstein

The greater the scientists the more this fundamental limitation of their craft seems to impress itself upon them. All whose names have been cited are in the forefront of the scientific world to-day. Einstein, however, is still to be heard from. His reported testimony appears in a bit of other confession by Jeans which is too good to omit. There are two in one in this quotation:

> "Photons, electrons and protons have become about as meaningless to the physicist as <u>x</u>, <u>y</u>, <u>z</u> are to a child on its first day of learning algebra. The most we hope

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1. Eddington, The Nature of the Physical World, p. 280

for at the moment is to discover ways of manipulating x, y, z without knowing what they are, with the result that the advance of knowledge is at present reduced to what Einstein has described as extracting one incomprehensible from another incomprehensible."[1]

Neither of these leaders of thought would raise our hopes too high in the science of the present. Their candid words appear to uphold even to-day the truthfulness of a sagacious remark made years ago by one who said that "Science is the topography of ignorance."[2] At any rate, all indications are that physics has come to a blank wall too stubborn as yet to yield any information about what is beyond to those who use only the sign language of science. The inner structure of the world has offered thus far a Promethean defiance to the greatest "guns" of science with which man hopes to break the reticence of matter and make it yield up its secret. Whether it will capitulate in time or not under the impact of the new and more powerful attack developing in the present cannot be dogmatically asserted. All that one can say is that there is no news from the besiegers indicating that surrender is imminent.[3]

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1. Jeans, The New Background of Science, p. 65
2. Holmes, Oliver Wendell, Medical Essays
3. A recent experiment conducted for the purpose of "weighing" the neutron with precise accuracy has partially revealed the instability of the deuton (the nucleus of the heavy hydrogen atom) and has given scientists the hope that the citadel of the nucleus may not be so impregnable as has been believed. It remains to be seen, however, how far this hope will be realized by further experiment. Cf. New York Times, February 19, 1934. Cf. also the footnotes on this subject in the next chapter.

4. The Apparent Sense of Humility in the Face of the New Problems

All these statements here given are very revealing in many ways. Besides acquainting one vividly at first hand with the much restricted province of physical science, they mirror the deep humility of the great minds in the presence of the present baffling problems of the world, which is in great contrast to the proud certainty of scientists in the period which is past. De Sitter, coming back from a survey of worlds unknown, including the "island universes", reflects the spirit of his kind in these words:

> "The great men of science, as well as the great artists, are filled with a spirit of reverence, with a consciousness of the presence of mystery and sublimity in the simplest and smallest as well as the greatest of things and phenomena, and with faith in the order and unity of all things."[1]

Millikan, too, implies that scientists have accepted this humble status when he says:

> "the day has gone by when any physicist thinks that he understands the foundations of the physical universe as we thought we understood them in the nineteenth century. The . . . discoveries of our generation have taught us a wholesome lesson of humility, wonder, and joy in the face of an as yet incomprehensible physical universe."[2]

Jeans pins this badge upon all who are patiently working to decipher the secret code of nature when he likens them to a mere infant looking out upon the universe and trying to understand its incomprehensibility. Thus

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1. De Sitter, Kosmos, pp. 137-138
2. Millikan, Evolution in Science and Religion, pp. 27-28

he says with the perfect candor of a child:

> "Sooner or later the pieces of the puzzle must begin to fit together, although it may reasonably be doubted whether the whole picture can ever be comprehensible to one small, and apparently quite insignificant, part of the picture. And ever the old question obtrudes itself as to whether the infant has any means of knowing that it is not dreaming all the time. The picture it sees may be merely a creation of its own mind, in which nothing really exists except itself; the universe which we study with such care may be a dream, and we brain-cells in the mind of the dreamer."[1]

This is only a different way of recognizing what the historian of science has found in his contact with this vastly expanding realm of knowledge. His statement shows the ever-growing magnitude of the task awaiting him who would see each part in relation to the whole, for, as he says:

> "There seems no limit to research, for, as has been well and truly said, the more the sphere of knowledge grows, the larger becomes the surface of contact with the unknown."[2]

Indeed, science itself has said the same thing in almost identical words. Planck gives his imprimatur to this general description of the humble task of science when he says:

> "The aim of science is something more. It is an incessant struggle towards a goal which can never be reached. Because the goal is of its very nature unattainable. It is something that is essentially metaphysical and as such is always again and again beyond each achievement."[3]

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1. Jeans, Eos, p. 88
2. Dampier, A History of Science, p. 491
3. Planck, Where is Science Going?, p. 82

And so, man, at the close of his search, unless aided by those other God-given means at his disposal, is quite prone to say:

> "The great Design now glows afar;
> But yet its changing Scenes
> Reveal not what the Pieces are
> Nor what the Puzzle means.
>
> And Nature smiles—still unconfessed
> The secret thought she thinks—
> Inscrutable she guards unguessed
> The Riddle of the Sphinx."[1]

F. Conclusion

At this point the summary is brought to a close. Many competent authorities have intentionally been made to present their own evidence, since it has not been the purpose of this survey to construct a case out of what it might be possible, by a process of legerdemain or even unintentional misrepresentation, to make these scholars say. The leaders in the field have been permitted to make their own case with their own words. At the expense sometimes of seeming repetitious, facts from different scientists of distinction have been marshalled for the double purpose of collecting from those who are said to know information useful for the painting of a picture in our minds of what present science is, and for creating a background and an atmosphere for the investigation which is to follow. In spite of the many shadows in the

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1. Dampier, A History of Science, p. vi

scene, it is possible for one who has made this picture to say with Millikan:

> "I feel altogether confident that the historian of the future will estimate the past thirty years as the most extraordinary in the history of the world up to the present in the number and the fundamental character of the discoveries in physics to which it has given birth, and in the changes brought about by these discoveries in man's conception as to the nature of the physical world in which he lives."[1]

And when one has done this, it is still more important that the impression left upon the mind be such as to enable one to feel the force of Dean Inge's words when he said:

> "A philosopher or theologian who wishes to write on cosmology--on the relation of God to the universe--must in these days acquire some knowledge of modern astronomy and physics, two closely allied sciences in which new discoveries and new theories are being published almost every year. It is no longer possible to brush these researches aside as irrelevant to metaphysics or to theology."[2]

If one is prepared to concur in this statement, he is ready to take up a sympathetic study of the new views and of the religious implications involved in them such as is here attempted.

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1. Millikan, Science and the New Civilization, p. 114
2. Inge, God and the Astronomers, p. v

Chapter III

THE SCIENTIFIC VIEW OF THE MICROSCOPIC ELEMENTS OF THE WORLD

A. Introduction

1. Remarks on the Major Divisions of This Thesis

It is appropriate at this point where the investigation actually begins to say something in explanation of the manner in which the material as a whole is to be treated. In a general way the findings have been marshalled under three headings. The first of these aims to bind together those facts which relate most directly to a view of the material world. In the second division are included discoveries and their interpretation which influence the conception of man when an attempt is made to harmonize it with the new facts. The last section deals with the statements of the scientists which involve some idea of God. In presenting the results of this bit of research in this fashion there is no intention of creating the impression that this is the only way it could be done. Other arrangements might be even more effective, but this one has appealed to the writer as best suited to his own purpose. Although the plan was arrived at independently, one might well recall that a similar one with slight changes was followed by Descartes in working out his philosophy and presenting it to the world.[1] A charge of plagiarism, then, cannot fairly be

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1. Cf. Weber and Perry, History of Philosophy,pp. 248-249

sustained in the present instance, but, instead, an opportunity is here afforded at the start to point out a more fundamental connection than that just mentioned which exists between some of the views held by Eddington and Jeans and those of Descartes. The relationship has been indicated in some detail in a very able, recent book dealing with this phase of the subject and need not be discussed here at length.[1] Attention is called to the fact simply because of the light it may cast upon what follows in this work.

2. The Purpose of This Chapter

The present chapter, in dealing with the view of the world outlined by modern science, does not discuss the problems relevant to a comprehensive survey of the cosmos. It would undoubtedly have been following the method of the new approach to all these questions to have taken that course, for the new impulse to more intense investigation in the field of physics was clearly created by the necessities faced in a more thorough study of the heavens that was made possible by the new telescopes. But it has seemed more logical to begin nearer home and work out from there towards the circumference of the universe. This course of procedure has the advantage of trying first to enlist interest in the study of things more familiar to

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1. Cf. Joad, Philosophical Aspects of Modern Science, pp. 30, 31, 59

man before seeking to acquaint him with things foreign to his experience. It seems hardly necessary to say that some matters discussed in this chapter will, of course, appear again in later chapters in different connections. If, as Professor Hasbrook has said, "things hook and eye together",[1] then it is impossible to keep the different approaches to the subject from crossing and recrossing one another at various points. There has been an earnest attempt, however, to avoid needless duplication while seeking at the same time to throw all possible light upon the subject and to see it from every angle.

B. The Problem of Matter and Mind

1. The Conception of Matter

a) The Nineteenth-Century View

(1) A General Statement

Before the new century began science held an entirely different conception of matter from that of the present. As a part of an histpric movement it has been referred to as atomic materialism,[2] but more often it has been spoken of as just materialism. At any rate, it is true, as Bertrand Russell has pointed out, that "in old days, whatever philosophers might say, physics proceeded technically

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1. Quoted from "Some Elemental Slogans of the '541' Method", published for private circulation by The Biblical Seminary in New York
2. Cf. McDougall, Modern Materialism and Emergent Evolution, pp. v and 2

on the assumption that matter consisted of hard little lumps."[1] It was believed then that this position, which was generally accepted by most people, was impregnable. There was no widespread thought in the minds of scientists that this basic truth would ever be challenged.

(2) Its Chief Points of Emphasis

This unshakable belief in materialism seemed to rest upon a number of impressions which man received from his daily contact with matter. Some of these have been recorded by one who attempts to describe what man felt as he formerly looked out upon the material world. He says concerning this world:

> "There it seemed to stand, solid, indestructible, insensitive, forming a wall between us and the spiritual world, if such a thing as a spiritual world existed. Indeed, the material world seemed so complete and self-sufficient that many were tempted to regard it as the only reality. It was simple, it was tangible, it was visible. Why, men asked, should we spend time and thought on an invisible, intangible, elusive world, when a simple and concrete one was at our disposal?"[2]

The descriptive adjectives in this quotation which are applied to matter make transparently clear what the strength of the appeal of materialism was, and where the emphasis in the doctrine was laid. Kirk has well summarized this matter by crystallizing this emphasis into one word and then placing beside it another word of equal

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1. Russell, The Scientific Outlook, p. 120
2. Taylor, Does Science Leave Room for God?, p. 31

significance. His succinct statement of the truth is this: "The foundation concepts that dominated that view were substantiality and constancy."[1] This penetrating observation goes to the heart of the matter and leaves nothing more to be said. Concrete materiality and uniformity of action according to the causal law were regarded as the essence of materialism.

(3) Its Weaknesses

(a) The Superficial Character of Its Explanations

However great may have been the strength of this conception in the past,—and the fact cannot be denied that it exercised a powerful influence during the last century and even well on into this one, there was inherent in it certain fatal weaknesses. One of these was the superficial manner in which its underlying principle was applied to the explanation of all phenomena. No event happened, it was believed, for which a mechanical explanation, based upon the idea of material substance and force, could not be found. In fact, this was held to be the only possible and rational explanation. Referring to the ambitious character of this conception, a recent authority has written as follows:

"According to that scheme the physical world consists,

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1. Kirk, Stars, Atoms, and God, p. 35

> without remainder, of atoms, or minute particles of solid matter, in motion; all energy is the momentum of such atoms; and all happenings, all events, all processes, are their motions and accelerations; and all changes of motion are produced by, all influence, all causation consists in, the impact of one particle upon another."[1]

The very presumption of this notion about the material and mechanical character of all things and events, to say nothing about the testimony of the human organism, is enough to condemn it in the past. To-day man knows too much about matter to take these old assumptions too seriously. He is now more wary about claiming to have reached the final explanation.

(b) Its Failure to Consider Values Other Than Material

In this old view of matter as material and substantial, and as governed by a law suitable for a machine, there was another weak spot greater than the first. The Achilles' heel of the whole scheme was its failure to recognize as real anything other than that which man could see or feel or measure. It was, in fact, not comprehensive enough in its viewpoint. Consequently, an indictment was brought against it and sustained, times without number, to its own detriment and final undoing. The accusation ran as follows:

> "Value was not something which you could see or touch, and it did not work like a machine; it followed that

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1. McDougall, Modern Materialism and Emergent Evolution, pp. 2-3

value together with the mind which apprehended it must be dismissed from the catalogue of things that really and independently were; they were not real, objective factors in the world, they were phenomenal aspects of pieces of matter."[1]

A continuance in this course, in flagrant violation of the rights of other values inherent in the world and in human life, necessitated at last the pronouncement of the death sentence upon its provincialism as well as upon its unscientific character.

(4) Summary

Before leaving this view it is well to reiterate the reason for its powerful sway over the minds of the past and the cause of its present, rapidly waning influence in all fields of thought, especially in the scientific realm. Ward summarizes the matter thus:

"Extended, solid, indestructible atoms have always been the stronghold of materialistic views of the universe. But, unhappily for such views, the hard, extended atom was not equal to the demands which increasing knowledge laid upon it."[2]

The upshot of this predicament has been the construction of an entirely new and revolutionary conception of matter that will better explain man's growing knowledge of his world.

b) The Picture of Matter Presented by Recent Physics

(1) The New Properties of Matter

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1. Joad, Philosophical Aspects of Modern Science, p. 187
2. Ward, Naturalism and Agnosticism, vol. I, p. 144

(a) The Energy-Property

Observed changes in the action of matter in the microscopic realm have led some scientists in recent years to hold the view that matter possesses the character of energy. Einstein, for instance, has maintained that energy can be converted into matter and vice versa,[1] and just recently this theory has received what is believed to be startling scientific confirmation. Professor Ernest O. Lawrence of the University of California, at the meeting of the American Association for the Advancement of Science, held in Chicago last year, reported his results from "weighing" the neutron, which seem to lend further prestige to this view. The neutron,[2] regarded by some scientists as the ninety-third chemical element, and believed to consist of a proton and an electron, was found upon experiment to weigh less than the proton which is one of its ingredients. In other words, the whole

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1. Cf. Barnes, Scientific Theory and Religion, p. 133
2. A further description of this recently discovered entity, beyond what is given in the text, is also interesting and instructive. It is thought to be one of the fundamental building blocks of matter. Its constituent elements,—one electron and one proton, are the same as those of the ordinary hydrogen atom, except that in the case of the neutron these elements are so closely packed together that the negative and positive charges, respectively, of the electron and the proton, are neutralized. The neutron, therefore, is believed to have no electrical charge at all. It is sometimes called the neuter particle of matter. Cf. New York Times, February 19, 1934. Cf. also the issue of December 31, 1932.

was discovered to be lighter than one of its parts, to say nothing about both. The only explanation which was found to satisfy this strange phenomemon was to the effect that, when the proton and the electron are held together in the neutron, some of the mass of the proton is turned into energy, which change results in a reduction of the total weight of the proton below that of its constituents.[1] Further investigation may confirm this view more strongly or may prove it to be false,[2] but the fact nevertheless remains that present-day science appears to lean heavily towards a view of close rapport between these two entities. So close, in fact, seems to be their association in thought that Barnes, while always recognizing the fact that matter may have other properties and characteristics which energy does not possess, and *vice versa*, has made the suggestion that matter may simply be congealed energy. He has even gone further, and estimated that in the congealing process matter may by some creative action become possessed of qualities not existent in the energy from which it was

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1. Cf. New York Times, June 24, 1933, Report by William T. Lawrence.
2. A very recent experiment by Professor Lawrence, in collaboration with his colleagues at the University of California, has evidently not changed this fundamental discovery. But the neutron has been found to be slightly lighter than it was previously thought to be. The present estimations place this weight at 1,646 billion-billion-billionths of a gram, which is 10 billion-billion-billionths of a gram less than was previously calculated. Cf. New York Times, February 19, 1934

derived.[1] These statements, along with others that might easily be given, prove that the mystery of the great affinity between the two phenomena has not yet been satisfactorily solved by scientists.

(b) The Electrical Property

At other times matter has taken on the character of electricity and has been regarded solely as a product of these electrical units which enter first into the constitution of the atom. It is not necessary to dwell at length upon this point; Jeans' statement of the new conception is sufficient for a working acquaintance with its essential features when he says:

> "Thanks mainly to the researches of Rutherford, it has now been established that every atom is built up entirely of negatively charged electrons, and of positively charged particles called 'protons'; matter proves to be nothing but a collection of particles charged with electricity."[2]

(c) The Property of Radiation

The theory of the annihilation of matter, invoked by some to explain cosmic radiation,[3] has aided greatly the development of another view which regards it as composed of radiations. The slowly dying sun is said to be losing weight at the rate of 4 million tons a second, or about 250 million tons a minute, through its radiation in the

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1. Cf. Barnes, Scientific Theory and Religion, p. 133
2. Jeans, The Mysterious Universe, p. 62
3. Cf. Jeans, Eos, pp. 45-46
   Cf. Jeans, The Universe Around Us, p. 185

form of light and heat.[1] Scientific calculations have shown that a ten-thousandth of an ounce of sunlight falls every minute on every square mile of earth directly under the sun's rays.[2] The loss of weight, therefore, at the sun's end in order to furnish radiation at the other, and the ability of science to calculate the weight of that radiation which reaches here, along with other significant facts concerning the stars, have led men like Jeans to hold the ideas of matter and radiation in juxtaposition to one another. In fact, the latter appears to take kindly to the suggestion of Mosharrafa and others to the effect that the only difference between matter and radiation is that matter is a congealed form of the latter which travels at a subnormal rate of speed.[3]

(d) The Wave-Property

All of the preceding discussion about the properties of matter has bordered upon the wave-theory of matter. This new conception has resulted from an effort to trace the actual behavior of the electron or the proton and has now found embodiment in that branch of mathematical physics, known as "Wave-Mechanics", which has been developed by de Broglie and Schrödinger and others.[4] In

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1. Cf. Jeans, The Universe Around Us, p. 172
2. Cf. Jeans, The Mysterious Universe, p. 67
3. Cf. Ibid., p. 93
4. Cf. Ibid., p. 49

speaking of the success of this new theory in explaining the complex structure of the atom, Jeans says:

> "the wave picture begins to appear as the true picture of reality, and the particle picture merely as a clumsy approximation to the truth, an approximation obtained by trying to force into a framework of space and time a structure which does not admit of representation in space and time."[1]

Similarly he writes:

> "Actually a system of waves provides a picture which has never yet failed to predict the behaviour of the electron, while the conception of an electron as a hard particle has failed on innumerable occasions."[2]

By contrasting this success of the new theory in the specific instances of small-scale phenomena with the failure of the old particle-theory of matter, Jeans becomes even more emphatic and explicit in regard to its character when he declares:

> "So long as science deals only with large-scale phenomena, an adequate picture can generally be obtained by supposing both to be of the nature of particles. But when science comes to closer grips with nature, and passes to the study of small-scale phenomena, matter and radiation are found equally to resolve themselves into waves . . .
>
> In this way, we are beginning to suspect that we live in a universe of waves, and nothing but waves."[3]

(e) Summary

Summaries are useful for binding together the loose ends of one's thought. So much has been said and implied in this discussion about the new theories of matter that

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1. Jeans, The New Background of Science, p. 252
2. Jeans, The Mysterious Universe, p. 51
3. Ibid., pp. 52-53

at first it leaves the mind stupefied and bewildered. There is need, therefore, to put all before the mind again in compact form before leaving the subject. It is almost natural in the face of such a task to call upon the writings of Jeans which seem to abound in fitting quotations of this character on all these difficult matters. Again the author rewards the seeker with these words:

> "To sum up . . . .", he says, "the tendency of modern physics is to resolve the whole material universe into waves, and nothing but waves. These waves are of two kinds: bottled-up waves, which we call matter, and unbottled waves, which we call radiation or light. The process of annihilation of matter is merely that of unbottling imprisoned wave-energy and setting it free to travel through space. These concepts reduce the whole universe to a world of radiation, potential or existent, and it no longer seems surprising that the fundamental particles of which matter is built should exhibit many of the properties of waves."[1]

(2) Revised Definitions of Matter

(a) The Difficulty of Definition in the Face of These New Facts

The scientist is not so ready to-day to define matter as he was a generation or more ago. Increasing knowledge of his subject has added much embarrassment to any such bold attempt and has made the scientist less willing to commit himself. He has been greatly humbled by what he has seen in nature in recent years with the aid of mechanical eyes. There is much which has come to light that appears to defy definition. It will not be compressed with-

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1. Jeans, The Mysterious Universe, p. 94

in the limits of human thought or language. So Millikan admits at the very threshold of such an attempt when he says that

> "in view of the growth of twentieth century physics and the changes in our conception of matter that it has brought, it is today quite as difficult to find a satisfactory definition of 'matter' as of 'spirit'."[1]

And when his thoughts range through the maze of problems which have recently been uncovered, he practically despairs of such an effort with this as his reason:

> "For matter is no longer a mere game of marbles played by blind men. An atom is now an amazingly complicated organism, possessing many interrelated parts and exhibiting many functions and properties—energy properties, radiating properties, wave properties, and other properties quite as mysterious as any that used to masquerade under the name of 'mind', so that the phrases, 'all is matter' and 'all is mind' have now become merely shibboleths completely devoid of meaning."[2]

Such a voice might be changed into a chorus if one had need to produce more evidence. But to tell what matter is, is ostensibly no easy thing; this fact needs no further proof.

(b) Millikan's Conception of Matter

However, man will never cease trying to define concrete reality, no matter how difficult the task may be. Since he is a thinking and reasoning animal, he will not quit philosophizing, though it be unscientific to do so. And it is interesting to note that not even does Millikan refrain from the attempt to solve the jig-saw puzzle. He

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1. Millikan, Evolution in Science and Religion, p. 18
2. Millikan, Science and the New Civilization, p. 182

comes to a definition of matter by a process of indirection. By trying to reconcile apparent contradictions he arrives at a personal view of matter which is hidden away among other things. The passage in which it is found is here quoted:

> "Some external physical things are happening and we cannot rest indefinitely content with two types of physical interpretation of the same phenomena that seem to be mutually exclusive. The ultimate elementary processes which constitute life cannot be both waves and corpuscles . . . The only way I can see out of the contradiction is to assume that all microscopic or elementary processes, whether they are processes of matter physics or of ether physics are at bottom discrete-particle-processes . . . Only when large numbers of these units are involved do we get over into the field of continuous processes of which waves constitute one of the best of examples. In other words, all apparently continuous phenomena represent statistical or mean behaviours of elementary particles . . ."[1]

If the protective covering, interesting in itself, is stripped from the definition of matter to be found here, it is evident that Millikan still regards matter in its elemental points as distinct particles. There is something of the old idea of matter left over in this view, no matter how much it has changed. Matter with him appears to be something not exactly solid, but yet tending towards the concrete. It at least has not become entirely nebulous after its metamorphosis.

(c) The New Definition of Eddington and Jeans

Not only has the definition of matter next to be

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1. Millikan, Time, Matter, and Values, pp. 63-65

given donned new garments, but the thing which is newly clothed is itself an entirely new appearance in physical science, though at the same time it is not a stranger to philosophy. At one place Eddington appears to be just at the point of jettisoning every corpuscular theory of matter. He says:

> "there does seem to be serious evidence that in the scattering of electrons by atoms phenomena occur which would not be produced according to the usual theory that electrons are purely corpuscular. These effects analagous to the diffraction and interference of light carry us into the stronghold of the wave-theory. Long ago such phenomena ruled out all purely corpuscular theories of light; perhaps to-day we are finding similar phenomena which will rule out all purely corpuscular theories of matter."[1]

In a footnote to these remarks he declares that at the time of writing the evidence was much stronger than when they were first made. It is not unexpected, then, to find this same writer giving expression later on to his inmost feelings on the question of the essential character of matter in these words:

> "To put the conclusion crudely—the stuff of the world is mind-stuff . . . The mind-stuff of the world is, of course, something more general than our individual conscious minds; but we may think of its nature as not altogether foreign to the feelings in our consciousness. The realistic matter and fields of force of former physical theory are altogether irrelevant—except in so far as the mind-stuff has itself spun these imaginings."[2]

Jeans approaches his definition primarily from the

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1. Eddington, The Nature of the Physical World, p. 203
2. Ibid., p. 276

standpoint of mathematics rather than of physics, but he arrives at practically the same place. Indeed it is interesting to note how nearly these two great scientists, with slightly different background, coincide in their thinking on this subject. Jeans puts the result of his reflection thus:

> "If we could translate our knowledge from the language of phenomena into the language of reality, the word 'mathematical' would, I think, have some sort of translation in the latter language; it would not drop away as having represented a mere form of apprehending phenomena. And if this is so, it would seem to suggest that reality must have something of a mental nature about it."[1]

It can be seen from these expressions of leading scientific thought in the present that there is a prevailing tendency to reverse our former attitude of approach to the physical world. Such conclusions as were unheard of in the Victorian age of physics have now become acceptable in many scientific quarters. It is not the material aspect of matter but the mental which, according to recent investigation and thinking, seems most capable of explaining its ultimate nature.

(d) The Position of Barnes

Yet it is not to be hastily concluded from these speculations that the question of the nature of matter is indubitably settled in the minds of most scientists themselves. There still remains with many patient

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1. Jeans, The New Background of Science, p. 294

scholars a baffled attitude in the face of this great mystery and a lurking suspicion that the whole truth regarding matter may not yet be uncovered. This is noticeable in the guarded statement of Barnes on this point in which he says: "What matter is 'in itself' is a puzzle: it may be psychical or merely a manifestation of psychical activity."[1]

(3) The General Philosophical Significance of the New View of Matter

(a) Its Idealistic Character

It is evident, nevertheless, from a careful scrutiny of the advanced positions of men like Eddington and Jeans, whose interpretations of the world have gained wide currency, that modern physics has taken on a distinctively new philosophical flavor. In spite of a past theoretical belief in the rigid restriction of science to exact description and experimentation, there has developed recently a determined effort to set the new discoveries of physics and astronomy in an appropriate framework of unifying thought. By contrasting this effort with that of the past in science, and by giving the reason for the change, Jeans attaches to this new attempt its proper label when he says:

> "Broadly speaking, the two new conjectures are those of the idealist and realist—or, if we prefer, the

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1. Barnes, Scientific Theory and Religion, p. 564

> mentalist and materialist—views of nature. So far the pendulum shews no signs of swinging back, and the law and order which we find in the universe are most easily described—and also, I think, most easily explained—in the language of idealism. Thus . . . we may say that present-day science is favourable to idealism. In brief, idealism has always maintained that, as the beginning of the road by which we explore nature is mental, the chances are that the end also will be mental."[1]

But while the label is a new one for science, it is not a stranger to philosophy. Much of what appears entirely new from the angle of modern physics, is at least as old as Kant and Berkeley in modern philosophy, and could well be traced in some respects as far back as Plato.[2] Joad has drawn attention to this fact in his recent reflections on modern scientific thought. His remarks are as follows:

> "In particular the physicists have been making a belated discovery of the uses of Idealism . . . Thus there is an increasing tendency to emphasize the rôle played by mind in determining the characteristics of the scientific world, and philosophically minded scientists, discovering for themselves the commonplaces of idealist philosophy, accord a somewhat naïve recognition to what the philosophers could always have told them, and would have told them with some unanimity until the last few years."[3]

(b) Its Relation to Realism

Not all of the modern scientists, however, who would be classed in a general way as idealists in their philosophical explanation of the new facts, can wear the new label

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1. Jeans, The New Background of Science, p. 296
2. Cf. Joad, Philosophical Aspects of Modern Science, pp. 30-31
3. Ibid., p. 11

in exactly the same form. It seems quite evident that the leaders in the new movement in science can be regarded as idealists, with something of a subjective tinge to their philosophy.[1] By common consent Eddington and Jeans head this group, but even their views are not identical at all points,[2] as further discussion in later chapters of this thesis will reveal. While there is always to be found a general agreement among these eminent authorities, even greater divergence of view will appear as one goes down the list of those whose names stand high on the scientific roster. The new data are quite uniformly acknowledged, but the method of their interpretation differs so widely that the comprehensive schemes which are advanced to explain them range all the way from the idealism of Jeans and Eddington through the modified realism of Whitehead[3] or of Bertrand Russell,[4] to the uncompromising realism of one like Joad.[5] These latter views have undoubtedly arisen as a protest against the subjective character of the dominant idealism of

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1. Cf. Whitehead, Science and the Modern World, p. 126
2. Cf. Inge, God and the Astronomers, pp. 36-45
   Cf. also Joad, Philosophical Aspects of Modern Science, Chapters I and II, for a very illuminating discussion of the views of these two men.
3. Cf. Whithead, op. cit., p. 127
   Cf. also Hocking, Types of Philosophy, p. 333
4. Cf. Joad, op. cit., p. 11
5. Cf. Hocking, op. cit., throughout
   Cf. also Inge, op. cit., footnote on p. 37

science, just as modern realism in the history of philosophy arose as a polemic against subjective idealism.[1] So recent is this new phase of the struggle that it is difficult to see what course it is likely to take in the future. Suffice it to say now that idealism unquestionably holds the field.

(c) Its Triumph Over Materialism

There is also to be said in its behalf philosophically that this new view of science has won a seemingly great victory over the materialistic philosophy of the past and has done it in a comparatively short time. Even those who hold as yet to some features of the old system, have had to modify their conceptions so completely to fit the new discoveries that they are now scarcely recognized as related to the former theories.[2] Most of these changes amount to a virtual abandonment of the materialistic principle which justifies one in saying that the view of hard materialism has received a crushing blow through the recent investigations of the physical scientist. It used to be believed that matter was indestructible, but the new viewpoint has entirely changed.[3]

c) Summary

Much of what has been said thus far about the new

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1. Cf. Hocking, Types of Philosophy, pp. 332-333
2. Cf. Joad, Philosophical Aspects of Moderm Science, p. 11
3. Cf. Jeans, The Universe Around Us, p. 179

physical theories of matter from every angle is so surprising and yet so essential to a fundamental grasp of the more fully articulated system of thought which underlies the facts that it may be well in preparation for further research in this field to quote a summary of this subject. Kirk has furnished us with a splendid compendium of the facts in the situation as they are known up to the present. He says:

> "Perhaps the most impressive position of the new physics is the proof that protons and electrons are not things at all, but simply convenient names for describing radiations in certain localities. In their ultimate nature they turn out to be waves, and the category of substance can no longer be applied to them. Thus matter assumes the ambiguous aspect of a ghost. Science has gone beyond the electron to something more mysterious still, and it is unlikely that the material world will ever regain the status of substantiality."[1]

2. The Conception of Mind

a) The Materialistic Explanation

Enough has already been said in discussing the conceptions of matter, old and new, to acquaint one quite thoroughly with the temper of mind associated with the doctrine of stark materialism. When once that mental attitude is grasped, it is easy to anticipate with reasonable accuracy the result of its application to the solution of any problem falling within its jurisdiction or out of it. It is not surprising, then, to watch it usurp the right to interpret mind and to do it in strictly

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1. Kirk, Stars, Atoms, and God, pp. 43-44

orthodox fashion. The rapid spread of the philosophy which that attitude sponsored developed a spirit of arrogance that would not be excluded from any realm, not even that of mind. As Kirk says:

> "Physics, firmly fixed to its categories, admitted the presence of mind, but there were good reasons for supposing that it was a refinement of material substance. The prevailing trends towards determinism increased the belief that we lived in a closed, law-bound universe; and if nature was controlled by a rigid law of causation, how could man be free?"1

Thus body and then mind came under the blighting influence of the dominating philosophy of the last century. In the case of the latter many curious explanations were given to explain its actions. The same writer just quoted also says in this connection:

> "Materialistic determinism passed from crude positions expressed in phrases such as, 'man is what he eats', and 'the brain secretes thought as the liver secretes bile', to more refined speculations in the functional psychology of the period. Science neither supported nor advocated such interpretations, but the trends towards the close of the century seemed to justify them."2

The mechanistic idea, justifiable within definite limits, became extensively applied to workings of the mind and issued in a certain fatalism with regard to all thinking and conduct. It has its counterpart to-day in that waning system of psychology which is called behaviorism.

It is needless to say that such a view of mind was

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1. Kirk, Stars, Atoms, and God, p. 39
2. Ibid., p. 39

false, and likewise the science invoked in support of it. A reduction to an absurdity of this whole scheme of psychology and its supposed scientific foundation has been made many times, but no one has done it more completely and in more telling fashion than Dr. Francis Patton, from whom it seems fitting to quote in seeking to bring this discussion to a close:

> "We need no argument to show that the science which teaches this is wrong. For it means that the entire scheme of interconnectedness which we call the world is nothing short of a mechanism; that Leonardo da Vinci's 'Last Supper' is as mechanical as the cheapest chromo; that the finest symphony is as much the result of a mechanical arrangement of material atoms as the 'record' of a Victrola; that the writings of Plato and Aristotle are the outcome of centuries of pre-arranged material atoms; and that what we call the knowledge of all this, is itself a certain state of material particles to which we give the name of 'thought'. A theory which so obviously refutes itself and destroys the meaning of thought, inference, belief, proof, and knowledge, needs no other and can have no better refutation than the statement of the case. A mindless world can neither make arguments nor accept proofs."[1]

Such words when pondered should silence forever any effort to maintain or resuscitate a theory that is so obviously contradictory to itself, and should also make any further defense against it unnecessary. But, as though such reasoning were not sufficient, modern science has helped to put an end to any such attempt by destroying its rendezvous which was known to be a gross materialistic view of the world. With that place now gone, it is, by

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1. Patton, Fundamental Christianity, p. 107

the irony of fate, destined to be a fugitive and a wanderer upon the face of the earth. Its grim spectre, however, will appear again later on in these studies in connection with the question of man's freedom which, because it will be treated at some length in its proper place, deserves no further mention in this chapter except in the consideration given to the relation which exists between mind and matter.

b) The New View of Recent Physical Thought

Having profited from the mistakes and failures of the materialistic conception of mind, and also from the new discoveries and data at man's disposal, modern science has looked afresh at this old problem of mentality. First of all, it began to question whether any theory which regards the mind as merely an object of nature could tell the whole truth about it. Remembering that each man has an opportunity to study his own mind close at hand, it began to question the legitimacy of any solely mechanistic explanation.[1] Confidence in the greater reality of things not seen as compared with those which do appear continued to increase until Eddington, in comparing the certainty of things spiritual and things temporal, made the famous statement that "mind is the first and most direct thing in our experience; all else is remote inference."[2] Mind, in

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1. Cf. Hocking, Types of Philosophy, p. 63
2. ~~Cf.~~ Eddington, Science and the Unseen World, p. 37
   Cf. also Eddington, The Nature of the Physical World, p. 281

this view, has again come into its own; it is not here subordinated to a position where it becomes merely a manifestation of matter or the result of the arrangement of particles.

But the tendency to exalt mind has gone even further. Once the pendulum was freed from the grip of materialism, it was quite obvious from past experience that it would swing in the opposite direction. Already it has gone very far. Jeans shows this trend in quoting with seeming approval the following words of Berkeley:

> "All the choir of heaven and furniture of earth, in a word all those bodies which compose the mighty frame of the world, have not any substance without the mind. . . So long as they are not actually perceived by me, or do not exist in my mind, or that of any other created spirit, they must either have no existence at all, or else subsist in the mind of some Eternal Spirit."[1]

That he accepts this as a fair expression of modern scientific thought on the importance and place of mind in the world is evident from what follows. There he proceeds to say that modern science seems to lead by a different road to a like conclusion.[2] Although Eddington says that "It is difficult for the matter-of-fact physicist to accept the view that the substratum of everything is of mental character",[3] the implication of his writings referred to seems to be that he, too, holds to

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1. Jeans, The Mysterious Universe, p. 171
2. Cf. Ibid., p. 171
3. Eddington, The Nature of the Physical World, p. 281

this belief in the primacy of mind in all things.

c) Summary

A glance, then, at the present situation as to this problem leaves one outstanding impression,--namely, that a hard and fast material concept of mind must quit the field because it is no longer tenable. It does not meet the demands of new facts. Idealism, on the other hand, in varying degrees of purity and intensity has taken its place as better fitted to coordinate the facts science now is facing. So far it has met with great success and with but little opposition. According to its standards mind is not a manifestation of matter as was once believed by many, but conversely, matter has become a manifestation of mind. To some this latter statement is true only in relation to an infinite Mind. To others it may be this and more. Some, it appears, are drifting toward the position that even though the former fact is true, the world cannot actually exist unless we recreate it in our own minds. Mind has thus become supreme over matter which is dependent upon this creature activity for its very existence. Such is the complete reversal of viewpoint that has come about in the science of the present. The reasoning which led to this conclusion and which has been already given, is well summarized by Dampier who says:

"While we know nothing of the intrinsic nature of the reality (if any) for which our model of the physical world stands, we do know something about the intrinsic nature of the mental world, and, as far as direct knowledge goes, the mental world is the more real. Physics cannot show that the intrinsic nature of the physical world differs from that of the mental world: mental and physical events may well form one causal whole."[1]

3. The Relation of Matter and Mind

a) A Brief Historical Review of the Problem

Much of the treatment of this chapter up to this point has dealt with questions related to that of the connection between matter and mind, and has, consequently, overlapped to some extent the present topic. The subject is so vital, however, to one's view of life that this whole field needs to be canvassed systematically by itself. It can best be introduced by setting it out briefly in its historical sweep. This Dampier has done in few words. The story runs thus:

"Till the seventeenth century it was universally assumed that man's soul was material, of the same nature as a gas. But Descartes drew the distinction between mind and matter which has lasted till our own day, and has assumed the form of psycho-physical parallelism. To avoid Descartes' dualism, two ways seemed open. The materialists took matter as the sole reality, and held mind to be an illusion. The idealists or mentalists believed with Berkely that mind was real and matter an illusion. In the work of phenomenalists such as Hume and Mach, a new view appears—that the concepts of mind and matter are different ways of looking at our picture of nature, or, as perhaps we may better say, different plane diagrams from which science constructs a solid model of nature. These ideas have been developed into what is called 'neutral monism' by many recent philosophers from

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1. Dampier, A History of Science, pp. 474-475

William James to Bertrand Russell. According to this theory, mind and matter are both composed of something more primitive, which is neither mental nor material."[1]

b) The Materialistic Answer

(1) Its Explanation

In a logical consideration of present views upon this subject, to which alone attention is here confined, the first one to be examined is the material view which prevailed when modern physical thought began to develop. It scarcely needs to be outlined again since it has been so fully explained in other connections. Pure materialism holds that mind is a form of matter, and is to be explained in terms of physical things, of which the body is composed.[2] Its chief psychological representative has been and is metaphysical behaviorism. This philosophy asserts that all our conscious life, including our sensations, our thoughts and our feelings, is simply the result of physiological reactions of the bodily organism and of adjustment to environment.[3] It proceeds upon the assumption that the mind is observable, and that since all one can observe is the physical conduct, the mind must be wholly interpreted by that.[4]

(2) Its Refutation

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1. Dampier, A History of Science, p. 474
2. Cf. Brightman, An Introduction to Philosophy, p. 201
3. Ibid., p. 184 (Cf.)
4. Cf. Hocking, The Self: Its Body and Freedom, p. 18

The view has many weaknesses and has been very ably refuted. Hocking appears to accept the assumptions which underly the theory, but not the conclusions drawn from them. For scientific purposes he holds that the principle, that the mind is what it does, is valid, but, as will be seen later, he would avoid the difficulties which a rigid behaviorism faces in building its philosophy upon this foundation.[1] However, it is not so much the purpose of this brief survey to examine the foundation, which is less evident, as it is the intention to view the superstructure which has been built upon it and can be readily seen.

There are three strong objections to the whole system as it has been reared. Behaviorism, in the first place, denies or ignores the facts of introspection. It finds no room for the phenomena of consciousness, such as one's feeling about his behavior, awareness of conscious life but not of behavior, consciousness of the meaning of words as distinct from their utterance. In the second place, behaviorism is wrong in making the behavior, which is a symbol or suggestion of meaning, the equivalent of the actual conscious experience of meaning. Lastly, much may be in consciousness which is not in behavior at all. Much is seen and heard to which the individual does

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1. Cf. Hocking, The Self: Its Body and Freedom, pp. 20-23

not react at all, and for which, therefore, there is no visible sign of any behavior. But this is nevertheless in consciousness and must be taken account of in seeking to understand it.[1] Again, as in the case of materialism, it is its insularity which condemns it as a plausible working theory. It does not embrace all the facts in seeking to understand the mind.

c) The View of Bertrand Russell

(1) Introductory Remarks

The remaining views, including the one now to be discussed, have all something in common. They recognize the need of seeking a unification of the activities of both mind and body,[2] but they refrain from trying to obtain that unity at the expense of entirely subordinating one member to the position of a mere appendage to the other. It is admitted that, as has been well expressed: "Mind and

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1. Cf. Brightman, An Introduction to Philosophy, pp. 186-188
2. Modern science has helped to create this need and to facilitate the efforts of philosophers and psychologists to meet it. Such statements as the following by Millikan show why scholars have been spurred on recently to think this problem through to a conclusion. In answering the question as to the meaning of the particle and wave theories of electrons and the corpuscular theory of light waves, he replies by saying: "Simply that there is an interrelatedness, a unity, a oneness about the whole of nature, and yet still an amazing mystery. Is it at all likely in the light of that history that we can long maintain airtight compartments separating ether (or matter, whichever you will) from life and mind?" Millikan, Science and the New Civilization, p. 81

Body, psychical and physical, psychosis and neurosis, the subjective and the objective life are incommensurable aspects of reality."[1] The truth that something exists behind the manifestations cannot be denied or explained away.

(2) Its Explanation

But Russell's view takes an entirely different course from the others. He quotes with full approval on this subject the words of Pavlov when he says: "We are now coming to think of the mind, the soul, and matter as all one, and with this view there will be no necessity for a choice between them."[2] In his own explanation of his views he is even more explicit. He writes as follows:

> "The dualism of mind and matter is out-of-date: matter has become more like mind, and mind has become more like matter, than seemed possible at an earlier stage of science. One is led to suppose that what really exists is something intermediate between the billiard-balls of old-fashioned materialism and the soul of old-fashioned psychology."[3]

Russell has called this view which he advocates "neutral monism".[4] It breaks down an essential distinction between mind and matter and postulates for all phenomena a common background that is homogeneous in character.[5] The

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1. Cotton, Has Science Discovered God?, p. 177, Quotation from J. Arthur Thomson
2. Russell, The Scientific Outlook, p. 54
3. Ibid., p. 127
4. Cf. Russell, Philosophy, pp. 209, 282
5. Cf. Joad, Philosophical Aspects of Modern Science, p. 83

observed differences between those entities are regarded as the differences in the forms of arrangement in this fundamental stuff that lies behind them.[1] This neutral world-stuff, by virtue of its descriptive title and its very purpose in the scheme of unification, cannot be either material or mental.

(3) Criticism of This View

The position taken by Russell, far from settling the question of the proper adjustment of mind and matter in their relation to one another, raises a number of objections. First of all, it identifies the act of experiencing with that which is experienced, eliminating the former as a separate thing of which we have direct knowledge. This view leaves this difficulty unsolved. It confuses subject with object and obliterates their separation which is necessary to any understanding of conscious life! Again, this view destroys the meaning of any distinction between true and false, right and wrong. A neutral event cannot be said to be true; it can only happen as the result of some shifting in the particles of the essential world-stuff. All things that happen, whether apparently contradictory or not, cannot be so regarded when viewed in the light of their cause. Such a view, if true, would make meaningless any effort to

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1. Cf. Joad, Philosophical Aspects pf Modern Science, p. 83

change what cannot be other than the background determines it to be.[1] Lastly, it is impossible to see how a neutral stuff can produce entities that do not appear neutral,—for instance, how what is apparently impersonal can change into that which is personal. This neutral material seems conveniently capable of magical qualities, of being able to pull rabbits out of a hat when needed. It acts too personal at times, in fact, to be wholly neutral.

d) The Principle of Interactionism

Another theory which has been proposed as a solution to the problem is called interactionism. This view rests upon the "belief that mind and body act on each other; that sometimes the iniative comes from one side, and sometimes from the other."[2] There is no physiological connection, but there is a subtle interaction that exerts a mysterious influence on both entities. The case for interactionism rests upon its attempt to consider all the facts, including all aspects of experience as well. Opposition to it comes only from those theories which are limited in their application to the physical aspects of the world. Modern scientific thought, by reason of the new facts at its disposal, tends to nullify this opposition in order to make room for

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1. Cf. Joad, Philosophical Aspects of Modern Science, pp. 108-110
2. Brightman, An Introduction to Philosophy, p. 204

a broader experience that speaks very largely in favor of this new theory.[1] A further explanation or defense of it, therefore, does not seem necessary in view of this fact.

e) The Theory of the Psychophysical Organism

Somewhat more advanced and recent than the previous theory is the view put forth by Hocking and backed also, it would seem, by the scientific authority of Whitehead. This new conception recognizes the distinction between the physical and the psychical, but it seeks to unify their activity in a view of self that recognizes both body and mind as a necessary part of the whole which functions as an organism. Hocking has clearly stated this position in the following:

> "Body and mind are different: we have no intention of denying this proposition. But how are they different? Not as two distinct entities which somehow interact. Nor as two parallel sets of phenomena, each complete in itself. They are different rather as a part is different from the whole. The body is an organ of the self as the brain is an organ of the body. The self needs its body in order to be an actual, active, social, historical self."[2]

That Whitehead supports this view is deduced from his strong advocacy of the concept of organism to be found in the whole of nature. Referring to this teaching con-

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1. Cf. Brightman, An Introduction to Philosophy, pp. 204-207, from which these facts are chiefly gleaned, for a fuller statement of the theory, and the arguments advanced against it with their refutation.
2. Hocking, The Self: Its Body and Freedom, p. 101

sistently upheld in one of his recent books, he says:

> "The doctrine which I am maintaining is that the whole concept of materialism only applies to very abstract entities, the products of logical discernment. The concrete enduring entities are organisms, so that the plan of the whole influences the very characters of the various subordinate organisms which enter into it. In the case of an animal, the mental states enter into the plan of the total organism and thus modify the plans of the successive subordinate organism until the ultimate smallest organisms, such as electrons, are reached. Thus an electron within a living body is different from an electron outside it, by reason of the plan of the body. The electron blindly runs either within or without the body; but it runs within the body in accordance with its character within the body; that is to say, in accordance with the general plan of the body, and this plan includes the mental state. But this principle of modification is perfectly general throughout nature, and represents no property peculiar to living bodies."[1]

In applying this view specifically to the body-mind problem, he seems to say more explicitly:

> "I have also sketched an alternative philosophy of science in which organism takes the place of matter. For this purpose, the mind involved in the materialist theory dissolves into a function of organism. The psychological field then exhibits what an event is in itself. Our bodily event is an unusually complex type of organism and consequently includes cognition."[2]

It is admitted that Whitehead's position is not so clearly expressed as in the former instance, but the trend of his philosophy undoubtedly appears to be in the same direction of a psycho-somatic organism. This theory is recent in origin, but it has gained increasing favor and appears to be in some respects closer to the scientific facts than

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1. Whitehead, Science and the Modern World, pp. 111-112
   Cf. Ibid., pp. 90, 105, 106
2. Ibid., p. 271

any which has preceeded it. It preserves the identity of body and mind and at the same time provides for them a <u>modus vivendi</u> that promises well to become permanent because it accords so closely with the plain facts of experience.

4. Summary

In concluding this study of mind and matter in the light of the new views of physical science, it seems proper to summarize the impressions which have been received. Certainly it can be fairly said that the old conception of matter as being composed of nothing but hard substantial particles is gone. To-day matter is regarded as porous, tenuous, insubstantial and even possessing a spectre-like character. There is now a question mark in the mind of the scientist as he peers into the heart of what was once thought to be beyond question as to texture. Yet, withal that, matter is looked upon by many scientists as still material in distinction from the spiritual. Mind is something other than the physical, but its closer relation to the material world is becoming more universally acknowledged among the scientists. Some common essence that enables these to interact is more and more being recognized.[1] In fact, there is a tendency to consider a Supreme Mind to be behind all that appears to us as

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1. Cf. Barnes, Scientific Theory and Religion, pp. 310-582

physical and psychical. Science is apparently becoming more spiritualized as it looks at matter separately and in relation to mind. Its conservative conclusions are voiced by Barnes in the following:

> "Mind and matter are not two disparate substances: but the physical and psychical series are two aspects of a single process. Neither series is primary: neither can be regarded as the cause of the other. So much would appear to be certain. But unfortunately we must admit that, of the nature of the fundamental process in which thinking is correlated to brain-changes, we are wholly ignorant."[1]

C. The Problem of Determinism

1. Introduction

Side by side with the problem which has just been weighed goes the troublesome question of determinism. It appears confederate with the former and might have been discussed in conjunction with it, were it not for the fact that its importance in relation to man's freedom, which will be investigated later, merits for it separate treatment.

2. The Character of Orthodox Determinism

In order to do this intelligently, however, it is necessary to define the character of determinism as it is commonly understood in relation to these problems. Eddington is of great assistance in this endeavor. After quoting two definitions, one from the mathematician, Laplace, and the other from the philosopher, Broad, he

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1. Barnes, Scientific Theory and Religion, p. 582

selects and approves, as best suited to convey the ordinary significance attached to the idea, a classic third, from the Rubaiyat of Omar Khayyam, which runs as follows:

> "With Earth's first Clay They did the Last Man's knead,
> And then of the Last Harvest sow'd the Seed:
> Yea, the first Morning of Creation wrote
> What the Last Dawn of Reckoning shall read."[1]

If the judgment of the great scientist as to the poet's description is accepted, certain conclusions necessarily follow. "Ideally the whole world past and future is connected into a deterministic scheme by relations of causality."[2] Such determinism presupposes not merely causes, but preexisting ones. It signifies also predetermination; in such a scheme nothing at all is left to chance.[3] The known laws of nature are considered to be of a type which leads to definite predictions of the future, and all unknown are expected to conform to the same type.[4]

3. The Case against the Old Determinism

a) Introduction

In opposing a mechanical view of nature in favor of an organic conception, Whitehead has said that "the only way of mitigating mechanism is by the discovery that it is not mechanism."[5] The same principle applies to any

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1. Cf. Eddington, The Decline of Determinism, pp. 141-142
2. Eddington, The Nature of the Physical World, p. 297
3. Cf. Eddington, The Decline of Determinism, pp. 142,144
4. Cf. Eddington, The Nature of the Physical World, p.300
5. Whitehead, Science and the Modern World, p. 107

attempt to overthrow the deterministic theory. Fortunately there are recent discoveries in science which seem to indicate clearly that the scheme is far from universally applicable and, therefore, cannot be made to interpret correctly all events.

b) The Scientific Data Which Oppose It

(1) The Quantum Theory

One of these discoveries is the quantum theory which developed from a more intensive study of the atom begun at the close of the last century in connection with certain unexplained phenomena of radiation.[1] Planck, of Berlin, put forward at this time an explanation of these phenomena of radiation which was non-mechanical in its nature and, therefore, unrelated to any scheme of interpretation of that time. This new view developed in time into the quantum theory which has become an outstanding principle of modern physics.[2]

The Bohr theory of the atom which was a direct result of Planck's work, was an attempt to interpret the atom in a manner consonant with the new facts. Although recent investigation indicates a need for some decided changes in this theory, it is still said to provide the best working model of the atom and to be absolutely essential to an

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1. Cf. Jeans, The Mysterious Universe, p. 22, previously quoted
2. Cf. Ibid., pp. 22-23

understanding of the more recent theories which incorporate its essentials.[1] According to this theory the atom consists of a central nucleus surrounded by electrons which move around the nucleus in circular or elliptical orbits much as the planets revolve around the sun. In fact, the whole structure has been likened to a solar system. But whereas in the solar system the planet's orbit may be of any size or eccentricity, the electron's orbit has only a definite number of possible states or configurations which are as distinct from one another as the steps on a staircase. The change in the position of the electron from a higher orbit to a lower, or vice versa, is effected through the medium of radiation. If the radiation falling upon the atom be absorbed in the form of energy by an electron, the electron's orbit is in turn increased in size. If the atom emits radiation by the conversion of its energy into that form, then one of the electrons in the outer ring drops down to a lower orbit. These changes in orbit are not arbitrary, but correspond to the amount of wave-energy sent out or taken in by the atom. This amount can only vary as do the distinct multiples of a unit of radiation called a quantum.[2] In consequence, the electron does not jump continually from one orbit to another, be-

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1. Cf. Jeans, The Universe Around Us, p. 125
2. Cf. Eddington, The Nature of the Physical World, pp. 190-193
   Cf. also Jeans, The Universe Around Us, pp. 121-123 on this subject

cause the quantum law states that the transformation of energy into radiation does not take place continuously, but in these small packets or quanta of finite amount.[1] Therefore, no definite prediction can be made as to when the electron will make the jump, nor which way it will jump, whether up or down. Neither can it be said whether it will skip an orbit and lower its position twice as much, or whether it will decide to raise it in the same fashion. In fact, it would appear that determinism cannot foretell any of these events because they are in the hands of some hidden power. Science can speak only in terms of probabilities, because, as Jeans says, "this is a matter which lies on the knees of the gods—whatever gods there be."[2] Because of these recalcitrant facts of recent sciences, Eddington, therefore, can say:

> "It is a consequence of the advent of the quantum theory that <u>physics is no longer pledged to a scheme of deterministic law</u>. Determinism has dropped out altogether in the latest formulations of theoretical physics and it is at least open to doubt whether it will ever be brought back."[3]

(2) The Principle of Uncertainty

The newest theoretical constructions in this field, however, are even more positive in their denial of determinism than the theory which has just been examined. In mentioning the Principle of Indeterminacy Eddington

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1. Cf. Barnes, Scientific Theory and Religion, p. 262
2. Jeans, The Mysterious Universe, p. 24
3. Eddington, The Nature of the Physical World, p. 294

associates with it an attitude definitely hostile to this fatalistic philosophy.[1] The picture of the wave-atom, which is inherent in this latest principle, was developed by Heisenberg and Schrödinger. It makes clear that the electrons in the atmosphere surrounding the nucleus of the atom do not follow the fixed orbits of the Bohr atoms, but may be found at any place within that atmosphere, which, like the envelope of air surrounding the earth, has no boundary. Of course, it also indicates that each of these individually will more likely be found in one place than another.[2]

A more detailed explanation of how this principle of indeterminacy is discovered is here appropriate.[3] If it

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1. Cf. Eddington, The Nature of the Physical World, p. 294
2. Cf. New York Times, June 19, 1933, Statement by A. H. Compton, reported by William Lawrence
3. A very recent theory, worked out by Professor J. R. Oppenheimer, of the University of California, and W. H. Furry, National Research Fellow, as a substitute for the famous theory of the electron of Professor Dirac, of Cambridge University, goes beyond the Heisenberg principle in one of its aspects, applying it to two new fields and giving two new final boundaries to experimental knowledge. In one case, it holds that while the total charge, current density and energy of a system of particles in the presence of an electromagnetic field can be determined, it is never possible to determine by any experiment the number of electrons and positrons (counterparts of electrons having a positive charge) which are responsible for that total. In the second case, it holds that science cannot with any degree of precision, as Dirac claimed, locate the position of an electron at rest. The limit of accuracy seems to be a Compton wave-length, or twenty-four hundred billionths of a centimeter. Cf. New York Times, February 18, 1934

is decided to attempt an experiment to determine the speed and position of an electron, one type of experiment will fix the position with great accuracy but its speed with great uncertainty. The electron in this picture is a short train of waves. Another type may fix the speed with great accuracy at the expense of great inaccuracy in position. In this case the electron is represented by a long train of waves. The two wave-pictures represent knowledge of the same atom under different conditions. The waves themselves represent subjective probabilities.[1]

Photons,[2] sometimes viewed as minute particles of energy and sometimes as bullets of radiation,[3] also have wave-pictures like those of the electrons. They are the ordinary waves of the undulatory theory of light. If these photons are pictured as being localized at points, then their views must be interpreted as waves of probability because of the mere likelihood of finding the photon at a given place. The waves represent nothing but a diagrammatic representation of the probable location of the photon.[4]

As judged by these facts, determinism seems not to enter into the picture of what is going on inside the

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1. Cf. Jeans, The New Background of Science, pp. 236,237
2. They are regarded as units of action
3. Cf. Jeans, op. cit., pp. 24-26
4. Cf. Ibid., pp. 238-239

atom and the photon. In defining its position relative to these discoveries, Jeans says:

> "We cannot include determinism in our picture of nature unless we have an experimental technique for discovering that it exists in nature. Now this requires that if we picture nature in terms of particles—whether photons or electrons and protons—existing in time and space, we must possess a means of discovering the positions and velocities of these particles with complete accuracy. This is precisely what the uncertainty principle denies us. Thus a picture which represents nature as consisting of particles in time and space cannot at the same time exhibit determinism."[1]

Not only has this principle been upheld by the new discoveries in the microscopic world, but it has also found support from the facts of relativity revealed in a study of the universe. These are not relevant to this subject except as their mention shows how the large-scale phenomena appear to corroborate the testimony of the sub-atomic world. The consistency of the witness from both sources to the facts underlying this principle is indicated by Millikan in a summary of this matter in which he says:

> "From two quite different points of view then, from the observed facts of relativity and from the observed facts of quanta, the first obtained from studying bodies moving with extraordinary high speeds, speeds comparable with the speed of light, the second obtained from studying microscopic phenomena or unitary elementary processes, physics has come to the conclusion that velocity and position, or energy and time, or more simply, length and time, are not at bottom independent of each other, in other words that there is no such thing as absolute time, nor indeed as absolute length, and therefore that in the world of <u>elementary</u> processes there is no

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1. Jeans, The New Background of Science, p. 256

> possibility of predicting . . . what is going to happen to a particular electron, or atom, or light-quant at a particular future instant of time, from any observations of what has happened to this electron, atom or light-quant at any preceding instant."[1]

c) Additional Considerations against It

(1) Its Superficial Character

Aside from these scientific facts which militate against determinism, there are two other considerations from the point of view of its universal application which bear mention. The superficial character of this scheme becomes apparent as soon as it is examined thoroughly. It links appearances together in the causal chain, but it does not search for the facts which underly the appearances. Jeans says a purely mechanical picture fails for the following reason:

> "materialistic science runs counter to the teachings of present-day physics in its assumption that everything can be fully represented in space and time; it fails to distinguish between the surface and the depths beneath. It takes the spatial qualities of objects to be their primary qualities, although science shews that the spatial qualities are merely those with which our senses can establish direct contact—the ripples on the surface which meet our eyes.
>
> The purely mechanical picture of visible nature fails for a similar reason. It proclaims that the ripples themselves direct the workings of the universe instead of being mere symptoms of occurrences below; in brief, it makes the mistake of thinking that the weather-vane determines the direction from which the wind shall blow, or that the thermometer keeps the room hot."[2]

(2) Its Unwarranted Generalizations

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1. Millikan, Time, Matter, and Values, pp. 29,30
2. Jeans, The New Background of Science, p. 260

Metaphysical determinism is also condemned on the basis of its entrance into fields where its principle has not been checked and as yet cannot be. Millikan no doubt registers the opinion of most scientists to-day with regard to it in this sense when he says:

> "Metaphysical or philosophical determinism I am not in the least interested in, because it represents one of those sweeping generalizations, or assertions of universal validity even when fields are entered outside those within which by a long process of prediction and experimental check the principle in question has been found to be a useful and dependable working hypothesis. . . . To me philosophical determinism is a pure dogma of no particular interest to the man who has even scented afar the scientific method."[1]

4. The Present Arguments in Defense of Determinism

a) A Doctrine of Indeterminism Unjustifiable

(1) Because It Is Based on Ignorance of the Facts

The protaganists of the deterministic principle, it must be remembered, have not kept silent all the while the evidence in this case against them was being compiled. There has been an effort in the meantime to build up a strong defense against it. Great encouragement to the opponents of the current theory has been given by one who himself accepts them. Jeans has intimated that the present views may simply be a half-way house on the road to a fuller knowledge when he says that "the appeal of the new physics to probabilities may merely cloak its

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1. Millikan, Time, Matter, and Values, pp. 97,98

ignorance of the true mechanism of nature."[1] Bertrand Russell has become an outstanding champion of the view here suggested. In support of it he says:

> "To prove that a given set of phenomena is not subject to laws is essentially and theoretically impossible. All that can be affirmed is that the laws, if any, have not yet been discovered. We may say, if we choose, that the men who have been investigating the atom are so clever that they must have discovered the laws if there were any. I do not think, however, that this is a sufficiently solid premise upon which to base a theory of the universe."[2]

Planck also favors this position. In seeking to explain the problem of the apparent nonconformity to statistical law of particular atomic phenomena, he finds the answer in our inability to make sufficiently refined experiments that would produce precise knowledge. He says regarding the matter:

> "And the non-fulfillment of the statistical rule in particular cases is not therefore due to the fact that the law of causality is not fulfilled, but rather to the fact that our observations are not sufficiently delicate and accurate to put the law of causality to a direct test in each case. If it were possible for us to follow the movement of each individual molecule in this very intricate labyrinth of processes, then we should find in each case an exact fulfillment of the dynamical laws."[3]

Ignorance of the facts, so long as it exists, it is said, does leave a choice of theories, but in this case there is a decided reason for choosing determinism in

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1. Jeans, The Mysterious Universe, p. 26
   Cf. also Jeans, The New Background of Science, pp. 223, 277
2. Russell, The Scientific Outlook, p. 108
3. Planck, Where Is Science Going?, p. 145

preference to indeterminism,—namely, because a definite answer is always preferable to one which is indefinite.[1]

(2) Because the Quantum Laws Are Not Incompatible With Causality

It is also maintained in defense of determinism that the quantum laws underlying the new views are not incompatible with causality. The present facts may result from trying to compress within the space-time framework things which do not fit into it. The cause, it is said, may be in the world behind that of our sense-perceptions. Jeans' partial refutation of his own views may be found in his remarks on this point. He says:

> "It is conceivable that happenings entirely outside the continuum determine what we describe as the 'course of events' inside the continuum, and that the apparent indeterminacy of nature may arise merely from our trying to force happenings which occur in many dimensions into a smaller number of dimensions."[2]

In even more explicit terms he questions whether determinism can be said to have been banished from the objective world when he writes:

> "The fact that the surface-phenomena of space-time shew a want of determinism leaves the question of whether real objective nature is deterministic or not completely open.
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> Space-time is not the framework of the world of nature, but of the world of our sense-perceptions, and when we represent objects beyond our senses in space-time, their apparent absence of determinism may be merely

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1. Cf. Planck, The Universe in the Light of Modern Physics, p. 51
2. Jeans, The Mysterious Universe, p. 148

> the price we pay for trying to force the real world of nature into too cramped a framework. So, when birds fly through the air, their shadows on the ground beneath obey no uniform or deterministic laws, even though the actual flights of the birds may do so."[1]

From these words there would seem, therefore, to be some warrant for the firm conviction of Planck that the quantum hypothesis will eventuate in a more exact formulation of the law of causality.[2]

(3) Because These Same Laws Apply Expressly to Measurement and Not to Causality

Another argument used to destroy belief in indeterminism is the one alleging that the principle of indeterminacy, rightly associated with measurements only, has been wrongly used to break down confidence in strict causal law with which it has no intelligent connection. This supposed indiscriminate use of the new principle to support indeterminism is challenged by Russell in this fashion:

> "The Principle of Indeterminacy has to do with measurement, not with causation. The velocity and position of a particle are declared by the Principle to be undetermined in the sense that they cannot be accurately measured. This is a physical fact causally connected with the fact that the measuring is a physical process which has a physical effect upon what is measured. There is nothing whatever in the Principle of Indeterminacy to show that any physical event is uncaused."[3]

(4) Because It Is Illogical

It is also affirmed by those who believe in a strict

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1. Jeans, The New Background of Science, pp. 259,260
2. Cf. Planck, Where is Science Going?, p. 143
3. Russell, The Scientific Outlook, p. 105

causal connection in nature that the indeterminism attributed to the quantum theory cannot be unrelated to some cause without destroying its meaning and making it appear as nonsense. To say that a thing is indeterminated in the sense that it is not caused at all is regarded as illogical. Planck puts this argument thus:

> "The indeterminism which belongs to quantum physics is a subjective indeterminism. It must be related to something, else indeterminism has no meaning, and here it is related to our own inability to follow the course of individual atoms and forecast their activities. To say that the arrival of a train in Berlin is indetermined is to talk nonsense unless you say in regard to what it is indetermined. If it arrives at all it is determined by something. And the same is true of the course of atoms."[1]

(5) Because It Introduces Caprice and Destroys Scientific Inference and Prediction

Possibly what is considered the strongest argument against the theory of indeterminism is the charge that such an hypothesis, if true, would introduce caprice into nature and make scientific inference impossible. Russell says regarding this:

> "Those who desire caprice in the physical world seem to me to have failed to realize what this would involve. All inference in regard to the course of nature is causal, and if nature is not subject to causal laws all such inference must fail. We cannot, in that case, know anything outside of our personal experience; indeed, strictly speaking, we can only know our experience in the present moment, since all memory depends upon causal laws."[2]

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1. Planck, Where Is Science Going?, p. 202
2. Russell, The Scientific Outlook, p. 107

This same writer elsewhere says that the question of great concern is whether the course of nature is determined by the law of physics.[1] It is his belief that this theory would answer the query in the negative. This would mean, as the quotation implies, that there could not possibly be any definite prediction of events which is an essential of a truly deterministic theory. Such a view, it is felt, would strike at the heart of any belief in the rigid uniformity and dependableness of nature upon which all our actions depend.[2]

b) Statistical Laws Associated With Indeterminism Necessitate Determinism

Associated with the theory that indeterminism prevails within the world of the atom is the belief that statistical laws apply with great accuracy to all cases where freedom of action seems to be granted. These will be explained later. What is here important is that those who favor determinism have sought to turn this admission by the indeterminist in their own favor. They maintain that adherence to the law in the aggregate necessitates dependence upon the functioning of the strict law of causality in every particular case.[3]

c) Determinism in Large-Scale Phenomena Apparently

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1. Cf. Russell, The Scientific Outlook, p. 120
2. Cf. Lodge, Beyond Physics, p. 147
3. Cf. Planck, Where Is Science Going?, p. 145

Undeniable

However much it may be true that the Galilean and Newtonian laws of mechanics seem no longer to apply in the world of individual electrons and protons, it is also true that in large-scale phenomena they appear to work with unfailing precision. Millikan indicates that they can so far be applied to these spheres without fear of contradiction and says further that the only realm wherein they have been checkmated is that of microscopic phenomena.[1] Apparently what is denied at one end of the scale is approved at the other. The determinist, therefore, holds that those who maintain that the theory of electrons introduces a fundamental indeterminacy in nature are faced with the compulsory problem of explaining away this larger determinism which refutes their hypothesis.[2]

d) The Universally Recognized Second Law of Thermodynamics Favors It

All present-day science, too, it is said, recognizes the validity of the second law of thermodynamics. But this law, which will be explained later, lends its support to determinism by the inexorable nature of the facts which it describes. As Inge expressed it, "There is nothing fortuitous in the degradation of energy, which proceeds

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1. Cf. Millikan, Time, Matter, and Values, p. 97
2. Cf. Levy, The Universe of Science, p. 165

with the regularity of a relentless fate."[1] How then, it is asked, can any other law contradict what is universally apparent? If there be contradiction, the other laws, only applicable to such a restricted realm, must be based upon false knowledge.

5. Answers to the Defense of Determinism

a) Indeterminism Is Justifiable

(1) It is Based on the Known Facts of Science

Science, however, has its answers for the arguments raised in support of determinism. In the first place, it does not wholly deny that there may be some ignorance of the activities going on within the world of the atom. But it asserts that the new principle is based upon what facts investigation has discovered and not upon those which science might like to find. It does not make the wish father to the thought, but keeps strictly within the bounds of scientific method. Eddington has phrased this answer as follows:

> "if the physicist is to take any part in the wider discussion on determinism as affecting the significance of our lives and the responsibility of our decisions, he must do so on the basis of what he has discovered, not on the basis of what it is conjectured he might discover. His first step should be to make clear that he no longer holds the position, occupied for so long, of chief advocate for determinism, and that if there is any deterministic law in the physical universe he is unaware of it."[2]

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1. Inge, God and the Astronomers, p. 34
2. Eddington, The Decline of Determinism, p. 146

In the second place, not all scientists are ready to admit that the new principle is only a revelation of our lack of knowledge. There is a categorical denial of such ignorance in the following quotation from Reichenbach who says:

> "It cannot be said that it is a lack of knowledge which leads to this renunciation of strict causality; it is, on the contrary, a very positive knowledge, the mathematical and empirical relations concentrated in quantum mechanics, which has led to this decision."[1]

No doubt Eddington, and possibly Jeans, would hold also to this opinion.

(2) The Quantum Laws, Ignoring Causality, Cannot, Therefore, Be Made to Support It

Those in favor of indeterminism do not deny that the modern quantum hypothesis may leave room for causality which lies behind the phenomena to which it applies. On this point Eddington writes:

> "It is quite true that the quantum laws for individuals are not incompatible with causality; they merely ignore it. But if we take advantage of this indifference to reintroduce determinism at the basis of our world structure it is because our philosophy predisposes us that way, not because we know of any experimental evidence in its favor."[2]

If the determinist's contention is accepted,—namely, that because the principle of indeterminism is based on lack of knowledge, it, therefore, cannot be correctly inferred, then

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1. Reichenbach, Atom and Cosmos, p. 279
2. Eddington, The Nature of the Physical World, p. 303

restraint must also be placed upon an attempt to assert determinism upon the same insufficient evidence. If the indeterminist cannot build upon what is called ignorance, the determinist must not be permitted to do so either. Ignorance cannot be the basis for an argument in his favor.[1]

(3) The Quantum Laws regarding Measurement Refute Prediction Associated With Determinism and Disclose Free Will

The statement that the principle of indeterminism applies to measurement and not to causality is only partially true. In the process of taking measurements, it is learned that accurate predictions with regard to both the velocity and position of an electron at a given time, present or future, are impossible.[2] But the deterministic scheme is essentially one in which the mechanical and causal laws are said to make such prophecies possible. If the laws break down at any point, then they are no longer universal in application and are open to serious question where the facts warrant it.

Another question arises in connection with this failure of the predictive character of determinism in re-

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1. Cf. Horne, Free Will and Human Responsibility, p. 117
2. Cf. Eddington, The Nature of the Physical World, pp. 306, 307. See further confirmation of this principle in footnote #3 on page 118 of this chapter

lation to the quantum laws which is pertinent here. Eddington speaks of rough-handling the particle, in an effort to determine its position,[1] so that its velocity is charged. But surely there is outside inference here by a force extraneous to the deterministic scheme. It can be injected into the scheme to disrupt its working in a manner which indicates a freedom of will that is foreign to a strict determinism. And so the defeat of prediction discloses some other determining agency besides what is found in the causal chain of nature.

Furthermore, if the quantum hypothesis be rejected as support for indeterminism because it deals with measurement and not with causality, the principle of determinism would have to be rejected on similar grounds as support for strict causality because it deals only with an observed order or succession of events and not with the underlying causes which cannot be fully known. It cannot actually tell more about these than indeterminism does. Thus the argument, aimed at indeterminism, can be made to cut two ways instead of one.

(4) It Is Not Contrary to Reason

The criticism that indeterminism is illogical or contrary to reason will not stand examination. Support of this statement will be given in greater detail in

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1. Cf. Eddington, The Nature of the Physical World, pp. 306, 307

connection with the question of human freedom, but the chief consideration in its favor needs to be mentioned here. Indeterminism does not deny causality, but fails to find evidence for it in the scientific data. It would leave room for causes other than those known to determinism which are just as valid as those supposed to operate in a mechanical way.[1] In other words, it recognizes that not all causes need be physical; that the law of causation does not exclude the psychical from this same sphere. Only determinism seeks to do that through ignoring some of the facts.

(5) It Does Not Introduce Caprice Nor Destroy the Dependableness of Nature

The orthodox theory of predetermined events makes much of the necessity for a uniformity in nature if science is to operate at all. As has been said, "it is axiomatic that in a deterministic scheme nothing is left to chance."[2] Everything must happen in a uniform manner according to preexisting causes. While, however, indeterminism opposes the rigid causal system of the old theory, it emphasizes its own dependableness because of the statistical laws which operate in one case as well as the other. These enable science to predict upon the basis of the new theory as

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1. Cf. Horne, Free Will and Human Responsibility, pp. 107-108 for a fuller, discriminating discussion of this matter
2. Eddington, The Decline of Determinism, p. 144

well as of the old. They do not imply real chance as one ordinarily understands the term.[1] The average behavior of vast numbers of particles, no matter what individuals may do, is as dependable as the statistics of a life-insurance company.[2] With this help science can go on predicting with as much certainty as before. In fact, even under the old philosophy there was no more certain prediction than in this case, for in most cases the predicting was done after the event. Therefore it is that Eddington says: "in any argument about determinism, the dating of the alleged causes is an important matter; we must challenge them to produce their birth certificates."[3]

b) Statistical Laws Do Not Necessitate Determinism

Moreover, because average laws are dependable, it does not follow that they must necessarily be determined in order to be such. This is a <u>non sequitur</u> from the character of these laws of aggregations. In explanation of these average statistics Eddington says:

> "when we ask what is the characteristic of the phenomena that have been successfully predicted, the answer is that they are effects depending on the average configurations of vast numbers of individual entities. But averages are predictable because they are averages, irrespective of the type of government of the phenomena underlying them."[4]

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1. Cf. Inge, God and the Astronomers, p. x
2. Cf. Eddington, The Decline of Determinism, p. 145
   Cf. also Eddington, The Nature of the Physical World, p. 300
3. Eddington, The Decline of Determinism, p. 142
4. Eddington, The Nature of the Physical World, p. 300

c) and d) Law of Large-Scale Phenomena and Law of Entropy Are Statistical Laws

There is no intention upon the part of the indeterminists to deny the seeming determinism represented in macroscopic phenomena and in the second law of thermodynamics. The laws representative of both phenomena are thus far well established and apparently dependable. But, it is maintained, both of these sets of laws deal with behavior in the mass. And just as it has been pointed out in the case of collective phenomena of the microscopic world that "when we are dealing with atoms and electrons in crowds, the mathematical law of averages imposes the determinism which physical laws have failed to provide",[1] so in the similar case of these phenomena, the same law stamps them with the seal of an inflexible order. This proves merely the valuable character of statistical laws which indeterminism also recognizes.

6. Summary

In the discussion of this difficult subject of determinism which is concluded with the presentation of the arguments pro and con, there has been a determined purpose to let the scientists speak for themselves as far as possible in order that the two sides of the problem might be presented by their own spokesmen. Several impressions

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1. Jeans, The Mysterious Universe, p. 34

are gained from this process. First of all, it is clear that the concepts associated with each view are sometimes confused to the extent that men ranged on opposite sides do not always understand one another's viewpoint. In the second place, the facts in the case are often teasing and do not all lend themselves to strict classification for or against determinism; they rest on debatable ground. Again, it is certain the preponderance of scientific opinion seems to be turned towards indeterminism. This view appears to make the wider appeal in the present. Lastly, whatever view may finally obtain, it is certain that scientific determinism will be greatly restricted in application in the future. There is a feeling abroad among patient scholars that it is all right in its place, but that it is mischievous when applied beyond its sphere. It is convenient at times as a working hypothesis, but it does not answer ultimate questions. Whitehead's description of scientific materialism seems to make a fitting conclusion to these observations. Concerning it he writes:

> "It is not wrong, if properly construed. If we confine ourselves to certain types of facts, abstracted from the complete circumstances in which they occur, the materialistic assumption expresses these facts to perfection. But when we pass beyond the abstraction, either by more subtle employment of our senses, or by the request for meanings and for coherence of thoughts, the scheme breaks down at once."[1]

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1. Whitehead, Science and the Modern World, p. 25

It is by the use of these names that mechanism in its essence is discovered to be more than mechanism and determinism likewise to be something other than it was superficially supposed to be.

D. The Religious Implications of These Facts

1. Justification of the Religious Significance of These Chapters

It remains yet to unfold the religious implications of the facts of science which have been brought to light in this chapter. This is the chief purpose of this investigation into the findings of modern thought in this field. Some scientists appear to be unwilling to let the religionist profit by these changes and advances of thought in this realm,[1] but the majority of the great leaders encourage him to do so by their own confession of need for a handmaid to science. On this subject Eddington lays bare his feelings in these words:

> "I am convinced that a just appreciation of the physical world as it is understood today carries with it a feeling of open-mindedness towards a wider significance transcending scientific measurement, which might have seemed illogical a generation ago . . ."[2]

The process by which this need is sensed is further explained as follows:

> "The external world of physics has become a world of shadows . . . It is all symbolic, and as a symbol the

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1. Cf. Brightman, Moral Laws, p. 280
2. Eddington, The Nature of the Physical World, p. XVI

> physicist leaves it. Then comes the alchemist Mind who transmutes the symbols. . . In the transmuted world new significances arise which are scarcely to be traced in the world of symbols; so that it becomes a world of beauty and purpose—and, alas, suffering and evil."[1]

It is impossible for the human spirit to refrain from satisfying this need which arises in the study of the physical world. There is an inner urge to keep on filling it in the most satisfying way possible. Because of it the words of Millikan are made understandable when he said: "If the beauty, the meaning and the purpose of this life as revealed by both science and religion are all a dream, then let me dream on forever!"[2]

2. Significance of the New Views of Matter

a) Is Matter Now To Be Regarded as Spiritual?

The recent explorations into the secrets of the atom have led to new conceptions of matter which tend to stress a more spiritual interpretation of nature. The lack of concreteness and of substantiality which is evident in the atomic world has induced some scientists and men of religion to maintain that matter is in reality spiritual. Studying this nebulous character of particles from the standpoint of mathematics, Eddington arrives at the conclusion that it possesses spiritual qualities. His line of reasoning is as follows:

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1. Eddington, The Nature of the Physical World, pp. XIV-XV
2. Millikan, Science and Life, p. 64

"The physical atom is, like everything else in physics, a schedule of pointer readings.[1] The schedule is, we agree, attached to some unknown background. Why not then attach it to something of spiritual nature of which a prominent characteristic is <u>thought</u>. It seems rather silly to prefer to attach it to something of a so-called 'concrete' nature inconsistent with thought, and then to wonder where the thought comes from. We have dismissed all preconception as to the background of our pointer readings, and for the most part we can discover nothing as to its nature. But in one case—namely, for the pointer readings of my own brain—I have an insight which is not limited to the evidence of the pointer readings. That insight shows that they are attached to a background of consciousness."[2]

This solution of a time-honored yet obstinate problem is strikingly popular to-day. It is a reaction from the oppressive materialism of the past that furnished no room for spiritual realities. In it can be found a fulfilment of the prophetic longing of the poet who sang:

"What if earth
Be but the shadow of heaven, and things therein
Each to other like more than on earth is thought."[3]

But while one may well agree with the spirit of the conclusion, it is difficult to see just how the method by which it is arrived at is wholly justifiable. In another place Eddington says: "Life would be impossible if there

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1. A pointer reading, as nearly as it can be briefly described, is a name applied by science to those terms, whose exact meaning we do not know, yet which are conveniently used to represent or to describe some object or its characteristics. Cf. Eddington, The Nature of the Physical World, pp. 251-255 for a further elucidation of the term.
2. Eddington, The Nature of the Physical World, p. 259 Cf. also Ibid., p. 260
3. Milton

were no kind of correspondence between the external world and the picture of it in our minds."[1] With this there is hearty agreement. Of course, he adds in this connection that the details cannot be relied upon unless confirmed by the exact methods of inference,[2] but the explanatory remark indicates that a general correspondence is taken for granted. The question arises, therefore, how there could be any semblance of such correspondence if, what in the mind is pictured as matter, turns out in the objective world to be spiritual according to Eddington's conclusion. This would be to make spirit and matter correspond, even though our mental pictures do not warrant such an association, but have rather kept them separate. It would mean that all attempts at differentiation in the objective world are bound to be abortive because they can represent nothing more than a distinction without a difference except that which may exist in the mind and is purely illusory. Either, then, the mind or nature is playing false with man in misrepresenting the facts to the extent that apparently dissimilar things begin to correspond.

This mingling of distinct and separate realities needs to be traced to its cause which, in turn, also de-

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1. Eddington, The Decline of Determinism, p. 146
2. Cf. also Ibid., p. 147

mands further investigation, before any abiding values can be attached to the religious implications here unfolded. But this study involves the more inclusive problem of the subjective character of much of present-day science. That question is related to other phases of this work and will be considered at length in the next chapter from various angles. It must be kept in mind, however, in seeking to make any true religious appraisal of the facts regarding the current views of matter, for the correctness or falsity of this fundamental attitude of the new physics will alter profoundly in one direction or the other one's opinion of the authority of scientific pronouncements and of the significance of deductions to be drawn from them. If this position be false, it is waste time to try to build upon it. There is no more reason in such action than there would be in trying to rest a cathedral upon a fog bank.

Barnes does not follow Eddington completely in his views upon this subject. He maintains that we cannot merge the psychical and the physical into one and decries the confusion of the material and the spiritual.[1] Inge also takes a different view from the preceding. The reason for his divergence of opinion is contained in the following quotation with which the writer expresses close

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1. Cf. Barnes, Scientific Theory and Religion, p. 310

sympathies. He says:

> "I have not been able to follow those who hold that the decomposition of material particles, which were formerly supposed to be solid and indestructible, is a valid argument in favour of a spiritual as opposed to a materialistic view of ultimate reality. Although I hold that ultimate reality is 'spiritual', not material, I cannot admit that matter dissolved into radiation is more 'spiritual' than matter in a solid or liquid state. We may refuse to call it any longer matter, but this is not a refutation of materialism, This argument, which is used by some Christian apologists, seems to me frivolous; it belongs to the old notion that spirit is matter in an ultra-gaseous condition."[1]

It does not seem reasonably possible, then, on the basis of these considerations to introduce the spiritual by dissolving matter. When such a course is tried, it produces hopeless confusion of thought. If matter be a mere fiction such as this view of Eddington would make it, what becomes of much of scientific method? For instance, if there is nothing but thought how can one speak of measuring anything, including the velocity and position of the electron, so prominent in the principle of indeterminacy? Can science measure mere thoughts? Science also speaks of "weighing" matter. Recent attempts at "weighing" the neutron have resulted, as has been pointed out, in a most minute calculation of this hitherto unknown quantity. But can it be accurately said that science by such a process is actually weighing the intimate thought of God? To ask such a question seems absurd, yet, if

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1. Inge, God and the Astronomers, p. viii

matter is in reality spiritual as science claims, it ought to be possible to answer this query in the affirmative. But, to sound out this position a little further, how can the mind of man from which thought proceeds fail to recognize thought as such wherever it exists? Is it possible that it does not know its own child? Or, to change the figure, can it not recognize the products of its own looms? Does the mind have an hallucination when it thinks it sees something called matter, that is distinct from mental entities, but in reality sees only thought? And how can it see thought unless by some transfiguring process this assumes when taken up into the mind a character which it does not have objectively, or which thoughts originating in the mind do not themselves possess?

Questions like these arise if one tries to attach pointer readings directly to something of an immediate spiritual background, instead of just linking them to matter recognized as real in itself. They suggest that possibly a better solution of this difficulty than Eddington's,—yet one which ultimately arrives at the same goal of belief in ultimate reality as spiritual, is that which recognizes that matter, however insubstantial, is still material, in distinction from the spiritual of which a chief characteristic is thought.[1] It may be viewed as

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1. Cf. Eddington, The Nature of the Physical World, p. 259

the objective thought of God to which He has given of His own volition a material form, and as such is different from God's subjective thought, much as man's subjective thoughts differ from those he has translated into actions. Such a view, of course, implies that all the thoughts of God are not of the same order or on the same plane, just as our own are not. Being the objective thought of God, it is subject to Him and is sustained by Him without being confused with that which we call the spiritual or the subjective in God. Such a clear-cut distinction between matter and pure thought in the world helps to remove the difficulties in the other view and to explain at the same time how apparently incongruous entities and events may be a part of the plan and working of a Supreme Mind. It merely displays the versatility of method employed by God in giving variety to His world.

Of course, even this proferred solution has its difficulties. It is adopted only because it seems to be freer from them than any other. But since the facts upon which a satisfying interpretation can be based are so meagre, there is ample room for difference of view. In answer, then, to the question as to whether matter is spiritual, opinion is divided. Some affirm that it is, and others deny that this is justifiable. It is not wise to hurry to any rash conclusions from the incomplete evidence. The foundation of fact is too insecure to attempt to rear any imposing theoretical superstruction upon it. Such an effort is not demanded, because there is other evidence in man's experience that the heart of the universe is spiritual. And it is permissible, even from the standpoint of science, to discover this through these channels.

b) Are Present Views More Favorable to the Spiritual?

Another question, which arises when the religious significance of the current views of matter is considered, concerns the relation of those conceptions to spiritual values. When the older philosophy was in the ascendancy, intangible realities suffered because they were not visible and concrete. But to-day they receive different treatment at the hand of those who support the present views. Man may not be able to prove that matter is spiritual, but he can prove that his ideas of the former have completely changed, and that along with that change has come a new attitude towards realities that do not conform to the older views of matter. The explanation of this change is well given in the following words:

> "Things, in short, are not what they seem; they are the seeming of a world invisible. Matter, let me repeat, used not to appear to require explanation. Now it does. It once seemed a refuge from mystery, but now it is itself manifestly a mystery. Minds which like a hard surface to dwell on stand dismayed.
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> Matter can no longer be regarded as a rival to any idea of an invisible world. On the contrary, it has become a window, or at least a feeler into the invisible."[1]

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1. Taylor, Does Science Leave Room for God?, pp. 32,33

This shift in viewpoint has had favorable results for religious values. They are now placed in a comfortable environment that will permit their growth and development. What the change implies for religion is clearly seen by Eddington who says:

> "Perhaps the most essential change is that we are no longer tempted to condemn the spiritual aspects of our nature as illusory because of their lack of concreteness. We have travelled far from the standpoint which identifies the real with the concrete."[1]

Science is no longer hostile to religious values; it does not condemn them because they lack the qualities which were formerly supposed to belong to matter. For matter itself has lost them and is almost on a plane with the intangibles of religion. Science has thus recently been brought more into sympathy with the data of religion because its own materials appear to be of such a similar character. It looks, therefore, like religion would have a better chance in the future to command a higher intellectual respect from all, including the patient scientific investigator. The scientist cannot deny the truth of spiritual entities without denying also the truth of those with which he works. Since he will not do this, he must entertain these other values on the same respectable footing as his own.

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1. Eddington, Science and the Unseen World, pp. 32, 33
   Cf. also Eddington, The Nature of the Physical World, p. 275

c) Scientific Knowledge of Matter Is Incomplete Without God

Deeper still than goes either of the questions, which have been asked and at least partially answered in this discussion of the religious significance of the new views of matter, is to be found the truth that present knowledge in the realm of physics is totally incomplete and devoid of meaning without the postulation of God behind it at every step. More so than at any previous time in the history of science has it now become necessary to admit the inadequacy of scientific description and explanation in the realm of matter without the aid of religion and God. This fact is especially patent in any review of the recent progress and development made in the scientific study of the atom.

A look at the phenomena of quanta and the symbolical character of present knowledge concerning them is sufficient to convince even the credulous that man's best efforts in recent years to fill in the gaps in his information about the world of matter have only proved disappointing. In fact, reality in this realm seems to be more elusive than ever. The symbols of science do not pretend to tpuch it, and the knowledge that man has of it is not conclusive or final.[1] Every attempt to lift it

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1. Cf. Kirk, Stars, Atoms, and God, p. 52

into the sphere of the known with the aid of man's coarse net of language has failed as surely as does an effort to raise water in a leaky bucket.

And when the interior of the atom is reached any hope of reaching bed-rock truth is still more remote. So impenetrable has this nucleus proved to be that the scientist has referred to it as the "jungle", the "darkest Africa of matter", the "No Man's Land of science".[1] New discoveries are being made all the time in this heart of matter which only seem to make its true character more bewildering. Until recently it was thought that the constituents of it were very few, but increasing penetration of this area which obstinately opposes every intrusion reveals increasing complexity of its structure. Professor A. H. Compton, who has painted one of the newest models of the atom, now estimates the number of possible elements in the vastness of this interior to be as many as eight.[2] And more may still be found, because the end of the treasure-hunt has not been reached; the trail into the heart of this unexplored kingdom is yet being blazed. But as the quest continues, it appears to be more exacting in its demands of the one who would attempt to reach its ultimate end. He cannot go alone; he must take God with

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1. Cf. New York Times, June 19, 1933, Article by William L. Lawrence
2. Cf. Ibid., loc. cit.

him as his Comrade in the search. Religion must most assuredly be his first aid. This is what Eddington virtually declares when he says:

> "I think we may say that, although the physicist has carried his work to greater perfection than formerly, he now puts it in a form which does not hide its incompleteness. Implicitly, if not explicitly, he advertises for someone to complete it."[1]

Even if the scientist were not being halted in his endeavor to complete his knowledge of the large-scale phenomena of the universe, there is clear evidence that he is being checked in the infinitesimal world of the atom. It is common experience now for the laymen to hear the scholar pleading ignorance in this realm when he works unaided by religion. Innumerable times his feelings must duplicate those of one who said, "Give me an electron and I can explain the world, but to explain an electron I need God."[2] This confession only betrays the rapid increase of imponderable facts in this region which make religion more and more indispensable. As science goes deeper into the atom, it discovers that the atom goes correspondingly deeper into the heart of reality. Its faith, therefore, draws nearer and nearer to that of the poet who said:

> "Flower in the crannied wall,
> I pluck you out of the crannies;
> I hold you here, root and all, in my hand,
> Little flower—but _if_ I could understand

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1. Science and Religion, Article by Eddington, p. 122
2. Class Notes in Philosophy of Education under Dr. H. H. Horne

What you are, root and all, and all in all,
I should know what God and man is."[1]

3. The Religious Significance of the New Views of Mind

a) Spiritual Values Are More Fundamental Than Material Ones

According to modern physical thought, the mind occupies an exalted position in the world. It has been freed from slavish bondage to matter and has been assigned the duty and privilege of giving meaning to the symbols of the physical world with which the scientist works. In fact, scientific opinion appears to be crystallizing into the firm belief that mind lies behind the whole of the physical world and is the key to its interpretation.[2] This view of mind lends further support to one of the implications drawn from a study of matter,—namely, that spiritual values are as real as the material. One may also say that, if mind undergirds the whole of the physical world, these values are more real than matter which was once thought to possess an unquestioned reality because it could be seen and felt. The conception of mind in the present is bringing the intangibles into their own. They seem upon the basis of the current view to be at the heart of things, because they are associated so closely with mind. It is mind, "the first and most

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1. Tennyson, Flower in the Crannied Wall
2. Cf. Eddington, Science and the Unseen World, p. 36

direct thing in our experience."[1] and that which also lies behind all phenomena, that has brought these values to the fore. If the one is given a regal status, its attendants must also be promoted to the place where they are recognized as having greater authority for life.

b) Personality Must Dominate the Unseen

In giving meaning to the symbols of science mind has been called into service as their only able interpreter. But mind is associated in man's experience with personality. It cannot be divorced from it in thought. If, then, mind alone can link together these symbols in intelligent fashion, and the symbols, in turn, have any application whatsoever to the nature of the world of matter and not merely to the mind of the dreamer, it seems necessary to think of personality being behind the physical world, and, therefore, of man's relationship to the universe as being a personal relationship. Since in man's experience only personality can communicate intelligently with its like, it is reasonable to conclude that in order for man to read God's thoughts, objectified in the material world, their Author must be no less than man who is a personality. In other words, if the mathematician is justified at all in constructing the world of science out of his symbols, then the religionist is likewise scientifically authorized to

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1. Eddington, Science and the Unseen World, p. 37

build the larger world of the spirit out of symbols of his realm which together make up the personality.[1]

4. The Significance of the New View of the Relation of Mind and Matter: More Respect for the Body

It may seem that with regard to the current views of the relations of mind and matter no religious significance is involved which has not already been mentioned. But in the case of the theory of interactionism, or in the view of psychophysical organism, the close relation of body and mind lend new significance to the regard which must be paid to the body. Little respect was had for it in a large part of the history of the human race, but to-day its value for the proper kind of interaction, or for the right functioning of the human organism has been enhanced. There is need of caring for it religiously in the true sense of that word. Matter influences mind, in spite of some religious philosophies to the contrary, and mind influences matter. The exertion of the right kind of influences in either direction cannot be possible if the medium by which these influences are conveyed is less efficient than it was meant to be. Not only is the material body of man the temple of the living God,[2] but it is also the temple of the normal human life. As such

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1. Cf. Eddington, Science and the Unseen World, pp.82-83
2. II Corinthians 6:16

it should be cared for like the soul. The union of the material and the spiritual in human life is indeed a sacred union that involves a sacred trust.

5. The Religious Implications of Indeterminism

a) Explanatory Statement

Much of what is involved in the new scientific views in the last part of the present chapter is so closely related to a later chapter on man and the new conceptions that it seems advisable to defer these considerations until the proper time for their unfolding under that caption. Only one or two general thoughts, therefore, which might escape notice then, will be briefly mentioned in these concluding remarks.

b) A Directive Intelligence of the Universe

The new view of indeterminacy that has destroyed determinism and taken away the strict uniformity of the old physical theory has not at the same time given us chaos. As Kirk has well expressed it:

> "I do not believe that the alternative to the classical doctrine of rigid determinism is abandonment of faith in either the reality or the rational control of the universe."[1]

Rather has the current view cleared the way for a belief on scientific grounds in a "directive intelligence" that holds these atoms in their courses yet gives to them an

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1. Kirk, Stars, Atoms, and God, p. 55

individual freedom of action.[1] Kirk has spoken discerningly on this point also when he said:

> "The direction science is now taking is to find this unifying principle in a mental conception of the universe, in terms of a Governing Personality, something like our finite selves, to which we are akin and in whose supreme will we find the justification of our being and the interpretation of our earthly experience."[2]

This belief must be postulated behind such a theory as the principle of indeterminacy if the world is not to be regarded as a topsy-turvy place. We must have some kind of direction to take the place of the old mechanical scheme of determinism, else the universe becomes a game of chance on a colossal scale and the old dependableness of nature in which science has boasted becomes nothing but a myth in the past.

c) Belief in Possibility and Becoming

But when allowance has been made for this fact, according to the current scientific theory that has undermined the mechanistic philosophy of the past, events need not be so stereotyped as was once thought. Since an element of contingency has entered in, which is due to the place given to mind in the new scheme, possibilities have also come with it. One can now talk of becoming which was meaningless in the old system of thought.[3] There is

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1. Cf. New York Times, March 7, 1931, Report of words of A. H. Compton. Reference cited on authority of Buttrick, Jesus Came Preaching, pp. 37-38
2. Kirk, Stars, Atoms, and God, p. 69
3. Cf. Reichenbach, Atom and Cosmos, pp. 279-280

also permitted in the world a capacity to make it in some small degree different from what it was before,[1] for the mental processes which are operating in the world are not those alone of the Superior Mind, but also those of His creatures. Whatever chance may rightly be said to inhere in this situation, it is certainly not blind, but reasoned, since it bears a definite relation to purposive activity. Moral significances, in other words, and with them moral responsibility, have made their appearance to lend color to life and to give to it an enriched meaning. Of these things more will be said later. Suffice it here to say as a last word that the new theories have broken the shell of that materialistic philosophy that was determined to keep man in a moral condition worse than that of untested innocency and not to let him become what it was purposed that he should become. Such a change can only eventuate in good.

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1. Cf. Jeans, The Mysterious Universe, p. 131

Chapter IV

THE SCIENTIFIC VIEW OF THE MACROCOSM

A. Introduction

1. A Résumé of the Outstanding Facts in the New Views of Matter

The previous chapter was concerned chiefly with the strange events taking place in the depths of matter. It pictured a microscopic world teeming with a kind of activity that until recent years was entirely unknown to the realm of material substance. The discovery of this apparently lawless phenomenon has put a new face upon matter and has given sanction to a new interpretation of the way in which the heart of the world works. Old schemes, in consequence, have been practically discarded for views of nature that leave room for freedom, for morality and for religion. The higher values of life have been elevated to a new position because of the welcome which they have received at the hands of those who now see that the facts of science cannot be completely satisfying while remaining separate from the other facts of life that are just as valid as their own and are needed to give them meaning.

2. The Outlook of the Present Chapter

From this inward look at strange things locked up in the infinitesimally small world at man's front door, the present chapter now turns attention to the bewildering sights in the cosmic depths of space and to the meaning of reflective thought on the stunning magnitudes of distances encompassed in the picture. It is even concerned with the efforts which have recently been made on the part of scientists to see this picture as a whole. This transfer of one's thought from the study of the atomic world, almost within reach of the hand, to an examination of objects, many of which lie far beyond the Milky Way, and whose distances are estimated in millions of light-years,[1] seems no easy shift to the ordinary mind. But, in reality, the world of stellar distances and the invisible world of protons and electrons are closely related in the thought of the investigator of nature's secrets. As Jeans has put it, "The infinitely great is never very far from the infinitely small in science."[2] So close are they, in

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1. The Milky Way, which is sometimes called the Galactic System, is the name given to the bun-shaped star-system of which our solar system is but the smallest fragment. About 1500 million stars have been revealed thus far in this corner of the universe by the present telescopes. (Cf. Jeans, The Stars in Their Courses, p. 104) The nearest of these, Proxima Centauri in the Southern Hemisphere, is about 25,000,000 million miles away, or approximately 270,000 times as far as the sun, which is about 92,900,000 miles distant. (Cf. Ibid., pp. 7,8,20) Beyond the Milky Way are other systems much like it, or in the process of becoming like it, which are called nebulae, or extra-galactic systems. Recent estimates, as has been shown, place the number of these now within range of the telescope at 75,000,000, which are on an average of 650,000 light-years apart. (Cf. New York Times, January 13, 1934)
2. Jeans, Eos, p. 31

fact, that each has made vital contributions to the solution of the other's problems and of those which concern the cosmos as a whole.

B. The View of Space

1. The Prevailing Views of Space Preceding Einstein

a) Their Common Euclidean Character

In viewing the outer world one of the first problems to be faced is that of the nature of space. This question has troubled the mind of man from very early times; but only the chief modern answers can even be briefly mentioned in this cursory attempt to sketch a background for the more recent views of astrophysical thought, since the paramount interest of this investigation lies in the new concepts and not in the past views. Concerning all of these former interpretations, however, it may be said in general that they are based upon Euclidean[1] geometry and Euclidean conceptions of space which were obtained directly from observed phenomena.[2] According to this

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1. Euclid, from which the adjective is derived, is the name of a famous mathematician who lived and taught in Alexandria during the reign of the first Ptolemy (B.C. 305-285). His most celebrated work was the Elements of Geometry, in thirteen books, to which two were subsequently added. The first six of these are still used in schools in spite of their defective arrangement. Since some of the propositions were known before Euclid's time, it is difficult to say what proportion of the work was wholly original with him.
2. Cf. Dampier, A History of Science, p. 45

ancient viewpoint, space was flat[1] and was measured by the customary three dimensions, since no others were then thought conceivable. It was also looked upon as infinite in extent.[2]

b) Their Metaphysical Differences

(1) The Newtonian Conception

The conception of Newton coincided well with these general ideas of space. To him space was boundless and flat, stretching indefinitely beyond the farthest star.[3] But Newton differed from some of the later views regarding the very nature of the concept itself. It was his belief that space existed in and of itself, independent of the mind which apprehended it and of the objects which existed in it.[4] In other words, his view was saturated with a genuine realism. These things to him were what they were because of their own intrinsic character.

(2) The Views of Leibnitz and Berkeley

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1. Cf. Jeans, The New Background of Science, p. 119
   Since Euclid in this passage is said to have believed that light traveled in straight lines, and to have defined a straight line as the shortest distance between two points, it can be inferred that he looked upon space as not curved but flat.
   Cf. also Eddington, The Expanding Universe, p. 53
2. Cf. Barnes, Scientific Theory and Religion, p. 44. The statement of Barnes to the effect that Euclid tacitly assumed that a straight line could be of infinite length implies that Euclid also looked upon space as infinite in order to make possible such a conception of the line.
3. Cf. Dampier, A History of Science, pp. 443, 482
4. Cf. Ibid., pp. 152, 211
   Cf. also Barnes, op. cit., p. 191

While the theory of Leibnitz also concurred with the distinguishing features of the older view, it, too, had some novel characteristics. These were due primarily to the particular view of knowledge, held by Leibnitz, which rested on a theory of monads that looked upon the entire life as developing from within by the laws of its own nature. In this view even sensations were regarded as innate.[1] Accordingly, Leibnitz interpreted even space as an empirical concept which is abstracted from man's sense-perceptions of the relations existing between real things.[2] Instead, therefore, of being an objective conception of space like that of Newton, this view of the philosopher turns out practically to be a subjective view identical with the concepts of the mind.

Leibnitz differed, however, from Berkeley, who was of the next generation after him, in holding that space "was constituted by the objective order of 'things in themselves'".[3] Berkeley's view of space was similar to that of Leibnitz with the exception of the difference which has been pointed out. Barnes feels that he was the first modern philosopher who can really be said to have challenged belief in the external reality of space. He

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1. Cf. Rogers, A Student's History of Philosophy, pp. 306-311, 319-321
   Cf. also Weber and Perry, History of Philosophy, pp. 294-295
2. Cf. Dampier, A History of Science, p. 211
3. Barnes, Scientific Theory and Religion, p. 560

regarded it as being merely the subjective result of sensations of sight, touch and movement. Absolute space he looked upon as a "mere nothing".[1]

(3) The Theory of Kant

The last of the former views to be mentioned here is that of Kant which, it has been said, "dominated metaphysics until the advent of the theory of relativity."[2] Speaking of its individual character, however, it, also, is in harmony with the older conception of an infinite space.[3] Dampier seems to think that Kant held a middle position between that of Newton and Leibnitz, refusing to classify space with either the data of bodily senses or the concepts of the understanding.[4] Jeans, in contrast to this explanation, appears to hold the view that Kant's theory of space is wholly subjective. He quotes with approval the following interpretations of the Kantian position on this subject:

> "(1) The notion of Space cannot be derived from external experience; because, in order that I may apprehend things as out of me and out of each other, I must have the notion of Space already in my mind;
> (2) the notion of Space is a necessary, a priori one; for I cannot imagine Space annihilated, though I can very well think it emptied of objects."[5]

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1. Cf. Barnes, Scientific Theory and Religion, p. 560
2. Jeans, The New Background of Science, p. 96
3. Cf. Whitney and Fogel, An Introduction to Kant's Critical Philosophy, p. 28
4. Cf. Dampier, A History of Science, p. 211
5. Jeans, The New Background of Science, p. 97, quoted from Sidgwick, The Philosophy of Kant, p. 38

The majority of the commentators would seem to support this latter opinion. Space, according to Kant, is to be looked upon as an intuition a priori which is not empirical.[1] His own statement of his views is as follows:

> "1. Space is not an empirical concept which has been derived from external experience. For in order that certain sensations should be referred to something outside myself, . . . the representation of space must be already there. Therefore the representation of space cannot be borrowed through experience from relations of external phenomena, but, on the contrary, this external experience becomes possible only by means of the representation of space.
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> 2. Space is a necessary representation a priori forming the very foundation of all external intuitions. It is impossible to imagine that there should be no space, though one might very well imagine that there should be space without objects to fill it. Space is therefore regarded as a condition of the possibility of phenomena, not as a determination produced by them; it is a representation a priori which necessarily precedes all external phenomena."[2]

From this it is clear, as Snowden has pointed out,[3] that Kant's theory of space is subjective. It is consonant with his view of knowledge in which the categories of the mind are supposed to give form to all the material of ideas which enters through the senses.[4] But while Kant's view of space is subjective, it differs from that of Berkeley in considering geometrical axioms to be antecedent to all experience.

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1. Cf. Whitney and Fogel, An Introduction to Kant's Critical Philosophy, p. 28
2. Snowden, The World A Spiritual System, pp. 58-59, quoted from Müller's translation of Kant's Critique of Pure Reason, pp. 18-19
3. Cf. Ibid., p. 58
4. Cf. Weber and Perry, History of Philosophy, p. 353

There is something to be said, however, for the contention of Dampier that Kant's position is a mediating one between Newton and Leibnitz. The great philosopher does not say that something corresponding to the conception of space in the mind may not exist in the objective world. In fact, he admits that this conception of space is built from the material with which the senses furnish the mind. In order that these sensations may be produced there must be an objective world which makes them possible. But with regard to the "things in themselves" that constitute that world he differed from Leibnitz only in saying that no knowledge of them is possible. Therefore, Kant's view, in some remote sense may be said to be both subjective and objective, with the emphasis on the former.

2. The Conception of Space Inherent in the Theory of Relativity

a) Introductory Remarks

Though this view of Kant regarding space has prevailed in the world of thought until the present day, another conception, non-Euclidean in character, has been known to mathematicians for over a century. It is only in recent years that the principles of geometry lying behind it have come to be acceptable to physicians.[1] These principles are associated in their development with a nota-

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1. Cf. Heyl, New Frontiers of Physics, p. 85

ble group of names, including those of Lobatchevsky, Gauss and Riemann. It was the contribution of the latter to this subject which laid the foundations for some of the strange physical developments of the present century.[1] Among the new views advanced by Riemann, not the least important in its consequences was the conception that space is finite and curved.[2] These ideas, chiefly through the work of Einstein since 1905 in the field of relativity,[3] have been taken up into the recent views of space which are entertained by modern astrophysics, and which are now to form the subject of investigation.

b) Principles Underlying the New Views of Space

(1) The Philosophical Difficulty of the Infinite

In considering the new positions it is helpful to know what have been the chief reasons leading to their formulation. The motivation of a change in view is often very enlightening. In the present instance it is quite evident that the difficulty of thinking of an infinite universe has been an incentive to the theoretical scientist to attempt the construction of some other picture more satisfactory because it could more easily be comprehended. As Eddington has expressed it, "Infinite space cannot be conceived by anybody . . ."[4] Barnes, in contemplating

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1. Cf. Heyl, New Frontiers of Physics, p. 85
2. Cf. Barnes, Scientific Theory and Religion, pp. 96-97
3. Dampier, A History of Science, pp. 419-420
4. Eddington, The Nature of the Physical World, p. 80

the conceptions, pours contempt upon it by referring to it as an "absurd idea" and as a "scandal to human thought".[1] His reason for this attitude is clearly explained in the following words: "If God's Universe is finite, we can hope to begin to understand the range of His activity: if it is infinite any such hope must be abandoned."[2] That this is the generally accepted basis for the new theories, is deducible from the fact that the author of this statement identifies himself with the scientific group when he makes this explanation.

If this difficulty is looked at through the eyes of the scientist, it can be most fairly appreciated. Jeans has undertaken to point out by means of a bit of explanation and historical retrospect the dilemma which is involved for science in the supposition of the infinite. His case runs as follows:

> "If matter extended through unlimited space, there would be an infinite amount of it exerting its attraction on planets, stars and galaxies, and this would cause them to move at speeds far greater than those actually observed—at infinite speeds, in fact. The only escape would be by supposing that there was only a finite amount of matter, and as this could only occupy a finite amount of space, it left an infinite amount of space entirely devoid of matter. Such a concept could not be disproved as being in any way ridiculous or impossible, but it was certainly not convincing by its inherent reasonableness. Kant had dismissed it on the grounds that an infinite space would contain nothing by

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1. Barnes, Scientific Theory and Religion, pp. 2, 97, 392
2. Ibid., p. 49

> which to locate the position of a finite material world. If the question 'Where is the finite matter in infinite space?' admitted of no answer, then there could not, according to Kant, be finite matter in infinite space."[1]

(2) The Supposed Unjustifiableness of Belief in Infinite Space

(a) Infinite Space Undiscovered as Yet by Science

The philosophical difficulty of conceiving the infinite has not been the only inducement to develop a new viewpoint with reference to the cosmos; science itself has issued a manifesto in its own name in favor of a change. Very frankly has it said that the facts do not warrant a belief in an infinite world. On this point Barnes says:

> "If absolute space, the vast tenement-house of our imagination, exists, we have failed to discover it. There may or there may not, be an 'ether' filling all space . . . but it is certain that, if an ether exists, we have failed to determine the motion of matter relative to it."[2]

It is evident that this failure to find infinite space rests upon the recent assumption of science to the effect that space cannot exist without objects to fill it, whereas the former view of Kant, Newton and then Descartes rested upon the belief that objects cannot exist without space.[3] Once this new theory is accepted, no space of infinite extent can then be postulated until some universal substance like an ether is scientifically known to

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1. Jeans, The New Background of Science, pp. 128-129
2. Barnes, Scientific Theory and Religion, p. 100
3. Cf. Ibid., pp. 183-184

occupy it. But since the latter fact is not demonstrated, science pronounces against the absolute character of the space supposed to contain it.[1]

(b) Infinite Space Opposed to the Recent Theory of Cosmic Ray Origin

A universe of unending extent also necessitates a belief that radiation from the stars is gradually being lost in the depths of space and completely dissipated. But if the cosmos were looked upon as a finite region, this radiation would never get so far away that it could not be returned to us in some way. It would still be possible to speculate upon the origin of matter in the depths of interstellar space in compensation for the loss of matter through radiation or annihilation in the stars. This would permit a two way process which, some scientists seem to believe, makes a strong appeal to reason by preventing hopelessness.[2]

c) The Essential Features of the New Theory of Space

(1) Space Viewed as Finite and Unbounded

From an examination of the new conception of the cosmos which has gained increasing favor in recent years, the first impression gained is the emphasis which it places upon the finiteness of the world. In comparing

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1. Cf. Jeans, The New Background of Science, p. 97
2. Cf. Barnes, Scientific Theory and Religion, pp. 183-184

the merits of the new position with those of the old one, Eddington attempts to give a reasonable presentation of this view as follows:

> "Prior to the relativity theory the orthodox view was that space is infinite. No one can conceive infinite space; we had to be content to admit in the physical world an inconceivable conception—disquieting but not necessarily illogical. Einstein's theory now offers a way out of the dilemma. Is space infinite, or does it come to an end? Neither. Space is finite but it has no end; 'finite but unbounded' is the usual phrase.
> Infinite space cannot be conceived by anybody; finite but unbounded space is difficult to conceive but not impossible."[1]

In his latest book the same author gives an even clearer explanation in this extract:

> "The whole area of the earth's surface is finite, and so too the whole volume of spherical space is finite. It is finite but unbounded; we never come to a boundary, but owing to the re-entrant property we can never be more than a limited distance away from our starting-point."[2]

It will be readily seen from a careful comparison of these statements that the new hypothesis, while championing a finite outlook on the world, at the same time studiously seeks to remove all ideas of boundaries to the finite. Thus do the theorists seek to make the concept a self-contained picture that does not require a further background to complete it.

(2) Space Viewed as Curved

(a) A General Picture of Curved Space

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1. Eddington, The Nature of the Physical World, p. 80
2. Eddington, The Expanding Universe, p. 50

The preceding view of space as limited in extent has necessarily involved a second characteristic of curvature to make the hypothesis tenable. So intimately is this idea bound up with the first that, in order to explain the one, the other must be introduced. This finite space, according to the new view is, therefore, to be looked upon as curved and, consequently, as capable of being 'girdled' with thought, if not with any known physical means. Jeans explains the view in very familiar terms when he says:

> "We are beginning to think of the universe as Columbus, and after him Magellan and Drake, thought of the earth—something enormously big, but nevertheless not infintely big; something whose limits we can fix; somthing capable of being imagined and studied as a single complete whole; something capable of being circumnavigated if you like . . .
>
> Scientists now believe that if we could travel straight on through space for long enough, we should also come back to our starting-point; we should have travelled round the universe."[1]

In seeking to answer a criticism that a finite space would eventually lead in thought to the edge of nowhere, the same writer remarks:

> "if we travel on in a straight line over the surface of the earth, we never come to anything which is not the surface of the earth. Space is like that; we can never pass from space to something which is not space."[2]

The view is calculated to end thinking about a beyond by imprisoning man in the envelope of space and never

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1. Jeans, The Stars in Their Courses, pp. 128-129
2. Ibid., p. 131

permitting him to get outside of it even in thought. Such a universe is rightly called a self-contained unit.

(b) The Scientific Explanation of Curvature in Space

An earnest attempt has been made to give this theory of curved space strong scientific support. Fundamentally, the view is based upon the belief of science that the material content of space is nothing but the sign of acute warpings in space-time.[1] That matter is such an agency, is inferred from the phenomenon of the curving of light-rays which is observed at a solar eclipse, and from the curvature which is traced in the paths of planets and comets. These occurrences used to be attributed to the gravitational pull of matter, but are now believed to be the direct result of the bending of space by the material bodies which occupy it. According to this theory, a universe, totally empty of matter, would have no curved space because there would be nothing to produce it. Its size would, therefore, be infinite. But since the universe is not empty, its size is determined by the quantity of matter it contains. The larger the amount of matter, the more sharply will space be bent back upon itself and the smaller, in consequence, will be its circumference.[2]

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1. Cf. Barnes, Scientific Theory and Religion, pp. 191-591
2. Cf. Jeans, The Mysterious Universe, p. 72

Thus the presence of material substance in the cosmos is made to serve two purposes instead of one in the new thought of science. It accounts scientifically for the facts formerly explained by gravitation, and it closes up the universe so that there is no need to face an infinite expanse outside the world in which one lives.

(3) Space Viewed as Expanding

(a) The Prevailing View

1) A Figurative Representation

While it is not extremely difficult to see the relation in thought of the theory of the curvature of space to that of its finiteness, one would never have suspected that these ideas in turn would be joined to a view of an expanding universe. But such has been the case in the new development of scientific thought. A recent theory that represents the cosmos as expanding like a soap-bubble has rapidly gained prominence. A Belgian mathematician named Lemaitre proposed it to show how Einstein's universe, as soon as it comes into existence, begins an indefinite expansion. As the process continues, the objects in the universe, like the particles of the bubble, grow further and further apart until the nebulae themselves are separated by an inconceivable gulf.[1] The only limit for such an expansion, if it can at all be said to have a boundary,

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1. Cf. Jeans, The Stars in Their Courses, p. 132

is, of course, infinity, which it approaches as the universe becomes more and more empty of matter.[1]

2) Its Compromising Origin

Preceding this view of Lemaitre there were two theories of the universe in the field which seemed to be in opposition to one another. In Einstein's earlier view the universe was thought to have "an inherent curvature, besides that produced by matter, of such a kind that its size would increase if the amount of matter increased."[2] This, of course, was contrary to the present belief that the more matter there is in the universe, the less space will be needed to hold it, because of the greater curvature.[3] Nevertheless, Einstein somehow, by a mathematical process not intelligible to the laymen, arrived at the conclusion that the universe is in a state of equilibrium and is without motion.[4]

But, on the other hand, de Sitter, while believing, like Einstein, in the curvature of the universe through the inherent properties of space and time, and through the presence of matter, looked upon the effect of the latter, because of its sparseness, as insignificant in comparison to the former. Accordingly, he came to a different con-

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1. Cf. Jeans, The Mysterious Universe, p. 73
2. Ibid., loc. cit.
3. Cf. Ibid., loc. cit.
4. Cf. Eddington, The Expanding Universe, p. 67

clusion by the application of mathematics to the problem. He held that there was a tendency for space to expand or contract, and for all the objects in it to drift apart or to rush towards one another. This seemed like an open contradiction of Einstein's view until Lemaitre came forward to show how the two concepts were complementary to one another. He showed how Einstein's universe was unstable and was expanding at a gradually increasing rate into the kind of universe pictured by de Sitter where the density of matter approaches zero. These two seemingly antagonistic views were thus revealed by Lemaitre to be the limits of possible universes, with many other models lying between them.[1]

3) Its Recent Scientific Confirmation

Recent scientific discoveries have tended to establish the theory more firmly in the minds of scholars. For some years it has been noted that the remote spiral nebulae appear to be rushing away from the earth, and presumably from one another, at terrific speeds which become greater as the distance increases. One of these nebulae, recently investigated at Mt. Wilson, was found to be receding at an approximate speed of 12,500 miles a second. Roughly speaking, it has been discovered at this same

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1. Cf. Jeans, The Mysterious Universe, p. 75
   Cf. also Eddington, The Expanding Universe, pp. 65-69

station that the speed of recession for the individual nebulae is proportioned to their distances from the earth. This fact is as it should be if the new cosmology of relativity is correct.[1]

(b) The New View of Einstein and de Sitter

However, this view is not the only one which has been put forth in late years. Dean Inge informs us, upon the authority of Professor Piazzio of Nottingham, that Einstein himself in 1931 abandoned this theory of a universe expanding to all eternity, substituting for it one in which there is alternate expansion and contraction. The Dean says that, if this be Einstein's settled view, it represents a revolutionary change of thought, which means a return to the old theory of cosmic cycles for which he has expressed a strong predilection.[2]

(c) The Latest Hypothesis

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1. Cf. Jeans, The Mysterious Universe, pp. 76-77
2. Cf. Inge, God and the Astronomers, p. 50
   Cf. also Snowden, The Discovery of God, p. 169 for confirmation of this statement.
   A reference in a recent scientific article in the New York Times to an identical view of de Sitter seems to indicate that the latter may have modified his own position until it accords with Einstein's newest conception. (Cf. New York Times, March 8, 1934) Certainly in de Sitter's former theory, according to the majority of the current explanations of it at least, there does not appear to be the possibility of both processes working at different times, (even though some have claimed this) but only that of one process or the other being pursued to a finish. But if this modification of view be correct, then the new hypothesis has the prestige of being sponsored by two great minds.

But the end of new cosmologies has not even been reached with Einstein's latest contribution to the subject. More recently still, Dr. Lemaitre and Dr. Shapley have jointly sponsored before a meeting of the National Academy of Sciences a view of the universe that does not see the whole of it expanding uniformly as a bubble. In this new hypothesis there are some spots in the cosmos where the two major forces of attraction and repulsion are balanced. These portions of the complete whole somehow defy the rest of it by remaining in a state of equilibrium, and break down, in consequence, the theory previously held to the effect that space, as Einstein said, is "eating up matter." When other parts of the universe seem to be in an explosive state, these stagnant spots, as Professor Shapley has called them, continue in a condition of quiescence that shows no sign of change. In addition to these strange patches of the sky, it is said that there are also other regions, distributed in the generally expanding space, which are literally collapsing while the opposite process is going on around them, or rather while they themselves, in this shrinking condition, are moving apart from one another at velocities proportional to the distance. While it is still admitted in this new view, that the major part of the universe is still expanding, these areas of collapse and equilibrium are said to be not insignificant parts of the universe. Lemaitre holds that they must be identified respectively with the extra-galactic nebulae and with the nebular clusters. According to this theory, too, the same collapsing process which forms the nebulae also produces the stars.[1]

d) The Mechanism of Its Defense against Criticism

(1) A General Explanation of It

Scientists who hold to the main features of the new view of space,—in particular, to the conception of its finiteness, have anticipated strong criticism of the hypothesis, and, accordingly, have sought to give it ample philosophical support. In endeavoring to obviate the seeming absurdities inherent in the latter idea, the scientific apologist says

> "we cannot attribute any reality to the space of the universe, except . . . as a mental concept; any attempt to assign a degree of reality different from this to space leads only to confusion and contradictions."[2]

Considering this troublesome difficulty in another connection, the same author says:

> "Space begins to appear merely as a fiction created by our own minds, an illegitimate extension to nature of a subjective concept which helps us to understand and describe the arrangement of objects as seen by us . ."[3]

Lest the critic's comprehension of the new scientific conception of space should be incomplete, Jeans outlines

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1. Cf. New York Times, November 21, 1933. Report by William Lawrence
2. Jeans, The New Background of Science, pp. 291-292
3. Ibid., p. 96

the chief objection to it from the standpoint of the impossibility of thinking of finite space without thinking of more beyond, and so on ad infinitum, and then makes the following reply:

> "The twentieth-century critics who make these comments are still in the state of mind of the nineteenth-century scientists; they take it for granted that the universe must admit of material representation. If we grant their premises, we must, I think, also grant their conclusion—that we are talking nonsense—for their logic is irrefutable. But modern science cannot possibly grant their conclusion; it insists on the finiteness of space at all costs. This of course means that we must deny the premises which our critics unknowingly assume. The universe cannot admit of material representation, and the reason, I think, is that it has become a mere mental concept."[1]

The previous remarks are evidently intended to accord well with the frequently expressed belief of this well-known scientist to the effect that "reality must have something of a mental nature about it."[2] If, therefore, one draws from these statements the intended conclusion, it is not surprising to hear this popular spokesman for the new view say, in answer to those who would create what seems, from the new view of science, to be an unnecessary problem, that "we need not puzzle over the finiteness of space; we feel no curiosity as to what lies beyond the four walls which bound our vision in a dream."[3]

(2) Its Wide Employment

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1. Jeans, The Mysterious Universe, p. 167
2. Jeans, The New Background of Science, p. 294
3. Jeans, The Mysterious Universe, p. 179

Such a subjective conception of space as that just presented has received a friendly welcome from many scientists and philosophers. Those most prominent to-day in the field of astrophysics have adopted it as their own view because it appears to them to put an end to innumerable questions which arise in any other attempted explanation. As Barnes has expressed it, "increasingly modern physicists accept Berkeley's conclusion that space is the subjective result of sensations of sight, touch and movement."[1] Many philosophers also are inclined to give the view hearty endorsement. Speaking for these, one has given the reason for this position when he says:

> "All our experiences of space are modes of sensation and thereby become involved in its subjectivity. We derive our ideas of space from the sensations of sight and touch and muscular effort. . .
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> . . . .
>
> Extension . . . is an experience occasioned in the mind by some reality whose nature at this point in our inquiry has not yet been reached. We do not experience objective space, but we spatialize subjective experience."[2]

Knudson undoubtedly shares this viewpoint also. Declaring that an ontological space would land us in hopeless difficulties, he proceeds to list the arguments against it and then to characterize space in a manner that is consonant with the recent position of science. His

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1. Barnes, Scientific Theory and Religion, p. 203
2. Snowden, The Discovery of God, pp. 61,62

discussion seems so pertinent to the recent scientific view of the subject, and is so well calculated to give it the philosophical support which it seeks, that it is fitting in concluding this presentation of the defense, in order to present the picture fairly, to quote his remarks in full. He says:

> "Such a conception of space (ontological) is inconsistent with our idea of reality as active, since space is not active and cannot be so conceived without being despatialized. It is inconsistent with the unity of the world-ground, since any being in a real space would be divisible. It is also inconsistent with the intellectual demand for an ultimate monism, since a real space alongside of the world-ground would involve a fundamental dualism. We reject, therefore, the metaphysical reality of space and hold that it is as phenomenal as the matter supposed to be contained in it. Apart from experience space has no existence. The spatial world is an effect in us and in thinking beings in general. We need a real space to see things in as little as we need a real space to dream things in. Both the reactions of the sensibility and the activities of the mind are spaceless, and it is these that give rise to the knowledge of space. Space, then, is simply the form of objective experience, and in and by itself is a bare abstraction. Without spatial objects there would be no space. Its phenomenality, therefore, is a corollary of the phenomenality of matter."1

3. Objections to the New Theory

a) Scientific Misgivings That Tend to Weaken It

(1) The Scientist's General Confession of Inadequate Knowledge of Space

From these statements explaining and defending the new view it must not be concluded, however, that there

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1. Knudson, The Philosophy of Personalism, pp. 234-235

are no objections or difficulties in the way of its wholehearted acceptance. Even the scientist himself, when he is not actually engaged in expounding the view, betrays unwittingly a certain distrust of his theoretical results. In discussing the curved continuum postulated by this theory, Jeans says that

> "it only tells us of the metrical properties of space, and nothing as to its essential nature . . . After 2,000 years of metaphysical discussion, the question stands much as Plato left it in the Timaeus (pp. 74,144); the growth of scientific knowledge has done little more than negative the speculations of subsequent philosophers. Of all external entities, perhaps space is the one whose essential nature is least likely to be understood by the human mind, since it is hardly probable that what is completely external to the mind, and without effect on the mind, will admit of being pictured in terms of familiar concepts inside the mind."[1]

(2) Objections to Questionable Scientific Facts about the Universe

(a) Infinite Space Not Yet Scientifically Disproved

Furthermore, in spite of all that has been said in behalf of a finite universe, the ardent advocates of the recent view admit by their own speculations that the new theory may have to be revised or even rejected in the future. But if it were an established scientific fact, based on ample knowledge, such forecasts of its possible, complete overturn would be unwarranted. Referring to the

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1. Jeans, The New Background of Science, p. 140

current status of knowledge about the universe, Jeans says:

> "The present situation may be perhaps summed up in the three statements:
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> (1) The earth is only one member of the sun's family.
> (2) The sun's family is only one member of the Galactic System.
> (3) The Galactic System is only one member of the system of star-cities in space.
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> This is the furthest that astronomy has travelled so far, but we may well wonder what the situation will be, say, a thousand years hence. Will the above three statements still suffice, or will they have been supplemented by more statements of the same kind? In other words, shall we find that the whole system of star-cities only forms one unit in a still vaster assembly, and this assembly perchance a mere unit in something vaster still?"[1]

The concluding portion of this statement, if it has any meaning at all, seems to be an admission that present knowledge of the cosmos is too inadequate for any theory about it to be dogmatically asserted as true, and that growing knowledge may necessitate the expansion of the present theory to take on infinite dimensions. If the boundaries of the universe, on the basis of present knowledge, are only tentative, it may be necessary as precise information grows, to push them back indefinitely. But such a theory is certainly a tacit concession that in reality we do not know scientifically how vast the totality of things may be. If the horizons enlarge as knowledge grows,--and we have only a finite knowledge of things at any time, it is seemingly reasonable to suppose that

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1. Jeans, The Stars in Their Courses, pp. 123-124

an infinite knowledge would reveal an infinite world.

(b) Interstellar Origin of Cosmic Rays, Said to Favor a Belief in a Finite World, Is Not Proved

An attempt to find the source of the cosmic ray has led some scientists to postulate the necessity of a finite, closed world for the formulation of any satisfying theory. If, they say, the world is open, then the vast majority of radiation is forever lost in the depths of space. But if this radiation goes out into a finite world self-contained, it is not lost, but remains within a definite volume of space and may some day return in one form or another. Consequently, the theory of Millikan, to the effect that these rays are produced in interstellar space by the formation of atomic nuclei from radiation dissipated by the stars,[1] has been seized upon by these men to support the new theory. But the difficulty with this argument for a finite universe is that it is based upon a precarious theory. In fact, Compton, writing after the extensive experiments which he conducted nearly two years ago in strategic places all over the world for the purpose of learning more about these mysterious rays, frankly declares that their origin is unknown.[2] So long as this

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1. Cf. New York Times, September 17, 1932, Article by Arthur H. Compton; also Ibid., April 30, 1933, Article by Waldemar Kaempffert
2. Cf. again New York Times, September 17, 1932

ignorance remains, no theory of a finite world can find scientific support from the actual phenomenon of the cosmic ray.

It is only fair to say, however, that a report of the recent remarks of this same author before the American Physical Society, in which he is said to have set forth the results of the study of cosmic rays in the stratosphere last summer by Settle and Fordney, indicates that he "now believes these rays really come from the remote parts of the cosmos" instead of from the distant parts of the envelope of air surrounding the earth.[1] Whether this be Professor Compton's actual statement, and if so, whether it be his settled opinion, is difficult to say. Even if this remark attributed to him be correct, it does no more than reveal the unsettled state of scientific thought with regard to this mysterious ray. Again, therefore, it may be said that so long as uncertainty regarding its origin obtains, it is not safe to make it the ally of any theory. Before it can be attached to any world view as a vital aid to its acceptance, its own birthplace must first be reasonably established. But if it should be satisfactorily demonstrated that the source of these rays is located in the depths of interstellar space, it is

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1. Cf. New York Times, February 25, 1934, Article by Waldemar Kaempffert

difficult to see even then how this fact would necessitate a closed universe. On the theory of an infinite space surrounding the universe, enough radiation from the stars of the galactic system, as well as from the distant nebulae, might perhaps fall within the area of the Milky Way and the adjacent regions of space to make possible the amount of cosmic rays reaching the earth. Certainly no scientist can measure with sufficient accuracy the amount of this radiation pouring in from all possible sources out in space to say whether or not this is an utter impossibility. To attempt to do so at this stage of knowledge would be presumptuous, to say the least.

(c) A Finite Universe, Required for the Retention of Heat, Cannot Be Proved To Be Helpful

Certain scientists also have feared lest a wide-open universe cause the loss of heat by its escape into the infinite distances and eventually bring about a heat-death in the regions where matter exists.[1] But some of those who advocate the new theory of a finite world have continued to maintain at the same time that the universe is slowly dying and approaching a condition in which all substance in it will be at a uniform temperature.[2] If all the matter contained in the present world should

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1. Cf. Barnes, Scientific Theory and Religion, p. 184
2. Cf. Jeans, The Mysterious Universe, p. 15. Further discussion of this theory will be found in the latter part of this chapter.

finally be dissolved completely into radiation, they have estimated that the temperature of space in the whole of this confined universe would not be raised more than eleven degrees above absolute zero, so vast is the area surrounding the heavenly bodies which would have to be heated.[1] This slight change in the temperature of the universe is too little to warrant closing in space in order to conserve the radiation.

Furthermore, it is well known that the temperature of the earth is determined largely by the heat and light which it receives from the sun, the radiation from all other stars and distant objects of the sky affecting it very little. It has been said that if the rest of the universe, apart from the sun, were suddenly to be melted into radiation, the temperature of the earth would be raised such a small fractional part of a degree that the change would be unappreciable.[2] On the strength of these facts, then, it would seem to make little difference, so far as living conditions upon the earth are concerned, whether the universe were self-contained or open on all sides. And any argument for a finite world, on the basis of the necessity for retaining its heat, fails to make a reasonable appeal because the facts in support of it are

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1. Cf. Jeans, Eos, p. 48
2. Cf. Ibid., p. 49

not compelling.

(d) The Curvature of the Universe Not Scientifically Demonstrated

In order to distinguish different kinds of space, it is necessary to study very large triangles and rays of light coming from vast distances. Consequently, the work of demonstrating the actual curvature of space belongs to astronomy.[1] But thus far this science has been unable to prove experimentally what has been assumed theoretically for the purpose of completing a new conception of the world that attempts to remove embarrassing questions about what lies beyond it. The lack of any genuine factual support for this theory, in the results of the scientific efforts to this end, is frankly revealed by de Sitter who says:

> "Even the most refined astronomical observations, however, fail to show any trace of curvature. The triangles that we can measure are not large enough, and, I fear, never will be large enough, to detect the curvature."[2]

When these facts are carefully taken into consideration, along with this author's further categorical statement that "we shall never be able to say anything about the curvature without introducing certain hypotheses",[3] it becomes clear that the scientific undergirding of this

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1. Cf. de Sitter, Kosmos, p. 118
2. Ibid., loc. cit.
3. Ibid., loc. cit.

new world is as yet very meagre. The whole concept may prove to be top-heavy when more facts come to light.

(e) The Facts Used to Support the Theory of an Expanding Universe May Be Explained in Other Ways

It has already been pointed out that the view of an expanding universe is principally dependent upon the evidence of the reddening of spectral lines, produced by distant objects in the sky, which is interpreted to mean that remote heavenly bodies are receding at high speeds from the earth and also from one another. The authority for this interpretation of the spectral lines is the well-known Doppler principle which declares that light emitted by a body receding from the earth is redder than that emitted by a body approaching it. The only reason, therefore, for concluding that the distant nebulae are receding from earth is, that their light appears redder in the spectrum than scientific calculations would seem to justify.[1] From this phenomenon of light, explained in terms of receding objects at vast distances from this quarter of the universe, it has become easy to infer that the cosmos is expanding. Hence has arisen the new theory.

But these facts employed to uphold the conception of an expanding universe are capable of an interpretation

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1. Cf. Jeans, The Mysterious Universe, p. 78

which does not sustain the recent hypothesis. As Jeans has said, other things than receding nebulae can produce the reddening of light. The sun's weight and the pressure of its atmosphere may cause sunlight to take on this appearance. Even the passage of this light through the earth's atmosphere may produce the same effect. Dr. Zwicky of the California Institute has further suggested that the reddening may be due to the gravitational pull of stars and nebulae on light passing close to them on its way to the earth. Compton has shown that radiation is deflected and reddened when it encounters electrons in space.[1] From de Sitter also has come a suggestion that light loses energy as it gets older and reddens with age as it continues to travel through space.[2] Jeans claims that, according to the theory of the universe which de Sitter holds, distance alone produces this mysterious effect upon light.[3]

There is other evidence, too, which suggests the spurious character of the observed recession of nebulae. Some of these nearest objects, for instance, produce a light bluer than normal, which so far as is known, can be caused only by some approaching body. This fact has been understood to mean that the nebulae closest to earth are

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1. Cf. Jeans, The Mysterious Universe, pp. 78-79
2. Cf. de Sitter, Kosmos, p. 132
3. Cf. Jeans, op. cit., p. 79

coming towards it. Furthermore, the apparent speeds of these nebulae, which are not always proportional to their distances, present a disturbing problem to those holding the new view of an enlarging universe. Both these observations, especially the former, seem to militate against the truthfulness of the new theory as a whole.[1]

These facts, nevertheless, do not hinder Jeans from holding to the conception of an expanding universe. His reason for continuance in his belief seems to be as follows:

> "if the universe is built in the way we have described, the nebulae as a whole must undoubtedly be running away from us; theoretical considerations demand this and cannot be satisfied with anything less, but they do not tell us the speeds of the nebular motions."[2]

He does admit, however, in discussing this matter, that most of the reddening may be due to the effect suggested by Zwicky, or to other causes, while very little may be the result of the motion of recession. This concession, as well as the reason actually given in the face of these facts for claiming partial support of the new hypothesis by the Doppler effect, seems to weaken the position considerably. In appraising the importance of this phenomenon, therefore, for sustaining any theory, it is easy, in the light of this uncertainty and hesitancy, to understand the greater modesty of de Sitter when he says:

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1. Cf. Jeans, The Mysterious Universe, p. 80
2. Jeans, Ibid., pp. 80-81

> "In fact, all that the observations tell us is that light coming from great distances--and which therefore has been a long time under way--is redder when it arrives than when it left its source."1

This statement makes clear that the numerous possibilities of interpretation for the known fact only produce embarrassment for the theorist and make his argument precarious when it is based upon an observation whose explanation is in dispute.

But a very recent interpretation of this shift towards the red in the lines of the spectra from distant nebulae would abolish entirely the theory of the expanding universe. Dr. I. P. Wold of Union College, speaking a short time ago before a joint meeting of the American Physical Society and the Optical Society of America at Columbia University, put forth the view that this phenomenon could best be interpreted on the assumption that the velocity of light is retarded as it travels continuously through space. If this decrease in speed were to amount to 5.72 ten-billionths of its velocity per year, he declared, the result would be sufficient to produce the observed shift towards the red in the spectrum. In other words, the new theory, instead of finding in this shift in the lines of the spectrum a confirmation of the hypothesis of an expanding world, interprets it merely as evidence that light in its travels

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1. de Sitter, Kosmos, p. 132

has become "tired" and has slowed down its pace somewhat.[1] Such theorizing as this shows that the possibilities of explanation have not yet been exhausted and that an entirely new interpretation of this strange fact may be on the road to acceptance among scholars. At any rate, it can be said that certainly not all the hypotheses that are extracted from the Doppler effect are in any wise sympathetic to the theory of a universe that is enlarging.

(3) The Present State of Cosmology

A final cause of scientific misgiving with regard to the new theory of the universe is the seemingly tentative character of present cosmological views. The hypotheses of even the great scientists in these matters are often confusing and even conflicting. Thus far there seems to be no established order in this field of thought. The current state of opinion regarding all cosmic problems appears to be one of restlessness. This unsettled condition of the present mental attitude towards these great questions is well described by de Sitter in the following passage:

> "Our conception of the structure of the universe bears all the marks of a transitory structure. Our theories are decidedly in a state of continuous, and just now very rapid, evolution. It is not possible to predict how long our present views and interpretations will remain unaltered and how soon they will have to be replaced by perhaps very different ones, based on new

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1. Cf. New York Times, February 24, 1934

observational data and new critical insight in their connection with other data."[1]

Such being the case, the scientific views cannot be taken too seriously. What is accepted as true to-day may be in the discard to-morrow. Science is only feeling its way and in many cases it may temporarily be on the wrong track. It behooves the laymen in these matters to tread warily and not to accept everything that appears in print, as though it were fully established even in the minds of scientists. In the face of these facts a healthy restraint needs to be exercised in considering the merits of the new position.

b) Philosophical Difficulties Inherent In It

(1) On the Basis of the Objective Reality of Space

(a) The Difficulty of Conceiving the Finite as the Whole

1) Introduction: The New Scientific Attitude

When one leaves the field of strict science and enters that of philosophy, even greater difficulties than those just considered begin to arise. The first of these originates with a study of the philosophical premise upon which the new theory is based. It will be recalled at this point how Eddington, in preparing to set forth his

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1. de Sitter, Kosmos, p. 134

new views, prefaced them with a statement to the effect that infinite space is inconceivable.[1] On the supposition, evidently, that it is best to avoid what cannot be conceived, he then proceeds to sketch the finite view of the world. Barnes adheres to this same fundamental reason for seeking a finite universe. As has already been pointed out, he frowns upon the idea of the infinite and refers to it as a scandal of human thought.[2] Such an idea is not acceptable to him because it makes hopeless, he thinks, the task of trying to understand the world.[3] This viewpoint appears to be quite general among those who accept the new cosmology. Jeans and others, while they have not so explicitly given expression to its sentiments, would undoubtedly take refuge in it.

2) The Scientist's Challenge to the New View

But not all scientists find this position wholly satisfying. Even its premise has been challenged by a member of their own group. Professor J. Y. Simpson, in reviewing Barnes' Gifford Lectures, takes issue with his statement that an infinite universe is an absurd idea. He says in reply that "it is a little difficult to understand why infinite space should be 'a scandal to human

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1. Cf. again Eddington, The Nature of the Physical World, p. 80
2. Cf. Barnes, Scientific Theory and Religion, p. 392
3. Cf. Ibid., p. 49

thought.'"[1] Previous to this remark he declares, in justification of his own conclusion, that "as a matter of fact, we do not know whether space—that convenient name which we give to the aggregate of relations between things—is finite or infinite . . ."[2]

3) As the Classical Philosophers Have Seen the Difficulty

The philosopher has also opposed the principle underlying the new view of science. While Kant, as a previous quotation in this chapter has shown, found difficulty with the problem of the relation of matter to infinite space, he apparently did not think it impossible to conceive of an infinite universe. In fact, his own speculations on the subject seem to make clear that he found this view more conceivable and reasonable than the finite one of the present. As early as 1755, Kant recorded thoughts like these in his Theory of the Heavens:

> "If the grandeur of a planetary world in which the earth, as a grain of sand, is scarcely perceived, fills the understanding with wonder, with what astonishment are we transported when we behold the infinite multitude of worlds and systems which fill the extension of the Milky Way! But how is this astonishment increased, when we become aware of the fact that all these immense orders of star-worlds again form but one of a number whose termination we do not know, and which perhaps, like the former, is a system inconceivably vast—and yet again but one member in a new combination of members! We see the first members of a progressive

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1. The British Weekly, May 25, 1933
2. Ibid

> relationship of worlds and systems; and the first part of this infinite progression enables us already to recognise what must be conjectured of the whole. There is here no end but an abyss of a real immensity, in presence of which all the capability of human conception sinks exhausted."1

Such thinking in ever-widening circles until the mind is lost in a haze of mystery is an indication that the great philosopher preferred the conception of the infinite to any circumscribed view akin to the modern one, because it is more satisfying to the intellect and, strange as it may seem, is more easily conceived.

Bradley, dealing with the dilemma of the finite and the infinite and showing that of its two horns the infinite is the easier to lay hold of, has also touched upon this subject. One cannot do better than quote him in order that the full force of this contention may be felt. He says:

> "For take space as large and as complete as you possibly can. Still, if it has not definite boundaries, it is not space; and to make it end in a cloud, or in nothing, is mere blindness and our mere failure to perceive. A space limited, and yet without space that is outside, is a self-contradiction. But the outside, unfortunately, is compelled likewise to pass beyond itself; and the end cannot be reached . . . Space, to be space, must have space outside itself. It forever disappears into a hole, which proves never to be more than one side of a relation to something beyond."2

After reading this, Jeans admits that there is here a real metaphysical problem for the believer in a finite universe.

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1. Jeans, The Stars In Their Courses, p. 124
2. Jeans, The New Background of Science, pp. 143-144, quoting Bradley, Appearance and Reality, pp. 37-38

In commenting on it he remarks as follows:

> "This quotation raises a metaphysical dilemma which science alone cannot claim to solve. If the whole continuum is finite, what can there be outside the continuum except more continuum?—which proves that our original continuum was not the whole continuum. And how can space be expanding, since there is nothing for it to expand into except more space?—which proves that what is expanding cannot be the whole of space . . ."[1]

From these words it is evident that the philosopher has made his case. Metaphysically, the statement that the infinite is inconceivable is no more true than its corollary that the finite is conceivable. There are difficulties in both, but it will not do without good reason to make one more plausible than the other.

4) As the Writer Conceives the Problem

A difficulty like that involved in the new conception of the universe, since it is of sufficient importance to merit consideration and since vital religious implications are involved in it, must not be dismissed in a study of this kind without the presentation of one's own view of it. In looking at this problem afresh, then, in the light of modern science, one's attention is first attracted to the conviction that underlies the current theory. The philosophical basis for the present conception has previously been shown to be a belief that infinity is unthinkable. Now the principal objection to this premise is that it is nothing more than an <u>ad hoc</u>

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1. Jeans, The New Background of Science, p. 144

assumption that makes the wish father to the thought. Barnes has shown this when he declares in his already quoted statement[1] that the chief reason for accepting a finite view is that, if it be true, we may then hope to understand God's activity, whereas if the infinite view be correct, no such hope can prevail. The conclusion to be drawn from this frank confession is that a view of an infinite universe is unacceptable to the modern theorist because it leaves unsatisfied his desire to know fully the size and character of the whole of things. He prefers instead the newer hypothesis because it may permit to come true his wish to comprehend the totality of nature. This, however, is not to make prejudice subservient to the facts, as science always seeks to do, but to make the facts conform to prejudice or desire. In so far as this is true, the metaphysical starting-point of the new theory is a mirage.

But if the genuine difficulty of the concept denied in this premise be conceded, it cannot be obviated by the acceptance of a finite view of the universe. If an infinite world be inconceivable, it does not help matters much to try to conceive the finite as the whole in place of such a view. In fact, the latter theory appears to raise more difficulties than it solves. Suppose, for instance,

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1. Cf. again Barnes, Scientific Theory and Religion, p. 49

that modern cosmology be permitted to shut man up within a universe which is finite, and out of which he cannot look. Because space is curved and bends back upon itself, thus dooming man to see in circles if his sight would carry far enough, must the mind also be compelled to think in circles and never reach out beyond this closed envelope of space? Rather will it persistently ask, What lies beyond the curved continuum? What is outside this orange skin of space? May there not be other self-contained universes like this one that exist beyond it? Is it not possible, as Kant has suggested, that each of these may form a part of a larger system, and these systems in turn may be parts of still greater systems, and so on in an infinite progression? Thoughts like these will not down; they are stubborn things and only serve notice on the theoretical scientist that the mind is unwilling thus to be permanently shackled. And if the mind be, as Eddington has declared, the most direct thing in all our experience, what is more entitled to be heard when it speaks and to insist on courteous treatment?

Of course, the mind recognizes, as the great philosopher of Königsberg did, the apparent antinomy of the conceptions of a finite and an infinite world in space and time. It knows that there are difficulties inherent in both these views, but since it must choose between them, it naturally inclines toward the one best suited to represent its desire for unfettered freedom. It thereby registers its firm protest against being classified as a mere mathematical calculator, and asserts that it is in sympathy with the philosopher as well. The thoughts which well up within it are not content to come to rest on this cosmic ball, or to go around it in circles, but they have a tendency to fly off at a tangent and project themselves in a straight line into the dim distances. This greatest of man's possessions will not be bludgeoned into complete silence on these great questions as to what lies beyond the farthest star. If theoretical physics seeks to hold the mind to this finite region, when it has once surveyed its realm, it cries out in the spirit of Alexander the Great for more worlds to conquer.

However, it must be said that not all scientific men, holding the new theory, deny the absolute possibility of the vaster conception held by Kant and all who believe in an infinite universe. They cannot do this because they view from the inside a world shut in by space, and are, consequently, unable to see out. To deny the utter impossibility of any reality to the greater view, would demand some knowledge of that which is outside their scientific domain. All that they can do, therefore, because of the prohibitions of their theory, is to refuse to affirm these opposing tenets, so long as they themselves continue to support the new hypothesis. Such is the attitude of scientific agnosticism which Jeans maintains towards Kant's view.[1] But to refrain from unequivocally denying that more lies beyond, and even to admit the possibility in the slightest, is to weaken the new position. It is not sure of itself, to say the least, when it cannot be certain of its limits.

(b) The Self-Refuting Character of the New Theory

The entangling problems of this current hypothesis are numerous enough on the basis of the preceding considerations, but they are even increased when one looks at attempts to articulate the subordinate ideas involved in it. To say that space is finite with nothing beyond it, and then to declare also that this same universe is expanding, seems like the enunciation of two contradictory ideas.[2] If nothing in reality surrounds this closed universe, how can the space enclosed in it expand when there is no room, figuratively speaking, which it may occupy? Does some miracle happen continuously which makes this non-entity recede as the balloon enlarges? But even to speak of a non-entity receding where nothing is, is meaningless. Upon this theory that takes the finite as the all, there is no opportunity even to speculate about what is or is

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1. Cf. Jeans, The Stars In Their Courses, p. 124
2. Cf. Inge, God and the Astronomers, p. 37

not outside. Matter cannot be encroaching upon a vacuum when there is no vacuum. If this be true, how then can the circumference of the sphere, enclosing all the ponderable material of the universe, find opportunity to increase by moving further from the center?[1]

Perhaps the objection may be raised against this criticism that it presupposes the concept of space as a vacuum while the view criticized regards it as dependent on matter. The former is akin to Kant's view of space, with the exception that in his view space is metaphysically unreal, while the latter is Einstein's latest theory.[2] According to the new conception, where there is no matter there is no space, though there may be a void which has nothing to do with a space that is always explained in terms of physical measurement.[3] Now the answer to this objection is that, if the current view of an expanding universe seeks to avert this criticism by denying the existence of empty space outside the closed universe on the grounds that it is contrary to its own view of the dependence of space upon matter, it must postulate something upon which an enlarging world may feed as its circumference increases. If it does not do this, then matter is endowed with the power of creating space <u>ex</u>

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1. Cf. Inge, God and the Astronomers, p. 49
2. Cf. Jeans, The New Background of Science, p. 97
3. Cf. Eddington, The Nature of the Physical World, p.137

nihilo, a characteristic which, so far as human experience goes, it is not known to possess. But if the new hypothesis does acknowledge a vacuum outside, the question then arises as to what the character of this vacuum is. Webster's dictionary defines a vacuum as empty space,—the very thing which the view underlying this criticism denies, for space cannot be empty if its existence depends upon matter that is not present in a void. On the basis of the new theory neither space nor matter can exist in a vacuum. What then can it be? It certainly is not anything that is known, since it contains even less than empty space. In this case, then, the expanding powers of the universe appear even more miraculous than they do according to the Kantian view which is said to have been presupposed in this criticism. Furthermore, to endow this vacuum with any characteristics, known or unknown, in order to save the new view from the preceding criticism, is to deny that the universe is finite; it cannot be so if the sphere of space is enveloped in another medium beyond man's present comprehension. Thus the theory wrecks itself on either the Scylla of finiteness or the Charybdis of emptiness.

But this expanding universe is also represented by some as continuing to swell eternally. The continuum which expands, as will be seen later, includes not only space but also time. The latter, though it had a beginning , is represented as enduring through all eternity.[1] The expansions also, therefore, must go on through eternity. But how can a finite universe go on expanding to eternity? This is to make the finite merge into the infinite, which is a seeming contradiction in ideas.

In view of these difficulties, one can well understand the expression of a wish by Dean Inge that the authorities had been more explicit in their unfolding of the idea of an expanding universe. There is also a kindred feeling that these same scholars are all the time using the terms universe and space in a sense unfamiliar to the average reader.[2] Language with them seems often to have lost its common meaning and to have taken on some strange and mysterious significance.

(2) On the Supposition of Its Subjective Reality

(a) Introductory: The Avowed Mentalism of Recent Scientific Thought

If one looks further, however, than the previous viewpoint will take him, his desire for a greater classification of the meaning of the ideas and words used in

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1. Cf. Jeans, The Mysterious Universe, p. 179
   Eddington does not hold this view in common with Jeans. He speaks of a point where time's arrow is lost and progress will cease (Cf. The Nature of the Physical World, p. 83) This idea will be discussed later.
2. Cf. Inge, God and the Astronomers, p. 49

explaining the new conception is somewhat satisfied. It becomes clear that the new cosmologists do not see the world in the light of the old epistemology. Their conception of the universe is decidedly subjective. The philosophy which best describes it seems to be that of mentalism. Jeans has clearly taken this position with reference to the problems of space. He himself recognizes many of the difficulties which have been pointed out on the basis of an objective reality for a finite universe in finite space.[1] Consequently, he would cast them all aside at one stroke when he says:

> "If we give up trying to attach any sort of reality to finite space except that of a purely mental concept, our way immediately becomes clear. Our everyday thoughts are never concerned with more than a finite part of space, so that finite space as a framework for mental processes is familiar to us all."[2]

Eddington's position accords well with this view when he declares:

> "The element of permanence in the physical world, which is familiarly represented by the conception of substance, is essentially a contribution of the mind to the plan of building or selection."[3]

Even more clearly in the following does he choose mentalism for his refuge when he states that the

> "world of physics is a world contemplated from within surveyed by appliances which are part of it and subject to its laws. What the world might be deemed like if

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1. Cf. Jeans, The New Background of Science, p. 291
2. Jeans, Ibid., pp. 291-292
3. Eddington, The Nature of the Physical World, p. 241

> probed in some supernatural manner by appliances not furnished by itself we do not profess to know."[1]

What he says about color and entropy might no doubt equally be applied to his view of space. Here are his own words:

> "If colour is mind-spinning, so also is entropy a mind-spinning—of the statistician. It has about as much objectivity as a batting average."[2]

From these quotations it would seem that Inge is justified, therefore, in placing Eddington in a class with Jeans with reference to his subjective idealism, as a method of extricating himself from the difficulties of an objective realism that might be associated with his finite conception of macroscopic phenomena.

(b) Mentalism Is Inconsistent With Scientific Measurement

Trouble begins, however, when one tries to apply the new theory of scientific knowledge to the solution of the persistent problems inherent in the current scheme of the universe on the basis of its objective reality. In the first place, this mentalism does not harmonize with the scientific process of measurement that lies at the heart of the new method of science. It has been frequently declared by the leaders of modern astrophysical thought that

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1. Eddington, The Nature of the Physical World, p. 225
2. Ibid., p. 95

mathematics is the key to the orderly construction of the present world view. This is undoubtedly true and there is no desire to deny it. But what value have pure mathematical concepts in science except as one associates them with material quantities? Pure mathematics may be entirely independent of concrete fact, but how can physics and astronomy be so?[1] For instance, the scientist measures the distances between stars and the earth in parsecs[2] and light-years.[3] The magnitudes of these vast expanses of space are at times shocking to our understanding. But what meaning do they have if what they represent is only in the mind? And if the entities to which they apply are mental, how can one rightly claim to have measured them at all? It is not generally conceded that mental concepts are capable of exact measurement.[4] Thoughts are too evasive to be bounded by the measuring-rod, or even to submit to the humiliating ordeal of being scientifically restricted in the scope of their activity.

But since these facts are true, what becomes of the boasted scientific accuracy of this new theoretical

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1. Cf. Inge, God and the Astronomers, p. 40
2. A parsec is a unit of astronomical measure equal to a distance having a heliocentric parallax of one second. It is almost exactly equivalent to 206,265 times the mean radius of the earth's orbit around the sun.
3. A light-year is the distance that light, proceeding at the rate of 186,000 miles a second, travels in a year's time.
4. Cf. Inge, God and the Astronomers, p. 36

scheme? Since when has physical science seen fit to drop its contact with the material world and work only upon the materials of the mind? With reference to the particular entity under discussion Barnes says:

> "Of space apart from matter, or from energy which is perceived as radiation and which like matter has inertia, we can say nothing. Matter is so closely bound up with our spatial perception that it seems to create space."[1]

He would not separate it from the material world lest it become a complete abstraction so far as man's knowledge goes. Even Eddington and Jeans do not always cling to this position. As Inge has said:

> "Eddington frequently forgets his subjective idealism when he is describing these discoveries. 'We see the atoms with their girdles of circulating electrons, darting hither and thither, colliding and rebounding.' Of course we do not see them, but Eddington surely means that they are really there. Jeans even says, 'The ether and their waves are the most real things of which we have any knowledge or experience, and are as real as anything can possibly be for us.'"[2]

Certainly, mentalism, therefore, cannot be said to be a legitimate philosophy to undergird a science dealing with nature. As Inge again says, "no science which has its starting-point in the objects made known through perception, can logically issue in pure mentalism."[3] If it could, then the study of the physical world would in reality become a study of the mind, and the mentalism of

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1. Barnes, Scientific Theory and Religion, pp. 49-50
2. Inge, God and the Astronomers, p. 41
3. Ibid., p. 41

science would prove to be nothing other than a science of mentalism. Natural science, in consequence, would give place to an attempted scientific psychology developed according to purely mathematical principles. Boundaries to definite fields of research, and names applied to the work done in these realms, would then cease to have any intelligent significance. But this would mean the destruction of all ordered progress, introducing confusion and defeating the very purpose for which science exists.

(c) Mentalism Is Not Consistent with the Truth

Closely allied with the previous difficulty is that of the inconsistency of subjective idealism in science with the truth. Ordinarily it is maintained that "truth is absolute, a quality of ideas that correctly represent facts and their connections, the harmony between the finite and the infinite thought."[1] Eddington in principle concedes the truth of this statement for scientific purposes, as has been previously shown, when he says: "Life would be impossible if there were no kind of correspondence between the external world and the picture of it in our minds . ."[2] Even though Jeans says that the universe cannot admit of material representation, because it has become a mere mental concept,[3] he also repeatedly intimates in his

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1. Horne, The Philosophy of Education, p. 303
2. Eddington, The Decline of Determinism, p. 46. Cf. comments on this passage on p. 140 of previous chapter.
3. Cf.again Jeans, The Mysterious Universe, p. 167
   Cf. Jeans, The New Background of Science, p. 282

writings that there must be some reality behind man's conceptions of the universe in order for him to have such conceptions at all.[1] When, for instance, he asserts that science cannot know the ultimate nature of things because of its lack of extraneous standards against which to compare them,[2] and that it has no present need of such knowledge to make its formulae work,[3] he implies by indirection that such entities must exist as the counterpart of the scientific symbols and other data in order for them even to be talked about. If this were not admitted, then, as Plato said,[4] this world would be a shadow-show, than which no greater could be conceived. But once this fact is recognized, two things happen simultaneously. Mentalism is, first of all, accused of being an inadequate philosophy of nature and of falsifying the facts with which science deals by breaking off the contact of the investigator with the raw material of his craft. For, as Whitehead says:

> "scientific laws, if they are true, are statements about entities which we obtain knowledge of as being in nature; and, . . . if the entities to which the statements refer are not to be found in nature, the statements about them have no relevance to any purely natural occurrence."[5]

In the second place, the old epistemology and its attendant

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1. Cf. Jeans, The New Background of Science, pp. 68-69
2. Cf. Jeans, The Mysterious Universe, p. 155
3. Cf. Jeans, The Universe Around Us, p. 326
4. Cf. Plato, Republic, Book VII
5. Whitehead, The Concept of Nature, pp. 45-46

difficulties come trooping back to break up the game of solitaire which subjective idealism is playing and to vindicate the truth that was ejected as an undesirable partner in a two-handed game.

(d) Mentalism Does Not Escape the Antinomy of the Finite and the Infinite

In a previous part of this chapter attention was directed to the purpose of the new procedure in the attempt to give present-day science a comfortable philosophical setting. A subjective viewpoint was finally arrived at through the desire to free the new scheme of astrophysical thought from any embarrassing metaphysical difficulties. But it is soon discovered that it is not to be unmolested even in this new rendezvous. The difficulties, attendant upon it under the familiar epistemology, now follow it into its strange environment; they cannot be left behind. Barnes evidently sees this when he remarks that "it must be admitted that the mathematician himself is not seldom disturbed by what appear to be the paradoxes of Riemannian (finite) space."[1] Even from the angle of purely abstract thought he notices there are still troublesome problems to be faced. Jeans does not so clearly betray this inward difficulty, but his endeavors at times to grapple with the apparent contradictions of the new theory lead one to be-

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1. Barnes, Scientific Theory and Religion, p. 96

lieve that he tacitly recognizes its presence. Otherwise it is hard to understand his concern over the theory of the expanding universe and to think that some of the arguments which he painstakingly produces against subordinate points in the theory are at all justified on the basis of his pure mentalism.[1] If his view in reality were not broader than this subjectivism, it would seem that all his scientific reasoning was being wasted in the harmless and useless exercise of knocking down men of straw. Such a prostitution of talent upon the part of a gifted man of science like Jeans is utterly unthinkable.

Inge, therefore, is right in taking exception to the statement, evidently from an article by Jeans, that "finite space is most easily understood as a mental concept." The Dean denies this on the ground that the mental concept of a limit with nothing beyond is self-contradictory. And, says he, "the contradiction is in the mind, not in the phenomenal world."[2] No solace, in consequence, can be found for the new cosmology by placing it under the shelter of a subjective philosophy. Even there its essential weakness works upon the mind and gives it no rest. For the antinomy of the finite and the infinite which it involves is in the mind before it is in any theory. Being

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1. Cf. Jeans, The New Background of Science, pp. 137-138
2. Cf. Inge, God and the Astronomers, pp. 36-37

in the mind, it cannot be escaped from by a recourse to subjective idealism.[1] If it originates there, it will always be found there to disturb the smooth working of any scheme that tries to free itself artificially of all difficulties.

4. Summary

Before bringing this intricate discussion to a close, it seems well to summarize briefly the chief impressions which this study of the new theory of space make upon one. It is first of all to be observed that the new cosmology is bold and revolutionary in its conception of the character of the universe. Its emphasis is clearly upon the finite character of space, which is to be maintained at all hazards. This view has associated with it the idea of the curvature of space which is employed to close in the universe and make it a self-contained sphere. It is looked upon as finite but unbounded, since, due to the re-entrant property it is impossible for the heavenly bodies to come to what might figuratively be called the edge of space. Furthermore, this cosmic shell is expanding, or more properly, exploding at a terrific rate. The radius of the universe is rapidly increasing as the nebulae and distant stars recede from earth and from one another at unimaginable speeds.

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1. Cf. Inge, God and the Astronomers, pp. 242, 243

Such a picture, however, creates great problems. The idea of a finite material universe with nothing beyond seems an impossible conception. Philosophically and realistically, it is difficult to believe. When the theory of an expanding universe is added to this, the problem is made still more troublesome. In fact, this theory seems to be a flat contradiction of the finite conception; the two are almost incapable of being harmonized. Attempts not only to do this but to obviate all other telling criticism have led to the withdrawal of science into a subjective position from which it has sought to defend its findings philosophically. But this attitude of mentalism has failed to stem the tide of criticism and to lessen the objections to the new cosmology. At present, therefore, science seems to be going its own way in a spirit of confidence,as to the rectitude of its course, taking many laymen with it as camp followers. But here and there one of their own class raises his voice in protest and gains the hearing of others who have been hesitant about plunging headlong with the crowd into this maelstrom of conflicting ideas and views, because they feel that science may temporarily be on the wrong course. At present, therefore, it remains to be seen what time and further investigation will reveal, and whether they will affirm or deny all or part of what has been produced in the present process of "mind-spinning."

C. The View of Time

1. Introductory Remarks

It is necessary now, since the new concept of space has been examined, to consider the present views of time in contrast to the older theories. The transition in thought from the one to the other is not so great as might at first be imagined, the reason being primarily that the two ideas have always been clearly associated in any discussion of such topics. Before coming to the current view of time, it is possible to give only the briefest review of leading conceptions which preceded it. The procedure in this instance will follow practically the same order as in the case with space.

2. The Prevailing Views of Time Preceding Einstein

a) The Newtonian Conception

For Newton, a mathematical time, such as is measured by a perfect chronometer, in distinction from a psychological time which is measured by man's sensations, was considered absolute. He had a conviction that it would be the same for one living on a swiftly moving star, as for an inhabitant of earth. This view has indeed been almost universally held until the present century.[1] Furthermore, Newton believed that time, like space, had an existence independent of human perception and knowledge, and of the

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1. Cf. Barnes, Scientific Theory and Religion, pp. 101,102

things with which it is concerned.[1] In other words, it was held by him to exist in its own rights. Lastly, the great scholar also viewed time as flowing on uniformly and forever, stretching to eternity.[2]

b) Views of Leibnitz and Kant

Leibnitz's view of time, on the other hand, differed from Newton's in somewhat the same manner that his view of space differed from that of the latter. He conceived time also to be an empirical concept which is abstracted by the mind from the raw material of the sense-perceptions of the relations of things which exist in the outer world.[3] It is a subjective view. Kant also regarded time as a subjective concept, but he looked upon it as a necessary form of perception, imposed by the mind and not by the sense-perceptions themselves. When, therefore, he spoke of things existing in time, his statement did not refer so much to things perceived as to the nature of perception.[4] As in the case of space, Kant held that time is empirically real and transcendentally ideal. Since things in themselves do not exist in it, it was by him regarded as metaphysically unreal. But the consciousness of time, in the apprehension of change, he clearly regarded as real.

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1. Cf. Dampier, A History of Science, pp. 152, 211
2. Cf. Ibid., p. 443
2. Cf. also Barnes, Scientific Theory and Religion, p. 560
3. Cf. Dampier, op. cit., p. 211
4. Cf. Barnes, op. cit., p. 560

Again, therefore, for the same reason as with space, his position is one which, it is said, hovers between Newton and Leibnitz.[1]

3. The Revolutionary View of the Present

a) General Remarks about the New Theory of Time

The difficult character of the present view of time may best be introduced by a scientist's confession of his lack of adequate knowledge of the subject, and by his attempted figurative representation of how time acts. Jeans says that "so little do we understand time that perhaps we ought to compare the whole of time to the act of creation, the materialisation of the thought."[2] In speaking of its usefulness, he declares that "time figures as the mortar which binds the bricks of matter together . . ."[3]

b) The Relativity of Time

(1) The History and General Character of the Idea

In coming to grips with the new view of time, however, one soon meets the present conception of its relativity in contrast to its traditional absoluteness. This idea was introduced by Einstein in 1905 in connection with his special theory of relativity, which was the outgrowth of the famous Michelson-Morley experiment conducted for the

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1. Cf. Dampier, A History of Science, p. 211
2. Jeans, The Mysterious Universe, p. 182
3. Ibid., p. 144

purpose of determining, if possible, the motion of the earth with relation to a hypothetical ether.[1] He maintained that absolute time as well as space, was a figment of the imagination—a concept not derived from the observations and experiments of physics, and that time was a reality always relative to the observer.[2] This meant that time, according to Einstein, is conceived to be "local" and that there are as many local times as there are different bodies moving through space, each time being fundamental for its own sphere.[3]

(2) The Theoretical Implications of This View

The theoretical considerations of physics, from which this view was developed, need not be discussed here, since they would add but little to that understanding of the new view of time which is required for this investigation. Very clear explanations of these matters may be found in the works of Barnes[4] and of Jeans.[5] Suffice it here to mention some of the major implications of this view as physics sees them. First of all, it is indicated that there is no absolute progression of time by means of which small intervals of time can be measured.[6] The

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1. Cf. Barnes, Scientific Theory and Religion, pp. 104-105, 203
   Cf. also Millikan, Time, Matter, and Values, pp. 24,25
2. Cf. Dampier, A History of Science, pp. 419-420
3. Cf. Jeans, The New Background of Science, p. 94
4. Barnes, op. cit., p. 121
5. Jeans, op. cit., pp. 93-94
6. Cf. Ibid., p. 94

concepts of objective or absolute time must, therefore, be abandoned in favor of an agnosticism with regard to absolute velocity and of an assertion of relative velocity instead. Furthermore, upon the basis of the relativity of time, one is told, it becomes as impossible to locate an event in time in an objective way as to locate an object in the same manner. The ideas of before and after under certain conditions may completely lose their meaning.

Reflection upon these consequences of the current theory prepare one to understand Jeans' own arresting statement of the case. He says, in a seemingly unperturbed manner, that

> "the theory of relativity goes . . . some distance towards stigmatising this steady onward flow of time and the cause-effect relation as illusions; it regards time merely as a fourth dimension to be added to the three dimensions of space, so that post hoc ergo propter hoc may be no more true of a sequence of happenings in time than it is of the sequence of telegraph-poles along the Great North Road."[1]

It is to be noted that this idea of relativity is subjective even to the point of some confusion. While it is possible, on the basis of the subjective theories previously mentioned, to imagine the same idea of time possessing the observer, no matter where he might be, whether on earth or a planet or a remote star, it becomes impossible to do this in connection with the view of relativity. Man's relative position will determine for

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1. Jeans, The Mysterious Universe, p. 37

him his view, which may change as his velocity in space changes. In conclusion, let it be said that there is undoubtedly something more subtle in this view than is to be found in any of the others. It will bear careful study and thought by all who approach it with the idea of trying to comprehend it.

c) The Space-Time Continuum

(1) The Common Scientific View of It

The result of the introduction of the relativity theory was that it seemed to bring immediate confusion into the ideas of time and space that were thought by the time of its advent to be at least reasonably settled. But Planck says that this view proved in the long run to be the completion of the classical physics. The reason for this, he says, was its fusion of time and space into one unitary concept.[1] This evidently is looked upon by the Professor as a clarifying step in the organizing of man's knowledge of the world. Barnes also sees the special theory of relativity as having fused space and time into a "four-dimensional manifold" which we refer to as space-time.[2] But he describes the character of this new entity more fully than Planck. According to him, it is not to be considered an objective reality independent

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1. Cf. Planck, The Universe in the Light of Modern Physics, p. 18
2. Cf. Barnes, Scientific Theory and Religion, p. 560

of experience. Rather is it to be considered a construct which is derived from the collective experience of humanity.[1] With hearty approval does this writer quote the words of Weyl which summarize this conception. They are reproduced here in part as a conclusion to this discussion:

> "The scene of action of reality is not a three-dimensional Euclidean space but rather a four-dimensional world in which space and time are linked together indissolubly. However deep the chasm may be that separates the intuitive nature of space from that of time in our experience, nothing of this qualitative difference enters into the objective world which physics endeavours to crystallise out of direct experience. It is a four-dimensional continuum, which is neither 'time' nor 'space'".[2]

(2) The Apparent Modification of the Former View by the Generalized Theory of Relativity

As in all of these problems with which theoretical physics is now dealing, there seems to be much in this revolutionary picture of time and space welded into one, which is very puzzling, not to say incomprehensible, to the uninitiated in the technical language and the labyrinthine ways of mathematical reasoning. Delicate nuances of thought, often superadded to already difficult conceptions, make confusion worse confounded. Such is the effect of the new twist in the continuum idea, if Jeans' description of it be correct, and if his description in turn be correctly understood. It would

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1. Cf. Barnes, Scientific Theory and Religion, pp.560-561
2. Ibid., p. 122

seem from this that the preceding explanation does not represent the latest view and will need to be modified considerably to be properly adjusted to this new pronouncement. Jeans states the new theory thus:

> "The generalised theory . . . suggests that just as our individual consciousnesses recognise a sharp and clear-cut distinction between space and time, so also does nature on the grand scale. This distinction, which we first find in our own minds, vanishes for a time when we study objective nature on the small scale, but apparently reappears in the cosmos as a whole."1

There is left in one's mind after pondering these words a question as to how two things which have been "fused" together in the case of small-scale phenomena can now be separated when the new macrocosm is viewed. It would seem that the cause of this discrepancy is due somewhere along the way to an incomplete understanding either of the actual separation of time and space, or else of the nature of their union. This shifting of viewpoint does not tend to develop confidence in the soundness of the facts which make it necessary.

(3) The View of Alexander

Alexander also fuses space and time into a space-time continuum, but the absolute character of the product thus evolved is worthy of some explanation in this brief treatment of the new concept. In this union space is subordinate to time, being, in fact, generated by it.

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1. Jeans, The New Background of Science, p. 141

Space is not viewed as empty, but space like time, is an abstraction from space-time. The latter is the real existence, the absolute reality. Its ingredients are the simplest characters of the world. From them issue things and events. Finites, including mind, are the coalescence complexes of this fundamental fusion. Space-time, or better still, time-space seems, according to this theory, to be invested with the creative attributes of the divine.[1]

(4) Fundamental Criticism of the Peculiarities of Alexander's View

This theory, however, is open to serious objections. Only basic criticisms can here be considered. In the first place, the creation of an absolute by the welding of space and time into a unit is a pure fiction, because it involves stubborn contradictions. If both are finite entities, an absolute cannot be produced by joining them together. Two finites cannot make an infinite. On the other hand, if both are regarded as absolute, then their union places two absolutes side by side, which is an impossible idea to entertain. The very meaning of the concept, if language has any significance, is the denial of an additional other that would rob it of its significance of totality. Furthermore, if either one be looked upon as absolute and the other as finite, there could be

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1. Cf. Inge, God and the Astronomers, pp. 110-112

no reason for their amalgamation into some hybrid concept, since one is already the all which cannot be added to or subtracted from. One absolute joined to a finite would in reality be a plain myth. Such a pretentious view of space-time involves, therefore, an absurdity at its very heart. Under the searchlight of these considerations this conception must either involve much more than it claims and change its name in consequence, or else be reduced to a monstrosity.

In the second place, it is pertinent to ask, what keeps either one of these ideas of space or time, which are welded into this absolute, from being a pure vacuum? Sheen has criticized the view keenly from this angle. He says as answer to the question:

> "Time is not empty only because it contains Space, and Space is not empty only because it contains Time. The two 'earn a precarious living by taking in each other's washing.'"[1]

The success of the idea of the absolute, as Alexander conceives it, depends upon injecting into it qualities which do not belong to either of its constituents by itself. Quality, he says, "is the great mystery",[2] but from whence do these qualities come? Surely not from time or space. A thing which needs to assimilate another nebulous quantity in order to be saved from complete

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1. Inge, God and the Astronomers, p. 115
2. Ibid., loc. cit.

annihilation cannot be looked upon as a very hopeful source of creative activity of this order. Therefore, as Sheen again has said in substance, when one idea is used to prop the other, the two do not make a very secure foundation for any satisfying philosophy of the cosmos.[1]

d) Time: Finite or Infinite?

(1) Explanatory Remarks

Another puzzling question that arises in the study of this subject is that as to whether time in the new view is to be considered finite or infinite. To answer this query according to the views of modern cosmological thought, anticipates to some extent a part of the discussion which is yet to follow in this chapter. The purpose here, however, is not to duplicate the material which will there be presented, but to record the results of scientific thought in another field of study, so far as they bear upon this inquiry.

(2) Eddington's View

Eddington's reply to this interrogation seems to favor the finite view. It is so intertwined with the thorny problems of space and with the phenomenon of entropy,[2] which is now being questioned by scientists themselves as

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1. Inge, God and the Astronomers, p. 115
2. Entropy is sometimes referred to after Rankine as the <u>thermodynamic function</u>. It is the name applied to the index of the relative amount of unavailable energy in a physicochemical system.

an irreversible one-way process, in spite of Eddington and Jeans to the contrary, that one has difficulty in being sure that he has correctly extricated the author's opinion on the subject from the confusing ideas which these other subjects introduce. It seems best first to let the scientist's own words speak for themselves. After disposing of the idea of infinite space in a manner satisfactory to himself, he says further:

> "But the nightmare of infinity still arises in regard to time. The world is closed in its space dimensions like a sphere, but it is open at both ends in the time dimension. There is a bending round by which East ultimately becomes West, but no bending by which Before ultimately becomes After.
>
> I am not sure that I am logical but I cannot feel the difficulty of an infinite future time very seriously. . . . It should also be noted that according to the second law of thermodynamics the whole universe will reach thermodynamical equilibrium at a not infinitely remote date in the future. Time's arrow will then be lost altogether and the whole conception of progress towards a future fades away."[1]

Looking forward into the future, Eddington sees time annihilated by the completion of the process of entropy by which time is measured. This inexorable law is made to work like a charm in eliminating an otherwise very troublesome problem about the endless continuance of time. But the difficulty of infinite past time would still remain to haunt the theorist, who apparently loathes such inconceivable ideas,[2] unless some way of finding a starting-

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1. Eddington, The Nature of the Physical World, p. 83
2. Cf. Ibid., p. 83

point for it can be discovered. Accordingly, the great astronomer brings this same process into use again in seeking to locate a beginning for time in the distant past. By postulating the need for a perfectly organized world at some remote point in former ages in order to make possible the present, irreversible disorganizing process, Eddington thus arrives at a moment before which time could not exist. By this picture of a completely organized universe he shuts out the dilemma of an infinite past, and with the opposite picture of a world in a state of maximum randomness, in which time will be meaningless, he would render impossible and needless any effort to look into an endless vista of future time.[1]

(3) The Puzzling Nature of Jeans' View

Most statements from Jeans' writings indicate that he is in accord with the previous view of Eddington. In speaking of time, he says in substance that, just as in the case of space, we must think of it as finite.[2] By employing the same general arguments as those used by the Cambridge astronomer, he seems to sew up the universe in a finite fabric of time in much the same manner as he enclosed it, along with many of his scientific contemporaries, in a finite shell of space.[3] But just when it

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1. Cf. Eddington, The Nature of the Physical World, pp. 83-84
2. Cf. Jeans, The Mysterious Universe, p. 179
3. Cf. Ibid., pp. 179-180

appears that his own ideas of time are on the road to being even loosely fitted together and understood, Jeans comes forward to inject some disturbing conception into them that offers obstinate resistance to all efforts at harmonization with the rest of the oddly shaped views. No wonder that Inge expresses surprise when he quotes Jeans as saying recently that "Time has a beginning in the past, but no end in the future."[1] There is a suggestion of this idea in a recent book of this author where he hints that it may be spread out before us to all eternity.[2] This is mute evidence that, hidden away in the scientist's mind, there are many unanswered questions concerning this nebulous theory which find their way to the surface at times and finally become vocal. Barnes, who shows great sympathy towards the new view sketched above, frankly declares what one learns only by indirection from Jeans,— namely, that infinite time yet remains to trouble one even after he has carefully canvassed the new ideas about this age-old subject.[3]

e) Time: Illusion or Reality?

In studying any view of time a matter of interest is always the question whether time within the framework of that scheme is to be regarded as real or not. Naturally

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1. Inge, God and the Astronomers, p. 240, Quotation from an article by Jeans in Philosophy, January, 1932
2. Cf. Jeans, The Mysterious Universe, p. 141
3. Cf. Barnes, Scientific Theory and Religion, p. 392

there is a desire to know what bearing the recent theory has upon this point. Jeans believes that, so far as present scientific thought is concerned, this question might be answered either way. Looking at it from one angle, he says time may be mixed into the already completed picture, with which one makes only momentary contacts, much as a bicycle does with the road. In this view, as Heyl said, "events do not happen; we merely come across them." From a second standpoint, time becomes the method by which the unfinished picture is being brought to completion.[1] Wrapped up in this view of time is the opportunity to influence the result in process of formation. Time is real for the one experiencing this consciousness. But such a condition could not exist in the first instance; there actual change and progress, as identified in some sense with the one experiencing the picture, would be entirely lacking in reality, and only their ghosts would be present to fool man as he walked across the stage of life. Of these two views Barnes tenaciously holds to the latter as more consonant with man's moral endeavor. Eddington also seems to be drawn naturally towards this same terminal when he emphatically declares that time may be more physically real than matter,[2] for scarcely could

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1. Cf. Jeans, The Mysterious Universe, pp. 141, 142
2. Cf. Eddington, The Nature of the Physical World, p. 275

this be said about time in the first picture. The latter view, in fact, looks like the only reasonable one. But it is not necessary to say more about it here, since this subject will be dealt with again in relation to its religious significance.

f) Summary

In summarizing these modern ideas about time, the first thing to mention is their complexity. It can hardly be said, except in a very general sense, that there is any uniform opinion regarding this very elusive subject. The views presented are oftentimes perplexing, and the thoughts involved are tortuous and difficult to follow. In some instances only a mathematically trained mind can comprehend the abstract concepts employed to describe it. But, nevertheless, any sustained effort to grasp the main features of the new theory reveals certain distinguishing characteristics common to all attempted explanations of it. The first of these is that time is now no longer to be regarded strictly as a separate entity. It is joined to space in the continuum known as space-time. Here it has taken on the character of a fourth dimension. In the second place, time is now regarded as relative instead of absolute. Its significance is determined with reference to the velocity and position of the observer, instead of in relation to some absolute standard. No longer does it need, in consequence, to be thought of as flowing steadily onward. This idea has had to be given up, in part, it is said, and room has had to be made for the possibilities of seeing time stand still or even flow backwards.[1] In consequence, the cause-effect relation is brought into question by some. In the third place, time is generally viewed as finite, hemmed in behind and before by the requirements of the process of entropy. Some confusion on this point is noticed with a tendency at times for the theorist to look beyond the limits prescribed by scientific considerations into an endless time in the future. Lastly, there is a strong inclination to select from alternative explanations of the new theory that one which upholds the genuine reality of time in opposition to its illusory nature.

D. The Running-down of the Universe

1. Scientific Support for This View

a) The General Evidence: The Second Law of Thermodynamics

(1) The Explanation of This Law

Since time has been intimately associated with the idea of entropy, it is logical to follow the discussion of that subject with a consideration of the running-down process which is said to be going on everywhere in the universe and to make possible time calculations. At the heart of this process runs the second law of thermodynamics,

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1. Cf. Jeans, The Mysterious Universe, pp. 36-37

which is easy to define because of the tangible nature of that which it describes. According to this law, all energy in the universe, which the first law decrees to be indestructible in amount, is gradually changing its character in the downward direction from a more available to a less available form. The law also indicates that the predominant change is always from the more highly organized state of energy to one of less organization in an irreversible order that finally leads to a state of thermodynamic equilibrium or heat-death. While under this law there may be minor changes in the opposite direction, the prevailing course of energy is always downward.[1] Entropy as a result continually increases until a state of complete disorganization obtains in the world. Bertrand Russell has graphically explained this law by saying it states "that the universe tends towards democracy, and that when it has achieved that state, it will be incapable of doing anything more."[2] In the progress of time, according to this law, more and more of the random element is introduced into the world through the increasing disorganization of energy, with a corresponding increase in the element of chance, until no further shuffling of the cards in these respects is possible.[3]

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1. Cf. Jeans, The Universe Around Us, pp. 314-316
   Cf. Eddington, The Nature of the Physical World, pp. 77-78
2. Russell, The Scientific Outlook, p. 91
3. Cf. Eddington, op. cit., p. 78

(2) Its Universal Application

That a belief in the universal character of this law is firmly entrenched in the minds of some of the foremost leaders in scientific thought to-day is evident from their writings. Eddington, whose word in matters scientific is authoritative for many of his colleagues, has spoken on this subject in emphatic terms in this fashion:

> "However much we eliminate the minor extravagances of Nature, we do not by these theories stop the inexorable running-down of the world by loss of organisation and increase of the random element. Whoever wishes for a universe which can continue indefinitely in activity must lead a crusade against the second law of thermodynamics . . .
>
> At present we can see no way in which an attack on the second law of thermodynamics could possibly succeed . . ."[1]

In another place he maintains that this law holds a supreme place among the laws of nature; that if our theories go against it, they must inevitably collapse in deepest humiliation.[2] So solidly is this idea rooted that Eddington does not even see the test of extrapolation weakening this law upon which science so largely depends.[3] From the viewpoint of some it would appear to be a commandment written upon the heart of the universe.

b) Important Specific Evidence

(1) Radioactive Substances

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1. Eddington, The Nature of the Physical World, pp. 85-86
2. Cf. Ibid., p. 74
3. Cf. Eddington, The Expanding Universe, pp. 177-178

For proof that the process described by this second law of thermodynamics actually goes on, it is not necessary to search among the stars. There is clear evidence nearer in the phenomenon of radioactivity. Russell has called attention to this, pointing out that the reversal of the process involved in the disintegration of the elements of this character, is unknown to science.[1] According to Barnes, three of the heavier elements[2] known at present break down into simpler elements in this mysterious manner which involves a series of complicated transformations. Their atoms appear, he says, to be so unstable that it is impossible to prevent their decomposition. Furthermore, the work of nature in this process of metamorphosis cannot be hastened or retarded by man. It goes on slowly and continuously toward the final goal.[3]

(2) Decreasing Radiation in the Universe

If the theory of the expanding universe be accepted, then there is proof in that also that this law accurately represents the prevailing process in the world. Eddington actually declares on the basis of this view that energy of radiation is decreasing in the same proportion

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1. Cf. Russell, The Scientific Outlook, p. 113
2. These elements are uranium, protactinium and thorium. Cf. Barnes, Scientific Theory and Religion, p. 207
3. The end of disintegration for each respective element, so far as it is known, appears to be electrons, helium and a form of lead. Cf. Ibid., pp. 207-208

as the radius of the universe is expanding. He says that this rapid loss, caused by the scattering of energy through expansion of the cosmos, cannot be compensated for by the new radiation pouring in from the stars and nebulae.[1]

(3) Dispersal of Energy in Cosmic Rays

Cosmic rays, as a later discussion will show, have been made an argument for a belief in a process contrary to entropy. But those opposing this idea have tried to turn the evidence in their own favor. The cosmic ray, it is said, is the result of the dispersal of a certain quantity of energy at the coming-together of electric particles to form a complex atom. In consequence, it is a still further proof of the dissipating process universally being carried on. Like the radiation of energy in the formation of a star from compacted nebulous matter, these rays also tell the story of the general running-down of the universe towards a state of thermodynamic equilibrium.[2]

(4) The Annihilation of Matter

Closely associated with the idea involved in the discussion about cosmic rays is the theory of the annihilation of matter which is adduced as an argument in favor of the running-down process. Briefly stated, it is a

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1. Cf. Eddington, The Expanding Universe, pp. 116-117
2. Cf. Ibid., pp. 176-177

belief that electrons and protons may fall into and annihilate one another, thus releasing enormous stores of energy as radiation.[1] Jeans says all attempts to escape from this hypothesis eventually lead to it again as the most plausible explanation of many scientific facts.[2] According to this theory, all the energy which makes life on earth possible can ultimately be traced back to its origin in the annihilation of matter in the sun. In consequence, it is said the sun is slowly dying through the complete destruction of its substance in order that we might live.[3] This also is thought to be true of the stars as well. Upon this theory, therefore, the origin of highly penetrating radiation, including cosmic rays, which reaches earth, is traced back to the annihilation of matter in the hot interiors of these distant objects of the sky. The view thus comes to be for some theoretical physicists a picture of one of the fundamental processes of the universe.[4] Millikan himself, who does not accept this origin for the cosmic ray, admits that this view is now a part of orthodox astronomy.[5]

2. Objections to the Theory and Some Attempted Answers

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1. Cf. Jeans, Eos, p. 36
2. Cf. Jeans, The Universe Around Us, p. 182
   Cf. also Jeans, Eos, p. 46 for explanation of this point
3. Cf. Jeans, The Universe Around Us, p. 183
4. Cf. Ibid., p. 185
5. Cf. Millikan, Evolution in Science and Religion, pp.16,17

to Them

a) Generally Considered

(1) The Second Law of Thermodynamics is Self-annihilating

A fundamental difficulty with the absolutely unchangeable law of entropy which supports this theory of a dying universe, is its self-effacing nature. If it be permitted to operate long enough as a law of the Medes and Persians, it automatically revokes itself through the discontinuance of the process that is said to have brought it into being. Like the sun, it is gradually being destroyed by its own activity. Its doom is certain; there will come a time, according to the calculations of the scientists, when the law no longer can operate. But this prospect also looks like the denial in the future of the law of uniformity so strongly urged upon nature.

(2) The Second Law of Thermodynamics Contradicts the Law of Nature's Uniformity

(a) The Contradiction Stated

From another angle, however, this second law even more clearly contradicts that uniformity. The running-down of the universe, depicted by this law, necessitates somewhere in the past a winding-up in order that the process of entropy can begin working.[1] But yet this

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1. Cf. Eddington, The Nature of the Physical World, p. 83

winding-up is a complete reversal of the law for which universality is now claimed.[1] Barnes recognizes this difficulty by referring to the mental discomfort of the man of science as he faces it.[2]

(b) Eddington's Solution of the Dilemma

Possibly Eddington has seen as clearly as any of the scientists the apparent obstacles encountered at this point by the acceptance of this popular theory of the running-down of the universe. He meets them by postulating at some remote time in the past the intervention of the Creator in order to set the world going in a perfect state or organization from which it has been fleeing ever since as it has been left to chance. For this view, however, he apologizes by saying that it should be accepted as a working hypothesis and not as a declaration of faith. To him it seems incredible, yet logically necessary.[3] His mental disturbance over its acceptance is recorded in these words:

> "As a scientist I simply do not believe that the present order of things started off with a bang. Unscientifically I feel equally unwilling to accept the implied discontinuity in the divine nature. But I can make no suggestion to evade the deadlock."[4]

Notwithstanding the last statement in this quotation,

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1. Cf. Inge, God and the Astronomers, p. 243
2. Barnes, Scientific Theory and Religion, p. 392
3. Cf. Eddington, The Nature of the Physical World, pp. 84-85
4. Ibid., p. 85

however, the scientist does seek mental rest from this troublesome problem, for there are difficulties still even in his attempted solution. In the first place, if the theory is incredible, it cannot be expected that man will willingly acquiesce in it. Again, the view that "things started off with a bang" is not incredible.[1] Indeed, many scholars to-day hold that it is freer from difficulties than any other theory; they find evidence to the contrary unconvincing. Neither does this hypothesis imply a discontinuity in the divine nature. If this argument could hold water, then every time the author of this statement has begun some new presentation of his theories, a discontinuity in his nature has been involved. The creative act of God does not imply a hiatus in His nature any more than the creative activity of the sculptor, as he puts his chisel to work on the marble, necessitates a break in the nature of his self.[2] Anticipating this criticism, therefore, Eddington suggests that entropy, which brings on these troubles, should be removed from the sphere of the debatable into the realm of the subjective.[3] As in the case with the problems of space, whenever the difficulties of this theory become too great, it seems best to remove it from the arena of combat by consigning

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1. Cf. Inge, God and the Astronomers, p. 244
2. Cf. Ibid., p. 244
3. Cf. Eddington, The Nature of the Physical World, p. 95

it to the inner prison of the mental realm. But, as previous discussion has proved, this does not eliminate trouble, for it breaks out again in the dungeon.

b) Specifically Stated

(1) The Theory of the Annihilation of Matter Made to Support This Theory Is Not Proved

One of the supposedly strongest bits of evidence advanced in support of the law of entropy is that relative to the loss of energy and weight by the sun and stars. The slowness with which the weight decreases, in comparison to the tremendous amount of radiation released, has led to the assumption that this could be accounted for only on the basis of the annihilation of matter by the complete disappearance of protons and electrons involved in the change.[1] Jeans advocates this theory everywhere in his writings, stating that what is produced as a result of its operations on a large scale is an enormous mass of radiation that cannot be fully accounted for by any other hypothesis.[2] This theory, it is said, especially applies with reference to the sun whose source of energy would be a real enigma on the basis of any other explanation.[3] It also is believed now to work equally well in the interior of stars.[4]

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1. Cf. Jeans, Eos, p. 36
   Cf. Jeans, The Universe Around Us, pp. 179-180
2. Cf. Jeans, The Mysterious Universe, p. 91
3. Cf. Ibid., pp. 81, 82
4. Cf. Ibid., p. 83

Now the objection to this view of the annihilation of matter is that it really does not prove, as its name would suggest, that matter is actually made to vanish into nothingness. Even after the annihilation has been reported, Jeans speaks unhestitantly of radiation being the residue which is left after the catastrophe.[1] But it does not seem to be an exact use of language to speak of annihilation and then to refer immediately to some entity resulting from it. If there be a residuum after the death of electrons and protons, matter can hardly be said to have annihilated itself. One is inclined to agree with Inge's criticism of the careless use of "annihilation" in this sense.[2] May the same critic not also be right when he says, "I do not believe in the annihilation of anything: I believe with Epicurus and Lucretius; nil fieri ex nili; in nilum nil posse reverti?"[3] At any rate, this theory cannot deny the affirmation, and there is apparently no other theory which does.

(2) Millikan's View of the Origin of Cosmic Rays

While Jeans strenuously asserts this annihilation hypothesis and uses it to explain the puzzling origin of cosmic rays, Millikan discounts the theory, first of all,

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1. Cf. Jeans, Eos, pp. 36-41
   Cf. Jeans, The Mysterious Universe, p. 82
2. Cf. Inge, God and the Astronomers, p. viii
3. Inge, God and the Astronomers, p. 39

on the basis of its waning influence. He says:

> "It seems to be becoming popular now for the astronomers to use this synthesis hypothesis instead of the annihilation hypothesis to explain the evolution of heat energy by the stars. Indeed, the annihilation hypothesis seems at present to be in a state of eclipse."[1]

Jeans admits that the question is not beyond dispute, and states that Professor Millikan's view is that cosmic radiation results from the building up of heavier atoms from simpler, lighter constituents, instead of from the annihilation of matter.[2] Millikan himself feels that the source of this abundant radiation lies outside the galactic system in the depths of interstellar space.[3] The atom-building process going on there is believed to counter-balance the opposite prowess which even he admits may be taking place in the interior of stars under conditions of an entirely different character.[4] Like the tides which ebb in one place only to rise in another, so is the working of this process of the alternate destruction and construction of matter.[5] Millikan says, therefore, that, according to his view, "the creator is still on the job."[6]

It would be interesting to list here the scientific facts which this great scientist and his assistants have

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1. New York Times, June 22, 1933
2. Cf. Jeans, The Mysterious Universe, p. 88
3. Cf. Jeans, The Universe Around Us, p. 140
4. Cf. Millikan, Science and the New Civilization, pp. 106-107
5. Cf. Jeans, Eos, p. 50
6. Jeans, The Mysterious Universe, p. 88

brought to the support of this theory; but these do not have any intimate bearing upon the purpose of this investigation and their enumeration would unduly extend this chapter.[1] Furthermore, the view is only a working hypothesis which, like its opposite, has not yet been sufficiently established to be appealed to as authoritative. It is simply pitted against the annihilation theory in this catalogue of arguments for and against the belief in a universe which is running down like a clock. In that setting it is worthy of due consideration as a theory, since it commands the support of a scholarly group which is just as much entitled to be heard as those championing the annihilation hypothesis. The division of opinion on this moot question, however, cancels the effectiveness of any argument built upon either side of it.

(3) Jeans' Testimony Concerning the Spiral Nebulae

Further support for the view opposing the universal application of the law of entropy comes from an unexpected source. Jeans, who is looked upon as upholding the validity of that law, even when applied to the whole of the cosmos, maintains at the same time another view, ex-

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1. Further consideration of these matters pro and con will be found in Millikan's, Science and the New Civilization, pp. 98, 108,109,161,162; New York Times for June 22, 1933 and June 24, 1933; Jeans, Eos, p. 46

plaining the character of the spiral nebulae, which appears to contradict his declared position and to favor the opposition. In an effort to account for the peculiar nature of the arms of these nebulae, he is led to suggest that

> "the spiral nebulae are the seat of types of forces entirely unknown to us, forces which may possibly express novel and unsuspected metric properties of space. The type of conjecture which presents itself, somewhat insistently, is that the centres of the nebulae are of the nature of 'singular points', at which matter is poured into our universe from some other, and entirely extraneous, spatial dimension, so that, to a denizen of our universe, they appear as points at which matter is being continually created."[1]

If the author takes this theory seriously, he has by it admitted that there may be a winding-up of this universe as well as a running-down. It is conceded by this scheme that matter may reach this universe from some fourth dimension.[2] The law of entropy, therefore, does not hold for distant worlds in space. And if it still should be maintained by Jeans that "science can give no support to such fancies"[3] as depict a world being newly fashioned, his own theories certainly do.

(4) The Theory of the Cyclic Universe

Although it has been said that the theory of a cyclic universe is wholly at variance with the law of entropy, and,

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1. Barnes, Scientific Theory and Religion, p. 397, quoting Jeans, Astronomy and Cosmogony, p. 352
2. Cf. Barnes, op. cit., p. 398
3. Jeans, The Universe Around Us, p. 319

therefore, is impossible,[1] its opponents acknowledge its popularity.[2] But in recent months the scheme has received the support of men like Einstein and de Sitter who see the universe alternately expanding and contracting.[3] Of course this is only an unproved theory and can have no more weight than any hypothesis of this nature. Nevertheless, in any balancing of arguments, this should be allowed to make its influence felt. Its significance is just this: if the universe be contracting as well as expanding, it must be possible to reverse this supposedly inexorable law. The running-down of the universe, said to be proved by its expansion, must then be disproved by its contraction. There would here be a complete reversal of the process described as the second law of thermodynamics.

(5) The Theory of Evolution

The theory of evolution is also called to the witness stand to bear testimony against the sovereign character of the second law of thermodynamics. Briefly stated, its evidence is to the effect that its own process is introducing organization into the world in contradiction to the law of entropy.[4] Evolution, however, is a very broad

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1. Cf. Jeans, The Mysterious Universe, p. 180
2. Cf. Ibid., p. 181
3. Cf. The New View of Einstein and de Sitter on p. 174 of this chapter
4. Cf. Russell, The Scientific Outlook, p. 93

term and may be used in many ways with more or less confusion unless its meaning is made clear. There are restricted and there are absolute views regarding its application. Before it can be talked about intelligently, the significance of the idea must be carefully defined. But even if its broadest application be allowed, the new cosmologists still maintain that it is then introducing increasing organization into only a small corner of the great universe, and that, in the end, the effect of its work will be lost in the general running-down of the whole.[1] Inge agrees with this criticism of its pretensions, stating that evolution is only local and temporary when compared with the totality of the cosmos and the vast reaches of time.[2] It would appear from these remarks that the prevailing view is that its feeble voice cannot be heard above the death knell of the universe. If the figure be changed, this idea may well be expressed in the words of Jeans who says: "If the inanimate universe moves in the direction we suppose, biological evolution moves like a sailor who runs up the rigging in a sinking ship."[3]

(6) The Phenomena of Life and Mind

With the preceding testimony it might seem that the

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1. Cf. Russell, The Scientific Outlook, p. 93
2. Cf. Inge, God and the Astronomers, p. 55
3. Jeans, Eos, p. 69

matter should rest. But the phenomena of life and mind cry out for the further privilege of being heard separately. They will not be subdued so easily. In living bodies the vitalistic biologist declares that the process of katabolism is resisted and the effort is made to maintain the normal vital activities and to protect the normal living structure.[1] The increase of entropy is thus retarded in this higher realm of nature.[2] This is especially true when the mental life is considered. The sum total of these observations, therefore, leads Lodge to say:

> "I doubt very much whether the second law of thermodynamics has the dominating position which Eddington claims for it—at least not when we go beyond physics. . . . He would surely admit that waste can be checked by mental operations, that is by the operations of life and mind. They are able to take things under control, and thereby restore order out of disorganisation.
> . . . .
> Their function is mainly that of winding things up, organising things, sorting things, introducing order. . . . In so far as life acts at all, it is an organising and directing or guiding power. Well, I want to recognise that on a cosmic scale."[3]

The opponents of this view, however, are unwilling that Lodge, or any one else, should do this. Again they would seek to introduce the devastating criticism levelled against the theory of evolution as a whole. By casting doubt upon the possibility of such a process as that

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1. Cf. Haldane, The Sciences and Philosophy, p. 65
2. Cf. Inge, God and the Astronomers, p. 54
3. Lodge, Beyond Physics, pp. 108, 111

sustained by life and mind ever going on except in small isolated regions of the universe, these critics, figuratively speaking, would leave this final wish of Lodge stranded on a shore from which the tides forever are receding. From this standpoint, the localized process of constructive effort is caught in the vaster scheme of opposing forces and is doomed to perish with the whole. But since this view is only in a hypothetical state at present, relief from it may be sought in the cumulative evidence, scientific and philosophic, which is advanced against it in these pages. So far as actual knowledge is concerned, one is privileged to choose that theory which best harmonizes with his convictions received from other sources of knowledge.

3. Summary

In concluding this division of the chapter, a recapitulation of the main points which have been discussed is in order. On the one hand, there has developed among a recent group of cosmologists a belief that scientific evidence supports the view that the universe as a whole is running down like a clock which cannot wind itself up, and which is not being wound up by any power. The inevitable conclusion of the process, it is said, will be the stoppage of the clock when it is completely unwound.[1]

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1. Cf. Jeans, Eos, p. 52

This condition, towards which the universe is moving, is known as the state of thermodynamic equilibrium or heat-death, in which energy loses all capacity for change.[1] The law expressing this general tendency in nature is known as the second law of thermodynamics or the law of entropy. It is supposed to be irreversible in its working, except by local and momentary processes which are eventually bottled up by its encompassing movement. The universality of this law, on the other hand, as well as the data produced in support of it, has been challenged by other reputable scholars who believe that, while there is evidence that energy is being demobilized, there is also contrary evidence to the effect that it is being used to reconstruct matter and to give to the universe an appearance of being recreated. This process is thought to take place in interstellar space. The theory is chiefly supported by the evidence from cosmic rays reaching this earth. Other facts and arguments, too, are listed in its favor and give to the view a considerable prestige. Between these two opposing groups of physicists there is a friendly rivalry. But no evidence thus far produced by either camp in defense of its position has been sufficiently damaging to the opponent's stronghold to produce confusion in the ranks. And so the battle line continues

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1. Cf. Jeans, The Universe Around Us, p. 317

to remain as it is, while volunteers recruit the ranks on either side.

E. The Religious Significance of the New Cosmology

1. The Implications of the New Theory of Space

a) A Finite Conception of God

(1) Explanatory Remarks on This Deduction of a Finite God

In turning now to a study of the religious implications of the theories presented at length under the caption of this chapter and the preceding one, it seems best to proceed in the order of the views examined, since this affords a logical method that is well adapted to the intricacies of the thought. A further word needs also to be said with regard to the present deduction and all others which follow. Because they are extracted logically from the given hypotheses, it does not also follow that the authors of the theories in question are to be regarded as sanctioning these conclusions which seem to be involved in their schemes. Often scholars have entertained for a time views which later have been promptly repudiated as soon as their full implications, at first unrealized, became known. No sinister purposes or crude thoughts, therefore, are meant to be imputed to those whose hypotheses may be found to contain startling religious implications. With profound respect for their attainments and for their sincerity of motive, should one listen to what these men have to say, giving heed to the significance of their teaching.

(2) The Basis for This Deduction of a Finite God

(a) The Desire for a Finite Universe Creates an Antecedent Presumption in Favor of This Deduction

The first justification for making the present deduction lies in the philosophical premise laid down for a belief in a finite universe. Repeatedly it has been said that an infinite world is inconceivable, and that only a finite conception can offer to the scientist the encouragement to proceed with the purpose of understanding it.[1] From these statements the question naturally arises, upon the basis of the present scientific temper and method, whether or not an infinite God could be more easily conceived than an infinite universe, and whether or not also a finite God might not better suit the desire of the scientist for something which he can hope to understand because it is capable of being compassed with the mind. If the prevailing purpose in science is to reduce everything to measurements and to speak always in terms of mathematical symbols and formulae, by rejecting what will not conform to this pattern, then the finite conception of God seems, antecedently at least, to be nearer to the

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1. Cf. Text and footnote on pp. 192-193 of this chapter

scientist's ideal than the infinite view of God. Should this conception of a limited God be rejected because the infinite view appears more reasonable and satisfying, it follows then that the idea of the infinite is not unthinkable and that from the metaphysical viewpoint an infinite universe is just as acceptable, if not more so, to the mind than one which can be circumscribed wholly by man's thought.

(b) The Finite Conception of the Universe Involves This Inference

This deduction, however, is not based primarily upon the current scientific attitude towards the infinite, but upon the recent conception of a finite universe which science itself has largely sponsored. This view has been referred to as indicating the range of God's activity.[1] From the words of Barnes it would appear that a finite conception of the world is synonymous with a restricted view of the activity of God. But if this be so, it is difficult to see how anything other than a finite God would fit into the picture of His finite actvities. More disturbing than the problem created by an infinite universe, is the embarrassment of trying to conceive of God with unlimited capacities engaging in only finite activities. If it were actually possible to comprehend

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1. Cf. Barnes, Scientific Theory and Religion, p. 49

such activity, God would be exposed to the charge of utilizing only an infinitesimal fraction of His powers, the remainder of which, in turn, might be looked upon, humanly speaking, as wasted energy or talent. The dilemma of this situation, stated in other words, is that of trying to reconcile the finite totality of God's activity, as represented in the finite universe, with an infinite capacity for activity which must of necessity reside in an infinite God. The problem resembles the opposite difficulty of trying to harmonize infinite activity with only finite capacity. It is abundantly demonstrated that the latter can only reproduce after its kind. The finite by the totality of its works will always be recognized as finite. In a similar manner the infinite by the sum of its activity should also reveal its true character. It cannot deny itself by its works. And so, for science to have pushed the antinomy of the finite and the infinite beyond the enclosure of a finite mathematical universe, has, therefore, only resulted in the admission of the contradiction again in the consideration of the philosophical and religious difficulties which the present scientific conception of the world implies. It is another indication that modern science cannot so easily dispose of all of the problems foreign to its interests by dumping them across the border of its realm. They remain there waiting to enter in as soon as the alien laws are lifted by internal pressure.

(3) The Denial of This Inference by Science

It is possible, however, to anticipate what answer modern theorists would make to the charge that their finite view of the universe necessitates a finite God. As in all previous instances where intransigent facts have confronted their hypotheses and brought them to an impasse, they would certainly seek first to escape from this situation by maintaining that this finite view of the cosmos is only a mental concept. But this view is exposed to all the criticism directed against it under the discussion of space. Not the least of these is the one impeaching a science that has lost all contact with reality and has shut itself up to a purely subjective interpretation of the universe. An equally strong objection to this metaphysics of science is its failure to remove the antinomy it was meant to obviate, because its residence is in the mind itself.

Defeated in this attempt, the present-day cosmologists might next try to say that there is an actual correspondence between this mental view of the world and that which lies behind it. God, they might claim, is also mind, and has revealed Himself in the world in ways which can be interpreted only by mental pictures. The difficulty, however, with this second effort to escape the inevitable conclusion of their scientific theory is that, if they are truly reading God's thought by their mathematical interpretation of the world, they still can report only a finite God behind the world, since the totality of His thoughts can be measured by science.

To extricate themselves from this unpleasant situation, the scientists might reply that, of course, they conceive of God as having other thoughts than those which man thinks after Him in his attempt to explore the universe. But this newway out proves only to be a _cul de sac_; two things can be said about it which completely close it against through traffic. In the first place, it contains an admission that there is something distinguishing these thoughts of God which constitute the world from the other thoughts of His which are not to be confused with it. Unless the former are segregated from the rest of God 's thoughts and in some sense objectified, how could the honest investigator know when he is charting the cosmos that he has at last come to its frontiers? But in this case, science becomes more than a mere subjective interpretation of the world and must take on an objective character, since God's thoughts in the outside world are different in form from those residing in man's mind. Here again the harassing problem of the old epistemology reappears in connection with an objective idealism. If the objective thought of God is finite, what lies beyond that thought? And how can an objective world of idealism expand into what is said, on the basis of this theory, to be subjective? There is here a conflict of ideas in the divine nature brought on by the new view of cosmology.

In the second place, this last proposed solution faces a handful of hostile spears when it is considered solely in relation to the problem of God. To begin with, how can the objective thought of God be finite and His subjective thought infinite? If one kind of God's thought be infinite, what logical reason is there for thinking that another kind proceeding from the same source is not infinite? Or, if the subjective thought be considered finite, too, then how can the sum of God's thought in two finite spheres create a picture of God as infinite in wisdom and knowledge? Yet this is the dilemma to which one comes when one speaks of a part of God's thought being objective and finite and the remainder as being subjective and finite. But suppose the solution of the problem by science is accepted by disregarding this difficulty. If there are other thoughts of God as suggested, on the supposition that He is infinite what is to hinder one from believing that outside this self-contained universe God has objectified His thought to an infinite degree until a picture of the universe, like that which Kant drew, may be nearer to reality than this limited concept now obtaining in science? Science cannot object, for if it can read its closed world from the inside only, it cannot say what lies beyond it. And certainly the present hypothesis about the universe, with its implicates about God, is not so pleasing to any philosopher who is seeking for a comprehensive view of the whole that he would raise his voice in protest against framing such an ambitious conception.

(4) The Religious Offense of This Position of Science

Nor is this conception any more satisfying to the religious nature of man. If there be a God, the mind, which is sensitive to Him, reasons that He must be greater than our thoughts of Him. With something akin to the divine in its nature, it, therefore, sallies forth in its inquisitive mood across the boundaries which science has set for it when it says by its closed world, "Thus far shalt thou go and no further", and looks beyond the run of measured space. It will be Kantian in its desire to reduce everything to reason, so far as this can be done, and it will rattle the categories of science with pleasure, when they do not deny reality to the most sacred part of our experience and belief; but just as the great philosopher went beyond his logical system to make room for freedom and morality,[1] so will the religious mind go beyond a finite universe to make room for an infinite God.

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1. Cf. Weber and Perry, History of Philosophy, pp.376-380

In a deeper sense than pure science can fathom, or even the poet imagined, the human spirit cries out before this closed world of finite structure and its restricted view of God, saying:

"Build thee more stately manions, O my soul,
As the swift seasons roll!
Leave thy low-vaulted past!
Let each new temple, nobler than the last,
Shut thee from heaven with a dome more vast,
Till thou at length art free,
Leaving thine outgrown shell by life's unresting sea!"[1]

(5) The Proposed Solution of the Scientific Difficulty

(a) The Advantage of This Solution

All of these difficulties, scientific, philosophical and religious, emanate from the same source. If science grants an infinite universe in real space, which at present it seems disinclined to do, then these problems are avoided, though, of course, not all troubles by any means are thereby removed. That would not be possible on the basis of any view. In defining one's own position, however, it is always well to proceed on the principle that a theory is reasonably acceptable when it answers more questions than it raises. But certainly the one proposed by present-day cosmologists does not meet this requirement. Contradictions bristle from it on every side. In its religious implications especially, it affords no resting

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1. Holmes, Oliver Wendell, The Chambered Nautilus

place for the soul that wants an infinite God to complement its needs.

(b) The Defense of the Proposed Solution Against Criticism

Again, therefore, it is necessary to affirm that only an infinite universe in objective space can satisfy the mind that such a God exists. But, if this position be accepted, objections immediately begin to be raised against it. Ontological space, it is said, is impossible because the very idea of it becomes involved in hopeless difficulties.[1] Knudson has pointed them out in a quotation previously given in this chapter.[2] It seems best, therefore, to attempt an answer to these criticisms in their order before proceeding to other considerations in support of this objective view. In the first place, since space is not active, it is held to be acting in a manner inconsistent with reality which is active to identify space in any way with it. But just how do we know that space is not active in some way? Science and philosophy both admit that we know very little about its real character,—in fact, too little to make any categorical affirmations about its character. Furthermore, it would appear that there are some senses in which space,

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1. Cf. Knudson, The Philosophy of Personalims, p. 234
2. Cf. p. 179 of this chapter

contrary to the opinion just presented, gives evidence of activity. The phenomena of gravitation acting through space and of light piercing it cannot be explained on the basis of the complete inactivity of space. These and other problems of science have inclined Sir Oliver Lodge to impute this active characteristic to some ether filling the whole of space. But since it has not been discovered, the credit must still go to space itself, whatever its ultimate nature may be. Then, too, recent science looks upon space as producing curvature in light rays. In addition to all this, space itself, on the testimony of recent scientists, is expanding and contracting. It is pertinent, therefore, to ask whether any entity could be performing all these duties assigned to it and not be in some sense active?

But it is further declared that such a view is inconsistent with the unity of reality, since it presents the possibility of a division in space and of any spiritual being said to occupy it.[1] In answer to this criticism it can be said that real space is, first of all, conceived of as infinite. An infinite substance is not divisible; there is always an infinite amount in existence if the term has any meaning to begin with. Again,

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1. Cf. also Snowden, The World, A Spiritual System, p. 60 The whole discussion of this subject from a strong subjective viewpoint is to be found in this same connection. Cf. the whole of pages 49-77

space is here viewed much as Bradley suggested,[1] as just one face of the divine reality. It is an expression of God's objective thought only, but the divine has also a subjective side. God's complete life, therefore, can never be divisible any more than it is possible for man's personality to be divided by powers extraneous to himself. The philosophy here presented is not acosmism which denies the existence of the universe as distinct from the life of God, but it is a belief in the reality of the world as being God's thoughts which are given concrete form. This belief is somewhat parallel to man's belief in the reality of his own thoughts which he has carved in matter. As the individual is separate from these real entities, so does God exist apart from His objective world.

Lastly, this view is said to be inconsistent with an ultimate monism and to favor dualism. But this objective thought of God is no more inconsistent with an ultimate reality than is the subjective thought of the reality of Him, which would be admitted by Knudson himself. Both issue from the same ultimate source. If the one creates dualism, so must the other. Instead, however, together they are taken up into the unity of that personal life of God which abolishes a contradiction at the center of His being.

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1. Cf. Jeans, The New Background of Science, p. 144

(c) Additional Considerations Favoring an Infinite Objective World in Real Space

Before leaving this subject, several general considerations in support of the objective reality of an infinite universe may be mentioned. First of all, science is not sure of its finite, subjective position as yet. Even Jeans warns his readers about taking present scientific conclusions concerning the world as final.[1] And Inge reminds us that every closed system of man's construction leaks somewhere.[2] Taking the liberty of suiting Emerson's words to the occasion, one may say, "There is a crack in all that God has made."[3] God's universe will often not hold man's puny philosophies because they are unworthy of a place in such a wonderful world.

Furthermore, since it has been implied that an infinite objective world is necessary to the belief in an infinite God, if any objective world is admitted at all, and since an infinite objective space is necessary to an infinite real world, what can be said positively in favor of such a space? It is difficult to doubt that there is some objective reality behind matter, unless one is willing to be content with living in a world of pure

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1. Cf. Jeans, The New Background of Science, p. 139
2. Inge, God and the Astronomers, p. 65
3. Ibid., p. 65

illusion. But man has not fashioned that reality; it is not the objective creation of his thought. Why then deny a similar objective reality to space when man's thought cannot be spatialized in this way? In order to believe in real matter, one is not called upon to create it by his thought; and the same is true with objective space. But because man's thought does not possess this power of objectifying itself in a creative sense, it does not follow that God cannot do this. It is anthropomorphic to say that because man's thought cannot be spacialized, God's cannot be. God has objectified His thought in matter and it is reasonable to suppose that He has done the same in space. Surely His thoughts can take more than one form if He so wills.

Lastly, it is false to argue that because man has a subjective experience of space, space must be only a subjective reality.[1] Yet much of the argument against an objectively real space proceeds in this fashion. It is forgotten that there may be a real space extraneous to the individual and there may also be an imperfect subjective experience of that space, due to the mind's imperfect means of transmitting the impression coming from the outside world. Space may be claimed to be both objective and subjective. This is in keeping with the common belief

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1. Cf. Snowden, The World, A Spiritual System, p. 52

that there is an actual world of nature and there is also man's experience of that world. It is correspondence between these two worlds that establishes truth. Man can assert the reality of space because this objective entity finds its counterpart in the subjective framework of the mind that can receive the impression of space. The inward experience of space is actually wrought by the concerted action upon one another of the objective and subjective entities involved in its production. Because the final act in the experience of space takes place in the mind, there is no justification for saying that space, therefore, is subjective and cannot have any objectivity. It is entitled to just as much consideration as a real entity outside our experience as any other reality of nature. Because it is not understood better is no reason for denying it this right. As far as this point is concerned, not even matter is as yet understood; its nature is still puzzling. But the scientist does not deny its existence for that reason, at least when he is engaged in active experiment. His attitude towards space need not be different.

b) A God of Supreme Intelligence

Although the new findings of modern astrophysics seem to involve some undesirable ideas about God, they also imply certain very pleasant teachings about His nature. In the macroscopic study of the universe, particularly in reference to the subject of space which comprehends the whole, it has become evident that the God behind the world is a God of supreme intelligence. His world challenges the powers of the greatest human intellects and partially yields its secrets only as reason rises to new heights in its endeavor to understand the Supreme Wisdom.

But science has not always looked upon its efforts exactly in this light. The Kantian view has often obtained, namely, that man has extracted from nature only that which he has put into it, or that the footprint discovered on the shores of the unknown has turned out to be man's own.[1] In his less philosophical moments, however, the physicist recognizes that he is trying to read the meaning of a world that is not primarily constructed out of his thought, but which exists to declare the mind of God to him who patiently seeks to discover in a measure its form and content. In other words, he recognizes that the world is objectively real and that in reading it by his mind, he is, as Kelvin said in substance, attempting to think God's thoughts after Him. Such a view is actually in accord with the view of Paul who said: "For the invisible things of him since the creation of the

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1. Cf. Eddington, Space, Time and Gravitation, pp.200,201
Cf. also Inge, God and the Astronomers, p. 45

world are clearly seen, being perceived through the things that are made, even his everlasting power and divinity . ."[1] Man is finding this more and more true as he traces out the secrets of the universe with his mind. The marvelous results that have been achieved by the application of newly reasoned theories only show that God's thoughts are high above our own and are only beginning to be revealed. Man has merely touched the surface of the great deeps of divine wisdom.

c) A Conception of the Exalted Character of Man's Mind

Closely related to the implication just unfolded is the suggestion concerning the greatness of man's mind. While it certainly cannot create in the sense in which God's mind creates, it can grasp in finite measure the thought of God as objectified in nature. As has been well said, the world is constituted for thought as well as by it.[2] The mind, therefore, which can fit itself into the divine thought of the universe does not so much declare that man's mind rivals God's as it shows that the human intellect is akin to the divine,—that, as Inge says, it is "of a piece with the intelligence which created . . . the universe."[3] This is especially indicated in the power of the human mind to deal with the concepts occupying

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1. Romans 1:20
2. Cf. Mullins, The Christian Religion and Its Doctrinal Expressions, p. 113
3. Inge, God and the Astronomers, p. 45

the attention of the modern cosmologists. These are colossal in their range and show how near to the divine is the mind which can fashion them even when they can be said to represent reality.

2. The Religious Significance of the New Views of Time

a) The Reality of Progress

(1) The Basis of This Implication

(a) Introduction

In the shifting of this inquiry concerning the religious implications of modern scientific thought from the viewpoint of space to that of time, one of the principal observations to be made is that the new views seem to guarantee reality to the idea of progress. This is based upon the prevailing opinion among astrophysicists that time itself is real.

(b) Scientific Confusion Regarding the Basic Fact

There are, however, certain seeming contradictions and difficulties in the scientific statements regarding this subject which make the basis for the implication less secure than one could wish it to be. In the first place, for one claiming that current theories favor the view of the reality of time, there exists the problem of reconciling the mathematical universe of present-day construction, in which time has no place, with the theory of entropy that presupposes time.[1] In other words, there faces the believer in a real time postulated by science the difficulty of adjusting the mentalism of the new views with the objective facts upon which the law of entropy is supposed to rest. If it be said that the data, upon which the second law of thermodynamics is built, are subjective in character and do not correspond to objective fact, then time, which is determined by that law, becomes in reality a subjective illusion. Even if it be held that the subjective is also authoritative and not illusory, there still remains the difficulty of explaining how time, originating in this way, could ever be thought of as coming to a close at some time in the distant future. That is to say, how can one be sure of a running-down of the world if the facts to prove it originate in the mind? Then, too, is it conceivable that mind does in this way pass a sentence of death which is eventually to be executed against itself? These questions, and others more extreme, which might be asked in chasing this dilemma into the very citadel of the mental realm from which it issued, need to be honestly faced before one is in a position to affirm or deny that science believes in real time. It is only when the fallacies of a purely subjective view become clear that this true foundation for any real progress seems

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1. Cf. Inge, God and the Astronomers, pp. 43, 70

assured.

In the second place, the contradictory opinions of the individual scientist holding to real time must also be weighed and evaluated. Jeans is a great source of trouble in this respect to the one wishing to believe in real time on the basis of scientific authority. He supports strenuously the law of entropy which, as time's arrow, points in only one direction. But in his theorizing about time he suggests that it may be running backward as well as forward, or even standing still.[1] If this second law of thermodynamics operates in only one way, it is rather puzzling to the ordinary student of these matters to know how it can tell time in three different ways. It appears to be a somewhat more versatile law in this respect than its unilinear function would permit, and less dependable than the claims for it would indicate. Furthermore, when removing the obstacles which science has put in the way of an unshakable confidence in real time, one must seek to harmonize Jeans' support of the law of entropy, which declares the end of time at some distant point in the future, with his paradoxical belief in time as going on eternally in the future.[2] Again, if the theory of this same scientist regarding the entrance

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1. Cf. again Jeans, The Mysterious Universe, p. 37
2. Cf. again Inge, God and the Astronomers, p. 240

of energy into the focal centers of the spiral nebulae from some source outside the known universe be correct, then the law of entropy is overturned just as it would be if cosmic rays were found to be proof that matter is being created. From such contradictions as these, and others which might be mentioned, it can be conceded that the testimony in individual cases for the law supporting real time is greatly weakened. But the preponderance of scientific opinion, when deductions have been made for lack of clear-cut views, goes unmistakably to the support of real time. It seems to confirm the statement of a theologian and philosopher to the effect that, do what one will, it is impossible to obliterate the objective reality of time.[1]

(2) The Importance of This Basis for Real Progress

The significance of this view of time is vital. In commenting on this subject, Barnes frequently declares that real time is fundamental for a belief in real progress. He quotes with approval the words of Rashdall who said: "You cannot believe in progress if you do not believe in real time."[2] Man's aspiration after goodness and his efforts by the help of God to attain righteousness require genuine time for their exercise if they are not to be more than mere illusions themselves.[3] Haldane has recognized

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1. Cf. Beckwith, The Idea of God, p. 231
2. Cf. Barnes, Scientific Theory and Religion, p. 650
3. Cf. Ibid., pp. 409, 650

this when he has looked upon the time-relation as expressive of the progressive unity of spiritual existence.[1] If this be a phantom world that appears to be on its way, but doesn't know where it is going, whether backwards or forwards, or perhaps remaining still, then all talk of moral development and of growth in ethical and spiritual discernment is a snare and a delusion. Man is to be classed in that case with the dumb animal on the treadmill that thinks it is progressing, but with all its efforts is only standing still. Such a concept of life would be stultifying to spiritual initiative and paralyzing to all moral endeavor.

(3) The Philosophical and Religious Difficulties Inherent in the Future and the Past of the Limited Character of This Real Progress

Science removes for the present such problems as these which are not pleasant to study. But if the concensus of scientific thought is to be accepted, they will return again in slightly altered form when the law of entropy has run itself out and ceases to be. What then will happen to all unfinished purposes? Will they be cut off at whatever stage of completion they have then reached? And will all progress and development end at this point? The answer, it seems, will have to be in the

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1. Cf. Haldane, The Sciences and Philosophy, p. 179

affirmative unless it is admitted that the process just completed will begin all over again and will continue in an endless cycle. Eddington does not like this idea. Continual repetition, in his view, would become boring to God.[1] But Inge seems to incline towards this idea, since he holds that there may be an infinite succession of finite purposes which, when they have been fulfilled, take their place in the eternal order.[2] He bases this belief on the premise that because infinite purpose is eternally frustrate, all purposes must be finite. The idea of everlasting universal progress is to him a mere superstition.[3] This position may be open to criticism, but it is not more so than that of science from which it seeks to save man. The prospect of eternal slumber in the world and of purposeless inactivity in God is more boring than any endless cycle of changing dramas in the universe could be.[4]

This last thought brings one to the consideration of the distant past as well as the distant future in the life of God when time was not and when, according to the law of entropy, it will not be again. Inge thinks that for the whole (meaning by this the realm of absolute values) time

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1. Cf. Inge, God and the Astronomers, p. 35
2. Cf. Ibid., loc. cit.
3. Cf. Ibid., pp. 35, 69
4. Cf. Ibid., pp. 36, 69

can have no significance.[1] But absolute values are inherent only in the life of God. Therefore, for the person of God time is said to have no meaning. This is a common interpretation of time in relation to God, but it raises certain difficulties. In the first place, it is hard to see how God can even exist without time, for the reality of God implies His existence and existence in turn involves time.[2] Even though Inge denies it,[3] the now in which God is said to exist, if it has any meaning whatsoever, must imply a consciousness of before and after. Furthermore, the fact that God has created time is additional proof that it is in His thought before it is in man's. To have caused time and yet always to have been heedless of its onward flow seem like contradictory acts of God. If God does not count time, how could the fulfilment of any of His purposes appear so well timed from the standpoint of earth? Surely God's redemptive plan in history has all the earmarks of one which a God, conscious of strategic moments and aware of "the fulness of time", would be likely to project. A study of history amply confirms this belief. Thoughts like these, therefore, have no doubt led Knudson to admit that the eternal and timeless character of God does not exclude the

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1. Cf. Inge, God and the Astronomers, p. 69
2. Cf. Beckwith, The Idea of God, p. 233
3. Cf. Inge, op. cit., p. 89

knowledge, on His part, of man's temporal experience, nor does it exclude the temporal from His own experience.[1] But if time is a part of God's experience now, there seems to be no good reason which can be advanced to show that this is not eternally true. Time, therefore, may have an endless existence and survive even the death of the universe, if this be according to fact. It can then be looked upon as inherent in the life of God and not dependent for its existence upon an entropy clock that is running down. Certainly God can have more than one time-piece in the universe, but if it should turn out that He doesn't, then it is possible to believe that God is His own time-keeper.

And from the standpoint of science, if Jeans' statement about an endless future for time also be accepted as the voice of science, it is impossible to see how any other view than this would suffice. The clock that science knows is running down and, it is said, is not being wound up. Some day it will stop and then man's means of measuring time will have failed. Having nowhere else to go, the scientist is inevitably driven back to God upon Whom he must rely to aid in filling out so many of his incomplete explanations of the nature of things and processes.

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1. Cf. Knudson, The Doctrine of God, pp. 282, 284

Before dismissing this subject of progress in time, it may be profitable to consider the objections of Inge to placing time or progress in the eternal order.[1] His reasoning seems to be as follows: progress involves purpose for its accomplishment, but purpose, to be kept from being eternally frustrated, must be fulfilled in time which can come to an end.[2] Therefore, he approves of the assertion of the Platonists that "Time is in the universe, not the universe in Time."[3] The view presented in this thesis is that time is in the universe and the universe is also in time because both are in a sense in God. This does not hinder the same measure of accomplishment with regard to the fulfilment of purpose that is to be found in Inge's view, but it does leave room for eternal progression which the other view prohibits. Finite life, under this view, may continue to develop in the eternal order of things and to approach more and more towards the perfection of the infinite. Such a view relieves a monotony of stagnant perfection and offers the creature the joy of eternally becoming, instead of the contemplation of having once for all attained. And it does not frustrate God's purposes, but recognizes that in Him what is eternally realized, and is viewed <u>sub specie aeterniti</u>

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1. Cf. Inge, God and the Astronomers, p. 35
2. Cf. Ibid., pp. 35,69
3. Cf. Ibid., p. 70

is also being eternally wrought out in the finite. To see this approach to His ideal upon the part of His creatures is what helps to give eternal satisfaction to God.

3. The Religious Significance of the Running-down of the Universe

a) The Indispensablness of God for an Explanation of the Universe

(1) The Alpha and the Omega of the Universe of Science

Some implications of the theory of a universe which is running down have already been included in the preceding discussion about the religious significance of time, because this seemed to be relevant to the thought which was there expressed. Still others, with an ethical bearing, which are closely related to the study of society in relation to the new views, will be reserved until a later chapter. In the following considerations, therefore, only those implications referring to the idea of God need be presented. The first of these indicates the absolute necessity of God for any adequate explanation of the reigning scientific view of the world. Laplace, it is said, when speaking about his own nebular hypothesis to Napoleon, told the great general that it did not seem to him to require God for its complete operation.[1] But

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1. Cf. Barnes, Scientific Theory and Religion, p. 583
Cf. also Taylor, Does Science Leave Room for God?, p.30

science cannot speak in that manner to-day about its newest theories. Rather do the cosmologists frankly admit that these necessitate God. In order, even, for the process described by the law of entropy to be instituted, God must, therefore, be invoked to wind things up and set them going on this downward course of disintegration. And when the complete scattering of energy has taken place and the world has reached the state of thermodynamic equilibrium, God still is needed, according to the new theories, to take charge of a world that can in no sense be said to take care of itself. Unless the scientist, after contemplating that remote time of universal quiescence, is willing to turn the world over to God and let Him work out its future, he is left in complete darkness as to the ultimate outcome of that which he must abandon as he would a sinking ship. Before and behind, then, God is needed to complete the meaning of the world as science knows it. But even this, as will presently be seen, is not all that the present view indicates.

(2) Objections to the Postulation of God as Creator and Their Answers

The postulation of the need of a Creator, however, has not been allowed to go unchallenged. Some have said that since the atoms constituting the material world may have existed eternally, according to the law of permutations and combinations, there has been an infinite possibility in their shuffling which was bound sooner or later to produce that condition of complete organization from which entropy could proceed without the help of God. This view, of course, which is based upon pure chance, begs the question to start with by asking for all the material with which to operate. But even if this be granted, the inherent possibilities claimed for this scheme seem ludicrously absurd. Who would even be foolish enough to think that by mixing together long enough the letters of the alphabet it would be possible to produce Milton's Paradise Lost? Or, as Inge expresses it, who would believe that "printer's pie might be shaken up till Hamlet emerged complete?" To ask the questions without answering them is to make the very theory, which proposes such an idea, cover itself with laughter. It does not merit further serious consideration.

Bertrand Russell objects to the recognition of God at the beginning of the process of entropy for a different reason than that just explained. Although he accepts the second law of thermodynamics as valid and agrees with current science, which says that the world had a beginning in time not infinitely remote,[1] he is opposed to inferring from this that a Creator brought it into being because such inference contradicts observed causal laws. Since

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1. Cf. Russell, The Scientific Outlook, pp. 117, 118

creation <u>ex nihilo</u> is an occurrence which has not been observed, he concludes that it is just as reasonable to suppose that the world was uncaused as to believe that it was caused by a Creator.[1] Either view, it is said, goes contrary to the causal laws. But the trouble with this method of reasoning is that it is too limited in its exposures to all the facts which aid one in making the final choice regarding the ultimate. Mind transcends logic and there are other testimonies to be heard besides that of cold reason. The decision between these choices presented by reason is easy when it is brought before the bar of experience. If, as Hocking says, "we are only justified in attributing reality to an idea if reality is already present in the discovery of the idea",[2] the idea of an uncaused world must go; but the idea of a Creator behind the universe remains because it answers to our need. Faith, therefore, when led into the valley of indecision by a cold hesitating logic that is divorced from experience, exclaims thus:

> "O World, thou choosest not the better part!
> It is not wisdom to be only wise,
> And on the inward vision close the eyes,
> But it is wisdom to believe the heart.
> Columbus found a world, and had no chart,
> Save one that Faith deciphered in the skies;
> To trust the soul's invincible surmise
> Was all his science and his only art.

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1. Cf. Russell, The Scientific Outlook, p. 118
2. Hocking, The Meaning of God in Human Experience, p. 313

> Our knowledge is a torch of smoky pine
> That lights the pathway but one step ahead
> Across a void of mystery and dread.
> Bid, then, the tender light of Faith to shine
> By which alone the mortal heart is led
> Unto the thinking of the thought divine."[1]

b) The Theistic Trend of the Law of Entropy

(1) Its Avoidance of Deism

Looking at this law of entropy, so universally acclaimed by science, for further light which it may throw upon God, one discovers in it an unmistakable trend towards a theistic conception of the Deity. At first, this does not appear so evident. Eddington himself says that in almost every textbook on thermodynamics there is to be found, in a suitably disguised form, the theological doctrine that at some time in the distant past God wound up the universe and left it to chance ever since.[2] Such an explanation of the present view appears to shelter the crude deistic doctrine that in the beginning God set the world going and then left it to run itself while He remained an absentee from its activities. But further study of the theory does not support this view. Instead of the freak occurrences of chance, one discovers in the universe the rigid operation of an inflexible law which led Inge to say: "There is nothing fortuitous in the degradation of energy, which proceeds with the regularity

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1. Santayana, George, Faith
2. Cf. Eddington, The Nature of the Physical World, p. 84

of a relentless fate."[1] For the sustaining of such a law, then, it is necessary to postulate a God who directs and controls the universe. But in doing this one has moved out somewhat from a rigid deism on the road towards theism. The chief proof of this, however, is not in this consideration alone, but also in previous facts presented under the study of the atom which strengthen it by their cumulative testimony.

(2) Its Complete Repudiation of Pantheism

The new theory, moreover, does not tend on its way to fall into the hands of pantheism which identifies God wholly with His world. Hegel has represented this philosophy clearly when he said in substance: "God is not more necessary to the world than the world to God. Without the world, God were not God."[2] In harmony with Spinoza's view he maintains that the very essence of God is involved in His creation.[3] Such a doctrine, however, is completely undermined by the second law of thermodynamics, which, if true, would jeopardize the very life of God by identifying the essence of His nature with a world whose life is heading towards extinction. If God is nothing more than an <u>animus</u> <u>mundi</u>, His doom is certain as the universe approaches dead center as a condition of

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1. Inge, God and the Astronomers, p. 34
2. Pringle-Pattison, The Idea of God, p. 304
3. Cf. Ibid., loc. cit.

endless activity. A God totally immanent in the universe and not above it, is under a sentence of death, which will be executed when the world, by the very law which rules it, falls into endless sleep.[1] But such an idea of God cannot satisfy the religious aspirations of scientist or layman; it comes far short of man's conception of a God in Whom he can trust. It is man's sober second thought that God is behind any thought of His and separate in His person from His works.

(3) Its Support of Transcendence and Immanence

The truly theistic view avoids the pitfalls of either of the preceding doctrines, yet it culls from each the truth that gives it strength. Theism upholds a belief in the transcendence of God in the universe which has gone to seed in deism and then lost its vitality. It also champions a belief in the divine immanence in the universe, which has been subverted in pantheism into a vague doctrine of impersonalism from which all the lustre of personal identity in the future life has been removed. Theism may now look for support for the former of these beliefs from the implications of the law of entropy. It cannot find much evidence as yet that this same law strengthens the latter of these beliefs, but it can look to another law of modern science,—namely, the quantum law,

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1. Cf. Inge, God and the Astronomers, p. vii

to give it respectability. Thus the theistic position is again being strengthened from unexpected sources.

4. Summary

The potencies contained in the facts from which the foregoing implications have been elicited with full appreciation of their difficulties and their incompleteness, are so important for the development of a new religious apologetic that a comprehensive summary, arrived at after a careful scrutiny of the theories, may now be presented. It is so nearly parallel in some respects to Kirk's statement on this point that it is fitting to introduce it with his words where he says that

> "as science advances towards the frontiers of its vast domain, imponderable features are disclosed; and these mysterious elements are precisely those that appeal to the religious mind."[1]

So mysterious have these features become, in fact, that the questions regarding them multiply more rapidly than the answers. Dr. Shapley, whose intense study of these puzzling problems of the universe entitles him to speak with authority, has recently made the humiliating announcement that "we are expanding our ignorance much faster than our knowledge."[2] Gradually science is learning, as it peers into the depths of space and studies the nature and the constitution of the world, that it is

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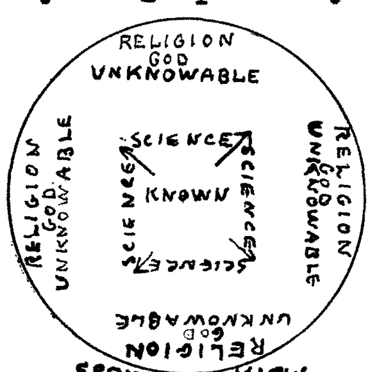
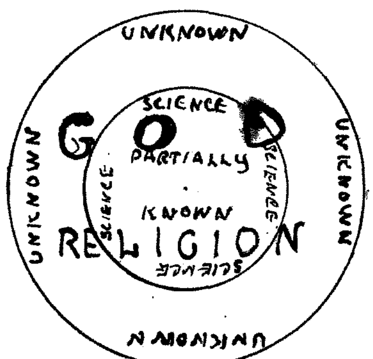
1. Kirk, Stars, Atoms, and God, p. xiii
2. New York Times, March 8, 1934

not sufficient in itself to relate man's knowledge intelligently to the enveloping darkness. Herbert Spencer sought to do it by making phenomena the objects of actual knowledge, and then by consigning all the enigmas of science to the realm of reality which to him was the unknowable. Only in this sphere of the unknown did he feel the need of calling in religion to the aid of science.[1] As knowledge grew, the area over which God through man's need of religion presided, gradually contracted, receding more and more towards the circumference of the absolute. This philosophy made God ruler over the unknown, but said little about His relationship to that which was supposedly known.

But modern cosmology finds difficulty with this theory, because it cannot speak with any degree of assurance to-day as to what is actually known. It has become skeptical of the ability of science to explain anything sufficiently to justify its refusal to call in outside help. The difference between this attitude and the former may be graphically represented somewhat as follows:



SPENCER'S VIEW



THE MODERN VIEW

1. Cf. Dampier, A History of Science, p. 316

It will readily be seen from these diagrams that the relation of modern science to religion is fundamentally different from that of Spencer. To-day religion deserves clearly more courteous treatment in the hands of science than it received in the past age,[1] because it is so indispensable even to all description of man's knowledge of his world. God in modern cosmogony has become a necessity for a satisfying interpretation of the world in part or as a whole. He is needed to give substance and reality to any study even of the phenomena of the larger world. Therefore, as Knudson says, science has come to see that "the physical world is not self-sufficient, that it is not its own explanation, that it points beyond itself to a transcendent cause."[2]

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1. Cf. Inge, God and the Astronomers, p. 38
2. Knudson, The Doctrine of Redemption, p. 69

PART TWO

THE MODERN ASTROPHYSICAL VIEW OF MAN

Chapter V

The Individual

A. Introduction

1. Justification for This Major Classification about Man

Thus far in this investigation interest has been concentrated upon the teachings of physics and astronomy with regard respectively to the nature and meaning of atomic configurations and processes, and to the character and significance of cosmic phenomena and concepts, which levy a heavy tax upon the reason in its efforts to fit them into any metaphysical picture of the whole. All these findings are known to have their bearing upon the view of man which is related to them in multifarious ways. But science has not waited for scholars in other fields to assess their meaning; rather has it expressed assiduous care in drawing from them its own conclusions as to their value in painting a new portrait of both the individual and society. Such abundance of interpretative material has resulted that it could not easily be built into the structure of the preceding chapters without destroying their designs. Because of this fact, and also because the opinions formulated are weighted with such serious consequences for good and evil, it has seemed best to consider them separately.

B. Man's Importance

1. Historical Retrospect to This Question

In modern times at least the first answer to the question as to man's place in the universe was given by Ptolemy who placed him at the center. This was in harmony with his own ideas of an immovable earth around which swung all the planets in a complicated system of cycles and epicycles. This view, accepted by the Church and given its official sanction and support, obtained generally until the seventeenth century when Galileo put forth another answer. About three hundred years ago that scholar declared that man's home in space is not the center of the universe but revolves like all the other planets around the central sun. Astronomy of the nineteenth-century went still further and asserted that this solar system, of which earth is a small member, is only one of many millions of similar systems throughout the vast region of space, to each of which may belong inhabitable planets like the earth. But twentieth-century astronomy has sought to correct this hasty generalization by claiming that life throughout the cosmos is more rare than formerly was thought,--in fact, so rare that it is probably only to be found in very few places.[1] This process, which

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1. Cf. Jeans, The Universe Around Us, pp. 3, 6

was begun by Galileo and which consisted in widening the boundaries of the universe and of continually shifting its center further away from this planet, has ever been more and more humbling, it is said, to the denizen of earth, who no longer can boast of his being at the heart of the universe, but must now accept the humiliating experience of being relegated to an almost insignificant corner of the world.[1] The extreme effect upon the mind which it sometimes may produce is seen in the attitude of Bertrand Russell who charges with excessive self-esteem any theologian who seeks in the face of these so-called facts to lift human life back again into the purpose of the creative activity of God.[2] Not all, of course, who follow this new thought sympathetically would go so far as Russell, but there is a strong tendency to-day, as a result of such an outlook on the world, to give free expression to a viewpoint kindred to his. It is this disposition which makes the careful examination of the reasons produced in behalf of it so necessary. In turning to this task, therefore, one should not lose sight of this fact.

2. Reasons Held Derogatory to Man's Importance

a) The Vastness of Astronomical Time as Compared With

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1. Cf. Jeans, The Universe Around Us, pp. 5, 6
2. Cf. Russell, The Scientific Outlook, p. 109

the Short Span of Human Life

Possibly the most satisfactory starting-point in the enumeration of the facts which are said to berate man's importance is the question of time which can be more easily comprehended than that of size. The consideration of this problem is also simplified by beginning the comparison of man's period of life with the age of that astronomical body with which his life is wholly associated. Various estimates of wide divergence have been given by the sciences as to how long the solar system has been in existence, but all of these indicate that the time must be reckoned in thousands of millions of years. Recently it has been said by astronomy that in round numbers it may safely be put at 2000 million years.[1] These figures, of course, do not even take into account the calculations of the vast sweep of years yet to be traversed before the earth becomes a dead planet, but when they alone are measured against the three score and ten years of the average span of human life, they have a tendency to place man in a very unfavorable light if he be studied solely from this angle.

The magnitude of time required in these numbers is almost paralyzing to the mind, but when it is compared with that employed in the estimates of the age of the

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1. Cf. Jeans, The Universe Around Us, pp. 146-150

universe, the earth's whole life seems only a minute fraction of the life of the stars. The astronomical clocks indicate that the average age of a star is from five to ten millions of millions of years.[1] Jeans' own estimate of the life of most stars magnifies these figures more than tenfold. But even upon the basis of the most conservative calculations, it is his opinion that man's life, when compared to these astronomical ages, becomes insignificant and looks like only a speck in time.[2] Its ephemeral nature in contrast to the abiding universe, can vividly be seen in reflecting upon the fact that the time required for flashing a signal from one star-city to the next and back again is 60,000 times the life of an individual.[3] From the point of time it seems literally true that the years of human existence are as a breath in the life of major heavenly bodies.

b) The Dimensions of the Universe as Compared to the Size of Man

Not much relief is found from this rather disconcerting picture, if one turns to a comparative study of the size of the universe and of man. Figures generally are inimical to a high estimate of man, but they are never more so than in this case. Man's stature is completely

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1. Cf. Jeans, The Universe Arouhd Us, pp. 167,168,175
2. Cf. Jeans, The Stars in Their Courses, p. 91
3. Cf. Ibid., p. 126

lost sight of in the computation of the extent of the known portion of the universe. Until recently it was said that the furthest objects seen in space were approximately 140 million light-years away.[1] Now it is claimed that nebulae as far away as 300,000,000 light-years are coming within the view of the great 100-inch reflector at Mount Wilson.[2] The calculation of the number of these nebulae which are now within the range of this telescope and which are thought each to represent a star-system much like the Milky Way, places their estimate at 75,000,000. If it be remembered that these star-cities are on an average of 650,000 light-years apart, some idea of the immense size of the universe will be formed.[3] But even these are not the whole of matter in space. In fact, the number of stars cannot be computed with any degree of accuracy. Jeans has suggested that they are probably as numerous as the grains of sand on all the seashores of the world, each averaging a size a million times that of the earth.[4] Viewing the colossal mass of matter represented by this number of stars which are sparsely scattered throughout a still vaster expanse of space, one can glimpse even better the picture of this huge world. So

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1. Cf. Jeans, The Stars in Their Courses, p. 136
2. Cf. New York Times, January 13, 1934
3. Cf. Ibid., loc. cit.
4. Cf. Jeans, op. cit., p. 137

big is it even on the basis of a finite conception that the time required for light to circumnavigate it would approximate 500,000 million years. Alongside of this huge ball, therefore, it is natural for those impressed only with bulk to wonder how man can entertain a sense of his own importance. Certainly in this light it must again be conceded that he does not present a very favorable appearance. Man's predicament solely from this standpoint can easily explain the timidity of the English writer who said that "it takes courage to return the stare of the stars."[1]

c) The Small Part of the Universe Inhabitable

A third reason sometimes given for lowering the esteem in which man is commonly held is the fact of his extreme loneliness in the universe. One might have supposed that a universe containing such a vast number of stars would be literally crowded with places habitable for man. The first suspicion that this might not be true comes when it is realized that the huge volume of space with which science is acquainted seems practically empty when compared with the quantity of matter which occupies it. It has been said that three wasps roaming the whole of Europe would crowd the atmosphere of that territory more than known space is crowded with stars.[2]

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1. Kirk, Stars, Atoms, and God, pp. 11-12
2. Cf. Jeans, The Stars in Their Courses, p. 137

A greater surprise comes, however, when astronomy declares that, even in this small portion of the universe which is filled with worlds, only an infinitesimal fraction is possibly inhabitable by man. Millions of millions of stars exist, it is said, which have never supported life and never will.[1] It seems pretty well established now that the physical conditions which support life can be found only on planets like the earth.[2] But the origin of a planetary system, resulting from the close approach of two stars, is a rare occurrence in nature. According to the tidal theory of Jeans this event might possibly happen once in 2000 million years,[3] but on the basis of the actual collision presupposed in de Sitter's view it could not take place more than once in every million, million years.[4] Such systems, therefore, as the solar system to which the earth belongs, are very scant throughout the universe because of the unusual conditions required for their formation.

Yet not even all of these sparse systems can possibly support life because some of them also fail to meet the temperate conditions necessary for human existence. In some cases the whole system is probably

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1. Cf. Jeans, The Universe Around Us, p. 331
2. Cf. Ibid., pp. 328-329
3. Cf. Jeans, The Mysterious Universe, p. 2
4. Cf. Kirk, Stars, Atoms, and God, pp. 18-19

lifeless, and in others, if life exists at all, it is confined to a few planets.[1] In the sun's family the case seems strong for believing that life exists only upon the earth.[2] By the gradual elimination, therefore, of all places unsuited to human welfare, it seems likely that life as it is known here can thrive on only a very few planets existing within this temperate zone which is surrounded by extremes of cold and heat. But since planets are so seldom formed and since those formed do so few times come within the prescribed areas, it has been estimated that only one star in 100,000 can have a planet revolving in this belt where life is possible. This, of course, makes plain that life cannot be a common thing throughout the universe. It is rather to be looked upon as a rare phenomeon. In contemplating this fact some, therefore, have said that the production of life does not appear to be the primary purpose of the universe, but rather to be an accident. Had it been the design of nature to produce life, a better proportion would have existed between the size of the mechanism of the universe and that of its product. The conclusion of this method of reasoning naturally is that man is a by-product and not so important in the eyes of the world as he thinks.[3]

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1. Cf. Jeans, The Universe Around Us, p. 331
2. Cf. Jeans, The Stars in Their Courses, p. 55
3. Cf. Jeans, The Mysterious Universe, pp. 6-7
4. Cf. also, Jeans, Eos, p. 86

d) The Indifference and Hostility of the Universe towards Man

If one looks further into these facts, it is said, the universe appears not only to have given man an insignificant home and a secondary place in its thoughts, but also to be actually indifferent or even hostile to his existence. Its present laws from the material standpoint appear to have been chosen to produce magnetism or radioactivity rather than life, since physics seems to play a greater part in this world than biology.[1] The finer things of life, such as emotion, ambition, achievement, art and religion, also seem foreign to its plan and purpose. Furthermore, man himself is relegated to a few scattered spots in the universe where his continued existence is precarious and where his present life is endangered by destructive radiation which drenches the whole of space.[2] These facts, it is maintained, prove that man cannot have the exalted position in the cosmos which he has arrogated to himself; they remove him from his pedestal.

3. Consideration of These Reasons

a) Concerning the Comparative Age of the Universe and of Man

(1) Aesthetic Considerations Which Minimize This

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1. Cf. Jeans, The Mysterious Universe, p. 12
2. Cf. Ibid., p. 4

Argument

The reasons which have just been given for reducing the size of the present portrait of man are taken seriously in many quarters to-day. They merit further consideration, therefore, in order to determine their weakness along with their strength. If one examines carefully the first argument based upon a comparison of time, one need not be disturbed by the inequalities which it exhibits, for the impressiveness of objects has never depended upon their duration. The seconds of a rainbow's brilliance are more precious than days and nights of fog upon the sea could ever be. The moments when the mysterious tones of twilight streak the sky are more of a source of inspiration to the poet than the long watches of the night. The flaming comet that comes for a few brief days within man's view and then speeds on its way, leaving a trail of light behind it, is more an object of human wonder and praise than some distant sentinel of the heavens that has looked down for ages upon the drama of earth.

(2) The Opposing Argument from History

The story of history, too, confirms this truth by showing that the richness and meaning of life have never depended upon length of days. So far as man's experience upon this planet is concerned, small periods of time have often been more important than long ones and have proved beyond all doubt that

"We live in deeds, not years; in thoughts, not breaths;
In feeling, not in figures on a dial."1

Who would not, for instance, consider that the brief span of years during which the Christ lived upon earth has been of greater moment to the world than the long period of the patriarchs? Or who would not say that His matchless life, lived within the space of thirty-three years was not infinitely richer in content than that of any one who lived before or since His time, no matter how long that life may be reckoned in years? Napoleon was right when he estimated this life in terms of value and not in days, and said concerning the Great Galilean that He had lifted empires from their hinges and turned the stream of history into new channels. Around this brief life, in fact, swings the whole of Christian history.

(3) The Scientist's Practice Inconsistent with This View

With similar results might examples be multiplied to show that extent of time and importance are not synonymous terms even in the mind of any well-informed scientist. What are the sweeping milleniums in darkest Africa's history to him when compared to the brief period in ancient life when Greece covered herself with glory? The Dark Ages are long, but what are they when measured

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1. Bailey, Philip James, "Festus"

against the swiftly moving years of the Reformation in which Europe awoke from her slumbers and put on new life? Yet even these lethargic centuries might be chosen to say with Tennyson:

"Better fifty years of Europe than a cycle of Cathay"[1]

And so it can palpably be shown that to whatever page one turns in history it seems to teach to science a different creed from that proclaimed by those who would make science the herald of any prejudice against mankind.

b) Concerning the Comparative Size of the Universe and of Man

(1) The Counterbalancing Fact of Man's Complexity

In weighing the second reason,—namely that man's position should be lowered because of his insignificant size in the universe, one might easily lighten it by showing that man's lack of bulk has been counterbalanced by the possession of an almost infinite complexity of structure such as is nowhere to be found in the universe, so far as is now known. Professor C. Judson Herrick, of the University of Chicago, told the American Association for the Advancement of Science at a meeting in Chicago last year that, in the cerebral cortex alone of man's brain, the number of individual lines connecting the brain cells with one another has been calculated conservatively to be equal

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1. Tennyson, "Locksley Hall"

to the figure of numeral one followed by fifteen million ciphers. To publish such a number would require thirty full-sized books of 350 pages each. This figure, it is said, is so tremendous that astronomical distances measured in megaparsecs and hundreds of millions of light-years become insignificant in comparison to it.[1] Truly man is "fearfully and wonderfully made",[2] and any attempt to dislodge him from his high estate by appeal to disquieting figures will have to reckon with these sober facts about the human body.

(2) The Quantitative Aspect Not Usually the Criterion of Importance

But if this argument is attacked purely on the basis of the great disparity of size between man and the universe, man does not even then become worsted. He is not by any means the smallest thing in the universe. He occupies a somewhat mediocre position between the infinitely small and the infinitely great.[3] The atom is a very minute body, and the electron appears infinitely smaller in comparison to it.[4] But yet the scientist accords to these entities

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1. Cf. New York Times, June 25, 1933
2. Psalm 139:14
3. Jeans makes a statement to this effect somewhere in his writings, but the exact reference could not be located by the writer.
4. The atom is said to have a radius of about 2×10^{-8} centimeters, yet this inconceivably small fraction is even said to be 100,000 times the diameter, or about a thousand million million times the volume of a single electron whose radius is about 2×10^{-13} centimeters. Such figures are even more disconcerting than the immense distances recorded in space. (Cf. Jeans, The Universe Around Us, p. 106)

a primary place in the structure and running of the universe. To him they constitute the building bricks of all material substance and are by no means insignificant. To disregard them because they are so small in comparison to the whole would be to give up all hope of scientifically solving the riddle of the universe and fitting its various parts together in harmonious relationships. But if the scholar must pay so much attention to the smallest known bits of matter because of their vital place in the world of nature, he is forced in so doing to recognize that not all strategic values inhere in quantitative distinctions.

What reason is left, then, for assigning to man, because of his relatively small stature, a rôle of minor importance, or a trivial meaning, in the framework of the whole? Certainly it cannot be due to the scientist's similar attitude in regard to other things of almost negligible dimension. Nor can it be the result of man's inveterate habit of making distinctions contrary to this so-called principle in his daily life. It is easy to determine in advance which will receive preference in any popular vote, the pansy or the sunflower, a ton of black diamond, or a gem of crystal-pure carbon. Man is not guided primarily in his judgments by the comparison of bulk; his standards are usually foreign to this idea. The quantitative aspects of nature do not frequently tip the scales of the mind in their favor.

(3) The True Register of Values

What, then, is the final register of human values?

This question is important because, if the bigness of an object is not the controlling factor in determining the impression which it will make upon the mind, then it may turn out that man's place in the universe is far greater than his unfavorable comparison in this respect would warrant. Kirk answers it in his own inimitable way by making the organizing mind itself that gives purpose and order and harmony to the cosmos the controller of values. Without it he says the universe would be a chaos instead of a cosmos.[1] Therefore, it is that Theodore Parker could rightly reason that the biggest star is at the small end of the telescope, "the star that is looking, not the star that is being looked at."[2] His irrefutable thought on this matter was expressed thus:

> "The number of stars and the limits of space are not more astounding than it is that man should be capable of knowing such things and staking them off. When man has measured the distance and weighed the bulk of Sirius, it is more appropriate to kneel in amazement before the inscrutable mystery of his genius, the irrepressible soaring of his soul, than to sink in despair under the swinging of those lumps of dirt in their unapproachable spheres because they are so gigantic! The appearaence of the creation to man is not vaster than his perception of it. To think the world is to be superior to the world."[3]

In other words, the mind which can roam in thought to the farthest bounds of known space and can construct a picture of that world within itself is greater than any or

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1. Cf. Kirk, Stars, Atoms, and God, pp. 13-14
2. Snowden, Can We Believe in Immortality?, p. 29
3. Ibid., pp. 29-30

all of the objects which occupy that vast expanse. Quayle has summarized this point in very pleasing lahguage which it is impossible to refrain from quoting.

> "The spiritual", he says, "always dwarfs the physical. The Mountain, lifting its forehead to the heavens, is less a giant than the man who stands at its far base and computes its altitude. . . The ocean . . . is not so great as the dreamy man who stands upon its shore and meditates its mastery. Columbus is greater than the dread Atlantic."[1]

c) Concerning the Small Part of the Universe Inhabitable by Man

The only way to answer the argument against man from the small place assigned to him in which to live in the universe is to accept its statements as a fact and make one's own deductions from them. Inge seems to take great comfort in thinking that there are possibly many other places in the cosmos where life like that of man exists. To believe otherwise is to him to assume a "wildly improbable" position. He cannot conceive of the Deity making the universe for the sole purpose of man's creation upon this planet.[2] Astronomical knowledge, if true, does not wholly shut out the fulfilment of this wish, but even if it grants some enlargement of the habitable area of the universe beyond the bounds of earth, it does not offer a very flattering proportion of the whole to man for his

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1. Quayle, The Poet's Poet, p. 39
2. Cf. Inge, God and the Astronomers, pp. 248-249

existence. However, when one takes the calculations of science in this field at their face value, they do not speak so disparagimgly concerning man as some have claimed. If this planet is one of the rare places in the universe where life can possibly be found, then the earth returns to the status which it had before the Copernican astronomy removed it from its central position.[1] Whatever be the latitude and longitude to which man is restricted on the cosmic sphere, he is not disposed, as a result of this confinement, to think slightingly of himself or of his home. Rather is he inclined to feel that the rarity of his species gives to it a peculiar eminence in spite of the fact that nature appears to have been very prodigal in the process of its production.[2]

d) Concerning an Inhospitable World

(1) The Testimony of Science to a Different Attitude in the Law of Evolution

The conclusions to be drawn from the facts supposed to indicate a world indifferent, and even hostile, to man are largely determined by the attitude which one brings to their interpretation. Millikan is recognized as a great scientist of to-day and yet his study of the world does not dispose him to see it as unfriendly to man. The

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1. Cf. Kirk, Stars, Atoms, and God, p. 19
2. Cf. also Ibid., pp. 19-20

silent processes of evolution that have gone on for ages in the past are viewed by this scholar as having prepared the earth for the abode of man. To him they reveal a God who is good and is working out a world fitted for the welfare of His creatures.[1] But to take this stand is to deny the assertions made in behalf of the opposite view. Biology, according to this outlook, is not playing a minor rôle as compared to physics, at least so far as this planet is concerned. And if it be said in reply that its operation is restricted to this small corner of the universe, the answer which can be made is that, so far as present knowledge goes, it works to the advantage of man in the only place where it has a chance and proves thereby that not all laws of nature are inhospitable to him. Furthermore, its very purpose and goal appear to be the production of those finer qualities and virtues of life which are said to be a stranger to the universal activity of the cosmos.

(2) The Conscious Defiance of Destructive Forces by Man

Man's importance, however, does not rest upon the question of the truthfulness of this evolutionary scheme or of its breadth of application. To look upon the forces of the universe as truly hostile, just for the

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1. Cf. Millikan, Science and Life, pp. 60-61

purpose of seeing what such a view necessarily entails, does not force one to the conclusion that man is unimportant. His struggle against these forces about him only exalts the nature of the mind. As Pascal said in substance, the universe may crush man as a reed, but he is a conscious reed and will show his true nobility in defying its deadly work.[1] There is a grandeur about man that does not fade even in the presence of defeat, but shows itself sometimes to best advantage against a dark background of this character.

4. Summary

The conclusion to be drawn from the facts which have just been considered seems to be that, while in one sense they appear terrifying, in a deeper sense they take on an entirely different meaning. To think of man's length of life as compared to that of the nebulae, whose span of years is such that Lemaitre claims after 10,000 million years they may be ten magnitudes fainter than at present,[2] is very unsettling to some minds. Likewise man's size as compared to a universe whose radius is estimated at 50,000 million million million miles,[3] is also disappointing to those who would determine significance by bulk. The relatively tiny home of man in space

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1. Cf. Snowden, The Discovery of God, p. 48
2. Cf. Barnes, Scientific Theory and Religion, p. 395
3. Cf. Ibid., loc. cit.

and the supposed evidence of an indifferent universe are believed by men of this mentality to lend additional support to a pessimistic view of that little bundle of life which is called a human being. Yet others, as the discussion has revealed, surmount these difficulties in the way of thinking highly of man by declaring that the mind is not subject to the handicaps of the body, but encompasses for itself these magnitudes of time and space and asserts a form of spiritual mastery over the inhospitable elements in the world. Jeans, under the figure of the growing acorn contemplating whether success out of myriads of cases argues for a forest inimical to its best interests or for a special providence supporting it, counsels the student to beware of a hasty inference from the problems of this character which at present confront man as a rare product of the universe.[1] But Barnes seems encouraged upon the basis of these facts to speculate upon the superiority of the mind to the body and its survival after the destruction of its earthly tenement.[2] Now this is actually to exalt man above the material home in which he lives. And the tendency to do this when studying the previous facts closely seems irresistible to one who notes the place that mind must occupy in the

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1. Cf. Jeans, Eos, p. 87
2. Cf. Barnes, Scientific Theory and Religion, p. 395

development of any picture of the objective world. Each one, therefore, is left to draw his own conclusions from the case with the knowledge that there is support for either view, with the balance of opinion favoring the more lofty conception of the individual in spite of certain arguments to the contrary.

C. Man's Free Will

1. Introductory Remarks

The new thought of physics touches not only the subject of man's importance but also that of his free will. A groundwork for what is to follow has already been laid in the previous discussion of determinism which was presented in connection with the explanation of the recent views of the atomic world. It is not the purpose of this study to duplicate the material there set forth, but to supplement it with other scientific considerations particularly germane to this angle of approach to a subject of unfailing interest. What is said here must, therefore, be interpreted with the aid of former facts, and the brevity and seeming incompleteness of this presentation must be accounted for in the same manner.

2. The Scientific Basis for This Doctrine

It is almost unnecessary to point out again that the justification for belief in free will is to be found in the recent facts brought to light in the study of the interior of the atom. The peculiar character of the phenomena there discovered has given science a strong inclination to discard some of its time-honored theories in favor of very revolutionary concepts. The principle of uncertainty in particular, developed through failure to exactly determine at the same time the velocity and position of an electron, has resulted, for the present at least, in the complete break-down of scientific determinism.[1] The repercussion from this shocking news proceeding out of the inner world of the atom has recently been felt in the changed attitude of science towards the doctrine of human freedom which once was taboo among scholars in this field of learning. Certain problems, therefore, which this new attitude raises with regard to free will need to be investigated here briefly in order to further towards completeness this discussion concerning the new views of man.

3. Scientific Objections to This Doctrine

a) From the Standpoint of Law

(1) It Rests upon a Precarious Foundation Scientifically

This principle of indeterminism which lies at the basis of the new attitude of science towards individual freedom has not been allowed, however, to remain unchallenged in the effort to overthrow belief in free will.

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1. Cf. Dampier, A History of Science, p. 473

Bertrand Russell, who appears to be the protagonist of the opposition to free will, severely criticizes what he believes to be the flimsy character of the scientific foundation upon which the belief is built. He holds that the principle of uncertainty rests upon ignorance of the actual behavior of the atom which may be dispelled at any moment by experimental physicists who are searching for the laws which control atomic action. To erect a theological doctrine upon this momentary lack of knowledge is, as he sees it, a stupid procedure that has the bad result of making men wish that no further discoveries would be made which might necessitate a change in their views.[1]

(2) It Is Inconsistent With the Discovery of Scientific Law in Human Behavior

This same writer also objects to free will on the grounds that it contradicts known experimental facts concerning the operation of scientific law in animal and human behavior. The work of Pavlov in this field is appealed to as proof of this contention. It is Russell's opinion that free will ignores these facts and substitutes for them a belief in complete lawlessness. He does not seem to admit any other option in the case.[2]

(3) It Breaks the Universal Reign of Law in the Physical World

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1. Cf. Russell, The Scientific Outlook, p. 106
2. Cf. Ibid., pp. 106-107

The principal reason for opposition to this doctrine is to be found in the contention that it undermines belief in the universal application of physical law which is held to be at the basis of all science. If free will is granted, it is argued, then trust in the uniformity and dependableness of nature must be surrendered and predictability of events becomes impossible. Such a situation, it is feared, would destroy the whole scientific fabric.

b) From the Standpoint of Causality

(1) It Disrupts the Law That Every Effect Must Have a Cause

There is also a deep-seated prejudice against the doctrine of freedom in the minds of those who are obsessed with the idea that in nature every cause must have behind itself another cause of which it in turn becomes the effect. The law of cause and effect, according to those holding this view, must be absolutely uniform in its application if there is to be any scientific explanation of events and actions. Therefore it is that Einstein finds the idea of free will in nature wholly preposterous.[1] His objection to freedom on these grounds is explicitly based on a philosophy of determinism that opposes any interruption of the law of causality. It has been succinctly expressed by the scientist in these words:

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1. Cf. Planck, Where Is Science Going?, p. 210

> "Everything is determined, the beginning as well as the end, by forces over which we have no control. It is determined for the insect as well as for the star. Human beings, vegetables or cosmic dust, we all dance to a mysterious tune, intoned in the distance by an invisible player."[1]

Planck takes a similar attitude, maintaining that the principle of causality applies even to the minds of the greatest human geniuses which may be considered to be nothing more than instruments in the hands of an almighty law ruling the world.[2] In harmony with this position he also believes that the quantum hypothesis will eventually be found to conform to a more exact formulation of the causal law than that which has operated heretofore.[3] Other names might also be added to these, but what has been quoted is already sufficient to prove the strenuous character of the opposition to freedom on the grounds here mentioned and also the need for a reply to its fundamental postulate.

(2) It Introduces Chance in Place of a Strict Causality

Somewhat dependent on the validity of the last argument is a further objection to free will on the supposition that it implies real chance. This consideration, while originating in the fear of the dire results ensuing from

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1. Saturday Evening Post, October 26, 1929, Article "What Life Means to Einstein", an Interview by George Sylvester Viereck
2. Cf. Planck, Where Is Science Going?, pp. 155-156
3. Cf. Ibid., p. 143

any break in the complete causal nexus of nature, is also closely related to the idea of a universal scheme of law for the world in which there can be no possible room for contingency without destroying the meaning of this blue print which describes its working.[1] From this point of view, it is said, once the causal law is lifted, chance enters into every event and makes the calculation of any results entirely impossible. But since this seems contrary to scientific laws now well established, the theory that necessitates such a condition is rejected.

4. Answers to These Objections

a) From the Standpoint of Law

(1) The Foundation of Free Will Is Not so Precarious as That of Determinism

The answer to the first argument against free will may be given by taking the weapons from the hands of the opponent and using them to demolish the foundation of his own view. If the determinist objects to belief in free will because it is based upon a lack of knowledge with regard to the true behavior of the electron, he is not free in the face of that criticism to hold to determinism when the facts do not warrant it. To assert this right would be to declare omniscience in regard to what may happen,— the very thing which the believer in indeterminism is

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1. Cf. Eddington, The Decline of Determinism, p. 144

accused of doing.[1] A neutral position would seem under these circumstances to be the only logical one to maintain. Russell himself recognizes this fact.[2] But the case for indeterminism is not so weak as this compromising attitude would indicate. The fact of the matter is that the data which science now has in hand in a study of the atom are positively against strict determinism; they militate against this old theory, but favor an indeterminism that makes room for a freedom of action not subject to the old causal scheme. Until the determinist can find the explanation of these things which is missing in his theory, he is not at liberty to checkmate a hypothesis that works according to the facts in possession of the scientist.

(2) Free Will Is Not Inconsistent With Scientific Law in Human Behavior But Transcends It

The one who believes in the freedom of the will does not necessarily deny, as the next objection implies, the presence of all scientific law in the operation of the mind. He may well admit that there are methods of working which the mind employs that can well be charted, but he denies that they are invariable and precludes all possibility of change. A good case can be made out for holding that these laws were made for the mind and not the mind

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1. Cf. Eddington, The Decline of Determinism, p. 152
2. Cf. Russell, The Scientific Outlook, pp. 93, 106

for the laws. Upon the theory of free will the latter are regarded as the servant of the former and not its master. To deny this fact is to put the mind in bondage to law and to free it of all responsibility for its acts. This would make it a machine instead of a conscious agency that could interrupt the working of the machinery and change the direction of its running if desirable.

But such a view of mind makes hopeless any effort to get it out of its ruts. The very character of reason is destroyed by this view. The best argument against it is the illogical attitude of those who, favoring it, are yet determined to induce others against the fatal working of the laws of their minds to accept this mechanical conception as true. That is to say, they cannot impeach reason for its lawlessness and then propose to set the world right by its edicts. To do so is either to admit that the denial of freedom to the reason is false or else to be forced to confess that the results of the same process of law in men's mind may be so different as to necessitate an effort to harmonize them through an attempt to guide the activity of law towards a uniform result. But where does this purposive activity of the propagandist for a belief in a mind scientifically controlled by law arise in his scheme? Since when has law in itself taken on this characteristic? And how can its activity be expected to produce any effect without breaking the laws that it is meant to uphold? A law which is subject to change is no longer a law. In other words, so to temper with the mind as this theory would do is like sawing off the limb upon which one proposes to sit when he reaches after the fruit around him. To make out the reason to be always obeying set laws is to make meaningless any effort to change the opinion of matter that is the result of a similar obedience. As has been well said regarding this whole subject, one can carve his turkey, but he dare not carve his carving knife. He cannot eat his cake and have it too. A mind operating like a clock according to established laws without any power to change or direct those laws in any way is the victim of a process and cannot be expected to change its opinions even for a determinist.

(3) Free Will Admits That It Breaks the Universal Reign of Strict Law in the Physical World But Denies the Consequences

There is no need for denying the third charge made against free will, since the new discoveries of science with regard to atomic behavior lend ample support to this break with deterministic law. Physicists themselves are in grave doubt regarding the breadth of application of many laws which are now supposed to operate in nature. This appears to be due to a new awareness of the possibility that other laws at present unknown to science may restrict the sphere of operation of those already recognized.

Professor J. Arthur Thomson says that "there is reason to doubt whether we know as yet more than a very few of the Laws of Nature."[1] It is also his opinion that many of those laws which are known may need to be restated in time.[2] It is a feeling similar to this which has caused Eddington to divide laws into three classes: (1) identical laws, or laws applying to mathematical quantities used in the present scheme of world-building; (2) statistical laws, or laws relating to the behavior of crowds; and (3) transcendental laws which are concerned with the fundamental behavior of the phenomena of atoms, electrons and quanta.[3] This third classification, which attempts to cover those inner and more secret processes of nature associated more directly with the operation of a Supreme Mind, reserves a place for what is not yet fully known and in so doing makes room even for the phenomenon of free will which is felt to be akin to the character of the Supreme Mind. As in the cases of the new data of atomic physics, it is not explained by those laws but is believed in nevertheless. When viewing this anomalous situation from the standpoint of a desire to systematize everything, the scientist is forced to admit "that our experimental science is in error and that sooner or later we shall discover that conscious

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1. Has Science Discovered God?, p. 176
2. Cf. Ibid., loc. cit.
3. Cf. Eddington, The Nature of the Physical World, pp. 244-245

beings can interfere with those formulations of experience which we term natural law."[1] This acknowledgement is what was to be expected from the difficulties which science is now facing in trying to put "new wine in old wine skins." Further orientation of this view is given in the discerning remarks of Eddington upon this point which may be quoted in concluding this discussion:

> "Natural law is not applicable to the unseen world behind the symbols, because it is unadapted to anything except symbols, and its perfection is a perfection of symbolic linkage. You cannot apply such a scheme to the parts of our personality which are not measurable by symbols any more than you can extract the square root of a sonnet. There is a kind of unity between the material and the spiritual worlds—between the symbols and their background—but it is not the scheme of natural law which will provide the cement."[2]

But while the believer in free will pleads guilty to the third charge in common with leading scientists of the present, he denies the consequences which have been drawn from it. The uniformity of nature in the sphere to which it applies will continue just the same, for, as Barnes says, "the typical scientific scheme is a construct of the mind from which efficient causes are eliminated because variations due to individual activity are excluded."[3] If science picks from the events of nature that which will fit into a scheme of ordered sequence, how can there be

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1. Barnes, Scientific Theory and Religion, p. 583
2. Eddington, Science and the Unseen World, p. 53
3. Barnes, Scientific Theory and Religion, p. 569

any failure of this plan when something entirely extraneous to it is found incapable of being articulated with it.[1] It will always be able to get out of this pattern of law exactly what it has either put into it or included in it.[2]

Similarly, the dependableness and predictability of nature may be counted upon in this realm which has been selectively diagrammed by the mind.[3] And even beyond this behavior of indeterminate phenomena, it is possible to predict future events with some degree of accuracy.[4] This is true even of the mind which in its freedom develops certain habits of action which enable one familiar with them to pretty well foretell what known individuals will do in a given circumstance. Of course, there is always present in such prophecies an element of uncertainty, but it is this which proves the genuine character of human freedom.

b) From the Standpoint of Causality

(1) It Upholds the Law of Cause and Effect in Its Only True Sense

When looking at free will in relation to the idea of causality it becomes necessary to deny that human freedom nullifies the relation of cause and effect. Eddington

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1. Cf. Barnes, Scientific Theory and Religion, pp. 569,584
2. Cf. Eddington, The Nature of the Physical World, p. 244
3. Cf. Ibid., p. 243
4. Cf. Ibid., p. 244

might seem to take issue with this denial when he says in regard to the decision both of the atom and the brain that there is no cause for it.[1] But this statement of the great astronomer must be understood in the light of the prevailing belief that all physical knowledge is symbolical and descriptive rather than explanatory.[2] The real cause of these phenomena, he holds, must be outside the causal scheme of nature that is represented by a symbolic linkage which can have no meaning except as it is attached to a background of a more real character. It seems to be the unexpressed opinion of Eddington that, if science could be enlarged to take in the unseen background, it would then be possible to state the cause of events, concerning which science has now only a descriptive knowledge.

It seems fitting at this point, because of the suggestion just made, to inquire whether the causal weakness attributed to the theory of free will may not be more appropriately attached to the deterministic scheme. Determinism boasts of being able to explain phenomena, but few great scientists to-day believe that any scientific description of the method by which nature appears to work is more than a superficial explanation of the underlying facts. Long ago Hume made this clear when he showed that

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1. Cf. Eddington, The Nature of the Physical World, p. 312
2. Cf. Jeans, The Universe Around Us, p. 325

we do not get efficient causation in the physical realm. In considering the operation of causes he pointed out that all that is really known about it is that one event follows another in uniform sequence.[1] To find out real cause one must look behind the physical order. But of this realm a strict determinism knows nothing and, in consequence, has no inherent right to speak of supporting something which for it does not actually exist.

The chief difficulty with the deterministic view of nature, however, from the standpoint of its own philosophy, is that it regards every event as being produced by some antecedent cause, which in turn is thought to be the result of some other cause, and so on ad infinitum. This curious view of an endless chain of events causally related brings the one holding it to the necessity of wrestling with the dilemma of an infinite regress. Either he must in the last analysis come to the conclusion that there is some uncaused potency in this process of endless regress or else he must bring this chain to an end by stopping with some cause which is itself admitted to be uncaused. In both cases the determinist has actually postulated a cause behind which it is impossible to go. But this result is in accord with the philosophy undergirding belief in free will. From this standpoint the

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1. Cf. Barnes, Scientific Theory and Religion, p. 567

law of causation is interpreted to mean that every effect has a cause, and not that every cause has a preceding cause.[1] Therefore, since mind is regarded as a cause, it is not wholly subject to the causal law upon which determinism is based. It is rather to be looked upon as, partially at least, outside this deterministic order.

(2) It Does Not Imply Chance in the Ordinary Sense

Human freedom certainly does present a different picture from that painted by an unalterable determinism, but it is not the exact antithesis of the latter. There is undoubtedly an element of uncertainty associated with belief in free will, but it must always be remembered that this contingency is not that of chance but of rational freedom. No sane individual resents the normal laws of thought and conduct but rather believes that true freedom consists in seeking to conform to the ideal.[2] Ward has epitomized the answer to this objection in words that make no further explanation necessary, when he said:

> "But every act of a conative agent is determined by—what may, in a wide sense, be called—a motive, and motivation is incompatible with chance, though in the concrete it be not reducible to law."[3]

5. Conclusion

In concluding this study of the question of human freedom from the viewpoint of science several facts seem

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1. Cf. Horne, Free Will and Human Responsibility, p. 135
2. Cf. Ward, Naturalism and Agnosticism, Vol. II, p. 281
3. Ward, The Realm of Ends, p. 76

clear. In the first place, the practical impossibility of considering the problem of determinism in nature apart from its relation to determinism governing the mind has shown how inseparable are these questions. A complete determinism in one sphere must inevitably imply a complete determinism in the other. Conversely, an emancipation of the material world from a strict determinism implies also a liberation of the mind.[1] And since the discoveries of science favor the latter for the material world, there seems to be no good reason why freedom can not be fully granted to the mind. All of the arguments against it break down under careful examination. Science has no longer any unanswerable defense against man's innate feeling of free will.[2] Even the materialist must come to recognize this as he honestly faces the problem. His need for something in the physical world to take the place of an organizing and purposive consciousness urges him on to such a conclusion.[3] As Knudson well says in summarizing this problem:

> "Look at it in whatever way we will, there is no escape from the conclusion that freedom is essential to knowledge and that the denial of freedom leads logically to the overthrow of reason."[4]

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1. Cf. Eddington, The Nature of the Physical World, p. 310
2. Cf. Jeans, The Mysterious Universe, p. 36
3. Cf. Eddington, op. cit., p. 315
4. Knudson, The Doctrine of Redemption, p. 163

D. His Moral and Religious Life

1. The Scientific Grounds for This Life

a) The Impotence of Science to Deny Its Validity

In ferreting out what science has to say about the moral and religious life of man, one finds that its chief contribution to this subject is made by indirection. A fact which lends great encouragement and support to the development of this side of man's nature is the failure of science to advance any good reason why the religious life is not real or justifiable. This is due in the first place to the limited area of the whole of life over which science presides. Its facts are abstractions from the totality of experience and any conclusions based upon them must not be applied to those regions of life from which the facts have not been gathered. But in so far as the excluded portions of man's experience are important and vital for life, the modes of thought developed from contact with only the partial evidence are unsuited to frame any doctrine either positive or negative, about the character of that life which lies beyond their jurisdiction.[1] Only when there has been a determination to take into account the whole of experience can the scientist speak without indulging in one extreme of opinion or another.[2]

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1. Cf. Whitehead, Science and the Modern World, p. 82
2. Cf. Ibid., p. 261

When these facts are applied more closely to the present-day practices of science, it becomes evident that there is no justification for a denial of the religious experience from this quarter. For it is true that those who would recognize nothing but the measurements of the scientific realm overlook the vital fact that consciousness is much more than a mere recorder of sense-impressions.[1] It holds within itself more than a knowledge of the results attained by the aid of the physicist's tools. If the scientific test were applied to this remainder of man's experience with the purpose of casting out the religious feeling to be found there, then much more would have to go besides religion. In fact, everything would need to be dismissed which did not conform to the genius of the man-made scientific technique.[2] When this process of elimination was over, there would be left in the conscious life only a very drab residue which by itself could hardly be thought worth contending for.

b) Man's Inner Sense of Values

It will be gathered from what has just been said that science very definitely recognizes consciousness, either by implication or open acknowledgment, in all its activities. Its search for truth always starts at this

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1. Cf. Eddington, Science and the Unseen World, p. 44
2. Cf. Ibid., p. 48

very center of life from which issues the ability of the scientist to read intelligently the message of his instruments. But if science relies upon consciousness to properly record for it the indications of its measuring-rods, it is impossible to see how it can deny to it authority when it speaks of other values more intangible than measurements. A voice which is to be trusted to tell the truth about experiments in the outer world can certainly be counted upon to give man dependable information concerning interests and significances that are not confined to the material sphere.[1] And because consciousness does bear testimony to such things, these inner convictions should have as much validity as "the innate sense of the fitness of things" to be found at the core of physical science, or as "the unreasoning trust in reason which is at the basis of mathematics."[2] Since all of these values issue from the same source, it becomes impossible for man to discredit any part of them without discrediting all. But science does believe in those values relating to its realm and in so doing gives sanction to the inner witness of consciousness to the values of a more mystical character.

Perhaps this fact needs further elucidation in order that its importance may not be lost sight of. It can

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1. Cf. Eddington, The Nature of the Physical World, pp. 288-289
2. Cf. Ibid., pp. 349-350

best be given by showing how this conclusion is arrived at. To begin with, it may be said that the starting-point of all reasoning both in the visible and the unseen world is the self-knowledge of mind. Since not all the fancies of the mind can be trusted, every thought must be brought before the judgment seat of this inner sense of values that man may know what to follow. Consciousness alone can pass upon the validity of the opinions of the mind even concerning the physical world. Man cannot begin a survey of this realm without its sanctions.[1] If he would rule significances entirely out of this field, then someone must decide whether the material world with which he pretends to deal has any meaning in itself.[2]

Objection, however, may be raised to this method of reasoning on the ground that, though it starts where physical science does, it ends by taking one into a region of values outside the sphere of exact knowledge. This, it is said, is an irrational step which the reason cannot justify because it regards the thing so evaluated as only gross misrepresentations of physical entities that are behind them.[3] But since science cannot even explain its own data reasonably, it would by this argument be forced to surrender its own right to exist. To one taking this

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1. Cf. Eddington, Science and the Unseen World, pp. 73-74
2. Cf. Eddington, The Nature of the Physical World, p. 107
3. Cf. Ibid., p. 107

attitude Eddington advises whispering the word entropy[1] which is itself an unreasonable belief. It is pertinent to ask under such circumstances whether, because man cannot render an exact account of his environment, it would be better for him to pretend to live in a vacuum.[2]

Even when this position is defended against any objection, it, of course, cannot be argued that, because it supports a certain natural mysticism, the religious experience must necessarily be admitted as a foregone conclusion. But it can readily be seen that, once natural mysticism is admitted, all objections raised against the religious experience lose their force if they can be shown to apply to the former also. On scientific grounds religion enters life at the side of natural mysticism. If one is real, the other cannot be denied a similar character. But even in ways that cannot be analyzed and described at all this consciousness, which is responsible for all our knowledge, gives access to a spiritual world. As Eddington says, it looks out through a private door at the underlying character of the world.[3] In this same mysterious fashion which logic cannot chart it may also be said to commune with the Great Reality who is behind all things.

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1. Cf. Eddington, The Nature of the Physical World, p. 107
2. Cf. Ibid., pp. 324-325
3. Cf. Ibid., p. 91

c) The Feeling of Purpose

A further fact which points towards the reality of the religious life is the feeling of purpose which animates the scientist as well as the mystic. In the scientific world and in every realm of man's endeavor there is a purposive urge to make something out of the problem of life.[1] The desire to uncover truth in science and religion can onlyarise from something in man's nature which is consonant with the Truth behind the world.

d) The Sense of "Ought"

Besides these considerations pointing towards the reality of religion by their cumulative testimony, mention should be made of the sense of "ought" which science as well as religion discovers in the world. Though in the physical world laws must be obeyed, it is not so in certain other realms.[2] For instance, the laws of logic do not show us the way the mind thinks, but the way it ought to think.[3] But this sense of "ought" takes us beyond physics into a realm that cannot be ruled by laws which apply to the material world. It indicates a spiritual domain where a sense of responsibility to something higher is the reigning law instead of compulsion.

2. The Scientific View of the Religious Life

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1. Cf. Eddington, The Nature of the Physical World, p. 328
2. Cf. Ibid., p. 345
3. Cf. Eddington, Science and the Unseen World, p. 56

Since science has now discovered a door through which man may view the inner world as well as the outer, it is legitimate to ask what science conceives to be the character of the process by which this spiritual world is given a religious coloring. Eddington attributes this transmuting power to an element of the divine in man's nature.[1] The sanction for the religious yearning for God, according to him, is an Inner Light proceeding from a greater power than ours. This light is thought to beckon man ahead in both his intellectual and mystical pursuits.[2] In fact, all strivings of the mind after truth and the fulfilment of purpose are believed to be the result of an imbreathing of a High Power and Purpose into the life of man. Man's actions and aspirations are, in scientific language, the pointer readings of the divine working in the soul of man, while his inner awareness of the cause of these things connects him with the Divine Reality. A truly scientific analysis of this inner life, so far as it can be made, seems, therefore, to bring one face to face with the Divine at work upon the consciousness of man in an effort to elicit a response from the individual which recognizes God as the true background to all of life.

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1. Cf. Eddington, The Nature of the Physical World, p. 335
2. Cf. Ibid., pp. 327-328

3. Conclusion

The truth regarding this subject of the religious life of man from the viewpoint of science may be summed up in the word <u>consciousness</u>. From this depth of man's being proceeds the warrant for both science and religion. If man denies the correctness of its evaluations in the realm of religion, he must also do the same in the field of science. But this he cannot do without expressing a preference for living in a world which is a vacuum. Science must admit, then, that in his mystical mood man catches some glimpse of the true relation of the world to himself which is revealed directly to him through the back door of consciousness instead of indirectly through the symbols and pointer readings of science. This relation for him is a religious one because of the sense of "ought" and purpose which points to a Higher Power and Intelligence in control of the world behind the shadows which man sees.

E. The Religious Significance of the New Astrophysical View of the Individual

1. Introductory Remarks

At this point attention is turned from the new scientific views of man which have been presented to a consideration of the religious implications involved in them. No lengthy remarks are necessary with regard to the method of treating this phase of the subject. Suffice it to say that the plan of procedure is the same as in the last chapter, the presentation paralleling largely the general arrangement of the material by which the new conception of man has been set forth.

2. The Implications of the New Views of Man's Importance

a) Deductions from the Viewpoint Derogatory to Man

(1) The Insignificant Value of the Individual

A glance at the observations about man, which scientists have made from their recent discoveries and newly formulated theories of the universe, indicates that one of the chief religious implications to be drawn from these speculations by those who are hasty in arriving at conclusions is the insignificant value to be put upon human life. It is not true that scientists as a whole sanction this interpretation of the facts as they know them, but some of their number, aided by others who are reckless in their judgments, have hastened to push it into the foreground. Man is told by his fellow men that, when his life is compared in size and extent of years to the vast universe stretching almost infinitely in space and time, and when his insignificant home is viewed in reference to the millions of worlds in space which are thousands of times larger than this earth, the only inference which can be made is that man is of little account in this great universe which completely overshadows him by its bigness and its duration. He is of less comparative significance in the cosmos, it is said, than a grain of sand in relation to the whole of this planet. If there be this quantitative difference between man and the universe, how then, it is asked, can he hold up his head and feel important after he has faced the stars? They rebuke his littleness and frown upon his assertion of the infinite value of human life. This attitude is well expressed by Browning as follows:

> "O grandeur of the visible universe
> Our human littleness contrasts withal!
> O sun, O moon, ye mountains and thou sea,
> Thou emblem of immensity, thou this,
> That and the other,—what impertinence
> In man to eat and drink and walk about
> And have his little notions of his own,
> The while some wave sheds foam upon the shore!"[1]

Man's ennobling thoughts about himself, according to this philosophy, are muzzled when the sight of the overarching heavens and the vast vistas of time break upon his vision. These immensities are considered to be well calculated to put puny man in the place where he belongs. In the face of such considerations it is presumptuous for man, so the complaint runs, to think anything but lowly thoughts of himself and to put a premium on his life.

(2) The Unfriendliness of the Universe towards Man

A second implication in these facts about man is the unfriendly attitude of the universe towards human life. If one accepts the view that the cosmos has been parsimonious

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1. Browning, Prince Hohenstiel-Schwangau, Saviour of Society

in its acts of building comfortable domiciles for man throughout its vast expanse, and that even when it has done so it threatens as time proceeds to dispossess him by making conditions unlivable in those quarters,[1] it is easy to see how one's attitude towards God may be unfavorably influenced. A universe hostile to man is looked upon by many as an indication that the conception of God, Whom it portrays as one unkindly disposed towards His creatures, is too puerile to be regarded seriously. The conspiracy of the cosmic forces against the welfare of human beings is interpreted as an unfriendly gesture which in turn begets in the subject a questioning attitude towards the reality of a Sovereign Power behind the universe.

(3) The Discouragement of Religious Faith

Growing out of the last implication is another which assumes the form of discouragement to religious faith. When man believes the universe to be against him, he naturally imputes that enmity to a blind chance which presides over the affairs of the world. A result of this crystallization of thought upon the sinister manner in which seemingly uncontrolled forces are permitted to deal with human life is the open denial by the creature of any Creative Power or Purpose behind this display of unreason. The upshot of this situation is the development of a spirit

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1. Cf. Jeans, The Mysterious Universe, pp. 13-15

of cynicism in the individual which, outwardly at least, is unresponsive to the religious appeal and which scoffs at the attitude of trust in and obedience to a Higher Power as being the token of a belated fetichism. It is because this corrupting leaven has been slowly penetrating the minds of many to-day that William Lyon Phelps, with his keen powers of observations, is able to say that "the tremendous advance of science has had much to do with the weakening of religious faith."[1] In being more specific he declares further that "astronomy, which used to be regarded as spectacular evidence of the glory of God, is to-day one of the chief obstacles to religious faith."[2] It seems difficult for some to pierce through the haze and fog of these ill-formed ideas to the light of a clear faith. Were it not for this distressing situation, the importance of these views would not be such as to warrant for them any extended examination. But such a challenge as this condition presents must not be allowed to go unanswered.

b) Criticism of This Viewpoint Hostile to Man

(1) On the Basis of the Objective Reality of the Universe

(a) Summary of Previous Criticism on This

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1. Phelps, "Is Religion Dying?", The Delineator, August, 1933
2. Ibid

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The detailed reply to the individual arguments upon which these unpleasant implications are based has already been presented. In evaluating the religious significances drawn from them, one must keep in mind the weaknesses which belong to the foundation. The comparison of the age of the universe and of man fails to dislodge man from his eminence because the principle involved in it, by which human life would thus be minimized, is not practised extensively in the experience of the individual. Aesthetic values, history and even the scientist's own habits of action override any veto which an interpretation of nature may see fit to place upon the claims made for the preciousness of the soul. The quantitative judgment also contains the fatal defect of being seldom used as the criterion of values. If it is not consistently employed in determining the importance of the objects to which it is applied, then one cannot be sure that in any case when it is used it is congruent to the situation. Certainly it does not appear to be so in the present instance. The true register of significance is not magnitude; this is only one of the ways by which value is computed. But the agency which determines worth is the mind. To receive any pronouncement about the universe which may even be adverse to man, one must consult the mind. But by so doing one acknowledges either openly or secretly the superiority of the individual who possesses this power of weighing the stars in the scales of his judgment. In other words, since all decisions begin and end with mind, it is difficult to see how anything can be made to supersede it. This method of reasoning holds good also with reference to the argument about the insignificant home of man. It makes no difference, in fact, just where man is or how small his actual home is if by means of his mind the whole universe becomes the playground of his thoughts. When he is looked at from this angle, he appears more like a king over infinite space[1] than a beggar asking for alms from the universe.

The last stone in this foundation is of a slightly different character from the rest. It has written upon it the words <u>indifference</u> and <u>hostility</u>. But the testimony of evolution and the conscious defiance by man of any forces seemingly unfriendly to him lift this stone from its position where it supports the superstructure reared upon it, while the other facts just mentioned lend their moral support to this act completing the demolition of an insecure foundation for any philosophy that pretends to possess even the semblance of structural solidity.

(b) The Moral Character of the Individual

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1. Cf. Eddington, The Nature of the Physical World, p. 83

Opposes This Viewpoint

Aside from the direct answers to these arguments from science that belittle man, there are certain other thoughts which weigh in the mind of one unprejudiced towards the facts. The moral propensities of the soul distinguish man from his environment and give him a superiority to it. He is not a victim of circumstances but a being capable of rising above unpropitious surroundings by making them contribute something to the strengthening of the inner life and to the development of a moral beauty and purpose which can be found nowhere else, so far as is known, except in human life. This power of transmuting unfavorable conditions into servants of the higher life of man is a rare possession that lifts man out of the class of material things and puts him in a category by himself. It is the working of this power in man which enabled Kant to say that the one thing besides the starry heavens which filled him with unceasing wonder was the moral law within.[1]

(c) The Life and Teaching of Christ Deny This Hostile Viewpoint

The determination of the Christian attitude upon this whole question is not dependent alone upon man's unaided thinking with regard to these facts. It is possible when facing such problems to have light flashed upon them

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1. Cf. Snowden, The Discovery of God, p. 48

from the life and the teachings of Christ who claimed knowledge sufficient to teach man heavenly things far above his comprehension.[1] The deeds of Jesus declare more strongly than words the value which He placed upon the soul. It was to man He came to minister and to give abundant life. But this would not have been so if He had not thought the individual worth saving and being the object of His love and care. Furthermore, His teachings coincide with this spirit of His life. What meaning can be attached to those parables of the lost sheep, the lost coin and the lost son if they are not permitted to teach the priceless value of a single soul?[2] To attempt any other interpretation would be to turn exegesis into eisegesis and to make texts from His words to become only pretexts for airing one's opinions. To follow the Galilean in His teaching and to breathe the atmosphere of His life which always threw about itself an air of confidence and certainty with regard to things of vital concern to man, brings one to the place where he can say with the Scotsman, if he could not do so before on the basis of his own reasoning, that he refuses to be "astronomically intimidated."[3] He makes man feel that God can be and is concerned with the needs and cares of every individual.

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1. John 3:12
2. Luke 15
3. Cf. Buttrick, The Parables of Jesus, p. 181

It is the Christ who can help man out of his difficulties when, as Boreham has suggested in his interesting way, he makes God seem not too great but not great enough.[1] The cure for such a puny conception of God as weakens confidence in His ability to exercise minute care towards His children is a closer acquaintance with Him who was sent from God to interpret the Father to man.

(2) On the Basis of the Subjective Reality of the Universe

(a) Justification for This Criticism

Not only is it possible to answer the arguments berating man upon the basis of the objectivity of the facts to which they relate, but it is also possible to criticize them from the standpoint of subjectivity. At times men like Jeans appear to defend a reality to things external to the mind of man by making them the creation of a Supreme Mind in which they exist as thoughts.[2] This is certainly to be looked upon as an objective idealism. The mind of man in this view is also greatly elevated because the atoms out of which it has grown are said to exist in the Supreme Mind in the same fashion. There even seems to be special deference paid to it in this philosophy because it appears, when it thinks in mathematical terms, to show something more in common with the Universal

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1. Cf. Boreham, The Luggage of Life, p. 167
2. Cf. Jeans, The Mysterious Universe, p. 186

Mind than the other objects of this Mind's thoughts.[1]

But at other times these same scientists speak as though the universe existed only in the mind of man. This became evident when the dilemma created by belief in a finite world presented itself to the theorist. In order to escape from this he retreated to his mental dugout where no criticisms hurled at him could bother him because there was no objective world recognized in this subterranean region. How this same scholar can feel now that he ought to be permitted to come to the surface after the battle is over and to declare that he has always been there is not easy to understand. His speech betrays him in manifold instances that would require an Argus-eyed critic to keep the thought mentally localized at any given time.

(b) The Comparison between the Universe and Man on This Viewpoint Is False

Accepting, then, this subjective position so pleasing to men like Jeans, one is driven to the assertion that any comparison between the universe and man, like those which have been made in the name of science, are false. A cosmology ruled by a subjective philosophy has no authority beyond the domain of the mind where it was manufactured. It cannot bring pressure to bear upon the effort to deflate human values. In fact, it has no right to throw stones

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1. Cf. Jeans, The Mysterious Universe, pp. 186-187

as an act of enmity at the individual, for it, too, lives in a glass house that is bound to be ruined if the mind of man tumbles in a fall. Or to change the figure, a subjective world view cannot use its ammunition with effectiveness, for either it fires a blank cartridge or its powder is wet when it attempts to fell the individual with the hard facts regarding a world extraneous to the mind and in comparison to which man appears as but a speck of dust raised by the revolution of great wheels. The reason for this failure is that the theorist in his deadly efforts has no real objective facts that his hands can handle. As long as they are in the mind, they are perfectly harmless to make possible any invidious comparison between man and the outer world.

(c) The Individual Is Exalted Rather Than Debased by This View

Carlyle said that man is a creature "having the geometry of heaven in his brain."[1] This is gloriously true on the basis of the reality of an objective world which man can explore with his mind, but it is not the whole truth regarding this subjective view of science which has sometimes been asserted. In this case not only the geometry of heaven is in the mind, but the heavens are there also. Mentalism must ever look to the mind to say

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1. Burrell, The Religion of the Future, p. 8

"Let there be light", and must also expect the same creative agent to report that "there was light". Turning from the rather humiliating picture of man which some have painted from the facts, Jeans makes bold to suggest that the mind may be "the only reality, which creates, instead of being created by, the colossal masses of the stars and nebulae and the almost inconceivably long vistas of astronomical time."[1] The result of this new mathematical view of the universe, to which Jeans seems fully to subscribe in spite of some statements to the contrary, is clearly expressed in the writer's own words in which he says:

> "It is probably unnecessary to add that, on this view of things, the apparent vastness and emptiness of the universe, and our own insignificant size therein, need cause us neither bewilderment nor concern. We are not terrified by the sizes of the structures which our own thoughts create, nor by those that others imagine and describe to us . . . The immensity of the universe becomes a matter of satisfaction rather than awe; we are citizens of no mean city."[2]

If these remarks by the scientist be weighed carefully, they are seen to cancel the negative views about man which issue from the same source,--namely, the recent speculations about the cosmos. And it may be granted that those who do the "mind-spinning" are best able to evaluate the results. Even upon the authority of Jeans,

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1. Jeans, The Universe Around Us, p. 332
2. Jeans, The Mysterious Universe, pp. 178-179

one is priveleged to say that through this process of the enlargement of thought about the world the mind has come out on top. In a more complete sense than some would wish to admit, this cosmologist holds that man is "monarch of all he surveys". Whether this view be accepted or rejected,—and good reasons have been presented for rejecting it, it indicates, along with the considerations previously brought to light, that the mind does occupy a conspicuous place in the world and in man's thought about it and cannot be relegated to a subordinate place in the life of the world. When science tries to submerge it, it turns out to be like an unsinkable ship.

3. The Implications of Man's Free Will

a) Man Is Not a Robot But a Responsible Being

The declarations of current physics are so decidedly in favor of indeterminism, and of free will as a consequence of that doctrine, that it is only necessary in considering the religious implications of these scientific views to unfold without argument what is implicit in them. Among the outstanding teachings elicited from these new theories is one to the effect that man is no longer to be looked upon as a puppet but as a being responsible for his own acts. Free will discharges permanently from its services the belief in man as only a robot who is helpless until he is set going and who can even then operate only like a machine. As Professor A. H. Compton has put it:

"Man cannot be considered as an automaton in this picture. He must no longer to be viewed as blindly obeying fixed, exact laws without any chance to do anything about it. There is some freedom of choice."[1]

In other words, the new conceptions change their thought of man from that of one being responsible to fixed laws to that of a being responsible for obeying and utilizing laws for his own aims and purposes.

b) His Moral Life Is Not a Fiction But a Scientific Fact

With the sense of personal accountability goes the feeling of moral action. When man is shown to have freedom of conduct, he begins immediately to realize the moral qualities inherent in life. While this morality haw been very generally acknowledged, belief in it has heretofore had little direct sanction from science. But now this support is forthcoming on all sides and gives a feeling of satisfaction to the moralist. For though free will has been believed in even during the reign of determinism, it has been well known that

"freedom must be an illusion and mental process must be a purely secondary consequence of mere sequences of physical change, if the mechanical theory of the Universe is valid. There can on this view be no meaning in reason, no pursuit of truth or goodness; and all talk of high aspirations and ideal standards of conduct must be idle."[2]

Ethics and religion, while holding to their convictions,

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1. New York Times, March 27, 1931. Article previously referred to.
2. Barnes, Scientific Theory and Religion, pp. 579-580

have had to wait until the present for scientific confirmation of that which they have all the while been heralding as true. This happy issue to a long struggle between determinism and free will is indeed a great victory for the moral forces of the world and shows how the truth is always vindicated in time.

c) The Progress and Development of the Soul Are Scientific Possibilities

It is possible also in the face of these facts to speak of the development and culture of the soul as scientifically justifiable. A lifeless clock, running only when it is wound up, cannot be looked upon as a subject of progress, but a being, who is acted upon by his environment and in turn reacts upon it, can grow inwardly through his contacts with his surroundings. His attitude, when once it is admitted that he is free, is not that of mere passivity, but of active participation in the control of events and of experiences in which he shares. It is these things with which he has to do that help to shape his life and determine his future as well as his ultimate destiny.

d) The Religious Life Involves a Personal Relationship

So long as man continues to be regarded as a machine, it is difficult to conceive of his relationship with the High Power as being personal in its nature. Though God who is behind the visible universe is viewed as personal, He still cannot establish a personal relationship with an unresponsive creature that moves only when it is moved. Only when man is accorded the freedom which is associated with responsible, personal action can his relation to God be denoted in this fashion and his religion be lifted to the level of human intelligence. But science now acknowledges that this personal character belongs to man and simultaneously raises religion in its own eyes to the dignity of a personal communion, at least from the standpoint of man.

4. The Implications of the New Views of the Religious Life

a), Science Can No Longer Be Unfriendly to Religion

The hostile attitude which science has sometimes manifested towards religion breaks down entirely in the presence of the recognition by modern astrophysical thought of a common starting-point in both science and religion. They meet in consciousness which provides the urge to discover truth in either field and gives to the seeker after this precious gem in both domains a trust in its innate sense of values. Since this inward monitor warns of dire results which would follow a declaration of independence from its judgments, it has a tendency to draw these long-time enemies into closer cooperation for the discovery of reality and the furtherance of truth. It is now being recognized that men in both spheres are seeking to reach Reality, and that of the two pursuits religion has possibly the most direct means of coming into contact with it since it approaches it through the private door of personal communion.

b) Religion Is as Well Authenticated as Science

The setting of religion has also become more comfortable in recent years in respect to the fundamental postulates of science. The symbolical character of much of present-day science and the need for the attachment of values to those symbols have together made the scientific spirit more sympathetic towards the intangibles of religion with which man has linked important significance. Science finds that in its work its credentials for giving meaning and value to the materials with which it deals are no better than those which religion possesses when it assesses the worth of its own commodities. Since the reports of findings are made out in the same central office of consciousness, religion when it speaks can demand for itself an authority equal to that of science. The day is past when its assertions can be regarded as subjective and mystical while those of science must be looked upon as purely objective. Science, before it can even go into the outer world and bring back its results, must get from consciousness a warrant which is countersigned by the same hand as that which issues authoritative writs to religion.

c) Religion Is Direct Contact through Consciousness with the Great Reality behind All Things

The scientific explanation of religion, as far as it goes, makes religion a means of direct contact with Reality instead of a method of indirect approach through symbols and sense-impressions. Science is hindered in the outer world by phenomena beyond which it cannot pass. It attaches to these symbolical meanings and then makes circles in its efforts to explain by the use of these symbols what lies behind them. But consciousness provides a direct way of reaching the unseen; it is an open window into that realm. Phenomena are not a hindrance to its contact with Reality. It looks directly at that world of which it is itself a part. It is in this province of man's life that God, to speak plainly, interprets the meaning of Himself to man and permits him to register his responses to the unveiling of the Truth which he seeks. Here is a picture of religion at work in the laboratory of human life.

Chapter VI

SOCIETY

A. Introduction

Not all of the scientific views about man could be compressed into the discussion of the individual which was completed in the last chapter. There were "fragments which remained" after the bread of scientific wisdom regarding the race had been distributed to the individual. It is the purpose of the present chapter, therefore, to gather together the residue in the basket of logical construction and present it for further edification in this subject. Some of this material has a very close affinity to the facts and arguments advanced in reference to the conception of the individual which has already been outlined, but all of the remainder is particularly apposite to the social phase of this subject. It is necessary to reflect upon these matters before one's understanding of the bearing of the new scientific theories upon human life can be said to be even measurably complete.

B. Facts Which Tend to Depreciate the Importance of the Race

1. The Quantitative Insignificance of the Individual Member of Society in the Universe

Since the view of human society is largely dependent upon the collective estimate of the individuals which compose it, it is not strange to find that, where the interpretation of the scientific facts about man is subversive of his high position, a lowered conception of the race follows as a natural consequence. As a government cannot rise to a level above that of the people which compose it, so the race cannot be more highly esteemed than the separate units which constitute it. But it has already been shown how some facts brought to light have been turned against man in an effort to dwarf his significance by adverse comparisons of a temporal or quantitative character, or by sinister suggestions regarding a universe either insensible to his needs or antagonistic to his purposes. The outcome of this attempted deflation of human values has been for some thinkers a decided reduction in the customary estimate of individual worth. From this opinion there has followed logically a lowered conception of the value, meaning and purpose of human society. Having begun to think meanly of themselves, they have not been content to restrict their estimate to a personal application, but they have taken the stand that an inferior view of the race is more in keeping with the scientific facts of the present. Unfortunately, there seem to be a considerable number who are affected in this way by the new cosmology.

2. The Brief Period of Human History Compared With the Ages of the Earth and of the Universe

Already the great disparity between the ages of the earth and of the universe and the short span of human life has been recorded on the unfavorable side of man's balance sheet. A similar comparison, with the total length of human history substituted for the individual life line, turns out to be only slightly more reassuring. When it is judged according to the same standards used in the endeavor to submerge the individual, it makes no showing to boast of, for the fact is that the whole of human life on this globe is less than the tick of a clock in comparison to the long day of earth's existence. Jeans has tried to make these contrasts clear by means of a graphic representation. He has pictured the time of man's sojourn on earth in an uncivilized state as a penny in thickness. A postage stamp stuck to this would then represent the period of man's civilized life. Now if these together, he says, were placed on top of Cleopatra's needle, their size relative to the obelisk would represent a fair comparison of the age of man to that of the earth.[1] The difference revealed by these inequalities in time appears tremendous, yet it does not begin to show the vaster divergence which would emerge if the age of the universe were used for that of the earth. In this case, as Jeans says elsewhere, "the whole history of the human race is but the twinkling of an eye in comparison with the

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1. Cf. Jeans, The Universe Around Us, p. 339

ages of the stars."[1] But the comparison need not be continued further; sufficient figures and suggestions have already been given to prove that man cannot entertain a very sanguine attitude towards the race so long as this method of measuring its importance is employed. Contrasts like these are always bound to discriminate against society.

3. The Depressing Effect of the Doctrine of a Dying Universe Upon the Race

The shadows seen in this picture of human society which is painted by the pessimistic interpreters of scientific theory are aggravated when one turns to consider the depressing effect that the doctrine of a dying universe has upon the race. Already this theory seems firmly rooted in the minds of many of the great astronomers and physicists of the present. Jeans thinks a dying sun, in which electrons and protons are being completely annihilated, can be the only possible source of the light and heat which make life possible on the earth.[2] But not only does he believe in this theory of annihilation as applied to the solar system; he also applies it to the whole of the universe, including the stars and interstellar space. Accounting for the cosmic ray and other highly penetrating

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1. Jeans, The Stars in Their Courses, p. 138
2. Cf. Jeans, The Universe Around Us, p. 183

radiation in this manner, he makes this process to be fundamental to the life of the universe.[1] From astronomical evidence, according to Jeans, it now seems possible, contrary to the demand of the quantum theory, to believe in the complete break-up and annihilation of the atom.[2] In speculating upon the results throughout the cosmos of such a theory if true, he declares that every atom in the universe is doomed to destruction, and that the earth and stars are destined to melt away in radiation.[3] The famous lines from Shakespeare's Tempest which he quotes apply most appropriately to this picture of a dying world:

"The cloud-capped towers, the gorgeous palaces,
The solemn temples, the great globe itself,
Yea, all which it inherit, shall dissolve,
And . . . leave not a rack behind."[4]

But the effect of this thought upon the individual and the race is felt in the reaction of the scientist himself to this view when he asks whether, if this be all the universe amounts to, the quotation should not be continued through the following confession of the futility of life in which Prospero says:

"We are such stuff
As dreams are made on; and our little life
Is rounded with a sleep."[5]

This spirit of pessimism, emanating from the theory of a

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1. Cf. Jeans, The Universe Around Us, p. 185
2. Cf. Ibid., p. 186
3. Cf. Ibid., p. 187
4. Ibid., p. 187
5. Ibid., p. 187

universe which is vanishing into radiation, is more vividly expressed under a different figure by this same noted writer when he says:

> "Our position is that of polar bears on an iceberg that has broken loose from the icepack surrounding the pole, and is inexorably melting away as the iceberg drifts to warmer latitudes and ultimate extinction."[1]

Such is the gloomy outlook to which an uncompromising belief in the running-down of the universe brings some. There does not appear to be much on the horizon of this view that is bright with promise for the future of the race. About the least startling things which can be said about it were told by Professor Shapley to an audience which he addrsssed recently. According to his way of thinking on this subject, it cannot be denied that times are not what they used to be 100,000,000,000 years ago. The last time any constructive work was carried on in the galaxies was about 500,000,000 years in the past. Since that time very little repair work of any kind has been going on. And as for the future he reported that there are no signs of a new deal coming into astronomical affairs, since the cards are being dealt from the same old deck.[2] When one thinks of these sobering facts, it is no wonder that Northrop says regarding the second law of thermodynamics which lies behind them:

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1. Jeans, Eos, pp. 41-42
2. Cf. New York Times, February 17, 1934

"This is one of the most unethical and discouraging laws, from the point of view of human interests and values, in the whole of science, for it means that the universe in which we live is headed to a complete destruction of us and our solar system with an utter indifference to human values. It is also one of the most fascinatingly important and elusive laws in science."[1]

4. Summary

A comprehensive survey of these facts, which are said to subtract greatly from the capital of the race, does not furnish a very strong motive by itself for a superlative encomium on human society. It rather suggests the singing of a funeral dirge and the performance of the last rites for a species that will soon become extinct because it is doomed to perish in the final catastrophe of the universe. The pensive mood is descriptive of the temper of the mind reflecting upon these things:

"Is this, then, all that life amounts to—to stumble, almost by mistake, into a universe which was clearly not designed for life, and which, to all appearances, is either totally indifferent or definitely hostile to it, to stay clinging on to a fragment of a grain of sand until we are frozen off, to strut our tiny hour on our tiny stage with the knowledge that our aspirations are all doomed to final frustration, and that our achievements must perish with our race, leaving the universe as though we had never been?"[2]

Who can say that such a mental attitude is not dangerous and that it is not actually inimical to the welfare and ordered progress of humanity? Certainly since it cannot

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1. Northrop, Science and First Principles, pp. 46-47
2. Jeans, The Mysterious Universe, pp. 15-16

be productive of any good, the facts upon which it is based need to be seriously challenged.

C. Facts Which Uphold the Importance of the Race

1. The Strategic Place of the Individual Member of the Race in the Whole Picture of the Universe

a) Philosophically Considered

But as in any debatable subject, the facts are not all on one side as the preceding picture might lead one to think. In this case it may even be confidently affirmed that the bulk of the evidence seems to favor a different conclusion from that which has just been arrived at. Part of this evidence lifts humanity out of the slough of despond by pointing to the place of eminence which the individual member of the race occupies in this entire scheme of the universe. He is not simply the "quintessence of dust",[1] for with his mind he roams the universe and frames the objects of earth and sky in his thoughts. As Ovid expressed it, "God gave man an upright countenance to survey the heavens, and to look upward to the stars."[2] No philosophy of these things can ever be formulated without paying deference to the mind as its builder. The architectonic powers of the human intellect elevate it

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1. Shakespeare, Hamlet
2. Ovid, Metamorphoses

above the universe or any metaphysical conception of it, no matter how depreciative of man the latter may be. But if man is such a noble piece of work with such admirable and commanding faculties, the dignity which rightly belongs to him must also be accredited to the race from which he springs. It is difficult to think that the whole could ever be less than any of its parts.

b) Ethically Viewed

Man comes off the field no less a victor in his struggle with the opposition if one considers him ethically in his situation in the universe. However many facts may be adduced to show the indifference and actual antagonism of the universe towards man, they merely prove in the last analysis his greatness. For man is not a football to be kicked about from place to place at the discretion of the players in the game; he is himself a player. Like the skilled oarsman rowing against the current, he struggles against whatever adverse forces may be playing upon his life and utilizes their hostility to strengthen his stamina and enrich his nobler qualities of life much as the boatsman builds the resistance to his skiff into his physical and muscular development. To adopt another figure, the truth is that environment is the instrument and man is the player, and not the reverse. The music which comes from his life in the form of inherent moral power and of ethical practices is the result of his divinely inspired contact with the instrument which becomes his servant by his mastery of its moral possibilities. Come what may, then, in the outer world, man will survive it because he surmounts it. As Addison sang, so may man sing of his inner self:

"The stars shall fade away, the sun himself
Grow dim with age, and nature sink in years,
But thou shalt flourish in immortal youth,
Unhurt amidst the wars of elements,
The wrecks of matter, and the crush of worlds."[1]

But, again, if this be true of the individual in his moral and spiritual life, the race must also be lifted upon the wings of man's moral greatness to an altitude where it can view with equanimity the prospect of such vicissitudes in a changing material universe. Its prestige must rest upon its ability to produce that which may possess survival value even in a world catastrophe and can break through the decaying material order into the spiritual or eternal.

2. The Doctrine of a Universe Which Is Winding Up

a) The Scientific Evidence for a Winding-up of the Universe

The value of society, however, does not depend entirely upon these facts that concern the individual units of which it is composed. There is enough direct scientific evidence of an antithetical character, put forth by

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1. Addison, Cato, Act V, Scene I

reputable authorities of recent years, to neutralize any claims derogatory to society which are made by the sponsors of the theory of a dying universe. Dr. Millikan has been outstanding in his advocacy of this winding-up theory. He finds the process of atomic disintegration a failure as a source of available energy.[1] In consequence, he champions the process of atom-building as the only possible method whereby the immense amount of energy pouring in upon the earth from the depths of space in the form of cosmic rays could be produced.[2] To him this is the "music of the spheres"[3] which indicates not the death of matter but its birth.[4] Even later utterances of this noted scientist than those recorded in the work just referred to reveal a more settled conviction as to the truth of this theory rather than a tendency to abandon it. It looks at present as though the hypothesis were here to stay. At least its scientific status seems as good as that of the negative position of Jeans and others, and it has also its very ardent supporters. But the point to be emphasized concerning this hypothesis is that, if it be true,—and science does not know enough to deny it any more than it knows enough to affirm positively the opposite view, then

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1. Cf. Millikan, Science and the New Civilization, p. 96
2. Cf. Ibid., loc. cit., also p. 106
3. Cf. Ibid., p. 134
4. Cf. Ibid., p. 98

one of the strong arguments brought against a lofty view of human society is completely eliminated.

b) Philosophical Support for the Winding-up View

Philosophy has also attempted to come to the support of those scientists holding to a belief that the creative process is now going on in the universe. The argument which it uses is to the effect that, when the universe is completely run down according to the second law of thermodynamics, only a finite number of permutations, reckoned on the basis of the finite view of the universe, need be exhausted before the right one is reached which will start the universe again on the upward road towards a state of complete organization. Consequently, it is said that the demobilization of energy can be only one aspect of a twofold process which runs half of the time in one direction and half of the time in the other.[1]

The objection to this view is, first of all, that it is based purely upon a theory of the universe which knows no controlling power within it except blind chance. This hypothesis was discussed previously in relation to the effort to dispense with the need for a Creator who wound up the universe and set it going on its downward course. There it was shown to be so preposterous as not to merit serious consideration. The same criticism holds good

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1. Cf. Northrop, Science and First Principles, pp. 163-164

here. While logically this theory might appear to work out as indicated in the method which was just outlined, it does not impress the mind as being at all practical,— certainly not as the way the universe actually works. There is too much evidence of design and purpose in the world for one to hold tightly to this belief. Then, in the second place the view is weak because it itself, being only an hypothesis, is based in turn upon the theory of a finite universe which is not yet generally received as the correct view. It still has, and probably will always have, too much conjecture about it to make a solid foundation for any argument based upon it.

3. The Long Time Still Remaining according to the Theory of the Dying Universe for Society To Reach Its Ideal

The comparison of the age of human society with that of the earth, which was made at the beginning of this chapter to show how puny is the racial history when measured against the greater span of the earth's existence, was anything but encouraging to man. But if the future of man's history be compared with the period of the race's past, the result is much more hopeful in every way. From the standpoint of life in the universe, it is said, man undoubtedly arrived near the close of its history, but as a dweller on the earth he is just at the threshold of his existence, and a day of almost inconceivable length, with vast privileges and opportunities accompanying it, stretches out before him.[1] If figures are of any help in grasping the long future before man, one might recall the statement of Jeans to the effect that a million million years from now the sun will still be shining much as it is now and the earth will yet furnish an abode for man in a somewhat colder climate than at present.[2] A more graphic representation of the tremendous extent of man's future is also given by this writer through the continuation of an illustration which was used before. If, says he, the postage stamp be made to represent 5,000 years as the period of man's civilized life, then other stamps could be placed on this until they were as high as Mount Blanc before man's life on earth, according to the present prophecy of science, would come to an end.[3] From the astronomical viewpoint humanity is really in its infancy with all the possibilities of a life of exploration and realization before it.[4] This picture, therefore, greatly atones for any exaggerations introduced into the adverse comparisons of the negative view of the meaning and value of the race. It gives ample time, if true, for the full development of any social projects and for the accomplishment of many ideals now in the offing. By the end of this period the value of

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1. Cf. Jeans, The Universe Around Us, p. 340
2. Cf. Jeans, Eos, p. 11
3. Cf. Jeans, The Universe Around Us, p. 339
4. Cf. Jeans, Eos, p. 12

eugenic plans and of schemes for the social amelioration of the race should have been fully tested. Religion should have had time to work itself out in the production of a higher and nobler type of life, and human brotherhood should have approached well nigh unto perfection.

4. Summary

In glancing back over these considerations which have been mentioned for the purpose of balancing the debit and credit sheet belonging to society, one is impressed with the fact that, from whatever angle this whole subject of the importance of society is viewed, the race looms up into prominence and refuses to be trampled down under the feet of hostile forces. It, too, is like an unsinkable ship that will not down. Arguments based on the character of the individual and on purely disinterested science brings the race back into its own after it has been made to wander in the wilderness of doubt by the subtle suggestions of a group of curious misanthropes whose influence is all out of proportion to their numbers among the scientists and the laymen who are well informed on these matters. It can only be hoped that their propaganda will be checked by the sober facts and that wiser counsels will prevail in the future to steer the minds of men in more fruitful channels of thought.

D. The Religious Implications of the New Astrophysical View of Society

1. Introductory Remarks

The remaining portion of this chapter deals with the religious implications of that view of society which has been under careful observation in these pages. Before attempting to peel the bark from this conception in an effort to reach the cambium layer where the vital tissues of the view are to be found, one needs to be reminded that there are two theories as to the method whereby this tree of new knowledge about society subsists. The one maintains that it has no roots in the material world and that it grows by feeding upon itself. Space and time, in other words, are regarded by some as the products of "mind-spinning"; they are said to issue from within and yet are used to berate the importance of their subjective birthplace. This viewpoint, which is the dominant one to-day in science and philosophy, can hardly be said to have any legitimate right to make invidious comparisons between the universe in space and time and the mind of man which creates that world of nebular distances and of astronomical time. If it is all in the mind, then the mind has the greater circumference and transcends any of its concepts. Likewise, society, to which the individual with such creative faculties belongs, is also to be placed above any of these criticisms adverse to it, for if one goes back far enough in thought it is necessary to look upon the individual himself as issuing from the womb of the race. His achievements in some sense reflect upon the character of the social organism.

The other theory, to return to the figure again, maintains that this tree is rooted deeply in the material world from which it seeks to derive its strength. It is unwilling that the scorching sun of criticism should cause it to wither and die immediately because its roots have no deepness of earth. And this is the only view that needs here to be considered, since the other position was examined at some length in the last chapter. Whatever follows in this discussion, therefore, is to be understood as dependent upon this more secure anchorage for the view under consideration.

2. Questions Which the View Raises about God

a) Is He Friendly towards the Race?

(1) The Negative Answer

Among the first implications to be faced in this process of deduction is one which can best be framed in the form of a question. The query which arises in the mind is, Is God friendly towards the race? Looking at the precarious tenure of existence which man has upon this globe and knowing that sooner or later he will be forced out of his present habitat, man betakes himself to asking whether God be kindly disposed towards His creatures whom He treats in this fashion. His temptation to answer in the negative is not lessened when his mind dwells upon the bigness of the universe in comparison to which his earthly home seems like a molehill beside a mountain. He is disposed to think that God has too much to do and too many larger plans to operate to worry much about this little side-show put on by humanity in a remote corner of the universe.

(2) The Positive Answer

But further reflection proves that these facts about the universe and about man's place in it do not at all require this construction to be placed upon them. The conception of God embedded in them may clearly be shown to involve a fatherly concern for the welfare and the happiness of the race. The pleasant conditions surrounding the present home of man are the product of His creative plan and purpose. The fact that so few places seem to be favorably located for the development of life argues not so much for a God disinterested in life as for a God particularly concerned about the comfortable conditions where life is to thrive. The rarity of the human species, too, in comparison to the size of the universe need not be interpreted as an indication that God has put upon it a low estimate; this fact may be adduced to show the preciousness of human life. This is the more easily proved when the vast preparation for its appearance is taken into consideration. It is not foolishness to think that God should have made such lavish expenditures upon man if it is man's conviction that He cares for him enough to do so. His ways are no doubt more reasonable than those based upon human calculations of what ought to be done. At any rate, the fact remains that He has done something which can justly be pointed to as indisputable evidence of His deep concern for humanity which is the crowning work of His creation.

b) Is His Activity Purposive?

(1) The Negative Reply

The next question raised concerns the purposive character of God's activity. It is closely related to the facts upon which God's attitude towards the race is based. Some see in the comparison of the vast areas of the universe which are unproductive of life with those insignificant portions where human existence is possible a lack of purposiveness upon the part of God in planning. Planning would have meant less waste and more rsults in the production of complex human life. It is also said by those who take this view that the seeming indifference of the universe to human life, once it has arrived, argues either for the absence of purpose in the universe or for a purpose inimical to the race.

(2) The Positive Reply

Neither one of these conclusions, however, need be accepted. God's prodigality from man's standpoint does not necessarily imply the same conclusion from His own.

Since it is only God's prerogative to create and since He has done it by objectifying His thoughts and paying for it, so to speak, at His own expense, it may be argued that in His mind the end justified the means because of the great value which He has attached to it. There is more reasonableness in interpreting the world and man's place in it in this manner than there is in looking upon the whole picture as the result of blind chance. The former view has fewer difficulties. Then, too, the future of the race does not at all indicate a God hostile to humanity. Not all of God's plans for man are completed in this world of material substance. Though the universe be dissolved, He can still bring to fruition the plans for the race which He devised before the foundations of the world. What might otherwise seem like castrophe may be taken up into His larger purpose and become a greater blessing to the race. It does not do to judge God after man's imperfect standards of judgment.

3. Questions Which the View Raises about Society

a) Is the Struggle after Social Progress Futile?

(1) The Answer of Pessimism

Those disposed to cross bridges before reaching them may become gloomy over the sentence of death which they now see pronounced upon the universe and which they believe will in ages to come be executed against everything organic and inorganic in the cosmos. Already they begin to mourn for the future. Others would defer this sad outlook to some distant day when the end is fast approaching. Jeans says of that time:

> "Life will be more of a routine and less of an adventure than now; it will also be more purposeless when the human race knows that within a measurable space of time it must face extinction, and the eternal destruction of all its hopes, endeavours, and achievements."1

But whether the agony be present or in prospect, it has with some a tendency to make all efforts for human betterment seem futile. The psychology by which they support their purposeless activity in behalf of the higher interests of self or society is expressed by Macbeth when he says:

> "Out, out, brief candle!
> Life's but a walking shadow, a poor player
> That struts and frets his hour upon the stage,
> And then is heard no more; it is a tale
> Told by an idiot, full of sound and fury,
> Signifying nothing."2

(2) The Answer of Optimism

Others, however, are not bothered in the present by a catastrophe which to them seems so far removed. It is their view that a great deal of water will flow under the bridge before the human race has reached the place where it must negotiate passage. It is in the light of this pleasant thought that Jeans dares to say after his last quotation that

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1. Jeans, The Universe Around Us, p. 334
2. Shakespeare, Macbeth

> "by what light we have, we seem to discern that the main message of astronomy is one of hope to the race and of responsibility to the individual—of responsibility because we are drawing plans and laying foundations for a longer future than we can well imagine."[1]

But while Jeans finds this encouragement for the present only by pushing back the evil day for the race, there does not seem to be any good reason for the slacking of social zeal even if the day be near at hand. History shows that many who have looked for the speedy dissolution of the present order of things have labored earnestly to redeem the time and to work for righteousness while there is still time to work. They have believed, and it is possible for one now to believe, that man is not shut up to that melancholy prospect, either immanent or distant, for they have been conscious that there is that which transcends the present order and changes not, though all about them be change and decay. In other words, as the Great Teacher expressed it, man can lay up treasures in heaven, and there need be no stronger motive for abundant living in spite of the storm-clouds that may be looming up on the horizon.

b) Is the Religious Life of the Race a Myth?

(1) The answer of Reason

All of the preceding questions have naturally been leading up to the greatest of them all,—namely, Is the

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1. Jeans, The Universe Around Us, p. 341

religious life of the race a myth? If one becomes firmly convinced that the whole of the universe has entered into a conspiracy against man, and that whatever evidence is available in the world proves that there is no purpose at the heart of nature; and if, moreover, one views the attainments of the race as totally destroyed in the final heat-death of the universe, nothing of eternal value being salvaged from this calamity, then it is easy to understand how such a person might say that religion in this case is a hollow mockery and the worst of superstitions that need to to be eradicated from the human mind. And it is possible to conceive of reason, willfully unaided by any other of man's ways of knowing, coming to such an impasse in its thinking on the basis of the many confusing facts and views of the present.

(2) The Reply of Faith

But to put this latter question to faith is to get a different answer. For, as Pascal has said: "the heart has reasons which the reason does not know. It is the heart that feels God, not the reason." Physics, which concerns the reason in its efforts to rationalize the world, cannot tell man which way to orient the universe. If man puts the future on top he must trust some inward sense of fitness. Likewise, if he would orient the spiritual world with the good on top, he must consult some inward monitor.[1] Religion, too, does not get its sanction from the reason alone. It is this inner voice that tells man it is right to recognize this Higher Power that makes for righteousness. Experience prompts man in this situation to say what he has often found it necessary to say before,—namely,

> "I would not always reason. The straight path
> Wearies us with the never-varying lines,
> And we grown melancholy. I would make
> Reason my guide, but she should sometimes sit
> Patiently by the wayside, while I trace
> The mazes of the present wilderness
> Around me. She should be my counsellor,
> But not my tyrant. For the spirit needs
> Impulses from a deeper source than hers;
> And there are notions, in the mind of man,
> That she must look upon with awe."[2]

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1. Cf. Eddington, The Nature of the Physical World, p. 339
2. Bryant, The Conjunction of Jupiter and Venus

PART THREE

THE MODERN ASTROPHYSICAL VIEW OF GOD

Chapter VII

A. Introduction

The transition from the modern scientific view of man to that of God is the next and final step in any honest endeavor to concatenate the diverse thoughts of astrophysics about the universe. An investigation which probes the depths of matter and lays its finger on the uttermost star is gradually forced before its work is far advanced to turn aside from its telescopes and its microscopes in order to look at man who, by peering out through the windows of his mind, is capable of directing the inquiry and of framing its results in his thoughts. But, once attention is directed as it must necessarily be by such a phenomenon, reflection does not come to rest upon man; he furnishes only a temporary landing place for thought that eventually wings its way into the shadowy regions which surround this universe of earth and sky. Questions like the following impel it onward in its course: if the mind of man can think the world, must there not be a Great Thinker who has first thought the world and given to that thought objective form? And must it not be that the mind of man is but a broken light of the Superior Mind Which thinks in terms of wholes what man can think only in part? In seeking to answer these and other questions raised by its own quest for knowledge, science has given definite embodiment to those views of God towards which it seems to be tending in the present. It is these specific representations, and not so much the implications about God drawn from other views, which form the subject of interest in this chapter.

B. Is God Knowable by the Method of Modern Science?

1. The Answer of Science

Before turning to a consideration of these matters, however, there is a previous question which needs to be faced in order that one may be prepared to form discriminating judgments concerning these direct statements of science about God. It relates to the ability of modern science to know God by the sole employment of its own methods. A recent writer has said that from the beginning research has probably been concerned to find God, but that only in recent years has it openly declared its purpose to discover Eternal Reality.[1] So sure is he that this aim will result in success that he also declares "if God is found research will find Him . . . ."[2] In fact, he states emphatically that no method except the scientific is agreeable to reason in its efforts to feel after God.[3]

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1. Cf. Cotton, Has Science Discovered God?, p. XlI
2. Ibid., p. XlIII
3. Cf. Ibid., loc. cit.

The way of religion he finds, by way of contrast, very unsatisfactory because it has given man a hazy and uncertain conception of the Supreme Being.[1]

But in spite of this almost credulous belief of the layman in the miraculous powers of the scientific method, the scientist himself is ever conscious of its acute limitations. He is under no misapprehensions as to its present weaknesses. It will be recalled that Jeans says science cannot know anything positive about the external world. He affirms that science deals with phenomena, not with the underlying reality, that its province is occurrences and not what lies behind them.[2] Eddington also confirms this viewpoint. So skeptical is he of the ability of science to touch reality that he pictures the activity of scientific research as being like that of a kitten chasing its own tail.[3] To him science moves in circles and never reaches the world-stuff or fundamental reality at all. As he sees it, the method of science is such that it can deal only with the very superficial appearances which are simply an indication to the investigator that something more fundamental is underneath them but cannot be reached. In other words, it is the peculiar province of science, when it adheres strictly to its task, to describe phenomena

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1. Cf. Cotton, Has Science Discovered God?, p. XLIII
2. Cf. Jeans, The New Background of Science, p. 57
3. Cf. again Eddington, The Nature of the Physical World, p. 280

and not to attempt an explanation of them.[1] If, therefore, as Millikan says so clearly, science has scarcely anything to say about ultimate causes,[2] it would seem that any very sanguine expectations from this source concerning the nature of God are without secure foundation.[3]

Eddington has made explicit explanation of the reason for the impotency of science in furthering greatly man's knowledge of God. His expression of the facts cannot be ignored if one would be aware of the elements other than scientific which enter into any view of God presented to the world by present-day science. The substance of the author's thought is to the effect that, since science deals with abstract principles and with the codification of facts, any treatment of God which it presents is bound in the very nature of the case to reduce Him to something like an ethical code which may throw light on the nature of the scientific method that produces it, but will not cast much light on the intrinsic nature of God.[4] Concerning those fundamental assurances about God with regard to which every man wishes to know Eddington feels that science is incapable of speaking. He as a scientist would consign to the

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1. Cf. Jeans, The Universe Around Us, p. 325; also The Mysterious Universe, p. 151
2. Cf. Millikan, Evolution in Science and Religion, p. 53
3. Cf. pp. 60-61; 67-71 of this thesis for further confirmation of this position
4. Cf. Science and Religion, p. 128

sphere of the religious experience the power to discover this kind of certainty,[1] the very power which was denied to it by a religionist himself. He even goes further and says that "if God really has a part in our everyday life, I do not think we need mind if the critic trips us up for speaking and thinking of him unscientifically."[2] The entire attitude of the scientist is one which minimizes the importance of strict science in furnishing religious knowledge and exalts the religious experience in its own realm. It is in direct contrast to the position stated by the man of religion and indicates that at times the scientist may be more religious than is the recognized devotee of spiritual things. At any rate, the testimony is consonant with that of Barnes who clinches it by saying that

> "the only foundations for any belief in God worth preserving must be discovered, not in inanimate nature, but in that moral order, emergent through animate nature, from which man's spiritual longings have been derived."[3]

2. The Further Requirements of the Symbolical Character of Science

But while science to-day does not in itself assist much in furnishing knowledge about God, it provides a strong incentive for the scientist or the scholar in other

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1. Cf. Science and Religion, p. 128
2. Ibid., p. 127
3. Barnes, Scientific Theory and Religion, p. 180

fields to proceed with the aid of religion and metaphysics to deeper research upon the basis of scientific data. The symbolical character of the current knowledge in the field of physics and cosmogony does not fully satisfy the mind inquiring after the nature of the unifying entity behind the manifold appearances of the universe. The desire for an interpretation of the reality represented in the symbols imposes on the scientist an inward necessity to speculate upon the character of their background because he does not recognize the mathematical formulae and the pointer-readings as a complete statement about the underlying facts.[1] But to meet this necessity science must acknowledge the legitimacy of a belief in a background and the ability of the mind to make judgments regarding its significance.[2] It must invite religion and philosophy to come to its aid in completing the work that it has been enabled only to begin. This procedure is tantamount to saying with George Herbert Palmer that "without the presupposition of God, Science is fragmentary and baseless. He is the antecedent condition of all being, the unitary ground of existence."[3] Because of this fact the scientist may be pardoned for leaving his laboratory or his

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1. Cf. Kirk, Stars, Atoms, and God, pp. 74,76
2. Cf. Ibid., pp. 74,75
3. Quoted from Contemporary American Philosophy, Vol. I, p. 40, on the authority of Van Dusen's The Plain Man Seeks For God, p. 93

observatory for a little while in order to explain what he thinks the other side of the picture is like which he is viewing through his instruments both large and small. And the layman may likewise be excused if he sets down in order the things which the physicist and the astronomer have to say about these matters.

C. The Views of God towards Which Science Tends

1. Explanatory Remarks

The presentation of these conceptions of God held by modern astrophysical thought is somewhat difficult because of the fact that there are divergences of opinion even among those writers to whom special attention is given in this investigation. The plan determined upon is one in which the view that indicates the most popular present tendency is presented as being representative, while any other view of the great scientists which does not accord with it is pitted against it in the section dealing with the criticisms and implications of these prevailing views. This method has the advantage not only of showing any disagreements which may exist among the leaders in this realm of thought, but also of pointing out the different angles from which the facts themselves may be viewed. Upon this balancing of opinions it is easier for one to reach at least a tentative decision as to the view embracing the largest deposit of permanent values.

2. The View of God as Finite

Possibly the view of God which is less definitely stated by the modern cosmologists and which, in consequence, is more likely to be open to question and debate is that which represents Him as finite. However, a review of the problems involved in the new conceptions of a finite universe is ample evidence that those who would hold to a limited view of the material world and to an infinite conception of God at the same time have many puzzling dilemmas to wrestle with in their efforts to harmonize the diverse conceptions. Just why a cosmos of finite proportions argues for a parochial view of God has been made ostensible in the previous discussion of this subject to be found in the fourth chapter and will be discussed somewhat further when the criticism of this position is undertaken later on in the present study. No additional remarks concerning the view need be made in this connection with the exception of saying that its implications are of vital significance to one's faith in God.

3. The View of God as Personal

In the midst of all the confusing statements with respect to the intrinsic nature of the Supreme Reality behind the world, there seems to be a tendency to-day to attribute to it all the characteristics which belong to human personality. In referring to the background in which all the cycles of physics have their being, Eddington says that "it is in this background that our mental consciousness lies; and here, if anywhere, we may find a Power greater than but akin to consciousness."[1] This great astronomer also gives it as his judgment that present scientific theory justifies a belief in the idea of a universal Mind.[2] But since the distinctive features of personality are always associated with mind, this statement of the scientist warrants a belief that science to-day is veering towards a personal view of God. Millikan has left no doubt in the mind of the inquirer into the facts of the case when he summarizes the present attitude in very explicit terms:

> "No man . . . can picture nature as devoid of these attributes which are a part of your experience and mine, and which you and I <u>know</u> are in nature. If you, then, in your conception identify God with nature, you must perforce attribute to him <u>consciousness</u> and <u>personality</u>, or better, <u>superconsciousness</u> and <u>superpersonality</u>. You cannot possibly synthesize nature and leave out its most outstanding attributes."[3]

A close study of this quotation convinces one that, if this is not a defense of the personal character of God who is behind the natural world, then it would be difficult to phrase any statement about God which could be said to meet the requirements of such a concept. From what Millikan has said elsewhere it would appear that Einstein's con-

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1. Eddington, The Nature of the Physical World, p. 282
2. Cf. Ibid., p. 338
3. Millikan, Science and Life, p. 58

ception closely coincides with this. From his own words it becomes clear that this noted scientist concedes at least a belief in an eternal conscious life and in an intelligence manifested throughout nature.[1] This goes a long way towards supporting the strong stand which Millikan has taken by integrating the fragmentary views of the leaders in current scientific thought.

4. The View of God as Pure Mathematician

The study of the universe by modern methods of science has also led the scientists almost unanimously to think that the universe is more like a great thought than a great machine.[2] This conclusion has been arrived at through the discovery that mathematics more exactly explains phenomena than mechanics. Jeans says that mathematics is the alphabet which was used in writing nature's language[3] and that this alphabet appears not to have sprung from the mind of man, as Kant declared, but rather to have entered into the world from above.[4] Whether the language be mental in meaning or not, he holds that science can discover in nature no reality different in character from mental concepts. These concepts he finds to be of the kind associated, not with the work of the engineer or the

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1. Cf. Millikan, Time, Matter and Values, p. 74
2. Cf. Jeans, The Mysterious Universe, p. 186
3. Cf. Jeans, The New Background of Science, p. 290
4. Cf. Jeans, The Mysterious Universe, p. 159

poet or the moralist, but with the thinker who deals with pure thought alone.[1] On the basis of these observations Jeans thinks that it is justifiable to state "that the universe appears to have been designed by a pure mathematician."[2] He arrives at this same decision, he says, whether the evidence upon which it is based is due to the fact that man's mind impresses its laws upon nature or whether nature forces its laws upon the mind.[3] Either position, if true, seems to him to lead to an identical conception of God.

5. The View of God as Artist

The mind of Jeans seems very fertile in the production of figurative representations of God. Not only has he likened the Creator to a mathematician at work in his study, but he has also compared Him to an artist at work upon a picture. Under this similitude he looks upon the universe as a finite picture whose dimensions are space and time and whose coloring is produced by the protons and electrons which serve as paint. If one traces time as far back as he can in this picture, Jeans sees him arriving at the edge of the picture and not at the point of its creation. The creation, he says, lies as much outside the picture as the artist is outside his

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1. Cf. Jeans, The New Background of Science, p. 290
2. Jeans, The Mysterious Universe, pp. 156, 165
3. Cf. Ibid., p. 165

canvas. To attempt to understand the Creator in terms of time and space is to him as futile as trying to discover the artist in the process of painting by going to the edge of the picture upon which he is working.[1] With Augustine he would say: _Non in tempore, sed cum tempore, finxit Deus mundum._[2] This view of God, the scientist thinks, approaches near to that philosophy which regards "the universe as a thought in the mind of its Creator."[3]

D. The Implications and Criticism of These Views of God

1. Consideration of the View of God as Finite

a) The Implications of This View

In turning at this point to a consideration of those views of God which have been briefly outlined, one realizes that the implications of the first one, which regards God as finite, are too obvious to need mentioning. Such a view robs God of omnipotence and omniscience and makes Him less than one who can be wholly depended upon. He can never be to the creature the complete ground of surety if doubt lurks in the mind concerning His absolute mastery of all things known and unknown.

b) Objection to the Premise upon Which the Implications Are Based

But no doubt objection will quickly be taken to the

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1. Cf. Jeans, The Universe Around Us, p. 325
2. Cf. Jeans, The Mysterious Universe, p. 182
3. Jeans, The Universe Around Us, p. 325

premise upon which these and other implications are based. The scientist may say that God is represented by him as behind this finite world and that he is thought of as separate from His world in the same sense that an artist is separate from his painting. He may declare further that in His subjective life God is conceived of in such a way as to nullify the assertion that modern scientific theory about the universe implies a finite conception of God.

c) The Reply to the Objection

The answer to this defense of the view of an infinite God on the basis of modern cosmology is simple. It will be recalled from the last quotation of Jeans that the universe according to science is to be looked upon as the thought of God. But since the universe is finite, God's thought expressed in the world must also be viewed as finite. Now a God who is only capable of finite thought such as that revealed in the limited cosmos cannot well be an infinite God. It is natural and logical to think of an infinite God as having infinite thoughts. And since it is at least possible to conceive of Him in such a manner, only if He thinks thus can He be thought of in turn as infinite. Anselm was right when he said "God is a being than whom no greater can be conceived. If you can think of anyone greater than God, thereby your God has become secondary."[1] Surely a concept of God involving on His part ability always to think more than finite thoughts such as the cosmos represents is possible. The god of modern science must, therefore, be viewed as secondary. Such a conclusion can be avoided by denying the existence of the universe objective to us or by making it infinite in extent. Modern theory does not do the latter and it is not consistent in its adherence to the former position. If it were wholly inclined to accept the subjective view, then it would have no right to talk of finite or infinite, since these ideas can have no meaning whatsoever to the subject when they do not correspond to any objective reality. But since current science avoids this dilemma at times by recognizing a finite objective world, it must also face the necessary result of such a concept,—namely, a restricted view of God.

2. Consideration of the View of God as Personal

a) Implications of This View of God

When one comes to the view of God as personal, there is little need, as in the last instance, of pointing out its religious importance. To imagine God as being impersonal is to indicate by contrast the benefits which the personal concept of God brings to man. If God is impersonal, there can be no hope of knowing Him apart from

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1. Donald Mackenzie, "Distinctive Elements of the Christian Faith", Record of Christian Work, October, 1932

His identification with the universe. Neither can there be any possibility of personal communion with Him through consciousness, since the impersonal cannot possess this characteristic of consciousness. In fact, religion, as one commonly understands its exercise, would be under such circumstances a very colorless and emotionless practice. It would resemble the act of lifting the pump handle which responds only as energy is put into it from a source extraneous to itself. It would not bring much more thrill to the worshiper than the handling of a pair of dumb-bells. Prayer would resemble traffic on a highway where all signs pointed in one direction. But to believe that God is personal is to reverse this picture for religion and to introduce pleasant prospects for the creature who would know in the intimacy of communion Him who has fashioned man in His image. The fear of losing personal identity after the individual is compelled to break with the material order is also dissipated from this personal angle of vision. If God be personal, man is slow to believe that He would purpose to withdraw from the individual in the future what He has granted to him in his earthly existence.

b) Present Scientific Deviation from This View of God as Personal

Of course, it must be granted that not all scientists see the current views of science heading in this direction of personalism. Eddington, who undoubtedly holds to that view himself for other reasons than those which might be called strictly scientific, seems to feel that, while it is possible to infer a Universal Mind from the present state of scientific theory, it is impossible to declare anything about the mind beyond a doctrine of a purely colorless pantheism.[1] The theologian likewise has seemed to view the situation in modern science from this standpoint. His statement runs as follows:

> "Science and philosophy can never get beyond a vague mystical pantheism . . . Science cannot help us in the distinctive elements of our faith. It can only help us within its own limits.
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> What is the common philosophical view of men like Eddington? How far do they get? They get to a God who is the breath, the moving force within the universe. They cannot get further because their dealings are with things. Science does not look beyond the reality which it examines."[2]

c) Criticism of the Pantheistic Deduction from Current Scientific Thought

The latter statement with regard to the peculiar province of science is undoubtedly true, but it may be legitimately questioned whether any scientist ever adheres strictly to its requirements in his daily practice of trying to synthesize what he discovers through his contact with the world of nature. Certainly when he begins to

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1. Cf. Eddington, The Nature of the Physical World, p. 338
2. Donald Mackenzie, "Distinctive Elements of the Christian Faith", Record of Christian Work, October, 1932

consider the implications of some of the facts of science which to-day are thought to be undubitable, he cannot hold on reasonably to a pantheistic view, for these facts make it appear absurd. Since the scientist is just as naturally inclined as is the layman to be a philosopher in his unscientific moments, he must pay attention to the inherent reasonableness or else to the irrationality of any doctrines towards which he leans as a result of his research. But if he follows this course, regardless of whether it is scientific or not, then pantheism must be ejected from his scientific creed because it does not harmonize in any intelligent manner with the doctrine of a dying universe. To hold to pantheism in the face of this second law of thermodynamics is to believe in a God who is slowly growing old and who is eventually to arrive at a state of endless passivity. It is also to see God as helplessly caught in a world process from which He cannot extricate Himself. But such a conception of God is too ridiculous to be entertained seriously upon the basis of present scientific facts. It makes Him appear even less able than man to combat the world process in which He is involved.

d) Logical Confirmation of the Personal View of God

But, fortunately, such a view of God is not demanded by the logical requirements in the case. If, as has been indicated already, the trend of modern science is towards a belief in the universe as a thought existing in the Mind of a Thinker, it is reasonable to associate the Thinker with personality just as the thought of the individual is also associated with personality.[1] It is not rational to suppose that the Supreme Mind possesses less than the highest category known to man, for if it should, God would be less than a person and man would be superior to Him in so much as conscious thought is superior to unconsciousness which is associated with the impersonal.[2]

3. Consideration of the View of God as a Pure Mathematician

a) Implications of This View of God

The idea of God as a Pure Mathematician, which has now justly become famous among the many views which Jeans has set forth, must also be examined critically. But, briefly, its implications may first be mentioned. In the first place, it makes God less than a person if it be accepted in its strict sense, for personality contains more than thought; it involves feeling and will as well. God may be like a mathematician in some respects and still possess personality, but He cannot retain this personal character and be purely a Thinker. As soon as one conceives of God solely in the terms of thought, just so soon does he forfeit the right to interpret Him also in

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1. Cf. Kirk, Stars, Atoms and God, p. 82
2. Cf. Ibid., p. 83

the other terms of consciousness. In the second place, if God is merely absorbed in thought, the world cannot be real but must be nothing more than a thought is in the mind of a dreamer. All that science works with becomes, upon this theory, a mere phantom that has no separate existence. And even the mind of the scientist who thinks is then only a part of the subjective thought of God. God's inner life of thought is the only thing which, from this viewpoint, can be said to have any reality whatsoever; all else is pure deception.

b) Criticism of This View of God

(1) Bertrand Russell's Objections to the Concept of God as a Pure Mathematician

Bertrand Russell has criticized this view from two angles. First of all, it is his conviction that the conclusion at which Jeans arrives concerning God does not prove so much about God as it does about the skill of the mathematical physicist. When the scientist represents God as being a Pure Mathematician, Russell says in substance that he abstracts Him from all relation to the world and makes any knowledge concerning Him to be impossible of physical proof. The world, then, no longer remains the means by which the experimenter reaches his knowledge. Russell feels that the theorist might take any world and read into it certain mathematical laws which would in turn become a tribute to the genius of the organizing mind of the scientist. To him these facts, which Jeans interprets as indicative of a God who is purely a Thinker, tell only about the scientist who catalogues them according to the laws of his own mind. In the second place, he maintains that if God were exclusively a Mathematician He would have no desire to give gross external form to His thoughts. On the supposition that He is a Pure Mathematician, His desire to trace curves and geometrical models is regarded as childish.[1]

(2) Consideration of Russell's Objections

Some have taken exception to the first criticism of Russell on the ground that it is a mistaken objection. A recent writer has said in defense of Jeans' position that it does not imply that God is made in the image of the mathematician, but rather follows as a result of the observation of those facts of the world which fall within the sphere of mathematics.[2] It is further maintained by this same interpreter of Jeans' view that it pictures God only as He actually "operates in his relation to the 'structure' of physical nature . . ."[3] But the difficulty with this reply to Russell is that it fails to realize the full import of Jeans' representation. If God is a Pure Mathematician, in the sense in which the noted scientist

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1. Cf. Russell, The Scientific Outlook, pp. 111-112
2. Cf. Van Dusen, The Plain Man Seeks For God, p. 92
3. Cf. Ibid., loc. cit.

seems most frequently to apply that term to Him, then Russell's objection to this view appears to be true from more standpoints than his own, for there is no way whereby such an idea can be scientifically arrived at.

But since the charge against Jeans depends in reality upon the truthfulness of this latter statement, an extended explanation of the process of thought whereby it is arrived at is necessary to give this criticism any weight. To begin with, it must be said in fairness to Jeans that there are passages in his writings where he explicitly repudiates the Kantian position that the mind is a lawgiver to nature, stating his reasons for his rejection of that philosophy.[1] But in doing so he merely reveals one of the many instances of puzzling contradictions in his thought, for any careful attempt to unify the scientist's thinking on this subject shows clearly that the preponderance of his statements favors an idealistic conception greatly at variance with this denial. This conception in turn seems to have two centers around which it swings at different times in a very disturbing fashion.

In spite of the previous warning to the contrary, there is much to be said, in the first place, for locating this idealism of Jeans in the mind of man. Very clearly has this writer said that space and time are mere fictions

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1. Cf. Jeans, The New Background of Science, pp. 292-294

of the mind.[1] But if this be so, then the space-time continuum, which represents the very texture of nature and the field for all mathematical concepts, must also be a mental concept. In order to escape the criticism of a finite view of the universe, Jeans himself apparently is forced to acknowledge this fact.[2] It would be a logical deduction, however, from the concepts of space and time, whether Jeans accepts it as true or not, for two subjective ideas such as these, when welded together into one, cannot by any process except pure deception be made to represent objective reality. But if the world of mathematical relationships is subjective, how can the picture which one draws of that world be other than subjective also? In this case, as Eddington said, it is possible to take out of nature only what has been put into it.[3]

But there are times when Jeans seems to center his idealism in the subjective thought of God. To look upon the universe as the thought of God which is objectified, is permissible even upon the basis of science, for it gives the scientist something real with which to work. Nevertheless, Jeans does not philosophize in this fashion, he veers towards a view of the universe as existing in the mind of God in such a way as to make any discussion about

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1. Cf. Jeans, The New Background of Science, p. 96
2. Cf. Ibid., p. 292
3. Cf. Eddington, The Nature of the Physical World, p. 244

its material character seem futile.[1] The vision man has of the world is only a dream,[2] and, according to this author's further conjecture, man may be only a brain-cell in the mind of the dreamer.[3] From this standpoint, it may be true that "mathematics enters the universe from above",[4] but if it does, it continues always to remain above and can never possibly reach the mind of man.

In reflecting upon the truthfulness of this statement, consider for a moment how a God shut up to His own inner thoughts and aloof from the world,—if in truth a world can properly be said to exist at all upon this conception, is incapable of being even partially discovered by any experimental method known to science. If man attempts to represent God by this method, his effort will prove abortive unless, to save his face, he calls upon the processes of "mind-spinning" to aid him in his endeavor. He cannot call upon religion to assist him in arriving at such a conclusion, for it presents a broader view of God than pure mathematics allows. His procedure, therefore, must certainly be guilty of reading into the picture of God thus presented only what is in the mind of the pure mathematician. It is practically synonymous with the

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1. Cf. Jeans, The Universe Around Us, p. 325
2. Cf. Jeans, The Mysterious Universe, p. 179
3. Cf. Jeans, Eos, p. 88
4. Cf. Jeans, The Mysterious Universe, p. 159

act of creating God in a purely mathematical image. But, of course, it may fairly be said that such a deduction as this would be false if Jeans himself had seen fit to present an idea of God which does not necessitate His thinking to be subjective like the pent-up thoughts of a theorizer or the unsubstantial fabric of a dream. If he had merely permitted God in his view to give objective expression to His thought, then the extenuating explanation of his conception such as is outlined in the preceding interpretation would be perfectly in order. But there is no consistent evidence, however, in the author's view that this was the meaning which he intended to attach to it.

As to the second criticism of Russell little need be said. The main objection to it is that it presumes to determine the activities of God entirely according to human standards of wisdom and propriety, whereas it is impossible for man from his finite viewpoint to say just how God ought to act in every particular case in order not to appear puerile to hostile eyes. Suffice it to say beyond this that the criticism savors more of ridicule than reason and is not at all on a par with the more serious objection of Russell which has just been discussed.

(3) Further Strictures on Jeans' View of God as a Pure Mathematician

(a) It Makes God Subhuman

In addition to these criticisms, however, there are others which tend to berate its soundness. To begin with, there ought to be a common acquiescence in the feeling that a God who is a Pure Mathematician would present a strange appearance to beings possessed with more versatility of expression than belongs to Himself. A God who is less than personal in the variety of ways in which His conscious life is conducted can hardly be regarded with confidence by those whose individual life excels His in complex range of activity. The peculiar situation which such a view would create is utterly unthinkable in terms of reality.

(b) It Fails to Account for the Creating and Sustaining Activity of God

The extreme narrowness just now pointed out in this view of God presented by the great scientist is also suggestive of a need which it does not meet. Nearly all that has been said thus far about this concept has indicated a deficiency in it which does not enable it to fulfil all the requirements of the facts in the situation. In order that man may live in a world that has any claim at all to the right to be called real, there is need for a God who not only thinks but also acts. A mathematician in his study is not all that is necessary to make the world's work go on. There must be someone to translate his thoughts into action. Similarly it may be said that a God who merely cogitates, but does not act to give His subjective thoughts objective character cannot be regarded as a God adequate to the creation of the material order or to the sustaining of it after it has been brought into existence. Moreover, it may be also said that the conception of God which Jesus presents in His life and teachings does not conform to this view. It is that of a God working even until now just as the Son also works.[1] But the scope of that work is broader than the activity of subjective thought. It is the reaching out of love and power to create a pleasant habitation for the race and to meet the needs even of sinful humanity. The fatherly aspect of God's nature displayed in His ceaseless activity in behalf of mankind, is entirely ignored in the exclusive concept of God as a Pure Mathematician.

(c) It Would Dry Up the Normal Religious Experience

Such a God is also incapable of sustaining in the hearts of men the normal religious experience of His presence. A present-day theologian has said that "to believe in the supernatural . . . means <u>to believe in a God at work</u> . . . It means that God is making himself known to us in definite and recognizable ways."[2] But how intelligible would be the communication of God's will and purpose to the average worshiper if it were couched only in abstract mathematical terms and symbols? The interpre-

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1. Cf. John 5:17
2. Brown, God At Work, p. 7

tation of the Divine Mind acting upon human lives would under such a circumstance become an esoteric practice suitable and possible only to those who are mathematically inclined. The office of the priesthood would be automatically conferred solely upon those able to read this mathematical sign language of the eternal. Einstein's statement to the effect that the earnest men of research are the only deeply religious people of the present age would then be, mutatis mutandis, the true description of the religious situation not alone in this age but in every age.[1] In the life of those unacquainted with these mysterious symbols of science, religion would dry up at its very roots because whatever knowledge they could obtain about God would necessarily be second hand and lacking in vital authority. The thought of any personal communion, which is the sustaining power of religion in the soul, would be banished from their minds, and with it in time would go the forms of religion as well. Such are some of the deplorable consequences which would ensue if this conception of God were in reality the true one. But it is encouraging to know that not even all the great leaders of astrophysical thought in the present accept this view. At least it need not be taken too seriously when one like

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1. Cf. Einstein, "Religion and Science, The New York Times Magazine, November 9, 1930

Eddington declares "that the crudest anthropomorphic image of a spiritual deity can scarcely be so wide of the truth as one conceived in terms of metrical equations."[1]

4. Consideration of the View of God as Artist

a) Implications of This View of God

The last view to be discussed is that which represents God as an Artist. Reflection upon this representation of the Creator of the universe reveals several definite and important teachings about God which merely need to be mentioned in order to be made justifiable deductions from the picture. First of all, it involves the idea of God as a Purposeful Designer. As the artist conceives and plans his picture, so God is declared to have created the world. The universe cannot be according to this figure a haphazard, chance creation, but the result of a thoughtful activity. In the second place, this idea of God as an Artist involves a belief in God as a Lover of beauty. Rarely does one think of art without associating with it that quality which gives it lasting value. To conceive of God as applying the brush to the canvas when He creates the world is to think of Him as being in Himself the very author and essence of the beauty which one sees in nature. Furthermore, the conception of God as Artist implies that He is One who has engaged in creative activity. His

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1. Eddington, The Nature of the Physical World, p. 282

thought has taken on a tangible objective form which when studied will enable the creature to trace in part the mind of God. This view of the world as the creative work of an Artist gives to everything in it a diviner touch than that associated with the thought of a self-evolving universe. In this conception the whole of nature becomes the handiwork of God which, if it does not involve Him, at least contains His fingerprints. Even Jeans, it seems, would admit this legitimate deduction from his figure. Lastly, this figure justifies a belief in divine transcendence. It represents God as more than just the bare unity of the world's infinite multiplicity. He is more than the picture just as the mind is more than any single thought. By going to the edge of the picture, according to Jeans, one is not yet able to say that he has fathomed the mystery of God, for in his conception the Artist is beyond and above His creative work.

b) Criticisms of the View of God as Artist

(1) It Is Deistical in Its Outlook

Though in most respects this view of God can readily be accepted, a closer inspection of the details reveals one or two objectionable features. In the first place, this conception of God is such that it leans strongly towards the deistical position. If God be entirely separate from His world as the artist is from the picture which he paints, then it becomes a problem to know how He sustains His creation. Once the artist has finished his work, his vital relation to it is severed. It is impossible henceforth to say that one knows the artist when one has looked at the product of his genius, for this is not the painter in any sense of the word. If God's relation to His world is like this, then Jeans is right in saying that God cannot be known at all by surveying the picture. But how can the world continue to exist upon the supposition that God, when once He has created it, refuses to have anything further to do with it? Unless He resolves to continually reproduce it in His thoughts, it will pass into mere nothingness, and with it will go everything substantial, including the artist's picture. There is, in other words, a difference between the artist's relation to his picture and God's relation to His world, because in the one case the artist is not responsible for the permanency of the material which has gone into the composition of the picture, while God who creates must also sustain if all things are not to be rubbed out of existence altogether. There is needed, therefore, a conception of God which permits Him to be in touch with His world continuously. Nothing less than this will satisfy the facts regarding the behavior of atoms and even of the heavenly bodies. Only on this basis can it be said, as Whitehead has indicated, that the world is immanent in God and God is immanent in the world.[1] The picture of God as Artist conveys only a half-truth which needs to be completed before it is wholly acceptable. It is closer to the facts of science and more satisfying to the spiritual needs of man to say with the poet

> "Though one with all that sense or soul can see,
> Not imprisoned in His own creation, He,
> His life is more than stars or winds or angels—
> The sun doth not contain Him nor the sea."[2]

(2) It Contradicts the Representation of God as a Pure Mathematician

In the second place, this view of God as Artist seems inconsistent with the representation of Him as a Pure Mathematician. Jeans appears to have been unfortunate in his choice of figures which he applies to God. It would be difficult to conceive of a greater contrast between two ideas supposed to apply to the same Being. A pure mathematician does not attempt to objectify his thought so long as he remains a thinker in his study, but it is of the very nature of the artist to give concrete form to the dreams of his mind. The mathematician thinks, but the artist both thinks and acts. To make the view of the former consistent with that of the latter, the mathematician must be able at times to leave his study and give substantial shape to his pure thoughts as the artist studiously

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1. Cf. Whitehead, Process and Reality, p. 528
2. Richard Hovey

tries to do. Furthermore, the character of God's thought in both figures is entirely different. In the one case it is concerned with geometrical signs and symbols; in the other it is inspired by the sense of beauty. In order to unite these two figures into one consistent picture it is necessary to remove from the separate pictures the qualifying restrictions which make them mutually exclusive. The failure of the one to fit neatly into the other stirs misgivings in the mind of the investigator as to their accurate representation of the facts and challenges one to a complete rethinking of the facts upon which they are based. Whatever picture of God is to be presented, it must, if it is to be well received, at least be consistent and harmonious in its parts.

E. Summary

A review of the opinions and facts dealt with in this chapter leaves several impressions in the mind which ought to be expressed and added as a summary to this discussion before it is closed. The first of these is to the effect that the thought of the scientists has not sufficiently crystallized on any view of God which the facts at their disposal warrant to fully justify any hard and fast conclusions. Renowned men in this field still differ widely in their interpretations of their findings and make it very difficult for the scholar outside their domain to ferret out the consensus of opinion in these matters.

But, in the second place, careful observation does seem to justify the statement that scientific facts are to-day pointing definitely towards a belief in the unity of the God who is behind the universe. The finiteness or the infiniteness of this unified picture of God still remains an open question for science, with the infinite view being greatly favored upon other grounds. Furthermore, a distinct impression is gathered from a collation of all the facts that the only reasonable view of God which can be deduced from them must be a strictly personal one, notwithstanding some expression of opinion adverse to this position. The argument in support of this deduction has been previously stated and is so evident as to need no further strengthening. More truly now than in the days of Greece is it necessary, as Glover has said, for mankind to think that there is nothing greater than personality and that God must not be conceived of as less than personal.[1] But the urgency of the facts relative to the behavior of the atom and to the attempts of man completely to discover reality by the scientific method brings the mind to acquiesce in a view of a personal God who is both transcendent and immanent in the world. In a word, science by its efforts to read aright the book of nature is constantly lending confirmation to facts about God which have long been reached and assured by other methods and is also furnishing increasing testimony to the consistency of truth wherever found.

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1. Cf. Glover, Jesus In The Experience of Men, p. 94

Chapter VIII

SUMMARY AND CONCLUSION

A. Summary of the New Astrophysical Views

1. Concerning the World

a) The Microscopic Elements of the World

(1) The New View of Matter

In undertaking at the close of this study to give a brief summary of the main facts which have been brought to light during this investigation, one can deal only with the more important divisions of the thesis, if the review is to be at all practical in helping the student to see as a unit the problems with which this whole subject bristles. Mention should first be made of the new view of matter. It is obvious even from a superficial study of the new physics that the attitude of science towards matter has completely changed in recent years. The view of matter as composed of discrete particles like billiard balls which possess the characteristics of substantiality and concreteness has practically disappeared from science. To-day it is looked upon as being porous in texture even to the extent of appearing nebulous or like a ghost. Its rarefied composition has now taken it out of the class of things formerly declared for certain to be material and placed it in a questionable category where it finds close kinship with the spiritual. While there is difference of opinion concerning the ultimate character of matter, not even the most staunch defenders of its substantial nature care to be so dogmatic as in former days about its distinguishing qualities. Materialism with all its intolerance has now practically disappeared from the picture. The contrast between the outlook of the present and the past on this subject is clearly summarized by Jeans who says:

> "Our last impression of nature, before we began to take our human spectacles off, was of an ocean of mechanism surrounding us on all sides. As we gradually discard our spectacles, we see mechanical concepts continually giving place to mental. If from the nature of things we can never discard them entirely, we may yet conjecture that the effect of doing so would be the total disappearance of matter and mechanism, mind reigning supreme and alone."[1]

(2) The New View of Mind

The view of mind has likewise undergone a great change in recent years. When the doctrine of materialism was at its zenith, the mind had no right to call its life its own. Its existence was not regarded then as a separate entity, but merely as an appendix to matter. All its actions were believed to be the result of certain combinations and configurations of the material atoms of the brain. The mind did only what it was told to do by the material instrument with which it was associated; it could not declare its independence in any sense. But to-day it has been granted a certain freedom by reason of the new views of matter and of the method of working

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1. Jeans, The New Background of Science, p. 296

displayed by its fundamental units. The quantum theory and the principle of uncertainty have dislodged the old determinism from what was formerly believed to be an impregnable position and have introduced again into science a belief in freedom. Consequently, the decisions of mind are now considered to possess a measure of independent authority and a certain inherent right to be respected and obeyed. With this change of view it is not unexpected to hear the mind referred to as the most direct thing in all experience and to see the whole world of science interpreted by it in such a way as almost to obliterate material substance and to leave only the mental as the real. The latter view is an extreme reaction to the gross materialism of the last century and is bound after it has had its day to produce a healthy recoil from its own exaggerations. The more conservative view of the situation does not fail even now to recognize the material also as real and to try to harmonize the relation between the substantial body and the mind which are both involved in the mystery of personality. The best efforts in this direction have been crystallized in the theories of interactionism and of the psychophysical organism which are steadily gaining power with those who are well informed concerning the present movement of scientific thought.

b) The Macroscopic Feature of the Universe

(1) The New View of Space

When one turns to the new views of the outer world, they are found to be no less astounding than the present-day conceptions of the atomic processes. Space is now conceived to be finite, but yet of such extent that the distances enveloped by it are almost incomprehensible by the human mind. But in spite of its finiteness space is said to be unbounded because it bends back upon itself, making a closed sphere like that of the earth. Light is doomed to travel in circles and, if it continues long enough, returns to its starting-point like a circumnavigator of the globe. Theories about the exact nature of the universe contained within this shell of space are numerous and intricate. Dr. Shapley has very well expressed the situation when he said recently with regard to the character of this cosmic balloon that

> "Every independent theoretical cosmogonist has the answer and all the answers are different. In fact, there are two more cosmogonic theories than there are cosmogonists, because two of them hold two different theories at once."[1]

Some see the universe expanding and some see it contracting. Others view these processes as alternating in successive ages, while the latest theorists view the world as expanding and contracting in certain spots and remaining quiescent in others. Confusion in one's thought about the macrocosm seems often worse confounded after hearing this Babel of voices that are now speaking in behalf of

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1. New York Times, March 8, 1934

the newest views. The layman in these matters does not know at times which way to turn and is at liberty to take his choice among the hypotheses, since none of them are sufficiently established scientifically to speak with any degree of certainty. In any case, the general features of the new conceptions are much the same as those which have been mentioned; it is chiefly in the details where divergence of opinion arises. But even the general features involve grave logical and philosophical difficulties which cannot be avoided without recourse to a subjective idealism that has little in common with physical science.

(2) The New View of Time

The new concept of time is just as revolutionary as that of space which has been summarized. No longer is it possible to look upon this entity as absolute; the view of Einstein and others makes it now appear as relative. In fact, it is said to take on so much of the characteristic associated with relativity that it becomes different for every individual observer. Circumstances are conceivable where the ideas of past and future lose their commonly accepted meaning and where events are as difficult to locate in time as the objects of physical science. Furthermore, to make the view of time more incomprehensible, it is welded on to space in the concept of a space-time continuum in which the two ideas are inseparable, except in the new view of Jeans which grants them individual distinctness in the case of large-scale phenomena. How this separation is possible in one situation and not in another is as yet an unsolved puzzle. So also is Jeans' conception of time as having a beginning but no ending. Eddington makes it finite and in some utterances Jeans also does the same, but recently the latter has injected the new concept of time as a rope with only one end into the already overburdened picture of a very elusive entity. And now to make time still more difficult of interpretation, the whole continuum with which it is linked is regarded not as an objective reality but as a subjective concept growing out of the collective experience of the race. In this wilderness of ideas the layman, and even the scientist, may be excused if he loses his way at times and begins to move in circles, for the clearing has not yet been cited. The scholar himself is waiting for the light of day to aid him in his further penetration of this subject.

(3) The Running-down of the Universe

No concept in current astrophysical thought continues to receive more attention than that which pictures the running-down of the universe as an irrevocable one-way process. From this viewpoint the world is unwinding like a clock that has no way of regaining the state of tense organization which it had when it was first set going. Except for minor and local instances of a reverse process, the major movement of the energy of the world is always in the direction of complete disorganization. The time will come, it is said, when the demobilization will have been completed and when a state of thermodynamic equilibrium will have been reached. Energy will then have passed into a condition of endless inactivity. The law expressing this concept is known sometimes as the second law of thermodynamics and sometimes as the law of entropy. Its inflexible character is upheld by both Jeans and Eddington, for the reason that to them the theory of the annihilation of matter, which comes under the jurisdiction of this law, best accounts for the immense amount of energy that is given out by the sun with such a comparatively small loss of its mass, and also most fully explains the huge quantity of radiation that saturates the earth and all of interstellar space.

But Millikan and his followers maintain that this law is reversible and that out in the depths of interstellar space the process of the continuous creation of matter is going on which is indicative of the fact that the Creator is still at work.[1] This theory is based upon

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1. A philosophical consideration which seems also to favor this view is that involved in the question as to whether, even on the basis of the opposing theory, a universe could run down at all without a Creator. If there be no Creator sustaining the universe in this demobilizing process, what makes it run down rather than remain in the same state? To say that chance does this is almost equivalent to investing this concept with divine powers.

the belief that the cosmic rays, which are so numerous in the earth's atmosphere and which have their origin out in these distant regions of space, are more easily explained as the result of the building up of heavier atoms from the lighter ones than as the result of the complete annihilation of matter. Other considerations also, such as the deductions from the theory of a cyclic universe and the testimony of Jeans regarding the spiral nebulae, together with the theory of evolution and the phenomena of life and mind, seem to favor this new view. But the facts in either case are not decisive. Opinion on this subject remains divided and will continue to be so until something much more compelling in the way of evidence tips the balance to one side or the other.

2. Concerning Man

a) The Individual

Astrophysics also has something to say about man. If one examines its pronouncements about the importance of the individual, they are not very encouraging from one point of view at least. When size or age is the criterion of judgment, man's comparison with the earth or the universe fares badly. Likewise if man's tiny home in space, or the seeming hostility of the universe in many respects to the life of the individual, be judged by any standards extraneous to the mental and moral life of man, they create an unfavorable impression upon man's thought.

But when all of these facts are viewed in relation to the intellectual and moral greatness of the individual, they are overpowered and become subservient to the higher conception of the soul. The individual rises upon these facts as stepping-stones to a more exalted position in the universe. This, of course, is possible only on the basis of man's free will which science now concedes is a legitimate deduction from its own views of the indeterminateness of the atom. Science no longer sees any reason for throttling that freedom of action necessary to all moral ascendancy. At the same time it grants a validity to the religious life of the individual which was heretofore denied, but which cannot longer be withheld without its challenging the legitimacy of the scientific procedure itself. Both man's religious activity and his scientific propensities receive their warrant from the inner voice of consciousness. If the one practice or the other is questioned, then the foundation of both is shaken and the other practice, too, becomes jeopardized. The authority for both pursuits issues from the same office; it cannot be questioned without endangering the whole structure that is built upon it.

b) Society

Invidious comparisons like those made between the individual and the universe do not eventuate in a much more happy outcome when the race is substituted for the single member of society. The brevity of human history, when measured against the astronomical time-scale, and the quantitative insignificance of the constituent units of the social organism in this universe of almost incredible distances place the race in a position of great inferiority to the world about it, if the same scales are used to weigh it which were used when the individual was found to be under weight. The additional fact of the final doom of humanity which is decreed by a dying universe also makes the picture of man discouraging.

But there are redeeming features about this otherwise shadowy scene. First of all, the inexorable character of the law of entropy is being questioned and proof is being gathered for the support of the atom-building process which, if it should prove to be true, would necessitate the changing of this law to include the reverse procedure as an established scientific fact in nature. In the second place, the theory of the dying universe grants a sufficiently long time to society to reach its ideals and fulfil its purposes. But, lastly, if these should not be realized, the human race is still exalted by reason of its ability to produce the individual who can by his moral and religious attainments break through the temporal order into the eternal.

3. Concerning God

In spite of the fact that the attention of the modern single member of society. The brevity of human history, when measured against the astronomical time-scale, and the quantitative insignificance of the constituent units of the social organism in this universe of almost incredible distances place the race in a position of great inferiority to the world about it, if the same scales are used to weigh it which were used when the individual was found to be under weight. The additional fact of the final doom of humanity which is decreed by a dying universe also makes the picture of man discouraging.

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3. Concerning God

In spite of the fact that the attention of the modern astrophysicist has been engrossed in the problems which concern the large and small aspects of the world, he has also found time to turn aside from this task to speak as a philosopher and a religionist on the views of God which the facts and theories of his own science seem to justify. But in addition to these views definitely stated there are others about God which can be clearly deduced from the statements of the scientist that are made regarding observations in his own field. One of the views of God that has been arrived at by this process is that which represents Him as finite. While this view has been logically extracted from the conception of a finite universe, it is readily recognized that not all scientists acknowledge it as their personal belief because they have not faced the full consequences of their theory. But if God's world is made out to be finite, it seems impossible to defend an infinite conception of the Creator behind that world. How the totality of God's handiwork could be finite and not argue for a finite Mind behind it is a question which cannot admit any superficial answer. If God thinks only a finite thought in the creation of the universe, how can one turn to the subjective side of His thinking and be sure that in that activity of the Supreme Mind cogitation is on an infinite scale? It is not easy to make this transfer without jarring one's logical faculties.

The second view of God ~~from~~ deduced the pronouncements of science on other subjects is that which regards Him as personal. Pantheism will not satisfy the facts which astrophysics presents for consideration. If the universe is dying, as the second law of thermodynamics indicates, a belief in a God identified completely with His world appears utterly absurd. Such a belief is almost worse than none at all. The view of God as personal, however, not only removes this impossible conception from the mind but also harmonizes better with the present positions of science. The belief in a Universal Mind behind the world and in a background to nature which is akin to consciousness points towards a personal God as being necessary to meet the requirements of such a faith, for the manifestation of these entities, so far as man's experience goes, is only associated with personality. Furthermore, if God is to be related to His world in any way which permits the scientist to learn something about Him by unifying the picture of nature, then it is impossible to attribute to Him less than that which is found to be the most essential element in the framihg of that concept of the totality of the universe. Man cannot pretend to have read the character of God revealed in the universe, if he omits the most important page in the book of nature. But when he examines the whole record, he is convinced that the Supreme Power behind the world since He cannot be less than that which He has created, must also be personal.

The figurative representations of God which have become popular of late are wholly the product of Jeans' thought upon this subject. They also must be considered in this summary. In the first of these God is conceived as a Pure Mathematician. He is viewed as disclosing Himself in ways which can be interpreted only in mathematical terms and symbols and which signify that behind them is a Pure Thinker. In the other representation God is likened to an artist applying his brush to the canvas. An examination of the picture in any or all of its parts does not bring one to an understanding of its creation or of the artist who painted it, and neither, Jeans thinks, does a study of the world of time and space being one to the Artist behind the universe. God is thus believed to be as much outside this world picture as the artist is outside his canvas. The Creator is viewed as the Thinker in which this picture of the universe exists as a thought.

B. General Critical Estimate of the New Astrophysical Views

1. Their General Speculative Character

Before summarizing the religious implications which may be drawn from these current views of physics and astronomy, it is well to put before the mind again the fundamental criticisms of the new positions in order that one may come to the final appraisal of these findings with an insight into the character of their source which will assist in their correct evaluation. Two things, therefore, need to be remembered about these views, if this aim is to be achieved. First of all, the speculative character of much of the new thought must not be forgotten when one turns to the serious consideration of the religious teachings involved in it. Most of the cosmological views, and even some things that science has to say about the world of the atom, are purely conjectural. The scientists themselves often confess that their theories are not based on evidence sufficient to make the conclusions drawn from it positively authoritative. The recognize a wide latitude for difference of opinion with regard to the solution of the problems with which their own speculations deal. Furthermore, in spite of their frequent assertions that science deals only with the description of facts and not with their explanation, these scientists admit the philosophical aspect of this phase of their work. So much of scientific thought in this field is now being occupied with almost purely philosophical questions that Einstein, when asked recently upon the basis of this shift what the difference is between physics and metaphysics, is said to have replied that "physics is metaphysics."[1] And it is worthy of mention that a study of much which is

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1. Snowden, The Discovery of God, p. 83

issued in the name of science to-day, especially in the field of astrophysics, corroborates this statement.

2. Their Predominantly Subjective Tinge

But if much of current cosmological science is metaphysics, then it becomes necessary to inquire what the character of the philosophy which best represents it is like, for it is obvious that not all constructive thought which attempts to unify the world is by any means pitched upon the same high level. It is Inge's observation that the well-known scientists in this realm "are playing with Berkeleyan idealism or pure mentalism."[1] Joad also arrives at this same conclusion with regard to Eddington and Jeans[2],—a conclusion which a study of their views of space and time and of the theories built upon them amply confirm in any unprejudiced mind. But such a philosophy, when employed by scientists, raises the question whether it can be reconciled with the declared practices and principles of science without vitiating the factual authority of the latter upon which its prestige has rested in the past. Inge feels that no science, which derives through the perception of objects in the world of nature the materials with which it works, can legitimately issue in pure mentalism.[3] Since reflection upon the very purpose and aim of

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1. Inge, God and the Astronomers, p. 38
2. Cf. Joad, Philosophical Aspects of Modern Science, pp. 11, 49, 123
3. Cf. Inge, God and the Astronomers, p. 41

science does not alter this opinion, it is evident that the utterances of present-day science which proceed from this subjective realm cannot be regarded as bearing the stamp of scientific genuineness. It is also recognized in this case that knowledge arrived at by other means need not bow to these conclusions unless they accord more closely with observed facts. In other words, religion need not fear a metaphysic that does not at all possess the raison d'être which adheres to the apologetic for the religious experience.

3. Their Lack of Any Consistent Epistemological Background

One of the most noticeable weaknesses in the modern hypotheses about the world comes to light only when one attempts to articulate the scattered parts of each cosmologist's view of the universe. Then it is that any schematic arrangement of the separate contents of the theories, upon the basis of a consistent theory of knowledge underlying the whole, becomes conspicuous by its absence. This accounts fully for the baffling shift of viewpoint, often in the same author's presentation of his case, which introduces confusion so frequently in the mind of the student and makes any effort at coordination of thought seem at times so hopeless. The failure of these men to study adequately the problem of a sound epistemology has led Joad to summarize its lamentable consequences in words which are sufficient to complete the remarks necessary upon this point. With reference to it he says:

"It leads Professor Eddington . . . to exhibit the world which the scientist knows sometimes as a creation of the scientist's mind and sometimes as an aspect of reality which is independent of mind; to make statements which are intelligible only on the basis of an extreme subjective Idealism, and to make others which presuppose that something exists which is unaffected by our knowledge of it; to describe the relation of sense experience to the object experienced in half a dozen different ways, and of the thinking mind to the object thought about in almost as many. It leads Sir James Jeans to argue as if to be constructed by a mind and to be a thought in a mind were the same thing, and as if the relation of the mind to what it knows is the same as the relation of the mind to what it creates."[1]

C. Summary of the Religious Implications of the New Views

1. Concerning the World

a) The Microscopic Elements of the World

(1) Significance of the New View of Matter

The first religious implications of the new views appear in the recent studies connected with the microscopic world of the electron and the proton. Science has so refined its instruments of investigation and its methods that it is now able to penetrate deeply into hitherto unexplored regions in the heart of the atom. The consequence of this investigation has been realized in a growing tendency to-day to break down in thought the middle wall of partition between the material and the spiritual. Some are even saying now that the material is basically spiritual. This view has

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1. Joad, Philosophical Aspects of Modern Science, pp. 122-123

many difficulties. In the first place, it seems unreasonable to think that the spiritual is nothing more than gross material particles reduced to an ultra-gaseous condition. The divergence between the two, though it is difficult to define, appears greater than this. In the second place, the practice of science in "weighing" these fundamental building bricks of the universe seems ridiculous if one regards them as spiritual. If they are what some claim, then man's terminology regarding the universe will need considerable readjustment in order to be even a fair representation of fact.

But while this view seems yet to be extreme, it is undoubtedly true that the modern conception of matter has made science in most instances more courteous and friendly towards religion. Science, too, has begun to realize that, since its commodities are almost as intangible as those of religion, it is not always the substantial things which are the most real. This fraternizing spirit which research has cultivated indicates for religion a great triumph whose fruits have not all been harvested by any means. In fact, the real benefits are just now beginning to be appreciated.

Even beyond this, however, science is discovering that its knowledge of anything with which it deals, unless it is supplemented by the teaching of religion, is fragmentary and even superficial. It has in recent years acknowledge its limitations and invited religion to enter its field and give meaning and significance to the facts which it has brought to light but cannot explain. More and more religion is being honored in high places and is gradually coming into its rightful position in the scheme of things. Science is lending its support to-day to the view that religion is indispensable to a satusfying philosophy of the world and must permeate the whole of knowledge before the latter can be made intelligent and meaningful.

(2) Significance of the New View of Mind

The exalted place which has been given to the mind in the new picture of the universe argues much for the view that spiritual values are more fundamental than material ones. If mind, in addition to being the most direct thing in man's experience, is now believed to form the background of the whole of nature, then the material world is less real than the Universal Mind which frames it, and than the mind of man which, possessing qualities akin to the attributes of that Superior Mind, undertakes to unify in itself the diversity of the universe and even to reach behind it after the Supreme Reality. Through this mental window man is also led to see that personality, which is always in human experience associated with mind, is the dominating characteristic of the world.

(3) Significance of Indeterminism

Since indeterminism has replaced determinism in the scientific views of the world, a belief in possibilities and in the capacity for improvement have entered into the world of science. Religion is encouraged under such psychological circumstances to push forward its own program for the betterment of the race. It does this the easier, since it can point to a Directive Intelligence behind the plan of the world with little fear of its word being challenged. For, in place of a rigid determinism, it is universally felt that some kind of direction must be postulated, if the world is not to be looked upon as a colossal game of chance. The views of science regarding matter greatly aid this belief in a Higher Intelligence which is at the root of all vital religion. Thus science, because of its new outlook on the material world, is peculiarly fitted to become in many ways a handmaid to religious effort in the present age.

b) The Macrocosm

(1) The Significance of the New Views of Space

On this point it is not necessary to say much, since the chief implication of this phase of the subject is the finite conception of God which has already been discussed twice in this thesis from slightly different points of view. Its vital importance for religious belief, however, should always be kept in mind, and also the precarious nature of the theory upon which it is based. No undue anxiety need be caused in one's religious thinking by this unverified hypothesis that makes such a deduction necessary, for a finite universe has not been found. Just a short while ago Dr. Shapley is reported to have said in substance in a lecture

> "that science has not yet reached the outer dimensions of the cosmos in any direction, that there are countless galaxies still hiding in disappointing obscurity behind space and the obstruction of interstellar absorption."[1]

If this be a true confession of man's meagre knowledge regarding the farthest reaches of the universe, one need not apologize for still holding to the belief that the world is infinite and will be proved scientifically to be heading in that direction when man gets beyond his present state of ignorance.

(2) The Significance of the New View of Time

Confusion in the scientific concepts of time, which is very elusive in its nature, makes it difficult to extract many religious implications from this subject. The most vital question involved in it is that relating to the reality of progress. Some of the views about time, which attach little meaning to past or future, would seem to make progress a pure illusion. Of course, any such view, if true, would be destructive of all moral and spiritual development. But science itself has not fully made up its

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1. New York Times, February 17, 1934

mind on this problem and recognizes that it must trust consciousness to orient the world in reference to direction.

(3) The Significance of the Running-down of the Universe

As in the case with the finite conception of the universe, so much has already been said on this subject from the viewpoint of religion that it is not necessary to repeat the facts which here might be set down. Suffice it to say that God now appears indispensable to any reasonable explanation of the origin of the world in a state of perfect organization from which it ever since has been gradually and unalterably running away. Barnes is not satisfied with this method of finding God at the place of creation. The Divine to him is more than the "God of the gaps" and "the God of the trigger";[1] he would see the Creator in the thought and plan and purpose which is behind the universe, instead of in these hyphens in human thought.[2] But it is possible to acknowledge Him in all of these ways and not in part of them. Devout science is merely helping man in these matters to see how inseparable God must be from all his thinking.

2. Concerning Man

a) The Individual

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1. Cf. Barnes, Scientific Theory and Religion, p. 409
2. Cf. Ibid., loc. cit.

(1) Significance of the New Views of Man's Importance

Opinion adverse to man has marshalled all possible evidence, supposedly furnished by recent science, which is said to be against the higher interests of the individual. The comparative littleness of man when compared to the vastness of the universe, and the brevity of his life as measured against the astronomical time-scale are said to argue for a reduction in the size of man's present portrait. Similarly, the singling out of facts about the world, interpreted so as to appear hostile to man's best interests, has been used to make the universe appear unfriendly and to discourage any religious faith whatsoever. But it has been shown on the basis of the objective view of the universe that these facts may be more easily interpreted in a way which makes them exalt man and points to a belief in a God who has taken extreme care to provide for man a home favorable for the development of his higher and ennobling qualities. On the basis of the subjective character of the universe, which at least has been declared by the scientist to obviate certain criticisms of his present views, man has been promoted still higher and made the ruler instead of the servant in the universal household. From this philosophical position it is impossible ever to look upon man in slighting terms.

(2) The Implications of Man's Free Will

Implications from the scientific approval of man's true freedom are almost too obvious to require repetition. If the mind is free, as science claims it has the right to be, then man is not a wooden mannikin but a being responsible for his acts. He cannot be made at all pessimistic by Schopenhauer's saying that "a man can surely do what he wills to do, but he cannot determine what he wills", even though Einstein approves it.[1] His moral life, in consequence of the new facts, is proved to be not a fiction but a fact; it has wrapt up in it the possibilities of noble achievement. The individual even in the eyes of science is raised to the status of the truly personal and can now be pardoned for looking upon his religious life as the consciousness of a personal relationship. The God with Whom he communes, since He cannot be thought to possess a character inferior to that of His creatures, must assure man of this.

(3) The Implications of the New Views of the Religious Life

From a study of the sanctions which surround all scientific endeavor, there has come about in recent years a gradual rapprochement between science and religion. Science now recognizes that it has no authority to enter into investigations or to report its findings without first gaining the consent of consciousness which it always must

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1. Cf. Has Science Discovered Go?, p. 93

consult before acting. But since religion carries on its practices with the aid of this same monitor, science has come to see that it cannot point its finger of scorn at what used to be regarded as an unscientific procedure in the life of man. To do this would endanger the validity of all scientific enterprise by casting reflections upon consciousness which gives to it, as well as to religion, its very excuse for being. Science now realizes that the religious experience is as well authenticated as its own methods and is coming more and more to befriend this spirit which issues from the same loins as the impulses which guide research. Moreover, scientific explanation to-day is pointing to the fact that religion through the individual consciousness has a more direct contact than science has with the underlying Reality of the world. The proof for this statement lies in the acknowledgment by science that religion makes its approach to Reality not through the medium of sense-impressions, which act as barriers to progress in this direction, but directly through the open door of consciousness which is believed to be akin to the Unity that binds together the diversified elements of the universe. In this view religion, by virtue of the fact that it is in closer touch with Reality, is held to be even more authoritative than science.

b) Society

(1) Significance of the New Views of Society in the Interpretation of God

The facts of science, adduced to berate the importance of the race, have been used by some to question the friendly and purposive activity of God, with a view to undermining religious faith altogether by showing it to be either an unreasonable practice or else a pure superstition which it is best to dispose of in the light of present knowledge about man's world. But the facts upon which this attitude is based admit of a different interpretation that reveals the purposive and friendly activity of God in behalf of man and fosters the further development of the religious life of the race. It is this view which harmonizes best with the universal experience of man and more intelligently explains those qualities of the soul which otherwise would remain a hopeless enigma in a hostile world.

(2) Significance of the New Views of Society Relative to the Question of Social Progress

Not only have these reduced conceptions of man reflected upon the view of God which they engender, but they have also brought into the foreground the whole question as to whether the struggle after social progress is mere futility. If the race is doomed to final extinction, some ask whether there can be any vital purpose in projecting plans for the social, moral and spiritual improvement of the race. In answer to this question it may be said that, on the basis of the new scientific calculations, the race has ample time to work out and test its social schemes and to produce if it can a more moral and religious life of the individual. But even if it did not have this long prospect, its endeavors would still be worth while. Its business in this case is to fit and prepare its members to enter from this material sphere into the eternal order of things. Here is ample scope for all its powers and sufficient encouragement for a work that can never be dull.

3. Concerning God

The views of God towards which science is tending today have been set forth from so many angles in this investigation and have been summarized so carefully in the preceding chapter that a further résumé of these concepts would here be superfluous. Two points of emphasis need only to be mentioned. On the one hand, science is lamentably weak in its portrayal of a finite universe which in turn argues for a finite God. Since man will not readily accept this view of God, science is most likely to repudiate it and the philosophy upon which it is based. But, on the other hand, science is becoming stronger in its emphasis on a personal view of God that involves more and more of a thoroughgoing theism. Yet even here, one is not privileged to affirm too much. Brightman has given with moderation all the credit which one is entitled to give to science for its help on this subject when he said:

> "It seems almost that while religion is becoming atheistic, science is becoming theistic. Yet it would

be easy to exaggerate the religious significance of current developments in science. Denial of the nineteenth-century physics is not identical with assertion of the eternal God."1

D. Conclusion

1. Science and God

In concluding this study, something ought to be said concerning the present status of scientific knowledge about God in relation to a conception of Him which can be adequate to meet human needs. Concentration upon the meaning of what the scientist has discovered in recent years has enabled the scientific philosopher to report more than a mere nebulous view of God. He has been able to formulate a conception that brings God nearer to the hearts of men because it pictures Him in terms which contain more of the feeling of the poet who saw God as one

> "Whose dwelling is the light of setting suns,
> And the round ocean, and the living air,
> And the blue sky, and in the mind of man;
> A motion and a spirit that impels
> All thinking things, all objects of all thought,
> And rolls through all things."2

2. Science and Religion

But even so it is woefully inadequate to touch life effectively where it can be deeply moved. What man wants to know is whether the universe has ever spoken to him, not alone in the symbolic terms of science or in recondite

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1. Brightman, The Problem of God, p. 32
2. Wordsworth, On Revisiting the Banks of Wye

theories about the universe, or even in the throbbing words of the poet, but in the language of human experience. He seeks, in other words, for a personal disclosure of God that may be assisted by these other ways of apprehending Him, but must not be supplanted by them.[1]

Yet while the religious life of man craves for this deeper revealing of the truth, it should not disregard the proferred aid of science in helping to correct any aberrations which may arise from the surrender of the soul to these fundamental impulses in man's nature. The service which science can render to religion in this sphere is well indicated by Whitehead who says:

> "Religion requires a metaphysical backing; for its authority is endangered by the intensity of the emotions which it generates. Such emotions are evidence of some vivid experience; but they are a very poor gurarantee for its correct interpretation."[2]

If these two fields of human endeavor can be made to touch one another at this point, and also at the point where science needs religion to give it meaning, then much of the animosity which has previously existed between them will have been absorbed in an effort to be mutually helpful.

3. A Personal Testimony

It is fitting at the very end of this study to say a final word about the personal benefits derived from this journey through the intricate mazes of current scientific

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1. Cf. Kirk, Stars, Atoms, and God, p. 89
2. Whitehead, Religion in the Making, p. 83

discoveries and theories. One who has gone this way cannot fail to have his vision broadened with regard to the immensity of God's world and to the infinite variety of the method whereby He governs its course. The present facts in these matters are breathtaking and yet are almost daily being superseded by more astounding news coming fresh from the observatory where man communicates with the stars and from the laboratory where he listens to nature's secrets. In outer space it is said by Dr. Shapley "that even with our best mechanisms we are unable to get anywhere near the edge of things."[1] In the world of the electron, so intricate are God's ways that man, in spite of his increasing ability to penetrate nature, thus far has succeeded only in extracting one mystery from another. But while this vision of the universe has become more entrancing, the dignity and worth of man have also been greatly enhanced as attention has inevitably been drawn to the human mind which photographs the picture of these startling things and gives it a mental background. This reflection can only induce one to say with greater emphasis than ever before that man must truly be made in the likeness of God in order to think such great thoughts after Him.

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1. New York Times, February 17, 1934

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