JOURNAL

of the

AMERICAN SCIENTIFIC AFFILIATION

The fear of the Lord is the beginning of wisdom. Psalm 111:10

Volume 2 **Number 3**

THE JOURNAL OF THE AMERICAN SCIENTIFIC AFFILIATION

Vol. 2 September 1950 No. 3

Single Copies $1.00

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BASIC ANXIETY AND ADAMIC MOTIVATION

Philip B. Marquart
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"But the wicked are like the troubled sea, when it cannot rest, whose waters cast up mire and dirt." Isa. 57:20.

"As for me, I shall behold Thy Face in righteousness; I shall be satisfied when I shall awake with Thy likeness." Ps. 17:15.

Basic Anxiety is universal in human nature; it lasts a lifetime; and it occurs in no other species except our own. It is to be distinguished from all other forms of anxiety and fear -- for it forms the roots of all these other fears, the so-called Manifest Anxieties. Strictly speaking, it is not an anxiety at all, but rather it is the basis of Anxiety. The Manifest Anxieties are definite fear states which the victims recognize as such, whether they recognize the object of their fear or not. Manifest Anxieties appear in such conditions as free floating Anxiety, Anxiety tension state, and Anxiety neurosis. Also the Basic Fears, which will be discribed later, are specific fears of a manifest variety. A scriptural description of such manifest fear is: "the cup of trembling, even the dregs of the cup of My fury." Isa. 51:22.

Basic Anxiety is a normal state of restless uneasiness and loneliness universally present in every human being, all of his life, and peculiar to our species only, but it is usually not sensed as a form of frank fear or anxiety. It is a gnawing, restless, irritable, intangible stimulus, which makes us go on and do things in order to cover up the dissatisfactions above. It is characterized by uncertainty, diffuseness, and a sense of incompleteness.

The basic requirement of human nature is love (I John 4:19). In Scritpture we are enabled to envision a time when human nature was truly motivated "at the impulse of Thy love." Sin is not only lawlessness and disobedience; it is also a violation of love.

Even though the Freudians have initiated and used the term, Basic Anxiety, their use of it has not been helpful, since each writer has used it in his own varying, implied definition. Some have even used the term to denote a condition which others would call free floating Anxiety. Hence it has become necessary to construct our own definition in keeping with the best currect usage. Shoemaker, a liberal Christian counselor, says that he believes Basic Anxiety "may be akin to the spark of life itself, and may have been put within us to keep us from becoming too much like vegetables.... But unless basic anxiety finds some adequate outlet and satisfaction, it causes us to live lives of 'quiet desperation'."[1] He says that some people eat and sleep in excess as an overcompensation for it and some use work and pleasure as a refuge from it. But none of these substitutes is quite what we want. So life is for many people a series of attempts to get away from themselves and to resolve their Basic Anxiety. He says there are only two possible centers for our basic emotion: ourselves or God. Basal anxiety is given a distionary definition of "the fear of being helpless in a potentially hostile universe."[2] Horney says that this helplessness is implicit in basic anxiety, the result of being in a delemma without being

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[1] Dr. Samuel Shoemaker, How You Can Help Other People (E.P. Dutton Co., New York, 1948) p. 55.

[2] P. L. Harriman, New Dictionary of Psychology (Philosphical Library, New York, 1947)

aware of it.[3] She also says that basic anxiety is in everybody, that it is the same everywhere: a feeling of being small, insignificant, helpless, deserted, endangered. The fear itself is often repressed.[4]

Men of the world have shown an interest in the origin of Basic Anxiety, but none can agree in their varied suggestions and conjectures. Some say that there is a phobic element in every successive breath. Others suggest that it arises out of the trauma of birth, but they fail to explain why animals experience birth without it, or if they refer to the usual spanking at birth, there are many humans who do not require spanking in order to induce them in initiate breathing. Others, who present a religious viewpoint, suggest that man was created with Basic Anxiety. None of these views is correct, because they do not coincide with the record of the origin of human nature in Genesis. The real cause of Basic Anxiety is the Fall of man, whereby he sinned against God, and has transmitted to us in some way, the sin nature with its inevitable accumulation of sin acts. Guilt and fear and overcompensatory striving are all involved in its origin and inevitable continuance. Man was not created with Basic Anxiety, but he acquired it through the original sin. Thus we see that Basic Anxiety has not only a relationship to the origin of sin in human nature, but that much of human motivation is involed as well. It is the purpose of this paper to outline the details of this relationship and to show the only possible solution of this problem in the Scriptures.

First let us look behind the scenes and see what human nature was like before the Fall insofar as this is revealod. The basic physiological drives of man were completely satisfied (hunger, sex, and activity) in a completely desirable way. The basic personality needs (security, affection, and success) were also so completely fulfilled through the presence of the Lord God, that man was probably unaware of these needs as he is at present. Since the Basic Losses, mentioned later, had not yet been sustained, the Basic Impulses, which arise from them, were not found in human nature. In other words, neither Ego Recognition nor Ego Satisfaction[5] was the impelling force in human nature. Through the presence of God, man received all the recognition and satisfaction he needed (See Chart I). Conscience, and its component function -- the moral judgment -- were intact, as shown by their reaction to the law laid down in Gen. 2:17. But conscience had not yet been activated by guilt, and therefore the awareness of it was minimal. Man was motivated by the Love of God.

Chart I shows the development of the changes in human nature from its primal state to its post-Edenic form. Man sustained two Basic Losses which gave rise to the two Basic Impulses, which are now commonly referred to by the secular psychologists. The Basic Needs also, now no longer provided abundantly, become the occasion of human striving. There is also a desperate attempt to substitute one of them for another. The infraction of Love, has brought lovelessness into human nature to such an extent that he no longer has his need for affection adequately provided for. Consequently he sets up a second-best striving for security and for success. As a result, he is passingly content when successful or secure, but these two are only occasionally available to him. Also, when he finds affection, there is always a fly in the ointment. Consequently, he is prone to turn in frustration to his physiologic drives as a substitute for his inner personal needs, thus making sex and eating and activity ends in themselves, to satisfy his lost personal fulfillments.

The turmoil into which human nature has been thrown by the upset of his Basic Needs and Drives, and the losses sustained, giving rise to the Basic Impulses, continues to motivate him in an unpleasant dissatisfaction so that he finally settles

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[3]Karen Horney, New Ways of Psychoanalyssis (W.W. Norton and Company, Inc., New York, 1937) p. 204, 205.

[4]Ibid., p. 92, 94.

[5]T. W. Richards, Modern Clinical Psychology, (McGraw-Hill Book Company, Inc., New York, 1946)

Chart I. Human Nature through the Fall. Gen. 2 & 3.

Before the Fall	The Fall	Immediate Consequences	Later Developments	
Moral Judgment	Transgression	Guilt	Basic Anxiety	Manifest Anxieties
Conscience (inactive)	Disobedience	Basic Losses - 1. Loss of recognition, fellowship. 2. Loss of joy and satisfaction.	Continued guilt	Cumulated guilt
Recognition	Lawlessness		Basic Impulses - 1. Ego recognition 2. Ego satisfaction	The Sin Nature -
Satisfaction	Pride	Became aware of his needs.	One Basic Need may substitute for another; sex and hunger may act substitute wants	The image defaced
Basic Needs satisfied (security, affection, success)	Unbelief in His Word	Panic	Egocentricity Humanism & self worship	The heart wicked
Basic Drives normal (hunger, sex, activity)	Deceit	Centering on the self.	Hate and suspicion	The flesh present
Chief Motive- (Love of God)	Lust of flesh	Seven Basic Fears are initially activated (See Chart II)		Like passions
	Infraction of love			Overt sin acts
				Basic Fears reactivable
				The Thirsts of world
				Lust of flesh
				Lust of eyes
				Pride of life
				The Anwser -
				Christ

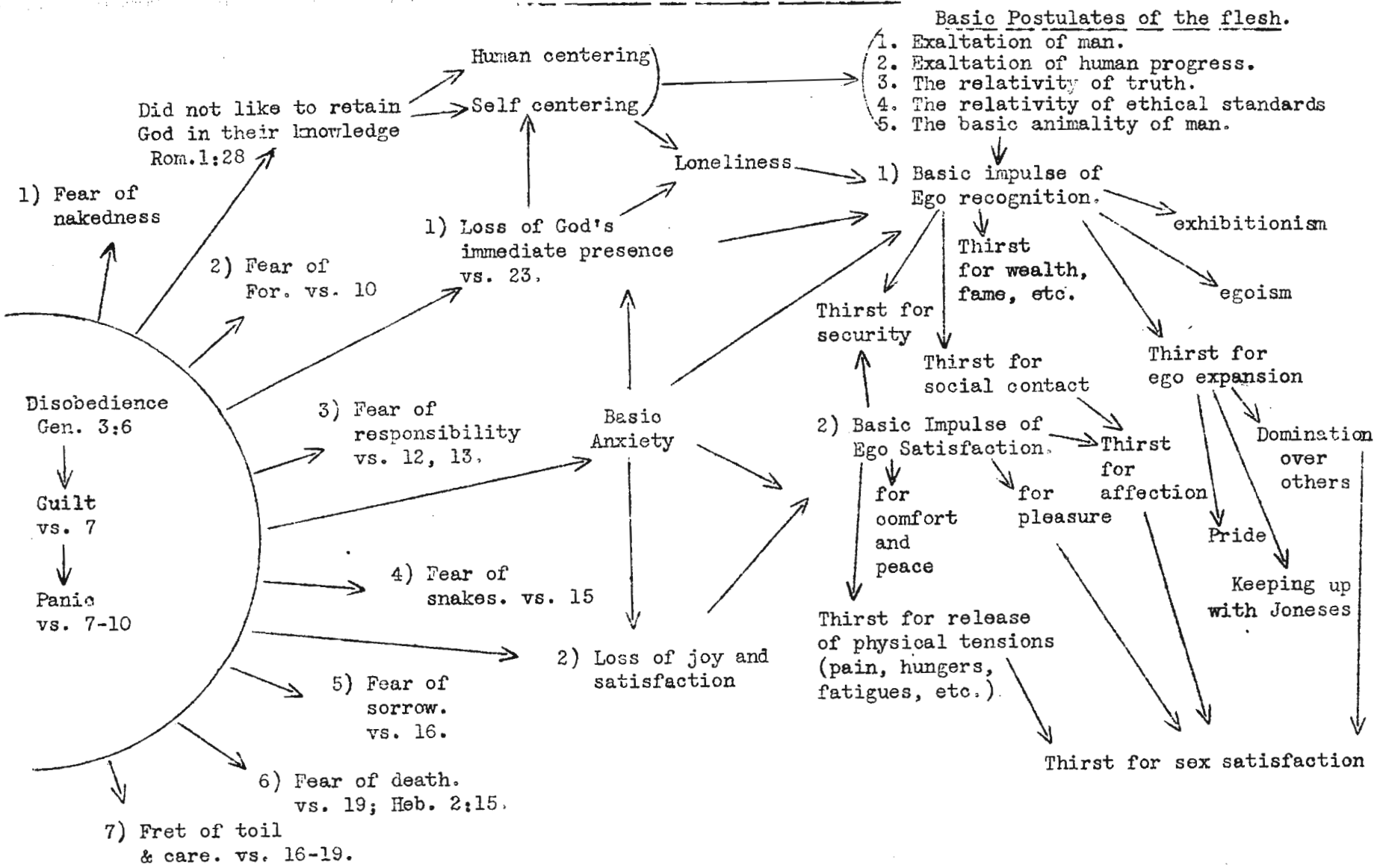
down into a pattern of conduct arising out of these things. Stimulating him into activity, it spurs him on to carry out the work of the world and all its pleasures, as a compensation for his lack. Also the motives and urges (the Bible term is thirsts) arise out of his Basic Impulses. These thirsts are mentioned in specific detail in Chart II, but it can be seen that they easily organize themselves into the three "things that are in the world" mentioned in I John 2:15,16. Altogether they comprise the Sin Nature of man, the background upon which overt sin acts are sure to occur. Their presence is due to the fact that the heart, that inner core of human nature, has been distorted and rendered wicked. (Jer. 17:9). In the believer, these constitute the Old Man or the former self. This part of us continues to constitute a part of us and can never be converted. It must be rendered inoperative. The flesh or the lower nature is that portion of the sin nature which is most specifically turned in upon the bodily self in egocentric interest.

Guilt has become constant, but the awareness of guilt is merely relative. With it come the various fears of human nature. When Adam had to face God with his sin, it set up a terror, described in Genesis 3, which was so severe that the only modern name for it is PANIC, in capital letters. In fact, the withdrawal of God's immediate presence was a mercy to prevent man from becoming undone. Even today, man cannot thus face God and live. At the same time the seven Basic Fears (see Chart II) were originally activated. All these fears may still be activated under proper stimulus, but since they are Manifest Fears they must have a stimulus. Also following this severe ordeal of PANIC, Basic Anxiety was aroused in human nature and continues on in its background even into the lives of believers. We have already shown that this so-called Basic Anxiety is really the basis of anxiety and that it is a motivating force which drives men on to do the things that men do in the world, unlike any other species. Rural electrification, battles of bulges, circuses, business, inventions, explorations, studies, all arise from this peculiarly human "stir craze" which comes to us through our Basic Anxiety.

Neither is it possible to be rid of this Basic Anxiety even in the Christian life. The warning against the frankly manifest forms of anxiety at the end of the sixth chapter of Matthew is not concerned with Basic Anxiety, but rather with manifest anxiety for the basic things of life, with which God promises to supply His true children. We are told to be anxious about nothing (Phil. 4:6) and then the peace that passes all understanding is promised to us. We may have all of this peace of mind and heart, but still we retain our Basic Anxiety. It never leaves in this life. "Perfect love casteth out fear" (I John 4:18). But believers do not yet have perfect love.

The Basic Anxiety as well as the Sin Nature come forth from the "heart," that core and center of man's personality. The "heart" in Scripture seldom refers to the organic pump within the body (as it does in Ex. 28:29), but refers usually to that part of personality which was supposed to have a relationship to the bodily organ (and modern psycho-somatics shows that it does have such a relationship). The heart is not the whole personality, but it represents the whole personality, for it is that point at which the whole personality converges to a focus. It is the very essence of personality -- the real you inside, -- in contra-distinction to the various functions of consciousness and conduct which we usually study as psychology. Out from the heart come all the various activities of our personalities. Animals do not have "heart" in this psychological sense and neither do they have Basic Anxiety. Animals also have bodily flesh, made of molecules, atoms and cells, but they do not have the "flesh" in its psychological sense of the lower nature. The reason that animals cannot have any of these three characteristics of human nature is that to have them would require the presence of mental images, conceptual thinking, reasoning, insight, and consciousness of self as self -- all of which are entirely absent from

Chart II. The Genesis of Adamic Motivation



animal consciousness -- as proved by various Scripture passages and by our own experience with their behavior. These are possible only in that erstwhile image of God which we call man.

God's ways are not our ways, and thus the "flesh" which arises with Basic Anxiety, due to guilt and sin, should by no means become the motivating force of our Christian lives. As Christians, we are told to seek the things which are above (Col. 3:1) and even to set the affections on the things above (Col. 3:2). Even now the Love of God is the specific cure for the manifest anxieties, and it should be the motivation for the Christian life. The rich motivation for the work of the world which is furnished in Basic Anxiety is thus replaced by something better and even more abundant. Christian motivation cuts diametrically across all the lines of both Basic Anxiety and the manifest anxieties. Indeed, it cannot be conformed to the things of this world because it is a genuine transformation, which is not of this world.

For instance, our fears are given this simple sedative: "I sought the Lord and He heard me and delivered me from all my fears" (Ps. 34:4). The itch for wealth is given this anodyne: "let him labour, working with his hands the thing that is good..." (Eph. 4:28). Self-seeking is given the lethal dose: "deny the self" (Mark 9:34). The search for pleasure is diluted with a greater love for God (II Tim. 3:4). Aggression also has its potent soporific in Gal. 5:26, where we learn that we should not be desirous of vain-glory nor the provoking of others.

In the face of these ideals of behavior, psychology has nothing to offer. Like human nature itself, it is unable to perform that which is good. Psychology is able to offer description of the things of Christian human nature, provided that it keep on scriptual grounds. It can also offer certain techniques of evaluating and manipulating human nature, but it can never give the dynamic of supernatural change. Only Christ can do that. But it can furnish method and pattern for the human effort, which partakes therein. Man must, in his heart, choose whom he will serve (Rom. 6:16) but only Jesus Christ, as Lord of the life, can deliver him from the way of the flesh (Rom. 7:25).

We shall be delivered from Basic Anxiety, and from the susceptibility to the Basic Fears, only when we are also delivered from the presence of sin. It is still normal for people to show fear of nakedness, even though individuals may be conditioned out of it. But it is present through-out the Christian life. We never become so Christian that we become nudists. Likewise the fear of death does not leave us, but it makes slaves of us. "That through death He might destroy him that had the power of death .... And deliver them who, through the fear of death, were all their lifetime subject to bondage" (Heb. 2:14,15). Only at the resurrection of the just will we be free from the uneasiness and dissatisfactions of Bacis Anxiety.

In summary, Basic Anxiety is a vague and intangible restlessness, universally and coninuously experienced by humans only, as a result of the guilt of the original sin, transmitted to every descendant in Adam's race. It gives rise to those adjustments and maladjustments which are so characteristic of human behavior, which are scripturally known as "the flesh." Through the Cross, the Lord Jesus has insured that that dissatisfaction which we call Basic Anxiety will be cured when the body is redeemed and raised. "I shall be satisfied when I shall awake with Thy likeness" (Ps. 17:15).

FIFTY YEARS OF DEVELOPMENT IN ASTRONOMY AND ITS IMPACT ON SCRIPTURAL INTERPRETATION

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The subject could just as well have been "Thirty-five Years of Development in Astronomy and its Impact on Scriptural Interpretation." Or "The One hundred inch Telescope and the scriptures." It was the 100 inch telescope that gave the great impetus to astronomical research about 35 years ago.

Genesis 1:1, "In the beginning God created the heavens and the earth." Forty years ago this verse was under attack. We were taught in the class room that matter was eternal, it could neither be created nor destroyed. You could drastically change the form of a given piece of matter but all of the original matter still existed as matter in some form. The conclusion, of course, was that our physical universe always existed, there was no creation and there could be no end.

Today we teach in our colleges that matter can be changed into energy and energy into matter. We even have a formula giving the equivalence of matter in energy. Thus the old ground for doubting the accuracy of this first verse is gone. Not only that but many new findings of science point to its absolute accuracy. 1. Radioactive methods have dated the age of the earth itself in the general neighborhood of 2 billion years. 2. Meteorites coming to us from outer space have been dated by the same process and it appears that the oldest of these are also about 2 billion years old. 3. The tidal effects between the earth and the moon cause the moon to recede from the earth. The problem, if the moon were originally very close to the earth how long would it take the tides to move it to its present place, has the answer of about 2 billion years. 4. Astronomers have long known that the energy from the sun can not be prodeced by the simple cooling off of a hot body. The Astronomer believed atomic energy to be the main source of the sun's radiation long before the physicist knew how to liberate atomic energy. It is now believed that the sun liberates energy in the change of hydrogen into helium. Since the amount of helium on the sun can be fairly well determined by the spectroscope it is possible to solve the problem if the sun has always given off energy at its present rate and this energy is produced by changing hydrogen into helium, how long would it take to develop the observed amount of helium on the sun. The answer has been given as about 2 billion years. 5. There is a considerable degree of uniformity of motion among the stars of our galaxy and the tendency is to ever increase the degree of uniformity. Since we can not know what degree of uniformity of motion existed at the creation or the beginning of our galaxy, the most extreme problem possible has been stated, that is, if there was no uniformity of motion but all stars moved with random velocities and in random directions how long would it take to reach the present degree of uniformity of motion. This probelm has an answer of about 10 billion years. This, of course, is the extreme outside limit to the possible age of our galaxy. It is not at all likely that our galaxy started in such a confused state. We are quite sure therefore, that the age of our galaxy is far under 10 billion years. 6. There is some question about the interpretation of the red shift of the spectra of the island universes. The velocities indicated by the shift are tremendous, present measured shifts indicate velocities as great as 600,000 miles per second. So many astronomers would like to find some interpretation for the shift other than velocity. Up to the present no such interpretation has been found. Our best authorities say that if the shift is not velocity its interpretation lies outside of the present knowledge of science. If this shift does measure velocity then all of our galaxies would have had a common starting point some 2 billion years ago.

Thus every bit of evidence which we have points to a definite beginning of the physical universe. The astronomer does not hesitate to speak of the day of creation. Two physicists from John Hopkins University have even gone so far as to attempt to determine how the creation took place. They have presented the startling theory that the matter of the physical universe came from very dense light. They believe the light to have been as dense as water and that this light changed into matter to make the universe and that it all took place in one hour, 60 minutes.

We should not give this theory too much weight as it is very new and will probably undergo rapid changes. It does however, have interest as the power of God is often demonstrated as light and light would have been a natural source of energy for God to use in creating the universe.

"In the beginning God created the heaven and the earth," and science says "Amen."

Genesis 1:2, "And the earth was without form, and void, and darkness was upon the face of the deep. - - -"

Perhaps there is no other verse in the whole Bible which has been subjected to such damaging criticism. The Nebular Hypothesis held sway, in the scientific field, for at least 150 years. This theory had the solar system start as a rather dense gas, disc shaped and giving off tremendous amounts of light. The critic looked at the second verse and said, you can not possibly believe your Bible for the second verse is evidently extremely erronious. He also asked, what is the verse talking about? What Astronomical body is shapeless, rare and dark? We had no answer. This condition continued until less than 35 years ago when Dr. Hubble turned the new 100 inch telescope to the study of the spiral nebulae. At this time the spiral nebulae were thought to be solar systems in the process of formation. They were thought to be members of our own galaxy and in various stages of solar system formation. In fact, the photographs of spirals was one of the very strongest evidences for the truth of the Nebular Hypothesis. The 100 inch telescope was powerful enough to resolve some of the closer spirals into individual stars. These nebulae were found to contain tremendous numbers of stars, they also contained variable stars, star clusters, bright and dark nebulae, etc.

Later, cepheid variables were isolated in a few of the nebulae, their periods were observed and their distances computed. The spirals were found to be far outside of our own galaxy. In fact, they were galaxies very similar to our own.

This was a serious blow to the Nebular Hypothesis, but the death blow came when a mathematical physicist set himself the problem, if we should have a hot gaseous body, disc shaped and rapdily rotating what will happen as it contracts? The answer came out that if it divided it would divide making two nearly equal bodies. Since the sum of all the planets is less than one tenth of one percent of the mass of the sun they could not have been formed as the Nebular Hypothesis indicated. Thus the Nebular Hypothesis died and in its place sprang up the planetessimal and tidal theories. These were short lived as they were both shown to be theoretically untenable. For a considerable period of time we were without any theory regarding the formation of the solar system. During this time the stellar sequence was developed and was quite generally accepted. It started a star as a tremendously big gaseous body just hot enough to glow red, it then contracted, heated up and went through a long period of changes before becoming a dead body. Of course, we all had to wonder just what the star was before it became hot enough to glow red. So during a considerable period of time the concept of a new astronomical body coming from a nebula grew until it met nearly universal acceptance. During this last year the concept of a solar system

coming from a diffuse nebula has been put in the form of a theory and has the promise of general acceptance. Dr. Henry Norris Russell has said that they are observing collections of matter in several diffuse nebulae and expect eventually to have observational evidence that new stars do evolve from diffuse nebulae.

Up until 35 years ago dark spots in the sky were thought to be holes, through which we were looking out into outer space. Soon after the 100 inch telescope was put into service it made a photograph of one of these spots and proved it to be a dark cloud. There followed an intensive study of dark nebulae. They were found to occur in every conceivable shape, they were found to be extremely rare and certainly dark. Dr. Alter, director of the Griffith planetarium, in a lecture on nebulae, quoted this second verse and said that that was the best description of a dark nebula that had yet been written.

This second verse thus is no longer a point of attack on the scriptures but stands as remarkable evidence of the inspiration of the Bible as it was probably written 4000 years before a dark nebula was discovered.

"And the earth was without form, and void, and darkness was upon the face of the deep - -." Again science says "Amen."

Genesis 1:3-5, "And God said, Let there be light; and there was light. And God saw the light, that it was good; and God divided the light from the darkness. And God called the light Day, and the darkness he called Night. - - "

It was earlier thought that the earth came off from the sun and shared its heat, merely a smaller star. If this had been true it would have given off its own light and there could have been no night. A limiting size has now been set for a star. If it is less than 1/100 the mass of our sun it will be too small to form a star. Our earth is only 1/333,000 the mass of the sun and therefore never could have been a star. It had its day and night as soon as the sun became hot enough to shine.

Genesis 1:14-18 " - - "

The critic has used this passage saying, your Bible claims that vegetation was on the earth before there was a sun, but vegetation can not exist without the heat and light from the sun. The sun was created in verse one and its shining on the earth is recorded in verses 3 to 5. Here it is made to shine on the earth so it can be used "for signs and for seasons, and for days, and years." Geology and Physics together tell us that the earth in an early stage was warm, so warm that most or all of the free water was in the atmosphere. The clouds were very dense, so dense that there were tropical conditions from pole to pole, every place was warm and very humid, there were no breaks in the clouds. There was no rain, only dampness and mist. The clouds broke before the devonian period and then very heavy rains and great erosion ensued. Genesis 2:4-6 says, " - - the Lord God made - - every plant of the field before it was in the earth, and every herb of the field before it grew; for the Lord God had not caused it to rain upon the earth - - But there went up a mist from the earth and watered the whole face of the ground." This refers to the time when God created vegetation, so both science and the Bible agree that the clouds so completely covered the earth that the sun could not have been used "for signs, and for seasons, and for days and for years," until a time before the advent of fish as recorded in this Genesis account of verses 14 - 18. They also agree that before this time the earth was a perfect hot house, just suited for the introduction of vegetation. The Bible implies that the clouds first broke between the pre-cambrian and devonian times, that the sun then first appeared and heavy rain first fell upon the earth. This sounds like a chapter from Historical Geology.

Thus recent developments in science have shown that there was a creation of the physical universe as stated in the first verse of Genesis. It has even set a date for that creation. It has shown that the earth probably came from a diffuse nebulae and most likely from a dark nebula as stated in the second verse. That the earth was never a star but always obtained its light from the sun as implied in verses 3-5. It has shown that the earth in its early stages was completely covered with dense clouds and that the clouds broke before the advent of fish as stated in verses 14-18. That there was no rain on the earth until after the advent of vegetation, just as stated in Genesis 2:4-6.

Time after time, in my own life, I have seen a disagreement between science and the Bible, then I have seen changes come in science which have proved the truth of the scriptural account. Never have I seen science once agree with the Bible and later change so as to contradict it. I have often seen it make additional changes which have further strengthened the former agreement and have helped to clarify the interpretation of the scriptural account. To the best of my knowledge there remains no statement in the Bible with which Astronomy in any way disagrees.

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GERIATRICS AND THE BOOK OF ECCLESIASTES

Thomas M. Durant, M.D., F.A.C.P.

There is a great need for discussion by physicians of the manner in which the Word of God may be used in the consultation room to supplement the other methods of medical practice. It is my conviction that the Bible is an indispensible item on the doctor's desk, and that prescriptions from its pages should be an important part in his therapeutic armamentarium. It is with these thoughts in mind that I have presented a brief discussion of the book of Ecclesiastes in relationship to that very important field of medical practice, Geriatrics, or the science which deals with the processes of aging.

Recently there came to my office a 65 year old widow whose presenting complaints were largely referable to the cardio-vascular system. Ordinarily in a person of this age one would expect such complaints to be based on organic disease, but in this instance complete investigation revealed a heart and vascular system which were very normal for her age. Furthermore the history obtained at the first visit strongly suggested a background of emotional disturbance, the somatic complaints appearing only as surface manifestations. Such was proven to be the case as the affective element in the patient's difficulty was uncovered. She was a woman of Germanic stock whose parents had migrated to this country in her youth and had managed to provide the necessities of life for their children only by dint of constant hard labor. Integrity had been the keynote of the parental instruction. The married life of the patient had been one of mixed happiness and drudgery, and strict economy had made possible the building of a reasonably comfortable nest egg. Following the death of her husband, however, the patient fell a victim of men who preyed upon a widow's gullibility, and, for the first time in her life, she was faced with the realization of the depths of deceit which lie behind the apparently trustworthy exterior of certain fellow men. The loss engendered bitterness which was projected in the form of racial hatred, an emotion which was in conflict with her own idealized image. Thus she had entered the evening of life in emotional turmoil, completely disillusioned, and with practically no spiritual resources to turn to for solace.

An example such as this one is by no means isolated in medical practice. In fact, the more physicians have come to stress the ever expanding problems of our increasingly aged population, the more it hasbeen realized that the psychological difficulties of senescence are of the utmost importance. If medical science is to increase the life span of human happiness and contentment to run parallel to the increased chronological life span, provision must be made to alleviate the factors which detract from the former. The development of psycho-somatic medicine as applied to geriatrics is an important step in this direction, but this is not enough, since man is trichotomous, not dichotomous. We must therefore stress what Dr. Wm. Witeley has termed PNEUMO-PSYCHO-SOMATIC medicine which places proper emphasis upon the importance of the Spirit or Pneuma in life.

As one listens to the stories of the aged and the aging one cannot but be impressed by the fact that many of their deeper thoughts are a paraphrase of the book of Ecclesiastes, though most of them are, of course, unaware of it. It is the viewpoint of man "under the sun," and all is vanity and vexation of spirit. The patient referred to at the beginning of this paper might well have said, as did the author of Ecclesiastes, "There is a vanity which is done upon the earth; that there be just men, unto whom it happeneth according to the work of the wicked; again, there be wicked men, to whom it happeneth according to the work of the righteous; I said that this is also vanity" (Eccles. 8:14).

Numerous other examples could be cited from Ecclesiastes as descriptions of common senescent viewpoints, but time permits the elucidation of only two others. One of these concerns the man whose life has been centered around his business. He has worked hard with but few vacations and the development of no hobbies. Success has attended his efforts, but throughout the years he has dreamed of the day in which he might enjoy the fruits of his labors upon retirement. When that day does come, however, the fruits are found to be bitter in his mouth. Recreation based upon physical exertion is denied him. His years of swivel chair existence have prevented complete metabolism of his rich diet and the linings of his important arteries are swollen with fat preventing sufficient increments of blood supply to permit exertion without pain or shortness of breath. Furthermore, the years of rigid adherence to work do not now permit the sudden development of ability to enjoy relaxation. Great restlessness is the result, and, if he tries to alleviate this by dabbling a little in business once more the younger generation which is now enjoying the management of his business finds his methods far too conservative for their more youthful spirits and disagreements arise which may be quite serious. Anxiety reactions and a feeling of loneliness are quite likely to result. In some instances there may be added to this the feeling that the younger generation is waiting for the day when his resources will be divided. We then turn to Ecclesiastes 6:1 (Moffatt) and read, "There is indeed an evil I have seen under the sun, that presses heavily on men--God making a man rich, wealthy, and honoured, till he has everything his heart desires, and yet he is unable to enjoy it; an outsider gets the good ot it. This is vain, a sore misfortune."

The other senescent viewpoint which we will discuss is the lamentation which we hear in practice so often over the physical handicaps of aging, and the difficulty which is experienced in achieving acquiescence to these degenerative manifestations. In Ecclesiastes this is expressed in a fashion which has often made me marvel at the powers of observation of the author. If symbolism were not used in the wording, one could well imagine the description to be that of a well trained clinician. In verse 3 of chapter 12 there is first mentioned the trembling of "the keepers of the house," or the arm tremor, presumably of paralysis agitans, which is such an extremely common neurological disorder of senility. This is followed by a reference to the fact that "the strong men bow themselves." Here the bowing of the legs which

results from the lessened activity of osteoid tissue in bones following the decline of adrenal stimulation is described. This is followed by a reference to the loss of teeth and to the decline of visual activity which are so commonly the lot of the aged. In verse 4 there is allusion to the auditory difficulties of aging, the early rising of the elderly, and the feeble voice that is characteristic of extreme senility. Verse 5 refers to the anxiety states, the white hair, and the feebleness and impotence of the aged. Verse 6 refers apparently to the three most common terminal events of life. The "loosing of the silver cord" (the spinal cord) and the breaking of the "golden bowl" (brain) would seem to indicate the hemiplegic death of cerebral hemorrhage. "The pitcher broken at the fountain" may well refer to the death in respiratory failure of pulmonary emphysema cases since the lungs are filled entirely by the effort of surrounding muscular structures, and are therefore in a sense passive as is the pitcher in the function it serves. Finally, the "wheel broken at the cistern" seems to refer to the ancient method of water supply whereby a system of conduits was supplied by a rotary wheel at the cistern. We therefore can visualize this as a reference to cardiac and circulatory failure. "Then shall the dust return to the earth as it was and the spirit shall return unto God who gave it. Vanity of vanities, saith the preacher; all is vanity."

The physician has therefore in the book of Ecclesiastes a presentation of the feelings of futility and despair which belong to a senescent individual whose life has been lived "under the sun." One is struck by the fact that the viewpoint is an entirely selfish one. It is of interest that the personal pronoun "I" is used 87 times in this short book. Nowhere are we led to believe that the author may have dedicated the utilization of his God-given gifts for the benefit of his fellow man. On the contrary, every attempt had apparently been made to use those gifts for the gratification of his own senses, and, as with the narcotic addict, increasing dosage was constantly necessary, leading to final complete disaster. It is of interest to mention at this point that Geriatric texts recognize the therapeutic importance for the elderly of attempting to stimulate these people by indirect suggestion toward attempting to alleviate the distress of others less fortunate than they are.

In giving us this book of Ecclesiastes in the Canon of Scripture, the Holy Spirit provided for us a picture which demands an answer, and, at the same time, shows us very definitely that the answer is not to be found "under the sun." If a man who was as richly blessed as the human author in all that this world has to offer can only say as he contemplates life under the sun that it is altogether vanity and vexation of spirit, then it is evident that man must look to God for the realization of his hopes and aspirations. It is an example of Verity through Vanity. In pointing out to our patients the fact that their viewpoints are echoed by a man who had all of the human advantages of the author, we are happily enabled by a loving God to present to them the fulness of His revelation. We can turn to the 7th Chapter of Romans to show once again the human viewpoint as depicted by Paul (the personal pronoun 'I' is used 34 times in this chapter), and then show that this is followed by that magnificent 8th chapter which begins with "no condemnation" and ends with "no separation." This glorious answer through the love of God which is in Christ Jesus our Lord is, of course, the final and perfect answer to all of the strivings of man under the sun, and is the keystone to the Penumo-psycho-somatic approach to medicine.

In conclusion, there is one more point which should be stressed from the teachings of Ecclesiastes, and this belongs to the realm of prophylaxis rather than treatment. In the first verse of the final chapter we read, "Remember now thy Creator in the days of thy youth." This powerful word of advice to the young takes into account the fact that there is a fixation of thought processes in the elderly, and to produce major deviations from the well worn ruts of habit is extremely difficult. The neuronal pathways follow courses through areas of low synaptic resistance, resistance

which has been lowered by oft-repeated stimuli throughout the years. Thus it becomes extremely difficult for the elderly to be shown a new approach to any problem, and this is no less true in spiritual matters than it is in the world of the material. We can well understand then why it is that, with advancing years, the likelihood of a person accepting Christ declines rapidly, and those who have had much experience in the field of evangelism tell us that this decline is practically in direct proportion to the age. We must therefore realize the tremendous importance of giving the Word of God to the young, long before the time when, in the words of the Preacher, the evil days come, and the years draw nigh when they shall say they have no pleasure in them.

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MODERN PHYSICS AND CHRISTIAN FAITH

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a) Physics is an experimental science, based upon observations and experiments.

This statement needs very little comment, it just describes what happens in a research project in physics. If a certain phenomenon is investigated, a number of observations are made, if possible under varying initial conditions, and it is then tried to give a clear representation of those observations. This sometimes only leads to a conclusion, sometimes to a general principle, usually stated in a mathematical form. If this result is achieved the investigation can be said to have been successful.

The mathematical formula or the general principle usually states more than the sum of all the observations made and it has to be investigated whether all the further conclusions which can be drawn from it are also verified by experiments.

I mentioned that one always tries to vary the initial conditions of the experiment. This is a very important part of the work, if it cannot be done, the work becomes much more difficult and progress is usually slow. In order to vary the initial conditions one has to be able to control the process which is investigated; as I said before this is not always possible but it is highly desirable.

As an example take the study of mesons, heavy ionizing particles having the same charge as an electron but a mass in between the mass of an electron and the mass of a proton. These particles are present in cosmic rays; one had studied those rays for many years, had discovered the particles as one type out of the great many kinds which were present in those rays, but one could not control the processes in which these particles appeared. Last year physicists in Berkeley were able to make mesons in their new powerful cyclotron. One can be confident that progress in the study of those particles will be much more rapid from now on, as one can not only control the process but also make mesons in much bigger quantities than occur in cosmic rays.

b) The aim of a theory is to interrelate the various observations and to give a unified description of them.

After having investigated one phenomenon the task of an experimental physicist is not finished; there are a large number of other phenomena which can be investigated

in a similar way. The next step is now to find relations between those phenomena and it is tried to describe the various observations by a single theory by starting from a few well established facts or from a few hypotheses. This is the task of the theoretical physicist, who has as his aim to cover as many phenomena as possible by a single theory.

Usually the theory states much more than all the observations made so far and it has to be investigated whether all further conclusions are also verified by experiment. If they are then the theory has got a more solid foundation; if they are not then the theory has either to be abandoned or to be improved. Usually, even for very successful theories, one finally comes at a point, where new phenomena are encountered which cannot be described by the existing theory. This may alter the whole picture drastically; I only have to refer to the beginning of the quantum theory in order to indicate how large the change can be. Such events cause the dynamic character of science, due to which the theory of today may be found to be wrong tomorrow.

Theory and experiment go side by side. If divorced from experiment, the theory becomes speculation; experiment without theory can only consist of assembling data and has very little future. The theory has to guide the experiment just as the experiment has to guide the theory. The progress of physics during the last two centuries is chiefly due to this close connection between theory and experiment.

c) Established fact and hypothesis.

The basis of physics is that the observations made are to be considered as established facts in so far as a repetition by other investigators gives the same results. A theory is not an established fact itself, though it may become so in face of further evidence. It is just a theory and nothing more; one has always to be open for the possibility that it may have to be abandoned in view of further developments.

I said that some hypothesis may become so firmly established by further evidence that one may consider them as experimental facts. About 150 years ago the molecular theory was no more than an hypothesis, made in order to give an adequate description of some facts in chemistry and physics. Today the evidence in favour of their existence is so large that nobody has any doubt about it.

Not all theories share this fate. About a few hundred years ago one introduced the ether in order to visualise the fact that light behaved as if it consisted of transverse waves; one used the argument that one had to postulate a medium for this wave motion. The same ether had to be used somewhat later in order to visualise the basic phenomena of electromagnetism. The link between the two fields was established by Maxwell who founded the electromagnetic theory of light. About 50 years ago some physicists boasted that the ether was one of the best known substances of the world. Today the picture has changed considerably; most physicists do not believe any more in the ether. They have realised that the ether was only a means for visualising electromagnetic and light phenomena; they could therefore abandon the whole ether concept without changing the mathematical formulas which describe electromagnetism and light.

d) Physics is a descriptive science.

Physics is not a philosophy; it does not discuss the "nature" of things, but it describes sufficiently what phenomena occur, how they occur and what we can do with them.

We still do not know anything about "the nature" of gravitation, but we know that the inverse square law (or the relativistic generalisation of it) holds and that is sufficient for astronomical applications. We know nothing about the nature of an electron, but we know its charge, its mass, its angular momentum and its magnetic moment; we also know the basic laws of the quantum theory and that is sufficient for giving an adequate description of atomic and molecular spectra. It also enables us to put the electron to work for us in radio and television with so much success.

In none of these fields it is tried to discuss the "nature" of things and still the progress has been spectacular. If we try to make science more than a descriptive science we just make it less as such an endeavour is usually accompanied by a dogmatic attitude. Scientists in the middle ages talked a great deal about the nature of things but did very few experiments and progress was therefore slow. If we keep physics within these limits and do not develop it into a philosophy, good progress will be made and it will have a great influence upon every sphere of human life. If it is tried to use physics in order to arrive at the "nature" of things physics will have much less influence upon many aspects of human life, but its influence upon religion may easily become disastrous, as its truth will then have a much more absolute character to which other truths, even religious truth will be subjected.

e) Analogies.

One can perhaps make a distinction between direct descriptions and analogies. Direct descriptions can be used if we have some notion of the quantities which are introduced in the theory. Analogies are used if we do not have such a direct notion of the concepts, we then relate the unknwon to the already known.

As an example take the quantities introduced in mechanics. Everybody knows what is meant when we talk about particles, about their position, velocity, acceleration and about the forces working upon them. The description of mechanics, though perhaps somewhat difficult for young students here and there, is completely in terms of those quantities. In the case of electricity, however, we use analogies in a large number of cases.

Everybody can visualise wave motion from the motion of water waves. He can also understand the phenomena of interference and diffraction from those waves. It is then observed that in sound and light those phenomena of interference and diffraction occur too and we therefore conclude that sound and light can be described by saying that it is just as if sound and light are wave phenomena. This was at first only an analogy. Further evidence showed that in the case of sound the air molecules are really vibrating longitudinally, so that we may drop the words "as if" and say that sound really is a wave motion of the air. We cannot say that something really vibrates in the case of light (unless we introduce a hypothetical ether) therefore we might better say that to call light a wave phenomenon is an analogy.

Analogies are extremely useful, because they indicate that an unknown problem can be solved in the same way as a familiar one; they are therefore widely used in physics. There is e.g. an analogy between the flow of current in an inhomogenous conductive medium and between the distribution of the electirc field strength in an inhomogenous dielectric medium. Those who are familiar with one type of problem can immediately solve the other type.

The danger is, however, that an analogy is taken to be a reality and that the two words "as if" are omitted. In that case only confusion will result. I only have to refer to many old textbooks on electricity, in which one happily used

analogies and thought that they were established facts. It is very illuminating to read in this respect A. O'Rahilly's book: Electromagnetics (Longmans, Green and Co.). Though not everybody will always agree with his statements, his criticisms are usually well-founded, his ideas are thought-provoking and his collection of wrong statements in textbooks is instructive and amusing.

If physics is thought to tell us something about the "nature" of things then there is always the danger that an analogy is taken to be a reality. If physics is thought to be a descriptive science, this danger is much less acute and analogies can have their rightful place.

f) Differentiation and synthesis.

Two opposing tendencies are always at work in science, differentiation and synthesis. By the process of differentiation a more primitive science is spread in many different directions. As an example the natural sciences of the 16th and 17th century spread into physics, astronomy, chemistry and biology. In the process of synthesis side-links are built between those new pathways of science. Astrophysicists have transformed the Universe into a large physics lab in which physical principles are tested in a way not dreamt of a few generations ago. Wave mechanics has linked chemistry and physics together by means of the theory of the chemical bond. Biophysics and biochemistry are building links between biology, chemistry and physics.

Both processes are always at the same time and complement each other. If differentiation is overemphasized, one will be finally left with as many theories as phenomena, which is certainly not very satisfactory. If synthesis is overemphasized one will in the end try to synthesize even those phenomea which have no connection whatsoever.

For it is not certain beforehand that two phenomena are related, and is even wrong to assume that they have to be related. It is the danger of a synthetic point of view that such an assumption is made where it should not be made. But it is worth while to investigate whether the phenomena are related and it would be wrong not to make at least an attempt. And one should not be too much biassed in favour of one of the two possibilities unless one has studied the presence or absence of a relationship. That is a dogmatic attitude which has no place in science.

If one has discovered a new principle, it is wrong to assume that it has to be applied to all fields. But it would be equally wrong not to try whether it can be applied to some other fields too. If it can, then it may lead to startling developments; if it cannot then one has to accept this fact at least for the time being.

It is dangerous to apply important principles to other fields if one has not sufficient knowledge of that field. A physicist might better stick to his own job, for there is still a large amount of work to be done in his own field. As an example take Heisenberg's uncertainty principle. After its discovery it was argued that this principle proved the human free will. After this principle the uncertainty in momentum Δp times the uncertainty in position Δx is of the same order of magnitude as Planck's constant h. This principle seems to hold in atomic physics, but from there to the human will is a very large step. And suppose this step is made, in what way do we have to find the freedom of this will? I know that Planck's constant is a very small quantity; does that mean that the limits between which the human will is a free will are quite close together too? Is not it much better to leave this problem to those people who have been thinking about it in the past?

g) Dogmatism in science.

I said before that dogmatism had no place in science. It is not always of a dangerous type; as such it occurs in popular science books, when very generalised statements are made about the nature of things. One notices e.g. in modern physics a tendency for abstract reasoning which is chiefly caused by the fact that concepts are used which are not familiar to us in every day life. But it would be wrong to conclude that all concepts in physics are of the abstract type. And it is even more wrong that they are "mental concepts." I doubt very much whether anybody who has such an extreme point of view will not be careful enough to stay away from intense beams of fast neutrons. Otherwise he will soon find out that these "mental concepts" are highly dangerous!

More serious is when one extends a certain principle to the whole universe and to every aspect of human life. It is dangerous, because it may have serious consequences on politics, religion and on the whole human society. As an example take the deterministic point of view in the nineteenth centruy. After Newtonian mechanics the path of a particle is known as soon as the law of motion and the initial position and velocity are known. This result was then extended to the universe and to human life. Nobody knew whether the principle could be applied to human life and nobody seemed to care either. One happily did so and called the results "scientific." It was completely unscientific of course, for a real scientific approach should always be open to the possibility that a principle which is assumed to hold in a particular field may later be found not to hold under all circumstances. And a scientific approach is much more critical in applications to other fields. The irony of history is that the above principle does not even hold in atomic physics; after Heisenberg's uncertainty relation one cannot know all the initial conditions at the same time.

We are facing here a very common error in human thinking; it is no exaggeration to say that practically all present and past -isms can be traced to an error of this type, that a principle which may be useful in some fields is extended dogmatically over all fields and to every aspect of human life. One finds the important part which heredity plays and one concludes dogmatically that everything is determined by heredity. One finds the important influence of environment upon human behaviour and one concludes that all crime will disappear if the environment is changed favourably. Or one notices the importance of your economic position upon your outlook of life and one puts forward the principle that all human behaviour and all human thinking is determined by economic factors. In all these cases there is a certain amount of truth in the ideas which are put forward; what is wrong, however, is that it is assumed to be the whole truth. And "the whole truth" is a very intolerant concept.

h) Physics and faith.

In the previous sections I said that physics does not discuss the nature of things. One should not have the idea, however, that I think it to be objectionable to discuss the nature of things. But one should make clear that one is not doing physics when one does so. There is no direct objection against discussing the reality of the outside world or the probability of a creation or the possibility of the existence of a Creator with the help of data supplied by physics. Whether or not objections have to be made depends upon the certainty of the results obtained and upon the way in which they are obtained. In the case of religion objections may also have to be made if the results obtained are in contradiction with the Christian doctrine.

In face of the existing astronomical and physical data it seems to be justified to assume that many things had a beginning. If radioactive elements had always existed they would all have decayed in the past. This is a very strong and sound argument, at least in view of our present state of knowledge. It is already more speculative to derive a similar argument from the expanding universe. Cosmological theories seem to indicate that the universe "started" a few billion years ago. It is tempting to call this beginning "Creation" but it is wiser to be cautious; the few observations which led to the concept of the expanding universe are open to other interpretations. In a recent paper in "Nature" (Feb. 5, '49) the idea is put forward to combine the ideas of an infinitely old universe with the idea of a "continuous creation" of matter. (Instead of "creation" one might perhaps better say "appearance" of matter, for the Christian concept of creation is certainly different). These speculations are extremely interesting but it would be unwise to tie our faith in the Creator to them.

Sir James Jeans once wrote that the mathematical structure of physics showed that the great Architect of the universe was a great mathematician. He derived this from the fact that physics could be so beautifully described by mathematical theories. But who is this great mathematician behind these theories? Might not it be after all the enlarged picture of the theoretical physicist himself who built this structure?

But why should one go to so great efforts to arrive at so meagre and vague results? Would not Christians do infinitely better when at this particular point they confessed openly their faith in God the Creator, in Jesus Christ, our Lord and Redeemer and in the Holy Spirit, our Comforter. Those which do not believe might otherwise get the wrong impression that our faith rests upon such doubtful and vague grounds.

For let us make one thing clear to them. The answer to the question whether there is religious truth and where it can be found does not come from physics or any other science. It comes from God Himself, from His revelation in Christ. The message of God's love and mercy towards us comes through the mouth of the prophets and Apostles, not through the mouth of scientists. The only work scientists can do in this respect is to say: "Amen" and to accept this message.

This is not a condemnation of science; science certainly is one of the greatest achievements of modern man and it certainly deserves its rightful place in the modern world. But it has its limitations, if we had to rely upon it for religious truth, we would still live in religious ignorance. Let us be thankful for it, for it relieves us from the task to seek God in and through science. God's revelation in Christ shows that this would be only a blind alley. It also opens up the possibility to work in our field of science without the constant fear that our next discovery might damage our faith beyond repair. Our certainty is in God and not in ourselves, our faith is a free gift from His hand and not our own achievement. For that reason we may say with the apostle Paul: "Nothing can separate us from the love of Christ (Rom. 8:35).

i) Physics and the Bible.

Much has been written about the existence or non-existence of harmony between science and the Bible. As our faith may be strengthened by a great many things of only relative importance (though they were not the origin of our faith) it is perfectly right to say that any harmony between science and the Bible may strengthen our faith. But it is certainly wrong to say that any lack of harmony between science and the Bible must weaken our faith. For the certainty of our faith does not rest upon such an agreement but it is in the hands of Him who revealed Himself to us in Christ.

SPIRITUAL TRUTHS IN MATHEMATICS

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Introduction

One may well question the title of this paper for surely few people would think of finding God in a mathematics lesson. One expects the manner of presentation of mathematical material in a Christian institution to be the same as that in any university. It is agreed that the mathematical facts presented would necessarily be the same. However, I have found that there are certain analogies between these facts and spiritual truths and it is a delight to bring these to the minds of students and urge them to make some of their own comparisons. This does not mean that the mathematics lesson becomes a time of devotion nor does it mean that an endeavor is made to spiritualize everything. Just a passing remark is made and it seems that the mathematics involved is remembered longer because of the illustration given. A few examples will show how this is accomplished.

Postulational Thinking

Nearly every person, whether engaged in scientific work or not, will some time in his life be confronted with postulational thinking. By postulational thinking, we mean simply deductive reasoning that is based on some defined terms, undefined terms and beginning axioms and postulates. In everyday life, certain decisions and judgments are made by postulational thinking when definite rules have been set up governing the problem at hand. Euclidean geometry is the classic example of a geometry built upon postulates. But when a mathematician decides to build a new geometry or some other system of mathematics, he sets up his system of postulates and then is careful that no violation is made of this system. These postulates must be consistent. They need not be eternal verities since for each system they are only human assumptions. However, it is necessary that there be certain basic principles and definitions upon which to build. A mathematician, who has a sense of the vast consequences which arise from certain antecedents, can surely appreciate what it means to establish one's faith firmly on an eternal verity like John 1:1, "In the beginning was the Word, and the Word was with God and the Word was God." If one believes this, other important truths will follow. There is the "if-then" reasoning in postulational thinking. If by faith we accept the truth that "in the beginning God" we proceed upon a firm foundation and can build our thinking upon such a fact.

Usually people classify scientists as people who know and it is rarely felt that faith is an essential element for a scientist. President George D. Birkhoff, past president of the American Association for the Advancement of Science, stated some few years ago in his retiring address to that body that "whether it is the mathematician dealing with number, or the physicist with matter, the biologist with organism, the psychologist with mind, or the sociologist with social values, there is behind one and all an inherent faith guiding the reasoned superstructure which they create upon intuitional concepts." He emphasizes faith as an "heuristically valuable, more general point of view, beyong reason, often in apparent contradiction, which the thinker regards as of supreme importance as he endeavors to give his conclusions the greatest possible scope."[1] If an outstanding mathematician recognizes the need of faith in scientific reasoning, is it not plausible that we must accept

[1] J. W. Lasley, Jr., "Mathematics and the Sciences," Mathematics, Our Great Heritage (New York: Harper and Brothers, 1948) p. 190.

certain facts by faith? "Through faith we understand that the worlds have been framed by the word of God, so that what is seen hath not been made out of things which do appear " (Hebrews 11:3). Either we accept the Word of the Scriptures by faith or we have to reject it on the grounds that the principles derived from the facts in it are untenable. It would seem that a mathematician then might reasonably be the one who would recognize the need of faith rather than the one who would say, "If it cannot be demonstrated, I will not believe."

As before mentioned, a set of postulates must be consistent. One can not violate or disregard any of them when establishing a new mathematical system. If one does so, he may find it necessary, in the end, to discard a whole body of truth thoughtto be correct. A person may not be willing to accept one law or truth found in God's Word and may feel that as long as he accepts the majority of the Bible, all is well but he may rest assured that the discarding of part of the Word is the beginning of disaster. Is it any wonder that the solemn warning is given in the very last chapter of the Bible concerning "taking away from the words of the book of this prophecy?" (Rev. 22:19)

There is no branch of mathematics which needs fear a searching into its foundations. A scientific study of the foundations is welcomed from century to century. The bases of Euclidean geometry have been more firmly fixed through a thorough search into its foundations. Christianity, too, need fear no searching inquiry. Throughout the centuries, Christian scholars have investigated the basic truths of Christianity but all of this inquiry has only led us to know more assurredly that the truths of God's Word are eternal verities. Mathematics is a body of consistent thought which has maintained itself for generations and has withstood the attacks of logic and the tests of practical life. The certainty of mathematics is not absolute; it is relative. But as Professor Carmichael of the University of Illinois has suggested we have a moral certainty for the consistency and permanence of mathematical truth for "when thousands of persons through thousands of years examine thousands of theorems proved by numerous methods and in numerous connections and there is always absolute unanimity in the compelling character of the demonstration and the consistency of the results, we have a ground of moral confidence so great that we can dispense with the proof of logical certainty and comfortably lay out our lives on the hypotheses of the permanence, consistency and accuracy of mathematical truth."[2] Surely we can say that throughout the ages, what Christ has to offer to mankind has worked. The claims which He made for Himself cannot be denied. Thousands of persons through thousands of years have found that He has been all that He claimed to be.

The Concept of Infinity

One cannot go far into the field of mathematics without some concept of infinity, nor is it long before a child feels the inadequacy of the numbers which he knows. Some years ago a six-year old nephew asked his mother what a Ph.D. in mathematics meant. She replied that it meant that one knew a great deal about numbers. He immediately inquired if he could ask me any question he wished about numbers upon my next visit. His question was "What is the biggest number in the world?" When I tried to explain to him that there were always larger numbers than any he could mention, he did not seem to understand and only expressed disappointment in my lack of mathematical knowledge. God tries to give us some concept of infinity in His Word when He says, "God telleth the number of the stars; He calleth them all by their names" (Psalm 147:4), or again, "The very hairs of your head are all numbered" (Matthew 10:30). As human beings we realize that the stars in the heavens and the hairs of

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[2]Robert D. Carmichael, "The Larger Human Worth of Mathematics," Mathematics, Our Great Heritage (New York: Harper and Brothers, 1948) p. 285.

our head are impossible to count and as we begin to get some grasp of the bigness of numbers, the greatness of our God is impressed upon us.

Or say to college students, "Take the numbers 1,2,3,4.5, ... indefinitely. Now secondly take, 2,4,6,8,10, ... indefinitely." Then ask, "Are there not just as many numbers in the second class as in the first class, since to each number one can have its double to correspond to it?" So there are as many numbers in the second class as in the first class but the second class is only part of the first class, or in other words, the part is equal to the whole. This gives one a helpless feeling about the whole concept of infinity. One can take away from infinity (take away the odd numbers in the first class) and still have infinity left.

So, how long will eternity be? Is there any way to express its endlessness? Perhaps the Lord wanted to bring to our attention the limitations of man's mind in regard to this matter when He says, "One day is with the Lord as a thousand years, and a thousand years as one day" (2 Peter 3:8). The best illustration of the concept of infinity I can think of giving the student, and I find it is one he never forgets, is the last verse of the hymn, "Amazing Grace." The hymn writer puts it this way:

> "When we've been there ten thousand years,
> Bright shining as the sun,
> We've no less days to sing His praise,
> Than when we first begun."

The student admits that it is inconceivable to take away ten thousand years from infinity and still have infinity left. To the human mind it is inconceivable, but in eternity our minds will not be bound by the finite. Only our own ignorance makes it impossible to conceive the idea. Does this not show how much greater our God is than any human being and are we not constrained to say with the Psalmist, "What is man, that thou art mindful of him? and the son of man, that thou visitest him?" (Psalm 8:14). Surely the unending character of eternity forces one to face the issue squarely as to where he or she individually will spend this unending time.

Or think for a moment concerning space. Just where does space end, or does it have an end? Why do we stop at three dimensions? With two variables one expresses the equation of a straight line in a plane, with three variables one expresses the equation of a plane in three dimensions. But now write an equation with four variables. What kind of a figure does one get? Have dimensions given out? Architects and physicists talk of four dimensions. "In architectural ornamentation, Claude Bragdon has shown the beauty in traceries that depend on four-dimensional order."[3] Physicists have tried to create a four-dimensional space-time world. But if four dimensions, why not have more? Where is to be the stopping place in this speculation concerning dimension? Many a religious skeptic will say that he does not believe that there is a possibility of a world beyond, but this same person will probably admit the probability of a dimension beyond the third or fourth. Does this not show us the bounds of human impotence? Where is place for boasting then?

Signed Numbers

In the study of algebra, one learns that in the addition of two unlike signed numbers, that the positive addend has to be larger than the negative addend if the sum is to be a positive number. The negative number may well speak of the downward pull of sin in one's life. It takes the positive grace of God to send him in a positive direction. The hymn writer caught the idea when he wrote, "Grace that is greater than all our sin."

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[3] James Byrnie Shaw, "Mathematics - The Subtle Fine Art," Mathematics, Our Great Heritage (New York; Harper and Brother, 1948) p.42.

The Functional Concept

Relations in the world are infinite in number. Mathematics is sometimes defined as the science of relations. Word problems in algebra require that a mathematical law be formulated which expresses the relationship between variables. For example, if a train travels at a uniform rate of speed, the distance travelled depends upon the time. The functional concept, or the idea of one quantity depending upon another, runs throughout the whole of mathematics. The human race is dependent upon a Being higher than itself, and it is only as the individual is rightly related to God and to His Son Jesus Christ, and he finds complete satisfaction in life. As the change in value of one variable affects the result so a change in one's relationship to the Lord Jesus Christ affects one's whole sense of life values.

Or think of the solution of a linear differential equation when the equation is not solvable until an integrating factor is introduced. As soon as this factor is introduced, the equation becomes exact or falls into some type which is readily solvable. Christ is the integrating factor in the individual's life. When He is introduced, and life's interests are integrated about Him, the problems in life resolve themselves into solutions.

Variables and Constants

In mathematics, we desire to find some unifying element, or unchanging law, about which other domains of truth may be systematically organized. In invariant theory, we are interested in certain combinations which have an unalterable value under certain transformations. "The 'laws of nature' are expressions of invariant relations under the changes occuring in nature or brought about by directive agency."[4] Most of us are interested in the "constants" of life. In the realm of one's earthly life, there are many variables; everything is changing but in the midst of it all, there is the unchanging Christ, who is the "same yesterday, today, and forever" (Hebrews 13:8). Happy is that one who finds that under the transformations of life, Christ remains constant, and is the unchanging One.

Translation

In analytic geometry, if the center of a conic section does not lie at the origin of the coordinate system, the axes are translated so that the equation of the curve is simplified. There are many advantages in having the center of the curve coincide with the center of the coordinate system. Here is an opportunity to speak of the translation in the spiritual realm of which the apostle Paul wrote in Colossians 1:13, "Who hath delivered us from the power of darkness, and hath translated us into the kingdom of His dear Son," for does not translation into the kingdom of His dear Son mean, among other things, a changing of the center of one's life and interests?

Conclusion

Other analogies could be given, such as the logical order of the system of truth in the mathematical realm, the contribution of one law to another, and the definite pattern of the whole, all of which is revealed in the world about us, but perhaps enough has been said to show that it is my conviction that mathematics should mean more than just mathematics to the Christian student. And surely the challenge is ours as Christian teachers to make our subject contribute something to the spiritual life of the students entrusted to us.

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[4] Robert D. Carmichael, "The Larger Human Worth of Mathematics," Mathematics, Our Great Heritage (New York: Harper and Brothers, 1948) p. 277.

GAMOW'S THEORY OF ELEMENT-BUILDING

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The phenomenon of universal expansion from a common point, as formulated by the astronomer Hubble in 1926, from data on the red shift of stellar spectra, resulted in renewed interest in the mode of formation of astronomical bodies from a primeval mass. The implication of a definite starting time was an important entity from which cosmogonical science and philosophy could launch a new attack. Physicists became interested in the possibility of the construction of elements from a mass of primary building blocks, a suggestion along this line having been made by Sterne[1] as early as 1933. The two problems, that of the origin of elements and of the origin of astronomical bodies, have often been studied together. To one school of thought the two are somewhat linked. However, as this paper is to cover only the former, the latter will be brought in only incidentally.

Basically, the problem consists in finding a process which, when solved, would give the present relative abundance distribution of the elements. The abundance drops rapidly with increase in atomic weight up to about weight one hundred. From that point on the abundances are practically constant[2]. A few elements vary considerably from the general abundance curve, to which reference will be made later.

Early attempts at the solution of the cosmogonical problem were based upon equilibrium studies of nuclear transformations at high temperature and density. The first rather complete cosmogony based upon these methods was developed by von Weizsäcker in 1938[3]. He assumed his starting material, the origin of which was beyond the scope of his cosmogony, to be the elements in thermal equilibrium with respect to nuclear transformations at high temperature and density. A change in physical conditions then froze the distribution. Later investigators extended the theory by assuming hydrogen to be the starting material.

The outline of this cosmogony is as follows. A mass of hydrogen at an extremely high temperature and density partially condensed into heavier elements in definite proportions for a given set of conditions. One might think of the condensation as being a result of loss in free energy of surface tension effects balanced against gain in free energy as a result of coalescence of two like-charged particles. It turns out that for elements having atomic weights below about silver in the atomic series, the surface energy is predominant and neutrons and protons tend to combine into larger groups while for elements having heavier nuclei than silver, the predominant electrostatic effect tends to break up the group. In either case, energy is is released. The latter effect is responsible for atomic energy as we know it today. The former principle rarely occurs terrestrially because of the extreme improbability of two nuclei coming so close together that they coalesce at ordinary temperature and pressure. A rapid change in physical conditions, including a drop in temperature, then caused that distribution to freeze.

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[1] T. E. Sterne, Monthly Notices 93, 726 (1933)

[2] V. M. Goldschmidt, Geochemische Verteilungsgesetz der Elemente und der Atom-Arten, IX (Oslo, Norway, 1938)

[3] C. von Weizsächer, Phyz. Zeit. 38, 176 (1937)
C. von Weizsächer, ibid. 39, 633 (1938)

This theory results in a relation in which the logarithm of abundance drops linearly with nuclear binding energy and with atomic weight. Calculated abundances fit data quite well up to about atomic weight seventy. Beyond that, calculated values are too low, the error at atomic number 90 being a factor of 10^{100}. Chandrasekhar and Heinrich[4] suggested that heavy elements were formed at an earlier state of higher temperature and density, were frozen, and the lighter elements formed at lower temperatures. Gamow[5], however, points out that at the temperature of 10^{10}° K and density of 10^6 g/cm^3 necessary for this type of reaction to form nuclei, transformations are primarily by absorption and evaporation of free neutrons and would occur for heavy as well as for light elements. Klein, Beskow, and Treffenberg[6] recalculated von Weizsächer's work using newer data and introduced high energy level studies which partially accounted for the discrepancy at high nuclear weights. van Albada[7] considered electrostatic effects at high densities but the discrepancy at high weight was not accounted for. Hoyle[8] suggested that O, B, and A stars had an interior temperature sufficient for such nuclear reactions to occur and identified the sudden freezing of the distribution with a supernova burst. ter Haar[9] assumes reactions to be taking place in stars because the initial expansion of material was too rapid to permit equilibrium to be established. Gamow[5] points out that early expansion was so rapid that the 10^6 g/cm^3 density necessary for equilibrium reactions was reduced by an order of magnitude in about one second. In a few minutes all transformations would have been halted, yet β-decay of neutrons requires approximately an hour. Therefore, equilibrium in the early stages was impossible.

Because of the failure of equilibrium methods to predict satisfactorily the distribution of heavier elements, Gamow[5] in 1946 suggested the possibility of a non-equilibrium process of nuclear construction. In 1948, Alpher, Bethe, and Gamow[10] identified this non-equilibrium process with that of neutron-capture. The formulation of this theory into mathematical terms and quantitative explanations has been done by Alpher, Gamow, and Herman[11, 12, 13]. Extensions into astronomical processes were also carried out by these authors[14, 15, 16, 17, 18].

Non-equilibrium cosmogony begins with the sudden appearance of a mass of energy at a temperature of the order of 10^{10}° K. At this point the mass was almost pure radiation. As cooling took place, conversion into material mass in the form of neutrons occurred. When the temperature dropped to 10^9° K, which was reached in a span of several minutes, and the density of radiation to a value of about 1 g/cm^3

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[4] S. Chandrasekhar and L. Heinrich, Astrophys. J. 95, 288 (1942)

[5] G. Gamow, Phys. Rev. 70, 572 (1946)

[6] Klein, Beskow, and Treffenberg, Arkiv. f. Mat., Astron. och Fysik 33B, 1 (1946)
Beskow and Treffenberg, ibid. 34A, 13 (1947)

[7] G. B. van Albada, Bull. of the Astron. Inst. of Netherlands 10, 161 (1946)
G. B. van Albada, Astrophys. J. 105, 393 (1947)

[8] F. Hoyle, Monthly Notices 106, 343 (1947)

[9] D. ter Haar, Am. J. Phys. 17, 282 (1949)

[10] R. Alpher, H. Bethe, and G. Gamow, Phys. Rev. 73, 803 (1948)

[11] R. Alpher, Phys. Rev. 74, 1577 (1948)

[12] R. Alpher, and R. Herman, Phys. Rev. 74, 1737 (1948)

[13] R. Alpher, R. Herman, and G. Gamow, Phys. Rev. 75, 332 (1949)

[14] G. Gamow, Phys. Rev. 74, 505 (1948)

[15] R. Alpher, and R. Herman, Phys. Rev. 75, 1333 (1949)

[16] R. Alpher, and R. Herman, Phys. Rev. 75, 1089 (1949)

[17] G. Gamow, Nature 162, 680 (1948)

[18] R. Alpher, and R. Herman, Nature 162, 774 (1948)

the first reaction began to take place, namely, that of capture of a neutron by a proton to form deuterium. The proton made its appearance by β-radiation from a neutron. This process of β-radiation from a neutron occurs not only at extremely high temperatures but also at much lower temperatures when neutrons are over-abundant in a nucleus.

In general, the lower-weight nuclei have small neutron-capture cross sections and relatively small proportions are hit by neutrons to be transformed into higher-weight nuclei. The result is that each element is much scarcer than the one next lower in weight. At atomic weights around 100, these cross sections increase at such a rate with increase in atomic weight that relatively large portions of existing nuclei are transformed into higher ones. By assigning suitable conditions it is possible to work out a theoretical distribution that fits the actual quite accurately over the range of known elements.

Calculations show this process to have occurred in a span of time 10^3 to 10^4 seconds long, by which time radioactivity of the neutron brought the process to negligible importance. During this period, and for a considerable time afterward, radiation mass was predominant and radiation pressure caused a very rapid expansion. In fact, it was not until a time of 10^7 years had elapsed that one-half of it had been transformed into matter. This process was probably similar to the formation of mesons today in the form of cosmic rays. At the time matter constituted one-half the total mass, the cosmogonical processes were influenced primarily by material mass. It was then possible for gravitational effects to operate in accordance with Jeans' law[19]. At a critical density and temperature, a mass of gas of a given diameter, or larger, began to break away from the surrounding gas and contracted into an astronomical body. This step could well be started by a statistical fluctuation in density within the body of gas. Details of this process have been worked out by Spitzer[20] and Whipple[21]. It is quite possible that dark nebulae represents such a process occurring at present. That this time of equality of radiation and matter density was the time of condensation into galaxies is suggested by the fact that when that point was reached, the universe went over into free expansion, and condensation would have become increasingly difficult after that[16].

Several additional facts support the theory of neutron-capture. The abundance of several heavier elements are somewhat greater than would be expected from a smooth abundance curve. Gamow[14] has pointed out that these particular isotopes have complete neutron shells in the nucleus and have an abnormally low neutron-capture cross section. There would be a tendency for isotopes to collect at these points, thus accounting for their abnormal abundances. On the other hand, the light elements lithium, beryllium and boron have abnormally low abundances. From proton-capture cross section data (see, for example, Bethe's article[22]) it is seen that these elements have unusually high cross sections in relation to the small size of the nuclei. Therefore it is to be expected that these elements would tend to be transformed by protons into higher elements. This process could occur for some time after termination of the neutron-capture construction period[23]. That the abnormally low abundances of the latter elements is observed not only terrestrially but throughout stellar media as well seems to recommend this theory over that of equilibrium methods using stars as the original generators of elements. In this connection it should be mentioned that the neutron density was too low for any capture to materially affect element distribution at resonance temperatures. This means the process was ended at a still very high temperature.

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[19] J. Jeans, Astronomy and Cosmogony, 1928

[20] L. Spitzer, Jr., Astrophys. J. 95, 329 (1942)

[21] F. Whipple, Astrophys. J. 104, 1 (1946)

[22] H. Bethe, Phys. Rev. 55, 434 (1939)

[23] R. Alpher, R. Herman, and G. Gamow, Phys. Rev. 74, 1198 (1948)

A few difficulties also appear, as pointed out by Alpher[11]. The elements containing 5, 8, and 11 nucleons are particularly resistant to neutron transformation. It was suggested that deuterium- capture might bridge the gap. Also, it might be questioned how the very-short-lived radioactive elements are bridged. It is possible that these elements did not become radioactive until one or more β-decays of neutrons took place. So it appears that neutron-capture offers a quite feasible explanation of the origin of the elements, granted a proper initial mass of energy. However, we naturally hestitate to put a stamp of finality to the process at this time.

A question comes up regarding Gamow's suggestion of the possibility[17] that this primordial mass of radiation and neutrons was the result of collapse of a previous universe. In other words, the universe may go through cycles of oscillation, collapsing to a primordial mass and expanding to great distances, finally to collapse again. Present data indicates, however, that expansion rates are such that the state of expansion is permanent. There appears to be no intention of the cosmic material to collect again. Therefore, it appears that the mass of radiation and neutrons at the beginning of the present expansion was a distinct creation at that time.

A further question is anticipated. On what basis is it stated that element-formation began several minutes after the initial appearance of energy? If the integral of the formation-rate curve is assumed to start at zero time, a singularity results -- it goes to infinity. Therefore, by adjusting the definite integral to the element-formation period with both limits as positive finite times, the curve approaches infinity at a time a few minutes earlier than the point of initial formation of deuterium[10]. This point is assumed to be the earliest limit of creation.

To the Genesiac exegete, present theories are refreshing in the implication of the sudden appearance of mass a finite length of time back. This could well be the creation of Genesis 1:1. The statement of this brief and general verse hardly requires limitation to an interpretation of creation of things in their present forms. Whether or not this theory is the correct interpretation of the Bible verse is, of course, impossible to determine. However, that new developments are compatible with Biblical cosmogony gives us further assurance that our faith in His Word is not misplaced.