Creation Research Society Quarterly

Haec credimus:
For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested on the seventh. — Exodus 20:11

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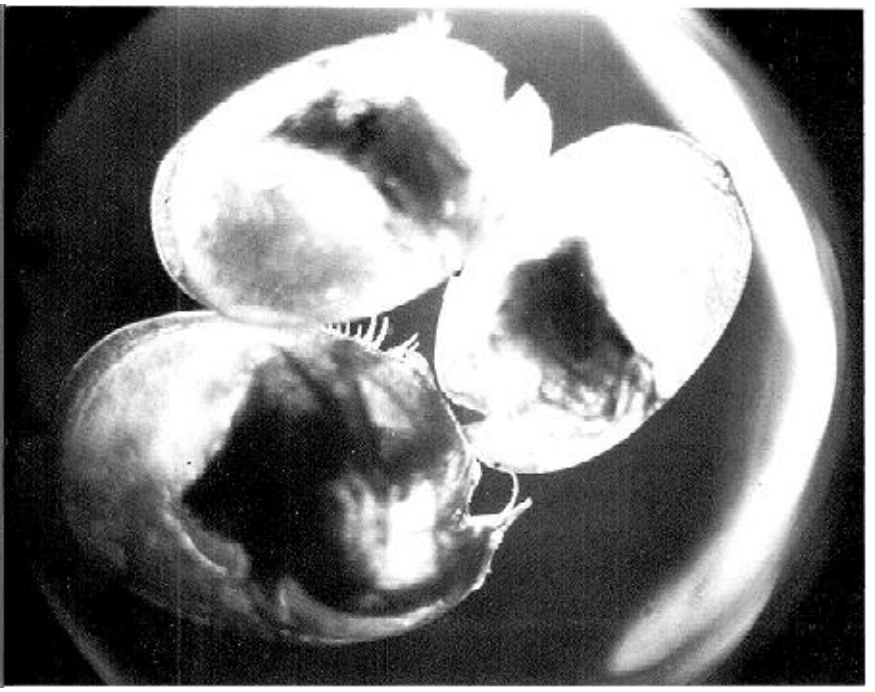
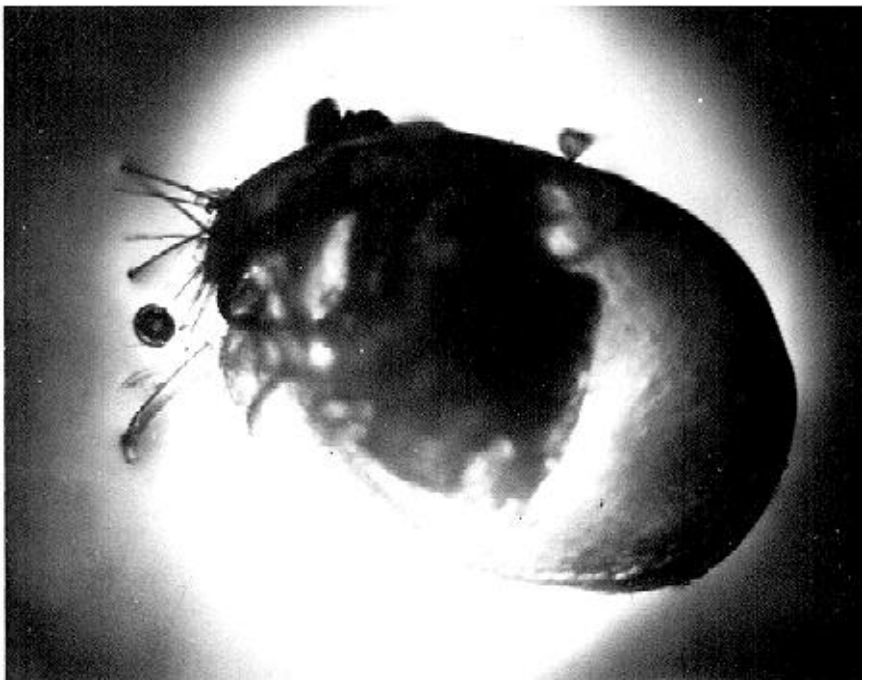


LUCIFER ON THE LOOSE

CYPRIDINA



BIOLUMINESCENCE

CREATION RESEARCH SOCIETY QUARTERLY

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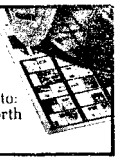

Cover Photograph

Photographs by Willis E. Keithley. For a "light" discussion on Lucifer on the loose or bioluminescence, see p. 131.

Letters to the Editor

MEMBERSHIP/SUBSCRIPTION APPLICATION FORM
CREATION RESEARCH SOCIETY

See the current *CRSQ* for membership information

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CREATION RESEARCH SOCIETY

History The Creation Research Society was first organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication, Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a real need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (with graduate degrees in science) and over 1100 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and now is recognized as the outstanding publication in the field.

Activities The society is solely a research and publication society. It does not hold meetings or engage in other promotional activities, and has no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund is maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. The Society operates two Experiment Stations, the Grand Canyon Experiment Station in Paulden, Arizona and the Grasslands Experiment Station in Weatherford, Oklahoma.

Membership Voting membership is limited to scientists having at least an earned graduate degree in a natural or applied science. Dues are $17.00 ($21.00 foreign) per year and may be sent to Glen W. Wolfrom, Membership Secretary, P.O. Box 14016, Terre Haute, IN 47803. Sustaining membership for those who do not meet the criteria for voting membership, and yet who subscribe to the statement of belief, is available at $17.00 ($21.00 foreign) per year and includes a subscription to the Quarterlies. All others interested in receiving copies of all these publications may do so at the rate of the subscription price for all issues for one year: $20.00 ($24.00 foreign).

Statement of Belief Members of the Creation Research Society, which include research scientists representing various fields of successful scientific accomplishment, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution), both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. In 1970 the Society published a textbook, *Biology: A Search for Order in Complexity*, through Zondervan Publishing House, Grand Rapids, Michigan 49506. All members of the Society subscribe to the following statement of belief:

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.

2. All basic types of living things, including man, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.

3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was an historic event worldwide in its extent and effect.

4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Saviour. The account of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Saviour for all mankind. Therefore, salvation can come only through accepting Jesus Christ as our Saviour.

Editor's Comments

Many interesting letters arrive at the Editor's desk. Some plead for less technical articles; others ask for more rigorous technical material. We will continue to provide a balanced diet in each issue.

Some have asked how the peer review process works. At the editor's discretion, manuscripts are sent to qualified readers who critique the paper. Names involved are kept confidential, a standard practice in peer review. The author is then notified whether the manuscript can be published in its present form, and reviewer comments are shared. The acceptance rate for manuscripts in the first reading is about 50%. Both authors and peer reviewers are to be thanked for their efforts to maintain the quality of the *CRSQ*.

Other letters from readers ask Creation-Science questions which yet need to be addressed in journal articles. People are looking for answers in all areas, from mountain building to Mars to mutations! Keep writing letters, and keep supporting the Society. The stronger we are, the better job we can do.

This issue begins a series of study articles on the constants of nature and their possible variation. Dr. Emmett Williams is overseeing this project, along with Dr. Eugene Chaffin. Initial response from writers and readers has shown that this area desperately needs to be addressed. Dr. Williams' article begins the constants mini-symposium with an overview of the subject. Watch it develop in future issues!

Don DeYoung, Editor

MINISYMPOSIUM ON VARIABLE CONSTANTS—I

SUMMARY OF THE SYMPOSIUM ON VARIABLE "CONSTANTS"*

EUGENE F. CHAFFIN**

In order to try to answer some important questions that seem to be puzzling creationists, Don DeYoung, Emmett Williams, and I organized a symposium on variable "constants." Variable "constants" is of course a contradiction in terms, but we use this terminology since physics may be incorrect in labelling some items as "constants." Emmett Williams provided an introductory article summarizing the *Creation Research Society Quarterly (CRSQ)* literature on the subject that has appeared to date. For readers who may not be familiar with the physics and mathematics of radioactive decay he gives an introductory discussion. He then covers Gentry's work on radioactive halos, along with thoughts on variable decay constants by Morton, DeYoung, Akridge, Chaffin, and others. The Setterfield emphasis on variable speed of light has been lurking in the background since the early 1980's, and some of the ideas that foreshadowed this, in articles by Harris and others, are reviewed.

Robert Herrmann is interested in nonstandard analysis and its application to mathematical philosophy. Nonstandard analysis starts with a rigorous treatment of infinitesimals more similar to Isaac Newton's original intuitive ideas than to the "modern" definition of limits, derivatives, etc. using epsilons and deltas (Jerome Keisler 1985, *Elementary calculus: an infinitesimal approach.* Second edition. Wadsworth) The article illustrates how the logic behind the nonstandard theory of infinitesimal changes can be used to support the idea of variable "constants," as well as to probe the limits of human model building. Readers may find the Bastin-Prokhovnik model of gravity to be instructive.

Donald DeYoung discusses the relations between the constants of physics including the gravitational constant, G, and points out the experiments and observations that so far have not given much evidence for G variation. The thrust of my paper is twofold. The first part presents an example of a theory which allows not only the constants, but the form of physical law to vary. The specific theory presented leads to an explanation of the redshifts in the light from distant galaxies. The second part points out some incomplete analyses of the Oklo natural reactor data which have been used to place unnecessary limits on the variation of the Coulomb force relative to the nuclear force.

Glenn Morton gives a comparison of the variable G, variable permittivity, variable permeability (speed of light), and related theories which are currently being considered by creationists. He discusses various problems that creationist theories need to explain and how the candidates fare in these respects. John Byl discusses objections, both on scientific as well as theological grounds, to the apparently bizarre idea of variable constants. None of the objections is found to be very compelling. Various models need investigation, since the unbeliever tends to set his own terms for acceptability, believers want to find God's answers, and multiple theories leave more opportunities to arrive at the truth.

Cam de Pierre uses a pragmatic approach to the decay of the speed of light idea, postulating an exponential form for this decay and investigating the numerical consequences. John Baumgardner cites evidence such as the differing characters of ocean floor sediments and the changing patterns of magnetic reversal data to support his contention that the fundamental constants of physics must have changed to allow continental drift to occur within the young Earth time frame.

Robert Brown discusses radiohalo evidence. Through noting that radiohalo diameters produced by a given nuclide were at least approximately the same throughout the ages, he suggests the severe constraints this places on the types of models that should be acceptable. Robert Gentry, who is the most accomplished experimental expert in the study of radiohalos, and

*Editor's Note: This series begins in this issue of *CRSQ* and continues in future Quarterlies.

**Eugene F. Chaffin. Ph.D., 715 Tazewell Ave., Bluefield, VA 24605.

the world authority in this area, offers his own view of whether the experimental evidence, and in particular the Geiger-Nuttal law, speaks in favor of variable decay rates. His article is a response to Brown's article in many respects, which I requested in order to clarify the issues involved. Alan Montgomery discusses the recent redshift and mass treatment in Barry Setterfield's privately distributed, unpublished "Atomic constants, light and time" manuscript of 90 pages. He finds contradictions in Setterfield's approach that may be difficult to handle.

MINISYMPOSIUM ON VARIABLE CONSTANTS—II

VARIABLES OR CONSTANTS? AN INTRODUCTION

EMMETT L. WILLIAMS*

Received 9 September 1989; Revised 28 September 1989

Abstract

The creationist literature, particularly from CRSQ, *is reviewed concerning proposals that the radioactive decay constant, permittivity of free space, or the speed of light changed with time. Questions involving extrapolation, predictability, symmetry and conservation are explored.*

Introduction

As one reads the *Creation Research Society Quarterly (CRSQ)* over the last 25 years occasional themes arise to the effect that certain quantities which are deemed to be constants in modern scientific theory actually could have varied since creation. Therefore at a recent CRS Board of Directors meeting, I discussed with Don DeYoung and Gene Chaffin the possibility of having a minisymposium in the Quarterly presenting the various views on whether radioactive decay constants, the speed of light and the permittivity of free space have changed with time.

Many scientists were invited to participate and several responded affirmatively. It is hoped that their contributions will be of interest and that the implications of "variable constants" will be explored. After reading over the various papers, if you have any thoughts to contribute, I urge you to write a letter to the editor on this topic.

It is my purpose to review some literature on the subject, mainly from *CRSQ,* and offer a few comments as an introduction to the minisymposium.

Radioactive Decay Law

It is assumed that the decay of a particular radioactive nucleus is a matter of chance since such factors as pressure, temperature and chemical surroundings are not supposed to affect the rate of transformation (Goble and Baker, 1971, p. 319). Also the probability of decay is assumed to be the same for all nuclei of the same species. For instance, the probability of decay of all U^{235} nuclei is the same regardless of external environment. Allow this probability of decay to be p. With the above assumptions, the only factor that affects the decay of a particular nucleus is time (t). If the length of time that a nucleus is "observed" is Δt, then

$$p \propto \Delta t \text{ or } p = \lambda \Delta t \quad (1)$$

where λ is called the disintegration constant which is assumed to be characteristic of the decaying nuclei.

*Emmett L. Williams, Ph.D., 5093 Williamsport Drive, Norcross, GA 30092.

Conversely the probability (p_1) of the "observed" nucleus not decaying in the time interval Δt is

$$p_1 = 1 - \lambda \Delta t. \quad (2)$$

Thus, the probability of (p_n) of the nucleus not decaying in the time interval $n\Delta t$ is

$$p_n = (1 - \lambda \Delta t)^n. \quad (3)$$

The total "observation" time (t) for n intervals is

$$t = n\Delta t \quad (4)$$

and equation 3 becomes

$$p_n = \left(1 - \lambda \frac{t}{n}\right)^n.$$

Let $\Delta t \rightarrow 0$ and $n \rightarrow \infty$; thus

$$p_t = \lim_{n \rightarrow \infty} (1 - \lambda t/n)^n$$

or

$$p_t = e^{-\lambda t} \quad (5)$$

becomes the probability of a nucleus surviving for a time t without decay. Multiply p_t by the number of original nuclei (N_0) and

$$N = N_o e^{-\lambda t} \quad (6)$$

where N is the number of undecayed nuclei at any time t. Equation 6 is referred to as the law of radioactive decay (Goble and Baker, 1971, p. 320).

Employing a different approach, the change in the number of nuclei because of decay can be written as follows

$$dN = -\lambda N dt \quad (7)$$

where N is the number of nuclei at any moment and dN is the number transforming in a time interval dt. The negative sign indicates that the number of nuclei remaining is decreasing. Equation 7 can be rewritten as

$$dN/dt = -\lambda N \quad (8)$$

where dN/dt is referred to as the activity of a decaying sample.

The half-life, $T_{½}$ (the time for one-half of the nuclei to decay) of a radioactive species can be derived as follows. Using equation 6, allow $N = N_0/2$ and $t = T_{½}$

then $N_o/2 = N_o e^{-\lambda T_{½}}$

and $\ln ½ = -\lambda T_{½}$ or

$$T_{½} = 0.693/\lambda. \quad (9)$$

The half-life is considered one of the chief characteristics of any type of radioactive nucleus (Goble and Baker, 1971, p. 321).

Commentary by Creationists

Gentry (1968, pp. 83-85)* in an early *CRSQ* suggested that the radioactive decay constant λ may have varied over geological time. He carefully outined the possibility that so-called fractures or blasting halos might be the result of a period where radioactive decay was greater than is observed today. In other words he asked, was there a time when $\lambda\Delta$ did not represent the probability of a single radioactive nucleus decaying within the interval Δt? Gentry (1968, p. 85) states:

> The isotropization of the host minerals would have occurred very rapidly due to an anomalous decay rate, and hence fracturing of the outer mineral would be expected.

DeYoung (1976, pp. 38-41) in a study sponsored by the Research Committee of the Society examined the possibility of variable nuclear half-lives. He noted that a variety of experimentors succeeded in changing nuclear decay rates several percent by various techniques (DeYoung, 1976, p. 39). The various effects are summarized as follows:

Chemical Effects
Bonding and valence effects
Stress in molecular layers

Physical Effects
Applied electric and magnetic fields
Applied pressure
Magnetic and electric ordering transitions
Superconducting transition
Temperature extremes

DeYoung (1976, pp. 39, 40) claimed that radioactivity should be influenced by incident cosmic radiation. He suggested that the wide differences in ages shown by lunar samples (which were supposed to be the same "age" as the Earth) could have been caused by cosmic ray or solar wind particles not opposed by a strong magnetic field as is present on the Earth. This excellent article contains many instances of possible variable radioactive decay rates and should be studied carefully and updated by a young-earth creationist. DeYoung (1976, p. 39), as if to caution creationists not to swing wildly to a view of a continual drifting of the magnitude of physical constants, notes that the Creator has established a stable physical universe (Psalm 89:2). Thus the ambivalence of a thoughtful creationist on the subject of this minisymposium can be seen in this treatise.

*This issue of *CRSQ* [5(2)] has several excellent articles on radioactive dating and the young Earth: Brown, 1968, pp. 65-68, 87; Cook, 1968, pp. 69-77; Whitelaw, 1968, pp. 78-83.

In discussing Gentry's work on radiohalos, Talbott (1977, p. 103) claims the reader's attention with one of three startling statements: "Current physical laws may not have governed the past." He (p. 104) continues:

> Whereas radiohalos have been thought to afford the strongest evidence for unchanging radioactive decay rates throughout geological time (and these rates enable scientists to determine rock ages), in actuality the overall evidence from halos requires us to question the entire radioactive dating procedure: something appears to have disrupted the radioactive clocks in the past.

Talbott (1977, p. 106) predicted that a storm would fall on Gentry because of his creationist interpretation of radiohalos. See Gentry (1986) for a verification of this prophecy.

Chaffin, in a series of two articles (1982, pp. 32-35; 1985, pp. 10-16) on the Oklo natural uranium reactor, attempted to interpret the known data within a young Earth framework. He carefully explained his postulates and assumptions, honestly offering alternates to his interpretations. Chaffin, in his first article (1982, p. 33), mentioned that decay constants may have been variable (based on Gentry's pleochroic halo work). In the later study (1985, p. 15), he suggested that the decay constant λ of various radioisotopes rose to a large value at sometime in the past, possibly at the Flood, then decreased exponentially to its current "stable" value. Chaffin claimed that if this increase in λ did occur, it would cause increased production of nuclei of mass numbers above 140 (particularly increased production of neodymium isotopes) which would offer another young Earth possibility for the Oklo data. This interpretation involves a variation of k_0 in Coulomb's law,

$$F = \frac{k_o q_1 q_2}{r^2} \quad (10)$$

where F is the electrical force (attraction or repulsion) between two charges, q_1 and q_2 separated by a distance r. The constant, k_0 is referred to as the electrostatic constant. For an interesting discussion of Coulomb's law, see Lobkowicz and Melissinos (1975, pp. 142-48).

In an article review, Chaffin (1986, pp. 118-20) discussed some of Hermann Weyl's work. (Chaffin referred to him as the ultimate relativist.) In a section headed "Time Variation of Constants" (1986, p. 118), Chaffin started with Newton's second law for a central force, modifying the equation so that it is scale covariant to allow for Weyl's postulate of "relativity of magnitude." A term, β, is introduced such that constants can vary with time (a scale transformation). "In the context of such a theory, β would be a slowly varying function of time" (Chaffin, 1986, p. 119). He offered a similar suggestion in his 1985 Oklo reactor paper; a transient episodal variation in β could have occurred at the time of the Flood.

Morton, *et al.* (1983, pp. 63-65) warned that any proposed model involving radical changes in radioactive decay rates would be faced with the possible release of sufficient quantities of heat to vaporize the Earth.* This letter to the editor demonstrates that creationists are concerned over both sides of an issue

and realize the necessity of constructing models that maintain a stable environment for man as promised by the Creator. However, keep in mind that God has caused changes in the natural world as a result of man's sin and violence-prone tendencies, i.e. at the Fall and the Flood.

Radioactive Decay—Perspectives

The so-called radioactive decay law is actually a rate equation and belongs in the realm of kinetics. For instance see Walas (1959, pp. 44-46) for chemical reaction rate equations of the same form as equation 8. Thus the decay constant λ is based on an observed rate of change in a particular situation. Often in the science of kinetics a wide gulf exists between theoretical calculations and the actual rate of change. Many circumstances can cause variations in the rate of reaction and the same may be true of radioactive decay.

Therefore creationists who suggest that the kinetics of today may not have been the same as that of a past era are not tampering with natural law in the sense of the uniformity of nature. A physical law may govern two different situations (one occurring at time t_1 and the other at t_2 where $t_2 > t_1$) but the rate at which its ultimate effects are observed can vary. No principle of nature is being altered, only the rate of the change involved. However caution must be observed so as not to violate good science and good sense.

Creationists assume that during the Flood and its aftereffects, the rates of sedimentation, erosion, etc. were accelerated. Likewise the rapid hardening of sedimentary layers envisioned during and after the Flood seem to have no modern analogy. Did this acceleration (increase in the rates of formation and/or rates of destruction) of certain natural processes (in an unnatural event) spill over into the rates of radioactive decay?

Considering the standard model for the formation of the universe, Weinberg, (1977, pp. 102-05) in a very readable popularization, claimed that nucleosynthesis began at 900 million degrees Kelvin (13% neutrons, 87% protons) and was complete in the interval from three to 35 minutes after the big bang, leaving helium and hydrogen! Later in the evolution of the universe, heavier elements would be formed in stars. See Wilt (1983, pp. 60-72) for a discussion of nucleosynthesis. The point is that the standard model has many amazing features that cannot be duplicated by present-day science. Thus in considering Gentry's proposal (1986) that the time between nucleosynthesis and crystallization of certain Precambrian rocks was quite short,* is some creationist speculation in order?

During creation, could not nucleosynthesis through the heavier elements followed by some radioactive decay** sequences have occurred within a brief period of time with fantastic energy release and removal during the formation of the Earth? Absolutely wild speculation, I confess. Nucleosynthesis in this framework is viewed as a process*** coupled with high available energy content overseen by intelligent design and purposiveness. The standard model speculation as well as the Biblical account of creation belong in the area of miracles. One is a naturalistic miracle, the other a supernatural one.

Some creationists may object to the speculation that some radioactive isotopes could have decayed during the creation week. They consider that when God overlooked His finished creation, He pronounced it "very good" (Genesis 1:31) this would preclude radioactive decay. Peterson (1982, p. 226) feels that radioactivity developed at the Fall and that the decay rates were higher then than at the present.

Permittivity of Free Space (ϵ_0)

It has been proposed that the permittivity of free space (ϵ_0) was changed miraculously by God during or after the Flood (Morton, 1982, pp. 227-32; 1983, pp. 219-24; 1987, pp. 53-58). The proponent of this view believes that an expanding Earth after the Flood would account for many features of the present-day Earth. The mechanism proposed to accomplish this expansion is by an increase in ϵ_0, the size of all atoms would increase, but different minerals would expand at different rates to cause the changes envisioned! Weaknesses in the expanding Earth hypothesis were explored in a question and answer exchange in the orogeny minisymposium (Waisgerber *et al.,* 1987, pp. 58-61).

Considering the relationship between the speed of light (c), permittivity of free space (ϵ_0) and the permeability of free space (μ_0):

$$c^2 = \frac{1}{\epsilon_0 \mu_0}. \qquad (11)$$

If ϵ_0 were 1676 times smaller than its present value (Morton, 1983, p. 222) and μ_0 remained constant, then:

$$c^2 = \frac{1}{\mu_0 \frac{\epsilon_0}{1676}}.$$

Since $\mu_0 = 4\pi \times 10^{-7} \frac{\text{N-sec}^2}{\text{coul}^2}$ and $\epsilon_0 = 8.85 \times 10^{-12} \frac{\text{coul}^2}{\text{Nm}^2}$ presently then

$$c = 122.7 \times 10^8 \text{ m/sec before the Flood.}$$

Then the speed of light before the Flood would have been approximately 41 times greater than it is today. Morton (1982, pp. 229-30) also relates his changing permittivity argument to radioactive decay constants claiming that a lower ϵ_0 would imply greater decay constants in the past.

The ϵ_0 constant appears in many of Maxwell's equations dealing with electromagnetic fields. When one is faced with either a changing ϵ_0, μ_0 (Morton, 1982, p. 23l)* or c then it is necessary to deal with differences in electromagnetic field intensities as well as energies

*Humphreys (1989c) suggests that since heat conduction is a slow process, most of the heat released by radioactive decay would still be present inside the Earth. Very rapid radioactive decay followed by only a few thousand years of heat release would not appreciably change the temperature distribution in the Earth Anderson (1981).

**Neilson (1977, p. 181) suggested that some radioactive decay could have occurred during creation week.

*For a recent exchange concerning aspects of this model, see Gentry (1989) and Wise (1989).

***I believe that creation occurred in six literal days by direct acts of God. The term process can be employed for anything physically occurring during a day of creation in an attempt to formulate a "scientific" model. The procedure is hazardous, fraught with extreme difficulty and prone to human error and ignorance.

*Morton implied that μ_0 could vary but he did not pursue the issue.

and effects of such fields when extrapolating into the past and comparing the past with the present. Examples of equations involving the constants ε_0 and μ_0 are as follows:

$$\mathbf{D} = \mathbf{e_0 E} \text{ in free space} \quad (12)$$

where **D** is the electric displacement vector and **E** is the electric intensity of the electrical field. Where matter is present ε is used in place of ε_0 such that:

$$\epsilon = k_e \epsilon_o \quad (13)$$

with k_e being the dielectric coefficient of the material. Thus:

$$\mathbf{D} = \mathbf{eE} \text{ in a linear medium.}$$

Likewise

$$\mathbf{B} = \mathbf{m_0 H} \text{ in free space} \quad (14)$$

where **B** is the magnetic induction and **H** is the intensity of the magnetic field. Where matter is present μ is used in place of μ_0 such that:

$$\mu = k_\mu \mu_o \quad (15)$$

with k_μ being the relative permeability. Thus,

$$\mathbf{B} = \mathbf{mH} \text{ in a linear medium.}$$

Interested readers wishing to delve into this topic could profit by employing a very readable textbook on the subject (Barnes, 1977) which includes some of the author's work on the decay of the Earth's magnetic field as well as his approaches to the unification of physics.

Other creationists have developed models that utilize electromagnetic equations involving ϵ_o, μ_o and c. Barnes'[a] and Humphreys'[b] concepts of the Earth's decaying magnetic field and Barnes'[c] and Lucas'[d] efforts to obtain equations for the unification of physics are examples.

Assume that ε_0, μ_0 and c do vary with time and suppose a person wishes to extrapolate back in time to determine magnetic or electric field strengths, etc., what magnitude of ε_0, μ_0, or c should he use? How can he be sure he is using a correct value? Will the predictions obtained from such a procedure be worth the effort?

Speed of Light

When one speaks on the topic of creationism and the subject of a young universe is introduced, when the session is opened for questions from the audience, someone often will pose the following problem. "If the universe is young, how is it that we can see stars that are millions of light years away from us?" Of course the assumption is the light was generated when the star formed and had to travel vast distances to be seen millions of years later on the Earth. Generally creationist replies-for the past 25 years can be categorized into dissertations on the speed of light or a possible smaller sized universe (Moon and Spencer, 1953; Akridge, 1984, pp. 18-22; Byle, 1988, pp. 138-40). I will discuss the speed of light reasoning only.

One solution is that when God created the light-bearing objects (stars—Genesis 1:14), He created the light reaching all points in the physical universe. Akridge (1979) in a very interesting paper, developed a theoretical framework for such a possibility. He proposed that when electrical charges were created, it was accomplished by having mature or fully-developed electromagnetic fields associated with the charges. He claimed that the demands of conservation of energy were fulfilled as well as having light visible in all points of the universe as soon as it was created.

> Order in the universe would not be threatened if the mature electromagnetic fields were created at the same time their charge sources were created. With the complete field present at the instant of creation, there are no expanding Coulomb regions causing discontinuities in the motion of other charges. Rather the field from each charge extends outward to all other charges at creation and therefore acts on them in a continuous manner after the creation event.
>
> The paradox of light from the distant stars is no longer a paradox. Light is an electromagnetic disturbance. Creation of the charges in the star would be accompanied by the creation of the mature electromagnetic field of the charges in the star. Unlike the evolutionary field, this mature electromagnetic field would extend throughout the entire universe at the instant of creation. Thus, the light from the distant stars would be created enroute from those stars at the instant of creation. Therefore, when one observes the light from a star one billion light-years away, he does not observe the light that actually left the star one billion years ago. Rather, he observes the light that was created enroute only a few thousand years ago. As strange as this concept may seem, it is required for an orderly universe in which energy is conserved. (Akridge, 1979, pp. 70-71).

Another solution is that the speed of light was infinite when the stars were created and decreased immediately or some time later to its present value. Harris (1978) proposed that the velocity of light was infinite at creation and it became constant, c, at the Fall. He speculated that at the Fall a boundary layer or bubble expanded away from the Earth into space at a velocity v where $v < c$. Outside the boundary $c = \infty$ and inside c was constant.

It may be instructive to graphically represent some of the possibilities of a decreasing speed of light without considering the expanding bubble concept. The Akridge model is visualized in Figure 1. Immediately at the creation of the stars ($t = 1$), light with a velocity c is seen throughout the universe. It could be argued that actually the speed of light was infinite at $t = 1$,

[a](Barnes, 1971, pp. 24-29; 1972, pp. 47-50; 1973, pp. 222-30; 1975, pp. 11-13; 1983a; 1984a, pp. 109-13; 1986a, pp. 30-33; 1989, pp. 170-71).
[b](Humphreys, 1983, pp. 89-91; 1984, pp. 140-49; 1986, p. 115; 1988a, pp. 130-37).
[c](Barnes, 1980, pp. 42-47; 1983b, pp. 208-12; 1983c; 1984b, pp. 56-62; 1985, pp. 186-89; 1986b; Barnes and Upham, 1976, pp. 194-97; Barnes, Pemper and Armstrong, 1977, pp. 38-46; Barnes and Ramirez, 1982, pp. 198-200, 235; Barnes, Slusher and Akridge. 1982, pp. 113-16; Pemper and Barnes, 1978, pp. 210-20).
[d](Lucas, 1987, pp. 127-32).

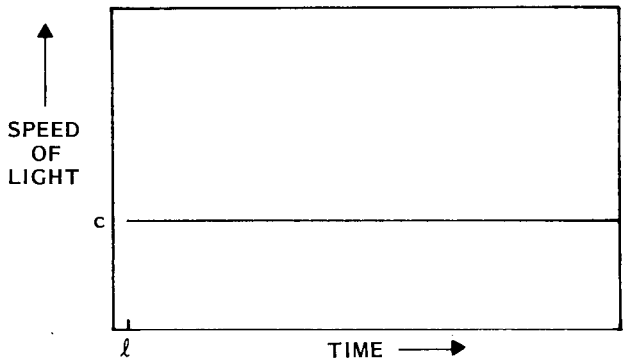

Figure 1. Akridge (1979) model for the speed of light. At t = 1, light is created and is seen everywhere in the universe with a speed, c. Drawing by Joe Whitaker.

immediately dropping to c as noted in Figure 2. Other possible models could be suggested to the effect that the decrease in the speed of light was not instantaneous but an exponential decay from some higher speed to its present value (Figure 3). Since the creation model of science contains two known supernatural acts that affected the physical world; the Fall and the Flood, some creationists may prefer to postulate changes in the speed of light developing at these two events (Figure 4). Different models could be suggested other than the ones I have offered, however I have listed these three to illustrate the point.

Many creationists believe that the speed of light has decreased from some higher value. However the so-called proof that such a decrease has occurred is open to argument (Aardsma, 1988, pp. 36-40; 1989a, pp. 208-209; 1989b, p. 30; Akridge, 1983, pp. 65-66; Bowden, 1989a, pp. 207-208; 1989b, pp. 32-33; Brown, 1988, pp. 91-95; 1989, p. 32; Holt, 1988, pp. 84-88; 1989, p. 68; Humphreys, 1988b, pp. 84-88; 1989a, pp. 30-32; 1989b, p. 33; Morton, *et al.*, 1983, pp. 63-65; Setterfield, 1983, pp. 66-68; 1984, pp. 210-11; 1989, pp. 190-97; Steidl, 1982, pp. 128-31). The concept of a decreasing speed of light is very attractive to creationists as is the hypothesis of decreasing radioactive decay rates, for they offer possibilities for young Earth interpretations.

Assume that the speed of light has decreased. What value does a scientist use if he wishes to extrapolate to a past date and make some calculations? Considering equation 11, if one desires to extrapolate some electromagnetic field calculations into the past, he is faced

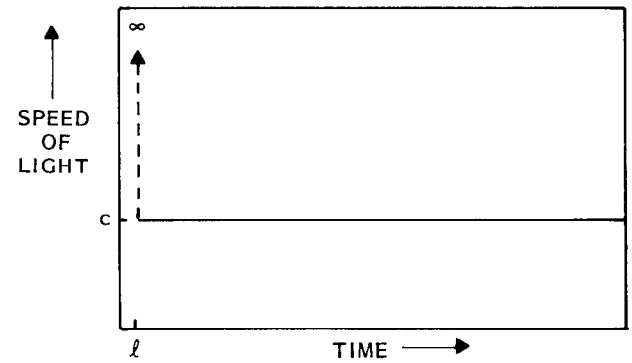

Figure 2. Speed of light is infinite at t = 1, instantaneously decreasing to c. Drawing by Joe Whitaker.

with a dilemma. If c has changed, it affects the magnitude of ε_0 and/or μ_0. Which is the correct value at a given past date?

Consequences of Variable "Constants"

It is necessary to discuss the startling consequences resulting from the assumption that a constant such as c or ε_0 can vary with time. Morton has not pursued very deeply his hypothesis of changing ε_0. However Setterfield has delved into his model to outline the adjustments that must be made by science to accommodate a changing c, thus I will use his work as an example.

Akridge (1983, pp. 65-66) pointed out that a changing speed of light construct violated the principle of energy conservation. Setterfield in his reply (1983, p. 88), stated that he needed more time to study Akridge's comments and toyed with the idea of either abandoning or restricting the principle of conservation of energy:

> Also, if it is admitted that things which have been supposed to be constant, such as the velocity of light, actually have varied, it may be that it is necessary to look a little more carefully at the various principles of conservation. Presumably conservation of energy did not apply right at the beginning of creation; maybe some thought is in order as to when it did begin to apply.

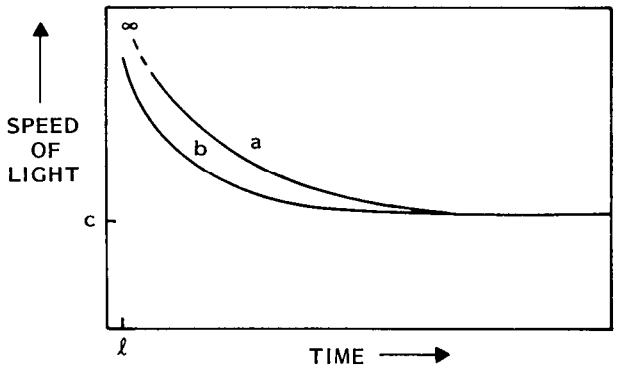

Figure 3. Possible models for a decrease in the speed of light with time. Drawing by Joe Whitaker.
a. Speed of light is infinite at t = 1, decreasing to a value of c.
b. Speed of light greater than c at t = 1 decreasing to a value of c.

By 1985 (pp. 210-11) Setterfield had tinkered with his model, deciding to maintain energy conservation. He developed a table (1985, p. 210) that reappeared in the Norman and Setterfield report (1987, p. 28, Table 12) to explain the adjustments that the principles of physics would have to make to accommodate a changing speed of light. Setterfield (1985, p. 210) claimed that Akridge's criticism:

> . . . resulted from a misunderstanding. The whole basis of the velocity of light (c) decay research has been to uphold the energy conservation laws . . . he is incorrect when he states that magnetic permeability would need to be constant for the magnetic energy to be conserved.

Setterfield then explained however that other constants in physics also would have to vary.

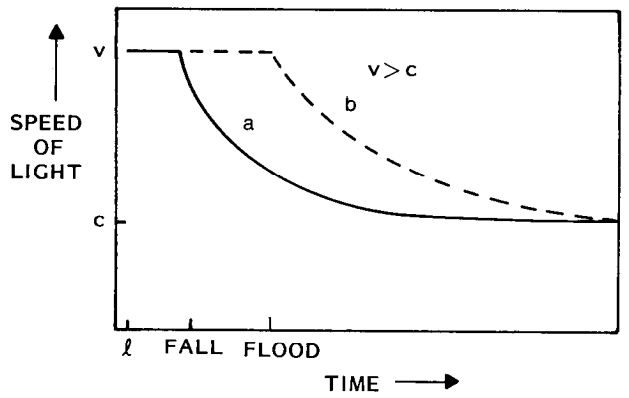

Figure 4. Possible models for a decrease in the speed of light with time in conjunction with the Fall or the Flood. Drawing by Joe Whitaker.
a. Speed of light begins to lessen at the Fall.
b. Speed of light begins to lessen at the Flood.

In 1983 Setterfield was perilously close to a collision with the symmetry concepts of physics, particularly the symmetry of time. Consider the following comments by Ford (1963, pp. 104-05):

> Symmetry of time is an obvious extension of spatial symmetry; the fact that nature's laws appear to remain unchanged as time passes is a fundamental symmetry of nature . . . The laws of nature are the same, so far as we know at all points in space and for all time . . . The chain of connection we have been discussing is: Symmetry → invariance → conservation.

However as Ford (pp. 104-05) notes:

> It might seem hard to visualize any science at all if natural law changed from place to place and time to time, but, in fact, quantitative science would be perfectly possible without the homogeneity of space-time. Imagine yourself, for example, on a merry-go-round that speeded up and slowed down according to a regular schedule. If you carried out experiments to deduce the laws of mechanics and had no way of knowing that you were on a rotating system, you would conclude that falling balls were governed by laws which varied with time and with position (distance from central axis), but you would be quite able to work out the laws in detail and predict accurately the results of future experiments, provided you knew where and when the experiment was to be carried out. Thanks to the actual homogeneity of space and time, the results of future experiments can in fact be predicted without any knowledge of the where or when.

In justice to Setterfield, he wisely chose to embrace the symmetry of time concept and thus maintain conservation of energy in his model. However Holt (1988, pp. 84-88) has questioned the conservation of rotational kinetic energy in relation to the consistency of pulsar signals within the framework of the changing speed of light model. Possibly Setterfield must adjust his concepts again?

To preserve conservation of energy with a changing c, several other physical constants must also vary. Some of these are listed with the particular pages from the Norman and Setterfield report (1987).

Permeability of free space	$\mu_o \propto 1/c^2$	p. 28	(16)
Atomic rest mass	$m \propto 1/c^2$	p. 31	(17)
Planck's constant	$h \propto 1/c$	p. 33	(18)
Gyromagnetic ratio	$\gamma \propto c$	p. 39	(19)
Radioactive decay constant	$\lambda \propto c$	p. 56	(20)
Thermal conductivity of a substance	$\kappa \propto c$	p. 57	(21)

If one accepts the thesis that a statistical "trend"* of the decreasing speed of light has been demonstrated, then one must abandon the constancy of the quantities illustrated in the proportionality relations 16-21. Next the problem of so many varying quantities must be faced. As one extrapolates into the past, all of the now-varying "constants" (with time) must change in *synchronization* with each other so that energy has been conserved at all times. Rather than being satisfied with proportionality relationships, exact curves for each quantity variation with time must be derived from the available data and extrapolated into the past. Any lack of synchronization of increase or decrease of these proposed variables (once constants) will violate conservation of energy principles. The quantities must increase or decrease with time in a regular manner together!

Then if all of these vastly complex changes can be arranged into a synchronized, regularly-varying network, Setterfield has only changed one set of constants for another set. All of the proportionality relationships (16-21) must be placed in equation form employing proportionality constants for it is "the constants that make the equations work." Then it would be advantageous to find physical meanings for the new constants. For instance the inverse product of ε_0 and μ_0 yields the speed of light squared in equation 11.

According to Norman and Setterfield, the decrease in the speed of light has stopped. If future measurements of the constants listed in relationships 16-21 "continue to increase or decrease," not in conjunction with speed of light, the symmetry of time principle will be violated. Of course *ad hoc* hypotheses can be developed to save the model but these will not be very satisfying except to those who wish to believe in the decreasing speed of light concept. I admire Setterfield for going into considerable depth with his model but he still has only investigated the tip of the iceberg. If he is correct the principles of present-day physics will have to be modified greatly.

Correlation of Proposed Models

Morton has proposed an increasing ε_0 in his model and the stipulation that μ_0 could vary whereas Setterfield has opted for a varying μ_0 with ε_0 as a constant. The two models are opposed to each other in this circumstance. Thus either Morton or Setterfield is correct or both are wrong.

Barnes, Humphreys and Lucas have developed models employing electromagnetic concepts assuming that μ_0 and ε_0 are constant (thus c is constant also). These models in their present forms cannot mesh with

*A statistical trend in a set of data is often in the eye of the beholder. One person can utilize a specific statistical method and "prove" that a trend exists, whereas another person can employ a different statistical tool and "prove" that no trend exists.

the ones proposed by Morton and Setterfield. Consider the models of the decreasing strength of the Earth's magnetic field (Barnes, 1971; 1972; 1973; 1975; 1984a; 1986a; 1989; Humphreys, 1983; 1988a) and the model of the decreasing strength of the planetary magnetic fields (Humphreys, 1984; 1986). Using these models, if extrapolation into the past is desired, how can one be sure that the calculated field and pole strengths are not a result of μ_0 varying rather than the interpretation offered by Barnes of greater field strength in the past? As hazardous as extrapolation is, not knowing what can and cannot vary, renders the exercise even more dangerous.

Also if the speed of light has ended its descent according to Norman and Setterfield, any possibility of verifying the change in speed of light model by future measurements is zero. But the models of the Earth's and other planets' magnetic fields can be checked with future measurements. Humphreys has obtained close agreement with his model from the recently-obtained Uranus data.

Conclusions

The variation of radioactive decay rates appears to be a substantial possibility. Other factors besides the speed of light may have greater effects on decay rates. This area offers possibilities for future creationist research. If the models offered by Morton and Setterfield are accepted, then major, if not total, restructuring of physical science theory would be necessary. Considerably more work is necessary and more evidence should be offered to demonstrate the feasibility of any decreasing speed of light model. Present physical science theory may be in need of repair but serious consideration should be given by everyone interested in science before such a leap into a new framework is contemplated.

Reflections

Lest someone think that creationists are merely tilting windmills and anti-creationists have their feet on solid ground, I offer the following quote by Jaki (1989, pp. 16-17).

> Whereas few physicists are willing to consider the possibility of fluctuating values for the speed of light, most physicists have been for some time entertaining something far more daring, if not outright foolhardy. With a few exceptions, they have been wallowing for the past two generations in an elementary philosophical fallacy while taking it for good science. For it is an elementary fallacy, a patent non-sequitur, to claim that a physical interaction that cannot be measured exactly, cannot take place exactly. It is a flouting of plain logic to rush from a purely operational situation, the inability to measure certain interactions exactly, to a situation where interactions do not take place exactly. The latter inexactitude refers not to the quantitative aspects of things, but to the ontological reality of those very things.
>
> If this elementary fallacy is ignored, one ushers in a world view in which all things, all processes, all perceptions are seen as resting on nothing, even if in place of the word "nothing" one uses the scientifically respectable word chance though it ultimately stands for nothing. One is in the presence here of the most radical flippancy conceivable; its object is no longer this or that fact, or situation, or custom, or belief, but the very ground of reality of existence.
>
> It would be tempting to blame physicists for the emergence of this frightening prospect within which no coherence can be claimed by anything. For even if the prospect is merely a possibility, it would give priceless support to those who on other grounds have already claimed that there are no objective, let alone absolute truths and norms. The support is priceless because it is provided by that very enterprise, science, which commands the highest premium in modern culture. It is in this light that one should appraise the countless declarations of physicists that causality, which is the very clue to ontological coherence in a world of change, has been shown by quantum mechanics to have no basic validity. The same holds true of presentations, again by countless physicists, of the theory of relativity as a proof that everything is relative.
>
> The real culprits are not physicists or scientists in general, but the philosophers. They should have been the ones to shout their heads off, a task for which they had, however, incapacitated themselves. Prior to the advent of relativity and quantum theory, the world of philosophy had only heads but no external and coherent things, that is, the kind of world which is called universe. For no external things forming an objective world but only minds thinking unto themselves were allowed to exist by Neo-Kantianism which ruled supreme in circles that still professed themselves to be philosophical. Philosophers with a sense for the real decided to appear as empiricist interpreters of science which was taken for an economical correlation of sense data and not for knowledge of objective reality.

Is it possible that the only constant in this world is the Creator Himself?

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MINISYMPOSIUM ON VARIABLE CONSTANTS—III

CHANGING CONSTANTS AND GRAVITATION

DON B. DEYOUNG*

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Abstract

Implications of variation in physical constants are discussed. Efforts to measure change in the gravitational constant are summarized.

Introduction

Some physical constants are not really permanently invariable. For example, the *Hubble constant* supposedly relates the speed of galaxies with their distance from Earth. However, the Hubble value is very uncertain and is changed drastically from time to time, sometimes by doubling or halving. The *solar constant* is a measure of sun power that arrives at the Earth's surface. Since the sun is somewhat variable in its light output, the solar constant varies continually on a small scale. Most other constants, from the electron mass to the Boltzmann constant, are measured to many decimal places and have always been assumed fixed. This assumption is seldom questioned, although it has recently been of interest to both creationist and secular scientists.

Implications

Table I summarizes the positive and negative sides to the issue of constancy in nature. From the Biblical perspective, one cannot argue dogmatically that the constants of nature should or should not vary. Scripture makes no explicit statements as to the constancy of light speed or gravity. In view of the overall deterioration of Creation, theological support is somewhat in favor of nothing being absolutely constant in nature. However, creationists need to be reminded of the seriousness and the implications of challenging science with respect to the values of basic constants. It should never be done lightly or in an *ad hoc* way to solve present problems. Most constants, including the speed of light, have been tested over many years of experiments. Creationists have grown accustomed to questioning mainstream science, and rightly so. In doing so, however, clear, strong unambiguous evidence needs to be present.

Table I. Summary of Ideas in Support of Changing Constants and Related Cautions (see article for explanation).

Perspective	In Support of Change	Caution
Biblical	Since the curse, the entire physical creation is degenerating.	The Creator upholds (bears, carries) all things by the word of his power (Heb. 1:3). The Lord does not change (Mal. 3:6).
Creation science	A slowing c solves several problems.	Not all implications of a changing c have been considered. A decreasing G, as a different example, would support the self-formation of stars in the past.
General science	Many constants are currently being checked for variation or modification: c, G, proton lifetime, etc.	Beware of joining the bandwagon of contemporary science.

c—speed of light; G—gravitational constant.

Gravitation

If one is looking for "variable constants," the universal gravitational constant G would seem a likely candidate. The value of G is remarkably independent of all the other physical constants, which typically form interconnecting sets (Cook, 1987, p. 71). That is, a change in value of the speed of light or the electron mass has consequences for several other constants. A variation in G, on the other hand, is not "locked in" to other physical constants. The constant G controls the force F of gravitational attraction between any two objects of mass m_1, and m_2, separated by distance d,

$$F = \frac{Gm_1m_2}{d^2} \qquad (1)$$

G was first measured by the English physicist Henry Cavendish, nearly a century after Newton had first announced the gravitational relationship in 1687. Cavendish used a torsion balance to detect small changes in the gravitational attraction between metal spheres. This method continues today with precision to four decimal places (Cook, p. 74),

$$G = 6.6726 \times 10^{-11} \frac{\text{newton} \cdot \text{meter}^2}{\text{kilogram}^2}$$

This value is less precise than most other constants, which are often known to six or more decimal places. The problem is that the local gravity force is very weak, and a torsion balance experiences competing forces from convection currents.

There are two chief reasons why theoretical science is in favor of a decaying G value. This does not simply refer to a change in local gravitational acceleration values due to density, or to some "non-newtonian" addition to equation (1). Instead, the reference here is to a basic universal variation in gravity. The *first* reason for support of change is that decaying gravity is basic to many theories of a slowly evolving universe, including some of the currently popular "grand unified theories" (Will, p. 202). The *second* reason is that a stronger gravitational attraction in the past

*Don B. DeYoung, Ph.D., is editor of the *CRSQ*.

could be responsible for the initial formation of stars and galaxies. Astrophysicists have always had difficulty explaining the presence of these compact objects in a universe which is dissipating, or "thinning out" (DeYoung, 1989, p. 76).

Experiments to determine a change in the value of G have thus far been unsuccessful. Methods include analysis of ancient eclipse data, and lunar laser-ranging experiments. Will lists 10 tests performed on G during the 1970's (Will, 1981, p. 203). Three of the results hint at a possible G variation of infinitesimal range, but other researchers have pointed out errors in these reports (Will, p. 203). The constant G has not cooperated in showing a decay that would be beneficial to either universal evolution or spontaneous star formation.

Conclusion

The search for a variation in the gravitational constant has proved negative. This has implications for current creationist thinking. If natural constants do indeed change, gravity should be one of the best candidates. Also, if a particular constant such as the speed of light does indeed change, others would also likely change. This is not the case for the universal constant of gravitation.

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PANORAMA OF SCIENCE

Lucifer on the Loose

When you excite *Cypridina,* Lucifer's on the loose.

Well, perhaps that needs some explaining; but the word to express it probably is not much help either. The answer to the riddle hides under the diabolical-sounding title of bioluminescence.

By the time you have waded through those six or seven syllables, no doubt you are ready to turn out the light. But that is what it is all about. Here is a beastie that can turn himself on, as that six-cylinder word refers to living organisms which can generate their own light.

And this one can light up even after it is dead. The tiny crustacean *Cypridina* illustrated on the cover lives in the ocean and is only about the size of a pinhead. Yet it has the unique property of providing its own light as it comes out to feed at night. This is accomplished by a chemical reaction triggered by an enzyme.

The shells of this amazing flashlight retain their light-giving quality even after being dried; they may be stored and kept for years, yet will glow with a soft blue light when moistened again. A cupful will produce enough light to read two paragraphs. In fact during World War II, Japanese soldiers used a handful of dried *Cypridina* to read their maps during blackout when conventional flashlights were too risky.

One of the remarkable aspects of this bioluminescence is the amazing diversity of organisms that have "developed" this bewildering ability to generate light. They include members of almost all the so-called "simple" animals and plants, such as clams, crustaceans, fungi and insects, to name just a few. Representatives of the evolutionary tree from amphibian up through mammal are conspicuously absent from this flashy fraternity.

Why has not man developed some kind of spotlight on his head to guide him in the night? Ludicrous? The beetle *Phrixothrix* has both head and tail lights! Surely man should be able to outdo some baroque bug. Evolution is supposed to progress from the simple to the complex, and here is a process that is far from simple. One of the criteria for the age and arrangement of the geologic column is the degree of complexity. Certainly *Cypridina* and its "simple" cousins should upset the strata. Dare we say that they could throw a lot of light on the subject?

Many of those animated sparklers use their unique beacon to aid in feeding or flirting; but for some, notably the bacteria and fungi, there seems to be no apparent purpose or necessity for this ability. The burning (no pun!) question of course, is why and how these seemingly naive organisms were able to compound some rather exotic chemicals to produce a cold light, plus a triggering mechanism to turn it on and off.

But the most acrid accent of that light is the chemical which is secreted to produce it. Ironically, it is called Luciferin, which means "brightness" or "light-bearer"—named after Lucifer who was Satan, the fallen angel of light that rebelled against God. With its enzyme luciferase, one molecule of luciferin will produce one photon of light. The genus *Cypridina* refers to Aphrodite, the licentious goddess of love and fertility. Thus we are reminded of a false light, typical of the Devil's deception. Satan's delusions are always counterfeit. This light substitute has no vital power of radiation and cannot promote life. Its only function in these animals is to perplex and confuse. It can only disturb and distract. Nor can we generate our own spiritual (or even scientific) light; it would only deceive ourselves as well as others around us; a deception which is amplified by rejection of God's light and revelation of creation.

Willis E. Keithley*

*1819 N.W. 25th, Lincoln City, OR 97367.

Evolutionism: Punctuational Gradualibria?

The evolutionist camp would seem to be divided into two major factions. There are those who continue to hold to the tenet of uniformitarianism, the notion that evolution has proceeded in small, gradual steps over vast periods of time. The opposing forces have proposed long periods of stasis for evolution, punctuated by short (in geological terms) dramatic changes. Such debate, however, would seem to be nothing more than a simple rehash of an old idea under a new label.

> On November 23, 1859, the day before his revolutionary book hit the stands, Charles Darwin received an extraordinary letter from his friend

> Thomas Henry Huxley. It offered warm support in the coming conflict, even the supreme sacrifice . . . But it also contained a warning: "You have loaded yourself with an unnecessary difficulty in adopting *Natura non facit saltum* ("nature does not make leaps") so unreservedly (Gould, 1977, p. 12).

If Darwin could legitimately be taken to task for his anti-saltational viewpoint, he would seem to have support for that view even today. At least one latter-day paleontologist seems to have adopted a similar position.

> . . . each sample of Cantius (an early Cenozoic primate) from successive stratigraphic levels is itself intermediate and transitional between earlier and later samples. There is relatively little change from one sample to the next, yet the net change over two million years or so of geological time is profound. Change here is so gradual that the boundaries between successive species are necessarily arbitrary. *Cantius rastoni* and its descendent C. trigonodus are linked by an insensibly graded sequence of intermediate transitional forms. (Gingerich, 1983, p. 142).

Yet, fellow paleontologists, who have just as much vested interest in the fossil record as Gingerich, did not agree with his findings. "We do not see the same unambiguous evidence for gradualism that Gingerich affirms." (Gould and Eldredge, 1977, p. 131).

Such instances of evolutionary infighting would seem to me to present a serious problem for those who promote evolutionism. Yet, if there is one characteristic that seems to be universal in the evolutionary scheme, it is plasticity. The "theory" of evolution can be accommodated even to contradictory testimony. Some evolutionists even seem to point to such contradiction with pride. "The lack of agreement and the changing hypotheses and theories in actual science are often treated by pseudoscientists [Biblical creationists] as if they constituted a weakness. They are its strength." (Pine, 1984, p. 14).

There may be any number of instances of evolutionist disagreement that can be classified as healthy debate. However, it would seem to us not to be the case in the testimony quoted above. When two evolutionist factions can view the same fossil evidence and arrive at diametrically opposed conclusions, We feel justified in questioning the claim of strength.

According to Pine, it would seem only an evolutionist may consider his lack of agreement with another evolutionist as a "strength." Many Biblical creationists have disagreed with evolutionists, but Pine gave them no such credit. Another example of evolutionist literary "strength" was provided by a well known biologist who explained why he accepted punctuationism. "Niles Eldredge and I . . . proposed the theory of punctuated equilibrium largely to provide a different explanation for pervasive trends in the fossil record." (Gould, 1981, pp. 36-37).

He further strengthened the evolutionary cause by gradually explaining to those who hold to the old Darwinian tenet, just where they went wrong.

> As a special term, methodological uniformitarianism was useful only when science was debating the status of the supernatural in its realm; for if God intervenes, then laws are not invariant and induction becomes invalid . . . The term today is an anachronism; for we need no longer take special pains to affirm the scientific nature of our discipline. Paradoxically, in suggesting that this term drop from use, we pay a most fitting tribute to its vital role in the history of geology (Gould, 1965, p. 227).

Yet, even in the "hallowed" halls of evolutionism, where dogmatism supposedly does not exist, it seems there will be found an old dogma which apparently will not be allowed 'natural' death. If God has indeed been eliminated from "science," the evidence of His intervention (catastrophism) remains and must be explained away. Still, at least one evolutionist ecologist seems to be unconvinced. "If scientists reject the principle of uniformitarianism, they can no longer do science." (Futuyma, 1983, p. 71).

When "science" can no longer be done without the inclusion of "an anachronism," we contend the boundary between healthy debate and flagrant, self-serving discourse has been crossed. It seems especially true in view of the admission that an anachronism was needed "to affirm the scientific nature of our discipline."

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Bill Crofut and Raymond M. Seaman*

*Catholic Creation Ministries, P.O. Box 997, Jordan, NY 13080.

New Evidence for Rapid Reversals of the Earth's Magnetic Field

A recent paper in *Earth and Planetary Science Letters* offers startling new evidence for a creationist view of reversals of the earth's magnetic field. The conventional evolutionary view is that a transition from one magnetic polarity to the other generally took millions of years, certainly no faster than thousands of years. Even small changes in the earth's field today are thought to be slowed down to a time scale of several years by the field's passage from the earth's core up through the earth's semiconductive rock mantle (Courtillot, 1984). However, at the 1986 International Conference on Creationism, I proposed that geomagnetic reversals took place very rapidly, with periods of days to weeks, during the year of the Genesis Flood (Humphreys, 1986). In the conclusions of that paper I suggested that a good test of my hypothesis would be "to look for strata which clearly formed within a few weeks and yet contain a full reversal," in particular,

"distinct lava flows thin enough that they would have to cool below the Curie temperature (500 to 700°C) within a few weeks."

To my delight, two geoscientists have examined such a basalt flow and found just such a polarity transition recorded in it (Coe and Prévot, 1989). Robert Coe, from the University of California at Santa Cruz, and Michel Prévot, from the Université des Sciences et Techniques at Montpelier, are respected paleomagnetists, well-known for their detailed investigations (along with a team of other geoscientists) of magnetic polarity transitions in the huge Miocene lava flows at Steens Mountain, Oregon (Prévot *et al.*, 1985). Coe and Prévot went back to Steens mountain and carefully sampled a relatively thin lava flow, number B51, at a point where their previous investigations suggested a rapid transition was likely to be recorded.

The seven flows stratigraphically above B51 are of normal polarity and the 10 flows below it are of reversed polarity. Numerous samples taken through the several-meter thickness of flow B51 show a bumpy but continuous transition from the reversed polarity below to the normal polarity above. Using a simple model of heat conduction, Coe and Prévot calculated that flow B51 "would cool to 500°C or below in about 15 days." Since magnetic grains in the basalt would "freeze" their magnetizations at about that temperature (Humphreys, 1988), this means that the transition had to be made in less than a fortnight. Coe and Prévot comment: ". . . even this conservative figure of 15 days corresponds to an *astonishingly rapid rate of variation of the geomagnetic field direction of 3° per day"* [my italics]. The authors acknowledge that such a rate is hard to believe:

> The rapidity and large amplitude of geomagnetic variation that we infer from the remanence directions in flow B51, even when regarded as an impulse during a polarity transition, *truly strains the imagination* [my italics].

As a result, they carefully consider a number of alternate explanations, but decide that the most straightforward interpretation explains the data best:

> We think that the most probable explanation of the anomalous remanence directions of flow B51 is the occurrence of a large and extremely rapid change in the geomagnetic field during cooling of the flow, and that this change most likely originated in the [earth's] core.

Are Coe and Prévot correct? As far as I can tell from their paper, their work is very meticulous and quite thorough. A recent commentary on the paper in *Nature* is cautiously favorable to their interpretation (Fuller, 1989), even though its author appears to be hoping that some alternative explanation will eventually emerge which will relieve him from the implications of rapid reversals. If Coe and Prévot are correct, we can infer two important facts about the earth at the time when this Miocene lava was flowing, a time which most creationists would place during the latter part of the Flood year, or soon thereafter. First, the earth's mantle had to have been at least 4 to 5 times less electrically conductive than it is thought to be today, or such a rapid change could not have been observed. Second, some physical process was at work in the earth's core which could produce very rapid reversals of the earth's magnetic field. I have been making good progress on a theory of such a process, which I hope to outline at the 1990 International Conference on Creationism.

However, with or without a theory, the most important implication relates to the geomagnetic time scale. The magnetic field change recorded in flow B51 was about 50,000 times faster than the 2000 years previously thought to be the theoretical minimum time for reversals. According to the conventional time scale, it was millions of times faster than the shortest reversals actually recorded in the geologic strata. If all recorded reversals occurred as fast as the one in B51, or even thousands of times slower, then the age of the geologic strata would be much less than billions of years. Thus this data is important new evidence for a young earth.

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D. Russell Humphreys*

*9301 Gutierrez, N.E., Albuquerque, NM 87111.

Origin of Mountains

Introduction

I have been rereading the articles* on mountain-building (Morton, 1987; Northrup, 1987) and would like to point out some facts that were not covered. For years geophysicists pondered the problem: How could great mountain ranges maintain their altitude against the enormous force of gravity? The answer was determined by extensive research into the movement of earthquake waves through the earth's crustal rocks. Continental mountains were found to have great "roots" which plunge deep into the magma beneath them (Scheidegger, 1982, p. 55). The displacement of magma serves to support the mass of the mountains, just as the hull of a ship displaces water to support its weight. Basically, mountains float freely on the magma, with no tendency to sink. Of course, they have been subjected to many other forces which have caused faulting, uplift, volcanism, intrusions of magma and numerous other effects.

*Editor's Note: The following articles were in the minisymposium on orogeny: Howe, G. F. 1987. Mountain moderated life: a fossil interpretation. *CRSQ* 24:9-12; Nash, K.A. 1987. Mountains and leeside climate: an indicator of change. *CRSQ* 24:12-14; Morton, G. R. 1987. Mountain synthesis on an expanding earth. *CRSQ* 24:53-61; Patten, D. W. 1987. Mountain—a tidal (astronomical flyby) phenomenon. *CRSQ* 24:61-69; Northrup, B. E. 1987. Mountains, meteorite and plate tectonics. *CRSQ* 24:125-29; Waisgerber W. 1987. The mechanics for mountain building from a creationist perspective are not yet understood. *CRSQ* 24:129-36.

What is important here is that orogeny is not a simple affair of pushing or pulling part of a continent to a higher elevation than the surrounding land. Any theory of mountain building must provide not only for the elevation of the surface but also for the construction of crystalline rock for many miles beneath the average depth of the continents.

The crust of the earth is a truly amazing combination of thicknesses. Seismic studies of the ocean floors disclose a thickness of four to six km, roughly three miles (mi). The average depth of the continents is 18 to 20 mi. However, the total for great mountain ranges, from the tops of the mountains to the depth of the "roots" may be as much as 40 mi. This indicates that while mountains may rise as much as five mi above sea level, the "roots may extend as much as 15 mi below the average continental thickness. These might be called "inverted mountains," but more vast by far than those we see.

These facts indicate a specific reason for each thickness. Continents must have great depth in order for the surface to be above sea level. They maintain elevation by displacing magma, only on a much broader scale than mountains. The relatively thin under-ocean crust would provide little flotation, indicating lower elevations. Water would tend to gather in these areas, loading and depressing the ocean floor until it reached equilibrium with the continents.

There are some circumstances where historical facts are also scientific facts. Genesis 1:9 states, "And God said, 'Let the water under the sky be gathered to one place, and let dry ground appear' " (NIV). The creation of great thickness of continent and a thin layer for the oceans assured this result. How are we to regard the great "roots" under the mountains? I believe that they are also a part of creation, because they are necessary to maintain elevation. These roots must be subject to intense heat both due to pressure from above and magma around and underneath. What maintains their crystalline structure is a mystery to me, but I do not question the ability of scientists to detect these structures. Furthermore, I do not wish to minimize the enormous and drastic modifications which have affected the original mountain ranges, but it is possible that the difficulty geophysicists have experienced developing theories of orogeny is because they are unwilling to admit that the "roots" are an essential part of the structure of mountains.

There are, however, great mountains in the oceans, the mid-ocean rifts, which have no roots. The strata under the ocean are about three mi in thickness, but the mountains are formed because the floor rises as the rift is approached. The rocky crust does not thicken; it is simply elevated for an average width of 1500 to 1600 km with average height at the rift of about three km (Scheidegger, 1982, p. 20). It is supported only by magma. Could this be called "displaced magma?"

Contrary to the facts about mountains on the continents, the mid-ocean rifts give every indication of being elevated after creation. If the floors of the ocean were originally more or less flat, it would take an enormous force to fracture 40,000 mi of mid-ocean rift and elevate it to its present position. If this occurred, magma or lava would flow out and roll down both sides. Oceanographers have confirmed this, but one of the most striking proofs is that, as the ocean floors rose, the diameter of the earth, at that point, would increase. Since circumference increases more than three times as rapidly, the edges of the rift would be stretched and break into fractures perpendicular to the rift. These fractures are still a very prominent feature of the mid-ocean rifts, often extending from 100 to nearly 1000 mi on each side of the rift.

Cause and Effect

If we consider the elevation of the ocean floors as an effect, then we are ready to look for a cause which is capable of making these great changes. Let us examine cause and effect on a small scale that we can easily understand. If we squeeze a basketball a few inches in a hydropress, it does no harm, but the internal air pressure increases. If, however, we fill it with liquid, since liquids do not compress a slight squeeze will displace some liquid, causing the cover to expand. Additional pressure will cause the cover to burst. The essential fact is that a sphere has no place for *displaced* liquid, unless the outside is elastic and can stretch.

Can we apply the same cause and effect to the earth? Information on this subject comes from the science of geodesy, which is the study of the size and shape of the earth. In general, it bulges at the equator and is slightly flattened at the poles. When satellites began to orbit the earth, geodesists were thrilled with the fact that the precise tracking of satellites would provide extremely accurate information on both the size and shape of the earth. They found that the earth is slightly "pear-shaped" (Wilson, 1961, p. 86). There are two depressions of the crust in the Northern Hemisphere. One includes part of the north-eastern United States and the eastern part of Canada and is centered on Hudson Bay. The other is centered on the eastern shore of Sweden at the Baltic Sea. The existence of the Baltic Sea is partly dependent on this depression. Geologists have known of these depressions for many years, but one of the most interesting facts is that both of these depressions are rising as the earth slowly returns to a spheroidal shape (Scheidegger, 1982, p. 44).

It was not until scientists were able to track satellites that they discovered that the Antarctic continent was depressed. Now if these depressions are effects, what was the cause? Geologists, particularly those specializing in glaciology, believe that these depressions were caused by the immense weight of ice caps in these areas.

The Massive Antarctic Ice-Cap

There has been heated debates for many years about the reality or the extent of the northern ice cap. However, there is little room for argument about the ice cap in the Antarctic; ice exists to depths of 10,000 ft or more.

A calculation of the amount of Antarctic ice is given by Flint, a glaciologist. His estimate is 23,450,000 km^3 or 5,625,000 mi^3 of ice cap still on earth today (Flint, 1971, p. 84). The total area enclosed by the 48 contiguous states of the U.S. is slightly less than 3,000,000 mi^2. The ice on the earth today is therefore sufficient to cover the entire 48 states to a depth of *nearly* two mi. Flint discusses glacial-isostatic deformation at considerable length (Flint, 1971, pp. 343-66).

In view of such facts, is it surprising to find that certain continental areas have been depressed by great quantities of ice? When continental areas are depressed, however, *magma must be displaced.* This initiates a cause and effect series which is not difficult to determine. If the first effect is the elevation of the ocean floor, the next effect is the displacement of ocean water. It has only one place to move; onto the continents.

Consider a balance scale, for example, with five one-pound weights on each side. If one weight is moved to the other side, the *difference* becomes two pounds. Likewise if before the breakup of the ocean floors the continents and oceans were in approximate balance, the transfer of water from ocean to continent would change the relationship drastically. The continents would begin to sink, displacing more magma, which would further elevate the ocean floors. Genesis 7:11, ". . . the same day were all the fountains of the great deep broken up . . ." (KJV). Genesis 7:19, ". . . all the high hills under the whole heaven were covered." Furthermore, God says in Job 38:8, "Who shut up the sea behind doors when it *burst* forth from the womb . . ." (NIV).

Continents are High Plateaus

In the recent minisymposium on orogeny Waisgerber (1987, p. 135) made some important comments. He stated, "The Flood does not explain why alleged turbulent energy of waves heaped sediments on continents, which are for the most part above sea level. If the Flood was so vigorous, would not the turbulence have directed sediments to the bottoms of oceans, which are below sea level?"

Creationists have ignored this problem far too long. All of our experience indicates that sediments are scoured from high elevations and deposited in the lowest *available* elevations. Today, continents are 10,000 ft. and more above ocean floors. Yet a high percentage of continental sediments contain marine fossils. If continents sank below sea level at the Flood and ocean floors were elevated, we could expect sediments and fossils to be deposited on the lowest elevations *at that time.* When secular geologists find great deposits of marine fossils, they do not hesitate to say, "This area was at one time below sea level."

A Raft in a Frozen Pond

Let us use another simple analogy to examine the effect of ice caps. If we consider a raft made of a few logs tied together, we know that any weight placed on it will cause it to sink until water equal to the exact same weight is displaced. However, continents are not free-floating rafts because they are part of the rocky crust of the entire earth. So they are more like a raft frozen in a pond. We know that a great deal of weight may be placed on the raft and it will not sink as long as the water is totally covered with ice. The water supports the raft but if the weight becomes too great, the water will apply upward pressure on the ice until it breaks. Then, of course, the raft quickly sinks.

From this analogy, it appears that continents might sink rather suddenly. This would displace such massive amounts of magma that enormous force would be applied to the rifting and uplift of the ocean floor. Some understanding of this force may be obtained by examining what happened at the Eastern Pacific end of the rift.

In the North Atlantic, the rift runs northward through Iceland and across the Arctic Ocean, but stops at the Siberian coast. In the Pacific the rift passes between Australia and New Zealand on the north, and the Antarctic to the south. East of New Zealand it immediately turns north-eastward and heads directly towards Mexico. The mainland of Mexico has a great mountain range, with its associated "roots," so the rift was not able to penetrate. Instead, it turned north into a weak spot, the Gulf of California. Even though this is a thin part of the continent, it still may be 15 mi of solid rock. This formed no barrier whatsoever to the splitting force which attacked it, for it continued for several hundred miles through California in the form of the San Andreas Fault (Flint, 1974, p. 359). This fault is a part of the mid-ocean rift system. It has fractured two mountain chains, and two interstate highways take advantage of this fact. The faulting and subsequent erosion opened Cajon Pass for Interstate 15 through the San Gabriel Mountains near San Bernardino. The fault continues westward along the northern edge of these mountains until it turns northwest and bursts through the Tehachapis to the San Joaquin Valley. It also provides Tejon Pass for Interstate 5 at an elevation of about 4100 ft. The Tehachapi Mountains are a substantial range, the lower end of the great Sierra Nevadas. They probably represent a crustal thickness of 30 to 35 mi, still no barrier to the enormous tensile, splitting force which was available.

Far from being subdued, the faulting continued along the Coast Range at the west side of the San Joaquin, north past San Francisco some miles and then plunges straight west into the Pacific again for about 1000 mi, as the Mendocino fracture zone. At every weak place on the ocean floor, magma burst through and built a volcano, of which there are several hundred. Only a few of them, such as the Hawaiian Islands, ever reached sea level. Most of these were unrecognized until oceanographers systematically mapped the ocean floor. This massive internal pressure may also have caused some of the intrusions found on the continents.

Gradual Emergence of Continents

Facts have been presented to support a rapid sinking of the continents. Recovery, however, probably occurred much more slowly. It may also have been uneven, i.e., continental areas with no ice could rise much more readily than those still covered. The immense quantities of magma which flowed from mid-ocean rifts would have an enormous heating effect on the ocean waters. Thus, any ice which extended over the ocean could melt fairly quickly. Melting on the continents would surely be much slower. It seems quite probable, therefore, that these changing forces would bring about great tectonic movements. If we recognize that the most important aspects of the Flood were the sinking of the Continents and the elevation of the ocean floors, we can understand the deposit of great bodies of sediment on the continents. By the same token, the melting of the ice and the gradual uplift of

the continents, over a period of many years, must have caused substantial "reworking" of the surface of the continents.

It appears to this writer that enormous, irregular earth movement must have taken place. This is the very force that can generate widespread and powerful "tsunami" type of waves. These are not efficient for the deposit of sediments, but they are the very type of movement which could rework previous deposits. It is mostly the results of such movement which present-day geologists are able to examine.

Waisgerber (1987, p. 130) points out that one flood year cannot provide for all the varied and puzzling aspects of geology. Creation scientists have recognized that following the Flood, very substantial geologic effects of the ice caps may have lasted for 100 years or more.

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James Honeyman*

*28999 Los Angeles St., Shafter, CA 93263.

Anthropology, Bone Munching and Science

Gnawed Bones

In an interesting note in *Nature* Sutcliffe (1973, pp. 428-30) described how bones and antlers gnawed by Norwegian reindeer and Scottish red deer could "resemble human artifacts and have sometimes been mistaken for them" (p. 428). It was thought that this bone munching by herbivores was a symptom of phosphorus deficiency. The author noted that the "chewing of bones by artidactyls is widespread" (p. 428) and many examples were offered to substantiate the claim (pp. 428-29).

One is tempted to speculate as to how many anthropologists may have been misled by gnawed bones when studying some site previously occupied by early man. One instance was given by Sutcliffe (p. 430). In one of his figures Sutcliffe (p. 429) showed a reindeer metatarsal that had been munched by Norwegian reindeer until it resembled a fork with a zig zag pattern on the proximal end (Figure 1). If a scientist were anxious enough to "discover" human artifacts at a site, a good case could be made that some ancient man carved the fork during his leisure time for an ornate tool or an object for his religious needs.

Philosophical Problems

It is not my intent to pounce on anthropologists and rail against them. However this interesting example

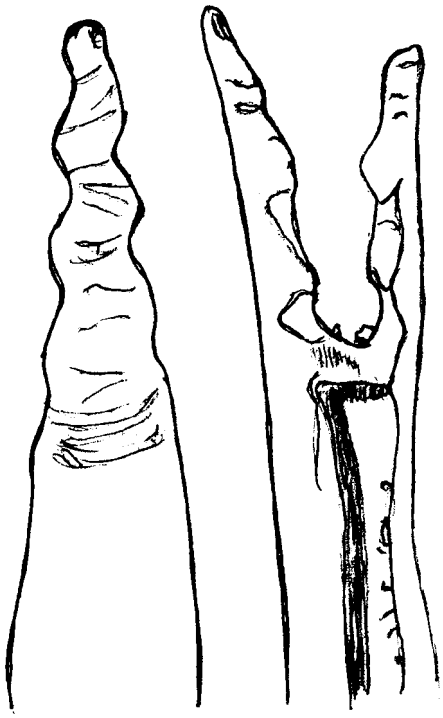

Figure 1. Sketch of metatarsal gnawed by wild reindeer generating a fork with a zig zag pattern at its proximal end. Photograph may be seen in Sutcliffe, 1973. (1.24x magnification)

brings to mind the problems involved in scientific work when postulating a past event or extrapolation into the past based on existing evidence. If the scientist was not there to observe *exactly* what happened, the available evidence could be juggled by him to fit his preconceived notions i.e., a carving by ancient man rather than a gnawed bone.

Ascribing fossils found in sedimentary layers to some macroevolutionary sequence and the observation of red-shifted light for some star as evidence of a primordial explosion are examples of hypotheses consisting of 0.01% evidence and 99.99% sheer speculation. Nothing is wrong with this game playing in science, but when it is offered to the layman and the educational establishment as fact and the only possible interpretation of origins, it becomes a travesty beyond imagination.

Itching Ears

Many ideas based on the smallest threads of evidence have been promulgated by scientists and yet are often readily accepted by other scientists without any hesitation. For instance evolutionists may believe their peers unreservedly and creationists may believe each other without proper investigation into the hypothesis being proposed. Basically each group has "itching ears" to listen to only what they wish to hear.

I have read anticreationist arguments against creationist concepts that are completely flawed yet they are accepted and passed on by other anticreationists as THE answer to creationist "foolishness." Also creationists often accept an antievolutionary proposal only to discover later that it was flawed and not as conclusive as first thought.

Skepticism

All scientists need to develop a very healthy skepticism when dealing with models that require endless speculation or inflation of the most meager evidence to world-view proportions. Caution should be exercised when presenting any hypothesis. Peer review should be encouraged. Let us not "fall in love" with our models so that we cannot detect or simply refuse to see their flaws. Let us promote our models with large doses of humility and skepticism, something lacking in science today. After all, humans are prone to error.

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Emmett L. Williams*

*5093 Williamsport Drive, Norcross, GA 30092

Noctilucent Clouds

In the latitudes from about 50 to 70° in the summer time (June to August in the Northern Hemisphere) special forms of cloud are often seen. They are called 'Noctilucent' or 'Night-Glowing' clouds. It is not immediately obvious that these are unusual clouds. However they are much higher than most, at an altitude of 80 km. The next highest clouds are Cirrus Clouds which attain a maximum altitude of 13 km. Because of their great altitude Noctilucent Clouds can be seen long after sunset. When the sun is from 6 to 16° below the horizon it can still be seen at an altitude of 80 km and it will light up any clouds that are there. Such Noctilucent clouds can cover an area of up to three million km^2 and may last several hours. Even below a latitude of 50° they are sometimes seen for several hours. They are very obvious because they are seen against a dark sky.

In the Ionosphere, where noctilucent clouds occur, the temperature is at a minimum, about -100°C. Both above and below this altitude the temperature will increase. Above 85 km the sun's radiation ionizes the air, charging it electrically and heating it as high as 1,750°C. Below this the ozone layer converts ultraviolet light intercepted from the sun into heat energy, and it heats the air to about 25°C. At this altitude, 25°C is above the boiling point of water. For this reason, if any liquid water or ice exists in the center region, it is trapped. If it moves downward, it will evaporate and rise again. This is somewhat similar to the model of the pre-Flood canopy of water.

If water droplets, dust or other tiny substances are ejected to altitudes of about 30 km and higher (the upper stratosphere), it will move through the ozone layer at 50 km and on to the Ionosphere where the air is electrically charged. This takes about two years. Noctilucent clouds were first seen in 1885, in Germany. They have been seen frequently ever since, but no clear records exist of their detection before this time. This is true even though we know from other records that observations were made of the areas of the sky that would have shown these clouds, had they been there. Two years earlier a major event occurred that could have initiated the Noctilucent clouds (Anon., 1989). The island volcano Krakatoa exploded on August 26-27, 1883. Australians heard the explosion 3,500 km away. Winds (pressure waves) from Krakatoa were recorded around the entire world. Twenty km^3 of rock were thrown into the air, along with a tremendous quantity of ash and water vapor. Nearly half the island vanished in the explosion. The water vapor and ash particles took two years to reach the Ionosphere, and may have formed Noctilucent clouds at just the time that they were first seen. Rocket-borne instruments have established that the clouds are composed of particles about 0.1-0.3 microns in diameter. They are probably meteor dust particles, or dust from the Krakatoa explosion. The particles themselves are too small to reflect sunlight, but many of them have crystallized water vapor surrounding them.

For many centuries, even though reputable scientists have made observations in areas where Noctilucent clouds should have existed, they were not seen. We can assume from this that they were not there. It required a catastrophe to place water (frozen, liquid or vapor) at this altitude. Once there it stayed for over a century in the form of clouds, and they are still there today. Good science requires that the simplest explanation that fits with the facts is probably the correct one. The simplest explanation in this case is that once water is placed at this position in the Earths atmosphere, it stays there, barring a catastrophe. The most popular model of the ante-diluvian atmosphere is that of a water canopy surrounding the Earth at high altitude. Noctilucent clouds show that such a model not only can exist, but to a lesser extent it still does. Creation science is once again shown to be a science that can postulate a model, then test it. In this case the model is supported by the evidence gathered from observational atmospheric science.

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David M. Harris*

*19 Orleans Drive, West Hill, Ontario M1C4T1, Canada.

QUOTE

The second feature to be noted about Buridan's statement is that it implies the notion of autonomous laws of nature. Once God gives motion to the universe, the universe keeps it and keeps acting in accordance with it. In other words, the proper idea of creation secures the notion of a nature acting consistently with the laws given to it. It is this consistency which is presupposed by all physicists as they do their research.

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STATISTICAL ANALYSIS OF C AND RELATED ATOMIC CONSTANTS

ALAN MONTGOMERY*

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Abstract

The Setterfield thesis that the speed of light (c) has decreased over time is examined from the perspective of Statistical Hypothesis testing. The Student's t test, the Mean Square Successive Difference (MSSD) test and the Run test show strong support for time variance not only for 'c' data but also for c-dependent quantities. No support is found for time variance of c-independent quantities. An examination of statistical work of T. Norman, G. E. Aardsma, D. R. Humphreys, and R. H. Brown reveals some weakness in the statistical supports for their arguments. In addition, some comments are made regarding considerations of Setterfield's theory.

What is Statistical Hypothesis Testing?

Statistical hypothesis testing involves making decisions about a population based on sampling from that population. In particular, it is a technique used to determine the plausibility of some specific statement about the population. The test requires two mutually exclusive hypotheses; H_0: the statement about the population is false (This is the Null Hypothesis) and H_1: the statement is true (This is the Alternative Hypothesis). The null hypothesis is assumed to be true unless the statistics from the sample data force us to accept the alternative hypothesis. This is analogous to a jury who assumes the innocence of the accused until proven guilty. The nature of the hypotheses depends on the nature of the statistic.

As well as hypotheses, a test must also have a critical region for the statistic. If the statistic falls within the critical region, the null hypothesis is considered rejected. The size of this region is determined by the investigator according to his willingness to risk erroneous rejection of the null hypothesis. Typically tabulated are 95%, 99%, 99.9% confidence levels which translate into 5%, 1% and .l% risk of erroneous rejection of the null hypothesis. The values of the statistic associated with these confidence levels for the appropriate size of sample become the critical values beyond which the null hypothesis is rejected. For a more detailed treatment see Bhattacharyya and Johnson, 1977, p. 165. For the purposes of this paper a 95% confidence level is used on a single tail test.

Data Consideration and Statistical Tests

The Setterfield and Norman (1987) report contains nine tables of 'c' data obtained by various methods plus a tenth table of most "reliable" values. It is not within the scope of this paper to examine the credibility of these values as others more competent have done so. Setterfield has reported the results of different reviewers and I am prepared to accept Setterfield's editing of the data until some specific criticism arises.

Aardsma (1988, p. 36) and Humphreys (1988, p. 40) have objected to the earliest values, namely the Roemer and Cassini results. Norman's analysis without these values still shows a significant rate of decrease. My analysis also omits these data.

Aardsma maintains that only analyses using all data should be considered unbiased. However, the elimination of data which is statistically out-of-step with the rest of the data is quite acceptable in making statistical inferences as long as edits are admitted openly. Excluding data which in the opinions of competent authorities is not acceptably accurate is equally valid. While Setterfield edited by the elimination of values rejected by physicists, I have edited the data for 'bad' data (outliers) in a statistical sense. I have removed values which are more than three standard deviations from the sample mean unless there were other similar values nearby. This resulted in eliminating Roemer values 1 and 2 from Setterfield and Norman's Table 1 (1987, p. 12); values 1 and 2 from the tooth wheel method (1987, p. 18); value 1 from the rotating mirror (1987, p. 20) and value 1 from the electrostatic-electromagnetic ratio (1987, p. 30). Four of the six values were higher than 299,792 km/s and so their removal biases against Setterfield's thesis. Also value 1 of the Rydberg table (1987, p. 32) and value 4 of the Gyromagnetic ratio (1987, p. 49) were removed among the c-dependent data. For the Student's t test, the hypotheses are H_0: c is constant at 299,792.458 km/s versus H_1: c is greater than 299,792.458. A rejection of H_0 by this test does not necessarily confirm c time variance as c may be constant but not equal to 299,792.458, or systematic errors may be present. The test does, however, give the opportunity for the data to deny a changing light speed.

The hypotheses for both the MSSD and Run tests are H_0: c is constant versus H_1: c is time dependent. A rejection by the test supports Setterfield directly. Both tests require time sequenced data but only the MSSD requires a normally distributed random variable. Where data is reported in the same year, the values have been averaged into a single value. The data is reasonably close to a normal distribution if one assumes one of the four curves in Table 21 in the Setterfield and Norman report to be valid. More detail about MSSD is available in Lindgren, 1962, p. 330 and Crow, Davis and Maxwell, 1978, p. 63. A description of the Run test can be found in Lindgren, 1962, p. 326 and Draper and Smith, 1966, p. 95.

Discussion of Results

Table I shows the results of all three tests on nine tables of c data. The confidence levels for the Student's t test ranged from 74 to 99%. Only the toothed wheel and the post 1960 results were not rejected at the 95% confidence levels. If one accepts Setterfield's explanation of the post-1960 data is that during the 1960's the experimenters used clocks based on the atomic time standard, then only one table yields results contrary to the Setterfield theory.

The MSSD results ranged from 25% to 99.9%. In fact six of the tables yielded results better than 97.5% confidence level, suggesting trend. The post-1960 results again suggested constancy. The two methods yielding

*Alan Montgomery, B.S., 29 Radford Drive, Ajax, Ontario L1T 2G5, Canada.

Table I. Statistical Test Results for c-Data

	Confidence Level of Test Agreement with Theory					
Method	T-Test	MSSD	Runs	T-Test	MSSD	Runs
Roemer	98	99.9		Y	Y	—
Bradley	95	99	98	Y	Y	Y
Pulkova		99.8		—	Y	—
Toothed wheel	84	40		N	N	—
Rotating mirror	96	98		Y	Y	—
Kerr cell	2	60		—	N	—
1945-60	99	98		Y	Y	—
1960-83	90	25		Y	Y	
esu/emu ratio	99	99.9	95	Y	Y	Y

Positive Results (Y = Yes, N = No): T-Test 6 of 7; MSSD 7 of 9; Runs 2 of 2; Total 15 of 18.

negative results to the Setterfield theory were the toothed wheel and Kerr Cell methods. The toothed wheel contains the largest percentage of values rejected by the experimenters or other scientific authorities. Kerr Cell has only four data points and contains a systematic error which was later corrected with the geodimeter. The three largest tables—Bradley, EMU/ESU Ratio and 1945-60 all yield strong results in favor of trend. The confidence level of 2% for the Kerr Cell indicates also that c is under the expected value, so much so that the null hypothesis would be rejected under a two tailed test.

The Run test was more limited. In order to obtain reasonable results at least 15 data values should be used. Due to the requirement to average data in the same year only two tables were useful, namely the Bradley and ESU/EMU Ratio tables. The Run statistic on both tables yielded results above 95%. Overall the test statistics rejected c-constancy in 15 of 18 tests and favored trend in 9 of 11. The three statistical tests were also applied to the five c-dependent quantities e/mc, h/e, gyromagnetic ratio, Hall resistance, and m (where e is electron charge, h is Planck's value, m is electron mass) and results are tabulated in Table II. All five confidence levels for the Student's t test were between 93% for electron mass and 99.9% for gyromagnetic ratio. The table for the mass of the electron was obtained from Setterfield's previous work (1983) and appears to be missing all post-1963 values. The confidence level for m should be regarded only as tentative until the post-1963 values are published.

The MSSD test gave results for the five c-dependent quantities from 97.5% to 99.9%, a strong indication of trend for each test. Furthermore each trend is in the direction theoretically predicted by a decline in the value of 'c.' The Run test was applied to four of the five tables. All four tests rejected constancy at the 95% confidence level. The results ranged from 95% to 99.999% for the h/e values, the highest confidence level of any test. The first 10 values of h/e were below the mean and the last 12 values above the mean, a distribution most improbable for a constant with normally distributed error. In total, for c-dependent quantities, 12 of 14 tests reject constancy at the 95% confidence level. Also nine out of nine tests favor time dependent trend in c.

Table II.
Statistical Test Results for c-Dependent Data

	Confidence Level of Test Agreement with Theory					
Value	T-Test	MSSD	Runs	T-Test	MSSD	Runs
e/mc	99	99	99.9	Y	Y	Y
h/e	99	99.9	99.999	Y	Y	Y
Gyromagnetic Ratio	99.9	97.5	95	Y	Y	Y
Hall Resistance	93	98	—	N	Y	—
Mass of electron	94	99.9	99	N	Y	Y

Positive Results (Y = Yes, N = No): T-Test 3 of 5; MSSD 5 of 5; Runs 4 of 4; Total 12 of 14.

Table III shows the results of the three tests as applied to c-independent constants. The Boltzmann constant and gas constant (R) tables were taken from Setterfield's earlier book (1983). The t test results ranged from 51 to 98% with two values, the Bohr magneton and Boltzmann constant, rejecting constancy at the latest values. These two and the gas constant are tentative until post-1963 data becomes available. The MSSD test ranged from 56 to 89% confidence levels. All five results failed to reject constancy and none of eight indicate a time dependent trend. Out of 45 tests in this paper, 38 or 84% rejected the assumed negation of the Setterfield position. In the MSSD and Run test 18 of 20 tests rejected it. But is this enough? Are some data more important than others?

I consider the Bradley data to be essential because it would be close to impossible to hide a trend with time in such a large amount of data over a period of 150 years. The high accuracy and amount data in the 1945-60 results also make it important. The two c-dependent data sets with the most precise data and longest duration are h/e and e/mc. Without a change in these there is no theory. Of 11 tests conducted on these, all 11 rejected the negation of Setterfield!

Table III.
Statistical Test Results for c-Independent Values

	Confidence Level of Test Agreement with Theory					
Value	T-Test	MSSD	Runs	T-Test	MSSD	Runs
Charge of electron	56	60	60	Y	Y	Y
Boltzmann Constant	96	56	82	YYN		
Gas Constant	51	89	—	Y	Y	—
Rydberg Constant	65	65	75	YYY		
Bohr Magneton	98	60	—	N	Y	—

Positive Results (Y = Yes. N = No). T-Test 3 of 5 MSSD 5 of 5. Runs 3 of 3: Total 11 of 13

How important are the seven tests which did not reject the negation of Setterfield? Two of the results in the c-dependent group were within 2% of rejection and therefore are only marginal. Two others are in the c-independent group. But while the t tests cause us to doubt the canonical value of the Boltzmann and Bohr magneton, the MSSD and Run tests do not indicate any trend. The three tests in the 'c' data are the only one's which are of concern. The Kerr cell result is based on only four data points, which is hard to accept in the face of the results in larger data sets. This leaves only the toothed wheel data as counter-indicative of the Setterfield theory. The toothed wheel results are not so easily dismissed. Both the t test and the MSSD are favoring the null hypothesis. In addition the data is not sufficient to do a run test. Although only five of the data are accepted by the experimenters and authorities this is not much help as the MSSD changes little for these five data.

Conclusions

With 15 of 18 results on c-tables and 12 of 14 c-dependent tables indicating a time dependent trend it is reasonable to conclude that 'c' has been decreasing with

time. Whether it is continuing today may be open to question. The acceptance of constancy in 11 of 13 tests on c-independent constants strongly confirms that only c-dependent quantities are changing with time.

How coincidental are these predictions? Suppose six of 11 physical quantities were chosen randomly. The odds of choosing the six time-dependent ones would be only 1 in 462. This shows that Setterfield's theory is highly restrictive in its predictions yet exactly accurate in choosing those which the statistical tests indicate as time-dependent. Given a decline in c, the five remaining values are restricted to trend in one direction. Using one-half as the probability of up or down, there is only 1 chance in 32 of choosing the combination required by Setterfield's theory. Together the chances are 1 in almost 15,000. In addition, Setterfield and Norman's Table 24 (1987) on the percentage change per year show that the percentage rate of change of all five time-dependent values are very close to each other and that there is a consistent decline in all rates coincidentally. These tables support the conclusion of a monotonic decline in c with time with covarying c-dependent values. The author cannot think of another factor that would account for all of these coincidences.

Remarks on the Statistical Work of Setterfield and Norman

Although Setterfield and Norman's paper (1987) has much to commend it there are some areas which require improvement. Their analysis uses the least squares regression method, a valid measure of the average rate of decline. However, the use of confidence levels is not strictly valid because, by their own admission, the c-curve is not linear. Even if the c-curve were linear, a check that the residuals are normally distributed is required to justify the use of confidence levels. Since the best fitted c-curves are approximately linear over short time periods some values may still be correct. Their conclusions on radioactive decay are not strong, and they are overstated. A quick comparison of the rates of change in half-lives with all other c-dependent values indicate that they are not coincidental. Some values show change rates 1000 times greater than corresponding 'c' rates. Obviously, other factors, such as low accuracy of results, are at work.

Much of the credibility of the Setterfield and Norman study depends on the explanation of the post-1966 'c' data, that there is no appearance of change in c due to the use of atomic time clocks instead of the standard clocks. This needs clear documentation. Since c-dependent data also have values in that era, it is necessary to specify which time clock is applicable in each experiment. For example, the test statistics for the Hall resistance show change over time. This only supports Setterfield's theory if dynamic time standards are used. Documentation of the timing standard is necessary to validate these results.

Remarks on the Statistical Work of Aardsma, Humphreys and Brown

Aardsma (1987, p. 36) and Humphreys (1987, p. 40) have claimed support for c constancy using a weighted linear analysis. There are two major problems with this claim. First, a weighted linear regression is meaningless if the relationship is not linear, especially when the results have a very low coefficient of determination or poor fit. Before a weighted analysis is done, the residuals of the simpler linear regression should be analyzed. A funnel shaped pattern of residuals indicates that the linear relationship is right but that there is a variation in the standard deviation of the data. This can be adjusted by a weighted linear analysis described in Draper and Smith, 1966, p. 98. The residual on the least squares linear regression actually show a bow shape. Typically, this is indicative of the need for a time dependent polynomial function of degree two as the regression line. The functions in Setterfield and Norman's study (1987, p. 46) including the polynomial show excellent fit to data. The residuals are funnel shaped indicating a weighted regression line on these formulae.

Second, Aardsma has chosen to weight the data by the inverse square of the error bars rather than the number of observations or the inverse variance of the observations. The normal practice would be the inverse of the error bar or one of the other two. His choice results in the worst fit of any method. The residuals of Aardsma's line are badly skewed and he is forced to resort to the "intellectual phase-locking" argument. This says that experimenters prejudice their results to fit results of previously published experiments. No details are given as to how this worked on the Bradley aberration method where the post-1900 results are conspicuously below both today's values and the other values of its day. That this rationalizing of results could affect 163 data collectively and yet go undetected is a strong claim.

The statistical arguments against the Setterfield hypothesis are even weaker than they appear, as they fail to cope with the most powerful of confirming evidence. The c-dependent values, such as m and h, also vary with time in the direction and approximate magnitude of c. Do critics believe "intellectual phase-locking" has occurred not once but six times? Is the direction of this phase-locking merely coincidentally in favor of Setterfield's theory? Is the magnitude of change in percentage per year so close by chance? Is the lack of any intellectual phase-locking in c-independent constants also mere coincidence? The failure to come to grips with this evidence is indeed a major flaw in the criticisms.

Brown (1988, p. 91) also claims that no variance with time can be found. His analysis shows that the data are within two population standard deviations of the sample mean. Since the random variable for the t test is the sample mean of size n, the standard deviation of the sample mean is required rather than that of the population. By confusing these two, he has arrived at a spurious conclusion. The Student's t statistic expressed as

$$t = \frac{x - \mu}{s/\sqrt{n}} \qquad (1)$$

and never as

$$t = \frac{\bar{x} - \mu}{\sigma}, \qquad (2)$$

where $\bar{x}$ = sample mean, μ = expected value, $s/\sqrt{n}$ = sample standard deviation and σ = population standard deviation. The statistical arguments against Setterfield's hypothesis are unconvincing.

Theoretical Considerations

I avoid the use of the term decay as it suggests loss of energy or organization. None is evident in Setterfield

and Norman's paper (1987). The term decrease has been used so as not to lead the reader to premature conclusions. *Is a c decrease viable with respect to energy emission and reception rates in the past?* Higher radioactivity in the past produced more photons per second than today. This is balanced by a lowering in energy density of the individual photons so that collectively a beam of light has the same energy density as a beam today. In the past, however, the energy in the beam would arrive at a faster rate which causes Aardsma (1988) to question whether this would produce unacceptable temperatures. Temperature is dependent on two factors: energy received and the energy emitted per unit time. Since conductivity is proportional to c, matter loses energy faster in the past. It requires more energy transmission in the past to keep matter at the same temperature. In other words increased energy reception is balanced by a proportional increase to energy emission from the receiving object.

Does the decrease in the speed of light cause a redshift? Setterfield suggests that decreasing c causes an increase in energy density and a corresponding increase in E_0, the electrical component of light. This results in a redshift curve where z varies directly with the changes in c. The resulting redshift curve does not fit observed values well and Setterfield must add the additional constraint that the universe is contracting. However, the galaxies themselves are not contracting. Therefore they should exhibit the c decrease redshift without correction for universal contraction. But the required redshift does not fit observations. For example, a star on the galactic perimeter may be 30,000 light years away. Under the cosecant squared formula,

$$c(t)/c_0 = 58 \tag{3}$$

so that z = 57. No such redshift value exists in our galaxy.

I suggest that Setterfield's energy density for photons

$$W(t) = \epsilon_0 E_0^2/8\pi \tag{4}$$

requires an additional factor of $c_0/c(t)$ so that

$$W(t) = \epsilon_0 E_0^2/(8\pi c(t)/c_0) \tag{5}$$

where the additional factor represents the increased volume that the photon travels through at time t. Since at time t, atomic sources give off $c(t)/c_0$ times as many photons per second, a beam of photons will have an energy density of

$$c(t)/c_0 W(t) = \epsilon_0 E_0^2/8\pi \tag{6}$$

i.e. a constant. This would imply no redshifting due to a decrease in c.

Another way of looking at the redshift situation is this: since all photons are traveling at the same speed at the same time it is impossible to change the distance between them by decreasing c alone. This implies no change in wavelength and no redshift. An interesting non-Hubble model for the red shift was proposed by LaViolette (1986). He assumes a static Euclidean universe in which 5-7% of the photon's energy is lost every one billion light years. This model is superior to the Big Bang model in four cosmological tests.

Does c decrease cause a time dilation effect? By time dilation, I mean that the slowing of light causes us to see events in slow motion. Setterfield (1983) used this time dilation effect to explain why changes in redshift were not observable, i.e., why we see them in super slow motion. Consider an event in Andromeda occurring at creation. The light showing this event arrives at the Earth some months later. Today, supposedly 6,000 years later, another event occurs. The light will not arrive here for another two million years! Thus two events 6,000 years apart will not be observed 6,000 years apart but two million years apart. This can only happen if events are seen in slow motion.

For atomic processes at time t, an observer today sees them at $c_0/c(t)$ of the actual rate. But the actual rate is $c(t)/c_0$ times faster than today so that they cancel and are observed at the current rate. For non-atomic processes, however, the observer sees the event at $c_0/c(t)$ of the actual rate. This has two important consequences.

The observation of superluminal velocities cannot be due to a decrease in c. Whatever relationship is observed today also exists at the source at time t in the past. A decrease in c will change the frame of reference but it does not change the relationships. Superluminal velocities still require reconciliation with relativity. It does raise an interesting question. Suppose some quasar had an initial velocity many times the current c_0. What happens as c(t) falls below the velocity?

Secondly, over the course of time the ratio $c_0/c(t)$ will increase causing non-atomic events to appear to increase in speed. Thus, binary stars' motions should appear to increase in velocity and their periods should undergo a corresponding decrease. I suggest that this is a test for Setterfield's theory and a method of establishing fossilized values of c.

Does a c decrease give results compatible to carbon-14 testing? Aardsma (1988) points out that the polynomial of degree 8 does not give reasonable results for carbon-14 dating. However, the cosecant function gives very good agreement, even to objects dated 4000 B.P. Since at least one curve conforms to carbon-14 dating, Setterfield's hypothesis is not refuted. *Does Setterfield's theory contradict gravity?* Setterfield's treatment (1987, p. 44) of gravity is confusing. He identifies Einstein's gravitational tensor

$$\kappa = 8\pi G/c^4 \tag{7}$$

as a constant. This implies that G varies as c^4. He later states that according to observed values of G, they are constant. He uses gravitational permeability to explain the difference between the two. It becomes clearer if one introduces

$$G^* = G\mu^{*2} \tag{8}$$

as the gravitational constant with G as the atomic counterpart. This differentiates the terms for gravity in the same fashion as he has distinguished gravitational mass from atomic rest mass. Then the gravitational force

$$F = \frac{Gm_1m_2}{r^2} = \frac{G^*m_1m_2}{\mu^{*2}r^2} = \frac{G^*M_1M_2}{r^2} \tag{9}$$

where $M = m/\mu^*$ is the microscopic mass, G* is the microscopic gravitational constant and m_1 and G are the corresponding atomic values and vary as $1/c^2$ and $1/c^4$.

Summary

Setterfield and Norman have made a major contribution to science and creationism. They are to be commended for their perseverance in compiling, analyzing and documenting an enormous quantity of data from many different sources. Although the report needs additional information on time-clocks used in various tables and a more cohesive explanation of gravity, it contains a wealth of data to support the hypothesis that c is time dependent. The statistical evidence provided here unequivocally supports the Setterfield hypothesis and its consequences to c-dependent physical values. Critics have been unable to establish a major point of refutation. Humphreys' suggestion that Setterfield should provide a statistically oriented report to establish the basic hypothesis and follow it with another on the geological, physical and astronomical consequences in a later report is still valid. There remains much theory to settle once the statistical justification is solidly established.

I am indebted and grateful to Stephen Cheesman for clarifying many of the issues involving energy density, wave amplitude and time dilation. I would also like to thank Lambert Dolphin for his encouraging words.

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SPEED OF LIGHT STATISTICS

R. H. BROWN*

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Abstract

This is a response to the Alan Montgomery article (CRSQ 26:138-42), and also a supplement to my earlier article (Brown, 1988).

The academic community is deeply indebted to Trevor Norman and Barry Setterfield (1987) for the information regarding the propagation speed of electromagnetic radiation which they have brought together and made conveniently accessible. They and others who share a similar commitment deserve particular commendation for effort to establish an uncompromising and sound coordination between the testimony of Scripture and information which comes under the classifications of natural science.

Readers who wish to get a complete perspective on the Montgomery manuscript, and the issues it treats, should carefully reread the earlier Aardsma (1988), Humphreys (1988) and Brown (1988) manuscripts. The conclusions from an analysis such as that presented by Norman and Setterfield, or by Montgomery, must be kept subject to a rigid evaluation of the applicability of the technique employed. The papers by Aardsma and Humphreys clearly indicate that Norman, Setterfield, and Montgomery have reached unwarranted conclusions. Figure 1 in each of these papers gives adequate support for an assertion that within the available experimental data there is *no* evidence for a significant change in the propagation speed of electromagnetic radiation. Any claim that such change has occurred is a purely theoretical or philosophical proposition, regardless of the mathematical adornment with which it is presented.

Before becoming aware of the analyses made by Aardsma and Humphreys, I had prepared for private distribution an evaluation of the Norman and Setterfield report. When my analysis was published as part of the symposium on the speed of light, I was certain that some readers who had strong reasons for proposing a major decline in the speed of light would object to my handling of the square root of n factor (Brown, 1989). My position in that analysis was to advocate only views which were consistent with a sound unbiased data evaluation such as may readily be made from the Aardsma and Humphreys Figure 1 plots.

I thank Alan Montgomery for the impetus to share a statistical treatment which I had considered including with my 1988 feature. This is a regression confidence limits analysis of the data from which the Aardsma and Humphreys Figure 1 plots were made. In my data set I use the corrected Roemer value, as discussed by Humphreys (1988) and I omit the Cassini value on the basis of the evidence that it is in need of correction, but adequate information with which to make a reliable correction is lacking (Humphreys, 1988). Any analysis of 163 data points that is *critically* affected by discarding any one point is not a sound analysis. In statistical analysis of data it is standard practice to discard outlyers as far removed from the data trend as is the Cassini value—a practice which is justified as long as such outlyers are rare, their rejection is acknowledged, and can be defended.

During the time that was available to me for preparation of this response, I did not have access to computer facilities that were capable of plotting a regression analysis for the entire data set as a unit. Because

*R. H. Brown, Ph.D., Geoscience Research Institute, Loma Linda University, Loma Linda, CA 92350.

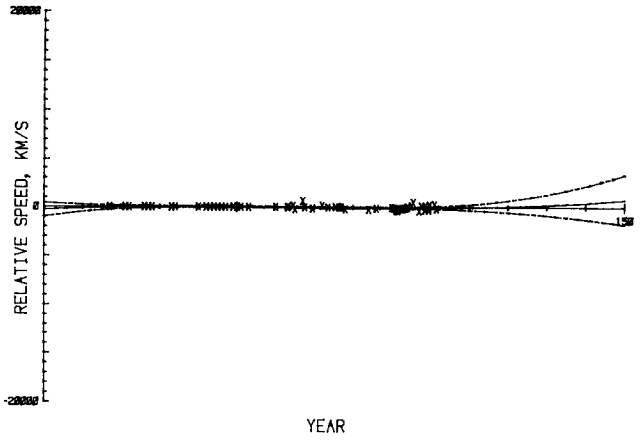

Figure 1. Plot of data from 1983 to 1898.5. Year scale values are 2000 minus the date of measurement. See text for explanation.

of this limitation I have divided the data into two equal-sized groups, one covering years 1983 back to 1898.5 (Figure 1), and one covering 1898 to 1675 (Figure 2). To further reduce data processing demands, all speed of light values for any specific time reference (year, month, or decimal year) were averaged to provide a single entry for each time reported. There were 30 averages of two, 7 averages of three, and 2 averages of five data values as a result of this reduction. This is no different than was done to varying degree by the publishers of the original reports, except in the few cases in which results obtained by different techniques were averaged. All points were weighted equally, regardless of the above averaging and the probable error reported by the investigator.

Since regression analysis is most readily interpreted if the data treatment is based on the terminal region which has the least scatter, I have reversed Figure 1 as given by Aardsma and Humphreys and used age measured into the past as the independent variable. In my Figure 1 the year value is 2000 minus the measurement date, and the plotted data range from AD 1983 to AD 1898.5 (total scale 150 years). In my Figure 2 the year value is 1900 minus the measurement date, and the plotted data range from AD 1898 to AD 1675 (total scale 270 years). In both figures the ordinate

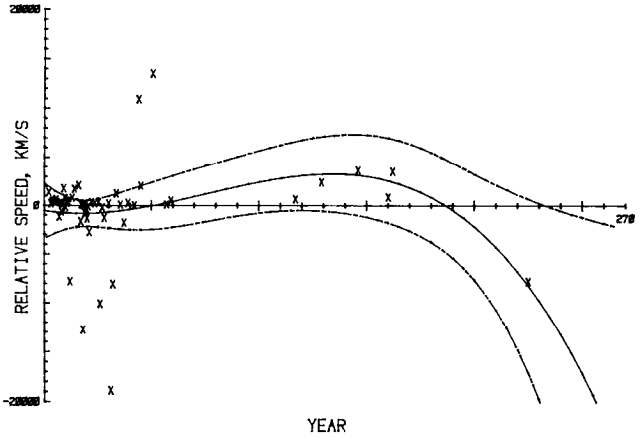

Figure 2. Plot of data from 1898 to 1675. Year scale values are 1966 minus the date of measurement. See text for explanation.

scale is the same, expressing kilometers per second difference from the AD 1983 value for the speed of light.

The solid curved line in each figure is the best third degree (cubic) polynomial regression fit to the data. It is drawn to assist with a visualization of the data trend. The dot-dash curved lines designate the region within which one can have 95% confidence (certainty) that the "true" trend of data falls. If the two plots had been combined in one statistical treatment, the dot-dash lines at the right side of the data region in Figure 1 would have diverged more rapidly, and those at the left side of the data region in Figure 2 would have diverged less to make a smooth junction between them.

From Figure 2 it is clearly evident that prior to AD 1889 the data is characterized by wide scatter (the first low value at slightly less than -8000 km/s is for AD 1888, 12 years further into the past beyond the AD 1900 reference for Figure 2). But the data continue to cluster around the 1983 value for the speed of light (zero relative speed). Throughout the entire range of the available data, including the AD 1675 Roemer value, the 95% confidence band includes a straight regression line at zero relative speed. Consequently I can with full confidence reaffirm that there is no sound statistical support for speculation that the propagation speed of electromagnetic radiation has changed significantly over the time that attempts have been made to measure it. On the basis of the statistical evidence at hand, the only statement that can be justified concerning the future beyond 1983, or the past before 1675, is that most probably this speed will be and has been the same as the reference value for Figures 1 and 2.

To individuals who wish to become better acquainted with regression analysis I heartily recommend Mendenhall, *et al.,* 1981.

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QUOTE

The sage knows that life begins and ends in mystery. And he apprehends the end of genuine learning, which begins in the fear of God. That end is to know God and enjoy him forever.

Thus is the sage oriented. The fundamental purpose of learning for us creatures here below is to orient ourselves, that we may take our bearings in the midst of divine creation.

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THE ROLE OF METEORITES IN A CREATIONIST COSMOLOGY

WILLIAM S. PARKS*

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Abstract

A catastrophic origin for meteorites is proposed, on a recent time scale. The model supposes the explosion of a planet originally located between Mars and Jupiter, the present asteroid belt. The idea is further connected with the Genesis Flood event. The ideas are clearly speculative, but a starting point for further discussion.

Crustal Nickel

One of the arguments which has been advanced in support of the belief that the earth had a recent origin is based on the observation that, at the present rate of meteoritic dust influx into the earth's atmosphere, the amount of meteoritic material which has accumulated in the earth's crust is not commensurate with an age of the earth on the order of 5×10^9 years.** Specifically if the earth were five billion years old, considerable meteoritic nickel would have accumulated such that the nickel content of the crust would be of mainly meteoritic origin:

> Nickel, for example, is a very rare element in the earth's crust and especially in the ocean. Pettersson estimated the average nickel content of meteoritic dust to be 2.5 per cent, approximately 300 times as great as in the earth's crust. Thus, if all the meteoritic dust layer had been dispersed by uniform mixing through the earth's crust, the thickness of crust involved (assuming no original nickel in the crust at all) would be 182 x 300 feet, or about 10 miles!
>
> Since the earth's crust (down to the mantle) averages only about 12 miles thick, this tells us that practically all the nickel in the crust of the earth would have been derived from meteoritic dust influx in the supposed (5×10^9) year age of the earth! (Morris, 1985, p. 152)

However, from the viewpoint of an evolutionary cosmology, it may not be unreasonable to suppose that most of the crustal nickel was supplied by an extraterrestrial source. Nickel is a heavy element and, if the earth had formed from a molten state as some evolutionary cosmologists have claimed, virtually all the original nickel could have settled toward the earth's core. Almost all the nickel found in the earth's crust today could have then resulted from meteoritic accretion. The amount now present would be consistent with an estimated age of the earth of 5×10^9 years. Even if the NASA data (Hawkins, 1976) are correct in indicating a rate of meteoritic dust influx approximately 14 times greater than what Pettersson (1960, p. 132) had determined, the resulting estimate of the earths age still would be several hundred million years.

Yet, the relative absence of meteoritic dust on the surface of the moon (Morris, 1985, p. 152) would tend to constitute evidence against this argument, since apparently little or no erosional and depositional mixing has occurred on the moon and a deep meteoritic dust layer, perhaps hundreds of feet thick, should have accumulated over a period of five billion or even several hundred million years.

A Possible Scenario

Another possibility which must be considered: While the earth and moon might be ancient, meteorites might be of a relatively recent origin; hence meteoritic material would not have had time to accumulate to a significant extent either in the earth's crust or on the moon's surface. For example, most or all meteorites and meteoritic dust might be the products of a planetary explosion which occurred within the last few hundred thousand years. Some astronomers have hypothesized that there was a planet in an orbit between those of Mars and Jupiter, and this planet exploded leaving remnants in the form of the asteroid belt. This same explosion also might have produced the meteorites which bombard the earth and moon.

It might be countered that radiometric dating has been used to estimate the age of meteorites to be about the same as that of the earth and moon, and that meteorites could not have resulted from a relatively recent explosion. Ignoring legitimate questions about the extreme unreliability of radiometric dating techniques, this objection could be answered with the assumption that the debris from the explosion did not melt and recrystallize. It retained the same proportions of radioactive elements to decay products as the planetary material from which the meteorites were derived. If the debris did melt, the recrystallized material could still have retained the same proportions of elements.

In view of the above considerations, it seems that the data concerning influx of meteoritic material easily could be reconciled with a long geologic time scale, and might favor such a time scale. However, there is at least one more factor which may create insurmountable difficulties for any hypothesis about meteorites which is based on an evolutionary cosmology. While the surfaces of the moon and the "stony" planets Mars and Mercury are covered with numerous large meteorite craters, the surface of the earth is amazingly devoid of such craters. With the possible exception of a 200-mile-diameter circular structure which was recently identified in Czechoslovakia and which may represent the remnants of an enormous meteorite crater (United Press International, 1989), the earth has nothing to compare with even a medium-sized lunar crater. Secular geologists have attempted to explain this deficiency through the hypothesis that erosional processes have removed all traces of large meteorite craters from the earth's surface. But this explanation

*William S. Parks, A. A., P.O. Box 1242, Prescott, Arizona 88302.

**Editor's Note: This topic has been covered in the Quarterly previously. The following selected bibliography may be of interest to the reader. Slusher, Harold S. 1971. Some astronomical evidences for a youthful solar system. *CRSQ* 8:55-57; Mulfinger, Jr., George. 1973. Review of creationist astronomy. *CRSQ* 10:170-75; Morris, Henry. M. 1975. The young earth. *CRSQ* 12:19-22; Steveson, Peter A. 1975. Meteoritic evidence for a young earth. *CRSQ* 12:23-25; Chaffin, Eugene F. 1987. A young earth?—a survey of dating methods. *CRSQ* 24:109-17.

presupposes that the craters were formed so long ago that erosional forces had time to obliterate them. In areas of sluggish erosion this might require tens of millions of years, yet, the almost total absence of meteoritic dust on the moon's surface would seem to preclude such a time scale.

Reasoning based on the premises of conventional geology can be used to explain *either* the relative absence of meteoritic material in the earth's crust and on the moon's surface by the hypothesis that meteorites had a recent origin or the absence of craters on the earth's surface by the hypothesis that meteorites did *not* have a recent origin. Because of the mutually exclusive assumptions involved, such reasoning apparently cannot account for *both* of these facts together.

However, it appears that a Biblically based interpretation could account for both observations. Such an interpretation might be as follows: Before the time of the worldwide Flood, there was a planet in an orbit between those of Mars and Jupiter. When God decided to obliterate the face of the earth, He caused this planet to explode. Some of its fragments had such a trajectory as to remain approximately in the orbital path of the destroyed planet, and became what we now know as the asteroids.* Other fragments spread outward, many of them bombarding Mars, Mercury, the moon and the earth (as well as the other planets, but these would not show traces because of their dense atmospheres). On Mars these fragments not only formed craters but also triggered eruptive activity which formed the volcanic mountains which have been discovered on the planet's surface. On the moon and Mercury, the meteoritic bombardment caused numerous impact craters. But on the earth the meteoritic assault cracked the earth's crust, not only initiating volcanic activity as on Mars but also causing "all the fountains of the great deep [to] burst open" helping to bring about the Flood. Additionally, the sudden influx of a large quantity of meteoritic dust from the explosion might have disturbed and precipitated the primeval vapor canopy which many creationists believe to have existed above the earth's atmosphere as the "waters which were above the firmament" (Genesis 1:7).** According to this explanation, all the meteorite craters on the earth would have been formed recently but *before* the Flood. The massive erosional and depositional activity during and after the Flood would quickly obliterate or bury them under thousands of feet of sediment.

*Editor's Note: For a recent creationist discussion of this concept see Unfred, David W. 1984. Asteroidal impacts and the Flood-judgment. *CRSQ* 24:109-17.

**Editor's Note: For readers interested in this topic the following bibliography may be helpful. Udd, Stanley V. 1975. The canopy and Genesis 1:6-8 *CRSQ* 12:90-93; Kofahl, Robert E. 1977. Could the Flood waters have come from a canopy or extraterrestial source? *CRSQ* 13:202-265; Dillow, Joseph C. 1978. Mechanics and thermodynamics of the pre-Flood vapor canopy. *CRSQ* 15: 148-59; 1979. Scripture does not rule out a vapor canopy. *CRSQ* 16:171-73; 1982 The waters above. Moody Press. Chicago; 1983. The vertical temperature of the pre-Flood canopy. *CRSQ* 20:7-14; Morton, Glenn R. 1979. Can the canopy hold water? *CRSQ* 16:164-69; Akridge, G. R. 1979. Venusian canopy. *CRSQ* 16:188-89; Westburg, V. Luther. 1979. Floodtime changes in the earths heating and lighting. *CRSQ* 16:182-84; Peterson, Everett C. 1981. The necessity of canopies. *CRSQ* 17:201-204, 213.

While this explanation is purely hypothetical, it seems to account for several concepts: (1) the origin of meteorites and meteoritic dust; (2) the origin of asteroids; (3) the existence of numerous and often enormous meteorite craters on the moon, Mars and Mercury; (4) the virtual absence of such craters on earth; (5) the relative absence of meteoritic material in the earth's crust and on the moon's surface; (6) the initiation of the Flood as well as of volcanic activity on the earth and on Mars; (7) the current absence of widespread volcanic activity on the scale observed in the geologic record, since the earth's crust is no longer being disturbed and broken by the impacts of large meteoritic bodies. Additionally, this hypothesis would have the considerable merit of explaining why we see evidence of destruction and chaos on other planets, when God presumably created the universe and solar system in a state of perfect order and harmony. Thus a potential source of embarrassment to the creationist view of the cosmos could be explained.

Suggested Research

Although testing the hypothesis would be difficult, there are several possible approaches based on the following considerations. 1. Meteorites are the products of an explosion. 2. They and the craters formed by them are of recent origin. 3. The craters formed within a very short period of time. Therefore, it would be necessary to search for evidence to determine if these three assumptions are correct. Some possible avenues of research might include recording the number of meteors entering the earth's atmosphere periodically. After a number of years of extensive sample-counting it might be possible to determine whether there is a significant progressive decrease in the rate at which meteors are entering the atmosphere. If this were found to be the case, an extrapolation backward in time could be made to determine if the rate was extremely high several thousand years ago, about the time of the hypothesized planetary explosion and meteoritic bombardment of the earth. Additionally, meteorites could be examined for physical and chemical evidence that they were the products of an explosion. Mathematical calculations could be made to determine whether or not the explosion of a planet could produce a mass of debris which would form meteorite craters just prior to and during, *but not after* the Flood.

Conclusion

The ideas in this paper are completely speculative and would need extensive research to establish them. However, whether or not the particular hypothesis presented is correct, scientific creationists, as well as evolutionary cosmologists, must face the highly significant realities that the moon and other bodies in the solar system were at one time bombarded by thousands of meteorites, many of which were of enormous proportions and capable of causing cataclysmic impacts; and that virtually all traces of those impacts have been erased from the surface of the earth. It seems reasonable to say that no cosmology can be considered complete until it has accounted for these and other facts of meteoritics. It appears that the weight of the evidence at this time favors the creationist interpretation over the evolutionary one.

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BOOK REVIEWS

*Quasars, Redshifts and Controversies** by Halton Arp. 1987. Interstellar Media. Berkeley. 198 pages. $19.95.

Reviewed by Allen W. Jang**

Halton Arp has spent over three decades of research at some of the world's largest observatories. He is currently on the staff of the Max Planck-Institute for Astrophysics in West Germany. Once described as "The Most Feared Astronomer on Earth," his work is potentially revolutionary (Kaufmann, 1981). If Arp is correct, then much of the foundational basis for modern astronomy will have been overturned. The purpose of the book, according to Arp, is to present important information about the nature of the universe (p. i). He points out that "there is massive, incontrovertible evidence for important phenomena and processes . . . which we cannot currently understand or explain" (p. 2).

Redshift describes the fact that in a spectral analysis of remote galaxies and extragalactic sources, the characteristic lines due to the presence of various elements, compared to the position of those same lines as they would appear in a laboratory, appear shifted to the red. The standard interpretation, known as the Hubble law, attributes this to a recession velocity of the emitting source, or Doppler Effect. The greater the redshift, the farther away the object is and the faster it is moving away from us.

Scientists predicted that objects near each other would have similar degrees of redshifts. It was a shock when quasars were discovered with redshifts many times greater than that of galaxies to which they are observed to be connected. The reaction of most astronomers was to simply assume that the visual closeness was due to an optical illusion and that the quasars were actually at a much greater distance in the background. In the many cases which are documented in this book, these are not optical illusions. They are objects that have been verified, by the use of various standard non-optical viewing instruments, to be physically linked together. If a high-redshift object can occur close to a low-redshift object, then it is obvious that the degree of redshift does not always indicate distance. This book is a compendium of observational evidence of galaxy pairs and galaxy-quasar combinations in which each member has a significantly different redshift. This challenges the redshift-distance relationship and suggests that there must be a non-doppler mechanism at work. One implication of this is that standard estimates of the size and age of the universe may be greatly exaggerated.

Arp asks "In case the thesis of this book is correct, we want to know what the factors are that led to this long, inplacable rejection of new knowledge, the wasted effort, and the retardation of progress" (p. 5). In subsequent chapters, he recounts the attempts by some scientists to censor his findings. The last chapter, entitled, "The Sociology of the Controversy," recounts the cases of Galileo and Fred Hoyle (who agrees with his findings) and how establishment science has often been guilty of engaging in the non-scientific work of censoring viewpoints that are in disagreement with the standard view.

The conclusion states:

> It is of profound importance to recall now that for a number of classes of . . . objects there was never any shred of evidence that they obeyed a Hubble relation . . . The assumption that . . . objects obeyed a redshift-distance relation sprang simply from the feeling that if one kind of object [Sb galaxies] did, all objects must do so. Such a generalization is an example of the oldest of logical fallacies. Nevertheless, it has become an article of faith despite many examples of contradictory evidence (p. 178).

The book is well-written, illustrated and clearly organized with many charts and graphs, appendices and notes at the end of each chapter, a glossary, and an index. The subject treatment is basically non-mathematical. This book is highly recommended as an important reference source documenting the research of a gallant non-creationist scientist who has been the target of censorship efforts by scientists committed to the status quo.

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**201 N. Sycamore Drive, San Gabriel, CA 91775.

Creationist Research (1964-1988), by Duane T. Gish. 1989. Creation Research Society, P.O. Box 14016, Terre Haute, IN 47803. 32 pages. $4.95.

Reviewed by Clifford L. Lillo*

In 1975 the *Creation Research Society Quarterly* published an article by Dr. Gish titled, "A Decade of Creationist Research," in which he summarized significant articles that had appeared in the *Quarterly*. A similar summary of geological creationist research over the past 14 years (1974-1988) by Gish was published in the March 1989 *Quarterly* and biological research for the same time period was summarized in the June 1989 *Quarterly*. The current pamphlet by Gish is a composite of the three summaries.

According to the author, "Evolution is the dogma of the scientific and educational establishments" (p. 2). It is well known that government money from taxpayers is made available to scientists conducting research on the evolution theory. In contrast, says Gish, ". . . as far as I know, not a single tax dollar . . . is available for research by scientists who openly attempt to correlate their results within the concept of special creation" (p. 2). Even so, considerable research has been conducted and significant results have been obtained.

Gish reports that from 1964 to 1974 research was conducted in the fields of geology, genetics, natural selection, biology, taxonomy, and thermodynamics. Creationist research has continued since then and two major areas are covered by Gish's summary: geology and biology.

In 1975, Clifford Burdick examined thrust formations in Northern Scotland, including some which extended over five miles, and concluded they are indeed thrusts. He also examined the Glarus formation in Switzerland and stated that it reveals no evidence of overthrusting, even though evolutionists claim it to be because of the order of fossils found there.

Palynology studies in 1985 by Howe, Williams, Matzko and Lammerts in the Grand Canyon resulted in support for Burdick's earlier report of pollen grains of various land plants in Precambrian Hakatai Shale, thus refuting evolutionists' beliefs that this sedimentary material was laid down before pine trees and flowering plants existed on the earth.

In another study in which plants and marine organisms were subjected to mixtures of salt water and fresh water such as might have occurred during the Flood of Genesis, it was found that "all animals and plants survived the 30-day duration of the experiment" (p. 25). Gish reports that the experimenters, Norbert Smith and Stephen Hagberg, believe that "the vast majority of marine life was destroyed by the Flood" but that small protected areas permitted "certain marine organisms to survive the duration of the Flood" (p. 25).

Howe and Meyer have suggested several research projects that may be conducted at the Creation Research Society Grand Canyon Experiment Station in the future and a research building at the site is planned as soon as adequate funding can be obtained.

Creationist writers and speakers should be aware of all the creationist research already done and of that planned for the future. Also, whenever evolutionists claim that research on creationism is not being conducted, copies of this pamphlet should be thrust into their hands. It might open some eyes.

Science and Earth History by Arthur N. Strahler. 1987. Prometheus Books. Buffalo. 552 pages. $39.95.

Reviewed by Wilbert H. Rusch, Sr.*

With regard to this book's physical appearance, I felt that the price at least should call for a book where the text was justified on the right hand margin of the pages as well as the left. Because of the book's size, the lack of this feature was a bit of an annoyance. The size of the book, over 550 pages, is probably responsible for its high price. However, it is possible that the wealth of material included might still make the volume a worth while investment for the serious student of the subject, as well as for a library.

In the preface, the author explains why and how he got into this controversy. Although he professes to have maintained a balanced and fair position throughout, I cannot quite agree that he succeeded. In the preface, for example, he indicates that his ire was aroused by the bare thought of anyone doubting the theory of evolution in any way. Strahler says (p. vii)

> But why expend so much effort to stand up for monumental scientific achievements that had long been accepted without question? Surely organic evolution (descent with modification) by natural selection needs no public defenders a century after Darwin, nor should anyone have to get up on the lecture platform to defend the radiometric age of four and one-half billion years for its oldest rocks.

This book would be helped by the author's consistent distinguishing between microevolution and macroevolution. Admittedly this is a common failing in discussions on this matter. Strahler also fails to mention that there are several kinds of creationists as well as several kinds of evolutionists. He seems unaware of the existence of *ancient creationists*, as well as *recent creationists*.

The author quotes from the *Creation/Evolution Newsletter* and refers to 'creationist' Michael Denton (p. 397). Oddly enough, he does not quote Denton himself to substantiate this opinion. Strahler himself does not seem to have read Denton. I have read Denton, and I cannot agree with Strahler that Denton is a creationist. For example, Denton refers to Genesis and creation as a cosmogenic myth, hardly the statement of a creationist (Denton, 1986, p. 359).

Strahler's work consists of 54 chapters. These are grouped into nine parts with each part having an introduction. There were sections where I felt that I had picked up one of Strahler's earth science texts by mistake. I list as a sampling the first three chapters, chosen because of possible special interest to those who are engaged in the study of, or the teaching of the philosophy of origins.

*Clifford L. Lillo, BEE, MA, 5519 Michelle Drive, Torrance, CA 90503.

*Wilbert H. Rusch, Sr., Prof. Em. Biology, 2717 Cranbrook Rd.. Ann Arbor, MI 48104.

I found that Strahler's work has a large amount of selective documentation. I would probably have preferred that he also include a list of works such as: Denton, Michael, *Evolution: A Theory in Crisis;* Dewar, Douglas, *The Transformist Illusion;* Gentry, Robert, *Creation's Tiny Mysteries;* Hoyle, Fred and Chandra Wickramasinghe, *Evolution From Space;* and Thaxton, Bradley and Olsen, *The Mystery of Life's Origin*. All of these raise valid questions about the origin of life as well as the theory in general. To the best of my knowledge, the only creationists in this list of authors are Dewar and Gentry. It is also interesting to note that some quotes from Robert Gentry are taken from a single work, an invitational paper edited by Awbrey and Thwaites (1984). Although a considerable number of Gentry's articles on these matters appeared in *Science* and *Nature,* Strahler did not see fit to list them. Yet the works of Brush and York in critique of Gentry are listed in complete form in the references. I further noted that Strahler, in discussing the subject of turtle evolution (pp. 434-35), quotes the work of a graduate student in anthropology. However, he seems to have failed to check the work of a researcher on this matter such as Dr. Wayne Frair.

I believe that the task of a reviewer is to evaluate the work on the basis of subject interest, informativity and scholarly worth, just to name a few characteristics. However, to start a systematic discussion of each of the arguments pro and con on the matter in a review the size of this one, albeit a useful project, would still be a monumental work in itself.

As a matter of fact, I have often felt that some creationist or group of creationists could take on this task for each of the critical works that have appeared lately on this subject of origins, pro and con. However, such a project in each case would take up at least a number of times the pages of each of the original works. Creationists suffer under the dual handicaps of lack of free time, as well as the lack of the relatively large amounts of funds often available to macroevolutionists. A case in point might be the federal support granted the work on the BSCS biology texts.

I found this work fascinating reading, given my interest in the subject. However, Strahler comes from a different set of presuppositions than the majority of creationists. The subject of macroevolution is a difficult subject, since the presuppositions will so influence one's arguments, both as to selection as well as validity thereof. Strahler believes that the validity of microevolution validates macroevolution. This concept is not valid at all, as many current writers attest. I did note that Strahler included Weinberg's warning about the existence of a wide disagreement on what constitutes a species (p. 397). This would of necessity color any discussion of the question of the creation of new species.

The book is a compendium of a large selection of anticreationist literature. Having a large concentration of such material in one volume might be of help to the interested scholar. It could well serve as a valuable source book of such material.

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Addendum to Rusch Review

by Emmett L. Williams*

In chapter 13, Entropy and Universal Decay, Strahler offers his rebuttal to creationist arguments about the improbability of molecules-to-man evolution in the face of degeneration processes operating in the universe. The first part of the chapter deals with a brief discussion of thermodynamic systems and the laws of thermodynamics. He prefers a statistical interpretation of the second law to understand it (p. 87). The concepts of order and randomness are discussed. From consideration of statistical thermodynamics most systems should exhibit a random rather than an ordered arrangement simply because the possible random arrangements are more numerous, thus they are more probable (Williams, 1970, pp. 69-79). The chore facing naturalists is to demonstrate why most systems in nature are ordered/complex without resorting to an Orderer/Designer. Admitting that entropy is a difficult concept to explain and comprehend, Strahler relates the concept of increasing entropy to increasing disorder in a system (per statistical thermodynamics). Unfortunately he mistakenly claims that the order/disorder concept is a product of classical thermodynamics (p. 91) whereas it developed from applying statistical ideas to thermodynamics. Actually classical thermodynamics deals with the relationship between heat and work.

*Emmett L. Williams, Ph.D., 5093 Williamsport Drive, Norcross, GA 30092.

The author claims that the origin of the universe (big bang) was a state of low entropy (p. 88) which corresponds to a state of high order and complexity. His needed low entropy initial state is assumed, a defect in all naturalistic reasoning, without bothering to explain why the universe was in such a highly improbable state as a result of natural processes only. Nor does the oscillating universe hypotheses (p. 90) solve the problem. See Williams, 1983, pp. 27-40 for a creationist thermodynamic interpretation of the big bang initial state and oscillating universe postulates. Strahler suggests that the universe has an enormous entropy capacity (p. 88) possibly to allow for molecules-to-man evolution as entropy increases. However the universe cannot act as an entropy sink as irreversible processes occur (Prigogine, 1967, p. 17; Williams, 1981a, p. 100).

The author presents an unthermodynamic concept of open "subsystems," the purpose of which is to allow for a "local" entropy decrease through an injection of order/information/complexity while being coupled to a more ordered "subsystem." Of course entropy is increasing in the overall larger system to obey the second law. See Williams, 1981b, pp. 20-21 for a brief discussion of the fallacy of system coupling to allow for an entropy decrease in one portion of a system. Also the question is avoided of where did the initial higher order of the coupled "subsystem" originate.

Strahler admits however that cosmic creation and the origin of life must be explained by an act of God or spontaneous generation. See Thaxton, Bradley and Olsen, 1984, for problems involved with the spontaneous generation of life concept and the so-called "chemical evolution" experiments.

The hydraulic ram (p. 90) is offered as a "proof" for the occurrence of an entropy reduction "subsystem" while the entropy of the whole is increasing. The hydraulic ram (Gibson, 1952, pp. 664-74) is a machine designed, engineered, built and maintained by intelligent beings. It is a beautiful creationist analogy that indicates the introduction of order (decreasing entropy) must be accomplished by intelligence and cannot be employed legitimately as an example for the introduction of order by supposed brute natural processes. The hydraulic ram is used improperly as an analogy to growth in living systems. Growth is simply a replication of prior created order (Williams, 1981a, pp. 101-106).

Strahler seems disturbed over how often creationists comment on the inapplicability of crystal formation as a violation of the second law (p. 92), then he attempts to debunk the creationist arguments. Unfortunately the remarks are not aimed at the correct target. Over the years professional biologists have related to me that some of their professors employed crystal formation as a violation of the second law implying that molecules-to-man evolution could occur in spite of degeneration processes in nature. Also when I lectured on thermodynamics and the origins controversy throughout the country, college biology students would relate that their instructors presented crystal formation in this fashion in their classes. It is in this vein that creationists have spread so much ink attacking this bit of evolutionary folklore. Strahler notes (p. 92) that crystal formation is not a proper analogy for molecules-to-man evolution.

The author favors the hypothesis that clay particles could have been good sources for the origin of complex molecules needed for chemical evolution. He even suggests that they may have been our ancestors (pp. 521-24). This concept is not new (Williams, 1967). Strahler had better be careful for he is perilously close to suggesting a Biblical concept (Genesis 2:7)—not allowed for a materialist!

Strahler claims that creationists with the exception of Robert Gentry do not publish their origin papers in "mainstream" science journals because they are of inferior scientific quality. Could prejudiced peer review be a factor? Also he states that most creationist research is library work, not field and laboratory studies. A quick cure for this misconception would be a review of the 25 volumes of *CRSQ* referred to incorrectly as the Quarterly Journal of the Creation Research Society (p. 526). His reference list includes only eight articles from the Quarterly. With this lack of knowledge of creationist efforts he makes the sweeping statement that all creationist research is almost devoid of substantive results (p. 526).

In the reviewer's opinion, the rebuttal to creationist thermodynamics arguments and the origin of life discussion are shallow and outdated. At best creationist arguments are either not understood or are misrepresented.

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The Illustrated Origins Answer Book, by Paul S. Taylor. Films for Christ, 2628-A West Birchwood Circle, Mesa, AZ 85202. 128 pages. $8.95.

Reviewed by Dudley J. Benton*

The Illustrated Origins Answer Book is an improved and expanded version of the one which was originally intended to accompany the Films for Christ motion picture series *Origins*, featuring A. E. Wilder-Smith. In addition to clarifying and correcting a few points in the previous book, this latest work includes a large appendix with further explanations and references for the material in the main body (which is actually much smaller than the appendix). The main body—or really

*Dudley J. Benton, Ph.D., 1611 Hightop Trail, Knoxville, TN 37923.

the first part—of the book is illustrated and written on a basic level. The appendix—or second part—is much more detailed and has an extensive bibliography.

Both parts of the book are divided into six corresponding sections:

1) The Origin of the Universe
2) The Earth, a Young Planet?
3) The Origin of Life
4) The Origin of Species
5) The Origin of Mankind
6) The Fossil Record

There are 47 illustrations, from Archaeopteryx to our supposed ancestral tree. The appendix is divided into 318 subsections with titles such as "Suggested Sources for Information on Problems with Darwin's Interpretation of the Galapagos Finches" and "The Earths Magnetic Field."

Either of the two parts of the book even by itself is a valuable resource. Having the two bound together with an index and cross reference makes this book of even greater value. Paul Taylor has done an excellent job of explaining origins from the creationists' perspective and compiling the evidence for that position. The *Origins Answer Book* contains the most information on the subject in one concise package that this reviewer has ever seen.

INVITED PAPER

THE IMPACT OF MODERN THEORIES OF EVOLUTION UPON WESTERN INTELLECTUAL THOUGHT*

ELLEN MYERS**

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Abstract

The two major theories of evolution today are Darwinism and cosmic evolutionism. Because of the major scientific difficulties besetting both theories, neither can offer reliable guidance to man's thought and action. As a result, radically different and mutually contradictory movements and social action programs have arisen from these two theories.

In her extensive discussion of Darwinism's impact upon politics and society Gertrude Himmelfarb speaks of Darwinism's "inadequacy as a social theory" and points out that "In the spectrum of opinion that went under the name of social Darwinism almost every variety of belief was included." Jacques Barzun found that from about 1900 through World War I all political parties in every European country, no matter how mutually antagonistic, "invoked Spencer and Darwin." Robert C. Bannister reports that already in the 1880s the phrase "social Darwinism" meant "brutal individualism" for some, and at the same time a rationale for social reform and class struggle for others (Bannister, 1979, p. 4). This ambivalence and resulting confusion led Eric F. Goldman (1955, p. 71 ff) to distinguish between "social" and "reform" Darwinism. Both laissez faire, individualist free market economists as well as socialists have leaned upon Darwinism or related evolutionist world views for "scientific" support. Thus evolutionism, rejecting fixity of species and of the nature of man himself, led to confusion of human thought in politics and economics.

Numerous commentators agree that there was ample room for divergent interpretations of Charles Darwin's *Origin of Species and Descent of Man*. This was evident already in Darwin's own generation. Thus Thomas H. Huxley, "Darwin's Bulldog," thought that Darwinian natural selection undergirded state socialism since nature provided examples of socialism in the societies of bees and ants. Alfred Russell Wallace on the other hand saw sharp differences between animals and men so that in his opinion natural selection did not even apply to man (Bannister, 1979, pp. 31-32; Brackman, 1980, p. 346). Barzun (1958, pp. 74-86) has shown in meticulous detail that such differences were compounded by the lack of clarity in Darwin's writing style, by Darwin's hedging and self-contradiction, and by his vacillation over and modification of his theories in successive editions of *Origins*.

Darwinian evolutionism is a materialistic world view; its hypothesis is that all things are ultimately descended from one single unit such as the hydrogen atom. Leading New Age thinkers reject this materialism, including its alleged "scientific" mechanisms (Roszak, 1975, p. 99; Ferguson, 1980, p. 159; Rifkin, 1983, first four chapters). Nevertheless "materialistic" Darwinism and "spiritual" New Age pantheist mysticism agree on the essential oneness of all things. Loren Eiseley recognized this monistic New Age element (though not by that name) in Darwinism when he praised Darwin for "one of the most tremendous insights a living being ever had." It was the vision of man's and animals' "origin in one common ancestor—we may be all melted together." Eiseley (1962, pp. 351-52) commends this "statement of almost clairvoyant perception" and regrets that "very few youths today . . . are capable of saying to themselves, 'We are all one—all melted together'." Today many youths share Darwin's "tremendous insight."

Both imperialism and pacifism before World War I claimed Darwinism as their rationale as Bannister (1979, Chapter 12, pp. 226-42) and Richard Hofstadter (1955, Chapter 9, pp. 170-200) have shown. Hofstadter (1955, p. 200) reported that William Jennings Bryan,

*Editor's Note: The topic of the influence of the theory of evolution on modern intellectual thought has been covered by many creationist writers in the past. Yet it is a vital pursuit and Ellen Myers' article offers some fresh perspectives. For a recent Quarterly article on the subject, see Carson, C. B. 1988, Naturalistic outlook. *CRSQ* 25:16-24.

**Ellen Myers, M.A., 1429 N. Holyoke, Wichita, KS 67208.

troubled about the social implications of Darwinism, said after reading Darwin's *Descent of Man* in 1905 that Darwin's teachings would "weaken the cause of democracy and strengthen class pride and the power of wealth."

Modern racism and its sister movement, eugenicism, which flourished between the 1880s and 1940s and is resurgent again today through the contemporary push for "euthanasia" ("medical treatment" by starvation or outright killing of the severely handicapped, comatose and the infirm aged), is also rooted in Darwinian evolutionism. The founder of eugenicism was a cousin of Charles Darwin, Sir Francis Galton (1822-1911). Mark A. Haller (1963, pp. 3-4) writes that "eugenics was the legitimate offspring of Darwinian evolution, a natural and doubtless inevitable outgrowth of currents of thought that developed from the publication in 1859 of Charles Darwin's *The Origin of Species."* Galton "claimed that eugenics was practical Darwinism. His intention was . . . 'to see what the theory of heredity, of variations and the principle of natural selection meant when applied to Man' " (Jones, 1980, p. 99). Galton states that:

> There is nothing either in the history of domestic animals or in that of evolution to make us doubt that a race of sane men may be formed, who shall be as much superior mentally and morally to the modern Europeans, as the modern European is to the lowest of the Negro races (quoted in Howard and Rifkin, 1980, p. 44).

Eugenicism spread all over the western world including America where it was spearheaded by Harry H. Laughlin and birth control pioneer Margaret Sanger. Its "finest hour" arrived in 1924 when Congress passed an immigration law restricting immigration to two per cent of the foreign-born from each country according to the 1890 census in order to preserve a "nordic" balance among the American population. This law remained in effect until 1965 (Howard and Rifkin, 1980, pp. 66-70). Eugenic sterilization laws were also passed in 30 states between 1907 and 1931, Canada, all Scandinavia and Iceland, and of course in Nazi Germany. The Nazis considered themselves the most forthright enforcers of Darwinian evolutionism, as especially Daniel Gasman (1971) has incontrovertibly shown.

The acceptance of Darwinism by Karl Marx and his followers is well documented. Marx praised Darwin's *Origin of Species* because "the death blow [is] dealt here for the first time to teleology in the natural sciences" (quoted in Himmelfarb, 1962, p. 421). Gasman (1971, p. 107) perceptively comments that Marx discovered in Darwinism:

> a scheme of development, similar to his own, which excluded the intervention of both God and man. For Darwin, nature evolved inexorably and alone, free of outside interference. For Marx, the course of history was determined largely by the unconscious operation of the forces and relations of material production.

Marxist-Communists were not alone in adopting evolutionism and importing it in Russia. Vladimir Solovyov (1853-1900), Russia's greatest philosopher, preached a New Age-type world view permeated by Darwinism as well as pantheist-gnostic concepts until shortly before his death when he completely reversed his views and returned to orthodox Christianity. He expressed his earlier enthusiastic and somewhat mystical acceptance of evolution out of primeval chaos in his influential paper "Beauty, Sexuality, and Love" (Schmemann, 1977, pp. 73-134, especially pp. 80-84 and pp. 94-95). The artists, poets and writers of the famous Russian Silver Age of art and literature before World War I deeply imbibed Darwinian as well as "New Age" type cosmic "spiritual" evolutionism from Solovyov and also directly from the West, where the "vitalist evolutionism" of Henri Bergson (1859-1941) and George Bernard Shaw (1856-1950) was then winning many followers. Pierre Teilhard de Chardin (1881-1955), the apostate French Jesuit priest who may have been involved in the Piltdown Man fraud, was a student of Bergson and became a chief developer of the New Age evolutionism of our own day. Teilhard is a sort of cult hero of the New Age movement as is evident from New Age leader Marilyn Ferguson's seminal work *The Aquarian Conspiracy*. "Scientifically" speaking, Ferguson along with other New Agers like Roszak and Rifkin (see above) rejects Darwinism. Instead she endorses the Gould-Eldredge evolutionary model of "punctuated equilibrium" because "it opens us up to the possibility of rapid evolution in our own time, when the equilibrium of the species is punctuated by stress" (1980, p. 159). Ferguson (1980, p. 162) speculates that mankind's imminent evolutionary leap may lead to a community like a Kenyan flattid-bug colony which "is, in a sense, a single individual, a single mind, whose genes were influenced by its collective need." This speculation is akin to the collectivist utopianism of Marxists, socialists and communists. It is adopted almost verbatim from vitalist evolutionist British author Colin Wilson's book *The Occult* (Wilson, 1971, p. 128). Its enormous influence especially among young people today cannot be overestimated.

In conclusion, the influence of evolutionism in both its modern Darwinian "materialist" and its New Age style "cosmic-spiritual" forms has been powerful and all-pervading. Mutually antagonistic movements sprang from evolutionism which is unable to offer unambiguous guidance for human action. Evolutionism has spawned such scourges of Western society as social Darwinism, racism, eugenicism, Nazism, socialism, Communism, and related collectivist trends. Though "cosmic-spiritual" evolutionists often reject Darwinian evolution mechanisms, they join the still powerful Darwinists in denying creation as the explanation of origins. The modern creation movement offers the only consistent alternative to evolutionism in both forms.

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LETTERS TO THE EDITOR

Genesis and Genetics

In his letter "Genetic Variability" (1989), Raymond Bray criticizes conclusions drawn by Dr. Walter Lammerts, but then draws some unwarranted conclusions of his own. He suggests that the word "perfect" (Genesis 6:9, KJV) means that Noah was genetically perfect. However word meanings should be drawn from their usage in Hebrew, not what the English might be taken to mean. Given Bray's meaning, would we then conclude that the sacrifices offered at the temple were all "genetically perfect" (Leviticus 22:21), or that Israel was commanded by God to be "genetically perfect" (Deuteronomy 18:13)? (Compare 1 Kings 8:61.) The word *tamim* when applied to human beings is better translated "blameless" and refers to the kind of lifestyle that flows from a consistent walk with God. We need to be careful not to impose OUR imagined meanings on the Biblical text.

It is also less than certain that "the human stock had been contaminated by the genes of fallen angels" (Bray, 1989, p. 67). That is one, but not the only possible interpretation of Genesis 6:4. Bray assumes his interpretation to be fact. Bray's other points may well have some value.

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Vernon A. Raaflaub
4836 52A St.
Camrose, AB Canada
T4V lW4

More Thoughts on Relativity

Since my paper on the Special Theory of Relativity, STR, (Benton, 1988), I have received several letters from readers questioning my quotation of Michelson rather than Einstein and my use of the terms "actual" and "apparent." I unashamedly admit to preferring Michelson's explanation of the STR to Einstein's own. First, I believe Michelson to be more objective than Einstein when defending his own theory. Second, Einstein was not known for being particularly consistent or sequitur in his logic. Michelson, on the other hand, was known for being meticulous in these matters.

Third, I think it important to consider the STR objectively, as a scientific theory and to separate it from its philosophical baggage, which is a separate issue. I believe Michelson to have approached it in this way. I have never seen any evidence to suggest that Michelson and Einstein ever collaborated on anything. However, Einstein's theory would not be remembered were it not for the work of Michelson.

As to my use of "apparent" vs. "actual," the best way I can think of to explain this is with an analogy. I see the STR as being analogous to the Coriolis force discussion. To the observer walking about on an iceberg or carousel there "appears" to be a force acting mutually perpendicular to the rotation and velocity. "Actually" there is no such force. What "appears" to be a force is "actually" a component of the total acceleration, a bias of the moving observer. The most basic statement that can be made about the STR is that it is an attempt to relate the bias of one moving observer to that of another.

I think it is necessary to approach the STR on two levels: scientific and philosophical. It is important to make a distinction and to address each. I have not attempted to address all of the philosophical implications of the STR. Furthermore, I do not consider it an inescapable conclusion that all of the philosophical baggage which the STR has collected over the years is confirmed simultaneously with any and every high energy particle experiment which might agree with the mathematical formulae. Specifically, if I choose to employ the formulae in a numerical model of a plasma, this does not mean that I do so without reservation or that I also accept such things as the Twin Paradox.

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Dudley J. Benton, Ph.D.
1611 Hightop Trail
Knoxville, TN 37923

Granite Intrusions

I followed with interest the arguments between Wise (1989) and Gentry (1989), but I felt I should comment on Gentry's hypothesis that granite bodies intruding Flood-deposited Phanerozoic strata were emplaced cold and solid by tectonic processes and not as hot 'crystal mushes.' Several logical predictions can be derived from this hypothesis, some of which I will enlarge upon here since Gentry seems to be unaware of the gravity of these criticisms. If Gentry's hypothesis is correct then:

1. *Granite bodies should be fault-bounded blocks* (i.e. they should exhibit faulted contacts with the surrounding country rock).
2. *Granite bodies should not exhibit chilled margins,* since chilled margins form by rapid cooling of the magma upon contact with a relatively cold country rock.
3. *Granite bodies should not contain any xenoliths of surrounding country rock,* since these could only be incorporated into the granite if it were still fluid.

Unfortunately, numerous cases of direct field evidence conflict with each one of these logical progressions from the initial hypothesis.

1. Whitten and Brooks (1972, p. 50) write: "Some batholiths or parts of batholiths have relative sharp contacts with the country rock, while others have diffuse, transitional contacts." I have examined contacts of granites with sedimentary strata myself (e.g. the South West England batholith) and have seen contacts which are certainly not fault boundaries.
2. Convincing finer-grained chilled margins can be documented from many plutonic bodies as Wise (1989, p. 173) notes. This demonstrates that the batholiths were still cooling when emplaced.
3. Many granites can be observed in the field containing xenoliths, assimilated to varying degrees. One example is the xenolith-rich Thorr granodiorite of Donegal, Ireland (Pitcher, 1952). Hall (1987, p. 71) writes: ". . . there are many examples of granites rich in undigested xenoliths." Xenoliths seem to demonstrate conclusively that the granite was fluid enough for blocks of country rock to sink into it, and hot enough in many cases to partially melt them, giving them diffuse edges. Furthermore, some xenoliths appear to have been aligned and flattened by the flow of the granitic fluid.

Unless Gentry can provide convincing, alternative explanations of these phenomena it would appear that his hypothesis of granite emplacement has been falsified. This is not to detract from Gentry's investigation of the origin of the mysterious polonium halos. It is not at all clear to me that uniformitarian geology adequately accounts for them. However, it does appear conclusive to me that granites were, on the whole, intruded into Phanerozoic rocks as hot fluid magmas during and after the Flood, and not as tectonically-emplaced blocks of supernaturally-formed Creation Week basement.

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Paul A. Garner
11 Brookside Grove
Littleport, Cambridgeshire
CB6 1JN England

Reply to Garner

I appreciate the interest in my work shown in the foregoing comments and the opportunity to respond to them in this issue of the Quarterly. To a large extent those comments involve interpretations based on the usual concepts of conventional geology. As will now be seen, my Creation Model—outlined in my response to Wise—involves other possibilities for interpreting the same phenomena.

1. *Granites, sharp contacts, and diffuse contacts*— In my Creation Model granites are a type of created (primordial) rock. They may sharply contact with other types of created rock—such as gabbro—or they may grade into still other types of created rock, which geologists may classify as "country rock." Neither of these examples would involve faulted contacts.

Granite contacts with sedimentary rocks — In instances where granites contact sedimentary strata, there is the possibility that granite blocks were uplifted into sedimentary strata freshly laid down by action of the Flood. I have seen considerable evidence to support this view at some of the open-pit copper mines in southern New Mexico. Quite possibly, the degree to which the sediments had become indurated prior to the granite uplift would determine the degree to which faults would develop under these conditions. There is also the possibility that in certain instances granite blocks were uplifted during the Flood *prior* to the deposition of sedimentary strata in a given area. Subsequent erosion—primarily of the softer sedimentary rock—would expose a contact between granite and sedimentary rock, but under these conditions no fault contacts would be expected.

2. *Granites and chilled margins* — Garner claims that fine-grained chilled margins *demonstrate* that batholiths were still cooling when emplaced. This is untrue. No demonstration is involved. What is involved is an interpretation based on uniformitarian geology. In particular, "cooled margins" represents an interpretation associated with fine-grained rocks. Experimental evidence shows that rapidly cooling magmas do produce fine-grained rocks, but I do not accept the conventional geologic view that all fine-grained rocks are the result of rapid cooling. My Creation Model includes both coarse-grained crystalline rocks—such as granite, gabbro, diorite, and granodiorite—as well as certain fine-grained rocks as being the result of creation. This is, I believe, the explanation of certain areas where coarse-grained primordial rocks grade into fine-grained primordial rocks. In these instances the fine-grained rocks do not represent chilled margins just as the granites themselves do not result from a slowly cooling magma.

3. *Granites and xenoliths* — Garner concludes that the existence of xenoliths in granites is inconsistent with granites being primordial rocks. I believe, however, this conclusion results from imposing a uniformitarian geological framework onto a very restricted interpretation of my views on the origin of various rocks. I have not restricted the types of created rocks except to exclude those that contain fossils. My Creation Model, outlined in my response to Wise, encompasses several different possibilities wherein a host "intrusive" rock might contain rocks of an entirely different composition and texture.

To briefly reiterate, in my Creation Model there are: (i) rocks that were created, (ii) rocks that formed during the Flood, and (iii) rocks that formed subsequently. The tremendous upheavals at the time of the Flood provided an ideal setting for the incorporation of both small and large pieces of primordial rocks into underground magmas, which, when cooled, formed composite rocks. This would be an example where a xenolith would be a created rock in the matrix of a secondary (non-primordial) intrusive rock. Undoubtedly, this same process has occurred many times since the Flood, with the additional possibility that certain Flood rocks may have themselves become xenoliths in other subsequently formed rocks of magmatic origin.

Next, my Creation Model includes a scenario wherein granites—being the rock type which is presently under discussion—were created containing a variety of other types of rocks of various sizes. However, when uniformitarian geologists view this created rock within a created rock occurrence, they would interpret it as a xenolith within an intrusive rock because they have been trained to believe that granite formed from a slowly cooling magma. Generally they are unaware of the polonium halo evidence for creation of the granites, and for the most part have not fully considered that *their* view of the "intrusive" origin of granite is contradicted by the fact that a granite melt in the earth cools to form rhyolite, not granite. Geology textbooks have long stated rhyolite is the extrusive form of granite, but the experimental evidence from deep drill cores is that rhyolite, not granite, is also the intrusive rock that cools from a granitic melt. In other words, rhyolite is formed both extrusively and intrusively. In contrast, granite is primordial.

That granites—large bodies of created rock—should contain isolated pieces of other types of created rock is no different in principle from the fact that created entities of lesser size—minerals, for example, such as hand-sized crystals of biotite—often contain a considerable variety of even smaller created entities, as evidenced by the occurrence of isolated, microscopic grains of accessory minerals. In my view this is an integral part of the hierarchical order of creation in the mineral kingdom, which is akin to the hierarchical order of creation so clearly evident in the plant and animal kingdoms, and so spectacularly displayed in the realm of the cosmos—moons, planets, stars, galaxies, and clusters of galaxies.

Summarizing, nothing in my Creation Model excludes granites from containing other types of created rocks. Thus, there are undoubtedly instances where geologists may have used the term xenolith to describe what is actually a created rock embedded within a created rock.

Now because of their uniformitarian training, most geologists would find it impossible to accept a category of xenoliths that includes the occurrence of primordial (created) xenoliths within primordial granites. Yet if we search the literature on the Sierran granites in California, we find descriptions of a most interesting geological phenomenon which bears on this topic. In particular, we find descriptions of a phenomenon having compelling implications about the origin of xenoliths within the Sierran granites and, in fact, implications relative to the question of the origin of the Sierran granites themselves. I refer to an article published over six decades ago in the well-known *University of California Publications in Geological Sciences* series, entitled "Inclusions in Granitic Rocks of the Sierra Nevada," (Pabst, 1928). The first section describes the geological phenomenon as follows:

> Far more abundant than any clearly xenolithic material in the granitic rocks of the Sierra Nevada are certain dark inclusions, most of which have a definite group resemblance wherever they occur and which have not been traced to any definite sources outside their present matrix. These are the chief subject of the present inquiry.
>
> Such dark inclusions have been called basic concretions, basic segregations, autoliths, and other names carrying some genetic implication. . . .
>
> For brevity Holland's word "autoliths" will here be used to designate those bodies in the Sierran granites which have not been shown to be derived from some preexisting rock. (Pabst, 1928, p. 328)

According to Pabst's article, his results on the autoliths were based on observations in widely separated parts of the Sierra range, and thus were taken to be representative of conditions throughout the range.

He describes the autoliths as being extremely variable in size, ranging from just a fraction of an inch to more than a yard in length, with their distribution being very irregular. They occur singly, or in great concentrations in swarms. However, in either case their appearance is similar. The shape is most often spherical or ellipsoidal, but ribbon shapes are also observed. The problem in accounting for these autoliths on any conventional basis is that while they appear to have experienced plastic deformation at the time of emplacement—thus suggesting to geologists that they originally were derived from a magma—the rims of the autoliths show rather sharply defined contacts with the enclosing granite. But "granite magma" in contact with "autolith magma" should have merged as any two hot liquids will do—especially when there is fluid flow—and there should be no sharply delineated contact. In other words, there is a flat contradiction between the expected appearance of the autoliths based on the conventional view that both granite and autoliths had somehow cooled from a magma, or magmas, versus the actual physical appearance and mineralogical characteristics of the autoliths in their relation to the host granite.

If, however, granites are created rocks, then we can understand that, in addition to the trillions of microscopic evidences for creation which God left in the granites in the form of primordial polonium halos, He also left an enormously large number of macroscopic evidences for creation in the form of autoliths. Moreover, these evidences for creation are easily visible, and can be understood even by individuals who have little or no scientific training.

Indeed, in my view the occurrence of the autoliths in the Sierran granites is just a part of the undeniable evidence of the hierarchical order of creation in the realm of the rocks. The hierarchical order of creation for the rocks—stretching from the smallest, to the intermediate, to the largest—from polonium halos on the microscopic scale, to the easily visible autoliths in the granites, to the magnificent, gargantuan 100 ton crystals of minerals in the pegmatites, all reveal the outworking of creative activity in nature which is beyond the power of science to reproduce.

Reference

Pabst, A. 1928. Inclusions in granitic rocks of the Sierra Nevada. *University of California Publications in Geological Sciences* 17:325-86.

Robert V. Gentry
Earth Science Associates
P.O. Box 12067
Knoxville, TN 37912-0067

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QUOTE

There are three modern commonplaces among dilettante students in psychology, theology, and religion: (1) the Freudian dictum that religion is an infantile neurosis which must be overcome, although Freud himself was pessimistic that this could happen; (2) the Feuerbachian claim that man created God in man's image, instead of God creating man in the divine image; and (3) the Comtean positivist assertion that this universe is simply there; that phenomena are cold, bald facts; that what many of us would call the soul or spirit of each person is merely the epiphenomenal vapor that is momentarily created by the physiological motion of the blood, by synapses in the brain, and by the bright spark in the eye, in much the same way that a locomotive puffs out elusive and transitory clouds of steam. Once the trip is over, the vapor disappears. Hamlet's "immortal longings" are mortal, indeed!

Reist, Jr., John S. 1987. Telling the truth: a Biblical view of personality in Burke, T. J. editor. *Man and Mind: A Christian Theory of Personality*. Hillsdale College Press. Hillsdale, MI pp. 159-60.

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