MINISYMPOSIUM ON VARIABLE CONSTATNS--VII

ON THE VIABILITY OF VARIABLE CONSTANTS

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Abstract

The feasibility and implications of variations in the fundamental constants are examined. Although such proposed changes appear at present to be strongly ad hoc, it is argued that this is not a fatal deficiency. The apologetic function of theorizing is briefly discussed. The distinction between operation and origin science is emphasized. It is suggested that more emphasis should be placed on the underlying philosophical issues.

Introduction

Recently there has been much discussion regarding the possibility that some entities normally considered to be fundamental constants are in fact time-dependent. Barry Setterfield (1981), in particular, has argued that the speed of light was much higher in the past. By developing this thesis he hopes to reconcile an apparently large universe with a young age.

The notion that some of the fundamental constants may be variable is not new. On the basis of measured values of the speed of light c, the suggestion that it is decaying was made at least by 1931 (de Bray, 1931), if not earlier. On theoretical grounds, it was proposed by Milne (1935, p. 292) and Dirac (1937) that the gravitational constant G varied with time. Gamow (1967) considered also the possibility that the electron charge e was time-dependent. This raises questions as to the reality and feasibility of changes in the fundamental constants, as well as the physical and philosophical implications of such changes. I will also discuss whether such apparently bizarre theories are worthy of consideration.

Empirical Evidence

Direct experimental measurements of variability of a fundamental constant would, of course, present the most compelling grounds for belief in such hypotheses. Unfortunately, none of the direct evidence is of a decisive nature. Norman and Setterfield (1987) have extensively analyzed historical measurements of c and have claimed to demonstrate an exponential decay. However, their analysis has been questioned, particularly with regards to the values of a number of crucial historical determinations of c. No less disturbing is the fact that over the last few decades, when very sensitive measuring devices are available, the decay seems to have stopped.

Although Van Flandern (1975) did measure a small linear decay in G, the effect is only about twice the estimated probable error. Again, the uncertainties are such that more accurate observational evidence is needed before definite conclusions can be drawn. I conclude that the empirical evidence is, at present, open to question.

Even if the variability of a fundamental constant can be observationally demonstrated, it is quite another matter to extrapolate this exponentially into the more distant past, as Setterfield has done. The hypothesis that the speed of light was virtually infinite six millennia ago must surely be regarded much more speculative than the mere notion of variability of c.

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The Possibility of Variability

In the absence of unambiguous empirical confirmation, are there other weighty considerations as to the feasibility of variable constants?

(a) The Problem of Induction

Scientists often take for granted that induction (i.e., the assumption that the laws of physics observed operating here and now are valid universally) is valid. At first sight induction may seem to argue against variable constants. However, the justification of induction is one of the outstanding problems in the philosophy of science. As David Hume pointed in 1739, there is no compelling reason for believing it. Induction cannot be justified by observation (since the unobserved universe is, by definition, unobserved) nor by logic (since there is no logical reason why the universe must behave uniformly). It may be the most convenient possibility, but that in itself does not guarantee its truthfulness. Thus, in this regard, we must leave open the possibility of variable constants, of which a miracle is just a special extreme case.

(b) Theological Objections

Are there perhaps theological difficulties? It has been asserted by the Dutch philosopher Herman Dooyeweerd and some of his followers that the cosmic law order is unchangeable in time. J. M. Spier (1966, p. 31), for example, interprets Genesis 8:22 to mean that God promised "that nature would conform to a constant law."

To this a number of comments are in order. First, the promises of God concerning his covenant with nature (e.g., Genesis 8:22, Jeremiah 33:25) refer directly only to a continuous succession of day and night, summer and winter, etc. God promises that there will be no more drastic catastrophes of the magnitude of the Flood. To infer from this that, say, the length of the day is invariable is to go beyond the text. Although numerous texts do refer to the unchangeability of God, these are always with regard to God's faithfulness towards man. They do not refer explicitly to an unchangeable law structure. Indeed, it is precisely because of God's unfaltering faithfulness that he sometimes modifies the normal sequence of cause and effect (e.g., the crossing of the Red Sea).

Second, even if God's laws were fixed, the same need not apply to our human formulations of them. It may well be that what we consider to be a fundamental constant is actually a variable whose changes are controlled by deeper, divinely ordained, fixed laws. Note also that, if Genesis 8:22 is used as proof of the constancy of natural laws, the further implication is that before the Flood this was not the case. Indeed, some theologians have suggested a (discontinuous) change in the law structure after the Fall (and after the Last Judgment). I conclude that also on theological considerations there appears to be room for variable constants.

(c) Physical Objections

What about the physical implications? Does it not imply breaking fundamental principles, such as conservation of energy and momentum? It must be kept in mind that there is nothing sacred about the conservation laws. In classical mechanics such laws as those of conservation of energy and angular momentum can be derived from Newton's laws. But in allowing fundamental constants to vary we are making drastic changes to these laws and, consequently, the normal conservation laws may require reconsideration. For example, in a number of scientific papers where variation in G has been considered, it has been speculated that energy, mass, or angular momentum may perhaps not be conserved—not for all choices of units (Dirac, 1972). In steady state cosmology the postulation of the continuous creation of matter clearly violated the usual conservation laws. Similar challenges to conservation laws are presented by inflationary big-bang cosmology, in which it is hypothesized that the entire universe—with all its energy, mass, and entropy* —spontaneously appeared out of nothing.

Norman and Setterfield (1987, p. 29) do assume that, for appropriate choices of units, certain quantities are conserved (e.g., energy, magnetic and electric potential). But this requires further change in other fundamental constants. It is thus evident that conservation laws pose no insuperable objection to variation hypotheses: one can either modify the conservation laws or postulate compensating changes in other physical constants.

Saving the Phenomena

Given that changes in the fundamental constants are at least possible, let us next consider whether they can readily "save the phenomena" (i.e., account for the observational data). Can Setterfield's theory, for example, be made to fit the facts? It is clear that there are various consequences arising from the hypothesis of a varying c. We have seen that, in modifying and applying conservation laws, other fundamental constants are likely to be affected. There will undoubtedly also be further observational implications. For example, if light from distant objects was emitted when c was very high and rapidly decaying, this may well entail observable effects in such phenomena as stellar spectra or pulsar rates. A change in c and e (charge on the electron) may alter the stability of atoms, thus further modifying the radioactive decay rates.

Setterfield has dealt with some of these questions. But can he account for everything? In principle, at least, the answer is affirmative. According to the Duhem-Quine principle, a scientific theory is never tested by itself in isolation, but always together with a host of secondary theories. Thus any favored scientific theory can always be made to fit the facts by suitably modifying the auxiliary hypotheses. And hence, given sufficient ingenuity and some fancy theoretical footwork, it would seem that Setterfield's theory can always be rescued.

Ad Hoc Theories

Of course, a theory that must be supported by artificial, ad hoc devices is generally not highly ranked in terms of plausibility. Nevertheless, however difficult it may be to demonstrate a particular ad hoc theory to be true, it is even harder to conclusively disprove it. In science there are no definite, objective criteria that enable us to readily distinguish true theories from false ones. Even ad hoc theories, particularly concerning the distant past, can not be proven to be false. Indeed history is replete with unlikely events that actually occurred.

Moreover much of origin speculation is of a decidedly ad hoc nature. Thus, for example, the recent inflated big bang model has been criticized for being excessively untestable and ad hoc (Oldershaw, 1988). Similarly, evolutionary scenarios for the origin of life, involving various unlikely recipes for primordial soup, seem equally artificial. Or consider Nobel Laureate Francis Crick's (1973) hypothesis that life arrived here via a rocket from outer space.

Why are ad hoc theories, in spite of their repugnant nature, still advanced? Primarily because, in the absence of better alternatives, they do explain the observations in terms of a favored theoretical or philosophical principle. Thus, in the above cases, the proposed theories are approved in spite of their ad hoc nature simply because they are still the best theories that satisfy certain imposed constraints (e.g., Biblical data, or a purely naturalistic account of origins). Of course, those who do not accept these (often implicit) restrictions have little incentive for accepting the proposed ad hoc theory. Thus Setterfield's model, ad hoc as it may be, does have the advantage of satisfying the Biblical framework. As such, at least to those who accept the authority of the Bible, it still is to be preferred over competing theories that do not.

The real difficulty that evolutionists have with creationists is not so much with the ad hoc nature of their theories as with their prior acceptance of the Bible and the restraints it imposes on theorizing. To quote just one prominent evolutionary spokesman: "the major reason why Creation-science is not genuine science is that its supporters have to believe, without question or dispute, in the literal truth of Genesis" (Ruse, p. 393). It is evident that the basic issue here is one of religious presuppositions.

Apologetic Considerations

One might object that ad hoc theories should still be avoided since a prime goal of creationists is to convince the unbeliever of the reasonability of Biblical events. It might then be argued that, rather than spending limited resources on seemingly unlikely theories, research should be concentrated on polishing up the details of the most promising model.

***Editor's Note: Entropy is not subject to conservation laws.**

There are, however, dangers involved with staking too much on one model. First, the more elaborate the model, the more susceptible it is to observational disproof. Of course, it can always be patched. But should the model turn out to appear too implausible (in the eyes of the sceptic) then, in the absence of alternatives, its demise may well result in the subsequent rejection also of the Bible which it purported to support. Caution must be taken to avoid falling into the trap of justifying faith in the Bible on the basis of our ability to provide "scientific explanations" of Biblical events.

An instructive historical illustration of this is described by Allen (1963). In the 17th century, theologians were asked many scientific questions regarding the Flood. The Catholic theologians met scientific difficulties by declaring that the impossibility of explaining the mechanics of the Flood clearly showed that it was a miracle. But the Protestants, being anxious to prove that all of the Bible accorded with human reason worked out precise scientific solutions. Their failure to explain the details to the satisfaction of the critics eventually led to the inspired history of Noah being relegated to simply a myth. Do not forget that if a scientific model is to be judged acceptable by the unbeliever then it must satisfy criteria set by ***him.*** Since such standards are bound to be at heart unbiblical, the verdict is a foregone conclusion. Those who have rejected God can hardly be expected to objectively evaluate His Word.

Finally, rather than confronting the unbeliever with God's Word and the need for repentance, the above apologetic implies that the unbeliever is justified in rejecting Scripture until acceptable scientific explanations of it have been established. The Biblical data must be adopted as basic, as a non-negotiable article of faith. The trustworthiness of God's Word must not be made contingent upon our ability to explain it or prove it "reasonable" by human standards. Let the onus be on those who reject the accuracy of the Bible to demonstrate the alleged impossibility of Biblical events. And if the Biblical data are not readily explicable in terms of a scientific model this should merely serve to illustrate the inadequacy of human theorizing.

Multiple Theory Approach

Let us be clear then that our prime allegiance is to God and His Word, rather than to any human, scientific explanation of any portion of it. Granted that all scientific models are speculative and probably wrong, at least in their details, no undue emphasis should be placed on any particular model. Let us not be tied down unnecessarily: any theory in accordance with Scripture should be worthy of consideration. Better six sketches of possibilities than one detailed theory upon which too much trust is placed.

'In this regard, a multiple-theory approach to origins carries with it a number of advantages. The multiple model approach has more chance of finding good possibilities and underlines the fact that the observational data can be interpreted in many different ways. It cautions against accepting any model as the final truth. It emphasizes the subjective, conjectural element in model building, the great gap between observational data and theories that claim to explain the data.

Thus, for example, with regard to the light travel time problem, there are other possibilities. Perhaps light was created en route. Perhaps space is curved. Perhaps c is not time, but space-dependent. Consider, for example, the formula $c = c_o + A\,(V_o/V)^B$, where c_o is the speed of light near the Earth, V_o is the gravitational potential at the Earth, V is the gravitational potential at the point of space of interest, and A and B are chosen to make c very large in interstellar space. No doubt other possible solutions can be constructed. Which one is correct? Only God knows, and beyond that which He has revealed through direct observation and through His Word, we can only guess.

Origin and Operation Science

Recently the distinction has been made between origin science and operation science (Geisler and Anderson, 1987). The latter is concerned with repeatable events, the former with singularities such as creation. I believe this difference to be very important. Operation science is certainly justified by the cultural mandate (i.e., Genesis 1:28), in so far as its goal is that of useful application. Origin science, on the other hand, is chiefly concerned with conjectures about the distant past. Given the highly speculative nature of its theories, I question its cognitive value. In the absence of objective, valid epistemological criteria that would enable us to detect true theories of origins, origins science can be rated little better than an amusing intellectual parlor game: fun to play, perhaps, but hardly deserving of too much devotion.

Instead, further attention should be focused on the underlying philosophical questions. Here devastating offensives can be mounted against the alleged reliability of secular origin science. The secular scientific community should be challenged to acknowledge the highly subjective nature of theory construction, selection, and justification; to concede the major role in science played by religious and philosophical presuppositions; and to be less dogmatic about pronouncements regarding origins. Hopefully the recent book ***Christianity and the Nature of Science*** by J. P. Moreland, which gives an excellent overview of the philosophical issues pertaining to the creation/evolution debate, will help stimulate further thought and action in this direction.

Conclusion

It would appear that the current status of creationist variable constant theories is that they are largely ad hoc. But this in itself is not lethal. For all we know, they may still be close to the truth.

The main problems are those of epistemology: what do we take as our prime source of knowledge, how do we choose and justify theories, etc. We must accept the Bible as the inerrant Word of God on the basis of faith, as a fundamental presupposition, rather than on the basis of how well our models can account for the Biblical data. Consequently, we should present any model merely as a possible explanation of present observations in terms of Biblical events. However, a better defense of the faith against secular science is not a demonstration as to how well the Bible fits in with human theories and standards, but an exposure of the highly subjective nature of scientific theorizing, particularly with regard to origins. Let us shift the creation/evolution debate to more philosophical lines, for at heart the battle is one of prior religious commitments.

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MINISYMPOSIUM ON VARIABLE CONSTANTS—VIII

A CHANGING VARIABLES MODEL FOR THE SPEED OF LIGHT

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Abstract

The speed of light is thought to be a fundamental constant of physics. This paper proposes a model for allowing the speed of light, c, to be changing with time. It is shown that a decaying exponential with the appropriate boundary conditions would accommodate the apparently constant value for c that modern measurements have provided, even if the value of c is changing.

Introduction

Science began when man attempted to systematically catalog repeatable experiences. Collections of observable, repeatable experiments led to the development of scientific models. These models provided a framework for understanding how the bits and pieces of experimental data fit together. A necessary condition for a model to be classified as scientific is that it be falsifiable. A model which is not falsifiable is usually classified as a tautology, whether true or false, and is not classified as a scientific model or theory.

Models can change as new data are gathered. If the new data results in only minor changes to the model, then the model is robust. If the new data requires major changes to the model, or the new data makes the model contradictory, or reliant on secondary assumptions to maintain its integrity, the model becomes weak and probably should be discarded.

Our present model of the speed of light, c, assumes that it is a constant parameter. There is a model which will allow us to consider c as a variable, and still give us a closely constant c at this time in history.

Conditions for Model Revision

Classical physics fails to explain the behavior of very small things (sub-atomic particles) and things which travel very fast (close to the speed of light). Because of this, the classical model was revised to account for high speed phenomena (relativistic mechanics), and further revised to account for very small particles (quantum mechanics). Whether or not relativity or quantum mechanics do describe what is really happening, the addition of these two ideas to the original classical model does seem to explain what cannot be explained apart from them. The quantum mechanical and relativistic models, however, are not independent of the classical model. The revised model does not negate the original model. The classical model still holds true for relativistically slow and quantum-relationally large objects.

If classical physics can undergo such a revision in its model, then perhaps our present models based on physical "constants" may be only an approximation of a better model which would use physical "variables" instead of "constants." The new model, however, cannot abandon wholesale, the previous model, just as quantum mechanics and relativity do not abandon classical physics. The revised model would accommodate the constant constants model within the framework of a larger superset called the changing variables model. The changing variables model would approximate to the constant constants model, given the right boundary conditions. Such is the case, for instance with relativity for slow moving objects, and quantum mechanics with large objects. They both a proximate to classical physics given the right boundary conditions, i.e., large and slow objects.

The Speed of Light as a Changing Variable

One such parameter which might be variable is the speed of light. If it is changing, then the change is very small. It is so small in fact, that it has evaded our most sensitive instruments. Changes of many orders of magnitude, however, may have occurred in the past. What sort of time relationship satisfies the condi-

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