its beginning and at its end by real-world observations. I trust that this overcomes your difficulties.

EINSTEIN'S RELATIVITY AND SPEED OF LIGHT DECAY.

Some questions from Mr K. Nolan of East Keilor, Victoria, Australia.

The notion that the speed of light in vacuo, c, has varied strikes me as ludicrous. Apparently the fundamental principle of relativty, in its broadest sense, has been attacked. One must ask the fundamental question: "if the speed of light varies, what could it be **relative** to?" It is universally accepted that the chemical linking forces between atoms and molecules, of which the physicist's measuring instruments, and indeed the physicist himself, are composed, is electromagnetic in nature. Indeed, the most successful physical theory ever devised, Q.E.D., interprets the electromagnetic force as a photon exchange between particles such as electrons and protons. "Light", of whatever wavelength, is also a conglomeration of photons, or quantized electromagnetic field. Once this is grasped, it is immediately apparent that any "speeding up" of light photons, must of necessity mean a "speeding up" of photon exchanges within ordinary matter to a **precisely equal degree**, so that **relative** to the observer and his instruments, nothing could possibly change.

It is only meaningful, and possible, to talk about a possible variation with time of the **ratio** between the fundamental forces of nature, i.e. gravitation: weak force (related to radioactive decay): electromagnetism: strong force (nuclear forces, quarks). Thus it is meaningful to talk of gravity getting "weaker" with time, meaning that the ratio (gravitational force)/(electromagnetic force) is decreasing. There is in fact increasing, though still tentative, evidence to suggest such an effect, and it logically follows if we accept Mach's principle and that the universe is indeed **expanding** (as virtually all astronomers agree).

To claim that the value of c has varied IN EVEN THE MOST MINUTE DEGREE, is to claim that the strength of the electromagnetic field varies relative to itself!! If this were indeed true, the physical universe is a far stranger place than anyone can possibly imagine. We would have to discard the idea of laws of nature and conclude that reality is only an illusion (perhaps Christian Science dogma is right after all!).

Really though, Romans 1:19,20 tells me that the creation of God is very real, and in order to testify to Him, must obey consistent, rational laws.

Consider for example the classic illustration of the relativistic effects of length contraction and time dilation at speeds near that of light. A hypothetical space traveller in a space capsule moving at high velocity **relative** to a stationary observer will appear to be aging much slower, and to contract in the direction of motion. A naive conclusion would be that our space traveller friend would himself notice his "flattened out" wrist-watch on his "flattened out" arm was "going too slow". Of course this is nonsense, and shows a lack of understanding of the principle of relativity; and indeed, **relative** to the "astronaut", the "stationary" observer is the one who is "going too slow" and is "contracted" in length! These same considerations apply to any supposed "tired light" theory.

Let's not fall into the same trap with the evolutionists, who mould and squeeze the "evidence" to support their pre-conceived ideas.

Comments by Barry Setterfield. . .

Mr Nolan seems to have somehow missed one of the key points of Einstein's work in his discussion about relativity. He says "One must ask the fundamental question 'if the speed of light varies, what could it be relative to?'". The whole thrust of Einstein's work is that the SPEED OF LIGHT WILL ALWAYS HAVE THE SAME VALUE AT ANY INSTANT IN ANY AND ALL FRAMES OF REFERENCE no matter how they are moving. This is expressed in another way by saying that the SPEED OF LIGHT IS INDEPENDENT OF THE MOTION OF THE SOURCE OR OBSERVER. If either are moving, then the speed is still measured as having the same value, but there is a Doppler shift in the wavelength. (See 'Principles of Modern Physics', A.P. French, p. 141 ff.).

Mr Nolan, on the other hand, seems to have grasped the main idea behind Part 2 of the printed presentation (see Ex Nihilo, vol. 4, no. 3, 1981, pp 55–81) dealing with the change in c and the atom when he says that any 'speeding up' of light must of necessity mean the 'speeding up' of the exchanges within matter to a precisely equal degree, so that relative to the observer and his instruments nothing could possibly change". This is largely true for atomic processes. When the conservation laws are applied to the atom in a changing c situation it turns out that the electrons move in their orbits at a speed proportional to c. As a consequence, (since the energy of each orbit is constant and the emitted photon wavelength will therfore also be constant), it means that the frequency of light emitted is proportional to c as frequency is proportional to orbital speed. As our reference frequency is also higher, no change would be noticed. It is precisely at this point that Mr Nolan seems to have grasped what Prof. R. T. Birge intimated in Nature, Nov. 17, 1934, p. 771, that if c was decaying, observation required "the value of every atomic frequency to be changing". While Mr. Nolan appreciates that fact, it was unfortunate that Prof. R.T. Birge, who admitted that the observations indicated that c was decaying, rejected the possibility of any effect on the atom and so ignored the observational trend by maintaining that c must be constant.

While there would be no noticable effect on light from a nearby source as indicated above, there IS an effect for light from distant sources in which c has had some decay in transit. The effect of the decay in speed is to induce Doppler-type red-shift as W. Michelson pointed out in 1901. The higher the difference between the initial and final velocities, the greater the red-shift. Thus it can be predicted that there should be an effect of galaxies showing an increasing red-shift with distance. This is observed. However, this part of the approach must be in accord with observation also, just as the computer curve is. When it is discovered that the observed red-shift can be accounted for by c decay, one is left to ask what is the Universe doing? The red-shift that was taken as universal expansion is explained logically in another way, so is the Universe still expanding, stationary, or contracting — these are the 3 choices. We turn to observation for the answer. If the value of the red-shift for a given object coincides with that predicted from c decay theory, then the Universe must be static. This is unlikely on several grounds and is not found to be the case. If the observed value of the red-shift is greater than that predicted by c decay, then there must be a Doppler shift added to it from Universal expansion to make up the difference. If on the other hand the observed red-shift is less than c decay predicts, then it must be offset and partly counteracted by Universal contraction. That latter case is the one suggested BY OBSERVATION.

Mr Nolan has also commented that "if c has varied in even the most minute degree, it is to claim that the strength of the electromagnetic field varies relative to itself". The answer is that for c decay the energy of the electric and magnetic fields of the photon remain constant but their component parts vary: they vary in such a way that there is no nett change in energy. In the approach adopted in Part 2 in the published work (see Ex Nihilo, vol. 4, no. 3, 1981, pp. 55–81) it was intimated that the electric permittivity of free space ϵ_0 was constant and that it was the magnetic permeability μ_0 that varied. It varied according to Maxwell's equation

$$\epsilon_0 \mu_0 = 1/c^2 \qquad \text{................(1)}$$

With fixed as above, it follows that the permeability is proportional to $1/c^2$ or

$$\mu_0 \sim 1/c^2 \qquad \text{................(2)}$$

It then follows that as the magnetic potential is constant from conservation laws that

$$V = m^2/(4\pi\mu_0 r) = \text{constant} \qquad \text{................(3)}$$

As a consequence

$$m^2/\mu_0 = \text{constant} \qquad \text{................(4)}$$

and so the magnetic pole strength m is proportional to 1/c or

$$m \sim 1/c \qquad \text{................(5)}$$

Now the magnetic field H is the field producing unit force on a unit pole m, and since force

$$F = m_1 m_2/(4\pi\mu_0 r^2) \qquad \text{................(6)}$$

then it follows that the magnetic field H is given by

$$H = m/(4\pi\mu_0 r^2) \qquad \text{................(7)}$$

which, as m is proportional to 1/c and μ_0 is proportional to $1/c^2$, then from (2) and (5)

$$H \sim c \qquad \text{................(8)}$$

that is, the magnetic field is proportional to the speed of light. This is in perfect accord with Maxwell's Laws as the energy of an electromagnetic plane wave W is given by

$$W = \mu_0 H^2/4\pi = \epsilon_0 E^2/4\pi \qquad \text{................(9)}$$

As we have noted above E is constant as is ϵ_0, and so from the right hand side of (9) we expect W to be constant in accord with conservation laws. But what about the middle term? As H is proportional to c from (8) then H^2 must be proportional to c^2. But we note from (2) that the other numerator term μ_0 is proportional to $1/c^2$ which exactly cancels out the effect from H^2 leaving the whole equation balanced and the result that

$$W = \mu_0 H^2/4\pi = \text{CONSTANT} = \epsilon_0 E^2/4\pi \qquad \text{................(10)}$$

Accordingly the magnetic and electric field energies in a photon are entirely constant for all c, the c dependent terms cancelling. The increase in the magnetic field is compensated for by the decrease in the permeability leaving a nett result unchanged. It was after a presentation of this work in the USA that Prof. Thomas Barnes, the world's leading authority on electricity and magnetism, said to me "Your presentation is absolutely correct. I completely agree with you. If I can help you in any way I will."

To conclude it may be of interest to point out one feature of c decay that comes out of general relativity equations. General relativity still holds if (a) the speed of light is independent of the motion of the source and (b) if the value of the speed of light is the same throughout the universe at any given instant. The second condition implies that there is such a thing as absolute time as far as the Universe is concerned, and yet it is needed for relativity! There are three basic quantities in physics-mass, length and time. Planck obtained these quantities in terms of other parameters. Thus we have

Planck Mass $M = \sqrt{(h\ c/[2\pi G])}$ ....(11)

Planck Length $L = \sqrt{(h\ G/[2\pi c^3])}$ ....(12)

Planck Time $T = \sqrt{(h\ G/[2\pi c^5])}$ ....(13)

These quantities are related to c in the following fashion since Planck's constant h is proportional to 1/c, and Newton's gravitational constant is proportional to c^4

$M \sim 1/c^2$ ....(14)

$L = \text{Constant}$ ....(15)

$T \sim 1/c$ ....(16)

Equation (14) comes as no surprise as the inverse square dependence on c for mass is already formulated in Part 2 (Ex Nihilo, vol. 4, no. 3, 1981, pp 55–81). Equation (15) is a highly desirable result and prevents any 'wierd' effects from c decay. But the effect of (16) is startling until it is realised that this is atomic time, time as seen by the atom, not time as seen from our frame of reference (universal). For an observer outside the atom the atom's time intervals are shorter as the speed of light is higher. For us the time intervals are constant. This latter statement is verified by the equations of relativity. In the Swarzschild equations, for example, the time interval t^2 for the universe is always expressed as c^2T^2, where T is the atomic time mentioned above. Accordingly, we may express the relationship between universal time t and atomic time T as

$t = cT = \text{const};\ t^2 = c^2T^3 = \text{CONSTANT}$ ....(17)

In each case the last step followed directly from relation (16). Thus while the atom is affected by c decay, our time is constant.

The result of (17) explains in a very logical way why the atom behaves as it does with c decay. From the atom's point of view it is behaving in an entirely consistent way throughout. As far as the atom is concerned, an electron has always taken the same time interval ΔT to travel once around its orbit. Seen from the outside this time interval has been lengthening and we say that the electron is slowing down, but the atom is oblivious to that and goes on its merry way. As far as the atom is concerned for a radioactive element, it has always taken the same time interval ΔT for half of a lump of its material to decay into daughter products. Seen from the outside we say that interval is getting longer and that as a consequence the half-lives were shorter in the past proportional to 1/c, but that is because the atom's time interval was shorter in proportion to 1/c as seen from (16). The atom on the other hand is completely oblivious to this inconsistency as seen from our point of view and maintains the rightness of its own ways. Again, as seen from the atom, which is where light comes from in the first place, light has always travelled at a completely constant speed, always moving precisely the same distance in the interval of atomic time ΔT. Seen from the Universal time frame we say that light has travelled further in one second many years ago than it does now, but that is only because one of our seconds lasts longer than that of the atom. The atom in all innocence would counter that the distance that light has travelled in one unit of its time, T, has been absolutely constant throughout its history. And so we could go on. From this it is apparent that atomic time is slowing down uniformly throughout the Universe and that all things are governed by an absolute time which is in the Hands of the Eternal Timekeeper.

THE NUMBER OF SPEED OF LIGHT DETERMINATIONS

A question from Mr C. Butel of Pymble, N.S.W., Australia

By chance I looked at at a copy of **Theoretical and Experimental Physics** by Jerrard and McNeill (Chapman and Hall, 1960). Although I quickly decided that its contents were matters that I as a layman would not be able to understand, the following footnote on page 18 came to my attention: —

"*Bergstrand (1956) gives 2.99793 ± 0.00003 × 10^8 m/sec as the mean value for c. This figure has been obtained by the analysis of the results of several thousand observations made by different experiments using different methods.*"