The majority view among chronologers seems to be that we must use secular history to fill a gap in Bible history. Larry raises legitimate questions from that gap-theory view. And I raise some questions from the Bible-only view. One is: Where in Scripture do we find a hint of a gap? Another: Is it reasonable to expect that the Bible would give a detailed chronology for 3,000 years of OT history and then omit 60 years or so from the last 1,000 years? And another: Does this Bible-only view deserve a place at the discussion table in our time? Other questions concern which decree to use for the return from captivity. Discussing the decrees needs a whole article of space.

I am not qualified to take up Larry's challenge to debate secular history. But I can point out that many people also said of Egypt's history that it was 'very well documented by many historians', yet now a good many scholars are saying that there is error of up to several centuries in that history. Of archaeology, Larry himself wrote that it has caused much grief as people have tried to harmonize it with the infallible Word of God.

I believe that we still have chronology problems to solve and I hope that *TJ* will continue to follow up on this topic.

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Distant starlight and Genesis: is 'observed time' a physical reality?

In Newton's definitions of time conventions,[1] light from the most distant stars reaches the Earth instantly in 'observed' time, but at a time equal to the distance ÷ the speed of light (c) in 'calculated' time. Newton explains that physical observers can only measure the two-way or average speed of light, and it is physically impossible to make a one-way speed of light measurement without making certain assumptions. Thus, he argues that 'observed' time may also be a valid convention to measure physical or absolute time, not just a phenomenological convention. I agree with his discussion on the phenomenological interpretation but I disagree with his physical interpretation.

According to my understanding of Newton's paper:

a. 'calculated' time is the generally understood time-measuring convention. It provides the basis by which we make calculations within the laws of the physical universe. As I understand it, Newton also agrees with this but we all need to be careful not to lose sight of the wealth of discovery that has gone on before, based on this convention.
b. 'observed' time is a time-measuring convention that can be broken into two sub-groups,
   i. a phenomenological convention on time stamping events as they occur,
   ii. a physical or absolute fundamentally true time measurement convention that relates to the concept of the one-way speed of light.

Looking at 'observed' time in a phenomenological sense, I see no contradiction with observation because it simply moves the origin of the time axis that we are normally used to, to the beginning of Creation (Day 1) approximately 6,000 years ago. It does, however, require a progressive creation of stars and galaxies, possibly in shells radially inward centred on the Earth, so that the light of all stars first arrives at the Earth on Day 4. The light travels at the normally understood value of the speed of light c, and it takes millions of years to get to Earth. This all takes place on the negative side of the time axis before the creation of the Earth and the solar system on Days 1–4.

The concepts of one-way and two-way speed of light are presented in Newton's paper.[1] There are two possible interpretations of Newton's concept in regard to the one-way speed of light. In his reference 3, he cites an equation involving the angle θ, which is not clearly defined. This ambiguity is crucial to the arguments used by Newton and it would be of great benefit if Newton could clarify this.

I can see two possible interpretations of this angle. My first impression, based on my understanding of Special Relativity and papers like Ref. 2, is that the angle is the angle in a particular reference frame wherein only light coming inward and parallel to the observer's absolute motion against a universal reference frame would have infinite speed. The speed of light in the direction of this motion is infinite. In the opposite direction it is half c and at right angles to the motion it is c. This is the usual interpretation of the equation in Newton's reference 3. If this is the case, an observer would mostly see stars in one particular direction of the night sky and very few in any other direction. Obviously this is not the case.

The second possibility is that this angle is the viewing direction against some arbitrary axis. To see the stars in all directions in the sky the angle θ must always be zero for the light to travel instantaneously from source to receiver. This concept is consistent with the observed time concept in a phenomenological sense but not in a physical sense. For this to be true, no physical interpretation can be placed on the interpretation. Newton says *'observed time is a fundamentally true—not just phenomenological—language of appearance'* (p. 81, bottom of column 1 of Newton's paper). However, later in the paper he says *'this paper does not strictly require that observed time be an absolute (non-phenomenological) quantity'* (p. 83, middle of column 2). I argue that, regardless of the synchronization convention adopted, the physical interpretation (b (ii) above) is not valid.

Let us consider two co-ordinate systems in relative motion and write

the generalized transformation between Σ (*T,X,Y,Z*), the preferred or universal frame, and *S* (*t,x,y,z*), the moving or laboratory frame;

$$\left.\begin{aligned} t &= e_1 T + e_4 x \\ x &= f(X - vT) \\ y &= gY \\ z &= gZ \end{aligned}\right\} \quad (1)$$

where v is the velocity of the *S* frame in the Σ frame and e_1, e_4, f and g depend on v. It is assumed that a universal frame can always be chosen where the speed of light is the same in all directions. If the Special Relativity principle and the invariance of the velocity of light are assumed, the transformations in (1) reduce to the Lorentz transforms. More generally it has been shown[2] that when values are chosen such that

$$e_4 = \sqrt{1-\beta^2} - e_1 \beta c_0,$$

$$f = 1/\sqrt{1-\beta^2},\ g = 1 \quad (2)$$

where $\beta = v/c_0$, the transformations in (1) satisfy the well-established experimental conditions of constant two-way speed of light (c_0) relative to all frames, Lorentz contraction, and Larmor retardation of clocks. In these equations e_1 is unknown and is fixed by synchronization of the clocks. Under these conditions the speed of light can be shown to be

$$c(\theta) = \frac{c_0}{1 + \Gamma\cos(\theta)} \quad (3)$$

where $\Gamma = e_1 e_4 \sqrt{1-\beta^2} - \beta$ and θ *is the angle between the light propagation direction and the absolute velocity* v *of S.* If Einstein synchronization is chosen, Γ = 0, but the choice is really quite arbitrary. If Γ = 1 is chosen, which is the interpretation that Newton seems to accept (if my first interpretation is correct), and light propagates towards the observer, then $c(180°) = \infty$. Also if light propagates away from the observer $c(0°) = c_0/2$. These results are completely consistent with experimental physics but take *note of the meaning placed on the angle* θ. Also note that the angle above is transformed θ → θ +180° to be consistent with Newton's equation in reference 3. This is merely due to the definition of the direction of the light beam relative to our system of co-ordinates. Because –cos(θ) = cos(θ +180°), with Γ = 1, (3) can be rewritten

$$c(\theta) = \frac{c_0}{1 - \cos(\theta)} \quad (4)$$

where θ is the same as Newton's.

Considering this interpretation of Newton's 'observed' time convention, an infinite speed of light is only observed for an incident light source parallel to the absolute velocity of the observer with respect to the universal frame. If we suppose that this frame is the cosmic microwave background radiation, then only stars in one particular direction would be visible in such a universe. Perpendicular to this direction the speed of light would be c_0 and in the opposite direction, the speed of light would be half c_0. Therefore, only light from stars within a small volume of space would reach the Earth within the 6,000 years since Creation.

The second possible interpretation of this angle θ requires clarification of what the one-way speed of light means when 'so-called' in the literature. As Newton correctly points out, a true one-way measurement cannot be made without certain assumptions regarding clock synchronization. This, however, is only valid within the Relativistic framework described above. Often a measurement of the speed of light is called a 'way-one' measurement in the literature but in fact contains implicit assumptions. However I contend that these assumptions are reasonable and consistent with two-way speed of light measurements that have been carried out on Earth.

For example, it was the early astronomical observations that first determined a value for *c* and that it was finite. The measurement by the Danish astronomer Roemer in 1675 may appear to be a true one-way speed of light measurement. Not so, because it depends on the periodicity of the occultation of Jupiter's moon Io. He assumed the observed period of revolution of the moon as measured by his clock on Earth was constant and synchronized to his own clock. Then, as he observed different times for the occultation, he deduced that the difference was solely due to the longer travel time of the light as the Earth and Jupiter moved in their respective orbits around the Sun. He observed about a 600 s accumulated delay (or advance) (currently 500 s is measured with more precise clocks) in the onset time of Io's eclipse of Jupiter between 3-month observation intervals. In that time the Earth had moved 1 AU (the distance between Earth and the Sun) away from (or closer) to Jupiter. The total delay (or advance) was the time for light to travel this 1 AU.

The assumption of clock synchronization was clearly made and hence the measurement was not really a true one-way speed of light measurement. But, if the speed of light was infinite and the period constant there would be no delay or advance observed. So *this observation proves the one-way speed of light is finite*, provided we make the reasonable assumption of clock synchrony.

In 1725 the astronomer James Bradley, in an attempt to measure the distance of stars, discovered an apparent change in their positions as the Earth moved around the Sun. This effect is known as aberration and it is quite separate from parallax, which is a much smaller effect. Aberration is greatest when the Earth's motion is at right angles to the line joining the Sun and the star.

It depends on the Earth's velocity in that direction and not the Earth's position in space. The Sun, as viewed from the Earth, also has aberration, as the light from the Sun takes about 8.3 minutes (~500 s from Roemer) to reach Earth. In this time the Sun moves through about 20 seconds of arc. So the light indicates where the Sun was 8.3 minutes earlier. The true instantaneous position of the Sun is about 20

seconds of arc east of its visible position. So as the Earth orbits the Sun, all stars will exhibit a total of about 40 seconds of arc motion east-west and will trace an elliptical apparent motion in the sky. The angle of a telescope has to be adjusted, depending on the Earth's relative velocity (v) to the star. The aberration angle is then proportional to v/*c*.

The aberration effect is analogous to what happens when we are driving through rain. If the rain drops are falling vertically at speed (w) and we are driving in a vehicle at speed (v) we see the rain coming in straight lines inclined to the vertical at an angle of arctan(v/w). *The very existence of stellar aberration proves that the one-way speed of light is finite.* It also provides a measure of the value from the ratio $v/c \sim 10^{-4}$ (radians). From the orbital speed of 30 km s^{-1} Bradley improved the estimate of $c \sim 3 \times 10^5$ km s^{-1}. Applying Ockham's razor to this and Roemer's measurements tells us that the one-way speed of light from the distant stars cannot be infinite, but is finite.

In the Humphreys' model,[3] clocks on Earth run much slower than clocks on the edge of the universe. The model attempts to solve the light-travel-time problem with a manipulation of 'calculated' time. Newton attempts to do so with his 'observed' time. His physical interpretation however is not valid, regardless of the interpretation you apply to the angle θ. I see no problem however with the phenomenological language of appearance, that is, just recording time from when the light arrives on Earth (b (i) above). Newton's 'calculated' time is clearly physical, but requires billions of years before Day 1.

The correct view then relies on the interpretation of Genesis and whether the stars could have been created before Day 1, the origin of the time axis in creationist cosmology. Can any model consistent with modern relativistic test theories explain the light-travel-time problem in creationist cosmology? His physical interpretation of 'observed' time cannot. Newton's phenomenological 'observed' time convention may be a simple answer.

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Robert Newton replies:

I do allow for John Hartnett's view that observed time may be valid in a phenomenological sense only, rather than in a more physical sense. In my original paper[1] on the subject, I argued that observed time cannot be disproved empirically due to the immeasurability of the one-way speed of light without some degree of circular reasoning. One must first assume the one-way speed of light, or make some equivalent assumption about synchronization, in order to measure the one-way speed of light. This concept is called 'the conventionality of simultaneity'. But, as I stated in that paper (and I reiterate here), this idea is not universally accepted. And I do allow for the view that observed time may be valid only in a phenomenological sense.

Dr Hartnett's examples highlight the assumptions of one-way speed of light measurements. We know from Relativity that motion affects time. For example, suppose we have two synchronized clocks at the same location—point A. If one clock is moved from point A, to point B, and back to point A, it will (generally) not remain synchronized with the other clock that remained at point A. However, if the clock is moved *very slowly* (from A to B and back to A), it will be *almost* synchronized with a clock that remained at point A. In the limit of zero velocity, the two clocks will be exactly synchronized when brought back together.

Some people would then argue that when the clock is at point B it is still (nearly) synchronized with the one at point A providing it was moved there slowly. This is known as the 'slow clock transport' method. But there is a hidden snag: How do we know that the clocks *remained* synchronized throughout the entire round-trip? What if the moving clock gained a few minutes when it was moved to point B and then lost a few minutes when it was moved back to point A (or the reverse)? (In the observed time convention, this is indeed what happens.) The clocks would be synchronized upon their return, but not synchronized when separated. We could check their synchronization status (while separated) by transmission of light beams—but only if we knew (in advance) the one-way velocity of light. It turns out that only if the speed of light is the same in all directions do the clocks remain synchronized when separated. It makes sense that this would be the case: The speed of light is fundamental in the relationship between space and time. Naturally, if the speed of light were not isotropic, then the passage of time itself must also be different for motion in different directions.

So Roemer's experiment must assume that the one-way speed of light is isotropic in order to establish this. It has assumed a synchrony convention, which is equivalent to choosing the one-way velocity of light. (To be specific, it uses the aforementioned slow clock transport method). The reasoning is circular, though self-consistent. It's not that this synchrony assumption

is irrational, or absurd. But it is an *assumption*—one which is fundamentally, empirically non-testable. One can choose to accept this convention and dismiss others (such as the observed time convention) as phenomenological on the basis of *simplicity*. I respect this choice; certainly calculated time (with an isotropic speed of light) is simpler mathematically, and conceptually. It is just rather fascinating that other conventions (in which the speed of light is *not* isotropic) cannot be eliminated by *empirical experimentation.* This is a remarkable result, and would not be true in a classical universe. If it were not for Relativity, instantaneous two-way communication would easily allow for absolute clock synchronization.

Stellar aberration is similar. In order to determine the angle at which a moving telescope is pointed, we must know the position of the top and the bottom of the telescope *at the same time*. Clearly, a synchrony convention must be assumed in order to determine this. Stellar aberration, Roemer's experiment, and other light-speed experiments are discussed in Wesley Salmon's article[2] 'The philosophical significance of the one-way speed of light'. I highly recommend this article to those interested in the conventionality (or non-conventionality) of simultaneity.

I'm happy to clarify the meaning of theta in the equation for observed time light propagation.[3] Theta is the angle made between the velocity vector of a photon, and a line connecting its position to the observer. Thus, any photon aimed directly at an observer on Earth would have theta = 0, and its effective speed would be infinite. So, observers on Earth would be able to see stars at great distance in all directions. This formula for the speed of light as measured in observed time can be derived from the conversion between calculated time and observed time ($t_c = t_o - r/c_0$) and the fact that *c* is constant and isotropic in calculated time. Here, 'r' is the distance from an observer to the photon. This is all done in spherical coordinates with Earth at the origin.

Thanks, Dr Hartnett, for these comments. I encourage *TJ* readers to build on my model and feel perfectly free to consider observed time to be merely phenomenological. This approach may be better in a practical sense since the conventionality of simultaneity is controversial, and since the model I have proposed should solve the distant starlight problem either way. I believe the model is the simplest Biblically compatible solution to starlight so far. The section 'An alternative perspective' in my original paper describes the creation process in the standard 'calculated' time. In this view, the creation of stars continues inward in concentric spherical shells at the speed of light. This would be seen as instantaneous from Earth's perspective. Could the recent reports of quantized redshifts support this model? It seems that matter in the universe is distributed in concentric shells at preferred distances from Earth.[4] Could God have created in spurts (in calculated time)? And might this be a hint of this Earth-directed display—an 'echo' of God's creative power?

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Evening and morning

I was pleased to read Mr Kulikovsky's *Viewpoint* on the phrase 'evening and morning' which recurs throughout Genesis chapter 1.

While there has been much ink spilt over the years as to the putative lack of a light source to create the fluctuation of lighting conditions which is our normal diurnal experience, I think it has missed the point. Mr Kulikovsky makes that point. That is, the author appears to be making certain we understand what these days are in which creation events occur. Are they long days, metaphorical days, indeterminant length days, etc.? No, they are evening and morning type days.

Looking at it another way, and setting aside the various views held of the duration of these days and the meaning of 'yôm', how would an author unambiguously convey the meaning of our normal 24 hour day? I can't think of a better way than repeating that the days are characterised as 'evening and morning' type days.

The message from Genesis chapter 1 by virtue of this phrase is that the author is telling us precisely about passing duration. It is described so as to convey clearly the duration that passes. Much exegesis strains at avoiding this issue, making all sorts of assumptions about the state of mind of the author and the intention of the Holy Spirit in inspiring these words, but they must strain to go past the direct meaning of the text: six evening and morning type days pass. It is similar to the straining of meaning we get with the chronologies in Genesis chapters five and eleven where explanations are sought apart from that which comes directly from the text: the author is providing a chronology in precise terms. Why else whould precise enumeration of durations of life be given?

It more than hints of hubris, I think, when some exegetes looking at the text blithely set aside its direct meaning to put into the author's mind some other meaning not implied by the text, but developed from the text 'deconstructed' in true, if unacknowledged, post-modern fashion.

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