Einstein's physics says there is no biblical creationist starlight travel-time problem

The Physics of Einstein: Black holes, time travel, distant starlight, E=mc²

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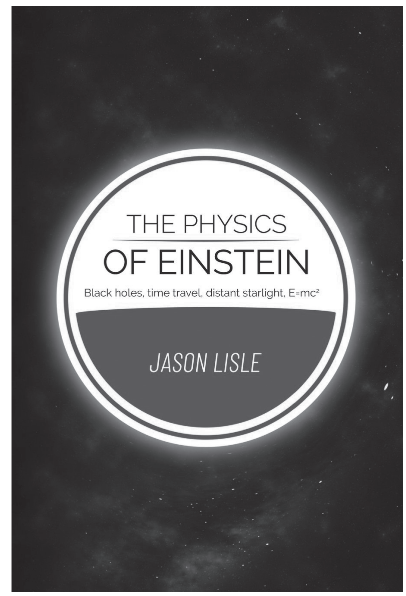

John G. Hartnett

There is no other biblical creationist book like this on Einstein's physics. Astrophysicist Jason Lisle explains the subject matter so that any educated non-specialist could understand. And while some sections contain equations, they are in isolated boxes so the reader may skip them and still follow the argument.

In the book Lisle addresses questions such as:

> "Is it possible to travel faster than the speed of light? Will future human beings build spaceships that can travel at 'warp' speed like in *Star Trek*? Is time travel possible? If so, could we ever travel back in time to prevent a catastrophe from occurring? What does $E = mc^2$ really mean? What are black holes, and do they really exist? What would happen to a person who fell into a black hole, and how do we know? Is the universe really expanding? How long does it take starlight to travel from distant galaxies to Earth? Does this distant starlight require the universe to be billions of years old?" (p.7)

The book starts with a short history of Einstein and his discoveries in physics. Though Einstein never performed any physical experiments to test his theory of relativity, today it is one of the best established theories of science.

Newton and Maxwell

Lisle first discusses Newtonian physics, including gravitation and Newton's three laws of motion. Newton realized that all motion is relative, i.e. any speed and direction of a particle is only meaningful with respect to a particular observer. As such, any experiment's outcome will always be the same for all inertial reference frames (a reference frame where the observer is not accelerating), though the measured values may vary. So Newton's laws of motion apply only to inertial reference frames. The earth is not an inertial reference frame but for some applications it is approximated as such.

Lisle next covers Maxwell's equations of electromagnetism. They indicate that all electromagnetic radiation must propagate in a vacuum at an absolute speed—the speed of light. Maxwell developed his theory before Einstein developed his relativity theory in the early 1900s. However, Maxwell knew approximately the speed of light (*c*, currently defined as 299,792.458 km/s) and realized it was the speed indicated by his equations.

So there is a paradox. Newtonian physics indicated no absolute motion. All motion is relative to any observer. But Maxwell's equations indicated that all electromagnetic radiation must travel at *c*, regardless of the observer's frame of reference. Albert Einstein solved this paradox with his relativity theory.

Einstein resolved the paradox

Physicists at that time had made one false assumption which Einstein realized. Motion is relative to any observer but the speed of light is not. We say it is 'canonical' because it is a fundamental physical constant, and all inertial observers measure the same speed.[1]

From chapter 2 onwards Lisle outlines how physics was changed by Einstein's key assumption. This resulted in *special relativity*, which does not consider the effects of gravity.

Then Lisle explains the consequences when gravity is added. This came through another key insight of Einstein, the *equivalence principle*. That states that any observer in an accelerating (non-inertial) frame cannot distinguish any measurement he might make from that he would make if in a uniform gravitational field.

Lisle clearly explains some of Einstein's thought experiments. They include trains or rockets (obviously hypothetical ones) travelling at near *c*. It predicts some very strange effects—e.g. on time, called time dilation.

Many have heard of the 'twin paradox', where one twin travels in a rocket at some fraction of *c* and returns from a nearby star hardly aged at all while his twin has grown to old age. Relativity theory predicted many effects on not only time, but also on space (lengths) and masses, but we cannot review those aspects in detail here.

However, standard special relativity assumes the speed of light is isotropic—the same in all directions. Both Einstein's thought experiments and all laboratory tests of relativity assume this. The formula used to calculate any time dilation effect (like on the age of the twin who went off in the rocket) assumes an isotropic speed *c*.

The expansion of the universe and the big bang

Lisle discusses general relativity, and explains how Einstein's field equations applied to the whole universe were solved in the 1920s. Lisle somewhat oversimplifies the application of Einstein's field equations to the universe, though it's unavoidable in a semi-popular book. He correctly states that Alexander Friedmann first found a solution for the universe assuming an isotropic homogeneous matter distribution (known as the *cosmological principle*[2]). Georges Lemaître also found the same solution in 1927, but he also had observational data he thought indicated that the universe was expanding.[3] Credit for that 'discovery' was however given to Edwin Hubble, who published in 1929.

Others also solved those field equations, including Einstein. But it seems Lisle has accepted that the Friedmann–Lemaître solution is the correct one because he goes on to state that the observed redshifts of galaxies indicate that the universe is expanding (p. 177).

However, we cannot be sure. Cosmology is not operational science. The universe is not a lab in which we do experiments like we might in an Earth-based laboratory. Cosmology is at best historical science.[4]

Unfortunately, Lisle seems to accept the notion that the universe is a lab on which we can do repeatable experiments. He recognizes that the big bang is not scientific but suggests that future measurements may refute or confirm e.g. dark energy (p. 181). A refutation is possible but big bang cosmology relies on *dark matter and dark energy*, so no matter what is observed the paradigm will be very difficult to kill off. I still think these are necessary fudge factors, and if the scientists operated by the same standards they use in their Earth-based labs the increasing need for all of these *dark entities* would fatally undermine the Friedmann–Lemaître model.

The real issue is that cosmology is underdetermined.[5] There are potentially many different models that might describe the same observational data. It's not clear that Friedmann found the correct solution for the universe and therefore the universe is expanding. Galaxy redshifts may be explainable by other mechanisms.[6]

Nor is it clear that Scripture describes an expanding universe. God spoke through human agents and used the cultural and linguistic knowledge they had at the time. When similes are used (e.g. referring to glass, curtains and tents) they make no connection to the well-known rubber sheet analogy for the expansion of space in big bang cosmology.[7]

The curious case of the one-way speed of light

Chapters 17–19 deal with the question of distant starlight: How do we see it when the universe is only about 6,000 years old?

Most attempts to measure the canonical speed *c* have involved some apparatus that reflected a light signal back to the source. These measurements calculate the round-trip,

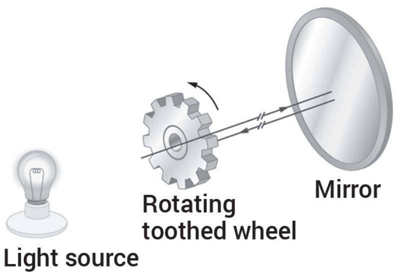

Figure 1. Historically, the speed of light was measured by Fizeau by reflecting a light signal from a mirror and timing the round-trip with a toothed wheel. This is clearly a two-way speed measurement and not a one-way measurement.

time-averaged speed also known as the two-way speed of light, because an outgoing and an incoming signal is used. There have been several proposals (even claims) to measure the one-way speed of light, but these have all turned out to be the two-way speed due to some implicit unrecognized assumption.

Why would the speed of light be different outgoing to incoming? Lisle answers:

> "I don't know of any reason why they should be different. But then I don't know of any reason why they would be the same. People might emotionally prefer the symmetry of having the speed from A to B be the same as the speed from B to A. But does preferring something automatically make it so? Should we expect the universe to conform to our emotional preferences?
>
> If there is one primary truth that we learn from the physics of Einstein, it is that the universe does not always conform to our preferences or expectations." (p. 209)

So why just assume, without evidence, the one-way speed of light is the same in all directions? One would need to measure the one-way speed. To do so one needs to exactly time the passage of a signal from points A to B, which are separated by some distance. Therefore, one needs synchronized clocks at A and B so that when the light signal is received at B we know what time it left A.

So how does one synchronize clocks separated by a distance? As it turns out the only method is to send a light signal from B to A to synchronize B with A. But then when A sends back a light signal to B it becomes a two-way round-trip measure. Measuring the one-way speed on the return journey from A to B doesn't work because it means we need to know the one-way speed from B to A. We need to know the one-way speed of light to measure the one-way speed of light.

Simultaneously sending radio pulses to A and B from M halfway between A and B does not work because it assumes the radio pulses travelling M to A and M to B, which are opposite directions, travel at the same speed.

And there is no getting around this problem, it is a catch-22. No matter what method you use, light, radio signals, sound waves through a rod, or whatever, it always means it is a two-way measure of the speed of light (p. 214).

But can we use what is called *Slow Clock Transport*? We take two clocks at one location and synchronize them. Then we separate one from the other very slowly and they should remain synchronized. However, special relativity indicates time dilation will occur if we move a clock with respect to another. Slow transport tries to minimize the effect—time dilation is assumed to be zero because the speed of moving one clock is very slow. But this again assumes the one-way speed of light is the same in all directions because time dilation physics depends on the one-way speed of light. Most text books on special relativity, with which the reader may be familiar, assume the isotropic one-way speed of light, which is the two-way speed c. Once again, the argument is circular.

Or didn't Danish astronomer Ole Rømer in 1670 measure the one-way speed of light using Jupiter's moons, particularly Io, as a clock? No! The details show it was a two-way speed measurement (and remarkably close to the modern-day measured value). Rømer assumed his clocks 'ticked' at constant rates regardless of whether Earth was moving toward or away from Jupiter. Since he reasoned that the duration of the eclipsing of the moon Io with Jupiter varied according to Jupiter's distance from Earth totally because of the change in the light-travel distance, he implicitly assumed the isotropic (two-way) speed of light. He didn't account for any time dilation effects. He wrongly assumed that time is absolute, and not affected by velocity.

The one-way speed of light issue has been debated for about 100 years. It has been found that no experiment can ever measure it. All experiments measure the two-way speed. As such, it seems it does not matter what we assume for the one-way speed, provided the round-trip speed always averages to c.

The epsilon equations

In 1970, John Winnie showed that the measurable effects of special relativity only depend on the round-trip speed and not on the one-way speed.[8] So, whatever the one-way speed might be, it can have no effect on the measurable physics in the universe. The one-way speed "only affects how we define 'simultaneous' and thus how we time stamp various events." (p. 221)

Winnie used the symbol c for the canonical two-way speed and introduced anisotropy via the symbol ε (Greek symbol epsilon). This is referred to as the Reichenbach synchronisation parameter.

Any choice of ε between 0 and 1 is valid. Einstein's derivation of special relativity assumes $\varepsilon = ½$, representing the isotropic speed of light (i.e. the one-way speed is the same in all directions). All other choices are anisotropic. For $\varepsilon = 1$ the inward-directed (to the observer) speed of light is infinite and the outward-directed speed is $\frac{1}{2}c$. In such a case (and all valid cases) the average round-trip speed is c. Winnie even derived special relativity equations for time dilation and length contraction, due to relative motion, without assuming a value for ε.

Lisle uses these equations to illustrate the relativistic effects when non-isotropic propagation is assumed, i.e. when $\varepsilon \neq \frac{1}{2}$. The time dilation equation gives a much stronger effect when $\varepsilon \neq \frac{1}{2}$ than when $\varepsilon = \frac{1}{2}$. For $\varepsilon = \frac{1}{2}$, the time dilation effect is quadratic in velocity. But for $\varepsilon \neq \frac{1}{2}$ there is an extra term in the time dilation equation that is quasi-linear in velocity. This means that at low velocities time dilation strongly affects any measurement, and is strongly direction-dependent.

For *slow clock transport*, with $\varepsilon \neq \frac{1}{2}$, even as velocities go to zero, a large time dilation term should be included, which depends on the distance of separation of the two clocks and the two-way speed of light. Thus the clocks are not synchronized. Only when $\varepsilon = \frac{1}{2}$ is chosen (isotropic speed of light) will the two clocks remain synchronized. Hence by assuming that the clocks are synchronized it is logically equivalent to assuming that the one-way speed of light is the same in both directions. Thus it is impossible to objectively measure the one-way speed.

But this is what Rømer was attempting to do. How did he get the correct value for the two-way speed when he was trying to measure the one-way speed of light?

> "Essentially, he made two (potentially incorrect) assumptions that exactly cancel. He assumed (1) negligible time dilation and (2) $\varepsilon = \frac{1}{2}$ (the one-way speed of light is the same in both directions)." (p. 229)

These two assumptions are related.

As seen from the Rømer measurement the full time dilation formula depends on ε in such a way that we can never distinguish the effects of time dilation from the optical lag due to the light-travel time. Thus it would seem we are free to choose the one-way speed of light.

This seems frustrating to many. Some suppose there must be a way to objectively measure the one-way speed. But both history and the physics tell us that it is highly unlikely.

Others suppose that a one-way speed does have an absolute objective value and that it should be the same in all directions but that it is impossible to measure it—even in principle. They might think this is how God would have made the universe. But our experience with the physics of Einstein should tell us otherwise. The notion resembles the once-believed-in luminiferous ether, which allegedly provided the medium for light to propagate through. It was once believed that an absolute frame existed where the ether is stationary. But Einstein showed that since the laws of physics are the same for all inertial frames it is impossible to detect the frame of the ether, and that led to the rejection of such a frame as having anything meaningful to say about the universe.

The third option is that perhaps there is no objective observer independent value for the one-way speed of light, in the same way that there is no absolute velocity rest frame.

The conventionality thesis

> "As strange as this may seem, it appears that the one-way speed of light is not a property of the universe, but rather a humanly-stipulated convention. It is something that we are free to choose, and then our choice allows us to have a definition of whether or not two clocks separated by a distance are synchronized (relative to a given observer)." (p. 235)

This is what we call the *conventionality thesis*. It has been disputed for over a century and never disproven. Most physicists agree it is true. This was definitely Einstein's view. Thus, we are free to choose a value of ε and use it to synchronize our clocks, provided that the round-trip speed is c. Most choose $\varepsilon = \frac{1}{2}$, with the one-way speed of light the same in all directions. Einstein used it because it greatly simplifies the equations of special relativity and creates a symmetry, which is very convenient to solve physics problems. This choice bears his name—the Einstein Synchrony Convention (ESC).

Objections to the conventionality thesis

Lisle writes that the most common objection is philosophical and not scientific. They ask, why would the speed of light be different in different directions? But again, to measure the one-way speed of light you need two synchronized clocks separated by a distance. But synchronisation is observer-dependent. Thus there is no way to synchronize two distant clocks such that all observers will agree they are synchronized. Different observers will disagree on the one-way speed of light as measured by those same clocks. Therefore, the one-way speed of light is not an objectively meaningful concept in this universe. To say that the one-way speed of light is 'really' the same in all directions, or 'really' different in various directions amounts to claiming that the correct unit of measure is feet and not yards.

Another objection is that Maxwell's equations of electromagnetism show that the one-way speed of light must be the same in all directions. But Maxwell's equations are derived in a closed system; i.e. they are most often implemented using integrals around closed surfaces. As such, they can only ever produce the round-trip speed of light.

The way the equations are usually written appear to imply that the one-way speed of light is *c*. However, the equations tacitly *assume* symmetry, i.e. $\varepsilon = ½$ and thus the propagation speed *c* can only be a measure of the two-way speed of light. If Maxwell's equations are written in the more generalized form[9] where ε can take any value then we find that the propagation speed of light *v* depends on the direction of propagation and the value of ε, as follows:

$$v=\frac{c}{2\varepsilon} \text{ for the negative x direction}$$

$$v=\frac{c}{2-2\varepsilon} \text{ for the positive x direction}$$

If you substitute $\varepsilon = ½$ for the isotropic case you get $v=c$ for both positive and negative propagation directions. This is then the standard way of writing Maxwell's equations. But for all other cases where $\varepsilon \neq ½$ the velocities in the two opposite directions are not equal and range between ½*c* and infinity for all allowed values of ε between 0 and 1.

So Maxwell's equations can never be used as an argument against the conventionality thesis. But as we saw, when expressed in their full generalized form they allow for the one-way speed of light to be different in different directions. Their standard form is just the special symmetric case with $\varepsilon = ½$ and hence they cannot be used to show that $\varepsilon = ½$.

The Anisotropic Synchrony Convention (ASC)

The ESC, by setting $\varepsilon = ½$ results in the physics being greatly simplified, making it a convenient choice. But another useful choice is to set $\varepsilon = 1$. Under this convention the outgoing light travels at ½*c* and the incoming light travels at an infinite speed, arriving instantly.[10] Lisle named this the Anisotropic Synchrony Convention (ASC).

Under the ASC, because the one-way speed of light towards the observer is infinite, events are time stamped the moment they are first observed. This is quite different from the ESC, in which the speed and direction of the observer must be considered when comparing the moment any observer determines the event occurred. Why? Time dilation due to their relative velocity affects the answer they would calculate. Thus under the ESC, the determination of whether two distant events are simultaneous depends on the observer's velocity.

But under the ASC it doesn't. All Earth-based observers would agree on the timing of celestial events when the ASC is used. However, if two inertial observers are not co-located they will not agree on the simultaneity of the same distant events. There is no possible synchronisation system that would allow all observers to agree on whether two clocks separated by a distance are synchronized. This is just the way God created the universe.

However, a subset of observers with the common property that they all have the same velocity (regardless of their location), using the ESC, will agree on whether two clocks separated by a distance are synchronized. Different observers with different velocities will disagree. Conversely, a subset of observers with the common property that they are all co-located (regardless of their velocity), using the ASC, will agree on whether two clocks separated by a distance are synchronized. But observers at different locations will disagree. These are the two special cases. For all other synchrony conventions with $\varepsilon \neq ½$ and $\varepsilon \neq 1$ simultaneity depends on both velocity and position of the observer.

Therefore, when computing relativistic effects due to velocity the ESC is the better choice, but when computing the timing of distant events

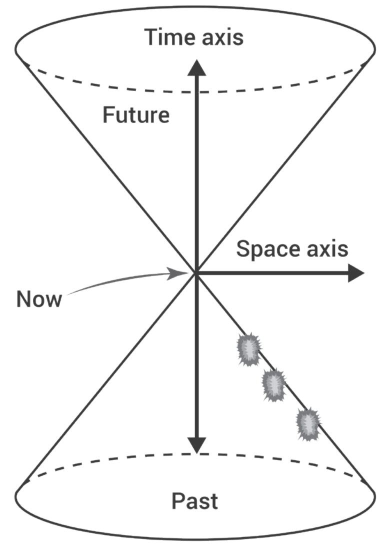

Figure 2. The light cone drawn under assumption of speed of light c. The flashes in the past light cone indicate celestial events which are seen 'now' (in real time) under the ASC but in the past under the ESC.

the ASC is the better choice since it does not depend on observer velocity but only her position. Thus, all Earth-based observers using the ASC will agree on the simultaneity of distant events. Using the *spacetime* diagram (figure 2) the ASC defines the surface of simultaneity as the past light cone. Note the flashes on the surface of the past light cone in figure 2. 'Now' extends to all events on the past light cone. The 'past' itself is not visible under the ASC. On the other hand, the ESC defines the surface of simultaneity as the horizontal plane perpendicular to the time axis exactly between the past and future light cones. See the solid arrow labelled 'Space axis' in figure 2. Each convention defines an observer-dependent 'now' with the ESC depending on the observer's velocity and the ASC on the observer's position.

One can freely convert from one convention to another. It is merely a change of coordinates and does not change the physics. In fact, this is routinely done. The ESC provides for the simplest equations to calculate with but one can also use the full ε-dependent equations.

The distant starlight problem

For many skeptics and even believers, distant starlight is the biggest problem for the Bible. The history given in the Bible cannot be made to exceed c. 6,000 years. So how do we see distant galaxies billions of light-years away? By definition, the speed of light *c* is one light-year per year. We must also conclude that we are actually seeing light that left those distant galaxies. We don't doubt the distances. Thus, some critics claim distant starlight shows that Genesis is wrong.

But once we understand the consequences of the physics of Einstein, the critics' arguments run into problems. They claim that the time between light leaving the distant galaxy and when it arrived at Earth is billions of years. But they have not specified the observer's frame of reference, and have ignored time dilation, but most significantly they have assumed the ESC is absolutely the correct convention to use; meaning that the one-way speed of light *must be c*.

Since light coming from distant galaxies travels one-way to Earth, the time it takes to get to Earth is the distance divided by the one-way speed of light. But we have seen that is conventional; we are free to choose it. Under the ASC the incoming speed is infinite and the travel time is zero. There is no travel time. Thus under the ASC we are seeing all of the universe in real time. The 'now' we experience on Earth is the same 'now' for the whole universe that we see. Only in that sense do all Earth-based observers agree on a universal 'now'. Differently located observers would not agree.[11]

The challenge for the critic is to show not only that the conventionality thesis is wrong but also to show, by an experiment, that the one-way speed of light is indeed *c*. So far no one has shown either. Therefore distant starlight is not a rational objection to the 6,000-year biblical timescale.

Does the Bible use a synchrony convention?

In the second last chapter of the book Lisle deals with some common objections not dealt with elsewhere. But, they fail to show the ASC false. The only question that remains: is the ASC legitimate from a *biblical* standpoint?

Several times the Bible mentions celestial events occurring at a particular time. Therefore, some synchrony convention is used. But if the Bible uses the ESC to synchronize clocks and for 6-day creation of the universe, then the distant starlight question remains unanswered. However, Lisle gives several reasons to think the Bible uses the ASC:

- Until modern times the ASC was the standard synchrony convention. According to their records, ancient astronomers used it for when celestial events occurred. They did not subtract any light-travel time. They knew neither the distance to the objects nor the speed of light.
- There is no evidence anyone used the ESC before the 1670s. Rømer was perhaps the first person to estimate a light-travel time from a distant source. He effectively assumed the one-way speed of light was the same as the round-trip speed, which is only true under the ESC. Since the Scriptures were written long before Rømer it seems reasonable that they too used the ASC. (This involves the implicit assumption of an infinite one-way speed of light.)
- But couldn't God have used the ESC long before *c* was first measured? Yes, but if He did, since nobody had yet thought of it, the ancients would not have correctly understood the Bible.
- God used the linguistic convention of the time and people group to whom the biblical text was written. This would include how we describe events observed in the cosmos. And they used the ASC.
- The difference in ESC or ASC for timing events is of little consequence[12] except when timing celestial events. Events observed today, by the ESC occurred in our distant past. But by ASC reckoning they took place today. Conversely, distant events that take place today, under the ASC, are seen today—instantly when they occur. But under the ESC they will not be seen until some distant future time.
- Biblical descriptions of celestial events indicate that the light travelled to Earth instantaneously. Genesis 1 says the celestial bodies included the stars (verse 16), and they were all created on the fourth day (verse 19). Verse 15 indicates that they were created 'to give light on the earth' but also it says 'it was so'. That is, the light from the stars illuminated the earth on the same day they were created. No delay, as per the ASC. Other examples are Psalm 33:9 and Isaiah 48:7, 13.

In conclusion, there is no distant starlight problem under the ASC because the universe appears in real time. What we call 'now' here on Earth is 'now' everywhere else in the universe. The language of the Bible uses a valid timing convention—the ASC—by recording all events when they are observed to happen. Objecting to its use makes about as much sense as objecting to the Bible for using cubits instead of the metric system of measurement.

I strongly recommend the book. It is an excellent resource and should find itself on the bookshelf of every keen biblical creationist irrespective of their understanding of the ASC. The book clearly shows that the physics of Einstein supports a biblical worldview.

References

1. Initially the speed of light was measured using standard length measures, but it was realized that the speed of light is fundamental to nature but length is not, and now, by international convention, *c* is defined.
2. The cosmological principle also states that there are no special places in the universe, i.e. it has no centre or edge. Thus any observer anywhere in the universe would, on the largest scales, see roughly the same distribution of matter. That is a greatly simplifying assumption that made it possible to get a solution of the Einstein field equations, but it is not necessarily the truth.
3. Plotner, T., The Expanding Universe—Credit to Hubble or Lemaître? *Universe Today*, 11 November 2011, universetoday.com/90862/the-expanding-universe-credit-to-hubble-or-lemaitre/; Block, D.L., A Hubble Eclipse: Lemaître and censorship, arXiv.org preprint, 2011, arxiv.org/vc/arxiv/papers/1106/1106.3928v2.pdf
4. Cho, A., A singular conundrum: how odd is our universe? *Science* **317**:1848–1850, 28 Sept 2007.
5. Hartnett, J.G., Cosmology's fatal weakness—underdetermination, *J. Creation* **32**(2):15–17, 2018.
6. If it could be shown that there is a physical association between low redshift galaxies and much higher redshift quasars, then that would bring into doubt the Hubble law which states that the higher the redshift the greater the distance. Such a claim has been argued by Halton Arp and others for many decades. For recent published research see Hartnett, J.G, Confirmed: physical association between parent galaxies and quasar families, *J. Creation* **32**(3):3, 2018.
7. Hartnett, J.G., Does the Bible really describe expansion of the universe? *J. Creation* **25**(2):125–127, 2011.
8. Winnie, J.A., Special relativity without one-way velocity assumptions: Part I, *Philosophy of Science* **37**(1):81–99, 1970; Winnie, J.A., Special relativity without one-way velocity assumptions: Part II, *Philosophy of Science* **37**(2):223–238, 1970.
9. Giannoni, C., Relativistic mechanics and electrodynamics without one-way velocity assumptions, *Philosophy of Science* **45**:17–46, 1978.
10. It should be noted that under the ASC the one-way speed of light can be determined from $c/(1-\cos\theta)$ where θ is the angle whereby the light beam departs from the directly incoming direction. For light coming directly toward the observer travels at infinite speed because θ = 0° and light moving directly away from the observer travels at ½c because θ = 180°. And light moving perpendicular to the incoming direction travels at *c* because θ = 90°.
11. For example, hypothetical observers on a planet in the nearby Alpha-Centauri system 4.3 light-years away would experience a different 'now' to those on Earth. They would see the same celestial event but offset by 4.3 years due to the time dilation factor. However, because there are no other living beings elsewhere in the universe, Earth is the only planet with sentient life, the universal 'now' we experience here is the only relevant one.
12. The light-travel time between any two places on the surface of the earth is extremely short—much less than a second. No human could perceive such a delay.