The Universe in Near Real Time and the Light Time Effect

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Abstract

At the 2009 CRS conference (Lancaster, SC), Steve Miller presented a paper entitled, "Universe in Near Real Time." This paper suggests the possibility that the astronomical universe is actually being observed in near real time. Miller gives scriptural evidence for this proposal in Revelation 8:12. He envisions an envelope surrounding the solar system in which light travels at velocity c. But outside this envelope the speed is nearly infinite. Observationally, it is readily seen that the *light-time* effect refutes this idea. We cite observations from the literature as well as our recent observations of FY Bootis, a very short-period binary, which displays a sinusoidal orbital light-time effect (an O-C curve). The light-time effect in this system is due to a close binary orbited by a third body. If the scenario of the "Universe in Near Real Time" were true, the O-C curve should be a straight line fit instead of a sinusoid and we could not make the determination given here. This is an example of how real astronomical observations can aid the creation community in testing proposed models, and it stresses our need for our own professional creationary astronomical observatory.

Miller (2010), in his paper "Universe in Near Real Time," proposed that astronomers are actually observing the astronomical universe in near real time. Thus, the recent image of two colliding galaxies taken by the HST shown in Figure 1 depicts a scenario that is currently taking place. The scriptural basis of this belief is Revelation 8:12. It is important to read the context of the verse, so we give it here.

> And the second angel sounded, and as it were a great mountain burning with fire was cast into the sea: and the third part of the sea became blood; and the third part of the creatures which were in the sea, and had life, died; and the third part of the ships were destroyed. And the third angel sounded, and there fell a great star from heaven, burning as it were a lamp, and it fell upon the third part of the rivers, and upon the fountains of waters; and the name of the star is called Wormwood: and the third part of the waters became wormwood; and many men died of the waters, because they were made bitter. And the fourth angel sounded, and the third part of the sun was

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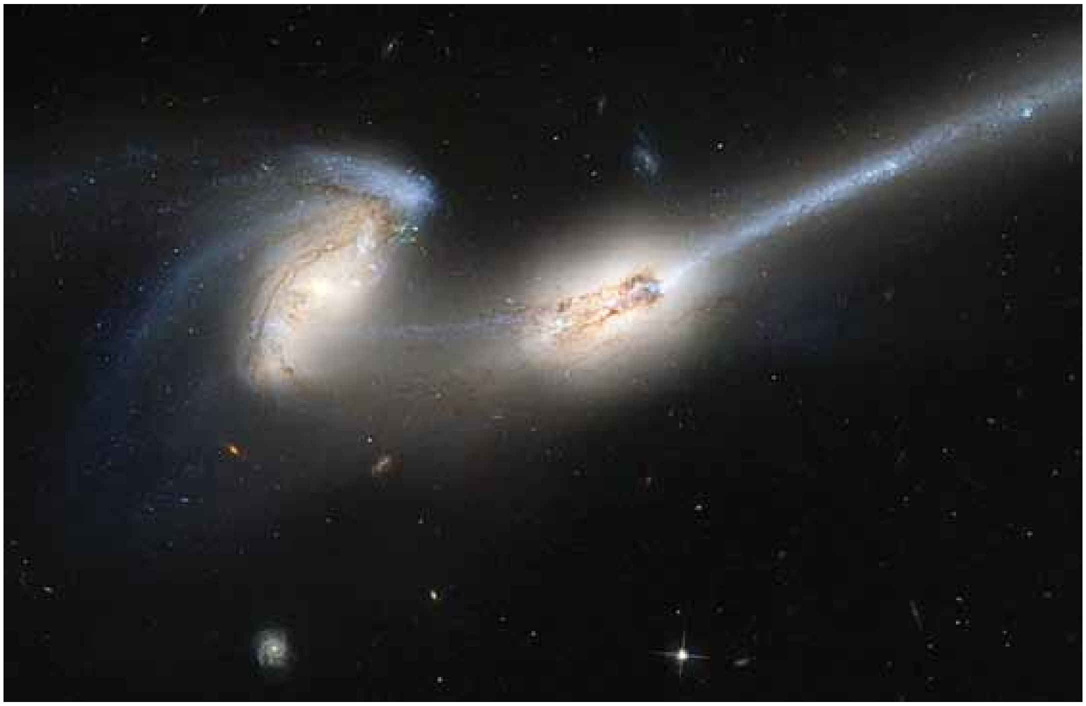

Figure 1 ***(above)*****. HST image of colliding galaxies named the "Tadpole" (UGC10214).**

Figure 2 ***(below)*****. The sun, moon, and stars on top image and darkened and reddened by 1/3 or about 1.2 magnitudes on the bottom image.**

> smitten, and the third part of the moon, and the third part of the stars; so as the third part of them was darkened, and the day shone not for a third part of it, and the night likewise. (Revelation 8:9–12 KJV)

We understand the scenario here to be the end times, during the Great Tribulation. In the first section (the second angel sounding), apparently an asteroid strikes the oceans killing a third part of the sea creatures. Next, the third angel sounds, and apparently a comet with its frozen, noxious gasses strikes the fresh water supply of earth and poisons it. We picture a time of great destruction, asteroids, comets and subsequent volcanism, earthquakes etc. With all this upheaval, the sun, moon, and stars are darkened by 1/3, or about 1.2 magnitudes. They all are dimmed, *as seen by the earth-based observer.* In fact, they are all dimmed nearly simultaneously (see Figure 2). Does it follow that solar system bodies, stars tens of light years away, as well as bright galaxies up to several million light years away instrinsically become less luminous? Miller (2010) concludes that light travels at near infinite speeds outside the solar system, while measurements of the speed of light in the solar system yield the speed, $c = 3 \times 10^8$ m/s.

Another scriptural evidence mentioned to me in casual conversation with Steve Miller was Joel 3:15. Again, exploring the context, Joel 3:14–18,

> Multitudes, multitudes in the valley of decision: for the day of the LORD *is* near in the valley of decision. *The sun and the moon shall be darkened, and the stars shall withdraw their shining.* The LORD also shall roar out of Zion, and utter his voice from Jerusalem; and the heavens and the earth shall shake: but the LORD will be the hope of his people, and the strength of the children of Israel. So shall ye know that I *am* the LORD your God dwelling in Zion, my holy mountain: then shall Jerusalem be holy, and there shall no strangers pass through her any more. And it shall come to pass in that day, *that* the *mountains shall drop down new wine*, and the *hills shall flow with milk*, and all the rivers of Judah shall flow with waters, and a fountain shall come forth of the house of the LORD, and shall water the valley of Shittim. (KJV, italics added)

Again, this is during the end times. The context is the Battle of Armageddon, and the sun, moon, and stars together are darkened *to the earth-based observer.*

In the Miller model, imagine an envelope separating the solar system from the rest of the cosmos. Since we gather from Scripture that God directly created everything in the solar system during Creation Week, and He placed the bodies in their particular orbits (Gen. 1:17), perhaps such an envelope might make some sense. To Mr. Miller, the speed of light inside this envelope is 3×10^8 m/s, and outside of it the speed is essentially infinite. Some supporters of the Miller model, who attended the 2010 CRS Conference, seem to think that the speed decreases, perhaps radially as it comes in from the distant universe and impinges on the sun, for instance, rather than changing suddenly at the boundary of the envelope. We will address that complication later. Of course, all this has to fit within a context of about 6000 years of earth rotations (days) since this model is hypothesized in a young-earth creationist context.

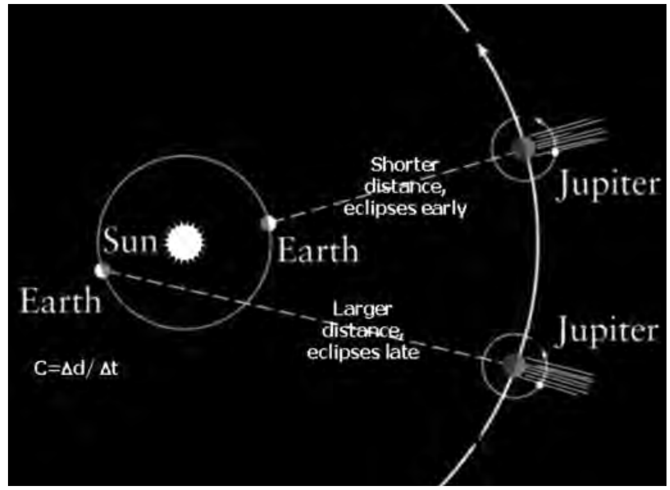

Figure 3. Roemer's determination of the speed of light using light time.

Further evidence given by Miller for the "Universe in Near Real Time" is that deep space images reveal the existence of mature clusters of galaxies. The Hubble Deep field is an example of this. This may be interpreted to mean that the universe was created in a mature form and everywhere we look, the universe has a mature age, regardless of distance.

What Is the Light-Time Effect?

A good explanation of the light-time effect is seen in Roemer's determination of the speed of light. See Figure 3. This is simply the measure of time between two eclipses of Jupiter's moon Io and the difference of the distances of the two occurrences. When Jupiter is closer to the earth in their relative orbital motions, the eclipses will be seen from the earth earlier than on average. When Jupiter is relatively farther away, the eclipses will be seen later. This happens since it takes light longer to travel the additional distance. The difference in time is called "light time." This particular light-time effect is allowed in the Miller model since it occurs inside the solar system "envelope." The light-time effect for stellar binary systems, however, is another matter. These systems are from about 50 ly to 10 Mly distant, so they are well outside the solar system envelope [ly = light-years]. The solar system is about 50 AU in size, out to the Kuiper Belt, which is about 0.0008 ly or 7 light-hours.

An eclipsing binary is a pair of stars that regularly eclipse each other. The eclipses happen periodically, which means

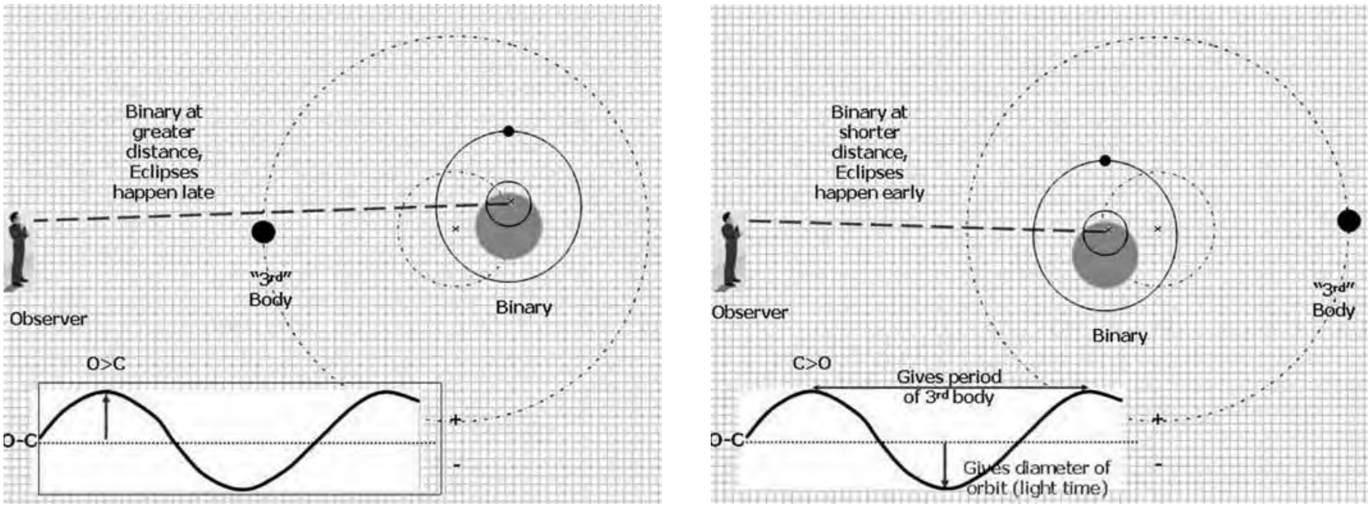

Figure 4. Light-time effect due to a close binary orbiting about a center of mass of a third body, left (a) and right (b).

that eclipse timings are equally spaced in time. The light-time effect we are referring to here, however, occurs when a close eclipsing binary systems has a "third body." This means that the close binary is orbiting the center of mass of a third body, usually a companion star. See Figure 4a. The observer is on earth. By the way, to eliminate the light-time effect of the earth's orbital motion, we calculate our time measurements from the sun's center (so called Heliocentric Julian Date) or from the solar system's center of mass, the Barycentric Julian Date. Here, we, as all other professional astronomers, will neglect this earth-caused light-time effect since it is already taken care of in our time calculations.

Compare Figure 4a to Figure 4b. The smaller dark star is undergoing eclipses with the large gray component as seen by the earth-based observer. This is the close binary system. In turn, the close binary is orbiting about a third star we refer to as a "third body." If the binary is on the far side of the center of mass orbit as seen by the earth-based observer, as in Figure 4a, the eclipses will happen late due to the light-time effect (it is farther away and the light takes longer to get here). We mark this point on our O-C diagram (see arrow), which is the time of the *observed* eclipse minus the expected or *calculated* time of eclipse (eclipse timing). It is a positive value (see lower left-hand plot) since the observed happens later than the calculated time. In Figure 4b, the close binary is in the near side, closer to the observer. In this case, eclipses happen early and the O-C is negative. If many observations are taken, the plotted points will produce a sinusoidal curve as shown (sinusoidal, if the orbit is circular). The time between two adjacent maxima or minima is the period of orbit, and the amplitudes have to do with the size of the orbit of the close binary about the center of mass of the third body.

In the Miller model, the eclipses from the close binary, near or far, will arrive at the earth observer so that there will be no time delay or gain due to the distance of the close binary. So the time delay of the eclipses or the light-time effect is erased in the model. This is due to the infinite speed of light outside the envelope or barrier. The eclipses will always be on time, and never be early or late. See Figure 5 (the line represents the edge of the envelope). Sinusoidal light-time effects are not rare in binary light curves since multiple star systems are not unusual! So the Miller model is found to be incorrect on observational grounds. There is nothing complicated about this effect. It is nearly as simple as $\Delta d/c = \Delta t$ where the time delay, Δt, is the difference of the two times and it is due to the difference of the distances, Δd. If the c is infinite, $\Delta t = 0$, there is no time-light effect!

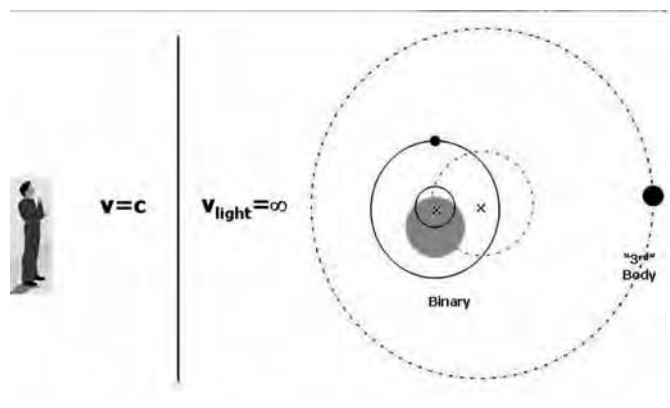

Figure 5. The timing of the eclipses in the binary are independent of distance. So the time delay of the eclipses or the light-time effect is erased in the Miller model.

Case One: VW Cep, ζ Phe, and HT Vir

There are many instances of the light-time effect in the astronomical literature. One example is from a paper in a series of articles by Zasche and Wolf (2007) on combining astrometry (positional analyses) with O-C diagrams. This combination confirms that O-C diagrams show that light-time effect is due to orbital motion of the third components. In this paper the astrometric orbits of three binaries, VW Cep, ζ Phe, and HT Vir, are shown, along with their O-C residual plots. The orbits are found to have periods of 30, 221, and 261 years, respectively. The orbital eccentricities also have been determined, e=0.63, 0.37, and 0.64, respectively, which is a strong indicator of orbital motion. Astrometric orbits and O-C diagrams are shown as Figures 6 and 7. Distances to these binaries are found to be 27.7 ± 0.7, 85.8 ± 5.7, and 65.0 ± 11.5 pc, or 90 ± 2, 280 ± 2, and 210 ± 40 LY. Since VW Cep is a solar type contact binary, the O-C residuals are affected by long parabolic trends due to mass transfer and lesser amplitude effects due to star spot cycles and ongoing spot activity, so the noise is apparent. Close binaries all have various degrees of extraneous effects that somewhat cloud the orbital effects. Real astronomical data are always complicated by effects that make results somewhat unclear. But regardless, the evidence is strong.

Case Two: FY BOOTIS, A Contact System with a Third, Dwarf Component

FY Boo was recently discovered by ROTSE I (Diethelm, 2001) and identified as an EW type (contact binary) variable with a period of 0.241168d. This makes it one of the shortest period W UMa binaries known.

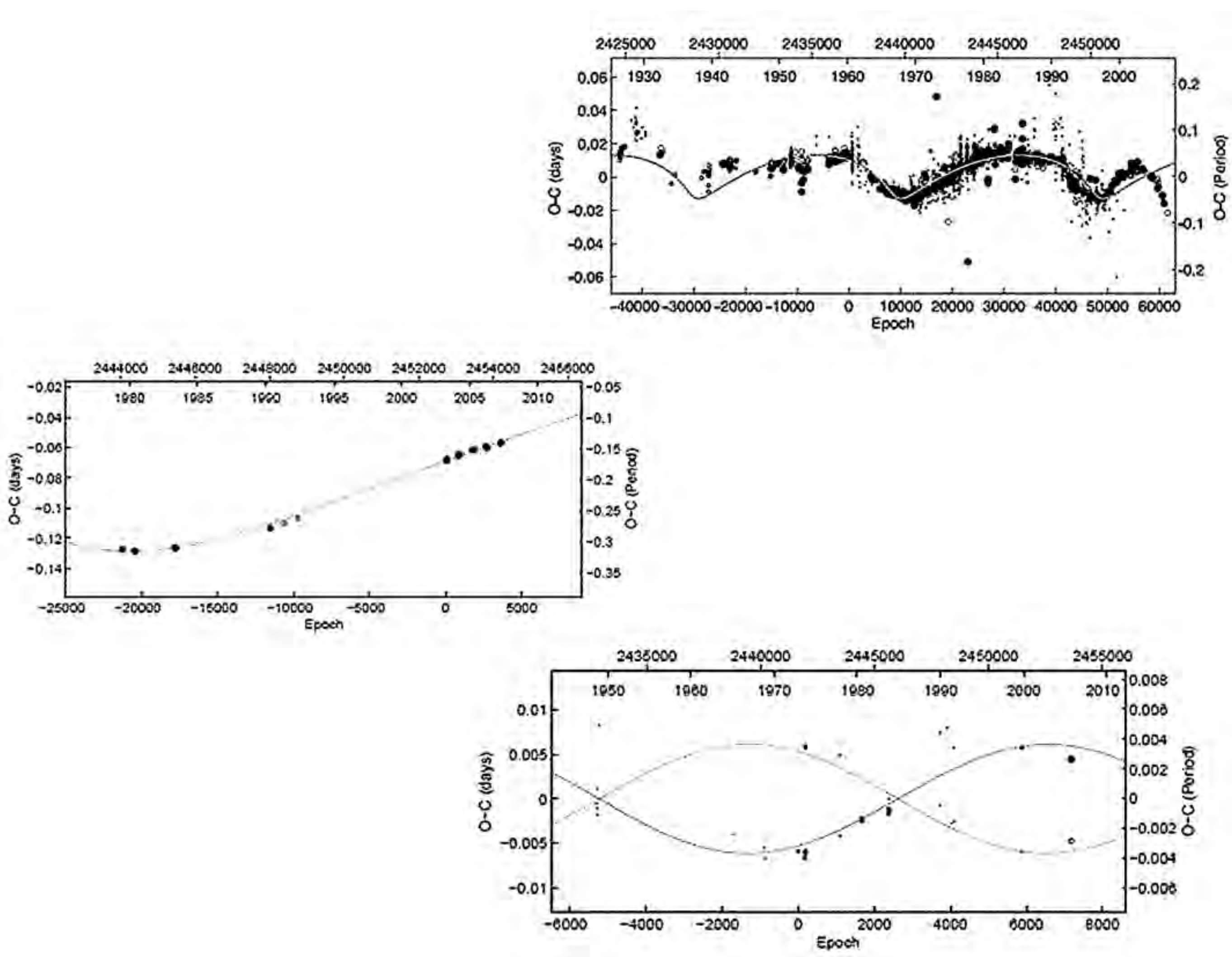

Figure 6. These are O-C (Observed minus calculated) diagrams of VW Cep (upper right), HT Her (left middle) and ζ Phe, right lower, the two curves are of the two components of the eccentric binary.

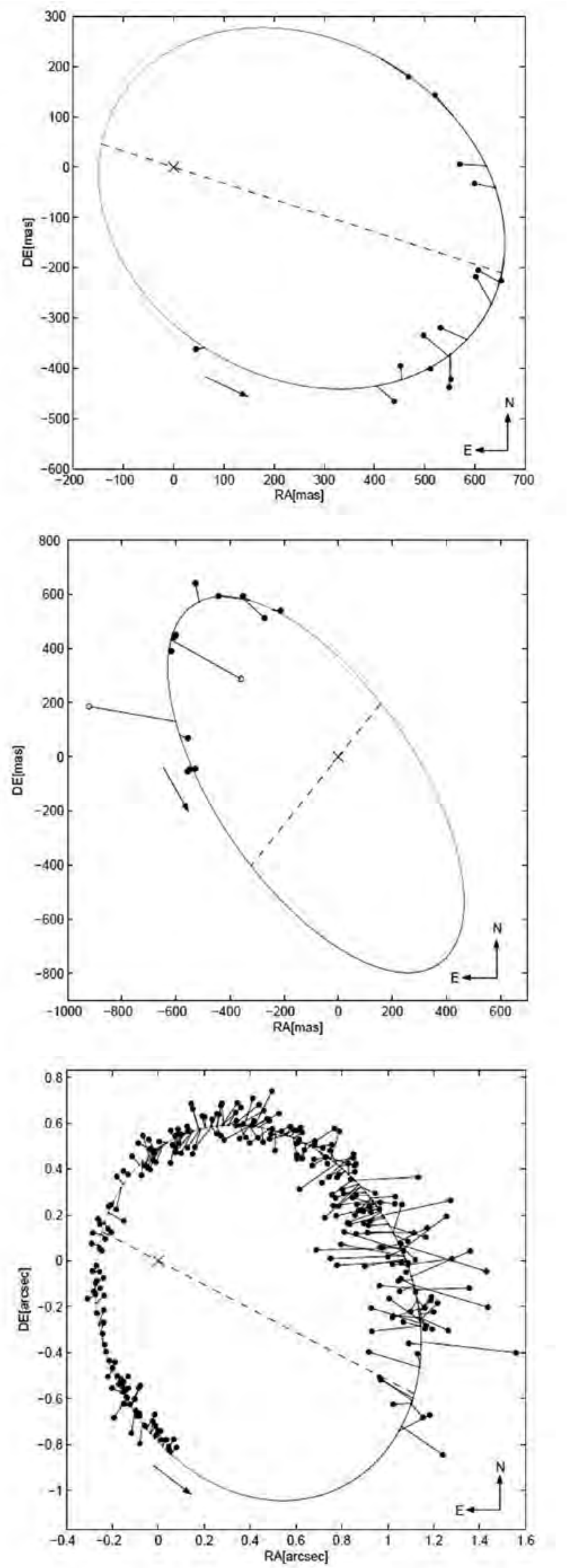

Figure 7. Astrometric orbit of (a, *left top*) VW Cep, (b, *left middle*) ζ Phe, and (c, *left bottom*) HT Her.

Our spring 2009 analysis of FY Boo was done as a project by Bruce Oliver (a physics and astronomy major at Bob Jones University). Interestingly, this binary also has a sinusoidal O-C curve. Because of that, we will provide a brief review.

We took B,V,R,I light curves of the binary with the Lowell 31-inch reflector in Flagstaff with a Cryotiger cooled (-100°C) NASACAM with a 2KX2K chip and standard BVR_cI_c filters. The dates of the observations were 11–15 March, 2009. We undertook the observing run under the auspices of the National Undergraduate Observatory (NURO) and were granted observing time by the Lowell TAC. We used the Lowell program LOIS to take our observations. Our modeled light curves included 107 B, 109 V, 95 R, and 98 I individual CCD observations. These observations were taken by Oliver, Samec and Faulkner. The photometric precision was ±0.008 in B, ±0.006 in V, and ±0.005 in R and I.

We determined six times of minimum light from our present observations. The times of minimum light were calculated from parabola fits. With their standard errors in parentheses, they include: HJDMin I = 2454901.9711 (±0.0022) d, 2454902.9350 (±0.0024)d, 2454904.8587 (±0.0002)d, 2454905.8304 (±0.0002)d and HJDMin II=2454904.9774 (±0.0007)d, 2454905.9491 (±0.0002)d. From our timings and 43 others from the literature, we calculated the following precision linear ephemeris.

$$\text{HJD Min I} = 2454904.8660 \pm 0.0003 + 0.24115955 \pm 0.00000005\ \text{d} \times E \quad [1]$$

Our fit revealed the presence of a low amplitude sinusoid. The sinusoidal ephemeris is:

$$\text{HJD Min I} = 2454904.8691(\pm 0.0003) + 0.24115955(\pm 0.0000005)\ X\ E + 0.0031(\pm 0.0005)^{*}\text{Sin}[4.2(\pm 0.3)X10^{-4} \times XE - 6.0(\pm 1.4)] \quad [2]$$

We believe this sinusoid is due to the light-time effect of a third, orbiting component. The ephemeris gives an orbital period of 9.9±0.2 years for the third component. From the

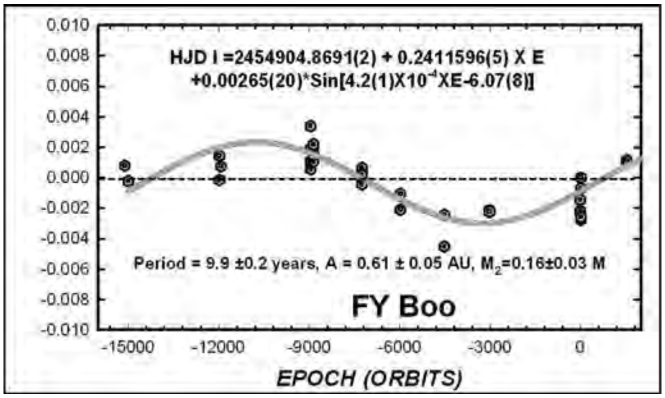

Figure 8. Sinusoidal O-C residuals from equation 2 revealing a third star orbiting the system.

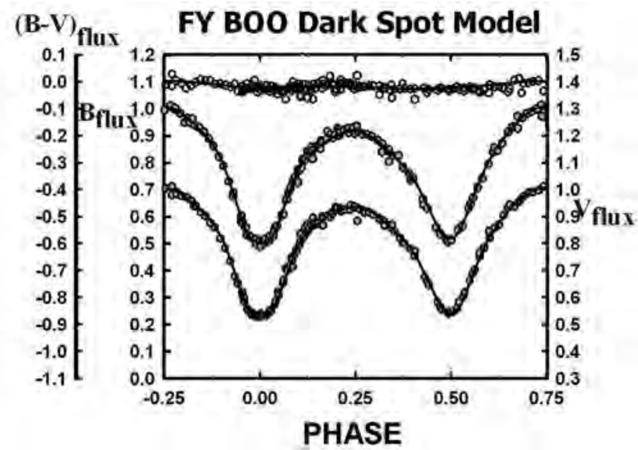

Figure 9a. B,V synthetic light curve solutions overlaying the normalized flux curves.

amplitude, we calculate an orbital radius of 0.61±0.05 AU in light travel time, assuming the orbital inclination of the third component is identical to the main binary. Using Newton's form of Kepler's harmonic law, the third body is found to have a mass of 0.16±0.03 solar masses. This mass is that of an ~M6 dwarf, which is small but comparable to the masses of the other two components. Assuming the system has an absolute magnitude near that of the sun (M_V=4.8) and an apparent V magnitude of 13.1 (from the SIMBAD data base), the star's distance is ~450 Parsecs (~1500 light years), far outside of the radius of our solar system (50 AU = 0.00024 Parsecs). The sinusoidal O-C residuals, calculated from equation 2, are given in Figure 8.

Our B,V,R,I light curves were hand modeled with Binary Maker 3.0 (Bradstreet and Steelman, 2002). Averaged values of parameters were then entered into the 2004 version of the Wilson Code (Wilson and Devinney, 1971 [WD]; Wilson, 1990, 1994; Van Hamme and Wilson, 1998; Wilson and Van Hamme 2003). From these we ran a full BVRI simultaneous solution. Intermediate modeling iterations were done with PHOEBE (Prša and Zwitter 2005), which runs the same Wilson code in the background and makes it possible to view the light-curve fit as the iterations progress. Full synthetic light-curve solutions follow. The temperature of the main component (4750K, K3V spectral type), which we used to model our light curves, was taken from a period-color relation from Batten (1973) using the W UMa period. Recent 2MASS B-V, V-R, J-H and H-K average to K1±4 and affirms our choice. We computed both a hot spot and a dark spot model. The dark spot model has a slightly better sum of square residuals. The dark spot light-curve solution is seen overlaying the normalized flux curves shown in Figures 9a and 9b. Two phases of the Roche-lobe model of the binary for the dark spot solution are shown as Figures 10a and 10b. Phase zero shows the total eclipse.

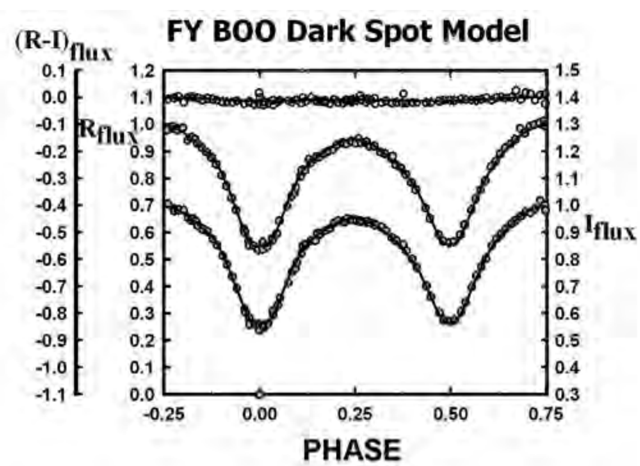

Figure 9b. R,I synthetic light curve solutions overlaying the normalized flux curves.

Our models show FY Boo is a W-type (the less massive component is the hotter) W UMa binary with a mass ratio of 2.5. The system parameters from our model include a contact fill-out of 11%, a slight temperature difference of 200 K, and an inclination of 82°. One large 68° radius magnetic region was modeled on the hotter companion with an average temperature of 0.96 times that of the photosphere. The T-factors and spot radii indicate that this is a *region* of spot activity rather than a giant single spot. The solution gives an eclipse duration of ~7 minutes. The shallow fill-out is quite normal for a W-type system. We believe that this results due to an early stage of contact. The fairly extreme mass ratio probably indicates that the components had nearly this value when they came

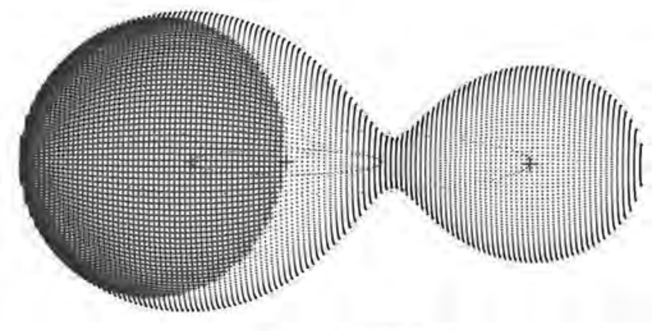

Figure 10a. Roche lobe surfaces from our BVRI solution, phase 0.74.

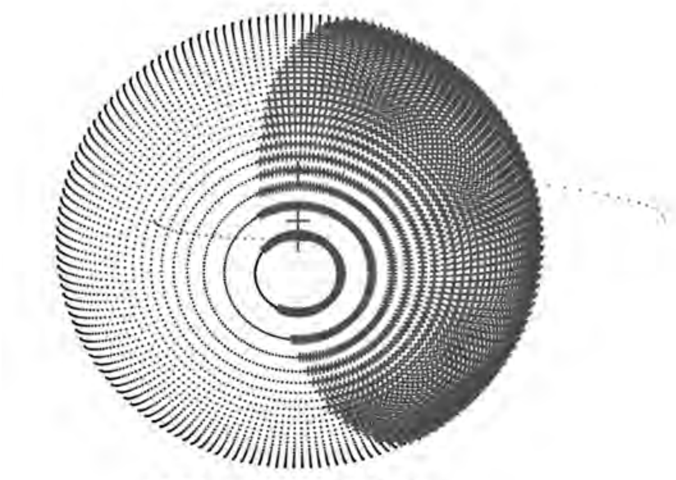

Figure 10b. Roche lobe surfaces from our BVRI solution, phase 0.0 (the primary eclipse).

in contact. We suspect that the mass ratio should progress to more extreme values in the future due to magnetic breaking. The is due to the torque supplied by outflowing winds along "stiff" magnetic field lines originating from this solar-type binary.

Should we be looking for eclipses of the third component? Our calculations show that the proposed dwarf orbiting at ~3.6 AU will never show any eclipses.

Decreasing Speed of Light?

In the situation where the speed of light is nearly infinite at the edge of the universe and equal to the value c in our local solar system, what effects would this have on light itself? We summarize this circumstance briefly here. If we accept the usually stated size of the universe, the distant galaxies are about 14 GLy distant. In the neighborhood of the solar system, the speed is near c and equal to c inside our special envelope. When distances are on the order of a 10^3 ly (as with FY Boo) as compared to 10^{10} ly we would expect the velocity of light to be near c at the nearer distance. Consequently, we would have to probe phenomena on the order of billions of light years to find inconsistencies with a decreasing or spatially decaying speed of light. The effects of the alternate model is very reminiscent to the model proposed by Barry Setterfield (1987) and carries with it all the problems that accompanies that idea. The only coordinate change in plots of this "alternate Miller model" is that they carry axis labels of speed of light versus distance instead of speed of light versus time. The conversion between both would be the formula, d = ct, where c varies with distance instead of time (t). And as the light travels through space, time advances. So these ideas are essentially the same. The "cdk" model has been objected to elsewhere (Aardsma, 1988, 1989; Humphreys, 1988; Holt, 1988; Brown, 1988; Byl, 1988; Chaffin, 1992; Hartnett, 2002; Wanser, 2003). Another model that is similar to this is the Harris model (Harris, 1978), where light starts with an infinite speed, then changes to the current value after the Fall as a function of time and distance from the earth. Hartnett states, "One problem with this model may be the massive blue shifts resulting from the change of infinite to finite speed of light. Also, the fine structure of atomic spectra from a stage of no fine structure to the current state as the bubble (the same as my envelope) passes. This would be observable in starlight, but it is not observed (Hartnett, 2007).

As we have mentioned, we would expect observational problems to arise in deep space objects, those billions of light years away in the "alternate Miller model." A light-time effect is used with deep space objects to determine their size using their light curves. This is particularly useful in determining the size of quasars. These objects have been found to be only light days in size and thus to fit a black hole model. The interval of the light curve variations tells us the size of the object. Figure 11 shows this light-time effect. For instance, if an accretion disk a light month across around a black hole emits a sudden flash, for example, when it evaporates a blob of swirling, in-falling matter, the event would be seen as a light pulse spread out over an entire month as viewed from the earth. This would reveal that the object is one light month across. However, in the case of the Miller model, this effect would be erased due to the near infinite speed of light. Actual observations tell us that quasar light curves vary on the order of light days. So they are light days across, hence they are probably due to black holes since these are on this order of that size. Other cosmological light-time effects explain the appearance of characteristics of jets emitted from the cores of active galactic nuclei, including the apparent superluminal motion, relativistic aberration, and the appearance of shocks and other features, which produce counterintuitive phenomena such as a single shock causing apparently separated features (Mioduszewski, at al., 1998). In addition, there is another observational effect that is governed by the speed of light, that is, Doppler shifts. Doppler shift is governed by the equation,

$$v=\frac{\Delta\lambda}{\lambda}c$$

Doppler-shift radial velocity measurements are made on a regular basis for deep space objects, galactic jets, galaxy rotational velocities, etc. If $c \rightarrow \infty$ in deep space, then the velocity measurements would go to ∞. The observations do not show this.

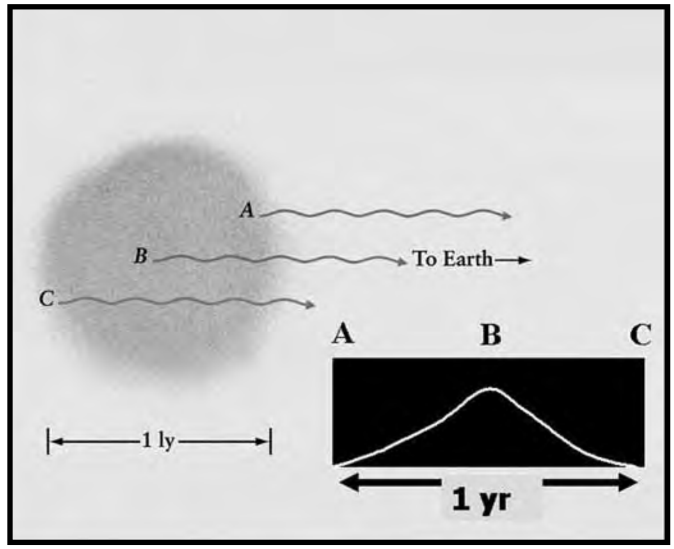

Figure 11. A black hole accretion disk flashes. However, due to its size (one light year across), the light curve pulse will take one year to be wholly seen. This is a cosmological example of a light-time effect.

The Scriptural Basis

Lastly, we would like to examine the scriptural basis of the Miller model. In reading the aforementioned passages and the verses surrounding them, we came across this reading in Joel 2:30–31.

> And I will shew wonders in the heavens and in the earth, blood, and fire, and pillars of smoke. The sun shall be turned into darkness, and the moon into blood, before the great and the terrible day of the LORD come. (KJV)

We immediately see the connection and a probable explanation of the darkening of the sun, moon, and stars. The darkening could be caused by dust, clouds, fumes from volcanic eruptions, and impacts by asteroids and comets arising from God's judgment. This would darken and redden all light (moon, sun, stars, and galaxies) in the sky. Matthew Henry (1991) suggests much the same—that these passages refer to the judgment of the wicked in the last days. He thinks that much of the description is figurative.

Finally, we admit to other possibilities. The aforementioned passages are all prophetic, during the season of end-time miracles. God is the God of miracles, and He is particularly active here. Miller's ideas would entail the continuous action of miracles rather then the rare occurrence of them, as during the end times. We also note that some elements of the passages are poetic such as the *mountains flowing with milk* etc. as Henry believes. We believe these elements are sufficient to explain the statements of Joel and Revelation.

The Anisotropic Synchrony Convention

As a postscript, we would like to note that the recent proposal that is called *the anisotropic synchrony convention* (Lisle, 2011) is also disallowed by light-time observations. The proposal suggests that the one-way travel time of light (in our direction from distant sources like stars, galaxies etc.) is "instantaneous." This would erase the freely observable light-time effects as noted in this paper. It gives the same results as Miller's "universe in real time." Furthermore, we have corresponded with Jason Lisle about this and he responds that this problem has been answered in the literature. However, we challenge that it has not yet been sufficiently answered in a public forum.

Summary

We find that the *universe in near real time* fails under observation, particularly due to the well-understood *light-time effect*, which is used regularly by the astronomical community and verified by independent observation. This paper serves as an example of how real astronomical observations can aid the creation community in testing proposed models, and it stresses our need for our own professional creationary astronomical observatory on a high-altitude, dry site. It also stresses the need to train astronomical professionals for the future who can help us establish a creation model in astronomy. We note that observations for the FY Bootis project were taken at a professional observatory with the instrumentation noted by the authors.

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