Look-back time in our galactic neighbourhood leads to a new cosmogony

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The cosmological model of D. Russell Humphreys is one of a number of innovative creationist models that address the question of light travel from distant galaxies within a young universe. From my studies, it appears that the model, as it stands, does not work well in the region of space close to our galaxy, within a few million light-years of Earth. This led me to develop a new cosmogony for the solar system, based on a different interpretation of the purpose and location of the 'waters above'. In this new model, the 'waters above' are distributed mostly as dispersed frozen chunks of ice of various sizes in a spherical shell. The Sun, Moon and planets are the 'lights' that were created in the expanse (firmament) separating the 'waters above' from the 'waters below' (Genesis 1:14). The stars were not created in the firmament, but beyond it. The shell containing the 'waters above' is located within the solar system and extends out to a few astronomical units beyond Pluto. It is the source of comets that pass through our solar system. Within this new model, a bombardment of comets contributed to the precipitation of the global Flood, adding water to planet Earth as part of the 'windows of heaven'. These 'waters above' may be also provide a source of comets associated with the final judgment in the day of the Lord.

Let us examine the predictions of Humphreys' cosmological model[1,2] for the region of space that we might call our local galactic backyard, in terms of the flight of a photon from relatively close galaxies. This analysis is similar to that of Bill Worraker[3] except I will focus in on a relatively small region of space where the redshifts of galaxies are very small or not observed. If interpreted according to the Humphreys' model this means little or no expansion of the cosmos (that is the fabric of space itself) has occurred in this region. For example, at a distance of 2.5 million light-years we can see

the beautiful spiral galaxy Andromeda or M31[4] (Figure 1). It is the closest neighbour to our galaxy except for some small clusters and nebulae like the Magellanic Clouds. Spectroscopic measurements show a change in wavelength of spectral lines towards the shorter wavelength end of the spectrum—a blueshift. This is interpreted as a relative motion toward us of about 300 km/s. When the motion is away from the Earth, measurements indicate a redshift, or a shift of wavelengths of spectral lines towards the longer wavelength end of the spectrum. When the motion of the Sun in the Galaxy is taken into account, the motion of M31 towards the center of our Galaxy is about 100 km/s. This is called the galactocentric frame. Arp[5] disputes the value of the galactic correction and would reduce this figure even further.

Hubble relation

Edwin Hubble spent a lot of time (1929–1941) documenting the apparent cosmological redshift of galaxies away from the Earth in all directions of space.[6] His observational data covers the region out to at least a redshift $z = 0.2$. Others have extended this out to near $z = 1$ and beyond.[7] For the region of low z the relation Hubble discovered can be relied upon with the most confidence[7] and may be written

$$r(z) = \frac{c}{H_0} z \qquad z \le 0.2 \qquad (1)$$

where c is the speed of light, approximately 300,000 km/s and H_0 is the Hubble parameter, which for small z evaluates to approximately 68 km/s/Mpc, and is constant. (This figure is variously quoted as high as 80 km/s/Mpc.) A Mpc (mega-parsec) is a distance measure of about 3.26 million light-years. In Humphreys' recent paper[8] he accepts the Hubble relation as a determinant of distance derived from cosmological redshift. In this paper, I employ the relation also, but I believe there remains reasonable doubt in relation to quasar redshifts. Others, like Arp,[9] believe that there is at least a large intrinsic component that does not result from a Doppler velocity or cosmological expansion.

If clocks throughout this region all ran at the same rate then we could write the relation for the time interval it takes a photon to travel at the speed of light to Earth from a galaxy at a distance r from the Earth as

$$t(z) = \frac{r(z)}{c} = \frac{1}{H_0} z \qquad (2)$$

This is the usual method big bang cosmologists use to calculate the age of the universe except (1) is somewhat more complicated allowing for curvature of space, deceleration parameters etc. As a result the value of $1/H_0$ is the approximate timescale of the universe, which, using the above

value, becomes 14 billion years. Humphreys' cosmology attempts to reconcile this timescale with the timescale of the Creation account in Genesis.

Local group of galaxies

Let's consider the Andromeda (M31) galaxy at about 0.77 Mpc or 2.5 million light-years. It follows from (1) that M31 should have a cosmological redshift $z_{exp} \approx 2 \times 10^{-4}$ due to space-time expansion. In this region the Hubble relation is expected to apply but can't be measured, as there is no observed expansion redshift. The observed motion of M31 towards our galaxy is considered to be 'local' or peculiar motion resulting from the gravitational pull of the Virgo cluster. In any case, the Local Group, of which the Milky Way is a member, cannot be used to determine the Hubble relation due to local motions of constituent galaxies. Because there is no observable expansion of space, it also follows that the matter distribution has not changed much in the period since the light was emitted. So in terms of clocks that are co-moving with the galaxy, photons have travelled for approximately the past 2.5 million years. But how does the Humphreys' model convert 2.5 million years into a period less than six thousand?

Humphreys' model claims that clocks on other galaxies run faster than the same clocks on Earth. That is, there is a relationship between the time interval (t) of cosmos time recorded by a clock co-moving with a galaxy and the time interval (τ) of the measured time on a similar clock[10] on Earth,

$$t = f(z, \tau) \qquad (3)$$

where f is some function of z and τ. If we fix z, as above, then (3) relates the time that passes on a star in the Andromeda galaxy to the time that passes on Earth. In Humphreys' earliest publication[1] he suggested this relationship is due solely to gravitational effects on space-time that are found in Einstein's General Theory. I don't dispute the validity of that theory as it has been experimentally tested at very high precision. But even if an expansion redshift could be measured for the galaxy and if the whole effect was due to the difference of gravitational potential between the source and the receiver, it would only contribute an insignificant time dilation term of about 0.02%. This can be simply understood from the following equation that defines the contributions to the observed redshift, where local motion has been discounted;

$$1 + z_{obs} = (1 + z_{exp})(1 - z_{grav}) \approx 1 + z_{exp} - z_{grav} \quad \text{for small } z \qquad (4)$$

where z_{obs} is the observed redshift, z_{exp} is the redshift due to Hubble flow or expansion and z_{grav} is the blueshift due to gravitational potential in a finite bounded universe. The minus sign indicates that if the Earth is near the center of the

universe then the gravitational effect will produce a blueshift instead of red. This is true for all z. Using (4) with $z_{obs} \approx 0$ for the Andromeda galaxy then $z_{grav} \approx z_{exp} \approx 2 \times 10^{-4}$. Hence the maximum time dilation possible is a mere 0.02%.

This is a region of space that is locally essentially flat, even considering the finite bounded universe in the Humphreys' model. Therefore **observations tell us that there can be no significant time dilation due to gravitational potential differences** or bending of space-time in this region. So where can it come from? Humphreys subsequently discussed a timeless region in the Klein metric,[2] which he used to provide a very large time dilation effect. Under conditions of extremely compressed matter and space-time this seems to be a valid outcome. He states 'Hellaby *et al.* showed that a (classical, not quantum) timeless zone can indeed occur in the late stages of black hole collapse and in the early stages of white expansion'.[2] Such effects nearly all happened on Day 4 according to the model. Also according to the model, the Earth is near the center of the universe and therefore, it would be nearly the last to leave the timeless region. According to Figure 2b of *New Vistas*[2] the Earth leaves the timeless region when the expansion factor (=1/1+z) reaches about 0.29. For the parameters chosen by Humphreys this is at a $z_{exp} \approx 2.4$. This means the light that left a galaxy with $z_{exp} < 2.4$ is not subject to any timeless zone effects. These type of redshifts are nearly at the edge of current observations. Certainly there is no observational evidence of any space-time distortions at least out to the galaxies discussed here, where $z_{exp} << 2.4$. The type of expansion redshift here means a mere 0.02% stretching has occurred out to the galaxy in question. Under these conditions, in the local galactic neighborhood, space has barely changed in scale (that is, radius of curvature) during the period back to $z_{exp} \approx 2 \times 10^{-4}$. **As a result, the timeless zone, as it stands, does not provide the necessary time dilation.**

There is no observational validity for a change in rates of the clocks out to at least the Virgo cluster,[11] which has a cosmological redshift of about $z_{exp} \approx 5 \times 10^{-3}$. Let's do a calculation, supposing that on galaxies where $2 \times 10^{-4} \leq z_{exp} \leq 5 \times 10^{-3}$, the relative rate of clocks compared to Earth clocks can be described by

$$\frac{\partial t}{\partial \tau} = a e^{a\left(\frac{\tau}{1 year}\right)} \qquad (5)$$

where τ is expressed in years before the present. This exercise does not exactly emulate the equations in the Humphreys' model, but **shows quantitatively that the needed level of time dilation is not possible, irrespective of the mechanism**. Here we have an exponential form that provides for an enormous relative difference. Integrating (5) and providing sensible boundary conditions we get

$$t(\tau) = e^{a\tau} - 1 \qquad (6)$$

where a $\approx 4 \times 10^{-3}$ in order that the age of the most distant galaxies might be 20 billion years in terms of their clocks. Combining (2) and (6) for small z galaxies we can calculate the relative rates of time dilation needed for a particular galaxy.

$$\frac{t(z)}{\tau(z)} = \frac{az}{H_0} \ln^{-1}\left(1 + \frac{z}{H_0}\right) \qquad (7)$$

It follows from (7), that for the Andromeda galaxy the dilation factor is 760 and for the Virgo cluster it is approximately 15,700. This means the clocks would run that much faster than on Earth. Therefore if the mechanism is due to a gravitational well, the galaxies would need to be blueshifted with $z_{grav} = 759$ and 15,699 respectively. Using equation (7) of Appendix C in *Starlight and Time*[1] for the gravitational potential, the gravitational blueshift calculates to be 8.3×10^{-3} for this region for $2 \times 10^{-4} \le z_{exp} \le 5 \times 10^{-3}$. It is consistent with the observed redshifts but opposite in sign.

Using equations (2) and (3) of *New Vistas* the relative time dilation between clocks, in inertial reference frames, on Earth and on a star in the galaxies in this region may be calculated. Using the same parameter for the matter at the edge of the universe as Humphreys and allowing the co-moving co-ordinate ($\eta = r/a$ defined in *New Vistas*) of the clock, at redshift z, to range between $0 \le \eta \le 0.5$, the time dilation factor ranges between 0% and 6%. This parameter

η should be nearly zero because on a cosmological scale, r (the radial distance from Earth to the star) is very close to zero for very small z. The result does not provide the enormous factors required above. The point is, even given the different detail of any specific model, **any dilation factor greater than a few hundredths of a percent is not observationally acceptable.**

So for the light to get to Earth in 6,000 years or less, the clock rates on those low z galaxies need to have been thousands of times greater than current Earth clock rates. This analysis is in agreement with Worraker[3] except that **I don't believe the relative clock rates can be tinkered with to achieve a sensible result**. Worraker quotes Humphreys in relation to the age/distance relation embodied in (2) saying that 'We would want the curves to be more like a straight line with a slope of 1/c, at least in the vicinity of earth'. I agree. After all, it is the basis of the Hubble relation for small z. However, no sensible relationship for clock rates that incorporates this relationship can yield the time dilation needed by the model. The numbers remain astronomical.

An explanation of time dilation factors in our local galactic neighbourhood is an absolute must for any cosmology trying to explain the light-travel-time problem in a period less than six thousand years. I don't believe any cosmological model that accepts the observational data, constant c, constant H_0 and the validity of (1) for z < 1 can do it.

It amounts to the same problem I found when mathematically modelling variable speed-of-light scenarios with built in rapid inflation of the early cosmos. It was relatively easy to have the light from the edge of the universe reach the centre in the initial stages of the expansion but as the speed of light rapidly reduced to bring it down to believable levels in our recent past the light became disconnected from us. This is exactly the horizon problem inflationists face with the big bang. There is a perfect analogy here. The current version of the Humphreys' model doesn't fit the facts in the small z region of the cosmos where the data is the most reliable. The big bang models don't face this particular problem because of the size of the Hubble constant, that is, $c/H_0 = 1.437 \times 10^{10}$ light-years. One needs **very large effects in the small z region** to account for the Hubble relation in a young universe. **But those effects are not observed**.

Figure 1. The Andromeda galaxy.
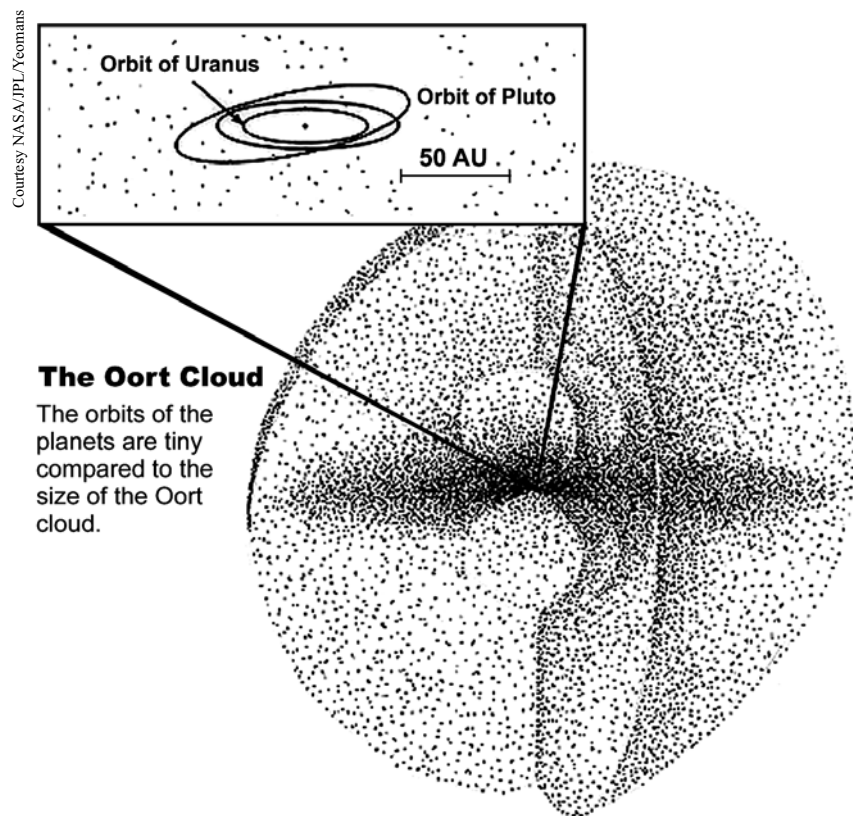
Figure 2. The frozen 'waters above' is the source of all comets. The real cloud is a scaled down version of the hypothetical Oort cloud shown here, (courtesy of <www.astronomy.com/photogallery/gallery_large.asp?idObjectLibraryGUID={A52A2F76-EE3C-11D4-9186-000629551DBC}>).

Supernovae light curves

The creationist physicist Robert Gentry[12] claims that expansion redshifts are merely an assumption and that there is no direct evidence linking them with observed redshifts. His NRI model[12] is attractive in its simplicity[13] though he offers no explanation for the light travel time issue. The only potential observational evidence I can find either way for cosmic expansion is the claim by Goldhaber *et al*.[14] that lengthening of supernovae (SN) type 1a light curves is evidence for cosmic expansion at cosmological redshifts $z = 0.35–0.46$. This region is much farther out than our galactic neighbourhood. Their claim is within standard big bang cosmology, that the decay times of the light curves are longer than those from nearby type 1a SNs indicating significant slowing of local time occurred in the source galaxies at cosmological distances. They found stretching factor of $1+z$ as expected. Gentry's model also explains this, in terms of relativistic Doppler shifts. In fact, his model also exactly matches the data by the correct dilation factor.

Humphreys' model, however, accepts the expansion redshift hypothesis. If the time dilation effects were dominated by gravitational blueshifts in Humphreys' model, then we would expect the opposite effect to stretching of these light curves. According to the first form of his model, the

farther one looks into the cosmos, the faster the rate of clocks attached to the distant galaxies, as compared to Earth clocks. Therefore the light curves of high-z SNs in distant galaxies compared to low-z SNs nearby should be **highly compressed, but the opposite is observed**. This then tells us that the dominant term in his cosmology must come from the timeless zone of the Klein metric. The redshift values of these observed supernovae may place the Earth in the timeless zone at the time the light was emitted. Humphreys' cosmology attributes the effect in this case to a $(1+z)$ expansion factor, the same as with standard big bang cosmologies.

Alternate cosmogony—young solar system (YSS)

In this section I suggest an alternative model for the Creation events. The time stamping suggested by Robert Newton[15] may be the correct frame of reference for the events recorded in Genesis. However it appears that the correct Scriptural interpretation rather than observational evidence may decide whether this view is correct. Ex 20: 9 and 11 are hard to contradict, where God tells His people to do **all** their work in six days and rest the seventh as He did. Newton says all events were recorded as happening in terms of the time of the observation of the event on Earth clocks. This is his 'observed' time in the phenomenological sense.[16] This does not mean the speed of light was ever infinite towards the observer in any physical sense. The value of the speed of light (c) has been constant for most of history at least, but may have been higher around Creation Week. But that doesn't come into this analysis.

In this new model, the meaning of the Days of Creation are as generally agreed, **except for two points, which I believe are open to interpretation**. The first point is that the reference to the stars being 'made' does not put their creation 'literally' inside the expanse. The lights that were placed inside the 'expanse' were all created on Day 4, to rule the day and night etc. (Genesis 1:14–18). The text says '*He also made the stars*' (NIV Genesis 1:16). I contend this does not rule out their creation outside the expanse, on Day 4. Some may contend that that means that the light arrived on Earth by Day 4 at the usual speed c, taking billions of years to get here. The stars therefore may or may not have been literally created on Day 4. Time to God is not the same as the way we view it and He created the whole universe (space and time) for His creation on Earth.

In a letter in response to Dr Duff, Dr Humphreys says

'Thus I suggest that the most straightforward meaning of the Hebrew verse is that God made the stars essentially simultaneously with the Sun and Moon, not beforehand'.[17] I agree but, as Newton pointed out, the most straightforward meaning of simultaneity in this instant is the simultaneous observation of the events (creation of Sun, Moon and stars) on Earth. Humphreys quoting Exodus 20:11 says it 'clearly and explicitly declares that Jehovah made not only the earth, but also the heavens in six ordinary weekdays'.[17] On this point I think Humphreys' argument is the strongest against Newton's model. The verse Ex. 20:9 presents the strongest case here 'Six days you shall labour and **do all your work**', followed by verse 11 'For in six days the Lord made the heavens and the earth, the sea, and all that is in them, and rested the seventh day'. So if we are meant to follow the Lord's example here, He must also have done all His work inside the six days.

Therefore the literal view taken by Humphreys may indeed be the only correct understanding of these verses and the light from the stars (at least those in our galaxy) arrived on Earth soon after being created on Day 4. However an as yet undiscovered time-dilation factor may have allowed the passage of light from the cosmos in a very short time. This point needs further investigation. It however does not negate the following point, which is the main thrust of the new model presented here. For example the Scripture may be interpreted that God created everything in six literal Earth days in the order as described in Genesis 1, but the phrase 'He made the stars also' does not necessarily put them inside the 'expanse' only that they were created on Day 4. The other heavenly bodies mentioned, Sun and Moon, and those not mentioned, planets etc. of the solar system, were placed inside the firmament.

The second point is a question: Where are the 'waters above' now? In Humphreys' model, they are at the edge of the universe (at the edge of matter)—and don't seem to serve any purpose. So why did God go to all that trouble to explain that He did it that way? Is there an alternative explanation? Possibly God placed the 'waters above' outside the Earth but within the solar system or as far as a few astronomical units[18] (a.u.) outside. This then is a concept that we can borrow from the evolutionists but instead a scaled-down-sized cloud of ice crystals varying from small grains to massive chunks. It is in fact the *real* waters-above cloud, the source of all comets and not the hypothetical Oort cloud evolutionists suppose has supplied the solar system with comets for billions of years. Comets have been found to be mostly composed of ice. That is what we see in their tails as they approach the Sun, water as ice particles being driven off the nucleus. There is a lot of ice coming in from out there, even raining down on Earth. Cometesimals[19–21] are very good examples of this.

Then the meaning of the Sun, Moon and planets as being the lights for day and night is consistent with them being in the 'expanse'/firmament (Genesis 1:14,15). As far as the celestial bodies (stars etc) farther out, I contend the

Scripture is not clear. The stars other than the Sun may have been created outside the expanse. The Earth/'waters above' system came from water and it was all placed in the heavens by God's creative power. I think this is a view consistent with all the facts. The existence of this icy 'waters-above' cloud would then be the test of the hypothesis. I expect it would be very sparsely distributed in an approximate spherical shell out to a few a.u. past Pluto (see Figure 2). Secular science suggests the Oort cloud extends out to 50,000 a.u. with an inner doughnut shaped Kuiper Belt just outside the orbit of Neptune. Why not a solar-system-sized cloud that includes the Kuiper Belt objects (KBOs)? The articles written in creationist literature against the Oort cloud have been on the basis that there is no need for its existence to explain long-period comets in a young solar system creationist cosmogony.[22] But the arguments don't specifically exclude the existence of a smaller cloud since the solar system is not billions of years old by any creationist cosmogony.

This brings us to another point; the meaning of the verses

'But the day of the Lord will come ... . The heavens will disappear with a roar; the elements will be **destroyed by fire**, and the earth and everything in it will be laid bare. … That day will bring about the **destruction of the heavens by fire**, and **the elements will melt in the heat**.' (2 Peter 3:10,12).

'All the **stars of the heavens will be dissolved** and the sky rolled up like a scroll; **all the starry host will fall** … .' (Isaiah 34:4).

'Therefore I will make the **heavens tremble**; and **the earth will shake** from its place at the wrath of the Lord Almighty, in the day of his burning anger' (Isaiah 13:13).

'The **sun will be turned to darkness** and the moon to blood before the coming of the great and dreadful day of the Lord' (Joel 2:31).

Could it mean some icy comet will impact the Earth? Could this be the meaning be that the surface of the Earth is destroyed by a comet? Could it be that such an impact of water could generate a thermonuclear explosion? And could this bring on a so-called 'nuclear winter' blotting out the Sun? It seems like the planet, at least Hollywood, is preparing for the judgment; for example, the movie *Deep Impact*. The idea is not inconsistent with these Scriptures. If we read the verses before the above verses from 2 Peter 3,

'But they deliberately forget that long ago by God's word the heavens existed and the **earth was formed out of water and by water**. **By these waters** also the world of that time **was deluged and destroyed**. **By the same word the present heavens** and earth are reserved for fire, being **kept for the day of judgment** and destruction of ungodly men' (2 Peter 3:5–7).

Here the text describes the Flood being the direct result of the 'waters' *of the* Creation through the agency of the Word of God. The same Word has prepared the judgment

of fire. Well, why not from the 'waters-above' which are mostly stored as frozen chunks in the *real* 'waters-above' cloud? Occasionally this water rains down on Earth as cometesimals or sometimes it is seen as large comets in the solar system. One of these large ones would definitely have the effect described above. Danny Faulkner has suggested that there were two episodes of bombardment of the Earth, Moon and planets by meteoroids.[23] The Earth, Moon and planets are pock-marked with craters. These episodes occurred during Creation Week and the Flood. In fact, he suggests comet-type objects, mostly composed of ice, may have impacted the Earth and Moon in a short intense episode. I suggest that during the Flood, all sizes of comets may have been involved in bringing a small portion of the Flood waters to the planet from this 'waters above' region. Also I suggest it is not too much more difficult to believe that the Lord may use the same mechanism to bring on the final judgment.

Discussion and summary

On the cosmological scale, the description of the cosmos promoted by Gentry, in my opinion, seems to have some experimental support. But Gentry makes no claims to explain the light travel time issue in terms of the very short time that has passed on Earth compared to the time it would take light to travel from the stars in the cosmos. However Newton has offered a simple explanation that solves this problem but may not survive correct Scriptural interpretation. Gentry rejects the interpretation of galactic redshifts as resulting from cosmic expansion but rather are largely due to the Doppler motion, even relativistic, of galaxies as they recede from Earth into the existing space. He says there is no experimental evidence for cosmic expansion or Hubble flow as it is called. A recent publication[24] describes a finding that has been known for the last decade—that the Pioneer 10 and 11 spacecraft both have experienced anomalous accelerations of the order 8×10^{-8} cm/s^2 directed towards the sun. They are now outside the solar system in interstellar space and provide an extremely long baseline for testing space expansion. A simple space expansion model yielded the best fit to the data though inconclusive. A more comprehensive model is needed. Could it be evidence for Hubble flow?

Gentry claims that the operation of the GPS satellites and the fact that no Hubble flow correction is made is proof positive for the rejection of the concept of space expansion. But this is incorrect as the contribution from space expansion, if it was measurable, would be about 9 orders of magnitude smaller than combined correction made for the gravitational blueshift from General Relativity (GR) and the Special Relativistic velocity dependent redshift (of opposite sign). I must also add, that while there is no direct confirmation of Hubble flow there is indirect evidence from the many successful tests of GR, which is the theoretical

basis for Hubble flow. In any case none of this matters much really because the gravitational redshift/time dilation effects follows from special relativity ($m = E/c^2 = h\nu/c^2$ for the photon) and the Principle of Equivalence. Soon after Einstein published GR someone pointed out that this effect was not a test of GR itself, but only of the Principle of Equivalence. It doesn't require, or test, the field equations of GR.

The Humphreys' model accepts the general cosmic expansion but differs from big bang cosmologies by assuming a finite bounded universe where Earth is near the center. Gentry's model also starts from the basis of a finite bounded universe where Earth is near the center. But Humphreys' model has a difficulty explaining the existence of 'old' stars relatively near Earth. That is, objects such as white dwarfs in the halos of nearby galaxies should not exist because those galaxies must be much younger than the galaxies much farther out. The model would predict closer objects are younger in stellar evolutionary terms. But most importantly, as it stands, it does appear to explain the light travel time issue that it was initially constructed to do.

The new cosmogony I suggest for the solar system offers a different interpretation of the purpose and location of the 'waters above' that God separated from the 'waters below'. In this model, the stars were not 'literally' created in the expanse or firmament separating the two waters. Rather, they were created outside this region. This interpretation can be extended to help explain to the events of the Flood as well as the coming judgment on ungodly men. The 'waters above' are distributed mostly in a spherical shell of dispersed frozen chunks of ice of varying sizes and are situated out to a few astronomical units outside the orbit of Pluto. This shell is similar to, but smaller than, the Oort cloud proposed by secular cosmologists as the source of long period comets that pass through our solar system. In this case, I suggest a purpose. Firstly, a bombardment of comets caused the precipitation of the Flood and added water to the planet as part of the 'windows of heaven'. This would fit well with the Catastrophic Plate Tectonics model of John Baumgardner[25] and provide a cause that initiated the event. Lastly, the 'waters above' may be the source of comets that bring the final judgment (2 Peter 3:7) in the day of the Lord.

Acknowledgements

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11. 'Because of the Virgo Cluster's enormous mass, its strong gravity accelerates the member galaxies to considerably high peculiar velocities, up to over 1,500 km/sec, with respect to the cluster's center of mass. Investigations over the past decades have revealed a quite complex dynamic structure of this huge irregular aggregate of galaxies. The Virgo cluster is close enough that some of its galaxies, which happen to move fast through the cluster in our direction, exhibit the highest blueshifts (instead of cosmological redshifts) measured for any galaxies, i.e. are moving toward us: the record stands for IC 3258, which is approaching us at 517 km/sec. As the cluster is receding from us at about 1,100 km/sec, this galaxy must move with over 1,600 km/sec through the Virgo Cluster's central region. Analogously, those galaxies which happen to move fastest away from us through the cluster, are receding at more than double redshift than [*sic*] the cluster's center of mass: The record is hold [*sic*] by NGC 4388 at 2,535 km/sec, so that this galaxy moves peculiarly in the direction away from us at over 1,400 km/sec' (<seds.lpl.arizona.edu/messier/more/virgo.html>).

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21. 'To the surprise and delight of astronomers, the Hubble telescope discovered a small armada of "mini-comets" left behind from what some scientists had prematurely thought was a total disintegration of the explosive Comet LINEAR. In one observation, Hubble's powerful vision has settled the fate of the mysteriously vanished solid nucleus of Comet LINEAR, which was reported "missing in action" following its passage around the Sun on July 26. Though comets have been known to break apart and vanish before, for the first time astronomers are getting a close-up view of the dismantling of a comet's nucleus due to warming by the Sun. The results support the popular theory that comet nuclei are really made up of a cluster of smaller icy bodies called "cometesimals." <oposite.stsci.edu/pubinfo/pr/2000/27/> also Don Yeomans, a cometary specialist with NASA, said Linear's break-up pointed up its contrast with Shoemaker-Levy and the diversity of comets in the solar system. "The primary lesson to be learned from this one is that it was an incredible wimp—so fragile it made Shoemaker-Levy 9 look like at tower of strength," Yeomans said. "Just goes to show you that Mother Nature's got a wide variety of comets to display—from hard-packed iceballs [perhaps] to fragile, wimpy fluff balls like Linear."' <www.space.com/scienceastronomy/astronomy/linear_breakup_000810.html>.

22. Cosmogony is a branch of astronomy that studies the origin of the universe. For example the nebular hypothesis of Immanuel Kant (1755) which failed due to its inability to explain the angular momentum distribution of the solar system. The planets contain only 1% of the mass but 98% of the angular momentum. Evolutionary cosmogonists today still face the same problem.

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