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The Apparent Age of the Time-Dilated Universe II: Gyrochronology, Magnetic Orbital Decay of Close Solar-Type Binaries and Errata

Ronald G. Samec*

Abstract

In creation time-dilation cosmologies, one major question is this: What maximum apparent age should be used to characterize the universe? In this paper, one particular age indicator is used. My larger plan is to determine estimates of the answer to this question for many age-bearing processes and then to give a reasonable answer to this question. In this case, I am pursuing astrochronology, the precise derivation of stellar ages from the orbital periods of single stars and interacting binaries. Here, I correct the earlier study (Samec and Figg, 2012) and expand the results using a simpler algorithm that applies to many more binaries. I increase the number of binaries in the earlier study from 18 to 124. The only basis for the selection of these systems is that they appear to be undergoing a clear and preferably long, decaying orbit indicative of magnetic braking. This is shown by a negative quadratic term in dP/dt (days/year), where P (days) is the orbital period of the binary. As before, I attempt an age estimate of these solar-type binaries apart from evolutionary time constraints assuming an initial period at the creation (or formation) of the binary (here, 5–20 days). This time a simpler kinematic approach is taken to extend the number of systems surveyed.

Introduction

Tian et al. (2009) noted that the rate of decay of orbits is 1–2 orders of magnitude faster than expected in binary star evolution (e.g., Guinan, Bradstreet, and Robinson, 1987). Although I find that this is nearer to 2–3 orders, their general observation is correct; that is, binaries are evolving at a rapid and easily observable rate. This paper is a follow-up to our pilot study for this project (Samec and Figg, 2012),

Thus, binary evolution occurs in real time—easily perceptible by human observers. Although I correct a calculation error that occurred repeatedly in Part I, this basic result remains true.

In review, *astrochronologies* are those dating methods used to determine the age of an astronomical object. In evolutionary astronomy, these schemes are usually biased by the assumption that the age of the Sun is 4.57 x 10^9 years or 4.57

* Ronald G. Samec, Emmanuel College
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Gyr. I call this the solar-age condition (SAC). The SAC is derived from the maximum radioisochron age of "primordial" meteorites. The term used to describe this particular study is *gyrochronology*, which is a derivation of stellar ages from the orbital period of solar-type stars and interacting binaries. The important result of the RATE (Radiosotopes and the Age of The Earth) project (Vardiman et al., 2005) was that isochronal dating is faulty, and actual geological ages are nearer to the chronology given to us in the early chapters of Genesis. The discrepancy—thousands of years versus billions of years—is due to an accelerated radioisotope decay rate occurring early in earth's history. Standard geology assumes that the present decay rate is the same as it was in the past ("the present is the key to the past," or uniformitarianism). This important study, yielded the age of the Earth and its surrounding solar system nearer to 7000 years than ~4.6 billion years.

Whereas the RATE results pertained to geological time-scales, I am finding a different time effect in astronomical time-scales. The cause is not *accelerated aging* but rather a difference in earth-bound clocks as compared to cosmological ones. In *Starlight and Time* (Humphreys, 1994), general relativity was used for the first time to solve the light-travel time problem: how can astronomical observations be made of objects billions of light-years away in a young universe? Humphreys' answer to this dilemma is that time dilation occurred in the earth-based observational frame.[1] In his first model, earth-based clocks ran slowly when a collapsing white hole[2] (or black hole in his newer cosmology) event horizon passed the earth. During these moments, light not only came from the deepest realms of space to earth, but the aging of physical processes passed as the light traversed the distances through the universe to the earth-based observer. That is, a million light-years of light travel resulted in a million years of aging. In subsequent work, Humphreys found that when the earth was in the interior of a white or black hole, it was in a timeless region (Vardiman, and Humphreys, 2011). So long as the Earth was inside the event horizon, objects outside of it continued to age and their light continued to impinge upon the earth. A mature cosmos was left in its wake. This was followed by the complete evaporation of the white hole and the termination of the event. During the event, in the frame of reference at cosmological distances, great ages passed, while in the earth time frame only a few days or less of time was experienced. This event may well have happened inside of Creation Week. An attempt is made here to determine the apparent age experienced by the universe outside the Earth's time frame or, "What apparent age can I use to characterize the universe?" The 13.80 billion-year answer provided by the big bang community (Ade et al., 2015) should not be accepted due to its false assumptions, which are at odds with biblical history of the Earth. The biblical basis for a recent creation has been covered elsewhere (see Morris, 1993, pp. 19–20). But the acceptance of general trelativity, which is proven as well as any of today's scientific theories, with its time-dilation physics is certainly allowed, especially with the detection of merging stellar black holes with LIGO using GR predicted gravitational waves (Abbott et al. 2016). Clearly, the acceptance of man's invention of the inflationary universe (Guth, 1997) or the cold dark matter model (Ade et al., 2015) is certainly not a part of my quest.

In addition, I will seek to avoid the use of the SAC in our observational studies. I prefer to base our timescales on natural reference clocks (NRCs) rather than clocks calibrated with the SAC. Such chronometers include Newtonian orbital periods, the speed of light, and situations where the physical rates, frequencies, velocities, and accelerations are known from observations (see Samec, 2011). In the Samec study, an apparent age in the range of 10^6–10^8 years was determined. In a similar study, spiral windup times as indicated by Humphreys (2005) gives an apparent age of less than **a few hundred million years**. This apparent age is only ~2% of the accepted evolutionary age of the universe.

Magnetic Braking

As in Part I (Samec and Figg, 2012), I use the orbital decaying process of magnetic braking to determine ages. This is described fully in Part I. Binary stars consist of two stars that orbit about a common center of gravity (barycenter) and have a common orbital period (tidally locked, circular orbits). With time, the entire binary steadily loses angular momentum via magnetic braking. As this happens, the orbit shrinks and by Kepler's third law, the orbital period shortens (see Figure 1). When the atmospheres of the stars touch, the stars are called *contact binaries*. The stars continue to coalesce into fast-rotating single stars such as A-type stars or subgiants, like the spotted FK Coma stars.

[1] I am using Russ Humphreys' first cosmology as an example of a creation cosmology, not as the defining one. I understand this model, so it is particularly easy to use. And I think that it has been around so long that it is most understood by the readers. I do not mean to not "prefer" it above the rest.

[2] Regarding White Holes: "Recent research discussed by Polchinski (2015) indicates that cosmologies based on event horizons, as with White Hole Cosmology, may need revision. However, the results of this line of research may not be known for some time, hence we continue to use these cosmologies based on classic general relativity, not on unknown improved theory needed for strong gravitational fields on the basis of quantum effects."—The editor.

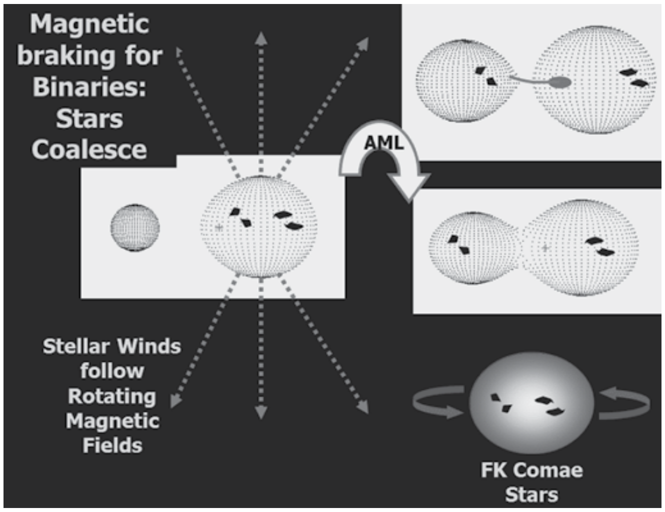

Figure 1. Magnetic braking on single stars. AML is an acronym for Angular Momentum Loss or "spin." As the binary undergoes AML, the orbital period will decrease due to Kepler's law.

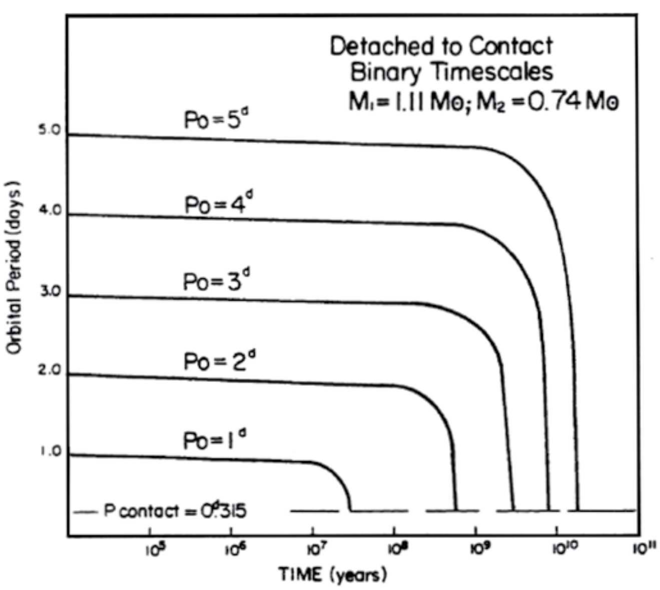

Figure 2. The time needed to brake from a, 1–5 d period binary to a 0.315 period binary with masses of 1.00 to 5.00 (Guinan and Bradstreet 1988). Po is the initial period. Pcontact is the orbital period that the binary achieves contact.

Astronomical Timescales, Binary Stars

As noted in Part I, Guinan and Bradstreet (1988) is the benchmark paper on the decay of binary star orbits. In that paper, they produce an example plot of the evolution of a detached binary star with a period of 1–5 days into a contact configuration of 0.315 days. This is reproduced here as Figure 2. The aging models in their work are calibrated by the SAC (4.6 X 10^9 years). The effect of this is seen in the time axis scales of tens of millions to tens of billions of years. Figure 3 (adapted from Guinan, Bradstreet, and Robinson, 1987) shows a graphic depiction of the same process including the final coalescence into a fast-rotating A-type star.

The Age Determination from Observations of Close Binaries Undergoing AML

Using our personal observations of close eclipsing binaries spanning a quarter of a century, Part I presented negatively measured dP/dt's (rate of period change) of a number of solar-type stars (Samec and Figg, 2012). I assumed that these period changes were due to magnetic braking and the resulting angular momentum loss (AML). Note that the results were *independent* of the usual SAC calibration. Rather that result is dependent only on the NRC chosen in lieu of the SAC; that is, the use of ordinary Keplerian orbital periods. However, due to a calculation error, the results in Part I are underestimated. Although I take a different tack in this paper, a listed retabulation is given in Tables 1–4. In Figure 4, I show a typical O-C residual plot from eclipse timings (O-C means Observed minus Calculated or Predicted by an extant ephemeris; it is the meaning of residual). This type of calculation gives the rate of period decrease of T= $-QE^2 + PE + To$, the standard form of quadratic ephemerides (i.e., the new eclipse happens at time T after so many epochs, or orbits, E, added to the initial eclipse, with a quadratic, Q ("deceleration" term in days/epoch/epoch or d/E^2), and P is the period in days. This acts the same way as a Newtonian kinematical calculation with a deceleration, $y = -\frac{1}{2}at^2 + bt + c$, like the motion of a car with its brakes on. The quadratic term, -Q is $\frac{dP}{dE}$, is the rate of change in period per orbital period (days/Epoch). The relationship of the rate of period change in days/year and $\frac{dP}{dE}$ in days/year is calculated from the formula:

$$\frac{dP}{dE} = \frac{1}{2}\frac{dP}{dt} \bullet \frac{P}{365.24} \qquad (1)$$

Part I used AML (angular momentum loss) equations from the analysis of Guinan and Bradstreet (1988). Here L_{orb} is the orbital angular momentum. Using those equations free of the SAC assumptions, equation (2) gives the orbital angular momentum of a gravitationally coupled binary star.

$$L_{orb}=1.24\ 2\times10^{52}\,q(1+q)^{-2}\,M^{5/3}\,P^{\,1/3}\,cm^2\,gm/s \quad (2)$$

where M is in solar masses.

Taking the derivative, assuming no mass transfer and an insignificant mass loss, the torque, $\mathfrak{I}=\frac{dL}{dt}$, becomes:

$$\frac{dL}{dt}=4.1\times10^{51}\,q(1+q)^{-2}\,M^{\frac{5}{3}}P_{orb}^{-2/3}\,\frac{dP_{orb}}{dt}\,cm^2\,gm/s^2 \quad (3)$$

where P in days, dP/dt in days/year. Ages, Δt, are calculated from this simple relation

$$\Delta t=\frac{\Delta L}{\mathfrak{I}} \quad (4)$$

In Part I, average values of AML were calculated, neglecting the small changes in mass over the lifetime of the short-period binaries (Maceroni and Rucinski, 2000) and that these binaries begin their life time with periods of 10 days or less (Maceroni

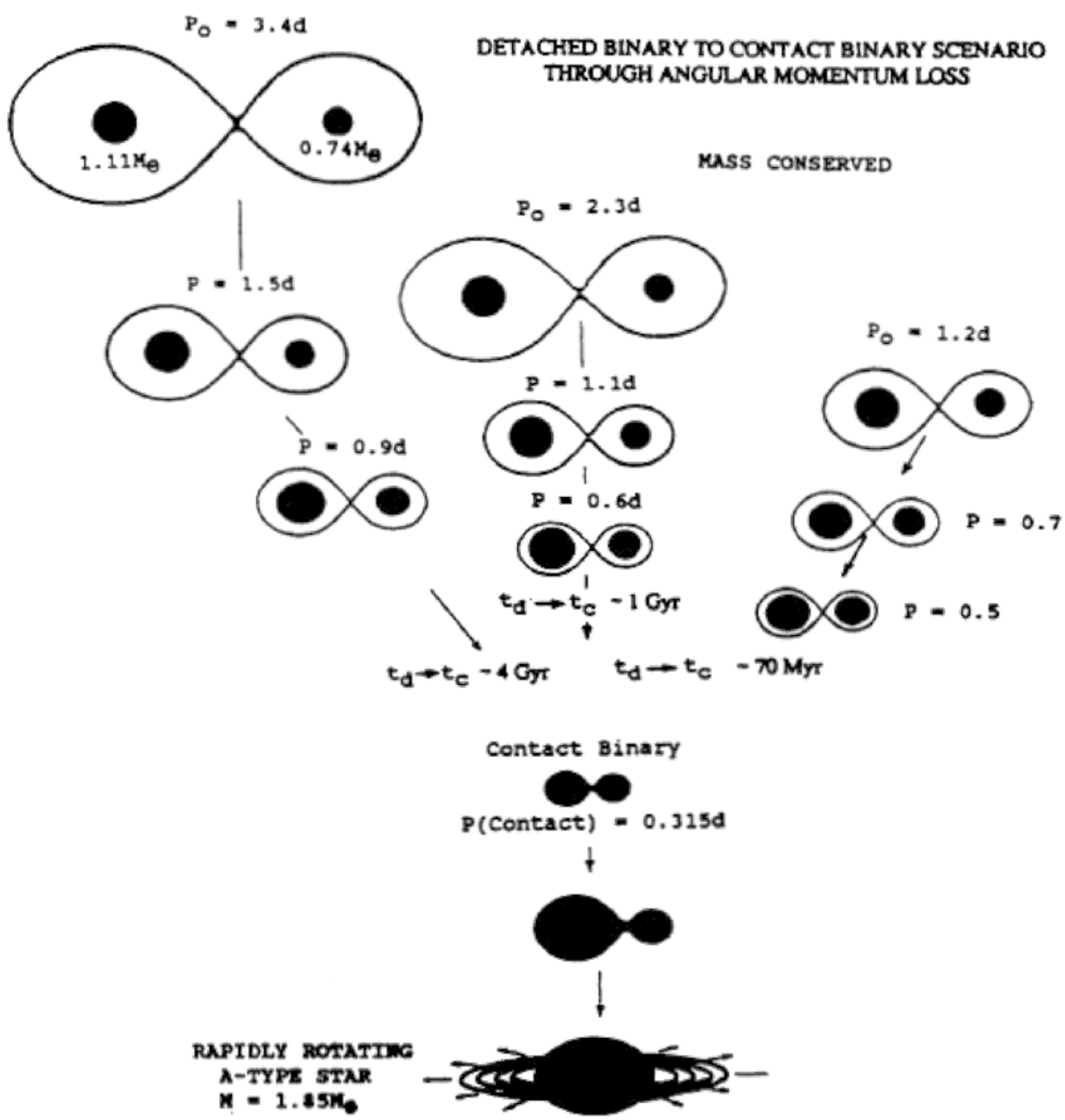

Figure 3. Graphic depiction of the time evolution of a solar-type binary braking from a 1–5 d period binary to a 0.315 period binary and on to a coalesced, rapidly rotating single star (Guinan, Bradstreet, and Robinson, 1987).

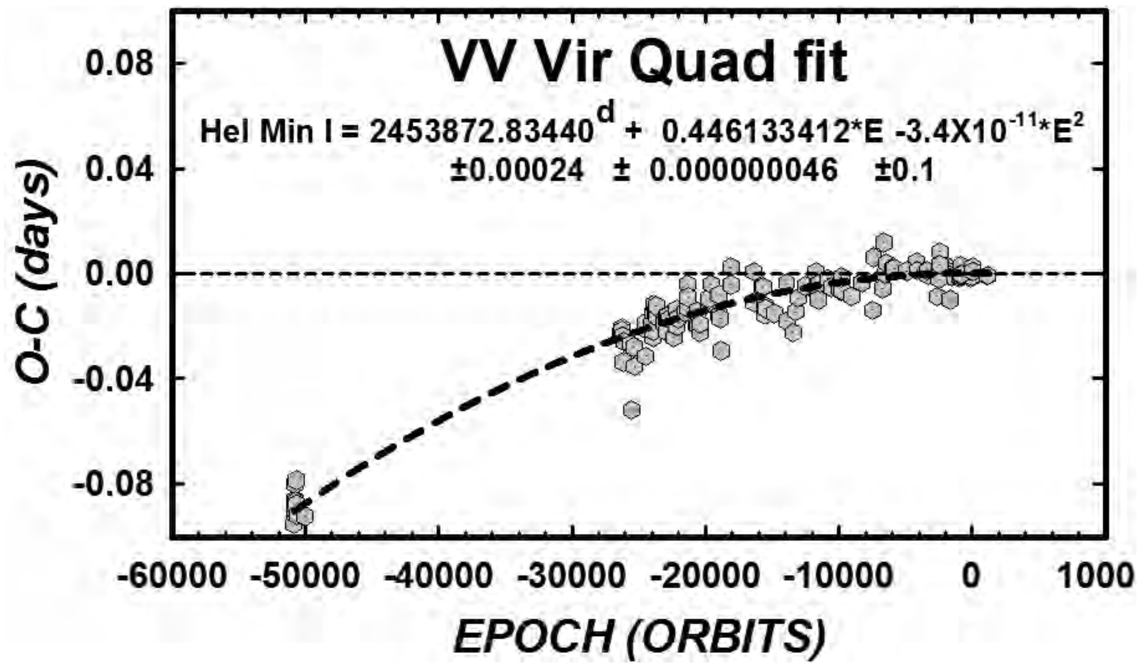

Figure 4. Our observation and calculation from previous eclipse timings shows that the orbit of VV Vir (Samec et al., 2008) is decaying. Since this system is of solar type, I conclude that the period change and the angular momentum loss are negative. I included this binary in our calculation of the age of such binaries.

and Rucinski, 2000; Guinan and Bradstreet, 1988; Kroupa and Burkert, 2001; Henderson and Stassun, 2012).

The Part I table of results included eighteen binaries. Here I correct and update the values from Part I in Tables 1–4. The average apparent ages range from ~25 to 35 million years, only 2–3% of the evolutionary age of the universe for our limited short-period sample. The next section improves on the sample.

A simpler but more accurate tack arises from the fact that the mass ratios used in the tables are not well known unless precision spectroscopic radial velocity curves and their analyses are available. This requirement makes our results questionable. An even simpler approach is possible that does not depend on mass ratios. In this methodology, I use the following equation to make our age calculations,

$$\Delta t = \frac{-\Delta P}{\dot{P}} \qquad (5)$$

so that I need only the period and rate of period change. The method only assumes that the chosen systems have a continuous, quadratically decreasing period. ΔP is the difference in the present orbital period of the binary minus its initial period. The quantity $\dot{p}$ is the rate of change in the period, $\frac{dp}{dt}$, equation (5). In addition, I have spent months surveying the literature and Internet sites, including the American Association of Variable Stars (AAVSO) O-C files created and maintained by Dr. Bob Nelson (AAVSO 2015). I also added additional binaries from my recent studies. The binary star community is indebted to Dr. Nelson's continued work in handling thousands of period studies of eclipsing binary stars. I was able to extend the original 18 systems of Part I to some 124 binaries with periods ranging in orbital periods 0.21 days to 9.3 days.

New Extended Results

I found that the observed rate of angular momentum loss has a much greater effect on the ages of short-period binaries than proposed by the binary-star community. Recently, I have been studying precontact WUMa binaries (Samec et al. 2015, 2014, 2013, 2012a, 2012b); that is, solar-type stars exist in detached (separated) binary stars with periods up to ~10 days. Thus the current study extends to longer periods than usually accorded to close binaries. Due to the inclusion of these longer-period

Table 1. Eratta[1]: Results of 25 Years of Observing Solar-Type Binaries AML

	dp/dE (d/E)	dP/dt (d/yr)	period (d)	Est. Spec. Type	M_1 ($M_☉$)	M_2	M
AK CMi	-5.00E-11	-6.45E-08	0.5658964	A3	2.40	1.56	3.96
AO Cam (14)	-5.69E-11	-1.26E-07	0.3299	G0V	1.20	0.40	1.60
AT Aqr	-3.90E-11	-7.54E-08	0.37802984	G5	0.92	0.33	1.25
BE Cep	-1.60E-11	-2.75E-08	0.42439404	K1	0.77	0.52	1.29
BM UMa	-5.40E-08	-1.45E-04	0.27122032	K3	0.73	0.37	1.10
CN And	-9.80E-11	-1.55E-07	0.46279007	F6	1.30	0.50	1.80
EH Hydra	-1.60E-11	-4.23E-08	0.27663622	G6	0.91	0.29	1.20
EK Com	-2.05E-11	-5.62E-08	0.26668637	K1	0.77	0.24	1.01
GSC 2537 -0520	-1.61E-10	-3.17E-07	0.3710377	G5	0.92	0.15	1.07
HM Mon	-1.80E-11	-3.23E-08	0.4076	G2	1.00	0.59	1.59
V1128 Tau	-3.40E-11	-8.13E-08	0.30537273	G3	1.00	0.51	1.51
V361 Lyr	-3.60E-11	-8.49E-08	0.30961373	F8	1.26	0.87	2.13
V524 Mon	-1.10E-11	-2.83E-08	0.28361604	G8	0.88	0.42	1.30
V803 Aql	-9.00E-11	-2.50E-07	0.26342299	K3	0.73	0.73	1.46
V965 Cyg	-6.50E-11	-7.41E-08	0.64056706	A3	2.45	1.59	4.04
VV CVn	-3.14E-09	-4.30E-06	0.53292205	F2	2.60	1.30	3.90
VV Vir	-3.50E-11	-5.73E-08	0.4461334	G0	1.05	0.45	1.50
XZ Cmi	-3.50E-11	-4.42E-08	0.57880796	F3	1.50	1.25	2.75
Average	**-3.22E-09**	**-8.40E-06**	**0.395258**		**1.24**	**0.67**	**1.91**

[1]Replaces Table IVa, Paper 1.

Explanation for Tables 1–4: Tables 1–4 replace Tables 4a, 4b, 5, and 6 respectfully in paper 1. As I state earlier in this paper, "The Part I table of results included eighteen binaries. Here I correct and update the values from paper 1 in Tables 1–4. The average apparent ages range from ~25 to 35 million years, only 2–3% of the evolutionary age of the universe for our limited short-period sample."

binaries, I have extended our range of initial periods to 20 days. In our results, I assumed 5 days as the birth period for binaries of period 0.2–0.5 days. Further, I assumed a birth period of 8 days for 0.5–0.8-day periods, 10 days for 0.8–1.5-day periods, and 15 and 20 day periods from 1.5–9.3 days.

The results begin in Table 7. The overall average age of our extended sample is about 80 million years. This is only 0.6 % (0.006) of the 13.80-billion-year evolutionary age of the universe. Although this does not equal the oft-cited age of 6000–10,000 years in creation literature, I remind the reader that this value is the apparent age of a *time-dilated universe*. The earth and, I believe, the entire solar system remains in the range of ages last mentioned. And only some ~100 million years (not 13.80 billion!) years of apparent history is exhibited at least in the nearby (<2 kiloparsec, or about 6000 LY) cosmos—and probably for the "deep" universe as well.

In the example given by Guinan and Bradstreet (1988), shown in Figure 2, using their magnetic-braking equations, which include the SAC, the scenario of a present-contact binary with a 0.315-day period is calculated. The sample calcu-

Table 2. Eratta[2]: Results, continued

	L_2 (today)	$q=M_2/M_1$	dL/dt	L_1, 5 d (initial)	L_1, 8d (initial)	L_1, 10d (initial)
	1.825E+51	0.65	-8.017E+40	1.613E+52	2.580E+52	3.226E+52
	1.450E+50	0.36	-1.228E+38	1.918E+51	3.068E+51	3.835E+51
	2.146E+50	0.68	-9.506E+37	2.528E+51	4.046E+51	5.057E+51
	9.582E+49	0.50	-1.666E+41	1.766E+51	2.826E+51	3.533E+51
	9.548E+49	0.37	-3.093E+38	1.702E+51	2.724E+51	3.405E+51
	3.406E+50	0.39	-1.713E+39	3.680E+51	5.888E+51	7.360E+51
	9.262E+49	0.31	-4.932E+37	1.674E+51	2.678E+51	3.348E+51
	6.600E+49	0.31	-2.693E+37	1.237E+51	1.980E+51	2.475E+51
	7.050E+49	0.17	-1.210E+38	9.500E+50	1.520E+51	1.900E+51
	2.816E+50	0.59	-2.760E+38	3.454E+51	5.527E+51	6.908E+51
	1.868E+50	0.51	-4.824E+38	3.059E+51	4.894E+51	6.118E+51
	3.605E+50	0.69	-3.596E+39	5.822E+51	9.315E+51	1.164E+52
	1.302E+50	0.47	-7.180E+37	2.296E+51	3.673E+51	4.591E+51
	1.691E+50	1.00	-2.189E+39	3.210E+51	5.136E+51	6.420E+51
	2.144E+51	0.65	-7.332E+40	1.674E+52	2.678E+52	3.347E+52
	1.564E+51	0.50	-2.825E+42	1.467E+52	2.348E+52	2.935E+52
	2.521E+50	0.43	-2.771E+38	2.825E+51	4.521E+51	5.651E+51
	1.055E+51	0.83	-7.782E+39	9.114E+51	1.458E+52	1.823E+52
Average	**5.050E+50**	**0.52**	**-1.757E+41**	**5.154E+51**	**5.154E+51**	**1.031E+52**

[2]Replaces Table IVb, Paper 1.

lation shows the decrease in the orbits over time of 5 different initial periods P_0 from 1d to 5d. It is of interest here that they state that systems having periods $P_0 > 6d$ may not experience this braking effect as main sequence stars since the tidal effects are small due to their relatively large separations, so they cut off their initial period at 5d. Note that all the stars except for two studied here have periods greater than 5d. These systems were selected only on the basis that they appear to be undergoing magnetic braking. Thus, my unwitting selection may lend credibility to their prediction. As shown in the figure, the time to reach contact depends strongly on the initial period. Their calculations yield an age of 17 Gyr (!) for an initial period of 5 days and 30 Myr for P_0=1d. In my sample, using binaries with periods from 0.30 to 0.32d, I find, from observational rates of decay that the time to attain contact ranges from 27 to 58 million years, averaging 47, nearer to the prediction for initial 1d periods. My result for this transition (braking from a 5d period to 0.32 d) is far short of 17000 million years (17 Gyr). In fact, it is only 0.28% of that age (some 2–3 orders of magnitude)! Binary evolution is taking place at a rate of nearly 400 times that predicted by theory! Using the 5-day limiting period of Guinan and Bradstreet, my sample decreases to 24 binaries, and the age of this group is about 60 million years. This is only 0.4 % (0.004) of the 13.80-billion-year evolutionary age of the universe. So our results remain the same order of magnitude.

Conclusion

The conclusion of this study is that the observable events in the cosmos outside of the solar system really did happen and

Table 3. Eratta[3]: Time (Years) to Change from 10-, 8-, 5-Day Periods to Present Orbital Periods (Corrected Table)

	Age (years) 5d	Age (years) 8d	Age (years)10d
	2.83E+07	3.77E+07	4.26E+07
	1.17E+07	1.50E+07	1.68E+07
	2.07E+07	2.68E+07	3.01E+07
	5.95E+07	7.76E+07	8.71E+07
	9.27E+03	1.18E+04	1.32E+04
	1.10E+07	1.44E+07	1.62E+07
	3.22E+07	4.10E+07	4.57E+07
	2.38E+07	3.03E+07	3.38E+07
	4.89E+06	6.32E+06	7.09E+06
	5.00E+07	6.50E+07	7.29E+07
	1.75E+07	2.24E+07	2.50E+07
	1.69E+07	2.16E+07	2.41E+07
	4.86E+07	6.20E+07	6.91E+07
	5.33E+06	6.78E+06	7.55E+06
	2.58E+07	3.46E+07	3.92E+07
	4.16E+05	5.50E+05	6.22E+05
	2.92E+07	3.81E+07	4.29E+07
	4.18E+07	5.56E+07	6.29E+07
Average	**2.38E+07**	**3.09E+07**	**3.47E+07**

[3]Replaces Table V, Paper 1.

Table 4. Eratta[4]: Average, Maximum and Minimum Results (Corrected)

	Age (years)		
	5d Initial Period	8d Initial Period	10d Initial Period
Average	2.38X 10^{+07}	3.09X10^{+07}	3.47X10^{+07}
Maximum	5.95X10^{+07}	7.76X10^{+07}	8.71X10^{+07}
Minimum	4.16X10^{+05}	5.50X10^{+05}	6.22X10^{+05}

[4]Replaces Table VI, Paper 1.

are therefore objects of scientific study for the creation scientist. Phenomena were not just created with *appearance of age*. The events are as follows: The stars were created, and perhaps many coalesced from clouds of gas and lived out their lives and are living out their lives. Normal solar-type stars went through their nuclear burning cycles to become AGB stars, followed by planetary nebula and finally white dwarfs after they spent their nuclear fuels. More massive stars went through their cycles faster, ending their lives as supernovae. Solar-type binaries began their lives as well-detached but orbiting stars, and they slowly decreased in period through magnetic braking as their orbits shrunk. They became semidetached, and then contact binaries that we presently observe. As an aside, but an important note, some astronomers believe that contact binaries are the most abundant of all variable stars in the cosmos—indeed, they are very frequent in the heavens! Their abundance conveys a message that should be heeded by the creation community. Finally, judging from the occurrence of very rapidly rotating spotted stars in clusters and in the field, I believe some of the binaries have already merged into single stars. *The occurrence of such objects in the evolutionary view is probably impossible age wise!* They should not exist in a universe of such a "young age" as 13.80 billion years—at least to an evolutionary astronomer.

This paper gives physical confirmation of the youthful age, in a creationary sense, of the universe in a *time-dilation* scenario. As I noted earlier in this article, and as someone has called to our attention at a recent meeting, *much of this prehistory took place during Creation Week following the creation of the first stars on Day 4*. So the event postulated by Humphreys falls into the category of a Creation Week event. Regardless, the phenomena did take place and are *not due to an apparent, ex nihilo, created history*. The events we see truly took place and are objects of legitimate scientific inquiry that the Lord has allowed His children to study. "O give thanks unto the God of heaven: for his mercy endureth for ever" (Psalm 136:26 KJV). "For in six days the LORD made heaven and earth, the sea, and all that in them is, and rested the seventh day: wherefore the LORD blessed the Sabbath day, and hallowed it" (Exodus 20:11 KJV).

Acknowledgments

I and my astronomical collaborators, which include well-known creationists, wish to thank the public and private observatories that I have been allowed use to make this contribution to creation science, and the Creation Research Society for their generous support of this project.

Table 5. Extended Study Including 124 Close Binary Stars

		Ref	dp/dE (d/E)	dP/dt (d/yr)	period (d)	Est. Spec. Type
1	V731 Her	28	-1.34E-10	-4.60E-07	0.2132017	F6
2	CC Com	8, 28	-5.02E-12	-1.66E-08	0.2206861	K4/5
3	V1104 Her	36	-9.28E-12	-2.97E-08	0.2278759	K5
4	RW Tri	21	-2.12E-12	-6.67E-09	0.2318830	G8
5	V579 Lyr	25	-2.92E-10	-8.78E-07	0.2429093	K3
6	V400 Lyra	24,25	-9.08E-11	-2.62E-07	0.2534250	K1
7	V1067 Her	28	-1.89E-10	-5.34E-07	0.2581060	K2
8	V803 Aql	28	-9.00E-11	-2.50E-07	0.2634230	K3
9	EK Com	28,30	-3.29E-11	-9.00E-08	0.2666848	K2
10	V384 Ser	28	-5.55E-11	-1.51E-07	0.2687280	K1
11	BM UMa	33	-2.78439E-11	-7.50E-08	0.2712000	K0V
12	EF CVn	28	-4.63E-11	-1.24E-07	0.2720490	G6
13	EH Hya	28	-1.60E-11	-4.22E-08	0.2766362	G6
14	VW Cep	28	-6.84E-11	-1.80E-07	0.2783101	G5
15	BX Peg	16,28	-4.64E-11	-1.21E-07	0.2804170	G8
16	BL Leo	2	-1.78E-11	-4.61E-08	0.2819207	G5
17	EI CVn	15	-1.20654E-10	-3.11E-07	0.2834000	K5V
18	V524 Mon	28	-1.10E-11	-2.83E-08	0.2836160	G8
19	EP Cep	34	-2.96E-10	-7.46E-07	0.2897391	K1
20	V676 Cen	28	-8.58E-12	-2.14E-08	0.2923940	G6
21	TZ Boo	4	-9.00E-12	-2.21E-08	0.2971599	G1
22	GZ And	28	-2.44E-11	-5.85E-08	0.3050165	K5
23	V1128 Tau	28	-3.40E-11	-8.13E-08	0.3053727	G3
24	AV Crb	28	-9.55E-11	-2.26E-07	0.3081900	K1
25	V361 Lyr	28	-4.50E-11	-1.06E-07	0.3096121	F8
26	HRBoo	28	-7.4E-11	-1.71E-07	0.3159669	G6
27	TY Boo	28,35	-7.81E-12	-1.80E-08	0.3171484	G8
28	BO Aur	28	-9.78E-11	-2.25E-07	0.3181935	M2
29	V1115 Cas	28	-3.81E-10	-8.61E-07	0.3232785	K2
30	TU Boo	28	-4.31E-11	-9.70E-08	0.3242870	G3
31	V369 Cep	34	-6.94E-11	-1.54E-07	0.3281891	K1
32	AO Cam	14	-5.69E-11	-1.26E-07	0.3299000	G0V
33	AH Tau	14	-3.18809E-11	-7.00E-08	0.3327000	G1
34	AQ Boo	28	-8.09E-11	-1.77E-07	0.3331376	F2
35	EQ Tau	20	-1.06E-11	-2.27E-08	0.3413485	G0
36	BY Peg	20	-1.18E-10	-2.51E-07	0.3419380	K3

Table 5. Extended Study Including 124 Close Binary Stars

		Ref	dp/dE (d/E)	dP/dt (d/yr)	period (d)	Est. Spec. Type
37	VW Boo	6	-6.81E-11	-1.45E-07	0.3423155	G5
38	ES Cep	34	-5.06E-11	-1.08E-07	0.3424552	M0
39	V781 Tau	28	-2.25E-11	-4.77E-08	0.3440983	G0
40	GR Vir	10	-2.05E-10	-4.32E-07	0.3469788	F9-G0
41	KN Vul	28	-1.1522E-10	-2.36E-07	0.3573325	G0
42	VZ Lib	28	-1.71E-04	-3.49E-01	0.3582550	G2
43	GSC 0883–1116	28	-7.00E-10	-1.41E-06	0.3636090	F0
44	GV Boo	28	-6.83E-10	-1.36E-06	0.3678660	G8
45	GSC 3108–0057	28	-1.94E-10	-3.84E-07	0.3687510	G6
46	V417 Aql	28	-2.36E-10	-4.65E-07	0.3703180	G2
47	GSC 2537 -0520	28	-1.61E-10	-3.17E-07	0.3710377	G5
48	U Peg	28	-6.06E-11	-1.18E-07	0.3747797	F3
49	AT Aqr	28	-3.90E-11	-7.54E-08	0.3780298	G5
50	AD Phe	28	-6.94E-11	-1.33E-07	0.3799210	G8
51	V1094 Her	28	-7.52E-10	-1.40E-06	0.3921114	G3
52	V356 Mon	5	-4.65E-11	-8.57E-08	0.3963413	F9
53	V2240 Cyg	28	-1.02E-09	-1.84E-06	0.4041940	F3
54	GSC3208–1986	28	-7E-10	-1.26E-06	0.4045659	F3V
55	SS Ari	11	-2.13E-10	-3.83E-07	0.4059940	F8
56	HM Mon	28	-1.80E-11	-3.23E-08	0.4076000	G2
57	DE Lyn	28	-3.15E-10	-5.63E-07	0.4088170	G6
58	CU Tau	9	-1.02E-09	-1.81E-06	0.4125378	G0
59	V1095 Her	28	-2.88E-10	-5.07E-07	0.4153750	K5
60	WZ Cep	7, 28	-2.12E-10	-3.71E-07	0.4174409	F7
61	EH Cnc	28	-1.77E-10	-3.10E-07	0.4180321	F3
62	BE Cep	28	-2.15E-11	-3.71E-08	0.4243978	K1
63	AP Leo	28	-6.38E-11	-1.08E-07	0.4303572	G0
64	AW UMa	28	-6.023E-11	-1.00E-07	0.4387249	F0
65	BS Cas	28	-1.70E-10	-2.82E-07	0.4404632	G5V
66	TV Mus	9	-1.32E-10	-2.16E-07	0.4456794	G0-G1
67	VV Vir	28	-3.50E-11	-5.73E-08	0.4461334	G0
68	V502 Oph	28	-9.83E-11	-1.58E-07	0.4533908	F9
69	CN And	28,32	-9.80E-11	-1.55E-07	0.4627901	F6
70	V653 Lyr	28	-3.58E-10	-5.57E-07	0.4688106	F6
71	FT Lup	28	-1.17E-10	-1.82E-07	0.4700790	F5
72	II Per	28	-4.514E-11	-6.87E-08	0.4798500	K2V

Table 5. Extended Study Including 124 Close Binary Stars

		Ref	dp/dE (d/E)	dP/dt (d/yr)	period (d)	Est. Spec. Type
73	TT Cet	28	-3.97E-11	-5.98E-08	0.4859530	F6
74	GSC 2038–0293	28	-3.43E-10	-5.06E-07	0.4954110	K3
75	V724 Aql	20	-3.49E-11	-4.93E-08	0.5175994	F7
76	RU UMi	18	-7.186E-11	-1.00E-07	0.5249259	F1
77	V878 Her	28	-1.341E-10	-1.85E-07	0.5294733	F8
78	VV CVn	28	-3.14E-09	-4.30E-06	0.5329221	F2
79	AK CMi	28	-5.00E-11	-6.45E-08	0.5658964	A3
80	V530 And	28	-1.40E-08	-1.77E-05	0.5771072	F4V
81	DF Lyr	28	-7.73E-11	-9.78E-08	0.5771280	F8
82	XZ CMi	28	-3.50E-11	-4.42E-08	0.5788080	F3
83	WZ Cyg	28	-6.26E-11	-7.83E-08	0.5844680	K0
84	GSC4968–0725	28	-1.00E-08	-1.23E-05	0.5962390	K0
85	RS Ser	28	-1.12E-10	-1.37E-07	0.5981380	F8
86	CC Peg	28	-4.45E-12	-5.37E-09	0.6055974	F5
87	BX And	31	-1.03E-10	-1.23E-07	0.6101101	F4
88	EG Cas	28	-1.60E-10	-1.91E-07	0.6114435	A4
89	ZZ Cyg	28	-1.07E-10	-1.25E-07	0.6286163	F6
90	RU Eri	13	-1.90E-12	-2.20E-09	0.6321987	F3V
91	V965 Cyg	28	-6.50E-11	-7.41E-08	0.6405671	A3
92	V0355 Vir	28	-3.00E-08	-3.34E-05	0.6555290	K5
93	IK Per	28	-2.33E-10	-2.52E-07	0.6760347	A2
94	IR Cas	1	-1.19E-10	-1.28E-07	0.6806860	F4
95	V104 Cyg	28	-1.64E-10	-1.74E-07	0.6856900	G4
96	CU Hya	28	-1.343E-09	-1.36E-06	0.7190649	F6
97	CN Com	28	-1.79E-10	-1.78E-07	0.7354410	K0
98	AW Cam	28	-2.67E-11	-2.53E-08	0.7713460	A0
99	DZ Cas	3	-9.88E-11	-9.20E-08	0.7848864	A9
100	RT Per	12	-1.08E-10	-9.29E-08	0.8494069	F5-G0
101	VW CVn	28	-5.17E-09	-4.44E-06	0.8499056	A4
102	RR Lyr	28	-7.61E-11	-6.07E-08	0.9154230	F5
103	NZ Per	28	-1.56E-09	-1.22E-06	0.9379200	G2
104	V501 Oph	28	-5.49E-11	-4.15E-08	0.9679500	F4
105	X Tri	19	-1.89E-10	-1.42E-07	0.9715397	A2/G3
106	CV Cyg	28	-5.6384E-10	-4.19E-07	0.9834178	FGIII
107	V346 Aql	28	-8.06E-11	-5.32E-08	1.1063625	A0
108	XZ Per	28	-4.32E-10	-2.74E-07	1.1516210	G0

Table 5. Extended Study Including 124 Close Binary Stars

		Ref	dp/dE (d/E)	dP/dt (d/yr)	period (d)	Est. Spec. Type
109	YZ CVn	28	-1.01E-10	-6.30E-08	1.1755540	G1
110	IM Aur	28	-4.95E-10	-2.90E-07	1.2472866	K0
111	GS Boo	28	-5.61E-09	-3.26E-06	1.2567870	G0
112	GSC 0262–0948	28	-1.30E-08	-6.95E-06	1.3714155	G8
113	W UMi	28	-1.00E-09	-4.29E-07	1.7011576	A3
114	RW Mon	28	-6.40E-10	-2.45E-07	1.9060910	A0
115	V640 Ori	28	-1.55E-09	-5.61E-07	2.0227500	F7
116	CW Peg	21,22,28	-5.29E-09	-1.63E-06	2.3725133	A2
117	TX UMa	12	-2.99E-09	-7.13E-07	3.0632881	B8V,G0 III-IV
118	TY Peg	28	-4.93E-10	-1.16E-07	3.0922550	A2/G
119	PX Cep	28	-1.36E-08	-3.17E-06	3.1268280	F8
120	RY UMi	28	-2.51E-08	-5.62E-06	3.2648140	K2
121	WY Per	28	-3.41E-08	-7.50E-06	3.3270300	F2
122	Y Psc	28	-4.78E-09	-9.26E-07	3.7700000	A5
123	RT Lac	28	-3.96E-08	-5.70E-06	5.0737202	G5
124	RY Gem	28	-8.31E-08	-6.52E-06	9.3002990	A2

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Table 6. Estimates of the "Apparent Age" of the Universe

P0 5d (initial)	Po, 8d (initial)	Po, 10d (initial)	Po 15d (initial)	Po 20d (initial)
1.04E+07	1.69E+07	2.13E+07	3.21E+07	4.30E+07
2.88E+08	4.68E+08	5.88E+08	8.89E+08	1.19E+09
1.61E+08	2.61E+08	3.29E+08	4.97E+08	6.65E+08
7.15E+08	1.16E+09	1.46E+09	2.21E+09	2.96E+09
5.42E+06	8.84E+06	1.11E+07	1.68E+07	2.25E+07
1.81E+07	2.96E+07	3.72E+07	5.64E+07	7.55E+07
8.88E+06	1.45E+07	1.82E+07	2.76E+07	3.70E+07
1.90E+07	3.10E+07	3.90E+07	5.90E+07	7.91E+07
5.26E+07	8.59E+07	1.08E+08	1.64E+08	2.19E+08
3.13E+07	5.12E+07	6.45E+07	9.76E+07	1.31E+08
6.31E+07	1.03E+08	1.30E+08	1.96E+08	2.63E+08
3.81E+07	6.22E+07	7.83E+07	1.19E+08	1.59E+08
1.12E+08	1.83E+08	2.30E+08	3.48E+08	4.67E+08
2.63E+07	4.30E+07	5.41E+07	8.20E+07	1.10E+08
3.91E+07	6.39E+07	8.05E+07	1.22E+08	1.63E+08
1.02E+08	1.67E+08	2.11E+08	3.19E+08	4.28E+08
1.52E+07	2.48E+07	3.12E+07	4.73E+07	6.34E+07
1.66E+08	2.72E+08	3.43E+08	5.19E+08	6.96E+08
6.31E+06	1.03E+07	1.30E+07	1.97E+07	2.64E+07
2.20E+08	3.60E+08	4.53E+08	6.86E+08	9.20E+08
2.13E+08	3.48E+08	4.39E+08	6.65E+08	8.91E+08
8.03E+07	1.32E+08	1.66E+08	2.51E+08	3.37E+08
5.77E+07	9.46E+07	1.19E+08	1.81E+08	2.42E+08
2.07E+07	3.40E+07	4.28E+07	6.49E+07	8.70E+07
4.42E+07	7.24E+07	9.13E+07	1.38E+08	1.85E+08
2.74E+07	4.49E+07	5.66E+07	8.58E+07	1.15E+08
2.60E+08	4.27E+08	5.38E+08	8.16E+08	1.09E+09
2.08E+07	3.42E+07	4.31E+07	6.54E+07	8.76E+07
5.43E+06	8.92E+06	1.12E+07	1.71E+07	2.29E+07
4.82E+07	7.91E+07	9.98E+07	1.51E+08	2.03E+08
3.02E+07	4.97E+07	6.26E+07	9.50E+07	1.27E+08
3.71E+07	6.09E+07	7.67E+07	1.16E+08	1.56E+08
6.67E+07	1.10E+08	1.38E+08	2.10E+08	2.81E+08
2.63E+07	4.32E+07	5.45E+07	8.26E+07	1.11E+08
2.05E+08	3.38E+08	4.26E+08	6.46E+08	8.67E+08
1.85E+07	3.05E+07	3.84E+07	5.83E+07	7.82E+07
3.20E+07	5.27E+07	6.64E+07	1.01E+08	1.35E+08
4.32E+07	7.09E+07	8.95E+07	1.36E+08	1.82E+08

Table 6. Estimates of the "Apparent Age" of the Universe

P0 5d (initial)	Po, 8d (initial)	Po, 10d (initial)	Po 15d (initial)	Po 20d (initial)
9.76E+07	1.60E+08	2.02E+08	3.07E+08	4.12E+08
1.08E+07	1.77E+07	2.24E+07	3.40E+07	4.55E+07
1.97E+07	3.24E+07	4.09E+07	6.22E+07	8.34E+07
1.33E+01	2.19E+01	2.76E+01	4.20E+01	5.63E+01
3.30E+06	5.43E+06	6.85E+06	1.04E+07	1.40E+07
3.42E+06	5.63E+06	7.11E+06	1.08E+07	1.45E+07
1.21E+07	1.99E+07	2.51E+07	3.81E+07	5.11E+07
9.96E+06	1.64E+07	2.07E+07	3.15E+07	4.22E+07
1.46E+07	2.41E+07	3.04E+07	4.62E+07	6.19E+07
3.92E+07	6.46E+07	8.15E+07	1.24E+08	1.66E+08
6.13E+07	1.01E+08	1.28E+08	1.94E+08	2.60E+08
3.46E+07	5.71E+07	7.21E+07	1.10E+08	1.47E+08
3.29E+06	5.43E+06	6.86E+06	1.04E+07	1.40E+07
5.37E+07	8.87E+07	1.12E+08	1.70E+08	2.29E+08
2.50E+06	4.13E+06	5.22E+06	7.93E+06	1.07E+07
3.64E+06	6.01E+06	7.59E+06	1.15E+07	1.55E+07
1.20E+07	1.98E+07	2.51E+07	3.81E+07	5.12E+07
1.42E+08	2.35E+08	2.97E+08	4.52E+08	6.07E+08
8.16E+06	1.35E+07	1.70E+07	2.59E+07	3.48E+07
2.53E+06	4.19E+06	5.30E+06	8.06E+06	1.08E+07
9.04E+06	1.50E+07	1.89E+07	2.88E+07	3.86E+07
1.23E+07	2.04E+07	2.58E+07	3.93E+07	5.28E+07
1.48E+07	2.45E+07	3.09E+07	4.71E+07	6.32E+07
1.23E+08	2.04E+08	2.58E+08	3.93E+08	5.28E+08
4.22E+07	6.99E+07	8.84E+07	1.35E+08	1.81E+08
4.55E+07	7.54E+07	9.53E+07	1.45E+08	1.95E+08
1.62E+07	2.68E+07	3.39E+07	5.16E+07	6.94E+07
2.11E+07	3.49E+07	4.42E+07	6.73E+07	9.04E+07
7.95E+07	1.32E+08	1.67E+08	2.54E+08	3.41E+08
2.87E+07	4.76E+07	6.03E+07	9.18E+07	1.23E+08
2.93E+07	4.87E+07	6.17E+07	9.40E+07	1.26E+08
8.13E+06	1.35E+07	1.71E+07	2.61E+07	3.51E+07
2.49E+07	4.15E+07	5.25E+07	8.00E+07	1.08E+08
6.58E+07	1.09E+08	1.39E+08	2.11E+08	2.84E+08
7.55E+07	1.26E+08	1.59E+08	2.43E+08	3.27E+08
8.91E+06	1.48E+07	1.88E+07	2.87E+07	3.86E+07
9.10E+07	1.52E+08	1.93E+08	2.94E+08	3.96E+08
4.48E+07	7.48E+07	9.48E+07	1.45E+08	1.95E+08

Table 6. Estimates of the "Apparent Age" of the Universe

	P0 5d (initial)	Po, 8d (initial)	Po, 10d (initial)	Po 15d (initial)	Po 20d (initial)
	2.42E+07	4.04E+07	5.12E+07	7.82E+07	1.05E+08
	1.04E+06	1.74E+06	2.20E+06	3.36E+06	4.52E+06
	6.87E+07	1.15E+08	1.46E+08	2.24E+08	3.01E+08
	2.50E+05	4.19E+05	5.32E+05	8.14E+05	1.10E+06
	4.52E+07	7.59E+07	9.63E+07	1.47E+08	1.99E+08
	1.00E+08	1.68E+08	2.13E+08	3.26E+08	4.40E+08
	5.64E+07	9.48E+07	1.20E+08	1.84E+08	2.48E+08
	3.59E+05	6.04E+05	7.68E+05	1.18E+06	1.58E+06
	3.21E+07	5.40E+07	6.86E+07	1.05E+08	1.42E+08
	8.18E+08	1.38E+09	1.75E+09	2.68E+09	3.61E+09
	3.57E+07	6.01E+07	7.63E+07	1.17E+08	1.58E+08
	2.30E+07	3.87E+07	4.92E+07	7.53E+07	1.02E+08
	3.51E+07	5.91E+07	7.52E+07	1.15E+08	1.55E+08
	1.99E+09	3.36E+09	4.27E+09	6.54E+09	8.82E+09
	5.88E+07	9.93E+07	1.26E+08	1.94E+08	2.61E+08
	1.30E+05	2.20E+05	2.80E+05	4.29E+05	5.79E+05
	1.72E+07	2.91E+07	3.70E+07	5.69E+07	7.68E+07
	3.37E+07	5.72E+07	7.28E+07	1.12E+08	1.51E+08
	2.48E+07	4.20E+07	5.34E+07	8.21E+07	1.11E+08
	3.14E+06	5.34E+06	6.80E+06	1.05E+07	1.41E+07
	2.39E+07	4.08E+07	5.20E+07	8.01E+07	1.08E+08
	1.67E+08	2.86E+08	3.65E+08	5.63E+08	7.61E+08
	4.58E+07	7.84E+07	1.00E+08	1.55E+08	2.09E+08
	4.47E+07	7.70E+07	9.85E+07	1.52E+08	2.06E+08
	9.34E+05	1.61E+06	2.06E+06	3.18E+06	4.31E+06

Table 6. Estimates of the "Apparent Age" of the Universe

	P0 5d (initial)	Po, 8d (initial)	Po, 10d (initial)	Po 15d (initial)	Po 20d (initial)
	6.72E+07	1.17E+08	1.50E+08	2.32E+08	3.14E+08
	3.33E+06	5.80E+06	7.44E+06	1.15E+07	1.56E+07
	9.73E+07	1.70E+08	2.18E+08	3.39E+08	4.59E+08
	2.83E+07	4.95E+07	6.35E+07	9.87E+07	1.34E+08
	9.59E+06	1.68E+07	2.15E+07	3.35E+07	4.54E+07
	7.31E+07	1.29E+08	1.67E+08	2.61E+08	3.55E+08
	1.40E+07	2.50E+07	3.23E+07	5.05E+07	6.88E+07
	6.07E+07	1.08E+08	1.40E+08	2.19E+08	2.99E+08
	1.29E+07	2.33E+07	3.02E+07	4.74E+07	6.46E+07
	1.15E+06	2.07E+06	2.68E+06	4.21E+06	5.74E+06
	5.22E+05	9.54E+05	1.24E+06	1.96E+06	2.68E+06
	7.68E+06	1.47E+07	1.93E+07	3.10E+07	4.26E+07
	1.26E+07	2.49E+07	3.30E+07	5.34E+07	7.38E+07
	5.31E+06	1.07E+07	1.42E+07	2.31E+07	3.21E+07
	1.61E+06	3.45E+06	4.68E+06	7.75E+06	1.08E+07
	2.72E+06	6.92E+06	9.73E+06	1.67E+07	2.38E+07
	1.64E+07	4.21E+07	5.93E+07	1.02E+08	1.45E+08
	5.91E+05	1.54E+06	2.17E+06	3.75E+06	5.32E+06
	3.09E+05	8.42E+05	1.20E+06	2.09E+06	2.98E+06
	2.23E+05	6.23E+05	8.90E+05	1.56E+06	2.22E+06
	1.33E+06	4.57E+06	6.73E+06	1.21E+07	1.75E+07
		5.13E+05	8.64E+05	1.74E+06	2.62E+06
			1.07E+05	8.74E+05	1.64E+06
Years	7.11E+07	1.18E+08	1.48E+08	2.26E+08	3.04E+08

Table 7. Time (years) to Change from 20-, 15-, 10-, 8-, 5-day Birth Periods to Present Orbital Periods (See Text)

	P_0 5d (initial)	P_0, 8d (initial)	P_0, 10d (initial)	P_0 15d (initial)	P_0 20d (initial)	Average	
AGE (Years)	6.05E+07	2.52E+08	6.65E+07	2.14E+07	2.44E+07	8.41E+07	Average
Maximum	7.15E+08	3.36E+09	1.67E+08	1.02E+08	1.45E+08	3.36E+09	MAX
Minimum	1.33E+01	2.20E+05	1.24E+06	8.74E+05	1.64E+06	1.33E+01	MIN
% age of Universe	0.4	1.8	0.5	0.2	0.2	0.6	

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