The stressed universe model can explain the discrepancies in the measured values of Hubble`s H

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Abstract:

Hubble demonstrated that the universe expands with velocity V= H D which increases with distance D between the Earth and a galaxy, where H has been known as the Hubble constant [1]. Cosmological researchers measured the value of H via observations of light coming from phenomena at various distances [2], the accuracy of such measurements being limited. A recent reference [3] reports accurate measurements from astronomical data close to the edge of the universe, and finds that H is not a constant. Indeed, its value varies with time in a manner that is compatible with the predictions of a proposed stressed universe model [4], according to which H is not a constant at all, but rather it varies with time/distance, and should be called Hubble`s parameter.

Introduction:

Although it has long been known that the universe expands with velocity that increases from the Earth according to Hubble`s formula and constant H, namely V=H D, even so the value of H has been much debated [2] because its measurement, e. g. via light from sources in the universe, is difficult. But now it is established accurately that H is not a constant [3], and a model of the universe is needed that explains why it varies. Reference [4] proposes the stressed universe model, which supplies such an explanation, and the subject matter of reference 4 is next reviewed as follows: The critical density of the universe ρ_c required by general relativity to stop the universe expansion is $1x10^{-26}$ kg/m^3 [1]. But the average density of the universe due to the cosmic bodies was evaluated as 3 $x10^{-28}$ kg/m^3 [1], which is smaller than ρ_c. Many scientists had expected that sufficient cosmic body mass would eventually be found so as to exceed ρ_c [5, 6], and thus stop the expansion of the universe. However, as sufficient mass, even with dark matter, had not been found, hence the dominant opinion has become that the universe will expand forever, especially as recent measurements indicate that the expansion is accelerating [7]. Reference 4 proposes that there exists everywhere in the whole of space a continuum of density ρ_p of compressive dark matter stressed to a level P, which is kept in place by the combined gravitational and stress forces, and which has permanently existed since matter became dominant over radiation. Thus, it proposes a universe of approximate radius R_u [8], mass M_u [9], which is composed mostly of compressed stressed dark matter that does not expand forever. Rather, the expansion stops and contracts, and the universe oscillates forever. Reference 4 demonstrates that this stressed dark matter oscillates because all its radial elements oscillate in unison with the same period T_{SHM} = 6.47x10^{10} years but variable amplitude R A which increases with R, where A is a constant. Reference 4 shows that the density ρ_p associated with the stressed dark matter, together with the density ρ_k of the kinetic energy of the oscillations [10], is such that the bulk of the total density $\rho_t = \rho_p + \rho_k + \rho_{cb} = \rho_{dm} + \rho_{cb}$ of this stressed universe is this very density ρ_{dm} of stressed dark matter itself. ρ_{dm} far exceeds ρ_c,, while the average density ρ_{cb} of the cosmic bodies such as the galaxies is relatively almost negligible. The dominant mass of density ρ_{dm} oscillates, and the cosmic bodies such as the galaxies merely ride along. Reference 4 demonstrates that the Hubble formula V = H D is the natural behavior of such a stressed universe, and that the expansion of such a universe presently accelerates but will eventually stop expanding and will oscillate with a period T_{SHM} = 6.47x10^{10} years. The value of the total density $\rho_t = \rho_{dm} + \rho_{cb}$ is very small, so that calculations may use solely gravitation to obtain a first approximation of a universe model, even if general relativity is neglected in the first set of calculations. The density ρ_p of stressed matter causes the expansion to decrease; the density ρ_k of kinetic energy associated with the oscillations causes the expansion to increase. Each of these densities is assumed to be uniform and independent of R. Thus reference 4 offers a very new approach to study the universe, an approach which challenges conventional understanding with a totally new stressed model of the universe. It offers much scope for further publications.

Calculation of H:

Dependence of the Hubble parameter H on the time of emission of the light from the phenomenon that emitted it: Hubble`s formula is V= H D, where V is the velocity of the phenomenon, and D is the distance of the phenomenon from the Earth [1]; so D is the distance travelled by the light from the phenomenon to the Earth. According to the stressed universe model [4], the velocity at which the phenomenon was moving when it emitted the light at time T1 is given by V=AWDcosWT1, where the amplitude A and the angular velocity W of the oscillations of the universe are constants, and T1 is the time when the light was emitted by the phenomenon. Hence H=V/D=AWDcosWT1/D=AWcosWT1, so that H is proportional to cosWT1. But the light emitted at T1 has to travel the distance D at the velocity of light `c` before it is recorded on Earth at time T2, so that T1=T2-D/c and for a given phenomenon at T1 then H is proportional to cosW(T2-D/c).

As an example of the prediction of H using the stressed universe model, the data in Choi`s article [3] will next be used. For this case, the value of H measured is H=67.6 km/sec per megaparsecs, which is one of the most accurate values ever measured, especially as it agrees with the value H=67.4 km/sec per megaparsecs measured by the Planck satellite at the same distance D [11], namely the edge of the universe D=42 BLY (billion light years), the value of which is evaluated in reference [12]. As explained and justified above, the stressed universe model gets acceptable approximate results by treating the universe as a body, the approximate radius of which at time T1 was R_U= 42 BLY, while the Earth is presently at radius R_E. The value of R_E is not yet fully determined by the stressed universe model, a value which will eventually be determined more precisely, as additional pertinent astronomical data becomes available; Choi`s results are such new data that has now become available. Thus, this article treats the Choi results to estimate a value for R_E which correctly explains the Choi results. It turns out that R_E=16.6 BLY does explain well the Choi results, although this choice is not critical to the final conclusions of this article. Accordingly, the distance travelled by the light between T1 and T2 is 42 BLY–16.6 BLY=25.4 BLY, or 240×10^{24} m, so that the time of the travel of the light from the edge of the universe to the Earth is 25.4 BLY/c $=8.00 \times 10^{17}$ seconds. Fig. 1 shows the location of the edge of the universe during a half cycle of the universe oscillations, according to reference 4, i. e. 2 quadrants, the first from angle zero to π/2 and the second from π/2 to π. Reference 4 identifies the second quadrant from π/2 to π as the quadrant in which are occurring the current universe oscillations, because this corresponds accurately with the known fact that presently not only does the universe expand but also that its expansion accelerates [7]. From reference 4, the duration of a full cycle is T_{SHM} = approximately 6.47×10^{10} years $=20.42 \times 10^{17}$ seconds, i. e. 5.1×10^{17} seconds for each quadrant. Calling the beginning of these 2 quadrants time zero, reference 4 estimates that presently the universe is at time $T2=5.1 \times 10^{17}+4.5 \times 10^{17}=9.6 \times 10^{17}$ seconds; the accuracy of this estimate is not critical to the conclusion below regarding the ratio of H(Choi) divided by H(present).

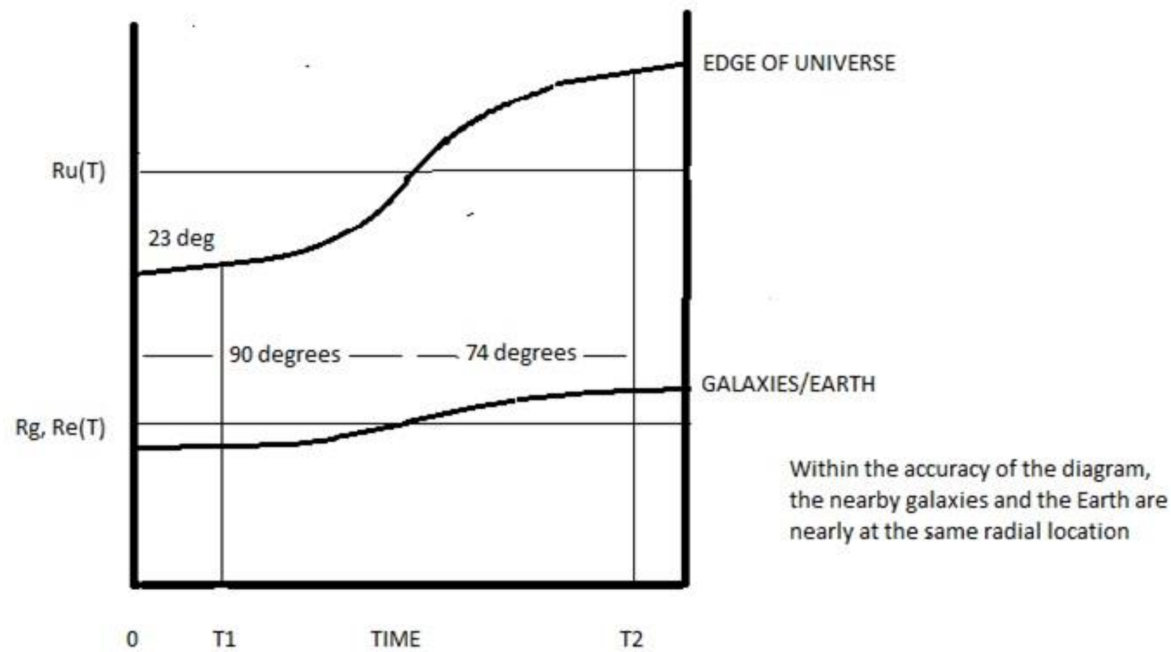

Figure 1 The edge of the universe at time T1, and the Galaxies and Earth at time T2.

Thus T1=9.6x10^{17}- 8.0x10^{17}=1.6x10^{17} seconds, which shows that the light was emitted in the quadrant from zero to $\pi/2$, i. e. the light was emitted while the universe was contracting. Hence when the light was emitted, H was proportional to cos W(T2-D/c)=cos Wx1.6x10^{17}, which in figure 1 corresponds to cos 23 degrees, whose magnitude=0.883, while presently H is proportional to cos WT2, which in figure 1 correspond to cos 90+74 degrees, whose magnitude is =0.961. Hence at the time when the light was emitted H(Choi) was 0.883/0.961=0.918 times H(present), which explains why the value of H determined by Choi is smaller than the present value of H. The calculations above also consider that the direction of the light travel and R_E are essentially parallel, again an assumption that is not critical to the conclusions derived from the calculations above.

Another example of the prediction of H using the stressed universe model is that for the average H as measured for galaxies after Hubble made his discovery of V=H D. For these there are very many results, but they are not at all as accurate as H in Choi`s article; they can be quoted as 66 to 80 km/sec per megaparsecs for an average of 74 km/sec per megaparsecs, at an average distance of perhaps 46 MLY from the Earth [2, 12]. Calculations similar to those for the Choi`s results show that cos[WT2-D/c] is essentially cos [WT2], since D is so much smaller than R_U= 42 BLY. Thus, from figure 1 it turns out that the ratio of H(galaxies) to H(edge of the universe) equals the ratio of 0.883 to 0.961, i. e. 0.918, which is compatible with the ratio of 67.5/74=0.912. Hence the calculations with the stressed universe model are compatible with Choi`s data and the galaxy data, thus explaining the results that H for the oldest light is smaller than that for light from the nearby galaxies. According to references 3 and 17, this is a result which some astronomers consider a discrepancy, and some authors propose that a new theory is needed to explain how the universe works, e. g. the following comments from various astronomers:

a) `That discrepancy suggested that a new model for the universe might be needed` [13]. b) `The discrepancy between the measurements suggests that either there is something missing in our cosmological model or there is something wrong with the measurements` [14]. c) `The growing tension between these distant versus local measurements of the Hubble constant suggests that we may be on the verge of a new discovery in cosmology that could change our understanding of how the universe works` [14]. d) `The ACT team will also scour those observations for signs of physics that does not fit the standard cosmological model` [15]. e) `If the Hubble constant is in fact changing, that opens the question of what is driving the change. Answering that question could require a new version of astrophysics` [16, 17, 18]. This article proposes that the stressed universe model is that required new theory.

Conclusions:

The discrepancy between distant versus local measurements of the Hubble parameter suggests the need for the discovery of a new theory that could change our understanding of how the universe works. The stressed universe model supplies such a new theory. It explains the Hubble discrepancy. It demonstrates that the Hubble formula V = H D is the natural behavior of such a stressed universe [4]. It supplies the missing dark matter which general relativity requires to get the universe to stop expanding. It explains the nature of this dark matter as being a continuum of stressed matter which governs the oscillating behaviour of our universe, while the cosmic bodies such as galaxies simply ride along with the oscillations. Since Hubble`s discovery of an expanding universe, notions about the way the universe works have been rather very limited in scope; a completely different approach is desirable in order to review and improve the cosmological model.

References:

1) Kenneth Krane, *Modern Physics*, John Wiley and Sons, New York, 1987, ISBN0-471-07963-4. Chapters 15 and 16 review cosmology in a very well organised manner.

2) E. Siegel, senior contributor, astrophysicist, Lewis and Clark College, `Surprise the Hubble constant changes over time`, Forbes.com, 2018.

3) S. Choi, Cornell Presidential Postdoctoral Fellow, N. Niemack, associate professor of physics and astronomy, `The Atacama Cosmology Telescope: a measurement of the Cosmic Microwave Background power spectra at 98 and 150 GHz`, published by the Cornell Center for Astrophysics and Planetary Science in the College of Arts and Science, December 30, 2020.

4) R. F. Favreau Ph.D., Professor Emeritus, Royal Military College, Kingston, ON, Canada, `A stressed universe model can make our universe stop expanding`, 2021, available on demand.

5) Dimitar Valev, `Estimate of the total mass and energy of the universe`, arXiv:1004.1035 v 1 [Physics.gen-ph] 7 April 2010.

6) P. Gupta, `Mass of the universe and the redshift`, International Journal of Astronomy and Astrophysics, 2018, **8**, 68-78.

7) Adam G. Reiss, etc., 'Observational evidence from supernovae for an accelerating universe and a cosmological constant', Astronomical Journal, 116 (3):1009-38, 1998.

8) C. Mercier, `Calculation of the mass of the universe, the radius of the universe, the age of the universe and the quantum of speed`, Journal of Modern Physics, 2019, **10**, 980-1001.

9) Dimitar Valev, `Estimate of the total mass and energy of the universe`, arXiv:1004.1035 v 1 [Physics.gen-ph] 7 April 2010.

10) C. Cataldo, `From the oscillating universe to relativistic energy: a review`, Journal of High Energy Physics, gravitation and cosmology, 2017, **3**, 68-77.

11) Plank Collaboration, `Planck 2015 results. XII Cosmological parameters`, Astronomy plus Astrophysics- 594: A13, Table plus arXiv:1502.0589 (2016).

12) M. Berger, Master Physics, Free University of Brussels, `What size was the universe when the CMB was originated? https://www.quora.com/What-size-was-the-universe-when-the-CMB-was-originated, August 31, 2017.

13) Staff writers, `Astronomers agree: Universe is nearly 14 billion years old`, Space Daily, January 05, 2021.

14) M. Niemack, `The Atacama Cosmology Telescope: a measurement of the Cosmic Microwave Background power spectra at 98 and 150 GHz`, published by the Cornell Center for Astrophysics and Planetary Science in the College of Arts and Science, December 30, 2020.

15) S. Staggs, `The Atacama Cosmology Telescope: a measurement of the Cosmic Microwave Background power spectra at 98 and 150 GHz`, published by the Cornell Center for Astrophysics and Planetary Science in the College of Arts and Science, December 30, 2020.

16) M. G. Dainotti et al, `On the Hubble Constant tension in the SNe la Pantheon sample`, Astrophysical Journal, May 17, 2021.

17) Webmaster, `Charting the expansion history of the universe with supernovae`, nao.ac.jp/en/news/science/2021 0514-dos.html.

18) Karoline Loeve, Kristine Simone Nielsen, Steen H. Hansen, `Consistency analysis of a dark matter velocity dependent force as an alternative to the Cosmological Constant`, arXiv:2102.07792v[astro-phys.CO] 15 Feb. 2021.

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