Hubble Tension – a refutation

While it might be felt by some that I am perhaps taking the Hubble Tension paper too seriously, I fear that the authors do actually believe in what they have written, else why would they say explicitly that their “very significant” result is “definitely not a joke”. Also, as I said in my original post, it is not the first time that this “explanation” has been put forward and so I do feel that a comprehensive refutation is in order.

The work is in fact inaccurate on a number of levels. Firstly, working backwards from the value of 63.01 derived as the result of the paper, it is clear that the value of d used in the calculation was 385,000Km i.e. the current (time averaged) Earth-Moon distance. However, the epoch of the value of v used was 600Myr in the past when, whatever the mechanism or value of its recession rate, the Moon must have been nearer to the Earth. Helpfully, the Wikipedia entry for Tidal Acceleration (Ref.1) states that the average recession rate between 620Myr and now was 2.17cm/yr, giving an Earth-Moon distance of 371,980Km at the quoted epoch and consequently a calculated result for H of 65.23 rather than as stated.

In addition, the value given in Wikipedia (also widely quoted elsewhere) casts doubt on the assumed value of 2.82cm/yr for the (total) recession rate at 600Myr. Given that the present value is 3.83cm/yr, a linear rise between 600Myr and now would require a historical value of 0.54cm/yr to give an average value of 2.17. It would need a very strange evolution of the rate to give an average of 2.17 when starting from 2.82 and ending at 3.83: note, however, that 0.54 is quite close to the “tides only” value for 600Myr quoted in the paper.

The above comments also illustrate the danger of trying to define a complex process from just one point. The recession of the Moon must have been a non-linear process, if for no other reason than that the interchange of energy and angular momentum produced by tidal action has a much greater effect at closer Earth-Moon distances. Taking a single point as representative of the process as a whole is thus bound to give an incorrect result. There is also compelling evidence that the amount of tidal action has varied greatly over geological time, mainly due to the various effects of continental drift – “tidal friction” will be much greater when the continents are divided up and spread across the Earth’s surface rather than gathered into large land masses (such as Pangea) – see Ref.2, for example. This is generally assumed to be the reason that the current value of tide-induced recession is anomalously high. Conversely, given that the frequency of creation and break-up of large land masses is estimated to be about 750Myr (from paleontological evidence), the period around 600Myr could well be one of anomalously low recession rate, as implied by the “average rate” calculation given above, and so an equally bad “typical” epoch to choose as the current one which the authors rejected.

All of which casts very serious doubt on the parameters from which the calculated value was derived, and therefore on the value itself. Over-riding these numerical concerns is a much greater issue however – Hubble Expansion is a very weak but long-range “force” and so is only noticeable over very large distances and, critically for the present discussion, where systems are not bound together by other stronger forces such as gravitation. This is a similar situation to gravity itself which, when compared to electromagnetic and nuclear forces, is also a weak but long-range force which is almost un-noticeable at “human scale” distances (thus ensuring that objects within our world don’t simply get crushed) but becomes dominant at larger distances. The overall cosmos is thus expanding because of “Hubble Flow” but the compound objects within it (such as solar systems) are not. The analogy often used is of the expansion of a yeasted currant bun during the proving process – whereas the doughy part of the bun expands at all points the individual currants do not.

This is not to say that Hubble Expansion has literally no effect at solar-system scales however. Although often thought of as being caused by the initial “explosive push” of the Big Bang, cosmic expansion is in fact a relativistic process consistent with Einstein’s field equations. It is therefore possible to use a set of metrics known as the FLRW equations (Ref.3) to calculate the effect of Hubble Expansion at small scales. This was done in a seminal paper by Cooperstock (Ref.4), who showed that, as compared to the observed rate of variation of the orbital period of the Moon round the Earth, Hubble Expansion has an effect which is approximately 22 orders of magnitude smaller. I think that probably qualifies as “negligible”, and quite clearly rebuts the basic principle upon which this paper is based.

So – just because it’s in a scientific paper doesn’t necessarily mean it’s true.

References

1. https://en.wikipedia.org/wiki/Tidal_acceleration
2. http://adsabs.harvard.edu/full/1994EM%26P...66..173K
3. https://en.wikipedia.org/wiki/Hubble%27s_law#FLRW_equations
4. https://www.researchgate.net/publication/1818788_The_Influence_of_the_Cosmological_Expansion_on_Local_Systems