Conference *Cosmology on Small Scales 2022*
Michal Křížek and Yurii Dumin (Eds.)
Institute of Mathematics CAS, Prague

RECALCULATION OF THE MOON RETREAT VELOCITY SUPPORTS EXPANSION OF GRAVITATIONALLY BOUND LOCAL SYSTEMS

Heikki Sipilä[1]

[1] Physics Foundations Society, https:www.physicsfoundations.org
Espoo, Finland
hjsipila@gmail.com

Abstract: The current paradigm of astronomy and cosmology denies the expansion of gravitationally bound local systems. The increase of the Earth to Moon distance, 3.82 cm/yr measured in the Lunar Laser Ranging program [1] for the last 50 years is explained as a tidal effect. If local systems expanded at a rate corresponding to Hubble constant 71 (km/s)/Mpc, 2.8 cm/yr of the increase resulted from the expansion and only about 1 cm/yr from the tidal interaction. An independent method to measure the retreat value is based on the ancient tidal sediment layers which give the development of the number of months in a year. The most accurate of those are the studies by [2], [3]. Based on the unchanged length of a year, he has obtained the average retreat value of 2.1 $\pm$ 0.1 cm/yr over 635 Myr, which is less than the value expected from expansion. The conclusion from the result has been that there cannot be any Hubble expansion and the current high retreat value is caused by a special ocean resonance. When the retreat from tidal sediment data is recalculated by assuming expansion of local systems and observing that the expansion is associated with a change in the length of a year, a perfect agreement between the Laser Ranging result and the sediment layer result is obtained.

Keywords: cosmology, celestial mechanics

PACS: 98.80.-k, 6.10.+i, 95.10., 96.15.Wx, 96.20.-n

1. Introduction

It is known that the rotation of the Earth is slowing down with time. This was shown convincingly as the development of the number of days in a year obtained from coral fossils by [4] in 1963. The fossil data shows that the Earth's rotation rate has been slowing down smoothly for the last 800 million years without major changes or jumps. In the Earth-Moon system, the slowing rotation of the Earth is associated with an increasing angular momentum of the Moon resulting in the increasing orbital radius of the Moon. Because Earth's rotation is slowing down almost linearly at present, it means that the retreat of the Moon must be also linear. In the current theoretical framework, there is a major conflict between the laser-measured retreat value and the value obtained from tidal sediment layers. In the framework of the Dynamic Universe (DU) theory by T. Suntola [5] all gravitationally bound local systems expand in direct proportion to the expansion of space which means that also the length of a year increases with the expansion. When solved in the DU framework, a coherent result is obtained from the coral fossil data, sediment layer data, and the Laser Ranging data.

2. Calculation of the Moon retreat value based on the current paradigm with non-expanding local systems and the associated constant length of a year

In Southern, Australia there is a well-preserved 635 Ma old tidal layer formation. G.E. Williams studied drilling cores from this formation and found a continuous 60-year footprint of lunar cycles. Typically, similar deposits contain a few months of continuous layers maximum. The current average distance to Moon is 384 400 km and the length of the sidereal month (rotation time of the Moon with relative to the fixed stars) is 27.3 days corresponding to 13.38 sideral months in a year.

The sediment layers are caused by tides. The observed number of months in a year in the 635-million-year-old samples is 14.1 ± 0.1, corresponding to the sidereal month of 25.9 current days in a year when assuming that the length of a year has been unchanged. This means that the sidereal month 635 million years ago was 0.944 times the present sidereal month. Based on Kepler's laws the orbital radius of the Moon corresponding to orbital period 635 Myr ago was 371 143 km which is 13 257 km less that the current orbital radius. This gives the average change of 2.1 cm/yr, which is substantially less than today's measured value of 3.82 cm/yr.

The number of months per year is theory-free; it is obtained from direct counting from layers. The interpretation of the result is theory dependent. It is that the length of the year does not change i.e. the Solar system does not expand. By using a theory that follows the current paradigm, we cannot find the reason for the conflict in the results between laser distance measurement and results from sediment layers.

3. Calculation based on Suntola's Dynamic Universe theory

DU theory is based on the balance of the gravitational and kinetic energy in spherically closed space. Space expands uniformly including gravitationally bound local systems. Applying the Hubble constant 71 (km/s)/Mpc the length of a year 635 million years ago was 349 current days, and the length of a month was 349/14.1 = 24.8 current days. The current length of a sidereal month is 27.39 days and the mean distance of the Moon is 384 400 km. Applying Keppler's law, the distance to the moon 635 Myr ago was 359 575 km, which means that the distance has increased by 24 825 km in 635 million years corresponding to the average annual change of 3.91 ± 0.2 cm. It should be noted that in this calculation we had no need to separate the tidal component and the cosmic expansion on the retreat of the Moon. In the DU framework, the expansion of space corresponding to Hubble constant Hubble constant 71 (km/s)/Mpc gives a 2.8 cm annual retreat, which leaves about 1 cm annual retreat to the tidal interactions in a good agreement with both the sediment results and the Lunar Laser results.

When assuming the tidal effect only, the high rate of the Moon's retreat has created a problem with the age of the Moon. We do not have reliable tidal data from the deeper in history. When incorporating the cosmic expansion, the tidal component today is about 26% of the total retreat value which presumably is low enough to solve the age problem.

4. Conclusions

This study gives strong support to the expansion of the Solar system in direct proportion to cosmic expansion. This study gives also a fully independent method to determine the Hubble constant. Calculations here indicate the accuracy of 71 $\pm$ 2 km/s/Mpc, see [6]. Future more thorough statistical analysis may give an even more strict error limit for the Hubble constant.

Acknowledgements

I thank Tuomo Suntola for helpful discussions during many years.

References

[1] Dickey, J. O. et.al.: Lunar laser ranging: A continuing legacy of the Apollo program. Science 265 (1994), 482.

[2] Williams, G. E.: Geological constraints on the Precambrian history of Earth's rotation and the Moon's orbit. Rev. Geophys. 38 (2000), 37–39.

[3] Williams, G. E.: Age of the Elatina deposit is 635 Myr according the latest aging determination. Private information (2021).

[4] Wells, J. W.: Coral growth and geochronometry. Nature 197 (1963), 948.

[5] Suntola, T.: The dynamic Universe, toward a unified picture of physical reality. 4th ed. Physics Foundations Society, Espoo (2018), `https:www.physicsfoundations.org/dynamic-universe`.

[6] Sipilä, H.: Is the Solar system expanding? J. Phys. Conf. Ser. 1466 (2020).