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The Cosmological Expansion of Small Regions and of the Earth

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Abstract. In contradiction to standard cosmology, this paper shows that cosmological expansion can be found in objects the size of the Earth. According to standard big bang cosmology, based on general relativity, cosmological expansion exists only at scales larger than galaxies. The Earth, being much smaller, should not expand as the result of cosmological expansion. This paper asserts that standard cosmology has two main shortcomings: 1) It equates cosmological expansion with radial velocity, which this paper argues is not true, and 2) it treats as coincidence that the Earth's rotational delay is equal to the Hubble constant, a measure of cosmological expansion (both values match to 18 orders of magnitude). Other measurements and calculations also match the rate of cosmological expansion. These include 1) the growth of the Earth's polar radius, 2) expansion of the Moon's orbit, 3) the anomalous acceleration of Pioneer Probes 10 and 11, and 4) the expansion rates of early galaxies. Because the expansion or retardation rates are nearly identical, this leads to the assumption that all of these phenomena have the same cause. If they do, this contradicts the basic postulate that cosmological expansion exists only at distances greater than galaxies. A number of conclusions result from the evidence that cosmological expansion exists at small scales. A minimum Earth expansion would be set at 0.06 cm per year. Likewise, the Earth would slow down at a rate fixed by this expansion (pirouettes effect). The author argues, contrary to standard theory, that cosmological expansion exists at scales dominated by gravity. Once the dominant force becomes electromagnetic, the expansion stops. The Earth which is dominated by gravity expands. The continents which are bound by electromagnetic forces do not.

Key words. Earth expansion – Cosmological expansion – Common expansion-rates

1. Introduction

According to standard cosmology, the universe expands and the distances between galaxies expand with it. But smaller units like galaxies, the distance between stars, the solar system, celestial bodies, continents, and atoms should show no signs of cosmological expansion. Cosmological expansion of the Earth is therefore not possible. However if there is evidence of cosmological expansion occurring at smaller scales, then it makes sense to see if the Earth is expanding. Also, the Earth's expansion for cosmological reasons would not preclude other expansion due to terrestrial causes.

Cosmological expansion at small scales is prohibited by standard cosmology because: At large scales the gravitational potential of individual objects is negligible so cosmological expansion dominates. At smaller scales, these potentials become comparable to the potential of cosmological expansion. At even smaller scales, these potentials dominate. At these scales, test bodies will always fall toward the object and never, according to standard cosmology, outward. Cosmological expansion is excluded at these scales. The Earth's potential generates an acceleration of 9.81 m/s^2 at its surface. But at an altitude of $760 \cdot 10^6$ km the Earth's potential only generates an acceleration of $6.9 \cdot 10^{-8}$cm/s^2 which would be similar to cosmological expansion there. Test particles at this range would not fall outward. So cosmological expansion at scales smaller than this, like the Earth or lunar orbit, would be excluded.

However, this postulate of standard cosmology has problems both theoretical and observational. As a result of these shortcomings, the possibility of cosmological expansion of the Earth should still be explored. This of course does not rule out a purely terrestrial mechanism for Earth expansion.

Theoretical shortcomings. – The redshift of the spectral lines from distant objects is no longer explained by assuming that they are moving away from us through space. We now assume that space (or space-time) itself is being created between us and the distant objects. There are several ways of calculating the distance and velocity of very distant objects and some produce velocities greater than the speed of light violating special relativity (Wikipedia, 2010). The lower limit of cosmological expansion is determined by comparing two very different phenomena. Gravity is a force which accelerates matter through space. Cosmological expansion is the creation of space between bodies. While the relative magnitude of the two phenomena varies from region to region, there is no reason to preclude a cosmological origin for Earth expansion.

Observational shortcomings. – The cosmological expansion of the Earth cannot be proven from observations of the Earth only. We must look for possible violations of the lower limit of cosmological expansion in other objects and phenomena of similar size. If they show evidence of expansion of the right magnitude then we have to acknowledge the possibility of cosmological expansion of the Earth. The following examples show just that.

In addition to measured values, there are theoretical values that are close to Hubble's constant. Schmutzer (2000) calculates a value for the expansion of the Earth ($3.6 \cdot 10^{-18}$ s^{-1}) which is close to cosmological expansion.

2. Hyperactive galaxies of the early Universe

Dokkum et al. (2008) examined a galaxy group at a distance of 10.7 billion light years. The light from these galaxies would have been emitted when the universe was about 3 billion years old. The mass of the galaxies is in the range of large present day elliptical galaxies. In the present day near universe, galaxies of this mass would have 5 times the radius. The inner density (approximately 5^3 or 125 times the density of present day galaxies) and dynamics of the observed galaxies is extreme. Such objects do not exist in the present day universe. There is no other obvious explanation other than the galaxies expanded over time. No mechanism is known, but Müller and Kokus (2010) expect that it would be the same as cosmological expansion.

The age and radii of these galaxies allow a calculation of the expansion rates if we assume that present day galaxies started at this size and density. To calculate the expansion rate, divide the change of radius per radius by the time:

$$\alpha = \frac{\Delta r}{r \cdot t} =$$

$$= \frac{5-1}{5 \cdot 10.7 \cdot 10^9 \cdot 31.56 \cdot 10^6 s} =$$

$$= \frac{4}{1.688 \cdot 10^{18} s} =$$

$$= 2.37 \cdot 10^{-18} s^{-1}, \tag{1}$$

where α is the expansion rate, r is the radius of a present day galaxy, Δr is the difference between present-day radius (5) and emission-radius (1), and t is the time that the light has travelled.

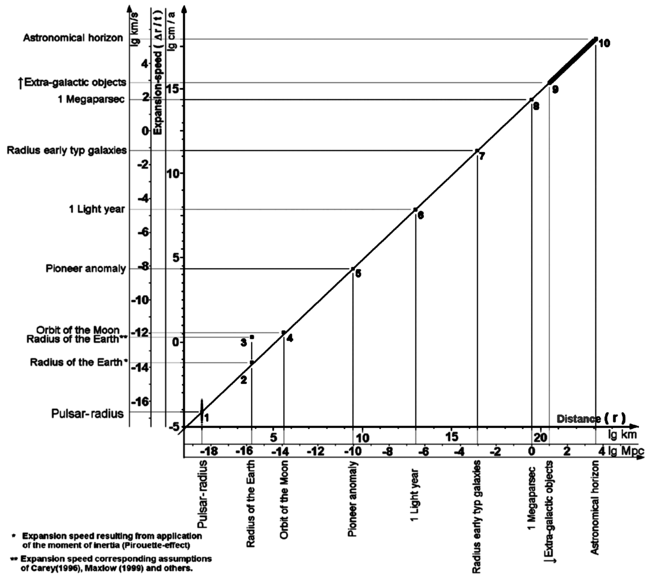

Fig. 1. Comparison of relevant values of the cosmological expansion in different size-areas (explanation in the text).

The necessary expansion rate of the examined objects is close to the Hubble parameter. We see that these examined objects show the same expansion rate as is observed in the present day from Earth (This interpretation finds confirmation in the analysis of the HST "Ultra Deep Field" photographs [HUDF09]).

Recently galaxies were observed at a distance of 12.9-13.1 billion light years (Oesch et al., 2010). This is about 600-800 million years after the Big Bang, or about $1/20^{th}$ the present age. They are also about $1/20^{th}$ the diameter of a large spiral galaxy so if we make the same assumptions, they will also expand at the rate of the Hubble parameter. There is strong evidence that cosmological expansion takes place in objects the size of galaxies.

3. Pioneer anomaly

NASA launched deep space probes Pioneer 10 and Pioneer 11 in 1972 and 1973. Both probes experienced an anomalous acceleration toward the center of our solar system. The probes acceleration in excess of standard theory was calculated by Anderson et al. (2001) to be $8.74 \pm 1.33 \cdot 10^{-8}$ cm/s^2. This is approximately a reduction of speed of 10 km/h over 100 years. The Ulysses and Voyager probes experienced similar anomalous accelerations. Dividing the anomalous acceleration by the speed of light we get a value very similar to the Hubble parameter:

$$\alpha = \frac{8.74 \cdot 10^{-8}\mathrm{cm} \cdot \mathrm{s}^{-2}}{299.792 \cdot 10^{8}\mathrm{cm} \cdot \mathrm{s}^{-1}} =$$

$$= 2.92 \cdot 10^{-18}\mathrm{s}^{-1}.$$

A phenomena of the same magnitude as the cosmological expansion is effecting space probes on distance scales of our solar system radius.

4. Expansion of the lunar orbit

The average radius of the Moon's orbit about the Earth has been measured by Lunar Laser Ranging and has been found to be increasing at the rate of 3.82 ± 0.07

1	2	3	4	5	6
Point	Phenomenon	Distance	Logarithm distance	Expansion-tempo	Log. tempo
10	Astronomic horizon	$1.265 \cdot 10^{23}$ km	lg 23.10	299805 km s^{-1}	lg 5.48
9	Extragalactical objects	$>3 \cdot 10^{20}$ km	lg 20.48	>700 km s^{-1}	lg 2.85
8	1 Mpc	$3.087 \cdot 10^{19}$ km	lg 19.49	71 km s^{-1}	lg 1.85
7	Radius of early-type-galaxies	$2.778 \cdot 10^{16}$ km	lg 16.44	0.07 km s^{-1}	lg -1.15
6	1 Light - year	$9.46 \cdot 10^{12}$ km	lg 12.98	$2.24 \cdot 10^{-5}$ km s^{-1}	lg -4.65
5	Pioneer-anomaly	$3 \cdot 10^{9}$ km	lg 9.477	22436 cm a^{-1}	lg 4.35
4	Moon-orbit	384600 km	lg 5.585	3.8 cm a^{-1}	lg 0.58
3	Radius of Earth **	6371 km	lg 3.804	2 cm a^{-1}	lg 0.30
2	Radius of Earth *	6371 km	lg 3.804	0.06 cm a^{-1}	lg -1.21
1	Radius of Pulsars	10 km	lg 1.000	$7.64 \cdot 10^{-5}$ cm a^{-1}	lg -4.12

Table 1. Composition of relevant values of the cosmological expansion in different size-areas (*Expansion speed resulting from the retardation and application of the moment of inertia (Pirouette-effect). **Expansion speed corresponds to assumptions of Carey (1996), Maxlow (1999) and others. For comparison: The growth rate is 35-40 times bigger than the cosmological rate of the expansion).

cm/yr (Dickey et al., 1994). Calculating the increase in radius per radius:

$$\alpha = \frac{\Delta r}{r \cdot t} =$$

$$= \frac{3.82\ cm}{3.844 \cdot 10^{10} cm \cdot 31.56 \cdot 10^{6} s} =$$

$$= 3.148 \pm 0.058 \cdot 10^{-18} s^{-1}. \qquad (2)$$

We get a rate just a little larger than the cosmological expansion. The increase in the lunar orbit could be interpreted as cosmological expansion. The value might be slightly larger due to tidal friction or by the combined effects of the gravitational fields of the Sun and Earth.

5. Post glacial uplift or Earth expansion

Ruder et al. (1990) at the Wetzell Observatory used a ring laser and a laser geodynamic satellite (LAGEOS) to measure the multi-pole moments of the Earth's mass. They then calculated the drift rate of the continents and the increase in distance between the north and south poles which was found to be 1mm/year. Convert this to a fractional increase in the Earth's radius per second.

$$\alpha = \frac{\Delta r}{r \cdot t} =$$

$$= \frac{0.05}{6371 \cdot 10^{5} \cdot 31.56 \cdot 10^{6}} =$$

$$= 2.5 \cdot 10^{-18} s^{-1}, \qquad (3)$$

So the measured expansion rate of the Earth's polar radius is almost identical to the cosmological expansion of the universe. So it becomes very plausible that the increase in polar diameter is cosmological in origin and not due to glacial rebound which is the most accepted explanation.

6. Relationship of Earth surface areas

The Earth's continental crust (including shelves) covers approximately $177 \cdot 10^{6}$ km^2. This area would completely cover a globe of radius 3750 km. If we assume that the continents completely cover an Earth of this radius $4.2 \cdot 10^{9}$ years ago, then one can calculate an expansion rate of $3.1 \cdot 10^{-18}$ s^{-1} which is a little over the Hubble parameter. So again, Earth expansion would be in agreement with cosmological expansion.

7. Earth and Mars rotation

The Earth's rotation is generally assumed to slow down because of tidal friction. It is usually calculated in units of seconds per day per year, but if we instead convert all of the time units to seconds we get a rate of $2.93 \cdot 10^{-18}$ s^{-1} . The closeness of this value to the Hubble constant, the expansion of the lunar orbit, and the Pioneer anomaly suggests that the Earth's slowing down might be of cosmological origin.

If retardation of Earth rotation is due to tides, we would expect a much smaller rate for a planet like Mars which only has two very small natural satellites. Mars rotation was measured in 1952 by Ahnert (1955) and 1980 by De Vaucouleurs (1980). If the measurements are corrected for the change from UT seconds to SI seconds, Mars slows down at a rate close to Earth. This would indicate a similar cause, not tidal friction. Again, this suggests a cosmological origin.

8. Conclusions

The above objects and phenomena should be below the lower limit for cosmological expansion. But they expand at the same rate as the universe, so it is only natural to assume that they might have the same cause. So the lower limit of cosmological expansion should be extended downward so that it includes the Earth.

All of these phenomena expand or change at similar rates, $2.3 - 3.1 \cdot 10^{-18}$ s^{-1}. They show remarkable agreement (18 orders of magnitude!) considering that they are very different phenomena and the measurements were done with different technologies.

Einstein and Strauss (1945) postulated that cosmological expansion does not exist at small scales. Unfortunately, this postulate now appears to be erroneous. Therefore, the author comes to the following assumptions:

The lower limit of cosmological expansion is not where it is presumed. It is not above gravitationally bound systems but below systems dominated by gravity. Planetoids less than 200 km across, continents and everyday objects are dominated by electromagnetic forces and not gravity. Therefore, they fall below the lower limit of cosmological expansion. Therefore, they do not expand.

The gravitational forces of the Earth and larger celestial bodies are obviously greater than the electromagnetic forces involved; and measurements show the effects of expansion. The rates of expansion match. Therefore the author assumes that the Earth behaves like the universe:

As the Universe expands, the Earth also expands.

It could be that we are using two sets of units without knowing it. The SI second is defined in terms of electromagnetic radiation and is generally treated as constant. The meter is defined in terms of this second. In this system of units, bodies dominated by electromagnetic forces such as bridges or continental plates have constant dimensions; while things dominated by gravity like planets, orbits, and galaxies would expand at the Hubble rate. The length of the UT second increases with respect to the SI second. The increase is close to the Hubble constant. If we defined a unit of distance using this (UT-) second, the dimensions of the planets, orbits, and galaxies would be constant. The bridges and continental plates would become contracts in the relationship to the Earth. The universe would be infinite in both age and size (Müller, 2010).

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