The Cosmic Energy in the Principle of Conservation

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Abstract Several theories have introduced an estimate for the total mass-energy of the observable universe, this magnitude can be determined upon the cosmic critical density, the extrapolation from number of stars or Hoyle based steady-state estimates; and all imply a finite universe. Using the assumption of the conservation of the total observable cosmic energy, and employing a form of Bohr's quantization; we apply a different method to estimate the mass-energy of the large scale universe.

Keywords Black Hole · Cosmology · Gravity · Quantization

1 Introduction

Our approach agrees with the existing values which are the upper limit estimates; not only for the total energy of the observable universe $E_U = M_U c^2$, but also for the present physical properties, such as the Hubble time $t_U = R_U / c$, the characteristic gravitational potential $n_U = 10^{122}$, the critical density, Planck force f_P and power P_P and the upper bound of the Bekenstein–Hawking entropy.

It has been noted that the universe can be quantized as a black hole (Alfonso-Faus 2010). We indicate that Planck time; length and temperature are identified with the quantum of gravity. Thus, for example, time is bounded below by Planck time and above by the characteristic time of the observable universe. Certainly, the upper bound can be applied to each property of the gravitational quanta.

2 Cosmic Quantization

Consider the quantum of the gravitational angular momentum, where $m = E/c^2$ is the mass equivalent to the quantum of the gravitational potential

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energy throughout the age of the large scale universe; similarly, $r = ct$ is the gravitational radius throughout the age of the large scale universe.

$$mcr = n\hbar \tag{1}$$

Assuming the conservation of energy principle holds for the cosmos, the estimated total energy of the observable universe is constant; we get by considering the centripetal force as being equal to the gravitational potential.

$$m\frac{c^2}{r} = G\frac{M_U m}{r^2} \tag{2}$$

Combining the above after simplifying,

$$n^2\hbar^2 = GM_U m^2 r \tag{3}$$

Consider that the quantized mass is equal to the gravitational mass.

$$\frac{n\hbar}{cr} = \frac{c^2 r}{G} \tag{4}$$

Converting to the Planck length $l_P = ct_P$, we get

$$n = \frac{r^2}{l_P^2} \tag{5}$$

The quantum of gravity n can be viewed as the information content of the universe. You might expect this to vary as the cube of the gravitational radius of the visible universe at time t, after all the material of the universe appears to be fairly uniformly distributed throughout its volume. The above equation, however, shows that it actually varies directly as the square of this radius. This suggests one of two things, either the black hole singularity from which the universe emerged was rotating; or, all matter in the universe is actually distributed along the boundary of the outer "shell" of the universe.

The first case might also explain why most galaxies seem to be relatively flat spirals. The angular momentum of the original universe, together with differences in speed of the ejecta caused by collisions would cause a natural flattening into spirals with a bias in the direction of the

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original rotation. Randomized collisions would tend to dampen out this bias over time, but it would not eliminate it. This rotation would cause the ejecta to flatten out into a more disc-shaped universe and result in the quantum number becoming proportional to area rather than volume.

We cannot see the universe as rotating directly because there are no outside points of reference. There is evidence, however, that this is the case (Longo 2011) as there is an apparent 7% bias toward counter-clockwise rotating galaxies in the northern hemisphere. This discrepancy is too large to attribute to chance and shows that the universe is not, as has always been assumed, isotropic.

A rotating universe would have to have a center for the rotation. The problem is that the distances involved, and the slowness of rotation, might make determining this center difficult. However, that does not mean it is impossible.

The second possibility for this would be for all of the matter to be located on the surface "edge" of the expanding sphere of the universe. But this should mean we would see a "bright spot" in the direction from which we came surrounded by a dark band having things too far away from us for light to have traveled, or a dim band as things get farther away from us on the edge. Either way, there would be a difference in the red shift as we view things in different directions. This has not been observed, so this possibility is not likely.

Substituting Eq. 5 into Eq. 3 and solving for m we get

$$m = \frac{\hbar}{l_P^2}\sqrt{\frac{r^3}{GM_U}} \tag{6}$$

Substituting GM_U for $c^2 R_U$, t for r/c (at Planck time and the characteristic time), and E for mc^2 we get the quantum of the large scale gravitational energy.

$$E = \frac{\hbar}{t_P^2}\sqrt{\frac{t^3}{t_U}} \tag{7}$$

This means that the gravitational energy is proportional to the square root of the cube of time, $t \to t_U$. This also supports the idea of a rotating

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universe as it is a direct consequence of Eq. 5. Observe that for the characteristic time, $t = t_U$, we obtain $E_U = 10^{70} J$.

In addition, we point out that for Planck time, $t = t_P$, we obtain $E = 10^{-21} J$, using the Planck relation we find that this is the peak frequency of the cosmic microwave background radiation (CMBR). This estimate is unique for more than one reason; it is the median between the energy of the smallest Planck-scale particle and Planck energy, also, it can be close to one electron volt.

Density is proportional to the mass and inversely proportion to the volume; hence,

$$\rho = \frac{1}{G}\sqrt{\frac{1}{t_U t^3}} \tag{8}$$

Observe that for the characteristic time we obtain $\rho_U = 10^{-26} kg/m^3$. Here the equation of mass density assumes that the universe is spherical. However, if the black hole from which it emerged was rotating then the true shape would be an oblate spheroid or a thickened disc. This means that the apparent sphericalness might be due to reflection from the "edge" of the universe or may be a relativistic effect from different speeds of expansion in different directions. By "edge" we mean the limit of the observable universe. Thus, things may not be where we think they are and there might be multiple images of the same object.

It might be possible to test this reflection theory. The bias in counter-clockwise turning spiral galaxies observed in the northern hemisphere might be balanced by an equal bias in clockwise turning spiral galaxies observed in the southern hemisphere. This check is on-going and the results have not yet become available. However, if the results are analyzed over the entire sky then just such a mirroring may be discoverable. This would also indicate that the universe is closed and increase the likelihood of a Big Crunch at the end of time. There is another problem.

Even if this is the case, it would not be conclusive if there is a difference in ages between the "reflections." The problem is that the angle of the universe would only approximately equal the angle of the solar system, so this bias may not be observable easily. Also, the reflection of any particular galaxy may "roll off" the edge (the times at which the light from that galaxy

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hit the edge would not all be the same) and change the apparent angle we see that galaxy from. The object and its reflection would not necessarily be viewed from the same point in time. This might introduce a second bias which would make it almost impossible to verify the shape of the universe as being an oblate spheroid or disc. Consider the amount of change our own stellar system has undergone in the last four billion years.

Regarding Eq. 7 as being the work done in the cosmic expansion, we get for the quantum of the large scale gravitational force,

$$f = f_P \sqrt{\frac{t}{t_U}} \tag{9}$$

and the quantum of the large scale gravitational power,

$$P = P_P \sqrt{\frac{t}{t_U}} \tag{10}$$

Observe that for the characteristic time we obtain Planck force and Planck power.

Using Schwarzschild radius, the temperature of the gravitational quanta can be given by Hawking relation,

$$T = \frac{\hbar}{kt} \tag{11}$$

Observe that for the characteristic time we obtain $T_U = 10^{-29} K$, this estimate is very close to $2.73\ K$, an exceptional temperature of the CMBR. Actually, this difference in estimate may be more of where it is calculated rather than from an actual difference in theory. Furthermore, it is worth mentioning that for Planck time we obtain Planck temperature.

From Clausius relation, $S = E/T$, we apply the above result to Eq. 7. This yields the quantum of the large scale gravitational entropy.

$$S = \frac{k}{t_P^2} \sqrt{\frac{t^5}{t_U}} \tag{12}$$

This is by far the fastest growth rate of any of the quanta considered and is proportional to the square root of the fifth power of time, $t \to t_U$. Observe that for the characteristic time we obtain $S_U = 10^{99} J/K$.

3 Conclusion

Our model predicts that the mass identified with the characteristic gravitational potential is about $10^{53} kg$. This is a conventional estimate that matches mass of the universe the largest unit exists in the observable universe. Our approach is another method to estimate the total mass-energy of the large scale universe under the assumption of conservation of cosmic upper-limit energy.

The formulas, in particular Eq. 5, support the idea that the universe is disc-shaped and rotating, perhaps resembling a super-sized spiral galaxy. Our conclusion, which is based upon this model, corresponds with the modern cosmological observations.

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