Cosmic Quantization with Respect to the Conservation of Upper-Limit Energy

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Abstract The conditions of the early universe are not known with any measure of certainty — they are only theories. Therefore, using the assumption that the estimated total energy of the observable universe is conserved, we propose a different lower limit for the gravitational energy; we attempt to unify the subatomic and the large scale universe into one coherent whole; thus, showing that the cosmos behaves like a quantum object. It uses a form of Bohr's quantization to strengthen the unification of quantum gravity. Our model is simple, yet comprehensive.

Keywords Black Hole · Cosmology · Gravity · Quantization

1 Introduction

Our approach agrees with accepted cosmology on the upper limit estimates, not only for estimated total energy of the observable universe $E_c = M_c c^2$, but also for present physical properties, such as the Hubble time $t_c = R_c/c$; the characteristic gravitational potential $n_c \approx 10^{122}$; the critical density; Planck force f_P and power P_P; and the upper bound of the Bekenstein–Hawking entropy.

As has been noted, the universe can be quantized as a black hole (Alfonso-Faus 2010). We suggest that the quantum of the gravitational potential field energy (the energy of one cosmic bit) is the initial cosmic potential energy, $E_0 = m_0 c^2$, although we get a different estimate for this initial value than the ordinary one. Our calculations turn out to occur at the peak frequency for the cosmic microwave background radiation.

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We point out that Planck length, time 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, these bounds 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 energy throughout the age of the universe; similarly, $r = ct$ is the gravitational radius throughout the age of the 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.

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

Combining the above, after simplifying,

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

Recall the bounds on m,

$$\frac{\hbar}{\sqrt{GM_c \ell_P}} \leq m \leq \sqrt[3]{\frac{n_c^2\hbar^2}{GR_c}}$$

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 $\ell_P = ct_P$, we get

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

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: 1) either the black hole singularity from which the universe emerged was rotating; or, 2) 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 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

$$m = \frac{\hbar}{\ell_P^2}\sqrt{\frac{r^3}{GM_c}} \tag{6}$$

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

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

Observe that for $t = t_P$, we obtain $E \approx 10^{-21} J$, using the Planck relation we find the peak frequency of the cosmic microwave background radiation; this estimate can be close to one electron volt, as well. This means that the gravitational energy is proportional to the square root of the cube of time (and thus radius). This also supports the idea of a rotating universe as it is a direct consequence of the Eq. 5.

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

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

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 ongoing 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 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 work done in the cosmic expansion, we get for the quantum of the gravitational force,

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

and the quantum of the gravitational power,

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

Both of these are proportional to the square root of the gravitational radius and are a direct result of Eq. 7.

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

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

Observe how the temperature is inversely proportional to time.

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

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

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.

Table 1 shows the values of various gravitational quanta at different times throughout the age of the universe. For instance, the gravitational mass varies from a photonic mass at Planck time, to a solar mass in about one second, to a galactic mass in about four months and finally reaching the cosmic mass in about 14 billion years. Using physical laws, we could extend the results to other physical quanta.

3 Conclusion

Our model predicts that the mass identified with the quantum of the gravitational potential is about 10^{-38} kg instead of the conventional estimate of 10^{-62} kg (Alfonso-Faus 2010). If our estimate is valid then our model unifies the essential physical properties at both the subatomic and the large scale universe. Our approach gives another way of estimating the total energy of the observable universe under the assumption that this total energy is conserved. It describes the cosmic inflation and the increase in entropy as an increase in the information content given by its quantum of gravity. We need to point out that our rate of inflation is different from that derived by Alan Guth (Guth 1981).

This model predicts that the mass equivalent to the quantum of the gravitational potential energy is on the peak frequency of the cosmic microwave background radiation; this estimate can be also close to one electron volt. Actually, this difference in estimate mentioned above may be more of where it is calculated rather than from an actual difference in theory.

The formulas, in particular Eq. 5, support the idea that the universe is disc-shaped and rotating, perhaps resembling a super-sized spiral galaxy. Other cosmologists have come to the same conclusion, but our conclusion is entirely based upon this model and does not come from any observations.

Table 1 Relative changes in gravitational quanta with respect to time

Gravitational Quantum	Proportion to time	Time (seconds)				SI Units
		10^{-43}	10^{0}	10^{7}	10^{17}	$\dots$
Radius	$r \propto t$	10^{-35}	10^{8}	10^{15}	10^{26}	m
Quantum of gravity	$n \propto t^2$	10^{0}	10^{86}	10^{100}	10^{122}	–
Energy	$E \propto t^{3/2}$	10^{-21}	10^{44}	10^{54}	10^{70}	J
Mass	$M \propto t^{3/2}$	10^{-38}	10^{27}	10^{37}	10^{53}	kg
Density	$\rho \propto 1/t^{3/2}$	10^{65}	10^{1}	10^{-10}	10^{-26}	kg/m^3
Force	$f \propto t^{1/2}$	10^{13}	10^{35}	10^{39}	10^{44}	N
Power	$P \propto t^{1/2}$	10^{22}	10^{44}	10^{47}	10^{52}	W
Temperature	$T \propto 1/t$	10^{32}	10^{-11}	10^{-18}	10^{-29}	$^\circ K$
Entropy	$S \propto t^{5/2}$	10^{-53}	10^{55}	10^{72}	10^{99}	$J/^\circ K$

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