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 $E_U = M_U c^2$, but also for present physical properties, such as the Hubble time $t_U = R_U / c$; the characteristic gravitational potential $n_U \approx 10^{122}$; 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, $E_\circ = m_\circ c^2$, although we get a different estimate for this initial value than the ordinary one. Our calculations turn out to occur at an infrared radiation (IR) frequency.

We point out that Planck length; time and temperature are identified with the quantum of gravity. Thus, for example, time is bounded below by

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Planck time and above by the characteristic time of the observable universe, these bounds can be applied to each property of the gravitational quanta.

Planck time can be viewed as an endpoint for Planck epoch which is a traditional (non-inflationary) era in Big Bang cosmology, this period of time proposes a singularity that breaks down all the laws of physics. Planck time is not only the starting point of the Big Bang and the cosmic inflation, but it is also the starting point of the universe. For this reason, the energy identified with the quantum of the gravitational potential occurs merely at Planck time. Accordingly, $10^{-62}kg$ can be viewed as an estimate that existed during Planck epoch. Perhaps, this estimate is the starting mass of the singularity: “the primitive atom”.

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.

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

Combining the above, after simplifying,

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

Recall the bounds on m ,

$$\frac{\hbar}{\sqrt{GM_U l_P}} \le m \le \sqrt[3]{\frac{n_U^2\hbar^2}{GR_U}}$$

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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: 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

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

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 gravitational energy.

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

Observe that for $t = t_P$, we obtain $E_\circ \approx 10^{-21} J$, using Planck relation we find IR. Additionally, this estimate is relatively close to the high frequency of the cosmic microwave background radiation (CMBR) and it can be close to one electron volt. 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 Eq. 5.

Heisenberg principle, $\Delta E \Delta t \geq \hbar/2$, can relate the uncertainty of mass-energy and space-time within the subatomic scale (a scale of $\Delta E \leq E_P$ and $\Delta t \geq t_P$). For example, ΔE is Planck energy when Δt is Planck time. Remember, ΔE cannot be $\leq\leq E_P$ and Δt cannot be $\geq\geq t_P$. For this reason, $10^{-46} J$ is out of the cosmic limits because it corresponds $\approx 10^{11}\,\sec$ which is $\geq\geq t_P$. However, $10^{-21} J$ can be a cosmic endpoint because it corresponds $\approx 10^{-14}\,\sec$ which is only $\geq t_P$. Moreover, it is worth mentioning that $\Delta m \Delta r \geq \hbar/2c$.

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

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

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 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,

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

and the quantum of the gravitational power,

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

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,

$$T = \frac{\hbar}{k}\frac{1}{t} \tag{11}$$

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 a calculation error rather than a result derived from theory. Furthermore, it is worth mentioning that for Planck time we obtain Planck temperature. Note that 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.

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

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.

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.

The property of the gravitational quanta	Proportion to Time	Time (sec.)				SI Units
		10^{-43}	10^{0}	10^{7}	10^{17}	
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}	$°K.$
Entropy	$S \propto t^{5/2}$	10^{-53}	10^{55}	10^{72}	10^{99}	$J/°K.$

Table 1 Relative changes in gravitational quanta with respect to time

3 Cosmic Quantization of Space-Time and Mass-Energy

Space-time is quantized, remember $r = l_P\sqrt{n}$

$$t = t_P\sqrt{n} \tag{13/a}$$

But why it appears that space-time is continues?

This can be simply explained by understanding Δt

$$\Delta t = t_P(\sqrt{n} - \sqrt{n-1}) \tag{13/b}$$

Space-time appears continues because the universe is reaching t_U

$$n \to n_U \;\Rightarrow\; \Delta t \to 0$$

In addition, mass-energy is quantized. The equation $E = \frac{\hbar}{\sqrt{t_P t_U}}\sqrt[4]{n^3}$ is a result from substituting Eq. 13/a in Eq. 7, or

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$$m = \frac{\hbar}{c^2 \sqrt{t_P t_U}} \sqrt[4]{n^3} \tag{14/a}$$

But why it appears that mass-energy is continues?

This can be simply explained by understanding Δm

$$\Delta m = \frac{\hbar}{c^2 \sqrt{t_P t_U}} (\sqrt[4]{n^3} - \sqrt[4]{n^3 - 1}) \tag{14/b}$$

Mass-energy appears continues because the universe is reaching m_U

$$n \to n_U \;\Rightarrow\; \Delta m \to 0$$

4 Conclusion

$10^{-62}\,kg$ (Alfonso-Faus 2010) is viewed as a value that existed during Planck epoch; this estimate could be the starting mass of the singularity. Our model predicts that the universe started at Planck time only, therefore, $10^{-38}\,kg$ is viewed as the mass identified with the quantum of the gravitational potential. 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).

The energy identified with the quantum of the gravitational potential $E_\circ \approx 10^{-21} J$ is energy of IR that existed in a universe of a singularity; it is the highest amount of energy that is found before the Big Bang. The universe only started to inflate at Planck time with an amount of IR energy, but with energy less than this there was only a "primitive atom".

In addition, this lower limit of cosmic energy is relatively close to the energy that is on the high frequency of CMBR; this estimate can be close to one electron volt as well. 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. Our conclusion, which is based upon this model, corresponds with the modern cosmological observations.

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5 The Electric Charge Hypothesis of the Subatomic Universe

From Planck relation, $E = h\nu$, we apply the above result to Eq. 7. This yields the quantum of gravitational frequency of the early cosmic Electromagnetic radiation (EMR).

$$\nu = \frac{1}{t_P^2}\sqrt{\frac{t^3}{t_U}} \tag{15}$$

Corresponding Coulomb's potential energy to Eq. 7, we get the quantum of gravitational electric charge of the early cosmic EMR.

$$q = \frac{q_P}{t_P}\sqrt[4]{\frac{t^5}{t_U}} \tag{16}$$

Matching Eq. 15 with Eq. 16,

$$q^6 = q_P^6 t_P^4 t_U \nu^5 \tag{17}$$

This is a relation between the electric charge of the early cosmic subatomic particles and its frequency. Observe that the range of the electric charge for the early cosmic EMR is $10^{-42}C \leq q \leq 10^{-24}C$, this differs from the conventional estimate $q \leq 10^{-35}e$. Also notice that for $t = t_P$, we obtain $\nu \approx 10^{12}Hz$ and $q \approx 10^{-33}C$, on the other hand, $\nu \approx 10^{31}Hz$ when $q \approx 10^{-19}C$.