Some Results due to a Possible Cosmic Quantum Mechanics in Astrophysics

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Abstract
Recent observations confirm quantized galactic redshifts and hint a possible new form of quantum mechanics, which could probably explain these observed properties of the galaxies. This brief contribution investigates a possible relation between the new cosmic Planck constant $\hbar_g$ and other fundamental constants of physics.

Introduction
Since it was found that the recession velocities for single and double galaxies appear to be quantized, [1] then a new quantum of action was also derived to yield [2], [3]:

$$\hbar_g = \frac{\left(1+\sqrt{3}\right)^2 M}{H} V^2 \cong 7.0\times 10^{74} \text{ erg·s} \tag{1}$$

where: V = 12 km/s, $M = 10^{44}$ gm, and $H = 1.7\times10^{-18}$ s^{-1}. If we now use Weinberg's relation for the mass of an elementary particle [4] and changing $\hbar \to \hbar_g$ we have:

$$m_\pi = m_g = \left(\frac{\hbar^2{}_g H_o}{Gc}\right)^{1/3} = 7.466\times10^{42}\,\text{g} = 3.77\times10^{9} M_\otimes \tag{2}$$

This value of mass can be considered as a lower bound for the mass of a galaxy now playing the role of a "particle" in this new scheme of cosmic quantum mechanics. Next, the upper particle mass can be obtained via the substitution $\hbar \to \hbar_g$ into the Planck mass formula namely:

$$m_{g_{upper}} = \left(\frac{c\hbar_g}{G}\right)^{1/2} = 1.774\times10^{46}\,\text{g} = 8.961\times10^{12} M_\otimes \tag{3}$$

Looking at the numbers just obtained in (1), and (2) we can easily see that they represent galactic masses of some kind. The first mass obtained for a typical elementary particle in the cosmic quantum mechanics hypothesis, where galaxies are treated like particles, simply represents a mass slightly greater by a factor of hundred than that of dwarf galaxies, since $M_D = (10^5 - 10^7) M_\otimes$ [5]. This could also suggest that the lower bound for a galactic particle might be higher than the dwarf but less than most galaxies in the universe as a first choice, and as a second choice within the mass ranges of the elliptical galaxies since $M_E = (10^8 - 10^{13})M_\otimes$ [4]. Looking now at the second mass representing, the upper bound for the mass of a particle, it is simply the upper limit of the mass for most of the galaxies in the universe $M_G = (10^{10} - 10^{12})M_\otimes$ [5]. That could also suggest the possibility that an elliptical galaxy could represent the upper particle limit.

Next we look at the rest of the Planckian relations when again for $\hbar \to \hbar_g$. This substitution makes the relation for the Planck length be:

$$\ell_g = \left(\frac{G\hbar_g}{c^3}\right)^{1/2} = 1.315\times10^{18}\,\text{cm} = 1.390\ \text{ly} = 0.425\text{pc} \tag{4}$$

Simply we just say that this is a new Planck length in the cosmic quantum mechanics scenario which, can also be written as:

$$\ell_g = 8.218\times10^{50}\,\ell_P \tag{5}$$

Similarly we can write down the cosmic quantum mechanics version of Planck time:

$$t_g = \left(\frac{G\hbar_g}{c^5}\right)^{1/2} = 4.383\times10^7\,\text{sec} = 1.391\,\text{y} \tag{6}$$

which, can also be written as:

$$t_g = 8.116\times10^{50}\,t_P \tag{7}$$

Now if cosmic quantum mechanics can be postulated with the galaxies playing the role of "particles". In an analogous fashion with particle physics there must be a cosmic distance where these quantum phenomena become unavoidable [6]. This distance will be equal to the cosmic Compton wavelength, which can be calculated as follows, depending on the values of the masses found above:

$$\lambda_{g(upper)} = \frac{\hbar_g}{m_g c} = 3.125\times10^{21}\,\text{cm} = 3303.382\,\text{ly} = 1011.32\,\text{pc} \tag{8}$$

and

$$\lambda_{g(lower)} = \frac{\hbar_g}{m_g c} = 1.315\times10^{18}\,\text{cm} = 1.390\,\text{ly} = 0.425\,\text{pc} \tag{9}$$

From the numbers obtained in (8) and (9) we can speculate that quantum phenomena on this cosmic scale can occur for the above distances between the centers of these galaxies. Depending on the masses used, we can say that these quantum phenomena will occur at some distances from the galactic centers, distances that are fractions of the linear galactic size.

As a next step, we will use a quantitative relation that, predicts the lifetime of main sequence stars, employed by Tipler and Barrow in order to approximate the age of the universe, and therefore we [7]:

$$t_{MS} \cong \left(\frac{hc}{Gm_N{}^2}\right)\left(\frac{h}{m_N c^2}\right) \tag{10}$$

where: m_N = the mass of the proton, c is the speed of light, G is the gravitational constant, and h is Planck's constant. We expect that if the mass of the proton is replaced by the mass of a galaxy as calculated above in (2) (3), and also if we replace $h \to \hbar_g$, (10), the age of the universe can be obtained in a similar way, therefore (10) becomes:

$$t_{Univ} \cong \left(\frac{\hbar_g c}{G m_g{}^2}\right)\left(\frac{\hbar_g}{m_g c^2}\right) \tag{11}$$

Upon substitution of the two possible masses found from (2) and (3) we obtain the following time scales:

$$t_{1g} = 1.867 \times 10^{10}\,\mathrm{y} = 18.67\mathrm{Gy} \tag{12}$$

$$t_{2g} = 4.384 \times 10^{7}\,\mathrm{s} = 1.392 \quad \mathrm{y} \tag{13}$$

A mass of $m_g = 7.466 \times 10^{42}$ g gives us a time of 18.67 Gyr which is very close to the age of the universe obtained when H_o = 50 Km / sec Mpc or t = 1 / H_o = 18.65 Gyr, which is close to 20 Gyr, when $H_o \approx$ 50 Km /sec Mpc.[8] The second value of this excessively small number seems to be an equivalent of a "macrocosmic Planck time" when $m_g = m_{g\,(Planck)}$ in the above relation (11). We can also see what is happening if we substitute $m_{g\,(Planck)}$ and obtain:

$$t_G(m_g(Pl)) = t_g(Pl) = \left(\frac{G\hbar_g}{c^5}\right)^{1/2} = 4.38 \times 10^7\,\mathrm{s} = 1.390\mathrm{y} \tag{14}$$

This particular result of a new "macrocosmic Planck time" was also found by direct substitution of $h \to \hbar_g$ into Planck's formula.

As a next step, Weinberg's result, which we already used for the mass of an elementary particle, can be derived if in the relation used for the age of the universe Eq. (11) we take to be of the order $1/H_o$ and therefore we obtain:

$$\frac{1}{H_0} = \left(\frac{\hbar_g c}{G m^2{}_g}\right)\left(\frac{\hbar_g}{m_g c^2}\right) = \left(\frac{\hbar^2{}_g}{G c m_g{}^3}\right)\ \mathrm{s} \tag{15}$$

finally we obtain the relation for the mass of the "elementary galactic particle":

$$m_\pi = m_g = \left(\frac{\hbar^2{}_g H_o}{Gc}\right)^{1/3}\ \mathrm{g} \tag{16}$$

This result could probably be a kind of derivation for Weinberg's relation, considered so far to be purely empirical. This could ensure some kind of further connection between microphysics and macrophysics, especially in the cosmic quantum mechanics scenario where galaxies are thought to be like particles.

Next, there will be is an upper bound for the density of the mass in the universe where quantum phenomena become important. In a similar way we can define this "galactic particle density" somewhat analogous to "quantum density" when $h \to \hbar_g$ and therefore we have that:

$$\rho_g = \frac{\mathrm{c}^5}{\hbar_g\,\mathrm{G}^2} = 7.0 \times 10^{-9}\ \mathrm{g\,cm^{-3}} \tag{17}$$

The number above appears to be much larger than the critical density of the universe, as well as the mass density of the galaxies today. If cosmic quantum mechanics is possible in the universe and between galaxies, it would suggest a moment in time which can be found from the relation below if we solve for H_o and for the density value found above: [9]

$$\rho_g = 3.1\times 10^{-31}\left(\frac{H_o}{75\ \text{Km /sec Mpc}}\right)\ \text{g cm}^{-3} \tag{18}$$

Therefore we have:

$$H_0 = 3.64\times 10^{-7}\,\text{s}^{-1}\ \text{ or }\ t = 2.74\times 10^{6}\ \text{s} \tag{19}$$

The time found in (19) belongs to the radiation era in the history of the universe which appears to be within the time frame of t = 10-10^{12} s.[10] It is only after a time $t > 10^{12}$ s and around $t > 10^{16}$ s where galaxies stared forming by some condensation process [10]. Based on this approximate number found for the time, we can say that this quantum density analog for the particle galaxies in the cosmic quantum mechanics scheme would occur long before the final galactic formation. This would also imply the following relation in densities between cosmic and ordinary quantum mechanics:

$$\rho_{\text{g}} = \rho_{\text{qua}}\left(\frac{\hbar}{\hbar_g}\right)\quad \text{g cm}^{-3} \tag{20}$$

Next, we are going to look if there is a possible upper bound for the macroscopic Planck's constant. Our assumption will be that in the relation already used in (1) the mass of the galaxy particle will be the mass of the universe. Therefore, using $m_g = M_{un}$ = 7.5×10^{55} g [5] we obtain:

$$\hbar_g(\text{max}) = \frac{\left(1+\sqrt{3}\right)^2 M_{univ}(\Delta v)^2}{H_o} = 4.741\times 10^{86}\ \text{erg}\cdot\text{s} \tag{21}$$

Next, making use of the formula for the maximum possible curvature in the universe which also signifies the presence of quantum gravity effects and calculating it at the new cosmic Planck constant $\hbar \rightarrow \hbar_g$ as well as at the maximum estimated cosmic Planck constant $\hbar \rightarrow \hbar_g(\text{max})$, we have [11]:

$$\Lambda_g(\text{max}) = \frac{c^3}{G\hbar_g} = 5.78\times 10^{-37}\,\text{cm}^{-2} \tag{22}$$

$$\Lambda_g(\text{min}) = \frac{c^3}{G\hbar_g(\text{max})} = 8.538\times 10^{-49}\,\text{cm}^{-2} \tag{23}$$

It is rather curious that for the maximum value of the cosmic Planck's constant the curvature value obtained is a value very close to that of the cosmological constant, which is given approximately as $\Lambda = 10^{-48}$ cm^{-2} [12]. There also seems to be an upper value for the cosmological constant $\Lambda = 10^{-37}$ cm^{-2} which corresponds to cosmic Planck constant value as calculated by (1). Because we find a value close to the value of the cosmological constant given in [12] may be an indication of some kind of a relation between the cosmological constant Λ and the value of the cosmic Planck constant.

If now the universe was thought to be a huge particle of mass M_{un}, composed of "cosmic elementary galaxy particles" we could probably approximate its mass, by applying Weinberg's relation and making use of this maximum value of the cosmic Planck constant $\hbar \to \hbar_g(\max)$ and substituting we obtain:

$$M_{un} = \left(\frac{\hbar_g^{\,2}(\max) H_o}{Gc} \right)^{1/3} = 5.476 \times 10^{50}\,\mathrm{g} \tag{24}$$

This mass found in (24) is quite close to the mass of the universe by a factor of 1.04×10^5. It could be possible that for such a representation, an even higher value for $\hbar_g(M_{un}) = 2.228 \times 10^{94}$ erg·s maybe required, unless one of the other parameters has to change in (24). For example, the speed of light could be varying, or perhaps also G, thus compensating for the exact result of the mass of the universe. From (2) and (24) we also obtain:

$$M_{un} = m_g \left(\frac{\hbar_g(\max)}{\hbar_g} \right)^{2/3} \mathrm{g} \tag{25}$$

The above relation shows a connection between ordinary quantum mechanics and cosmic quantum mechanics, or a connection between the masses of galaxies and that of the universe. It is worth mentioning that another familiar number, which can be obtained for the cosmological constant $\Lambda=1.816\times10^{-56}$ cm^{-2}, when the value of $\hbar_g(\max) = 2.228 \times 10^{94}$ erg·s is substituted in the Weinberg relation which now can identically give the mass of the universe. We should mention that there is a limit on the cosmological constant of $\Lambda = 10^{-54}$ cm^{-2} which is mentioned by Hawking [13]

Next, if we use the maximum value for the cosmic Planck constant, and specifically that ensures the mass of the universe in (25) in the formula, which gives the quantum density limit, we obtain:

$$\rho_{\mathrm{g(qua)}} = \frac{c^5}{\hbar_{g(\max)} G^2} = 2.451 \times 10^{-28}\ \mathrm{g\ cm^{-3}} \tag{26}$$

Looking at the number obtained above, we can see that this it is just the critical density in the universe within a factor of a factor of 10^{-1}. The critical density of the universe is given by:

$$\rho_{\mathrm{c}} = \frac{3H_0^2}{8\pi G} = 1.88\times10^{-29} h^2\ \mathrm{g\ cm^{-3}} \tag{27}$$

We could also see that the critical density of the universe can be now written as:

$$\rho_{\mathrm{c}} = \left(\frac{3GH_o^{\,2} \rho_{g(\max)}}{8\pi\, \mathrm{c}^5} \right) \hbar_{g(\max)} \tag{28}$$

This way we can say that the critical density of the universe is quantized in units of $\hbar_g(\max)$.

Conclusions

Some relations of quantum mechanics have been investigated in the grand scheme of a possible cosmic quantum mechanics, which has been postulated by observing the recession velocities of the galaxies, and for which a cosmic quantum of action has long been calculated. Numerical results analogous to those of quantum mechanics is investigated, and thus new macroscopic limits for mass, time, and length, in this cosmic quantum mechanical scenario have been obtained. For a possible maximum value of the new cosmic Planck constant, the mass of the universe and its cosmological constant, as well as the critical density can be obtained to closely agree with today's standard results. Because some of the known parameters of the universe can be retrieved for a greater value of $\hbar = \hbar_g(\max)$ could suggest that a better estimate of the quantities on which $\hbar_g$ depends might be necessary. Finally, the age of the universe can be retrieved from a relation, which actually gives the age of a star, via a substitution of the proton mass with the mass of the elementary galactic particle, having changed $h = \hbar_g$. After all, there might be a relation between ordinary and cosmic quantum mechanics based on the results found, a relation between microcosm and macrocosm, an idea, which for long has been long suspected.

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References

[1] Cocke, W., Tifft, W., *Astrophysical Journal*, 287, 1984, 492.
[2] Dersarkissian M., Lett. *Nuovo Cimento*, 40, 1984, 390.
[3] Dersarkissian M., *Lett. Nuovo Cimento*, 43, 1985, 274.
[4] Weinberg S., *Gravitation and Cosmology*, John Wiley, New York, 1972.
[5] Padmanabhan, T., *Structure Formation in the Universe*, Cambridge 1993
[6] Bernstein J., *An Introduction to Cosmology*, Prentice Hall, 1995.
[7] Barrow, J., D., Tipler F., J., *The Anthropic Cosmological Principle*, Oxford University Press, 1988.
[8] Piran T., Weinberg S., *Intersection between Elementary Particle Physics and Cosmology*, Vol.1, World Scientific, 1986.
[10] Ohanian, H., C., and Ruffini R *Gravitation and Space-Time*, W. W. Norton, & Company, 1994, Second Edition.
[11] Sivaram C., Sabbata V., *Astrophysics and Space Science*, 176, 145-148, 1991.
[12] Islam, J., N., *An Introduction to Mathematical Cosmology*, Cambridge University Press, 1992.
[13] Islam, J., N., *Phys. Lett*. 97A, 239, 1983b.