How inevitable is the quantization of the gravitational dipole? Implications for the tired light hypothesis and cosmology in general.

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Abstract.

It is shown that similar to distance, pulse, momentum, wavelength (quantization rules were discovered around 100 years ago) the gravitational dipole must be quantized. Implication of this is the obligatory non-zero gravitational dipole for photon and interesting new way for light to lose energy on the long travel, which may create the competing to Big Bang mechanism of red shift and change the cosmology in general.

Introduction.

After Plank successfully quantized energy of photon, many other scientists applied the same idea to other physical values. Bohr quantized momentum m*r*v=n*h and created the quantum mechanics. Heisenberg quantized production of pulse and distance dp*dr~ h/2 and later De-Broglie quantized the wavelength for any matter λ=h/(mv) (which for relativistic particles equals to Compton wavelength λ=h/mc). It seems that in the most general relation: m*r*v=n*h (or may be (½+n)*h) every pair is quantized.

So it seems very probable, almost inevitable that the gravitational dipole is also quantized:

m*r=h*n/v (or may be m*r=(½+n)*h/v, which for experimentalist aiming to discover such fundamental property of matter almost the same [1]).

This relation may be re-written as follows (for n=1): m*r=m*h/(mv)=m*λ

Where λ is De-Broglie wavelength. Indeed, the mass of the particle is not obligatory placed exactly in the center of the spread of the particle approximately in the region of λ, it may be said larger on one side and smaller on another, thus creating the sum of centered mass and mass dipole (gravitational dipole). Seems that such quantization of the mass dipole (or gravitational dipole, assuming the weak equivalence principle is also true for gravitational dipole as it is true for mass) is inevitable and soon will be discovered.

Main part.

a.Quantization of the gravitational dipole for slow particles.

The easiest way to discover is of course for ultra-cold particles which also have very small mass. Indeed, the dipole gravitational force should be (for the ball at the distance of r from the center):

$F_d=[2GM/r^3]*h/v$ (1)

For the n=1 (the smallest value of the dipole). This force is independent upon the mass of the particle and for electron it would be much easier to discover the generated displacement because the acceleration would be inversely proportional to mass (it is much easier make the ultracold neutron, but the mass is 2000 times larger).

The acceleration in the direction of the force would be: $a=F_d/m_e=[1/m_e]*[2GM/r^3]*h/v$ (2)

The smallest velocity of the electron reached is around 1000 m/s [2]. If such beam is hold circling inside the magnetic field without accelerating for long enough time, it will create enough displacement in the electron beam to measure the deviation. Acceleration in the gradient created by the angled source compare to the simple ball may be estimated as increased 2-4 times depending upon the structure. For the material with the highest density (osmium) density is ρ=24000 kg/m^3 and for the M=ρ*(4/3)*π*r^3 we have:

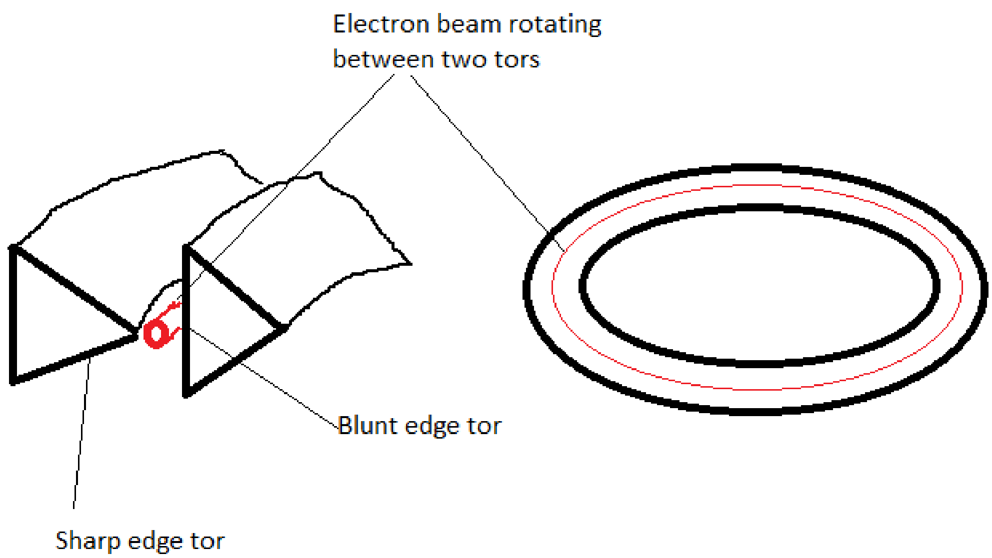
$a\sim 8*G*\rho*h/(m_e*v)=1.4*10\exp(-17)\ m/s^2$ (3)

To get the displacement of around 1 um (10^-6 m) the time of presence of such acceleration (rotation time in the magnetic field) should be:

$S=1/2*a*t^2$

And t=3.8*10exp(5) seconds (105 hours).

It means that if the electron of so low energy will be rotating in vacuum in circles between two heavy tors (one with sharpened edge to have as high gravitational gradient as possible and second with small gradient to counterweight the influence of gravitational attraction), slowly but steadily the electron beam will be split according to quantization rule.



For the neutrons of enormously low temperature the situation looks like this [3]: velocity of just 8 m/s but the mass is 1839 times larger. It means that acceleration will be even smaller and there is no simple way to reach the necessary splitting – because neutron will only live for 15 minutes.

Thus the best way to make such observation is to try to cool electrons – they are easy to handle using the electric and magnetic fields.

One more interesting way to observe this property is to measure the electric dipole moment of the ultra-slow electron. The electric dipole moment for the electron is indeed predicted from standard model but it is independent of velocity. It should be 10exp(-40) e*m to around 10exp(-29) e*m for different theories [4] and modern measurements demonstrated it is definitely below 10exp(-31) e*m.

The measurements are done for the electrons in the atoms, where the electron's velocity is not determined and instead of the De-Broglie wavelength it is correct to use the Compton wavelength (it means that formally electron is moving with the speed of light). Than electric dipole moment should be:

$d_e=r*e=(r*m)*e/m_e=(h/c)*e/m_e=1.9*10exp(-31)$ e*m,

the value very close to the experimentally observed high limit on the dipole [4]. Supposedly once the experimentalist improve the accuracy of the experiment just a little bit, they will discover this elusive property of the electron.

The experiment for the ultraslow electrons should discovery it much faster – for the electrons with velocity of 1000 m/s the electric dipole should be 1.2*10exp(-25) e*m.

b.Quantization of the gravitational dipole for ultra-relativistic particles and photons.

Since no particle may move faster than speed of light, the gravitational dipole for ultrarelativistic particles should be:

m*r=(1/2+N)*h/c or N*h/c depending upon what quantization rule is used (since so far this is pure prediction it is not clear, whether the Bohr rule or Feynman rule should be used). For example, for the De-Broglie wavelength (the closest analogy) it is more like N*h/c, but only experiment may determine the exact rule.

Here comes the idea that photon is nothing more but ultra-relativistic particle which has an enormously small mass [1] and then it should also have the obligatory non-zero gravitational dipole:

m*r=h/c (at least)

Why it is so important? Even despite the mass of photon may be way too small to explain the Hubble red-shift, the presence of the dipole means the photon is generating gravitons while traveling (exactly in the same way as any dipole is generating electromagnetic waves). It means that this mechanism of energy loss is inevitable for photon and may after all justify **the tired light hypothesis** and explain Hubble red shift **instead of Big Bang** (and that is indeed a revolutionary shift in cosmology since Big Bang is actually the only explanation of Hubble red shift for today).

However, that value h/c is an enormously small. Estimations shows that if the frequency of the oscillations of the gravitational dipole coincides with the frequency of light, this is 30 orders of magnitude not enough to explain red shift (so small is the gravitational dipole for ultra-relativistic particle). In addition it would be enormous (frequency in the power of 4) dispersion of the red shift (similar to blue sky explanation through the Rayleigh scattering) which is not observed.

Only postulating that the gravitational dipole is oscillating with the universal for all photons frequency of $\omega=l_f/c$ where c is speed of light (essentially the same for all photons) and l_f is some distance independent of wavelength it is possible to explain the Hubble shift. In this case l_f would be fluctuations length of quantum vacuum (Compton wavelength of the electrons, because it is assumed that the quantum vacuum fluctuations are determined mainly by the particles with the smallest mass, which is electron). In this model the photon with the smallest possible dipole h/c during its travel across the space stumble on each fluctuation of the space and irradiate the gravitons, thus slowly losing the energy.

c.Evaluation of the energy loss by photon from the present day gravito-electromagnetism theory.

Despite from my point of view the final theory of gravito-electromagnetism is far from completion [1] the evaluation from the point of view of present day understanding would be useful to complete.

Using the classical formula for the electric dipole radiation in all directions (Joules per second) [5]:

$$P=[\mu_o*\omega^4*p_o^2]/[12\pi c] \qquad (4)$$

Here μ_o magnetic permeability of vacuum, ω is the frequency, p_o is the electrical dipole, c is speed of light. From this formula the blue light of the sky may be deduced (very strong dispersion).

The gravitoelectromagnetic Pointing vector is 4 times larger than the corresponding Pointing vector in electromagnetism due to Einstein correction [6]. Since the gravitational waves (real waves, not space time distortions observed by LIGO) should have (presumably, question of debates actually) the same speed c (very close to it) the following relation holds:

$\mu_{og}*\varepsilon_{og}=\mu_o*\varepsilon_o=1/c^2$ (5)

(production of gravito-electromagnetic permeability and permittivity and electromagnetic permeability and permittivity are the same and equal to c^2)

Then, substituting (5) into (4) it is possible to obtain for gravito-electromagnetic radiation:

$P_g=4P=[\mu_{og}*\omega^4*p_{og}^2]/[3\pi c]=[\omega^4 p_{og}^2]/[3\pi\varepsilon_{og}c^3]$ (6)

Here p_{og} is gravitational dipole (gravito-electric dipole), ε_{og} is the gravito-electromagnetic permittivity. Similar to Coulomb law the value of G may be written as follows:

$G=1/(4\pi\varepsilon_{og})$ (7)

And substituting (7) into (6) yields:

$P_g=[4G\omega^4 p_{og}^2]/[3c^3]$ (8)

Since the value of gravitational dipole for photon for evaluation may be taken as N*h/c, final result is:

$P_g=N^2*[4G\omega^4h^2]/[3c^5]$ (9)

And the minimum possible for photon (because in theory N may be very large number) gravitational dipole is:

$P_g=[4G\omega^4h^2]/[3c^5]$ or for a different quantization rule $P_g=[G\omega^4h^2]/[3c^5]$

This is enormously small value (because both G, h are small and speed of light is huge) but it is not equal to zero (obligatory). So may be the photon traveling for hundreds of millions of years across the universe finally will start to lost energy due to this process.

Evaluation shows that if ω=9*10exp(16) Hz (green light) the energy loss is 30 orders of magnitude below the Hubble shift for green photon. Only if this frequency is roughly equal to another fundamental frequency:

$\omega=2\pi\nu=2\pi c/\lambda_c=2\pi m_e c^2/h$=7.8*10exp(20) Hz (10)

where λ_c is Compton wavelength for electron and m_e is mass of electron. This frequency may be interpreted as the "stumbling" of the photon on each fluctuation of space time on its way. In this case from (9) the energy loss (for N=1) is 6*10exp(-36) J/s or for different quantization rule 1.5*10exp(-36) J/s.

For the red shift for the green light (Hubble constant) of V=9000 km/s for 100 Mps [7] (1 ps=3.26 light years) the frequency shift ($\nu-\nu_o$) would mean:

$(\nu-\nu_o)/\nu_o=V/c$

or for energies: $(h\nu-h\nu_o)/h\nu_o=V/c$ (because $h\nu=E$) $\Delta E/E_o=V/c$=9*10exp(6)/3*10exp(8)=0.03

It means that for green photon with energy of around 3.2*10exp(-19) Joule the energy loss is 9.6*10exp(-21) Joule for 326 millions of years (1.03*10exp(16) seconds) or 9.3*10exp(-37) J/s – the value close to the estimation (because the quantization rule only may change the estimation 4 times, this is relatively good agreement).

The largest problem is that energy loss is independent of wavelength and thus dispersion should be present in the spectra (they are not only shifts but rather distorts relatively strongly, what was never observed). However, the idea outlined creates a real mechanism which may in principle explain the red shift observed by Hubble without any “Big Bang”.

Most probably the assumption about photon stumbling on each quantum fluctuation of vacuum is not really plausible and such red shift should be much smaller and may reveal itself as an addition to the other dominant mechanism of red shift. From philosophical point of view it means however that the “Big Bang” after all do have many alternatives which may be summarized as “tired light hypothesis based on new physical principles”.

In my blog [8] I also explained in detail how the other problem associated with infinite and eternal Universe may be sold: why the stars are still present, what is the origin of the material if not Big Bang. In short: there are already discovered mechanisms of conversion energy back into matter (bi and three proton decay of excited nuclei) which allows to create energy-matter cycle with conservation of the barionic number (like water cycle on Earth). The energy is released at nuclear fusion (very visible process, stars) and transferred back into matter in much less visible process of acceleration of protons and other particles in the different fields (2 GeV protons are main component of interstellar radiation) thus utilizing the energy, the interaction (invisible but present everywhere) of such energetic particles with other matter (dust) re-creates protons and eventually atoms of hydrogen, which are condensed back into stars and make fusion again and so cycle repeats again and again.

Conclusions.

In this article the idea of quantization of gravitational dipole (mass dipole) is developed based on the same idea of quantization which led Bohr, De-Broglie, Heisenberg and others to quantum mechanics primary laws. The idea may be checked on ultraslow particles (large De-Broglie wavelength is necessary) but may be also applied to any particles, including photon. The gravitational dipole of photon should be at least h/2c and obligatory non zero, thus allowing to develop the tired light hypothesis based on new physical principles instead of Big Bang idea.

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