Quantum Effects in Gravitation

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Abstract: ***We need to construct a quantum theory which might be well for us to keep in mind whether there would be any observable effects of such a theory. The prediction of the quantum theory of gravitation would be that the force would be mediated by the virtual exchange of some particle, which is usually called graviton. Therefore, it is expected that under certain circumstances some gravitons have been to observe photons.***

Keywords: Quantum, Graviton, Virtual Exchange, Photons, Gravitation

1. Introduction

The extreme weakness of quantum gravitational effects possess some philosophical problems may be nature is trying to tell us something new here, maybe we should not try to quantize gravity. Is it possible perhaps that we should not insists on a uniformity of nature that would make everything quantized? Is it possible that gravity is not quantized and all rest of the world is? There are some arguments that have been made in the world by a complete Monster Wave function (which includes all observers) obeying a Schrodinger equation

$$\mathrm{i}\frac{\partial\varphi}{\partial t} = \mathrm{H}\varphi \text{ ------- } (1.1)$$

Implies an incredibly complex infinity of amplitudes. Even though light has been observed very early in man's history it was not until 1898 that electromagnetic waves were produced with conscious knowledge of their field nature, and that the quantum aspects of these waves were not observed until even later. We observe gravity, in that we know we are pulled to the earth, but classical gravitational waves have not as yet been observed; this is not inconsistent with that we expect- gravitation is so weak that no experiment that we could perform today would be anywhere near sensitive enough to measure gravitational radiation waves, at least, those which are expected to exist from the strongest sources that we might consider, such as rapidly rotating double stars. And the quantum aspect of gravitational waves is a million times further removed from delectability; there is apparently no hope of ever observing a graviton.

Let us consider the gravitation as perturbation on the hydrogen atoms. Evidently, an extra attraction between the electron and proton produces a small change in the energy of bound hydrogen; we can calculate the energy change from perturbation theory and get a valueϵ. Now, the time dependent wave function of a hydrogen atom goes as$\varphi = \exp{(iEt)}$, with E of such a size that the frequency is something like 10^{16} cycles per second. Now, in order to observe any effects due to ϵ, we should have to wait for a time until the true wave function should differ from the unperturbed wave function by something like 2π in phase. But the magnitude of ϵ is so small that the phase difference would be only 43 seconds (of phase) in a time equal to 100 times the age of universe. So, gravitational effects in atoms are unobservable.

2. Gravitation as a Consequence of Other Fields

Let us return to a construction of a theory of gravitation. In general we expect that there would be two schools of thought about what to do with the new phenomenon. These are: 1. That gravitation is a new field 2. That gravitation is a consequence of something that we already know, but that we have not calculated correctly. And, if we take up the second view for a little while, to see whether it has any possibilities. The fact of a universal attraction might remind us of the situation in molecular physics; we know that all molecules attract one another by a force which at long distance goes like $\frac{1}{r^6}$. This we understand in terms of dipole moments which are introduced by the fluctuations in the charge distribution of molecules. This is universal well-known from the fact that all substances may be made to condense by cooling them sufficiently.

The quantum mechanics falls in that very often infinities crop up in summing over all states. We might look for a connection between gravity, the size of the universe, and this failure of quantum mechanics. The infinities always occur when we sum over denominators$\sum_n \frac{1}{(E-En)}$. Now, it is conceivable that if we were to consider that whole universe, we would not be summing over virtual states in the usual fashion, but that we should sum only over those virtual states for which we could borrow enough energy from the rest of the universe.

3. Radiation of Gravitons with Scattering Particle

A soft graviton may be emitted when two particles scatter by any process including graviton exchange. In the low energy limit, the graviton vertex joins a free particle, are important. The other two are processes much less probable if the graviton momentum k is much smaller than the momentum transfer q. As far as the radiation is concerned the exact nature of over-all scattering process is not important. Gravity is not always negligible-only in process of atomic collisions. If we describe the graviton polarisation by a tensor e, the total amplitude is proportional to the scattering amplitude for no graviton, to some energy factors, and so the quantity

$$\alpha = \sum_i (-) i \frac{p.e.i_v}{1-i_v \cos\theta} \text{ --------(3.1)}$$

The denominators represents the product i_p.k = Eω-p.k when two energies E and ω have been forced out. On the other hand, the polarisation tensor is always transverse to the graviton momentum. In electromagnetism, a vector polarisation is also transverse to the photon momentum; there is only dot product in the numerator so that, when θ is small and v$\approx c$,

$$\alpha_{e.m} \to \frac{p.e}{1-v\cos\theta}\ \alpha\ \frac{\sin\theta}{1-\cos\theta} \approx \frac{2}{\theta} \text{ ---------- (3.2)}$$

The photon emission can become very large for small angles. It does not actually blow up because v is never quite equal to c.

4. Conclusion

Quantum theory of gravitation would be mediated by the virtual exchange of some particle called the graviton. We, therefore, expect that under certain circumstances some gravitons have been able to observe photons. The quantum aspects of these waves were not observed until even later. The electromagnetic waves were produced with conscious knowledge of their field nature. We might consider whether gravitational forces might not come from the virtual exchange of a particle which is already known, such as the neutrino. After all, superficially it has the right qualities, since it is a neutral particle with zero mass, so that its interaction would go and will be very weak. If one such consequence were to be the existence of gravitation itself, then there must be quantum theory of gravitation, which would be terrifying idea. These are very wild speculations, and it would be little profit to keep in mind the possibility that quantum theory must be in existence.

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