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ORIGINAL ARTICLE

Gravity from the uncertainty principle

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Abstract It is shown here that Newton's gravity law can be derived from the uncertainty principle. The idea is that as the distance between two bodies in mutual orbit decreases, their uncertainty of position decreases, so their momentum and hence the force on them must increase to satisfy the uncertainty principle. When this result is summed over all the possible interactions between the Planck masses in the two bodies, Newton's gravity law is obtained. This model predicts that masses less than the Planck mass will be unaffected by gravity and so it may be tested by looking for an abrupt decrease in the density of space dust, for masses above the Planck mass.

Keywords Gravity · Uncertainty principle · Quantum gravity · Space dust

1 Introduction

The strong, weak and electromagnetic interactions are modelled using the quantum exchange of virtual bosons, whereas gravity is modelled using the continuum of spacetime which is curved by matter and energy (Adelberger et al. 2003). The unification of these two models has been the goal of physics for a century, but so far it has not been shown that quantum mechanics predicts gravity, and although general relativity has been verified close to the Earth (Ashby 2003) it may have problems further afield since it predicts singularities, and also fails to predict observed galaxy rotations and cosmic acceleration without the ad hoc addition of extra dark mass or energy.

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It may be that quantum mechanics is the deeper theory, since its predictions are already known to be very accurate, and also recently Nesvizhevsky et al. (2002) have shown that gravity is quantised. They used neutrons, which only feel the gravitational force, and confined them to a gravitational potential well formed by gravity pulling downwards and a mirror reflecting them back up. They showed that the neutrons did not fall smoothly, but jumped vertically—just as electrons jump between quantum levels in an atom.

One of the problems in quantising gravity is that the gravitational force for a single particle in a quantum field theory at high energy is infinite. It is possible to resolve this using a one-dimensional particle instead—a string, but in string theory six additional dimensions of space are needed and they are undetectable, and string theory itself makes no testable predictions (Rovelli 2003). Another attempt to quantise gravity is loop quantum gravity (Ashtekar 1986) in which spacetime itself is quantised into spin networks that change in discrete steps. It is consistent with general relativity without requiring extra dimensions, but this theory also makes no testable predictions as yet (Rovelli 2003). It is therefore useful to look for alternative ways to quantise gravity.

Recently a new quantum mechanical model for inertial mass (quantised inertia or MiHsC) has been proposed by McCulloch (2007). This model assumes that (1) inertia is due to Unruh radiation, and (2) this radiation is subject to a Hubble-scale Casimir effect. The philosophy behind MiHsC is that as the acceleration of an object reduces, the waves of Unruh radiation that it sees, and that are assumed to cause its inertial mass, get longer in relation to the Hubble-scale and so a lesser proportion of them can be observed, so a greater proportion are disallowed by the Hubble-scale Casimir effect, reducing the inertial mass in a new way for low accelerations. MiHsC successfully predicts the observed cosmic