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ORIGINAL ARTICLE

The number of information bits related to the minimum quantum and gravitational masses in a vacuum dominated universe

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Abstract Wesson obtained a limit on quantum and gravitational mass in the universe by combining the cosmological constant Λ, Planck's constant $\hbar$, the speed of light c, and also the gravitational constant G. The corresponding masses are 2.0×10^{-62} kg and 2.3×10^{54} kg respectively, and in general can be obtained with the help of a generic dimensional analysis, or from an analysis where the cosmological constant appears in a four dimensional space-time and as a result of a higher dimensional reduction. In this paper our goal is to establish a relation for both quantum and gravitational mass as function of the information number bit N. For this reason, we first derive an expression for the cosmological constant as a function of information bit, since both masses depend on it, and then various resulting relations are explored, in relation to information number of bits N. Fractional information bits imply no information extraction is possible. We see, that the order of magnitude of the various parameters as well as their ratios involve the large number 10^{122}, that is produced naturally from the fundamental parameters of modern cosmology. Finally, we propose that in a complete quantum gravity theory the idea of information the might have to be included, with the quantum bits of information (q-bits) as one of its fundamental parameters, resulting thus to a more complete understanding of the universe, its laws, and its evolution.

Keywords Cosmological constant · Quantum mass · Gravitational mass · Information bit · Fractional information bit · Large number hypothesis

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1 Introduction

Observational data from galaxies and gravitational lensing of high z quasars and cosmic microwave background radiation, suggest that the 99 % of the universe material consists of dark matter (Overduin and Wesson 2003). Therefore the density of the vacuum contributes a high fraction of the corresponding dark matter, whose energy density is given by:

$$\rho_v = \rho_\Lambda = \frac{\Lambda c^2}{8\pi G} \tag{1}$$

where Λ is the cosmological constant, c is the speed of light and G is the gravitational constant. Today's data indicate that $\rho_\Lambda = 6.0 \times 10^{-30}$ g/cm^{-3} and therefore $\Lambda = 1.117 \times 10^{-52}$ m^{-2} (Krauss and Starkman 1999), which makes that the distance to the horizon approximately is $R_H \cong 1.70 \times 10^{26}$ m (Krauss and Starkman 1999). It is now common knowledge that the cosmological constant of general relativity is a parameter derived out of higher-dimensional theories in a four dimensional reduction, in an effort to unify gravity with particle physics (Wesson 1999). Some of these theories include $10D$ supersymmetry, $11D$ supergravity and $26D$ string theories. The aforementioned theories should present the natural ground where the quantum of action $\hbar$ should naturally appear. In particular, theories like the basic extension of $4D$ Einstein theory and the low-energy limit of higher-D theories consti-