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Large Numbers Hypothesis: Reply to a Paper by Beesham

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We discuss a recent paper by Beesham, showing that his criticism of an article by Berman is based on a contradiction, though his arguments are interesting.

1. INTRODUCTION

Beesham (1994) claims that the generalized large number hypothesis (GLNH), which allows for a cosmological "constant" varying with the negative square of the age of the universe,

$$\Lambda \propto t^{-2} \tag{1}$$

can be obtained by applying the LNH without recourse to the additional hypothesis that N_3 is a large time-varying number, like N_1, N_2, and N in Dirac papers (1937, 1938, 1979), where

$$N_1 = \frac{e^2}{Gm_p m_e} \tag{2}$$

$$N_2 = \frac{t}{e^2/(m_e c^3)} \tag{3}$$

$$N_3 = \frac{c}{H}\left(\frac{m_p m_e}{\Lambda}\right) \tag{4}$$

$$N = \frac{4\pi(ct)^3 \rho}{3m_p} \tag{5}$$

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where N_1 stands for the ratio of the electric to the gravitational force between a proton and an electron, N_2 is the age of the universe, expressed by the atomic light crossing time (atomic units), and N is the amount of matter in the visible universe, expressed in terms of the proton mass, while N_3 is the ratio of the radius of curvature of the de Sitter spacetime to the geometric mean of the electron and Compton wavelengths.

Berman (1992b) made the hypothesis that

$$N_1 \sim N_2 \sim N_3 \sim \sqrt{N} \sim t \tag{6}$$

thus generalizing Dirac's hypothesis (Berman, 1992a).

2. A CRITIQUE OF BEESHAM'S PAPER

Beesham (1994) argued that LNH is "not compatible with Einstein's general relativity"; however, in his conclusion, he claims that it is not necessary to postulate a GLNH, "as the so-called generalization follows directly from the LNH and Einstein's gravitational equations."

According to mathematical logic, out of a contradiction, anything is provable, so we are not surprised that he proved in his paper that (1) is derived without (6) being imposed.

3. CONCLUSION

Dirac's LNH and our additional hypothesis do not involve any particular gravitational theory. At most, it can be argued that

$$G \propto t^{-1} \tag{7}$$

$$\rho \propto t^{-1} \tag{8}$$

$$\Lambda \propto t^{-2} \tag{9}$$

follow from heuristic considerations; Fry (1990) pointed out that this generalization of Einstein's theory, as in Beesham's paper, probably cannot be derived from a variational principle, so that Beesham not only makes an additional hypothesis, but a weak one, and also depends on another hypothesis, *verbi gratia*, the perfect fluid model. Beesham reproduces a "proof" of relation (8), which is also very weak. Berman (1992b) has shown indirectly that we could use, for instance, relation (7), and then, by applying Mach's principle, represented by the Withrow–Randall relation, get relation (8).

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Due to errors by the Post Office, the author never received a letter of acceptance, proofs, etc., in connection with Berman (1992a), and so, not

realizing it had been accepted for publication, he resubmitted it to another journal (Berman, 1994); he regrets any inconvenience this might have caused.

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