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ORIGINAL ARTICLE

Radar signal delay in the Dvali-Gabadadze-Porrati gravity in the vicinity of the Sun

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Abstract In this paper we examine the recently introduced Dvali-Gabadadze-Porrati (DGP) gravity model. We use a space-time metric in which the local gravitation source dominates the metric over the contributions from the cosmological flow. Anticipating ideal possible solar system effects, we derive expressions for the signal time delays in the vicinity of the Sun. and for various ranges of the angle θ of the signal approach, The time contribution due to DGP correction to the metric is found to be proportional to $b^{3/2}/c^2 r_0$. For r_0 equal to 5 Mpc and θ in the range $[-\pi/3, \pi/3]$, Δt is equal to 0.0001233 ps. This delay is extremely small to be measured by today's technology but it could be probably measurable by future experiments.

Keywords Dvali-Gabadadze-Porrati gravity · Radar signal delays · De Sitter background · Friedman-Lemaitre-Robertson-Walker phase · Accelerating phase

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1 Introduction

There is recent attention for the so-called Dvali-Gabadadze-Porrati (DGP) model. This is a five dimensional gravity model that explains the observed acceleration of the expansion of the Universe. Furthermore, it predicts minor post-Einstein effects, testable at local scales resulting to information on the Universe's global properties in relation to the ongoing cosmological expansion (Iorio 2005a, 2005b, 2005c). So far, two-body scenarios have been investigated in which the time rates of change for the longitude of pericenter and the mean anomaly of the secondary have been carried out (Lue and Starkman 2003; Iorio 2005b), with the effects being functions of eccentricity. Following Iorio (2005b, 2005c), one might say that the "ideal test-bed for such tests is the inner planets of the solar system". Measurements of such precessions lie in the limit of precision of today's planetary data. For a more detailed and complete overview on the DGP gravity, see Lue (2006).

The DGP model is based on an extra flat dimension w, and a free crossover parameter r_0 which defines a radius beyond which the four-dimensional gravitational theory transitions into a five-dimensional regime. The last parameter is defined by $r_0 = k^2/2\mu$. The constants μ^2 and k^2 define the energy scales of the theories of gravity: the first one is Newton's constant, $\mu^2 = 8\pi G$, while the second represents the energy scale of the bulk gravity (Sawicki et al. 2007). The crossover parameter is also fixed from observations of IA type supernova to a value approximately equal to 5 Gpc (Lue and Starkman 2003). For distances greater than 5 Gpc Newtonian gravity needs to be modified, which can lead to different explanations for the dark matter when somebody tries to interpret the accelerations observed in the Universe.

In this short contribution we consider the case when the Newtonian-Einstein gravity is modified according to the