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MOND WITH EINSTEIN'S COSMOLOGICAL TERM AS ALTERNATIVE TO DARK MATTER

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RESUMEN

Se postula un modelo cosmológico FRW con $\Lambda \equiv \Lambda(r)$, como alternativa a la materia oscura no bariónica. Este potencial se construye por reflexión especular del potencial de Yukawa: nulo dentro del sistema solar, poco atractivo en distancias interestelares, muy atractivo a rangos de distancia galácticos y repulsivo en escalas cósmicas. Este modelo es compatible con la densidad crítica observada, y con la teoría Milgrom.

ABSTRACT

It postulates a FRW cosmological model with $\Lambda \equiv \Lambda(r)$ as an alternative to the non-baryonic dark matter. This potential is build starting from a speculate reflection to Yukawa potential: zero in the inner solar system, slightly attractiveness in interstellar distances, very attractiveness in galactic distance ranges and repulsive to cosmic scales. This model is compatible with the density critical observed, and Milgrom theory

Key Words: cosmology — dark matter

1. INTRODUCTION

Assuming that the dynamics of the universe is prescribed only by the Newton gravity force we encounter serious difficulties in describing the Universe: it cannot explain the rotation curves of galaxies, the missing mass in rich clusters of galaxies and that the observed baryonic matter density is much lower than predicted by the FRW models with cosmological constant and zero curvature. The problem of missing mass appears to affect the dynamics at all length scales beyond the Solar System (Freese 2000). One solution has been to assume non-baryonic dark matter, however, its existence is only paradigmatic. Other alternatives are the modification of the Gravitation Universal Law to scales larger than the solar system, as MOND theories (Milgrowm 2009). Although the formalism is lacking to connect these ideas with FRW models and the observables in Big Bang model. Remember that there is no experimental evidence to confirm the validity of Newtonian dynamics beyond the Solar System (Adelberger et al. 2003).

2. INVERSE YUKAWA FIELD (IYF)

We assume the existence of new fundamental interactions, whose origin is baryonic matter, similar to Newton gravity and which acts differently at different length scales, as did the approach of Yukawa for the strong interaction. This Yukawa type inverse potential per unit mass, is built starting from a reflection to speculate of the Yulawa potential: null very near the solar system, slightly attractive at interstellar range distances, very attractive at distance ranges comparable to galaxies clusters and repulsive at cosmic scales:

$$U(r) \equiv U_0(M)(r - r_0)e^{-\alpha/r}, \qquad (1)$$

where $U_0(M)$ is the magnitude that causes the field (in units of N/kg), α is an coupling constant of order of $2.5\mathrm{h}^{-1}$ Mpc (the average value of an almost smooth transition distribution of galaxies to strong agglutination) and r_0 is of the order $50\mathrm{h}^{-1}$ Mpc (the average distance between clusters of galaxies). As usual $H_0 = 100\mathrm{h}$ km s^{-1} Mpc is the Hubbble constant. Figure 1 shows the variation of U/U_0 relative to the adimensional variable $x \equiv r/r_0$. We assume that any particle with nonzero rest mass is subject to the Newtonian gravitational force by the law of Universal Gravitation, and to an additional force that varies with distance, we call it the Inverse Yukawa field (IYF). Thus the gravitational force is bimodal (bigravity): it varies as the inverse square for $r \ll 1$ kpc, and it behaves in a very different manner when the comoving distance is of the order of kiloparsecs or larger.

We can see that in distance scales of the order of the Solar System this contribution is null; it is mildly attractive for distances of the order of kiloparsecs, strongly attractive at megaparsec distances, and repulsive at cosmological scales. Thus IYF, namely the bimodal complement large-scale Newtonian gravity is:

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