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ORIGINAL ARTICLE

Rotation curve of galaxies by the force induced by mass of moving particles

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Abstract Many attempts have been made to explain the flat rotation curve of spiral galaxies regardless of distance from the center, in disagreement with the Newtonian prediction that this speed should diminish as the inverse square of distance. One explanation for this discrepancy is that the galaxy is embedded in dark matter, which interacts with baryonic matter only gravitationally. Many studies have focused on finding the distribution of this dark matter that fits well with observed data, but it is by definition undetectable by current technology, and must therefore remain hypothetical. Instead of dark matter, we propose a novel force, named mirinae force, generated by the mass of relatively-moving particles, and demonstrate that this force explains the rotation curve and evolution of a galaxy in which some of the inner mass of the supermassive black hole at the galactic center is assumed to be revolving at a relativistic speed. The calculation yielded important results that support the existence of mirinae force and validate the proposed model: First, the mirinae force explains why most of the matter is in the galactic disk and in circular motion which is similar to that of particles in a cyclotron. Second, the mirinae force explains well both the flat rotation curve and the varied slope of the rotation curve observed in spiral galaxies. Third, at the flat velocity of 220 km/s, the inner mass of the Milky Way calculated by using the proposed model is $6.0 \times 10^{11} M_{\odot}$, which is very close to $5.5 \times 10^{11} M_{\odot}$ ($r < 50$ kpc, including Leo I) estimated by using the latest kinematic information.

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1 Introduction

General relativity is the theory that has been considered to describe experimental results related to gravity and cosmology most successfully to date. However, some observations indicate that the theory is incomplete because, for example, the problem of quantum gravity and the question of the reality of spacetime singularities remain open (Geroch 1968). The flat rotation curve of spiral galaxies is one of the questions under debate. Many attempts have been made to explain why the rotation speed of galaxies is constant ("flat") regardless of distance from the center, in disagreement with the Newtonian prediction (Stavile and Scelza 2011; Sofue and Rubin 2001). Many studies have tried to find a correct form of the gravitational law, or a distribution of hidden dark matter that fits well with observed data. Although these efforts have been rather successful, two important questions still remain: first, do we correctly consider all factors that affect the rotation curve of the galaxy? Second, do we have a correct theory of gravity?

In this study we suggest a novel force generated between relatively moving particles by their mass; this force is analogous with the magnetic force between electrically charged particles that are in motion. Considering the fact that magnetic field is induced by a variation of an electric field in a spacetime that lacks a magnetic monopole, it seems reasonable to expect an analogous force; i.e., a gravitational magnetic field, generated by a variation of gravitational field in the identical spacetime in which the electric and magnetic fields are correlated. We named this hypothetical gravitational counterpart of magnetic force "mirinae force": the