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Dark matter puzzle in the framework of $f(R)$ gravity

The nature of dark matter remains one of the most compelling puzzles in modern cosmology and astrophysics. Different observational evidences on galactic and cosmological scales strongly indicate the presence of a non-luminous matter component in the Universe, the existence of which is still a mystery. In this work, we consider a promising modified framework, the $f(R)$ theory of gravity, as a suitable approach to study the dark matter problem on the galactic scale. The study examines how $f(R)$ gravity can account for the flatness behavior of galaxy rotation curves without requiring elusive dark matter within galaxies. We consider a specific form of an $f(R)$ model that effectively mimics dark matter effects and highlight its theoretical consistency and viability, and compare its predictions with astrophysical observations. Thus, a good agreement of theoretically predicted results with observations has been obtained. Our analysis sheds light on the potential of $f(R)$ modified gravity as a compelling alternative to the elusive dark matter paradigm.

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