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Galaxy Rotation Curves from Self-Consistent Gravitational Energy Distributions

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Abstract : This paper explores a gravitational configuration arising as a solution to the Einstein field equations, grounded in a reinterpretation of the gravitational pseudo-tensor. The proposed solution encapsulates a stable, extended, and localized energy distribution that self-consistently generates its own gravitational field. By leveraging this methodology, we examine the structure's properties and its compatibility with observations of galactic rotation curves. A detailed analysis demonstrates that the gravitational effects of this configuration align with the observed flat rotation curves of galaxies, such as the Milky Way, without requiring the introduction of additional material components. Using the Milky Way as a case study, we calculate the velocity profile induced by the structure and show its consistency with observed data across a range of galactic radii. The profiles of key physical quantities such as mass density, gravitational potential, radial pressure, and tangential pressure are derived and analyzed, revealing the intrinsic properties of the configuration. These profiles provide insight into the balance of forces that stabilize the structure and ensure its consistency with observations. Beyond rotation curves, the implications of this gravitational solution extend to broader cosmological phenomena. In particular, the structure offers a potential mechanism for enhanced gravitational clustering in the early universe, aiding in the rapid accumulation of baryonic matter and providing a pathway for the formation of the first galaxies. Additionally, the configuration's energy distribution and spatial extension suggest possible interactions with the large-scale expansion of the universe, raising questions about its role in influencing cosmic acceleration. The methodology underlying this solution involves a re-evaluation of the energy-momentum tensor and its contribution to spacetime curvature, emphasizing the importance of non-local effects and self-consistent feedback mechanisms. This approach leads to a stable, scale-dependent configuration whose properties bridge the gap between small-scale structures and cosmological dynamics.

Keywords : einstein field equations, galactic rotation curves, gravitational pseudo-tensor, cosmological dynamics
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