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Editorial

Dark Matter and Dark Energy Cosmologies and Alternative Theories of Gravitation

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Presently we are witnessing a period of rapid and intense change in our understanding of the gravitational force, at a rate that is quickly increasing since the important observational discoveries of the late 1990s. With the advent of new observational techniques, we can see the emergence of interesting new cosmological paradigms, from which the CDM seems to fit the best cosmological observations, indicating that the present day Energy Cosmologies Universe is dominated by two mysterious components, dark energy and dark matter, with the former responsible for the accelerated expansion of the Universe, while the latter is required by the strange behavior of the galactic rotation curves. Up to now, no direct detection/observation of the dark matter has been reported, and presently the only evidence for its existence is its gravitational interaction with baryonic matter. Presently, after a long period of intensive observational and experimental results the particle nature of the dark matter is still unknown.

Hence, a large number of astronomical observations strongly suggest that at large scales the force of gravity may not behave according to standard general relativity, as derived from the Hilbert-Einstein action, and that a generalization of the Hilbert-Einstein action, either at the geometric level or at the matter level, may be required for a full understanding of the gravitational interaction.

This special issue is focused on some extensions of the standard theoretical concepts in gravity and cosmology. It includes state-of-the-art research contributions in the following areas: coupled dark energy models, occurring as a q-deformed scalar field, spinor quintom dark energy models with intrinsic spin, in the framework of Einstein-Cartan-Sciama-Kibble theory, black hole solutions in $1 + 1$-dimensional Horava-Lifshitz gravity, the study of the dark sector of the Universe by considering the dark energy as an emerging q-deformed bosonic scalar field, which is not only interacting with the dark matter, but also nonminimally coupled to gravity, and the comparison of the galactic rotation curves with the observations in the Bose-Einstein Condensate dark matter model.

In the paper by E. Dil, the q-deformed bosons models having a negative pressure are considered, and it is proposed that the associated scalar fields produced by these deformed bosons represent the dark energy in the Universe. The coupling between q-deformed dark energy and dark matter inhomogeneities in the Friedmann-Robertson-Walker spacetime is also considered.

The spin contribution to the total energy-momentum tensor giving the energy density and the pressure in a spinor quintom dark energy model with intrinsic spin, in the framework of Einstein-Cartan-Sciama-Kibble theory, is obtained in the paper by E. Dil. The equation of state parameter, the Hubble parameter, the deceleration parameter, the state finder parameter, and some distance parameters were obtained in terms of the spinor potential. Choosing some suitable potentials leads to a scenario involving crossing between the quintessence and phantom epochs, respectively, or vice versa. Three quintom scenarios are analyzed, which provides stable expansion phases avoiding Big Rip singularities and yielding matter dominated era through the stabilization of the spinor pressure via the spin contribution.

The article by M. Halilsoy and A. Ovgun is devoted to investigating whether the Banados, Silk, and West type effects, which arise in higher dimensional black holes, are also present in the 1 + 1-D naked singularity/black hole system. This investigation is performed by using the Horava-Lifshitz gravity theory. In this theoretical framework it is shown that the center-of-mass (CM) energy of the particles grows unbounded in some cases. An interacting dark matter and q-deformed model of dark energy nonminimally coupled to the gravity in the framework of Einsteinian gravity is considered in another paper by E. Dil. The dynamics of the model are investigated, including a phase-space analysis that explicitly shows if the model will give stable attractor solutions, indicating an accelerating expansion of the Universe. Finally, in the paper by M. Dwornik et al., a comparative and comprehensive comparison of both the Bose-Einstein Condensate and the Navarro-Frenk-White dark halo models with galactic rotation curves is performed. Both the advantages and disadvantages of the Bose-Einstein Condensate model over the N avarro-Frenk-White model are pointed out. It is also shown that the weaker performance of the Bose-Einstein Condensate model for the High Surface Brightness type II galaxies is due to the Bose-Einstein Condensate density poles dropping rapidly to zero outside a nearly constant density core.

We hope that this special issue will serve as a reference for initiating and continuing state-of-the-art research in the fundamental fields of modified gravity, dark energy, and dark matter.

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