Physical Space-Time and Gravitational Interaction at Cosmological and Astrophysical Scales

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Abstract

The application of gauge invariance principle, which underlies the modern theory of fundamental physical interactions, by construction of gravitation theory leads to generalization of metric gravitation theory. Gauge gravitation theory in 4-dimensional Riemann-Cartan space-time (GTRC) is necessary generalization of metric gravitation theory by including the Lorentz group into the gauge group corresponding to gravitational interaction. Investigations of GTRC based on the sufficiently general expression of gravitational Lagrangian $\mathcal{L}_g$, including both the scalar curvature and various invariants quadratic in the curvature and torsion tensors with indefinite parameters, show, that by certain restrictions on indefinite parameters of $\mathcal{L}_g$, GTRC leads to the change of gravitational interaction by certain conditions in comparison with general relativity theory (GR) and allows to solve some principal problems of GR (see, e.g., [1] and refs. herein). The important role of geometrical structure of physical space-time, of its torsion in the change of gravitational interaction is being discussed in the current report. The gravitational repulsion effect provoked by space-time torsion created by spinless matter leads to appearance of limiting energy density and possible solution of the problem of cosmological singularity [2], and the vacuum gravitational repulsion effect allows to explain accelerating cosmological expansion at present epoch without using the notion of dark energy [3]. The interaction of space-time torsion (specifically vacuum torsion) with proper angular momentums of astrophysical objects (stars in galaxies, galaxies in galactic clusters) can lead to appearance in addition to the Newtonian force of additional gravitational force, which can be manifested in the motion of these objects in non-relativistic approximation [4].

[1] A.V.Minkevich, "Relationship of Gauge Gravitation Theory in Riemann-Cartan Space-Time and General Relativity", *Gravitation and Cosmology* **23** (2017) 311 [Arxiv:1609.05285v2 [gr-qc]].

[2] A.V.Minkevich, "Limiting energy density and a regular accelerating Universe in Riemann-Cartan spacetime", *JETP Letters* **94** (2011) 831.

[3] A.V.Minkevich, " De Sitter spacetime with torsion as physical spacetime in the vacuum and isotropic cosmology", *Modern Physics Letters A* , **26** (2011) 259 [Arxiv:1002.0538].

[4] A.V.Minkevich, "Gravitational interaction in astrophysics in Riemann-Cartan space-time", in press.