On the Ontology of Spacetime in a Frame of Reference

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Abstract

The spacetime ontology is considered in General Relativity (GR) in view of the choice of a frame of reference (FR). Various approaches to a description of the FR, such as coordinate systems, monads and tetrads are reviewed. It is shown that any of the existing FR definitions require a preexisting background spacetime, which, if defined independently of the FR, renders the spacetime absolute in violation of the principle of relativity, or, if defined within an inertial FR (IFR), as it is usually done, make the argument circular. Consequently, defining a FR in a preexisting spacetime is unacceptable. We show that a FR defines a differentiable manifold with, generally, non-Euclidean geometry. In a noninertial FR (NIFR) the observer must chose a coordinative definition either admitting existence of a universal – inertial – force or settling for non-Euclidian spacetime. Following Reichenbach, it is preferable to eliminate all universal forces and opt for a non-Euclidean geometry. It is shown that an affine connection with metric is best suited to describe the geometry of spacetime within a FR. Considering a gravitational field in an arbitrary FR, we show within the framework of Einstein ' s GR that the gravity is described by nonmetricity of spacetime. This result may shed new light on the nature of the cosmological constant and dark energy.

Keywords:	spacetime ontology, frame of reference, reference frame, relativity, general relativity inertia, inertial force, noninertial frame, noninertial observer, coordinate system, monad, tetrad, tau-field, nonmetricity, metric-affine space, Weyl space, Minkowski space, coordinative definition, universal force, non-Euclidean geometry, affine connection, Levi-Civita connection, gravitational field, cosmological constant, dark energy, energy problem
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