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On a first-order hyperbolic formulation of the pure tetrad teleparallel gravity

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Motivated by finding a hyperbolic reduction of Einstein's theory of general relativity (GR) for numerical relativity, we discuss a Riemann-Cartan reformulation of GR, also known as teleparallel equivalent of GR (TEGR) [1]. In particular, we consider the pure tetrad formulation of TEGR, that is when the spin connection is supposed to be zero globally and the affine connection equals to the Weitzenböck connection. In such a theory, the non-flatness of the spacetime manifold is characterized not by the Riemann curvature tensor (which is zero) but by the torsion tensor.

The Euler-Lagrange equations of TEGR forms a system of second-order partial differential equations on the torsion tensor. By treating the torsion and tetrad fields as formally independent state variables, we have a found a first-order 3+1 reformulation of the TEGR equations that also can be written as a system of quasi-linear symmetric hyperbolic equations. The resulting system resembles the equations of electrodynamics of moving media [2]. As discussed in [3], the proposed framework can be also used for modeling the complex internal structure in material science and fluid mechanics.

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