Geometry and the Nature of the Gravitational Field

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Abstract: In this paper we show (using the Clifford bundle formalism) how a gravitational field generated by a given energy-momentum distribution (for all realistic cases) can be represented by distinct geometrical structures (Lorentzian, teleparallel and non null nonmetricity spacetimes) or that we even can dispense all those geometrical structures and simply represent the gravitational field as a field, in the Faraday's sense, living in Minkowski spacetime. The explicit Lagrangian density for this theory, which contains besides an Yang-Mils term and a gauge fixing term also an interaction term in the form of the coupling of four Chern-Simons terms (build from the gravitational potentials, i.e., the tetrad 1-form fields of the deformed vacuum) with themselves and which describe the interaction of the vorticities of the gravitational potentials is given, and the field equations (which are Maxwell's like equations) are shown to be equivalent to Einstein's equations. Some examples are worked in details in order to convince the reader that the *geometrical structure* of a manifold containing a gravitational field (modulus some topological constraints) is conventional as already emphasized by Poincaré long ago, and thus the realization that there are distinct geometrical representations (and a physical model related to a plastic deformation of the continuum supporting the Lorentz vacuum which in its ground state is conveniently represented by Minkowski spacetime) for any realistic gravitational field strongly suggests that we must investigate the origin of its physical nature. We hope that this paper will convince readers that this is indeed the case.

References

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