On the solutions of the Einstein-Hilbert and Gauss-Bonnet metric-affine lagrangians

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ABSTRACT

In this work, we focus on the second order of the Lovelock expansion, Gauss-Bonnet, in the metric-affine formalism. We give a particular solution for the four dimensional case that is an arbitrary Weyl connection plus a projective term. The existence of this solution is related to a two-vector family of transformations, that leaves the Gauss-Bonnet action invariant when acting on metric-compatible connections. We argue that this solution is physically inequivalent to the Levi-Civita connection, giving thus a counterexample to the statement that the metric and the Palatini formalisms are equivalent for Lovelock gravities. We have also found other non-trivial solutions but for particular metrics.

For Einstein-Hilbert gravity in the metric-affine formulation in $D = 2$, it can be shown that the most general connection that solves the dynamics is the one mentioned above. This is not an arbitrary connection so the lagrangian is not topological (due to the presence of the non-metricity).

We think that the solutions we found for Gauss-Bonnet in $D = 4$ are not trivial due to topological reasons, since Einstein-Hilbert in $D = 2$ has non-trivial solutions. This leads to the open question whether the general metric-affine (with non-metricity) Lovelock action in the corresponding critial dimension is topological.

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