

Characterizations of a Lorentzian manifold with a semi-symmetric metric connection

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Abstract. In this article, we characterize a Lorentzian manifold \mathcal{M} with a semi-symmetric metric connection. At first, we consider a semi-symmetric metric connection whose curvature tensor vanishes and establish that if the associated vector field is a unit time-like torse-forming vector field, then \mathcal{M} becomes a perfect fluid spacetime. Moreover, we prove that if \mathcal{M} admits a semi-symmetric metric connection whose Ricci tensor is symmetric and torsion tensor is recurrent, then \mathcal{M} represents a generalized Robertson–Walker spacetime. Also, we show that if the associated vector field of a semi-symmetric metric connection, whose curvature tensor vanishes, is an $f - \text{Ric}$ vector field, then the manifold is a space of constant curvature. Therefore, the spacetime reduces to the Minkowski spacetime whenever the scalar curvature $R = 0$; de Sitter spacetime whenever $R > 0$; anti de Sitter spacetime whenever $R < 0$. Moreover, if the associated vector field is a torqued vector field, then the manifold becomes a perfect fluid spacetime. Finally, we apply this connection to investigate the Ricci solitons.

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