Hopf25

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Noncommutative Levi-Civita connections

We review different approaches to Levi-Civita connections on noncommutative spaces. Considering the metric as a dynamical field, no compatibility between the metric and the noncommutative structure is a priori required. For noncommutative spaces that are triangular quantum groups or their associated quantum (homogeneous) algebras existence and uniqueness of the Levi-Civita connection for arbitrary metrics is shown. Explicit examples, in particular associated with Sweedler Hopf algebra are presented. This generalises previous results on noncommutative Riemannian geometry obtained in the more restrictive context of Drinfeld twists. A key ingredient is the Cartan calculus with noncommutative covariant derivatives (connections). This leads to the Cartan structure equations and the Bianchi identities. Vacuum Einstein equations leading to noncommutative Einstein spaces are presented.