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The classification of general affine connections in Galilei geometry: towards metric-affine Newton–Cartan gravity

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Galilei geometry, which may be obtained as a degenerate limit of Lorentzian geometry, allows for a coordinate-free formulation of Newtonian gravity, called Newton–Cartan gravity. This enables a geometric understanding of the Newtonian $c \to \infty$ limit of standard general relativity (GR). Recently, analogous geometric descriptions of the Newtonian limits of the (metric) teleparallel equivalent of GR (TEGR) and the symmetric teleparallel equivalent of GR (STEGR) have been developed.

In this talk, we will discuss the classification of general affine connections on Galilei manifolds in terms of independently specifiable tensor fields. This classification lays the foundation for the discussion of generic metric-affine geometric formulations of Newtonian gravity. Our result generalises the well-known case of (torsional) connections compatible with the metric structure of the Galilei manifold.

Similarly to the well-known pseudo-Riemannian case, the additional freedom for connections that are not metric-compatible lies in the covariant derivatives of the two tensors defining the metric structure (the clock form and the space metric). However, differently to the non-degenerate pseudo-Riemannian case, these two non-metricities are not fully independent of each other.

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