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Spontaneous breaking of Lorentz symmetry for canonical gravity

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In Hamiltonian formulations of general relativity, in particular Ashtekar variables which serve as the classical starting point for loop quantum gravity, Lorentz covariance is a subtle issue which has been the focus of some debate, while at the same time being crucial with regard to possible experimental tests. After reviewing the sources of difficulty, we present a Lorentz covariant formulation in which we generalise the notion of a foliation of spacetime usually used in the Hamiltonian formalism to a field of "local observers" which specify a time direction only locally. This field spontaneously breaks the local SO(3,1) symmetry down to a subgroup SO(3), in a way similar to systems in condensed matter and particle physics. The formalism is analogous to that in MacDowell-Mansouri gravity, where SO(4,1) is spontaneously broken to SO(3,1). We show that the apparent breaking of SO(3,1) to SO(3) is not in conflict with Lorentz covariance. We close by outlining other possible applications of the formalism of local observer, especially with regard to phenomenology of quantum gravity.