General Relativity and Quantum Cosmology

Twisted geometries: A geometric parametrisation of SU(2) phase space

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A cornerstone of the loop quantum gravity program is the fact that the phase space of general relativity on a fixed graph can be described by a product of SU(2) cotangent bundles per edge. In this paper we show how to parametrize this phase space in terms of quantities describing the intrinsic and extrinsic geometry of the triangulation dual to the graph. These are defined by the assignment to each triangle of its area, the two unit normals as seen from the two polyhedra sharing it, and an additional angle related to the extrinsic curvature. These quantities do not define a Regge geometry, since they include extrinsic data, but a looser notion of discrete geometry which is twisted in the sense that it is locally well-defined, but the local patches lack a consistent gluing among each other. We give the Poisson brackets among the new variables, and exhibit a symplectomorphism which maps them into the Poisson brackets of loop gravity. The new parametrization has the advantage of a simple description of the gauge-invariant reduced phase space, which is given by a product of phase spaces associated to edges and vertices, and it also provides an abelianisation of the SU (2) connection. The results are relevant for the construction of coherent states, and as a byproduct, contribute to clarify the connection between loop gravity and its subset corresponding to Regge geometries.

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