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Causal Space-Time on a Null Lattice with Hypercubic Coordination

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I discuss the discretization of causal space-times on a topological lattice of events with hypercubic coordination whose links are light-like. Conditions that ensure this lattice is the discretization of a causal manifold are derived. They are encoded by a local topological lattice theory which has a particularly simple and appealing form when null-coframes are represented by spinors.

Summary

Any causal 3+1 dimensional Lorentzian manifold may be discretized on a lattice with hypercubic coordination whose links are (non-constant) null-vectors. The nodes of this lattice are events at the intersection of 4 light cones from spatially separate (adjacent) nodes. I present this construction for two, three and four-dimensional Lorentzian manifolds – and as an example, flat Minkowski space. Every causal manifold in this sense foliates into spatial sub-manifolds whose relation is provided by lightlike signals. However, not every hypercubic lattice with null-separation between the nodes is the discretization of a causal manifold. This converse holds only if the light-like links satisfy certain triangle inequalities. The constraints may be encoded in a local (topological) lattice theory without dynamical degrees of freedom. The constraints and the topological lattice theory that encodes them is quite elegant for a spinorial representation of the null-vectors.

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