Mathematical Physics

A Lorentzian Quantum Geometry

Felix Finster, Andreas Grotz

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We propose a formulation of a Lorentzian quantum geometry based on the framework of causal fermion systems. After giving the general definition of causal fermion systems, we deduce space-time as a topological space with an underlying causal structure. Restricting attention to systems of spin dimension two, we derive the objects of our quantum geometry: the spin space, the tangent space endowed with a Lorentzian metric, connection and curvature. In order to get the correspondence to differential geometry, we construct examples of causal fermion systems by regularizing Dirac sea configurations in Minkowski space and on a globally hyperbolic Lorentzian manifold. When removing the regularization, the objects of our quantum geometry reduce precisely to the common objects of Lorentzian spin geometry, up to higher order curvature corrections.

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