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Nucleation of Wormholes and Topology Changes in Lorentzian Geometry.

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The possibility that the topology of space can change even at a classical level in General Relativity necessitates abandoning either the causality conditions or the equivalence principle. If the causal structure is regarded as fundamental, topology changes are possible by allowing singularities, degenerate tetrads, or gravitational instantons, i.e., Riemannian solutions of the Einstein equations with interesting geometrical and topological properties. Conversely, if the equivalence principle is considered fundamental, spacetime is described by an everywhere non-degenerate Lorentzian geometry, requiring the existence of closed time-like curves for topology transitions to occur. Specifically, the formation of a wormhole from a topologically trivial configuration of space is constrained in the Lorentzian case by topological invariants of the spacetime manifold, even allowing for causality violations. Such topological restrictions are kinematical, independent of the equations of motion, and arise only from global requirements on spacetime. In this session, these topological constraints are presented in the case where the transition occurs in a finite region of space and is mediated by a Lorentzian cobordism. Special emphasis will be given to the nucleation of a wormhole by 3-dimensional topological surgery and the maintenance of the Lorentzian structure by employing Misner's trick of taking connected sums with closed 4-manifolds.

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