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Effective Length in Extended Causal Sets JOSE L. BALDUZ JR., Mercer University — Causal sets are directed simple graphs with partial ordering. They describe spacetime at the smallest possible length and time scales, and are thought to be a suitable starting point for a theory of quantum gravity. We extend the definition of causal sets in three ways. First, we acknowledge the transitivity ambiguity, which is related to time-like geodesics and nonlocality, by explicitly identifying the local geodesic core and the nonlocal halo for any given causal set. Second, we relax the partial ordering condition by allowing causal loops. Third, we define an action or cost function, as a sum over all loops in the causal set, which highlights nonlocal links and causal loops. We then use this extended causal set scenario to calculate the effective length (distance, invariant interval) between causally related points, using a directed conductance model, wherein resistance is equivalent to distance; this measure is compared to the naive graph distance (i.e. the number of links along a geodesic connecting two points). We first consider the smallest causal sets and exact quantum states. For larger causal sets, we use an approximation in the spirit of Born-Oppenheimer, with a fixed geodesic core and a statistical distribution of nonlocal and causal loop links.

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