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Entropy and the Vacuum State in Causal Set Theory

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One of the best known interactions between quantum field theory and general relativity is the way that horizons gain an associated entropy, given by an area law. Entanglement entropy is a particularly promising candidate as the source of this entropy, and providing an explanation for black hole entropy as entanglement entropy was one of the initial motivations behind the formulation of causal set theory. To understand entanglement entropy in causal set theory, we must be able to define quantum fields upon the causal set, and the Sorkin-Johnston prescription provides a means of doing so. We will go over the details of how we can use this prescription to define a vacuum state. We will also give a covariant definition of entropy suitable for use within causal set theory, and go on to explain why the Sorkin-Johnston vacuum state must necessarily be pure. Finally we will show how this entropy formula can be leveraged to perform calculations of entanglement entropy within the causal set that would be intractable in continuum theories.

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