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Generalized Entanglement Entropy and Space-Time Geometry of Quantum System ZHAO YANG, PATRICK HAYDEN, XIAOLIANG QI, Stanford Univ — Entanglement entropy plays a key role in relating quantum information with quantum gravity and condensed matter physics. Based on the proposal of arxiv:1309.6282, we would like to use quantum entanglement between two regions of a quantum system as a measure of the geometrical distance between them. However, since entanglement entropy can only be defined between space-like separated regions, we are forced to treat space and time inhomogeneously. In this work, we propose a generalized entanglement entropy (GEE) which is defined between two generic regions of the system which do not have to be space-like separated. We study the generalized mutual information defined using this generalized entanglement entropy, and demonstrate for several different systems that this provides a reasonable measure of space-time distance. The generalized mutual information is complex-valued and the space-like distance and time-like one are determined by the amplitude and the phase of the generalized mutual information, correspondingly. We study the properties of this generalized entropy and generalized mutual information, and apply this framework to the exact holographic mapping of free fermions in various conditions.

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