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32 - Localizing and excluding quantum information; or, how to share a quantum secret in spacetime

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When can quantum information be localized to each of a collection of spacetime regions, while also excluded from another collection of regions? We answer this question by defining and analyzing the localize-exclude task, in which a state must be localized to a collection of authorized regions while also being excluded from a set of unauthorized regions. This task is a spacetime analogue of quantum secret sharing, with authorized and unauthorized regions replacing authorized and unauthorized sets of parties. Our analysis yields the first quantum secret sharing scheme for arbitrary access structures for which the number of qubits required scales polynomially with the number of parties. We also study a second related task called state-assembly, in which shares of a quantum state are requested at sets of spacetime points. We fully characterize the conditions under which both the localize-exclude and state-assembly tasks can be achieved, and give explicit protocols. Finally, we propose a cryptographic application of these tasks which we call party-independent transfer.

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