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On sufficient conditions for holographic scattering

In AdS/CFT, scattering in the bulk can be mediated by entanglement on the boundary. The connected wedge theorem (CWT) of May, Penington, and Sorce is a concrete example where bulk scattering implies correlation between certain boundary regions. However the converse does not hold. We investigate a recent proposal of Leutheusser and Liu for a generalization of the CWT with converse. We prove the forward direction: having pairs of CFT "input" (and likewise "output") regions in a phase with connected entanglement wedge implies that a particular bulk subregion (the intersection of "input" and "output" entanglement wedges) is non-empty. We then establish a modified version of the proposal which has a converse, and identify counter-examples to the stronger conjecture.