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Subalgebra-subregion duality: emergence of space and time in holography

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n holographic duality, a higher dimensional quantum gravity system emerges from a lower dimensional conformal field theory (CFT) with a large number of degrees of freedom. We propose a formulation of duality for a general causally complete bulk spacetime region, called subalgebra-subregion duality, which provides a framework to describe how geometric notions in the gravity system, such as spacetime subregions, different notions of times, and causal structure, emerge from the dual CFT.
Subalgebra-subregion duality generalizes and brings new insights into subregion-subregion duality (or equivalently entanglement wedge reconstruction). It provides a mathematically precise definition of subregion-subregion duality and gives an independent definition of entanglement wedges without using entropy. Geometric properties of entanglement wedges, including those that play a crucial role in interpreting the bulk as a quantum error correcting code, can be understood from the duality as the geometrization of the additivity anomaly of certain algebras.
Using general boundary subalgebras rather than those associated with geometric subregions makes it possible to find duals for general bulk spacetime regions, including those not touching the boundary. Applying subalgebra-subregion duality to a boundary state describing a single-sided black hole also provides a precise way to define
mirror operators.

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