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Generalizing the Ryu-Takayanagi formula to probe entanglement shadows of BTZ black holes

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We define a generalized entanglement measure in the context of $\text{AdS}_3/\text{CFT}_2$. Compared to the ordinary entanglement entropy between spatial degrees of freedom dual to the area of the Ryu-Takayanagi surface, we take into account both entanglement between spatial degrees of freedom as well as between different fields of the boundary CFT. We then calculate this generalized entanglement measure in a thermal state dual to the BTZ black hole in the setting of the D1/D5 system at and close to the orbifold point. We find that the entanglement entropy defined in this way is dual to the length of a geodesic with non-zero winding number. Such geodesics probe the entire bulk geometry, including regions known as entanglement shadows which are not reached by any Ryu-Takayanagi surface. This allows us to describe regions close to the black hole horizon in the one-sided black hole and the wormhole growth in the case of a two-sided black hole from entanglement data in the boundary field theory. Therefore, we propose that entanglement is in fact enough to reconstruct the full BTZ geometry from boundary data.

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Collaboration / Activity

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