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Hydrodynamics, Thermalization & Entanglement from Spacetime Geometry

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Ultracold gases, the quark-gluon-plasma generated in heavy-ion collisions, as well as black holes constitute isolated quantum systems. They all may start their time-evolution from an initial pure state while they may end up in a mixed final state having produced entropy, which seems like a paradox if time evolution is unitary and the system is isolated. This begs the question how entanglement evolves and how thermalization occurs within these systems. Is there a precise relation among these seemingly different systems? In fact, the answer is yes, holography (gauge/gravity correspondence) provides such a relation [1].
As two examples, we discuss first how heavy-ion collision data and numerical holographic model data indicate that hydrodynamics is a valid approximation even when the system is far away from equilibrium [2,3]. Second, we compute the entanglement entropy [4,5] for a strongly coupled quantum many body system in different states [6].

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[2] Chesler and Yaffe, Phys.Rev.Lett. 102 (2009) 211601.
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