

Quantum systems out of equilibrium, quantum simulation and the quest for quantum supremacy

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Dynamical analogue quantum simulators allow to probe a plethora of physical phenomena related to the physics of quantum systems out of equilibrium. In this talk, we will consider questions of equilibration, Gaussification, the dynamics of quantum phase transitions and the absence of thermalization - present in disordered interacting models that show features of the multi-faceted phenomenon of many-body localization. We discuss both new theoretical results, as well as tools used in collaborations with experimentalists working with cold atoms in optical lattices and on atom chips.

In the last part of the talk, we will have a look at work in progress on conceptual questions that seem to be key to the idea of a quantum simulator: This in on the one hand one of how to devise quantum simulators that have the potential of computationally outperforming classical devices, discussing variants of IQP circuits. On the other hand, it the question of the certification of quantum simulators for which no classical simulation algorithm is known.