Exploring far-from-equilibrium physics of dissipative spin systems with highly excited atoms

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In recent years cold atomic gases have been established as a versatile platform for the study of quantum many-body phenomena. Especially atoms excited to highly-lying electronic states — so-called Rydberg atoms — offer rather intriguing possibilities for the exploration of strongly correlated dynamics. In this talk I will show that the out-of-equilibrium behaviour of these systems is governed by emergent kinetic constraints, which are often used to mimic dynamical arrest or excluded volume effects in idealised models of glass forming substances. In Rydberg gases exposed to a noisy environment these constraints emerge naturally and lead to a remarkably rich dynamics although the final stationary state might be entirely uncorrelated and trivial. Dynamical features include a self-similar relaxation, the existence of correlated growth as well as the emergence of non-equilibrium phase transitions of the directed percolation universality class, whose experimental observation so far has been challenging. Moreover, Rydberg gases offer an opportunity for the systematic exploration of the role of competing quantum and classical dynamical effects on the aforementioned non-equilibrium phase transitions.