Non-equilibrium Relaxation and Aging Scaling in Driven Systems

Uwe C. Täuber

Virginia Tech., USA

If systems characterized by slow (algebraic) dynamics are prepared in an out-of-equilibrium initial configuration that is quite distinct from its asymptotic equilibrium or non-equilibrium stationary state, one may observe a "physical aging regime" in the ensuing relaxation kinetics that is governed by broken time translation invariance and non-trivial, often universal scaling laws. Dynamical systems near a critical point constitute proto-typical and now well-understood examples. Indeed, measuring critical exponents in the intermediate aging rather than the asymptotic stationary temporal regime has become a standard numerical tool. In this talk, I will demonstrate that these concepts can also be employed to gain a better understanding of both generic scale invariance and critical dynamical scaling in driven system far from thermal equilibrium.

I shall first address the critical dynamics [1] and aging scaling [2] for driven-dissipative Bose-Einstein condensation, which in the continuum limit is captured by a noisy complex Ginzburg-Landau or Gross-Pitaevskii equation that also describes the synchronization of coupled non-linear oscillators, as well as various non-equilibrium pattern formation scenarios. Next I will discuss driven lattice gases that relax towards non-equilibrium stationary states displaying generic scale invariance [3], and the continuous non-equilibrium phase transition in two-dimensional driven Ising lattice gases [4]. Finally, I shall show how critical aging scaling might be employed as a early warning signal for the extinction transition in spatially extended stochastic predator-prey competition models, and to characterize the ensuing directed percolation universality class [5].

This research is supported by the U.S. Department of Energy, Office of Basic Energy Sciences, Division of Materials Sciences and Engineering under Award DE-FG02-09ER46613.

References:

[1] U.C.T. and S. Diehl, Phys. Rev. X 4, 021010 (2014) [arXiv:1312.5182];
[2] W. Liu and U.C.T., J. Phys. A 49, 434001 (2016) [arXiv:1606.08263];
[3] G.L. Daquila and U.C.T., Phys. Rev. E 83, 051107 (2011) [arXiv:1102.2824];
[4] G.L. Daquila and U.C.T., Phys. Rev. Lett. 108, 110602 (2012) [arXiv:1112.1605];
[5] S. Chen and U.C.T., Phys. Biol. 13, 025005 (2016) [arXiv:1511.05114].