MAR13-2012-020555

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Non-Equilibrium Dynamics of Ultra Cold Atoms and Effective Spin Models in Optical Cavities

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There has been spectacular progress in exploring the properties of ultra cold atoms using light. Recent experiments [1] on Bose–Einstein condensates in optical cavities have reported a novel self-organization transition of the atom-light system. This coincides with the superradiance transition in an effective non-equilibrium Dicke model, describing two-level "spins" coupled to light. The light leaking out of the cavity provides valuable information on this hybrid matter-light system, and the time-dependent nature of the experiments demands consideration of the associated dynamics. We present a rich dynamical phase diagram [2,3], accessible by quench experiments, with distinct regimes of collective dynamics separated by non-equilibrium phase transitions. These findings open new directions to study the emergent dynamics and non-equilibrium phase transitions of quantum many body systems and effective spin models.

In collaboration with J. Keeling (University of St Andrews), J. Mayoh (University of Cambridge) and B. D. Simons (University of Cambridge).

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[3] M. J. Bhaseen, J. Mayoh, B. D. Simons and J. Keeling, "Dynamics of Nonequilibrium Dicke Models," Phys. Rev. A 85, 013817 (2012).