Quantum Systems under Drive: From Micro- to Macrophysics

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Recent developments in diverse areas - ranging from cold atomic gases over light-driven semiconductors to microcavity arrays - move systems into the focus, which are located on the interface of quantum optics, many-body physics and statistical mechanics. These driven open quantum systems share in common that coherent and driven-dissipative quantum dynamics occur on an equal footing, placing them far away from thermodynamic equilibrium. We will highlight two phenomena, which witness the microscopic breaking of equilibrium conditions on a macroscopic scale, and thus do not have immediate counterparts in equilibrium many-body physics. First, we investigate the fate of the famous Kosterlitz-Thouless phase transition — a topological phase transition in two dimensions — under driving conditions. We show that an infinitesimal non-equilibrium perturbation is sufficient to suppress this transition in large systems. On the other hand, we point out a new intrinsic non-equilibrium phase transition characterized by the onset of deterministic chaos. Second, we argue that drive and dissipation need not to act destructively on fragile quantum mechanical correlations such as phase coherence, entanglement or topological order, but on the contrary the latter can be even created by suitably combing the former to a new dynamical resource.