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OUT-OF-EQILIBRIUM STATISTICAL AND DYNAMICAL PROPERTIES OF LONG-RANGE INTERACTING SYSTEMS

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Abstract

For all physical systems in nature, the interactions between fundamental elements of the system can be grouped into two classes, i.e. short-range forces and long-range (LR) ones, depending on the form of the two-body potential. The LR systems are characterized by a two-body potential V(r) which decays with distance r as $V(r) \sim r^{-\alpha}$ where α is smaller or equal to the dimension of the system. The fundamental difference between the two classes of systems can be found in their dynamical behavior, as well as in their thermodynamical properties. Long-range systems have enhanced complexity, mainly due to their non-additivity, which means that the total energy of a system does not coincide with the sum of the energies of its subsystems.

The goal of this seminar is to present numerical investigation of LR system dynamics, in their way from a non-equilibrium to equilibrium state in the presence of an applied external magnetic field by overviewing existing LR studies and reporting on my present and future contribution to the field. My first aim is to elucidate fundamental mechanisms leading to the formation of quasi-stationary states (QSSs) in LR systems. QSSs are intermediate states which persist for a long time before the system relaxes towards the thermodynamical equilibrium. This study is motivated by its fundamental importance for physics in general as exploring characteristic features of long-range interaction in a simplified system can lead to useful insights and better understanding of unusual phenomena observable in nature, such as ensemble inequivalence, long-time relaxation (QSSs) and violations of ergodicity. My second aim is to present the Hamiltonian Mean Field (HMF) model, which was crucial for the identification of the QSSs and has proved to be an effective theoretical framework for detailed analysis of QSS formation and evolution. QSSs dynamics can be studied using HMF with and without external magnetic field, following the evolution of the magnetization **m**, a global parameter of the HMF model which measures the degree of clusterization of the particles on the ring.