Abstract

A flashing ratchet refers to an overall directed motion of particles in a ther- mal environment under the influence of an asymmetric potential, switching on and off stochastically. This model has been studied in the context of active dy- namics of molecular motors, as a mechanism of particle segregation, transport of cold atoms in optical lattice, in motion of flux quanta and in describing the collective dynamics of elastically coupled motor proteins. While a large body of work has been concentrated on the ratcheting effect of non-interacting systems in one spatial dimension, there has been fewer studies that focuses on the effects of interaction in one or higher dimensions. Despite moderate efforts, the collec- tive dynamics of interacting system of particles under ratcheting drives remains largely unexplored. It is also worth noting that in most of such studies the focus had been on the transport properties of the system and its dependence on the external control parameter. In the first part of the thesis, we present our results on the study of equi- librium phase transition in a two dimensional system of interacting colloidal suspension and compare it with that of the predictions from KTHNY theory and grain boundary melting. The melting transition is identified from the trans- lational and the orientational order parameter and their correlation functions. The nature of the phase transition is determined from the distribution of the order parameters and the local density fluctuations. In the second part of the thesis, we look at such a two dimensional colloidal dispersion of soft-core particles driven by a one dimensional stochastic flashing ratchet that induces a time averaged directed particle current through the sys- tem. It undergoes a non-equilibrium melting transition as the directed current approaches a maximum associated with a resonance of the ratcheting frequency with the relaxation frequency of the system. We use extensive molecular dy- namics simulations to present a detailed phase dia- gram in the ratcheting rate- mean density plane. With the help of numerically calculated structure factor, solid and hexatic order parameters, and pair correlation functions, we show that the non- equilibrium melting is a continuous transition from a quasi-long ranged ordered solid to a hexatic phase. The transition is mediated by the unbinding of dislocations, and formation of compact and string-like defect clusters.