Chapter 7

Summary and future scope

7.1 Summary

In the first part of the thesis, we have modeled the active matter system with intrinsic and extrinsic inhomogeneities. In chapter 2 and chapter 3, we have introduced the extrinsic inhomogeneity in the form of the quenched disorder that affects the local orientation of apolar particles in two dimensions. In chapter 2, we have introduced quenched disorder in two-dimensional dry-active nematics and referred to the system as "random field active nematics (or RFAN)". We write the hydrodynamic equations of motion in terms of slow variable *viz.* density and orientation. The disorder is introduced in the orientation, and it is quenched in time. The numerical solution of equations of motion and the calculation of two-point orientation correlation function using linear approximation show that the ordered steady-state follows a disorder-dependent crossover from quasi-long-range order to short-range order. Such crossover is due to the pinning of $\pm 1/2$ topological defects in the presence of finite disorder, which breaks the system in uncorrelated domains. In chapter 3, we study the "wet" case of the RFAN and find that the disorder slows the ordering kinetics, and the density growth was found to be faster than the nematic order parameter, which is not seen for the dry case of the RFAN. Both the dry and wet case of the RFAN shows dynamics scaling in the presence of disorder, but no static scaling.

In chapter 4, we study the intrinsic inhomogeneity in a system composed of active Brownian particle (ABPs) in two dimensions. Inhomogeneity is introduced as the “polydispersity” in the size of the ABPs. We use overdamped Langevin’s dynamics to study the system. The results from the numerical simulation insinuate that the polydispersity enhances the dynamics of ABPs, and the system shows four distinct phases of particle dynamics: solid jammed phase, liquid jammed phase, MIPS-liquid phase, and the pure liquid phase.

In chapters 5 and 6, we investigated the dynamics of noninteracting particles in one and two-dimensional Lorentz lattice gas (LLG). The results from the numerical simulation suggest that the particle dynamics is confined (or closed) and ballistic for the deterministic model of LLG. In contrast, it shows anomalous diffusion for probabilistic cases.

7.2 Future prospects

In the case of RFAN, we can introduce dynamics disorder, i.e., the disorder in the form of polar particles, and study its effect on the system dynamics and the steady state.

In the case of intrinsic inhomogeneity in ABPs, we can model the system with electrostatic attraction along with the sort range repulsive force among the particles. Such a configuration of the system leads to the density of the system is equal to one. This situation will be very similar to the cells in biological tissues. With this change to the model, we can study the effects of polydispersity in the system.

In the LLG models, we can make a random lattice and then study the particle dynamics. Further, we can add the activity to the model to make it a nonequilibrium system.