Chapter 7

Summary and conclusion

7.1 Summary

In the first chapter we have discussed the detailed introduction of nonequilibrium statistical mechanics including the historical background. In chapter2, We have studied the binary mixture of polar self-propelled particles with variable speed. The speed of the particle depends on its neighbours, it is maximum in well-aligned region and almost zero in random disordered region. Dependence of local speed on local orientation is controlled by a variable speed parameter γ. The model is motivated with experiments on a fish school where the speed of individual fish depends on its neighbours. We mix the two different types of particles with two different γ values. We find four different phases: (i)(OPS), (ii) (OM), (iii) (DMP), and (iv) (DS) depending on variable speed parameter γ, and noise strength η.

In chapters 3 and 4, We introduced a minimal model of a collection of self- propelled particles with the random-bond disorder. Each particle has a different ability (interaction strength) to influence its neighbours. In chapter3, model is studied in away from the order-disorder transition. We have found that the random-bond disorder leads to a more cohesive flock and the global density fluctuation remains unaffected and the system shows the usual giant number fluctuation (GNF). Further, the coarsening for density and orientation fields remain unaffected in the presence of random-bond disorder as opposed to what is observed in the corresponding equilibrium model. In chapter4, model is studied near to the order-disorder transition. We find that the nature of the phase transition changes from discontinuous to continuous type by tuning the strength of the disorder. The bond disorder also enhances the ordering near the transition due to the formation of a homogeneous flock state for the large disorder. It leads to faster information transfer in the system and enhances the systems'information entropy.

In chapter5, we study the properties of polar self-propelled particles along a thin junction. Inside the junction, particles experience a high noise disorder state, and outside they are in the ordered state. The model is motivated by the Josephson junction, an analogous equilibrium system. At the junction, we have found the current orientation reversal for a critical width of the junction. Further, the particle current at the junction decreases with an increase in the junction width.

In chapter6, we studied the phases of passive disk-shaped particles of different sizes with external potential on a two dimensional substrate using overdamped Langevin dynamics. Where the potential is obtained from the binary mixture of active and passive particles for favorable size ratio and activity. We find four different phases of passive colloids depending on the interaction among them as: (1) HDP, (2) HCP, (3) DPS, and (4) OPS. Further, four phases are verified by microscopic simulation of both ABPs and passive mixture.

7.2 Future prospects

In the variable speed model, our study is limited to steady state behaviour, it is also interesting to study the ordering kinetics of two types of particles in such a mixture. For the bond disorder models, it will be interesting to see the steady state behaviour and ordering kinetics of the system, with other kind of extrinsic and intrinsic inhomogeneities. Further, for the order- disorder flock across the interface, it will be interesting to derive the obtained results by analytics. Finally for ABPs and passive particles mixture, the problem will be more general if we introduced the polydispersity among passive particle size. Further, the shape of active particles can be taken as rod like elongated particles. Finally, it will be interesting to derive the obtained potential of active-passive mixture analytically.

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