

Inhomogeneity Formation in Active-Passive Particle Mixtures

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Systems composed of elements with different motility often exhibit ordering behaviors. For example, in the cell nucleus, chromosomes are spatially separated due to their motility [1]. Understanding the effects of motility inhomogeneity is crucial for understanding those phenomena observed in nature and living systems. However, the behavior of systems containing self-propelled particles (SPPs) strongly depends on the model.

In this study, we simulate two-dimensional binary mixtures of SPPs and passive particles as a simple system comprising elements with different motilities [Fig.1]. We adopt orbital motion for the SP disks, in which the pure system neither forms swarms nor exhibits MIPS. By employing such a minimal SPP model, we aim to isolate and clarify the direct effects of SPP activity on the passive particles. In all simulations, all particles are disks of the same size and interact only through steric repulsion.

As SPPs' self-propulsion increases, the system exhibits self-organization. At low self-propulsion, SPPs and passive particles are well mixed. As the self-propulsion increases, clusters of passive particles emerge. With further increases in self-propulsion, the system undergoes macroscopic phase separation into dense and dilute regions [Fig.2]. In the dense regions, the passive particles form ordered structures.

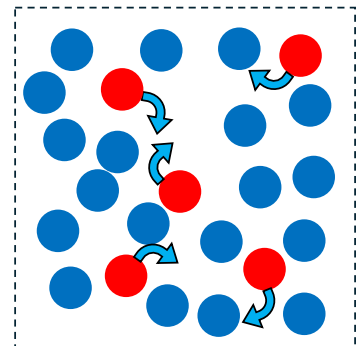


Fig. 1: The system consists of SPPs (red) and passive particles (blue). The SPPs rotate.

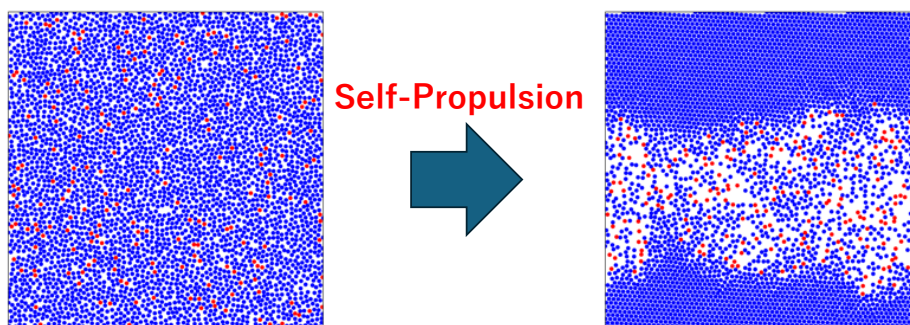


Fig. 2: As the self-propulsion increases, the system exhibits phase separation into dense and dilute regions.

[1] N. Ganai, S. Sengupta, & G.I. Menon, *Nucleic acids research* **42**,7 (2014).