سمینار هفتگی ماده چگال نرم

Emergence of collective changes in active matter from fluctuations of individual agents

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Abstract

Active matter systems are made up of units that consume energy. The study of active matter has gathered a great deal of attention in the past decades. The collective behavior of living matter such as the murmuration of the flocks of birds is an example of these systems. In order to study different aspects of these systems, variant models have been studied and change of behavior, phase shift and the existence of multiple phases have been observed. Vicsek model was one of the first models studying these systems, where an aligning pairwise interaction causes the agents to move in the same direction. We investigated Vicsek model by considering an over-damped Langevin dynamics for few-particle systems. We showed Vicsek model in few-particle systems induces spontaneous change of direction. Also, we showed these collective changes emerge from fluctuations of velocities at the individual level. By solving the model analytically, we derived relations for its collective behavior, fluctuations of velocities, and change of direction then validated these relations by simulating the model, exploiting molecular dynamics techniques. Further, we calculated collective memory using auto-correlation of CoM velocity. Finally, we studied clustering effects on change of direction and compared the results for 2d and 3d cases.

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