Inertial effects in active matter

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Active particles which are self-propelled by converting energy into mechanical motion represent an expanding and flourishing research realm in statistical physics. For micron-sized particles moving in a liquid (microswimmers'), most of the basic features have been described by using the model of overdamped active Brownian motion [1]. However, for macroscopic particles (such as vibrated granules) or microparticles moving in a gas (such as a complex plasma), inertial effects become relevant such that the dynamics is underdamped. Therefore, recently, active particles with inertia have been described by extending the active Brownian motion model to active Langevin dynamics which includes inertia [2,3]. In this talk, recent developments of active particles with inertia (microflyers, hoppers or runners) are summarized. These include a fundamental inertial delay effect between particle velocity and self-propulsion direction [4] which has recently discovered by experiments on vibrated granules and by theory. Overdamped particles exhibit a nonequilibrium phase transition termed motility-induced phase separation and growth of particle clusters. Here the influence of inertia on motility-induced phase separation and the cluster growth exponent [5] is discussed. It is shown that coexisting phases can have different kinetic temperatures which is unknown from equilibrium. As an application the construction of active refrigerators [6] is put forward. Moreover the formation of active micelles (rotelles) by using inertial active surfactants [7] is proposed. All these effects document that inertia can play a significant role for active matter. Finally examples for applications in medicin for these macroscopic active inertial particles will also be highlighted.

References

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