MPIDS Colloquium

MAX-PLANCK-GESELLSCHAFT

Dynamical self-assembly and large-scale ordering in anisotropic active fluids

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Ensembles of active anisotropic particles can exhibit intriguing collective behaviours. In my talk I will discuss two phenomena in this area occurring on different length scales. The first part concerns the formation of large-scale patterns, particularly vortex formation and so-called mesoscale turbulence. Here I will focus on how these large-scale structures are affected by constraints such as (weak) geometrical confinement or an orienting external field. Our investigations are based on a recently derived fourth-order field theory for a vectorial order parameter representing an effective micro swimmer velocity. Combining this continuum theory with experiments on a suspension of motile bacteria Bacillus Subtilis, we unravel the role of self-induced topological defects imposed by tiny obstacles (pillars) on the local flow profile of the active fluid. Beyond the stabilization of square and hexagonal lattices, we also provide a striking example of a chiral, antiferromagnetic lattice induced by arranging obstacles in a Kagame-Like array. We then discuss, for the same system, the impact of an orienting external field which can suppress the turbulent state and stabilize a traveling stripe pattern.

In the second part I will discuss, on a particle-resolved level, the dynamical self-assembly of active Brownian particles with dipolar interactions stemming from permanent (magnetic) moments. Depending on the parameters we observe chains, clusters, and flocking states characterized by ferromagnetic order, which is absent in the corresponding equilibrium system. We also provide evidence that strong dipolar interactions suppress the motility-induced phase separation seen in ensembles of non-dipolar active Brownian particles.

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MPIDS, Prandtl lecture hall,
Am Faßberg 17, Göttingen

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