MPIDS Colloquium

Pattern formation in active biological matter

Prof. Dr. Markus Bär

Head of "Mathematical Modelling and Data Analysis"
Physikalisch-Technische Bundesanstalt
Adjunct Professor at TU Berlin
Berlin, Germany

Active biological matter like swarming bacteria, mixtures of molecular motors and biopolymers like actin and microtubuli or suspensions of microswimmers consist of individuals that are able to transform internal energy into a directed motion. The talk introduces two examples for spatiotemporal self-organisation of active matter, namely mechano-chemical waves in microplasmodia of the giant amoebae Physarum polycephalum and patterns of collective motion. For Physarum, we introduce a two-phase model coupling the cytosolic fluid to the viscoelastic solid cytoskeleton. The model exhibits an oscillatory instability causing a variety of mechanochemical patterns in line with experimental findings for small resting plasmodia. The nonlinear dynamics arising from the instability also explain polarization and stepwise motion of the plasmodia.

Colonies of Bacillus subtilis provide a prime experimental realization of self-propelled swimmers. Emphasizing the importance of the competition of alignment and longer range hydrodynamic interactions, we discuss the phase diagram of swarming behavior in a submonolayer on a substrate and the emergence of mesoscale turbulence of dense suspensions of bacteria. Mesoscale turbulence is well described by a model exhibiting a linear finite wavelength instability and a sufficiently strong Navier-Stokes type nonlinearity. Whereas experimental swarming behavior of mutants with aspect ratios larger than 10 is well-described by self-propelled rod models with short-range alignment interactions, swarming in submonolayers as well as active turbulence requires the interplay of active motion, local alignment of swimmers and long-range hydrodynamic interactions as is illustrated with microscopic simulations of a simple extension of the classical Vicsek model and the derivation of linear kinetic and hydrodynamic equations.

Wednesday, December 18th, 2019 at 2:15 pm

MPIDS, Prandtl Lecture Hall,
Building AI, Am Faßberg 11, Göttingen

Max Planck Institute for Dynamics and Self-Organization
Living Matter Physics
Dr. Philip Bittihn
Email: philip.bittihn@ds.mpg.de, Phone: +49-(0)551/5176-157
Am Faßberg 17, 37077 Göttingen, Germany