Elżbieta Ratajczyk

A kinetic approach to self-propelled particles dynamics in confined domains

Active matter consists of large numbers of self-driven agents converting chemical energy, usually stored in the surrounding environment, into mechanical motion. The main motivation for our work is a potential usage of active ink (ink with active bimetal nanoparticles) in 3D printers. It may result in smaller voxel size and increase the printing speed. Decreased viscosity allows for smaller outlet of nozzle which, in turn, results in better resolution of printing.

In this presentation I focus on a kinetic description of active matter represented by self-propelled rods swimming in a viscous fluid and in presence of confinements. It is well-known that confinements may significantly affect trajectories of active rods in contrast to unbounded or periodic containers. Among such effects are accumulation at walls and upstream motion (also known as rheotaxis). We rigorously derive boundary conditions for the active rods' probability distribution function in the limit of zero inertia. These boundary conditions are important since the active rod possesses self-propulsion thus its velocity does not vanish at the no-slip wall, as for passive particles. Moreover, this limit allows us to reduce a dimension (and so computational complexity) of the kinetic description.

The second part of the talk is devoted to investigation of vanishing translational diffusion. This case is natural, because in experimental observations, rod-like microswimmers, are more likely to spontaneously turn rather than jump to another position implying that translational diffusion is small. It is a singular limit, that is one cannot simply set D_{tr} to zero in the Fokker-Planck equation and no-flux condition. This is because active particles tend to accumulate at walls and in particular they form a boundary layer.

This is a joint work with Mykhailo Potomkin, Leonid Berlyand and Pierre-Emmanuel Jabin.