Self-assembly of Janus swimmers

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Janus particles are characterized by having two faces with different physical or chemical properties. This feature leads to anisotropic interactions between them. These interactions are the source for a wide variety of morphologies, which lead to a rich phase diagram. The anisotropic Janus interaction can also lead to the self-propulsion of these particles, turning them active. Active Janus suspensions are an example of non-equilibrium system. We can expect non-equilibrium Janus particles will also present a rich variety of self-assembled morphologies. In this contribution, we present a computational study of the morphology of such system employing Lattice-Boltzmann (LB) simulations for a two-dimensional system.

LB provides a computational environment capable of dealing with non-equilibrium systems at a mesoscopic level.

We represent our swimmers using a simplified version of the squirmer model[1], for which we use a coefficient B_1 to account the squirmer self-propulsion (at velocity $v = 2B_1/3$), and a coefficient B_2 to account the active stress performed by the particle to the fluid. The ratio $\beta \equiv B_2/B_1$ determines the squirmer behavior, with $\beta < 0$ being *pushers* (i.e. they displace pushing the fluid behind them), and $\beta > 0$ being *pullers* (i.e. they displace pulling the fluid in fron of them).

The interaction between particles is isotropic and repulsive at very short distances, and attractive and anisotropic at longer distances. We consider two particular cases of the attractive interaction: one that favors the alignment of pairs of particles pointing at each other (*head-to-head*), and the other that favors their alignment pointing against each other (*tail-to-tail*).

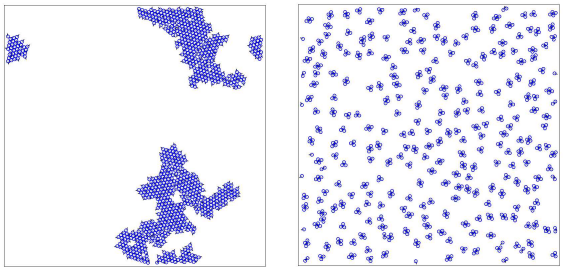

Figure 1: Left panel: suspension of pullers with tail-to-tail interaction with a longer range; the system presents coarsening. Right panel: suspension of pushers with head-to-head interaction with a shorter range; the particles group in small clusters of three or four particles.

We analyze the morphology and size of the self-assembled structures varying parameters such as the ratio between hydrodynamic and inter-particle interactions, the range of the attractive force between particles and the coefficient β.

[1] M. J. Lighthill, Communications on Pure and Applied Mathematics. **5** (2), 109 (1952).