Sedimentation and orientational order of active bottom-heavy particles

Katrin Wolff [1], *Marc Hennes* [1], *Holger Stark* [1]

[1]Institut für Theoretische Physik, Technische Universität Berlin, Germany

Self-propelled particles in an external gravitational field have been shown to display both an increased sedimentation length and polar order even without particle interactions [1,2]. Here, we investigate self-propelled particles which additionally are bottom-heavy, that is they feel a torque aligning them to swim against the gravitational field. We study their dynamics in an external gravitational field analytically and numerically using Brownian dynamics simulations. For bottom-heavy particles the gravitational field has the two opposite effects of i) sedimentation and ii) upward alignment of the particles' swimming direction. Depending on the strength of gravity, the particles' swimming speed and the aligning torque, we observe either effective sedimentation with increased sedimentation length (compared with the passive case but also the active case without bottom-heaviness) or inversion where particles swim towards the top of the box. We will give analytical results for sedimentation lengths and polar order in the dilute limit [3] and numerical results for the case with hydrodynamic interactions where particles form vortices and columns.

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3. K. Wolff, A. M. Hahn and H. Stark, *arXiv:1302.7268*.