Self organized dynamics of modular micro-swimmers

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An elegant way of swimming at low Reynolds numbers is phorectic motion, which does not rely on any moving part. Rather, a self-generated gradient induces a relative motion between the swimmer surface and the immediately surrounding solvent. Depending on the type of generated gradient, this motion classifies as electro-, chemo-, or thermo-phoresis. Several fascinating experimental realizations have been demonstrated using individual compact swimmers of mainly rod or sphere type [1]. The approach to phoretic micro-swimming followed by our group is different in the sense, that our swimmers are modular objects [2].
Even the minimal modular swimmer consists of a reservoir particle releasing a local electrolyte gradient and the substrate providing a gradient driven electro-osmotic solvent flow (the motor) propelling the reservoir particle. Several reservoir particles organize to form schools, which show a schooling-swimming transition, once a single larger reservoir particle enters to teak the lead. In fact the same effect is observed for any single reservoir particle and added inert colloidal particles taking the role of a gearing. Also other particles may be assembled by or attached to the reservoir particle carrying these along as cargo. Finally several ideas have been proposed to realize a convincing remote steering of the resulting complex [3]. None of the complex constituents shows any phoretic motion under isolated conditions. Propulsion here is an emergent property of the collective and cooperative self-organization into a dynamic complex. The talk will shortly sketch the present state in experimental micro-swimming, explain the mechanisms behind and the challenges involved in realizing, understanding and optimizing modular micro-swimming and finish with an outlook on open issues.

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