Clustering-induced self-propulsion of isotropic catalytic particles

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Catalytic particles exploit local gradients in solute concentration to self-propel at the micron scale. A fundamental requirement for their self-propulsion is to break the symmetry of the concentration around them: an isotropic active particle can not swim. Different routes have already been identified for breaking this symmetry. Some are based on the design of the system (e.g. chemical patterning [1], or geometric asymmetry [2]), while another is linked to the non-linear advective coupling of the solute and fluid dynamics [3]. Here, we demonstrate that a fourth route exist, which exploits interactions between individually-non-motile isotropic systems. Such uniform and isotropic particles can achieve self-propulsion by forming geometrically-anisotropic clusters with other particles under the influence of phoretic and hydrodynamic interactions.

Using full numerical simulations as well as theoretical modeling of the clustering process, we obtain the statistics of the propulsion properties for arbitrary initial arrangement of the particles. The robustness of these results to thermal noise is also analysed.

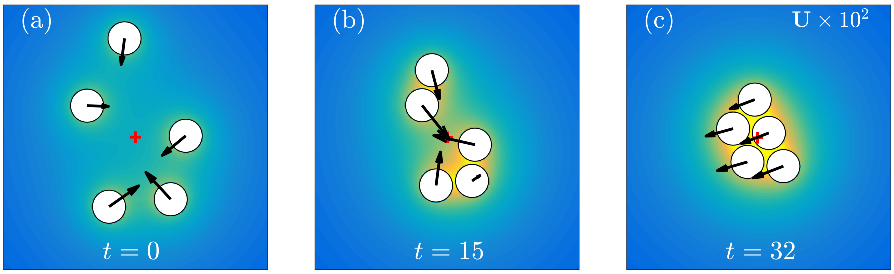

Figure 1: Clustering dynamics of five identical isotropic catalytic particles. Phoretic attraction of the particles resulting from the inhomogeneous concentration field (in color) leads to the formation of cluster (a,b), which can then self-propel due to its geometric asymmetry (c).

[1] J. L. Moran & J. D. Posner, Phoretic self-propulsion, Annu. Rev. Fluid Dyn., **49**, 511–540 (2017)

[2] S. Michelin & E. Lauga, Autophoretic locomotion from geometric asymmetry, Eur. Phys. J. E, **38**, 7 (2015)

[3] S. Michelin, E. Lauga & D. Bartolo, Spontaneous autophoretic motion of isotropic particles, Phys. Fluids, **25**, 061701 (2013)