Clustering of Active Colloids in Crowded Environments

Abhimanyu Nowbagh[1], Venkata M.S.G. Tanuku[1], Manuel A. Escobedo-Sánchez[2] and Ivo Buttinoni[1]

[1] Experimental Colloidal Physics, Heinrich Heine University, Duesseldorf, Germany 40225
[2] Experimental Soft Matter, Heinrich Heine University, Duesseldorf, Germany 40225

abhimanyu.nowbagh@hhu.de

Active colloids are microscopic particles that propel through aqueous media by converting the externally available energy into directed motion. Understanding interactions of active colloids with crowded systems, and emergent phenomena of ensembles of active particles, remain an important and open question in non-equilibrium physics.
Active colloids are known to form clusters spontaneously due to motility induced interactions[1,2]. But what happens when these particles move through crowded environments? Here we investigate the dynamics of AC-field activated Janus particles (gold coated silica microspheres) in a passive crowd of uniform silica microspheres. The alternating electric field is used to control: i) the velocity of active particles and ii) the inter-particle interaction between passive colloids. We show experimentally that a passive crowd has a non-monotonic effect on the clustering of active particles: intermediate crowd densities accelerate the cluster growth dynamics compared to the free case, while higher crowd densities suppress it. This counterintuitive behaviour arises from a competition between the reduced motility of active particles in crowded environments and the increased stability of formed clusters in a crowded environment.
Our findings demonstrate that passive crowding can act as a tunable parameter for controlling self-organisation in active matter systems, with broader implications for understanding clustering in biological environments.

Keywords:
Active Matter, Active-Passive Interactions, MIPS, Induced Charge Electrophoresis (ICEP)

References:

[1] Cates, M. E., & Tailleur, J. (2015). Motility-induced phase separation. *Annu. Rev. Condens. Matter Phys.* , *6* (1), 219-244.
[2] Van Der Linden, M. N., Alexander, L. C., Aarts, D. G., & Dauchot, O. (2019). Interrupted motility induced phase separation in aligning active colloids. *Physical review letters* , *123* (9), 098001.