Physics and Physical Oceanography Seminar

Self-propelling Janus particles: dynamics in Newtonian and viscoelastic media

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DATE: Thursday, Nov 5, 2020
TIME: 3:30 pm
Place: Webex (link will be sent out)

ABSTRACT: Active colloids (ACs) are nano/micro-reactors able to transform local energy into motion. Among synthetic ACs, much interest has been focused on a new class of colloidal particles called Janus particles. These particles self-propel by creating a concentration gradient across a particle's interfacial region thanks to an asymmetric surface distribution of a catalyst. In this seminar, we present an overview of our recent efforts in theoretically [1, 2] and experimentally [3] investigate the problem of self-propelling Janus particles in Newtonian and viscoelastic media.

Experimentally, we focus on platinum (Pt) coated silica microparticles as model system to study self-diffusiophoresis. Specifically, these particles were dispersed in Newtonian (water) and non-Newtonian (polyvinylpyrrolidone and polyacrylamide water solutions) media. Self-propulsion was activated by the addition of hydrogen peroxide whose decomposition is catalyzed by the Pt side of the particles. In Newtonian fluids, we discuss the emergence of active particle rotation as transition from polar to chiral symmetry. In viscoelastic media, the particle trajectories and their mean square displacements showed a super-diffusive (but not quadratic) behavior caused by the coupling between the rheological properties of the media and the active motion. This suggests the possibility of tuning active motion via medium rheology.

SHORT BIO: Giovanniantonio Natale is an assistant professor in the Schulich School of Engineering in the Department of Chemical and Petroleum Engineering at University of Calgary. His research interests lie at the interface between rheology, soft matter and colloidal suspensions. Before coming to the University of Calgary, Dr. Natale was a postdoctoral fellow at the University of British Columbia where he investigated the dynamic of active colloids in weakly viscoelastic fluids. He received his Ph.D. in Chemical Engineering at Ecole Polytechnique de Montreal on the rheology of rod-like nanoparticle suspensions. For his work, he already received prestigious awards such as the Best Poster at the 86th Annual meeting of the Society of Rheology (2014) and the Best Presentation award at the 10th Annual European Rheology Conference (2015). He also received an early career NSERC Discovery Grant Accelerator Award supporting his research on active colloids.

[1] Datt, C., Natale, G., Hatzikiriakos, S. G., & Elfring, G. J. (2017). An active particle in a complex fluid. Journal of Fluid Mechanics, 823, 675.
[2] Natale, G., Datt, C., Hatzikiriakos, S. G., & Elfring, G. J. (2017). Autophoretic locomotion in weakly viscoelastic fluids at finite Péclet number. Physics of Fluids, 29(12), 123102.
[3] Saad, S., & Natale, G. (2019). Diffusiophoresis of active colloids in viscoelastic media. Soft Matter, 15(48), 9909-9919.

ALL ARE WELCOME!