# ME Seminar

## Dynamics of a microswimmer in nematic liquid crystal

**Dr. Shubhadeep Mandal, Dept. of Mechanical Engineering, IIT Guwahati**


### ABSTRACT

Microswimmers exhibit fascinating behaviour due to the interplay of activity and hydrodynamics. We report the rich dynamical behaviour of a model microswimmer, a squirmer, in a rheologically complex fluid, namely a nematic liquid crystal. We have employed a mesoscopic particle-based simulation method called multi-particle collision dynamics (MPCD), which captures hydrodynamics and thermal fluctuations. The fluid is represented by point-like particles that perform streaming and collision steps so that the linear and angular momentums are conserved. We extend the MPCD method for nematic liquid crystal by incorporating the anisotropic viscosity and elasticity of the nematic fluid in a generalized tensorial framework. We also couple a spherical squirmer with the nematic fluid via the exchange of linear and angular momentums between the squirmer and fluid particles during squirmer-particle collisions. A squirmer in a homeotropically aligned nematic liquid crystal cell shows remarkable behaviour compared to squirmer dynamics in Newtonian fluids. In the nematic liquid crystal, the squirmer trajectories depend strongly on the self-propulsion mechanism, self-propulsion strength and degree of confinement. The confinement has drastic effects on the dynamics of the squirmer and on their steady-state. We find that pullers settle along the channel centreline, while pushers can hover in front of the walls or display oscillatory dynamics depending on the strength of their propulsion. We identify that anisotropic viscosity-induced hydrodynamic torques and wall-induced hydrodynamic and elastic interactions are the key effects which govern the squirmer dynamics. We propose an analytical model that qualitatively reproduces all the dynamical regimes found in simulations.


### ABOUT THE SPEAKER

Dr. Shubhadeep Mandal is currently working as an Assistant Professor in the Mechanical Engineering Department of the Indian Institute of Technology (IIT) Guwahati, India. Dr. Mandal graduated from the Mechanical Engineering Department of Jadavpur University in the year 2012, securing 9th rank out of a pool of more than 120 students. Thereafter, he joined IIT Kharagpur for his masters study, where he was the topper in the Thermal Science and Engineering specialization. After completion of his MTech in 2014, he continued at IIT Kharagpur for his doctoral research. He completed his PhD thesis work in about three years. The broad area of his doctoral research is microfluidics with particular emphasis on the low-Reynolds-number hydrodynamics of droplets in presence of external flows and fields. After submitting his PhD thesis, Dr. Mandal went for post-doctoral research for two years in the Max Planck Institute for Dynamics and Self-Organization in Gttingen, Germany. In his post-doctoral research, he worked on the development of a mesoscale simulation method for nematic liquid crystals. The broad area of his current research is complex fluids and active matter with a special focus on the hydrodynamics of microswimmers in complex environments.

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