Physics Colloquium

Michigan Technological University

Thursday, December 5, 2013
at 4:00 pm
Room 139 Fisher Hall

Rotation Dynamics of Anisotropic Particles

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Abstract: In both physical and biological science, we are often concerned with the dynamics of the small particles, which are suspended and carried about by the motion of the fluid. The first complete mathematical treatment of the problem has been given by Einstein in 1905, who considered the case of spherical particles and gave a simple formula for the increase in the viscosity. Jeffery extended this work to characterize the rotation of anisotropic particles in a simple linear shear flow in 1922, which is usually referred to as Jeffery orbits. Previous experiments showed many fascinating dynamics of anisotropic particles even in simple flows. But flow in nature is usually complicated and turbulent. The fast advances in imaging technology have made it possible to obtain time-resolved rotation dynamics of anisotropic particles in turbulence using high-speed stereoscopic imaging. We have developed a general methodology to experimentally measure the time-resolved orientation and solid body rotation rate of anisotropic particles with arbitrary aspect ratio, which are designed and fabricated through 3D printing technology. In order to measure the flow surrounding the anisotropic particles, we built a scanning particle tracking system to measure the velocity of high concentration tracer particles along with the orientation of a small concentration of anisotropic particles. We found that the long axis of the anisotropic particle is preferentially aligned with the direction of the vorticity vector. The reason for that is because both the anisotropic particle and vorticity vector tend to be independently aligned with the largest stretching direction.

Bio: Rui Ni is a Postdoctoral scientist for a joint position in the Department of Physics at Wesleyan University and in the Department of Mechanical Engineering and Materials Science at Yale University. His research interest primarily focuses on the nonlinear physics of complex system. He received his Ph.D. in experimental physics from the Chinese University of Hong Kong in 2011 for his studies of Rayleigh-Bénard convection. During his Ph.D., he also built a new biophysics lab and started an experimental study of the collective motion of magnetotactic bacteria. He started his current joint position in January, 2013. At Wesleyan University, he has successfully built a cutting-edge scanning particle tracking system to study the motions of anisotropic particles in turbulent flow. At Yale University, he developed a new method to extract information about spectral transfer processes from poorly-resolved velocity fields in both two-dimensional and three-dimensional turbulent flow.

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