PHYSICS SEMINAR

Preferred-orientation transport and wall accumulation of confined active Janus colloids.

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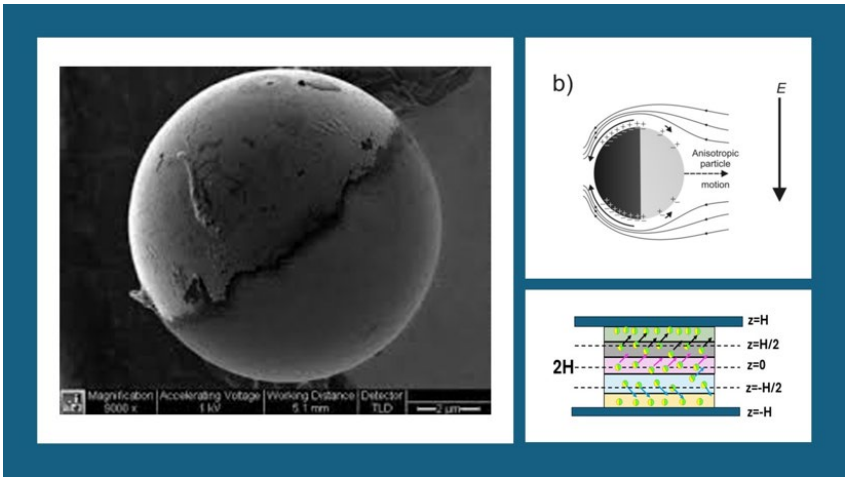
Thursday, September 24, 2026
12:30 – 1:30 p.m.
Wubben 264

Active matter refers to a broad class of systems composed of individual agents that consume energy locally to generate motion. These agents span a range of scales, from molecular motors and artificial colloidal swimmers to fish, birds, and even crowds of humans. Because they are driven by an internal or local energy source, active systems are far-from-equilibrium by nature. Yet collections of active agents can organize in ways that sometimes resemble equilibrium phenomena, and sometimes they display behaviors with no equilibrium counterpart. In this talk, I will introduce some of the basic ideas of active matter through experiments and modeling of electrokinetically driven "Janus" particles (JP's)—microscopic particles with two materially distinct faces—confined between parallel walls. When driven by an applied electric field, these particles redistribute across the channel. The interior becomes depleted while particles accumulate at the walls, with a preferential bias for accumulation at the top wall. We investigate how this behavior emerges from the interplay between directed propulsion, particle orientation, random fluctuations, and confinement. A theoretical model based on driven Brownian motion shows how these microscopic ingredients set the timescale for particle redistribution. At the same time, the model reveals an important limitation. Bulk transport alone cannot explain the strong accumulation observed at both walls, pointing to additional physics near the boundaries. Aside from potential technological applications in drug delivery, tunable rheology, and materials/advanced manufacture, active matter systems provide an accessible example of how simple rules for motion and fluctuations at the scale of individual particles can produce organized, collective transport far from equilibrium.



Refreshments!