Soft Living Active and Adaptive Matter

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The role of shape and mechanics in biological active matter

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Abstract:

Active matter refers to a collection of individuals, from animal groups to micro-organisms to cytoskeletal filaments, that extract energy from their surroundings at a single-particle level to generate motion and forces. Active matter displays a wide range of emergent behaviors, such as coordinated migration, self-organization, phase transitions, and self-assembly. Here we show that Plasmodium sporozoites, a crescent-shaped form of malaria parasites, provide a unique model system of active matter that combines the aspects of self-propulsion, curved shape, and mechanical flexibility into one system. We investigate the motion of sporozoites in collectives extracted from the salivary glands of mosquitoes, where they form large rotating vortices. We find that single sporozoites within the vortices are sorted according to their curvatures and speeds. Further, the vortices undergo oscillatory breathing in their shape. We explain these intriguing observations using agent-based simulations where each agent is represented by an active curved polymer that mimics the behavior of a motile sporozoite. In summary, we establish malaria parasites as a new active matter system and provide novel insight into the role of shape and mechanics in collective behavior.

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About the speaker:

Dr. Patra is a postdoctoral researcher at the Institute for Theoretical Physics at Heidelberg University. He specializes in the field of biological physics and active matter. He completed his Ph.D. in Theoretical Biological Physics at the Max Planck Institute of Colloids and Interfaces in Germany under the guidance of Prof. Stefan Klumpp, focusing on the population dynamics of bacterial persistence. Following the completion of his Ph.D.

Dr. Patra worked as a postdoctoral researcher at the Bioengineering Department of Rice University. During this time, he developed computational models to gain insights into the mechanisms of colony expansion of Myxobacteria. Apart from his research contributions, Dr. Patra has a keen interest in science outreach. He is currently associated with two Twitter groups, "Collective Dynamics of Living Systems" and "Theoretical Biophysics," where he shares recent research articles, job opportunities, and news related to these areas.

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