



MECHANICAL ENGINEERING SEMINAR

Thursday, June 15, 2023 at 13:15, D. Dan and Betty Kahn Building, Auditorium 1

From Robot Uprising to Rise of the Dead – Lessons in Engineering and Biology from a New Type of Active Particles

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Hosted by: Prof. Alon Wolf

Cooperation is vital for the survival of a swarm. No single bird is faster than a jet plane, and no single fish is faster than a speed boat — humans beat individual animals in air, land, and sea. But, when animals cooperate and swarm, they beat us since biblical times. Inspired by non-equilibrium statistical mechanics I will shed light on cooperative behavior observed in the animal kingdom. I will present our recent experimental findings that generalize the dynamics of known active particles such that they align in response to an external force. The force-alignment is characterized by a charge-like parameter that is empirically well-defined, has units of curvature, and stems from a mechanical description of a vibrating walker. We find that particles with a negative “active charge” are attracted to repulsive potentials, effectively going uphill. Some animals have a tendency to go uphill, and the proposed force-alignment mechanism suggests a bio-mechanical contribution to this widespread behavioral trait. Moreover, the force-alignment response leads to unique collective behavior — an ensemble of such active particles spontaneously displays cooperative transport. This allows particles to coordinate the movement of a much larger object without using any circuitry, sensors, nor communication. We call such active particles “Transportons”, and using both experiments and simulations, I will show that the transport propensity of a swarm of transportons is super-linear with group size, a hallmark of cooperation.

Dr. Ben Zion earned his bachelor's degree from Tel Aviv University. He later continued for a PhD at the Center for Soft Matter Research at New York University where he worked on programmable self-assembly and development of synthetic microswimmers (under the supervision of Prof. Paul Chaikin and Prof. Nadrian Seeman). Following his PhD, Dr. Ben Zion took a postdoc position at the Institute for Intelligent Robotic Systems (ISIR, Sorbonne Université), jointly with the Superior School for Industrial Physics and Chemistry (ESPCI) in Paris. There he worked with prof. Nicolas Bredeche and Prof. Olivier Dauchot on embodied computation and decentralized learning in robotic swarms.

