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Exploring aspects of non-equilibrium physics: Activity, non-reciprocity and signalling

Abstract: The tendency to exhibit a non-equilibrium behaviour is a fundamental aspect of living matter. Our studies address three facets of non-equilibrium physics, inherently related to biological processes, and demonstrate ways to manipulate the corresponding emerging behaviour. We first explore an exemplary active system of particles striving to align their velocity with that of their neighbours, as relevant e.g., for birds' flocks. By employing a moving substrate, the naturally occurring Vicsek band patterns self-organize into a strongly polarized macroband, which propagates against the direction the substrate moves, thus enabling controllable particle transport. A less intuitive attribute of various non-equilibrium systems, ranging from social crowds to complex plasmas, is the presence of non-reciprocal interactions. In the latter context, we show that the wake-mediated interactions between microparticles in a flowing plasma result in crystalline structures, exhibiting unconventional structural transitions, tuned by the microparticle density. Finally, focusing on the mechanisms behind living matter's dynamics, rather than its effective description, we explore the utility of a chemotaxis-inspired signalling on a living group. Assuming that the group members strive to optimize their individual state within a shared field themselves generate, as relevant e.g., for aerotactic bacteria or penguin huddles, we find that emerging many-body interactions allow ultimately the group to collectively self-optimize. The above indicate that exploiting different aspects of non-equilibrium physical systems could enable the control of their involved dynamical behaviour, with important implications for their biological analogues.

Alexandra Zampetaki received her Ph.D. degree in physics from the University of Hamburg in 2016. In 2019 she joined the Max-Planck Institute for Extra-terrestrial Physics (MPE) in Garching as a joint postdoctoral researcher with the Heinrich-Heine University of Düsseldorf, where she is currently affiliated.

All interested colleagues are welcome to this lecture
(45 min. presentation followed by discussion)

The seminar will be also held as a

Zoom Meeting: shorturl.at/fAFQ0
Meeting ID: 938 2716 3728
Passwort: ei87snR9

