Institute of Science and Technology Austria

SLAM Seminar

Trapping active particles up to the limiting case: bacteria enclosed in a biofilm

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Active matter systems are composed of constituents, each one in nonequilibrium, that consume energy in order to move [1]. A characteristic feature of active matter is collective motion leading to nonequilibrium phase transitions or large scale directed motion [2]. A number of recent works have featured active particles interacting with obstacles, either moving or fixed [3,4,5]. When an active particle encounters an asymmetric obstacle, different behaviours are detected depending on the nature of its active motion. On the one side, rectification effects arise in a suspension of run-and-tumble particles interacting with a wall of funnelled-shaped openings, caused by particles persistence length [6]. The same trapping mechanism could be responsible for the intake of microorganisms in the underground leaves [7] of Carnivorous plants [8]. On the other side, for aligning particles [9] interacting with a wall of funnelled-shaped openings, trapping happens on the (opposite) wider opening side of the funnels [10,11]. Interestingly, when funnels are located on a circular array, trapping is more localised and depends on the nature of the Vicsek model. Active particles can be synthetic (such as synthetic active colloids) or alive (such as living bacteria). A prototypical model to study living microswimmers is P. fluorescens, a rod shaped and biofilm forming bacterium. Biofilms are microbial communities self-assembled onto external interfaces. Biofilms can be described within the Soft Matter physics framework [12] as a viscoelastic material consisting of colloids (bacterial cells) embedded in a cross-linked polymer gel (polysaccharides cross-linked via proteins/multivalent cations), whose water content vary depending on the environmental conditions. Bacteria embedded in the polymeric matrix control biofilm structure and mechanical properties by regulating its matrix composition. We have recently monitored structural features of Pseudomonas fluorescens biofilms grown with and without hydrodynamic stress [13,14]. We have demonstrated that bacteria are capable of self-adapting to hostile hydrodynamic stress by tailoring the biofilm chemical composition, thus affecting both the mesoscale structure of the matrix and its viscoelastic properties that ultimately regulate the bacteria-polymer interactions.

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Thursday, February 23rd, 2023 11:00 - 12:00

Seminar Room B / Sunstone Building

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