

## **Driven transport of passive and active matter in complex environments**

An archetypal example of a complex environment is a living cell. Putting it simply, it can be compared to a large urban agglomeration. Its interior is a crowded and heterogeneous environment that is constantly in motion. In order to function efficiently, it must have the appropriate infrastructure, including, for example, a road network, public transport, water and energy supply. An analog of the road network are microtubules along which molecular motors (e.g. a kinesin) transport substances inside cells. They are isothermal engines working far away from thermodynamic equilibrium but still outperform by orders of magnitude any machine which we are able to manufacture. Fascinated by this fact in the proposed project we want to investigate

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for better understanding of living matter and nonequilibrium physics which despite so many years of intense research still remains a *terra incognita* for physicists. In doing so we will generalize the concept of a Brownian motor, i.e. the classical Brownian particle far away from thermodynamic equilibrium moving in a spatially periodic potential, which serves as a paradigmatic model of a molecular motor. Using this approach we will analyze e.g. its average velocity, velocity fluctuations, kinetic energy and thermodynamic efficiency of the energy conversion.

The main scientific goal of the proposed project is to apply methods of modern theoretical statistical physics to push further our current understanding of nonequilibrium transport in complex environments as well as to develop its new control strategies and novel applications. Our efforts will be focused especially on answering two questions: (i) How far from equilibrium is the system and which quantifiers can measure it? and (ii) What new transport phenomena emerge due to such a nonequilibrium state?

Research planned in this project will allow to face a number of fundamental challenges in nonequilibrium statistical physics, thermodynamics and theory of transport in the micro and nanoscale domain. On the other hand this proposal is promising also in terms of its potential future applications such as efficient strategy for separating of passive and active matter as well as designing and fabricating biologically inspired micro and nano motors.