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Faculty of Physics

Physics Colloquium

Surprises in the statistical physics of active matter

09 December 2024



The Physics Colloquium is a series of public lectures hosted by the Faculty of Physics of the University of Vienna, featuring internationally renowned speakers covering the full breadth of our fields of research.

Michael Cates

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maths.cam.ac.uk/person/mec22

Surprises in the statistical physics of active matter

Classical statistical mechanics describes the macroscopic properties of large numbers of particles. It has a hidden weakness: it assumes that the microscopic forces derive from a Hamiltonian. The same mathematical object then controls both the equations of motion, and the Boltzmann distribution. This is why quantities like pressure are not only time averages of forces (on a wall), but also thermodynamic state functions (which exist independently of any wall). Active matter systems are different. Their particles take energy out of the environment, and use it for dissipative self-propulsion, violating Hamiltonian dynamics. Examples include swimming micro-organisms, and synthetic colloids propelled by optical or chemical energy. The absence of a Hamiltonian-derived detailed balance principle requires a rebuild of statistical mechanics, with some surprising outcomes. For example: (i) the pressure of an active fluid on a wall is not a state function – it depends on the type of wall; (ii) various interfacial phenomena, governed in equilibrium by a single surface tension, now involve different tensions, some of which can be negative. I will survey these among other surprises and, if time allows, say how they affect kinetic questions such as nucleation rates.

Monday, 09 December at 13:30-15:00

A light lunch buffet will be offered before the lecture at 13:00.

Lise-Meitner lecture hall

Faculty of Physics, Strudlhofgasse 4, 1090 Vienna

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