Mathematisch-Naturwissenschaftliche Fakultät
Wissenschaftliche Einrichtung Physik

Physikalisches Kolloquium

Donnerstag, 23.01.2025, 16:30 Uhr – Hörsaal 5J

Dynamic control of many-body systems using neural force functionals and topology

Prof. Dr. Daniel de las Heras
Theoretische Physik II, Universität Bayreuth

A precise control over the flow and the structural properties of many-body systems is a requisite in applications such as cargo delivery with colloidal carriers and lab-on-a-chip processing. In this talk, I will explore two distinct methods for controlling the dynamics of a collection of particles [1,2]. Using a spatially inhomogeneous magnetic pattern coupled with a time-dependent uniform magnetic field, it is possible to topologically transport identical microparticles independently and simultaneously [1], paving the way for multifunctional lab-on-a-chip devices designed for biological applications. The complexity of the transport can be rationalized by means of a set of topological invariants. Measuring, with computer simulations, the response of a many-body system to randomized external fields allows us to predict the dynamics of the many-body system at the one-body level [1]. We use a neural network to learn the kinematic mapping predicted by power functional theory. The trained network can be employed to elucidate the system's response to arbitrary external fields. Moreover, we use a local learning approach that allows us to process systems of size much larger than that of the training data, opening a route to study the dynamics of macroscopic systems with microscopic resolution. The methodology applies to both overdamped and inertial many-body systems including active particles.

[1] N. C. X. Stuhlmüller, F. Farrokhzad, P. Kuswik, F. Stobiecki, M. Urbaniak, S. Akhundzada, A. Ehresmann, T. M. Fischer, and D. de las Heras, Nat. Commun. 14, 7517, (2023)
[2] T. Zimmermann, F. Sammüller, S. Hermann, M. Schmidt, and D. de las Heras, Mach. Learn.: Sci. Technol. 5, 035062 (2024)

Ab 16:00 Uhr Kaffee, Tee und Gebäck im Foyer vor dem Dekanat der Math.-Nat.-Fakultät (Gebäude 25.31. Ebene 00)

Für die Dozenten der Physik
Prof. Dr. Hartmut Löwen