Physikalisches Kolloquium — Physics Colloquium

Einladung — **Invitation**

Monday, 15 January 2024

Lecture Hall N24/H13, at 16:15
Coffee and cookies will be served in front of the lecture hall from 16:00

Collective quantum effects with nanoparticle tweezer arrays

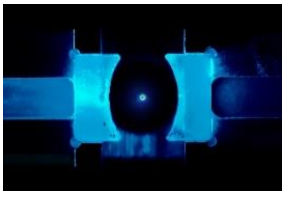
Dr. Uroš Delić

Department of Physics, University of Vienna
https://www.urosdelic.com/

Optical levitation of dielectric nanoparticles is an extremely promising platform to create macroscopic quantum states as it allows for a unique combination of optical control techniques of atomic physics with the detection methods and size of solid-state objects. One such example, and a significant milestone in the field of levitated optomechanics, is the realization of motional quantum ground state cooling of a single levitated nanoparticle in an optical cavity [1]. Although an important result, a pure ground state is just a prerequisite to show genuine quantum behavior, such as entanglement between multiple particles or creating macroscopic superpositions.

In my talk, I will report on our recent progress in extending the control to tweezer arrays of levitated nanoparticles. I will show how particles couple through nonreciprocal light-induced dipole-dipole forces and how we program arbitrary interactions in an experiment [2]. I will present our recent study of non-Hermitian collective dynamics of two particles, which results in parity-time symmetry breaking and a collective mechanical lasing phase [3]. Finally, I will discuss our new experiment that combines an ultrahigh finesse optical cavity with tweezer arrays, which will enable the realization of multipartite entanglement and the study of collective effects in the presence of nonreciprocal interactions.

[1] Delić, Reisenbauer, Dare, Grass, Vuletić, Kiesel, and Aspelmeyer, Science 367, 892 (2020)
[2] Rieser, Ciampini, Rudolph, Kiesel, Hornberger, Stickler, Aspelmeyer, and Delić, Science 377, 987 (2022)
[3] Reisenbauer, Rudolph, Egyed, Hornberger, Zasedatelev, Abuzarli, Stickler, and Delić, arXiv:2310.02610 (2023)



Host: Prof. Dr. Benjamin Stickler, Institute of Complex Quantum Systems

Organisation: Prof. Dr. Jens Michaelis, Institute of Biophysics, jens.michaelis@uni-ulm.de, +49-731-50-23050