universität ulm

Physikalisches Kolloquium — Physics Colloquium

Einladung — **Invitation**

Monday, 09 February 2026

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

Driven-dissipative Crystals of Matter and Light

Prof. Dr. Tobias Donner

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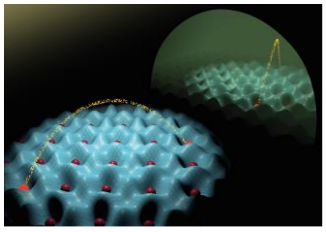
https://www.quantumoptics.ethz.ch/staff/donner.php

Exposing a many-body system to external drives and losses can fundamentally transform the nature of its phases, and opens perspectives for engineering new properties of matter. How such characteristics are related to the underlying microscopic processes is a central question for our understanding of materials. A versatile platform to address it are quantum gases coupled to the dynamic light fields inside optical resonators. This setting allows to create synthetic many-body systems with cavity-mediated long-range atom-atom interactions and tunable, well-controlled dissipation channels [1,2]. If the interactions are sufficiently strong, the system undergoes a structural phase transition to a superradiant crystal of matter and light.

After an introduction to this platform, I will describe experiments where we investigate the dynamics of the emerging phases. When the dissipation via cavity losses and the coherent timescales are comparable, we find a regime of limit cycle oscillations leading to a topological pumping of the atoms [3,4]. In a second set of experiments, we make use of the cavity-mediated interaction to induce the formation of pairs of correlated atoms. We demonstrate that this process is based on the amplification of vacuum fluctuations [5].

[1] Mivehvar, Piazza, Donner, Ritsch; Advances in Physics 70(1), 1 (2021).
[2] Defenu, Donner, Macri, Pagano, Ruffo, Trombettoni; Rev. Mod. Phys. 95, 035002 (2023).
[3] Dreon, Baumgärtner, Li, Hertlein, Esslinger, Donner; Nature 608, 494 (2022).
[4] Natale, Baumgärtner, Stefaniak, Baur, Hertlein, Rivero, Esslinger, Donner; arXiv:2504.17731 (2025).
[5] Finger, Rosa-Medina Pimentel, Reiter, Christodoulou, Donner, Esslinger; Phys. Rev. Lett. 132, 093402 (2024).



Host: Prof. Benjamin Stickler, Institute of Complexe Quantum Systems

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