University of Stuttgart
Germany

iRyd

SPP 1929 – Seminar

11 November 2019, 1:00 p.m.

Universität Stuttgart
NWZ II, Room 5.331
Pfaffenwaldring 57, 70569 Stuttgart

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QUANTUM MANY-BODY DYNAMICS OF DRIVEN-DISSIPATIVE RYDBERG SYSTEMS

The interplay between external driving and dissipation in strongly interacting quantum many-body systems leads to the emergence of rich nonequilibrium dynamics not found in closed quantum systems. The metastable excitations that are possible in Rydberg atoms lead to a natural dissipation channel and strong dipole-dipole interactions between atoms both make Rydberg systems a prevalent example of these kind of systems and lead to a great potential for the fields of quantum information and simulation.

The first part of the talk will focus on the analysis of atom-light hybrid states called polaritons that can occur between light fields and Rydberg atoms. We study their propagation through an optical lattice filled with atoms that can get excited to a Rydberg state. A dispersion relation and an effective Bose-Hubbard model are derived. We look at the time evolution and the two-time correlation function at one end of system after a polariton has travelled through it. The variational principle for open quantum systems [1] is used to analyse even large lattice sizes (≈ 23).

In the second part we show a more general approach for the usage of the variational principle. By combining it with the Glauber-Surdashan P-representation for density matrices we achieve a new tool to analyse bosonic fields without many arbitrary bounds on their particle numbers. We use two examples in the form of the Jaynes-Cummings model and Rydberg atoms inside a cavity to present the basic concept and possible applications for the idea.

[1] H. Weimer, Variational Principle for Steady States of Dissipative Quantum Many-Body Systems, *Phys. Rev. Lett.* **114**, 040402 (2015).