Aktuelle Fragen
der Nanophysik

**Montag, 23.05.2022 um 15:15 Uhr**
**HS 2, Wilhelm-Klemm-Str. 10**

# Strongly correlated excitons and exciton-polaritons in van der Waals magnetic crystals


**Dr. Florian Dirnberger**
Department of Physics, City College of New York
USA

The revolutionary impact of graphene and single layer transition-metal dichalcogenides on solid-state physics has led a quest for materials with novel optical, electronic and magnetic properties. As a result of this process, more and more van der Waals materials characterized by a collective behavior of their electronic constituents have made an appearance on the center of the stage of solid-state research. So far, these quantum materials encompass Mott insulators, topological insulators, and superconductors, as well as a fascinatingly broad palette of ferroelectric, multiferroic, and magnetic states.

In some of these materials, optical spectroscopy studies recently found excitons that are deeply intertwined with a collective quantum state in the host crystals. With properties that have no analog amongst excitons in conventional band semiconductors, these excitons not only inherit a tremendous potential for the design of novel optoelectronic devices, but also represent an exciting material platform to uncover new facets of light-matter interactions.

In this talk, I will introduce two different types of van der Waals magnetic crystals reported to host such strongly correlated excitons, followed by a discussion of their fundamental properties. I will then present our recent study [1] on strong light-matter coupling in the correlated van der Waals insulator nickel phosphorus trisufide ($NiPS_3$), a magnetic crystal that exhibits antiferromagnetic spin ordering below the Néel temperature. In this material, a previously unobserved class of polaritonic quasiparticles emerges from the strong coupling between spin-correlated excitons and the photons inside a microcavity. The hybridization with light offers unique opportunities to study the origin and interactions of magnetically coupled excitations in antiferromagnetic insulators. By establishing strong coupling between photons and correlated optical excitations in a magnetic crystal, our work introduces van der Waals quantum materials to the field of strong light-matter physics and provides a path towards the design and control of correlated quantum states via cavity quantum electrodynamics.

[1] F. Dirnberger, R. Bushati, B. Datta, A. Kumar, A. H. MacDonald, E. Baldini, and V. M. Menon, \Observation of spin-correlated exciton-polaritons in a van der waals magnet," arXiv: 2203.06129.