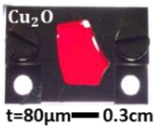
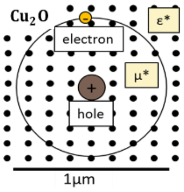
September, 2018

Master / Bachelor thesis

Laser Spectroscopy on Rydberg Excitons in the Semiconductor Cu_2O

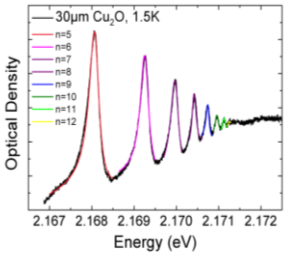


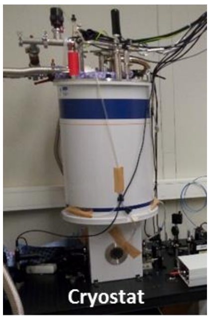
In analogy to Rydberg atoms, which are highly excited atoms having an electron moved to a level with large principal quantum number, Rydberg excitons in semiconductors are composed of an electron-hole pair, while the electron is separated from but still bound to the hole. [1]



The peculiarities of these single quantum systems are their large extension in space and the fact that they are in solid state. [2] These quantum objects in cuprous oxide have been discovered only recently and their potential as solid state quantum devices has yet to be realized.

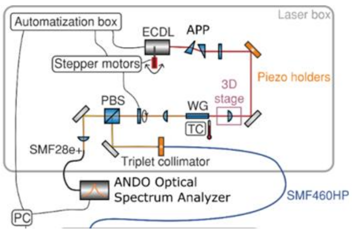
What one sees in an absorption spectrum is, in first place, determined by the dipole transition selection rules and the symmetry of the investigated system. [3] To see new physics, one can modify the selection rules. This can be done by either breaking the symmetry of cuprous oxide or by modifying the properties of the light. The latter one can be realized by adding angular momentum to the light in order to drive forbidden exciton states.





The method used to observe such physics is absorption spectroscopy. So far, we have implemented an automated setup containing an infrared external cavity diode laser in combination with a periodically poled lithium niobate crystal with waveguide channels, providing a tunable narrow line width (2MHz) light source emitting at around 2.17 eV. [4] We want to expand these studies and focus on higher spectral resolution in narrower frequency range in order to observe smaller features in the absorption spectrum lying spectrally closer to each other, e.g., higher angular momentum excitons. Therefore we need to extend the mode-hop free tuning range and develop an automated laser scan over several such ranges.

Current Laser Setup



Literature:

[1] Fröhlich, D., Physica Scripta **T35**, 125-128 (1991); [2] Kazimierczuk, T. et al., Nature **514**, 343-347 (2014); [3] J. Thewes et al., PRL **115,** 027402 (2015); [4] M. Fischer, Master Thesis (2017)

Your work includes:

- Laser spectroscopy
- Work with cryogenics and lasers
- Automatization of a spectroscopy setup using LabVIEW
- Work at the intersection of atomic physics and solid state physics

Qualifications:

- Basic knowledge of solid state physics and optics
- Basic skills in electronics and programming (LabVIEW)
- Reliable and safe working in laboratory

Contact:

Annika Konzelmann, a.konzelmann@pi4.uni-stuttgart.de, Tel.: 0711-685-69872
Harald Giessen, h.giessen@pi4.uni-stuttgart.de

We are looking forward to your application!