Classical and Quantum Scattering with Rydberg Excitons

V. Walther[1,2*], S. Tiwari[2], S. Lahiri[1]

[1]*Department of Chemistry, Purdue University, West Lafayette, USA*
[2]*Department of Physics and Astronomy, Purdue University, West Lafayette, USA*
**e-mail: vwalther@purdue.edu*

Excitonic Rydberg states provide very strong interactions between excitons as well as with the crystal environment. I will report on two ongoing projects, highlighting how these interactions can induce scattering of excitons and photons.

In the first part, I will delve into the role of defects in Cu_2O for the propagation of Rydberg excitons through the crystal. Starting from a microscopic calculation of the asymptotic charge-exciton interactions, I will discuss the scattering of excitons at various impact velocities. The goal of this ongoing project is to make predictions about the role of recently the discussed "crystal purification" using Rydberg excitons [1] in cavity experiments.

In the second part, I will discuss a proposal to create entangled pairs of excitons and photons from scattering off monolayered semiconductors. Combined with the collective response of excitons confined to two dimensions, Rydberg interactions can be used to scatter incoming photons into selected momentum modes. We will analyze the momentum-space dynamics and quantity the emergent entanglement.

References

[1] Bergen et al., Large scale purification in semiconductors using Rydberg excitons, Nat. Comm. **14**, 8235 (2023)