

Valentin Walther

Assistant Professor of Chemistry, Purdue University

Rydberg-based quantum technologies with atoms, solids and light

Wednesday, September 27, 2023; 2:00 p.m., BRK 2001

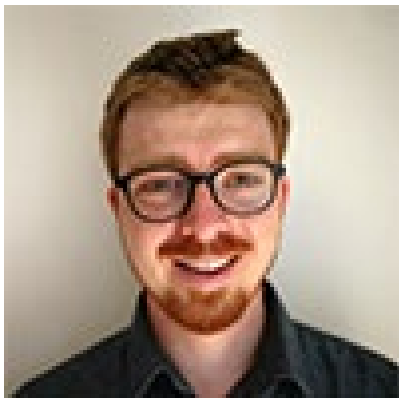
[Zoom Link](#)

Over 100 years ago, the discovery of Rydberg states ushered in the development of quantum mechanics. Recently, Rydberg states have emerged as a remarkably controllable and versatile platform for quantum science, offering diverse applications in quantum sensing, simulation, computation, and optics. This talk highlights the overarching potential of Rydberg states, focusing on two examples: Rydberg excitons and Rydberg macrodimers.

In the first part, we delve into the world of Rydberg excitons, highly excited bound states of electrons and holes in semiconductors, showcasing their ability to induce significant optical nonlinearities in crystals. Ongoing efforts to push these nonlinearities to the ultimate quantum limit of single photons will also be discussed.

The second part provides an overview of recent progress on giant diatomic molecules composed of two Rydberg atoms (Rydberg macrodimers), excited from an optical lattice. These molecules feature an intriguing binding mechanism mediated by van der Waals forces. We will explore how Rydberg macrodimers can be optically coupled to a continuum of free motional states, leading to the formation of multi-atom molecules bound by light.

Through these exciting examples, we demonstrate the profound potential of Rydberg states for future advancements in quantum science and technology.



Valentin pursued his undergraduate studies in theoretical physics in Frankfurt, Germany, and later completed his studies at Stony Brook University on a Fulbright fellowship, where he focused on nonequilibrium statistical mechanics under the guidance of Prof. Ken Dill. He went on to earn his PhD under the mentorship of Prof. Thomas Pohl at the Max-Planck-Institute for the Physics of Complex Systems (Dresden, Germany) and Aarhus University (Denmark), with a specialization in Rydberg interactions of semiconductor excitons. Following an independent postdoctoral appointment at Harvard University (The Institute for Theoretical Atomic Molecular and Optical Physics), he established his own scientific group at Purdue University in January 2023.