Manipulating Quantum Light in 2D Materials with Chemical Functionalization

Nathaniel P. Stern
Department of Physics and Astronomy
Northwestern University

The quantum conception of light consisting of particles of discrete energy, or photons, underlies its interaction with matter. This concept has facilitated groundbreaking applications in technologies ranging from sensors and displays to lasers. Ongoing advances in materials continue to enhance our understanding of how light interacts with matter in low-dimensional configurations. Layered materials of atomic-scale thickness present a two-dimensional (2D) landscape in which to manipulate and probe the interaction between photons and matter, revealing diverse opportunities for control based on morphology, surface chemistry, and electromagnetic environment. In this presentation, I will describe how the distinctive features of layered materials can be harnessed for generating and exploring optical phenomena. I will focus on two examples. First, I will briefly describe how the properties of 2D materials give rise to spin-polarized half-light, half-matter superpositions that can be manipulated at picosecond timescales like a two-level spin. The polarization-sensitivity of these materials can be an ingredient of chiral interactions. Further, I will discuss recent insights into how the surface of 2D materials can be used to manipulate and to improve quantum light emission from defects through chemical functionalization. Interactions with some molecules can result in narrow, localized photoluminescence peaks, while other chemical treatments can suppress native 2D material emission to isolate the single photon sources. The confluence of quantum emission, optical control, and chemical accessibility available with the optical properties of 2D materials expands the toolbox for engineering quantum optical applications.