University at Buffalo
Department of Electrical Engineering
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CONTROLLING EXCITONS IN 2D MATERIAL HETEROSTRUCTURES

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Abstract: Two dimensional (2D) semiconductors, such as MoSe2 and WSe2, host tightly bound excitons (electron-hole pairs) that interact strongly with light. These monolayer semiconductors can be stacked together to realize heterostructures that exhibit new excitonic effects. In this presentation, I will discuss the optical response of two different 2D semiconductor heterostructures. First, I will review the progress towards understanding interlayer excitons in MoSe2 -WSe2 heterobilayers. These interlayer excitons host a rich moiré physics associated with the spatially modulated interactions between layers. I will discuss our recent discoveries related to the origin of spectrally narrow photoluminescence from single photon emitters in these heterostructures. Interlayer excitons also possess a large permanent dipole moment that allows for their energy to be tuned with an out-of-plane electric field. By nano-patterning a gate on top of the MoSe2-WSe2 heterostructure, we are able to realize quantum dot-like potentials, which have potential applications toward realizing deterministic single photon emitters. Using the same architecture, we have demonstrated high speed interlayer exciton currents based on "slide" like quasi-one dimensional channels which have applications to excitonic circuitry.

Bio: John Schaibley is an Associate Professor of Physics at the University of Arizona (UA). He received his Ph.D. from the University of Michigan working under Duncan Steel, and did his postdoc with Xiaodong Xu at the University of Washington. He was an Assistant Professor of Physics at UA from 2016-2023. Schaibley is an experimental condensed matter physicist, with specific interests in quantum and optical effects in nanoscale semiconductors. Specifically, he investigates optical physics of 2D and 1D van der Waals materials and III-V quantum dots. His recent achievements include developing quantum dots based on 2D heterostructures and developing 2D semiconductor plasmonic modulators that realize slow-light effects.

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