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Engineering light-matter interactions in atomically thin semiconductors

Abstract: Studying and controlling light-matter interactions lies at the heart of modern physics and promises to bolster applications, such as quantum information processing. Two-dimensional (2D) semiconducting transition metal dichalcogenides, which feature strong interactions with light despite being only a few atoms thick, have emerged as a promising materials platform to investigate such interactions at the nanoscale. In this talk, I will focus on how to control light-matter interactions using 2D materials and how these studies lead to new insights into quantum many-body systems. In particular, I will first discuss the electromechanical tuning of the photonic environment in a suspended 2D materials device to realize dynamical control of exciton's radiative lifetime [1]. I will then describe how fabricating bilayer 2D heterostructures allows us to engineer chiral light-matter interactions [2]. Finally, I will demonstrate using optical probes to study exotic electron states, such as the crystallization of electrons, in 2D electron systems [4].

References:

[1] Controlling excitons in an atomically thin membrane with a mirror. Y. Zhou et al. **Physical Review Letter** 124, 027401 (2020).

[2] Electrically tunable valley dynamics in twisted WSe_2/WSe_2 bilayers. G. Scuri et al. **Physical Review Letter** 124, 217403 (2020).

[3] Broken mirror symmetry in excitonic response of reconstructed domains in twisted $MoSe_2/MoSe_2$ bilayers. J. Sung et al. **Nature Nanotechnology**, 15, 750-754 (2020).

[4] Bilayer Wigner crystals in a transition metal dichalcogenide heterostructure. Y. Zhou et al. **Nature**, 595, 48–52 (2021).

Bio: Dr. You Zhou is an Assistant Professor in the Department of Materials Science and Engineering at the University of Maryland, College Park. He was a postdoctoral fellow in Prof. Hongkun Park's group at Harvard University between 2015 and 2020, focusing on excitonic and electronic properties of 2D semiconductors. He earned his Ph.D. in Applied Physics from Harvard in 2015, studying under Prof. Shriram Ramanathan, studying metal-insulator transitions in transition metal oxides such as VO_2 and $SmNiO_3$, after receiving his bachelor's degree in Physics from Peking University in 2010.