Contribution ID: **291** Type: **Plenary**

2D Quantum Materials for Next-generation Quantum Photonic Devices

Two-dimensional (2D) van der Waals quantum materials have become important building blocks for future electronic, photonic, phononic and quantum devices. The highly enhanced Coulomb interactions in the atomically thin quantum 2D materials, arising from the reduced dimensionality and weak dielectric screening, allows the formation of tightly bound excitons, biexcitons and interlayer biexcitons. These tightly bound quasi-particles have been of keen interest for both fundamental studies and novel device applications, such as entangled photon sources, quantum logic gates, etc. The recently discovered single photon emitters at room temperature from the defects in 2D hexagonal boron nitride could find promising applications for quantum sensing and quantum communications. Because of their ultra-light weight, defect-less surface and low intrinsic losses, atomically thin 2D materials are also perfect candidate materials for ultra-sensitive transducers for sensing and communication applications. In this talk, I would like to talk about how to tailor the van der Waals interactions and engineer the light-matter interactions in ultrathin quantum materials, for next-generation nano-photonic and quantum devices. I will highlight our recent work on the discovery of new quantum phases from freestanding hetero bilayers, as well as the generation of entangled quantum light sources using ultra-thin nonlinear quantum materials. Finally, I will talk about my vision and discuss some possible future directions regarding the photonic and quantum applications of novel 2D materials and their heterostructures.

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Session Classification: Plenary