Exciton-phonon interaction in tuneable alloys of transition metal dichalcogenides

Two-dimensional (2D) materials such as transition metal dichalcogenides (TMDs) have attracted growing interest due to their unique optical and electronic properties. Their **alloys**—formed by combining different TMDs—offer even greater flexibility, as their **properties can be precisely tuned by adjusting the ratio of constituent elements**. This enables the design of materials that **emit light at specific wavelengths**, which is valuable for applications in tunable light sources and photovoltaics.

While the optical response of TMD monolayers is well understood, the **photoluminescence (PL)** behavior of TMD alloys remains largely unexplored. Similarly, the impact of thickness and strain on **phonon energies**—especially low-frequency interlayer modes—is not fully understood. These low-energy vibrations are highly sensitive to the number of layers, offering a non-invasive way to determine layer thickness—an essential parameter for designing structures like moiré superlattices and gated devices. Another important but poorly studied phenomenon is **exciton–phonon coupling**, which influences energy relaxation, linewidth broadening, and resonance effects in Raman scattering. Strain, particularly in naturally formed nanodomes or bubbles, can significantly alter both Raman and PL spectra.

This project aims to investigate **the optical and vibrational properties as well as exciton–phonon coupling in selected TMD alloys** with varying composition, thickness, and strain. Samples will be prepared via mechanical exfoliation from bulk crystals. Strained structures will be created through hydrogen ion irradiation, and high-quality samples will be fabricated using deterministic transfer techniques with encapsulation in hexagonal boron nitride (hBN). **The innovative aspect of this project lies in its combined use of advanced optical techniques under various external perturbations such as strain and layer thickness**. The findings will contribute to the development of next-generation tunable optoelectronic and quantum devices based on 2D materials.