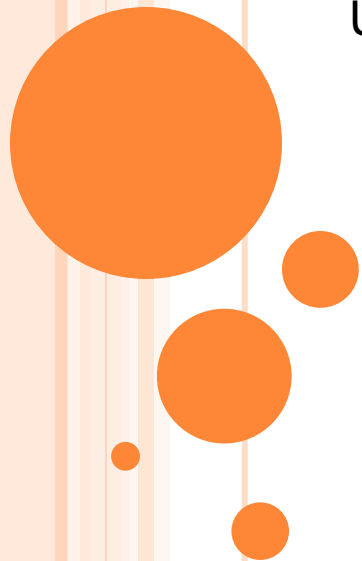


Photoluminescence and Second Harmonic Generation 2D Maps of Monolayer Semiconductors

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UW Physics REU 2013



Outline

- Introduction
- My Project
- Results
 - 2D images
- Future Work



What is MX_2 ?

- M is the group VIB transition metal (Mo, W)
- X is the chalcogenide atom (S, Se)



http://genevalunch.com/wp-content/uploads/2011/01/MoS2_crystal2.jpg



Figure a – Crystal structure of MX_2

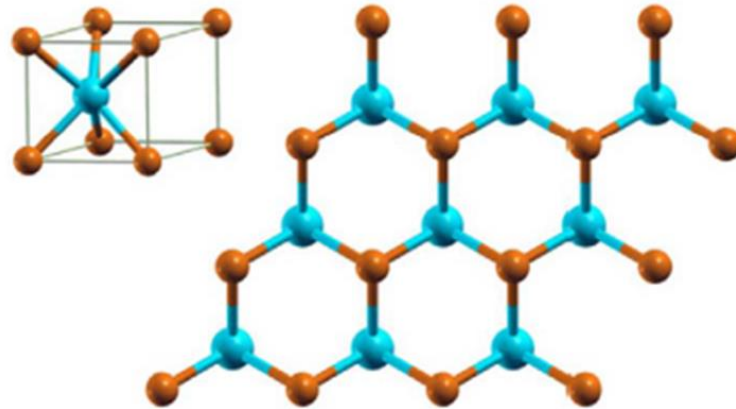
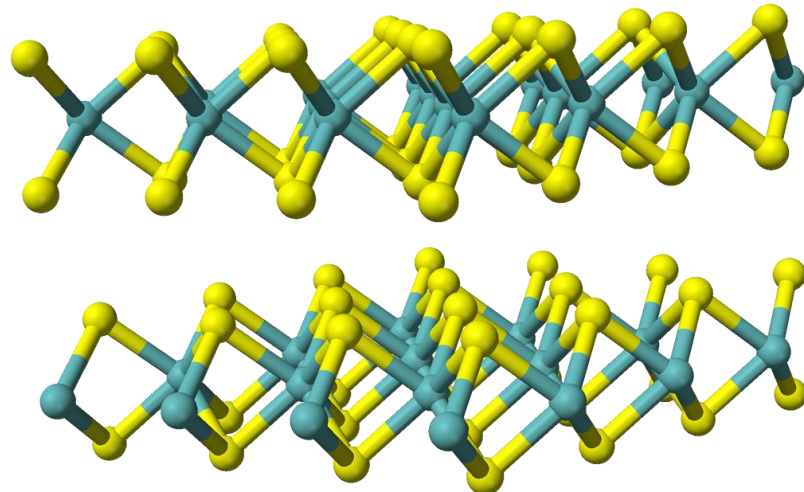


Figure b- Bilayer MX_2



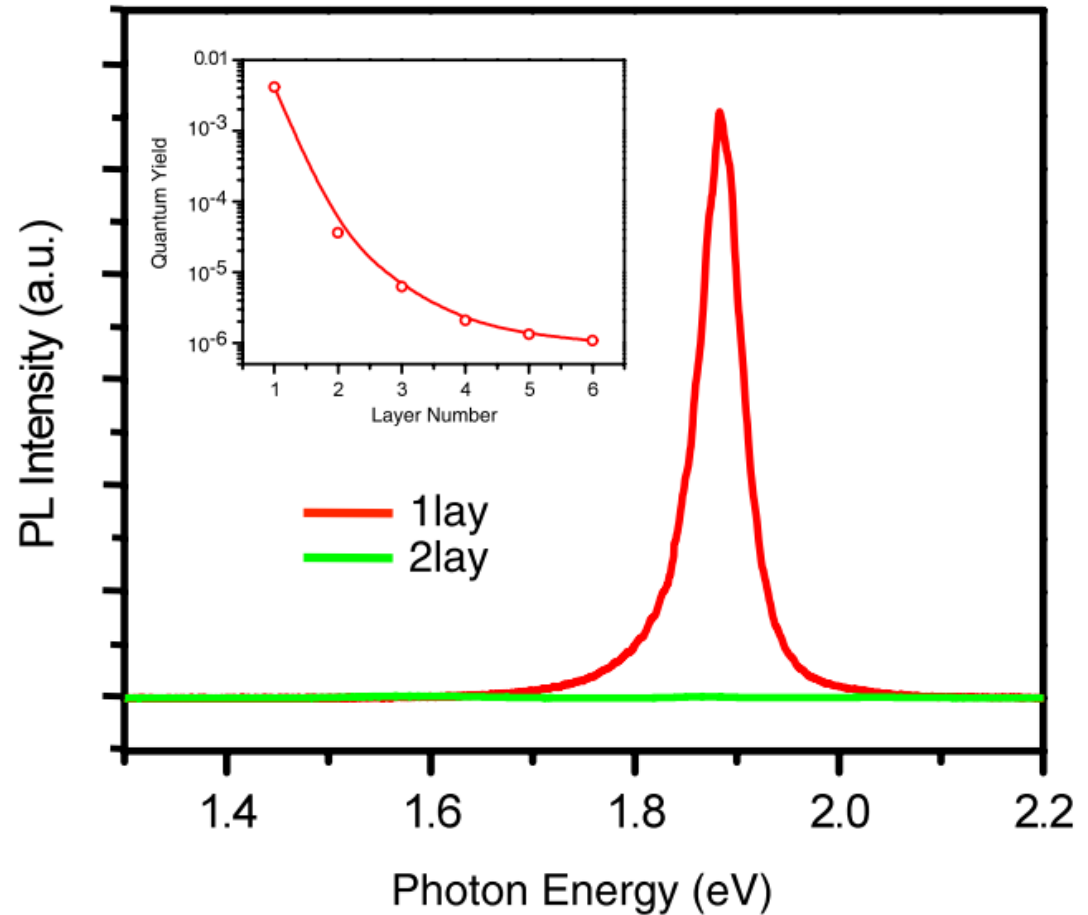
Why do we care about MX_2 ?

- Wide range of interesting optoelectronic properties in monolayer limit
 - Interacts strongly with light
 - Electrically controllable
 - Novel spin physics
- Applications?
 - LEDs, solar cells, nano-lasers, quantum information processing, etc.

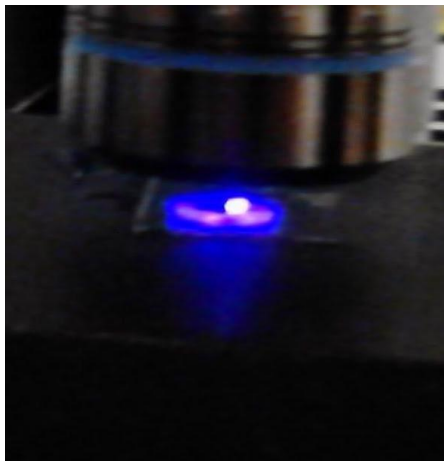
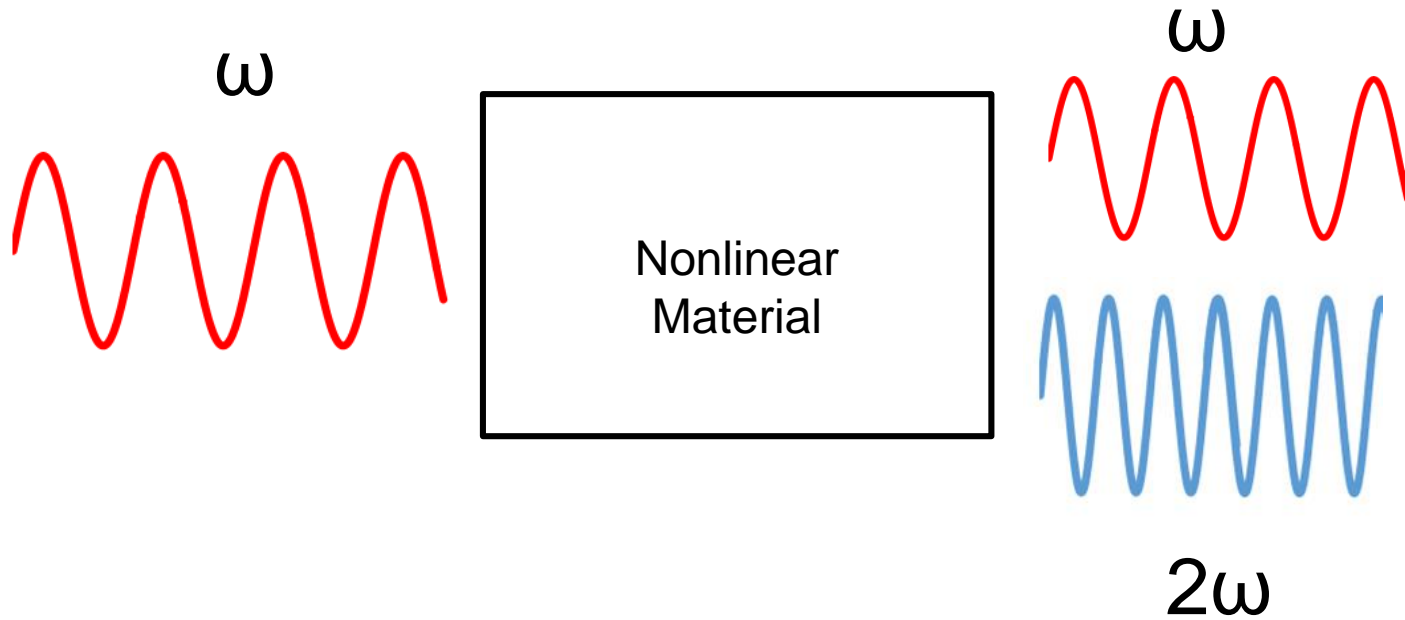


Strong Photoluminescence in Monolayer MX_2

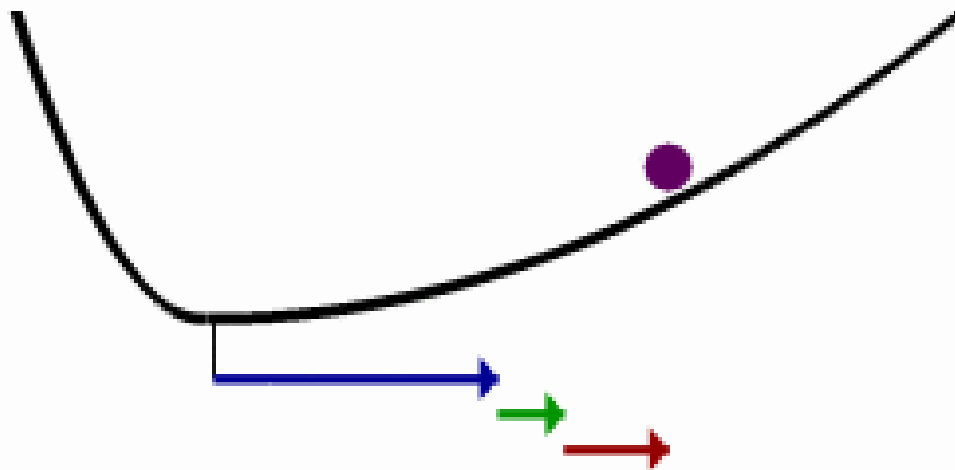
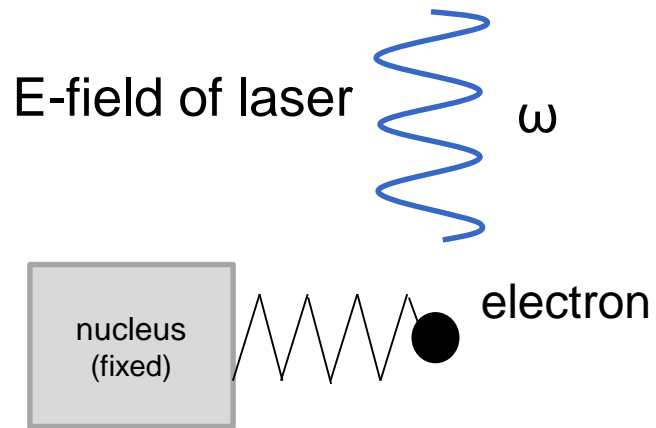
- Monolayer MX_2 strongly absorbs and emits light
- Identification of layers



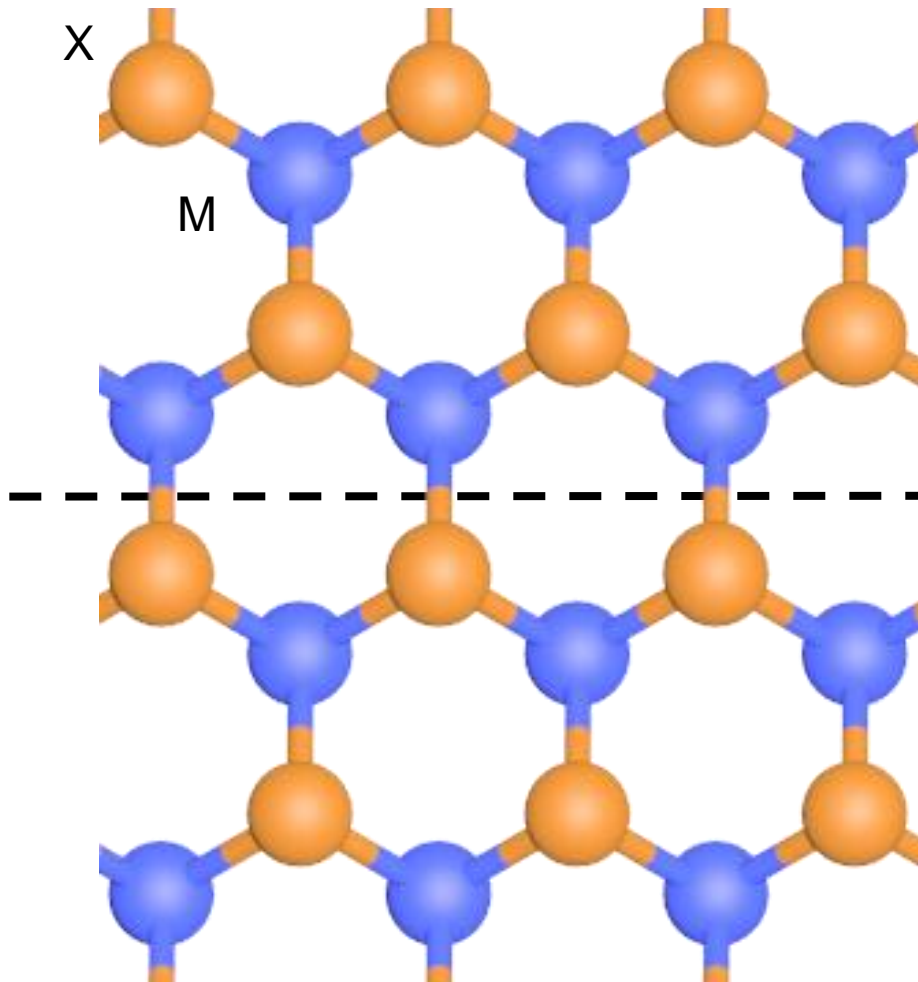
Second Harmonic Generation (SHG): What is it?



What causes SHG?

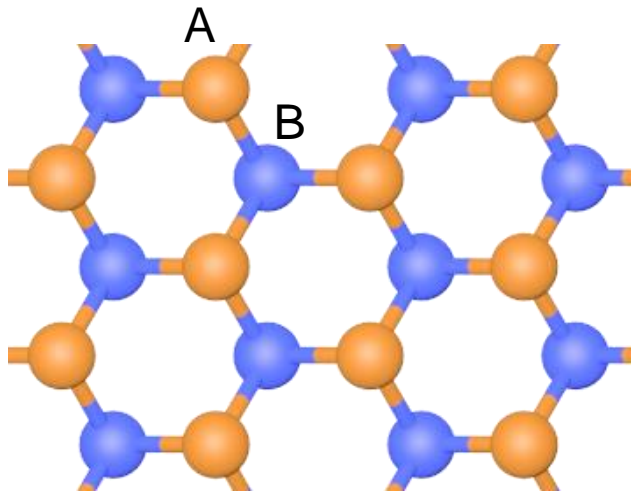


Broken inversion symmetry in monolayer MX_2

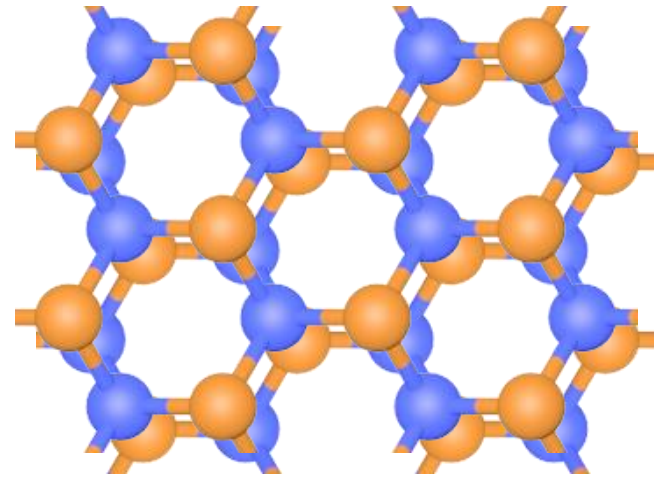


SHG in Few-Layer MX_2

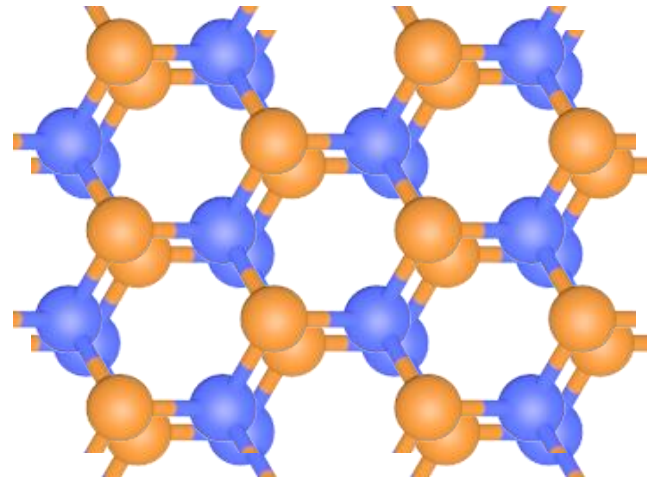
Monolayer



AB stacked bilayer



AA stacked bilayer

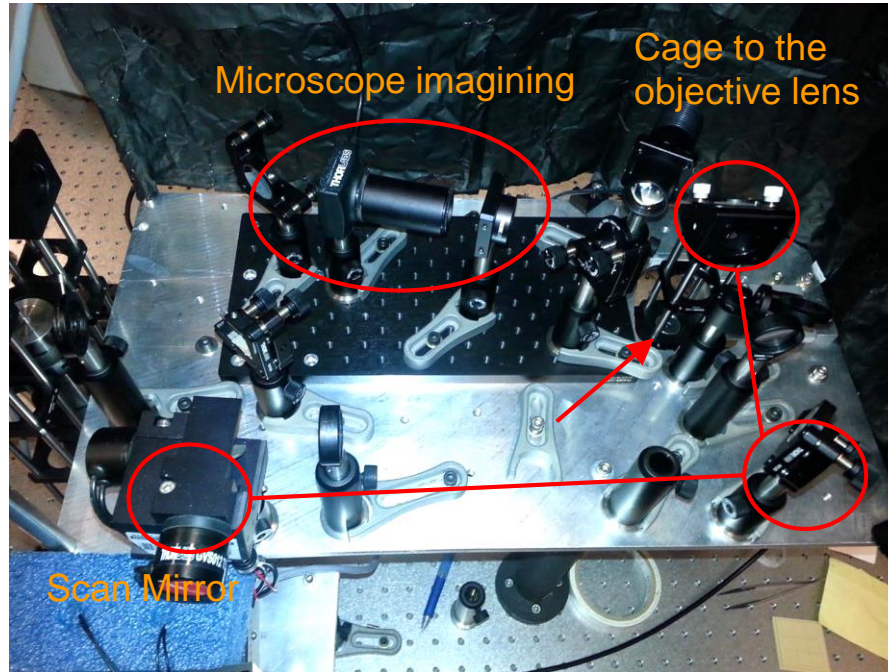


Can we spatially map the PL and SHG?

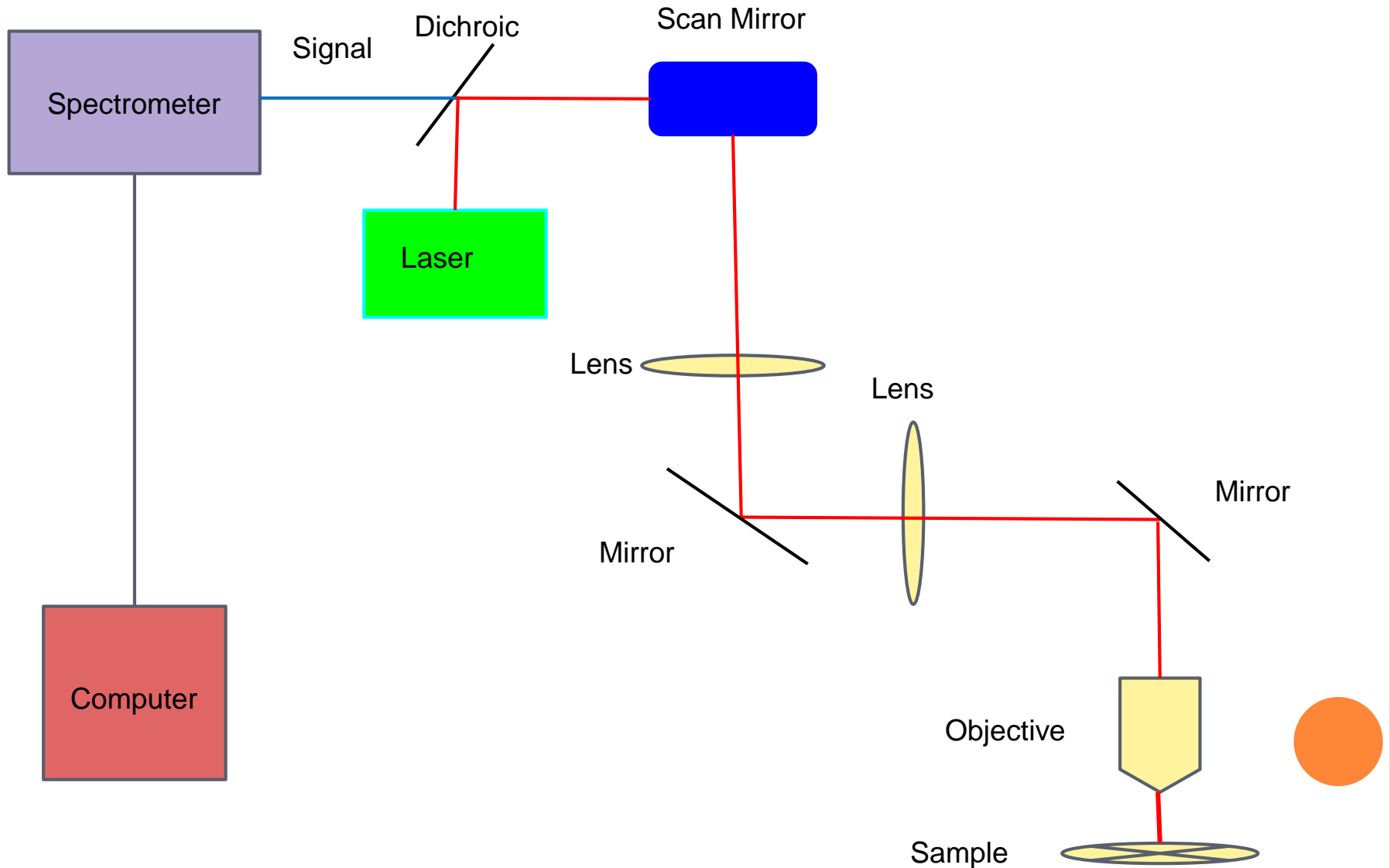
Microscope image



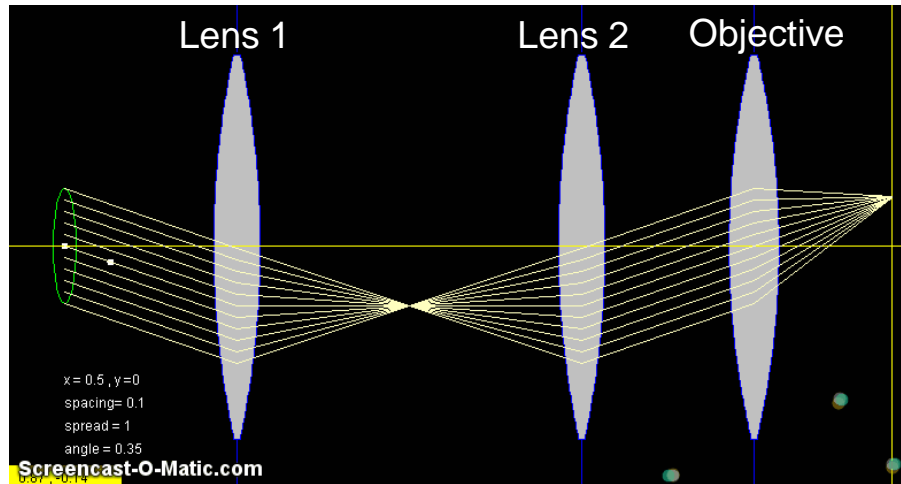
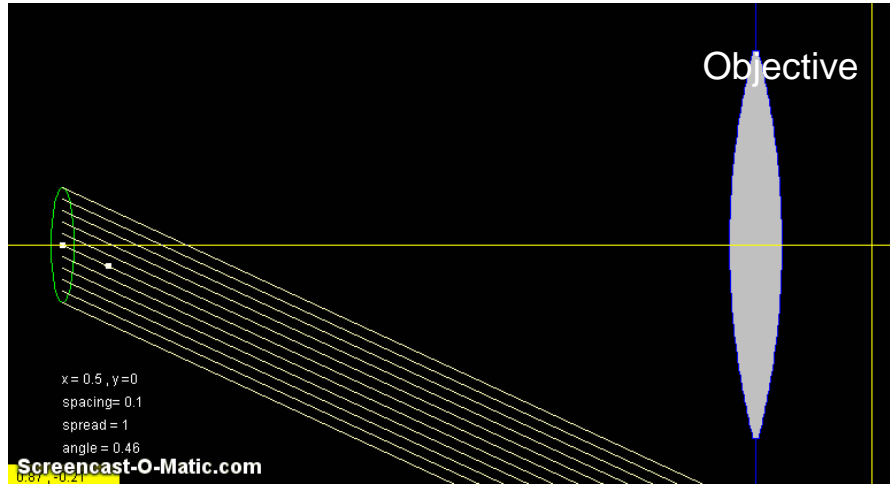
My Project: A Scanning PL and SHG Setup



Scanning PL and SHG Schematic



Theory of Scanning Setup

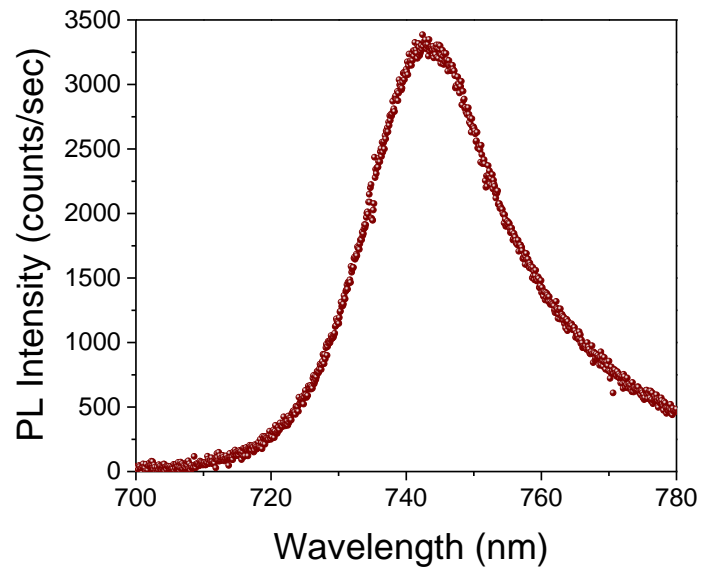
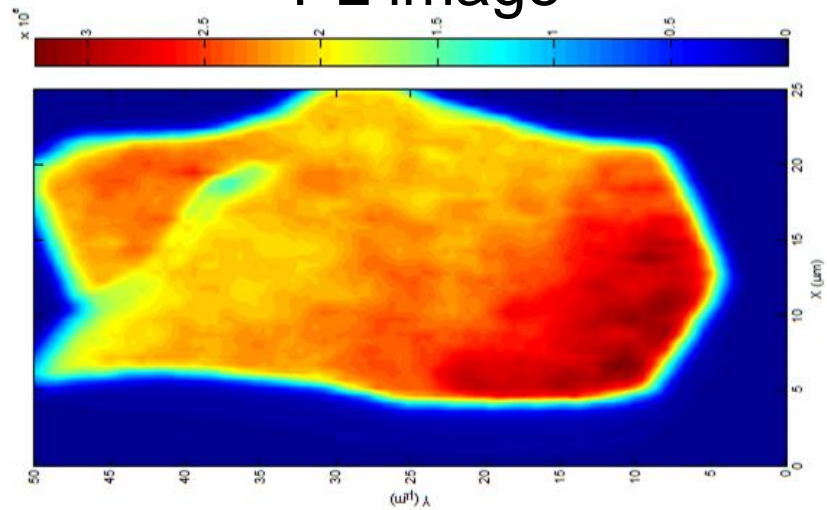


PL from WSe₂

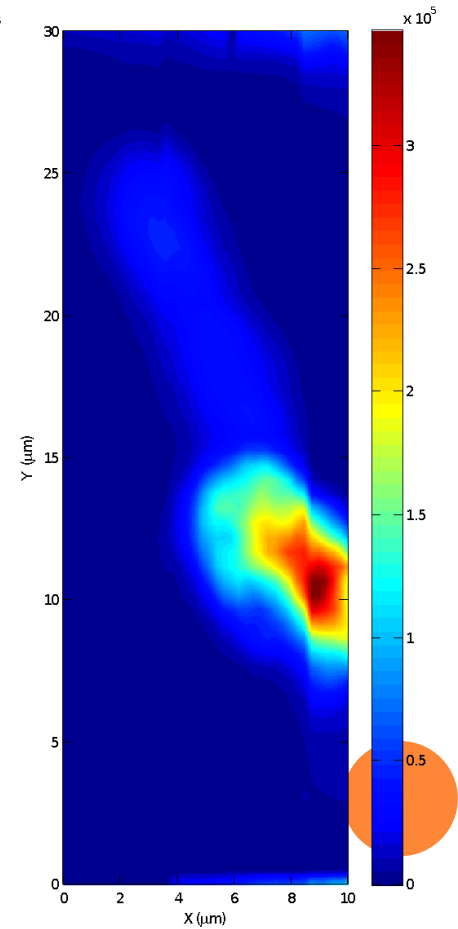
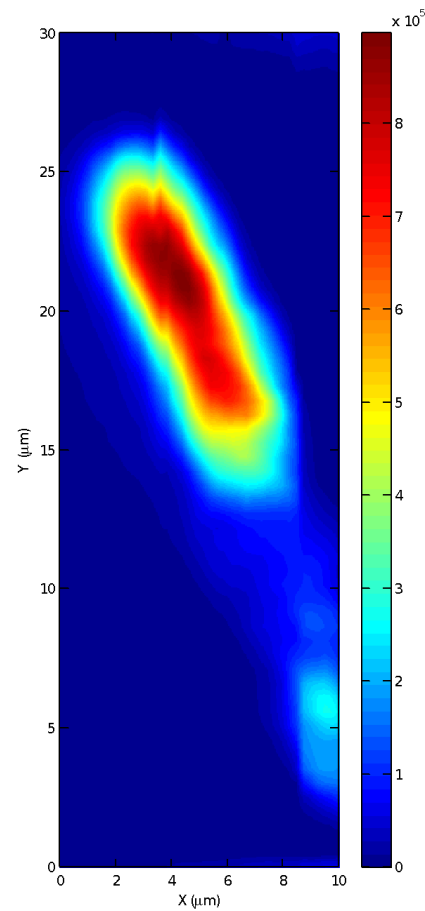
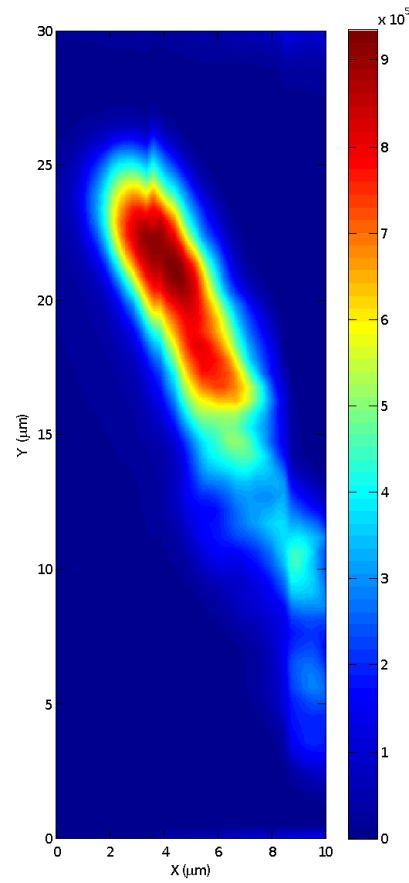
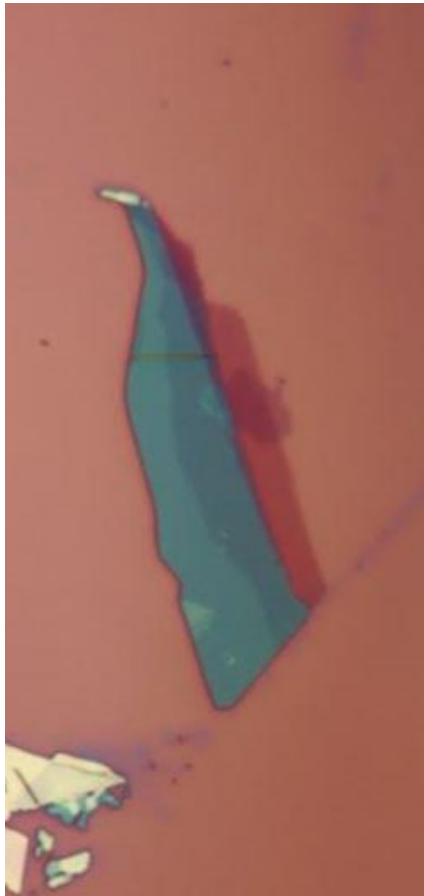
Microscope image



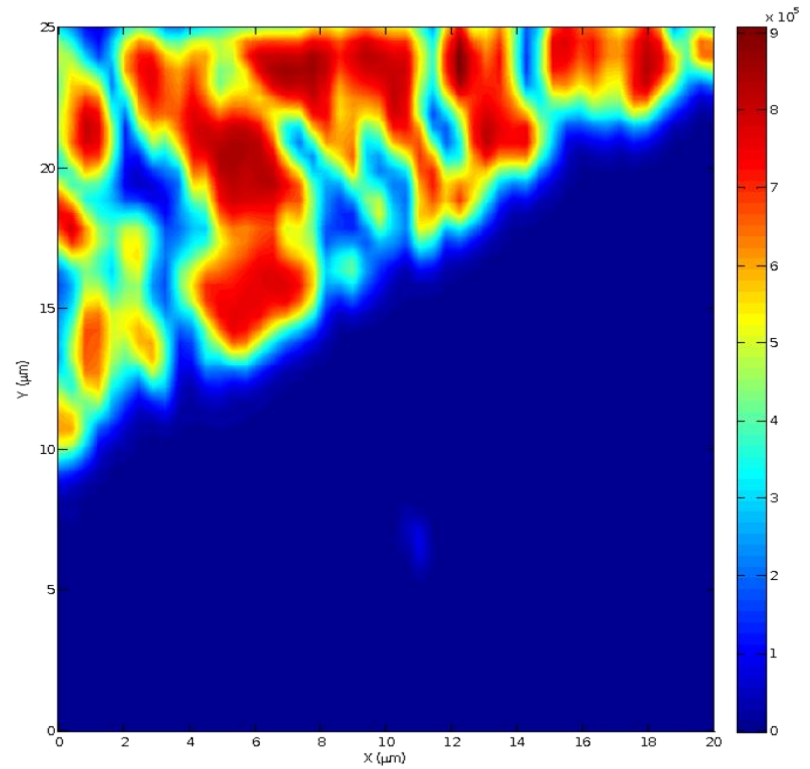
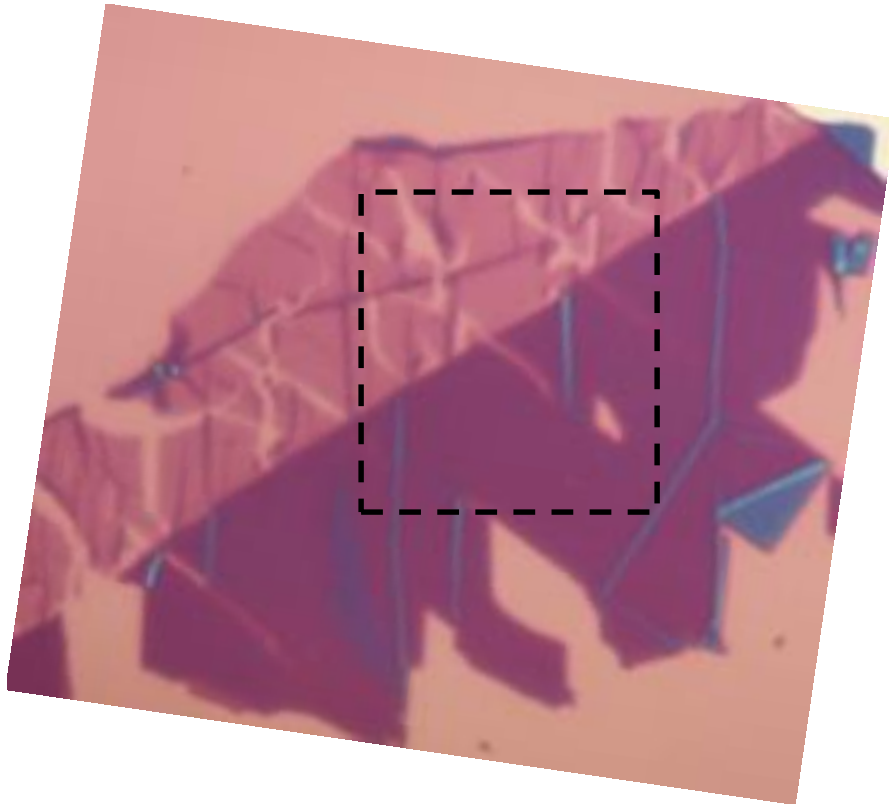
PL image



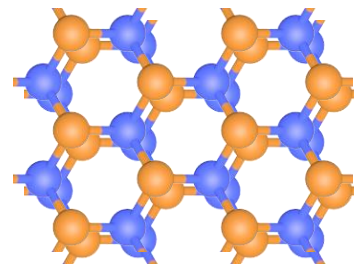
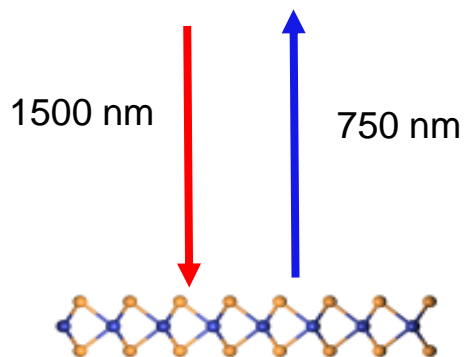
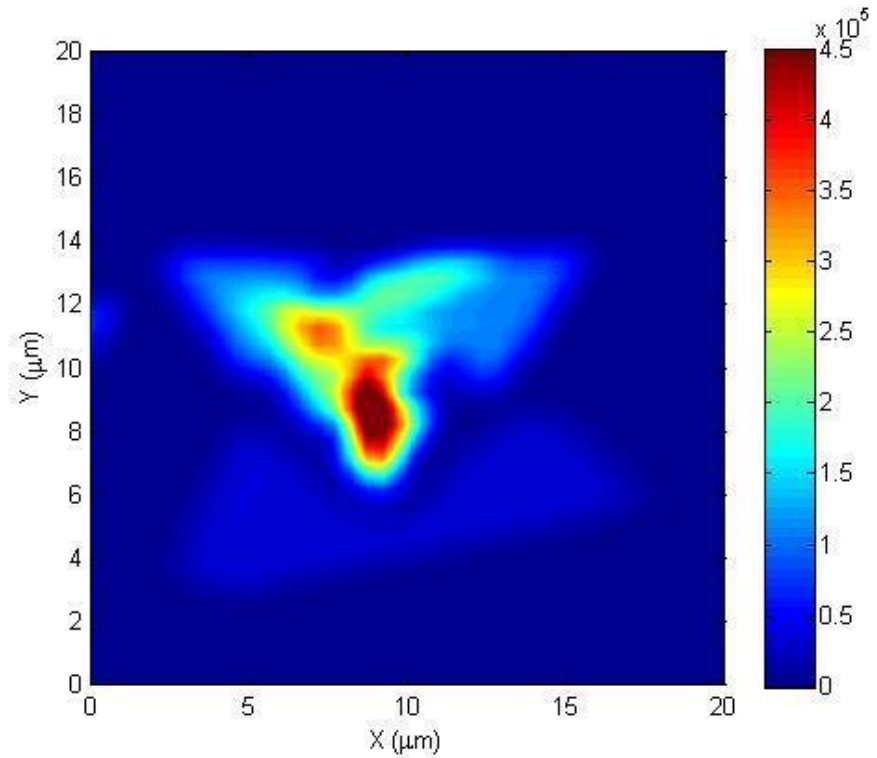
PL from a Heterostructure of WSe_2 and MoSe_2



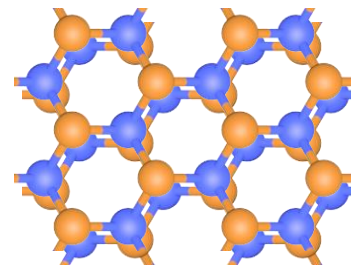
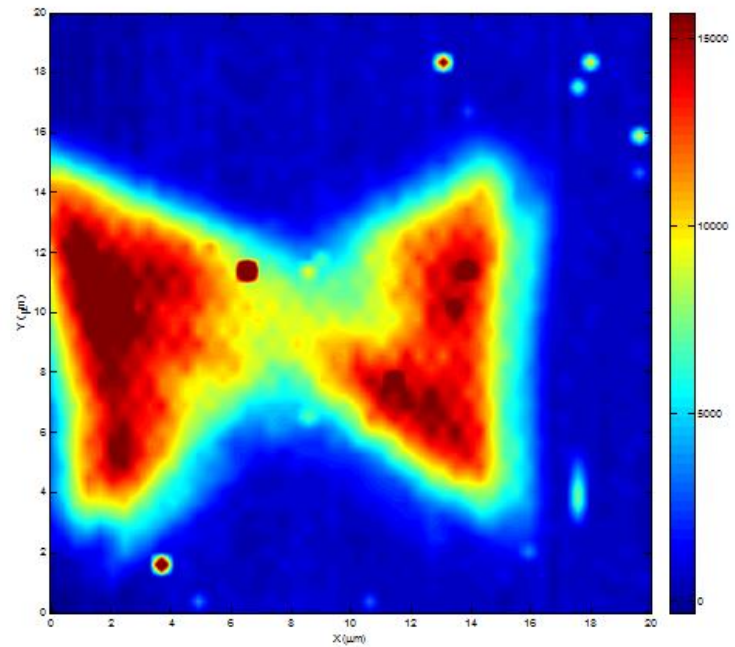
PL from Fold Dry Transfer



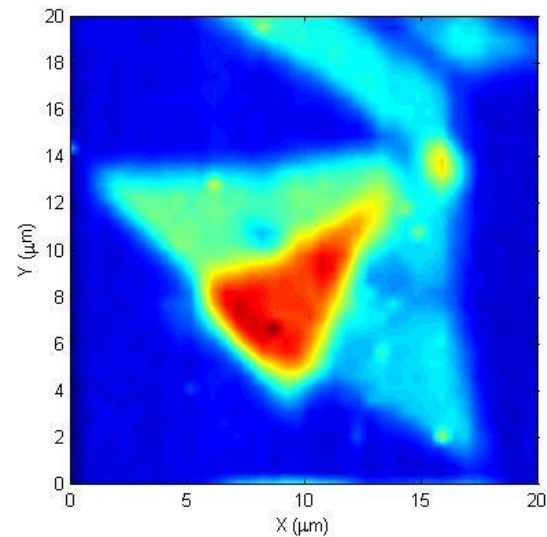
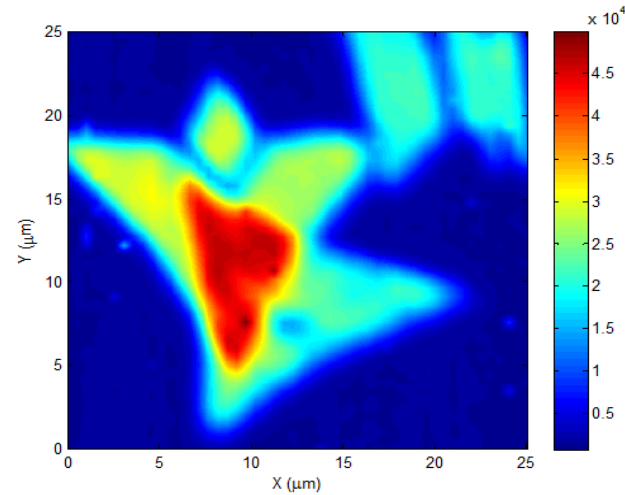
SHG from CVD WSe₂



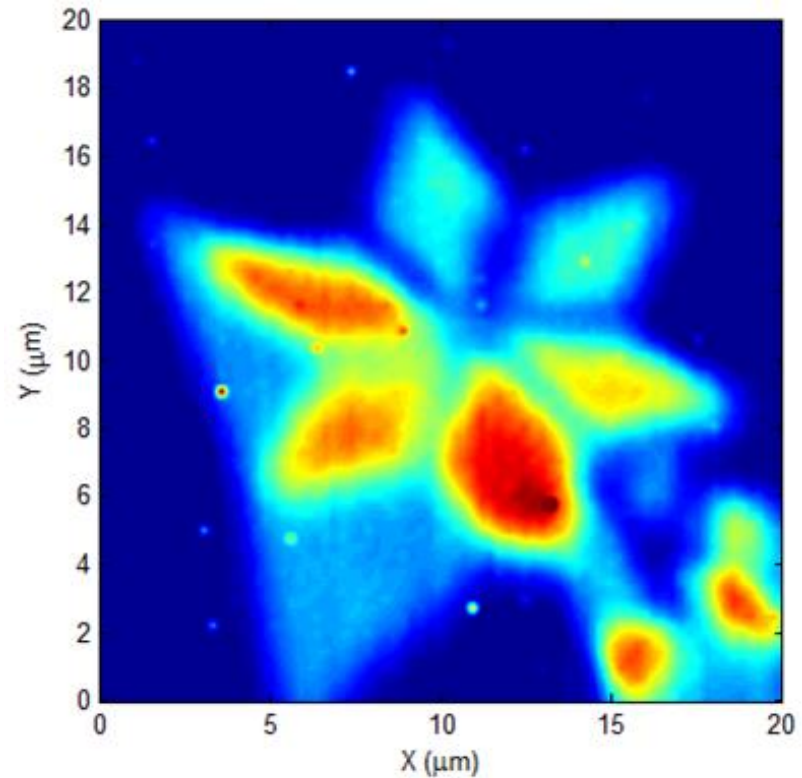
SHG from CVD WSe₂: AB Stacked



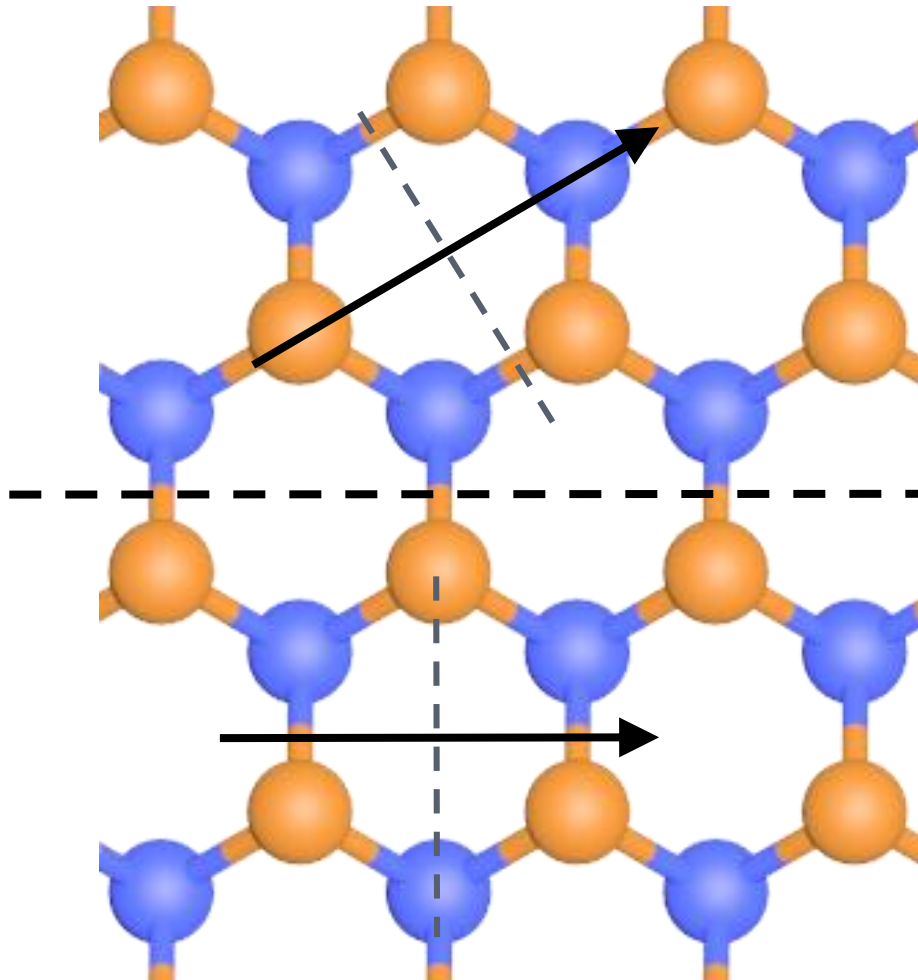
SHG of Stacked Bilayers: “The Dancing Man” and “Hanging Bat”



SHG Stacked Bilayer WSe₂: “The Star”



Future Work: Polarization-resolved SHG



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