Master / Semester Thesis

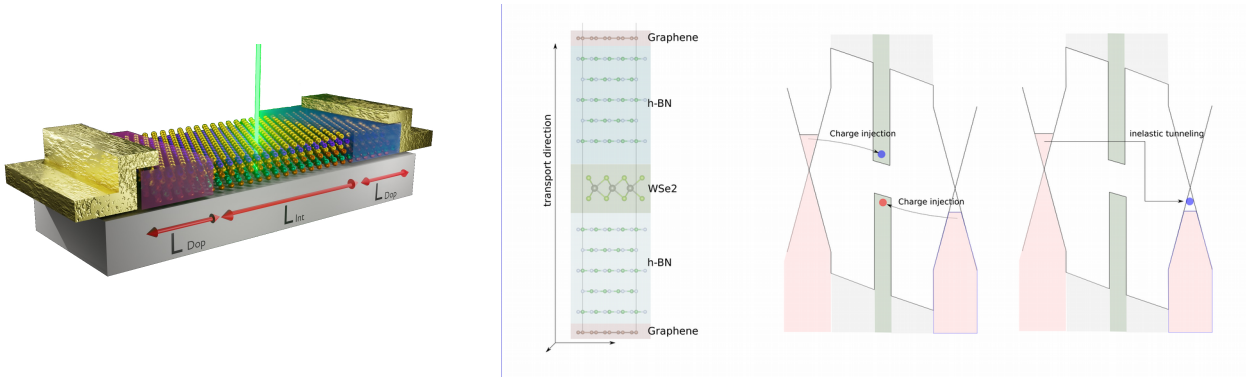
Vertical quantum transport and energy transfer in atomically thin 2D-material stacks

Short Description
Stacks made of 2D materials are important candidates for future efficient electronic and optoelectronic devices due to the great flexibility to tune their properties. The physical understanding of the charge and energy transfer mechanism in the vertical quantum transport through the 2D-material stacks will be the target of this project.

The big picture
Van der Waals structures are synthetic quantum materials composed of stacks of atomically thin 2D layers. In this project we focus on the transition metal dichalcogenide (TMDC), hexagonal Born-Nitride (hBN) and/or graphene heterostructures. TMDC are the most widely studied 2D semiconductors, featuring promising high mobility for future transistors and exciton states for optoelectronic devices with high energy conversion efficiency. The vertical quantum tunneling through the heterostructures are very important for a good understanding and optimization of the electronic transport in these future devices.

Type of work
Theory (20-30%), model development (40%), simulation & analysis (40%).

Prerequisites
You have (1) knowledge in nanoelectronics and semiconductor physics, (2) with Python and programming.



Left: an artistic rendering image of a photo-diode based on $MoSe_2/WSe_2$ heterostructures. Center: a van der Waals structure composed of graphene/hBN/WSe_2/hBN/graphene where transport happens vertically for electrical pumping. Right: band diagram of the van der Waals structure and two probable transport mechanism of the charged carriers.

Related reading
- https://pubs.acs.org/doi/10.1021/acs.nanolett.5b03740
- https://arxiv.org/pdf/2303.00363.pdf

Status: Available
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