Quantum transport in van der Waals heterostructures

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The rich and diverse properties of the several hundred different types of atomically thin, two dimensional (2D) materials offer exciting new research directions for both fundamental science and for technological applications. The character of these 2D crystals are often preserved and even enhanced when different layers are stacked together. These 2D crystal stacks are a new class of "designer" materials known as van der Waals (vdW) heterostructures which offer a way to tune and exploit the novel and exotic quantum properties of electrons in 2D materials. By choosing the appropriate combination of layer materials, electron transport characteristics can be built-in and tailored for specific device applications. Moreover, their electronic properties can be fine-tuned by modifying the relative twist angle between the layers of the devices. This provides a huge configuration space of material choice and relative twist angle for the development of new science and applications.

In this talk I will present an overview of our recent work on electron transport in vdW heterostructures. I will show how atomically thin graphene-boron nitride (hBN) tunnel transistors, comprising two graphene layers separated by a hBN tunnel barrier, can exhibit negative differential conductance with potential applications for high frequency electronics. I will show how placing ferromagnetic materials between the graphene layers have potential applications in spintronics. Finally, I will briefly review some of our work on ferroelectric Indium Selenide and give a wider perspective and review on how it can be combined with other 2D materials to develop applications for low-power digital memory.

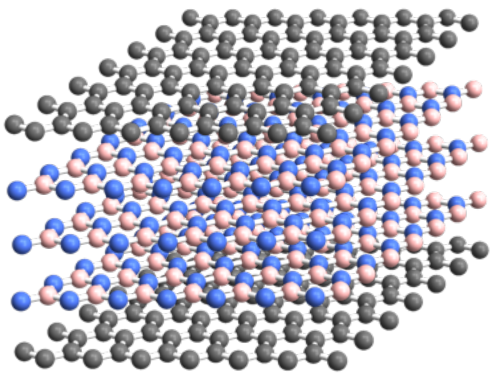

Figure: An example vdW heterostructure, comprising 2 graphene layers (grey) separated by a hBN tunnel barrier

References

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