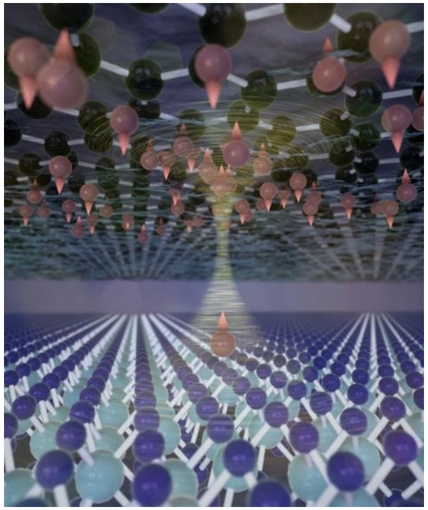
Quantum dots in two-dimensional heterostructures

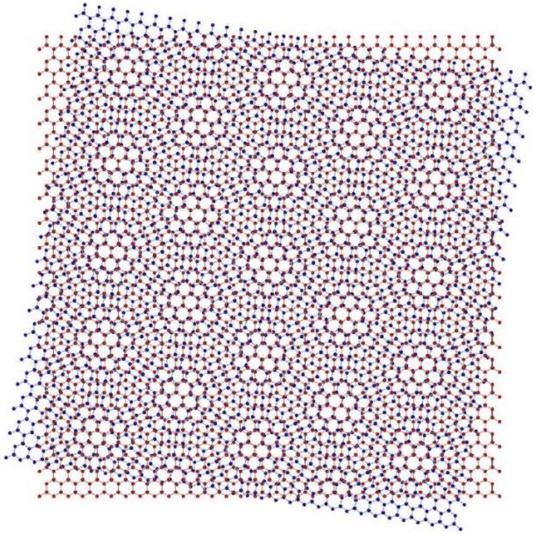
Speaker: Mauro Brotons-Gisbert
Heriot-Watt University

Date: Tuesday 18th February at 13:00

Room: P521

Van der Waals (vdW) heterostructures, in which a wide range of unique atomic layers can easily be combined, offer novel prospects to engineer and manipulate quantum confined states. Here I will present two approaches to this exciting prospect. I will first present Coulomb blockade in a vdW quantum dot device with tunnel coupling to a tunable Fermionic reservoir. Hybrid excitons, composed of localized quantum dot states (in WSe_2) and Fermi reservoir continuum states (in graphene), are observed due to ultra-strong spin-conserving tunnel coupling resulting from an atomically thin tunnel barrier (hBN). Secondly, I will present spin-layer locking of interlayer valley excitons (IX) trapped in moiré potentials. In a heterostructure of bilayer 2H-$MoSe_2$ and monolayer WSe_2, we observe two IX species trapped in moiré potentials with distinct spin-layer-valley configurations. Due to the phenomenon of locked electron spin and layer pseudospin in bilayer 2H-$MoSe_2$, the IX species exhibit opposite valley magnetic moments. Further, we find the 2H-$MoSe_2$ stacking intrinsically locks the atomic registries of IX^H and IX^R together. Finally, we will discuss photon antibunching of moiré trapped excitons to unambiguously prove their quantum nature.





Left figure: A cartoon of "quantum tunnelling" of electrons (red balls with arrows) between a sheet of graphene (top layer, black atoms) and tungsten diselenide (bottom layer, dark and light blue atoms).

Right figure: An illustration of the moiré superlattice formed in a "twisted" $MoSe_2/WSe_2$ heterobilayer.

University of Warwick Condensed Matter Physics Seminar