The electronic structure of 2D materials

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The electronic bandstructure contains complete information about the occupied electronic states which exist in a material. i.e. intrinsically it includes information on doping, Fermi velocities, confinement, the orbital nature of the bands, spin-coupling and all possible interactions. Measuring the electronic bandstructure is possible using techniques derived from photoelectron emission spectroscopy; and due to the exceptionally short probing length, this works particularly well for 2D materials and surface phenomena.

In this talk, I will describe some recent examples from our own research. In particular, I will describe how certain materials allow a smooth 3D to 2D transition, such that the role of dimensionality can be disentangled. Specifically, I will discuss the unusual phonon mediated scattering/coupling in graphene/graphite [1-3], the spin texture of monolayer transition metal dichalcogenides (TMDCs), and how the origins of this are derived from local symmetry breaking in the parent bulk compounds [4,5]. Finally, I will discuss the 3D to 2D transition in group-IV semiconductors (silicon and diamond) created as a result of a high-density dopant plane within the bulk material (see figure), and the implications of this confinement for the ultimate miniaturisation of classical and quantum devices [6-8].

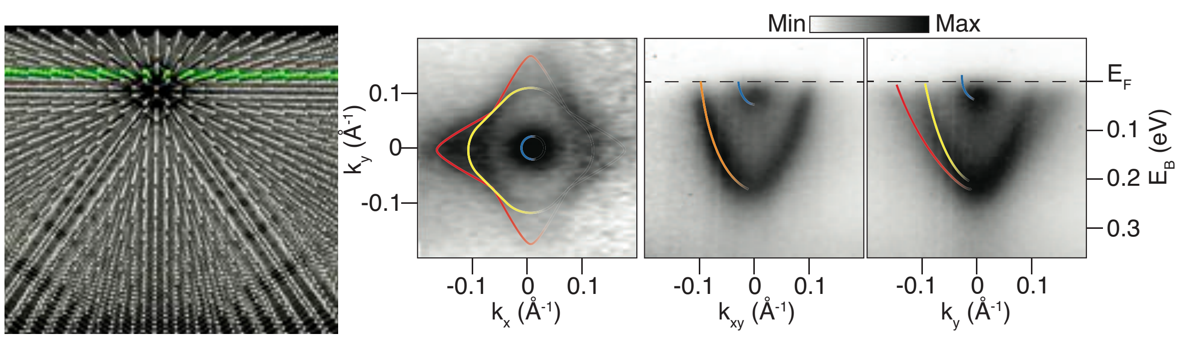

Figure: (Left) An atomically thin dopant layer (25% P doing) within a silicon host and (right) the corresponding electronic sub-band structure of the confined 2D electron gas which is created by this dopant plane.

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[8] Mazzola *et al.* PRL **120**:046403 (2018)

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