Electronic structure of 2 dimensional materials

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A joint Ph.D. project between CY Cergy Paris University (F) and University of Warwick (UK)
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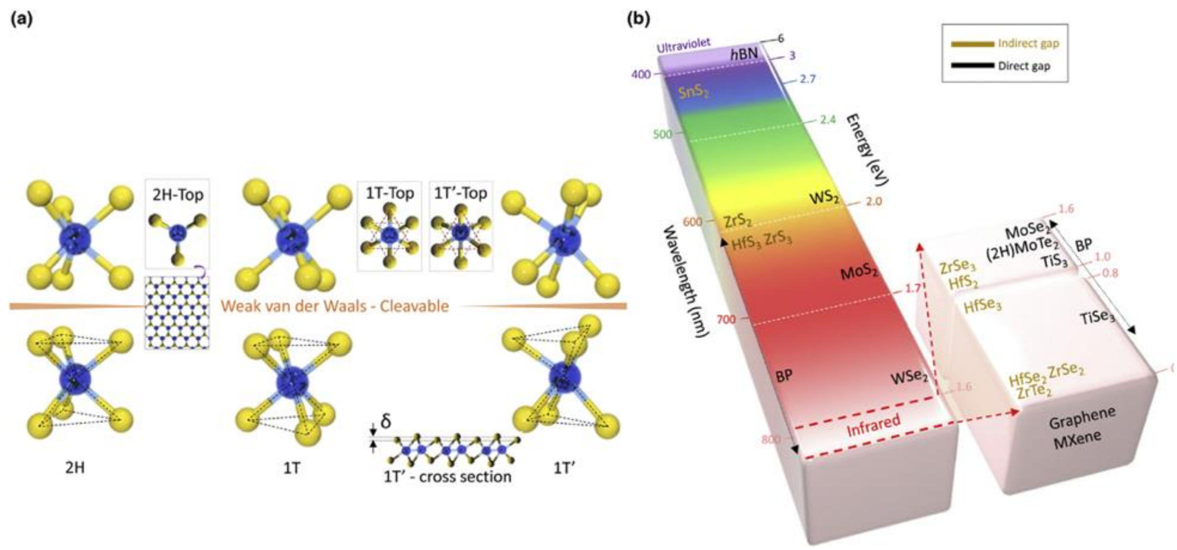
With charge-based electronics getting to their limits in storage density, speed and energy consumption, spin-based electronics (spintronics) is now a central research topic and promises significant improvements in device performance. Controlling spins is a major goal in spintronics since it is a low-energy-consumption handle to act on a fundamental property of matter.

Taking advantage of the predicted giant Rashba effect at their interfaces, transition metal dichalcogenides (TMDCs) can achieve this goal. TMDCs are referred to as 2 dimensional (2D) materials and their properties can be significantly modified by changing the material's thickness down to the monolayer limit.



(a) Typical structures of TMDCs. (b) Bandgap of 2D layered materials varying from zero band gap of graphene (white color) to wide bandgap of hBN. The color in the column is presenting the corresponding wavelength of bandgap. Indirect materials are represented at left and direct bandgap materials are represented at right side of the column.

By combining advanced angle- and spin- resolved photoemission spectroscopy (ARPES) and spin-resolved ARPES (SARPES), the project of this thesis aims at a thorough characterization of the spin-split bands of TMDCs deposited as thin layers down to a single monolayer via molecular beam epitaxy or mechanical exfoliation and transfer.

Experiments will include as well spin and time-dependent measurements at the ATTOlab laser facility in CEA with HHG (higher harmonic generation) photons, at synchrotron radiation centers and in the LPMS laboratory with 3rd and 4th harmonic of a Ti-Sp laser.

The PhD student will develop molecular beam epitaxy (MBE) growth of thin film TMDC samples (M = Hf, Ta, or, dichalcogen = Te, Se) in ultra-high vacuum (UHV) which she/he will fully characterize by using the SARPES setup of LPMS.

TMDC heterostructures will be prepared at Warwick university and characterized by electron and scanning probe microscopy as well as spatially resolved ARPES (at synchrotron light sources) and optical spectroscopies including ultrafast techniques such as terahertz spectroscopy.