Master 1: ***Quantum Engineering***

INTERNSHIP PROPOSAL

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Thesis possibility after internship: YES

Electronic properties of antimonene/graphene heterostructures

Since the isolation of graphene (Gr) in 2004, the research on 2D materials is experiencing an extraordinary rise [1,2]. Such materials, composed by single or few atomic layers, often display different physical properties with respect their bulk counterpart. Furthermore, their properties can be tuned by strain, by changing the number of atomic layers or coupling them to other 2D materials [2]. From an experimental point of view, two are the main objectives that drive this scientific field: *(1)* the **fabrication and characterization of novel 2D materials** which show novel properties [3,4] and *(2)* the vertical stacking of different 2D crystals to form the so-called **van der Walls heterostructures** with the desired properties [2]. Among the different 2D materails, **antimonene** is quite unique due to its **strong spin-orbit interaction**, which is one of the key ingredient of topological order of matter [5]. In fact, antimonene is a trivial semiconductor which become a 2D topological insulator when subjected to tensile strain [6]. Strained antimonene develops Dirac cones in its electronic dispersion which, due to the high spin-orbit interaction, present a band gap [6]. We recently produced a strained antimonene layer showing a spin-splitted Dirac Cone due to spin-orbit interaction. The next step of our study will consist in coupling the electronic properties of antimonene to the one of a graphene layer and address the mutual interaction of Dirac electrons in the heterostructure. In fact, by a careful choice of the orientation of the two lattices composing the structure, the Dirac cone of Gr will be located in the same reciprocal space region of the ones of antimonene. The aim of this intership is to study the electronic properties of the graphene/antimonene heterostructure, with particular attention to the effect of spin-orbit interaction induced in graphene by its interface with the antimonene. The internship will be focused on the optimization of the growth technique, in ultra-high vacuum conditions, and the *in-situ* characterization by angle resolved photoemission electron spectroscopy. This technique allows to measure the band structure of the material and represents the best tool to address the electronic properties of the system.

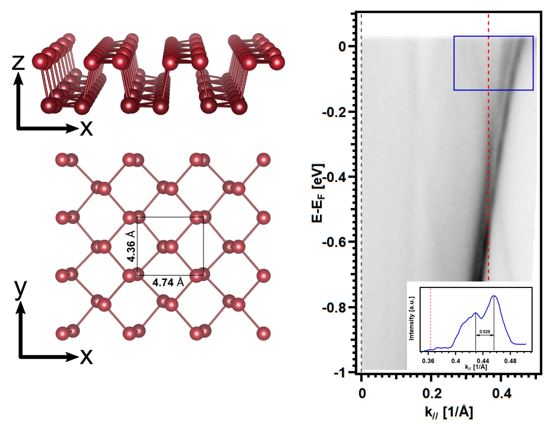

Fig 1 Left: Schematic representation of the structure of antimonene. Right: Our Angle resolved photoemission electron spectroscopy measurements showing a splitted Dirac Cone

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