Internship offered in M2
2017-2018

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Dirac Fermions in 2D Materials beyond Graphene

Two-dimensional (2D) materials are a wonderful playground for nowadays condensed matter physics and material science. A famous example of this class of materials is of course graphene, a single layer of carbon atoms having exceptional mechanical and electronic properties. Interestingly, graphene has opened an unexplored and broad road to new 2D materials, leading to a rich physics which intimately connects fundamental research and technological applications. The possibilities offered by these 2D materials seem endless and have triggered intense and fruitful research in the community.

Recently, the team of Prof. Matsuda at the University of Tokyo has obtained promising results on two new 2D materials: boron monolayer on a silver substrate and Cu_2Si layer on copper. For borophene, they could evidence its unusual electronic structure with a splitting of the Dirac cones due to periodic perturbations from the substrate [1]. In the case of Cu_2Si layer they revealed for the first time the existence of 2 dimensional Dirac nodal line fermions [2]. Their results suggest that these emerging 2D materials can be used as a new platform for novel high-speed and low dissipation devices. However, a strong limitation for these applications is that the boron or Cu_2Si monolayer is deposited on a metallic substrate.

This internship will deal with 2 main issues: the growth of the 2D sheets on a semiconducting substrate and the characterization of their electronic properties. In a first part, at INSP in France, we will study by Scanning Tunneling Microscopy boron and copper deposition on silicon carbide, a wide band gap semiconductor. In a second part, performed at ISSP and synchrotron Spring-8 in Japan, we will determine with (time-resolved) photoemission

the electronic structure of the 2D layers prepared in France.

This project can be pursued during a PhD. In that case, we will extend the study to 2D boron compound materials such as Fe_2B. Indeed, the combination of the exceptional electronic structure of the bi-dimensional layers with magnetism could lead to totally new properties.

[1] B. Feng et al., Physical Review Letters 118, 096401 (2017) (Featured in Physics)
[2] B. Feng et al., Nature Communications, accepted

Techniques involved: Scanning Tunneling Microscope, (Time-resolved) Photoemission

Type of internship: experimental
Paid internship: Yes
Can this internship be continued for a PhD? Yes
If yes, type of PhD funding envisaged is: Ecole Doctorale

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