Research Topic for the ParisTech/CSC PhD Program

Field: Physics, Material Science

Subfield: Physics, Electronic properties of matter, Spintronic

Title: Inducing spin-orbit and exchange interaction in 2-D materials by interface effects

ParisTech School: ESPCI Paris

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Short description of possible research topics for a PhD: The development of novel materials with non-trivial electronic properties is nowadays a major and competitive research field in condensed matter physics in the view of several possible applications in future electronics going from spintronics to quantum computing [1]. In this respect novel 2-dimensional materials (graphene, transition metal dichalcogenides, etc…) have attracted a considerable attention due to their outstanding electrons properties (Dirac Cone, outstanding mobility, etc...), although their use as building block for future electronics requires a modification of their band structure. One efficient way to achieve this goal consists in the use of interface effects. For example, the Dirac Cone spin degeneracy can be lifted by Rashba effect via the interface between graphene and high spin-orbit coupled materials [2]. It is expected that the coexistence of spin-orbit and exchange interaction in 2-D materials will open the access to novel quantum phases such as topological quantum spin Hall effect [3]. Such a situation has been little explored so far due to difficulties of sample preparation. In this project we propose to address the study of the electronic properties of such systems, where exchange and spin-orbit interactions are induced in the 2-D material by interface effects. The project will be carried on in collaboration with Prof. Yuriy Dedkov and Prof. Elena Voloshina at the Shanghai University (web page: https://shu2d.com).

[1] T.D. Ladd *et al.,* Nature, **464**, 45 (2010).
[2] I. I. Klimovskikh *et al.,* Phys. Rev. B **92**, 165402 (2015).
[3] Z. Qiao *et al.,* Phys. Rev. Lett. **112**, 116404 (2014).

Required background of the student: The successful applicant should have a strong background in solid-state physics and quantum mechanics. Knowledge of surface science and ultra-high vacuum techniques is welcomed.

A list of 5(max.) representative publications of the group: (Related to the research topic)
1) S. Vlaic *et al.,*. J. of Phys. Chem. Lett. **9**, 2523 (2018).
2) S. Vlaic *et al.*, Phys. Rev. Mat. **1**, 053406 (2017).
3) S Vlaic *et al.,* Appl. Phys. Lett. **104**, 101602 (2014).
4) Y. Dedkov and E. Voloshina, J. Phys.: Condens. Matter. **27**, 303002 (2015), Topical Review.
5) Y. Dedkov, E. Voloshina, *et al.,* Phys. Status Solidi B **252**, 451 (2015), Feature Article.