Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

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Internship location: IMPMC, Pierre and Marie Curie Campus
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ED397

Excitons and valence fluctuations in 2D transition-metal sulphides

Two-dimensional (2D) layered transition metal chalcogenides are remarkable for their tunable electronic and optical properties including semiconducting, semimetallic, superconducting and charge density wave (CDW) states. One open question is the possibility that these compounds host unconventional superconductivity induced by electronic excitations. In order to address this point, we shall explore the signatures of electronic excitations by means of electronic and transport properties in vanadium layered chalcogenides, characterized by large charge fluctuations arising from the mixed-valence V^{3+}/V^{4+} properties. Specifically, following previous proposals by Little and Ginzburg, we shall investigate the possibility that these fluctuations induce the formation of excitons stabilized by the poor screening of the charge carriers. We shall focus on the M_xVS_2 system characterized by VS_2 layers intercalated with a transition metal M. This crystal structure is suitable to tune the electron doping and the bandwidth by using the intercalant concentration, x, and pressure as control parameters, respectively. Main objective of the internship is to uncover experimentally the signature of excitons in the system by using advanced spectroscopic techniques, such as EELS (coll. D. Taverna, IMPMC).

This activity will be supported by *ab initio* calculations that take into account many-body effects (coll. TQM group, M. Casula, IMPMC). A systematic study by means of specific heat, magnetic, magnetotransport and thermopower measurements at low temperature and under high pressure shall provide complementary indications as to the signature of excitons on the thermodynamic and transport properties.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO