PhD EDPIF 2024-2027

Laboratory name: Laboratoire de Physique des Solides
CNRS identification code: UMR8502
PhD adviser : BROUET Véronique
e-mail: veronique.brouet@universite-paris-saclay.fr Phone number: 01 69 15 53 34
Web page: https://equipes2.lps.u-psud.fr/sqm/
PhD location: LPS Orsay

Funding: Through EDPIF competition

Exploring the physics of correlated metallic kagome networks

Strong electronic correlations give rise to exotic forms of electronic orderings, such as high temperature superconductivity or colossal magnetoresistance. In recent years, the question arose of how they could also influence topological properties, where exotic fermions, such as Dirac or Weyl fermions, have been discovered. Up to now, correlated and topological properties have been actively studied, but mostly separately, as they rarely coexist in the same materials. Most topological materials known today are weakly correlated semiconductors, which are rather well described by band theory, unlike correlated systems. Finding similar properties in correlated systems could add new dimensions to the problem. Magnetism is for example common in correlated transition metal, giving rise to new topological properties.

We propose the study of systems containing kagome planes of transition metals (Fe, Co, Rh…), which intrinsically bring together strong correlations and topologically non-trivial band structures [1]. The kagome network, named after a form of weaving in traditional basket in eastern countries, features corner sharing triangles and hexagons. A simple tight-binding model of a kagome plane leads to a very intriguing electronic structure, featuring Dirac points and flat bands due to quantum interferences. Many real bulk materials contain metallic kagome planes, but whether their electronic structure corresponds well to this model still and which electronic properties may emerge still has to be explored. One example is the magnetic Weyl semimetal $Co_3Sn_2S_2$, which display a record large anomalous Hall effect [2]. Another one is $Fe_{1-x}Co_xSn$, where magnetic and non-magnetic ground state can be stabilized. We propose to synthesize and characterize in the laboratory compounds from these families and apply to them various perturbations (doping, strain…) to modify their properties. We will then perform angle resolved photoemission experiments at the SOLEIL synchrotron near our laboratory to study its electronic band structure and check for the presence of topological and/or correlated properties.

Keywords : Strong electronic correlations, magnetism, topological properties, angle resolved photoemission, electronic band structures, crystal growth

Techniques : Angle resolved photoemission, transport and magnetic measurements, crystal growth, band structure calculations.