RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: ***Materials Science, Mechanics, Fluids***

Subfield: Physics, Applied Physics

Title: Bad metals and soft mode in the quantum paralectrics

ParisTech School: ESPCI Paris PSL

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Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Doped $SrTiO_3$ is a bad metal where the electrical resistivity does not saturate at high temperature when the mean free path is of the order of interatomic distances. Our recent preliminary results of neutron scattering show that the proximity of the ferroelectric instability, so-called quantum paraelectric phase, play an essential role in the increase of the carriers mass at high temperature (C. Collignon, Ph. Bourges, B. Fauqué and K. Behnia, Phys. Rev. X 10, 031025 (2020)). Further, the tendency towards that structural instability (associated with a soft phonon) is assumed to favour superconductivity in $SrTiO_3$ for dilute doping, even if both types of orders have a priori nothing in common. Motivated by these results, we propose a PhD research plan to study the effect of electronic doping in quantum paraelectric systems, that will follow two research paths: i) study of the electronic structure via electric and thermoelectric transport measurements ii) study the atomic structure and lattice dynamics by neutron scattering measurements. We will first focus on the doped $SrTiO_3$ compound (substitution with La and Nb, reduction in oxygen) and next to doped compounds of $KTaO_3$ and PbTe. These measurements will allow to understand the nature of the new electronic states of matter that occur in doped quantum paraelectric materials.

Required background of the student: material science, solid state physics

1. C. Collignon, Ph. Bourges, B. Fauqué et K. Behnia, Phys. Rev. X 10, 031025 (2020)
2. Xiaokang Li and al., Phys. Rev. Lett. 124, 105901 (2020)
3. C. W. Rischau and al., Nature Physics, 3, 643–648(2017
4. X. Lin and al., NPJ Quantum Materials 2: 41 (2017)
5. X. Lin and al., Science 349, 945 (2015)