Exploring the Interplay of Ordered and Fluctuating States in Fe(Se:S): The Role of Internal Parameters and Uniaxial Strain

Ana Milosavljević[1]
Jovan Blagojević[1], Tea Belojica[1], Bojana Višić[1], Sanja Djurdjić Mijin[1, 2], Marko Opačić[1], Andrijana Šolajić[1], Jelena Pešić[1], Aifeng Wang[3], Cedomir Petrovic[3, 4, 5] and Nenad Lazarević[1]

[1]*Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia*
[2]*Departamento de Fisica de Materiales, Facultad de Ciencias, Universidad Autonoma de Madrid, 28049 Madrid, Spain*
[3]*Condensed Matter Physics and Material Science Department, Brookhaven National Laboratory, Upton, NY 11973-5000, USA*
[4]*Shanghai Advanced Research in Physical Sciences (SHARPS), Shanghai 201203, China*
[5]*Department of Nuclear and Plasma Physics, Vinca Institute of Nuclear Sciences, University of Belgrade, Belgrade 11001, Serbia*
ana.milosavljevic@ipb.ac.rs

Unconventional superconductivity often arises in materials with complex interactions, where competing ordered states such as magnetism, nematicity, and superconductivity, interact and sometimes overlap, making their nature elusive. Among iron-based superconductors, the isostructural FeSe and FeS may appear similar at first glance but differ significantly in their physical properties. While FeSe undergoes a nematic and structural phase transition, FeS does not exhibit a structural transition even at the lowest temperatures, with its critical temperature (Tc) halved compared to FeSe. Interestingly, by substituting selenium with sulfur in FeSe, the nematic phase transition temperature can be suppressed to zero near a quantum critical point (QCP), resulting in a significant drop in T_c [1, 2]. It has been suggested that while spin-fluctuations dominate below the QCP and significantly affect electron-phonon interactions, nematic fluctuations become prominent above the QCP [3]. Given their exceptional sensitivity to variations in local crystal structure, iron-chalcogenides are ideal candidates for studying the interplay between ordered and fluctuating states through manipulation of internal parameters (doping) and external ones, such as uniaxial strain. Here, we present a study of all types of excitations, including phonons, charge, and spin fluctuations in Fe(S:Se) using inelastic light scattering experiments. Finally, we analyse the evolution of lattice dynamics as a function of uniaxial tensile strain along the Fe-Fe bond direction (that contains the nematic component) and along the direction diagonal to it in FeSe.

References

[1] A. Wang, A. Milosavljevic, et al., *Inorganic Chemistry 61* (29), 11036-11045 (2022)
[2] N. Lazarević, A. Baum, A. Milosavljević, et al., *Phys. Rev. B* 106, 094510 (2023)
[3] S. Neto, et al., *Nature Phys.* 21, 89–96 (2025)

*This research was supported by the Science Fund of the Republic of Serbia, 10925, Dynamics of CDW transition in strained quasi-1D systems - DYNAMIQS