11 de novembro de 2024 - 16h00 - Sala F-147 (IFSC/USP)

“Café com Física” – Probing quantum matter with multidimensional spectroscopy

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Probing quantum matter with multidimensional spectroscopy

Light-matter interaction is a powerful tool to probe the properties of electrons and phonons in correlated materials. Recently, multidimensional spectroscopy has gained increasing attention in condensed matter physics. This technique involves perturbing the system with a sequence of time-spaced coherent light pulses in the terahertz or optical range. The system's response is inherently nonlinear, producing a spectrum that is a function of the independent frequencies conjugated to the time spacing between pulses, hence the name "multidimensional spectroscopy." It has been demonstrated that the multidimensional spectrum reveals information about the nature, intrinsic lifetimes, and interactions of quasiparticle excitations which are not easily accessible through single-pulse spectroscopy, making it a promising tool to probe a wide variety of systems. In this talk, I will introduce the theoretical framework of multidimensional spectroscopy, highlighting its prospects in studying many-body systems. For instance, I will show how multidimensional Raman spectroscopy can be used to distinguish between different types of electronic nematic orders, namely nematic liquids and nematic glasses. In a nematic liquid, a state recently proposed in tetragonal $BaNi_2As_2$, rotational symmetry is not broken, but strong nematic fluctuations lead to distinctive features such as the dynamical splitting of selected phonon modes. In a nematic glass, on the other hand, rotation symmetry is broken, yet coexisting orthorhombic domains lead to a fourfold-symmetric response. Although distinguishing between nematic liquids and glasses poses a challenge for linear Raman spectroscopy, I will show that multidimensional Raman spectroscopy presents unique signatures of the liquid phase associated with a dynamic nematic order parameter.

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