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Nematic fluctuations and resonance in iron-based superconductors[1]

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The spontaneous appearance of nematicity, a state of matter that breaks rotation but not translation symmetry, is ubiquitous in many iron based superconductors (Fe SC), and has relevance for the cuprates as well. Here I will review recent electronic Raman scattering experiments which report the presence of critical nematic fluctuations in the charge channel in the tetragonal phase of several Fe SC systems. In electron doped Co-$BaFe_2As_2$ (Co-Ba122), these fluctuations extend over most of the superconducting dome. Their associated nematic susceptibility shows Curie-Weiss behavior, and its doping dependence suggests the presence of a nematic quantum critical point near optimal T_C [1,2] Similar nematic fluctuations are also observed in FeSe despite the absence of magnetic order, raising the question of the link between nematicity and magnetism in Fe SC [3]. In FeSe I will further contrast the evolution of nematic fluctuations under isoelectronic S substitution and hydrostatic pressures up to 8 GPa, with only the former showing evidence for a nematic quantum critical point. In the superconducting state of Co-Ba122, I will show that a resonance emerges in the Raman spectra near the nematic quantum critical point. This nematic resonance is a clear fingerprint of the coupling between nematic fluctuations and Bogoliubov quasiparticles, and can be thought as the nematic counterpart of the spin resonance observed in neutron scattering experiments [4]. [1] Y. Gallais et al. Phys. Rev. Lett. 111, 267001 (2013) [2] Y. Gallais and I. Paul, C. R. Phys. 17, 133 (2016) [3] P. Massat at al. PNAS 113, 9177 (2016) [4] Y. Gallais et al. Phys. Rev. Lett. 116, 017001 (2016)

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