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BCS-BEC crossover in $\text{FeSe}_{1-x}\text{S}_x$ superconductors

Among iron-based superconductors, FeSe has the simplest crystal structure but it exhibits arguably the richest physics. Unlike other iron-based materials, the bulk FeSe samples do not show magnetic order below the structural (nematic) transition at 90 K. The electronic structure is quite unusual, having very small and anisotropic hole and electron pockets with the very low Fermi energies [1]. This put the system deep inside the BCS-BEC crossover regime, and we find giant superconducting fluctuations above T_c consistent with the preformed pairs [2]. By substituting Se with isoelectric S, the structural transition temperature can be completely suppressed, which allows us to tune into a nonmagnetic nematic quantum critical point [3]. In the non-nematic (tetragonal) phase, the temperature dependence of specific heat shows quite unusual behaviors, suggesting an unexpected evolution of superconducting fluctuations with S substitutions.

[1] S. Kasahara *et al.*, PNAS **111**, 16309 (2014). [2] S. Kasahara *et al.*, Nat. Commun. **7**, 12843 (2016). [3] S. Hosoi *et al.*, PNAS **113**, 8139 (2016).