Enhancement of superconductivity near the lattice-coupled nematic quantum critical point

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In the context of the Cu- and Fe-based high temperature superconductors (FeSC) theoretical studies[1,2] have conjectured that the superconducting T_c increases significantly in the vicinity of a nematic quantum critical point (QCP). Such studies are based on electron-only models, that ignore coupling between the electrons and the lattice strain that is invariably present. In this work we study the effect of this coupling. The effective static electronic interaction becomes gapped in all directions of the Brillouin zone with the exception two high-symmetry axes ; along any other direction, the noncritical elastic constants cutoff the nematic fluctuations[3]. This lattice-generated cutoff allows us to analyze the problem within BCS theory right up to the QCP. Making use of the BCS-like linear gap equation, we show that there is a crossover between a regime of weak enhancement of the superconducting T_c, where the noncritical pairing interaction is dominant, and a regime of strong enhancement dominated by the nematic pairing interaction, provided that the nemato-elastic energy scale is sufficiently weak. These regimes are interpreted to cause the SC dome to be flat-shaped or peak-shaped, respectively. The former is the case for FeSC, which exhibit strong nemato-elastic coupling.

[1] Lederer *et al*, PRL **114**, 097001 (2015)

[2] Mishra *et al*, New J. Phys. **18**, 103001 (2016)

[3] Paul *et al*, preprint at arXiv:1610.06168