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Nematic Fluctuation Driven Quantum Criticality and High-T_c Superconductivity: Fe-based and Cuprate Superconductors

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Near the nematic critical point, remarkable quantum critical behaviors and the enhancement of superconductivity have been observed in Fe(Se,Te) [1]. Similar quantum criticalities have been reported in cuprate superconductors near the CDW phase. These charge-channel fluctuations originate from the higher-order vertex corrections [2,3]. However, it is highly nontrivial why these charge-channel fluctuations give ruse to prominent quantum critical phenomena because the electron-nematicity bare coupling constant $g^0_{\text{e-nem}}$ is very small in realistic Hubbard models. To understand this fundamental problem, we develop the "Bethe-Salpeter equation method" to calculate the nematic-fluctuation-mediated interaction accurately. We reveal that the effective coupling constant $g^{\text{eff}}_{\text{e-nem}}$ strongly increases near the critical point due to the beyond-Migdal many-body correlations. In FeSe families, s-wave high-T_c superconductivity is realized due to nematic fluctuations, based on Hubbard models with on-site U. Critical mass enhancement and T-linear resistivity are also obtained. We also find that the CDW and magnetic fluctuations cooperatively enhance d-wave T_c in cuprate superconductors.

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[2] H. Kontani et al., arXiv:2209.00539; to be published in Adv, Phys.

[3] R. Tazai et al., Sci. Adv. 8, eabl4108 (2022).

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