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Impact of nematicity on the competing superconducting instabilities of the iron pnictides

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Magnetic fluctuations have been proposed not only to give rise to unconventional pairing states in iron pnictides and chalcogenides, but also to be responsible for an emergent electronic nematic transition that breaks the tetragonal symmetry of the system down to orthorhombic. In this talk, we discuss the interplay between nematicity and superconductivity using both a phenomenological approach and a microscopic electronic model. When only the s^{+-} superconducting instability is present (i.e. gaps with different signs on electron and hole pockets), nematic order competes with superconductivity [1], resulting in a suppression of T_c and in a hardening of the shear modulus across the superconducting transition. However, this scenario changes dramatically when a competing d-wave superconducting instability is also present [2], as it has been suggested in several iron-based compounds. In this case, an unusual tri-linear coupling between the superconducting and nematic order parameters arises in the free energy, strongly impacting the phase diagram [3]. On the one hand, nematic order now leads to an increase of T_c, and the shear modulus is softened across the superconducting transition. On the other hand, nematic fluctuations promote an effective attraction between the s^{+-} and d-wave states, favoring a mixed phase that does not break time-reversal symmetry, but instead spontaneously breaks the tetragonal symmetry of the system. Our findings offer a new perspective on how T_c can be enhanced in the iron pnictides, and demonstrate that nematicity can be used as a diagnostic tool to probe exotic pairing states in these materials.

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[2] R. M. Fernandes and A. J. Millis, Phys. Rev. Lett. **110**, 117004 (2013).
[3] R. M. Fernandes and A. J. Millis, Phys. Rev. Lett. **111**, 127001 (2013).