



Pressure dependence of the Fermi surface of the nematic superconductor, $\text{FeSe}_{0.89}\text{S}_{0.11}$

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Introduction

Novel forms of nematic electronic orders play an important role in understanding superconductivity in iron-based and copper oxide superconductors. FeSe, is one of the simplest iron-based superconductor structurally, but one of the most complex system electronically with extreme tunability in its electronic and superconducting properties [1,2]. In bulk crystals, FeSe undergoes a complex electronic transition into a nematic state at 87K, in the absence of any long-range magnetic order, and it becomes superconducting around 9 K. Upon application of hydrostatic pressure, FeSe displays a strong increase in its superconductivity up to 37K, which is found to coexist with a new magnetic phase (Fig.1a) [2]. Quantum oscillations studies of FeSe under pressure suggested that a reconstruction of the Fermi surface could occur upon entering the magnetic phase, supporting a strong link between magnetism and superconductivity in FeSe [2,4].

Chemical pressure, using isoelectronic substitution of sulphur for selenium in superconducting $\text{FeSe}_{1-x}\text{S}_x$, is an alternative tuning parameter of nematicity, completely suppressing it above $x > 0.18$, without promoting a high- T_c superconducting phase or stabilizing a magnetic order, in contrast to applied pressure (Fig.1c) [1,3,4]. Interestingly, applying hydrostatic pressure crystals of $\text{FeSe}_{1-x}\text{S}_x$ within the nematic state, leads to the separation of the nematic and the magnetic state, but superconductivity is still enhanced by pressure (Fig.1b).

Experimental

We have performed temperature dependent magnetotransport and tunnel diode measurements in magnetic fields up to 45T as a function of applied hydrostatic pressure up to 17 kbar on different crystals of $\text{FeSe}_{0.89}\text{S}_{0.11}$ (Fig.1d).

Summary of our results

We have investigated the evolution of the complex Fermi surfaces and electronic interactions across the nematic phase transition using applied hydrostatic pressure up to 17 kbar in single crystals of $\text{FeSe}_{0.89}\text{S}_{0.11}$. We have observed quantum oscillations in the normal state above 20T in high magnetic fields up to 45T in the low temperature regime. We found an unusual Lifshitz-like transition associated with the disappearance of a small Fermi surface on the border of the nematic state, while the largest orbits continue to expand away from it. Similar trends in the electronic structure were also observed as a function of chemical pressure in $\text{FeSe}_{1-x}\text{S}_x$ [6]. These findings are in stark contrast to the reconstructed Fermi surface detected in FeSe under applied external pressure [2] and suggest a complex interplay between nematicity, magnetism and superconductivity in these materials.

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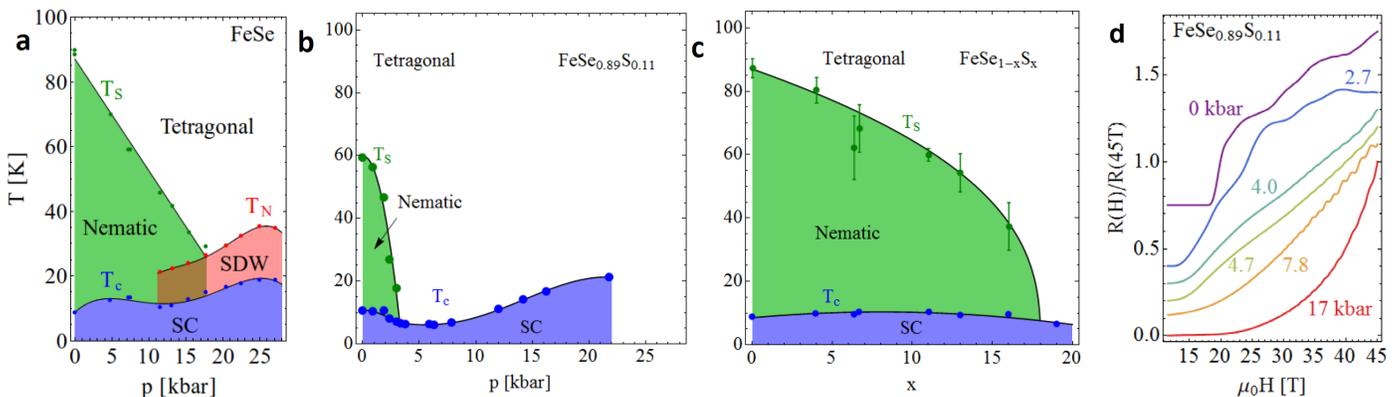


Fig. 1 Phase diagrams as a function of a) applied hydrostatic pressure for FeSe [5] and b) $\text{FeSe}_{0.89}\text{S}_{0.11}$ [7] as well as c) chemical pressure for $\text{FeSe}_{1-x}\text{S}_x$ (by iso-electronic substitution of Se by S) at ambient pressure [6]. d) The evolution of the quantum oscillations under applied pressure in $\text{FeSe}_{0.89}\text{S}_{0.11}$ [7].