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On nematicity, magnetism and superconductivity in FeSe[1]

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FeSe is unique among iron-based superconductors, notably regarding the interrelationships of structure, magnetism, and superconductivity. At ambient pressure, FeSe exhibits a tetragonal-to-orthorhombic (nematic) phase transition at $T_s = 90$ K, similar to other iron-based materials, but unlike them, no long-range magnetic order. One consequence is the unique possibility to study the in-plane resistivity anisotropy, arguably the most investigated nematic property, without interfering effects from the Fermi surface reconstruction induced by antiferromagnetic order. Recent findings pose the question whether nematicity in FeSe is driven by magnetic fluctuations, as often assumed in other iron-based systems. In particular, magnetic fluctuations, which are prominent at low temperatures, are not observed above T_s in FeSe by NMR [1,2], even though indicated by inelastic neutron scattering. The pressure-temperature phase diagram, recently obtained in new comprehensiveness using vapor-grown single crystals [3], shows that the structural transition is suppressed at 2 GPa and a new, likely magnetic phase is stabilized above 0.8 GPa, where T_c has a local maximum. Various theoretical scenarios have been proposed to explain this nematic transition far away from the magnetic order. Surprisingly, the degree of the orthorhombic distortion does not decrease below the superconducting transition at $T_c = 8$ K, suggesting that nematic and superconducting channels do not compete [4]. Our new results on the superconducting state under pressure, show a non-monotonic pressure dependence of the upper critical field, which is well explained by the Fermi surface evolution. Further, we have successfully detwinned FeSe crystals and measured the in-plane resistivity anisotropy and elastoresistivity coefficients and compared them with model calculations of inelastic scattering from spin fluctuations. [1] Böhmer et al., PRL 114, 027001 (2015) [2] Baek et al., Nat. Mat. 14, 210 (2015) [3] Terashima et al., JPSJ 84, 063701 (2015) [4] Böhmer et al., PRB 87 180505 (2013)

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