Orbital-driven nematicity and superconductivity in FeSe: NMR study

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Since the discovery of the iron based superconductors, the origin of the nematic tetragonal-to-orthorhombic transition has been hotly debated. Since in most iron pnictide families, the nematic transition occurs very close to the antiferromagnetic instability, it has been argued that the nematicity stems from the magnetic spin fluctuations, coupled to the lattice degrees of freedom. The iron selenide FeSe is different in that the structural transition occurs at Ts ~ 90 K without any sign of antiferromagnetism, and it is therefore tempting to conclude that an alternative scenario for nematicity, based on orbital (rather than spin) degrees of freedom, takes place. To establish whether this is indeed the case, we have conducted extensive nuclear magnetic resonance (NMR) measurements on FeSe. Below the nematic transition temperature Ts, we observe a clear splitting of the Se NMR line, which we show to be of electronic origin. Moreover, by measuring the spin-lattice relaxation rate and Knight shift, we establish unequivocally that this line splitting is driven by orbital nematic order. We furthermore establish a connection between orbital nematicity and superconductivity, showing that the two order parameters compete with each other. Intriguingly, this may provide an explanation for the very high superconducting transition temperature reported in the single-layer FeSe.

[1] Reference S.H. Baek et al Nature Materials, in print