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From magnetism to superconductivity in $FeTe_{1-x}Se_x$[1]

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The iron chalcogenide $FeTe_{1-x}Se_x$ is structurally the simplest of the Fe-based superconductors and exhibits a Fermi surface similar to iron pnictides. Despite this similarity, the parent compound $Fe_{1+y}Te$ orders antiferromagnetically with an in-plane magnetic wave vector (π,0) with an ordered moment of $\sim 2\mu_B$/Fe, suggestive of a localized rather than itinerant character of the magnetic order. This contrasts the pnictide parent compounds where the magnetic order has an in-plane magnetic wave vector (π,π) that likely arises from Fermi Surface nesting. Regardless both the pnictide and chalcogenide Fe superconductors exhibit a superconducting spin resonance around (π,π) as probed by neutron scattering. A central question in this burgeoning field is therefore how (π,π) superconductivity emerges from a (π,0) magnetic instability ? Using neutron scattering we show that incommensurate magnetic excitations around (π,π) are found even in the undoped parent compound $Fe_{1+y}Te$. With increasing x, the (π,0)-type magnetic long-range order becomes unstable and correlates with a weak charge carrier localization, while the mode at (π,π) becomes dominant for x>0.29. Our results suggest a common magnetic origin for superconductivity in iron chalcogenide and pnictide superconductors. This work was carried out in close collaboration with the groups of W.Bao (Renmin), Arno Hies (ILL), Zhiqiang Mao (Tulane), C. Brohom (John Hopkins) and I. Eremin (MPI-Dresden/Bochum).

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