Magnetism and Superconductivity in $LaO_{1-x}F_xFeAs$

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We present a detailed study on the magnetic order in the undoped mother compound LaOFeAs of the recently discovered Fe-based superconductor $La_{1-x}OF_xFeAs$. In particular, we present local probe measurements of the magnetic properties of LaOFeAs by means of ^{57}Fe Mössbauer spectroscopy and muon spin relaxation in zero external field along with magnetization and resistivity studies. These experiments prove a commensurate static magnetic order with a strongly reduced ordered moment of 0.25(5) μ_B at the iron site below $T_N = 138$ K, well separated from a structural phase transition at $T_S = 156$ K. The temperature dependence of the sublattice magnetization is determined and compared to theory. Using a four-band spin density wave model both, the size of the order parameter and the quick saturation below T_N are reproduced. (preprint: H.-H. Klauss et al., cond-mat/0805.0264)

Additionally, zero field experiments on underdoped (x=0.075) and optimally doped (x=0.1) samples rule out any static magnetic order above 1.6 K in these superconducting samples. From transverse field experiments in the vortex phase we deduce the temperature and field dependence of the superfluid density. Whereas the temperature dependence is consistent with a weak coupling BCS s-wave or a dirty d-wave gap function scenario, the field dependence strongly evidences unconventional superconductivity. We obtain the in-plane penetration depth of 254(2) nm for $LaO_{0.9}F_{0.1}FeAs$ and 364(8) nm for $LaO_{0.925}F_{0.075}FeAs$. Further evidence for unconventional superconductivity is provided by the ratio of T_c versus the superfluid density, which is close to the Uemura line of hole doped high-Tc cuprates. (preprint: H. Luetkens et al., cond-mat/0804.3115)

At the conference, we will present a detailed investigation of the magnetic and superconducting properties of the $La_{1-x}OF_xFeAs$ family. The magnetic and superconducting transition temperatures as well as the magnetic and superconducting order parameters have been determined for the whole phase diagram with fine steps in Fluorine doping. Special emphasis is laid on the doping region in which superconductivity emerges.

The data will be compared to our measurements on the oxygen deficient $RO_{0.85}FeAs$ (R=Sm, Nd, Gd). (preprint: R. Khasanov et al., cond-mat/0805.1923)