

COEXISTENCE OF SUPERCONDUCTIVITY AND MAGNETISM IN THE Fe-As and Fe-Se NEW MAGNETO-SUPERCONDUCTORS

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Since the discovery of Mössbauer spectroscopy (MS), superconductivity (SC) was one of the subjects the method was able to investigate. MS in conventional superconductors yield little information. However in the new magneto-superconducting systems where SC is confined to the Fe-As or Fe-Se layers, ^{57}Fe MS may contribute much, since the Fe ions are not probes, but rather part of the layers to which SC is confined.

MS and Magnetization studies of a large variety of AFe_2As_2 ($\text{A}=\text{Ba}, \text{Eu}$) and $\text{B}_x\text{Fe}_2\text{Se}_2$ ($\text{B}=\text{K}, \text{Rb}$ and Tl) single crystals, including substitutions (i) of Fe by Co or Ni or (ii) As by P in the AFe_2As_2 system have been performed. We shall summarize our present knowledge about the phenomena observed to date, including the results obtained in the $\text{B}_x\text{Fe}_2\text{Se}_2$ systems, in which the high AFM state ($T_N > 500$ K) coexists with SC (below 30 K) within the **same** Fe layers. In some materials, the paramagnetic Meissner effect is observed. Of particular interest is the $\text{EuFe}_2(\text{As}_{1-x}\text{P}_x)_2$ system, for which two Mössbauer isotopes, ^{57}Fe and ^{151}Eu , enable to

investigate simultaneously the mutual interactions between the magnetic Eu and the Fe layers. $\text{EuFe}_2(\text{As}_{1-x}\text{P}_x)_2$ is SC for $0.2 < x < 0.5$. For $x \leq 0.2$ the Eu^{2+} ions are AFM ordered with the moments in the *ab* planes. Whereas for $x \geq 0.2$ the Eu is FM ordered along the *c*-axis. In the FM region, the magnetic transition and the magnetic hyperfine fields (H_{eff}) of the Eu nuclei are higher than those in the AFM region. The ^{57}Fe Mössbauer studies show no magnetism in the iron site for $x > 0.2$, yet exhibit at 5 K transferred magnetic hyperfine fields (~ 1 T) from the FM ordered Eu sub lattice, even in the SC region. The observation of superconductivity in the presence of ferromagnetism is rarely observed, transferred magnetic hyperfine fields in the superconducting state are observed here for the first time.

[1] I. Nowik, I Felner, Z Ren, G H Cao and Z A Xu, *New J. Physics* 13(2011) 023033

[2] I. Felner, S. Jin, S. Wang, K. Zhu, and T. Zhou, *J. Supercon. Nov. Magn.* 24(2011) 2033