

Vacancies, local moments and Pauli limiting in Fe-pnictide superconductors

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An efficient method based on ⁷⁵As-NQR measurements to refine the As-vacancy (AV) concentrations in Fe-pnictides is proposed and applied to the La-1111 family. We report magnetization measurements of LaO_{0.9}F_{0.1}FeAs_{1- δ} ($\delta \approx 0.0625$) samples with improved superconducting properties [1] as compared with As-non-deficient optimally doped La-1111 samples. For the former a strongly enhanced spin-susceptibility by a factor 3-7 can be estimated. This is attributed to magnetic moments of about 3.2 μ_B per AV or 0.8 μ_B /Fe atom related to an electronically localized state around each AV. The magnetic moment increases with δ . These magnetic moments are formed, if the local Coulomb repulsion exceeds a small critical value below 1 eV in the dilute limit. The upper bound of 2.5 eV restricts the Coulomb repulsion at Fe sites beyond the 1st neighbor-shell of an AV to be below 2eV, i.e. to a weak correlation scenario. The high spin susceptibility is responsible for the Pauli limiting behavior (PLB) in LaO_{0.9}F_{0.1}FeAs_{1- δ} . In contrast, no PLB was found for the stoichiometric LaO_{0.9}F_{0.1}FeAs superconductor in accord with its low spin susceptibility. Similar effects are discussed for Fe-selenide and telluride superconductors.

[1] G.Fuchs, S.-L. Drechsler, *et al.* Phys. Rev. Lett., **101**, 237003 (2008), - NJP **11**, 075007 (2009).