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Local moments in iron-based superconductors probed with x-ray emission spectroscopy[1]

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We report Fe Kβ x-ray emission spectroscopy studies of local magnetic moments in various iron-based superconductors. X-ray emission spectroscopy (XES) is a fast, local probe that is bulk-sensitive and couples directly to the d-electron moment. Recently developed integrated absolute difference method of analyzing the XES signal [1] allows us to study even small fluctuating moments found in metallic systems such as iron-based superconductors. In our survey of various materials in their paramagnetic phases [2], we found local magnetic moments in all samples studied: PrFeAsO, $Ba(Fe,Co)_2As_2$, LiFeAs, $Fe_{1+x}(Te,Se)$, and $A_2Fe_4Se_5$ (where A = K, Rb, and Cs). The moment size shows very little dependence on temperature or carrier concentration, but varies significantly across different families. Specifically, all iron pnictide samples have local moments of about 1.5-2 μ_B/Fe, while FeTe and $K_2Fe_4Se_5$ families have much larger local moments of ?3 μ_B/Fe and ?5 μ_B/Fe, respectively. The extracted moment sizes agree well with energy and momentum integrated inelastic neutron scattering results. In addition, XES was used to study the spin-state transition in rare-earths doped $CaFe_2As_2$ [3]. When about 10-20% of Ca is replaced with Pr or Nd ions, this material goes through so-called collapsed tetragonal transition at 70 K, below which the c-lattice constant shrinks by almost 10% [4]. The XES data show that the local magnetic moment is quenched in this collapsed tetragonal phase. We also found that the moment size exhibits unusually large temperature dependence even in the high temperature regime, indicating that the crystal field splitting and the Hund's rule coupling are of similar strength in this compound [5]. Our experimental results illustrate the importance of multiorbital physics in describing magnetism of iron-based superconductors.

[1] G. Vanko et al., J. Phys. Chem. B 110, 11 647 (2006);
[2] H. Gretarsson et al., Phys. Rev. B 84, 100509(R) (2011);
[3] H. Gretarsson et al., Phys. Rev. Lett. 110, 047003 (2013);
[4] S. R. Saha et al., Phys. Rev. B 85, 024525 (2012);
[5] J. Chaloupka and G. Khaliullin, arXiv:1208.1197v1.

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