Probing Multi-band Superconductivity and Magnetism in SmFeAsO$_{0.8}$F$_{0.2}$ Single Crystals by High-field Vortex Torque Magnetometry


Introduction
It is important to reveal the true behavior of the anisotropic magnetization in the vortex state of the oxypnictides, particularly the extent to which vortex properties are affected by strong magnetic correlations, multiband effects and possible interband phase shift between possible order parameters on different pieces of the Fermi surface. For instance, multiband effects in MgB$_2$ manifest themselves in strong temperature and field dependencies for the mass anisotropy parameter $\gamma(T,H)$ and the London penetration depth $\lambda(T,H)$ even at $H < H_{c2}$.

Experimental
Underdoped single crystals of SmO$_{1-x}$F$_x$FeAs having typical sizes, 100 x 100 x 10 $\mu$m$^3$ and $T_C \sim 45K$ were grown by the flux method. The sample was attached to the tip of a piezo-resistive micro-cantilever placed into a rotator inserted into a vacuum can. The ensemble was placed into a 4 He cryostat coupled to a resistive 33 T dc magnet of the National High Magnetic Field Lab (cell 12). Changes in the resistance of the micro-cantilever associated with its deflection and thus a finite magnetic torque $\tau$ was measured via a Wheatstone resistance bridge [1].

Results and Discussion

Conclusions
Our results reveal a superconducting anisotropy that is both field and temperature dependent suggesting, by analogy with MgB$_2$ two (strongly-coupled) superconducting gaps but of nearly equal magnitudes.

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References