**Doping-Driven Collapse of the SDW Correlation Gap in SmFeAsO$_{1-x}$F$_x$**

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**Introduction**

We report the Hall resistivity, $\rho_{xy}$ of polycrystalline SmFeAsO$_{1-x}$F$_x$ for four different fluorine concentrations from the onset of superconductivity through the collapse of the structural phase transition. For the two more highly-doped samples, $\rho_{xy}$ is linear in magnetic field up to 50 T with only weak temperature dependence, reminiscent of a simple Fermi liquid. For the lightly-doped samples with $x < 0.15$, we find a low temperature regime characterized $\rho_{xy}$ (H) being both non-linear in magnetic field and strongly temperature dependent even though the Hall angle is small. The onset temperature for this non-linear regime is in the vicinity of the structural phase (SPT)/spin density wave (SDW) transitions. The temperature dependence of the Hall resistivity is consistent with a thermal activation of carriers across an energy gap. The evolution of the energy gap with doping is reported.

**Experimental**

The polycrystalline samples of SmFeAsO$_{1-x}$F$_x$ were synthesized using conventional solid state reaction [1] and cut into rectangular prisms with a typical size of 1.5 x 1 x 0.1 mm$^3$. The resistivity $\rho$ transverse to the applied magnetic fields was measured using the standard four-terminal digital ac lock-in technique in continuous fields up to 35T and in pulsed fields up to 60T at the National High Magnetic Field Laboratory.

**Results and Discussion**

In conclusion, we have defined a small-Hall-angle regime in SmFeAsO$_{1-x}$F$_x$ that is characterized by unusual behavior of $\rho_{xy}$ (H): nonlinear in magnetic field and exponential in temperature. This regime exists at low fluorine doping, $x < 0.15$, and at temperatures below the structural and SDW phase transitions. At either higher temperatures or doping, the Hall resistivity behaves like a conventional metal. Finally, the demarcation at $x \approx 0.15$ between the nonlinear regime and conventional metal behavior is the same doping where there is both an end to the SPT/SDW ordering and an insulator-to-metal crossover in the normal state.

Figure 1: Temperature dependence of the Hall number (right) and inverse Hall number, normalized to carriers per Fe-atom (left). The dashed lines are exponential fits. The inset shows the doping evolution of the energy gap, normalized to the value of $\delta$ at $x=0.05$ for this study (black up triangles) and Liu et al [8] (red down triangles). For comparison, the doping dependence of the spin density wave transition (blue crosses), TSDW, is also provided, normalized to TSDW ($x = 0.05$) = 114 K [8].

**Acknowledgements**

Part of this work was supported by NSF Cooperative Agreement No. DMR-0654118, by the State of Florida, and by the DOE. Scott C. Riggs would like to acknowledge the ICAM travel fellowship for financial support.

**References**