Probing Nematic Fluctuations of Quantum Critical Systems through Elastoresistance in High Magnetic Fields

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Introduction

There is a growing body of work that suggests anisotropic electronic phases and their associated fluctuations are closely related to high temperature superconductivity. In particular, the iron-based superconductors exhibit a large and diverging electronic nematic susceptibility above a putative quantum critical point close to optimal doping [1]. So far measurements of the nematic susceptibility have been performed above the superconducting transition temperature, but in this work we extend these measurements to lower temperatures, right above the putative critical point, by suppressing the dome of superconductivity with large magnetic fields.

Experimental

Elastoresistivity relates changes in resistivity to strain. Since anisotropic strain is a conjugate field of electronic nematic order, certain components of the elastoresistivity tensor are proportional to the electronic nematic susceptibility. A recent advancement in the elastoresistivity technique using oscillating strains has drastically increased the signal to noise ratio and speeds up the data acquisition [2]. This dramatically increases the data density in large DC magnetic fields and enables measurements in pulsed magnetic fields. Measurements have been performed in the 65T Multi-Shot Magnet (NHMFL, Pulsed Field Facility), the 31T 50mm Magnet (NHMFL, DC Field Facility) and the 45T Hybrid Magnet (NHMFL, DC Field Facility).

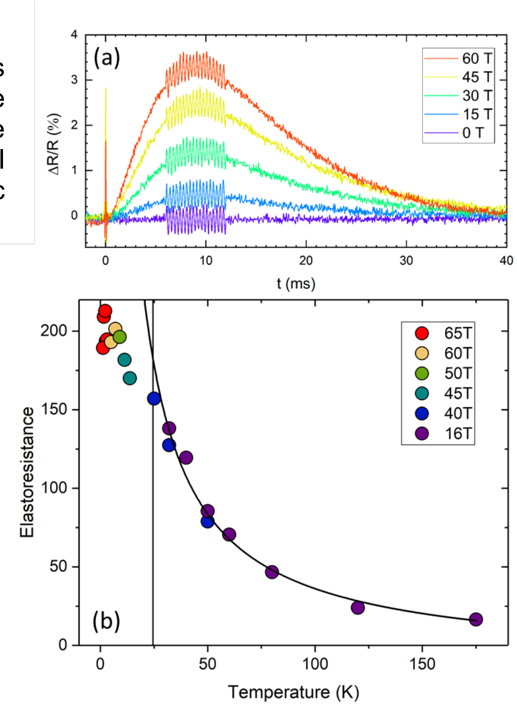

Fig.1 Elastoresistivity measurements of $Ba(Fe_{0.939}Co_{0.691})_2As_2$ in the 65T Multi-Shot Magnet. (a) Time traces of the sample response during a pulse at 28K. The magnet fires at 0ms and the oscillating strain is turned on at 6ms. (b) The extracted elastoresistivity as a function of field and temperature, fit to a Curie-Weiss functional form (black line).

Results and Discussion

We have measured a doping series of $Ba(Fe_{1-x}Co_x)_2As_2$ and optimally doped $BaFe_2(As_{0.7}P_{0.3})_2$ in DC magnetic fields and optimally doped $Ba(Fe_{0.939}Co_{0.691})_2As_2$ in pulsed fields up to 65T. Our pulsed field measurements are shown in **Fig.1**. We find that the nematic susceptibility is largely independent of field above T_c. The nematic susceptibility continues to grow underneath the zero-field superconducting transition temperature.

Conclusions

Our preliminary results reveal that the nematic susceptibility continues to diverge when the superconductivity is suppressed in large magnetic fields, and there is no evidence for a secondary phase transition.

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References

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