The Fermiology of $BaFe_2P_2$ and Charge Transport in Widely Doped BSCO2201

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1 Unresolved issues in High-Tc superconductivity

1.1 Fermi surface nesting as a pairing mechanism

- Describe nesting and link to susceptibility as an intro to BaFe2P2 dHvA results

1.2 The pseudogap versus the coherent state

- Describe current theories of 'friend' or 'foe' of superconductivity as intro to BSCO magnetoresistance results

1.3 Doping determination

- Discuss problem of doping determination, LSCO and comparisons with other cuprates as intro to BSCO Hall results

2 Experimental technique

2.1 Measuring charge transport

2.1.1 Fermi liquid theory

- Description of basic Fermi liquid theory to provide a contrast to behaviour observed in high-Tc superconductors

2.1.2 Hall effect

- Briefly discuss theory of Hall effect

2.1.3 Magnetoresistance

- Briefly discuss theory of magnetoresistance

2.1.4 Six probe technique

- Discuss geometry
- Mention high field measurements
- Briefly discuss Polo setup, amplifier characterisation
- Show Cu hall bar results (to be performed)

2.1.5 Sample size determination

- Discuss briefly FIB and optical microscope

2.2 dHvA torque oscillation

2.2.1 Theory

- Briefly describe Landau levels, Lifshitz-Kosevich equation, Onsager relation
- Some discussion as to limitations, i.e. non-superconducting state, only extremal areas, relatively long mean free path required etc.

2.2.2 Method

- Brief discussion of use of AFM cantilevers
- Discuss new sample mounting (grease)
- Introduce novel temperature correction techniques for use on Yellow Magnet
- Discuss angle determination using x-rays, coil and data symmetry

3 dHvA measurements on $BaFe_2P_2$

3.1 The $BaFe(P_xAs_{1-x})_2$series

- Discuss phase diagram, cleanliness of samples, pressure analogy
- Introduce existing measurements in Shishido, Analytis papers
- Present x-rays showing crystal quality

3.2 Angle dependent measurements

3.2.1 Mapping the Fermi surface with DFT calculations

- Angle measurement results
- DFT calculations, shifting to fit
- Demonstration of the nesting

3.2.2 Susceptibility calculations

- Explanation of Lindhard function
- Results of calculations in various conditions (i.e. $T = 0$K, $T = 300$K)

3.3 Measuring effective mass

3.3.1 Analysis techniques

- Discuss simple LK fits
- Discuss correcting for large field range using 'retrofitting'
- Discuss correcting for large field range using 'microfits'

3.3.2 Effective mass results

3.4 Determining the spin mass

- Discuss mass enhancement at the Fermi level due to spin excitations
- Fits to the peak amplitude and possible values for m_s

3.5 Conclusions

- Discussion as to possible origins of shift (compare with results on CaFe2P2 and SrFe2P2)
- Discussion of nesting conditions in non-superconducting end member
- Discuss relatively small mass enhancements
- Compare with previous results by Analytis et al. i.e. lack of Yumaji point, misidentification of bands

4 Hall measurements on $\mathbf{Bi}_{2+z-y}\mathbf{Pb}_y\mathbf{Sr}_{2-x-z}\mathbf{La}_x\mathbf{CuO}_{6+\delta}$

4.1 Field sweeps

- Compare techniques for determining the linear portion of data
- Show comparison of BSCO with existing LSCO and Thallium data and determine doping

4.2 Conclusisons

- Discuss validity and utility of method

5 Magnetoresistance measurements on $\mathbf{Bi}_{2+z-y}\mathbf{Pb}_y\mathbf{Sr}_{2-x-z}\mathbf{La}_x\mathbf{CuO}_{6+\delta}$

Recreate Pat's original analysis in a similar way to that in the LSCO paper and upcoming BSCO paper.

5.1 Temperature sweeps

- Show divergence in the differential as indicator of the onset of the decay of the pseudogap
- Mention use of temperature sweeps for minor temperature corrections in the field sweeps

5.2 Field sweeps

- Discuss techniques for determining H_2, i.e. the B^2 portion of the magnetoresistance curve. Look to alternate techniques to one Pat used
- Present data with comparisons to high field results from Toulouse and Nijmegan performed by Pat, XF and Ionna
- Discuss multi-carrier model fitting similar to analysis performed on YBCO
- Results on low temperature ($< 300\,\mathrm{K}$) resistivity
- High temperature BSCO if necessary – results not yet taken

5.3 Conclusions

- Discuss the further refinements to the phase diagram of BSCO and what this means for the pseudogap

6 Bibliography