

# Title?

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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 BaFe<sub>2</sub>P<sub>2</sub> 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 $\text{BaFe}_2\text{P}_2$**

### **3.1 The $\text{BaFe}(\text{P}_x\text{As}_{1-x})_2$ 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.  $T = 0\text{K}$ ,  $T = 300\text{K}$ )

## **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  $\text{CaFe}_2\text{P}_2$  and  $\text{SrFe}_2\text{P}_2$ )
- 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 $\text{Bi}_{2+z-y}\text{Pb}_y\text{Sr}_{2-x-z}\text{La}_x\text{CuO}_{6+\delta}$

### 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 Conclusions

- Discuss validity and utility of method

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

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 Nijmegen performed by Pat, XF and Ionna
- Discuss multi-carrier model fitting similar to analysis performed on YBCO
- Results on low temperature ( $< 300$  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