Universality of Quantum Oscillations across YBCO123 and YBCO248

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Introduction

A question under debate is the origin of small Fermi surface pockets in YBCO123, YBCO248, and Hg2201 families of underdoped cuprates. Charge order has been proposed as the origin of pockets in YBCO123, and has been observed in spectroscopic experiments such as x-ray diffraction. However, no signatures of such order have been observed in YBCO248 or Hg2201 cuprate families till date.

Experimental

Quantum oscillations in the in-plane transport are measured on single crystals of $YBa_2Cu_3O_{6.75}$ and $YBa_2Cu_4O_8$, which have similar superconducting transition temperatures ≈ 75K using PDO (proximity detection oscillator) measurements in pulsed magnetic fields up to 92 T in NHMFL, Los Alamos. Fig. 1 shows a comparison of quantum oscillations as a function of magnetic field between these two families of materials. Fig. 2 shows a comparison of the effective mass obtained by a Lifshitz-Kosevich fit to the quantum oscillation amplitude as a function of temperature between these two families of materials.

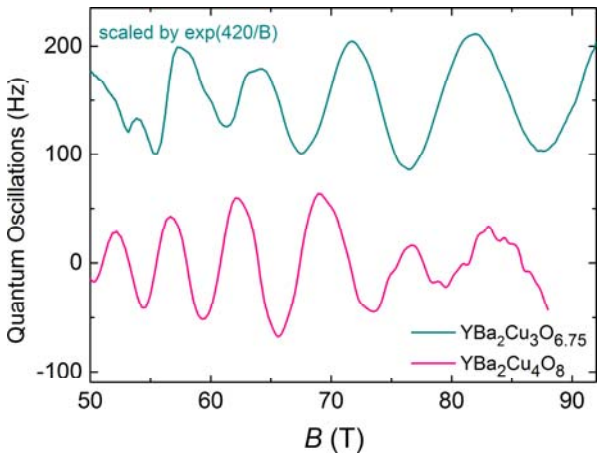

Fig. 1. Comparison of quantum oscillations in the in-plane transport measured using the PDO technique in $YBa_2Cu_3O_{6.75}$ and $YBa_2Cu_4O_8$.

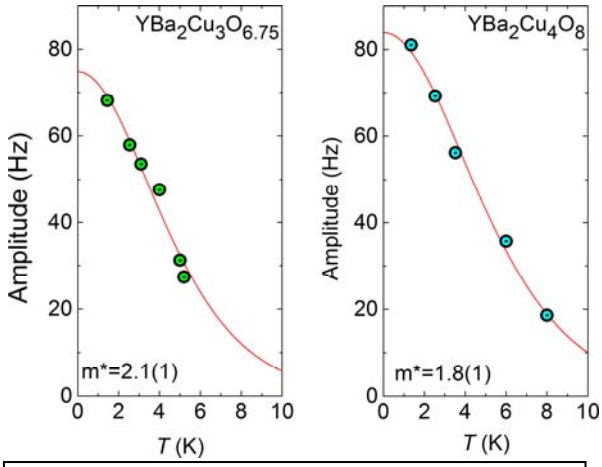

Fig. 2. Comparison of effective mass measured on $YBa_2Cu_3O_{6.75}$ and $YBa_2Cu_4O_8$.

Results and Discussion

We find that quantum oscillations in **$YBa_2Cu_3O_{6.75}$** and **$YBa_2Cu_4O_8$** have very similar properties. The measured quantum oscillation frequency in **$YBa_2Cu_4O_8$** has a value of 630 ±30 T, which is only higher by 10% compared with the value of quantum oscillation frequency in **$YBa_2Cu_3O_{6.75}$**, which has a value of 570±30 T, and in. The effective mass measured in **$YBa_2Cu_3O_{6.75}$** and **$YBa_2Cu_4O_8$** is also very similar, with a value of 1.8±1 m_e in **$YBa_2Cu_4O_8$** compared to a value of 2.1±1 m_e in **$YBa_2Cu_3O_{6.75}$**.

Conclusion

We report a close similarity in quantum oscillations observed in $YBa_2Cu_3O_{6+x}$ and $YBa_2Cu_4O_8$ high temperature superconducting families, indicating that they have the same origin. Given that signatures of charge order have thus far only been reported in the $YBa_2Cu_3O_{6+x}$ family of materials, this leads to two possibilities. The first is that signatures of charge order have been obscured in $YBa_2Cu_4O_8$ until now because of measurement sensitivity, or time scales over which the measurement is made, compared to that over which charge ordering occurs. Alternatively, it is possible that quantum oscillations in the underdoped high temperature superconductors, including $YBa_2Cu_3O_{6+x}$ and $YBa_2Cu_4O_8$ have an origin other than charge order.

References

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