

STUDIES OF METAMAGNETIC QUANTUM PHASE TRANSITIONS IN BILAYER RUTHENATE $\text{Sr}_3\text{Ru}_2\text{O}_7$

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Introduction

$\text{Sr}_3\text{Ru}_2\text{O}_7$ is the double-layered member in the layered perovskite Ruddlesden-Popper series $\text{Sr}_{n+1}\text{Ru}_n\text{O}_{3n+1}$ with $n = 2$. It is a paramagnetic Fermi liquid. Moderate applied magnetic fields can induce a metamagnetic quantum phase transition in this compound [1]. Our earlier tunneling studies on $\text{Sr}_3\text{Ru}_2\text{O}_7$ revealed unusual oscillations in tunneling magnetoresistance [3].

It is well known that under magnetic fields, the bulk resistivity in clean metals can oscillate periodically due to a famous effect of quantum mechanics (the Shubnikov-de Haas effect). However, all characteristics of the oscillations seen in our experiment suggest that it is unrelated to Shubnikov-de Haas oscillations. It is unclear if this oscillation is a direct reflection of an oscillation of the density of states at the Fermi surface, since no corresponding features have been observed in any bulk measurements so far. The purpose proposed for this project is to clarify the origin of this new oscillation phenomenon through extending our tunneling measurement to high magnetic fields.

Experimental

We requested two weeks of magnet time in 17.7/19 T and 18/20 T (SCM2) systems. This request was approved; our experiment was performed during the summer of 2004. Unfortunately, this experiment was not successful. The reason is following: According to our test measurements performed at Tulane, the oscillations in the tunneling magnetoresistance of $\text{Sr}_3\text{Ru}_2\text{O}_7$ occur only at lower bias voltage. So we had to measure tunneling resistance with relatively small current (<0.5 micro-ampere). At such a small current, we found that the magnetic field sweep of tunneling resistance in both systems was too noisy to see any oscillation feature. We had tried many ideas to resolve this problem, but it was not successful.

We requested another week of magnet time in SCM2 for September of 2005 to try more ideas for tunneling measurements of $\text{Sr}_3\text{Ru}_2\text{O}_7$. However, we were not able to use this magnet time because of the impact of hurricane Katrina. Instead my collaborator, Dr. Luis Balicas, did some measurements on another interesting ruthenate material $\text{Sr}_4\text{Ru}_3\text{O}_{10}$ using this magnet time. This project turns out to be very successful. Nice quantum oscillations in resistivity and evidence for Fermi surface reconstruction across the metamagnetic transition were observed. Dr. Balicas reported these results in his report, "Shubnikov De Haas Effect in High Quality Single Crystals of $\text{Sr}_4\text{Ru}_3\text{O}_{10}$ ".

Results and Discussion

We did not get any meaningful data on the $\text{Sr}_3\text{Ru}_2\text{O}_7$ project due to the noise problem described above. Since I am dislocated by hurricane Katrina, and have no access to my data, I could not show any piece of data taken at that time here.

Conclusions

Since we did not get any meaningful data on the $\text{Sr}_3\text{Ru}_2\text{O}_7$ project, no conclusion can be made this time.

Acknowledgements

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References

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