OBSERVATION OF SMALL FERMI SURFACE POCKETS IN Na_XCoO_2 (FOR X = 0.3 AND 0.75)

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Introduction

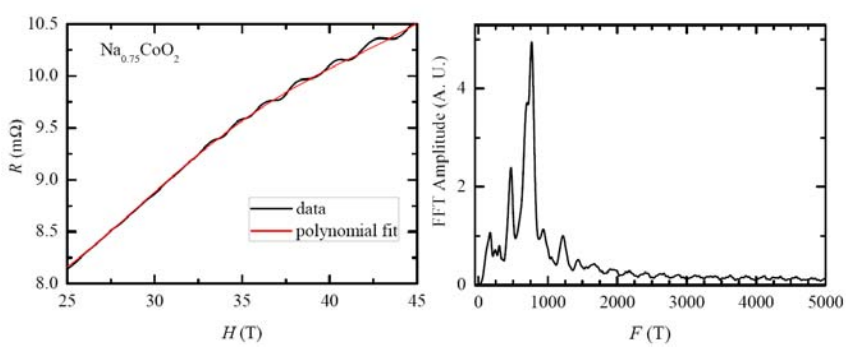
The unexpected discovery [1] of a superconducting phase of yet unknown origin in hydrated Na_xCoO_2 around $x = 0.3$ has generated renewed interest in this material. However, such basic issues as the low energy electronic structure and Fermi surface topology in the cobaltates have not been well understood. Local density approximation (LDA) calculations [2] predict a large Fermi surface (FS) associated with the a_{1g} band enclosing the Γ point and six small FS pockets of mostly e_{0g} character near the *K* points [2,3]. However, recent angle-resolved photoelectron spectroscopy (ARPES) measurements on the cobaltates revealed only a *single* holelike FS centered around the Γ point for a wide range of Na concentration *x* [4–7]. The area enclosed by the FS exhausts the Luttinger volume, which is consistent with the observation that the dispersion of the e_{0g} band associated with the FS pockets lies below and never crosses the Fermi level [4]. The absence of the FS pockets is unexpected and puts serious constraints on several proposed theories of non-phonon mediated superconductivity as well as magnetic properties based on the nesting conditions of the FS pockets. Here we report the observation of Shubnikov de Haas oscillations of small frequencies, contradicting the ARPES results.

Experimental

We performed magnetotransport measurements at ^{3}He temperatures using the hybrid magnet and a rotating probe. Shubnikov the Haas oscillations were measured in a conventional 4 terminal technique by using resistance bridges.

Results and Discussion

In Fig. 1 left panel, we show the in-plane resistivity as a function of the external field for a $Na_{0.75}CoO_2$ single crystal at $T = 0.6$ K. Notice the Shubnikov de Haas oscillations. In the right panel we show the FFT spectrum of the oscillatory signal and at least two peaks are quite apparent, indicating the existence of small FS pockets in strong contrast with ARPES measurements but also with the band structure calculations.



Conclusions

Our results are puzzling and suggest that the band structure calculations should be revisited, as well as the ARPES measurements. One possibility is that Na superstructures re-define the Brillouin zone and hence the Fermi surface.

Acknowledgements

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References

[1] Takada, K., *et al.*, Nature (London), **422**, 53 (2003).
[2] Sakurai, H., *et al.*, Phys. Rev. B, **68**, 132507 (2003).