The 65 T pulse-field transport study of nodal-ring Dirac semimetal CaAgAs

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Introduction

The application of topology concepts in condensed matter is one of the most investigated topics nowadays. The discovery of 3D topological insulators in 2007 gave rise to a lively new field. The surface states on topological insulators and the bulk states in semimetals (Dirac and Weyl) disperse linearly with momentum in *k*-space and exhibit unusual physical properties, such as large linear magnetoresistance, putative chiral anomaly, spin Hall effect, etc. At high magnetic fields, the interaction of Weyl points may lead to new electronic ground states. Here we study CaAgAs, a Dirac ring nodal semimetal candidate. Previous theoretical efforts proposed that CaAgAs hosts a donut-shaped Fermi surface at the chemical potential, with drumhead-shaped surface states. With spin-orbit coupling, a gap opening of ~ 70 meV has been suggested. To probe the band structure of CaAgAs, our goal is to study the transport properties of the nodal states in field to 65 T.

Experimental

We have grown high-quality single crystals of CaAgAs by the self-flux method. The 65 T pulse-field magnetoresistance measurements have been performed with applied magnetic field along the “a” and “c” crystallographic directions. The measurements were performed over a wide range of temperature, 4 K – 70 K.

Results and Discussion

In CaAgAs, magnetoresistance was measured with field **B** applied in the ab-plane as well as perpendicular to the Dirac ring. Clear quantum oscillations have been observed, suggesting a highly anisotropic nature of the Fermi surface that corresponds to the proposed donut-like shape. A typical magnetoresistance plot with quantum oscillations for B||a is shown in FIG 1(a). The oscillatory response in 1/B is shown in the inset of (a). Fig. 1b shows the obtained low-frequency oscillation when B||c.

Conclusions

The quantum oscillations in magnetoresistance of CaAgAs are observed for the first time. The frequencies of oscillations support the proposed high anisotropy of Fermi-surface corresponding to the donut-shaped band-structure at the chemical potential.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida.

The research was also supported by LDRD and DOE BESMSE Science of 100 Tesla programs.

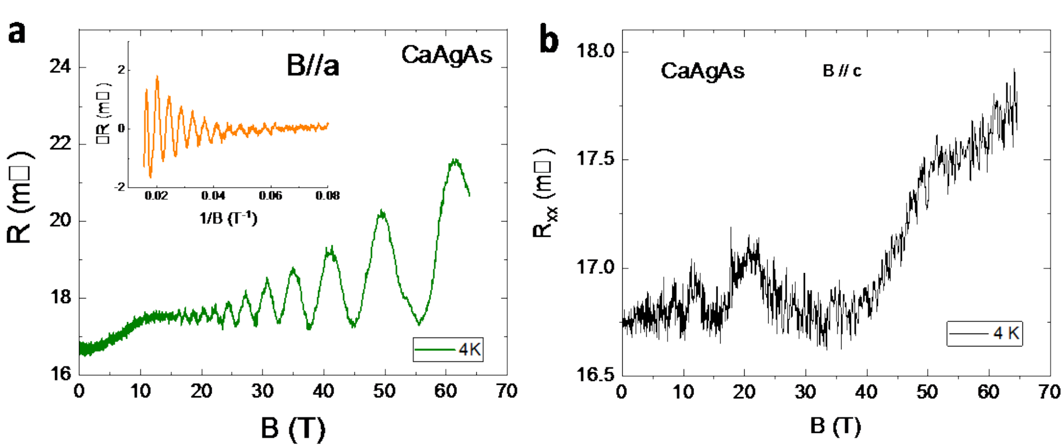

FIG. 1 (a) and (b) The magnetoresistance plots for CaAgAs recorded at 4 K with magnetic field **B** respectively along “a” and “c”. The inset in (a) shows quantum oscillations in inverse field. Our results point to a very anisotropic Fermi surface.