Shubnikov de-Haas Study of the Fermi Surfaces of Lithium (Li) at High Pressure

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Introduction

Li is the lightest metal and superconductor, with a nearly spherical Fermi surface. Under pressure, Li undergoes a series of symmetry breaking structural phase transitions. The pressure induced re-emergence of superconductivity in Li is attributed to the suppression of the martensitic phase under pressure and nesting effects in its Fermi surface. The available data on the Fermi surface of Li is based on studies of polycrystalline samples[1]. There are no experimental studies of the Fermiology of ^{6}Li. The bulk properties of Li are shown to be influenced by its zero point effects[2-4]. Here we study the P-dependence of the Fermi surface of Li isotopes.

Experimental

We have grown single crystal lithium samples of isotopically pure ^{7}Li, 96% enriched ^{6}Li and natural lithium. The samples were analyzed for chemical purity by EDS. The single crystal quality was determined using x-ray diffraction. The majority of the experiments were done using a piezo-resistive cantilever in 18 T magnet (SCM2) and ^{3}He cryostat. We searched for possible anomalies in the Fermi surface of the sample by 180° rotation and along three crystal axis. The effective mass and also Dingle temperature of the samples were measured (Fig 1).

Results and Discussion

All samples showed nice quantum oscillations and a peak close to the free electron value of 41250 T [1] (e.g. see fig. 2). The preliminary analysis, indicates that ^{6}Li at ambient pressure has small deviations from the spherical symmetry. Our estimate of the effective mass of electrons for ^{6}Li is ~2. Data processing and refinement of the analysis is currently being performed.

Conclusions

We successfully performed the first Fermiology measurements on ^{6}Li and isotopically pure ^{7}Li at ambient pressure. Data with superior quality to the available literature is also collected for natural lithium[1]. The current data shows that these experiments are possible using single crystal lithium in the 9R phase. High pressure experiments will therefore be justified on these samples during the next runs.

Acknowledgements

A portion of this work was performed at the NHMFL, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy. In addition, a portion of this work was supported by NSF-DMR grant # 1351986, University of Utah. The single crystal growth was supported by NSF MRSEC program at the University of Utah under grant # DMR 1121252.

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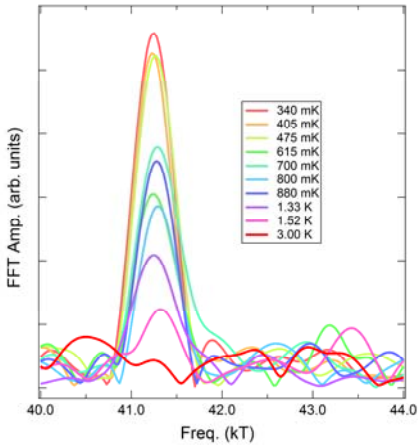

Fig 1. Measurements of the oscillation amplitude in natural lithium as a function of temperature to calculate the effective mass.

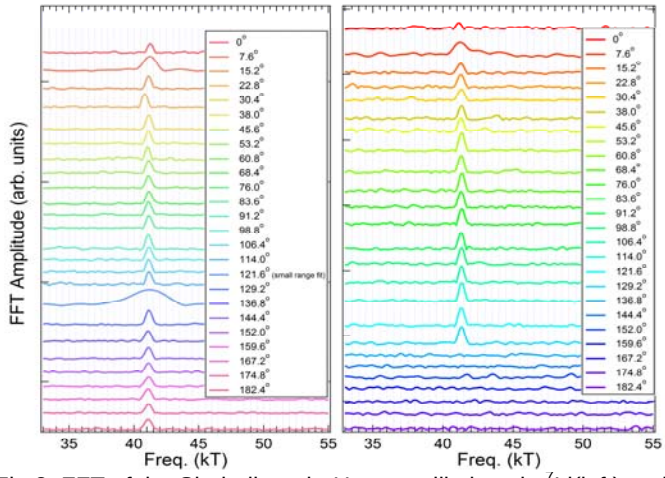

Fig 2. FFT of the Shubnikov-de-Haas oscillations in ^{7}Li(left) and ^{6}Li(right) for a wide range of angles.