Torque and TDO Measurements Comparison for deHaas - van Alphen (dHvA) in USb$_2$

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Introduction

The tunnel diode oscillator (TDO) technique has been used previously to study quantum oscillations in many materials in dc field and pulsed field magnet systems. However, the torque measurement has been successfully performed recently in pulsed field. Both techniques can detect these quantum oscillations and give information about the shape of Fermi surfaces and the cyclotron effective masses. In order to understand similarities and differences between these two techniques, a sample of USb$_2$ has been measured by both techniques. The USb$_2$ sample has a cylindrical Fermi surfaces as explained in Ref. [1, 2].

Experimental

In the TDO part of this experiment the USb$_2$ sample was in inserted inside a compensated measurement coil of diameter of 0.7 mm making the field parallel to the [001] direction as possible. In the torque measurement, the USb$_2$ sample was mounted on one side of the balanced cantilever, where the field making 12° with the [001] direction of the sample. Both measurements were performed in pulsed magnetic field up to 60 tesla and in He3 cryostat that can reach temperature as low as 0.4 K. The frequency of the oscillations was calculated by calculating the FTT for each wave form.

Results and Discussion

In this experiment the deHaas- van Alphen effect has been observed by both technique and in the same range of field and temperature. In both techniques, the analysis of the amplitude of the corresponding FFT spectrum around the [100] direction in USb$_2$ leads to almost the same effective mass $\approx 2.1 m_0$ as in Fig.1. However, the wave form in the TDO measurements looks different for the same parameters in the torque measurements.

Conclusions

The TDO and torque measurements give the same information when used to measure Fermi surfaces. However the TDO is more sensitive and gives us access to perform measurements around small angles that are not sensitive to the torque measurements. The corresponding FFT peaks in the TDO measurements are broader than the peaks in the torque measurements which needs attention.

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References

Examples: