MAGNETIC QUANTUM OSCILLATIONS IN THE NORMAL STATE OF YNi_2B_2C

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Introduction

Since the discovery of superconductivity in compounds of the type RT_2B_2C, where R is a rare-earth ion and T is a transition-metal ion, solid-state physicist were especially fascinated by the nature of the superconducting state in these materials as well as by the interplay between magnetism and superconductivity. Although in the nonmagnetic borocarbides, like YNi_2B_2C, an *s*-wave component of the order parameter seems to be dominant, a number of peculiarities led to the suggestion of a highly anisotropic gap function with nodes [1]. A direct method to investigate the evolution of the energy gap at the Fermi surface in the superconducting state is the measurement of magnetic quantum oscillations. The existence of any kind of superconducting gap results in an additional damping of the de Haas-van Alphen (dHvA) oscillations in the vortex state. For YNi_2B_2C, quite controversial results for the dHvA signal in the superconducting state were reported [2]. This might be related to the proposed anisotropic gap [1]. Since the upper critical field in YNi_2B_2C is at about 9-10 T, dHvA measurements up to high fields are essential for a reliable determination of the additional damping in the vortex state. Furthermore, not all dHvA oscillation frequencies predicted by band-structure calculations could be resolved up to now. Here, higher magnetic fields and systematic angular-dependent studies are necessary to obtain a more complete picture of the Fermi-surface topology.

Experimental, Results, and Discussion

We performed dHvA measurements by use of the cantilever torque technique with in-situ rotation down to about 0.5 K in ^{3}He cryostats. Data up to 15 T were obtained in a superconducting magnet at Dresden, data up to 32 T in a resistive magnet at Tallahassee. (A limited set of data could be collected for one day in the hybrid magnet up to 45 T.)
The high-field torque signal after background subtraction, for the magnetic field aligned 2 deg off the *a* axis towards the [110] direction, is shown in the inset of Fig. 1. In the Fourier spectrum (Fig. 1) three different dHvA frequencies are resolved, two of which have not been reported so far. For other field orientations a number of further orbits could be resolved. The assignment of the found dHvA signals to the calculated band structure is not straightforward and needs further work.
The frequency of the α orbit, F_α, has been reported to persist down to lower fields well within the mixed state. For the present samples, however, F_α can be well resolved only down to the upper critical field, B_{c2}, below which the oscillating signal vanishes surprisingly quick [3]. A systematic study of this discrepancy between differently grown crystals is under way.

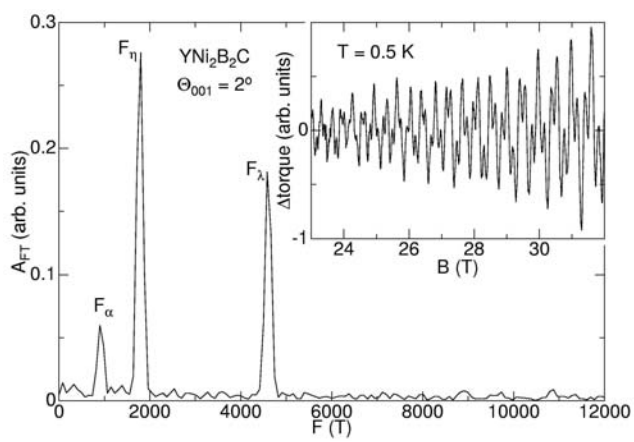

Fig. 1: Fourier spectrum of the torque signal shown in the inset. The magnetic field was aligned 2 deg off the *a* axis.

References

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