

HARD-AXIS MAGNETORESISTANCE AND METAMAGNETIC TRANSITION IN UPdSn*

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The magnetic phase diagram of UPdSn for fields applied along the c axis has been determined by means of magnetoresistance and neutron-diffraction studies. We established that the 13 T c -axis transition is connected with the 25 K zero-field transition, below which additional x -components to the magnetic moments are found.

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The hexagonal compound UPdSn has attracted substantial attention in the past decade since the uranium $5f$ electrons exhibit a more localized character which is rather unusual among uranium intermetallics. The magnetic properties of UPdSn are highly anisotropic with the c axis as the hard magnetization direction [1]. Neutron diffraction established a complex non-collinear antiferromagnetic arrangement of U magnetic moments within the

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b - c plane below 40 K, followed by a second antiferromagnetic transition at about 25 K, where additional x -components to the moments were found [2]. Both magnetic phases are of orthorhombic symmetry, which leads to the formation of three magnetic domains. For magnetic fields applied in the basal plane, the magnetic phase diagram was studied extensively and significant domain repopulation effects as well as a spin-flop transition at about 3 T were found [2].

For fields applied along the c axis, however, a small but significant step at about 13 T had been reported [1], and its phase boundaries had not been studied to date. The purpose of the present study is to determine whether this step in the magnetization is intrinsic to UPdSn or whether it had been an experimental artifact or due to a misaligned crystallite. It should be noted that our studies were performed on a different single crystal than used in the previous studies. Here, we present the results of magnetoresistance and neutron-diffraction studies on UPdSn in magnetic fields applied along the c axis.

The magnetoresistance studies were performed in the 20 T superconducting magnet at the Pulsed Field Facility, NHMFL, Los Alamos National Laboratory. We performed two kinds of experiments: temperature scans at fixed fields and field scans at fixed temperatures. The results are shown in Fig. 1. In zero field, we observe two transitions at about 40 K and 25 K

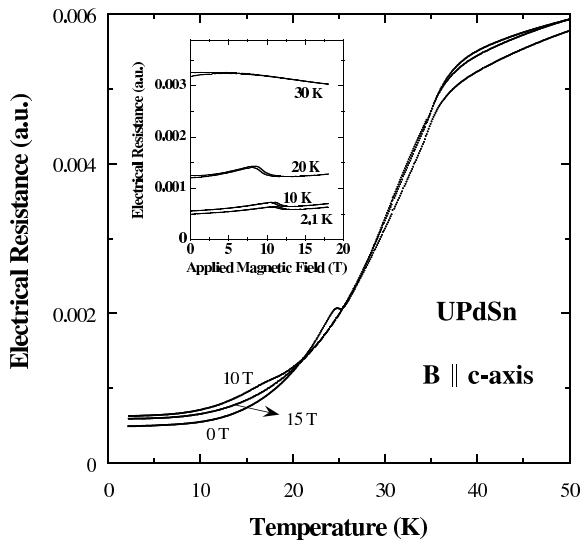


Fig. 1. Temperature dependence of the magnetoresistance of UPdSn at various magnetic fields applied along the c axis. In the inset, the field dependence of the magnetoresistance at various temperatures is shown.

in good agreement with previous studies [1]. From the temperature scans at fixed fields, we find that the 40 K transition is only marginally affected by the applied field, while the 25 K transition moves to lower temperatures with increasing fields up to about 10 T, above which the transition is no longer visible. This observation is consistent with the results of the field scans at fixed temperatures. Only for temperatures below 25 K, we observe a drop in the electrical resistance due to the metamagnetic transition. At the lowest temperatures measured, the magnetoresistance transition occurs at about 12 T, in good agreement with the 13 T from previous magnetization measurements.

From the anomalies in our temperature and fields scans, we were able to construct the magnetic phase diagram of UPdSn for $B \parallel c$ axis. The result is shown in Fig. 2, which provides clear evidence that the 12 T c -axis transition is connected with the 25 K zero-field phase boundary. Thus, the results indicate that application of a magnetic field along the c axis suppresses the x -axis components of the magnetic moments, which form below 25 K, while there is little effect on the b - c moment configuration that is stable between 25 and 40 K in zero field.

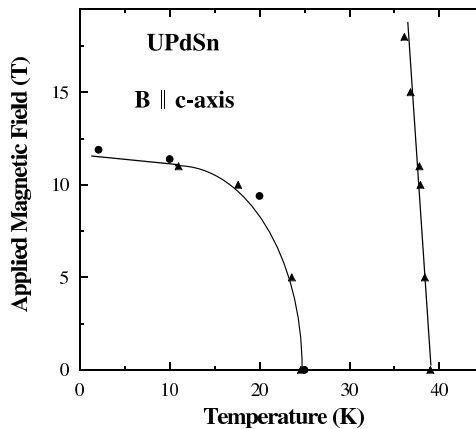


Fig. 2. Magnetic phase diagram of UPdSn for fields applied along the c axis. Triangles (circles) represent the points obtained from temperature sweeps (field sweeps). The lines are guides to the eye.

To verify the above picture, we performed neutron-diffraction experiments in magnetic fields applied along the c axis at BENSIC, Hahn Meitner Institute. This facility has a 15 T vertical-field split-pair magnet (17 T with a Dy booster) with large angular in-plane access that allows monitoring the magnetic intensities of all three domains at the same time. The intensities of some magnetic reflections of one particular domain are shown in Fig. 3.

Upon application of a magnetic field, similar behavior was found for the equivalent reflections of all three domains (which rules out any substantial domain repopulation effects). As can be seen in Fig. 3, the (010) reflection starts losing intensity higher than 12 T, while no significant change is found for the other reflections. Since the (010) reflection is a measure of the order parameter of the x -axis component to the magnetic moment [2], this is clear proof that the application of fields along the c axis indeed suppresses the x -axis component. It would be worthwhile to identify theoretical models that can explain such curious behavior.

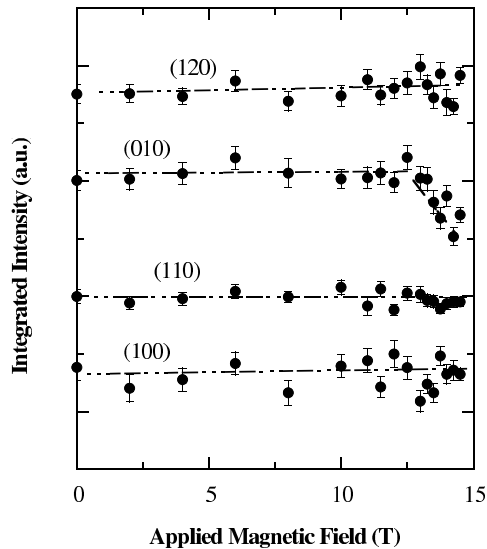


Fig. 3. Field dependence of the integrated intensities of selected magnetic reflections of one particular domain (orthorhombic notation). The lines are guides to the eye.

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