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High field magnetoresistance in antiferromagnetic monocristalline PrSn$_3$ and NdSn$_3$

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Abstract. — The transversal magnetoresistance of antiferromagnetic intermetallic PrSn$_3$ and NdSn$_3$ compounds was examined along [100] axis at temperatures lower than 4.2 K in the fields up to 14 T. The magnetoresistance was found to be anisotropic for PrSn$_3$ and isotropic for NdSn$_3$. However, for both compounds some maxima of the field dependence of the magnetoresistance were observed. The results have been discussed in terms of Yamada and Takada theoretical considerations.

The intermetallic compounds PrSn$_3$ and NdSn$_3$ are antiferromagnetics crystallizing in cubic AuCu$_3$ type of structure, with the Néel temperatures 8.6 K and 4.7 K, respectively. According to the neutron diffraction data [1] the magnetic structure of these two compounds is different, however with the magnetic moments aligned ferromagnetically in the (100) planes.

In this work the measurements of the magnetoresistance of PrSn$_3$ and NdSn$_3$ single crystals were performed in two sets of experiments.

First : experiment consisted of the measurement of angular dependence of the electrical resistivity at the constant external magnetic field for the sample rotated around the [100] direction.

Second : series of experiments concerned the measurement of the field dependence of the electrical resistivity $\rho(H)/\rho(H = 0)$ for the two positions of the sample : A, with magnetic field perpendicular to the (100) type planes, and B, with the magnetic field perpendicular to the (110) type planes.

The results were qualitatively compared with those predicted by Yamada and Takada [2], [3]. According to their considerations two kinds of peaks in the field dependence of the magnetoresistivity curves could be expected. One occurring when the antiferromagnetic state changes into the spin flopped state, and another, accompanied by the transition into the paramagnetic phase.

Figure 1 shows the magnetoresistivity anisotropy of PrSn$_3$ at 4.2 K. A pronounced maximum in a B position of the sample is evident in the fields up to 8.6 T. However, for the fields $\geq 9$ T angular dependence of magnetoresistivity is more complex showing over $90^\circ$ interval two maxima, whose positions are clearly dependent on the applied magnetic field.
On the other hand, no anisotropy of magnetoresistance has been observed in the case of NdSn$_3$, even in the field of 14 T.

Figures 2 and 3 show the field dependence of the electrical resistivity of PrSn$_3$ for two above mentioned positions of the sample, whereas figure 4 the same dependence for isotropic NdSn$_3$. The reason for different behaviour of these two compounds is not clear as yet. It is evident that in all cases the magnetoresistivity is positive. Initially it increases with increasing magnetic field and then it reaches a maximum at high magnetic fields. Particularly sharp maximum has been observed for the B position of PrSn$_3$. It may be supposed that it is due to the spin-flop transition.

On the other hand, the magnetic data suggest the metamagnetic transition [1] at 9 T, which may be responsible for the maximum observed for the A position of PrSn$_3$ or even for both positions of the sample (A and B).

![Fig. 2. — The field dependence of the electrical resistivity of PrSn$_3$, position A.](image1)

![Fig. 3. — The field dependence of the electrical resistivity of PrSn$_3$, position B.](image2)

![Fig. 4. — The field dependence of the electrical resistivity of isotropic NdSn$_3$.](image3)

However, there is no evidence for metamagnetic transition in NdSn$_3$ in the fields up to 26 T [4]. Thus the appearance of a flat maximum in the field dependence of magnetoresistivity of this compounds can hardly to be attributed to any of transitions foreseen by the theory.

References