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## Thermal conductivity of USb<sub>2</sub> and UBi<sub>2</sub> single crystals

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### ABSTRACT

The thermal conductivity ( $\kappa$ ) of single crystals of tetragonal uniaxial antiferromagnets USb<sub>2</sub> ( $T_N = 202$  K) and UBi<sub>2</sub> ( $T_N = 180.8$  K) has been measured along the  $a$ -axis ( $\kappa_a$ ) over the temperature range from 0.5 K to 300 K and along the  $c$ -axis ( $\kappa_c$ ) from 0.5 K to 70 K. The as-grown samples have RRR values of about 500 – 600 and 100 – 150 for UBi<sub>2</sub> and USb<sub>2</sub>, respectively.

The anisotropy of the thermal conductivity ( $\kappa_a(T)/\kappa_c(T) \sim 5$ ) and the low- $T$  Lorenz ratios are discussed in relation to Fermi surface topology for both compounds.

Keywords: uranium dipnictides, thermal conductivity, anisotropy

### § 1. INTRODUCTION

Uranium compounds display a wide variety of properties that are related to the behaviour of  $5f$  electrons. These phenomena vary from one uranium compound to another depending on a number of different factors including crystal structure, crystal electric field (CEF) effects, electronic configuration, etc. Thus, in order to gain a better understanding of the intrinsic nature of  $5f$  electron systems, it is useful to examine the evolution of physical properties in series of compounds. For this reason, the series of uranium dipnictides UX<sub>2</sub> (X=P, As, Sb, or Bi) has received considerable attention. These materials become antiferromagnets below room temperature and have ordered magnetic moments and effective paramagnetic moments as large as about 2  $\mu_B$  and 3.1  $\mu_B$  [1, 2, 3], respectively. Earlier measurements of the magnetic properties of UX<sub>2</sub> compounds were interpreted in terms of localised  $5f$  moments of U<sup>4+</sup> cations in the crystal electric field of the surrounding pnictogen anions [4]. More recent data addressing hyperfine interactions in the UX<sub>2</sub> series, studied by Mössbauer spectroscopy [5], were interpreted in terms of hybridisation between the  $5f$  and conduction electrons. The later approach was consistent with the results from angle-resolved photoemission spectroscopy for USb<sub>2</sub> [6], which revealed a narrow,  $5f$ -derived band with small dispersion at the Fermi energy. The topology of the Fermi surface of the UX<sub>2</sub> series, when determined either experimentally by de Haas-van Alphen (dHvA) and Shubnikov-de Haas (SdH) measurements [7, 8] or by means of *ab initio* calculations [9], both predict a significant two-dimensional character for the electronic properties. The two dimensional behaviour is thought to vary through the entire series and to reach the clearest difference between USb<sub>2</sub> and UBi<sub>2</sub>.

The uranium diantimonide and dibismuthide compounds crystallize in the tetragonal structure of anti-Cu<sub>2</sub>Sb type (space group P4/nmm or  $D_{4h}^7$ ) with two formula units (f.u.) per unit cell. Their lattice parameter ratios  $c/a$  are equal to 2.044 and 2.004, and the Curie-Weiss law determined magnetic moments,  $\mu_{\text{eff}}$ , are equal to 3.32  $\mu_B$  and 3.36  $\mu_B$  [1, 2, 3, 10, 11], respectively. Neutron diffraction experiments [1]

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3  
4 reveal antiferromagnetic ordering of the uranium magnetic moments, with values of  
5  $1.88 \mu_B$  for USb<sub>2</sub> and  $2.1 \mu_B$  for UBi<sub>2</sub> below the Néel temperatures,  $T_N$  of 202 K and  
6  $180.8$  K, respectively. The moments are parallel to the  $c$ -axis and create ferromagnetic  
7 planes which alternate perpendicular to the  $c$ -axis with the sequence ( $\uparrow\downarrow\uparrow$ ) in USb<sub>2</sub>  
8 and ( $\uparrow\downarrow$ ) in UBi<sub>2</sub>. This indicates a higher flattening of magnetic Brillouin zone (MBZ)  
9 in USb<sub>2</sub> [8] as compared to that in UBi<sub>2</sub>. Thus the ratios  $k_c/k_a$ , where  $k_c$  is the wave  
10 vector of the MBZ along the  $c$ -axis and  $k_a$  is the wave vector along the  $a$ -axis, for  
11 USb<sub>2</sub> and UBi<sub>2</sub> are equal to 0.24 and 0.5, respectively.  
12

13 The Fermi surfaces (FS) and paramagnetic Brillouin zone (PBZ) are basically  
14 the same in USb<sub>2</sub> and UBi<sub>2</sub>. Roughly speaking the FS consists of two types of  
15 branches. The first type of FS branch is a spherical surface and the second is a slightly  
16 corrugated cylinder parallel to the  $c$ -axis [8]. Magnetic ordering in UBi<sub>2</sub> does not  
17 change the BZ and hence the FS. The magnetic ordering in USb<sub>2</sub> reduces twice the  
18 MBZ and the spherical FS crosses the MBZ and transforms to the two cylinders. The  
19 same happens with the corrugated cylinder, which also transforms to the two  
20 cylinders. Thus the flattening of the MBZ in USb<sub>2</sub> enhances the two-dimensionality.  
21 Consequently, its resistivity anisotropy, which is several times lower than that of UBi<sub>2</sub>  
22 at room temperature, becomes several times higher at low- $T$  [11]. Here we extend the  
23 transport examination to studies of the heat conductivity in USb<sub>2</sub> and UBi<sub>2</sub> single  
24 crystals.  
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## 27 § 2. EXPERIMENTAL DETAILS

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30 The „molten metal solution” method was used to synthesize plate-like single  
31 crystals of USb<sub>2</sub> and UBi<sub>2</sub> [12]. From the as-grown crystals, it was possible to prepare  
32 rectangular specimens with typical dimensions of about  $6.5 \times 1.1 \times 1.3$  mm<sup>3</sup> (UBi<sub>2</sub>) and  
33  $4.0 \times 1.6 \times 0.7$  mm<sup>3</sup> (USb<sub>2</sub>) along the  $a \times b \times c$  axes for measurements of the thermal  
34 conductivity along the  $a$ -axis,  $\kappa_a(T)$ , and specimens of about  $0.7 \times 0.7 \times 0.6$  mm<sup>3</sup> (UBi<sub>2</sub>)  
35 and  $0.6 \times 0.4 \times 1.1$  mm<sup>3</sup> (USb<sub>2</sub>) along the  $a \times b \times c$  axes for measurements of the thermal  
36 conductivity along the  $c$ -axis,  $\kappa_c(T)$ . The thermal conductivity was determined with  
37 total uncertainty less than 2.5 % by the stationary heat flux method in the temperature  
38 range 5 – 300 K and setting the temperature gradient along the specimen's length from  
39 the range 0.1 – 0.5 K. The experimental setup and the measurement procedure have  
40 been described in detail in ref. [13, 14]. In the range 0.5 K - 80 K the  $\kappa(T)$  was  
41 measured by the modified set-up for the thermoelectric power measurements [15].  
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## 46 § 3. RESULTS OF THE THERMAL CONDUCTIVITY OF USb<sub>2</sub> AND UBi<sub>2</sub>

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48 The  $a$ -axis thermal conductivity data for USb<sub>2</sub> (specimen 2S<sup>a</sup>) and UBi<sub>2</sub>  
49 (specimen 2B<sup>a</sup>) measured in the temperature range  $5 \text{ K} < T < 300 \text{ K}$  are presented in  
50 Fig. 1. The values of  $\kappa_a$  ( $16.7$  and  $17.8 \text{ W m}^{-1} \text{ K}^{-1}$  at 300 K for USb<sub>2</sub> and UBi<sub>2</sub>,  
51 respectively) decrease with temperature down to  $T_N$  where  $\kappa_a(T)$  traces a shallow  
52 valley. Visible change of slope of the  $d\kappa_a/dT$  vs.  $T$  dependence at  $T_N$ , as shown in the  
53 inset for both compounds, relates this behaviour to the antiferromagnetic ordering  
54 temperature. The straight lines following the experimental data and constrained to  
55 cross at  $T_N$  are used to highlight the anomaly. Though the  $\kappa_a(T)$  anomalies at  $T_N$  are  
56 detectable, they are drastically weaker than the anomalies seen in the electrical  
57 resistivities along the  $a$ -axes shown by two lower curves in the inset, which are due to  
58 conduction electron scattering by phonons and fluctuations of magnetic moments  
59 [11].  
60

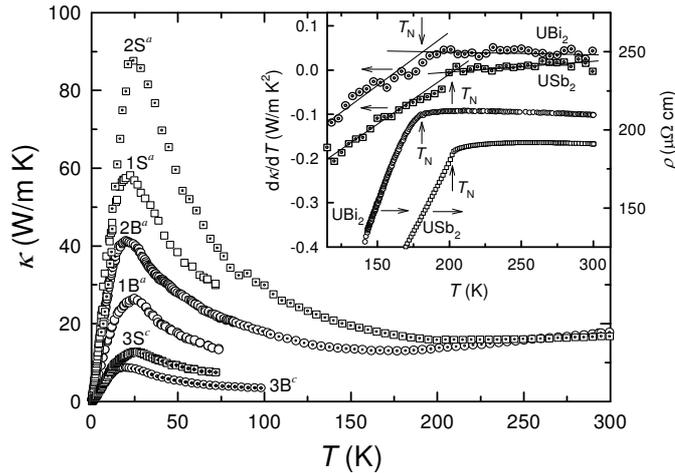


Figure 1. Thermal conductivity of  $\text{UBi}_2$  (specimens  $1\text{B}^a$  and  $2\text{B}^a$ ), and  $\text{USb}_2$  (specimens  $1\text{S}^a$  and  $2\text{S}^a$ ) single crystals vs. temperature measured along the  $a$ -axis and  $\kappa(T)$  data for  $\text{UBi}_2$  (specimen  $3\text{B}^c$ ) and  $\text{USb}_2$  (specimen  $3\text{S}^c$ ) measured along the  $c$ -axis. The inset presents the derivative  $d\kappa_a/dT$  for the specimen's  $2\text{B}^a$  of  $\text{UBi}_2$  and  $2\text{S}^a$  of  $\text{USb}_2$  around the magnetic transition temperature  $T_N$  and compares them with the  $\rho(T)$  data [11] shown by two lower curves.

For temperature below  $T_N$ ,  $\kappa_a(T)$  passes through a maximum  $\kappa_a^{\max}$  at temperature  $T_{\max}$ , which is dependant on the purity of the specimen, and finally proceeds to zero with decreasing  $T$ . In order to better demonstrate the impurity effect, we have determined the low- $T$  behaviour of  $\kappa_a(T)$  for several additional specimens prepared from crystals from different batches of  $\text{USb}_2$ , - specimen (spec.)  $1\text{S}^a$  - and  $\text{UBi}_2$  - spec.  $1\text{B}^a$ . Finally the specimens prepared for measurements of the thermal conductivity along the  $c$ -axis are denoted  $3\text{S}^c$  and  $3\text{B}^c$ , respectively. The electrical resistivity,  $\rho$ , of each specimen was also examined and residual resistivity  $\rho_0$ , for  $T \rightarrow 0$ , as well as the residual resistivity ratio,  $\text{RRR} = \rho_{300}/\rho_{4.2}$  were determined; here  $\rho_{300}$  and  $\rho_{4.2}$  are the resistivities at 300 K and at 4.2 K, respectively. It is well know that higher RRR values often indicate high purity. We can characterize specimens with sets of numbers (RRR):( $\kappa^{\max}$  in  $\text{W m}^{-1} \text{K}^{-1}$ ):( $T_{\max}$  in K) which are for  $\text{USb}_2$  specimens:  $1\text{S}^a$  - (97):(58):(22);  $2\text{S}^a$  - (150):(92):(24);  $3\text{S}^c$  - (2.4):(12.8):(26) and for  $\text{UBi}_2$  specimens:  $1\text{B}^a$  - (498):(26):(24);  $2\text{B}^a$  - (598):(41):(20);  $3\text{B}^c$  - (130):(8.7):(18.5).

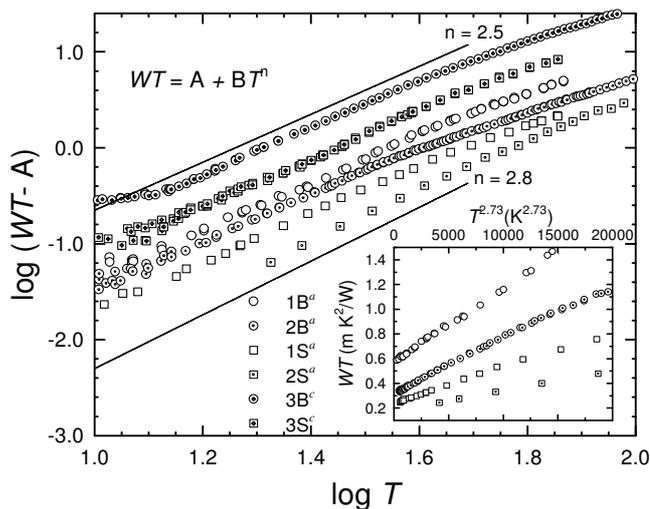


Figure 2. The plot  $\log(WT - A)$  vs.  $\log T$  for spec.  $1\text{B}^a$ ,  $2\text{B}^a$ ,  $3\text{B}^c$ ,  $1\text{S}^a$ ,  $2\text{S}^a$ , and  $3\text{S}^c$ . The solid lines represent eq.  $WT = A + BT^n$  for  $n = 2.5$  and  $2.8$ . The inset shows  $WT$  as a function  $T^{2.73}$ .

We use a metallic approach [16] to analyse the thermal transport in  $\text{USb}_2$  and  $\text{UBi}_2$  and assume validity of the Wiedemann-Franz-Lorenz law and electronic thermal resistivity  $W^e = \rho/LT$  where  $L$  is the Lorenz ratio which, under certain conditions, is equal to the standard Lorenz number  $L_0 = 2.45 \times 10^{-8} \text{ W } \Omega \text{ K}^{-2}$ . We assume that for the lowest temperatures  $W^e = 1/\kappa_{\text{exp}}^e$  is the sum of two components. One is the thermal resistivity due to the scattering of electrons by defects,  $W_d^e = A/T = \rho_0/L_0T$ . The

second component is the resistivity due to the scattering of electrons by phonons/magnons  $W_p^e = BT^n$  as the examined compounds undergo to antiferromagnetic transitions. Thus,

$$W^e = 1/\kappa_{\text{exp}}^e = W_d^e + W_p^e = A/T + BT^n. \quad (1)$$

The power  $n$  for scattering by phonons is expected to be 2 at low temperatures and a plot of  $W^e T$  against  $T^3$  should give something like a straight line. However, deviation from that expected behaviour is often observed. As a matter of fact, this is the case for  $\text{USb}_2$  and  $\text{UBi}_2$ . The  $W^e T$  data for four specimens of these compounds, plotted against  $T^{2.73}$  in the inset of Fig. 2, give something like a straight line. More detailed analysis shows that the widest temperature range of linearity is obtained for  $n$  selected for particular samples. It is observed that  $n$  decreases from 1.8 to 1.5 when  $W^e$  increases from the lowest values, as observed for the  $2S^a$  specimen, to the highest values for  $3B^c$ . This is illustrated in main part of Fig. 2 where  $\log(WT - A)$  data are plotted vs.  $\log T$  for  $A$  values assuring the best linear behaviours in the temperature range of about 10 – 50 K. These values of  $A$  point out  $\kappa_{\text{el}} = TL_0/\rho$  approaching or even exceeding  $\kappa_{\text{exp}}$  which, however, is expected to be higher than  $\kappa_{\text{el}}$ . Such higher values than that expected for  $A$  obtained in this approach results presumably from lattice contribution, not negligible in the considered temperature range. This is discussed in the § 4.

Finally we have assumed that the heat transport at the lowest- $T$  (0.5 – 2 K) is entirely controlled by defects. Then  $\kappa_{\text{exp}}^e = T/A$  comes from eq. (1), allowing us to determine  $A$  values as equal to reciprocal of slope of the  $\kappa_{\text{exp}}$  vs.  $T$  dependence. Such values of  $A$  determined at the lowest temperature point to  $L_0$  (in  $10^{-8} \text{ W } \Omega \text{ K}^{-2}$ ) equal to 4.1 and 72 for  $\text{USb}_2$  along the  $a$ - and  $c$ -axis and 0.95 and 10.6 for  $\text{UBi}_2$  also along the  $a$ - and  $c$ -axis, respectively. The values of  $\kappa_{\text{el}} = TL_0/\rho$  calculated for all these Lorenz numbers are compared in Fig. 3 to corresponding experimental data of the total thermal conductivity in  $\text{USb}_2$  and  $\text{UBi}_2$  and lattice conductivity,  $\kappa_{\text{ph}} + \kappa_{\text{mag}}$ . It is seen that beyond the lowest temperatures the lattice conductivity clearly exceeds the electronic conductivity in the all cases presented in Fig. 3.

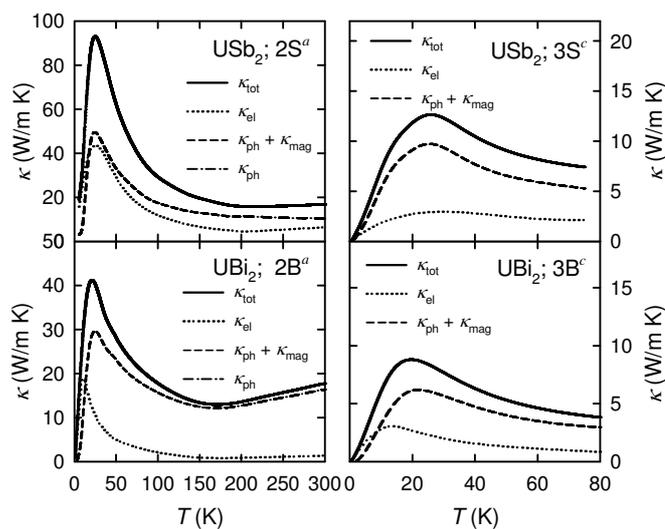


Figure 3. Electronic and phonon/magnon contributions to the total thermal conductivity of  $\text{USb}_2$  and  $\text{UBi}_2$  single crystals in the  $a$  and  $c$  directions. The following values of  $L_0$  were taken to evaluation of electronic contribution:  $4.1 \times 10^{-8}$ ,  $9.5 \times 10^{-9}$ ,  $72 \times 10^{-8}$ , and  $10.6 \times 10^{-8} \text{ W } \Omega \text{ K}^{-2}$  for the samples  $2S^a$ ,  $2B^a$ ,  $3S^c$ , and  $3B^c$ , respectively.

#### § 4. DISCUSSION AND SUMMARY

Aoki et al. [8] revealed by dHvA and SdH experiments that the spherical  $\alpha$  and cylindrical  $\beta$  branches of the FS in  $\text{UBi}_2$  occupies 9.9 % and 4.8 % BZ volume, respectively. The magnetic unit cell contains two molecules of  $\text{UBi}_2$  and it is expected

to be a compensated metal. Aoki et al. assumed that the spherical  $\alpha$  branch is an electron FS and it is compensated with two cylindrical  $\beta$  branches that are the hole Fermi surfaces. This results in either electron and hole carrier concentrations in  $\text{UBi}_2$  to be equal  $1.1 \times 10^{21}$  carrier/cm<sup>3</sup> ( $2 \times 0.099$  carrier/ $4.44^2 \times 8.91 \times 10^{-24}$  cm<sup>3</sup>) which is approximately 75 times lower than the concentration of conduction electrons in copper.

The magnetic unit cell of  $\text{USb}_2$  contains four molecules of  $\text{USb}_2$  and is also expected to be a compensated metal. Its two cylindrical FS,  $\alpha$  and  $\delta$ , originating from spherical FS in the PBZ occupies 16.8 % and 5.4 % of volumes of the magnetic BZ, respectively, and there are two electron FS branches. The two other cylindrical FS type branches,  $\epsilon$  and  $\gamma$ , respectively, originating from cylindrical FS branch in PBZ, which occupy 7.9 % and 3.3 % of the MBZ. Aoki et al. assumed that  $2\epsilon$  and  $2\gamma$  are hole FS branches occupying 22 % of MBZ compensate electron  $\alpha$  and  $\delta$  FS branches thus occupying also 22 % of the MBZ. This results in either electron and hole carrier concentrations in  $\text{USb}_2$  to be equal  $1.4 \times 10^{21}$  carrier/cm<sup>3</sup> ( $2 \times 0.22$  carrier/ $2 \times 4.27^2 \times 8.75 \times 10^{-24}$  cm<sup>3</sup>) which is approximately 61 times lower than the concentration of conduction electrons in copper.

In order to explore a possible correlation between the determined Lorenz number and the topology of the FS, the latter will be characterized, for simplicity, by the difference between its cross section as appropriate for the direction of the thermal conductivity examination and the cross section of spherical surface of a simple metal. For the  $a$ -axis thermal conductivity of  $\text{UBi}_2$ , the essential factor will be the shape of the FS cross sections by planes perpendicular  $k_c$ . All cylindrical FS branches ( $2\beta$ ) are parallel to  $k_c$  and their cross sections are circles, like the cross section of the spherical  $\alpha$  FS branch. For this case  $L_0 = 0.95 \times 10^{-8}$  W  $\Omega$  K<sup>-2</sup> was found. This value is lower than the standard  $L_0$  value and can be compared with  $L_0 = 1 \times 10^{-8}$  W  $\Omega$  K<sup>-2</sup>, as found for ferromagnetic nickel [17].

By comparison to  $\text{UBi}_2$ , there are 20 % more carriers in  $\text{USb}_2$ , which form two times as many FS branches. In spite of this difference, the FS are all corrugated cylinders parallel to  $k_c$ . Thus the cross sections of the  $\text{USb}_2$  FS with planes perpendicular to  $k_c$  are composed of six small circles (high curvature) so it is farther from spherical surface of simple metal than in the case of  $\text{UBi}_2$ . For thermal conductivity along the  $a$ -axis of  $\text{USb}_2$  the value of  $L_0 = 4.1 \times 10^{-8}$  W  $\Omega$  K<sup>-2</sup> has been determined. This is in turn higher than the standard  $L_0$  value.

The cylindrical FS branches in  $\text{UBi}_2$  can contribute to the transport coefficient along the  $c$ -axis only as a result of the corrugations in these branches. Any of the cross section with planes parallel to the  $k_c$  axis does not resemble cross sections of a spherical surface. The only circular FS cross section may come from the spherical FS  $\alpha$  branch, but in spite of this the overall similarity to a spherical cross section is reduced and an increased value of  $L_0 = 10.6 \times 10^{-8}$  W  $\Omega$  K<sup>-2</sup> was determined for the  $c$ -axis thermal conductivity in  $\text{UBi}_2$ . Finally,  $L_0$  increases up to  $72 \times 10^{-8}$  W  $\Omega$  K<sup>-2</sup> in the case of  $\text{USb}_2$  for the  $c$ -axis where all FS branches are corrugated cylinders parallel to  $k_c$ .

Based on a simple theoretical treatment, (see ref. [16]) the lattice thermal conductivity should be about one-third of the electronic component at high temperature if only phonon-electron scattering is important. Calculations done for copper show that the lattice contribution gives a very small fraction to the total thermal conductivity at high and low temperatures. It will suffice to remark that at high temperature the ratio  $\kappa/\sigma T$  is close to the standard value  $L_0$ . This is obviously

not the case of our compounds, which show layered chemical structure and are low carrier density systems. Instead, we make a comparison to the thermal conductivity of  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  as examined by Hagen et al. [18]. This material is a low carrier density system with a layered chemical structure and similar thermal conductivity anisotropy in the normal state where  $\kappa_{ab}/\kappa_c \approx 5 - 6$ . For this compound, it was found that the standard  $L_0$  indicates that the electronic contribution is 55 % of the total  $\kappa_{ab}$  and 1 – 2 % of  $\kappa_c$ . Thus, it was argued that detailed analysis of the latter casts serious doubt about the validity of applying the Bloch-Boltzmann theory to the transport behaviour along the  $c$ -axis. In the case of  $\text{USb}_2$  and  $\text{UBi}_2$  the low temperature  $L_0$  behaviour points towards lower contribution of the electronic thermal conductivity to the total conductivity as compared to that determined by standard  $L_0$  in the case of the  $a$ -axis thermal conductivity of  $\text{UBi}_2$  – 10 % - and the higher one in the case  $\kappa_{el}$  for the  $a$ -axis of  $\text{USb}_2$  – 36 % - and  $\kappa_{el}$  for the  $c$ -axis of  $\text{USb}_2$  – 38 % - and  $\text{UBi}_2$  – 23 %. In the latter case the  $\kappa_{el}$  contribution is nearly 30 times higher than that calculated for standard  $L_0$ .

Electronic thermal resistivity due to the scattering of electrons by phonons should show quadratic temperature dependence at low- $T$ . In our case, we observe a thermal resistivity term  $W \sim T^n$  with  $n$  decreasing from 1.8 for specimens with the lowest thermal resistivities to 1.5 for specimens with the highest resistivities, on this temperature range (see Fig. 2). The total thermal resistivity seems to be the main parameter controlling the decrease of  $n$ . Presumably,  $n$  is an effective parameter, which decreases with an additional scattering mechanism and gives an additional contribution to the total thermal resistivity. At these temperatures, we first consider a lattice term for which the temperature dependant contribution varies like  $T^{-2}$  and increases with increasing  $\rho_0$ . The lattice thermal conductivity would be about one-third of the electronic component at high temperature if only phonon-electron scattering was important in determining both contributions [16]. As the examined compounds are antiferromagnets, we should also consider the possible scattering of electrons by magnetic moments, for which the contribution to the electronic thermal conductivity seems to be well described by  $\kappa_{el}(T) = L_0 T / \rho(T)$ . Therefore it is surprising that the  $\kappa_a(T)$  data for both compounds show weak anomalies at  $T_N$  as compared with  $\rho_a(T)$  (inset to Fig. 1). There also is a weak and weakly temperature dependent anisotropy of the thermal conductivity. The ratio  $\kappa_a(T)/\kappa_c(T)$  at 80 K (maximum of  $\rho_c(T)$  for  $\text{USb}_2$ ) for the best specimens of  $\text{USb}_2$  and  $\text{UBi}_2$  is equal to 5.1 and 5.4, respectively, and does not change by more than 30 % with temperature down to 20 K. This result can be compared with the anisotropy of the electrical resistivity, as shown for the both compounds by the lower inset in Fig. 4.

To show high specimen sensitivity of another electronic transport coefficient, we present thermoelectric power for specimen  $2S^a$  showing RRR 150 and compare it with the previously examined specimen  $3S^a$  [11]. The increase of RRR enhances the phonon drag peak but lowers the thermoelectric power in the paramagnetic region. One might think that the weak manifestation of the aforementioned peculiarities of electrical resistivity behaviour in the thermal conductivity are possibly due to their signatures being overwhelmed by another scattering mechanism which dominates the total thermal conductivity.

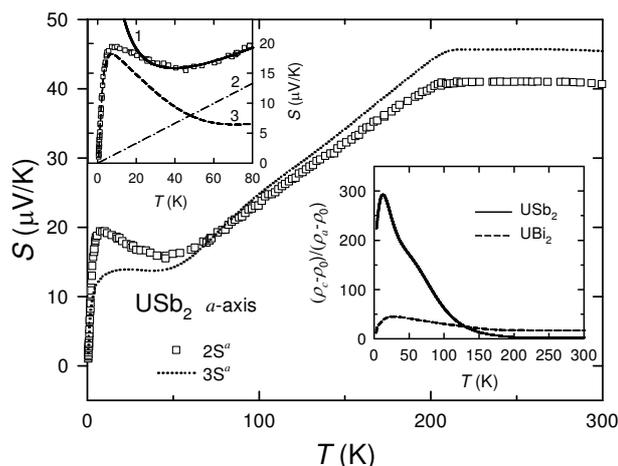


Figure 4. Thermoelectric power vs. temperature for  $USb_2$  single crystals along the  $a$ -axis. The squares denote the data for  $2S^a$  sample, while the dotted line represents the data for  $3S^a$  sample measured earlier [11]. Curve 1 in the upper inset displays the equation:  $S(T) = aT + b/T$  with the fitting parameters  $a$  and  $b$  equal to  $0.205 \mu\text{V K}^{-2}$  and  $285 \mu\text{V}$ , respectively. The straight line 2 and curve 3 present the diffusion and phonon/magnon drag contributions to the total thermoelectric power, respectively. The lower inset presents the ratio  $(\rho_c - \rho_0)/(\rho_a - \rho_0)$  for  $USb_2$  and  $UBi_2$  single crystals taken from ref. [11].

We conclude that the electronic thermal transport analysis at low temperatures leads to an estimation of various values of the Lorenz number  $L_0$  and gives a more realistic electronic contribution  $\kappa_{el}$  to the total thermal conductivity for both compounds  $UBi_2$  and  $USb_2$ . The lack of the spherical FS branches in  $USb_2$  and flat MBZ influence on the anisotropy of the electronic thermal conductivity  $\kappa_{el}^a/\kappa_{el}^c$  that is not so large as in electrical resistivity and thermoelectric power. The anisotropy of the total thermal conductivity is comparable with the other layered structures e.g. mentioned above YBCO.

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