Electronic Supplementary Information: Unveiling the Magnetism in a Single-Atom-Thick $GdPb_3$ Kagome Compound on Si(111) via Magnetotransport Measurements

N. V. Denisov[1], L. V. Bondarenko[1], Y. E. Vekovshinin[1], A. N. Mihalyuk[1,2], S. V. Eremeev[3], D. V. Gruznev[1], A. V. Zotov[1] and A. A. Saranin[1]

[1]*Institute of Automation and Control Processes FEB RAS, 690041 Vladivostok, Russia*

[2]*Institute of High Technologies and Advanced Materials, Far Eastern Federal University, 690950 Vladivostok, Russia*

[3]*Institute of Strength Physics and Materials Science, SB RAS, Tomsk 634055, Russian Federation*

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Abstract

Supplemental Materials includes:

1. Sheet magnetoconductivity of the $LaPb_3$ and $YbPb_3$ samples

1 Sheet magnetoconductivity of the $LaPb_3$ and $YbPb_3$

Magnetoconductivities of the $LaPb_3$ and $YbPb_3$ samples are shown to demonstrate occurrence of the weak antilocalization (WAL) effect in them. The WAL effect is commonly illustrated by the dependencies of the $[\sigma(B) - \sigma(0)]$ versus B, which shape is described by the Hikami-Larkin-Nagaoka theory [1] and in the limit of a strong SOC the weak-field conductance variation can be written as:

$$\Delta\sigma(B) = \frac{\alpha e^2}{\pi h}\left[\psi\left(\frac{1}{2} + \frac{B_\phi}{B}\right) - ln\frac{B_\phi}{B}\right], \tag{1}$$

where, ψ is the digamma function, the characteristic field $B_\phi = \hbar/4el_\phi^2$, l_ϕ is dephasing length and $\hbar$ is the Planck's constant. According to the HLN theory, coefficient α equals -0.5 for the the WAL in a 2D system.

By applying equation (1) to the experimental curves [Figures 1ESI (a) and (b)], the fitting parameters of l_ϕ and α are obtained, as a function of temperature [Figures 1ESI (c)]. One can see that coefficient α for the both $LaPb_3$ and $YbPb_3$ cases is quit close to the expected value of -0.5. Note that the dephasing length l_ϕ for the $YbPb_3$ is essentially greater than that for $LaPb_3$ at all temperatures. The reason can be related with the validity of the HLN equation. Its usage imply that the transport is in the diffusive and weakly disordered regime, i. e. $k_F l \gg 1$ [2, 3]. This condition is definitely valid for $YbPb_3$ samples with $R_s \approx 600\ \Omega/\square$ ($k_F l \approx 40$), while it is not strict enough for $LaPb_3$ samples with $R_s \approx 5\ \mathrm{k}\Omega/\square$ ($k_F l \approx 5$).

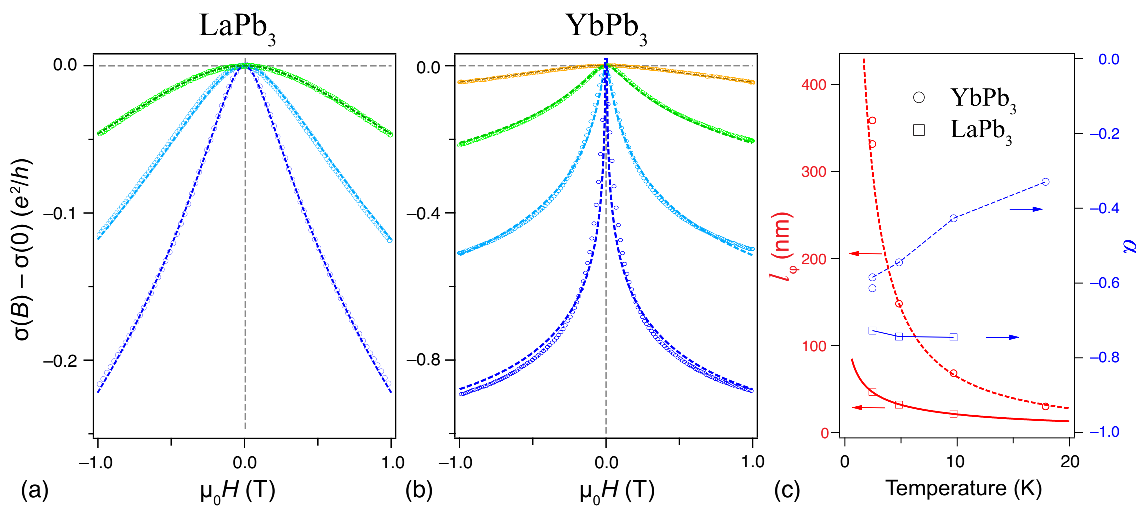

Figure 1ESI: Sheet magnetoconductivity of the (a) $LaPb_3$ and (b) $YbPb_3$ samples, measured in the field varied from -1.0 to 1.0 T and sample temperatures of 2.7, 4.8, 9.7, and 17.9 K, shown by open circles of various colors. Dashed lines of corresponding color represent theoretical fitting curves based on the HLN theory. (c) Temperature dependencies of coefficient α (blue, right scale) and dephasing length l_ϕ (red, left scale) derived from the fits in (a) and (b) for $LaPb_3$ and $YbPb_3$, shown by squares and circles, respectively.

References

[1] S. Hikami, A. I. Larkin, and Y. Nagaoka. Spin-orbit interaction and magnetoresistance in the two dimensional random system. *Progress of Theoretical Physics*, 62 (1980) 707–710.

[2] G. Bergmann. Inelastic life-time of the conduction electrons in some noble metal films. *Zeitschrift für Physik B Condensed Matter*, 48 (1982) 5–16.

[3] J. Chen, X. Y. He, K. H. Wu, Z. Q. Ji, L. Lu, J. R. Shi, J. H. Smet, and Y. Q. Li. Tunable surface conductivity in Bi_2Se_3 revealed in diffusive electron transport. *Phys. Rev. B*, 83 (2011) 241304.