研究プロジェクト名：　Charge and spin-dependent topological transport phenomena in antiferromagnetic Weyl semi-metals

概要：　The interplay of relativistic spin-orbit interaction, electronic band topology, and magnetic order in antiferromagnetic Weyl semi-metals (WSMs) manifests in novel properties prospective for antiferromagnetic spintronics. We aim to quantify the magnetotransport properties of antiferromagnetic WSM and WSM/non-magnet heterostructures. Our experimental results, supported by semiclassical modelling will provide a convenient approach for understanding of the manifestations of band topology in WSMs, crucial for topological antiferromagnet spintronics.

コアメンバー：　Samik DuttaGupta (CSIS, Tohoku Univ), Shunsuke Fukami (RIEC, Tohoku Univ), Yuta Yamane (FRIS, Tohoku Univ.), Jun'ichi Ieda (JAEA)

期待される研究成果：

The results obtained from this research entails the clarification of electronic transport phenomena associated with non-trivial topological band characteristics and spin-structures in WSM heterostructures. This will provide an electrical probe to access the relativistic effects arising from Berry curvature and topological Dirac or Weyl points in thin film Weyl semimetals. The proposed experimental and theoretical investigations is crucial for development of topological antiferromagnetic spintronics.

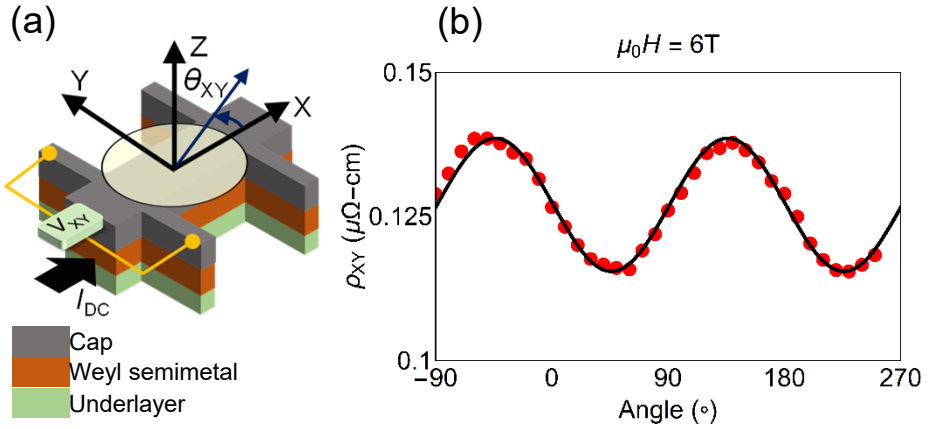

Figure: (a) Schematic diagram of the Weyl semimetal antiferromagnet hall bar structure. I_{DC} refers to the applied current while V_{XY} is the measured voltage under the application of external magnetic field rotated in the *x*-*y* plane (θ_{XY}). (b) Experimental results of Hall resistivity (ρ_{XY}) versus θ_{XY} under $\mu_0 H$ = 6T at RT demonstrates the existence of a planar Hall effect originating from a chiral magnetic effect arising from the topological nature of the electronic bands.

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概要: The interplay of relativistic spin-orbit interaction, electronic band topology, and magnetic order in antiferromagnetic Weyl semi-metals (WSMs) manifests in novel properties prospective for antiferromagnetic spintronics. We aim to clarify the impact of topology on the magnetotransport properties of antiferromagnetic WSM heterostructures. Our experimental result provides a convenient approach for understanding of the manifestations of band topology in WSMs, crucial for topological antiferromagnet spintronics.

We utilized C-plane (0001) and M-plane (1-100) oriented MgO sub./under- layer/Mn_3Sn (40 nm)/MgO/Ru thin films patterned into Hall-bar structures for the investigation of magnetotransport properties. Previous studies show a large anomalous Hall effect for M-plane orientations, while is zero for C-plane oriented structures.

Planar Hall effect measurements show a considerable anisotropic behavior among C and M-plane orientations. Our observations reveal the signatures of chiral anomaly on the magnetotransport features in antiferromagnetic WSM structures.

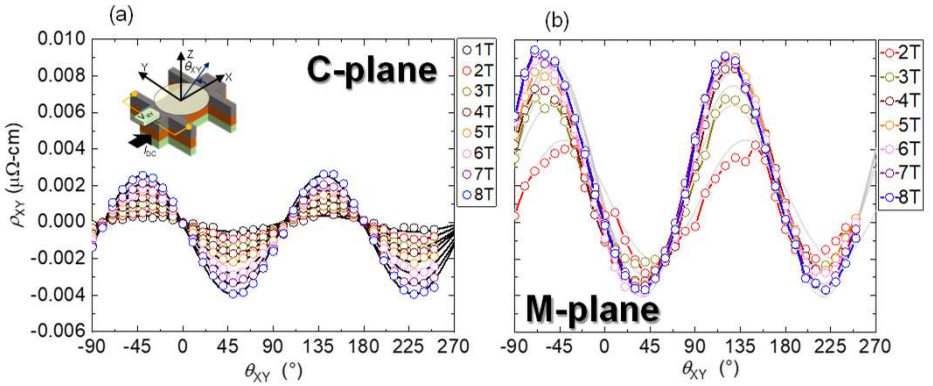

Figure: (a), (b) Experimental results of planar Hall resistivity vs applied angle of rotation of in-plane magnetic field for C-plane and M-plane Mn_3Sn structures, respectively. The inset in (a) shows the schematic of the measurement configuration. I_{DC} refers to the applied current while V_{XY} is the measured voltage.

主要発表論文等: