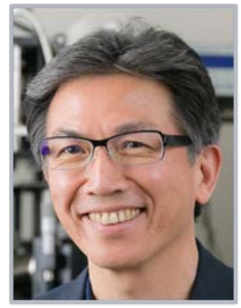
The 2020 Around-the-Clock Around-the-Globe Magnetics Conference: Invited speakers information



Name: YoshiChika
Surname: Otani
Affiliation: The University of Tokyo
Country: Japan

Title of the talk: <u>Novel functions observed in a topological antiferromagnet</u>

Biography:
YoshiChika Otani received the B.S., M.S., and Ph.D. degrees from Keio University, Japan, in 1984, 1986, and 1989. He was a research fellow at the Physics Department of Trinity College Dublin, the University of Dublin, Ireland (1989–1991), and a researcher at the Laboratoire Louis Néel, CNRS, France (1991–1992). He was an assistant professor at the Department of Physics, Keio University (1992–1995), and an associate professor at the Department of Materials Science, Tohoku University (1995–2002). From 2001 to 2004, he led the Quantum Nano-Scale Magnetics Research Team at the RIKEN Frontier Research System (FRS) as a team leader. In 2004 he became a professor at the Institute for Solid State Physics (ISSP), the University of Tokyo. Since 2004 he has additionally been the leader of the Quantum Nano-Scale Magnetism Research Team at the RIKEN Center for Emergent Matter Science (CEMS).
Prof. Otani has published over 250 technical articles in peer-reviewed journals, including book chapters and review articles, and has given more than 100 invited and plenary presentations at international conferences. He has been coordinating the Nano Spin Conversion Science project, supported by the Japanese Ministry of Education, Culture, Sports, Science, and Technology since 2014 to elucidate the interconversion mechanisms among phonons, photons, magnons, and electrons. He has been a committee member of the Commission on Magnetism (C9) of the International Union of Pure and Applied Physics since 2011 and will become vice chair in 2018.

Abstract:
Recently a chiral antiferromagnet Mn_3Sn has been demonstrated to exhibit a large anomalous Hall effect (AHE) at room temperature, the magnitude of which reaches almost the same order of magnitude as in ferromagnetic metals irrespective of a tiny spontaneous magnetization of about 1 mT [1]. The first principle calculation revealed that this large AHE originates from a significantly enhanced Berry curvature associated with the formation of Weyl points near Fermi energy [2,3]. Even more, recently detailed comparison between angle-resolved photoemission spectroscopy (ARPES) measurements and density functional theory (DFT) calculations revealed significant bandwidth renormalization and damping effects due to the strong correlation among Mn 3d electrons. Magnetotransport measurements provide strong evidence for the chiral anomaly of Weyl fermions, i.e., the emergence of positive magnetoconductance

only in the presence of parallel electric and magnetic fields. In this way, all the characteristic electronic properties of Mn_3Sn imply that the spin Hall effect (SHE) could also take place in the Mn_3Sn [4].

In this study, we set up our device that consists of ferromagnetic NiFe (blue squares) and nonmagnetic Cu electrodes formed on the top surface of a micro-fabricated single crystal of Mn_3Sn. We found that antiferromagnets have richer spin Hall properties than nonmagnetic materials, that is, in the noncollinear antiferromagnet Mn3Sn, the SHE has an anomalous sign change when it's triangularly ordered moments switch orientation. Our observations demonstrate that a novel type of contribution to the SHE (magnetic SHE, MSHE) and the inverse SHE (MISHE) that is absent in nonmagnetic materials can be dominant in some magnetic materials, including antiferromagnets. We attribute the dominance of this magnetic mechanism in Mn_3Sn to the momentum-dependent spin splitting produced by the noncollinear magnetic order. This discovery further expands the horizons of antiferromagnet spintronics and motivates a universal outlook on spin-charge coupling mechanisms in spintronics [5].

In this talk, we show experimental results of two complementary experiments, such as detection of spin accumulation induced by the direct SHE and spin pumping induced inverse SHE in Mn3Sn. Our experimental results demonstrate that we could observe the spin accumulation associated with the direct DHE and also the signals due to the inverse SHE. Furthermore, we will discuss antiferromagnetic domain wall dynamics experimentally observed in these novel antiferromagnets [6].

References:

[1] S. Nakatsuji et al., “Large anomalous Hall effect in a non-collinear antiferromagnet at room temperature” Nature, vol. 527, pp. 212–215, 2015

[2] J. Kuebler et al., "Noncollinear antiferromagnets and the anomalous Hall effect", EPL, vol. 108, pp. 67001 (2014).

[3] H. Yang, et al., "Topological Weyl semimetals in the chiral antiferromagnetic materials Mn_3Ge and Mn_3Sn", New J. Phys. Vol. 19, pp. 015008, 2017

[4] K. Kuroda et al., "Evidence for magnetic Weyl fermions in a correlated metal", Nat Mater., vol. 16, pp. 1090, 2017

[5] M. Kimata et al., “Magnetic and magnetic inverse spin Hall effects in a non-collinear antiferromagnet”, Nature, vol. 565, pp. 627-630, 2019

[6] S. Sugimoto et al., "Electrical nucleation, displacement, and detection of antiferromagnetic domain walls in the chiral antiferromagnet Mn_3Sn", Communications Physics vol. 3, pp. 111, 2020