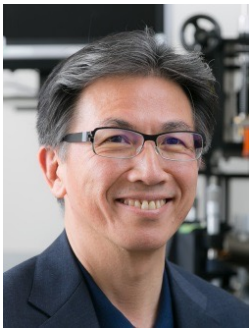
B : Nano Scale Science

Advanced
Materials Science

New generation spin conversion science

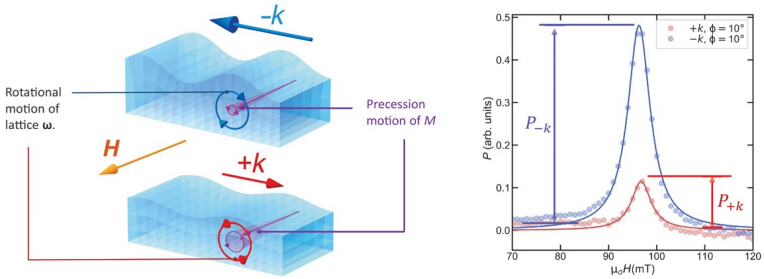
Otani Laboratory



The concept of spin current, a flow of spin angular momentum, was introduced at the end of the 20th century, and spintronics has developed as a new electronics that effectively utilizes both charge current and spin current. More recently, it has been clear that quasi-particles such as charge, spin, phonon, photon, and magnon can be converted each other through the mediation of spin in solids. These "spin conversion" has been further developed as a field of solid state physics.

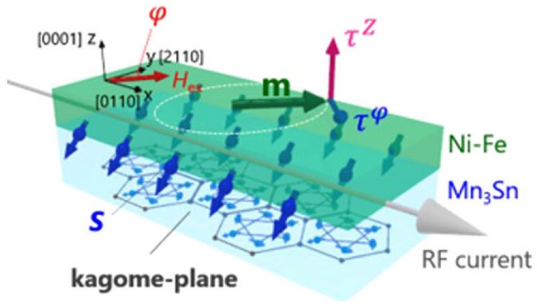
教授　大谷義近

In recent spintronic, antiferromagnetic materials, which have not seen the light of day in comparison to ferromagnetic materials, have attracted a great attention and are showing new developments as antiferromagnetic spintronics. Another important theme in spintronics is the realization of strong coupling among quasi-particles. We focus on these two areas. We welcome anyone who wants to challenge new things with curiosity. We are also engaged in a wide range of domestic and international collaborative research, so those who wish to participate in research activities that span the globe are also welcome.



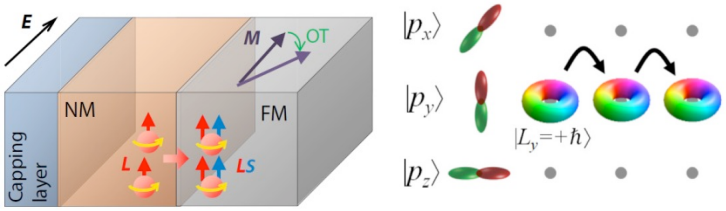
Nonreciprocal surface acoustic wave propagation via magneto-rotation coupling: The rotational motion caused by surface acoustic waves couples with the magnetization. This magneto-rotation coupling induces a nonreciprocal attenuation on the surface acoustic waves.

M. Xu, et al. Science Advances (2020)
Y. Hwang et al, PRL(2023)
L. Liao et al, PRL (2023)



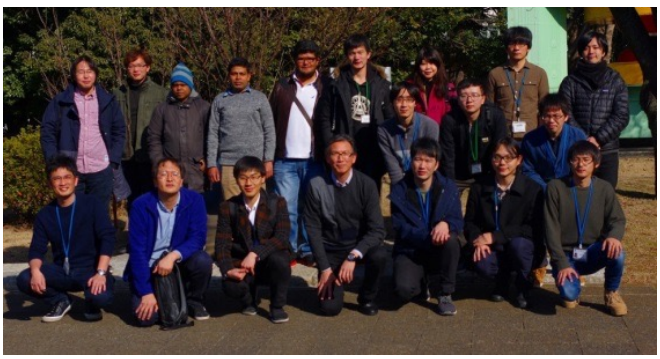
Spin-orbit torque via magnetic spin Hall effect of a Weyl antiferromagnet: Magnetic spin Hall effect, caused by the band structure of Weyl antiferromagnet, produces out-of-plane spin accumulation, which is useful to control the magnetic state of magnetic materials. We demonstrated that the sign of the magnetic spin hall effect can be tuned by changing the magnetic moment of the antiferromagnet.

M. Kimat, et al. Nature (2019)
K. Kondou, et al. Nat. Comm. (2021)



Injection of orbital angular momentum into ferromagnet: Recent theoretical works predict that not only spin injection but also the injection of the orbital angular momentum into ferromagnets can generate torque. We demonstrated that Nontrivial torque generation by orbital angular momentum injection in ferromagnetic-metal/Cu/Al_2O_3 trilayers

J. Kim, et al. PRB (2021)
J. Kim, et al, Physical Review Materials (2023)



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