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Spin Hall Effect in Spin Glass Systems

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The spin Hall effect (SHE) and its inverse play important roles in spintronic devices as they enable interconversions between charge and spin currents. The conversion efficiency, i.e. the spin Hall angle, strongly depends on detailed material properties, such as the electronic band structure and the nature of impurities. While most of the work has focused on the mechanism of the SHE and the magnitude of the spin Hall angle, there are only a few examples to utilize the SHE such as the detection of the spin Seebeck effect and magnetization switching. Further applications of the SHE are, however, still lacking. In this talk, we address a new direction of utilizing the SHE to probe spin fluctuations near glass temperatures T_g of spin glass systems. For this purpose, we chose CuMnBi ternary alloys [1]. When there is no Bi impurity in CuMn, it shows no SHE in the spin transport but shows a typical cusp structure in the thermo-magnetic curves. Once a small concentration of Bi is added in CuMn, a large SHE has been observed as shown in our previous work on Bi-doped Cu [2]. Most remarkable is that the SHE of $Cu_{98}Mn_{1.5}Bi_{0.5}$ is suppressed far above $T_g = 10$ K and it becomes 10 times smaller than that of CuBi at 5 K. This result clearly shows that the spin current generated by the SHE is much more sensitive to magnetization measurements.

[1] A. Fert *et al.*, J. Magn. Magn. Mater. **24**, 231 (1981).
[2] Y. Niimi *et al.*, Phys. Rev. Lett. **109**, 156602 (2012).