My Transversely-Polarized Spin Current Generation from Ferromagnetic Metals

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The anomalous Hall effect, discovered by Edwin Hall in 1880, describes a phenomenon that an electric current perpendicular to magnetization of a magnetic material can produce a charge accumulation in the direction orthogonal to both electric current and magnetization. Through century-long theoretical and experimental efforts, it is now understood that the anomalous Hall effect arises from the spin-orbit coupling. The understanding of the anomalous Hall effect has also led to the discovery of new spin-orbit effects, such as the spin Hall effect, where an electric current generates spin accumulations in nonmagnetic materials. The spin Hall effect also exists in ferromagnetic materials, in a more complicated and interesting way. There exist a group of spin-orbit effects associated with transverse spins – spins polarized perpendicular to the magnetization, which we refer to this group of spin-orbit effects as transverse-spin-orbit effects in magnetic materials. In my talk, I will present our experimental observations of two unique transverse spin-orbit effects: (1) spin-to-charge interconversion with unconventional spin rotation symmetry and (2) the generation of anomalous spin-orbit torque in a single-layer magnetic film – a hidden counterpart to the anomalous Hall effect. I will also discuss the impact of these effects on the understanding of general spin-charge conversion phenomena.

Reference

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Xin Fan received his Ph.D. in Condensed Matter Physics from University of Delaware in 2010 under the supervision of Prof. John Xiao. After graduation, Xin stayed in the same group as a postdoc fellow. He joined the faculty of University of Denver in 2014, and is currently an associate professor in Physics. He is a recipient of the NSF CAREER award and co-organizes the online spintronics seminar series since 2020. His current research interests include magnetization dynamics and spintronics.