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. However, despite the comprehensive understanding, I will argue that the anomalous Hall effect is incomplete in describing the spin-orbit coupling-induced phenomenology in magnetic materials. There exist a group of spin-orbit effects associated with transverse spins – spins polarized perpendicular to the magnetization, which have been previously overlooked. We refer to this group of spin-orbit effects as transverse spin-orbit effects in magnetic materials. In my talk, I will discuss 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.


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