Controlling Spin-Orbit Torques Through Symmetry using Van der Waals Materials

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The manipulation of magnetization using materials with large spin-orbit coupling is very promising for applications in magnetic memory devices. In these devices, a charge current flowing through the high spin-orbit coupling material generates a spin current which is used to apply torques on the magnetization of a ferromagnet. In addition to promising applications, the study of these spin-orbit torques can unveil many of the material's spintronic properties.

The large family of layered two-dimensional materials has shown to be an excellent candidate for the generation of spin-orbit torques. They provide large atomically-flat single crystals with various properties and very pristine interfaces which leads to an efficient transfer of spins from the layered material to the ferromagnet.

In this talk I will show how the crystal structure and electronic properties of 2D materials can dictate the magnitude, direction, and symmetries of spin-orbit torques. In particular, I will discuss results for devices based on WTe2 or NbSe2 showing torques which are forbidden by symmetry in conventional heavy metal/ferromagnet devices. I will also discuss recent results on the layered insulating antiferromagnet NiPS3, where we observe large interfacial torques, with torque efficiencies comparable to best devices based on heavy metals.