Title of Project: Spin manipulation without a magnetic field

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Short Description

The conventional wisdom tells us that the most straightforward way to change the direction of spins or switch the magnetization from one direction to the other is to apply a magnetic field. This in fact has form the basis of all kinds of magnetic sensors. However, the necessity of an applied magnetic will affect the way how spintronics can be applied to future nanoscale logical and memory devices. This is because it is more difficult to form an extremely localized magnetic field than its electrical counterpart. One of the promising techniques which has the potential to overcome this difficulty was proposed by Berger and Slonczewski independently in 1996. The underlying physics was that the flow of spin-polarized current can transfer angular momentum from carriers to ferromagnet and alter the orientation of the corresponding magnetization, even in the absence of an applied magnetic field. This phenomenon, known as spin-transfer torque, has since been extensively studied both theoretically and experimentally due to its rich physics and potential application in nonvolatile memory and high-frequency devices. Since its first demonstration in current-perpendicular-to-plane nanopillars, it has also been observed in magnetic tunnel junctions and domain wall structures in both metallic systems and magnetic semiconductors. On the other hand, the spins can also be manipulated by an electrical field through spin-orbit interactions. In this project, we will carry out current induced domain wall motion experiments on various types of magnetic nanostructures using a unique nanoprobe system.