

Injection, detection, and control of spin current

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Classical electronics is based on moving electrons controllably through devices, and using their location as a basis for information processing, transmission, or storage. The flow of these electrons is measured by a quantity we commonly call simply current. To be completely accurate however, one should refer to this as a charge current. In reality, electrons carry not only a charge, but also a spin. In traditional electronics, the spin of the electrons is random, so that any macroscopic movement of electrons will carry an equal amount of both spins, and any net spin flow will be practically zero. However, under appropriate conditions, the spin of the electrons can, like charge, be controlled, and electrons can be made to transport not only charge, but also spin from one location to the other. This allows for a new breed of electronics, called spintronics, where both charge and spin flow become active parts of device functionalities.

In this tutorial, I will review how such spin currents can be created, and transferred from one device part to the other (the problem of spin injection) and detected upon arrival. Building on these basics, I will show how spintronics devices, specifically those based on giant/tunneling magnetoresistance, revolutionized the information storage industry, and go on to show some more recent academic work which introduces ideas on how these spin currents may begin to play a role in information processing as well. If such efforts are successful, they would for the first time allow for all information handling functions (processing and storage) to be carried out in a single device, and conceptually be equivalent to the long sought after memristor device.