Semiconductor spintronics

Allan MacDonald
Univ. of Texas-Austin, USA

Current semiconductor memory and logic chips are technological marvels in which information is stored and processed by using gates and impurities to manipulate the flow of charge. Consistent rapid progress, taken for granted by the consumers of this technology, is increasingly challenged by physical and economic limits, motivating explorations of new functionalities based on new physical effects.

Spintronics, in which both the charge and spin properties of electron assemblies are manipulated, is one interesting frontier. The most robust spintronics effects occur in ferromagnets, in which macroscopic magnetization results from the collective behavior of all electron spins. Spintronics effects in a metal or a semiconductors occur because its quasiparticle bands change when its collective magnetization state is altered, for example by a weak external magnetic field. Spintronics in metals has enabled the latest generation of hard disk read heads and its potential as a future home for random access memory technology is currently being explored. Interest in spintronics in semiconductors has increased following the discovery that III-V semiconductors become ferromagnetic when doped with Mn. Semiconductor ferromagnets are more interesting than their metallic counterparts because their basic magnetic properties, Curie temperatures and coercivities for example, can be altered by gates, by dopants or by band-structure engineering.

I will discuss the status of efforts to understand the physical properties of (III,Mn)V systems, discussing in particular prospects for room temperature ferromagnetism, and mention some current ideas for potential spintronics devices in semiconductors.