

Challenges and emerging directions in spintronics

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Spintronics is a new field of research exploiting the influence of the electron spin on electronic transport. It is mainly known for the “giant magnetoresistance” (GMR) and the large increase of the hard disc capacity by read heads based on the GMR, but it has also revealed many other interesting effects and is now developing along promising novel directions.

After an introduction on the fundamentals of spintronics, I will review some of the most promising directions of today, which will include the study of the spin transfer phenomena, spintronics with semiconductors, spintronics with carbon nanotubes or graphene, neuromorphic devices..... In a spin transfer experiment, for example, one manipulates the orientation of a nanomagnet by transfusing spin angular momentum into it from a spin-polarized electronic current. This electronic spin transfer can be used to switch the magnetization (with near applications to the writing of magnetic memories) or to generate oscillations in the radio-wave frequency range (with promising applications in telecommunications). Spintronics with semiconductors aims to the fusion between conventional electronics and spintronics, while carbon-based spintronics is one of the most promising ways to go “beyond CMOS”, i.e. beyond the silicon-based electronics of today.