



II NanoFrontMag Scientific Workshop

Open questions in applied and fundamental nanomagnetism – Facing societal challenges of the 21st century

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Nanomagnetism considers magnetic phenomena at the scale of a few to a few hundreds of nanometers. In the modern sense it includes spintronics, exploiting the interplay of magnetization with (spin-polarized) conduction electrons. Although magnetism may seem an old piece of science, the number of new fundamental phenomena discovered over the past three decades is astonishing: giant- and tunnel magnetoresistance, oscillatory interlayer exchange coupling, interfacial magnetic anisotropy, spin-transfer torque, spin-orbit torques arising from spin-Hall and Rashba effects, Dzyaloshinskii-Moriya interactions and skyrmions. While researchers have been passionate in pushing ever forward the frontiers of fundamental knowledge in these fields, we should not neglect the importance of economics and societal challenges in supporting our research.

Magnetic hard disk drives have been a key technological background for the promotion of fundamental nanomagnetism. However HDDs are decreasing in importance as the prospects for long-term progress are dwindling. Thus, it is crucial to identify what will be the future technological and societal drivers for nanomagnetism, at a time when public funding tends to stress more and more the short-term benefit to the society. Thanks to its remanent features, magnetism has key assets to address low-power computing, at a time when information & communication rising requests come along with steeply-increasing energy consumption. Intelligent systems and the Internet of Things require the same, also coming with concerns of sustainability and material criticality, which needs to be addressed from the start, at the research level. Other opportunities arise such as in biomedical application, or radiation hardness for space or nuclear industry. Finally, I will end up mentioning a few of the societal considerations we should consider in the way we conduct our research: higher education, networking, links between the academics and the industry, broad public dissemination, open publishing, distant working.