复旦大学物理系物质科学报告

Physics Department Colloquium

Energy Scaling of Spintronics – A new paradigm

- From STT memory, MeRAM to low dissipation intelligent systems

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Abstract: The talk will first give a brief overview of the energy challenge of today's CMOS scaling. Then I will describe the advantages and impact of magnetic devices in terms of its low switching energy, high speed, high endurance, and scalability. The physics of spin transfer torque (STT) will be described for its application of spintronic memory. Next, we will describe in addition the physics of spin-orbit interaction and spin Hall to improve energy efficient switching via polarized spins. In particular, the physics of nanomagnetics and the new discovered engineering of spin-orbit interaction at the interface will be delineated. Only recently, it was shown to possibly use electric field to control magnetic properties of metallic ferromagnetic layers at the metal/insulator interface. For the latter, we will describe a couple of fundamental mechanisms of voltage control of magnetic moment and direction at the metallic surface. I will specifically describe a new concept of electric field control of metallic magnetism, that is, the use of electric field to manipulate magnetic field via engineering of the spin-orbit interactions at the metallic interface. This will lead to electric-field or voltage controlled magneto-electric (ME) memory (Me-RAM) , resulting in much reduced energy dissipation for switching. The dynamics of the switching as well as additional physical processes in improving the switching process will be outlined. Additionally the recent progress in using spin Hall to produce large torque for further reducing energy in switching nanomagets will be discussed. Energy scaling will be addressed.

Further advances are possible by adopting the spin wave bus concept -- the use of spin waves for logic and interconnect . With low energy, high density memory and spin wave bus, it may be possible to construct a new type of neuromorphic information processing electronics. These types of devices may be integrated directly on top of front-end processed CMOS to enable new generations of nonvolatile instant-on electronics and other systems. A potential new paradigm of intelligent nano-systems may emerge.

Time： 2:00 pm, Tuesday, 2014.4.8 Location： Physics Building, Room 221B

(Cookies and coffee are served from 1:30 pm)