NON VOLATILITY AND GHZ MAGNETIZATION DYNAMICS IN MAGNETO-ELECTRONIC DEVICES, FROM MEMORY TO LOGIC

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In the last ten years since its first product (the spin valve read head for hard disk recording by IBM in 1997), the applications of spin electronics have undergone a spectacular acceleration towards nano-integration of magnetic devices into solid state electronics. Among the latest examples are the Spin-RAM demos recently proposed by Sony [1] and Hitachi [2], which promise dense, scalable [3, 4], magnetic non volatile memories (MRAM) using spin angular momentum transfer switching (Spin-RAM). This incursion has been made possible by a chain of scientific breakthroughs that illustrate how Nanosciences can impact electronics. For instance, giant magnetoresistance of multilayers (Nobel Prize 2007) or the magnetic tunnel junction (MTJ) have made reading of smaller and smaller magnetic bits possible for today's record areal densities in hard disk recording.

One crucial aspect of magnetic storage, however, is the exceptional time span over which magnetization dynamics has to be controlled, from 10 years for non volatile storage to ~1 nanosecond for the writing speed [5]. The issue could even be worse for solid state applications, where writing power is expected to be limited. Furthermore, the potential to achieve writing speeds above one GHz through precessional dynamics [6-8] may be the best advantage of MRAM compared to other non volatile memory technologies, allowing, for instance, the use a single memory technology in microcontrollers and SoC. Furthermore, low power, error free GHz operation would open the way to the development of non volatile, programmable logic chips mixing MTJs and CMOS [9-16]. Application to RF sources is also actively pursued.

Our group has been exploring such issues on many different systems from MTJ nanopillars to current induced domain wall propagation, and the talk will give an overview of our understanding of the route towards achieving ultrafast non volatile spin electronics devices, on the road to magnetic logic chip.

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