MAGNETIZATION REVERSAL BY INJECTION AND TRANSFER OF SPIN: EXPERIMENTS AND THEORY.

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The magnetization of a ferromagnetic body can be reversed without applying a magnetic field but only by transferring spins from a spin-polarized electrical current. A reversal can be obtained either by the coherent precession of the magnetic moment generated by the transfer of spin, or by the motion of domain walls induced by the spin-polarized current. In other conditions the magnetization can also be maintained in precession by spin transfer. This maintained precession generates oscillations of the current in the microwave frequency range. Several theoretical approaches, extending the initial theories (Slonczewski, Berger), have been recently developed.

The first part of the lecture describes experiments of both types, that is current-induced reversal by coherent precession and current-induced domain wall motion. The first type of experiment is performed on F/N/F submicronic pillars fabricated by an e-beam lithography method (F = ferromagnetic metal or semiconductor, N = nonmagnetic metal or semiconductor). In the second type of experiments, the magnetic configuration of spin valves is switched by current-induced domain wall motion in the soft layer between two pinning centers. This type of current-induced magnetic switching, as it requires smaller current densities than the magnetization reversal in pillars and can also be obtained by very short current pulses, is promising for applications.

In the second part of the talk, I summarize the theoretical issue and describe the model we have developed to unify the interpretation of CPP-GMR and spin transfer experiments on pillars. This model is based on a self-consistent calculation of the longitudinal and transverse components of the spin current throughout the multilayered structure in the limit of quasi-interfacial spin transfer. The torques acting on the magnetic layers are derived from the transverse component of the spin current injected into each layer. I will also discuss the different behaviors expected in different ranges of applied field (direct reversal or maintained precession).