Transport and magnetism in nanowires

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Arrays of magnetic nanowires synthesized by electrodeposition into nanoporous media have recently aroused a considerable interest motivated by fundamental studies in various areas such as giant magnetoresistance, magnetization reversal in a single nanowire, domain wall magnetoresistance, spin-polarized current injection, … Magnetic nanocontacts have also recently been prepared using this templating method. The width of the constriction can be varied reversibly by controlling the potential between the electrodeposited nanowire and a ferromagnetic electrode. The electrical conductance shows quantization steps in units of e^2/h. Very large MR effects have also been measured.

In addition, high frequency studies are favoured in magnetic nanostructures as their dimensions are smaller than the skin depth. These nanowires exhibit very interesting properties such as resonance frequency tunability and zero field ferromagnetic resonance absorption. Examples of results obtained in the Louvain group on both arrays of nanowires and isolated nanowires will be presented and discussed.

Finally, a short overview of the results recently obtained on superconducting nanowires will be given. An increase in the thermodynamic critical field H_c is observed and is attributed to the small transversal dimension leading to an incomplete Meissner effect. A non-zero resistance occurs below T_c in these 1D-superconductor due to fluctuations of the superconducting order parameter (phase slips). The destruction of superconductivity observed in the V-I characteristics may be explained by the formation of phase slip centers. Switching mechanism between vortex states have also been evidenced in superconducting Pb nanowires.