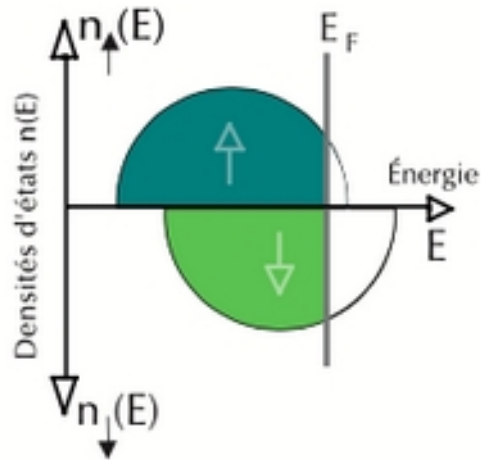


Spintronics

Ariane ARNAUD

Ferromagnetic materials

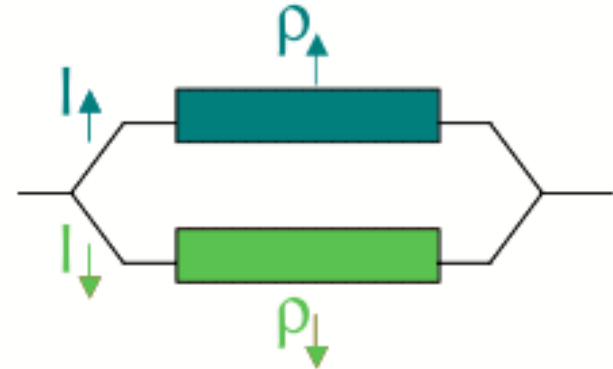
- Origin of the spontaneous magnetization of ferromagnetic



1. (a) Représentation schématique des densités d'états $n(E)$ des bandes d'énergie décalées pour les électrons de *spin* majoritaire (*spin* \uparrow en bleu) et minoritaire (*spin* \downarrow en vert) dans un métal ferromagnétique.

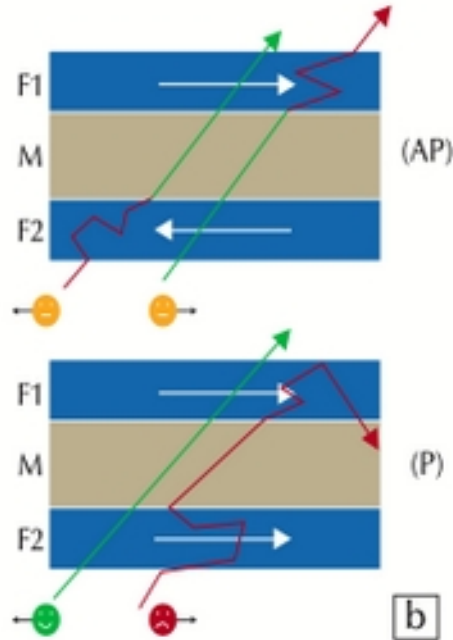
Electron with parallel and nonparallel spin have different density of state \Rightarrow different electric conductibilities

Parallel conduction by two paths with different resistivities:



(b) Illustration de la conduction par deux canaux indépendants de résistivités ρ_{\uparrow} et ρ_{\downarrow} pour les électrons de *spin* \uparrow et *spin* \downarrow respectivement. Selon le métal, l'on peut avoir $\rho_{\downarrow} > \rho_{\uparrow}$ ou $\rho_{\downarrow} < \rho_{\uparrow}$ pour les résistivités des deux canaux.

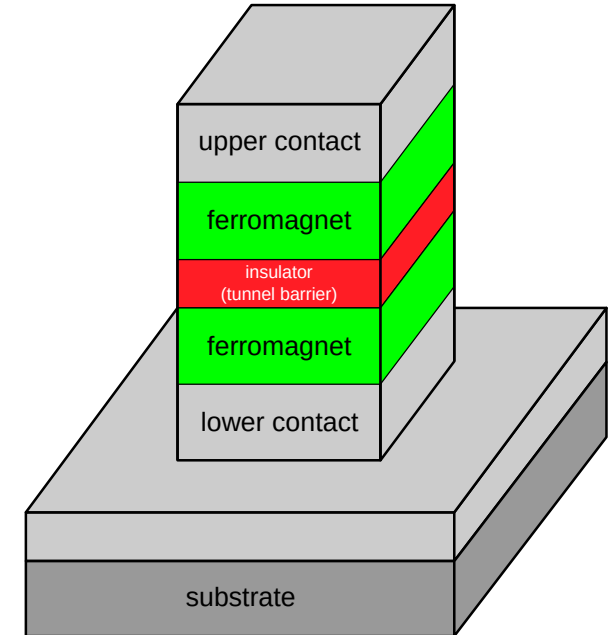
Giant Magnetoresistance Effect



-Possibility to change the resistivity by applying a magnetic field

-Thickness less than the mean free path of electrons : ~ 10 nm

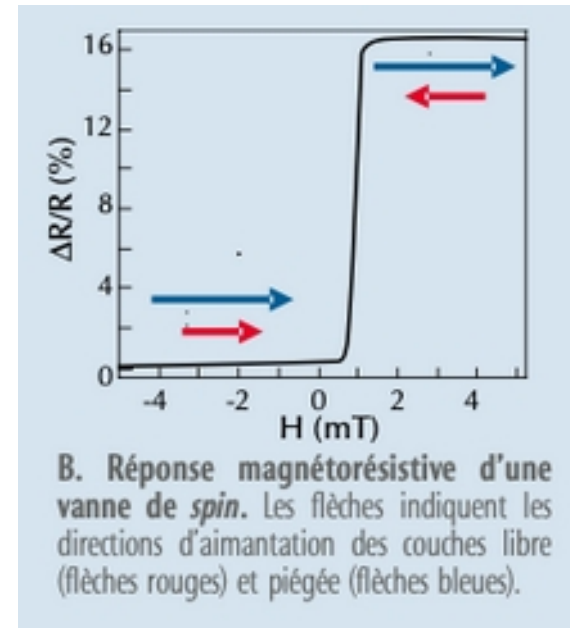
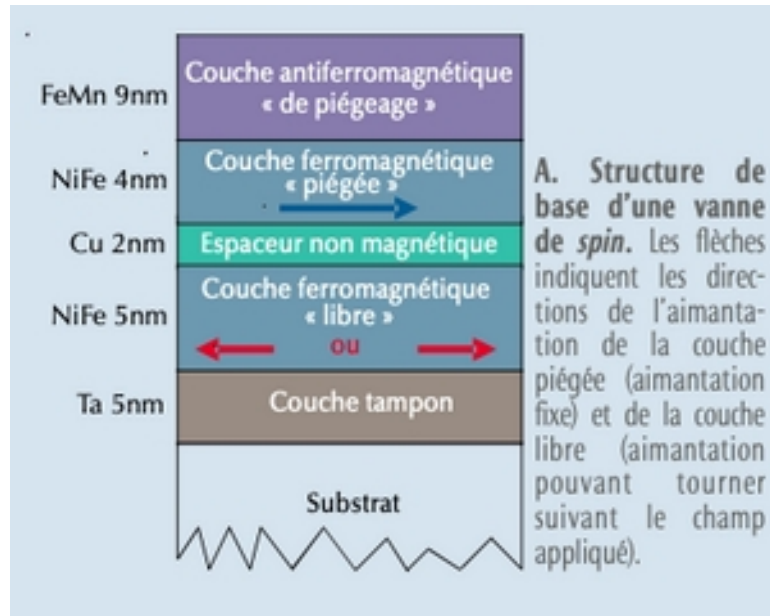
Representation of the giant magnetoresistance effect



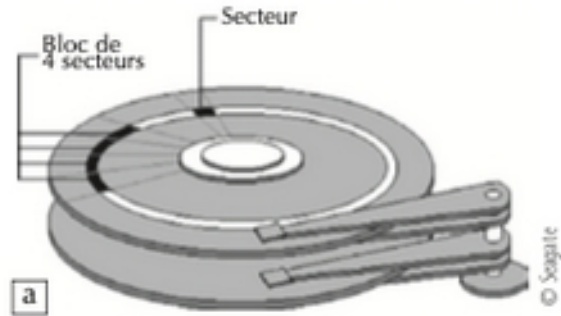
Representation of the giant magnetoresistance effect with tunneling effect

Application : spin valve

Pb : magnetic field needed for the magnetoresistance effect : 2T
Reason : antiferromagnetic coupling between the different slices of different magnetic orientation

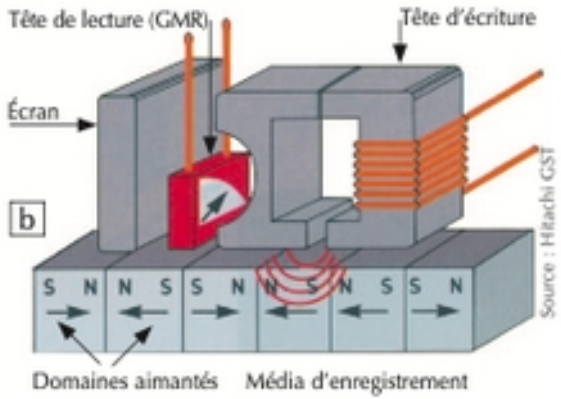


Application : hard disks



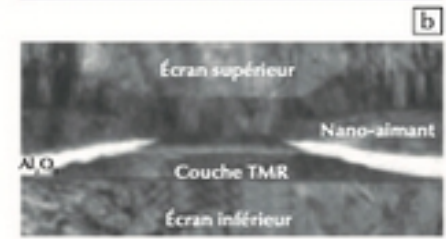
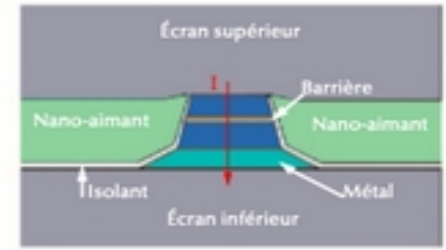
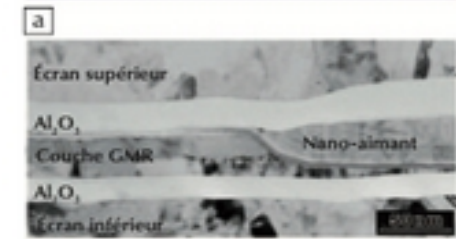
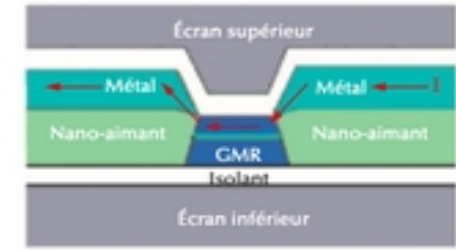
Writing part =
electromagnet

Reading part =
GMR or TRM



2. Schémas de principe d'un disque dur (a) et d'une tête de lecture/écriture magnéto-résistive (b).

Focus on the reading part :



3. Schéma et photo d'une tête GMR (a) et d'une tête TMR (b). Le courant de lecture (I) est indiqué par des flèches rouges.

-reading courant goes through the captor plane
-contact on the sides
 $\Delta R/R = 20 \%$

-reading courant goes perpendicular throught the captor plane
 $\Delta R/R = 100-200\%$

Thank you for listening !

Sources

- **Dossier_spintronique-Reflets_de_la Physique.pdf**
- **rs26-electronique-spin-electrons-exotiques-isolant-topologique.pdf**
- **MOOC : semaine 4 vidéos ES_1a, ES_1b et ES_2**