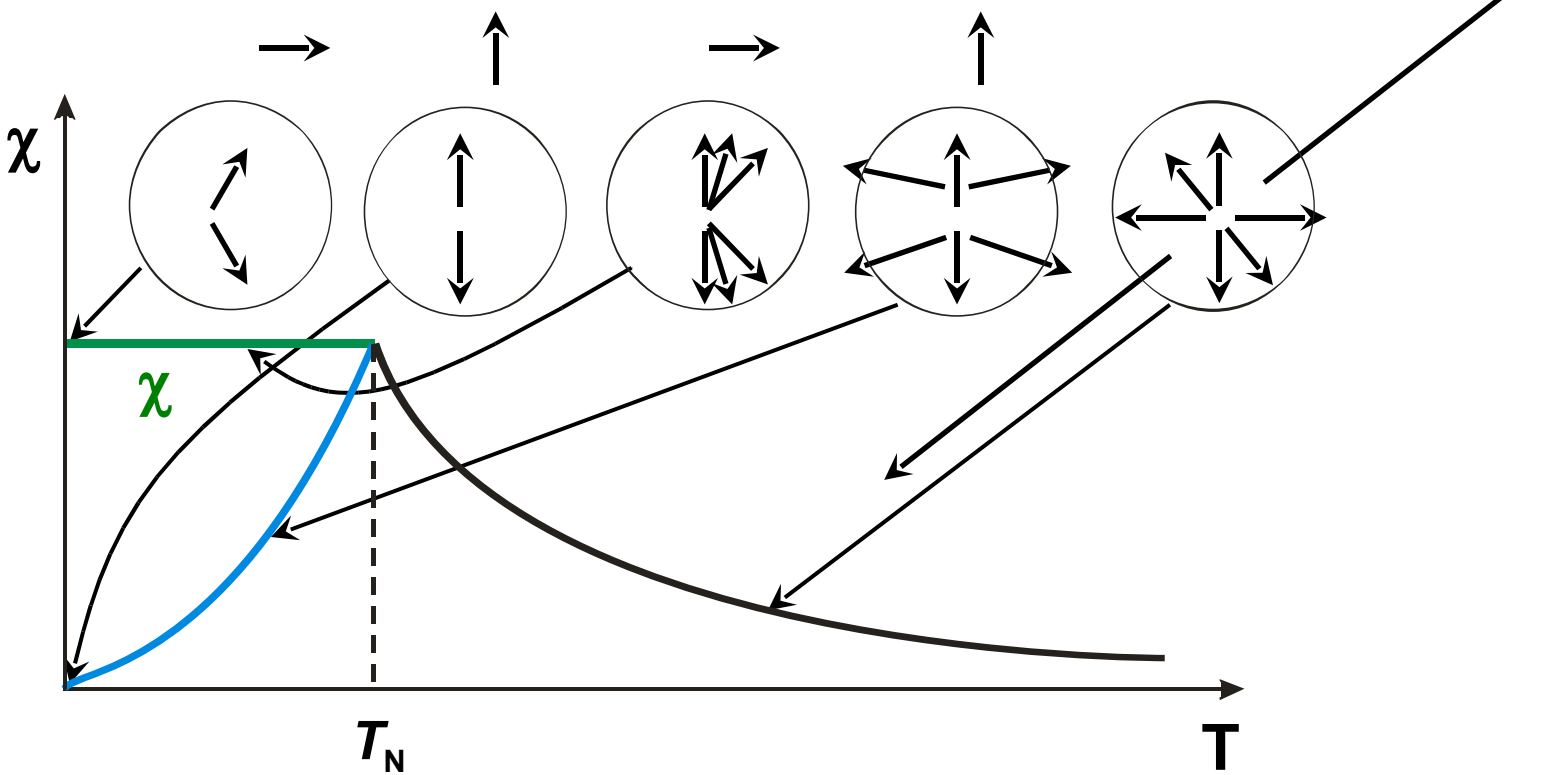
Spin flop and Spin flop
two examples of metamagnetic transitions

For and **antiferromagnetic compound** $\chi_{\perp} > \chi_{||}$



Zeeman energy in an applied field **H**,

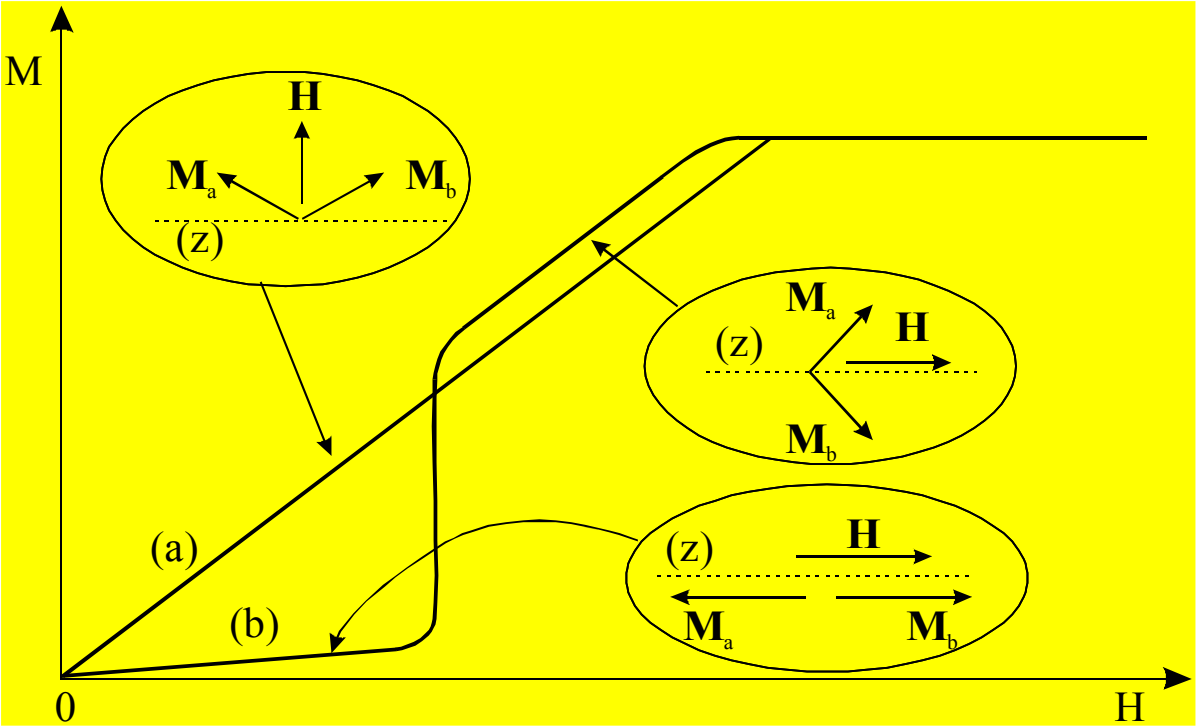
$$E = -\mu_0 HM = -\chi\mu_0 H \quad ,$$

The state with the field H perpendicular to the easy magnetization the two sublattices is more stable (favorable enereticallly) than with H parrallel to the easy magnetization

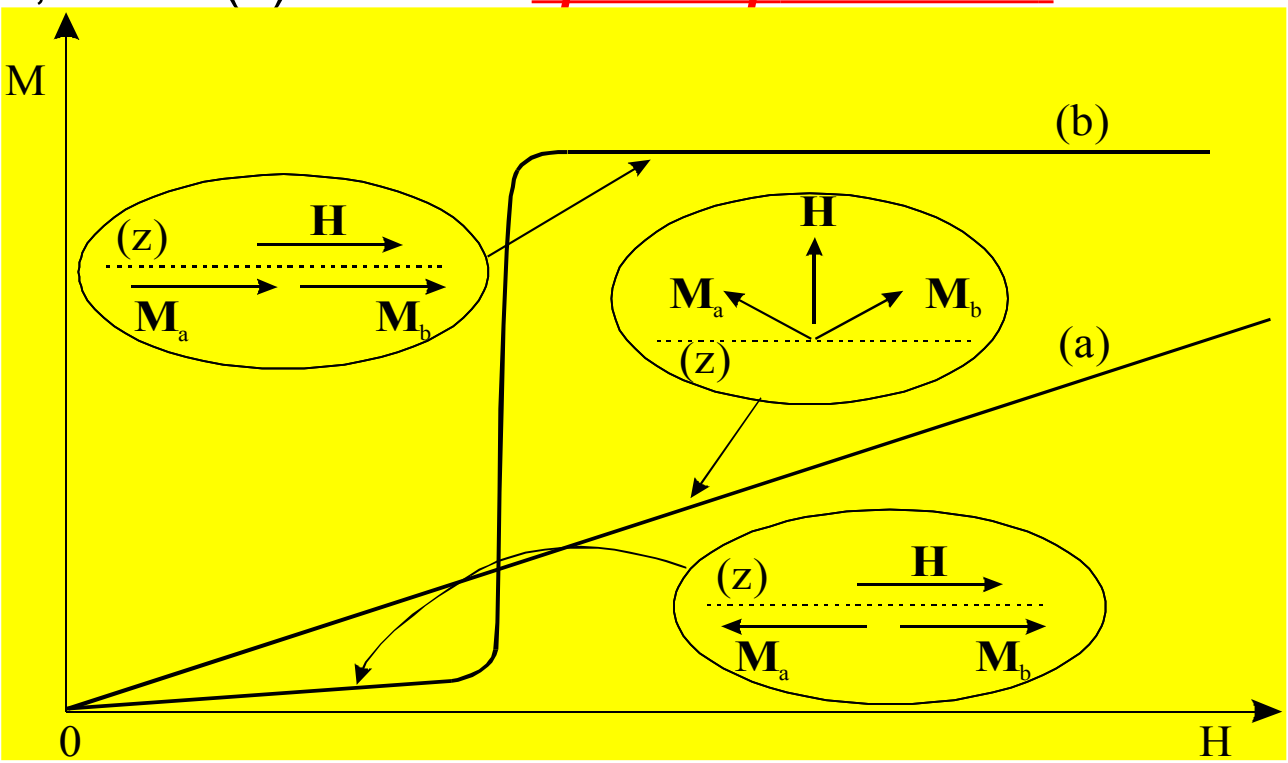
When applying a magnetic field parrallel to the magnetization direction it tends to rotate the magnetization perpendicular to the applied field. That is perpendicular to the easy magnetization direction.

Two cases may occur: large of weak anisotropy

Weak anisotropy energy, At a critical magnetic field the two sublattice magnetization rotates suddenly to a direction perpendicular to the easy magnetization direction, (*z*), consequently perpendicular to the applied magnetic field (*b*). This is a ***spin – flop transition***. Then a continuous rotation of the magnetic moment occurs upon increasing H



Large magnetocrystalline anisotropy, The magnetization of the 2 sublattices remains parrallel to the easy magnetization axis up to a critical field. At $\boldsymbol{H} = \boldsymbol{H}_{critic}$ a sudden rotation occurs of the sublattice magnetization antiparrallel to H, towards the field direction resulting to a parrallel arrangements of both magnetic moments. The saturation state is obtained, curve (*b*). This is a ***spin – flip transition.***



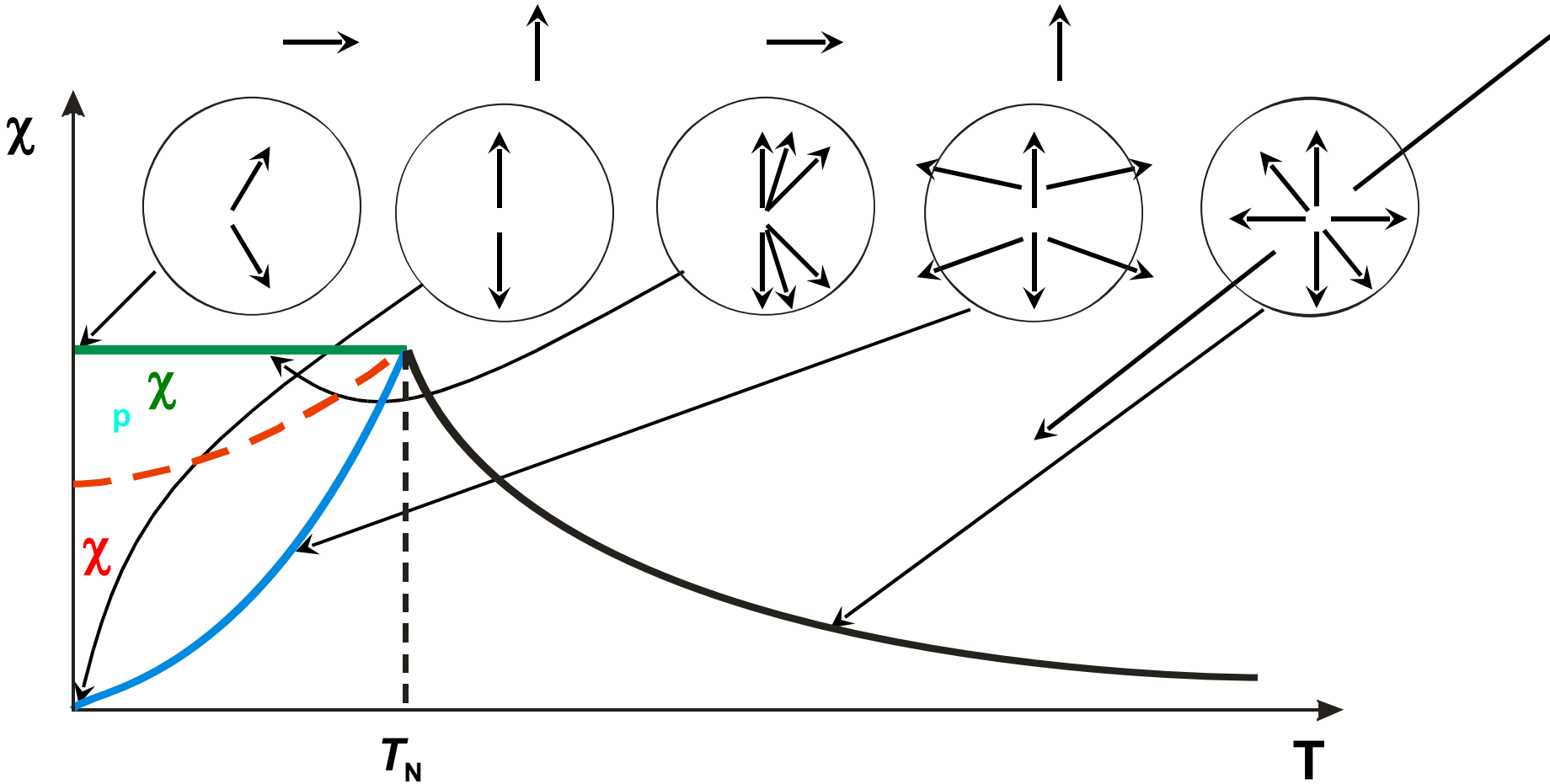
The spin–flip and spin–flop transitions are of *metamagnetic type ones* !

Beware : metamagnetic transition can also occur in non antiferro compounds ferrimagnetic compounds !!

Polycristal with unform repartition of crystals, χ is the mean value along the free axes, two perpendicular and one parrallel to the aplied field

$$\chi_p = \frac{1}{3}(\chi_{\parallel} + 2\chi_{\perp}) \quad (1.59)$$

$$\chi_p(0) = \frac{2}{3}\chi_{\perp} = \frac{2}{3}\chi_N \quad (1.60)$$



Cr, Mn, MnO…