Spin flop and Spin flop two examples of metamagnetic transitions

For and antiferromagnetic compound $\chi_\perp > \chi_\parallel$

Zeeman energy in an applied field $H$, 

$$E = -\mu_0 HM = -\chi\mu_0 H,$$
The state with the field H perpendicular to the easy magnetization the two sublattices is more stable (favorable energetically) than with H parallel to the easy magnetization.

When applying a magnetic field parallel 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 or 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 parallel to the easy magnetization axis up to a critical field. At $H = H_{\text{crit}}$ a sudden rotation occurs of the sublattice magnetization antiparallel to $H$, towards the field direction resulting to a parallel arrangement 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!!
Polycrystal with uniform repartition of crystals, $\chi$ is the mean value along the free axes, two perpendicular and one parallel to the applied field.

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

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