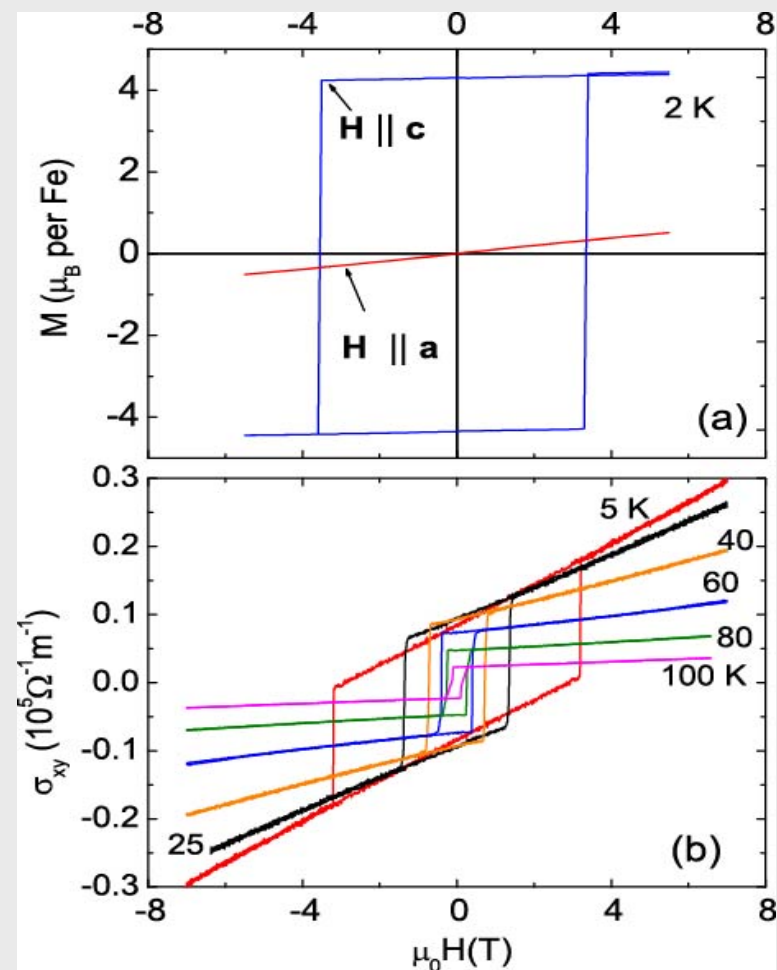




# Jumps in magnetization and Hall current in a hard magnet

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In general, electronic motion in a crystal possesses time-reversal symmetry. One cannot tell if a movie of the conduction electrons is running backwards. However, in a ferromagnet, this time-reversal “symmetry” is no longer valid. Because the spins are all aligned in a magnet, the time-reversed movie looks very different. A major consequence is the appearance of a sideways current called the anomalous Hall effect (AHE). There is intense interest in the AHE current because it reveals important aspects of electronic behavior in spin-aligned materials. However, it is often difficult to separate from the ordinary Hall current (OHC). Cava and Ong with Morosan, Checkelsky, Li and Lee (Ref. 1) recently discovered an unusual ferromagnet  $\text{Fe}_{1/4}\text{TaS}_2$  in which the spins (magnetization  $\mathbf{M}$ ) reverse direction very abruptly as a function of the magnetic field  $\mathbf{H}$  (Fig. a). The sharp reversal causes an abrupt jump in the Hall current, which allows the AHE current to be measured directly (Fig. b). The clean measurement of the AHE over a broad range of temperatures  $T$  reveals a previously unsuspected scaling relationship with the resistivity (Ref. 2).



Panel (a) The magnetization  $\mathbf{M}$  vs. the applied magnetic field  $\mathbf{H}$  (along  $c$ -axis) showing the abrupt jump in  $\mathbf{M}$  (Ref. 1) Panel (b) shows the observed Hall conductivity  $\sigma_{xy}$  vs.  $H$ . At each  $T$ , the jump, giving the AHE conductivity, is distinct from the linear background which reflects the OHC (Ref. 2).

1. E. Morosan et al., “Sharp switching of the magnetization in  $\text{Fe}_{1/4}\text{TaS}_2$ ,” Phys. Rev. B **75**, 104401 (2007).
2. J. G. Checkelsky et al., “Anomalous Hall Effect and magnetoresistance in the layered ferromagnet  $\text{Fe}_{1/4}\text{TaS}_2$ : the inelastic regime,” Phys. Rev. B (2008), *in press*.