

Magnetic Imaging Techniques

Laura Heyderman

ETH Zurich & Paul Scherrer Institut, Switzerland

Types of Magnetism

Ferromagnetism

Helimagnetism

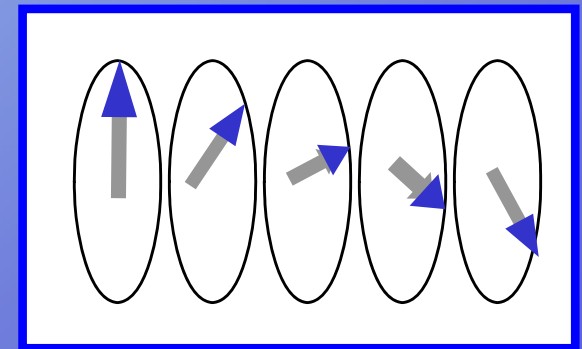
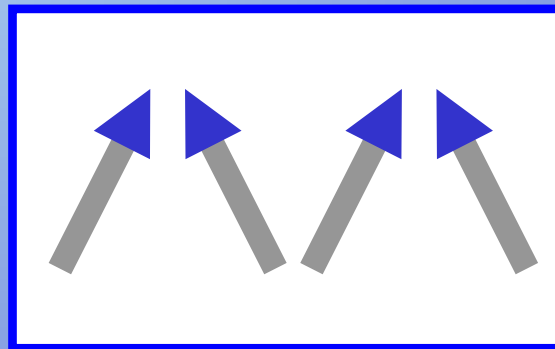
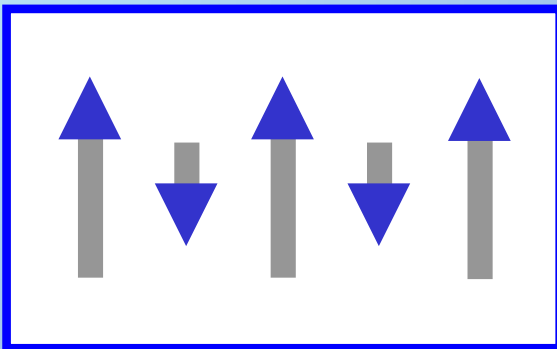
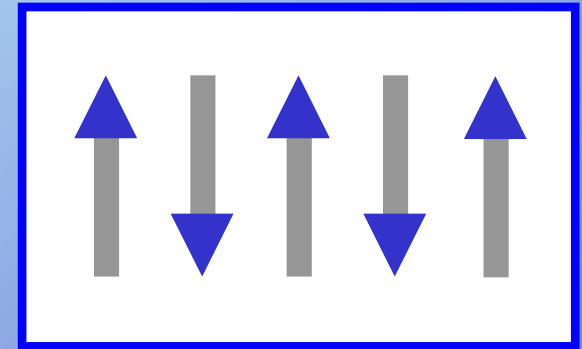
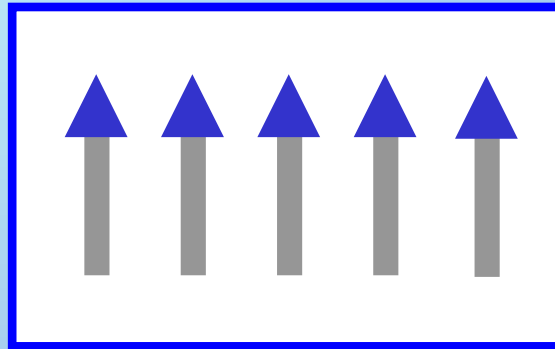
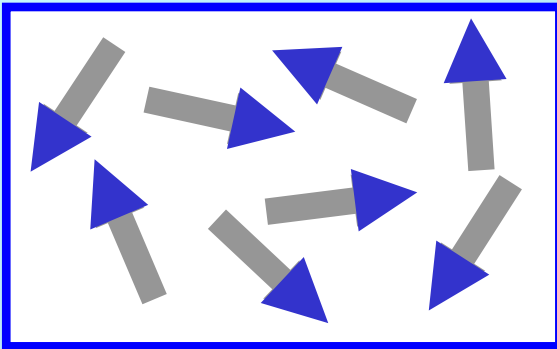
Antiferromagnetism

Ferrimagnetism

Spin-Canted Magnetism

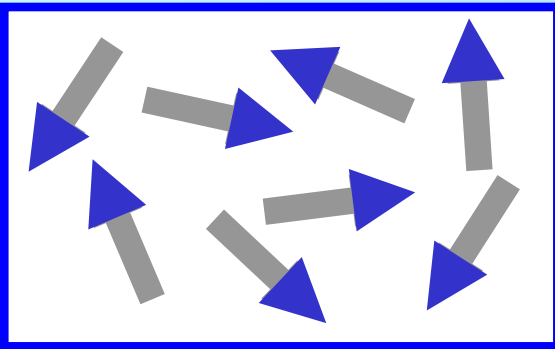
Paramagnetism

Types of Magnetism

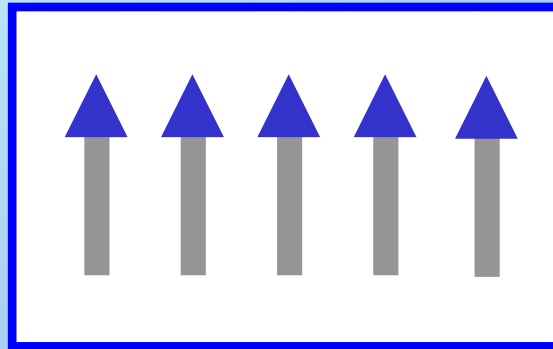


Types of Magnetism

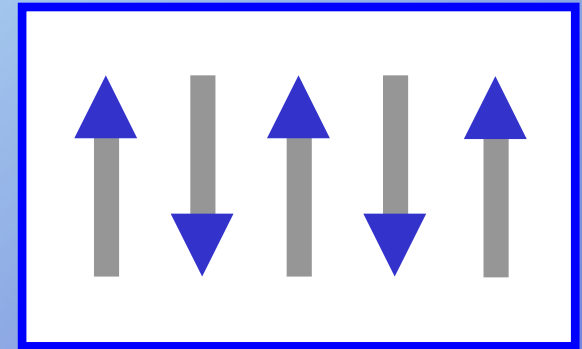
Paramagnetism



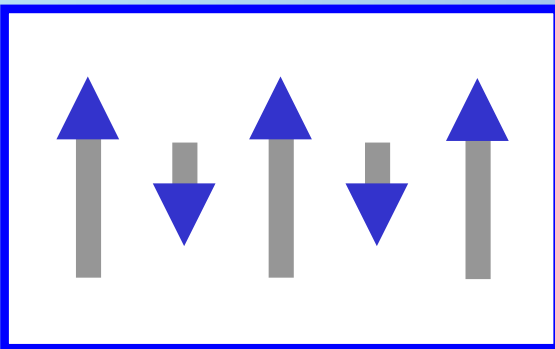
Ferromagnetism



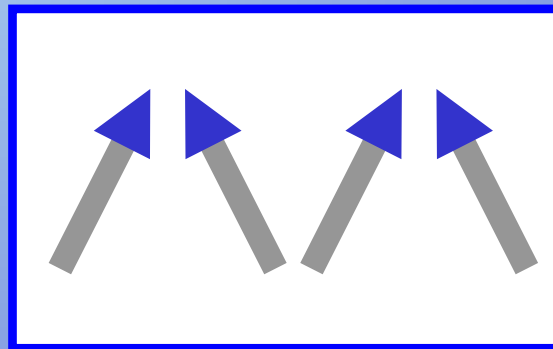
Antiferromagnetism



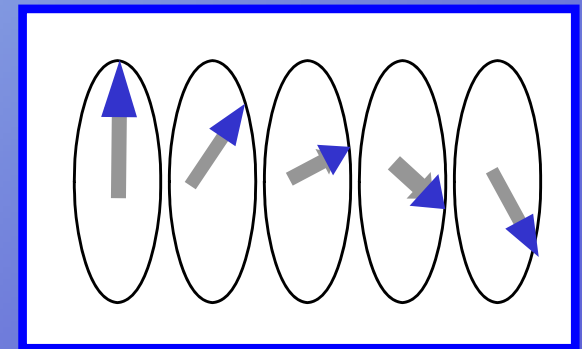
Ferrimagnetism



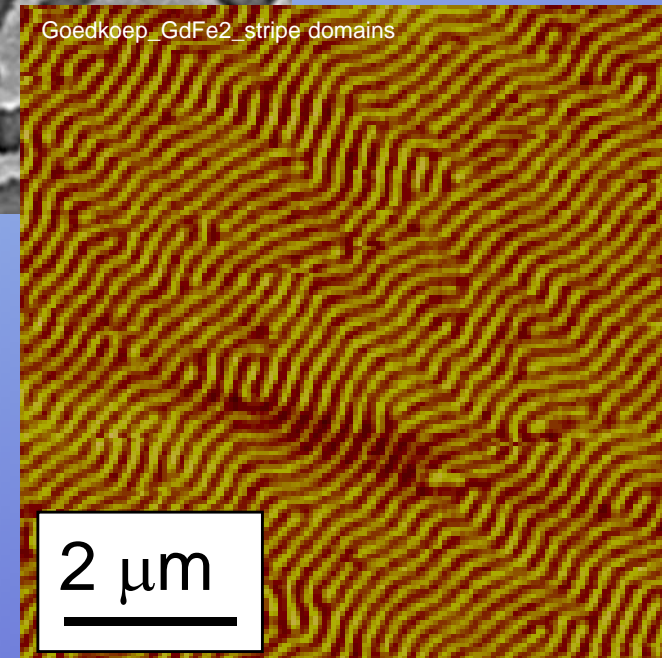
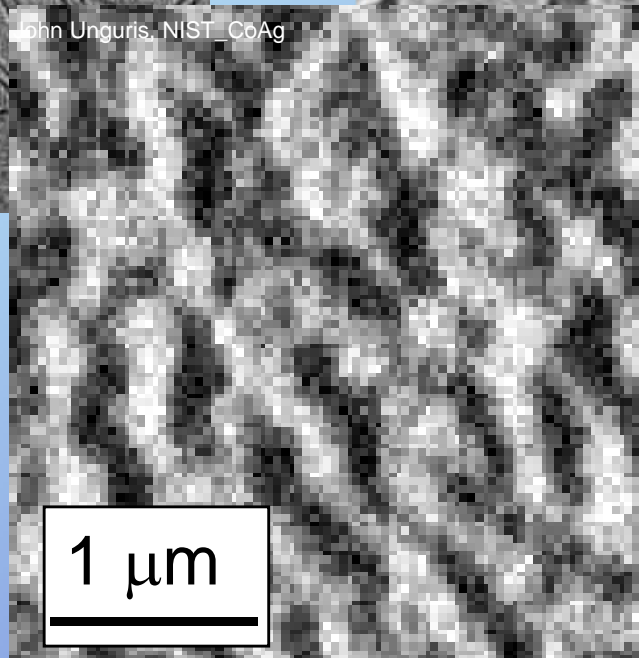
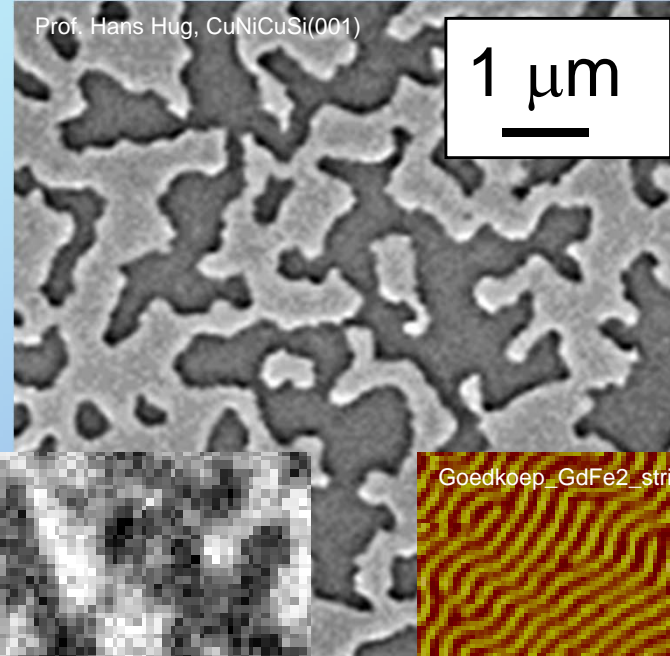
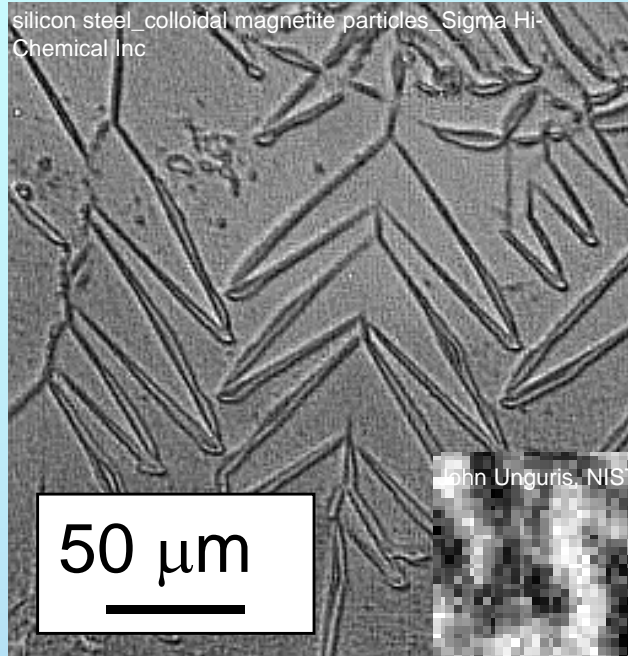
Spin-Canted



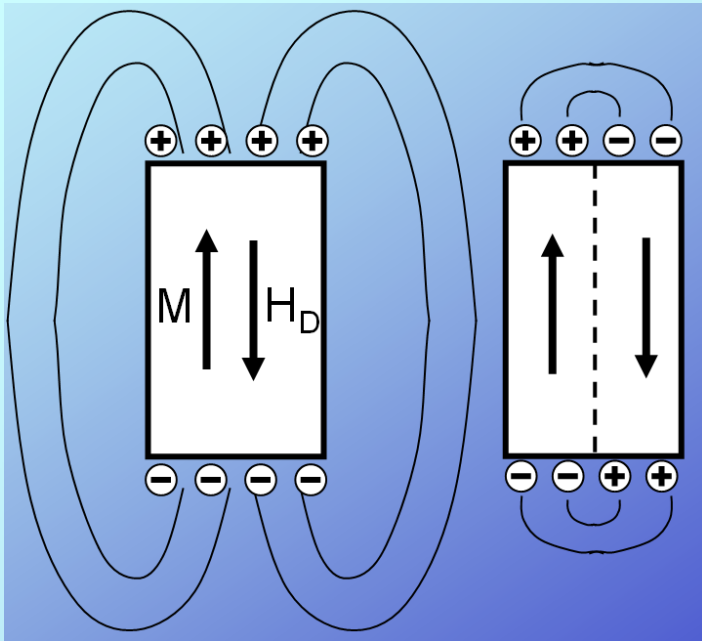
Helimagnetism



Magnetic Domains ?



Imaging Techniques



- Magnetic flux density (or induction):

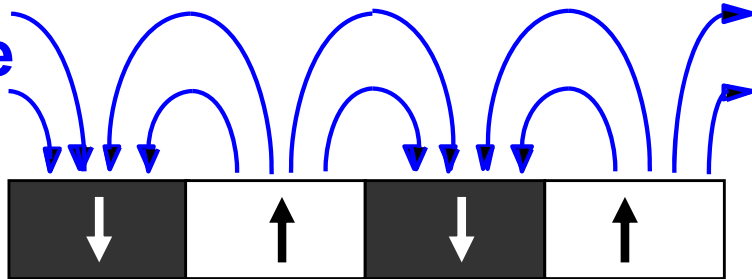
$$\mathbf{B} = \mu_0 \mathbf{H} + \mathbf{J}$$

\mathbf{H} = magnetic field (external + stray field)

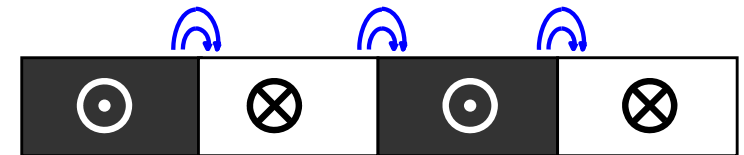
\mathbf{J} = magnetic polarization (magnetization $\mu_0 \mathbf{M}$
 = \mathbf{q}/V magnetic moment / volume)

- Maxwell's equation $\text{div} \mathbf{B} = 0$, therefore:
 $\text{div} \mathbf{H} = -\text{div} \mathbf{M} \rightarrow$ any divergence of \mathbf{M} creates a stray field \mathbf{H} (zero external field)

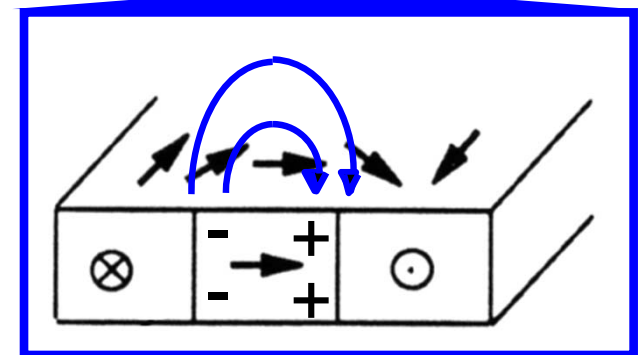
Out-of-plane



In-plane



Imaging techniques provide information on stray field, magnetization (magnitude and direction), magnetic induction (includes stray field and magnetization) at material surface or through a thin film



Imaging Techniques

Bitter Technique

Scanning Probe Microscopy

Electron Microscopy

Kerr Microscopy

X-Ray Microscopy Techniques

