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Imaging with polarized neutrons

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The neutrons are able to pass through thick layers of matter (typically several centimeters), but are sensitive to magnetic fields due to their intrinsic magnetic moment. Therefore, in addition to the conventional attenuation contrast image, the magnetic field inside and around a sample can be visualized independently by detection of polarization changes in the transmitted beam [1]. This is based on the spatially resolved measurement of the cumulative precession angles of a collimated, polarized, monochromatic neutron beam that transmits a magnetic field [2].

Solid state polarizing benders can be used to polarize and analyze a monochromatic neutron beam. The configuration allows for quantitative polarimetric experiments, where the polarization vector of the magnetic field associated with a sample is measured in three orthogonal directions. By applying an iterative algorithm to the measured rotation angles, it is possible to reconstruct the flux density of the 3D magnetic field that produced them.
Polarizing filters based on polarized ^3He gas can be used for high resolution imaging of magnetic materials using polychromatic neutrons. Neutron depolarization imaging allows for observations of phase transitions between ferromagnetic and paramagnetic states in single crystals, allowing position-sensitive mapping of the Curie temperature [3].
Examples of investigation of various magnetic materials will be presented.

REFERENCES

[1] N. Kardjilov et al, Nature Physics 4, 399-403 (2008)

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