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Magnetic field induced neutron phase contrast imaging with grating interferometry

Magnetism has always been in the spotlight and neutrons have played an essential role in understanding this physical phenomena due to their intrinsic magnetic moment. Polarized neutron imaging and the grating interferometer (nGI) technique have been established as powerful means [1; 2] for investigating superconductors and domain wall of ferromagnetic materials [3].
Here we present an upgrade of the regular nGI setup, which allows to operate with polarized neutrons (p-nGI) in order to retrieve differential phase contrast images (DPCI) induced by the magnetic field and to visualize its spacial distribution. The DPCI yields quantitative information about the phase shift induced by the refraction of the polarized neutron beam on the phase object, due to the magnetic interaction between the sample and the neutron spin state.
The talk reports our experimental results achieved at the Beamline for neutron Optics and other Application (BOA) [4] at Paul Scherrer Institut (PSI).
A beryllium filter was used as energy selector in order to improve the sensitivity of the setup to the magnetic field strength.
Two different cases were taken into account for demonstrating the feasibility of this technique: a tailored sample, consisting of an homogeneous square-shaped magnetic field aligned parallel to the guide field, and a rectangular Neodymium permanent magnet as a general case.
Hence, the magnetic phase shift image (PCI) of the experimental data was retrieved by integrating the DPCI, taking into account the energy spectrum of the beam and the visibility response function [5] of the p-nGI setup.
Subsequently, the experimental results were validated with the expected value calculated from the Hall probe measurements and finite element method (FEM).
We put particular emphasis on the understanding of the adiabatic and/or non-adiabatic nature of the process which define the condition for the accessible features.

References

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