An introduction to neutron spin echo techniques

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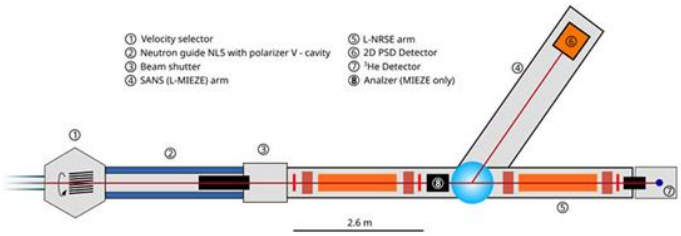
In this short seminar, I will give an introduction of Neutron spin echo (NSE) [1, 2] techniques and their applications.

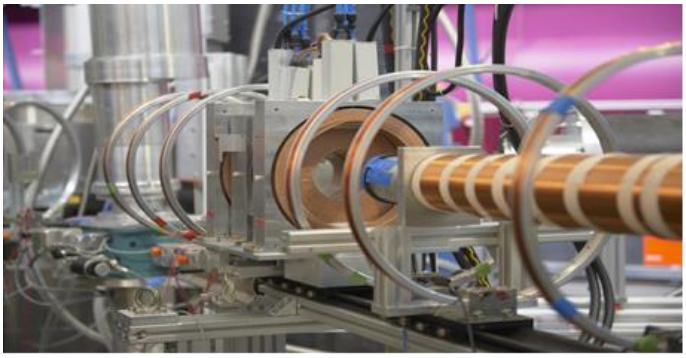
Typical NSE techniques achieve very high energy resolution in combination with very high neutron intensity by means of decoupling the energy resolution of the instrument from the wavelength spread of the neutrons. In NSE the Lamor precession phases of the neutron spin, acquired in a well-defined magnetic field region before and after the sample, are compared. A phase difference, caused by a scattering process within the sample leads to a reduction in neutron polarization. The final neutron polarisation yields the (normalised) Intermediate Scattering Function $S(Q,\tau)$, providing direct information on relaxation processes, activation energies, and the amplitudes of dynamic processes in the samples under investigation.

In 1987, Golub and Gähler proposed to replace the highly homogeneous constant field regions in NSE by resonant spin flippers, introducing the so-called Neutron Resonance Spin Echo (NRSE) [3]. This allows the technique to be adapted to different applications. A major disadvantage of classical NSE and NRSE is that depolarising conditions at the sample position lead to a loss of information of the spin phase.

A modification of NRSE overcoming this obstacle is the Modulation of IntEnsity with Zero Effort (MIEZE) technique operated at the Hein Maier-Leibnitz-Zentrum laboratories in Munich [4]. In MIEZE all neutron spin manipulation is completed prior to the sample, making the method insensitive to beam depolarisation at the sample position.

Typical applications for MIEZE are the investigation of quantum phase transitions, superconductors, vortex lattices, skyrmions, ferromagnetic materials and hydrogen containing samples [5].





[1] F. Mezei, Z. Physik 255, 146 (1972).
[2] F. Mezei, The principles of neutron spin echo (Springer, 1980).
[3] R. Golub and R. Gähler, Phys. Lett. A 123, 43 (1987)
[4] R. Gähler, R. Golub, and T. Keller, Physica B Condens. Matter 180-181, 899 (1992)

[5] C. Franz, S. Säubert, A. Wendl, F. X. Haslbeck, O. Soltwedel, J. K. Jochum, L. Spitz, J. Kindervater, A. Bauer, P. Böni, C. Pfleiderer, Journal of the Physical Society of Japan 88 (8) (2019) 081002.