Polarised Neutrons and Polarised Nuclei

Neutron scattering on nuclei is spin-dependent, particularly strongly for ^{1}H, which opens a wealth of experimental possibilities. An overview of recent projects performed at SINQ using polarised neutrons in combination with polarised nuclei will be presented.

Low resolution (SANS) measurements can benefit from polarised nuclei by changing selectively the contrasts (the scattering length density profiles) in SANS. In a recent technique, time-resolved SANS tries to make use of spatial polarisation gradients created around paramagnetic centres at the onset of dynamic nuclear polarisation (DNP). Such polarisation domains could enhance considerably the scattering amplitude off free radicals and thus contribute to determine their positions inside a complex molecule. In the past three years a series of experiments have shed new light on the mechanism of DNP. Applying these techniques to study model systems, we have shown that strong polarisation gradients exist for a short time until spin diffusion equalises the polarisation throughout the sample. The possible use and the limitations of this method as a spectroscopic tool are discussed.

Polarised nuclei are clearly the best way to provide broad-band spin filters with a large acceptance. Optically polarised ^{3}He is often considered the best choice, however its energy-dependent absorption cross-section makes it impossible to optimise the filter thickness in a large range. As an example for the use of a proton spin filter, the polarisation of the SANS I neutron beam has been determined to high precision for a broad wave length spectrum with a polarized proton target.

In the field of fundamental physics an ambitious experiment is presently running which aims at a precise determination of the poorly known doublet *nd*-scattering length, a low energy parameter which is particularly well suited to fit three-body forces in novel effective field theories. The understanding of such few-nucleon systems at low energies is essential, e.g. for accurate predictions of element abundances in big-bang and stellar fusion. The measurement is performed on the cold polarised neutron beam of FUNSPIN with a Ramsey apparatus for pseudomagnetic precession and a frozen spin target containing both polarised deuterons and polarised protons.