The Neutron Spin-Echo Spectrometer at NG5

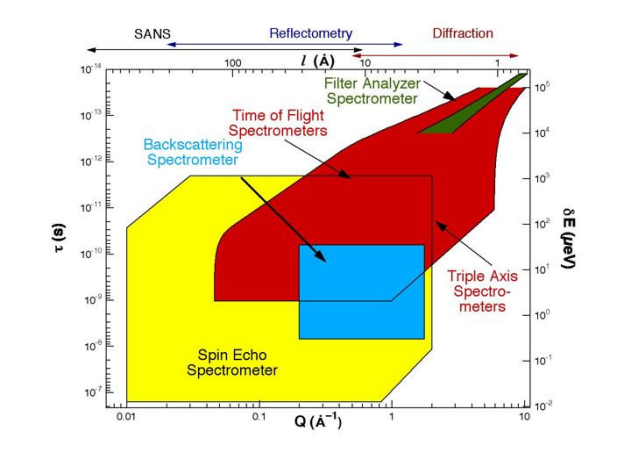
NSE directly measures the intermediate scattering function $I(Q,t)$

The NIST-NSE spectrometer is best used for measuring coherent diffusive or dispersionless excitations at long time in the range of 0.01 to 100 ns (several neV to several hundred μeV) and 0.02 to 1.5 Å^{-1} of the length scale.

Problems in the dynamical range are

1. Polymers
   Observation and quantitative description of the crossover in dynamics from local segmental diffusion to time-dependent behavior governed by entanglements occurring over longer length scale
2. Glassy dynamics
   Identification in polymer glasses of the intra- and inter-molecular dynamics responsible for the α and β_{slow} relaxation
3. Biological model systems
   Quantitative description of the effect of interlayer coupling in the extended diffusive mode of lipid bilayers
4. Proteins
   Intra-molecular diffusion in e.g., pig immunoglobulin G
5. Slow magnetic spin dynamics
   Spin dynamics in spin-glasses, frustrated magnets and magnetoresistive materials for example

Other forms of dynamical behavior (in the same dynamical range) are also accessible, with some more difficulty, such as incoherent dynamics.



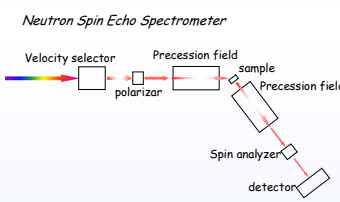
NSE covers the dynamical range in between conventional inelastic neutron scattering and dynamic light scattering techniques

NSE principle

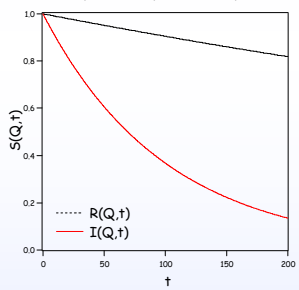
NSE technique has the highest energy resolution among the inelastic neutron scattering techniques. In the case of the conventional inelastic neutron scattering techniques, the velocities of the incident and the scattered neutrons have to be determined in order to know the energy transfer of neutrons at the sample position. Comparing to the conventional techniques, NSE technique uses the Larmor precession of the neutron spin in the magnetic field as a measure of the energy transfer of neutrons. This unique feature allows to decouple the energy resolution of neutron itself from the dynamical modes in the measuring sample. This is the reason why the highest energy resolution has achieved by this technique without loosing the neutron intensity.

Comparison between NSE and conventional inelastic neutron scattering techniques

Neutron spin echo technique

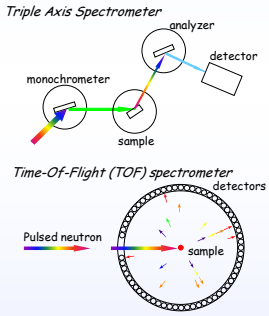


$I(Q,t)=S(Q,t)\times R(Q,t)$

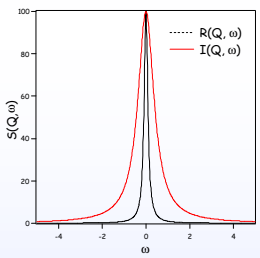


$I(Q,t)$: measured intermediate structure factor
$S(Q,t)$: intermediate structure factor
$R(Q,t)$: resolution of the spectrometer

Conventional inelastic neutron scattering techniques



$I(Q,\omega)=S(Q,\omega)\otimes R(Q,\omega)$



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$S(Q,\omega)$: dynamical structure factor
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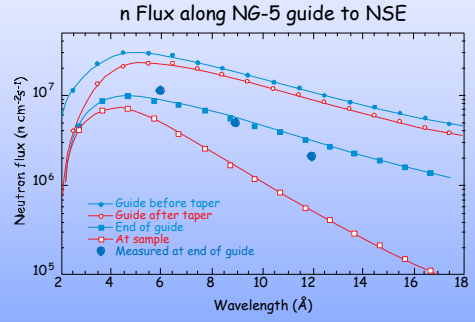
Characteristics of NG5-NSE spectrometer

wavelength, λ	5 -- 12 Å
scattering angle, 2θ	0 -- 105 °
maximum fierld integral,	0.438 Tm
field inhomogenity, ΔJ/J	~ 10^{-6}
Fourier time, t	0.005 -- 0.1 ns (by shorty operation) 0.05 -- 100 ns (by normal operation)
Momentum transfer, q	q_{min} ~ 0.02 Å^{-1} (by 11Å) q_{max} ~ 1.66 Å^{-1} (by 6Å)
beam size at sample	30 x 30 mm^2
polarizer	Mezei V cavity (transmission polarizer) 3q_c Fe/Si supermirror
analyzer	Pil92 Co/Ti supermirrors
flipping ratio, Up/down	9 for 6Å 8 for 8Å 7 for 11Å

n Flux along NG-5 guide to NSE



Resolution Function at NG5-NSE