What can be done using NEUTRON SPIN ECHO

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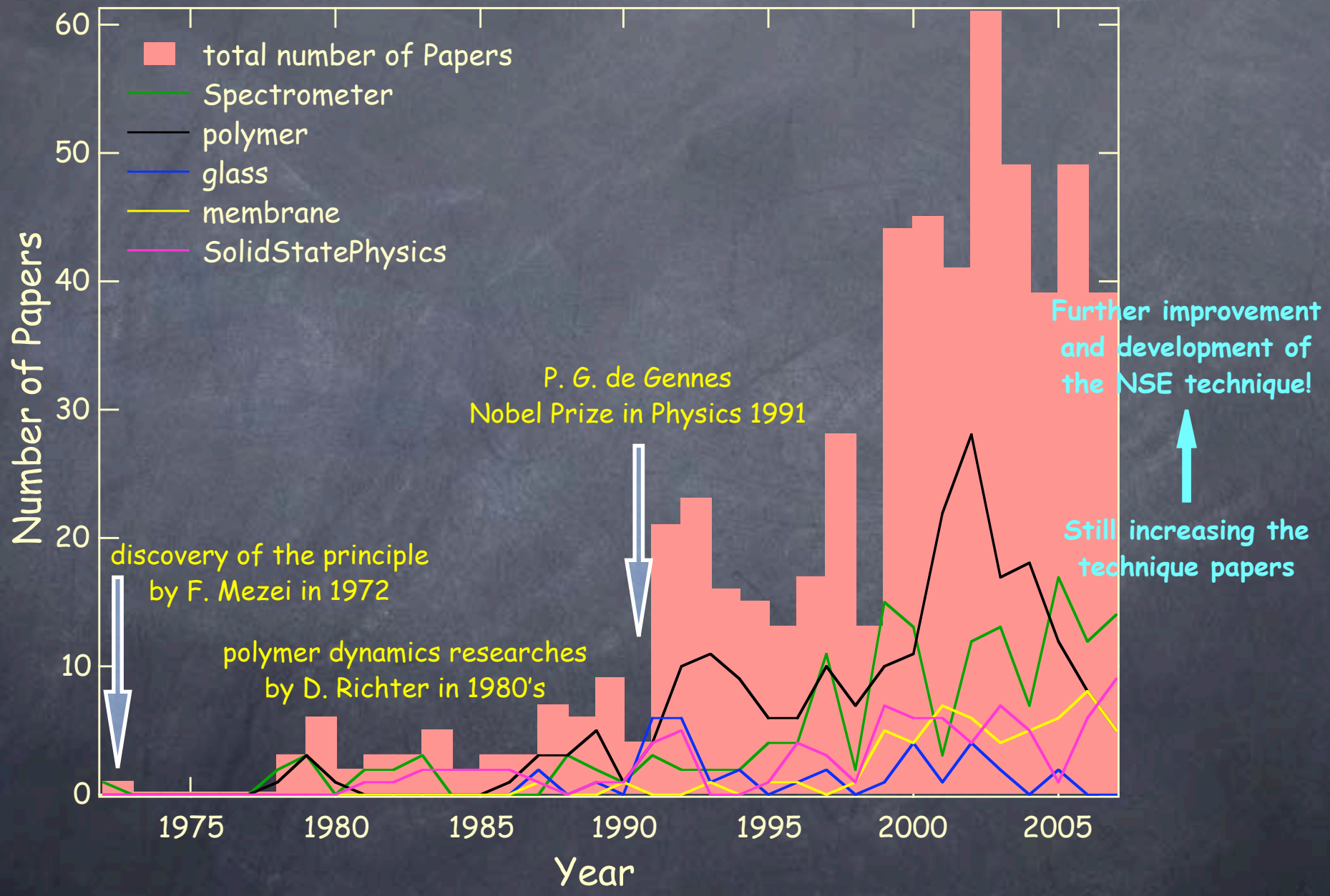
published papers using NSE



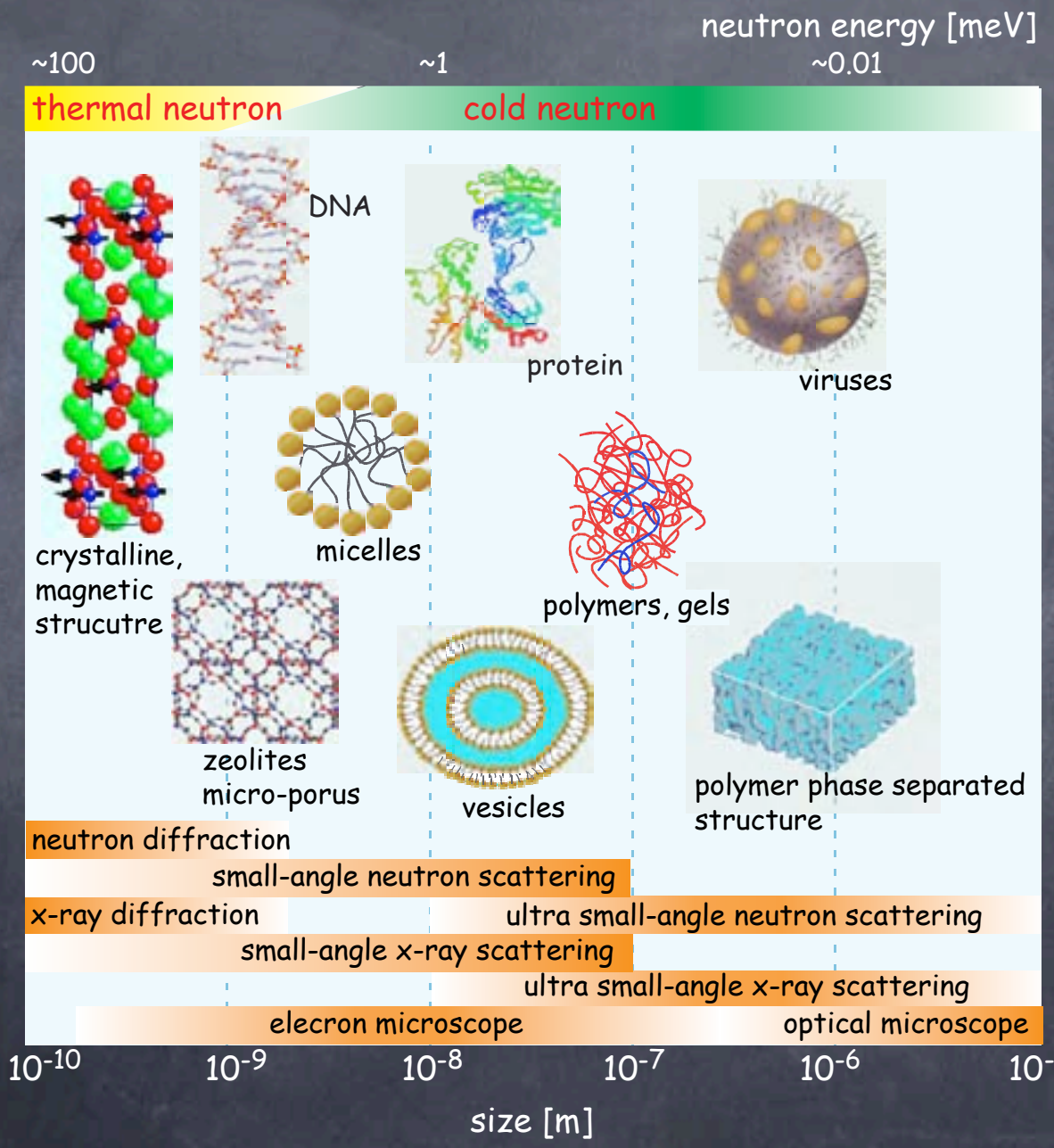
searched using web of science: keyword=neutron spin echo

how to choose a spectrometer

1. length scale

   diffraction? small-angle?

structure research & method



how to choose a spectrometer

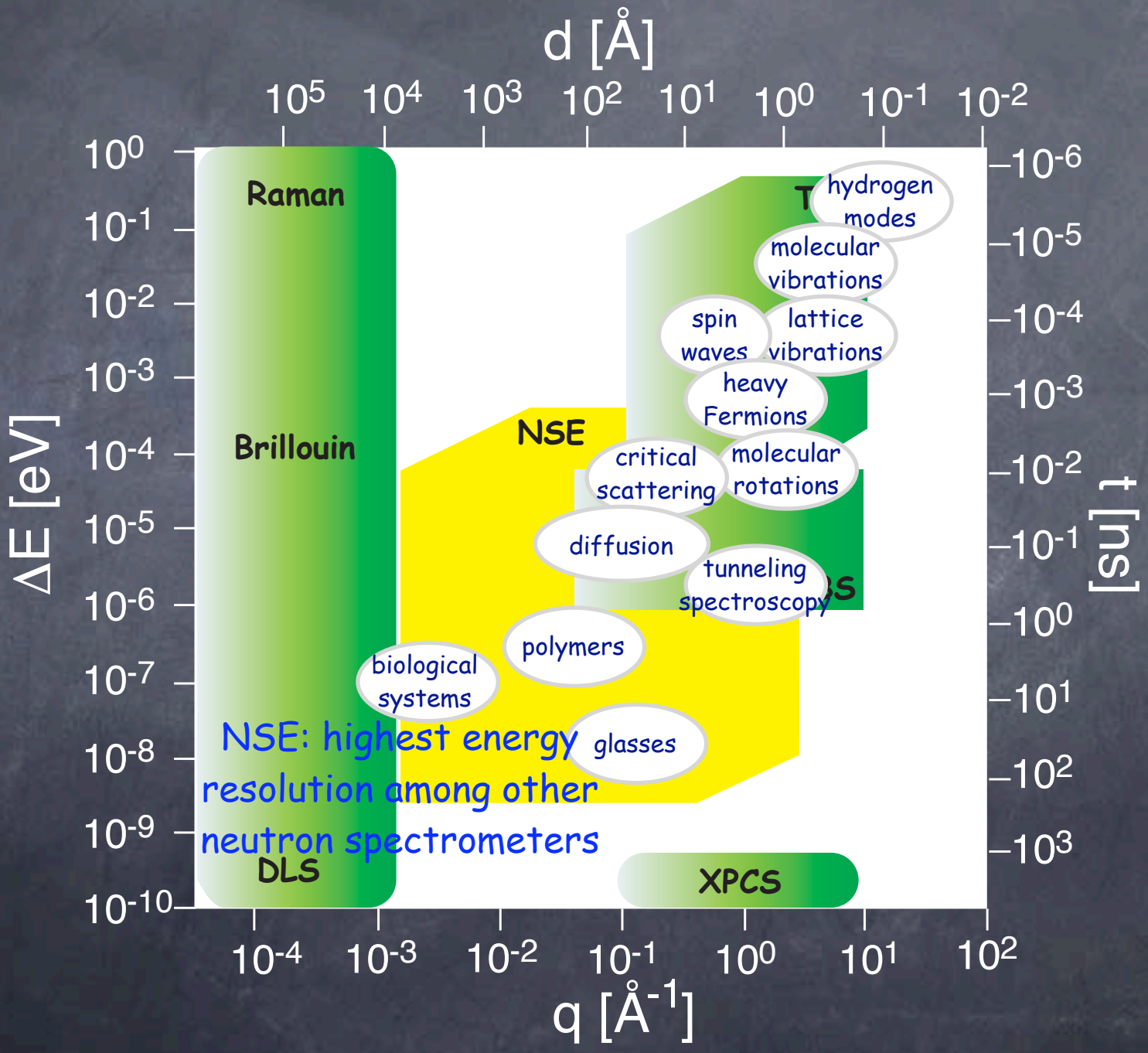
1. length scale

   diffraction? small-angle?

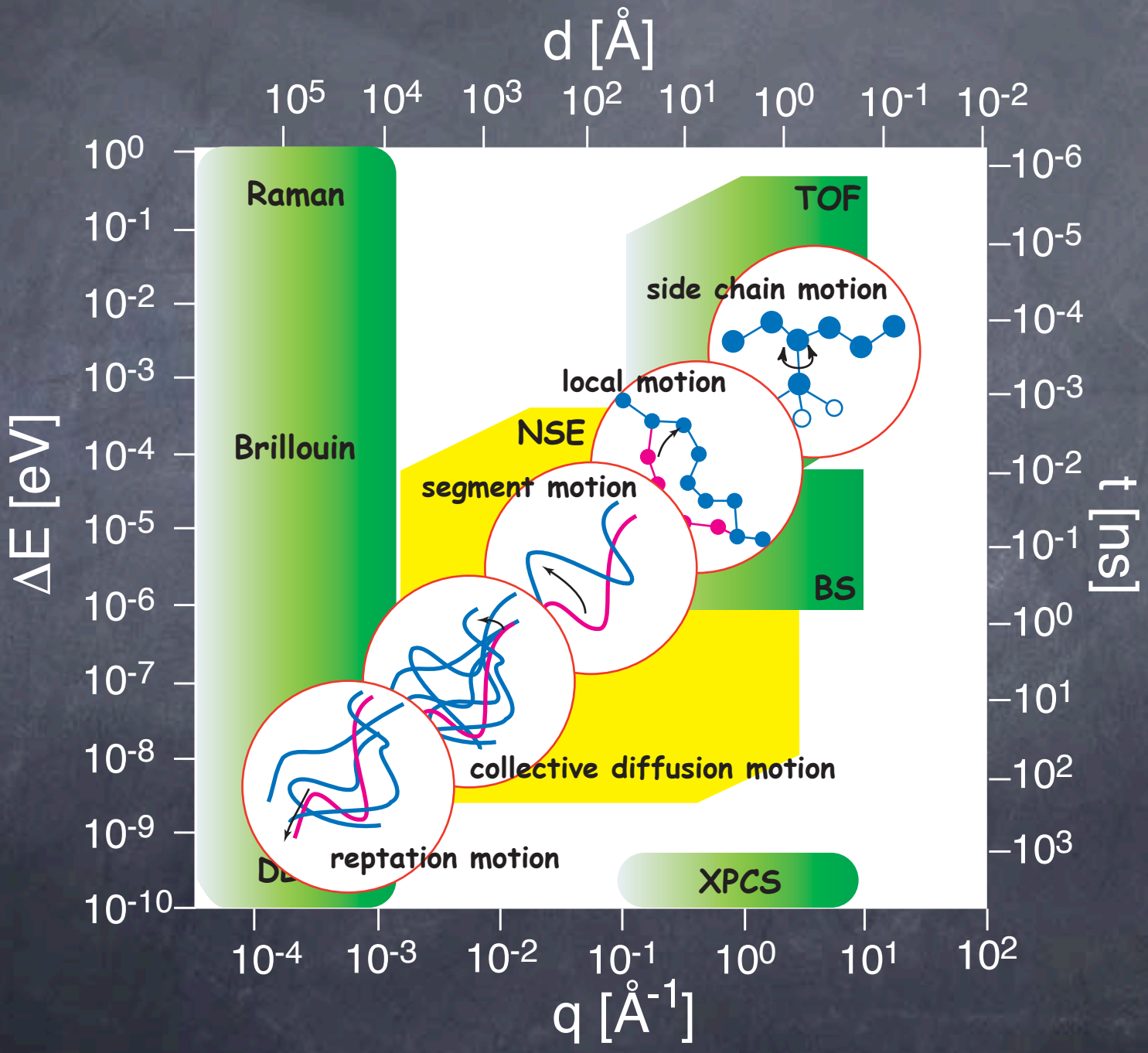
2. energy scale

   neV? meV?

dynamics research & method



dynamics research & method



how to choose a spectrometer

1. length scale

   diffraction? small-angle?

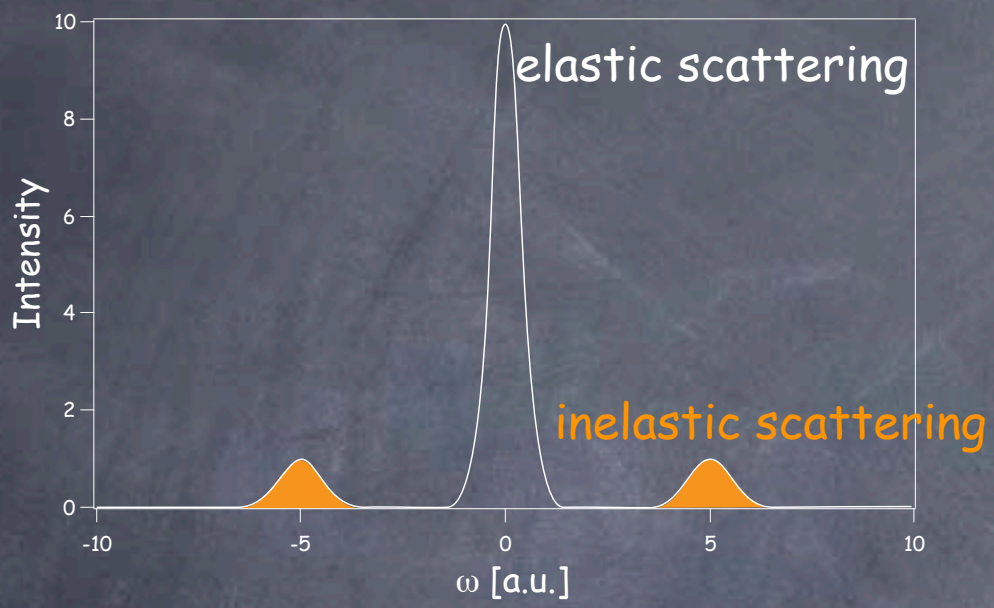
2. energy scale

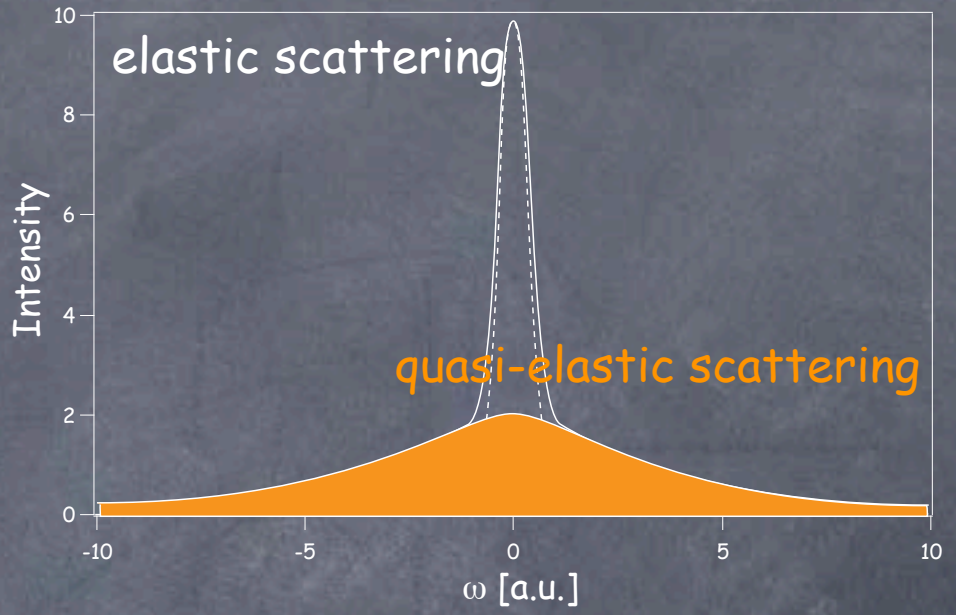
   neV? meV?

3. dynamics

   excitation? relaxation?

inelastic vs quasi-elastic scattering





excitation: neutrons exchange energy with an oscillation motion which has a finite energy transfer

phonon, magnon, ...

relaxation: neutrons exchange energy to make another new equilibrium state (no typical finite energy transfer exists)

mean energy of neutrons are the same before and after the scattering

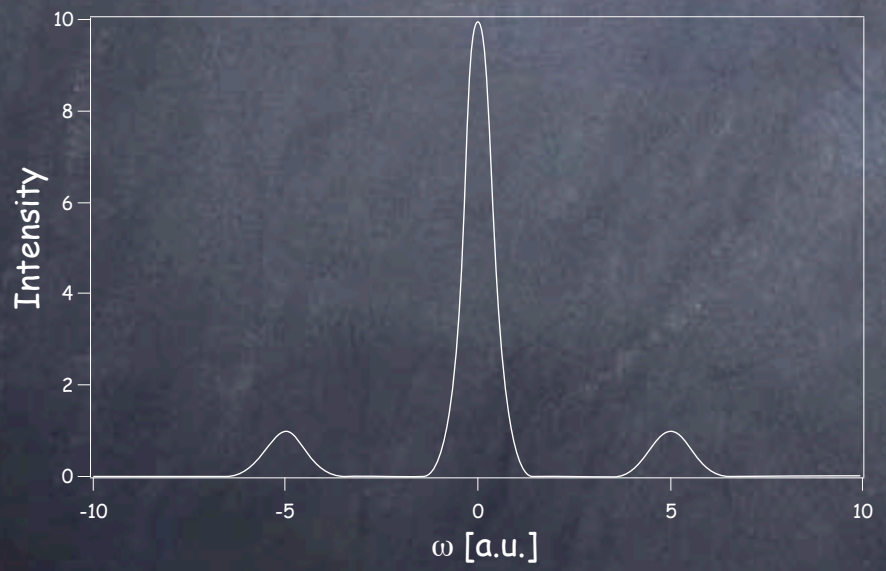
NSE works in time domain: S(q,ω) vs I(q,t)

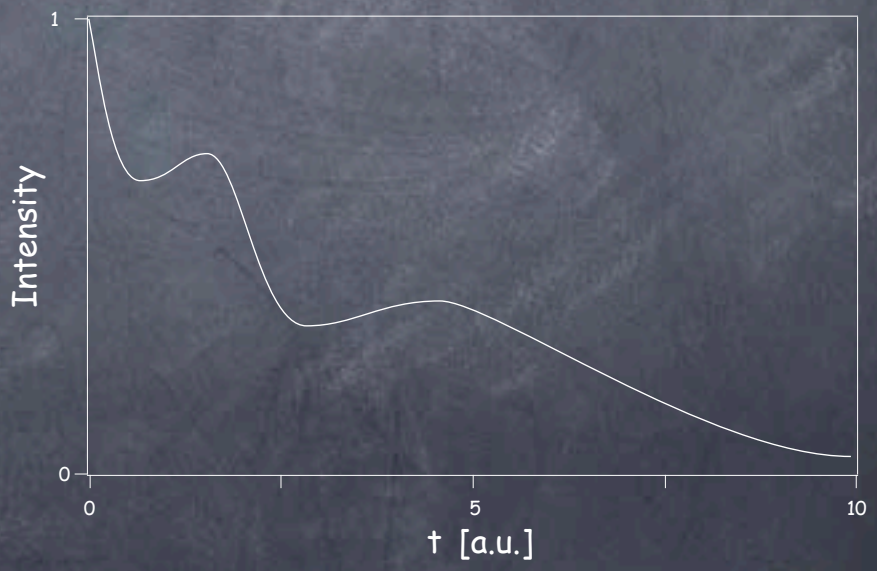
$$I(q,t) = \int S(q,\omega)\exp(-i\omega t)d\omega$$

intermediate scattering function is the fourier transform of dynamic structure factor

excitation

I(q,t) shows an oscillating function



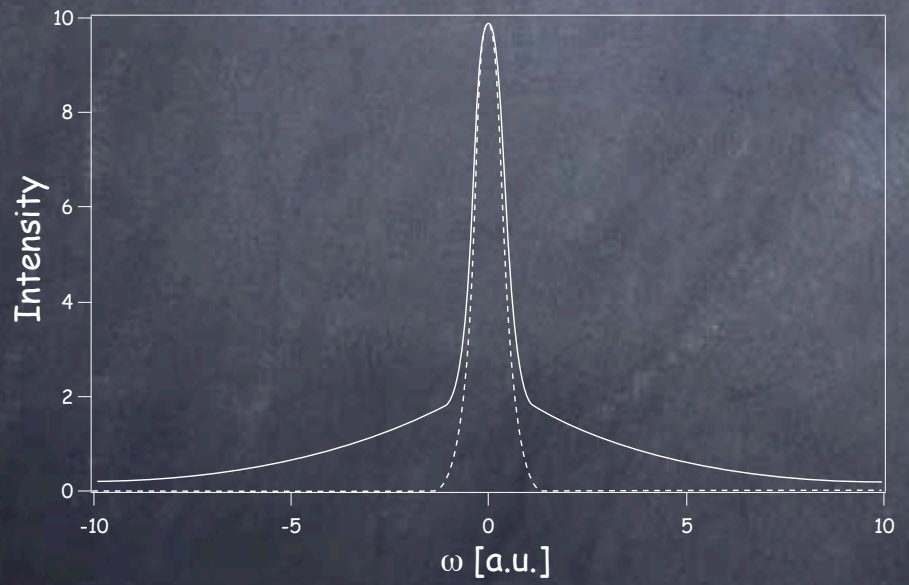


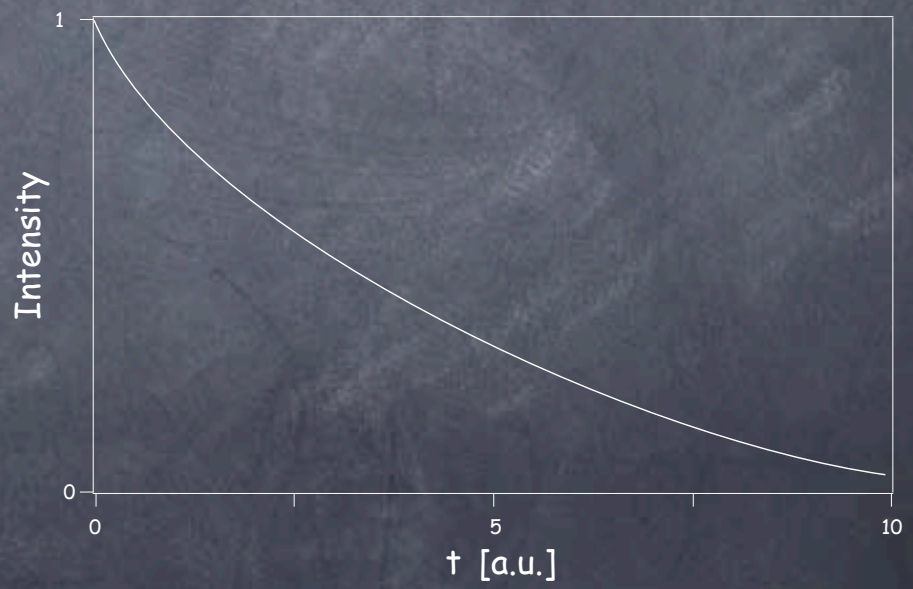
NSE works in time domain: S(q,ω) vs I(q,t)

$$I(q,t) = \int S(q,\omega)\exp(-i\omega t)d\omega$$

intermediate scattering function is the fourier transform of dynamic structure factor

relaxation I(q,t) shows a decaying function





NSE is the best suited to see relaxation dynamics

how to choose a spectrometer

1. length scale

   diffraction? small-angle?

2. energy scale

   neV? meV?

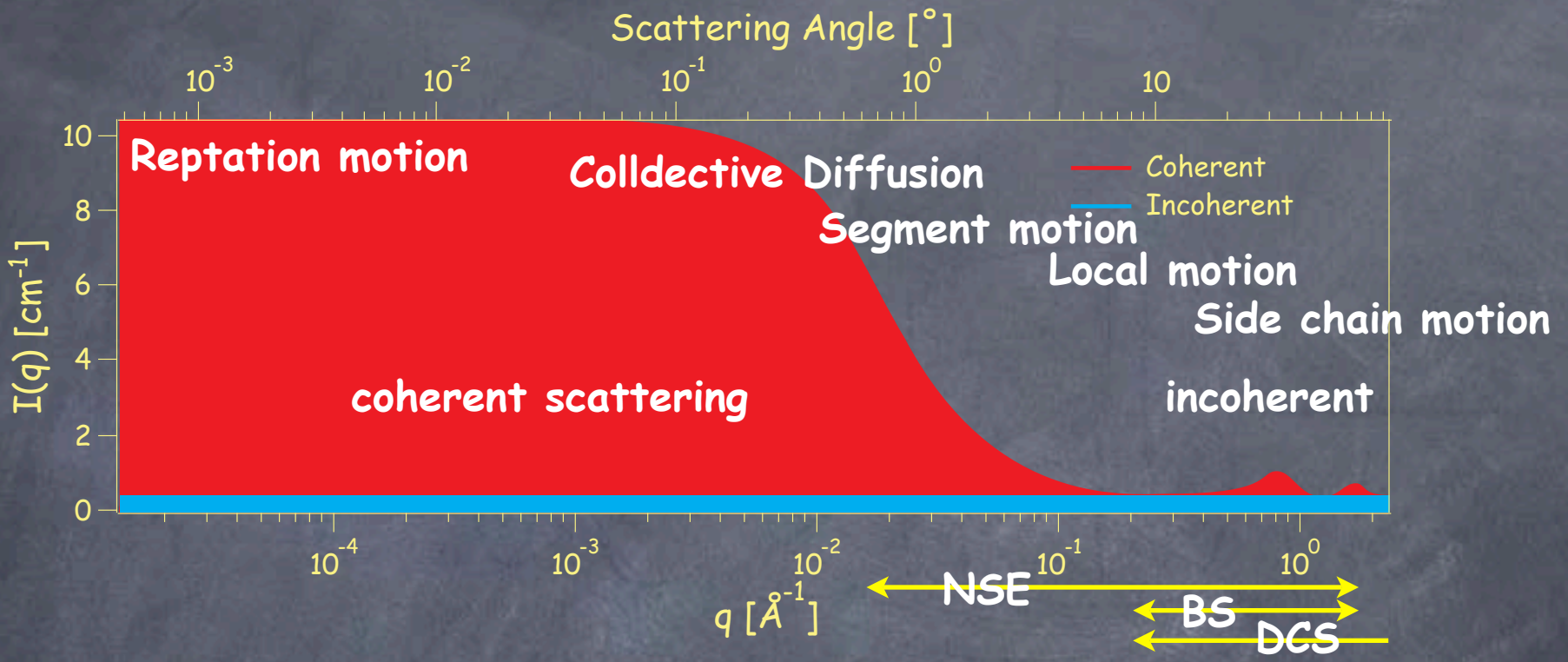
3. dynamics

   excitation? relaxation?

4. intensity

   coherent dynamics? incoherent dynamics?

Scattering Intensity



larger scale objects: slower dynamics

coherent dynamics

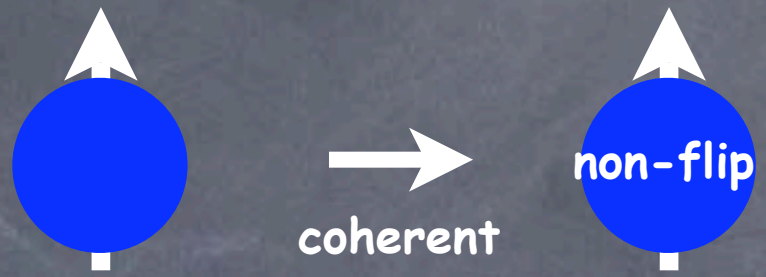
incoherent dynamics at high q

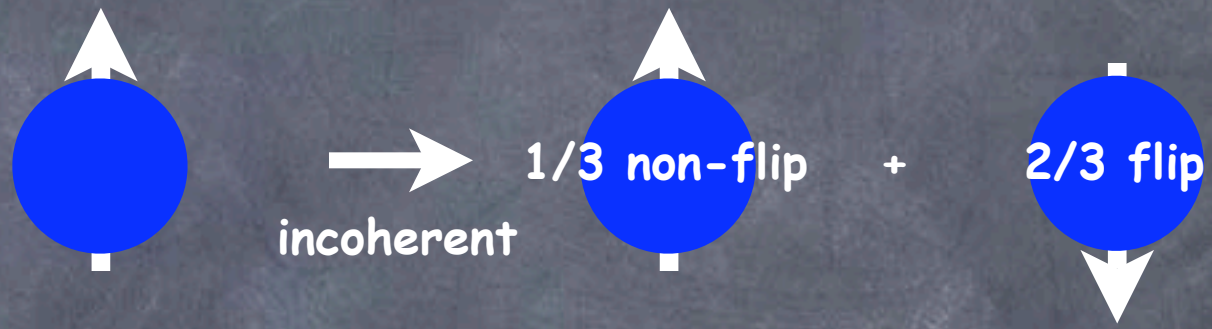
problems to observe incoherent dynamics ...

1: limitation of the detection area

2: spin flip scattering

Spin flip scattering





we loose 1/3 of signals when we measure incoherent dynamics

settings of NSE spectrometer for coherent nucleus scattering and magnetic scattering experiments are different

summary: usage of NSE

1. **length scale**

   We can cover q-range from 0.02 to 1.8 $Å^{-1}$. However, the detection area is limited and normally high-q experiment takes longer time.

2. **energy scale**

   We can cover energy range from several neV to sub meV (time range from ps to hundreds of ns). Highest energy resolution among inelastic/quasi elastic neutron scattering spectrometers.

3. **dynamics**

   Suited to observe relaxation dynamics.

4. **intensity**

   Coherent core scattering at low q is the best measured by NSE so far. Incoherent dynamics and magnetic scattering can also be measured.

large length scale (>1nm), small energy scale (neV), coherent dynamics, relaxation, ...

some keywords today

Neutron Spin Polarization & Precession

Neutron Spin Echo & Echo Signal

Fourier Time

how NSE achieves highest energy resolution

Coherent, Incoherent & Magnetic Scattering

Intermediate Scattering Function

we use I(q,t) and S(q,t) as the same meaning

Relaxation, Diffusion, Thermal Fluctuation,...

THANK YOU FOR
YOUR ATTENTION!