Spin Polarized Inelastic Neutron Spectrometer

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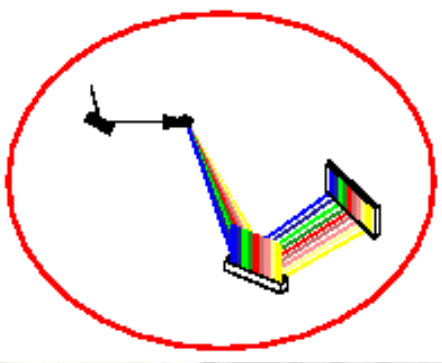
- Basic principles of Triple Axis Spectroscopy
- Multiplexing detection modes for TAS
    1. Horizontally focusing mode
    2. Position-sensitive-detector (PSD) mode
- Data Analysis using DAVE

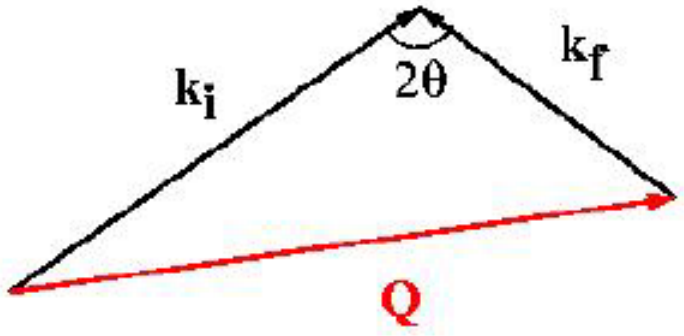


http://www.ncnr.nist.gov/instruments/spins/

The Objective: To Measure the Neutron Scattering Cross Section

$$\frac{d^2\sigma}{d\Omega d\omega}(\mathbf{Q},\omega)$$

Scattering triangle : Energy and momentum are conserved in the scattering process

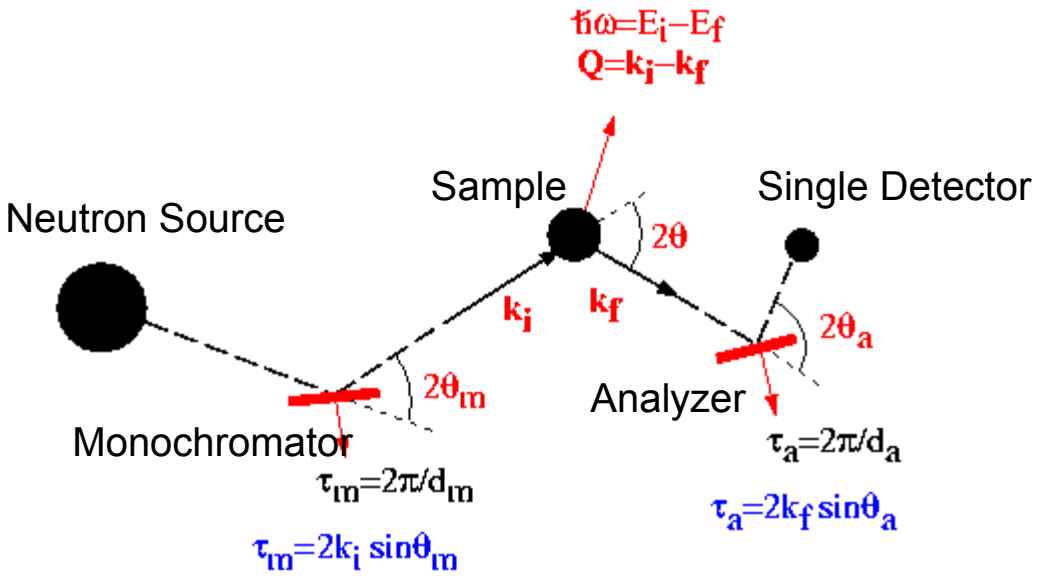


$$Q = k_i - k_f$$
$$\hbar\omega = \frac{\hbar^2}{2m}(k_i^2 - k_f^2)$$

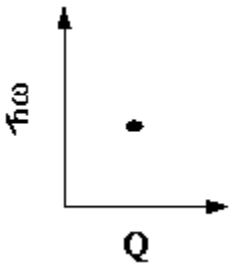
Now, how to determine k_i, k_f, and 2θ ?

- Triple-axis spectroscopy (TAS)
- Time-of-flight spectroscopy (TOF)

Conventional Triple-Axis Spectroscopy (TAS)



A single point at a time



Advantages and Shortcomings of conventional TAS

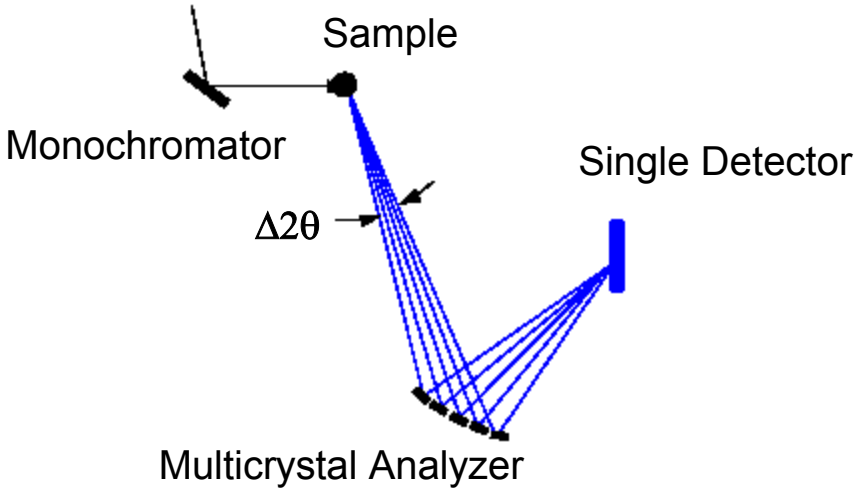
Advantages:
TAS is ideally suited for probing small regions of phase space
Simple To Understand

Shortcoming:
Low data collection rate

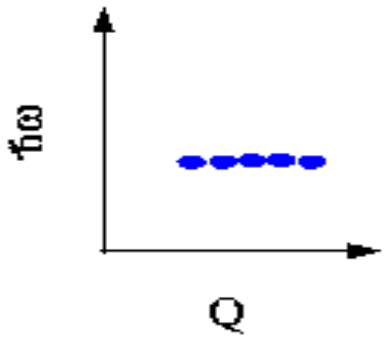
Recent Improvements

Multicrystal analyzer
Position-Sensitive Detector

Horizontally Focusing (HF) Analyzer Mode



Relaxed Q-resolution

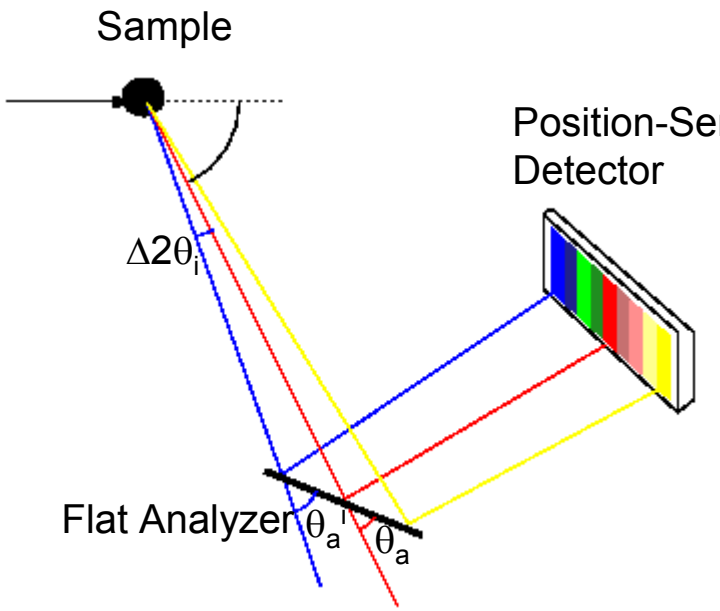


L = distance from sample to HF analyzer
w_a = total width of HF analyzer

$\Delta 2\theta = w_a \sin\theta_a / L \sim 9$ degree for E_f=5 meV at SPINS

Useful for studying systems with short-range correlations

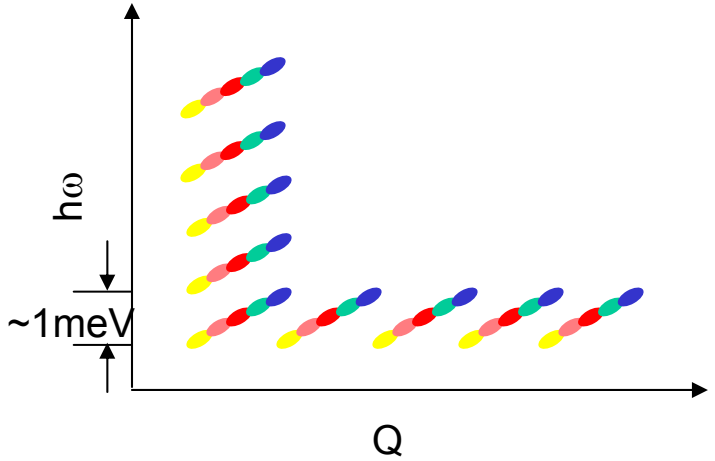
Multiplexing Detection System for TAS

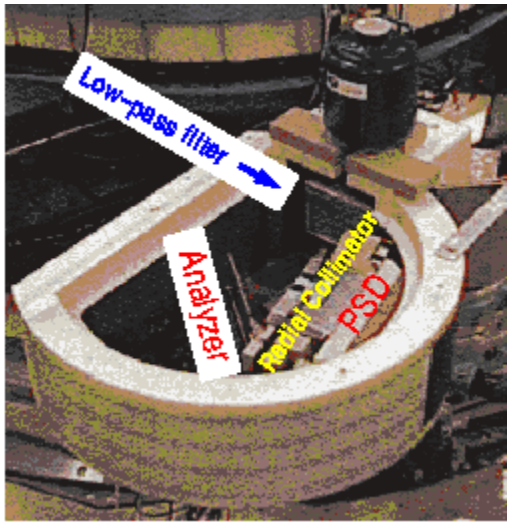


$\theta_a{}^i = \theta_a + \Delta 2\theta_i = \theta_a - \text{atan}(x \sin\theta_a/(L+x\cos\theta_a))$

$k_f{}^i = \tau_a/2\sin\theta_a{}^i$

$\mathbf{Q_i = k_i - k_f{}^i}$





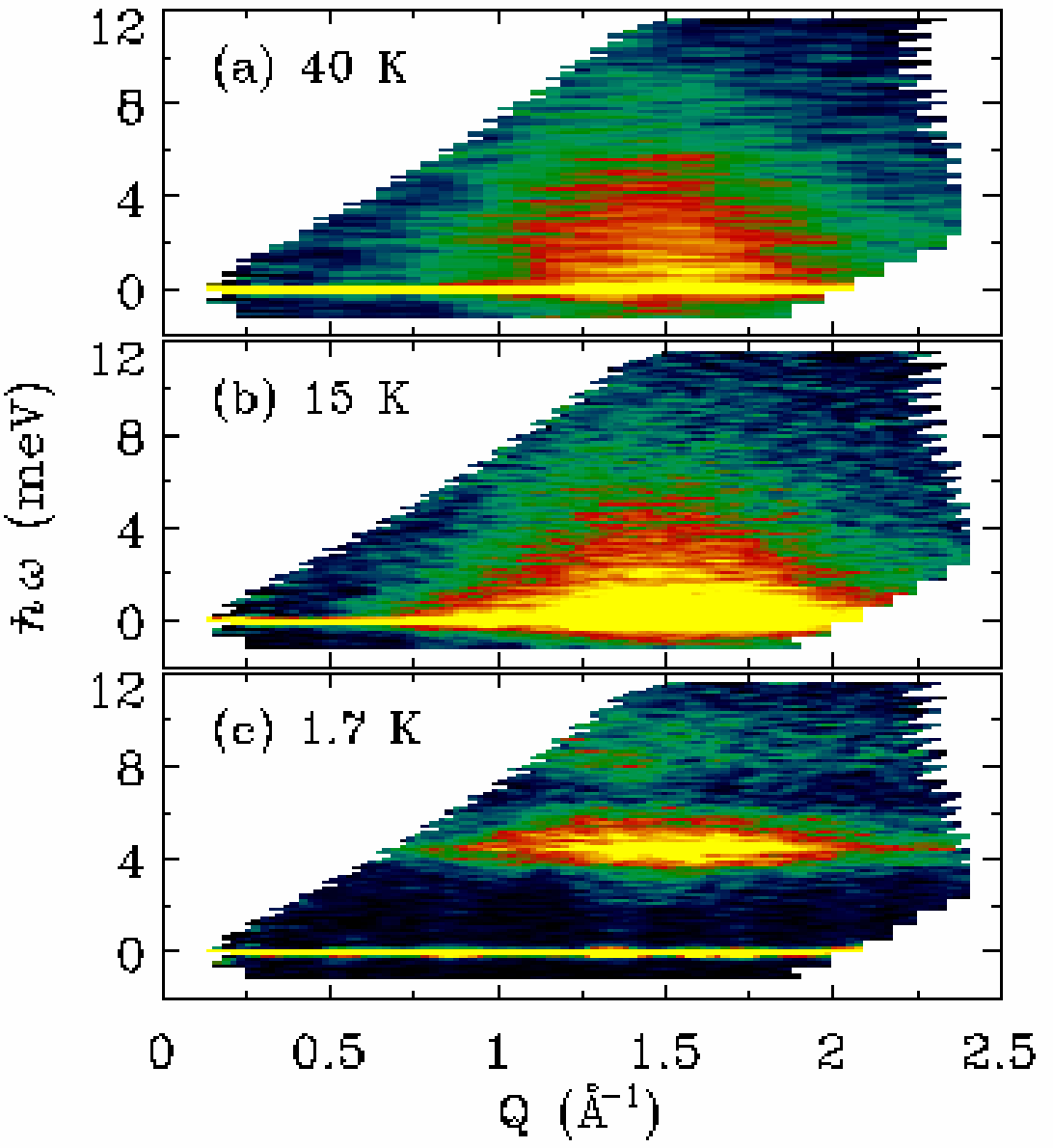
Probes scattering events at different energy and momentum transfers simultaneously

Survey (hω-Q) space by changing the incident energy and scattering angle

Using Multiplexing Detection Mode

- Repetitive 2θ Scans with changing E_i.
- Energy scans with changing T.

S.-H. Lee *et al.*, PRL 2000



PSD Data Analysis & Visualization Using DAVE

http://www.ncnr.nist.gov/dave/