Physics with neutrons 1

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Exercise sheet 9
To be discussed 2017-01-20, room C.3202

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EXERCISE 9.1

The insulating organo-metallic compound $NiCl_2 - 4SC(NH_2)_2$ (know as DTN) demonstrates magnetoelastic properties (Phys. Rev. B 77, 020404(R) (2008)). In an applied magnetic field its c-axis first shrinks by $6 \cdot 10^{-3}\%$ and then expands up to $2.2 \cdot 10^{-2}\%$ in comparison to the zero field value. Calculate whether it is possible to detect such a change in length of the c-axis using the powder neutron diffractometer HRPT located in PSI (the instrumental resolution is equal to $\Delta\theta/\theta = 9.5 \cdot 10^{-4}$ for $Q = (002)$). The unit cell is tetragonal (space group I4 number 79) and the lattice parameters (zero magnetic field) are: $a = b = 9.558$ Å, $c = 8.981$ Å.

EXERCISE 9.2

In the case of TOF measurements Bragg's equation can be rewritten as

$$Q = 4\pi \left(\frac{\sin\theta_B}{\lambda} \right) = \frac{4\pi m_n}{h} \left(\frac{L \sin\theta_B}{t} \right) \tag{1}$$

where L defines the moderator - detector distance and t the flight time. Calculate the instrumental resolution $\Delta Q/Q$ and discuss the main parameters influencing it. Assume you want to build a TOF instrument. How can you increase the instrumental resolution $\Delta Q/Q$? Furthermore, proof equation B.2.2 from the lecture notes.

EXERCISE 9.3

Look at Fig. 1 where the parallel and antiparallel configuration for Bragg scattering at an instrument with fixed wavelength is shown. In one of the two cases the so-called *focusing effect* arises from the finite angular spread. The width of the Bragg reflections increases with the angular spread of the incident beam but passes through a minimum for one of the two configurations. Discuss for which configuration the *focusing effect* occurs. Bragg's condition is fulfilled in both cases for the central beam. Suppose that the beam striking the monochromator has a divergence $\pm\alpha$.

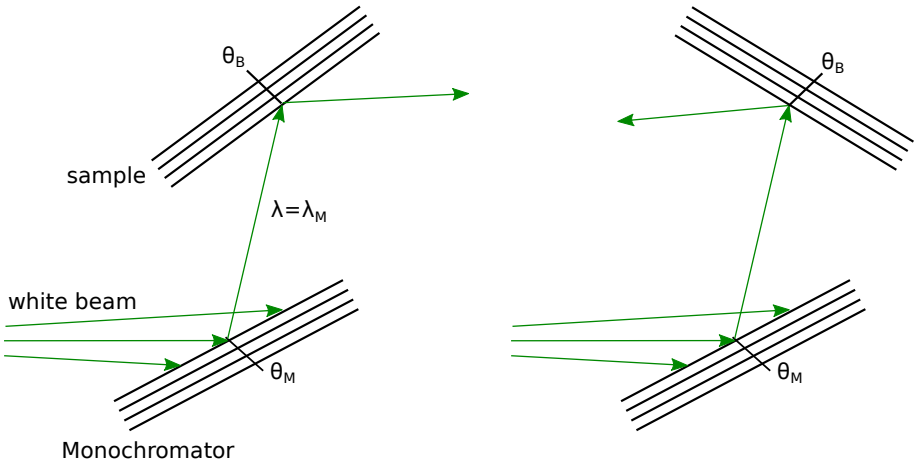

Figure 1: Parallel (left) and antiparallel (right) configurations for Bragg scattering at fixed wavelength.