Physics with neutrons 1

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Exercise sheet 10
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EXERCISE 10.1

1. Sample holders for diffraction experiments are often made of materials that do not scatter coherently (why?). A possible choice is a *zero-scattering alloy* which can be a mixture of natural titanium and zirconium. What is the composition of this alloy? Why is the term *zero-scattering* misleading?

2. A vanadium sample is a standard sample for calibration at many instruments. Can you think of a reason for that?

EXERCISE 10.2

The coherent elastic neutron cross-section is given as

$$\frac{\mathrm{d}\sigma}{\mathrm{d}\omega} = N_0 \frac{(2\pi)^3}{v_0} e^{-2W(\mathbf{Q})} \sum_{\tau} |S_\tau|^2 \, \delta(\mathbf{Q} - \tau) \tag{1}$$

with the structure factor

$$S_\tau = \sum_{\mathbf{d}} b_{\mathbf{d}} e^{i\tau \cdot \mathbf{d}}. \tag{2}$$

Calculate the structure factor for a diamond lattice (an fcc lattice with a two-atomic basis at $(0,0,0)$ and $(a/4, a/4, a/4)$). Briefly describe the origin of the other terms in eq. 1.

EXERCISE 10.3

In a powder diffraction experiment with a material having a cubic unit cell and using a neutron wavelength of $\lambda = 1.5\,\text{Å}$, the first few Bragg peaks occur at the scattering angles $\Theta = 43.31°$, $50.44°$, $74.12°$, $89.93°$. Determine the structure (bcc, fcc, etc.) these peaks correspond to. Based on the information, draw the reciprocal lattice with the allowed and forbidden Bragg peaks in the $(hk0)$ and the (hhl) plane. Draw the same reciprocal lattice planes for a diamond lattice.