Physics with neutrons 1

Sebastian Mühlbauer, sebastian.muehlbauer@frm2.tum.de
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Exercise sheet 6
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Lukas Karge, lukas.karge@frm2.tum.de, Tel.: 089-289-11774

Exercise 6.1

Prove the lattice sum equation:

$$\sum_{\mathbf{v}_{mnp}} \exp(i\mathbf{Q}\cdot\mathbf{v}_{mnp}) = \frac{(2\pi)^3}{V_{UC}} \sum_{\mathbf{G}_{hkl}} \delta(\mathbf{Q}-\mathbf{G}_{hkl})$$

Exercise 6.2

Calculate the structure factor for a diamond lattice (an fcc lattice with a two-atomic basis at $(0,0,0)$ and $(a/4,a/4,a/4)$).

Exercise 6.3

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.

Exercise 6.4

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?