

Assignment 1: Magnetic Neutron Scattering

1. For a simple antiferromagnetic structure with a cell doubled in c direction the magnetic propagation vector is $k = (0\ 0\ 1/2)$. Make a plot of reciprocal space in the a^*-c^* -plane indicating the positions of nuclear and magnetic Bragg peaks (crystal structure: simple cubic).
2. MnF_2 has a tetragonal crystal structure in which the Mn ions are situated at the body center position in the unit cell. Below 70 K, the spins of the Mn ions (at the corners of the unit cell) become antiferromagnetically aligned along the c axis with the spins of ions at the body center position in the unit cell. Sketch the results you would expect to observe at (a) 100 K and (b) 10 K in a neutron diffraction experiment from a powder sample of MnF_2 .
3. What is the origin of magnetic form factor in magnetic neutron diffraction?
4. If atoms of the following pairs of elements need to be clearly distinguished in a crystal structure, for which pairs does neutron diffraction offer the greatest advantage compared with X-ray diffraction and why?
 - a) N and O
 - b) Fe and U
 - d) W and Re
 - e) C and U
5. To determine the magnetic order in a polycrystalline sample, which probe (X-ray or neutron) you will use and why?
6. Prepare a pcr file for the crystal structural refinement of $\text{NdFe}_{0.5}\text{Mn}_{0.5}\text{O}_3$ (neutron diffraction data available on ANUVIDHYA portal).
7. You are performing a powder neutron diffraction experiment aiming at determining the magnetic structure of a compound (crystal structure: simple cubic) below its magnetic ordering temperature. If compound orders in a ferromagnetic structure with moment along the crystallographic c -axis, which of the following peaks will not have magnetic contribution and why?
 - a) (100)
 - b) (010)
 - c) (001)
 - d) (110)