Masterschool Exercises Wednesday 6.9.2017

1) What is the difference between a scattering and an imaging experiment? When would you choose one over the other?

2) Why does one observe Laue spots when a “white” beam of X-rays is scattered from a single crystal? How about scattering from glass?

3) Why are neutrons sensitive to the magnetic order in a crystal?

4) Neutron scattering and X-rays allows us to determine “where the atoms are and how the atoms move” in a condensed matter system. Discuss qualitatively the strengths and weakness of these.

5) Give orders of magnitudes for the energy [eV] and the wavelength [Å] of the following types of radiation which are being used for diffraction experiments: A. Thermal neutrons, B. X-rays

6) A. What is the basic problem in refining crystal structures from powder diffraction data?
B. Sketch the fundamental idea to solve this problem using the Rietveld refinement.
C. What kind of data can be obtained from a Rietveld refinement? (collect a list and sort into categories: Structural parameters, instrumental parameters, others)
D. Can powder diffraction data be used for structure determination? (yes or no plus arguments)

7) Choice of neutron wavelengths
A. Magnetic neutron diffraction experiments are usually done with rather long wavelengths: lambda = 1.87 Å or longer): Name one reason why.
B. Diffraction experiments aiming at obtaining precise atomic coordinates and displacements are done with much shorter wavelengths (lambda = 0.552 Å): Why?

8) Discuss ways to measure ferromagnetism using X-rays and neutrons.

9) You know that a given compound order magnetically below a certain temperature, but the type of magnetic order is unknown. Describe your strategy to study the magnetic order using neutrons or X-rays. Where would you look for the Bragg peaks in reciprocal space for for a given ordering vector **k**?