Physics with Neutrons I

Alexander Backs
alexander.backs@frm2.tum.de

WS 18/19
26.10.2018

Exercise sheet 1 https://wiki.mlz-garching.de/n-lecture06:index

---

Due on 02.11.2017

1. Particle properties

Neutrons, photons and electrons are widely used in physics to examine the static and dynamic properties of matter. Calculate the missing quantities in the table below and compare the results to the typical length and energy scales in solid matter.

	E (eV)	T (K)	λ (Å)	v (m/s)	k (1/Å)
Light (Red Laser)			6320		
X-rays (Cu K_α)					
Cold neutrons			6		
Thermal neutrons				2200	
Hot neutrons		2300			
Fission neutrons	$2.1 \cdot 10^6$				
Electrons				$1.2 \cdot 10^6$	

Use a software of your choice to draw the dispersion relation of all three particles and mark the examples from the list in the graph (except for the fission neutrons).

2. The Maxwell-Boltzmann distribution

From your previous studies you should remember the Maxwell-Boltzmann distribution in units of Energy E and particle velocity v.

$$f(v) = \frac{4}{\sqrt{\pi}} \left(\frac{m_n}{2k_bT} \right)^{3/2} v^2 \exp\left(-\frac{\frac{1}{2}m_n v^2}{k_bT} \right)$$

Express it in terms of the particle wavelength λ. Determine $\langle \lambda \rangle$, $\langle \lambda^2 \rangle$ and λ_{max} (i.e. the λ where $f(\lambda)$ is maximal).
Remember that the flux distribution is given by

$$\Psi(v) = v \cdot f(v)$$

3. Easy absorption

A simple model for the absorption of neutrons in matter is to allocate an effective area to each Atom which acts like a shooting target. If a neutron hits this area it is absorbed by the nucleus, otherwise it can pass through. Assuming an absorption area of 0.231 b (barn; 10^{-28} m^2) for aluminium and neutrons with a wavelength of 1.8 Å, calculate the transmission of a neutron beam through a plate of 1 mm, 1 cm and 10 cm thickness.