Physics with neutrons 1

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Exercise sheet 7
To be discussed 2016-12-16, room C.3202

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EXERCISE 7.1

Velocity selectors and choppers are used to define the wavelength λ and wavelength spread $\Delta\lambda/\lambda$ of a neutron beam in front of the sample. These are fast rotating devices with different geometries.

- In Fig. 1 a typical velocity selector is depicted. The basic concept for velocity selectors is to allow neutrons to travel in a rotating helical path. The neutrons flight path is parallel to the symmetry axis of the cylinder and the selector is defined by its frequency ω, length L, the angle δ defining the width of the absorbing blade and the angle β defining the width of the transparent area. Given these parameters calculate the neutron wavelength which passes through. Determine the relative wavelength spread and the shape of the transmitted wavelength distribution.

- In Fig. 2 a Fermi chopper is shown. Given its diameter d, frequency ω and blade distance a, calculate the minimal neutron velocity passing the chopper. How does the transmitted neutron velocity distribution look like and what is the transmitted neutron velocity for a given curvature r?

- Using choppers a time-of-flight experiment can be realized at a reactor like FRM-II. Draw the neutron flight path in a $L-t-$diagram where two identical choppers at distances $L_1 < L_2$ in front of the sample rotate with the same frequency. What kind of problems will occur and how can they be eliminated?

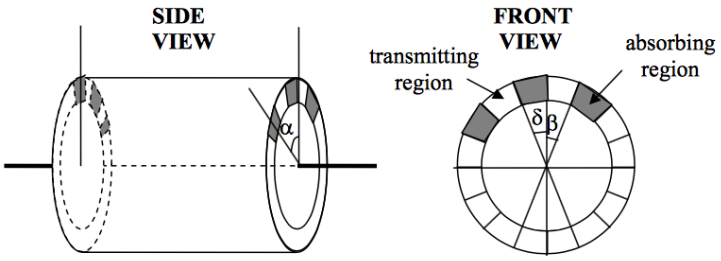

Figure 1: Velocity selector

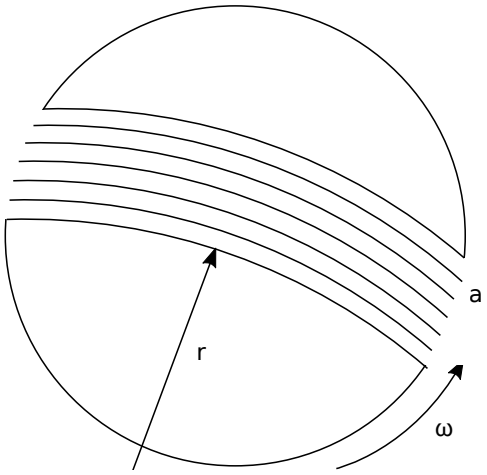

Figure 2: Fermi-chopper

EXERCISE 7.2

Consider a Soller collimator with length $l = 40\,\text{cm}$. How are the divergence and the blade distance a related? How does the transmitted beam profile look like and what is its FWHM and its variance? Two collimators with the same length l and blade distance a, one behind the other, are rotated to one another by an angle α. How does the transmitted beam profile look like?