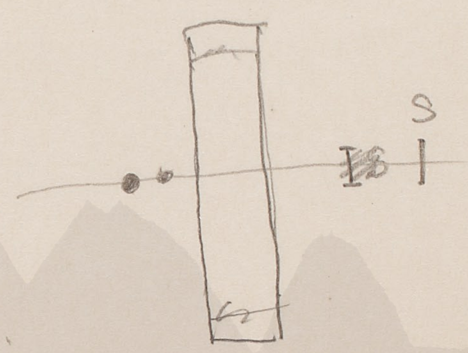
§ Scattering of Neutrons from a Point Source by ~~Thin Plate~~ a Circular ~~Disc~~ Plate.

~~Next example, which can more easily~~

Next, we want to deal with another simple ~~case~~ example, which ~~is~~ more practical than ~~the case~~ ~~that~~ the previous one. Consider a circular disc of radius r_0 and thickness h ~~small compared with~~



As shown in Fig. 4 ~~consider~~ A point source S emitting aN_0 neutrons of energy E_0 per unit time is placed at a distance b ~~from~~ on the axis of ~~the p~~ a circular plate P of radius r_0 and thickness h containing hydrogen, which is small compared with the mean free path λ_0 of the primary neutrons. ~~A detector~~ A small ~~detector~~ and thin detecting plate R of area ~~S~~ with surface area S is placed at ~~the same distance on the axis~~ at a distance b ~~from the centre~~ ~~on the axis~~ on the opposite side, ~~of the the distance from the circular plate~~ being also b.

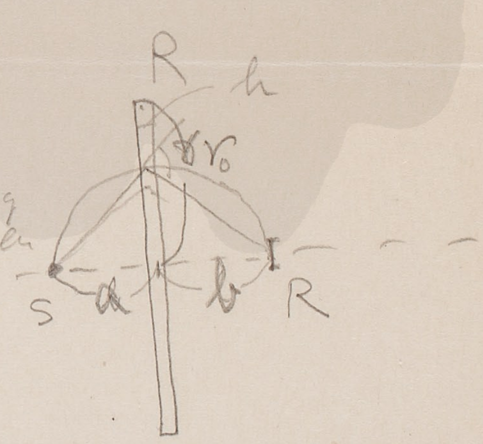
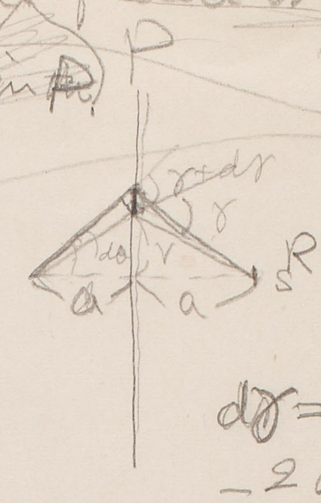


Fig. 4

We assume r_0 and a to be ~~the~~ ~~same~~ quantities of the same order, ~~magni~~ ~~as~~ ~~a~~ ~~but slightly larger than~~ ~~a, but the former is larger than~~ but the former being larger than the latter. $a \lesssim r_0$

~~in the plate P~~ on the circle of radius between r and $r+dr$.

The number of neutrons, which hit R per unit time ~~with~~ after deflected by an angle between ~~γ,~~ ~~$r+dr$~~ and $\gamma+d\gamma$ is given approximately by



$$\cos^2\theta = \frac{b^2}{b^2+r^2}$$

$$d\gamma = 2\,d\theta = \frac{2\,dr\cos\theta}{\sqrt{b^2+r^2}}$$

$$\frac{N_0\, 2\pi r\, dr \cos\theta}{(a^2+r^2)} \times \frac{2h \cos\gamma}{\lambda_0 \cos\theta} \frac{\cos\theta \cdot S}{(b^2+r^2)}$$

$$dr = \frac{\sqrt{b^2+r^2}\, d\gamma}{2\cos\theta} = \frac{(b^2+r^2)\,dr}{2b}$$

$\tan 2\theta$.

$$= \frac{N_0\, 2\pi\, dr}{(a^2+r^2)^{\frac{3}{2}}} \frac{2h\cos\gamma\, S}{\lambda_0}$$

$$r = b\tan\theta$$

$$= \frac{1}{\frac{\sin\gamma}{\cos\gamma}}(\cos\gamma - 1) = b\,\frac{\sqrt{1+\tan^2\gamma}-1}{\tan\gamma} \;!!!$$

$$\tan 2\theta = \frac{2\tan\theta}{1-\tan^2\theta}$$

$$= \frac{N_0\, 2\pi \cdot \cos\gamma\, d\gamma}{(a^2+r^2)^{\frac{3}{2}} \cdot b} \frac{hS}{\lambda_0},$$

$$(\tan 2\theta)\tan^2\theta + 2\tan\theta - \tan 2\theta = 0.$$

$$\tan\theta = \frac{-1 \pm \sqrt{1+\tan^2 2\theta}}{\tan 2\theta}$$

$$\frac{(1-\cos\gamma)}{\sin\gamma}$$

$$= b\,\frac{1-\cos\gamma}{\sin\gamma}$$

or ~~since~~ or, ~~since~~ the number of ~~deflected~~ neutrons having energy between ~~$E_0\cos\gamma$ and $E_0\cos\gamma$~~

$E = E_0\cos\gamma$ and $E + dE = E_0\cos\gamma + E_0\sin\gamma\, d\gamma$,

E and $E+dE$ ~~is given by~~ becomes app.

$$\frac{2\pi N_0\, dE\, a\, hS}{E_0\,(a^2+r^2)^{\frac{3}{2}}\lambda_0} \left(\frac{E}{E_0}\right)^{\frac{1}{2}} \frac{\left\{1-\left(\frac{E}{E_0}\right)^2\right\}}{\left(1-\frac{E}{E_0}\right)} = 2\pi$$

$$b^2 + r^2 = b^2\left(\frac{1+1-2\cos\gamma}{\sin^2\gamma}\right)$$

$$= b^2\,\frac{2-2\left(\frac{E}{E_0}\right)^{\frac{1}{2}}+\left(\frac{E}{E_0}\right)}{1-\frac{E}{E_0}}$$

$$= \frac{2\pi N_0 hS}{2^{\frac{3}{2}} a^2 \lambda_0} \cdot \frac{dE}{E_0} \cdot \left(\frac{E}{E_0}\right)^{\frac{1}{2}} \frac{\left\{1-\left(\frac{E}{E_0}\right)^{\frac{1}{2}}\right\}\left\{2-2\left(\frac{E}{E_0}\right)^{\frac{1}{2}}+\left(\frac{E}{E_0}\right)\right\}}{\left(1-\frac{E}{E_0}\right)^2}$$

provided that the mean free path ~~for neutrons~~ energy E is large compared with h.

If $E \ll E_0$, this reduces to

$$N(E)\,dE = \frac{4\pi N_0 hS}{2^{\frac{3}{2}} a^2 \lambda_0} \cdot \frac{dE}{E_0} \cdot \left(\frac{E}{E_0}\right)^{\frac{1}{2}}.$$

~~Thus, for,~~ so that, ~~for~~ slow ~~neutrons~~, as can be easily predicted, ~~the rate of increase of activity~~ the number of slow neutrons per unit energy range which hit the dector after single scattering is decreases ~~with as the square~~ $E^{\frac{1}{2}}$ ~~with the~~ as the energy ~~decrease~~ tend to 0, ~~Thus for very slow~~ in contrast to the result ~~obtained~~ obtained in the preceding sections, ~~(for the case of which corresponds to the case~~ for source at infinity

~~These results. Thus, for~~ the number of neutrons ~~Especially Thus~~, the increase of ~~with increase~~ with ~~of~~ of thermal energy will be approx. the thickness linearly ~~proportional~~ proportional to h^2, as the effect of double and higher order scattering will be predominating.

~~Thus, the~~ Moreover, the average energy of a certain group of slow neutrons, which activate strongly the detector, ~~will~~ be estimated from the rate of increase of activity with thickness h at the limit $h=0$.

This seems to be in agreement ~~the result~~ with the experiment of Nishikawa and Nakagawa[1)], ~~for slow neutrons~~ Rn-Be source on the slow down of neutrons by thin paraffin plate, which shows that the rate of increase of activity of ~~Ag (or I)~~ Ag (or I) with the thickness by neutrons of C group is nearly quadratic, whereas with thermal energy

1)

, whereas that ~~of~~ by neutrons of A group is linear.

[illegible]