

(30%) A central force potential frequently encountered in nuclear physics is the so-called rectangular well, defined by the potential:

$$V = 0, \quad r > a$$

$$V = -V_0, \quad r \leq a.$$

Show that the scattering produced by such a potential is identical with the refraction of light rays by a sphere of radius a and relative index of refraction

$$n = \sqrt{\frac{E + V_0}{E}}$$

Show also that the differential cross section is

$$\sigma(\theta) = \frac{n^2 a^2}{4 \cos \frac{\theta}{2}} \frac{\left(n \cos \frac{\theta}{2} - 1 \right) \left(n - \cos \frac{\theta}{2} \right)}{\left(1 + n^2 - 2n \cos \frac{\theta}{2} \right)^2}$$