# 2. Scattering theory

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# 2.1 Basic concepts

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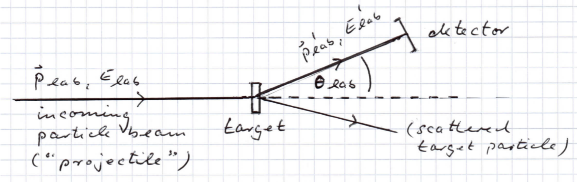
- typical scattering experiment (fixed target):



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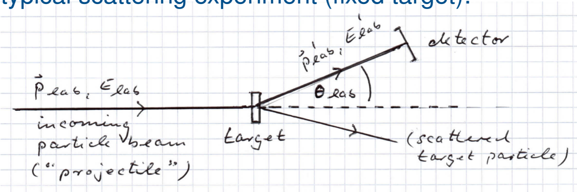
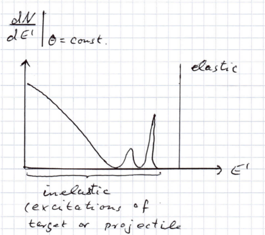
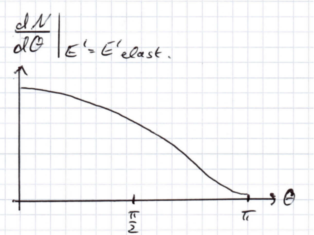
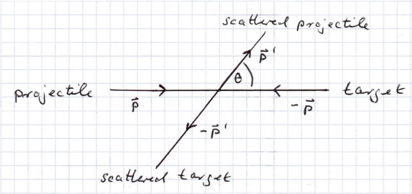



- measurement: counting rate $N(E'_{\text{lab}}, \theta_{\text{lab}})$



- usually better: center-of-momentum (CM) frame




scattering angle: $\cos\theta = \frac{\vec{p}\cdot\vec{p}\,'}{|\vec{p}||\vec{p}\,'|}$

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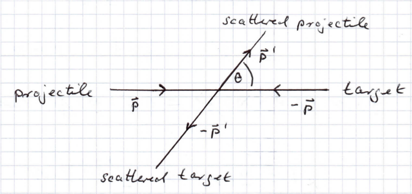


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- elastic scattering in the CM frame:

total energy: $E_{tot}^{in} = \frac{\vec{p}^{\,2}}{2m_p} + \frac{\vec{p}^{\,2}}{2m_t} = \frac{\vec{p}^{\,2}}{2\mu} \stackrel{!}{=} E_{tot}^{out} = \frac{\vec{p}\,'^2}{2\mu} \quad \Rightarrow \quad |\vec{p}\,'| = |\vec{p}|$

reduced mass: $\frac{1}{\mu} = \frac{1}{m_p} + \frac{1}{m_t}$

# Cross section

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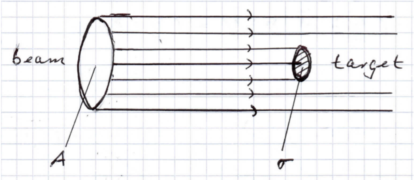


Number of “events”:

$$N_{abs} = \frac{\sigma}{A} N_{in}$$

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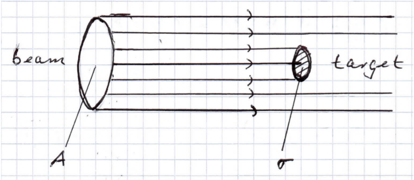


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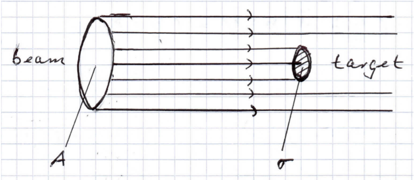


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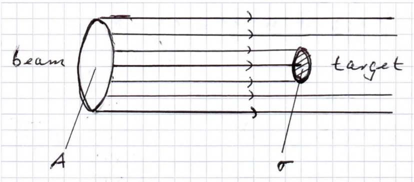


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  $= 10^{-24}\text{cm}^2 = 100\,\text{fm}^2 \quad = \pi R^2 \rightarrow R = 5.6$ fm ( $\sim$ large nucleus)

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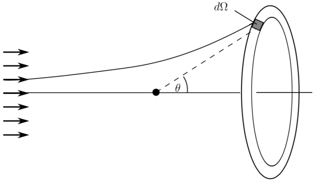
- somewhat more specific definition of the cross section (as relevant for us):

$$d\sigma(\theta,\varphi) = \frac{d\sigma(\theta,\varphi)}{d\Omega}\, d\Omega$$

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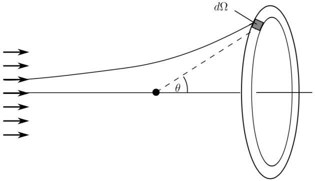


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- total cross section: $\sigma = \int d\Omega \, \frac{d\sigma}{d\Omega}$

($\frac{d\sigma}{d\Omega}$: differential cross section)