COULOMBICKÉ SRÁŽKY

$$b_{90} = \frac{q_1 q_2}{4\pi\varepsilon_0}\frac{1}{\mu g^2}$$

$$\cot\frac{\chi}{2} = \frac{b}{b_{90}}$$

dif. úč. průřez:

$$\frac{d\sigma}{d\Omega} = \frac{b}{\sin\chi}\left|\frac{db}{d\chi}\right| =$$

$$\underbrace{\frac{d\sigma}{d\Omega} = \frac{b_{90}^2}{4\sin^4\chi/2}}_{\text{Rutherfordův rozptyl}}$$

RELAXACE ENERGIE V COUL. SR.

$$\Delta E_1 = -E_1 \frac{2\mu}{m_1+m_2}(1-\cos\chi) \quad \Big| \cos\chi = \cos^2\frac{\chi}{2} - \sin^2\frac{\chi}{2}$$

$$(1-\cos\chi) = (\underbrace{1-\cos^2\frac{\chi}{2}}_{\sin^2\frac{\chi}{2}} + \sin^2\frac{\chi}{2}) = 2\sin^2\frac{\chi}{2}$$

$$\cot^2 x = \frac{\cos^2 x}{\sin^2 x} = \frac{1-\sin^2 x}{\sin^2 x}$$

$$\sin^2 x(\cot^2 x + 1) = 1$$

$$\sin^2 x = \frac{1}{\cot^2 x + 1}$$

$$\Delta E_1 = -E_1 \frac{2\mu}{m_1+m_2}\, 2\, \frac{1}{\cot^2\frac{\chi}{2}+1}$$

$$\Delta E_1 = -E_1\frac{4\mu}{m_1+m_2}\frac{1}{\left(\frac{b}{b_{90}}\right)^2+1}$$ — Coulomb. sr., $v_2 = 0$

aproximace: malé úhly rozptylu
$\chi \ll 1$; $b/b_{90} \gg 1$

$$\Delta E_1 = -E_1 \frac{4\mu}{m_1+m_2}\left(\frac{b_{90}}{b}\right)^2$$

svazek částic 1 v plynu 2 s koncentrací n_2

vzdálenost dl, počet srážek s $(b, b+db)$

$$dl\, n_2 \underbrace{2\pi b\, db}_{d\sigma} \cdot \Delta E_1 = E_{1eb}\, dl\, db$$

$$\frac{dE_1}{dl} = \int_0^\infty E_{1b}\, db = -n_2 E_1 \frac{4\mu}{m_1+m_2}\int_0^\infty \left(\frac{b_{90}}{b}\right)^2 2\pi b\, db =$$

$$= -n_2 E_1 \frac{\mu}{m_1+m_2} 8\pi b_{90}^2 \left[\ln b\right]_0^\infty \quad (=+\infty,\ =-\infty\ ?)$$

- pro $b\to 0$; výpočet má smysl pro $b > b_{90}$
- $b\to\infty$?

$$\varphi \sim \frac{1}{r}\exp\left(-\frac{r}{\lambda_D}\right)$$

$$\left[\ln b\right]_{b_{90}}^{\lambda_D} = \ln\frac{\lambda_D}{b_{90}} = \ln\Lambda_c$$

Λ_c … COULOMBICKÝ LOGARITMUS

$$\frac{dE}{dl} = -n_2 E_1 \frac{\mu}{m_1+m_2} 8\pi b_{90}^2 \ln\Lambda_c$$

srážková frekvence

$$\nu_E = v_1 \frac{1}{E_1}\left|\frac{dE_1}{dl}\right| = n_2 v_1 \frac{\mu}{m_1+m_2} 8\pi b_{90}^2 \ln\Lambda_c$$

$$= n_2 v_1 \underbrace{\frac{\mu}{m_1+m_2}}_{\cdots}\, 8\pi \left(\frac{q_1 q_2}{4\pi\varepsilon_0\, \mu\, v_1^2}\right)^2 \ln\Lambda_c \qquad \left(\to \frac{1}{m_1 m_2}\right)$$

$$= n_2 v_1 \underbrace{\frac{q_1^2 q_2^2}{(4\pi\varepsilon_0)^2}\frac{8\pi}{m_1 m_2 v_1^4}\ln\Lambda_c}_{\sigma_E \sim \frac{1}{v^4}}$$

$(\nu = n v \sigma)$

$$\nu_E = \frac{1}{\tau_E}$$

Cvičení:

spočítejte ν_E ; $\lambda_E = \frac{v_1}{\nu_E}$

v	E_1	n / cm^{-3}
tokamaku	1 keV	10^{13}
laserové fúzi	1 eV	10^{20}
slunečním větru	10 eV	10^{7}