2007–03–31

Subatomär fysik med Björn Jonson

CERN, ISOLDE, GSI → FAIR

⟨*insert PowerPoint presentation here*⟩ (Se kurshemsidan.)

Kärnans radie

Atom $\sim 10^{-10}\,\mathrm{m}$

Kärna $\sim 10^{-14}\,\mathrm{m}$

Volym $\frac{4}{3}\pi R^3$

$1 : 10^{12}$

Våglängd: $\leqslant$ dimension

'Typisk' kärna 10 fm. (1 fm $\equiv 10^{-15}$ m, kallas ibland en fermi).

$$\lambda \leqslant 10\,\mathrm{fm} = \frac{h}{p} = \frac{hc}{pc} = \frac{2\pi \cdot 197}{pc}$$

$[p] = \mathrm{MeV}/c,\ \hbar c = 197\,\mathrm{MeV\ fm},\ pc \sim 100\,\mathrm{MeV}.$

$$E^2 = p^2c^2 + m^2c^4, \quad E = E_\mathrm{k} + mc^2$$

Massenhet

$$1\,\mathrm{u} = \frac{1}{12}m(^{12}\mathrm{C}) = 1,66 \cdot 10^{-27}\ \mathrm{kg}$$

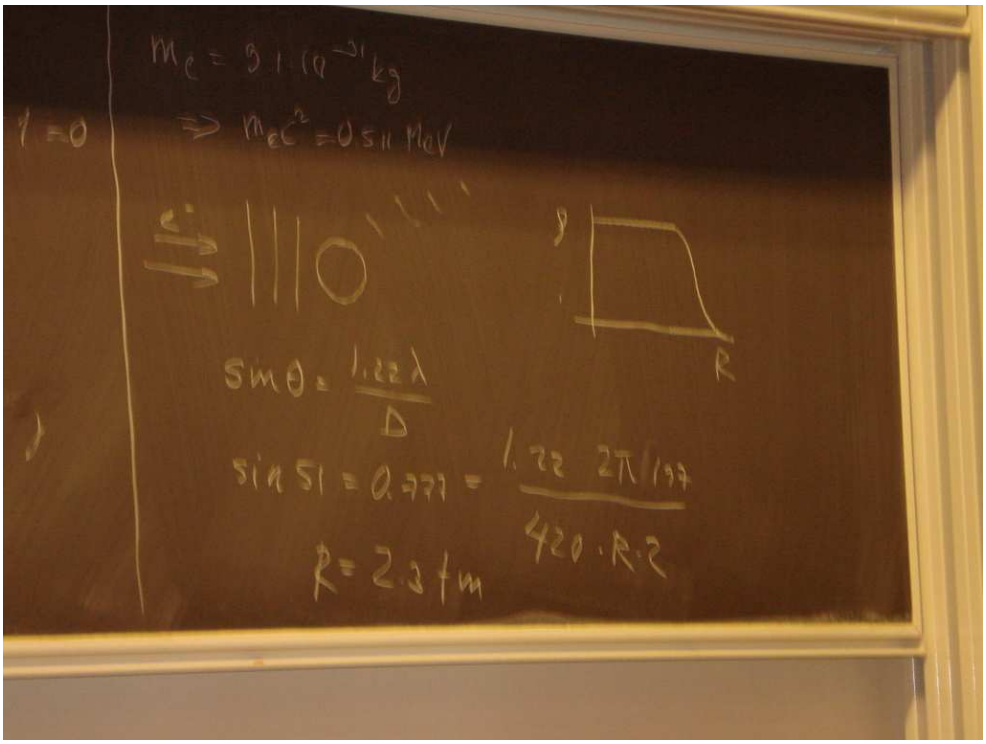
$$1\,\mathrm{u} \cdot c^2 = 1,66 \cdot 10^{-27} \cdot (3 \cdot 10^8)^2 = 1,49 \cdot 10^{-10}\,\mathrm{J}$$

$$1\ \mathrm{eV} = 1,6 \cdot 10^{-19}\,\mathrm{J}$$

$$1\,\mathrm{u} = \frac{1,49 \cdot 10^{-10}}{1,6 \cdot 10^{-19}} = 931,5\,\mathrm{MeV}/c^2$$

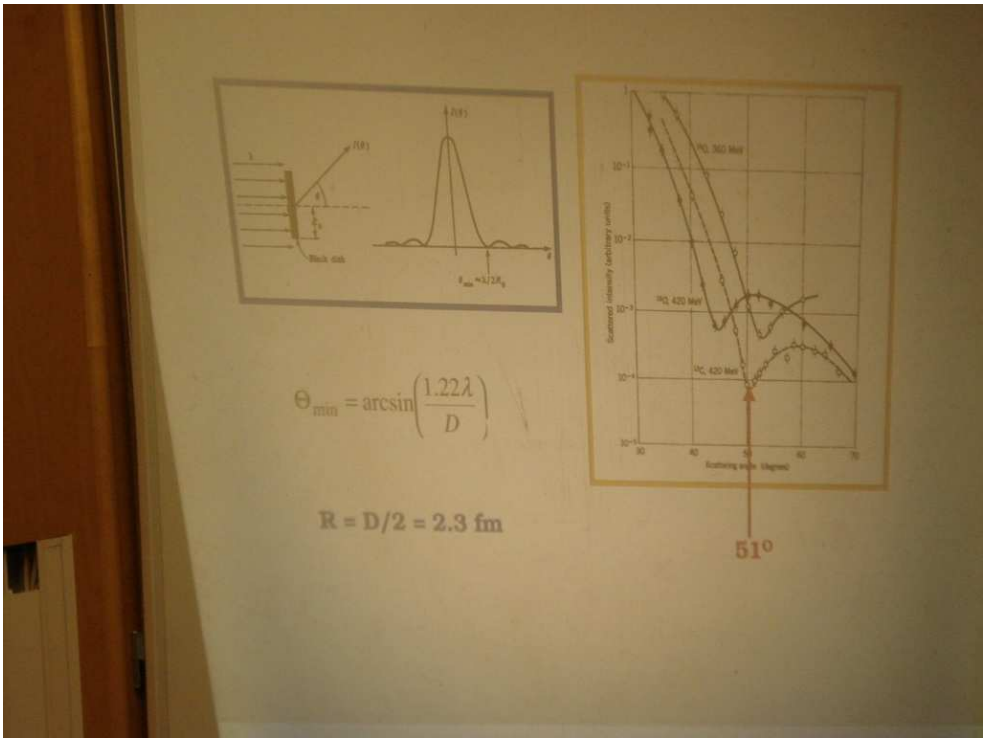
$$m_\mathrm{e} = 9,1 \cdot 10^{-31}\,\mathrm{kg}$$

$$\Rightarrow m_\mathrm{e}\,c^2 = 0,511\,\mathrm{MeV}$$



Figur 1.

$$\sin\theta = \frac{1,22\lambda}{D}$$

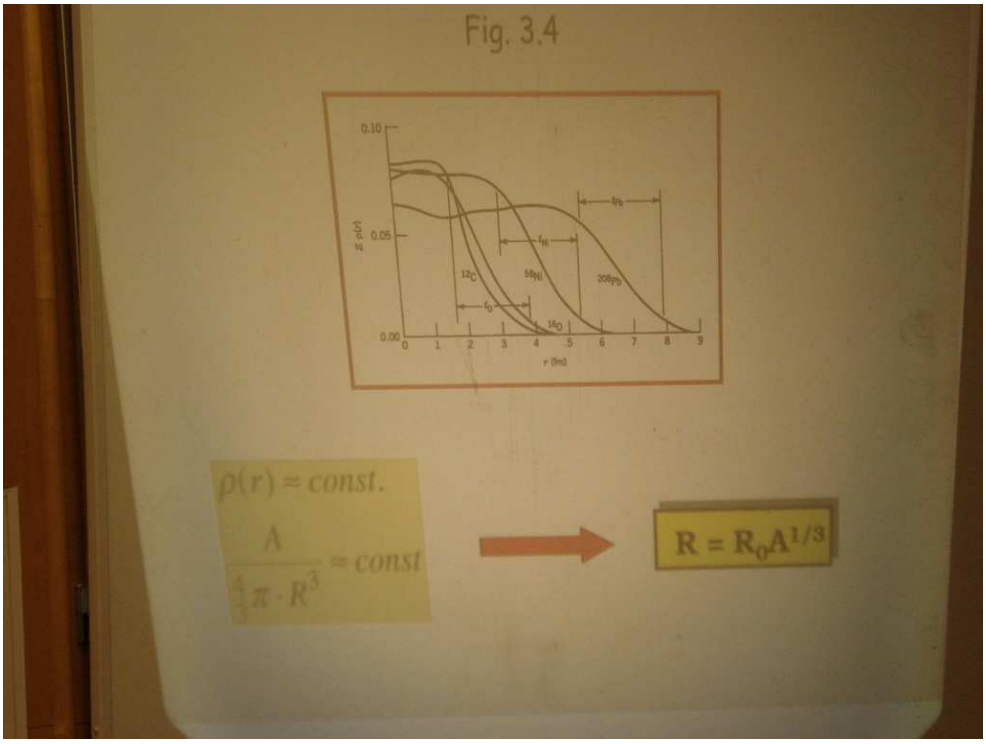


Figur 2. Overhead med $\Theta_{\min} = \arcsin(1,22\lambda/D)$.

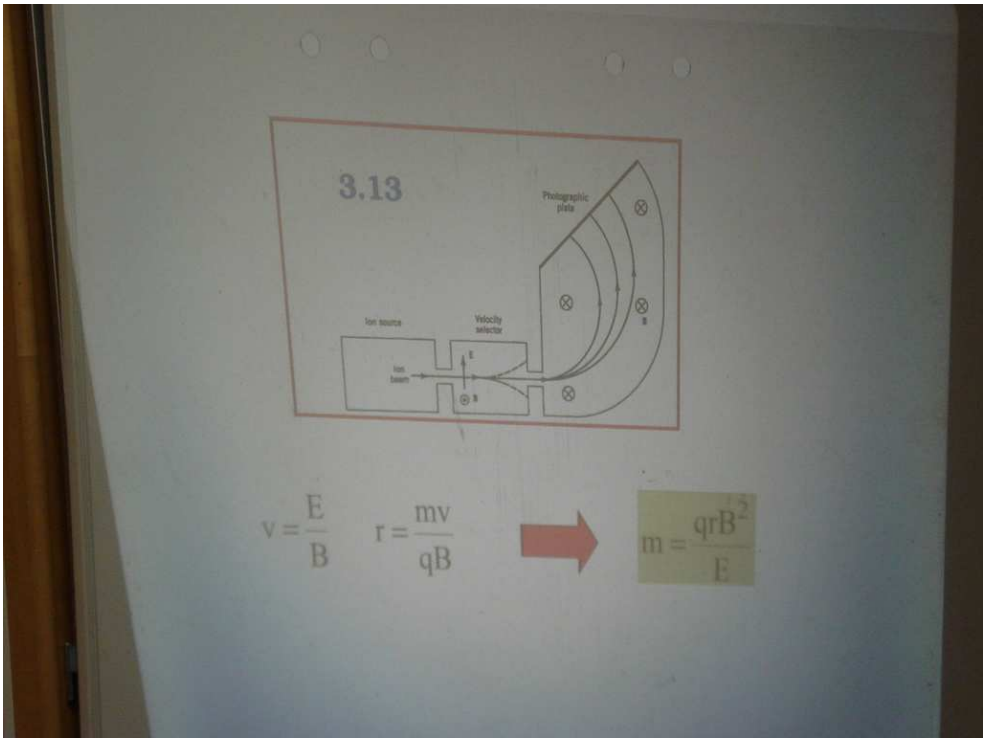
$$\sin 51° = 0,777 = \frac{1,22 \cdot 2\pi \cdot 197}{420 \cdot R \cdot 2}, \quad R = 2,3 \text{ fm}$$

Masstal $A = Z + N$:

$$\frac{A}{\frac{4}{3}\pi R^3} = \text{konst}, \quad R \sim A^{1/3}, \quad R = R_0 A^{1/3} \text{ med } R_0 = 1,2\,\text{fm}.$$



Figur 3.



Figur 4. Overhead med $v = E/B, r = mv/qB \Rightarrow m = qrB^2E$.

$$qE = qvB, \quad v = \frac{E}{B}$$

Vi får ett hastighetsfilter (Wien-filter).

$$qvB = m \cdot \frac{v^2}{r}$$

$$mv = qBr$$

$$r = \frac{mv}{qB} = \frac{mE}{qB^2}$$

$$m = \frac{qrB^2}{E}$$

$$\frac{r}{v} = \frac{m}{q \cdot B}$$

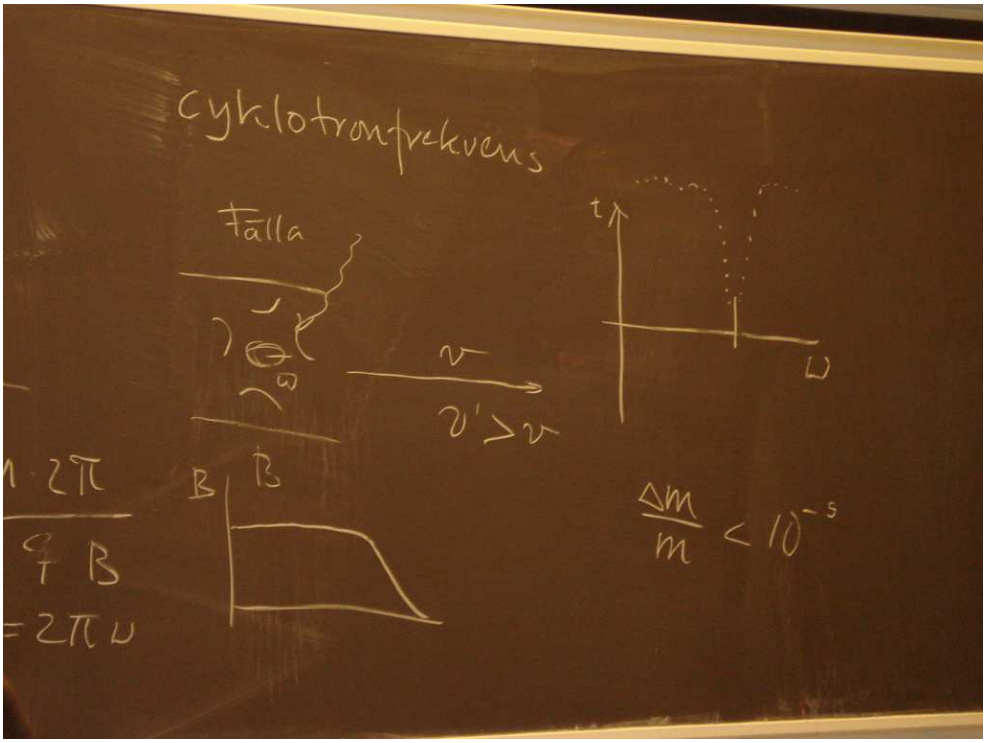
Cirkelbana. Tiden för ett varv

$$t = \frac{2\pi r}{v} = \frac{m \cdot 2\pi}{q B}$$

$$\frac{1}{t} = \nu, \quad \omega = 2\pi\nu$$

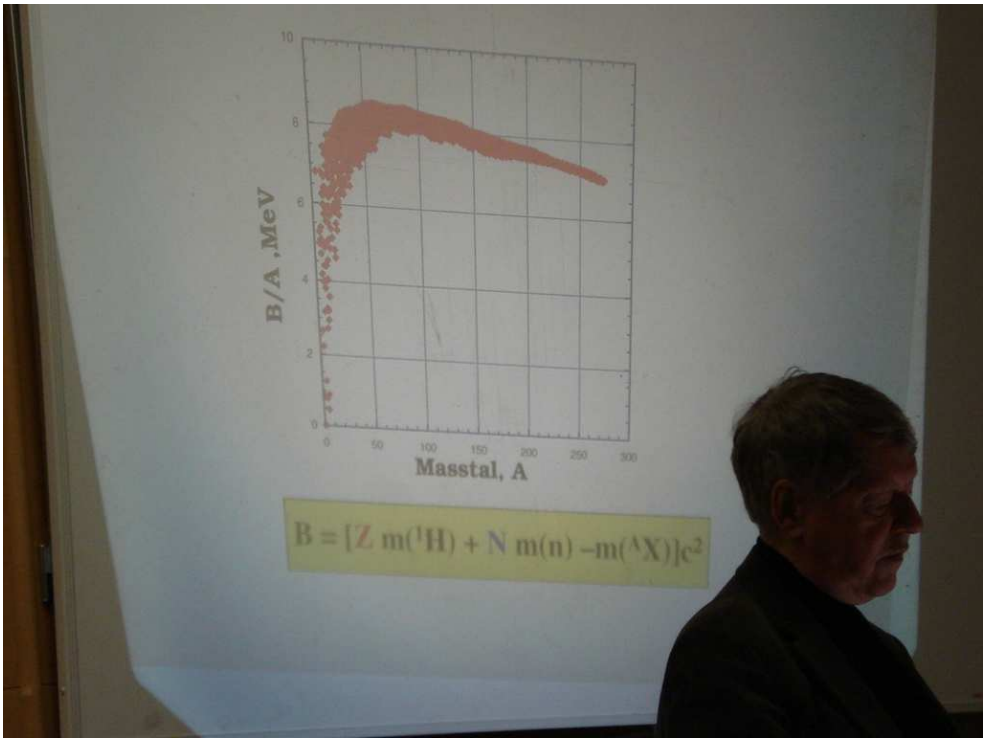
$$\omega = \frac{q B}{m}$$

Cyklotronfrekvens.



Figur 5. Fälla

$$\frac{\Delta m}{m} < 10^{-5}$$



Figur 6.