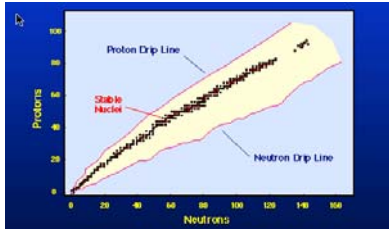




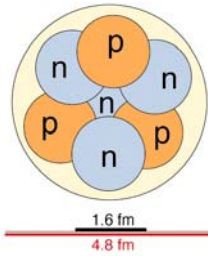
The valley of stability



The stable nuclides are found in the indicated region. It is important to notice that the N/Z ration increases weakly towards higher mass numbers



How is the nucleus composed ?

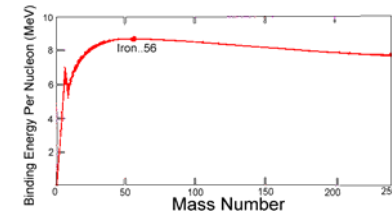


Size of a nucleon: approx. 1.6 fm
Size of the nucleus $\approx r_0 A^{1/3}$

1 fm (femtometer, fermi) = 10^{-15} m



Binding energy



The binding energy pr. nucleon as a function of the mass number

Increases rapidly at low masses, with a maximum at ^{56}Fe
Sinks slowly towards high masses



From the chart of nuclides

- We have roughly
 - Stable nuclides: approx. 275 (black)
 - Nuclides occurring in nature: approx. 300
 - Total number of nuclides: approx. 2200
- The radioactive ones are:
 - β^- - neutronrich nuclei
 - β^+ - neutrondeficient nuclei
 - EC -neutrondeficient nuclei near stability
 - α - heavy nuclei
 - SF - very heavy nuclides
- Internal γ - everywhere
- Exotic forms:
 - Proton-emission
 - ^{11}C -emission



More observations from the chart of nuclides

- Stable nuclides
 - Even Z, even N 163 60,8 %
 - Even Z, odd N 55 20,3 %
 - Odd Z, even N 49 18,9 %
 - Odd Z, odde N 4* 1,5 %
 - *) All with $A \leq 14$
- Stable nuclides
 - Only one on isobar chains with odd A
 - Up to three on isobar chains with even A
 - Max two stable isotopes with odd Z
 - No stable isotopes for $Z=43$ and $Z=61$
 - May be many stable isotopes for even Z (maxfor Sn, 10 stable)
- Other observations
 - Many isomers for certain elements (e.g. almost every In isotope)
 - Magic numbers
 - Strong occurrence of α -activity right above ^{208}Pb
 - No stable nuclides with $A=5$ or 8



Part of the chart of nuclides

Bi 208 $3,68 \cdot 10^5$ a ϵ γ 2615	Bi 209 100 ϵ 0,011 + 0,023	Bi 210 $3,0 \cdot 10^6$ a 5,013 d α 4,946; β^- 1,2 α 4,908; β^- 4,649; γ 266; 4,086 305; γ (305; 266)
Pb 207 22,1 ϵ 0,70	Pb 208 52,4 ϵ 0,00049	Pb 209 3,253 h β^- 0,6 no γ
Tl 206 3,7 m 4,20 m β^- 686; 453; 216; 266; 1021 β^- 1,5; γ (803, ...)	Tl 207 1,33 s 4,77 m β^- 1000; 351 β^- 1,4; γ (898, ...)	Tl 208 3,053 m β^- 1,8; 2,4... γ 2615; 583; 511; 860; 277...

^{208}Pb - double shell nuclide



Po 206 8,8 d ϵ ; α 5,2233 γ 1032; 511; 286; 807... e^- ; g	Po 207 2,8 s 5,84 h ϵ ; β^+ ... α 5,1152... γ 992; 743; 912...g	Po 208 2,898 a α 5,1152... γ (292; 571...) g
Bi 205 15,31 d ϵ β^+ ... γ 1764; 703; 988...	Bi 206 6,24 d ϵ β^+ ... γ 803; 881; 516; 1719; 537...	Bi 207 31,55 a ϵ β^+ ... γ 570; 1064; 1770...
Pb 204 67,2 m 1,4 ϵ β^+ ... γ 1764; 703; 988...	Pb 205 1,5 · 10 ⁷ a ϵ no γ $\alpha = 5$	Pb 206 24,1 ϵ no γ $\alpha = 0,030$