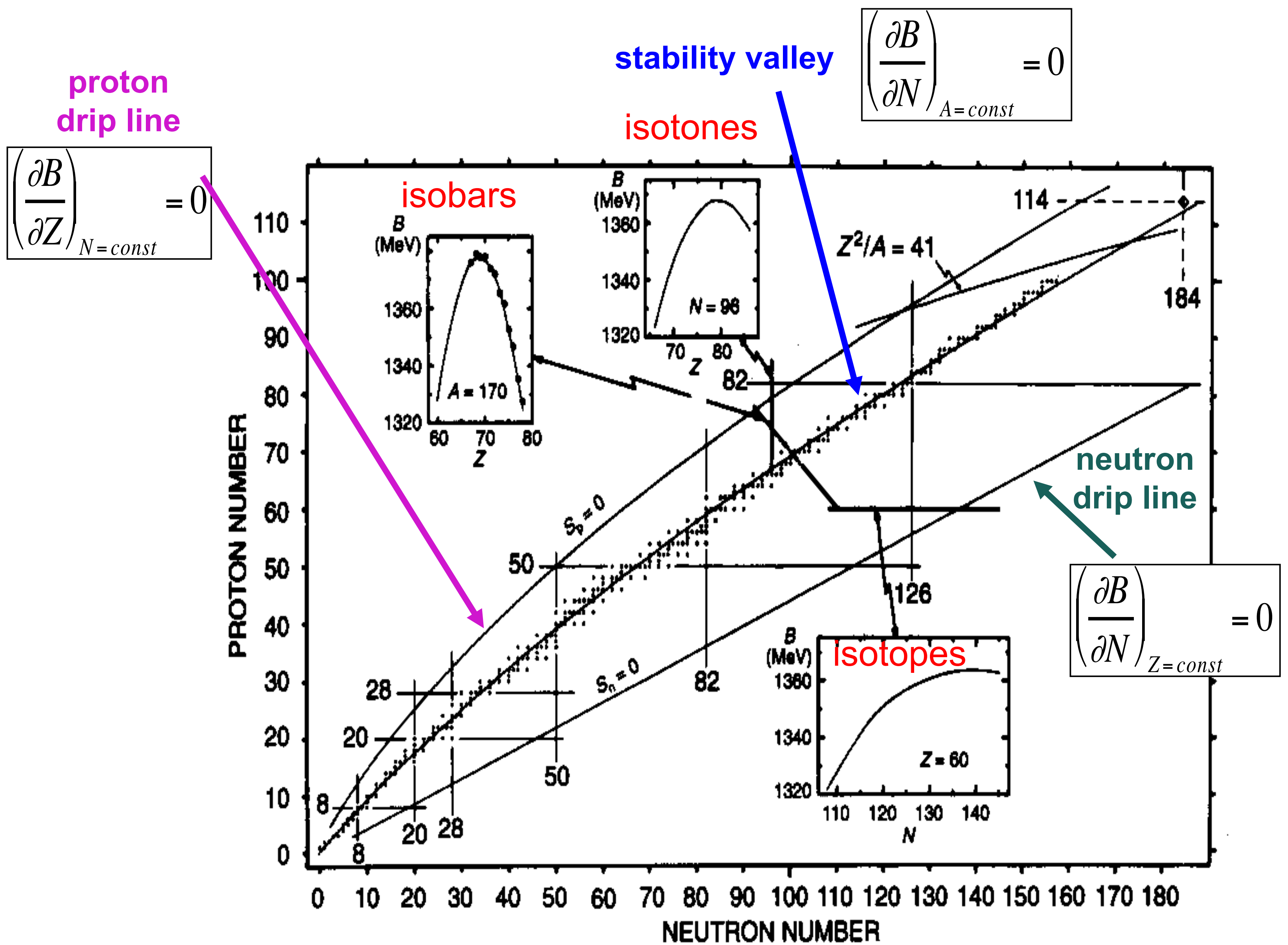
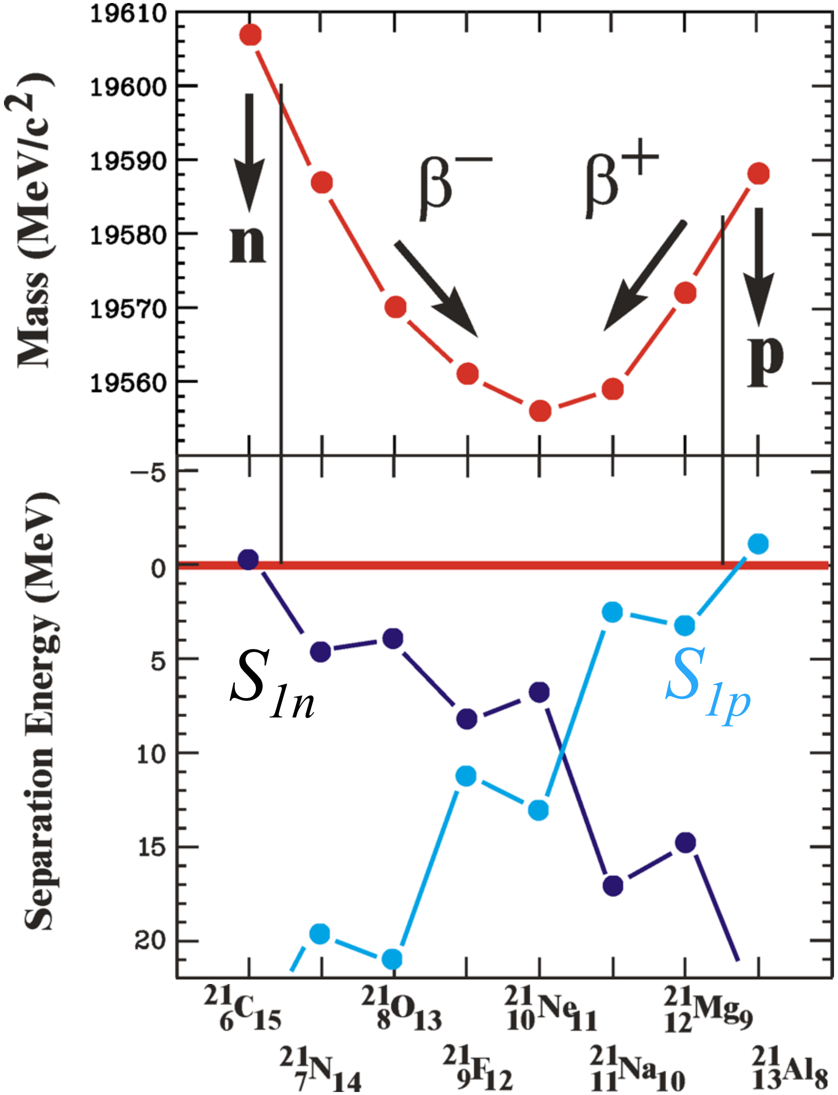


proton
drip line
$\left(\frac{\partial B}{\partial Z}\right)_{N=const} = 0$
stability valley
$\left(\frac{\partial B}{\partial N}\right)_{A=const} = 0$
isotones
isobars
isotopes
neutron
drip line
$\left(\frac{\partial B}{\partial N}\right)_{Z=const} = 0$
B (MeV)
A = 170
N = 98
Z = 60
$Z^2/A = 41$
$S_p = 0$
$S_n = 0$
114
184
126
82
50
28
20
8
PROTON NUMBER
NEUTRON NUMBER

Separation energies

A = 21 isobaric chain



one-nucleon separation energies

$$S_{1n} = B(N,Z) - B(N-1,Z)$$

$$S_{1p} = B(N,Z) - B(N,Z-1)$$

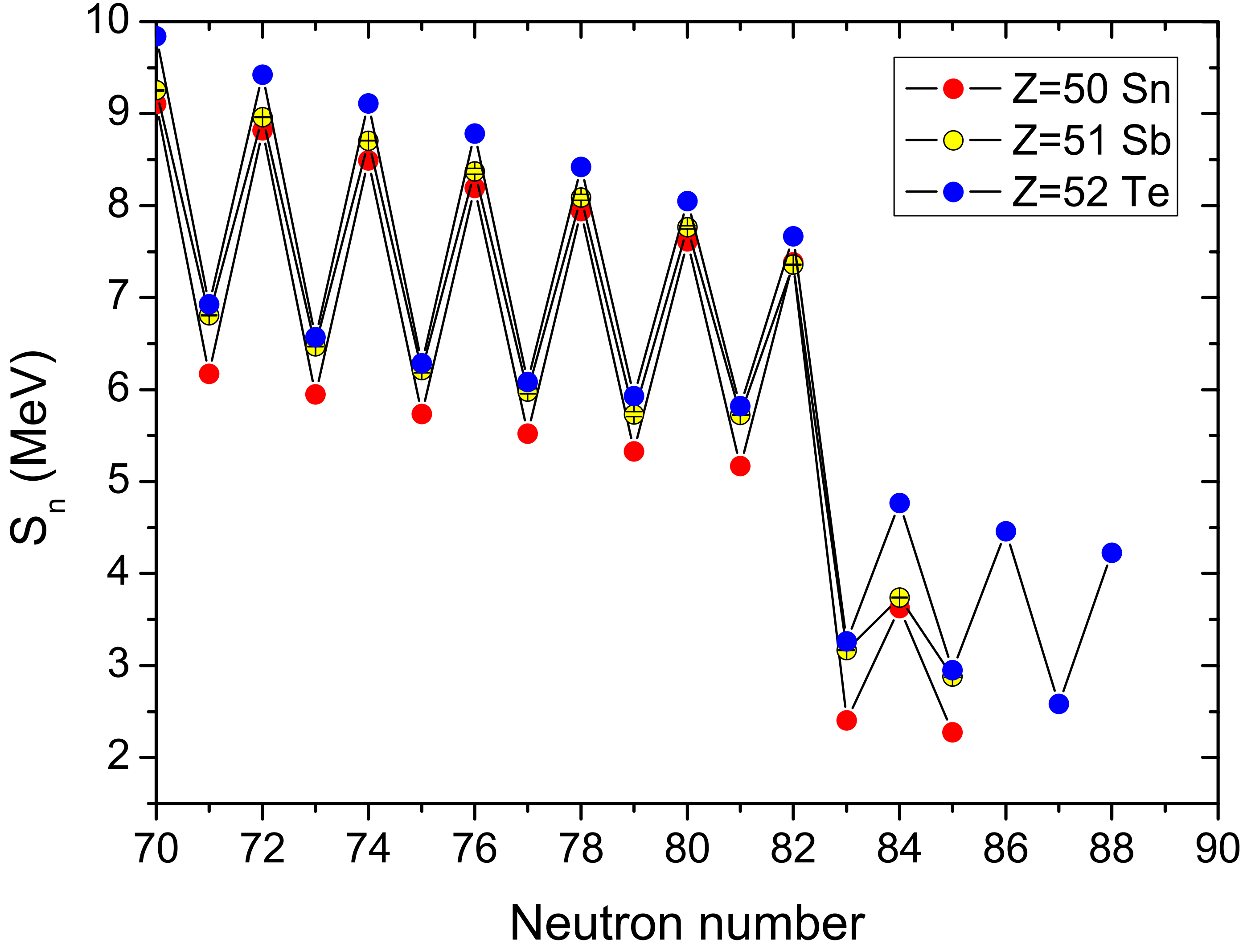
two-nucleon separation energies

$$S_{2n} = B(N,Z) - B(N-2,Z)$$

$$S_{2p} = B(N,Z) - B(N,Z-2)$$

http://www.nndc.bnl.gov/chart/

Odd-even effect



$$\lambda = -\frac{dB}{dN}$$

chemical potential

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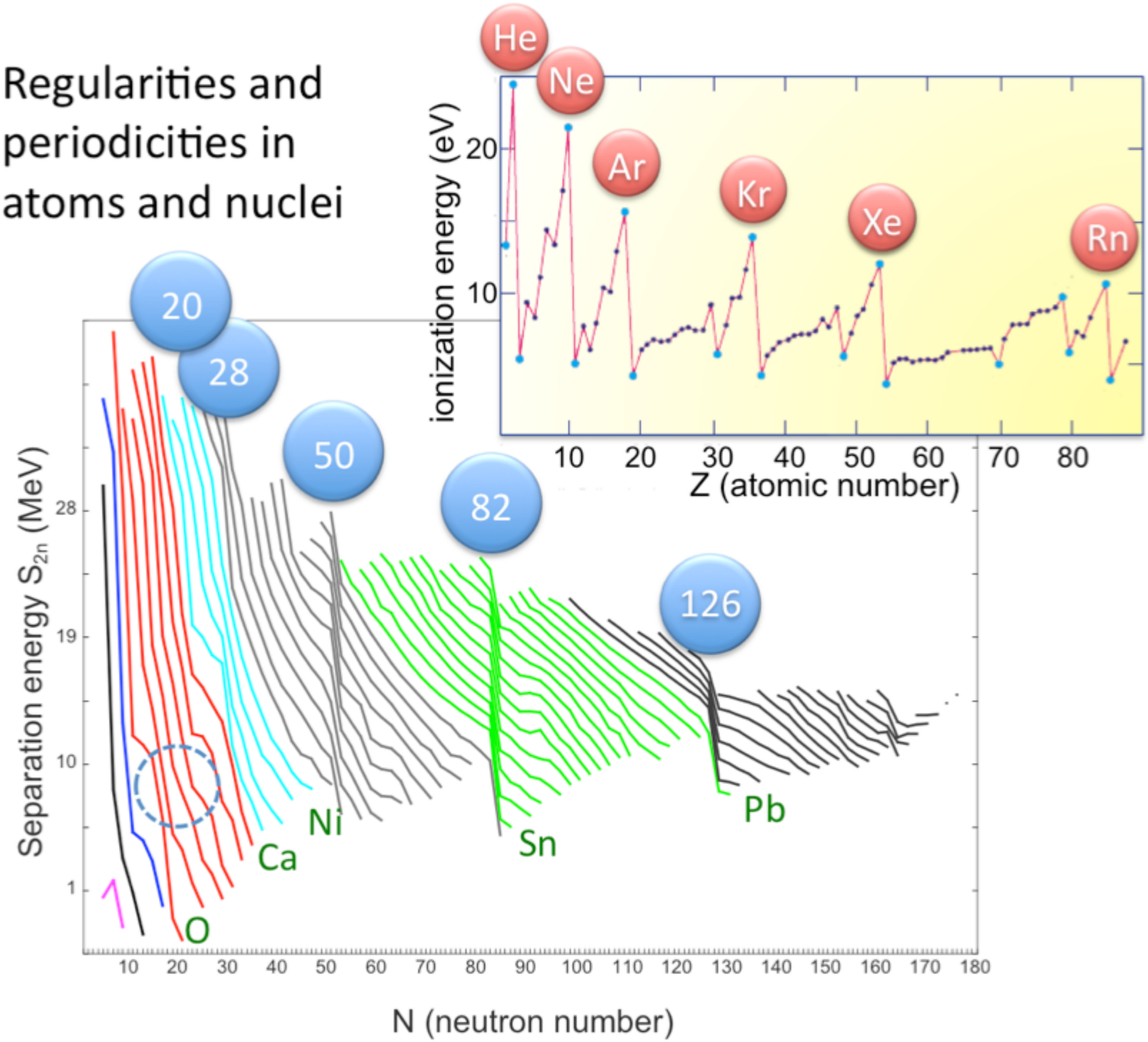
Regularities and periodicities in atoms and nuclei



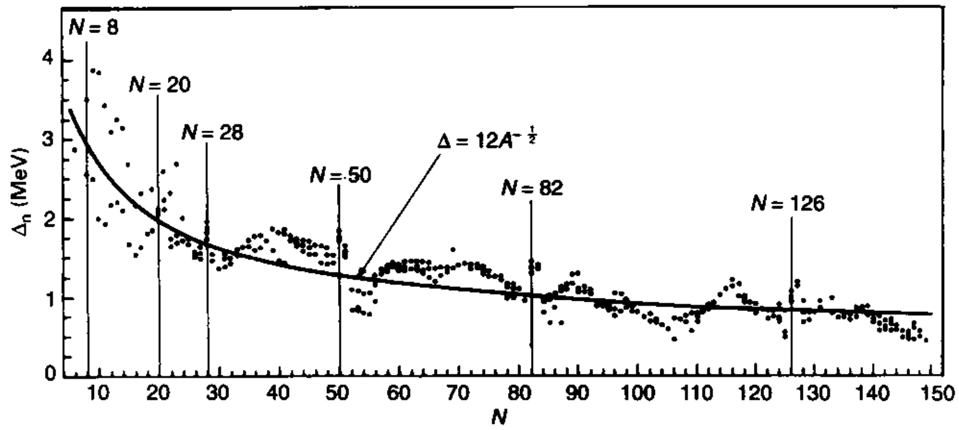
Pairing energy

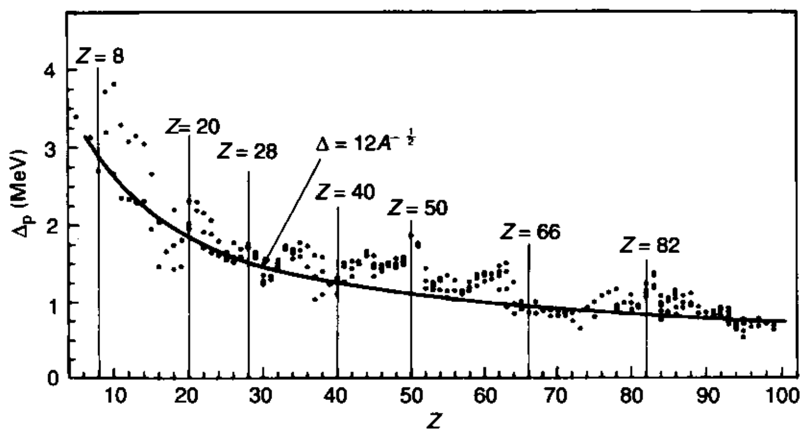
$$\Delta_n = \frac{B(N+1,Z)+B(N-1,Z)}{2} - B(N,Z)$$

N-odd

$$\Delta_p = \frac{B(N,Z+1)+B(N,Z-1)}{2} - B(N,Z)$$

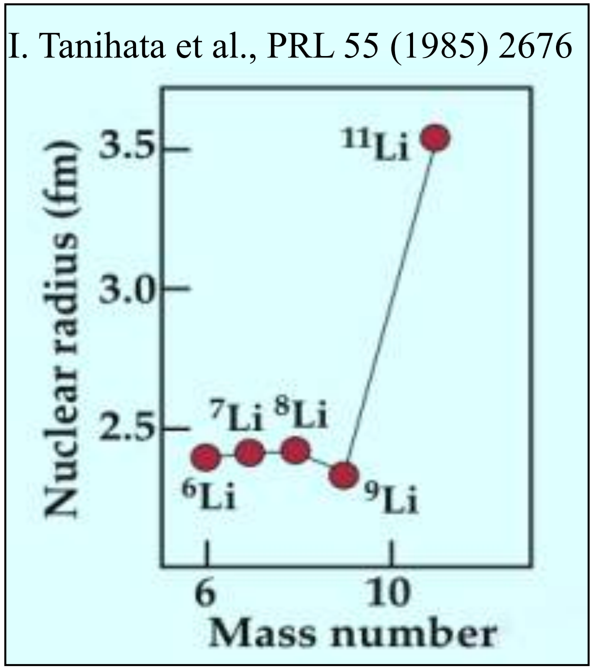
Z-odd



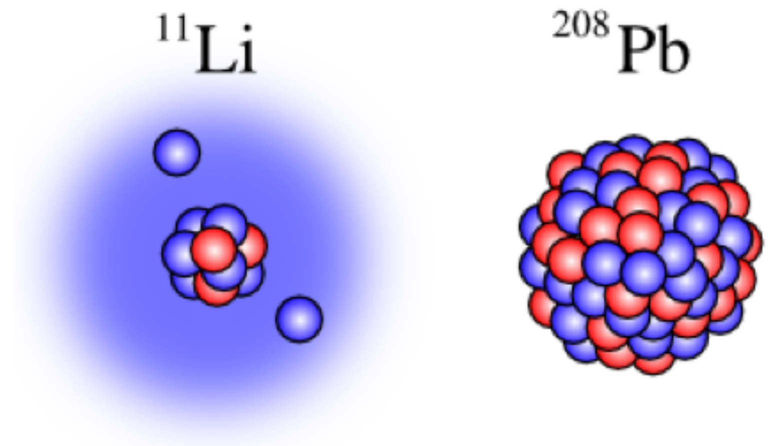


A common phenomenon in mesoscopic systems!

Example: Cooper electron pairs in superconductors…



Halos



Consider a spherical square-well potential such as in the figure. The energy of the last occupied neutron state is $\varepsilon < 0$ and its quantum numbers are n and $\ell = 0$. We assume: $\varepsilon \approx 0$.

For super achievers:

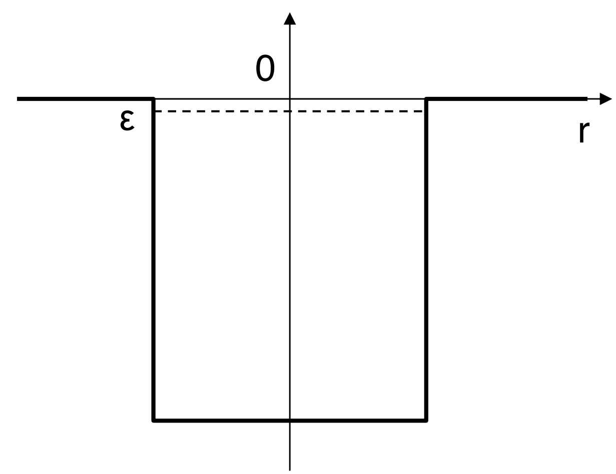
Prove that the r.m.s radius of the neutron orbit, defined as

$$R_{rms} = \sqrt{\langle \hat{r}^2 \rangle}$$

obeys the following relation:

$$R_{rms} \sim (-\varepsilon)^{-1/2}$$

Discuss the result.



Hint: The asymptotic behavior of the Bessel function at large distance is:

$$H_\ell(z) \underset{r \to +\infty}{\longrightarrow} 1 \times 3 \times \ldots \; (2\ell - 1) z^{-\ell - 1}$$