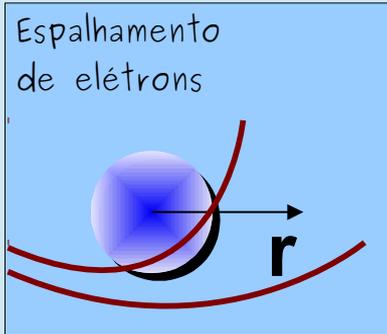


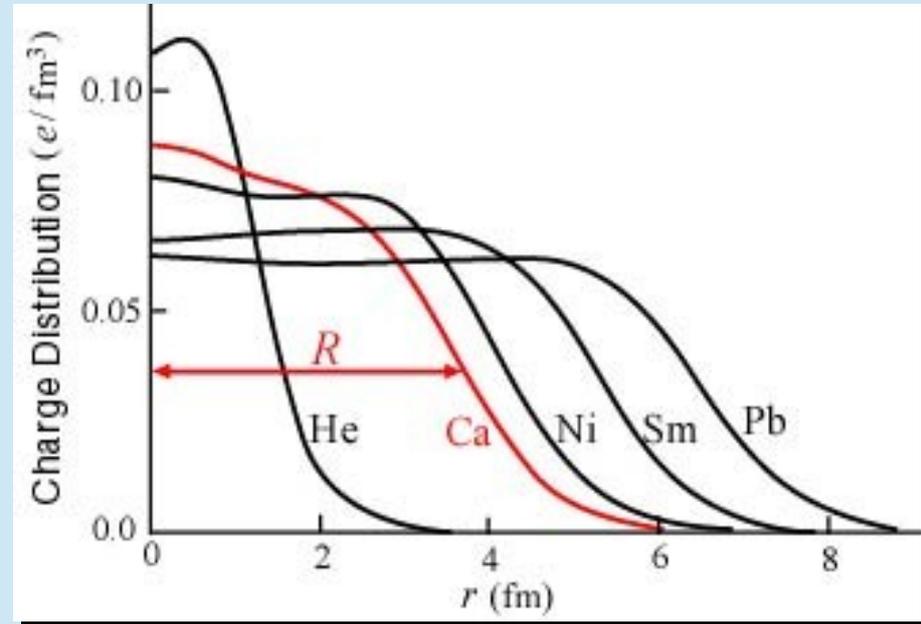
A distribuição de carga e massa do núcleo



Na região do vale de estabilidade

- Densidade aprox. constante

- Raio nuclear: $R = R_0 A^{\frac{1}{3}}$ ($R_0 = 1.2 \text{ fm}$)

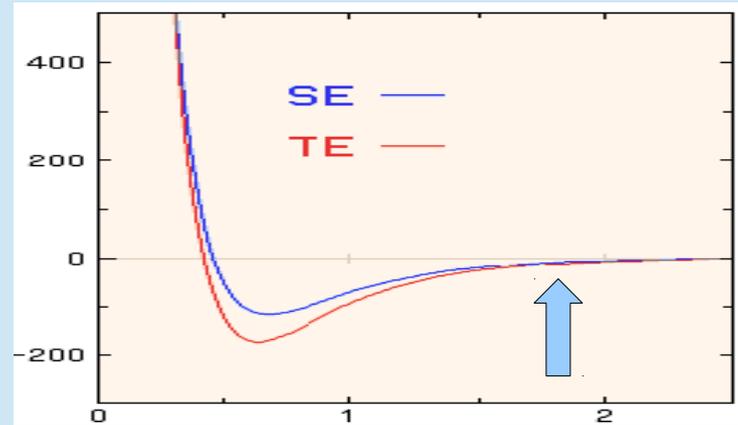


Modelo da gota líquida

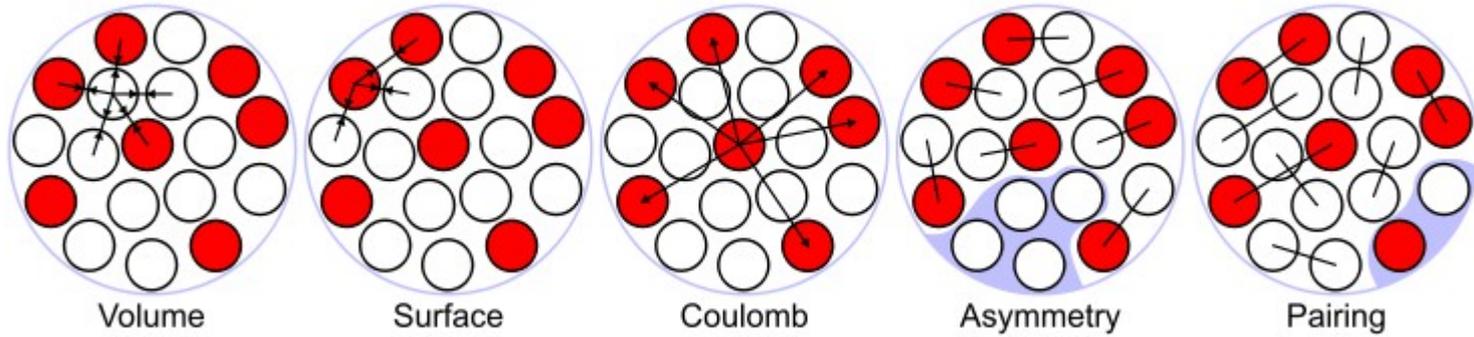
● Raio nuclear: $R = R_0 A^{\frac{1}{3}}$ ($R_0 = 1.2 \text{ fm}$)

$$\rho_0 \approx 0.17 \text{ fm}^{-3}$$

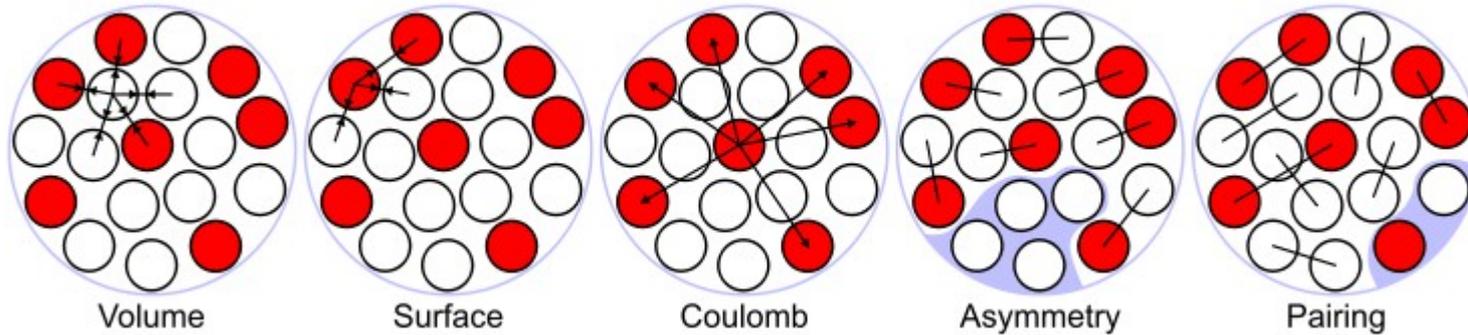
$$\langle r_{NN} \rangle \approx 1 / \sqrt[3]{\rho_0} = 1.8 \text{ fm}$$



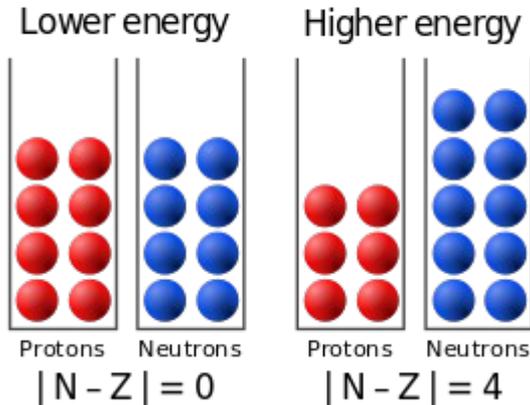
Fórmula semi-empírica de massa



Fórmula semi-empírica de massa

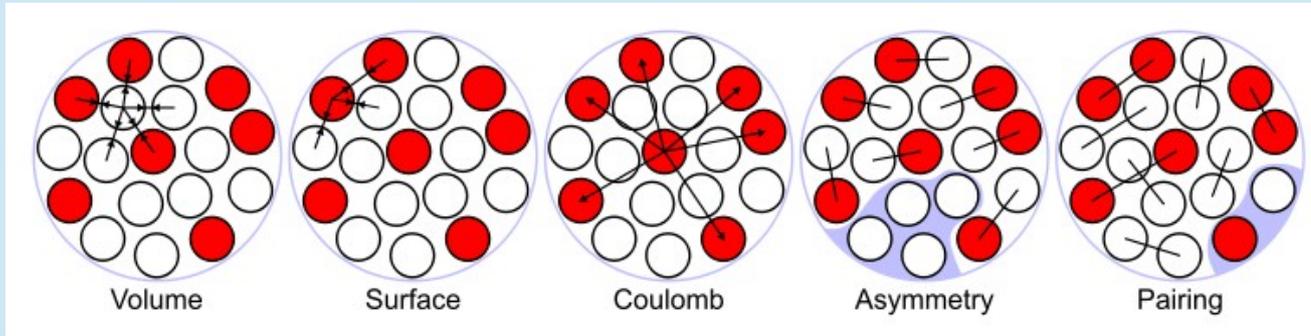


$$A = 16$$

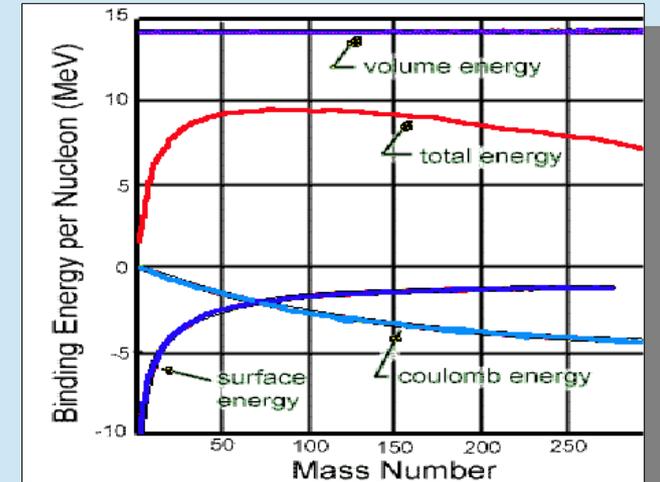


Fórmula semi-empírica de massa

Contribuição dos termos



$$E_B = a_V A - a_S A^{2/3} - a_C \frac{Z^2}{A^{1/3}} - a_A \frac{(N - Z)^2}{A} - \delta(A, Z)$$



$$E_B = a_V A - a_S A^{2/3} - a_A \frac{(A-2Z)^2}{A^{1/3}} - a_C \frac{Z(Z-1)}{A^{1/3}} + \delta(A, Z)$$

Volume
term

Surface
term

Asymmetry
term

Coulomb
term

Pairing
term

For pairing term:

$$\delta(A, Z) = \begin{cases} +\delta_o & A, Z \text{ even} \\ \mathbf{0} & A \text{ odd} \\ -\delta_o & A, Z \text{ odd} \end{cases} \quad 16$$

Coefficients:

$$a_V = 15.85 \text{ MeV}$$

$$a_S = 18.34 \text{ MeV}$$

$$a_A = 23.21 \text{ MeV}$$

$$a_C = 0.714 \text{ MeV}$$

$$a_P = 12.00 \text{ MeV}$$

where

$$\delta_o = \frac{a_P}{A^{1/2}}$$

Parábolas de massa

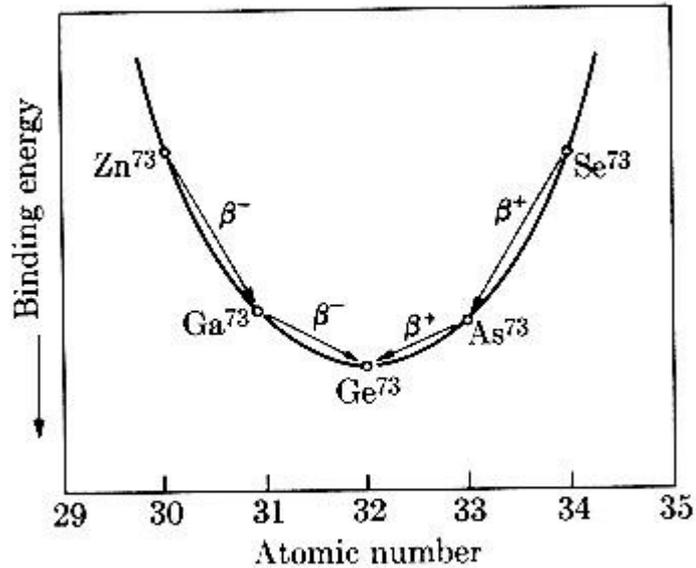


FIG. 17-9. Binding energies and decay properties of nuclides of odd mass number ($A = 73$).

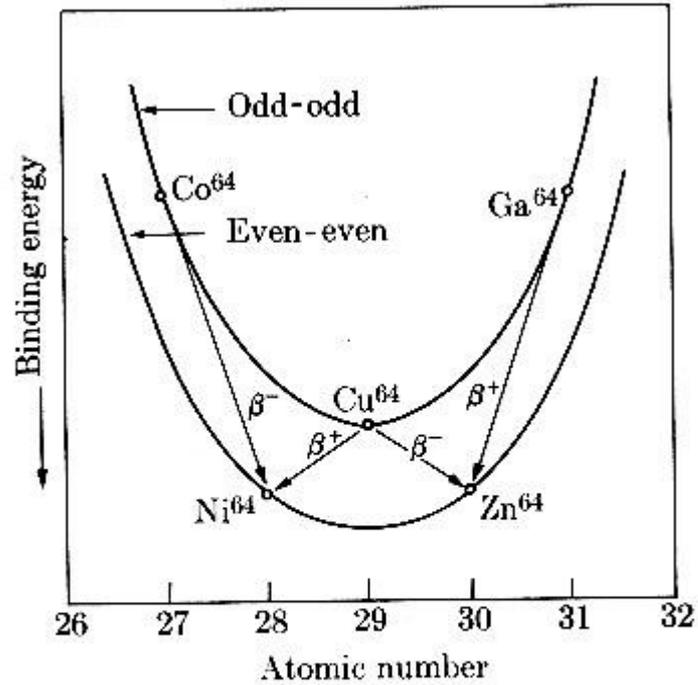


FIG. 17-10. Binding energies and decay properties of nuclides of even mass number ($A = 64$).

Parábolas de massa

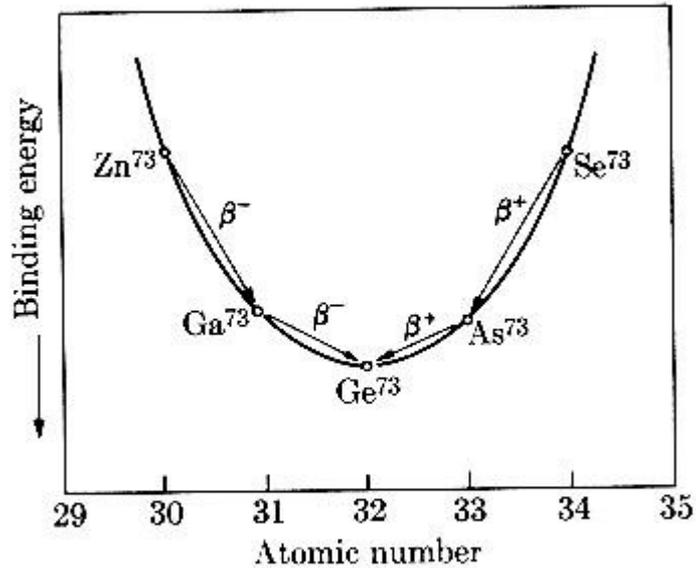


FIG. 17-9. Binding energies and decay properties of nuclides of odd mass number ($A = 73$).

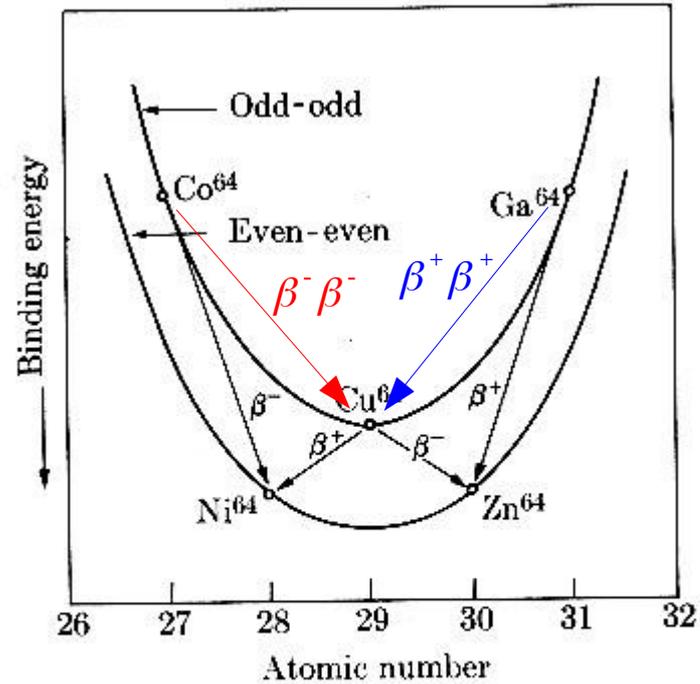


FIG. 17-10. Binding energies and decay properties of nuclides of even mass number ($A = 64$).

Ex.: Orbitais

• Função de onda

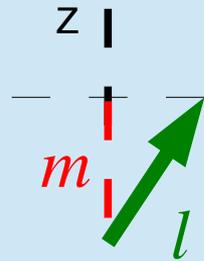
$$\Psi(r, \theta, \phi) = R_n(r) Y_{lm}(\theta, \phi)$$

Y_{lm} : Harmônicos esféricos

Auto estados de momento angular

m.a. orb.

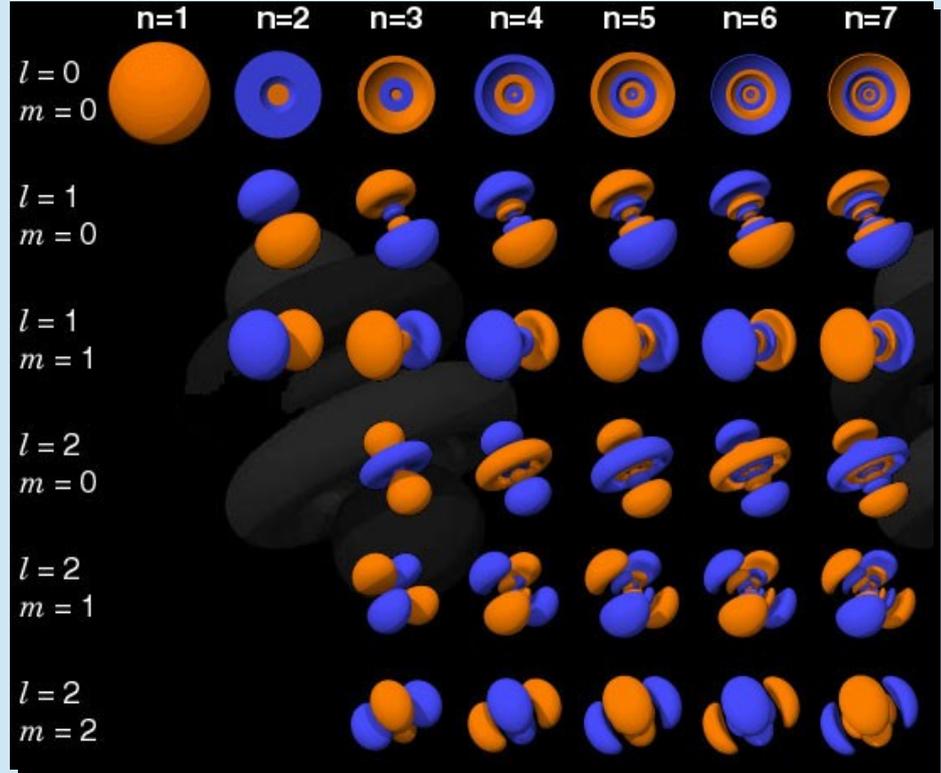
proj. z



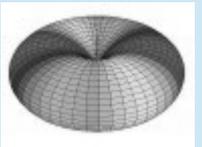
$$-l \leq m \leq l \quad 2l+1 \text{ estados}$$

ex.: $l=2: m=-2, -1, 0, 1, 2$

$\text{Re}(\Psi)$: +, -

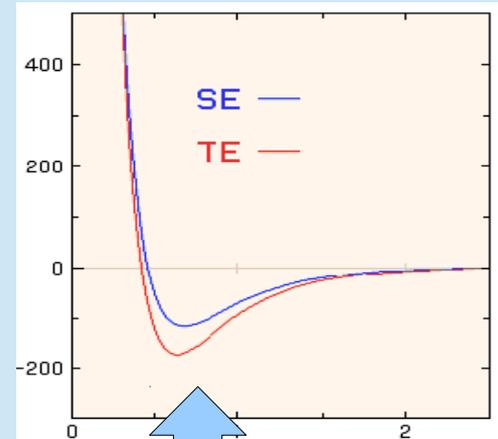
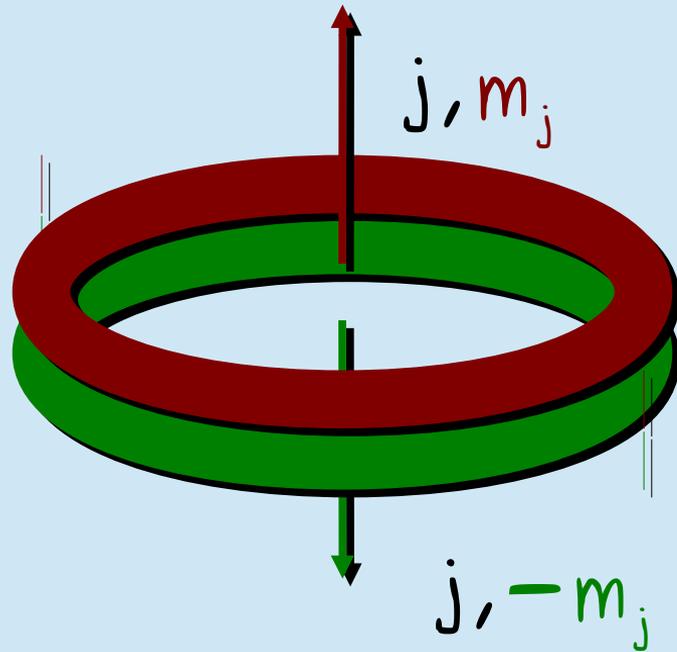
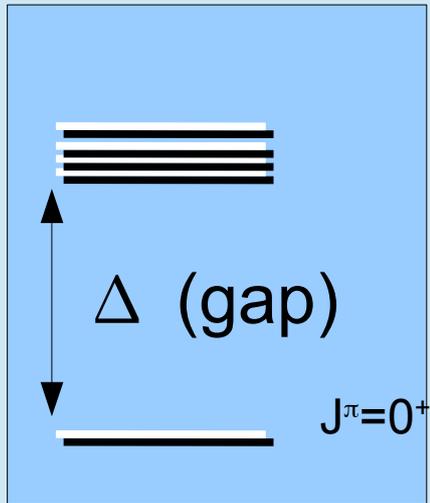


Distribuição de matéria $|\Psi_{2,2}|^2$



Emparelhamento

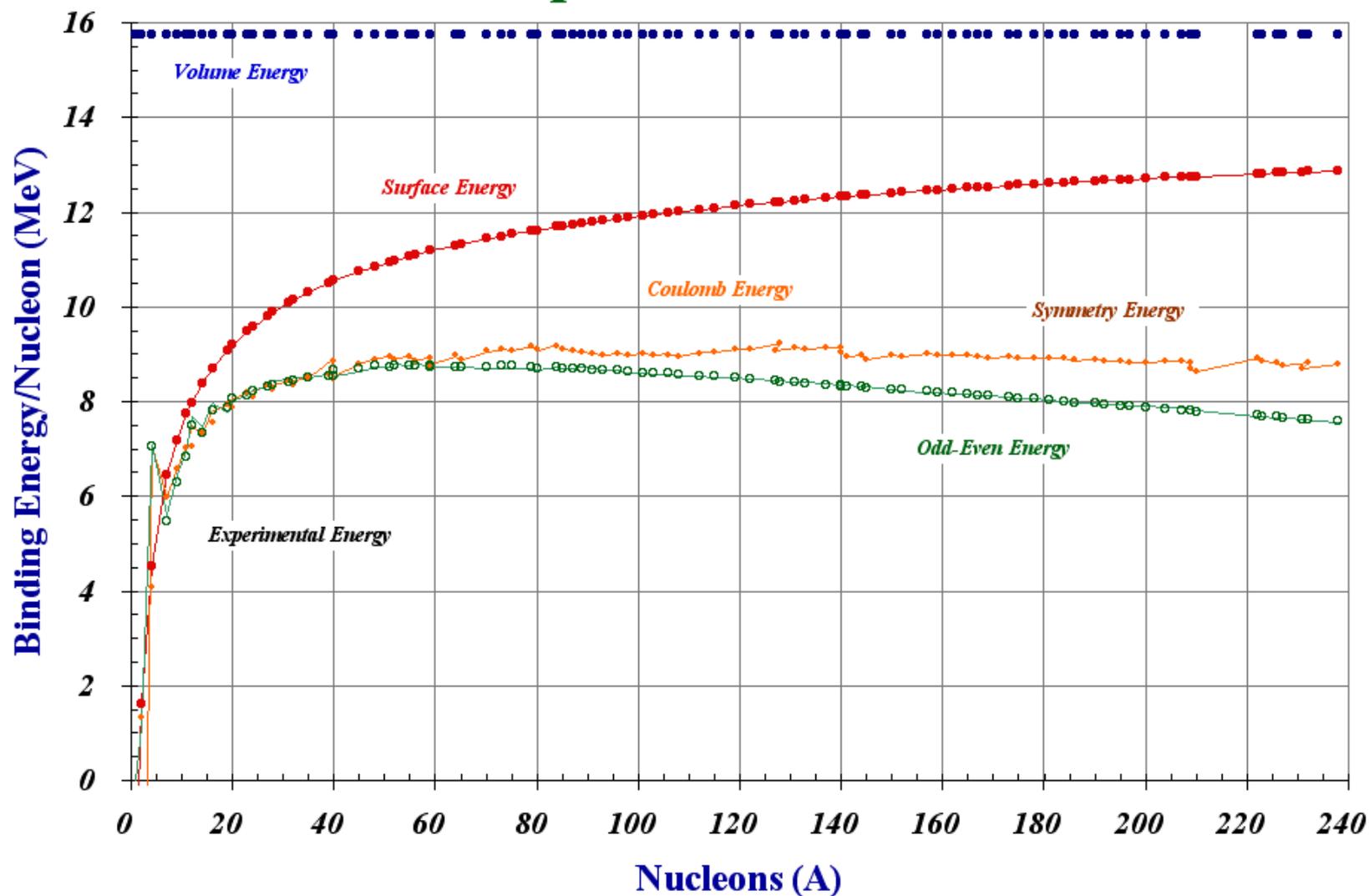
- Tendência ao acoplamento de órbitas com reversão temporal $\rightarrow \mathcal{J}_{\text{tot}}=0$

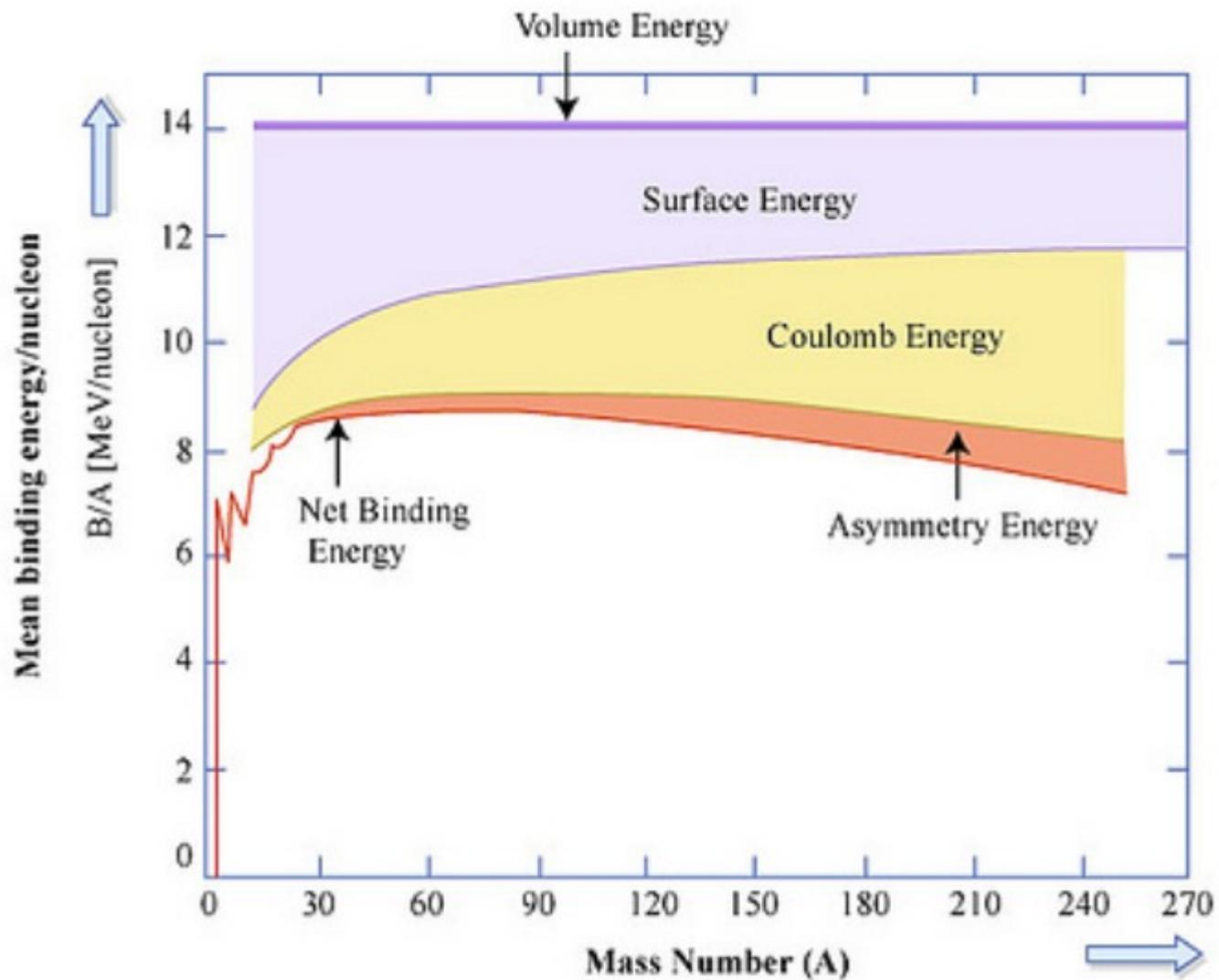


$$V(\vec{r} - \vec{r}') \approx \delta(\vec{r} - \vec{r}')$$

Correlações de emparelhamento (além do campo médio).
O núcleo é análogo a um supercondutor.

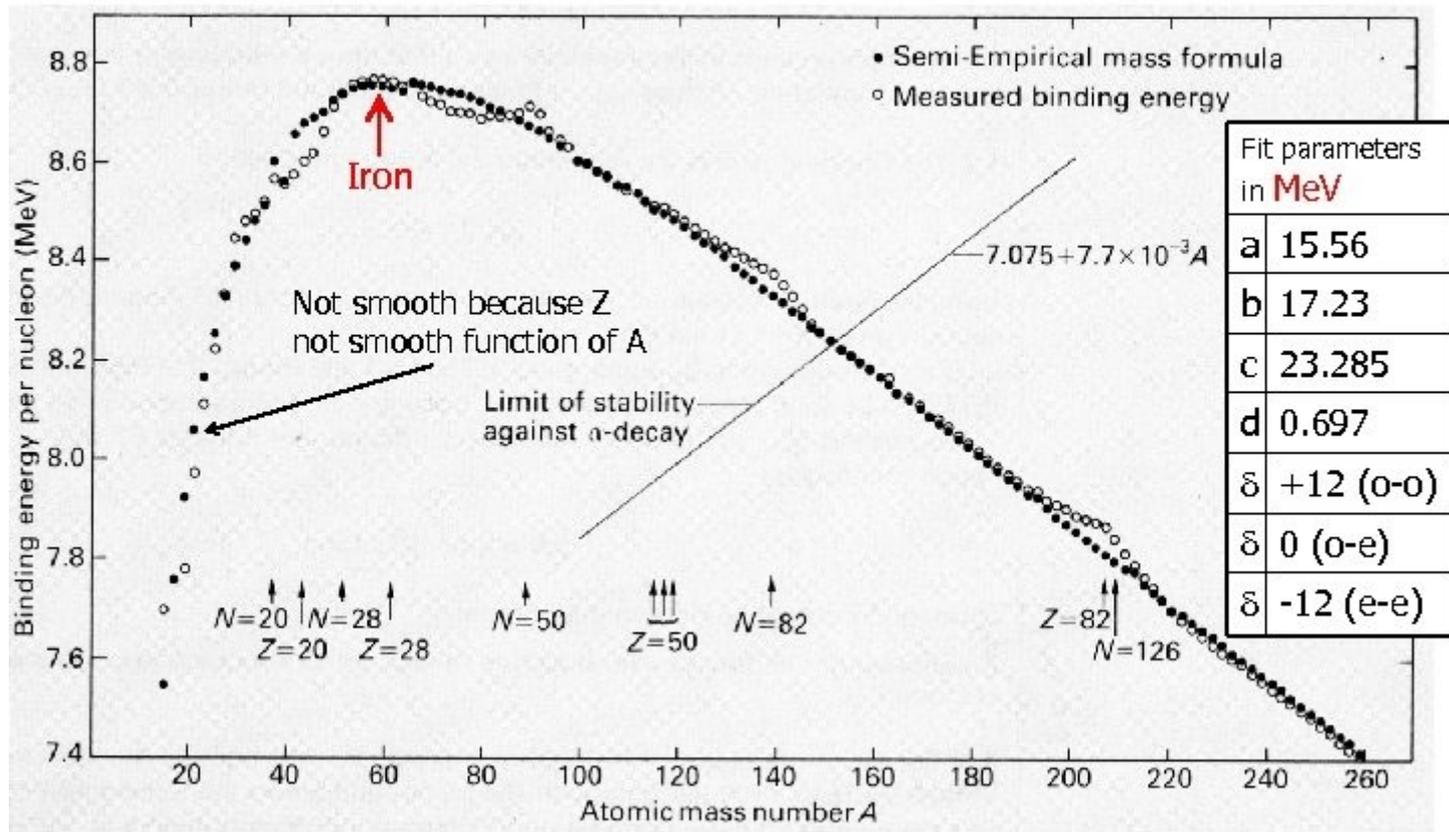
Semi-Empirical Mass Formula





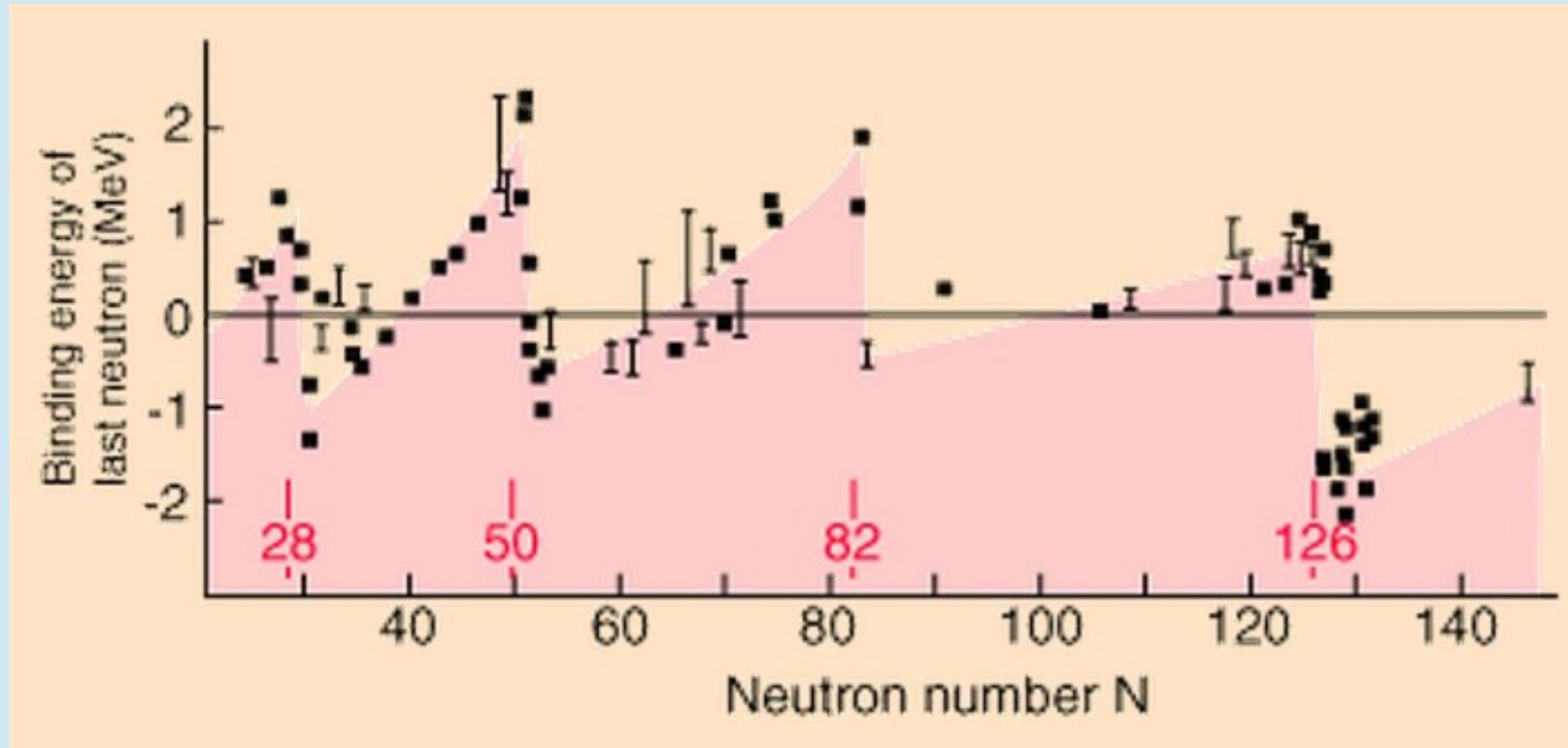
2.7 Semi Empirical Mass Formula

Binding Energy vs. A for beta-stable odd-A nuclei



Efeitos de camadas - Números mágicos

$N: 2, 8, 20, 28, 50, 82, 126$



Obs.: ao menos na região do vale de estabilidade!

Exp. - S.E.

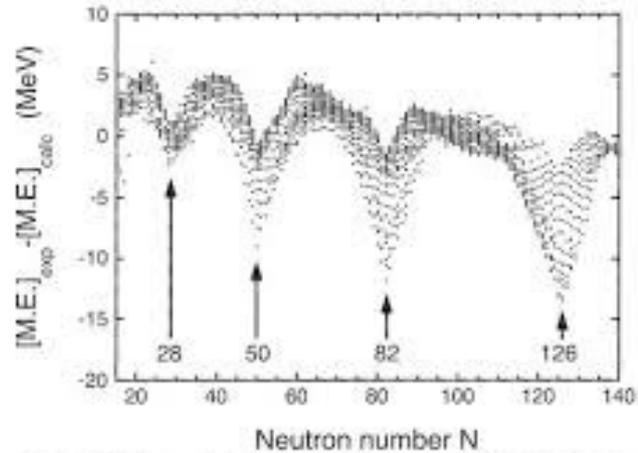
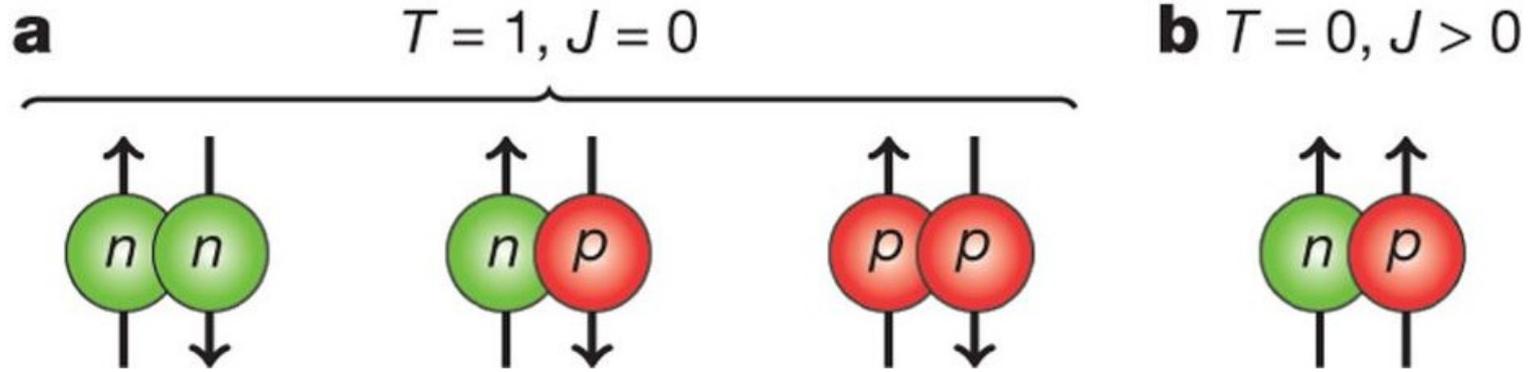


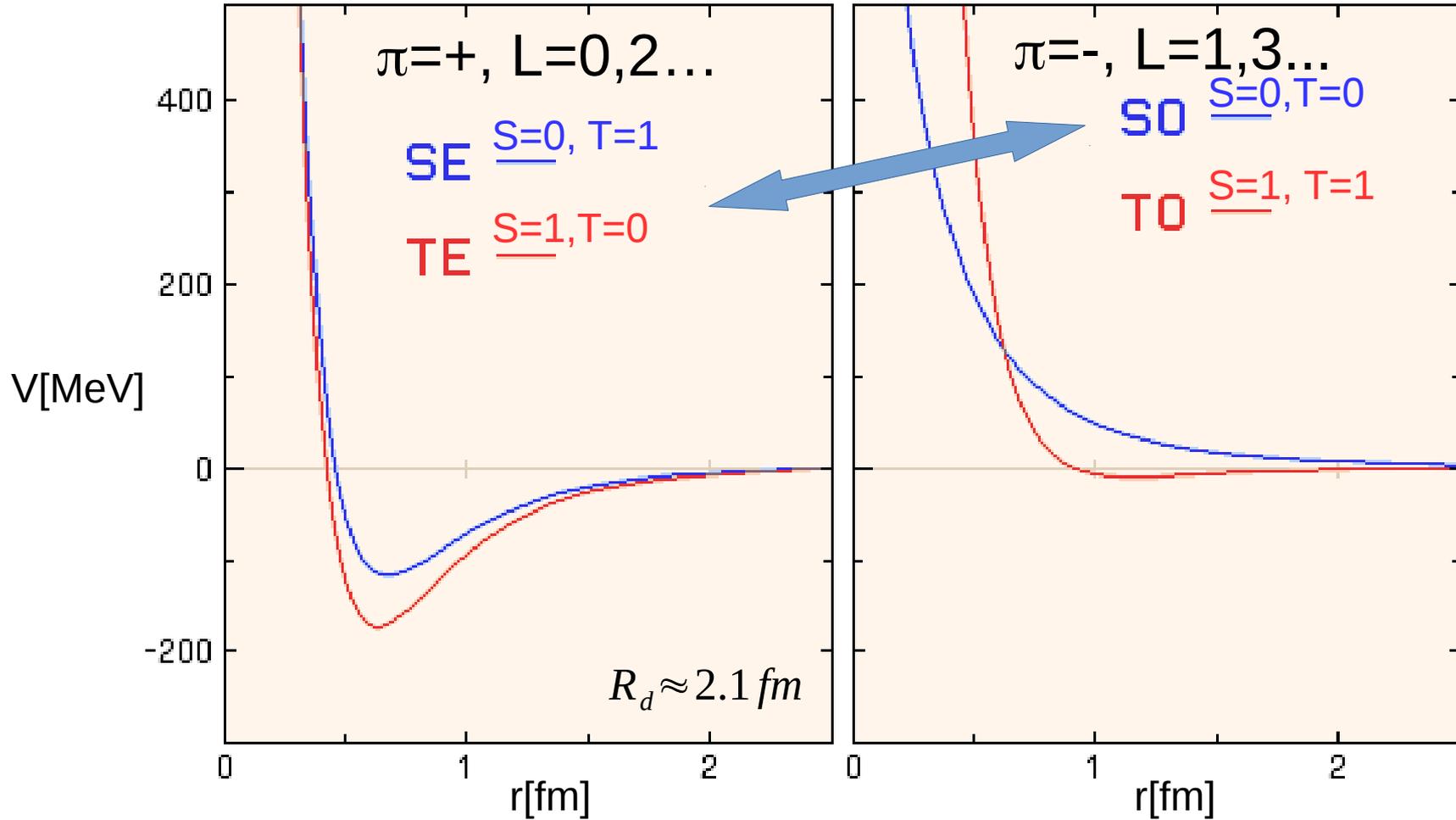
Fig. 1.11 Difference between experimental ground-state atomic mass excess (Audi et al. 2003) and the mass excess predicted by the spherical macroscopic part of the finite-range droplet (FRDM) mass formula (Möller et al. 1995) versus neutron number.

Emparelhamento np



a, The normal isospin $T = 1$ triplet. The two like-particle pairing components are responsible for most known effects of nuclear superfluidity. Within a given shell these isovector components are restricted to spin zero owing to the Pauli principle. **b**, Isoscalar $T = 0$ neutron-proton pairing. Here the Pauli principle allows only non-zero components of angular momentum.

Força N-N Paris potential



Modelo de camadas

Ex. oscilador
harmônico:

$$V(x) = \frac{1}{2} m \omega^2 x^2$$

$$E_n = \left(n + \frac{1}{2}\right) \hbar \omega$$

