Q value: β^+, EC decay

$$\beta^+ \quad {}^{A}_{Z}X \rightarrow {}^{A}_{Z-1}X' + \beta^+ + \nu$$

in terms of nuclear masses, ≈ 0

$$Q = m_N(A,Z) - m_N(A,Z-1) - m_e - m_\nu$$

but we have atomic masses

$$m(A,Z) = m_N(A,Z)c^2 + Z m_e c^2 - \sum_{i=1}^{Z} B_i$$

(electron binding energies)

so

$$Q = m(A,Z)c^2 - Z m_e c^2 + \sum_{i=1}^{Z} B_i - m(A,Z-1) + (Z-1)m_e c^2 - \sum_{i=1}^{Z-1} B_i' - m_e$$

$$Q = m(A,Z)c^2 - m(A,Z-1)c^2 - 2m_e c^2 + \left(\sum_{i=1}^{Z} B_i - \sum_{i=1}^{Z-1} B_i' \right)$$

$2m_e c^2 = 1.022\ \text{MeV}$

small-ish

E.C.

$${}^{A}_{Z}X + e \rightarrow {}^{A}_{Z-1}X^{*} + \nu$$

since usually inner electron captured, final atom in excited atomic state

$$Q = m(A,Z)c^2 - Z m_e c^2 + m_e c^2 + \sum_{i=1}^{Z} B_i - m(A,Z-1) + (Z-1)m_e c^2 - \sum_{i=1}^{Z-1} B_i'$$

$$= m(A,Z)c^2 - m(A,Z-1)c^2 + \sum_{i=1}^{Z} B_i - \sum_{i=1}^{Z-1} B_i'$$

most of the

not so small-ish

Initial | After capture | After relaxing

$2s^2$ ↑↓ | ↑↓ | ↑

$1s^2$ ↑↓ | ↑ | ↑↓

Z_i | Z_i^* | $Z_i^* + \gamma$

$\sim 55\ \text{eV}$

now. Empty K shell fills by cascade, so net diff is $B_n' - B_{Z-1}'$

B_n': captured electron

B_{Z-1}': outer e⁻ most