

MeV

$$\epsilon_{d_{5/2}} = 3.5$$

$$\epsilon_{s_{1/2}} = 1.5$$

$$\epsilon_{p_{1/2}} = -1.2$$

$$\epsilon_{p_{3/2}} = -4.7$$

$$\text{WS potential } R_0 = 1.2A^{1/3} \text{ fm} = 2.7 \text{ fm}$$

$$U = U_0(1 + 0.4E) \rightarrow (\text{exchange; Pauli})$$

$$R(^{11}\text{Li}) = 4.58 \pm 0.13 \text{ fm}$$

$$O = \left(\frac{R_0}{R}\right)^3 = \left(\frac{2.7}{4.58}\right)^3 \approx 0.2$$

$$m_k = \frac{m}{(1+O \times 0.4)} \approx \frac{m}{1.08} \approx 0.93m$$

$$^9\text{Li}_6; U_0 = \left(-51 + 30 \frac{N-Z}{A}\right) \text{ MeV} = -43 \text{ MeV}$$

$$\hbar\omega_{2^+} = 3.33 \text{ MeV}; \beta_2 = 0.66$$

clothing sp

$$\langle R_0 \partial U / \partial r \approx 1.4 U_0 \approx -60 \text{ MeV}; \langle j || Y_2 || 1/2 \rangle \approx ((2j+1)/4\pi)^{1/2} \approx 0.7$$

$$\langle H_c \rangle = \frac{\beta_2}{\sqrt{5}} \langle R_0 \frac{\partial U}{\partial r} \rangle O \langle j || Y_2 || 1/2 \rangle \approx \frac{0.7}{\sqrt{5}} (-60 \text{ MeV}) \times 0.2 \times 0.7 \approx -3 \text{ MeV}$$

$$\begin{pmatrix} (6.8 - \lambda) & -3 \\ -3 & (1.5 - \lambda) \end{pmatrix} = 0 \quad (0.0.1)$$

$$\begin{pmatrix} (-8 - \lambda) & -3.9 \\ -3.9 & (-1.2 - \lambda) \end{pmatrix} = 0 \quad (0.0.2)$$

$$\tilde{\epsilon}_{s_{1/2}} = 0.15 \text{ MeV}$$

$$\tilde{\epsilon}_{p_{1/2}} = 0.6 \text{ MeV}$$

$$|\widetilde{1/2^-}\rangle = 0.91|p_{1/2}\rangle + 0.41|((p_{1/2}, p_{3/2}^{-1}) \otimes 2^+)_{0^+} p_{1/2}; 1/2^-\rangle$$

$$|\widetilde{1/2^+}\rangle = 0.91|s_{1/2}\rangle + 0.41|(d_{5/2} \otimes 2^+)_{0^+} 1/2^+\rangle$$

halo-anti pairing effect s, p at threshold

$$H_D = \kappa_1 \mathbf{D} \cdot \mathbf{D}$$

$$\kappa_1 = s\kappa_1^0; \quad \kappa_1^0 \sim 5V_1 = 125 \text{ MeV}$$

$$\kappa_1 \sim 5.6 \text{ MeV } (s \approx 0.045); \quad (8\%) \text{TRK} = \frac{9}{4\pi} \frac{\hbar^2}{2M} \frac{NZe^2}{A}$$

$$\hbar\omega_{\text{pygmy}} = \left((\epsilon_{1/2^+} - \epsilon_{1/2^-})^2 + \kappa_1 (2 \times 0.08 \text{TRK})^2 \right)^{1/2} \approx 0.9 \text{ MeV}$$

$$|\tilde{0}\rangle = |0\rangle_v + 0.7|(p_{1/2}, p_{3/2}^{-1})_{1^-} \otimes 1^-; 0\rangle + 0.1|(s_{1/2}, d_{5/2})_{2^+} \otimes 2^+; 0\rangle$$

$$|0\rangle_v = 0.45|s_{1/2}^2(0)\rangle + 0.55|p_{1/2}^2(0)\rangle + 0.04|d_{5/2}^2(0)\rangle$$

$$E_{\text{corr}} \approx 2\tilde{\epsilon}_{s_{1/2}} + \Delta E_b + \Delta E_i = 0.3 - 0.1 - 0.5 \text{ MeV} \approx -0.3 \text{ MeV}$$

$$\langle V_p \rangle = -G_{\text{scr}} = -rG$$

$$= -0.048 \times \frac{25}{A} \text{ MeV} \approx -\frac{1 \text{ MeV}}{A}$$

$$\approx -0.1 \text{ MeV}$$

$$|s_{1/2}^2(0)\rangle$$

$$|p_{1/2}^2(0)\rangle$$

$$|s_{1/2}^2{}^+\rangle, |s_{1/2}^2{}^-\rangle$$

$$\Delta E_{ind} = -0.5 \text{ MeV}$$

$$\Delta E_{bare} = -0.1 \text{ MeV}$$

$$(E_{corr})_{exp} = -0.380 \text{ MeV}$$

$$V_\nu^2$$

$$\epsilon_F$$

$$q = \hbar \Delta L / R_g$$

$$\frac{p_{\text{final}}}{p_{\text{ini}}} = \sqrt{\frac{(E-E_x)}{E}} \approx 1 \quad \frac{p_{\text{final}}}{p_{\text{ini}}} < 1 \quad E \gg E_x \quad E \sim E_x \quad \mathbf{q} = \mathbf{p}_{\text{final}} - \mathbf{p}_{\text{ini}}$$

$$\Delta L = R_g \sqrt{2mE} \left(1 - \sqrt{1 - \frac{E_x}{E}} \right)$$

$$T_{m_i, m_f} = \sum_{L_a, L_b} \langle L_a \ 0 \ 2 \ M | L_b \ M \rangle \quad (0.0.3)$$

$$\langle J_i \ m_i \ 2 \ M | J_f \ m_f \rangle Y_{-M}^{L_b}(\theta) I(L_a, L_b), \quad (0.0.4)$$

$$T_{m_i, m_f}^{L_g} = \langle L_g \ 0 \ 2 \ M | L_g \ M \rangle \quad (0.0.5)$$

$$\langle J_i \ m_i \ 2 \ M | J_f \ m_f \rangle Y_{-M}^{L_g}(\theta) I(L_g, L_g), \quad (0.0.6)$$

where $M = m_f - m_i$, and

$$I(K, l_a, l_b) = 2\pi^{1/2} i^{l_a - l_b} e^{i(\sigma_i^{l_a} + \sigma_i^{l_b})} (2l_a + 1)^{3/2} (2K + 1) (2l_i + 1)$$

$$\times \sqrt{(2J_i + 1)(2l_f + 1)} \left\{ \begin{matrix} l_i & 1/2 & J_i \\ J_f & K & l_f \end{matrix} \right\} \langle l_a \ 0 \ K \ 0 | l_b \ 0 \rangle$$

$$\times \langle l_i \ 0 \ K \ 0 | l_f \ 0 \rangle Y_{-M}^{l_b}(\hat{k}_f) \int f_{l_a}(R) g_{l_b}(R) \rho_K(R) dR. \quad (0.0.7)$$

$$\approx 1.2 \text{ MeV } (10^{-2})$$

$$\beta = 0 \quad \beta = \pm 2$$

$$\xi = \frac{\hbar v_F}{\pi |E_{corr}|}$$

$$\xi = \frac{\hbar v_F}{\pi |E_{corr}|} \quad (0.0.8)$$

	$1p_{1/2}^{-1}2s_{1/2}$	$1p_{1/2}^{-1}3s_{1/2}$	$1p_{1/2}^{-1}4s_{1/2}$	$1p_{1/2}^{-1}1d_{3/2}$	$1p_{3/2}^{-1}4d_{5/2}$	$1p_{3/2}^{-1}5d_{5/2}$	$1p_{3/2}^{-1}6d_{5/2}$
X	-0.780	0.479	0.220	0.103	0.166	0.241	0.250
Y	0.078	0.108	0.106	0.075	0.139	0.208	0.221

$$v_F/c \approx 0.27 \text{ (0.16, } ^{11}\text{Li)}$$

$$\xi = 14 \text{ fm (20 fm, } ^{11}\text{Li)}$$

$$q_\xi = \frac{\hbar^2}{2m\xi^2} \frac{1}{|E_{corr}|} \approx 0.05 \quad (0.1, ^{11}\text{Li}) \quad (0.0.9)$$

strongly correlated ($q_\xi \ll 1$), weakly “bound” ($|E_{corr}|/\epsilon_F \lesssim 0.06$)

very extended ($\xi/d \gtrsim 7$, $d = \left(\frac{4\pi R^3}{3A}\right)^{1/3}$) objects

$$\langle r^2 \rangle_{def}^{1/2} = \xi = \frac{\hbar v_F}{\pi |E_{corr}|} \approx 29 \text{ fm} \quad (0.0.10)$$

$$(E_{corr} \approx 0.6 \text{ MeV})$$

$$\langle r^2 \rangle_{Cooper}^{1/2} = \xi = \frac{\hbar v_F}{\pi \Delta} \approx 21 \text{ fm} \quad (0.0.11)$$

$$(\Delta \approx 0.8 \text{ MeV})$$

$$\langle H_c \rangle_{p_{1/2}} \approx 1.3 \langle H_c \rangle_{s_{1/2}} \quad (0.0.12)$$

$$(v_F/c \approx 0.27) \quad (0.0.13)$$

$$\Delta \approx 1.5 \text{ MeV} \quad (0.0.14)$$

$$q = \frac{\hbar^2}{ma^2} \frac{1}{|v_0|} \approx 0.5 \quad (0.0.15)$$

$$q_\xi = \frac{\hbar^2}{2m\xi^2} \frac{1}{2\Delta} \approx 0.06 \quad (0.0.16)$$

$$\xi = \frac{\hbar v_F}{2\Delta} \approx 18 \text{ fm} \quad (0.0.17)$$

$$\Delta t = R_0/v = R_0 \sqrt{\frac{m}{2E}} \quad (0.0.18)$$

$$\begin{array}{l} \hbar\omega_2 \\ 2\times\hbar\omega_2 \\ 3\times\hbar\omega_2 \\ 2\times\hbar\omega_3 \\ \hbar\omega_3 \\ J^\pi \end{array}$$