the nucleus Lu-163 → evaluated for parameters obtained from a fit of $E^{TSD}_{exc}[I;P]$

$\boxed{J_1, J_2, J_3}$ → $\boxed{\text{MOi ordering}}$

$\boxed{H(\theta,\varphi)}$ → energy function $\{j, V\}$

$\{A_1, A_2, A_3\}$

$\boxed{\text{Contour plot}}$ → $\{C.P\}$

$\boxed{\text{identify the minima}}$

m_1

m_2

m_3

⇒ plot C.P. + minima

$\{m\}$

$\boxed{\text{rotational spin}}$

$\{C.P\} + \{m\}$ ⟶ Energy function $H \to {}^{163}Lu \to I$

$$H(\underbrace{\theta,\varphi}_{\text{coordinates}}; \underbrace{\overbrace{A_1,A_2,A_3}^{P}, V, \gamma, \overset{j}{j}}_{\text{deformation parameters}})[I] = H_I$$

$P + j$

$\{m\} \to (\theta_m, \varphi_m)$

$m_1 = \{\theta^1_m, \varphi^1_m\}$; $m_2 = \{\theta^2_m, \varphi^2_m\}$; $m_3 = \{\theta^3_m, \varphi^3_m\}$

$H(m_1) = H(m_2) = H(m_3)$ → minimal values

$f(I) \Rightarrow$ $H(m_1) \to I_1$
$H(m_1) \to I_2$
$H(m_1) \to I_3$

Fit Parameters
Double ϵ–shift approach
I_1:I_2:I_3→72:15:7
V=2.1 γ=22°
E_{RMS}=0.0794873
ϵ_{TSD2}=0.3 ϵ_{TSD4}=0.6

$> \{P + j\}$ → deformation parameters

Energy function:

(spherical coord.)

$$\mathcal{H} = \frac{I}{2}(A_1 + A_2) + A_3 I^2 + I(I - \frac{1}{2}) \sin^2\theta \left(A_1 \cos^2\varphi + A_2 \sin^2\varphi - A_3\right) + \frac{j}{2}(A_2 + A_3) + A_1 j^2 - 2A_1 I j \sin\theta - V\frac{2j-1}{j+1}\sin\left(\gamma + \frac{\pi}{6}\right). \quad (1)$$

Quantization

(in cartesian coordinates)

$$x_1 = I\sin\theta\cos\varphi,$$
$$x_2 = I\sin\theta\sin\varphi,$$
$$x_3 = I\cos\theta,$$

$$a_k = \left(1 - \frac{1}{2I}\right)A_k$$

$$H = \frac{I}{2}(A_1 + A_2) + A_3 I^2 + \frac{j}{2}(A_2 + A_3) + A_1 j^2 - V\frac{2j-1}{j+1}\sin\left(\gamma + \frac{\pi}{6}\right)$$
$$+ a_1 I^2 \sin^2\theta\cos^2\varphi + a_2 I^2 \sin^2\theta\sin^2\varphi - a_3 I^2 \sin^2\theta - 2A_1 j I \sin\theta$$

$$H = C + a_1 x_1^2 + a_2 x_2^2 - a_3 I^2 (1 - \cos^2\theta) - 2A_1 j I \sqrt{1 - \cos^2\theta}$$

$$H = a_1 x_1^2 + a_2 x_2^2 + a_3 x_3^2 - a_3 I^2 - 2A_1 j \sqrt{I^2 - I^2\cos^2\theta} + C$$

$$H = a_1 x_1^2 + a_2 x_2^2 + a_3 x_3^2 - a_3 I^2 + C - 2A_1 j \sqrt{(I + x_3)(I - x_3)}$$

Energy ellipsoid :

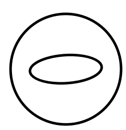
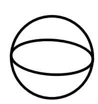
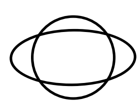
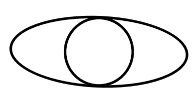
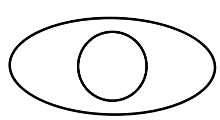
- Take all spins $\in TS01$
- Take $E^{th}_{TS01}(Exc) + E^{8.5}_{TS01}$
- Try comparison between TS01-excitation / TS01-absolute
- ellipsoid scaling :

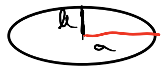
spin1[k]	ts01[k]	scale
1	1	2.2
21	21	1.2

id-k : 1 , 14 , 21

scale : 2.2 , 1.8 , 1.2

spin : $\frac{8.5 \quad\quad 2.2}{48.5 \quad\quad 1.2}$

- small-energy 
- touch-energy-small 
- real-trajectory 
- touch-energy-large 
- large-energy 

ellipse : 

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$

$$a=\sqrt{\frac{1-\frac{y^2}{b^2}}{x^2}}$$

$$\Rightarrow \sqrt{\frac{1-\frac{y^2}{b^2}}{x^2}} = R_{sph}$$

$$\sqrt{\frac{\left(1-\frac{y}{b}\right)\left(1+\frac{y}{b}\right)}{x^2}} = \sqrt{\frac{(1-y')(1+y')}{x^2}}$$

$$\frac{y}{b}=y'$$

$$\frac{1}{x}\sqrt{(1-y')(1+y')} = R_{sp}$$

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1 \qquad J_1=\frac{1}{2A_1} \qquad A_1=\frac{1}{2J_1}$$

$$E=A_1 J_1^2 + A_2 J_2^2 + A_3^2 \qquad A_k=\frac{1}{2J_k}$$

$$\frac{X_1^2}{\frac{1}{A_1}}$$

$$A_1 J_1^2 + A_2 J_2^2 + A_3 J_3^2 = \frac{X_1^2}{a^2}+\frac{X_2^2}{b^2}+\frac{X_3^2}{c^2}$$

$$A_1=\frac{1}{a^2}$$

$$A_2=\frac{1}{b^2}$$

$$A_3=\frac{1}{c^2}$$

the new energy function

$$t_1 x_1^2 + t_2 x_2^2 + t_3 x_3^2 + t_0 = E$$

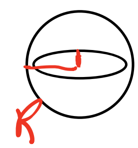
$$t_1 x_1^2 + t_2 x_2^2 + t_3 x_3^2 = (E - t_0)$$

$$t_1 = \frac{1}{a^2}; \quad t_2 = \frac{1}{b^2}; \quad t_3 = \frac{1}{c^2}$$

$$a = \sqrt{\frac{1}{t_1}}$$

☐ check value of the constant $(E - c)$

☐ $a = R$



$$\left\{ \frac{1}{a^2}, \frac{1}{b^2}, \frac{1}{c^2} \right\}$$

the energy ellipsoid:

$$H(x_1, x_2, x_3) = \left(1 - \frac{1}{2I}\right) A_1 x_1^2 + \left(1 - \frac{1}{2I}\right) A_2 x_2^2 + \left[\left(1 - \frac{1}{2I}\right) A_3 + A_4 \frac{j}{I}\right] x_3^2 +$$

$$+ \frac{I}{2}(A_2 + A_1) + A_3 I^2 + \frac{j}{2}(A_2 + A_3) + A_4 j^2 - I\left(I - \frac{1}{2}\right) A_3 - 2A_4 j I \rightarrow c_0$$

Ellipsoid: $e \rightarrow \frac{x_1^2}{a^2} + \frac{x_2^2}{b^2} + \frac{x_3^2}{c^2} = e$

$$\Rightarrow \left(1 - \frac{1}{2I}\right) A_1 \rightarrow \frac{1}{a^2} \equiv c_1$$

$$\left(1 - \frac{1}{2I}\right) A_2 \rightarrow \frac{1}{b^2} \equiv c_2$$

$$\left[\left(1 - \frac{1}{2I}\right) A_3 + A_1 \frac{j}{I}\right] \rightarrow \frac{1}{c^2} \equiv c_3$$

$\Rightarrow$ <u>triaxial ellipsoid becomes</u>

$$c_1 x_1^2 + c_2 x_2^2 + c_3 x_3^2 = e - c_0$$

$$\frac{c_1}{e - c_0} x_1^2 + \frac{c_2}{e - c_0} x_2^2 + \frac{c_3}{e - c_0} x_3^2 = 1$$

$$\frac{c_k}{e - c_0} = \frac{1}{a_k^2} \quad \Rightarrow \left(\frac{x_1^2}{a_1^2} + \frac{x_2^2}{a_2^2} + \frac{x_3^2}{a_3^2} = 1 \right) \rightarrow \text{final equation}$$

Add the modified ellipsoid shape

- start with $H(x_1, x_2, x_3)$

$\downarrow$

- transform in ellipsoid

$$c_1 x_1^2 + c_2 x_2^2 + c_3 x_3^2 + c_0 = E$$

$\downarrow$

- transform in pure ellipsoid

$$\frac{c_1}{E-c_0} x_1^2 + \frac{c_2}{E-c_0} x_2^2 + \frac{c_3}{E-c_0} x_3^2 = 1 \longrightarrow \frac{x_1^2}{a_1^2} + \frac{x_2^2}{a_2^2} + \frac{x_3^2}{a_3^2} = 1$$

find $\left(\frac{c_1}{E-c_0} = \frac{1}{a_1^2}\right)$; $\left(\frac{c_2}{E-c_0} = \frac{1}{a_2^2}\right)$; $\left(\frac{c_3}{E-c_0} = \frac{1}{a_3^2}\right)$

$$a_3 \to R \Rightarrow \quad \frac{c_3}{E-c_0} = \frac{1}{R^2} \Rightarrow E - c_0 = c_3 R^2$$

$$\boxed{E = c_3 R^2 + c_0}$$

energy at which the ellipsoid touches the poles