\[ \langle Q \rangle = e^2 \frac{2}{5} (5 - \frac{5}{2} \alpha) \]

Deformation parameter \( \delta = \frac{5 - \alpha}{\frac{5}{2} (\alpha + \frac{5}{2})} \)

\[ Q = e^2 \frac{4}{5} R \left( 1 - \delta \right) \]

\( \delta = 0 \) for closed shells.

If \( \delta \) can be as large as 0.7 in between closed shells.

Reduced quadrupole moment \( Q_{\text{red}} = \frac{Q}{2eR} = \frac{e^2}{5} \delta \)


Quadrupole moment in \( \mathbb{R}^3 \) cannot be explained from shell model. In case closed shells have \( \langle Q \rangle = 0 \)

\[ \text{31) Collective rotation of nucleus} \]

\[ \text{Rotation about symmetry axis does not exist in QM} \]

\[ H = \frac{R^2}{2l_c} \text{ moment of inertia about } R \text{-axis} \]

\[ R^2 Y_e^m = e (\epsilon_{+1}) + \frac{e}{2} Y_e^m \]

Parity of \( Y_e^m \) : \( (2l_c) \)