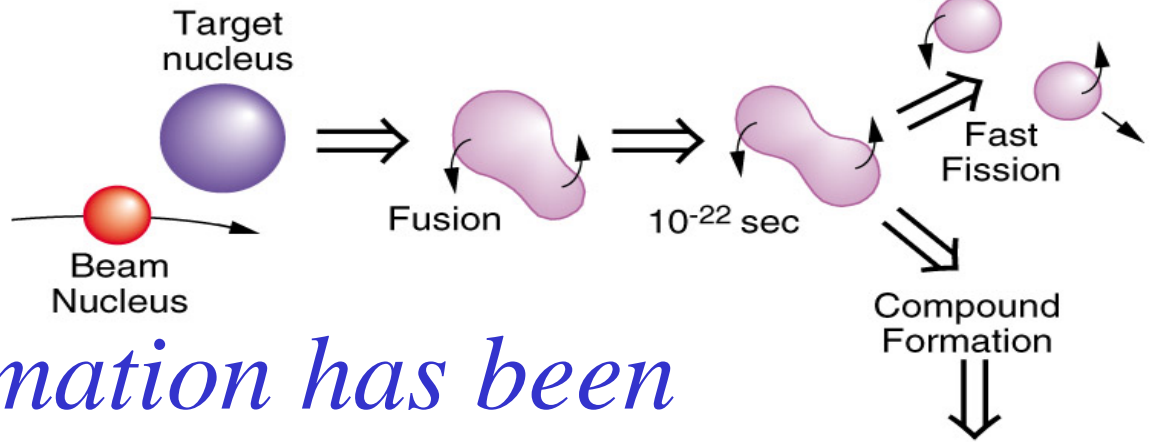


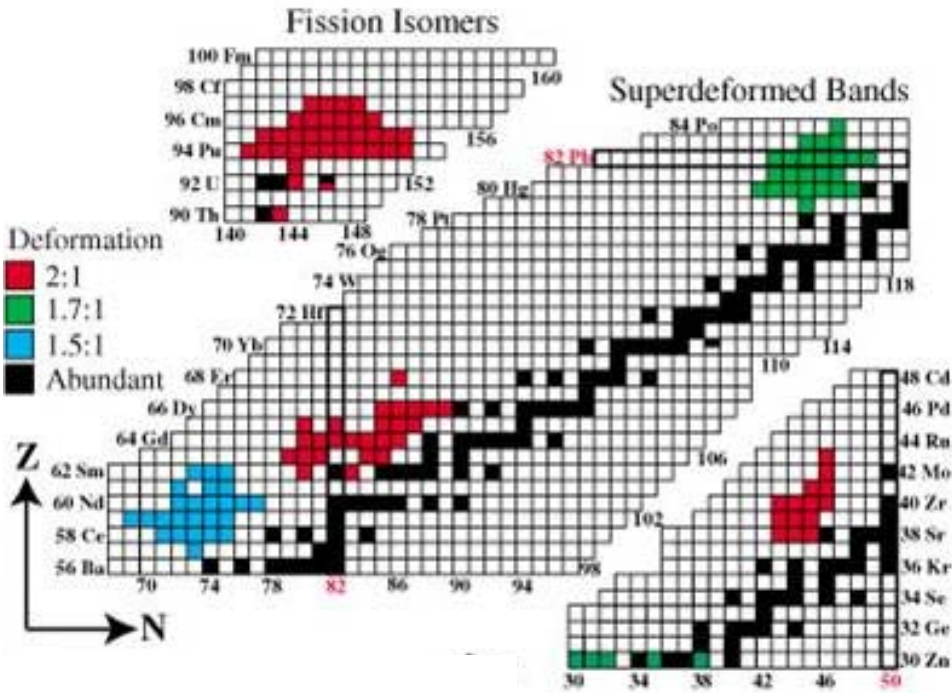
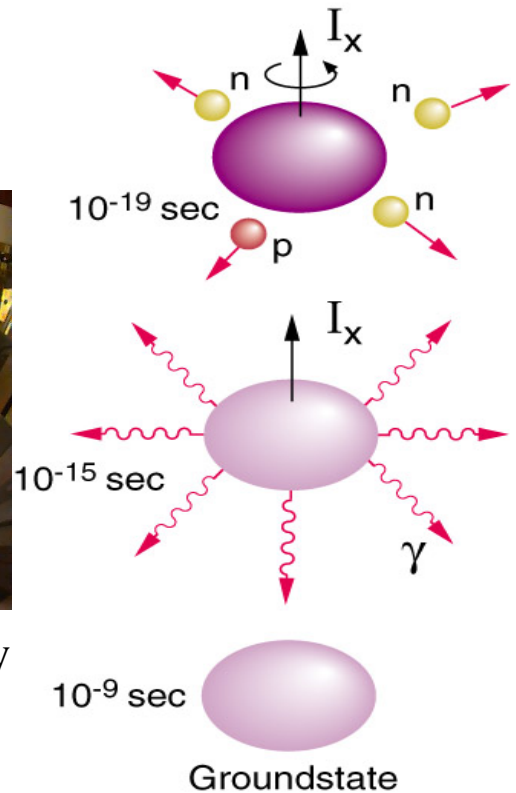
In-beam Fusion gamma-ray spectroscopy



Superdeformation has been observed in the proton-rich side.

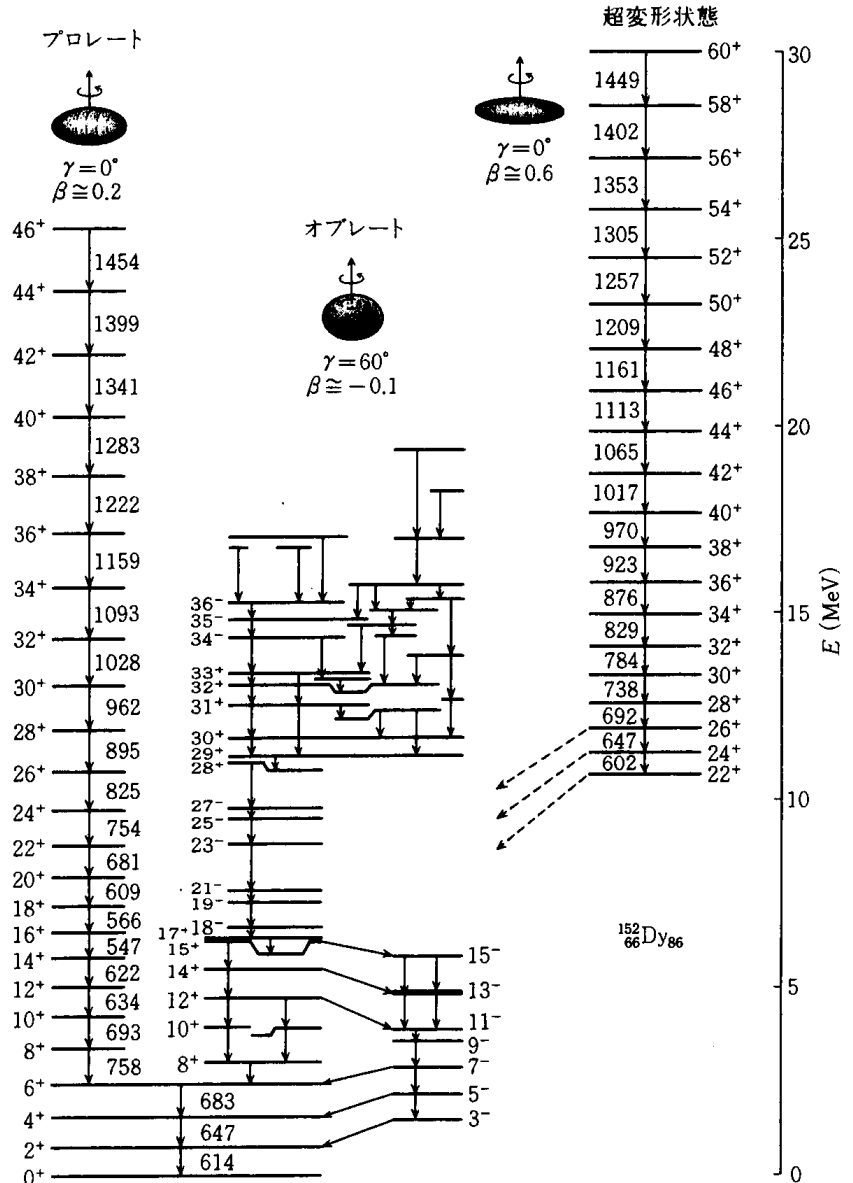
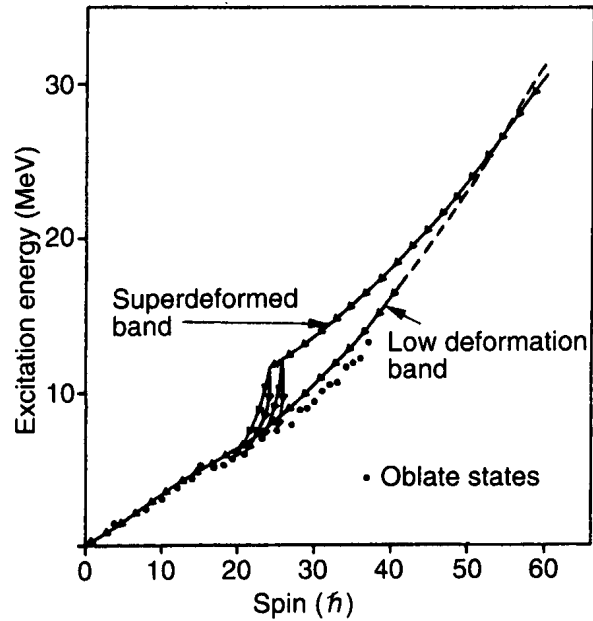
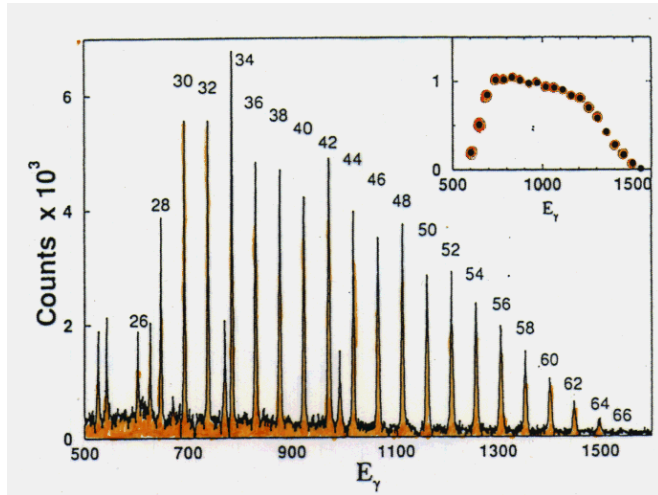
$\hbar\omega \sim 0.75$ MeV
 $\sim 2 \times 10^{20}$ Hz

Rotation

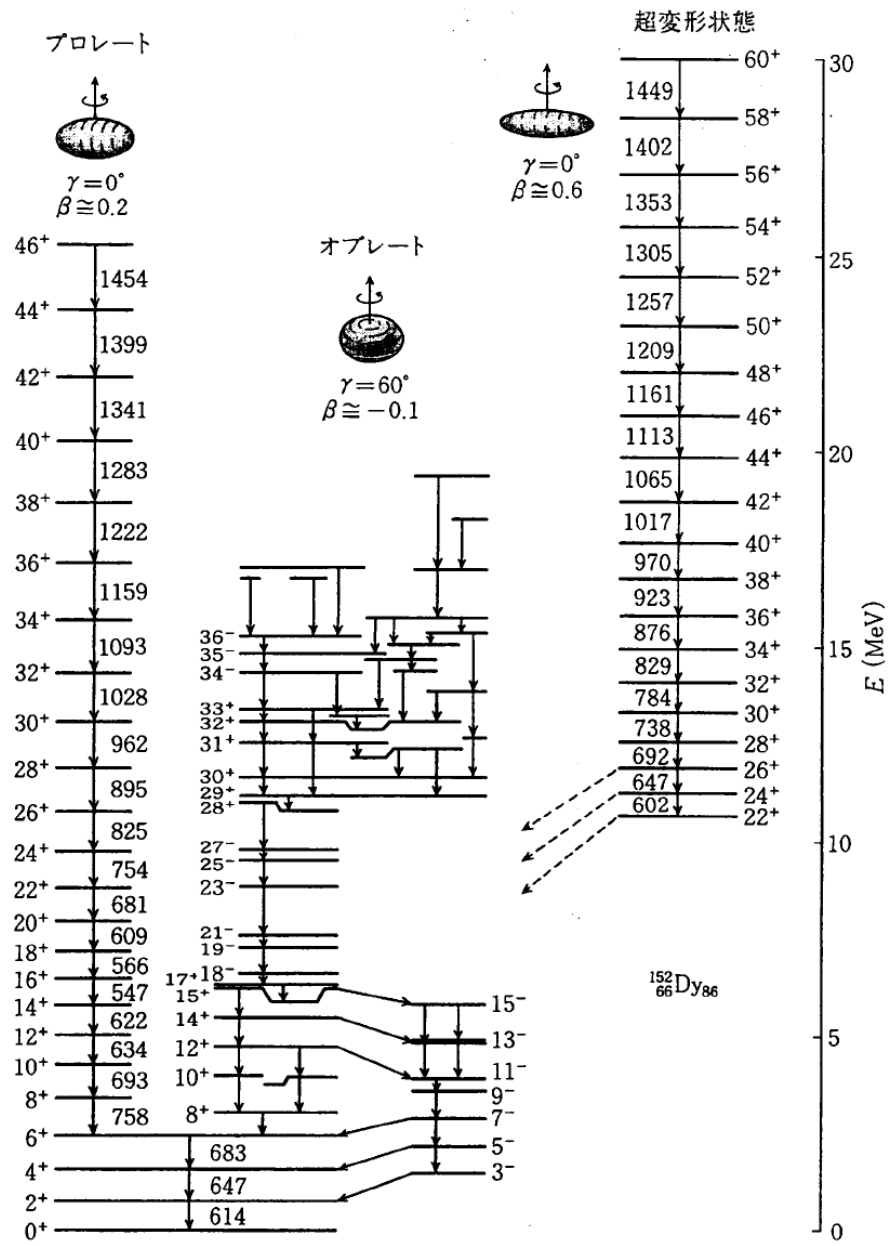
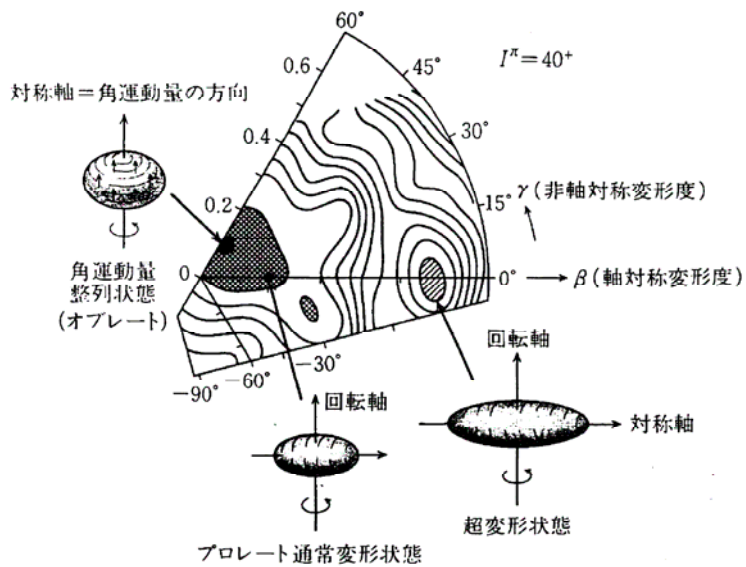


Large gamma-ray detector arrays

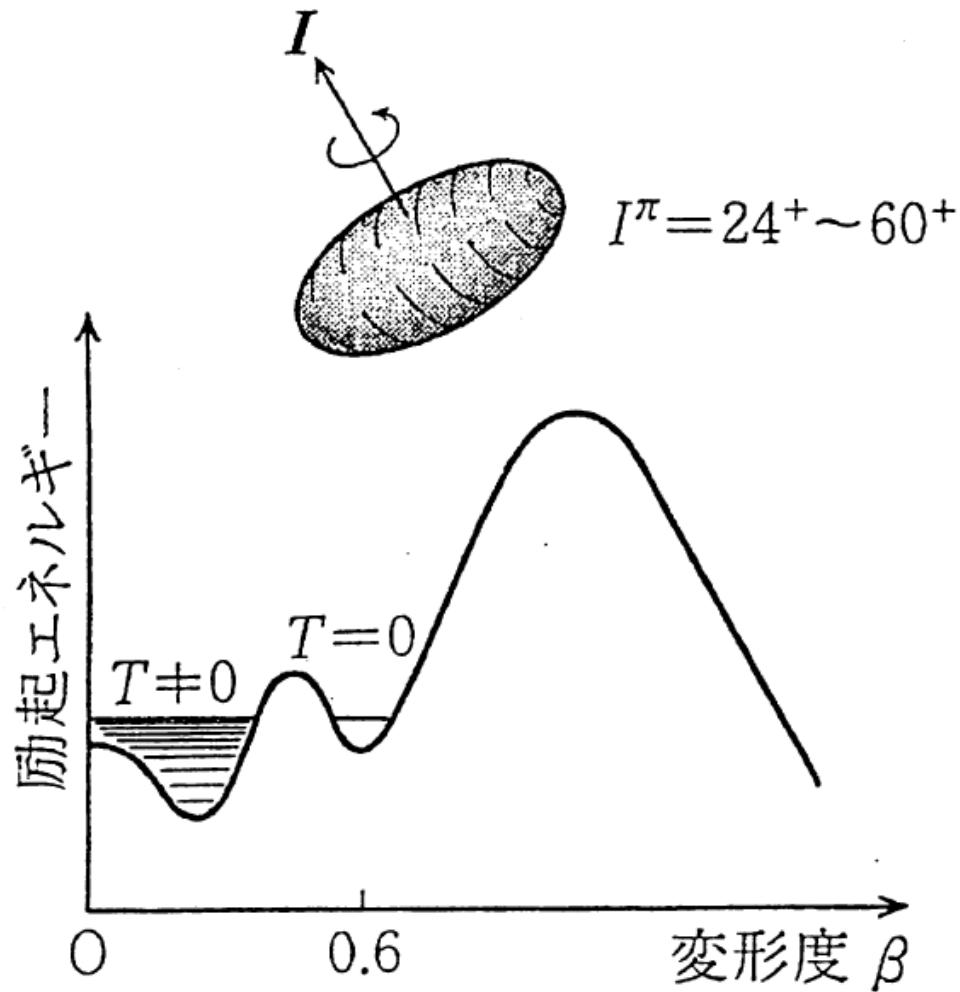
超変形回転バンド



異なる変形の共存



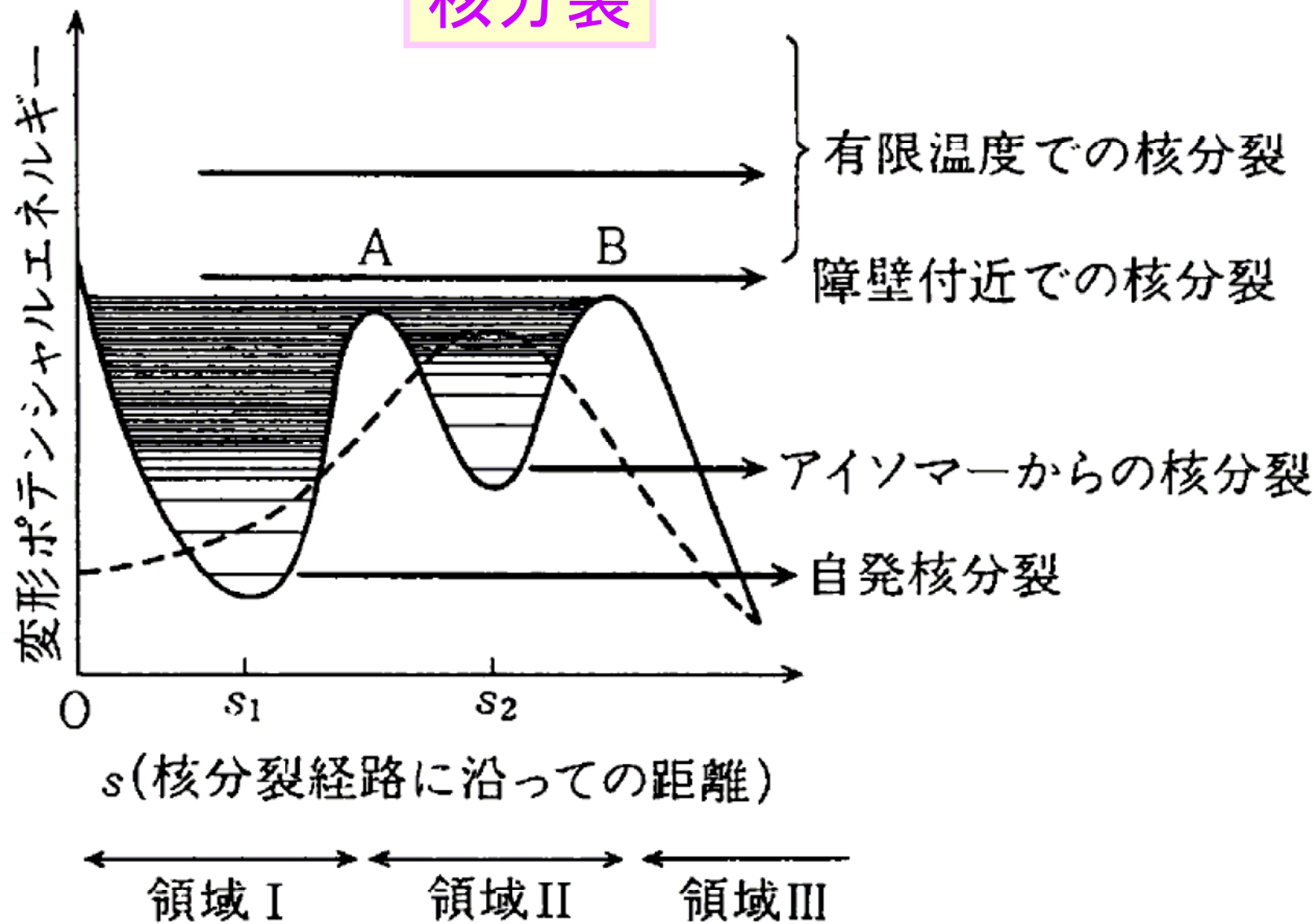
高速回転する超変形状態

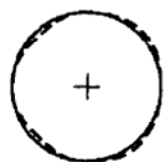


平均場の第2極小点
(二つの真空)

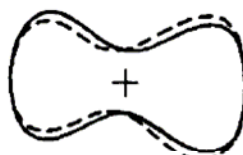
超変形状態から
常変形状態への
巨視的トンネル現象

核分裂

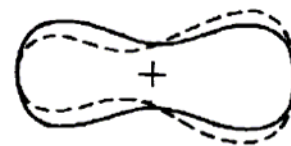
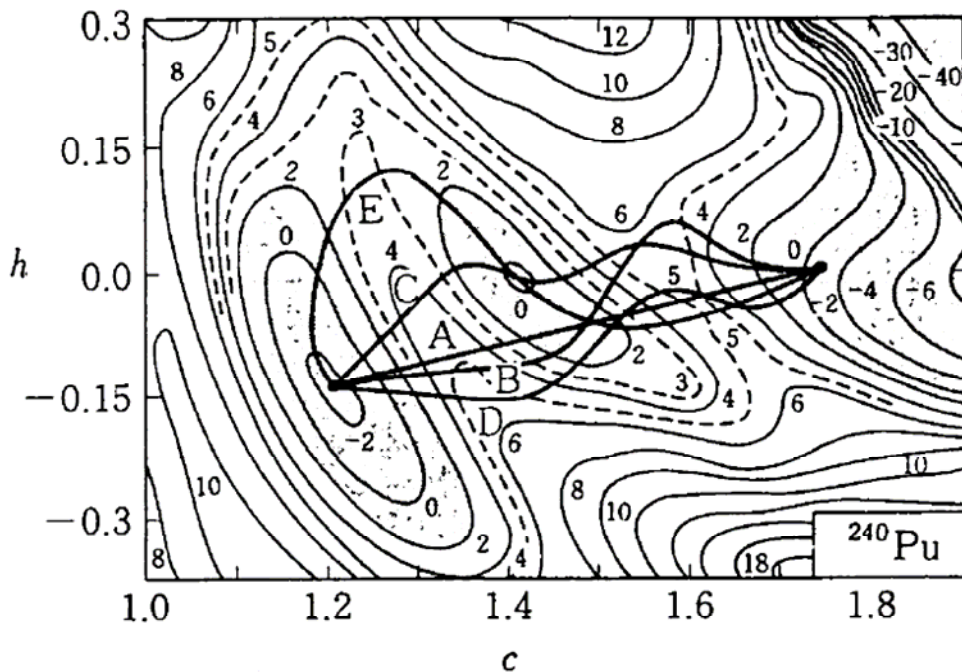




$c=1.0$
 $h=0.0$

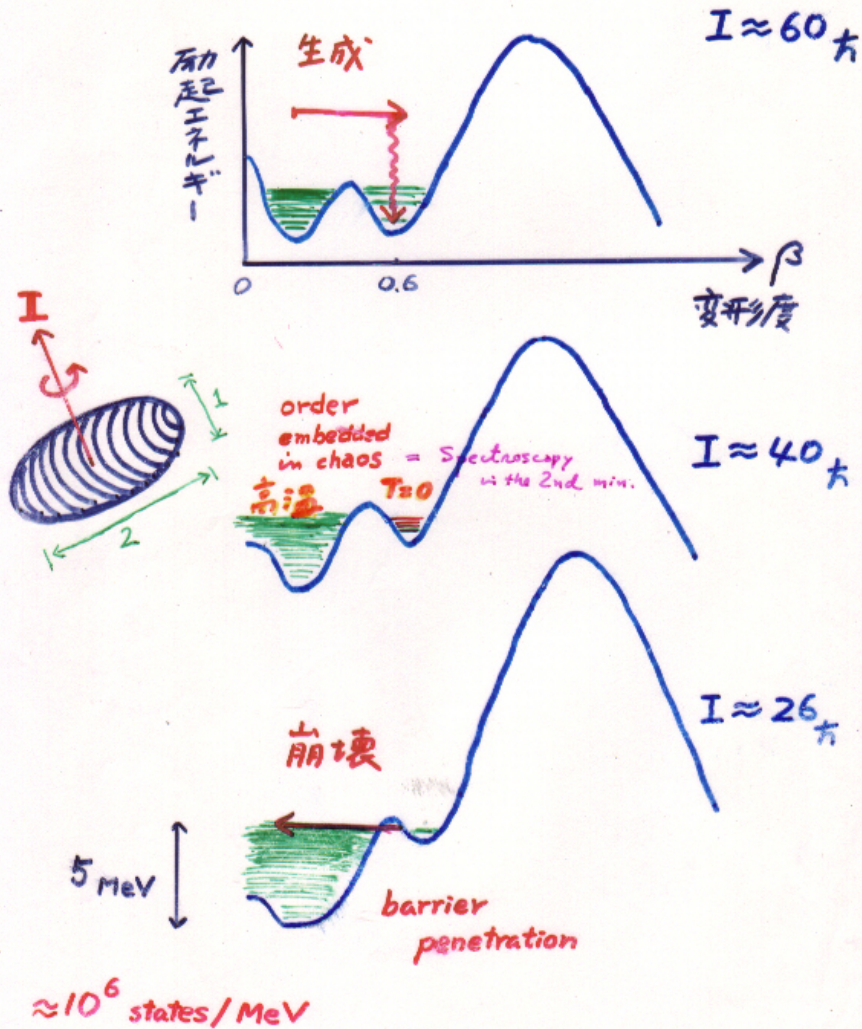


$c=1.6$
 $h=0.3$

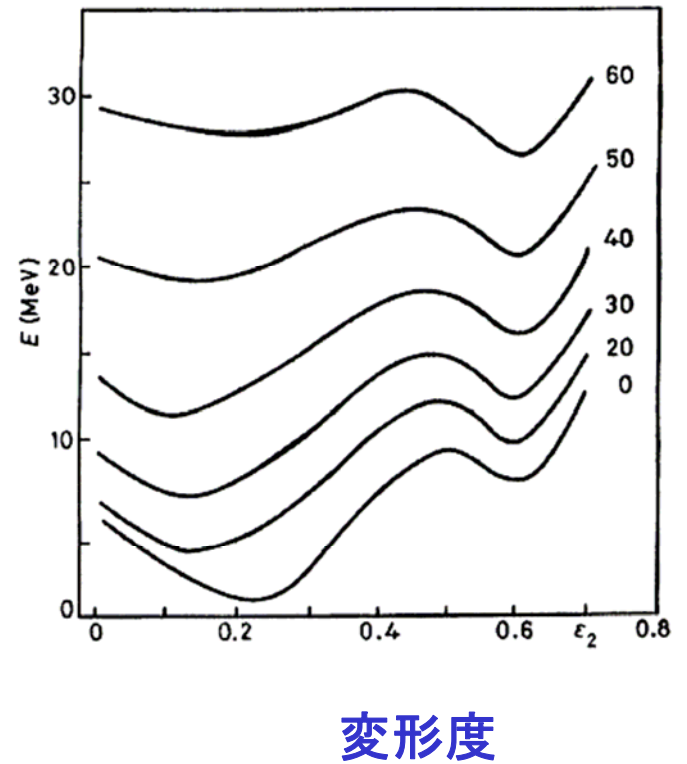


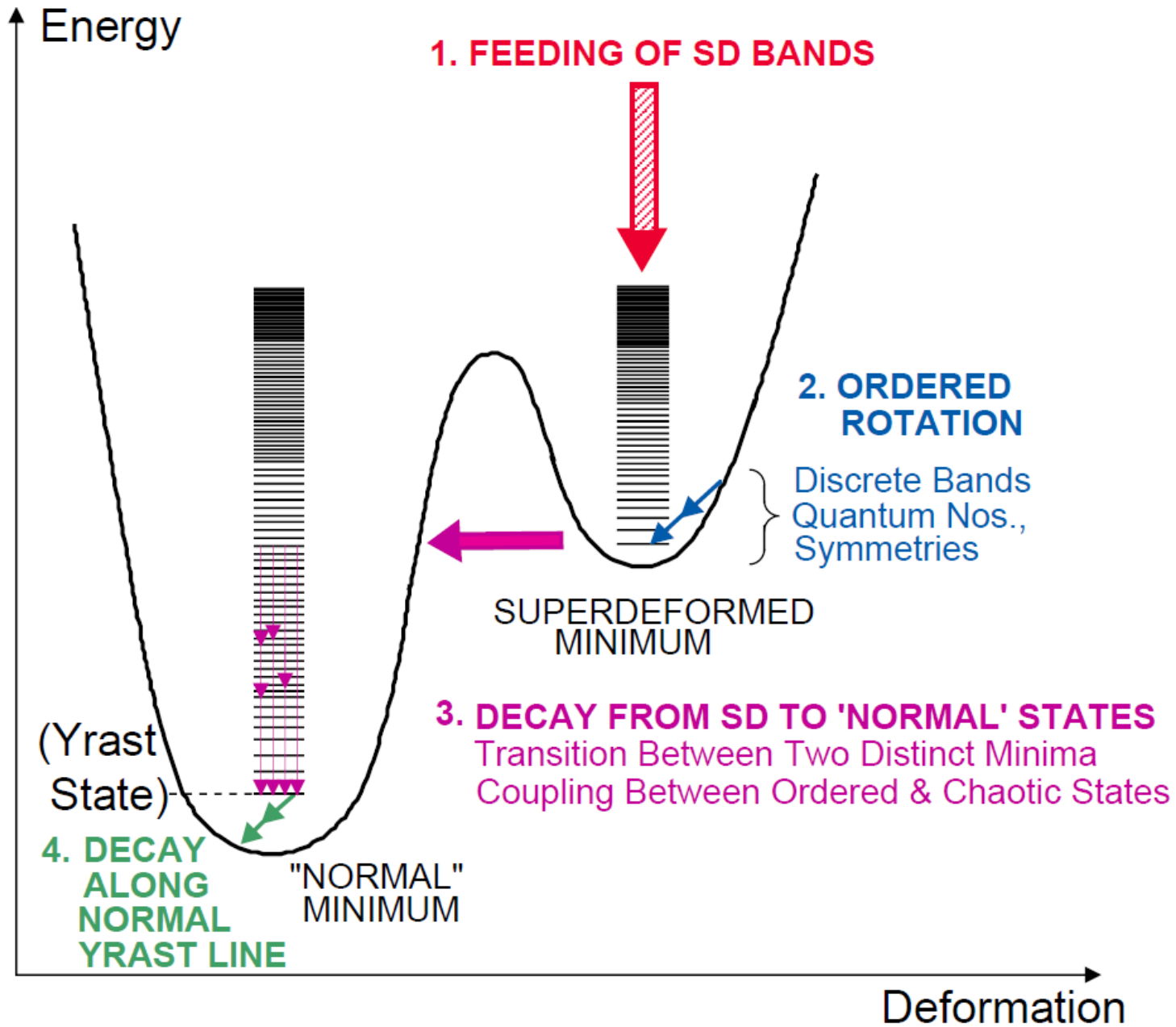
$c=1.9$
 $h=0.0$

superdeformed band
超変形回転バンドの生成と崩壊



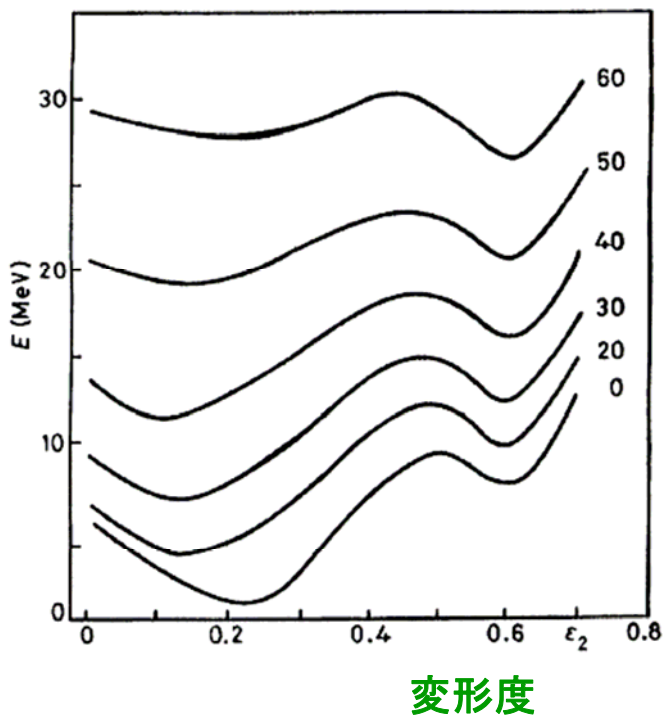
変形ポテンシャルエネルギーの角運動量依存性



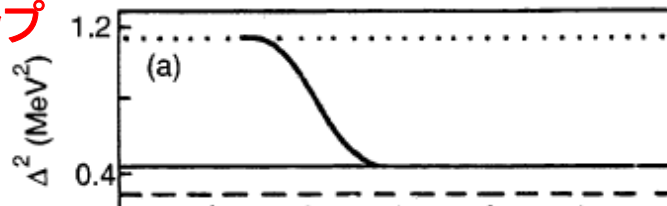


トンネル崩壊確率 の対相関依存性

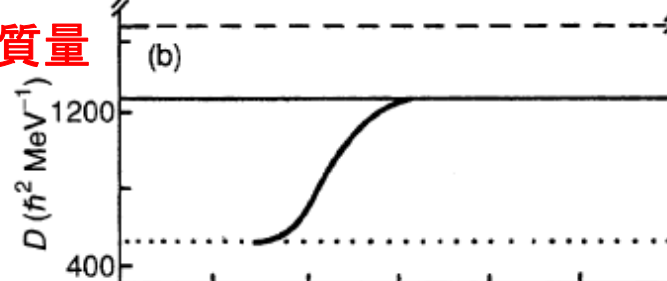
変形ポテンシャルの角運動量依存性



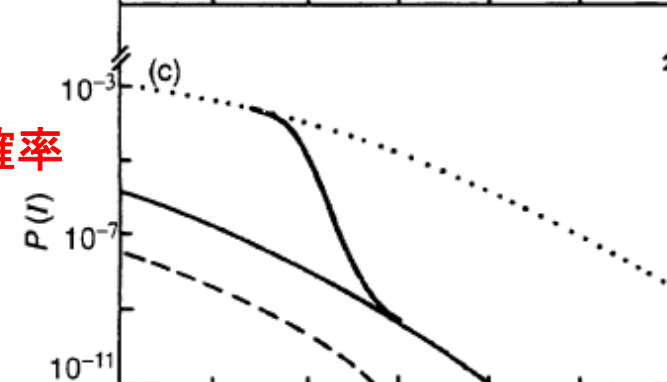
対ギャップ



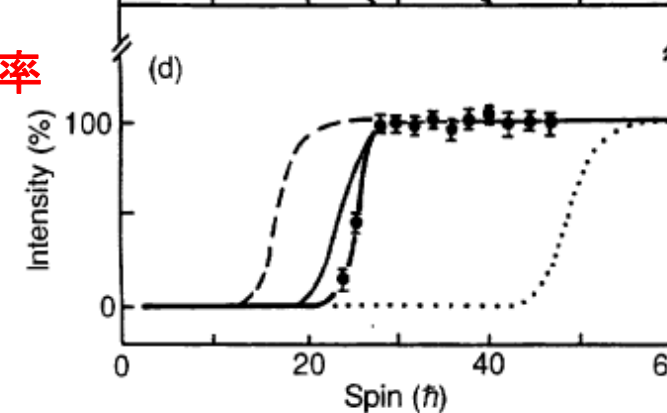
集団運動の質量



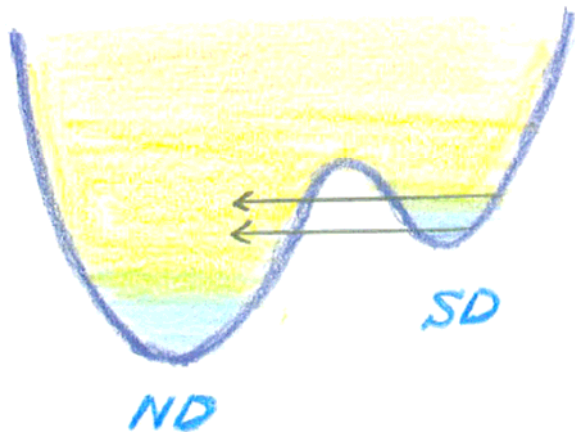
トンネル確率



生存確率



SD からNDへのトンネル崩壊



$$H = \frac{1}{2} \sum_{ij=1}^2 m_{ij}(q_1, q_2) \dot{q}_i \dot{q}_j + V(q_1, q_2),$$

透過係数

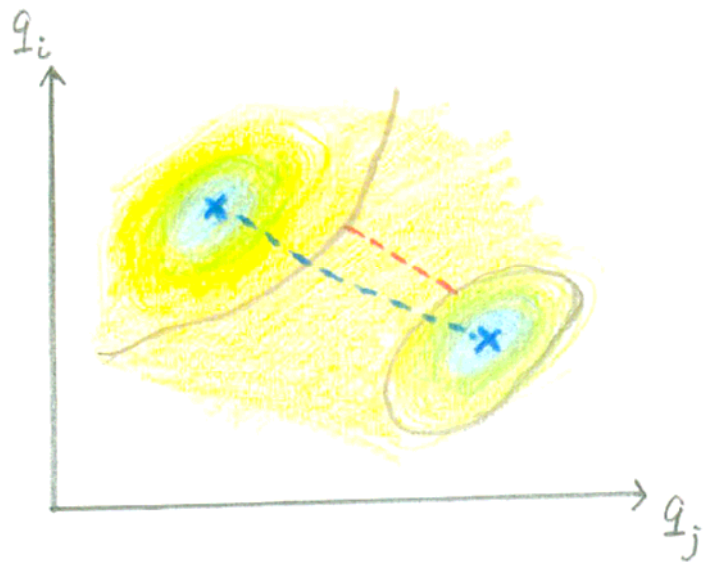
$$T = (1 + \exp 2S)^{-1}$$

作用積分

$$S(E) = \int_{\text{path}} ds \sqrt{2M_0(V(q(s)) - E)},$$

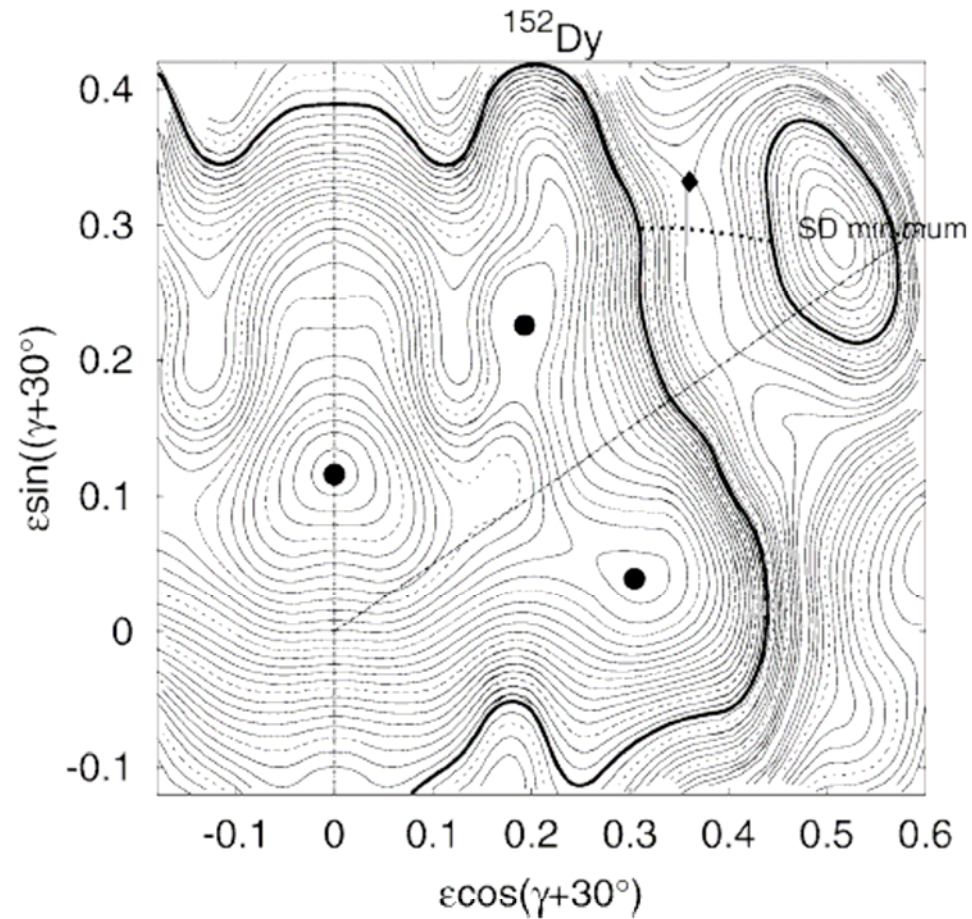
集団質量

$$M_0 ds^2 = \sum_{ij} m_{ij}(q) dq_i dq_j$$

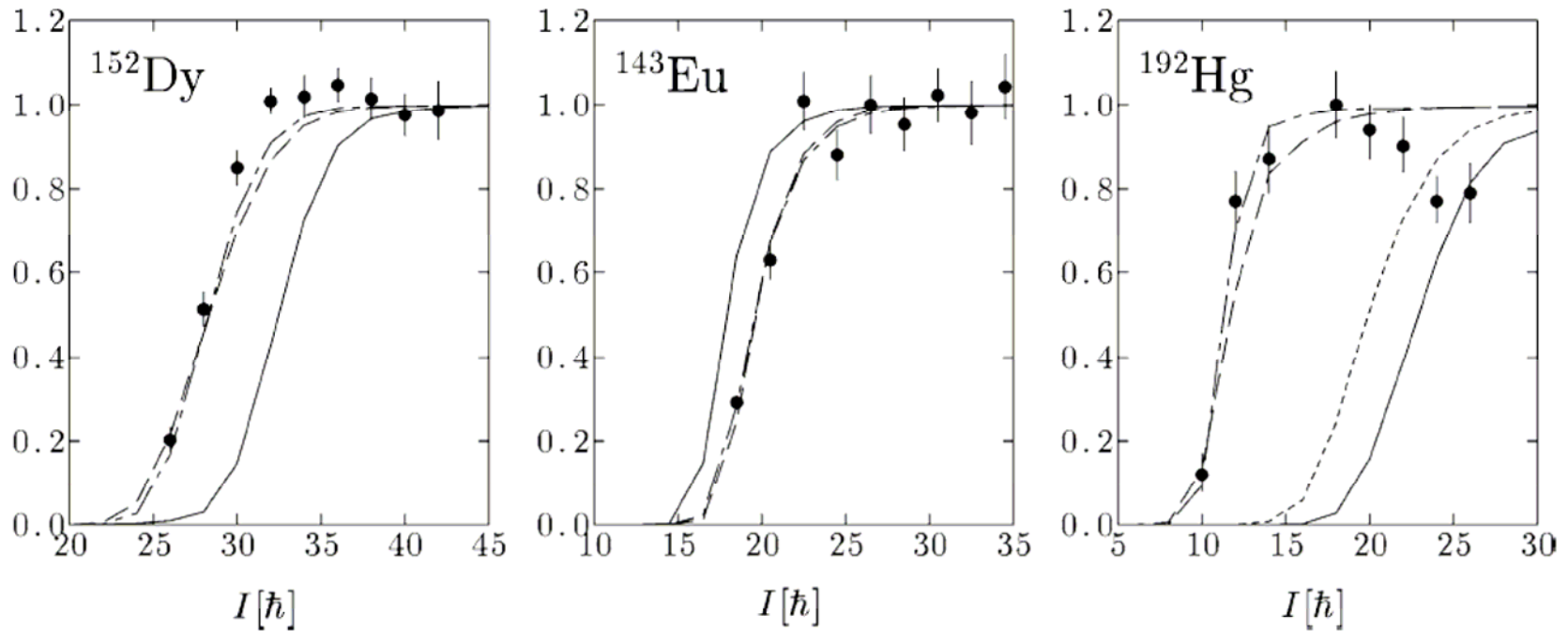


$$q_1 = \epsilon_2 \cos(\gamma + 30^\circ), \quad q_2 = \epsilon_2 \sin(\gamma + 30^\circ).$$

超変形状態から通常変形状態へのトンネル崩壊の経路

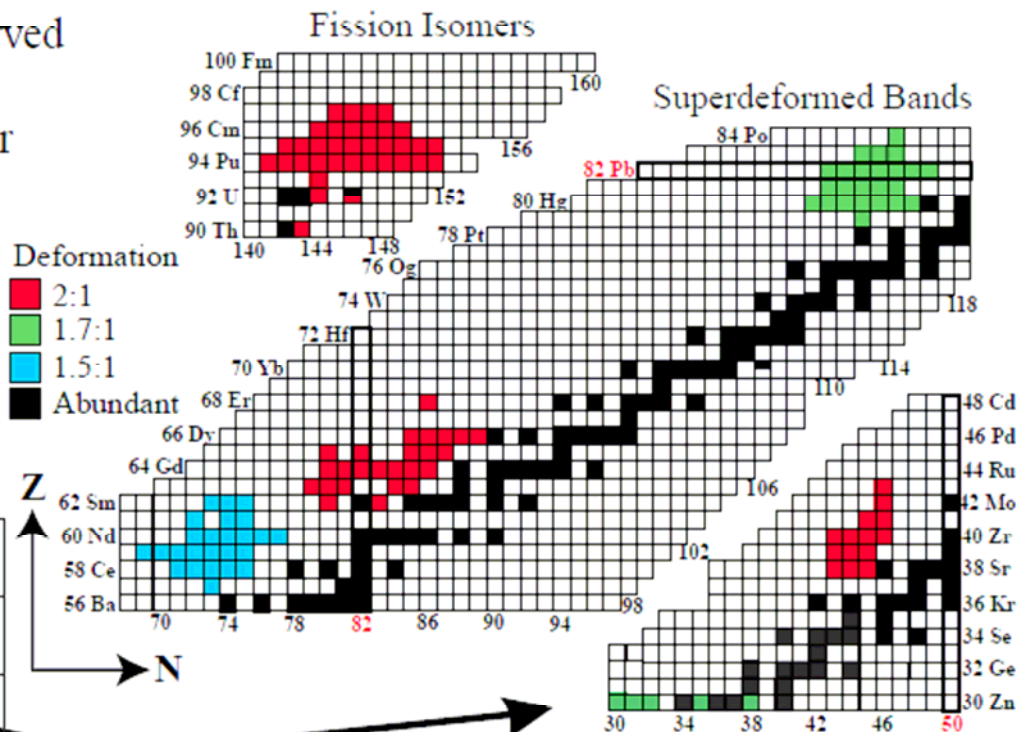
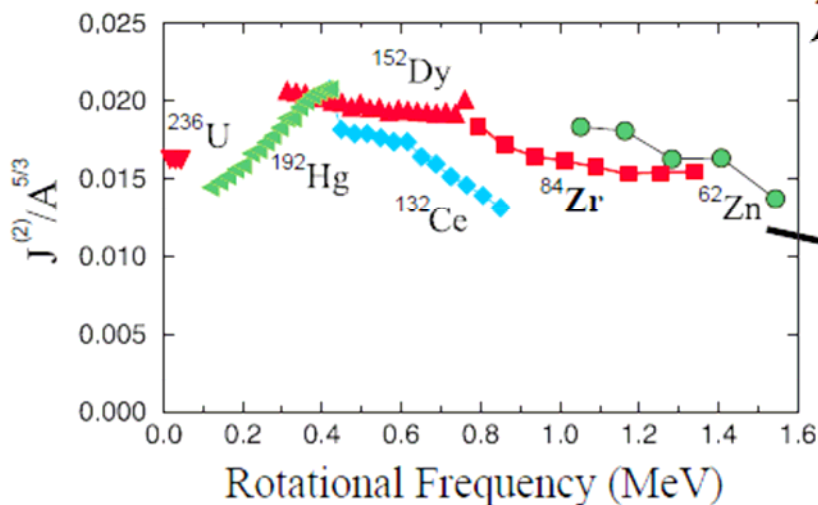


超変形状態から通常変形状態へのトンネル崩壊確率

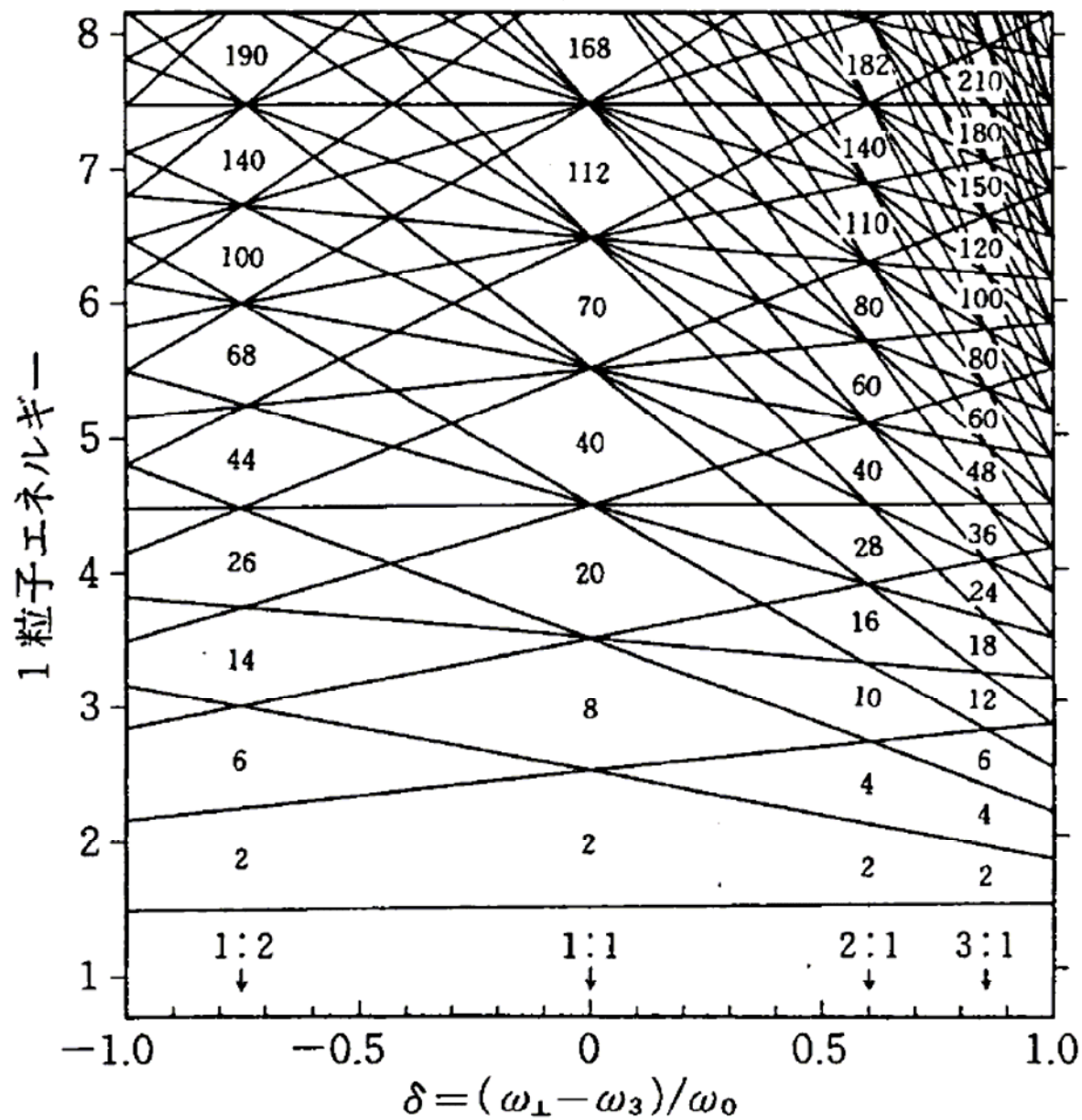


The Regions of Superdeformation

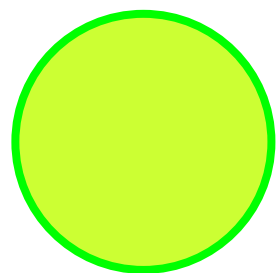
Superdeformed (SD) bands have been observed throughout the nuclear chart. The moments of inertia, after scaling to $A^{5/3}$, are all similar due to the fact that the shape (deformation) of a SD band is largely independent of the mass. The shell gaps, which define the SD shape, depend on the underlying symmetry of the nucleus, and occur at near-integer axis ratios.



The recent observation with GAMMASPHERE of a new region of superdeformation ($N \sim Z \sim 30$) opens up many exciting opportunities, including the possibility to study the most collective states known with a "Shell Model" description.



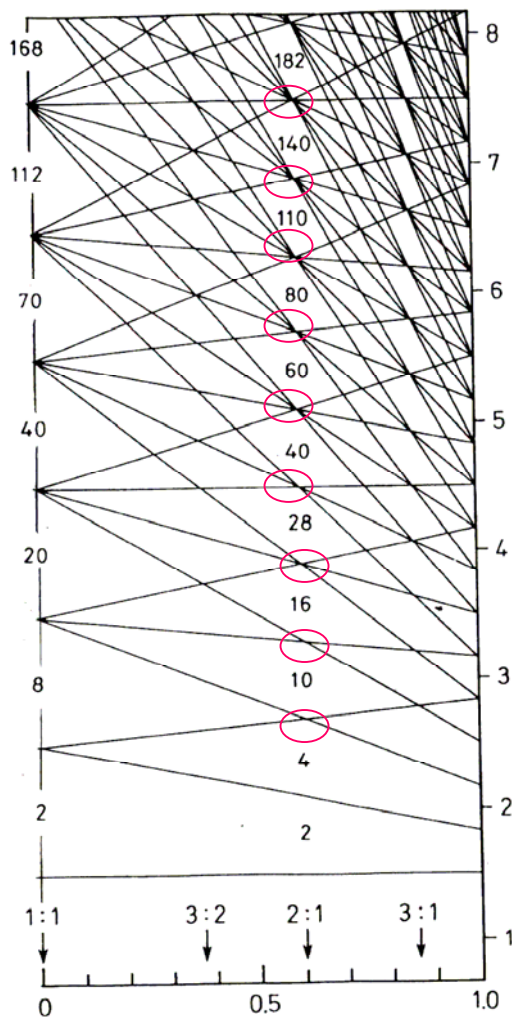
$$e(n_{\perp}, n_z) = \hbar\omega_{\perp}(n_{\perp} + 1) + \hbar\omega_z(n_z + \frac{1}{2})$$



球形

縮退度

- 56 →
- 42 →
- 30 →
- 20 →
- 12 →
- 6 →
- 2 →

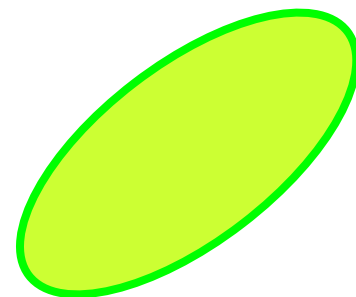


変形度 $\delta_{osc} = (\omega_{\perp} - \omega_z) / \bar{\omega}$

$\omega_{\perp} = \omega_x = \omega_y$

縮退度

- ← 42 } (red bracket)
- ← 42 } (red bracket)
- ← 30 } (red bracket)
- ← 30 } (red bracket)
- ← 20 } (red bracket)
- ← 20 } (red bracket)
- ← 12 } (red bracket)
- ← 12 } (red bracket)
- ← 6 } (red bracket)
- ← 6 } (red bracket)
- ← 2 } (red bracket)
- ← 2 } (red bracket)



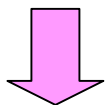
超変形

軸比2:1

調和振動子ポテンシャルの動力学的対称性

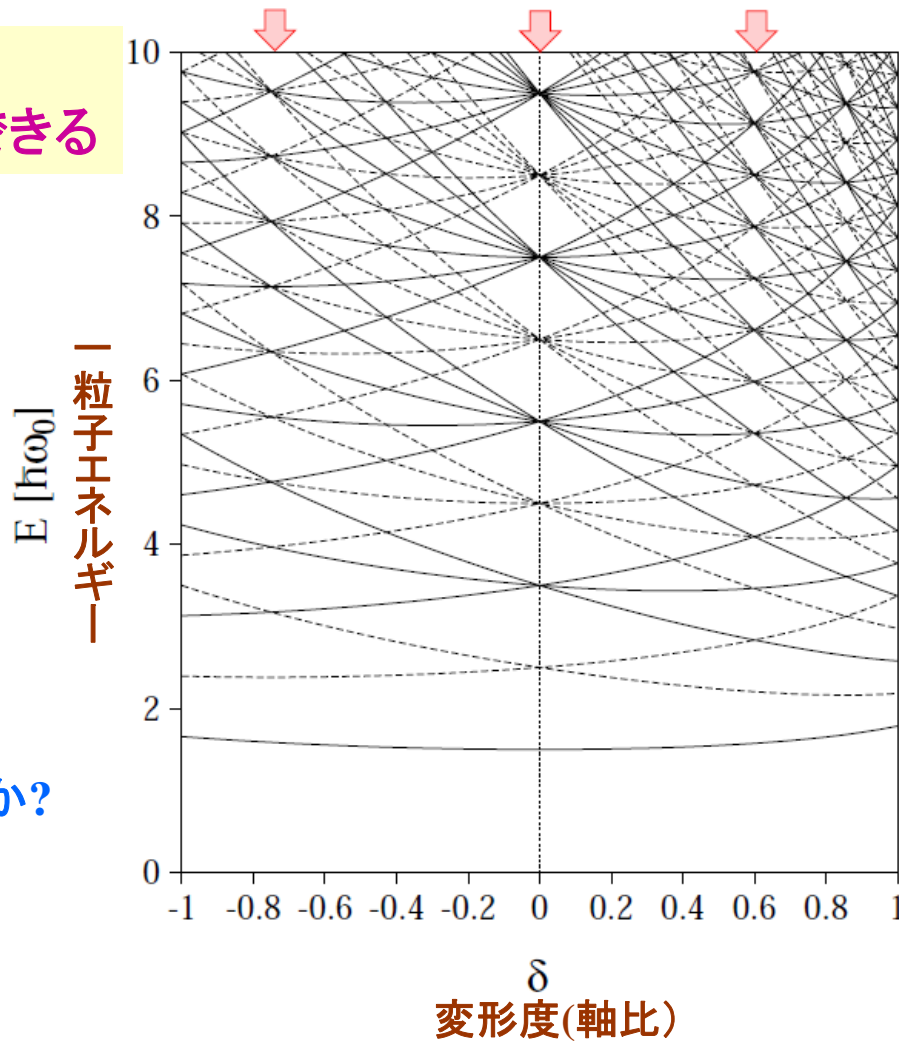
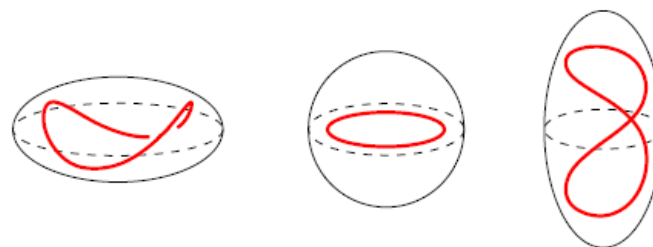
調和振動子ポテンシャル

軸比2:1のとき
8の字型の周期軌道ができる

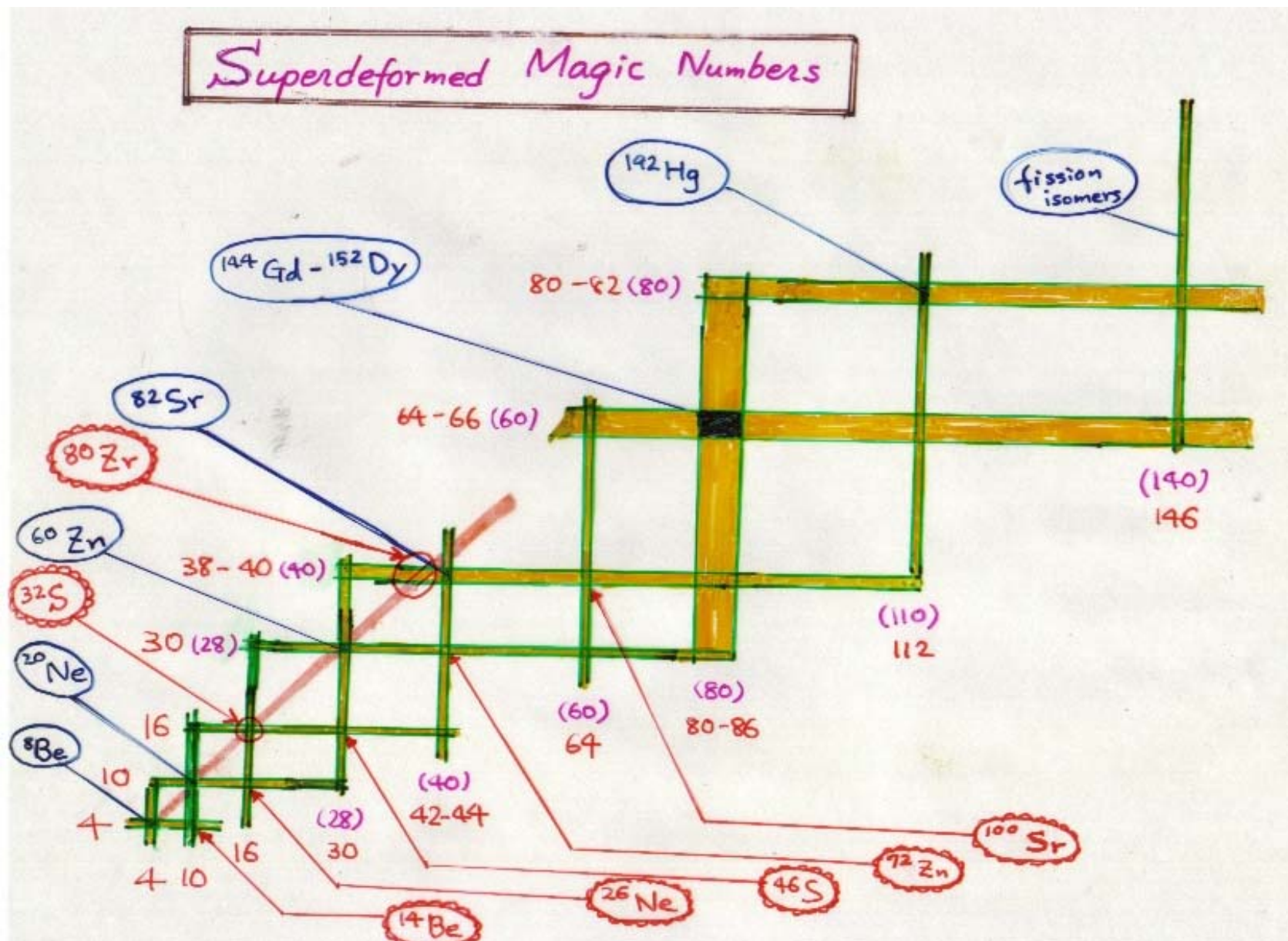


準位が縮退する
超変形シェル構造の形成

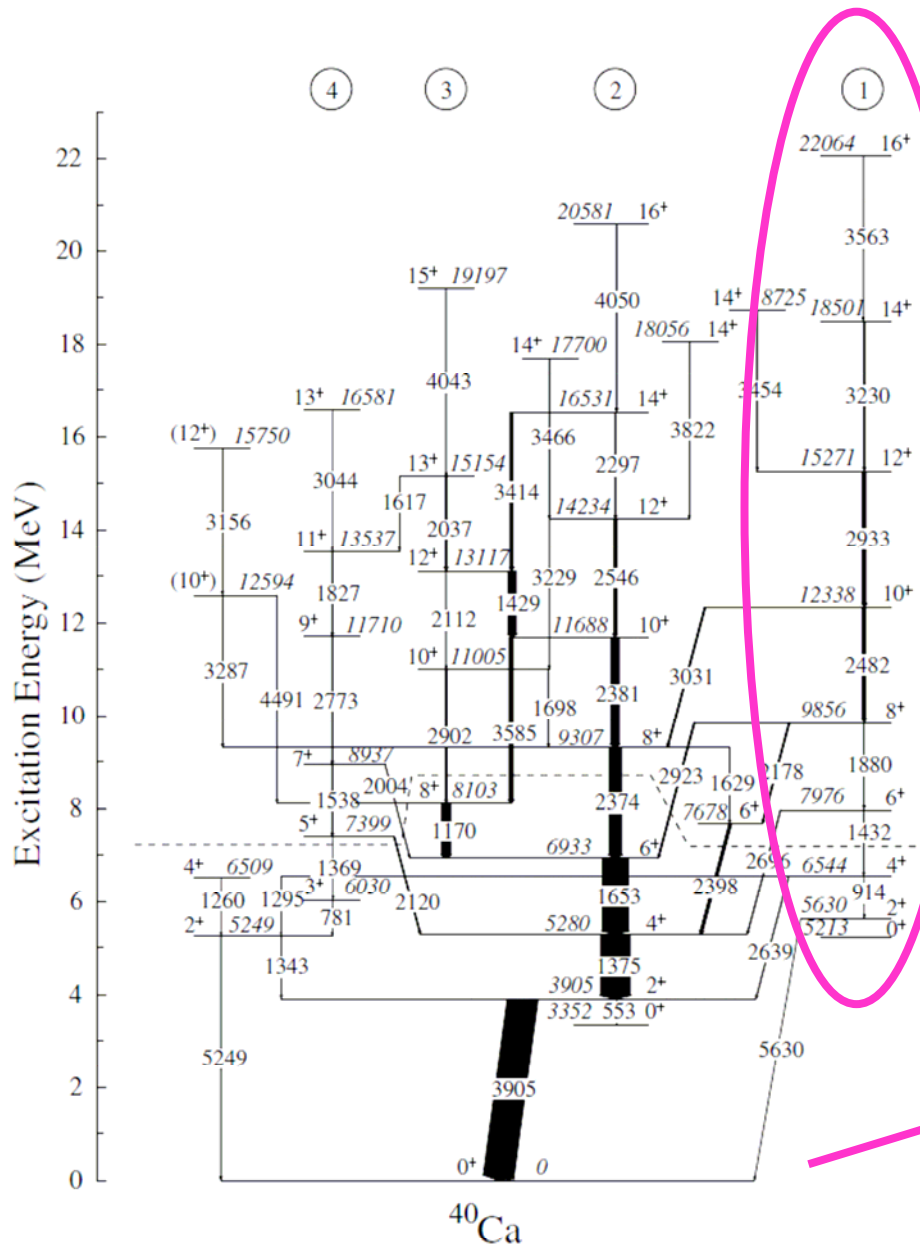
一般のポテンシャルではどうか?



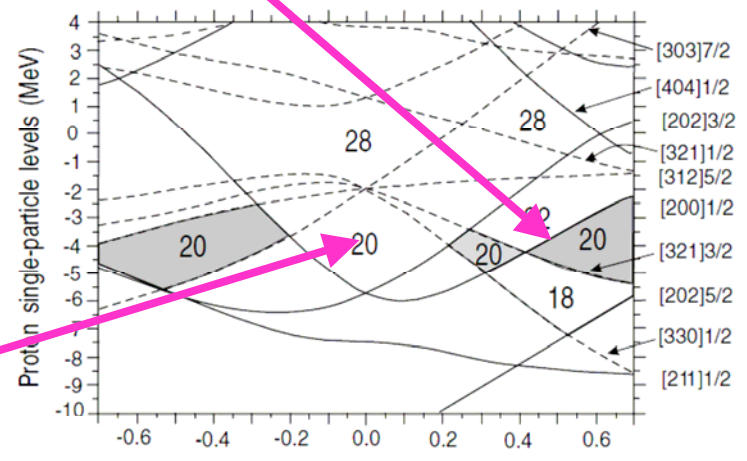
超変形の魔法数



Superdeformation in the Doubly Magic Nucleus $^{40}_{20}\text{Ca}_{20}$

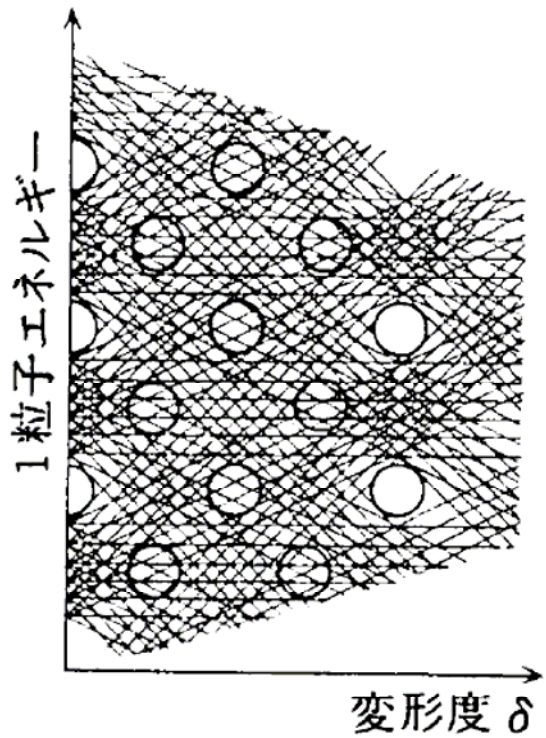


E. Ideguchi, et al.,
 Phys. Rev. Lett. 87 (2001) 222501

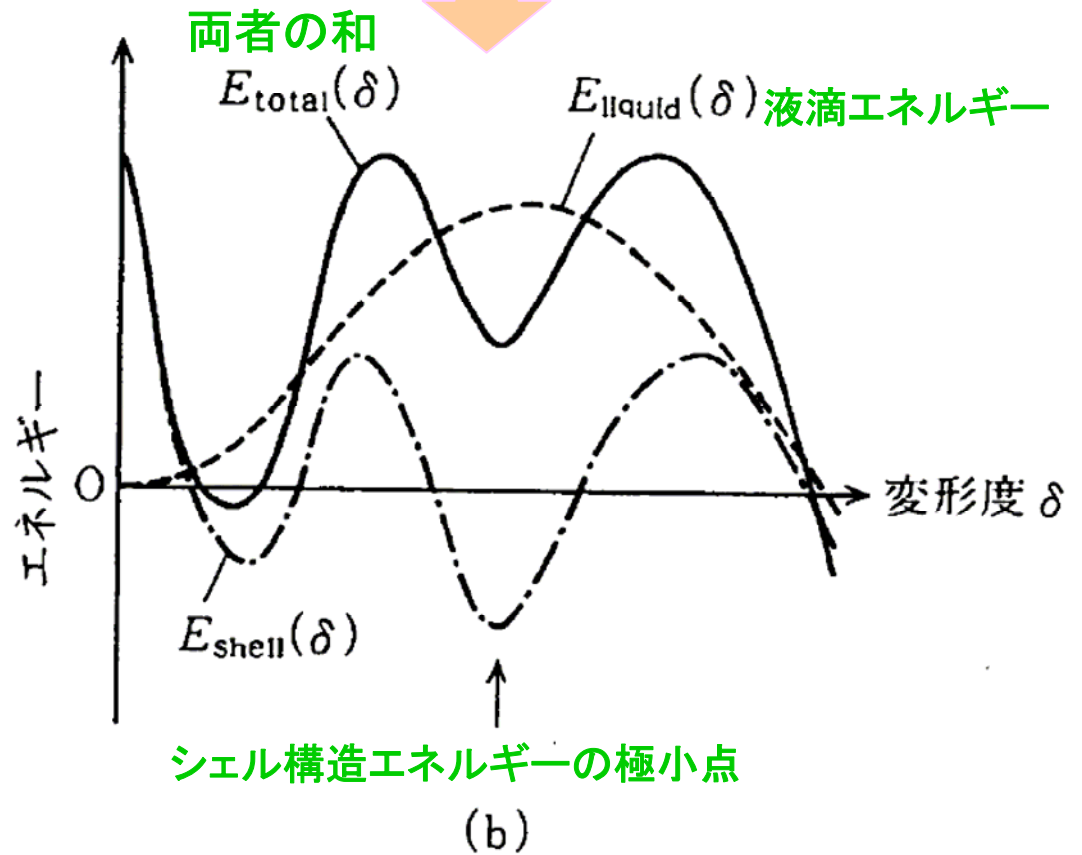


核分裂アイソマー

変形につれてシェル構造は変化する

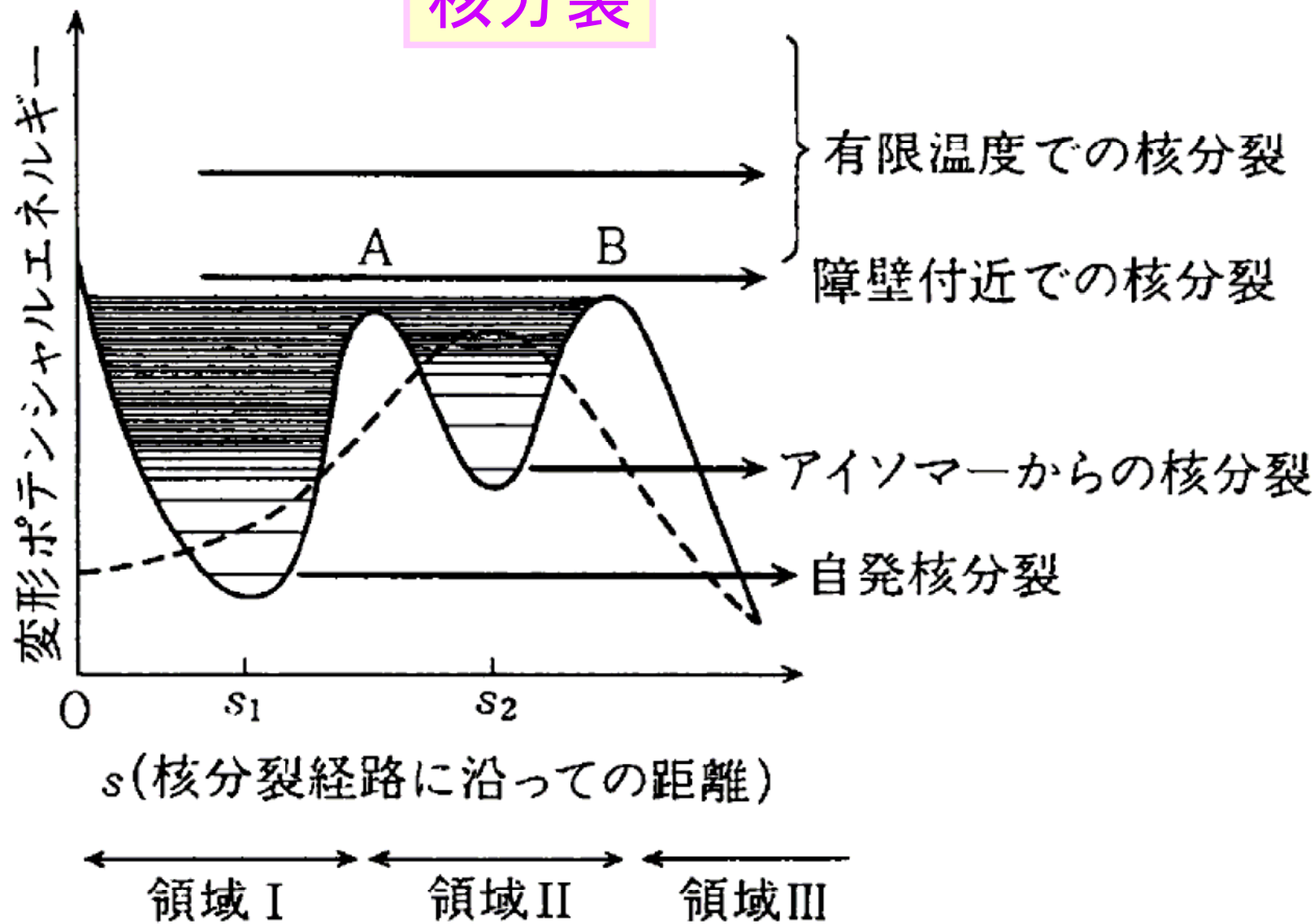


(a)



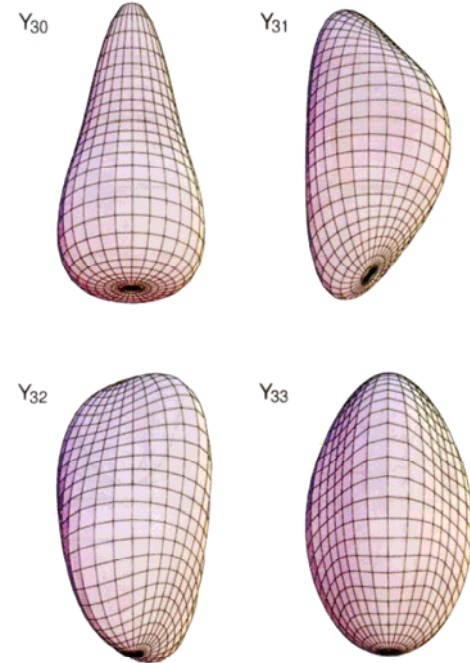
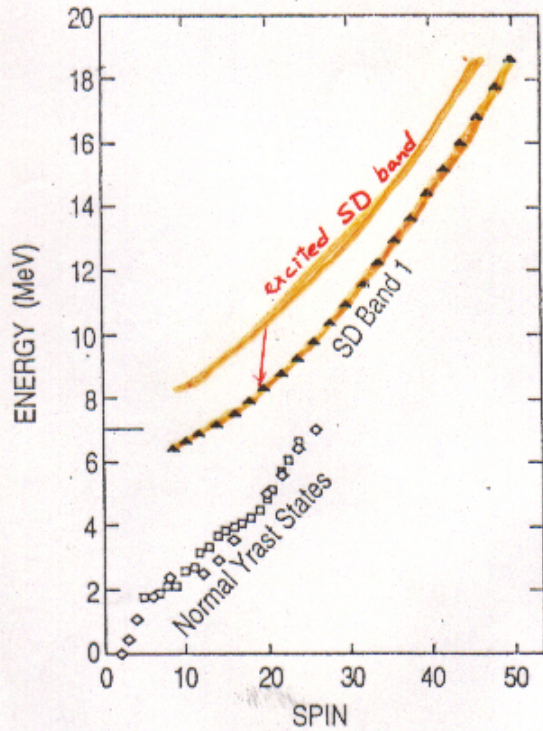
(b)

核分裂

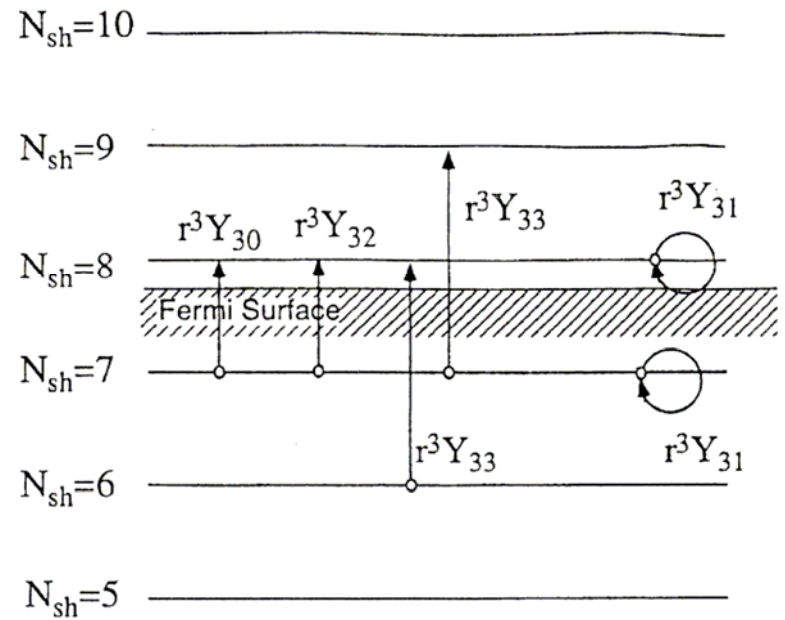
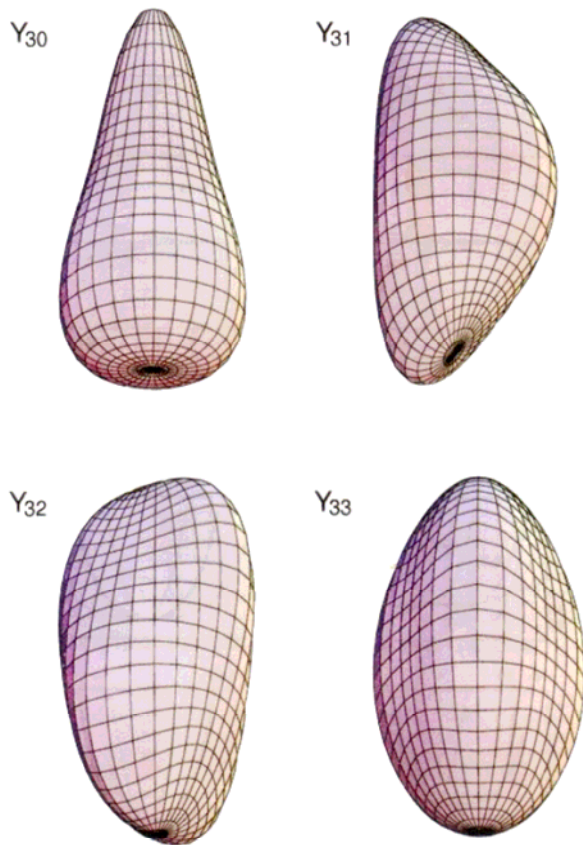


超変形イラスト状態の上に形成される新しい集団励起モードの探求

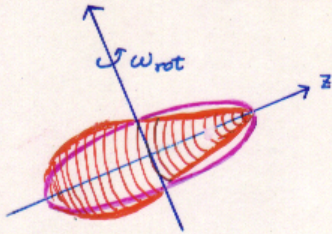
Search for New Collective Modes
built on SD High-Spin States



バナナ変形(Y31)モードは超変形のソフトモード

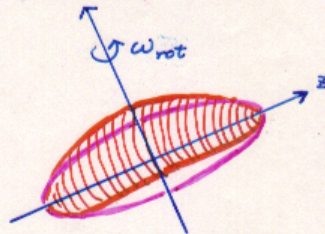


Octupole Vibrations at the 2:1 shape



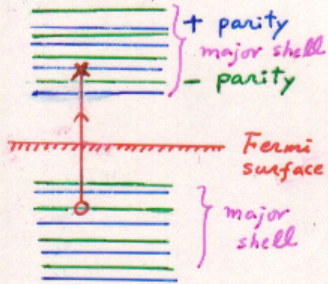
"pear"

$K=0$



"banana"

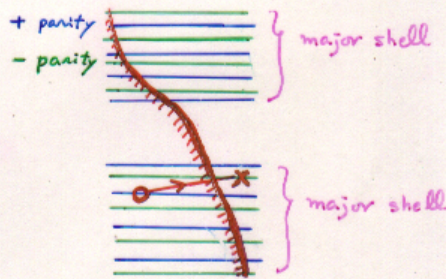
$K=1$



$\Delta=0$

$r^3 Y_{30}$

$\Delta N_{shell} = 1$



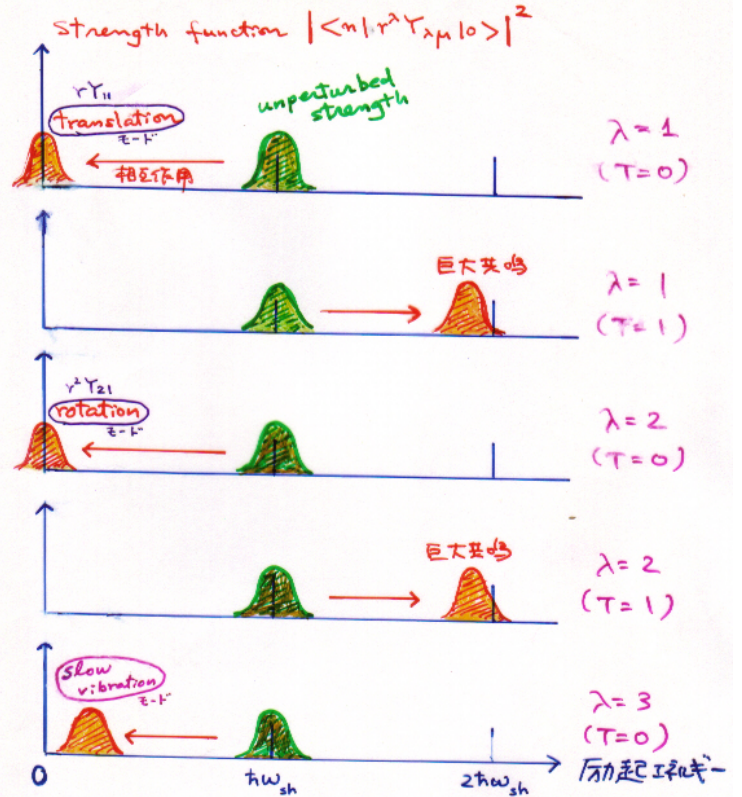
"Superconducting,
Superdeformed Nuclei"

$r^3 Y_{31}$

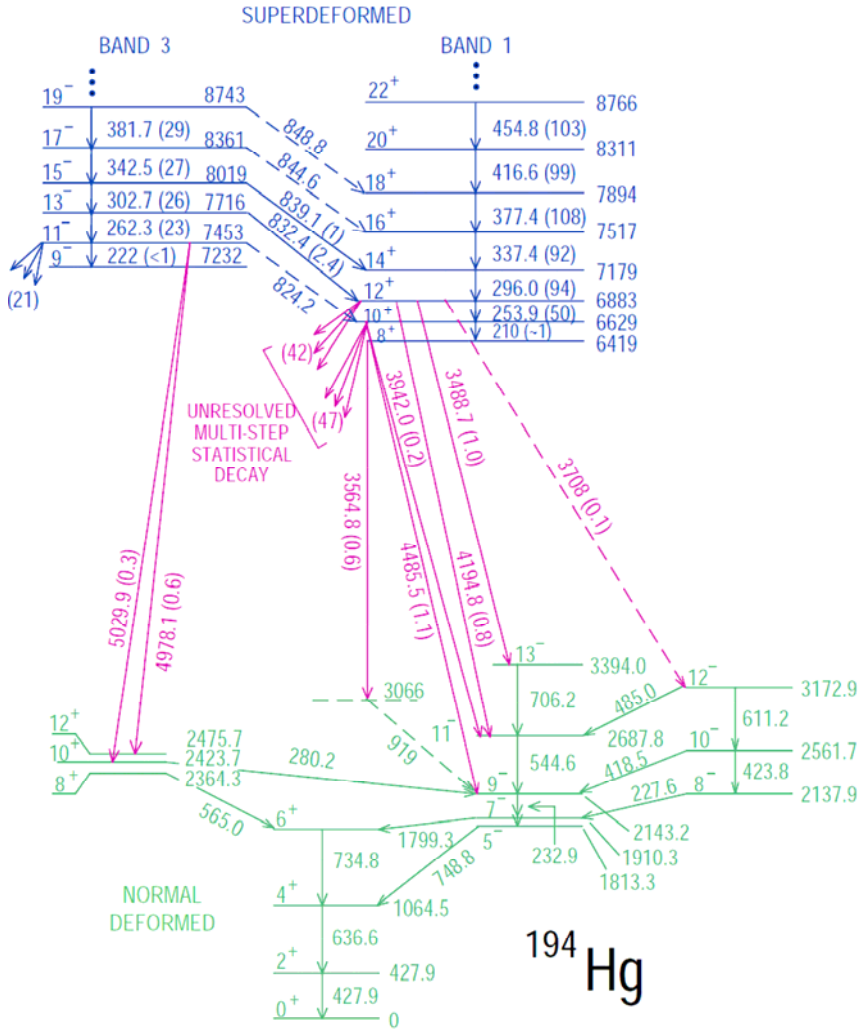
$\Delta \neq 0$

$\Delta N_{shell} = 0$

2:1 H.O. model



超変形イラストからの励起モード

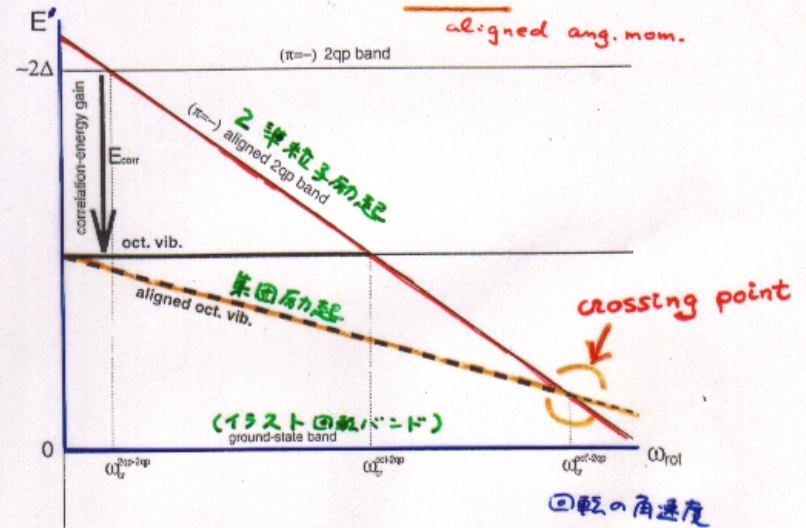


(根元念図)



イラスト系から測った

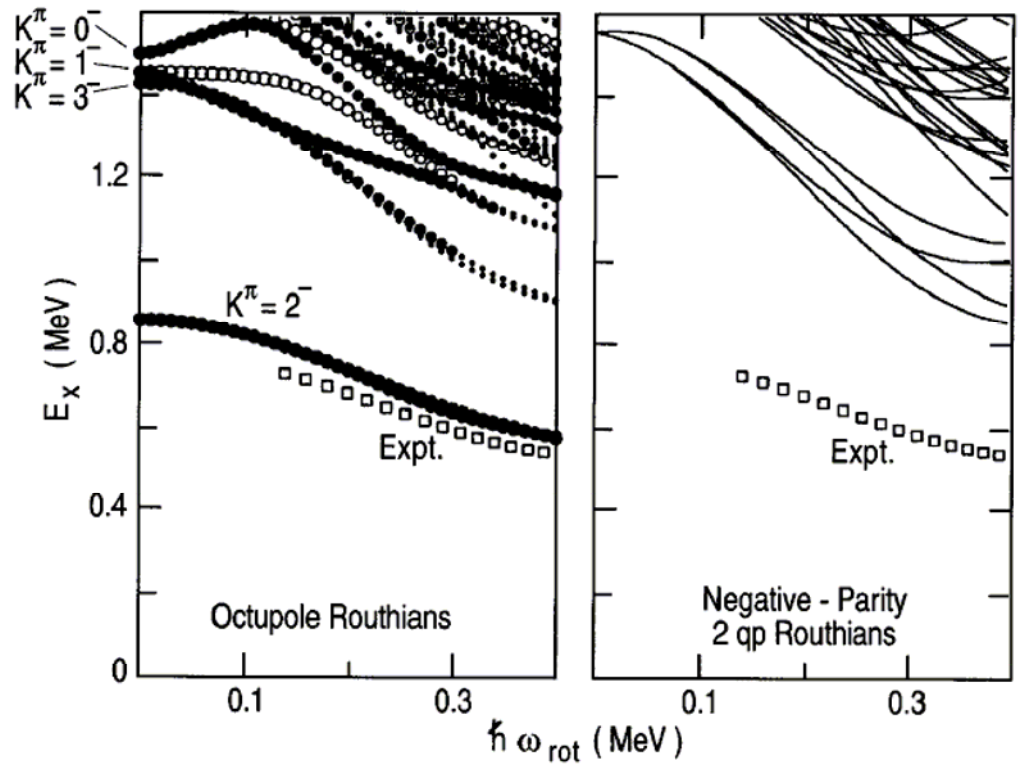
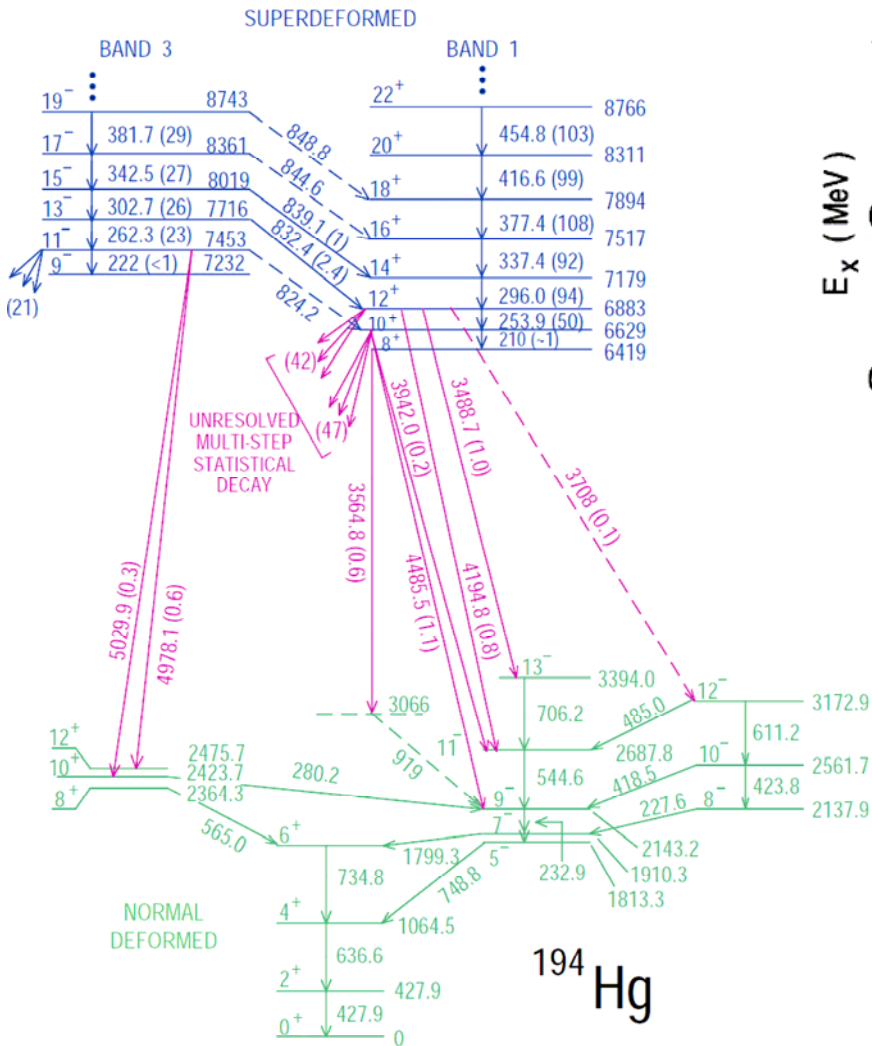
回転座標系でのエネルギー $E' = E - \omega_{rot} J_x$



aligned oct. vib. と aligned 2qp の競争

T. Nakatsukasa, K. Matsuyanagi, S. Mizutori, Y.R. Shimizu, Argonne Conf. (1996); Phys. Rev. C 53 (1996) 2213.

超変形状態の上のソフトOctupole振動モード



G. Hackman et al.,
Phys. Rev. Lett. 79 (1997) 4100