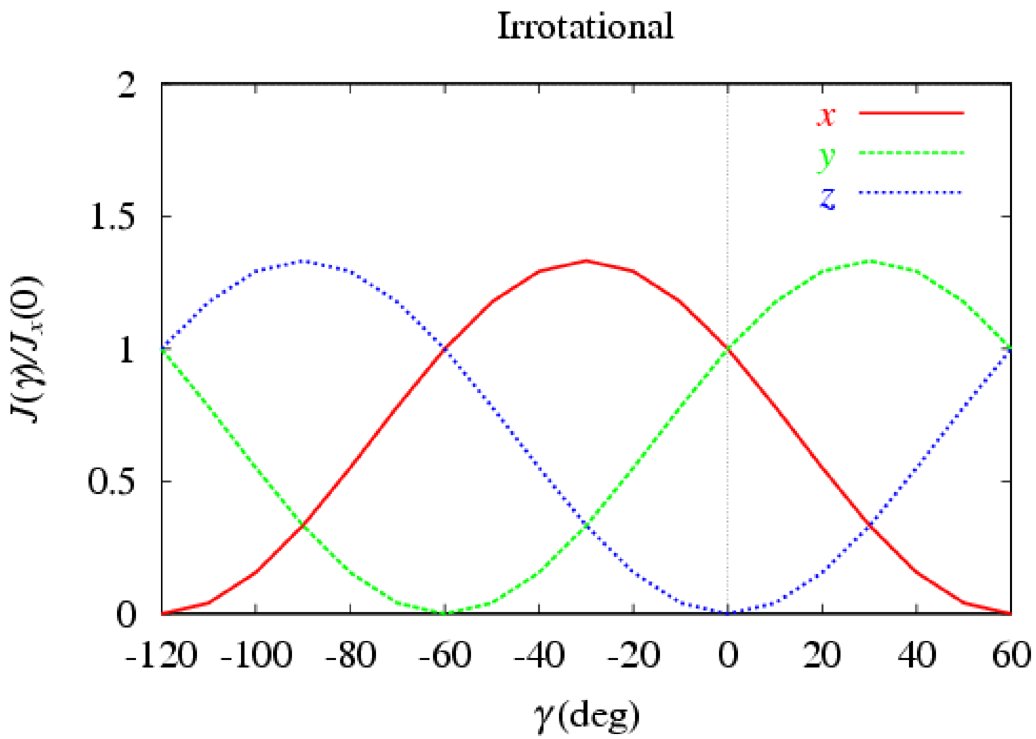
Dynamical Moments of Inertia and Wobbling Motions in Triaxial Superdeformed Nuclei

Masayuki Matsuzaki
(with S.-I.Ohtsubo, Y.R.Shimizu and K.Matsuyanagi)

Introduction

- Theory predicts Triaxial SuperDeformation at Lu-Hf region
  --- $\gamma \sim +20°$ is more favorable
- Its decisive evidence is wobbling motion
  --- Largest J_x for $\gamma > 0$?

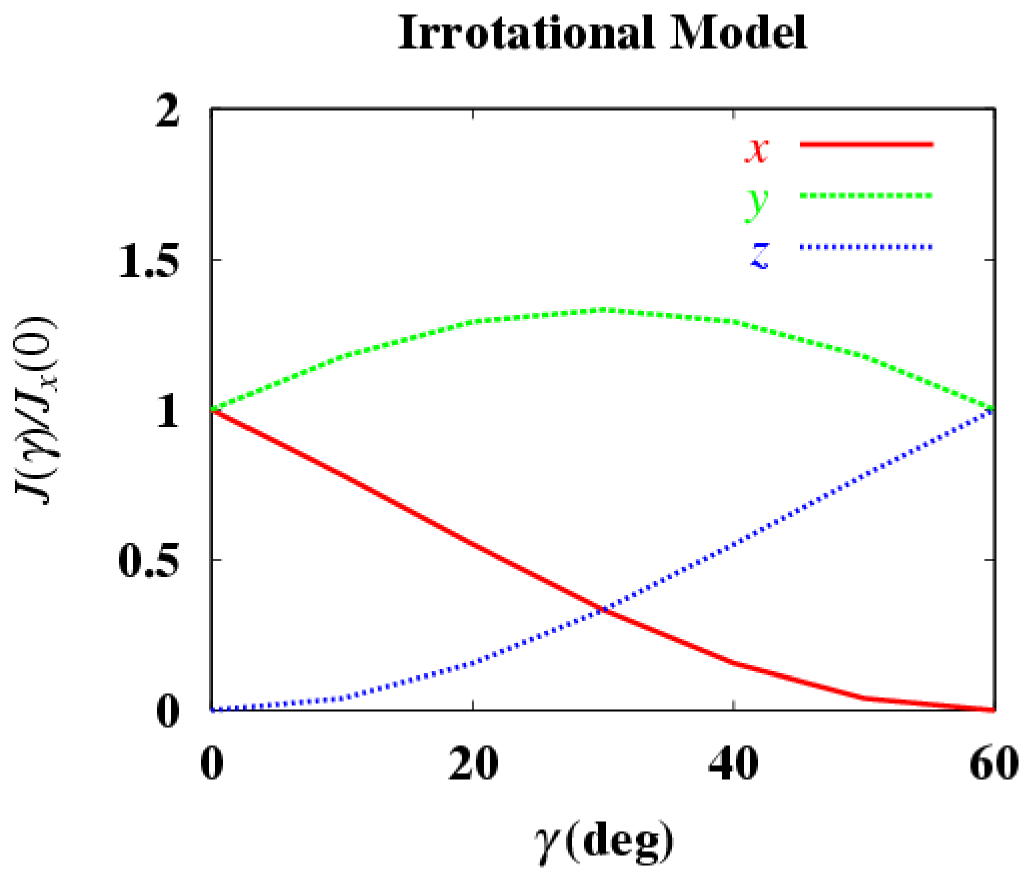
γ ~ +20° contradicts irrotational ?



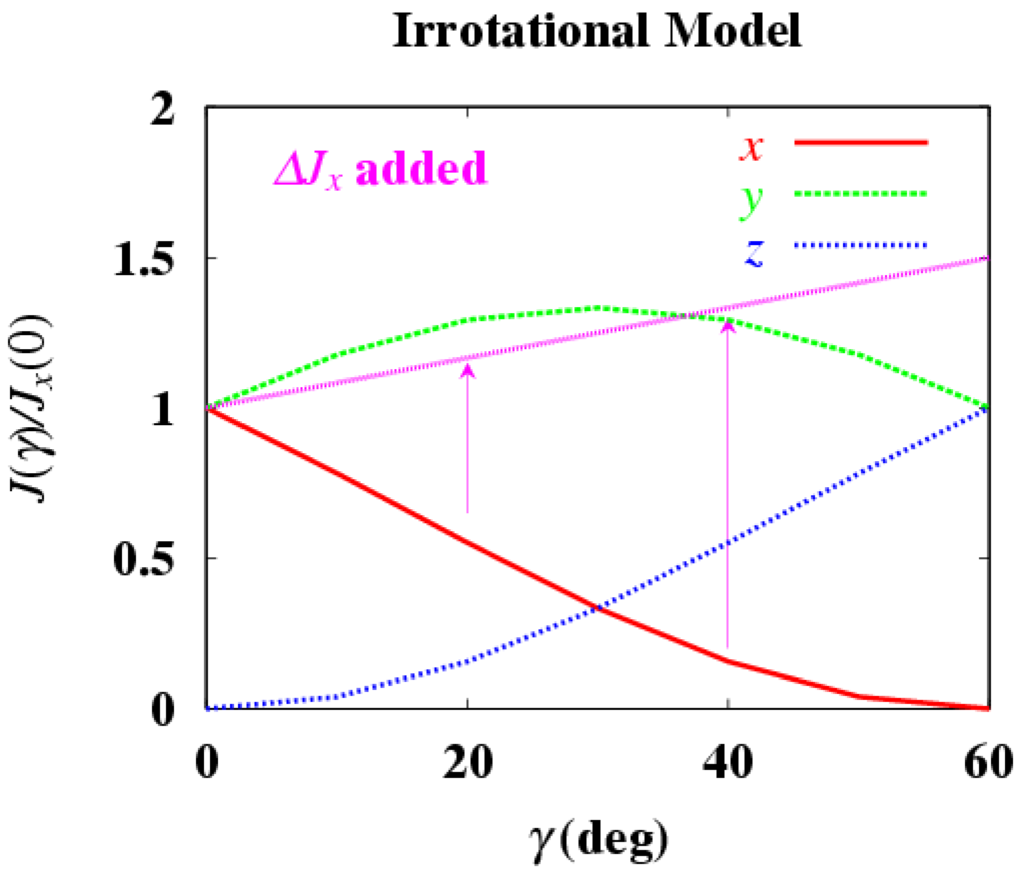
$$\hbar\omega_{\mathrm{wob}} = \hbar\omega_{\mathrm{rot}}\sqrt{\frac{(\mathcal{J}_x-\mathcal{J}_y)(\mathcal{J}_x-\mathcal{J}_z)}{\mathcal{J}_y\mathcal{J}_z}}$$ is imaginary $\Leftarrow \mathcal{J}_x < \mathcal{J}_y$

Inertia of the whole system

- Cranking model treats the “rotor” (0QP) part and aligned QP(s) on the same footing
- So does RPA …


Irrotational Model
2
1.5
1
0.5
0
0
20
40
60
x
y
z
J(γ)/J_x(0)
γ (deg)

Irrotational + QP align → $J_x > J_y$

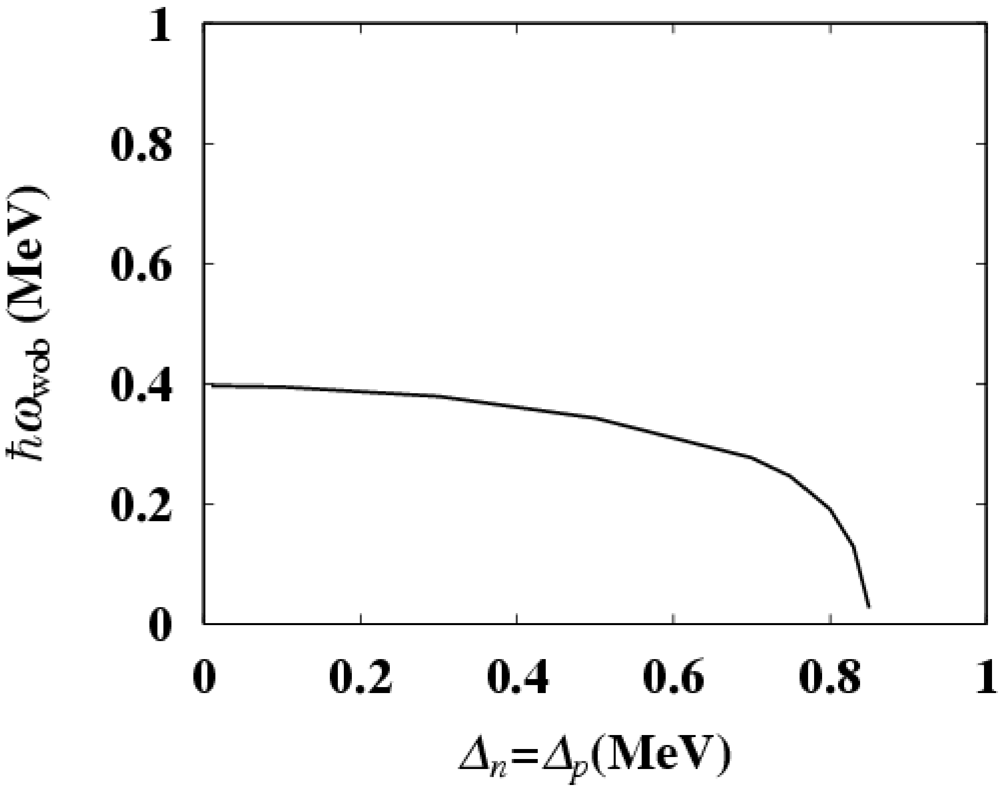


- RPA based on cranking model (à la Marshalek) gives wobbling motion:
  - excitation energy (in rotating frame)

$$\hbar\omega_{\rm wob} = \hbar\omega_{\rm rot}\sqrt{\frac{(\mathcal{J}_x - \mathcal{J}_y^{\rm (eff)}(\omega_{\rm wob}))(\mathcal{J}_x - \mathcal{J}_z^{\rm (eff)}(\omega_{\rm wob}))}{\mathcal{J}_y^{\rm (eff)}(\omega_{\rm wob})\mathcal{J}_z^{\rm (eff)}(\omega_{\rm wob})}}$$

  - dynamical inertia $\mathcal{J}_y^{\rm (eff)}(\omega_{\rm wob})$, $\mathcal{J}_z^{\rm (eff)}(\omega_{\rm wob})$

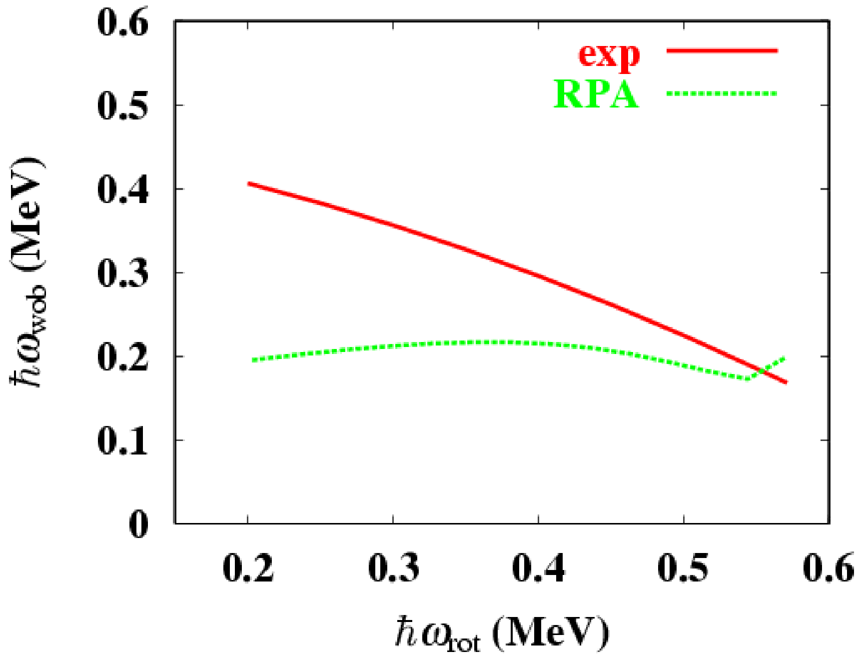
^{168}Hf (low spin)

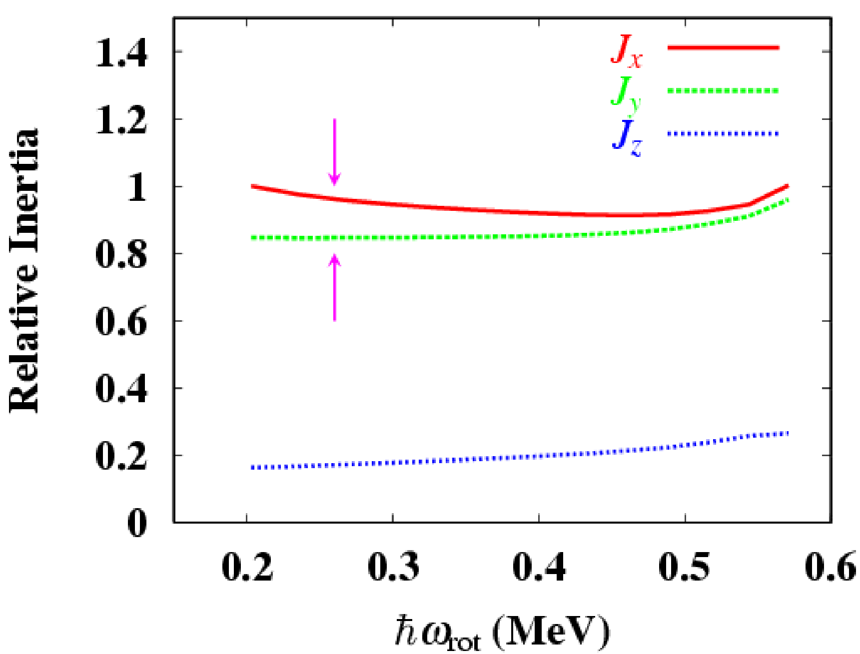


Exists at Δ→0
… contrastive to
β and γ vib.

PRC69, 034325 ('04)

^{163}Lu



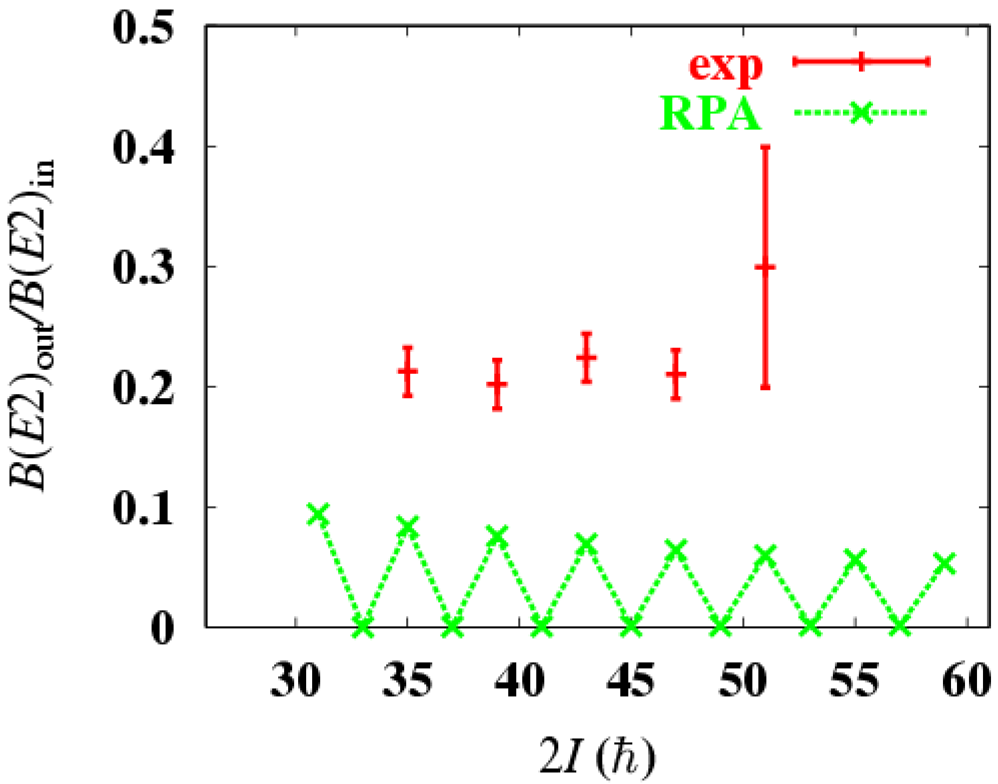


Not $\propto\omega_{rot}$!

Automatically ω_{rot}-dependent

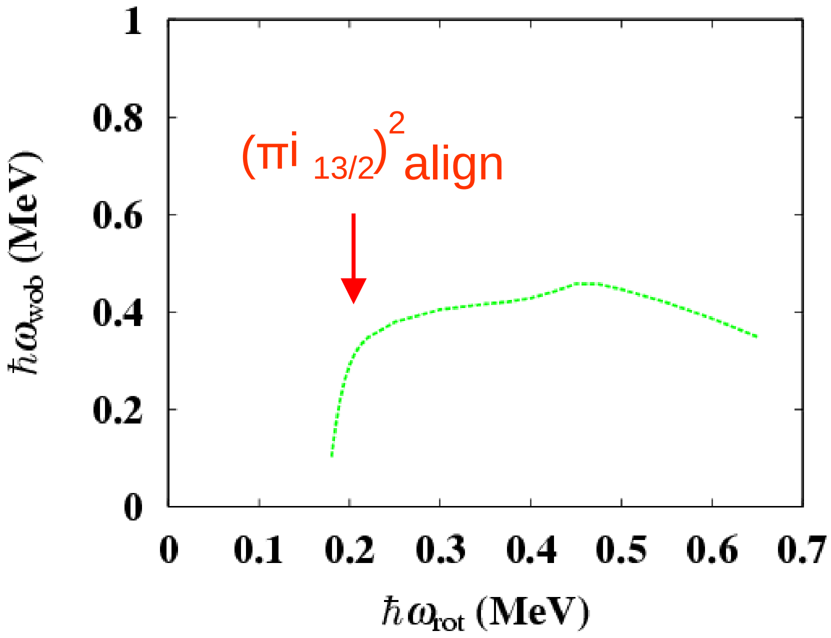
PRC65, 041303(R) ('02)

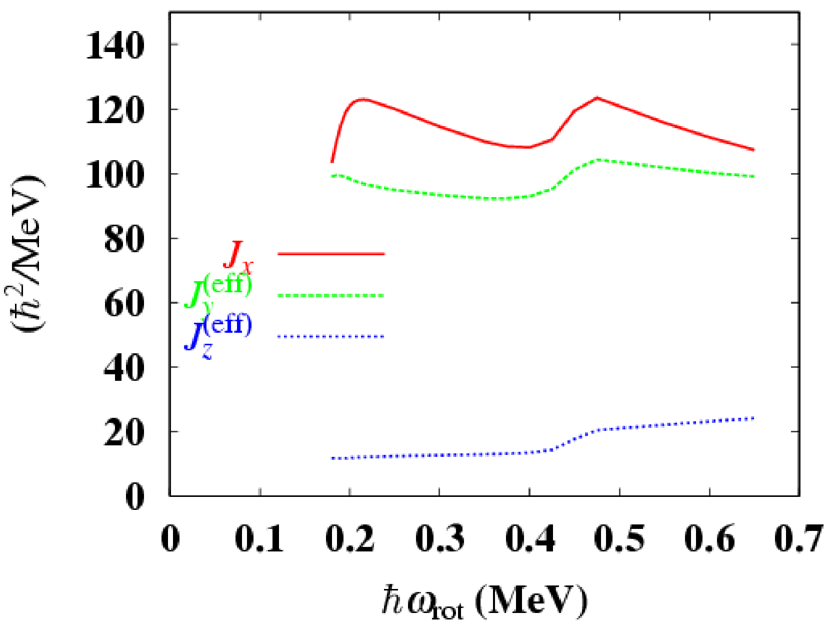
^{163}Lu



Extremely collective
as an RPA solution
but …

^{168}Hf

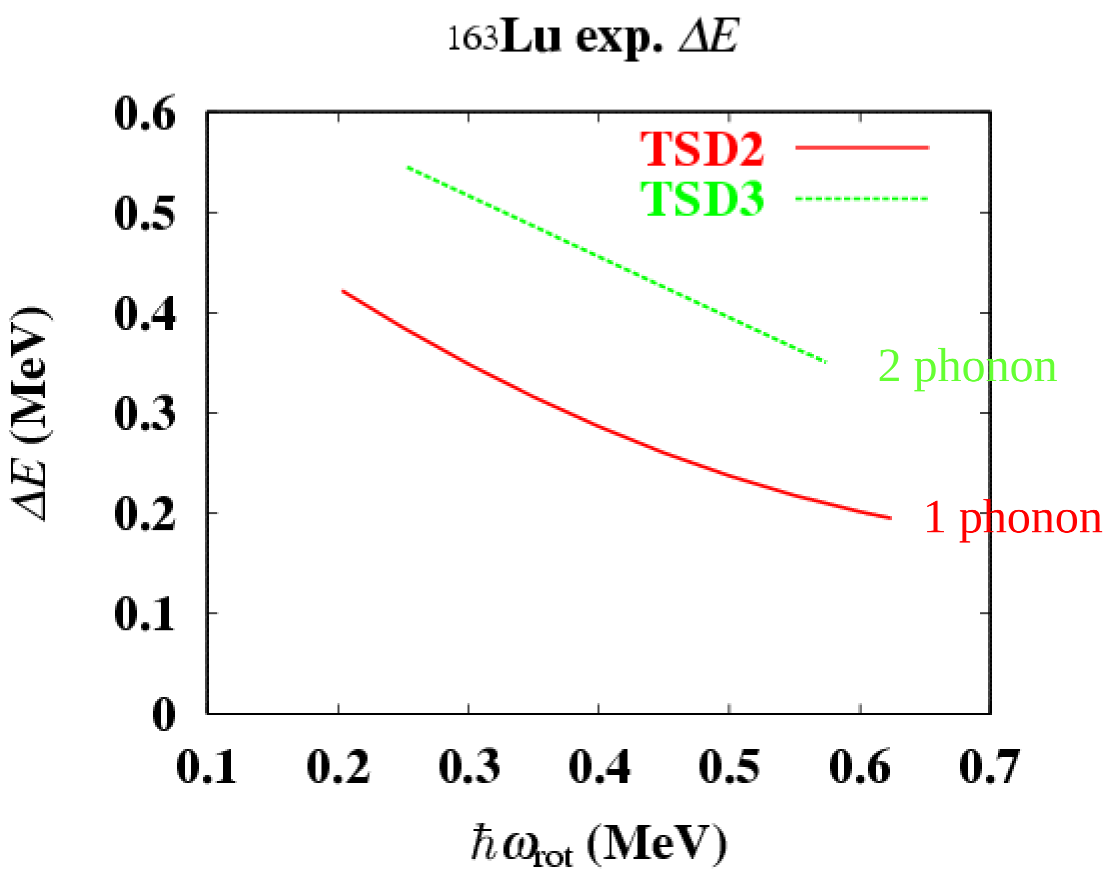


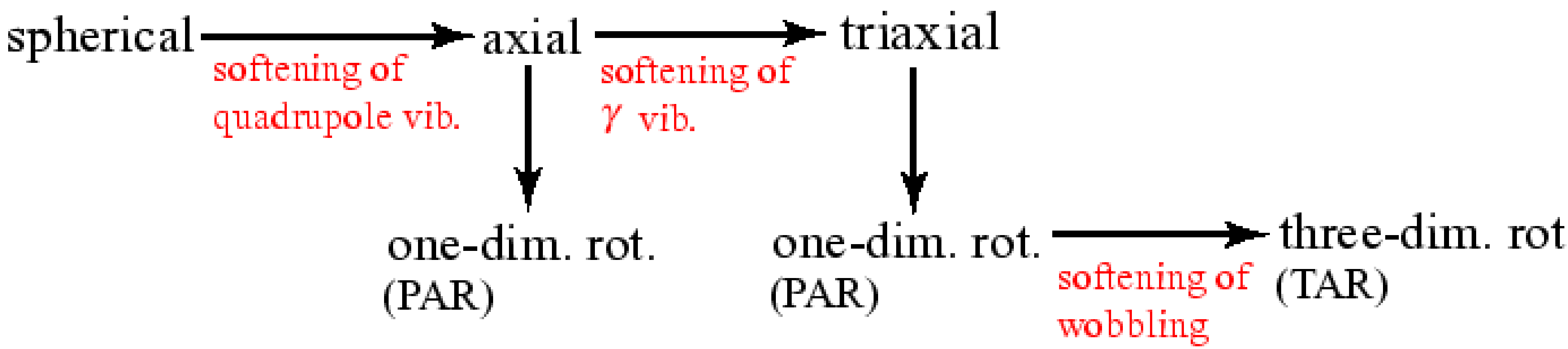


PRC69, 034325 ('04)

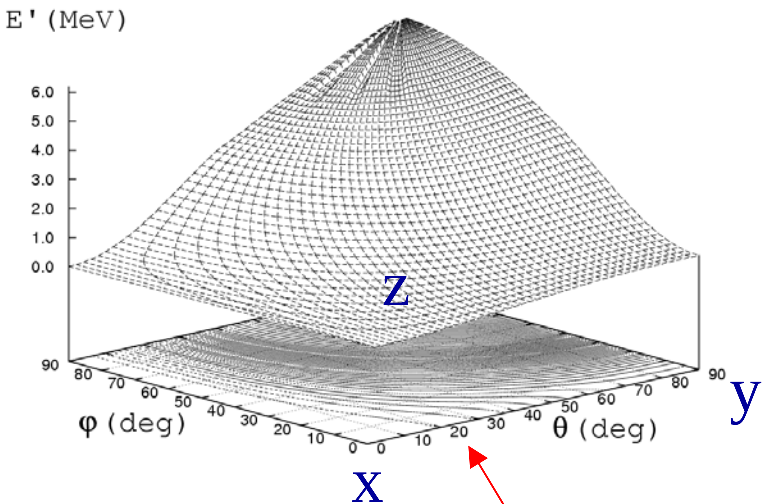
Summary (1)

- ΔJ_x from QP alignment superimposed on irrot.-like inertia brings $J_x > J_y$ for $\gamma>0$
- Wobbling mode in ^{163}Lu is naturally described semi-quantitatively but collectivity is insufficient


163Lu exp. ΔE
TSD2
TSD3
2 phonon
1 phonon
ΔE (MeV)
0 0.1 0.2 0.3 0.4 0.5 0.6
0.1 0.2 0.3 0.4 0.5 0.6 0.7
ħω_rot (MeV)

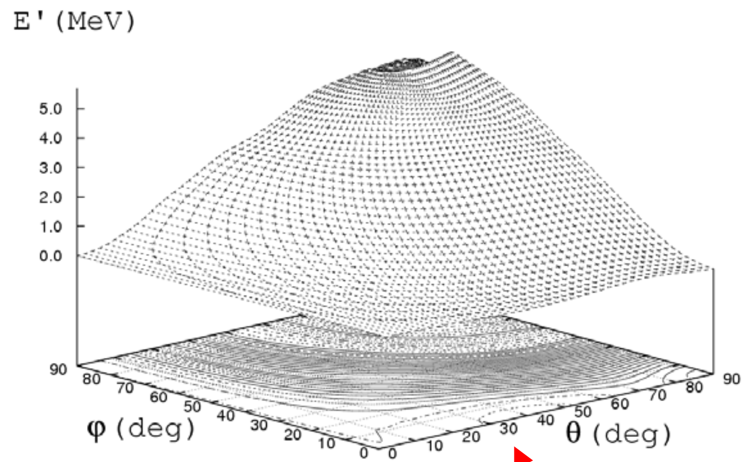

spherical
softening of
quadrupole vib.
axial
softening of
γ vib.
triaxial
one-dim. rot.
(PAR)
one-dim. rot.
(PAR)
softening of
wobbling
three-dim. rot.
(TAR)

^{163}Lu (1QP)



Shallow

^{162}Yb (0QP)



Tilted !

PRC69, 064317 ('04)

Summary (2)

- In general, instability of wobbling leads to tilted axis rotation --- "Phase transition"
- Anharmonicity in 2 phonon wobbling suggests softening of potential surface
- Tilted axis rotation would realize if it were not for the $\pi i_{13/2}$ QP