Nov. 2, 2000, INT, Seattle

## Why are there much more prolate nuclei than oblate ones ?

N. Tajima, N. Suzuki (Fukui Univ.)

- Macroscopic (Coulomb) or collective effects (W. Zickendraht, 1985) are not strong enough.
- Shell effect of anisotropic harmonic oscillator (Castel et al., 1990) is rather neutral.
- Woods-Saxon radial profile (H. Frisk, 1990)
- unique-parity high-$j$ intruder due to spin-orbit potential (N.T. et al., 1996)

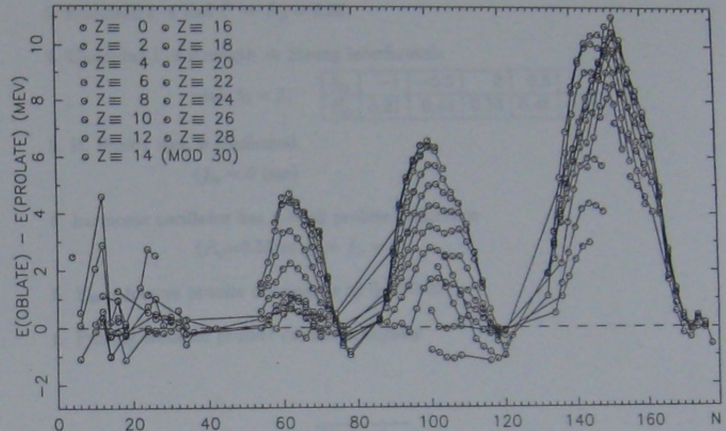
We study

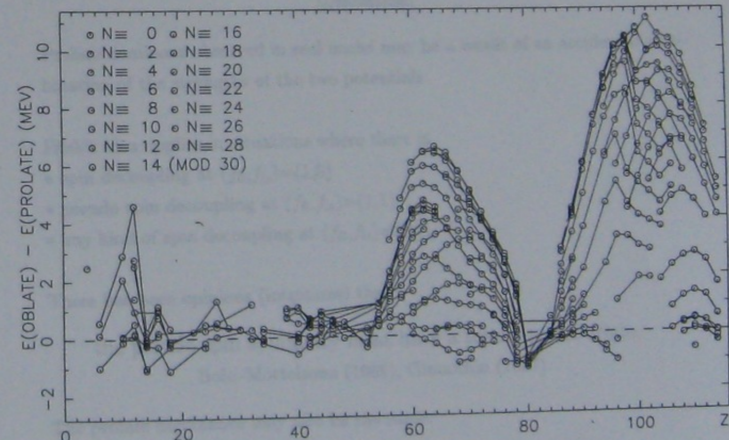
the ratio of prolate nuclei among well deformed nuclei, $R_{\rm p}$,

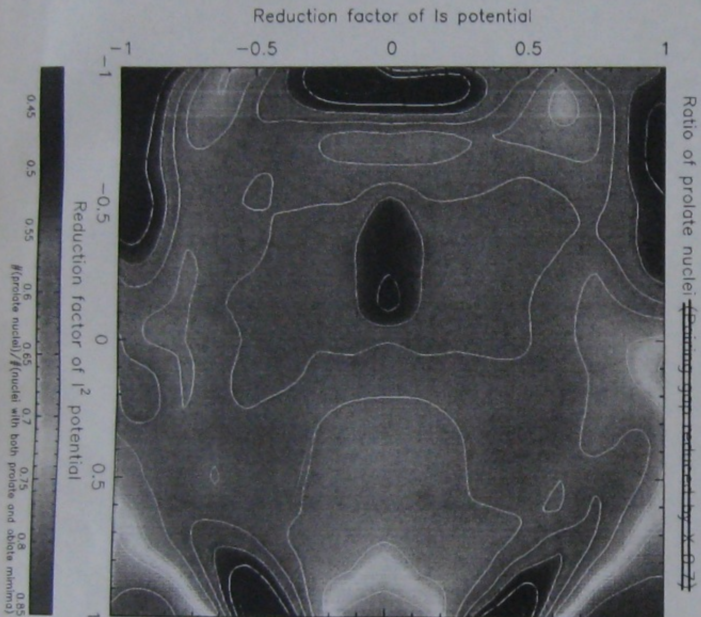
as a function of the strengths of $ls$ and $l^2$ potentials of the Nilsson model.

$$U(\mathrm{r}) = \frac{1}{2}\left(\omega_\perp^2 x^2 + \omega_\perp^2 y^2 + \omega_\parallel^2 z^2\right) + 2\hbar\omega_0 r_t^2 \sqrt{\frac{4\pi}{9}}\epsilon_4 Y_{40}(\hat{r})$$
$$+ f_{ls} 2\kappa\hbar\omega_0 \mathrm{l}_t\cdot\mathrm{s} - f_{ll}\kappa\mu\hbar\omega_0\left(\mathrm{l}_t^2 - \langle \mathrm{l}_t^2\rangle_N\right)$$

- volume conservation: $\omega_\perp^2\omega_\parallel = $ constant. $\to \omega_\perp(\epsilon_2), \omega_\parallel(\epsilon_2)$
- $\epsilon_4$ optimized for each $\epsilon_2$
- standard $\kappa$ and $\mu$ of Bengtsson and Ragnarsson (1985)
- pairig force such that average pairing gap $\bar{\Delta} = 13/\sqrt{A}$ MeV
- Strutinsky method
- 1834 even even nuclei with $8 \le Z \le 126$ and $8 \le N \le 184$ between drip lines for each of $17 \times 17$ sets of $(f_{ll}, f_{ls})$






## Summary of the results

1. Standard $\mathbf{l}\cdot\mathbf{s}$ and $\mathbf{l}^2 \Rightarrow R_p = 0.86$.
2. Changing $\mathbf{l}\cdot\mathbf{s}$ strength $\Rightarrow$ Strong interference:

   with $f_{ll} = 1$,

| $f_{ls}$ | −1 | −0.5 | 0 | 0.5 | 1 |
|---|---|---|---|---|---|
| $R_p$ | 0.81 | 0.44 | 0.78 | 0.45 | 0.86 |

3. H. Frisk's idea is confirmed.

   ($f_{ls} = 0$ line)
4. harmonic oscillator has a weak prolate preference

   ($R_p$=0.55 at $f_{ll} = f_{ls} = 0$)
5. $Y_{40}$ enhances proalte dominance by 0.03-0.05
6. Pairing weakens prolate dominace slightly

## Discussion

Prolate dominace observed in real nuclei may be a result of an accidental combination of the strengths of the two potentials.

Frisk's idea applies in situations where there is

- spin decoupling at ($f_{ll}$,$f_{ls}$)=(1,0)
- pseudo spin decoupling at ($f_{ll}$,$f_{ls}$)=(1,1)
- any kind of spin decoupling at ($f_{ll}$,$f_{ls}$)=(1,-1) ?

There has been opinions (intuitions) that

the pseudo spin symmetry must have a fundamental origin,

Bohr-Mottelsonn (1969), Ginocchio (1997).

The prolate dominance may also be the same.