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Shell Closure at N, Z=40 in the vicinity of ^{56}Ni region

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Plan

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Introduction

✓ Study of nuclei in the vicinity of closed shells has a great interest for nuclear structure identification, particularly nuclei with few valence nucleons around N, Z=28 shells.

✓ Spectroscopic properties of even-even $_{28}$Ni isotopes and N=28 isotones in mass region A=58-70 around ^{56}Ni were studied by performing shell model calculations using Nushell code with different effective interactions Jun45pn, jj44b and jj44pna for *f5pg9* model space.

✓ The calculated E(2^+_1), B(E2, $2^+_1 \rightarrow 0^+_1$), the ratios $R_{4/2}$ and $B_{4/2}$ are compared with the available experimental data.

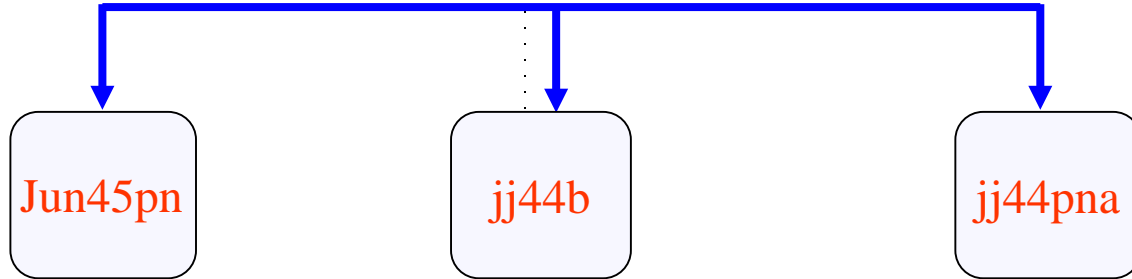✓ Our present investigation forecasts that N, Z=40 is a new magic numbers for ^{56}Ni region.

Model Space

f5pg9 model space

- ^{56}Ni core
- Valence orbits: *$2p_{3/2}$, $1f_{5/2}$, $2p_{1/2}$, $1g_{9/2}$*

Effective interactions

Jun45pn

jj44b

jj44pna
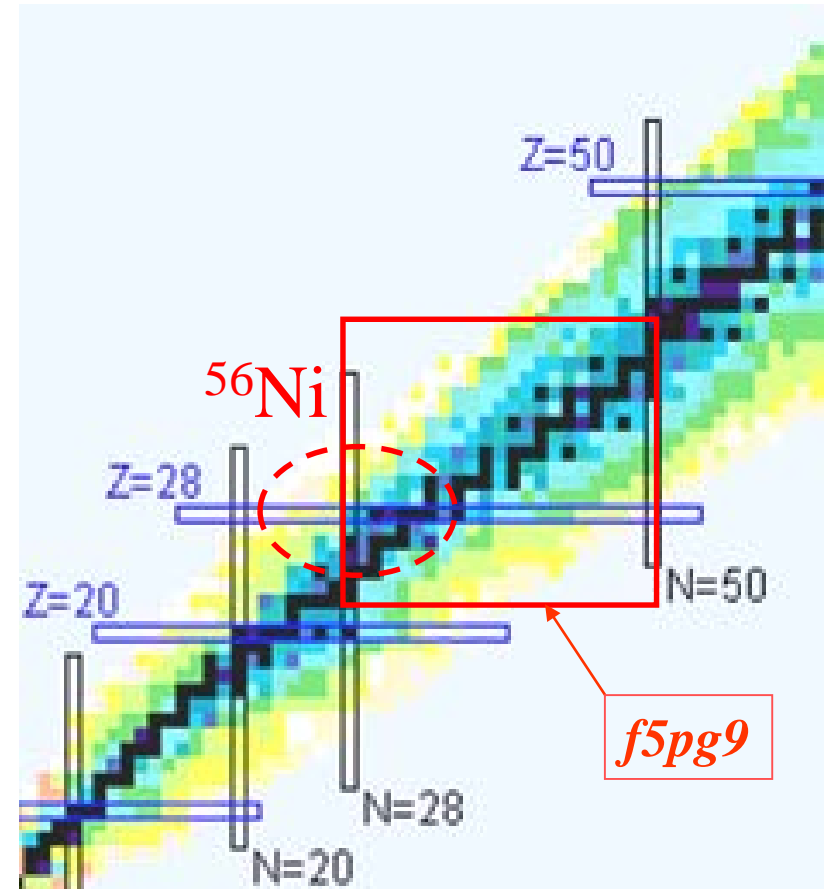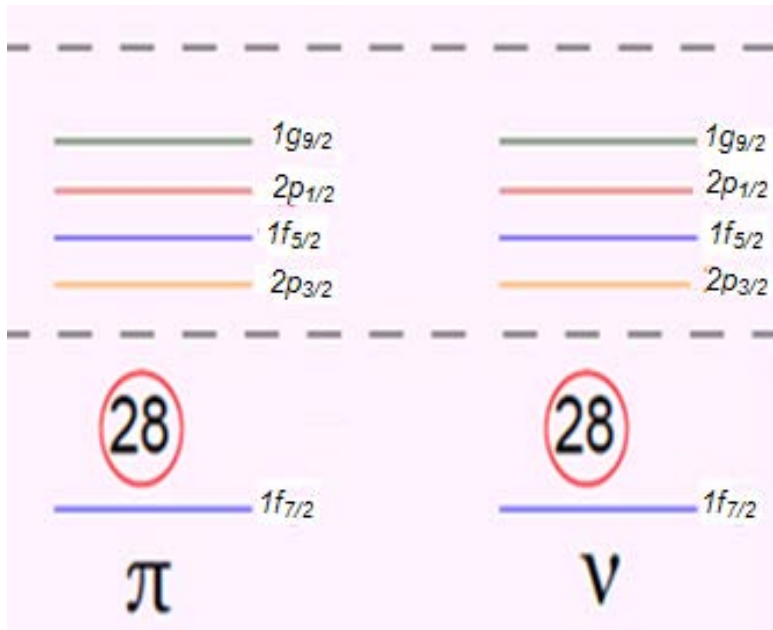
Honma *et al.* ,
Phys. Rev. C 80,
064323 (2009)

Brown and Lisetskiy
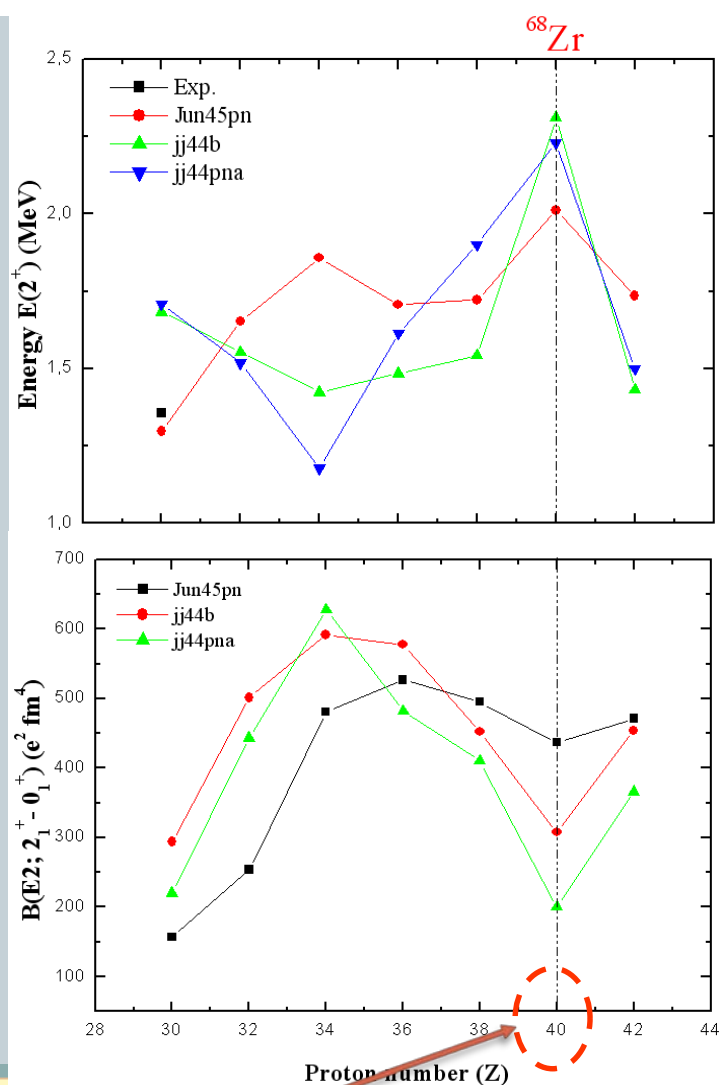(unpublished); or B. Cheal
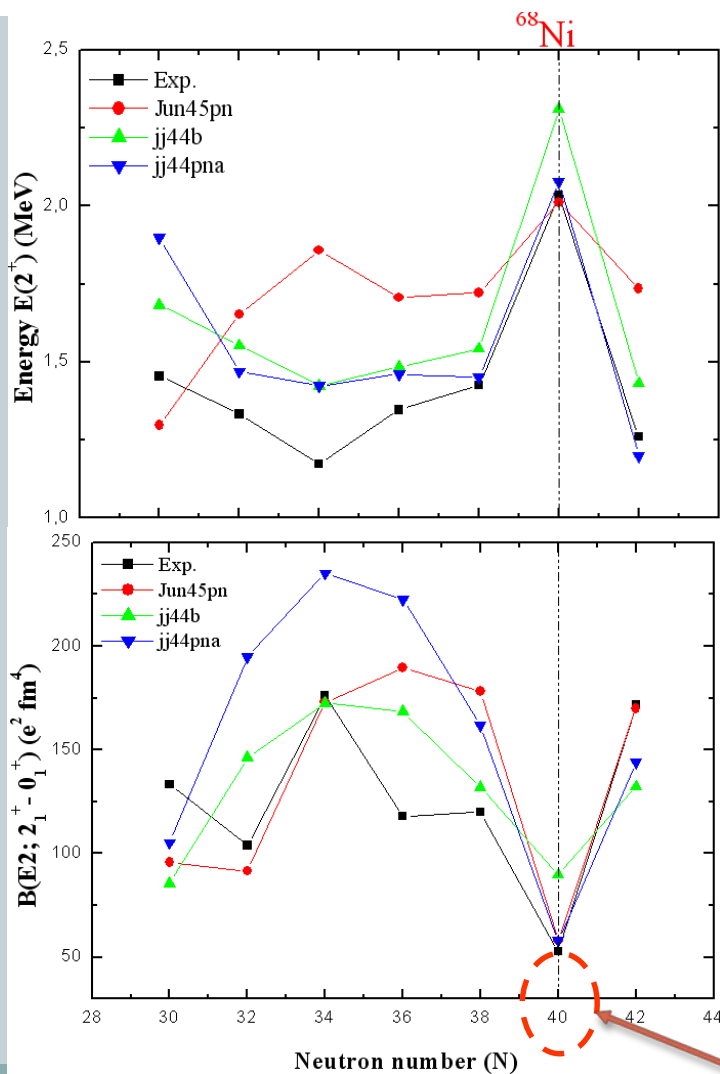*et al.,* Phys. Rev. Lett. 104,
252502 (2010)

Lisetskiy *et al.,*
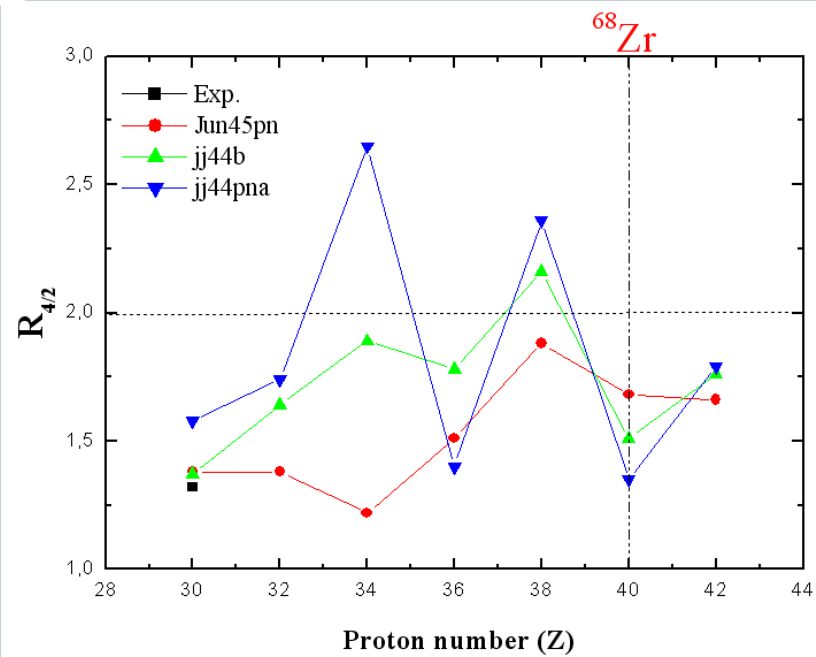Phys. Rev. C 70,
044314 (2004)

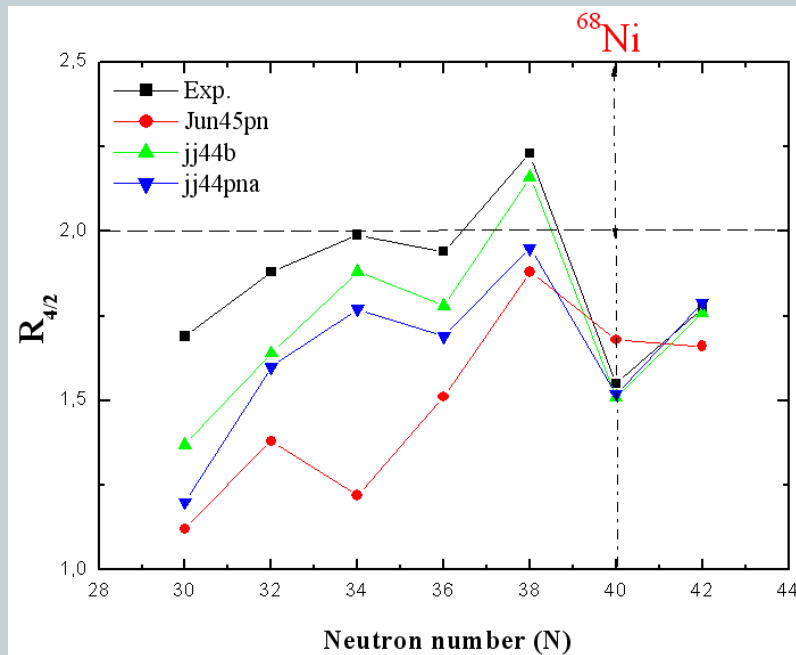## *Shell model code*

- Nushell

  B. A. Brown and W.D.M. Rae, Nucl. data sheets 120, 115 (2014)

$E(2^+_1)$, $B(E2, 2^+_1 \longrightarrow 0^+_1)$

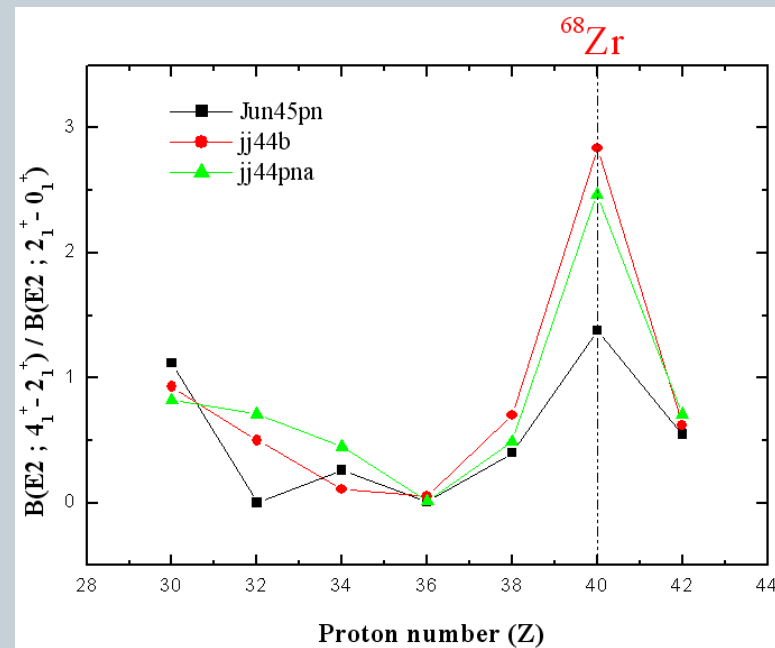*Subshell closure*
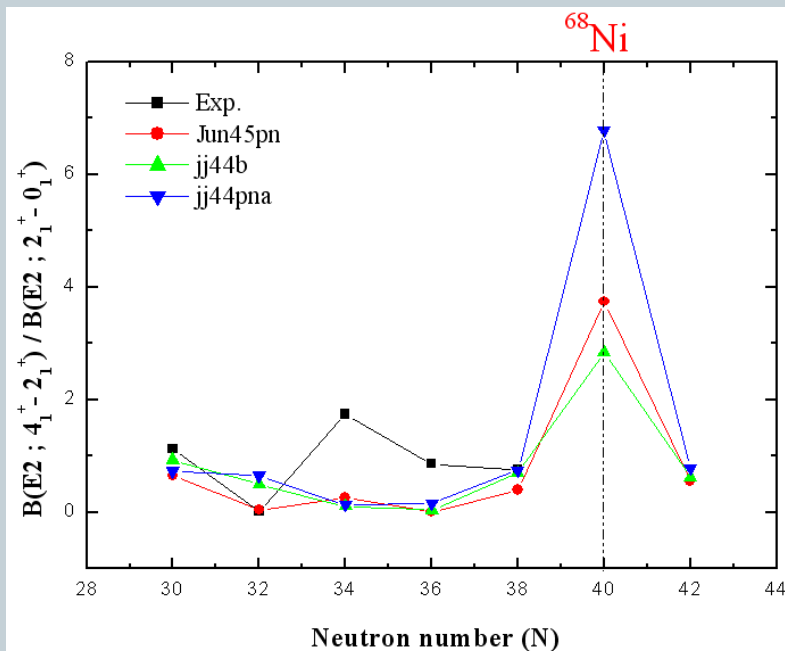
Energy ratio R$_{4/2}$

$$R_{4/2} = E(4^+_1) / E(2^+_1)$$

- $R_{4/2} < 2$ ⟹ Near sub shell closure at N, Z=40

Transition probabilities ratio $B_{4/2}$

$$B_{4/2} = B(E2, 4^+_1 \rightarrow 2^+_1)/B(E2, 2^+_1 \rightarrow 0^+_1)$$

A large ratio $B_{4/2}$ ⟹ Sub shell closure at N, Z=40

Conclusion

➢ The appearance of new shell closure in even-even $_{28}$Ni isotopes and N=28 isotones in mass region A=58-70 has been studied using *f5pg9* space model with ^{56}Ni core.

➢ The microscopic calculations have been performed by means of Nushell code with three effective interactions Jun45pn , jj44b and jj44pna.

➢ The results of our theoretical calculations have been compared with experimental data. A very good agreement was obtained with jj44b interaction.

➢ Based on the calculated values of the spectroscopic parameters, $E(2^+_1)$, B(E2, $2^+_1 \rightarrow 0^+_1$), $R_{4/2}$ and $B_{4/2}$ ratios, we have reproduced the new magic number N, Z=40 in ^{68}Ni and ^{68}Zr nuclei with all interactions.

➢ Finally, the experimental data have been well described by our calculations. Wherever data does not exist, our results will possibly provide predictions of unexplored properties of even-even Nickel isotopes and N=28 isotones in mass region A=58-70.

Thank you for your attention