Group Meeting 10.25

Reading Phys. Rev. Lett 127, 262502 (2021)

First Observation of the Four-Proton Unbound Nucleus ^{18}Mg

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Result

They assume the decay takes two steps.

$$^{18}_{12}Mg_{g.s.} \rightarrow \, ^{16}_{10}Ne_{g.s.} + 2p$$

$$^{16}_{10}Ne_{g.s.} \rightarrow \, ^{14}_{8}O_{g.s.} + 2p$$

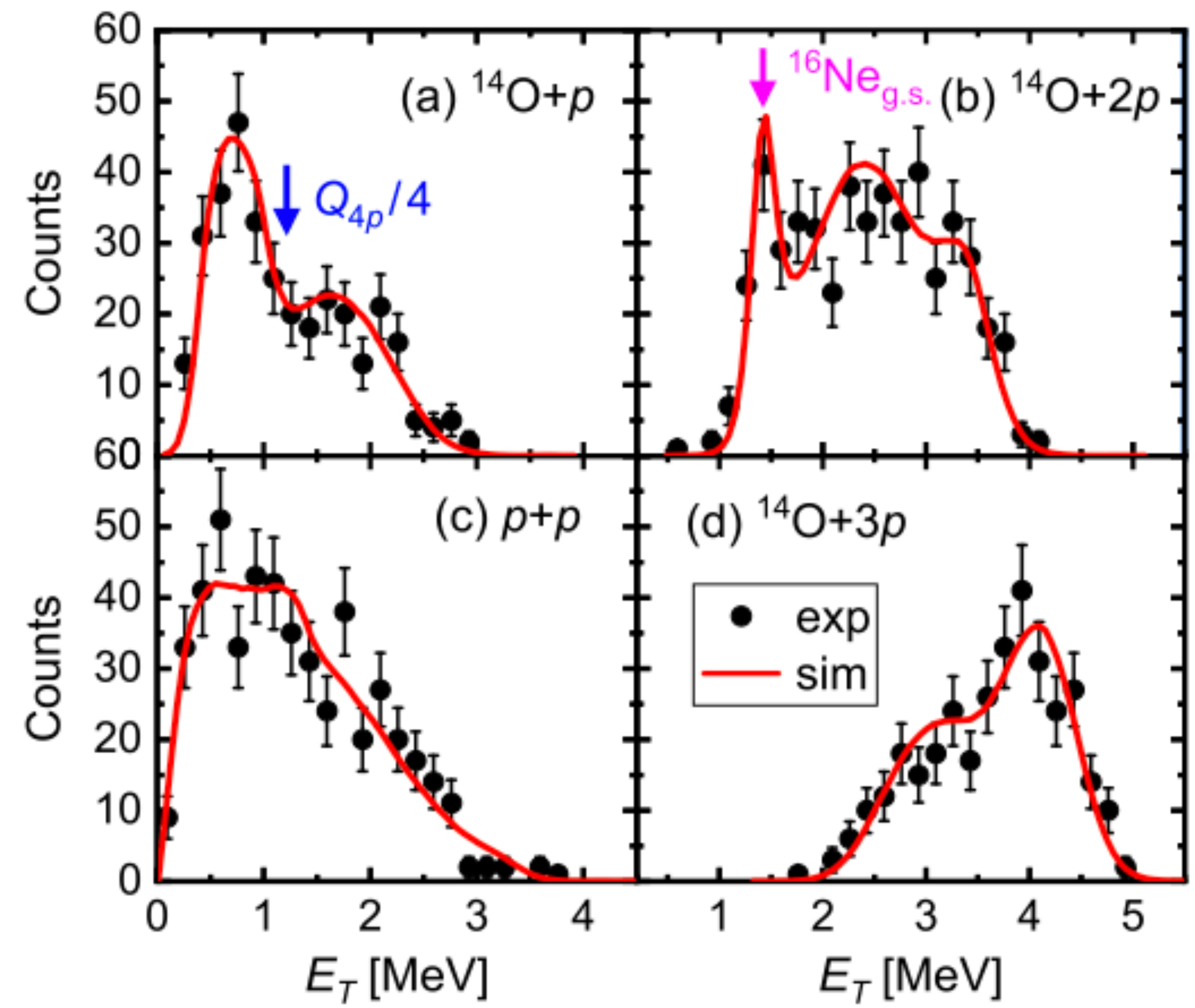
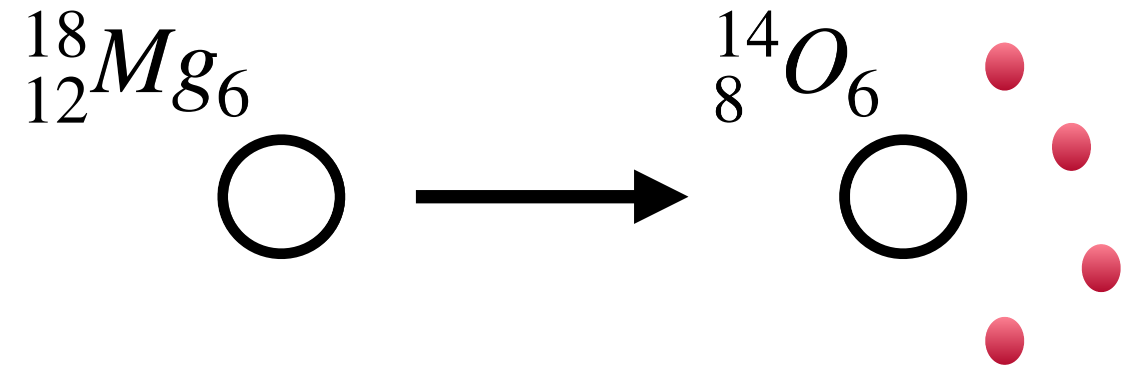
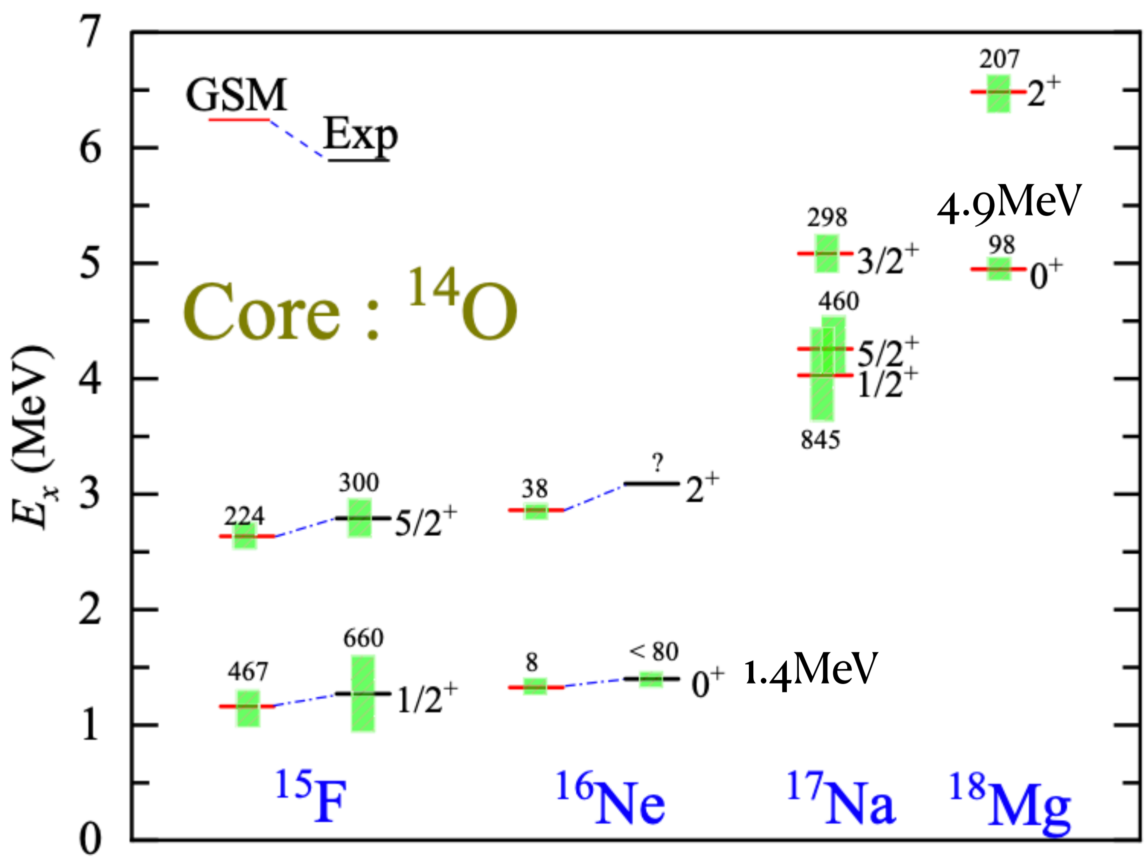


FIG 1: The Decay energy spectra for the indicated subsystems of $^{18}Mg_{g.s.}$, like core+p, core+2p, core+3p, p+p. The red lines are the result from

Result





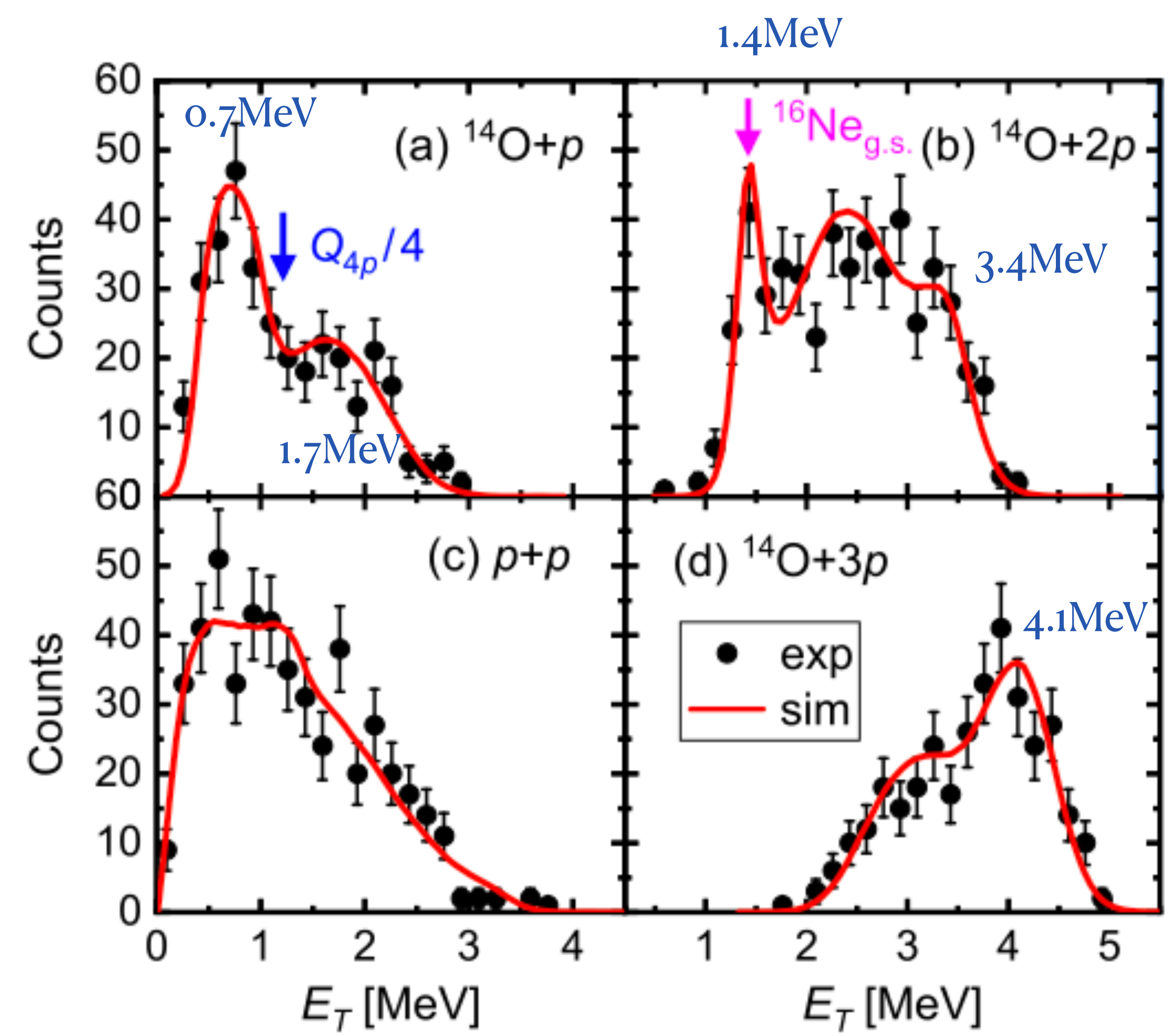
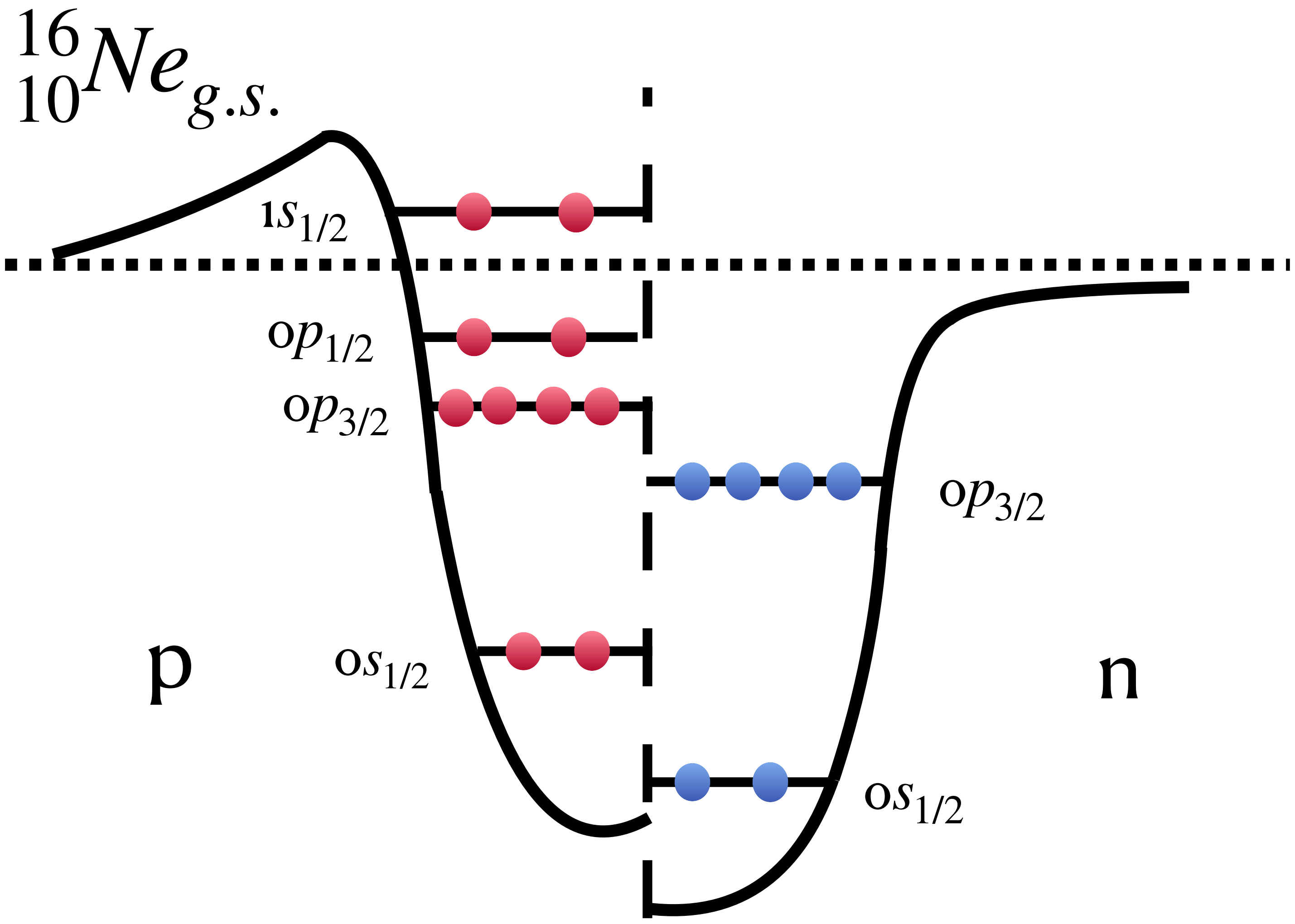


FIG 2: Excitation energies (E_X, in MeV) and widths (in keV) of ground and excited states. Energies are given with respect to the ^{14}O core. [1]

[1] N. Michel, J. G. Li, F. R. Xu, and W. Zuo, Phys. Rev. C 103, 044319 (2021).

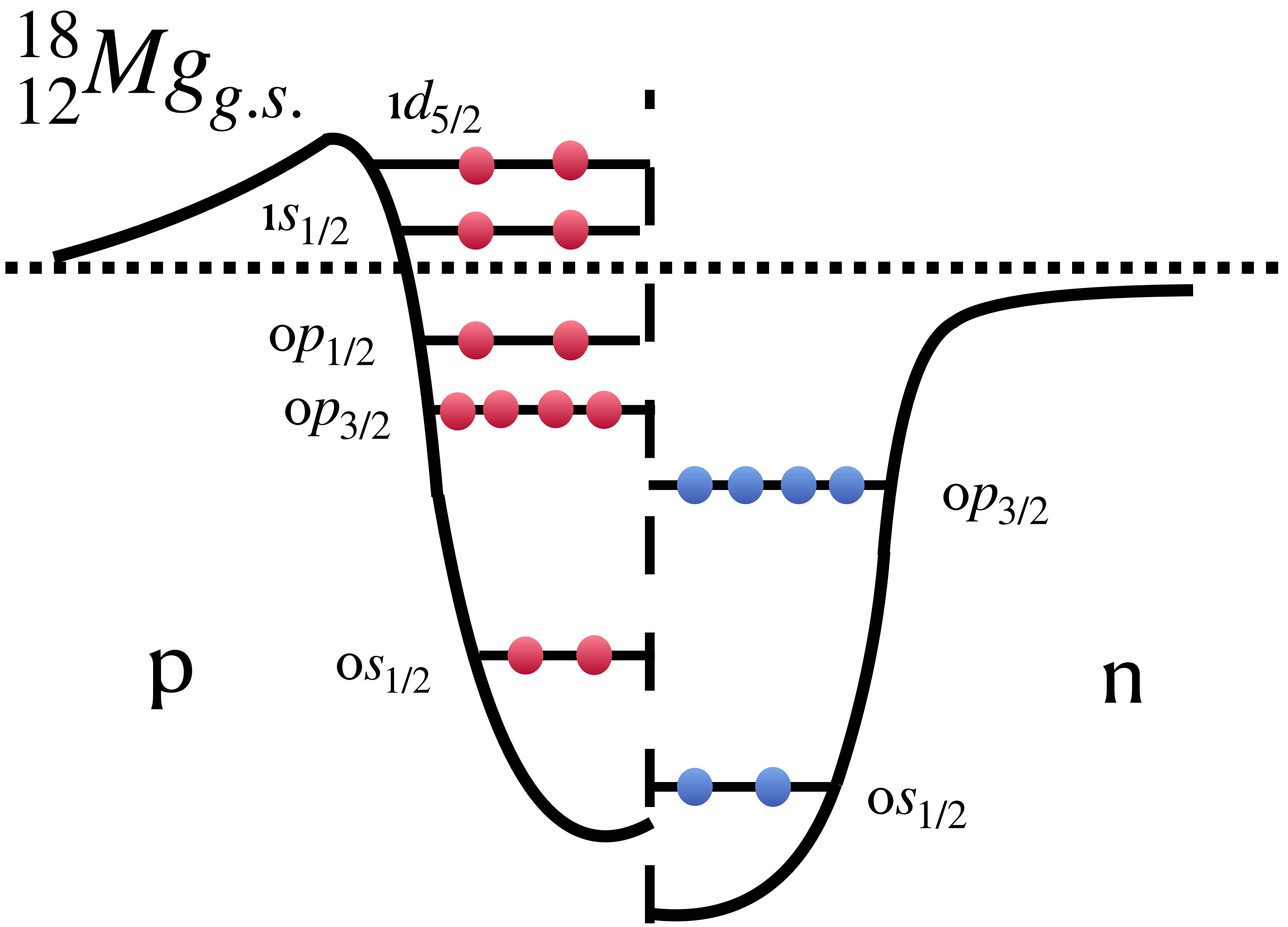
Result

The known $^{16}_{10}Ne_{g.s.}$ decay is dominated by the emission of 2 s1/2 protons.[2]

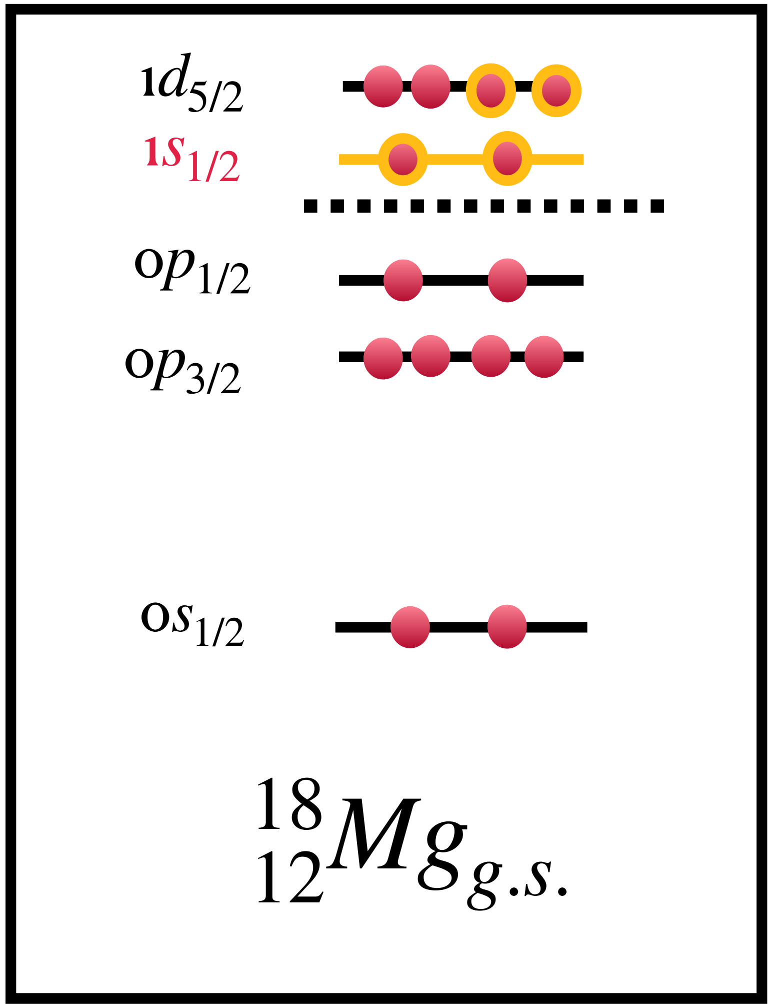


[2]. T. B. Webb, R. J. Charity, J. M. Elson, D. E. M. Hoff, C. D. Pruitt, L. G. Sobotka, K. W. Brown, J. Barney, G. Cerizza, J. Estee et al., Phys. Rev. C 100, 024306 (2019).

Result



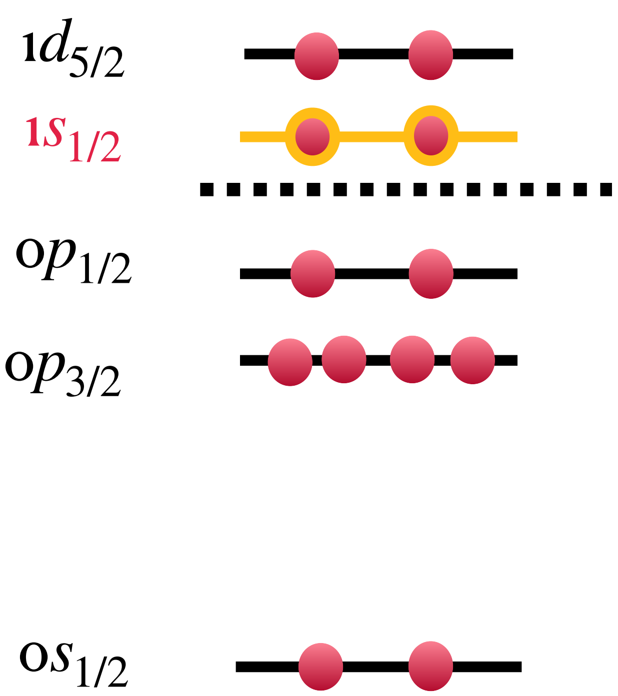
$^{18}_{12}Mg_{g.s.}$
$1d_{5/2}$
$1s_{1/2}$
$0p_{1/2}$
$0p_{3/2}$
$0p_{3/2}$
$0s_{1/2}$
$0s_{1/2}$
p
n



$1d_{5/2}$
$1s_{1/2}$
$0p_{1/2}$
$0p_{3/2}$
$0s_{1/2}$
$^{18}_{12}Mg_{g.s.}$

Calculation

The shell calculation also proved the change in levels.

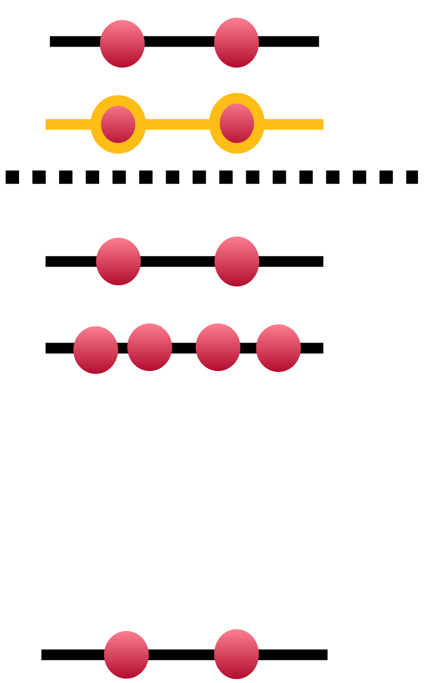


effective single-particle energies	Occupation number(0+)	Occupation number(2+)	
2.72MeV	2.14	2.40	+0.26
1.28MeV	1.62	1.40	-0.22

$^{18}_{12}Mg$ calculated by the Gamow shell model

Calculation

The shell calculation also proved the change in levels.

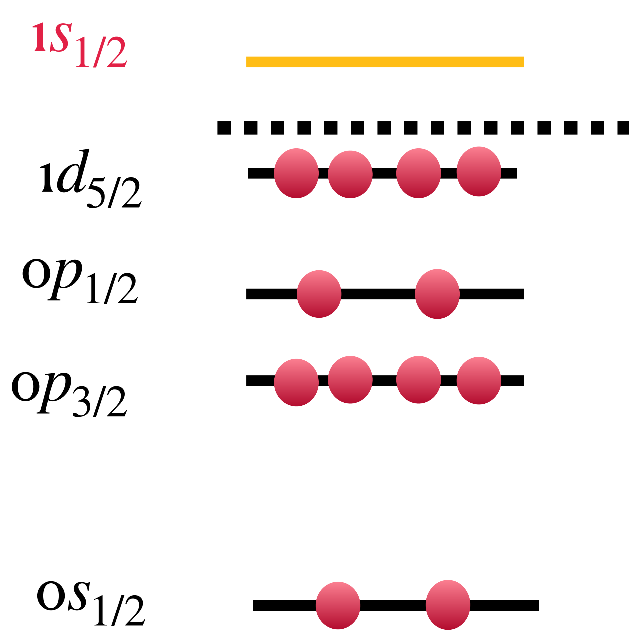


	effective single-particle energies	Occupation number(0+)	Occupation number(2+)	
$1d_{5/2}$	2.84MeV	2.40	2.56	+0.16
$1s_{1/2}$	2.00MeV	1.29	1.16	-0.13
$0p_{1/2}$				
$0p_{3/2}$				
$0s_{1/2}$				

$^{18}_{12}Mg$ calculated by the HO-SM(harmonic-oscillator shell model)

Calculation

The shell calculation also proved the change in levels.

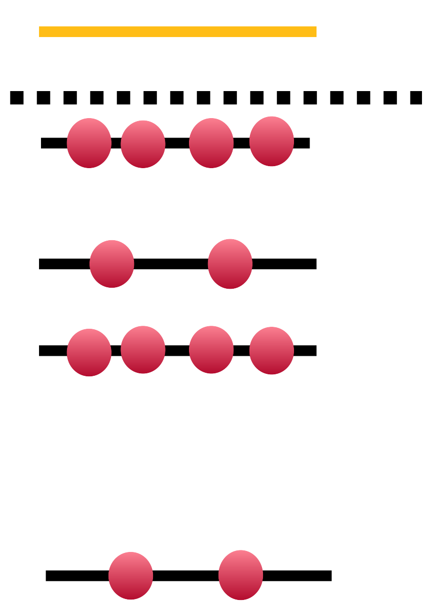


	effective single-particle energies	Occupation number(0+)	Occupation number(2+)	
$1s_{1/2}$	0.76MeV	0.27	0.45	+0.18
$1d_{5/2}$	-0.75MeV	3.46	3.33	-0.13

$^{20}_{12}Mg$ calculated by the GSM, with $^{16}O + 4p$

Calculation

The shell calculation also proved the change in levels.



	effective single-particle energies	Occupation number(0+)	Occupation number(2+)	
$1s_{1/2}$	1.12MeV	0.22	0.36	+0.14
$1d_{5/2}$	-0.74MeV	3.32	3.22	-0.10
$0p_{1/2}$				
$0p_{3/2}$				
$0s_{1/2}$				

$^{20}_{12}Mg$ calculated by the HO-SM, with $^{16}O + 4p$

Calculation

For $^{20}_{12}Mg_8$, it doesn't make a difference between GSM and HO-SM.

For $^{18}_{12}Mg_6$, GSM performs better than HO-SM.

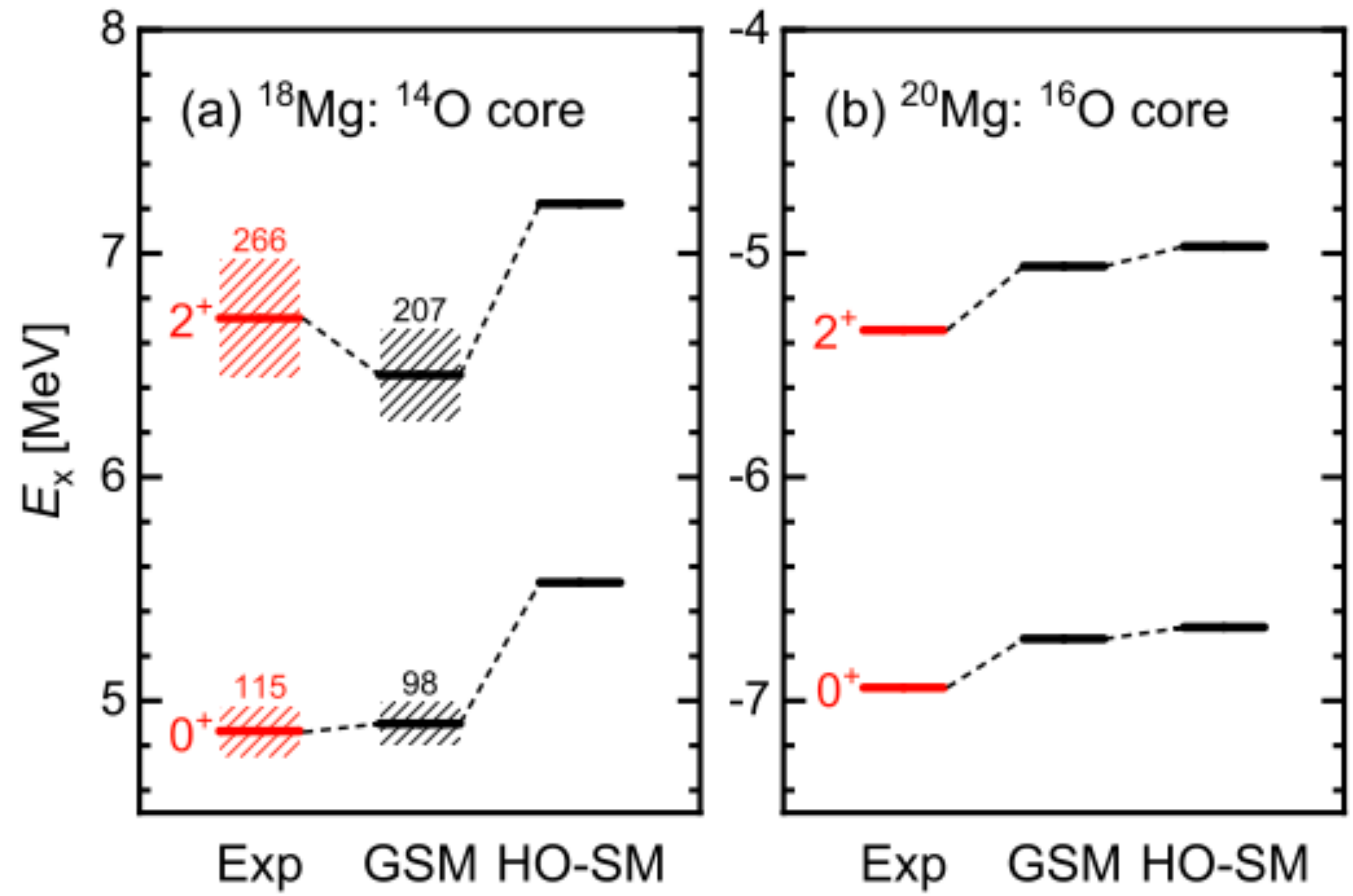


FIG 3: Comparison of experimental results and theoretical calculations of GSM and HO-SM.

Calculation

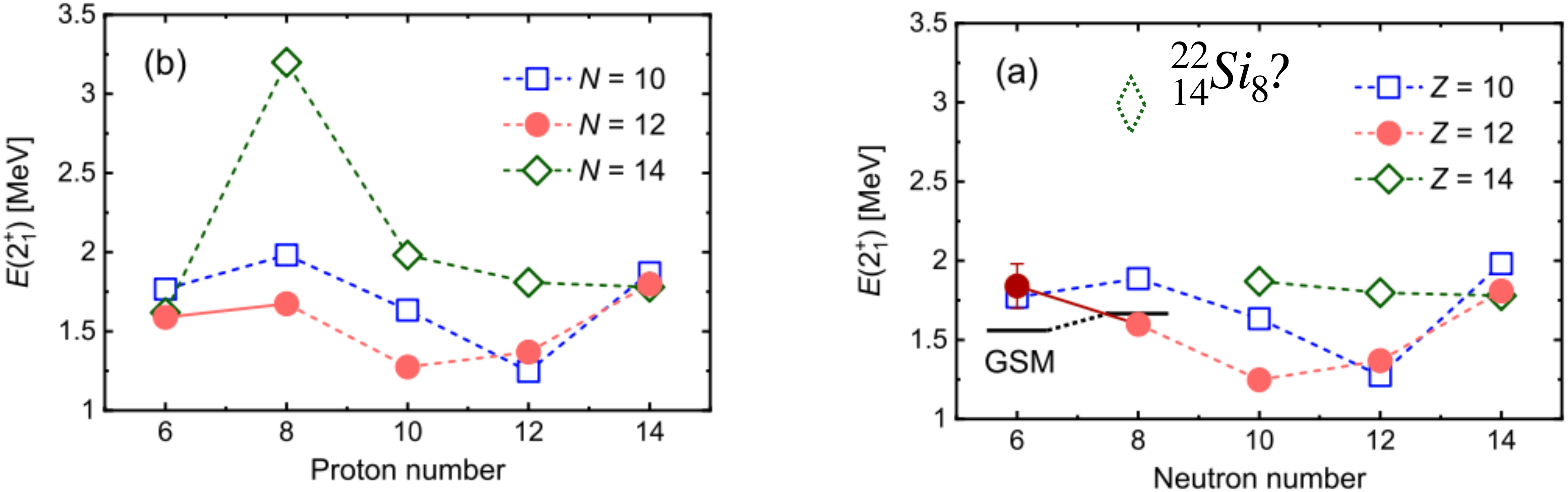
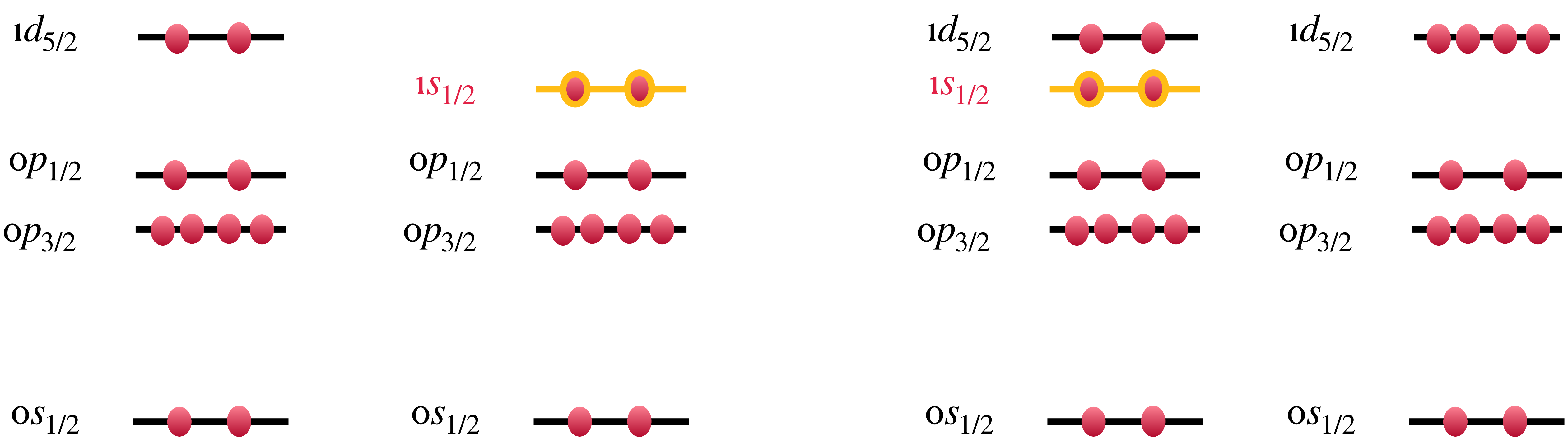


FIG 4: Excitation energies of the first 2+ states for a series of isotopes (a) and isotones (b) for Z or N = 10, 12, and 14.

Calculation



N(Z)=10 N(Z)=12