

# New land of deformation south of $^{68}\text{Ni}$

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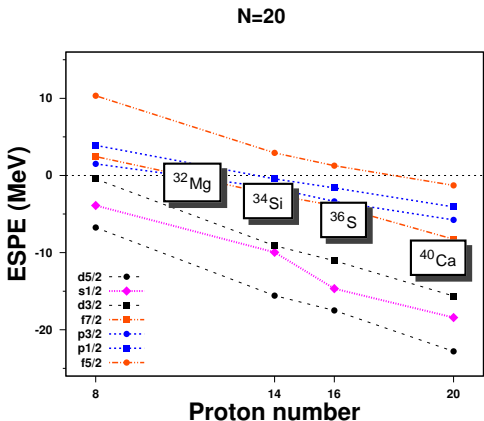
Institut Pluridisciplinaire Hubert Curien



*RIKEN, 18.06.10*

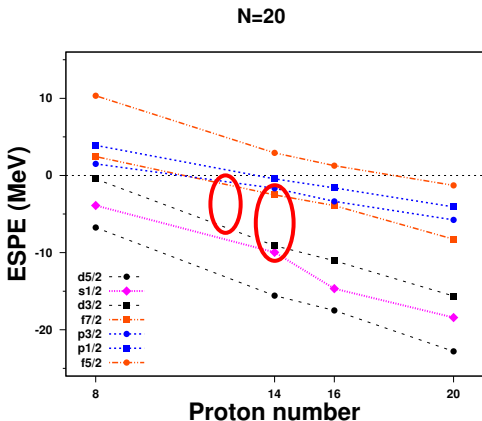
# Island of inversion at N=20

- reduction of  $f_{7/2} - d_{3/2}$  N=20 gap emptying the  $d_{5/2}$  proton orbital
- crossing of  $f_{7/2}$  and  $p_{3/2}$  when emptying the  $d_{5/2}$  neutron orbital



“Island of deformation” around A=32

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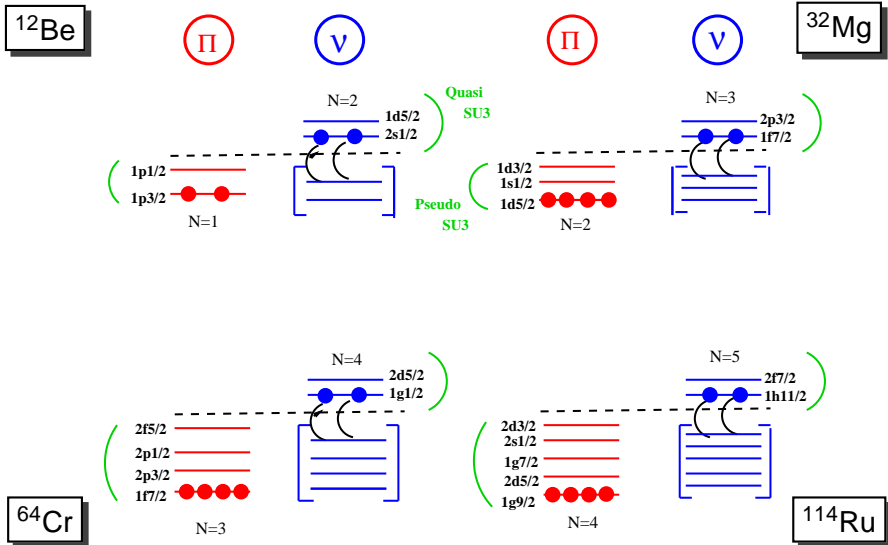
→ “Island of deformation” around A=32

## Spin-Tensor decomposition

$$\Delta \quad \frac{f_{7/2} - d_{3/2}}{2} \text{ Gap}$$

Tot	+1.17	SDPF-U
central	+0.70	
ALS	-0.12	
LS	-0.067	
tensor	+0.66	

# Development of deformation at N=8,20,40,70



# What do we know about N=40?

- N=40 closure:  $2^+$  state of  $^{68}\text{Ni}$  at 2 MeV,  $B(E2)=52 \text{ e}^2\text{fm}^4$

*O. Sorlin et al., Phys.Rev.Lett.88 (2002) 092501.*

- Enhanced collectivity in  $^{64}\text{Fe}$ :  
 $B(E2) = 470 \pm_{110}^{210} \text{ e}^2\text{fm}^4$

*J. Ljungvall et al., PRC81 (2010) 061301(R).*

- Recent measurement of excited states in  $^{64}\text{Cr}$ :  $2^+$  at 420(7)keV

*A. Gade et al., Phys.Rev. C81 (2010) 051304.*

- SM study of  $^{68}\text{Ni}$ : 50% of shell closure, pair excitations across the N=40 gap

*O. Sorlin et al., Phys.Rev.Lett.88 (2002) 092501.*

- Collectivity at N=40:  
-HFB-Gogny+GCM

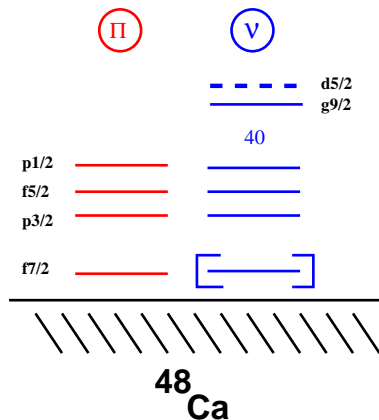
*L. Gaodefroy et al., Phys.Rev. C80 (2009) 064313.*

-SM with an empirical interaction in *pfg* space

*K. Kaneko et al., Phys.Rev.C78 (2008)064312.*

-SM with realistic-compatible interaction in *pfgd* space

*E. Caurier et al., EPJ A15 (2002) 145.*



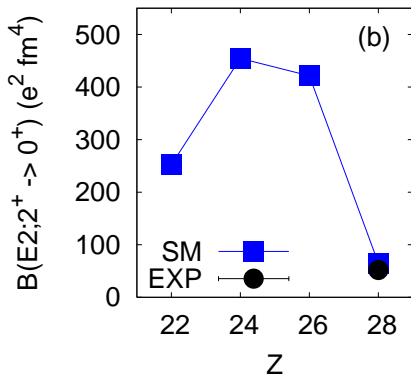
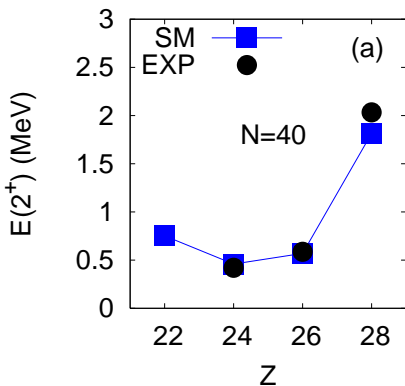
## LNPS interaction:

- based on realistic TBME
- new fit of the pf shell
- monopole corrections

## Calculations:

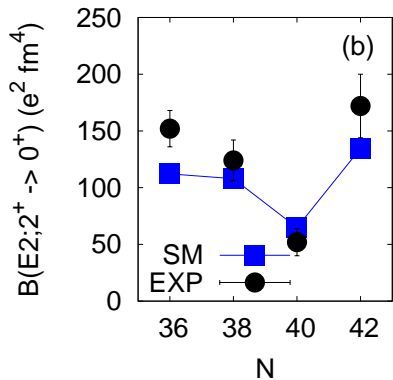
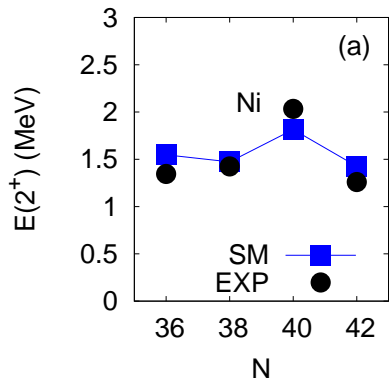
- up to 14p-14h excitations across  $Z=28$  and  $N=40$  gaps
- up to  $7 \cdot 10^9$
- m-scheme code ANTOINE

# Shape change at N=40



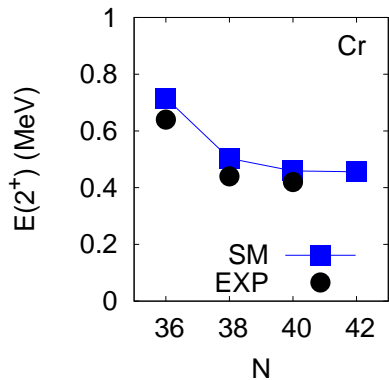
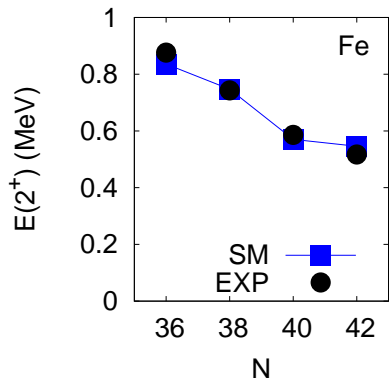
Nucleus	$\nu g_{9/2}$	$\nu d_{5/2}$	configuration
$^{68}\text{Ni}$	0.98	0.10	0p0h(51%)
$^{66}\text{Fe}$	3.17	0.46	4p4h(26%)
$^{64}\text{Cr}$	3.41	0.76	6p6h(23%)
$^{62}\text{Ti}$	3.17	1.09	4p4h(48%)

# Nickel chain

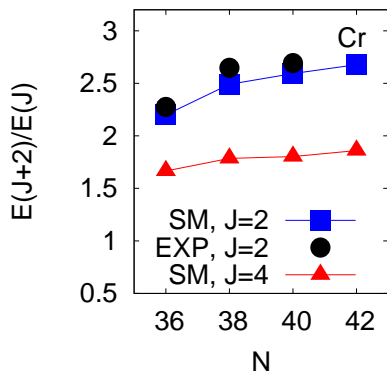
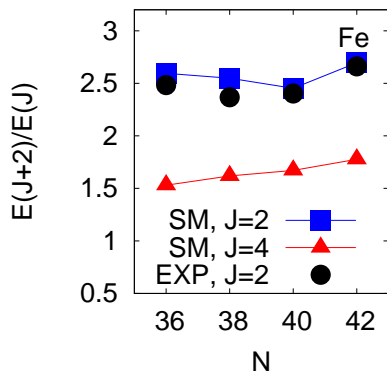




# Iron & chromium chains



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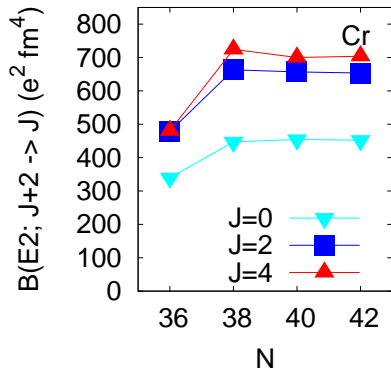
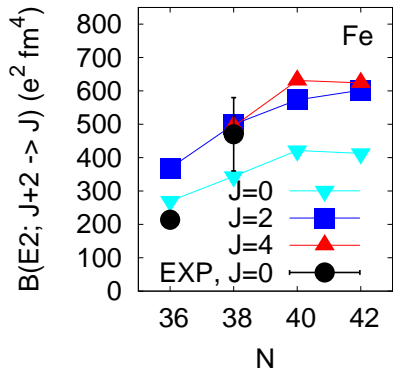


Rotational regime:

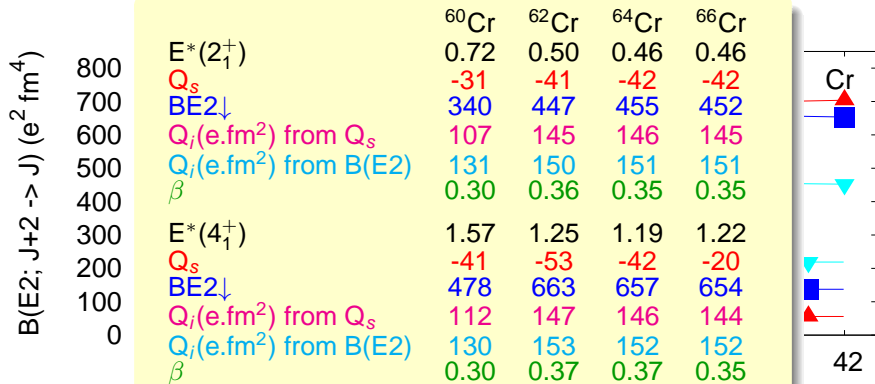
$$R_{4/2}=3.3$$

$$R_{6/4}=2.1$$

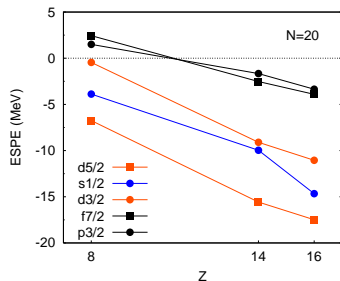
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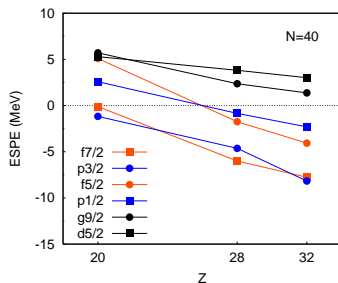
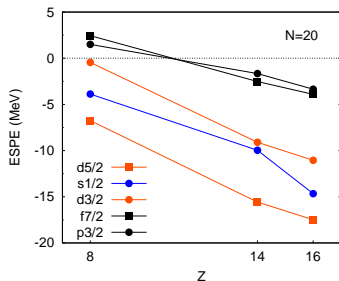


# Neutron effective single particle energies



- reduction of the  $\nu d_{3/2}-f_{7/2}$  gap with removing  $d_{5/2}$  protons
- proximity of the quasi-SU3 partner  $p_{3/2}$

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- reduction of the  $\nu f_{5/2}-g_{9/2}$  gap with removing  $f_{7/2}$  protons
- proximity of the quasi-SU3 partner  $d_{5/2}$

# Conclusions

- Deformation develops below  $^{68}\text{Ni}$  in analogy to **the island of inversion at  $N = 20$** .
- SM predictions using large valence space  $pf$  for protons and  $f_{5/2}pg_{9/2}d_{5/2}$  for neutrons and LNPS interaction fit well known experimental data **in both, spherical and deformed systems**.
- More experimental input in the region is welcome, especially  **$B(E2)$  rates can be crucial** for mapping the new land of deformation below  $^{68}\text{Ni}$ .