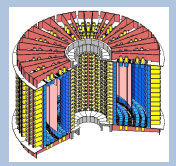
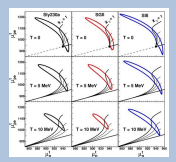




FUSTIPEN

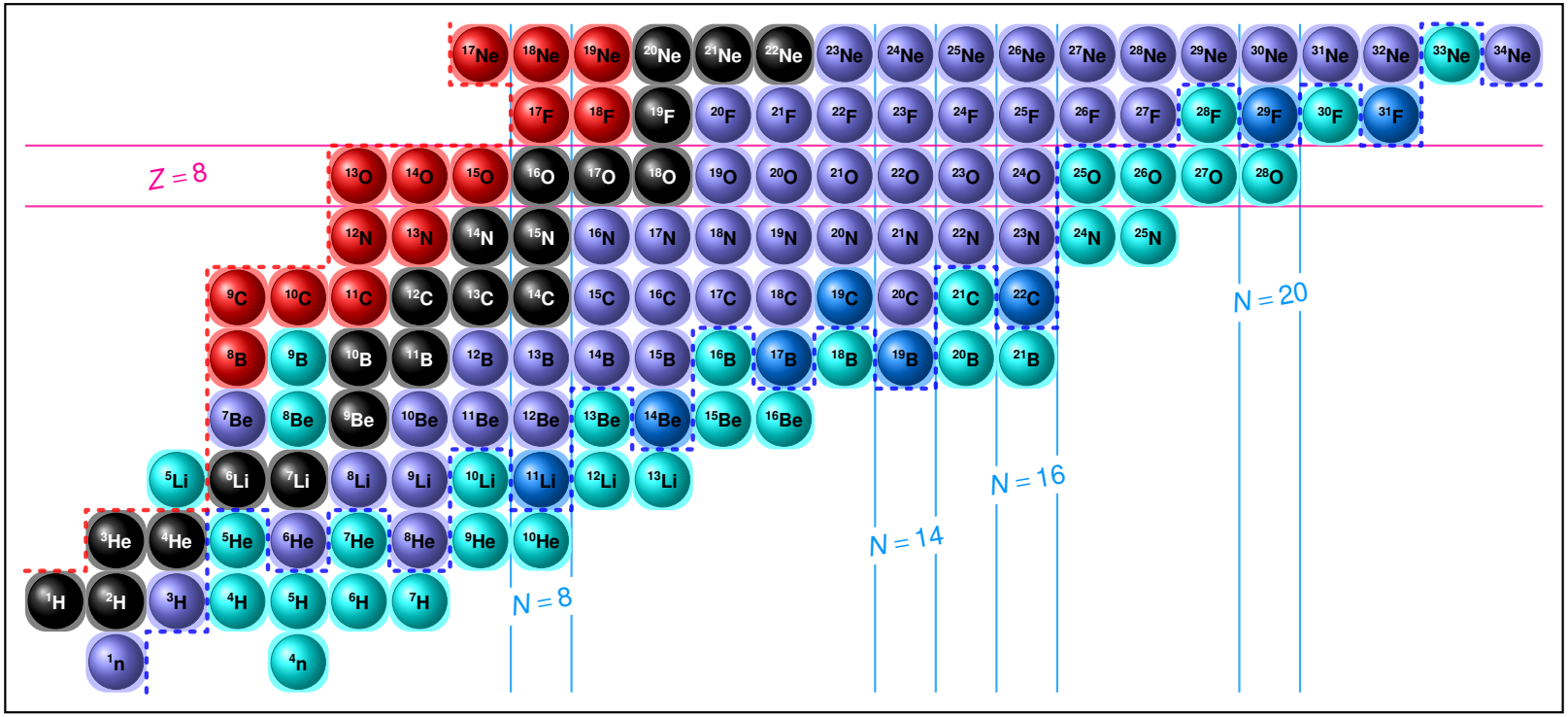
Probing the Structure of the Most Neutron-rich Isotopes of Boron and Carbon

"Groupe Structure Nucléaire":
S. Leblond, Q. Deshayes, FM Marqués, J. Gibelin, NA. Orr, *et al*

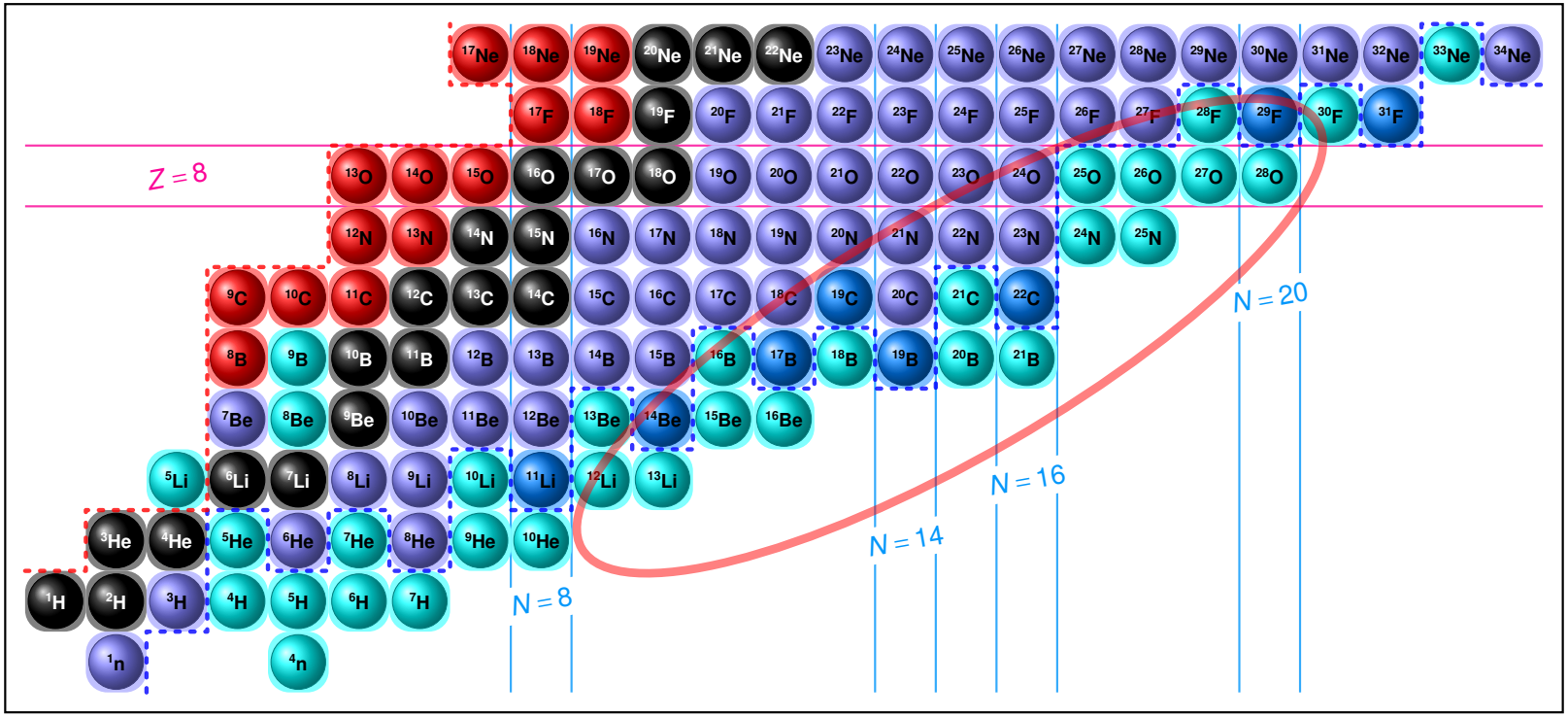
LPC Caen, ENSICAEN, Université de Caen, CNRS/IN2P3, Caen, France

Mar. th 2016

Light nuclei at the drip-line



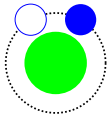
Light nuclei at the drip-line: our playground

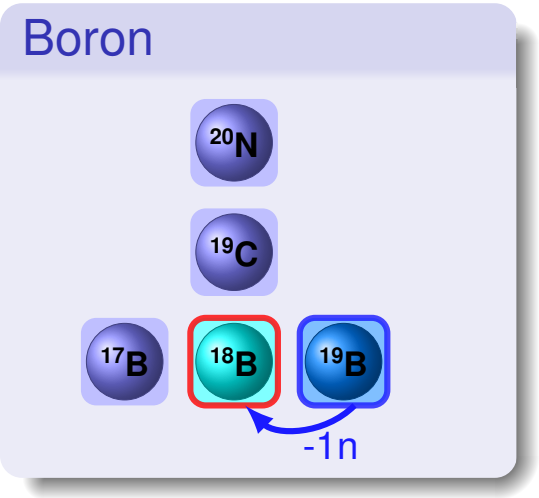


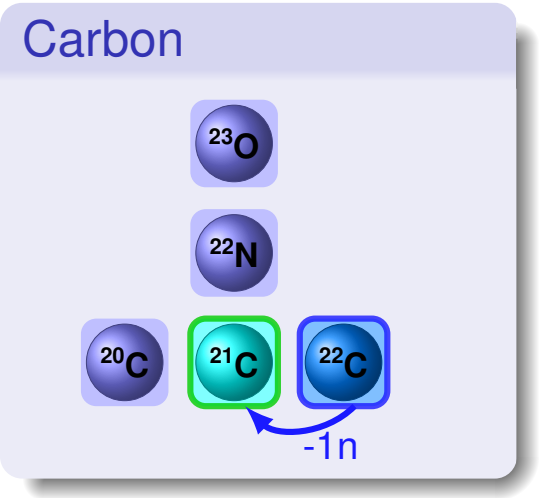
Strategies

Study of unbound ^{18}B & ^{21}C

^{19}B and ^{22}C: 1-neutron knockout to (core+n)

halo "hole" state 





Strategies

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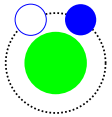
^{19}B and ^{22}C: 1-neutron knockout to (core+n)

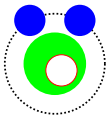
halo "hole" state

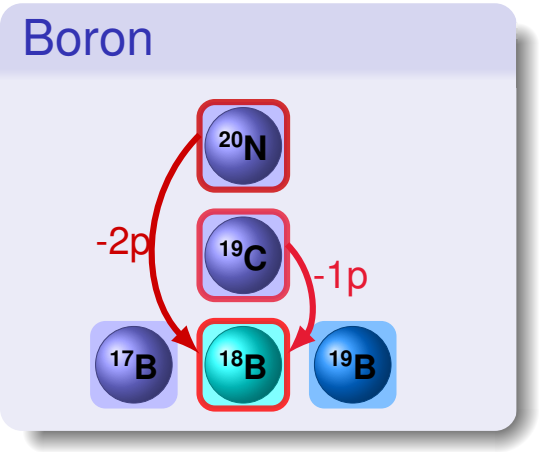


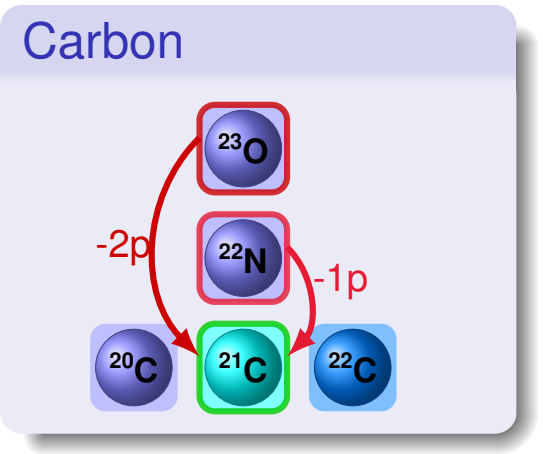
^{19}C and ^{22}N: 1-proton knockout to (core+n)

^{20}N and ^{23}O: 2-proton knockout to (core+n)

$\nu_{\text{final}} \approx \nu_{\text{initial}}$







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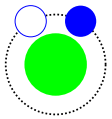
halo "hole" state 

^{19}C and ^{22}N: 1-proton knockout to (core+n)

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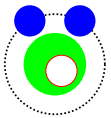
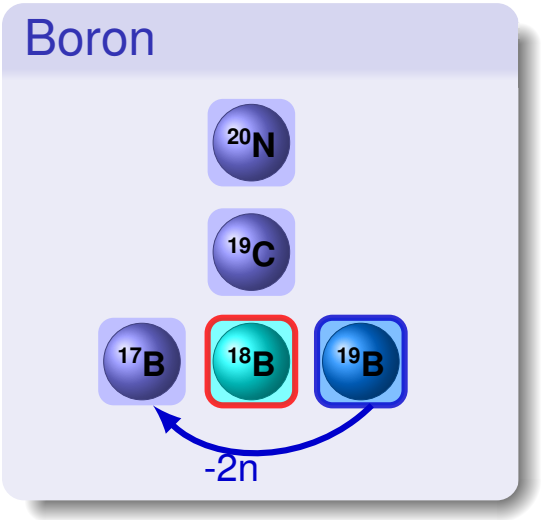
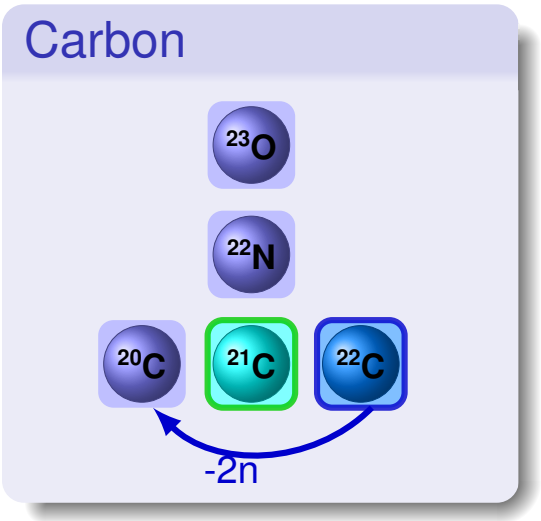
$\nu_{\text{final}} \approx \nu_{\text{initial}}$ 

Direct excitation

^{19}B and ^{22}C: inelastic scattering 3-body continuum states (core+n+n)

^{22}C(2^+) ; ^{19}B* + $d\sigma/d\Omega$ ...





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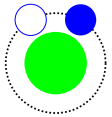
halo "hole" state 

^{19}C and ^{22}N: 1-proton knockout to (core+n)

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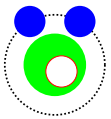
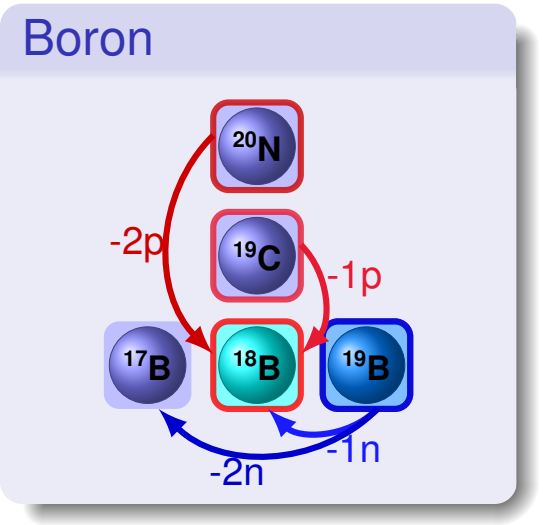
$\nu_{\text{final}} \approx \nu_{\text{initial}}$ 

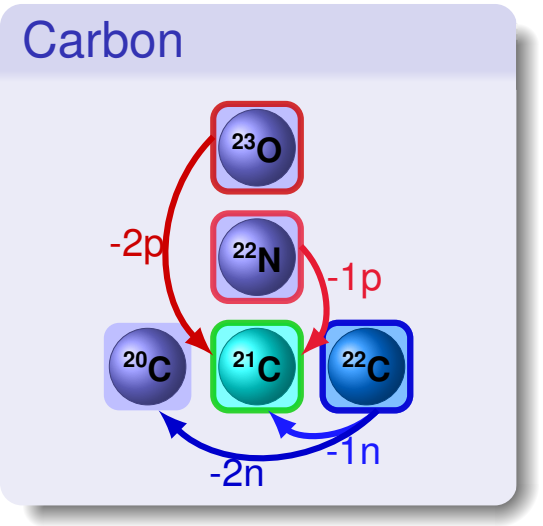
Direct excitation

^{19}B and ^{22}C: inelastic scattering 3-body continuum states (core+n+n)

$^{22}\text{C}(2^+)$; $^{19}\text{B}^\star$ + $d\sigma/d\Omega$ ...

^{19}B and ^{22}C: necessary for interpretation of (core+n)

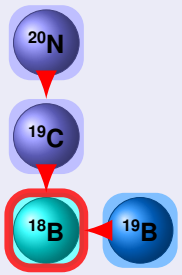




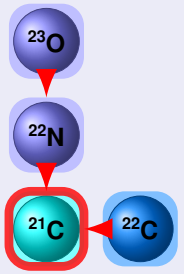
Additional reactions

- Neutron or proton(s) knock-out ⇒ states energy, width & J^{π}

Boron



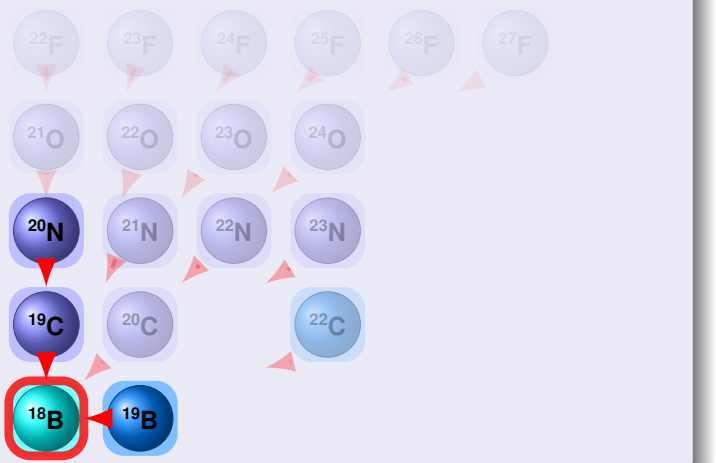
Carbon



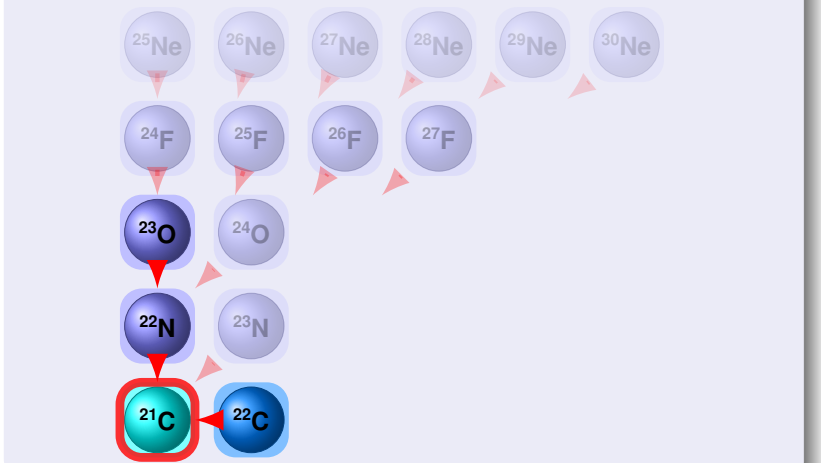
Additional reactions

- Neutron or proton(s) knock-out ⇒ states energy, width & J^{π}
- Break-up ⇒ energy & width (only !)

Boron



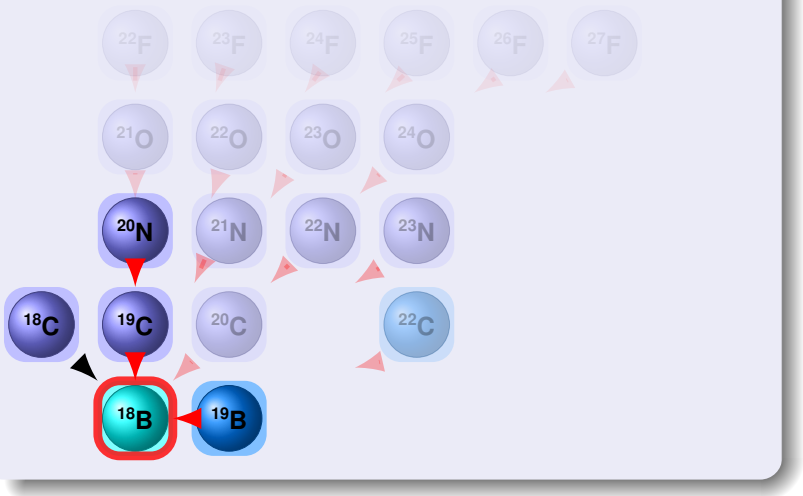
Carbon



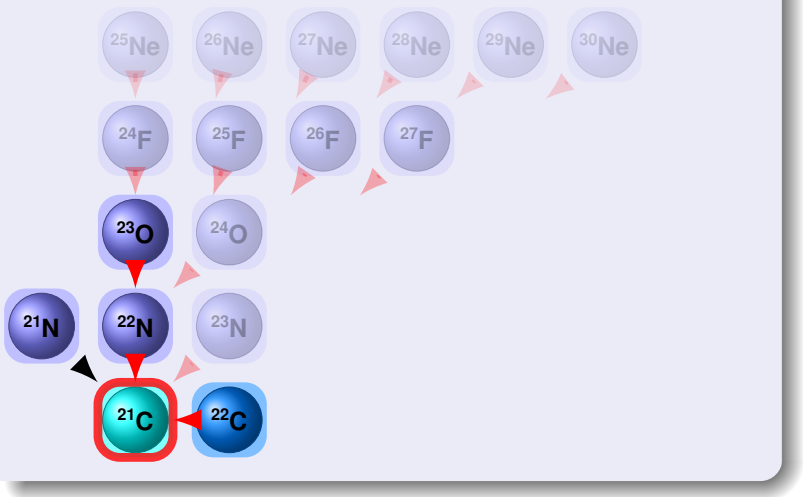
Additional reactions

- Neutron or proton(s) knock-out ⇒ states energy, width & J^π
- Break-up ⇒ energy & width (only !)
- Charge exchange ⇒ energy, width & J^π

Boron



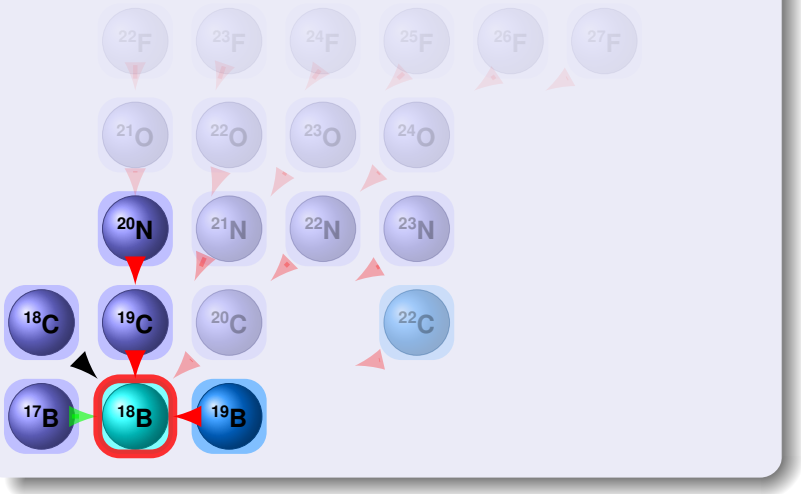
Carbon



Additional reactions

- Neutron or proton(s) knock-out ⇒ states energy, width & J^π
- Break-up ⇒ energy & width (only !)
- Charge exchange ⇒ energy, width & J^π
- Transfer? (very improbable)

Boron



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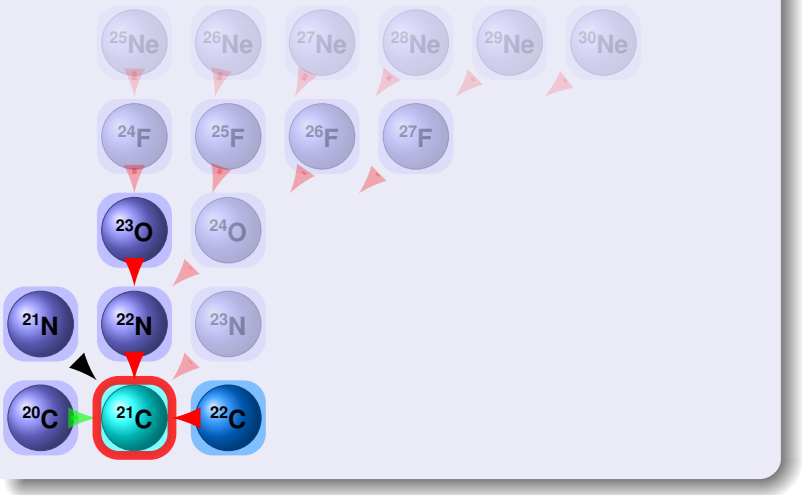
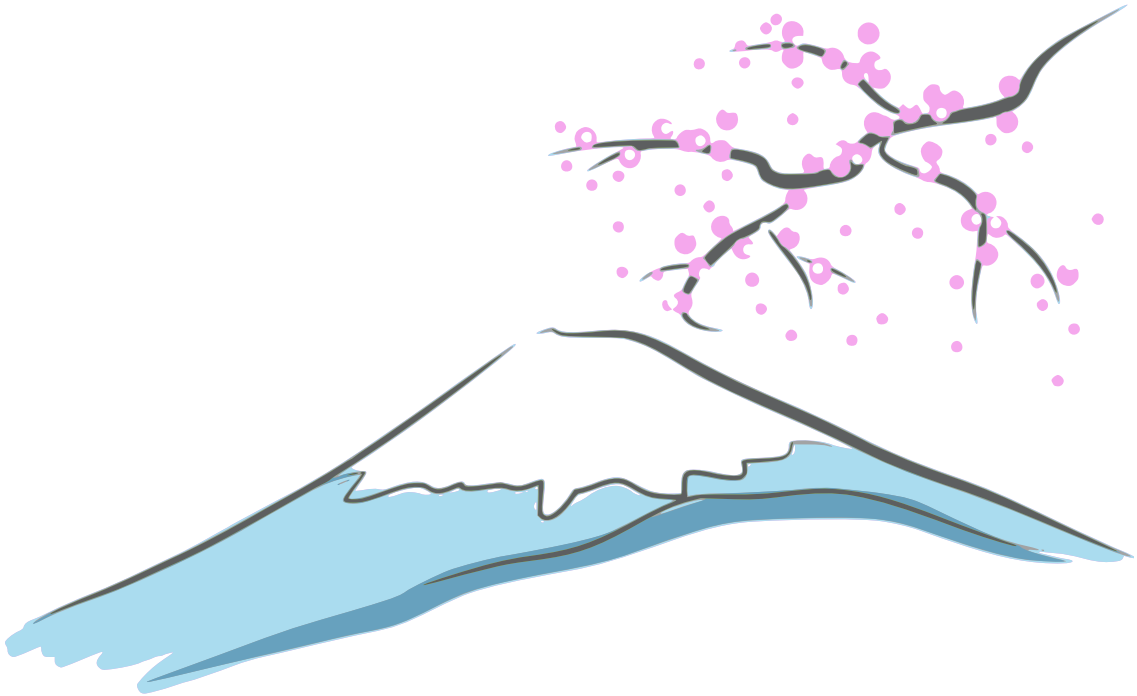


“Complete” picture



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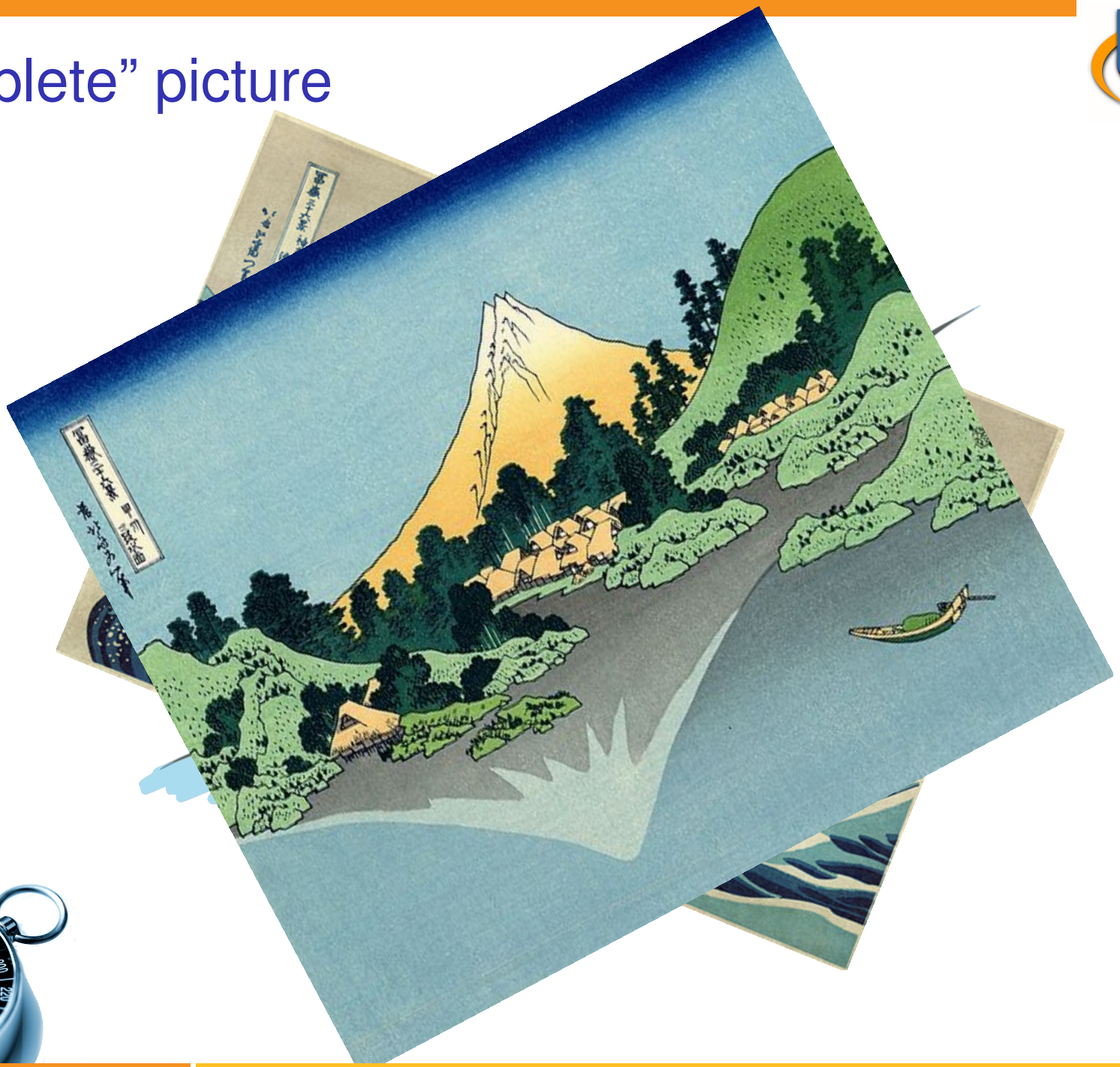

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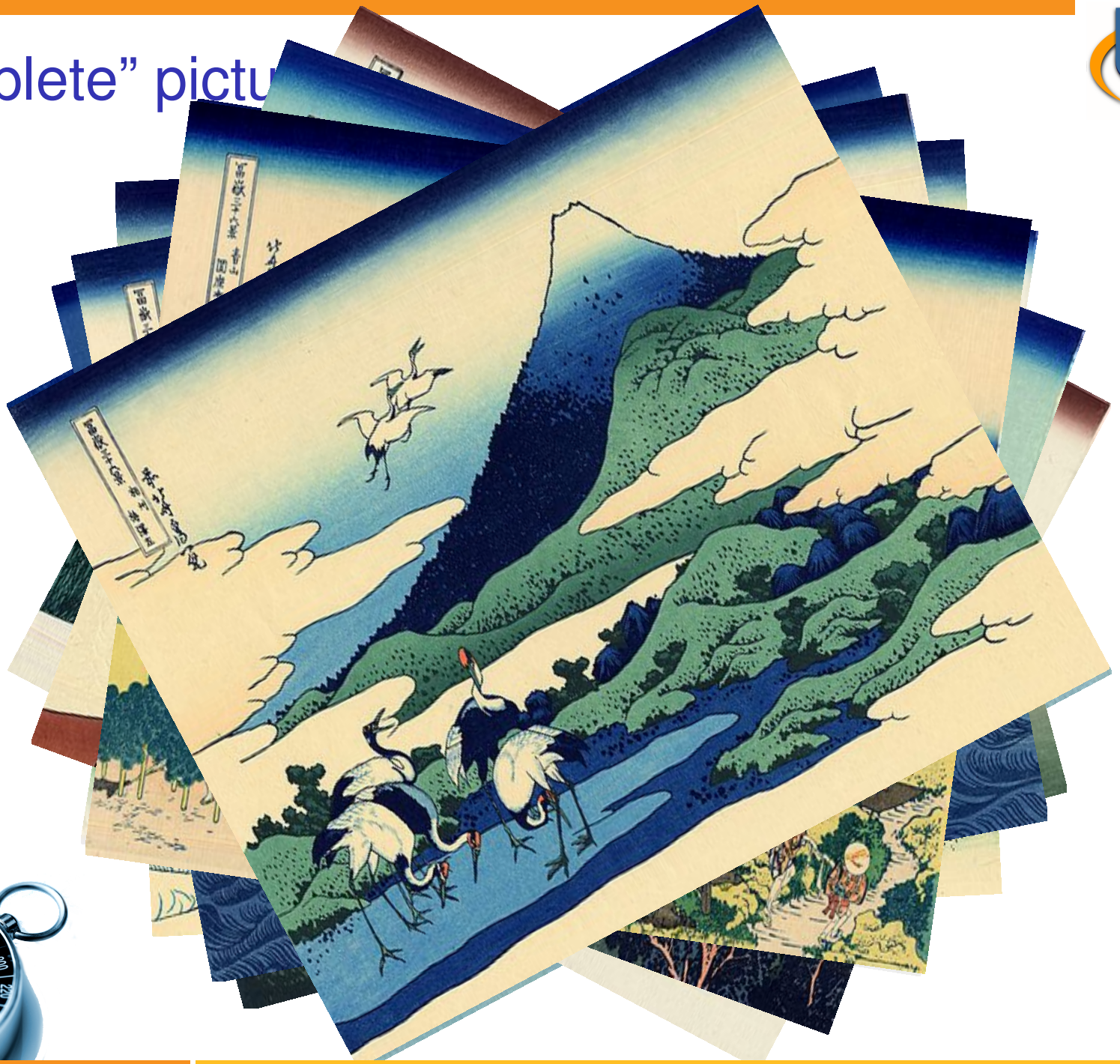
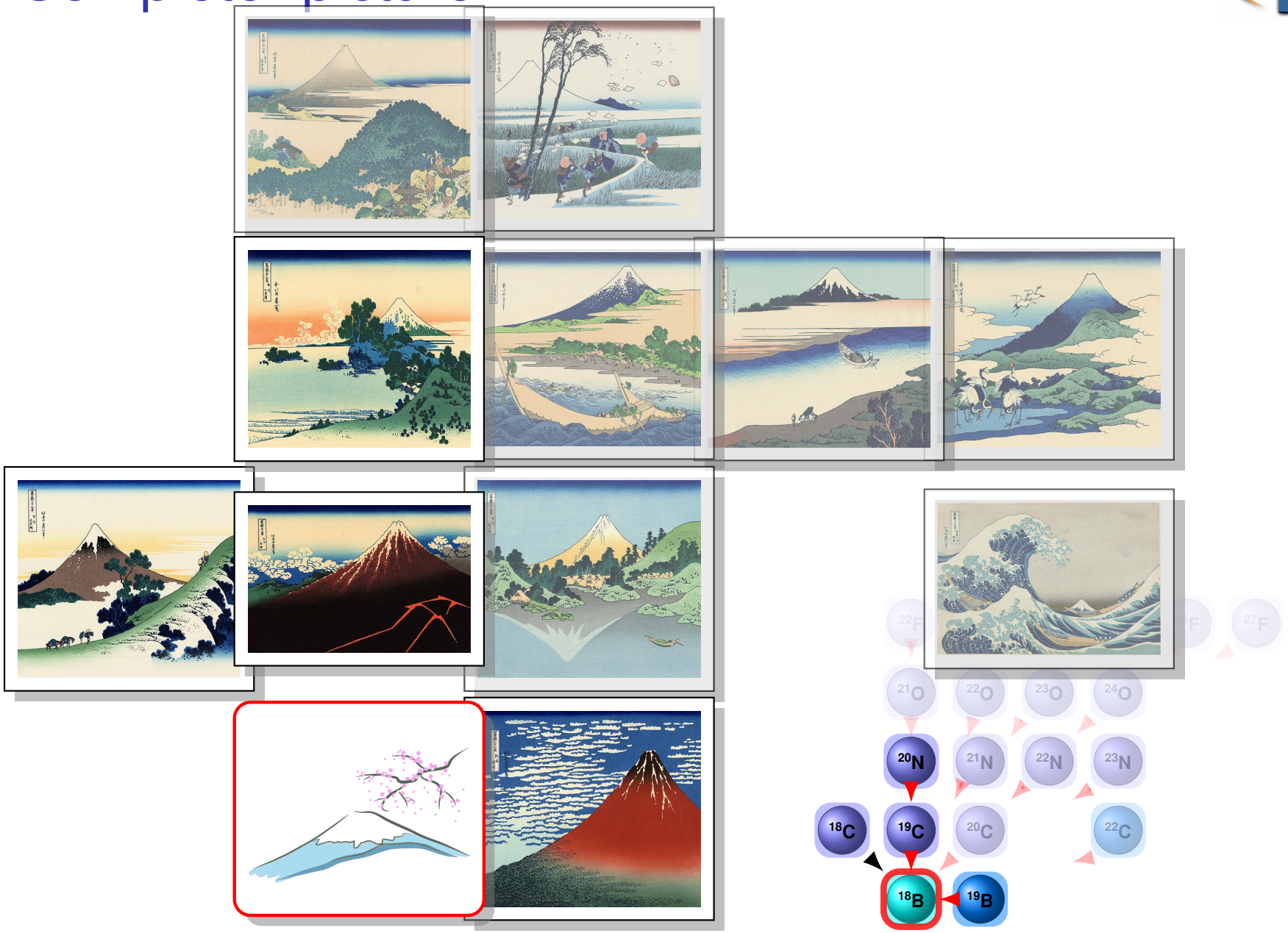


“Complete” picture



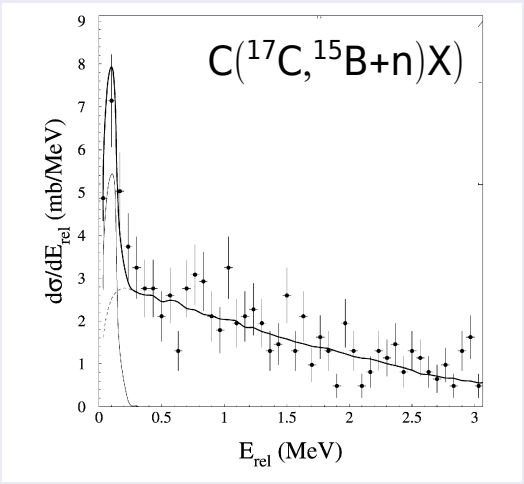
“Complete” picture

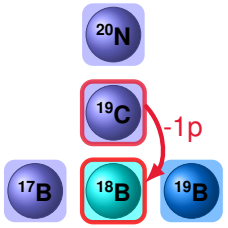
The setup

Boron isotopes

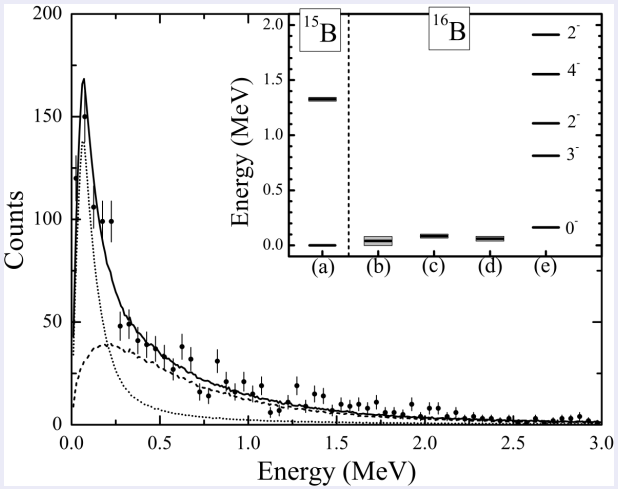
^{16}B: Illustration on the reaction ^{17}C → ^{15}B + n

J.-L. Lecouey *et al*, PLB 672 (2009)



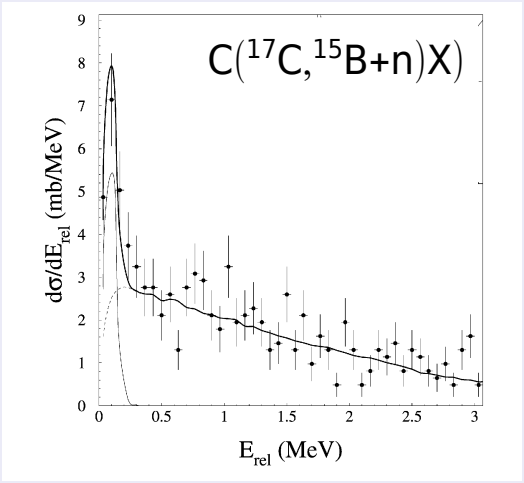


A. Spyrou *et al.*, PLB 683 (2010)

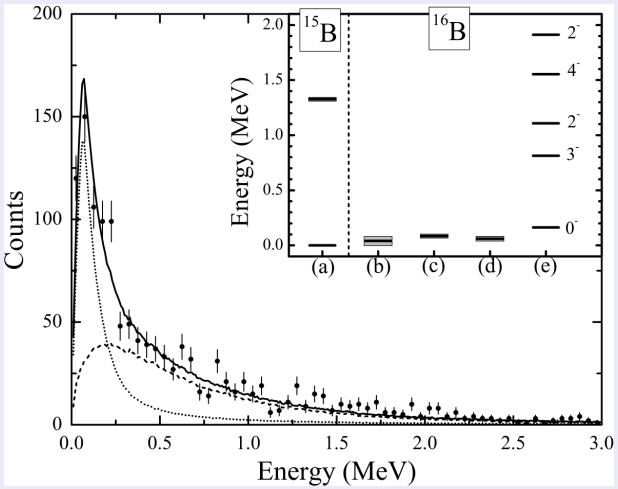


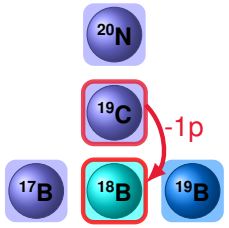
^{16}B: Illustration on the reaction ^{17}C → ^{15}B + *n*

J.-L. Lecouey *et al*, PLB 672 (2009)

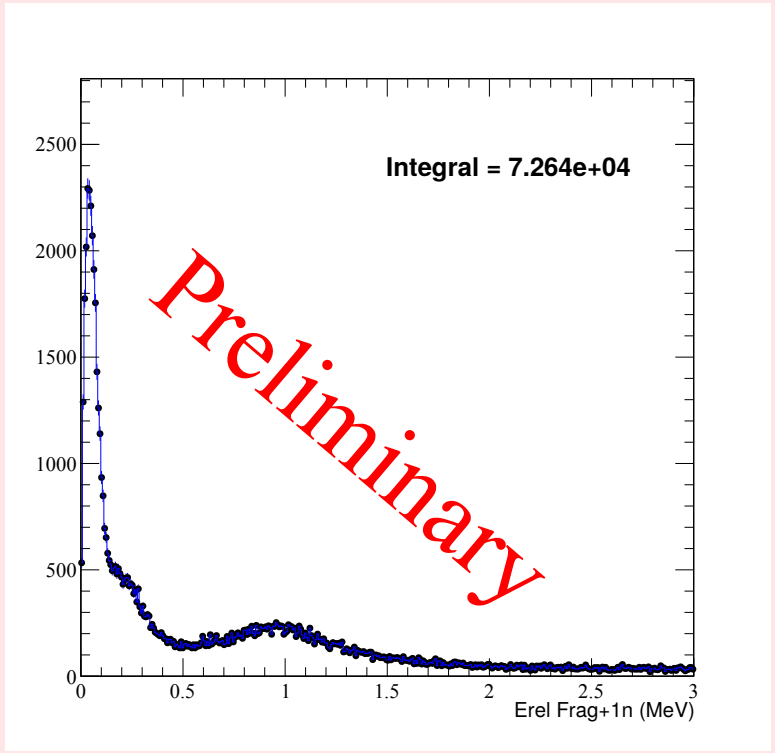


A. Spyrou *et al.*, PLB 683 (2010)

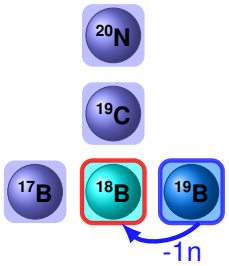




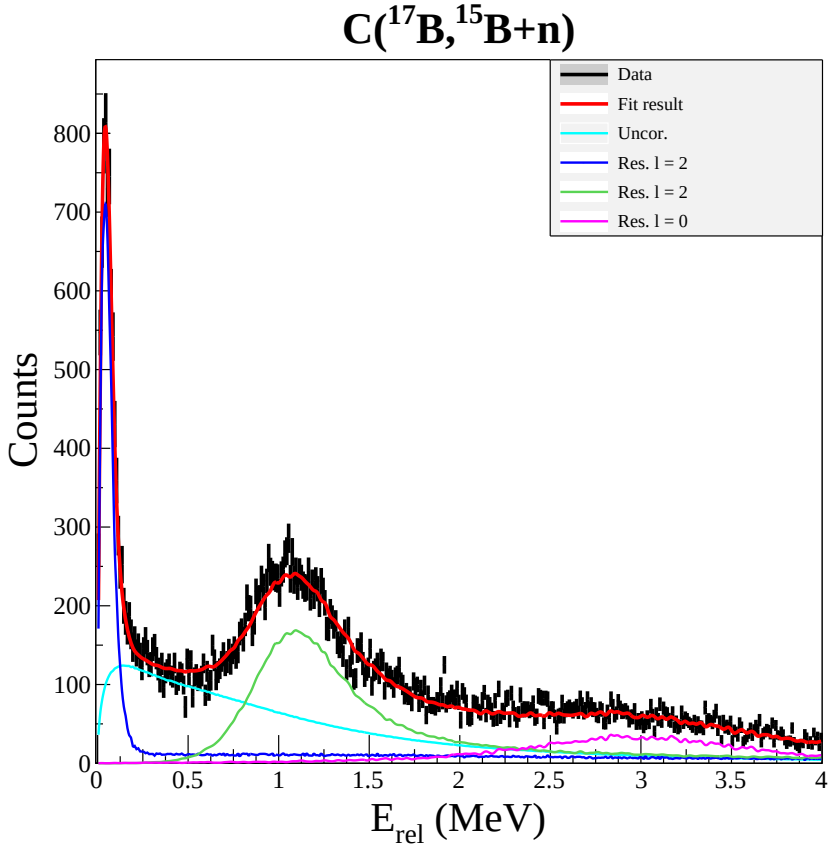
This work (few hours test run)



^{16}B: from ^{17}B → ^{15}B + n (S. Leblond's PhD)



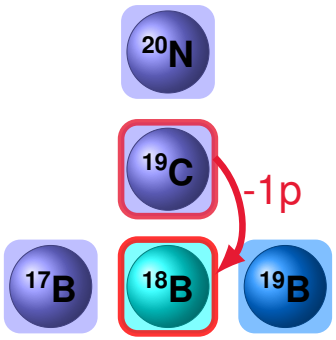
- Illustrate "selectivity"
- Validation calibrations & analysis procedures

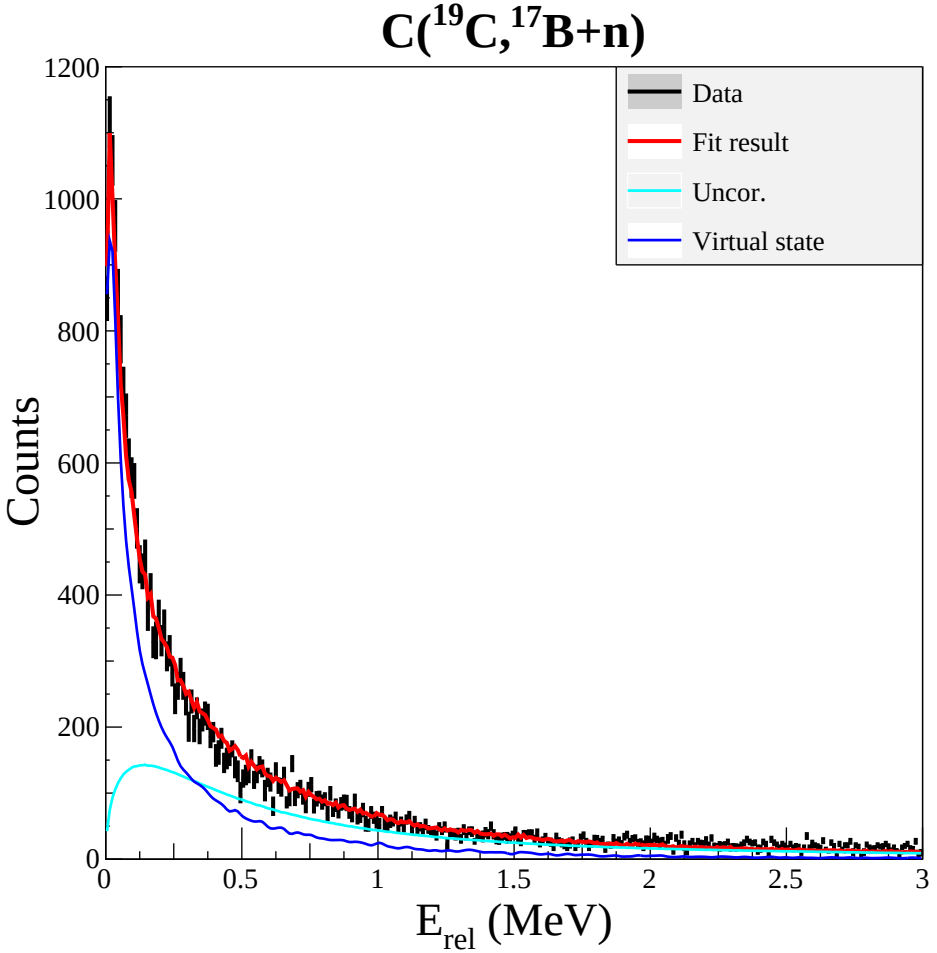


For the G.S.:

	ℓ	E_r (keV)	Γ (keV)
LPC	2	85 ± 15	Γ < 100
MSU	2	60 ± 20	Γ < 100
This work	2	40 ± 10	Γ < 100

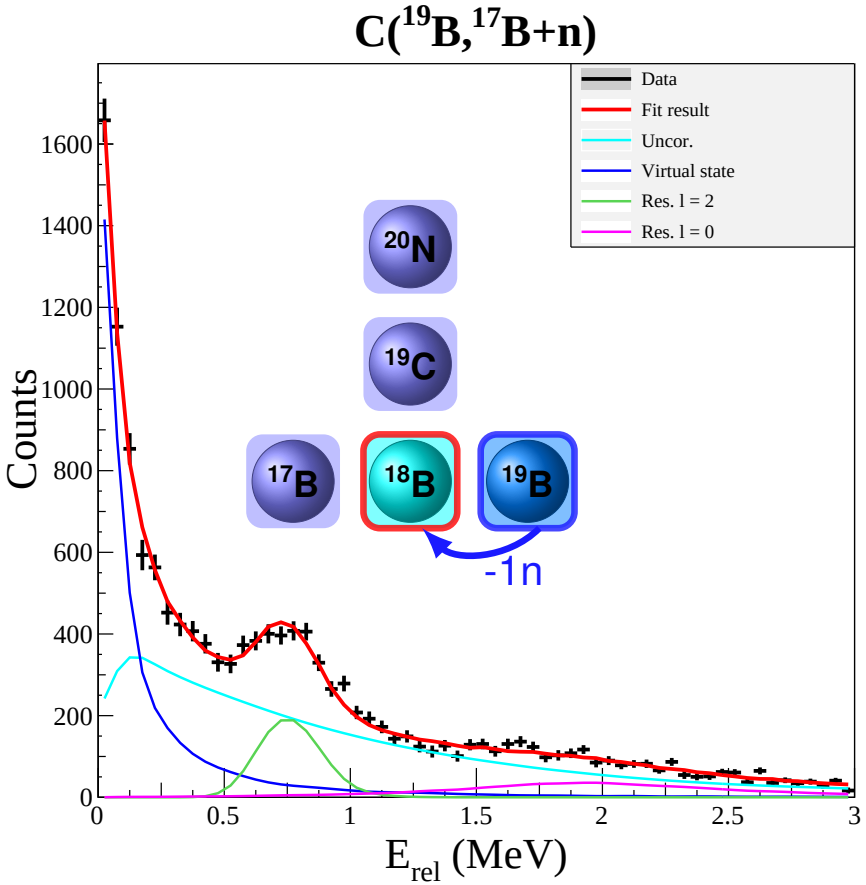
^{18}B: 1p knock-out reaction (S. Leblond's PhD)





$a_s < -50$ *fm*

^{18}B: 1n knock-out reaction (S. Leblond's PhD)



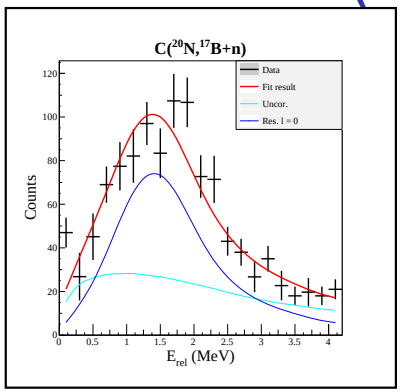
Fit results

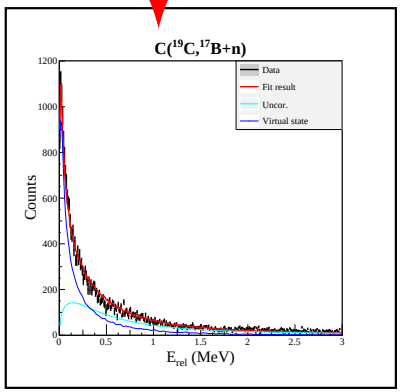
ℓ	E_r (MeV)	Γ (MeV)
0	$a_s < -50$ *fm*	
2	0.77 ± 0.09	< 1.0
0	2.0 ± 0.5	1.0^{+3}_{-1}

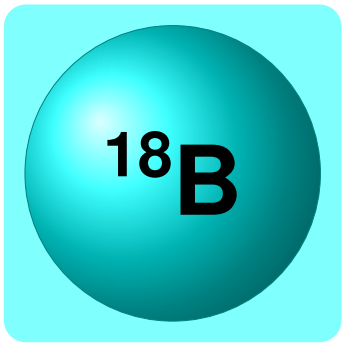
Theoretical prediction
(J.A. Tostevin)

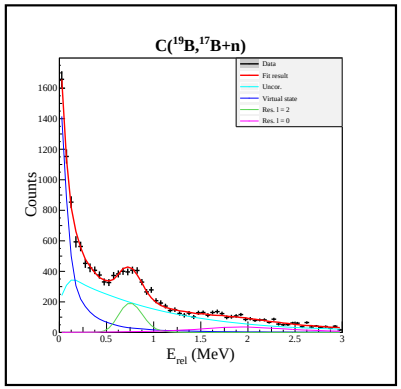
J^π	E_x	ℓ_n	C^2S
2^-	0.0	0	0.3
4^-	0.498	2	0.7
2^-	0.739	2	0.6
3^-	0.973	2	1.0
1^-	1.137	0	0.3

^{18}B: More channels? (S. Leblond's PhD)

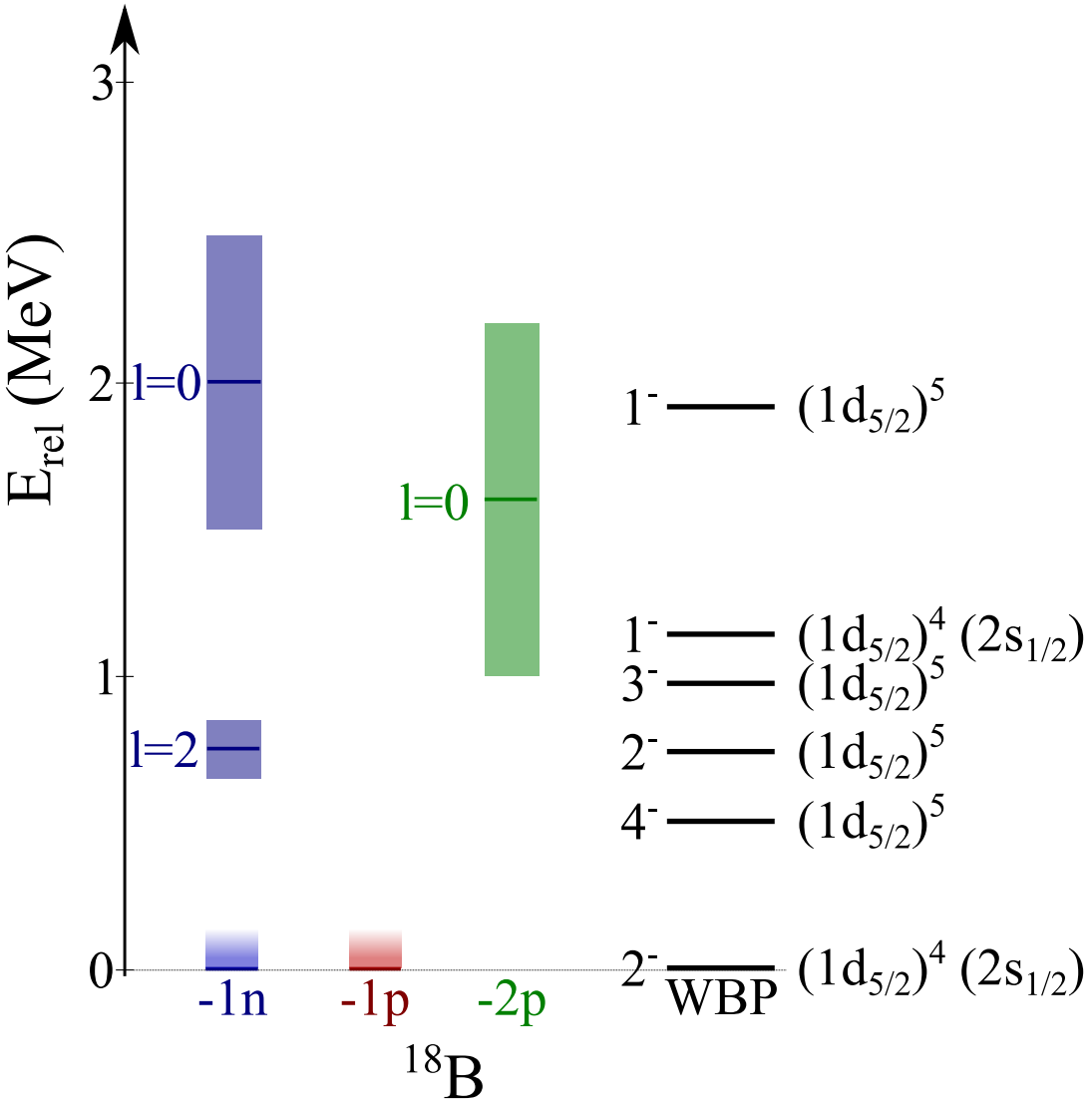


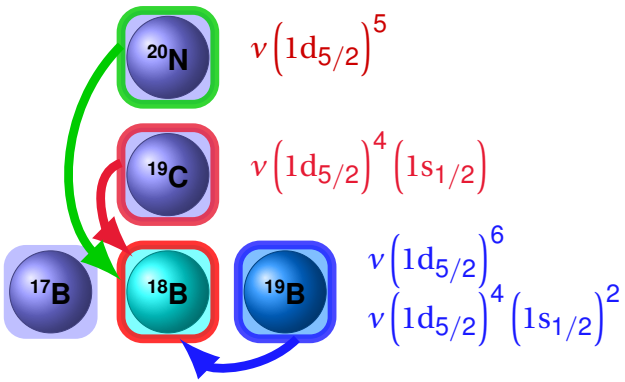






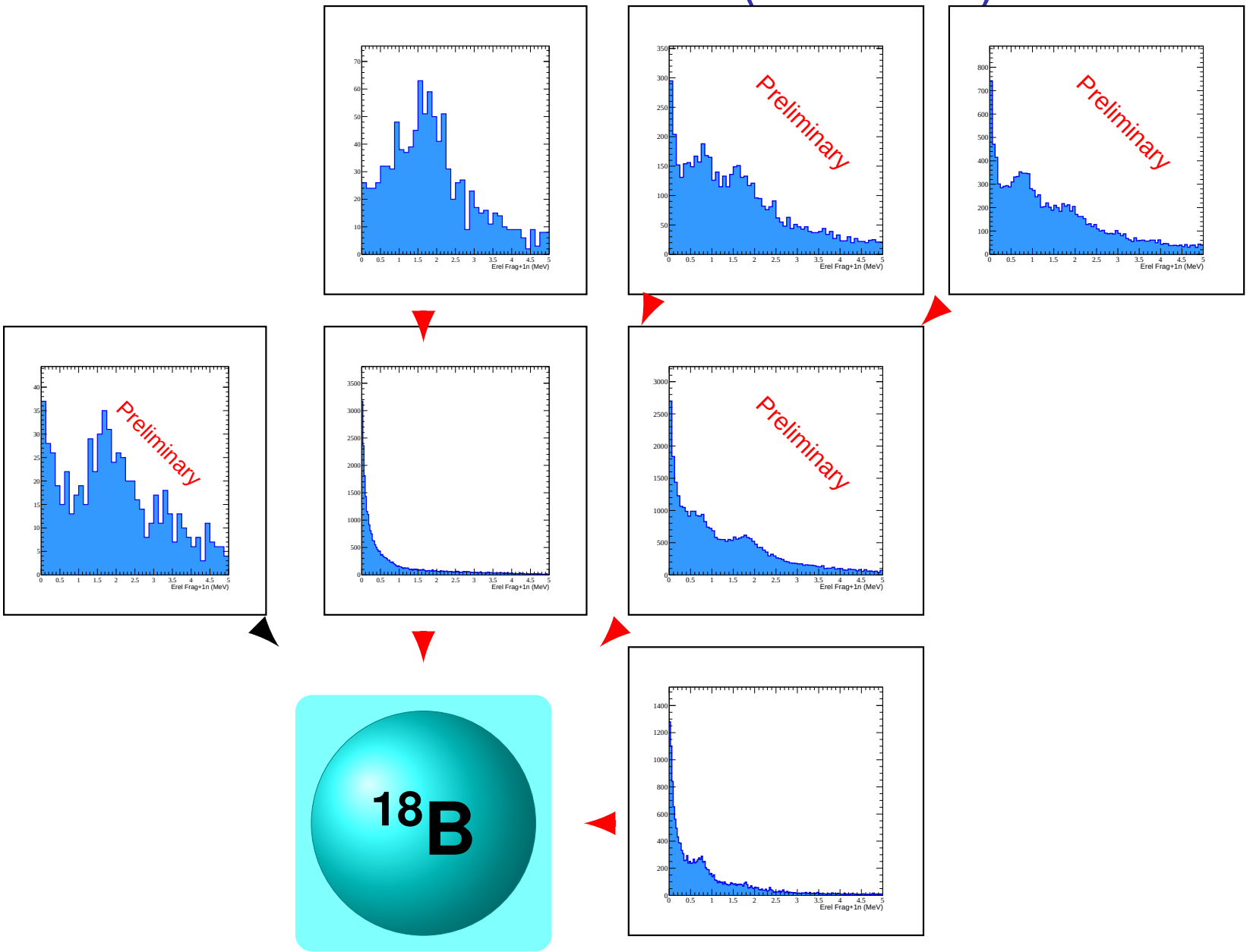
^{18}B: Analysis Summary (S. Leblond's PhD)



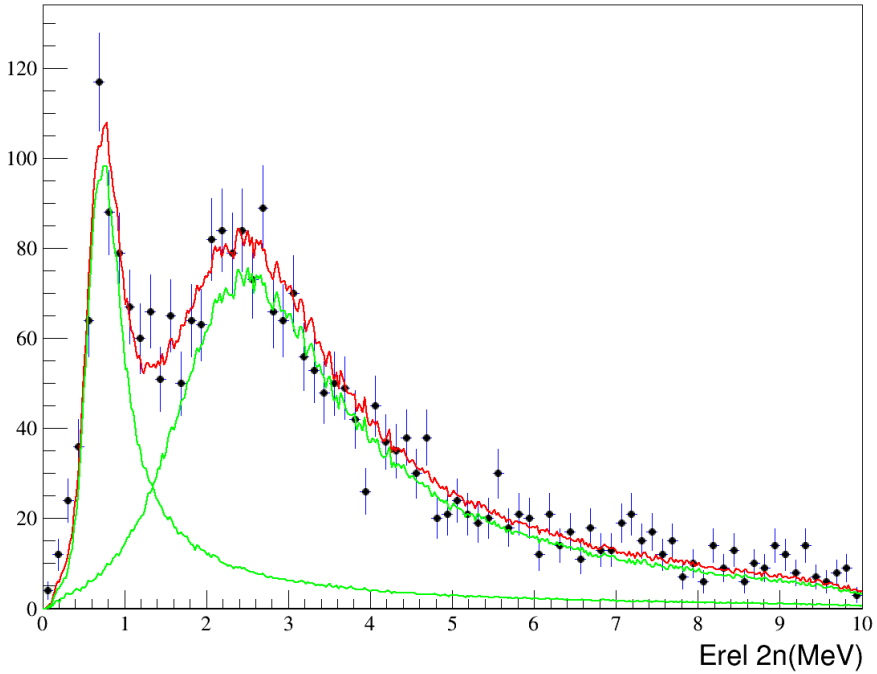


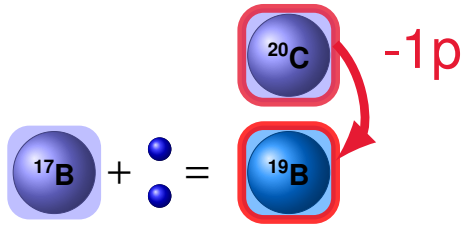
SM calculations: Spyrou, PLB **683** (2010) 129

^{18}B: Even more channels? (SL + JG)



^{19}B: 1p knock-out reaction (JG)





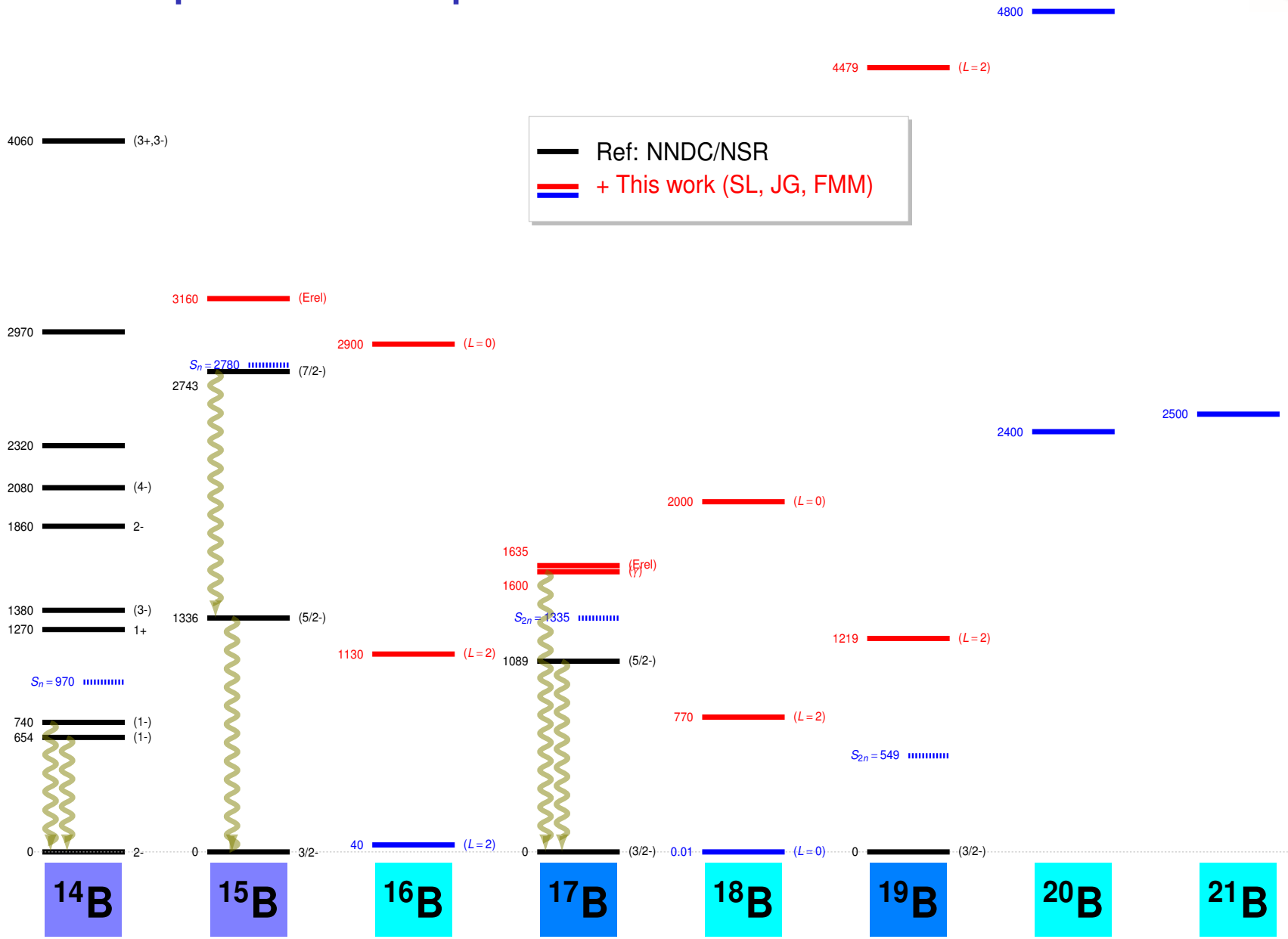
Fit results

ℓ	E_r (MeV)	Γ (MeV)
2 ± 2	0.67 ± 0.01	0.17 ± 0.77
2 ± 0.5	3.93 ± 0.11	0.50 ± 0.58

Rebuilt from $^{17}\mathrm{B} + 2n$ relative energy $\Rightarrow$ states above S_{2n}

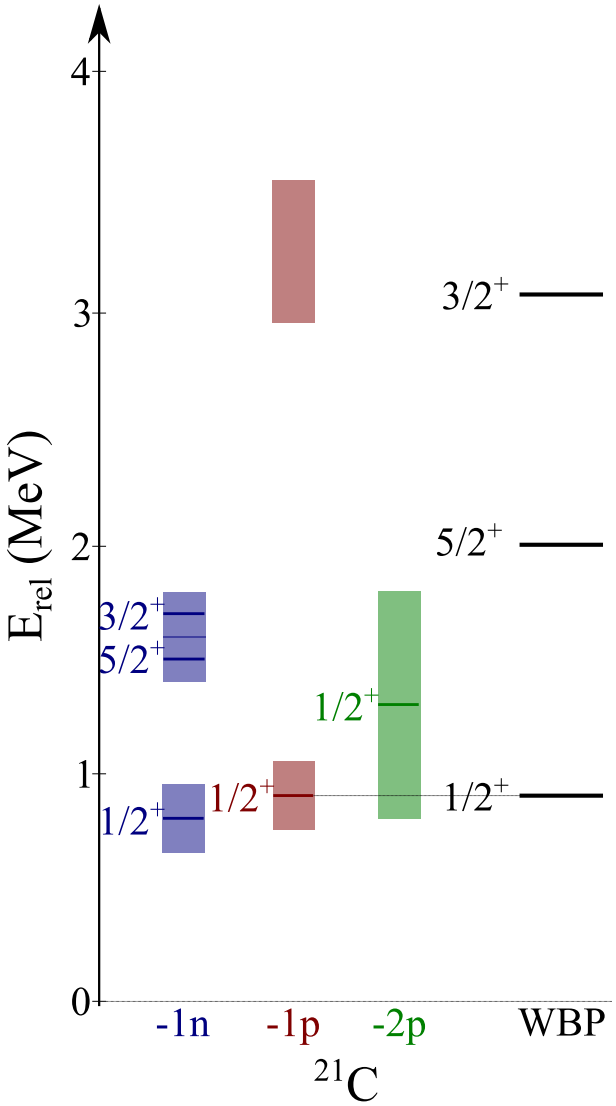
State @ 700 keV clearly present in other channels ($^{21,22}\mathrm{N}, ^{20}\mathrm{C} \rightarrow {}^{17}\mathrm{B} + 2n$)

$^{14\text{-}19}$B: present experimental status

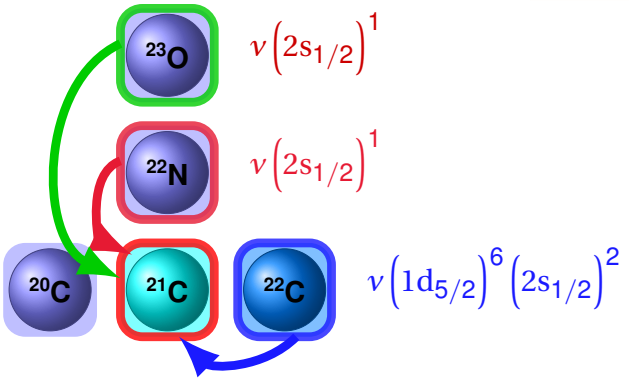


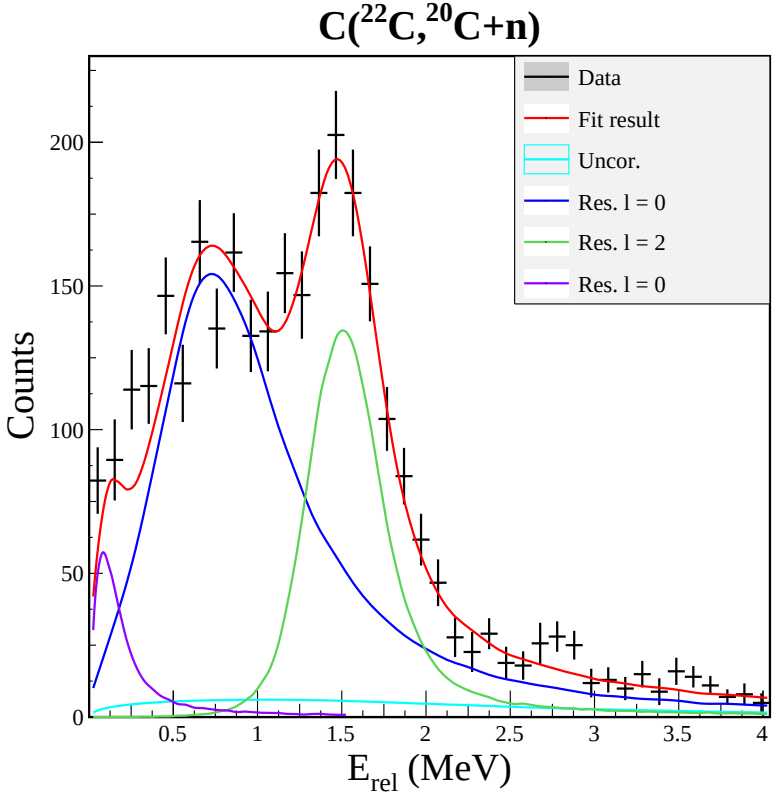
Carbon isotopes

^{21}C: Analysis summary (S. Leblond's PhD)

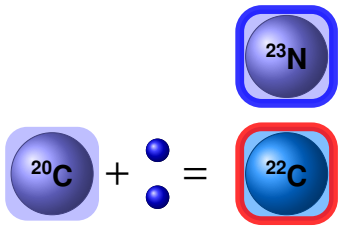


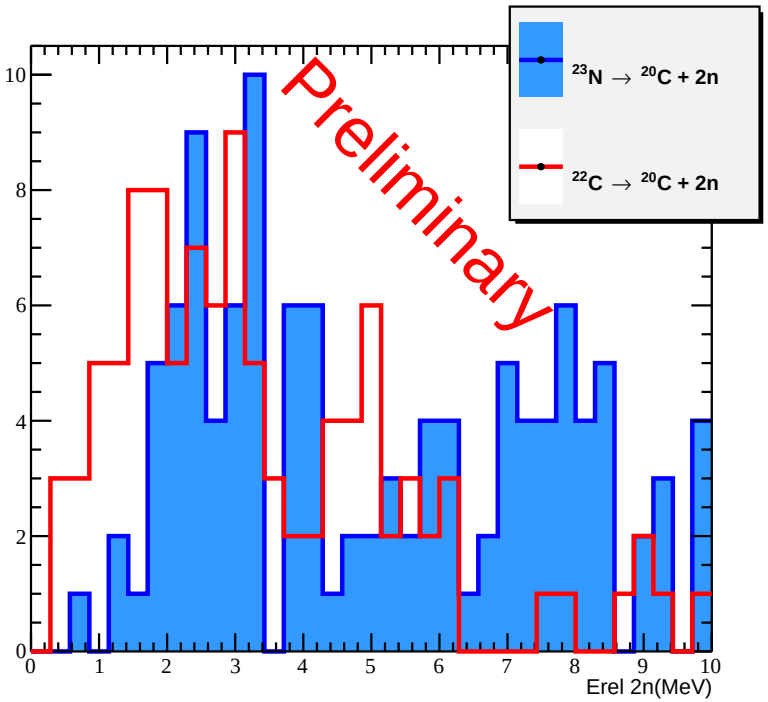
SM calculations: Kobayashi, PRC **86** (2012) 054604

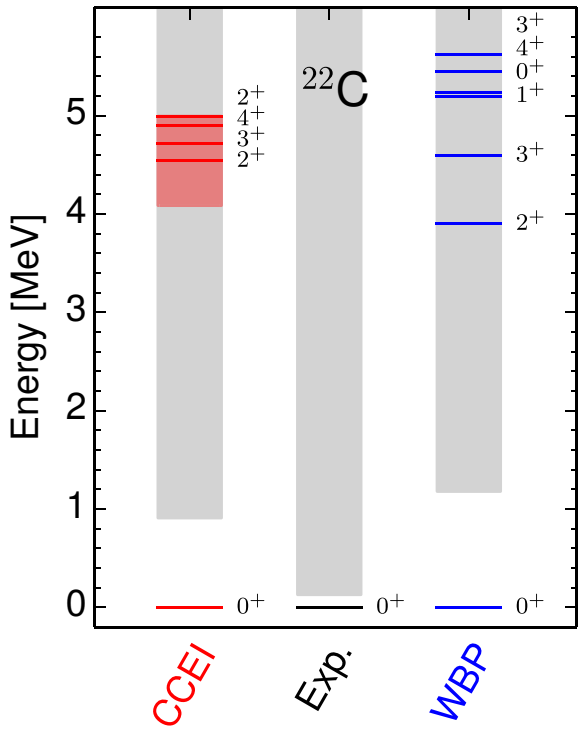




^{22}C: Analysis summary (JG)







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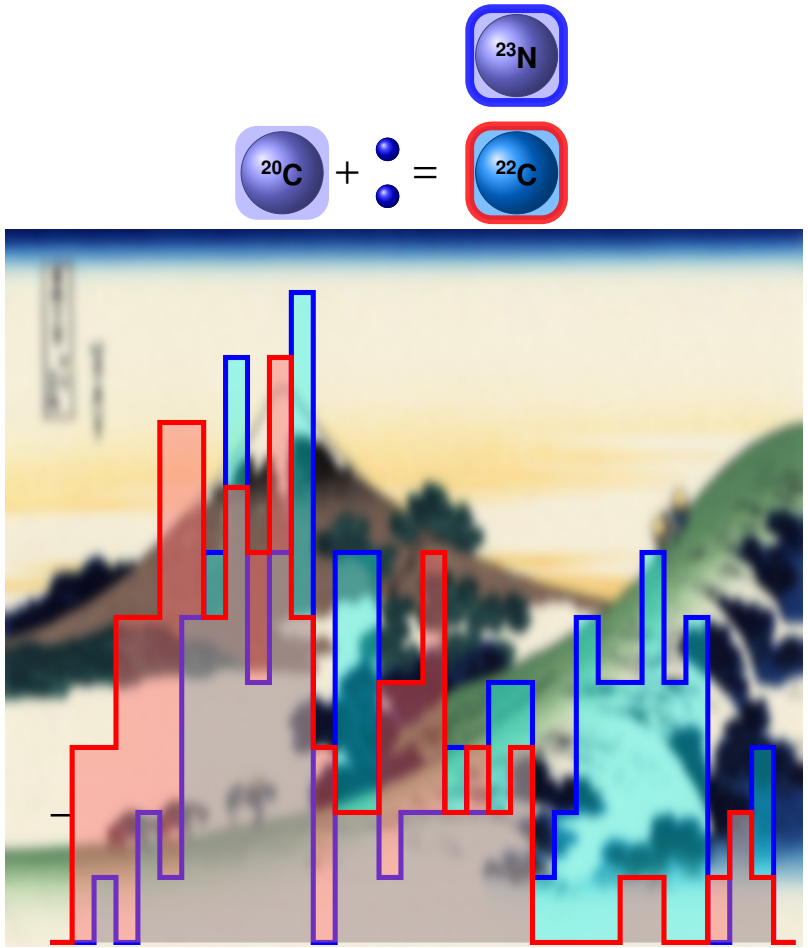
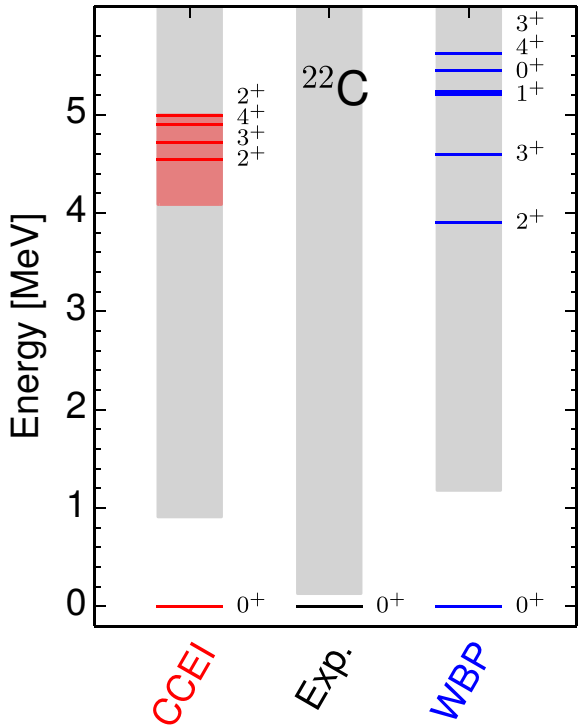
^{22}C: Analysis summary (JG)





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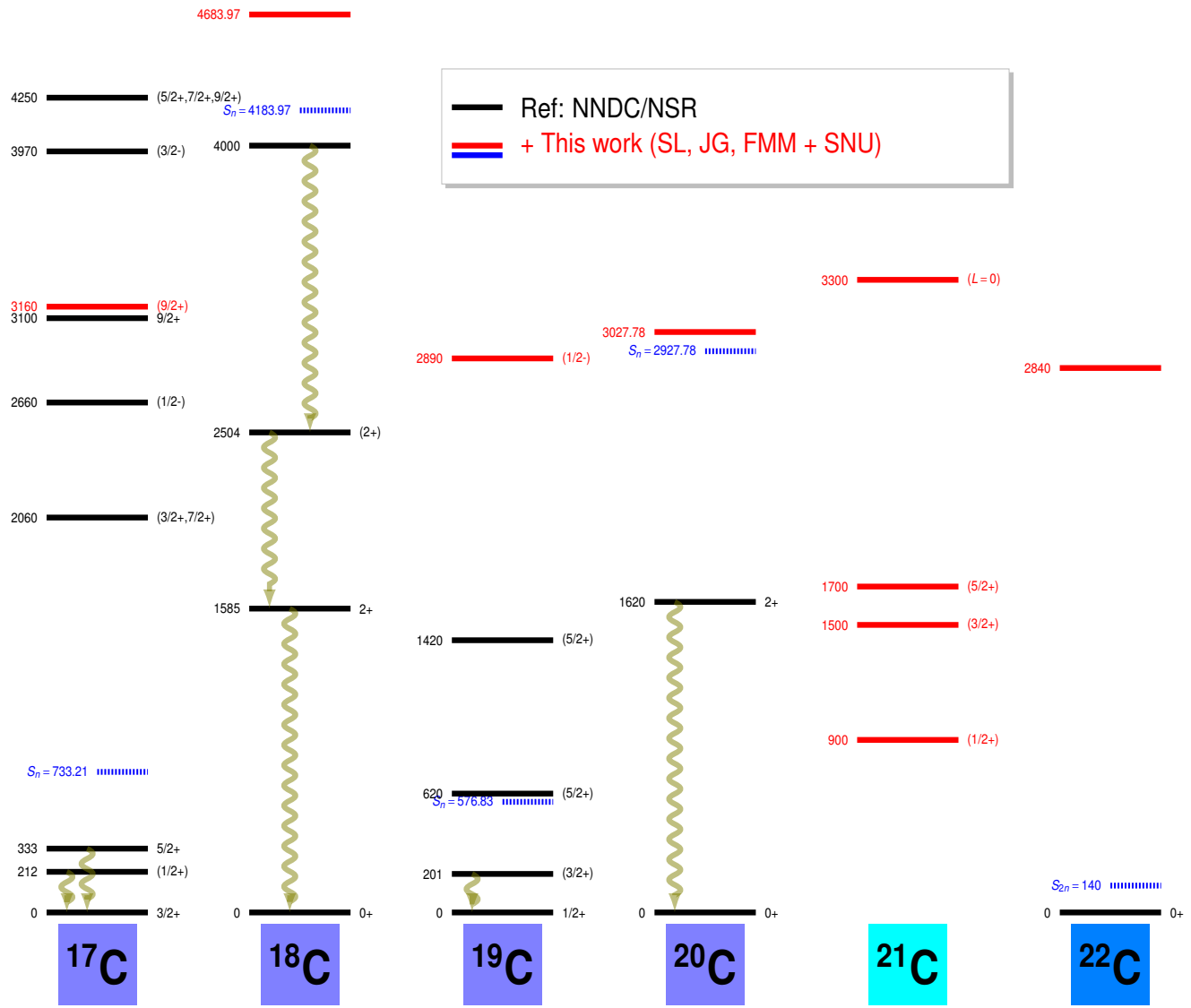
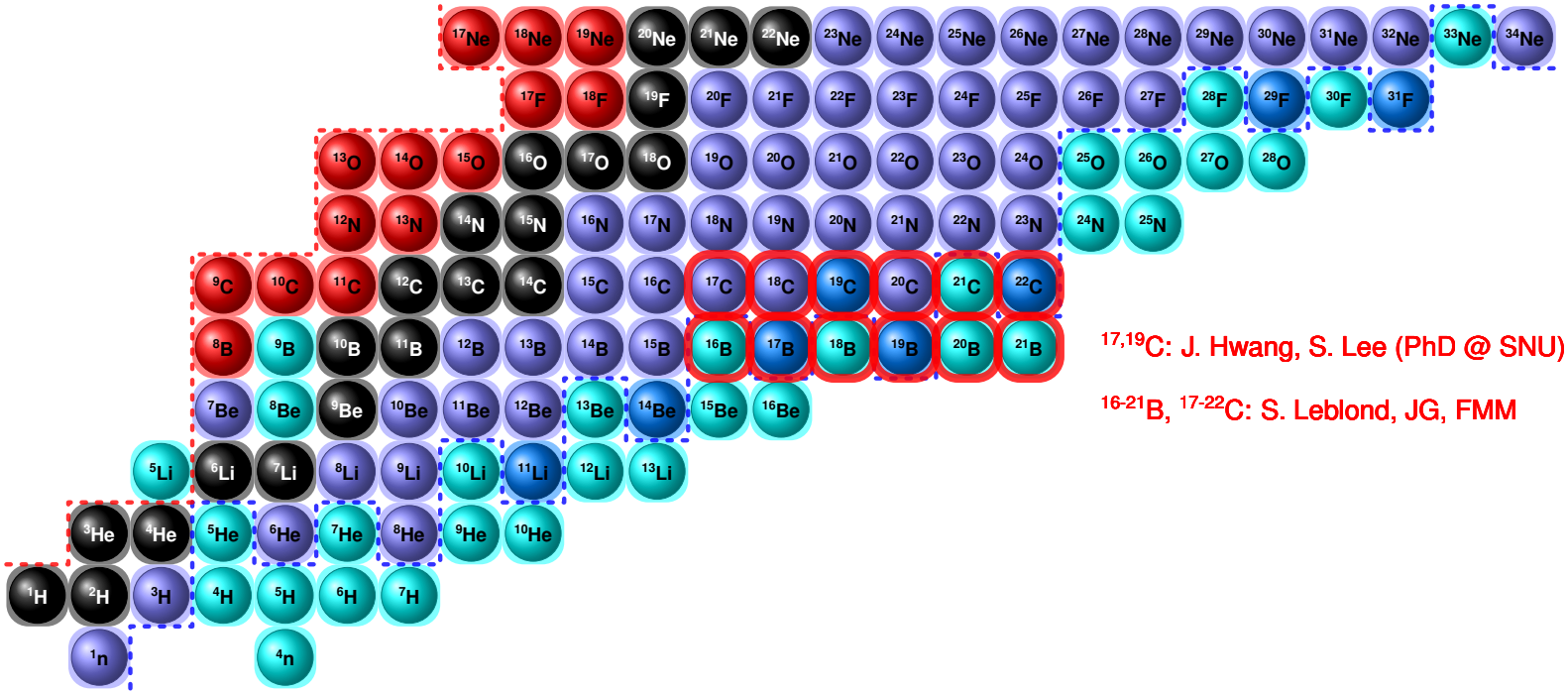
$^{17\text{-}22}$C: present experimental status



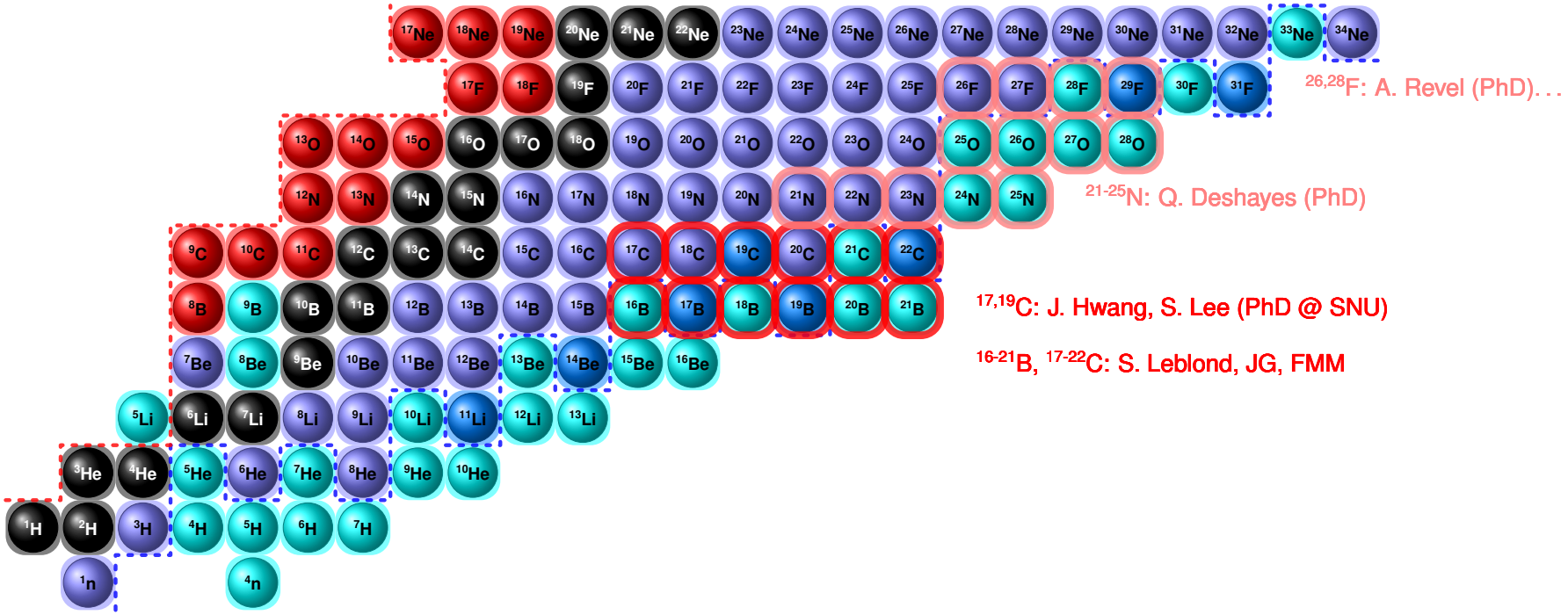
Status and future



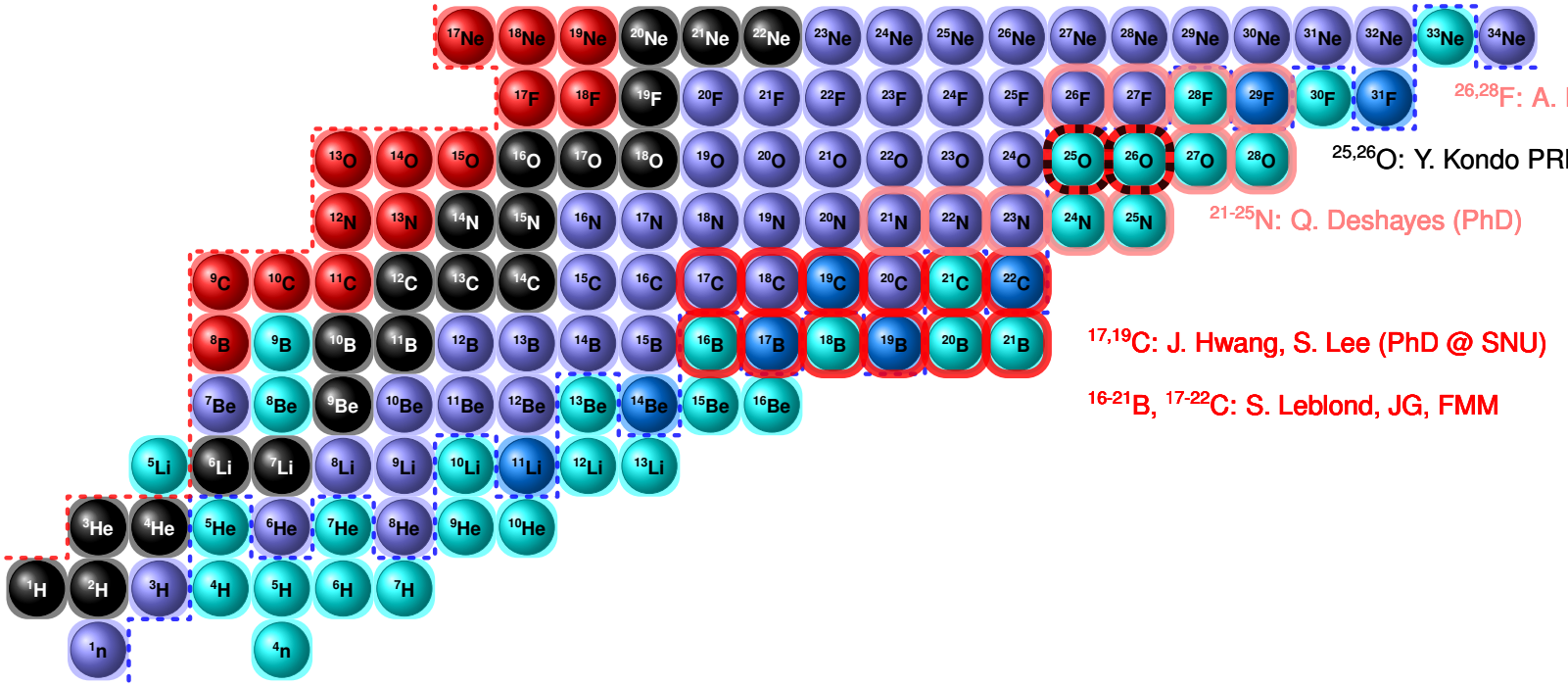
^{17,19}C: J. Hwang, S. Lee (PhD @ SNU)

$^{16\text{-}21}$B, $^{17\text{-}22}$C: S. Leblond, JG, FMM

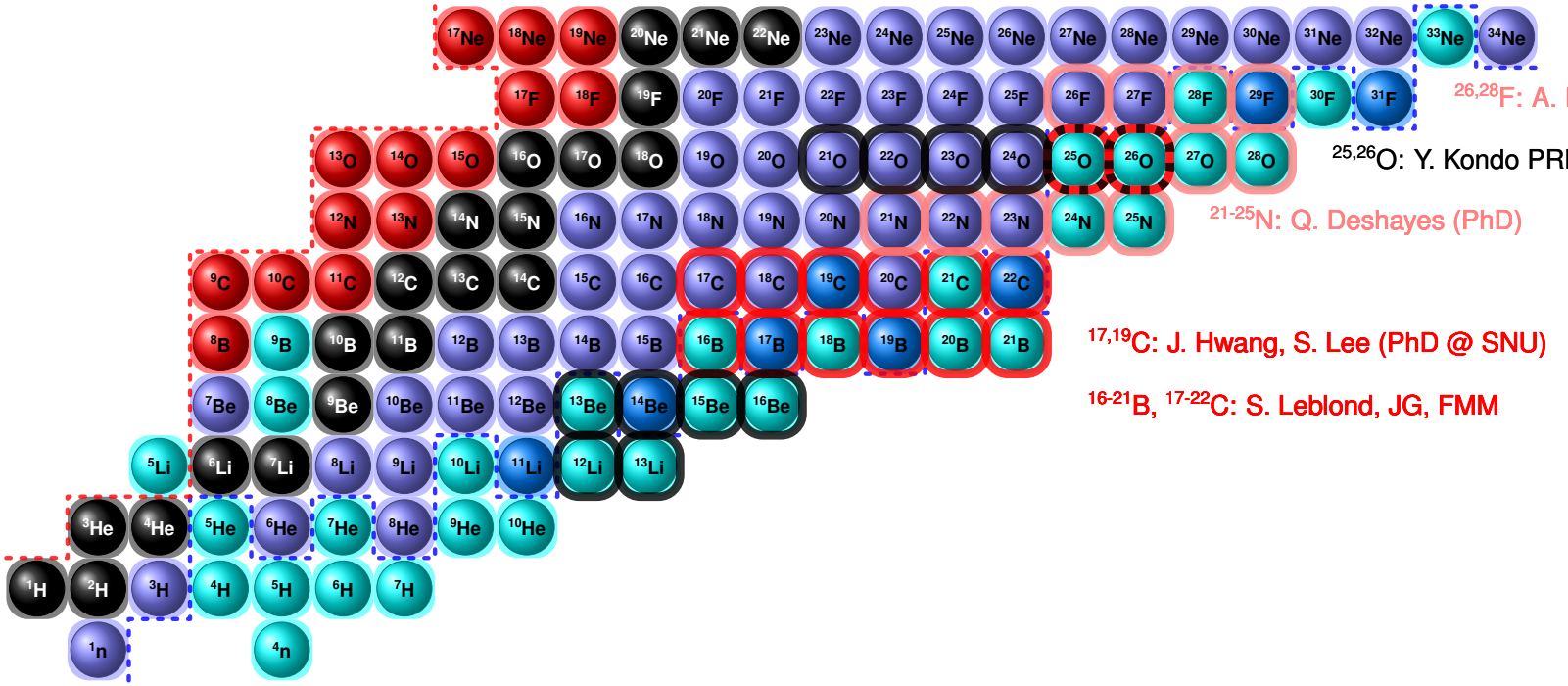
Status and future



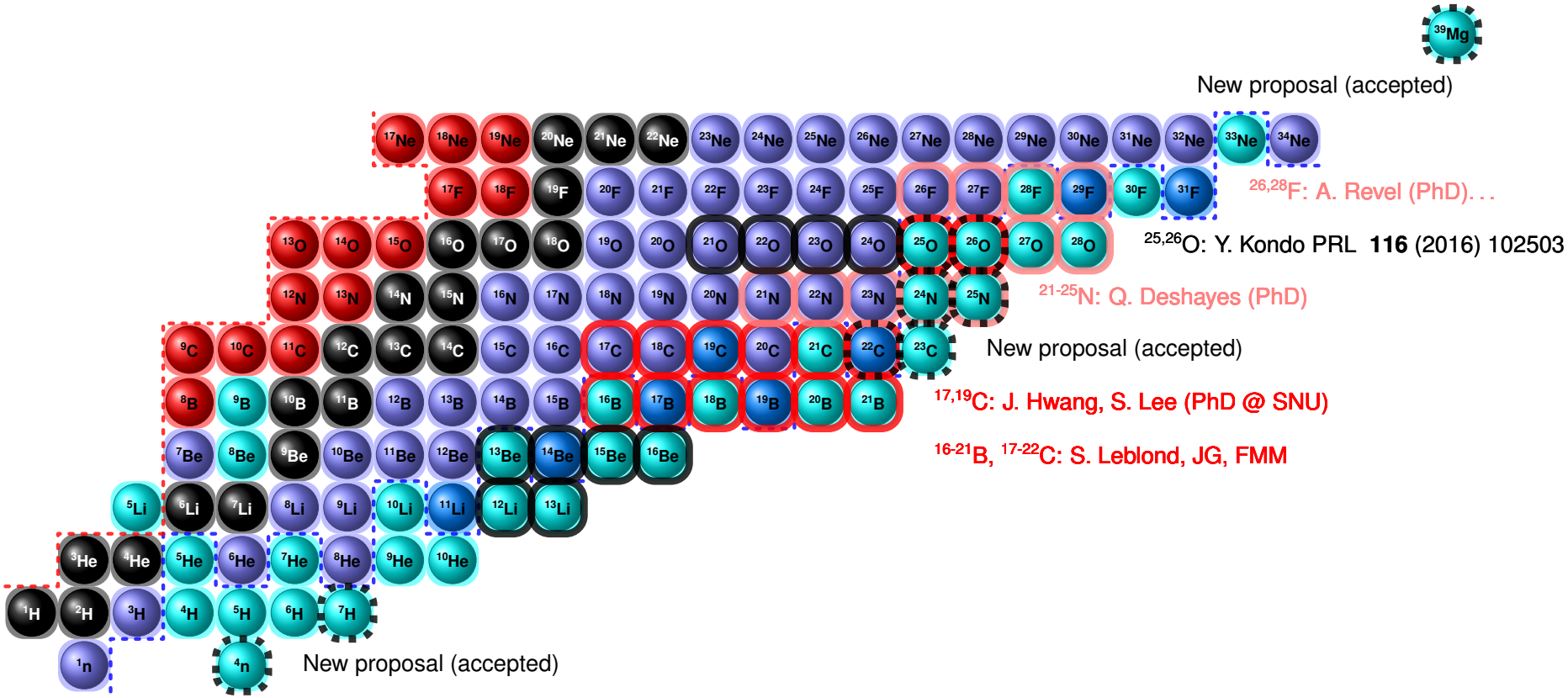
Status and future



Status and future



Status and future



Status and future