Level densities and γ strength functions in modeling neutron interactions with iron isotopes

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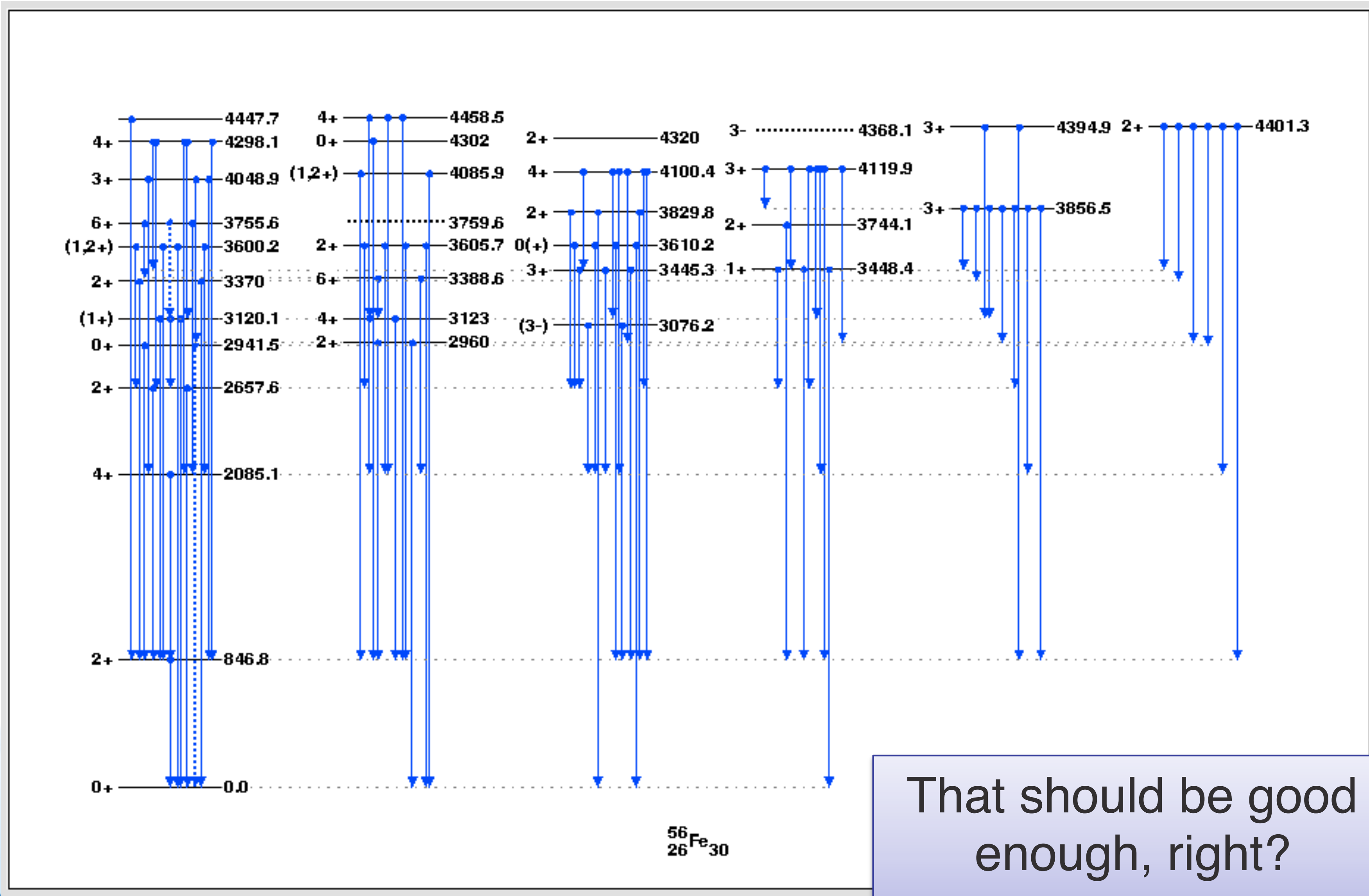
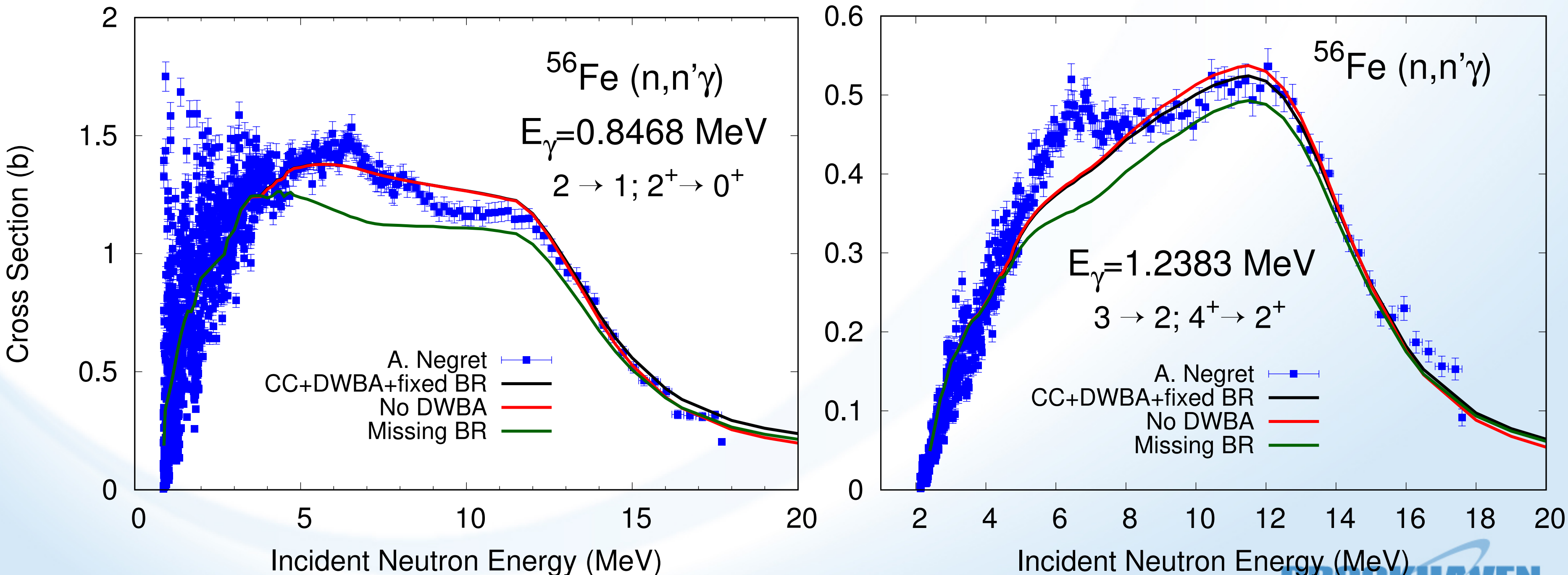
^{56}Fe has only 5 missing branching ratios (< 4.5 MeV)!

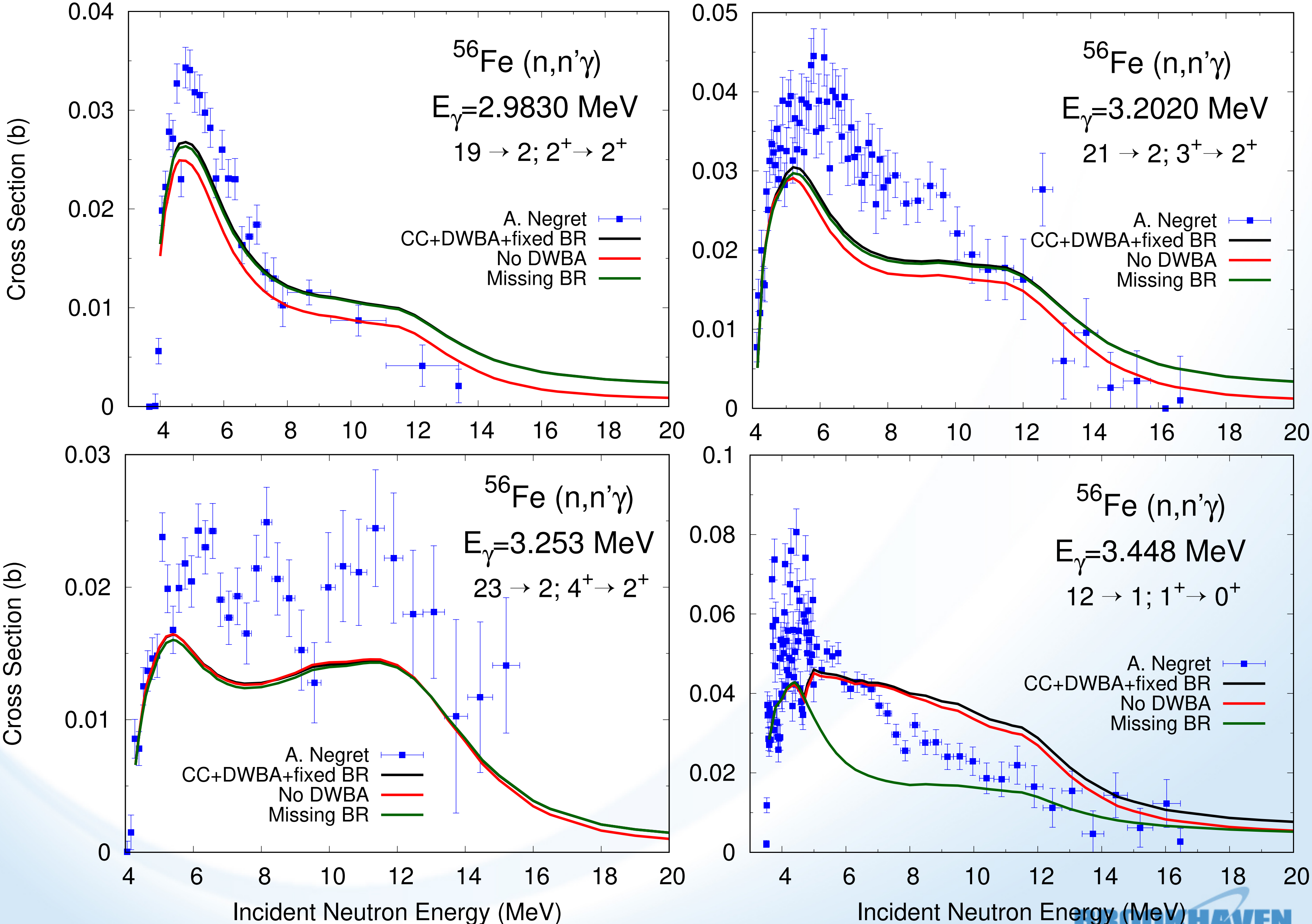


That should be good enough, right?

Gaps in ^{56}Fe can be relevant

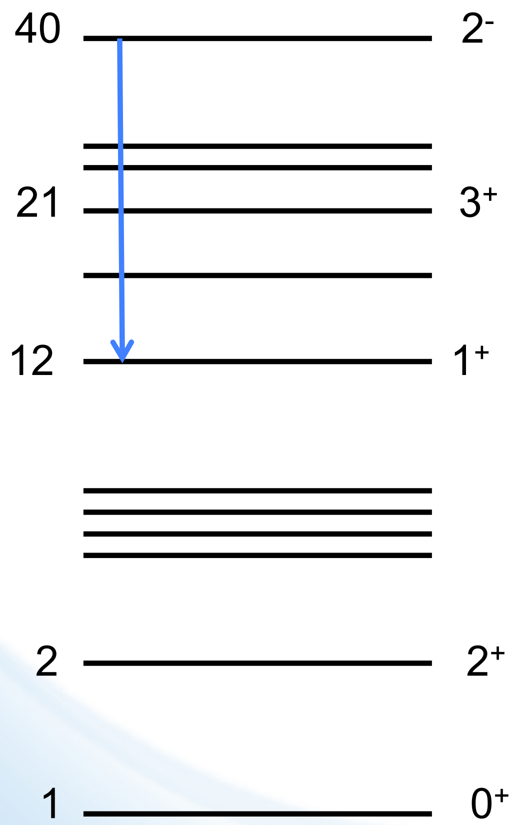
- Reaction codes **must** make a decision about such decays
- In many codes direct transition to g. s. is assumed
- Set of prescriptions: better choices for missing transitions




^{56}Fe (n,n'γ)
E_γ=2.9830 MeV
19 → 2; 2$^+$→ 2$^+$
A. Negret
CC+DWBA+fixed BR
No DWBA
Missing BR
^{56}Fe (n,n'γ)
E_γ=3.2020 MeV
21 → 2; 3$^+$→ 2$^+$
A. Negret
CC+DWBA+fixed BR
No DWBA
Missing BR
^{56}Fe (n,n'γ)
E_γ=3.253 MeV
23 → 2; 4$^+$→ 2$^+$
A. Negret
CC+DWBA+fixed BR
No DWBA
Missing BR
^{56}Fe (n,n'γ)
E_γ=3.448 MeV
12 → 1; 1$^+$→ 0$^+$
A. Negret
CC+DWBA+fixed BR
No DWBA
Missing BR
Cross Section (b)
Cross Section (b)
Incident Neutron Energy (MeV)
Incident Neutron Energy (MeV)

Branching ratio for level 40

- Level 12, 1^+ and did not have any BR changed
- Level 40, 2^- had missing BR, assumed an E1 transition to 12



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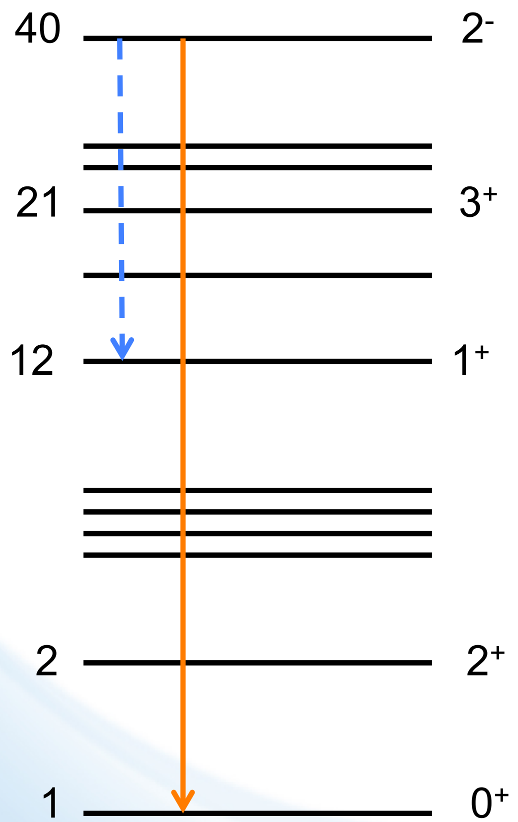

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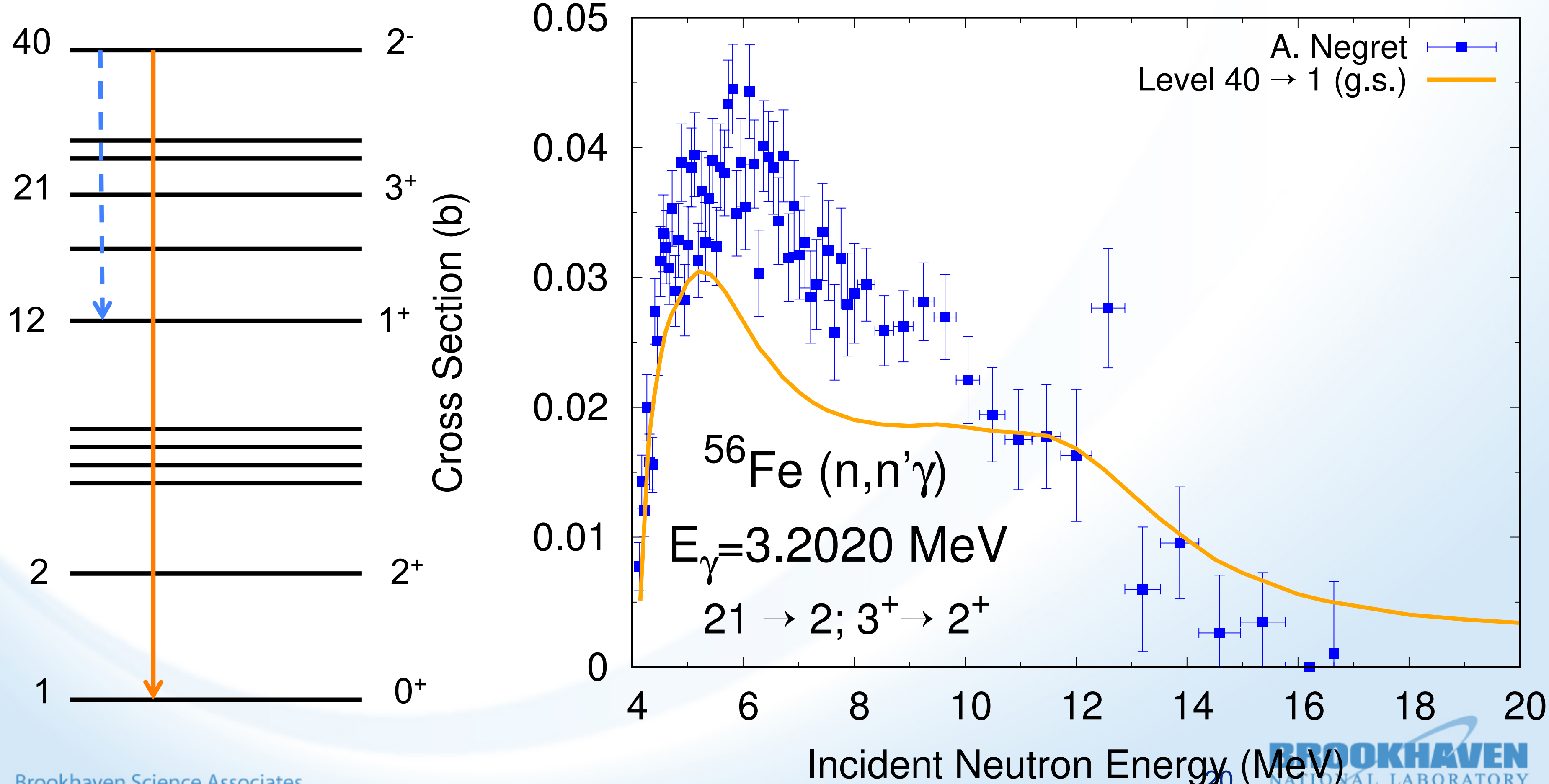

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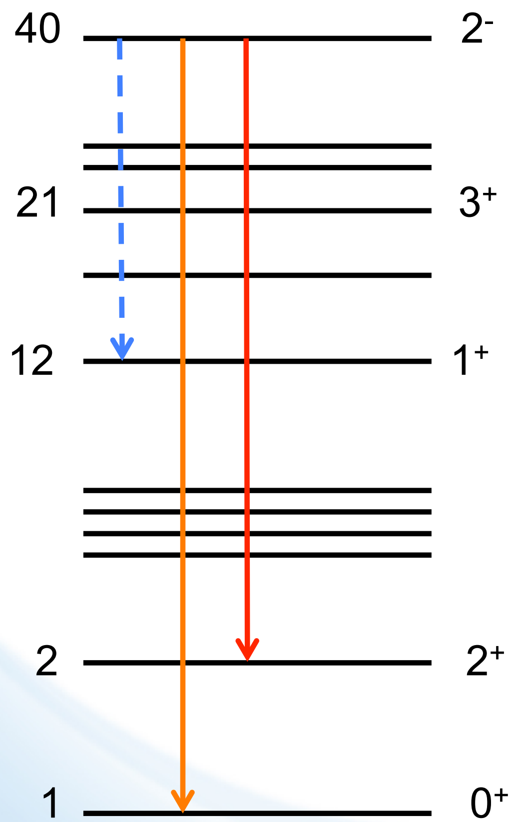

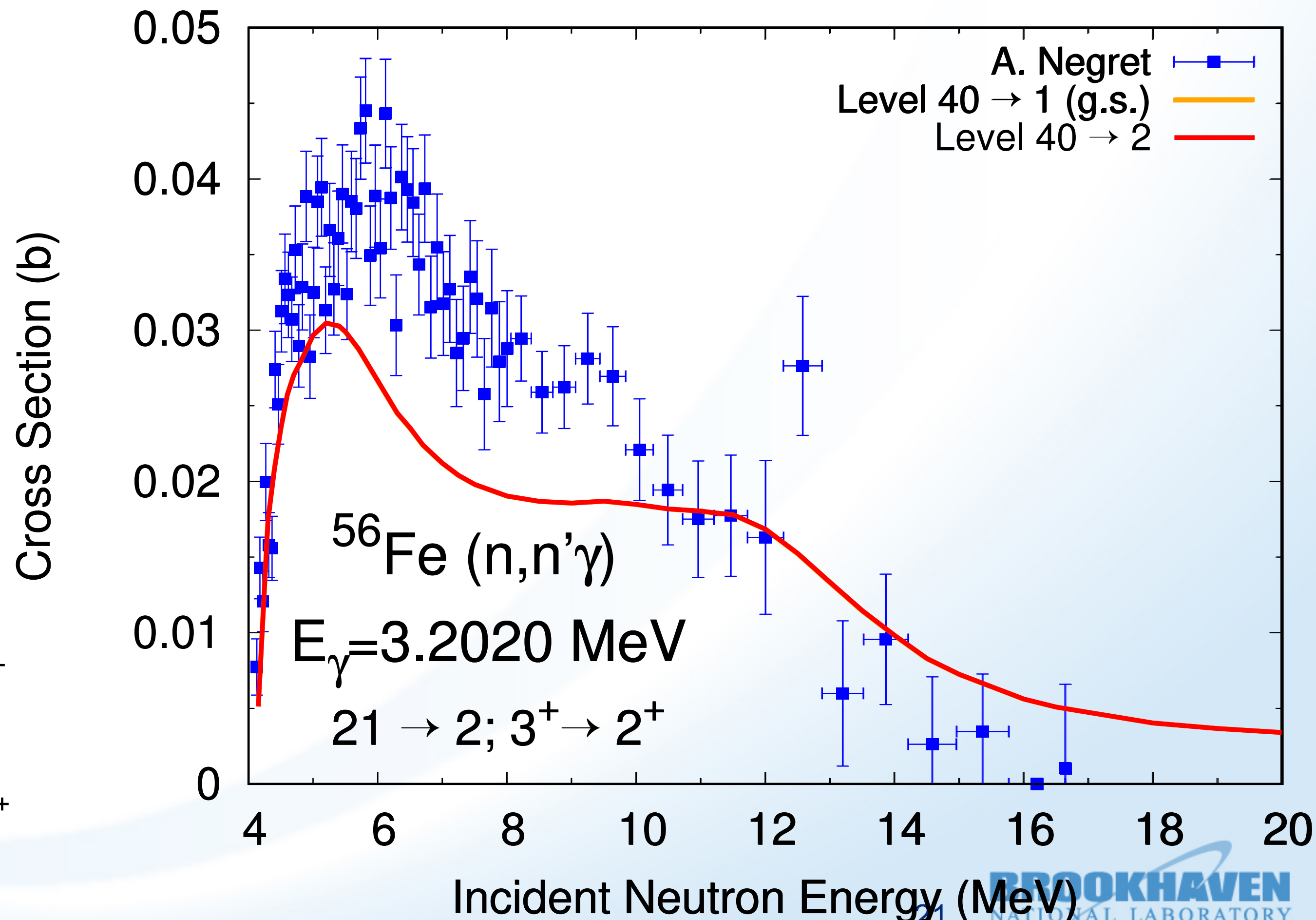

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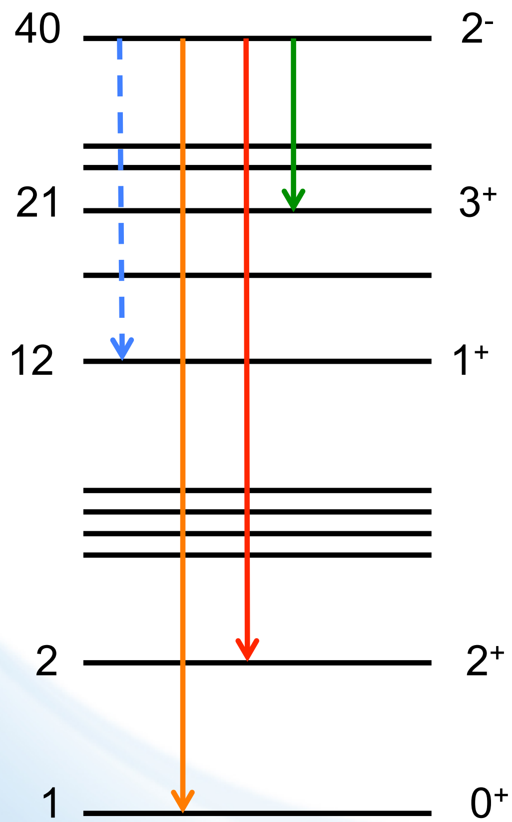

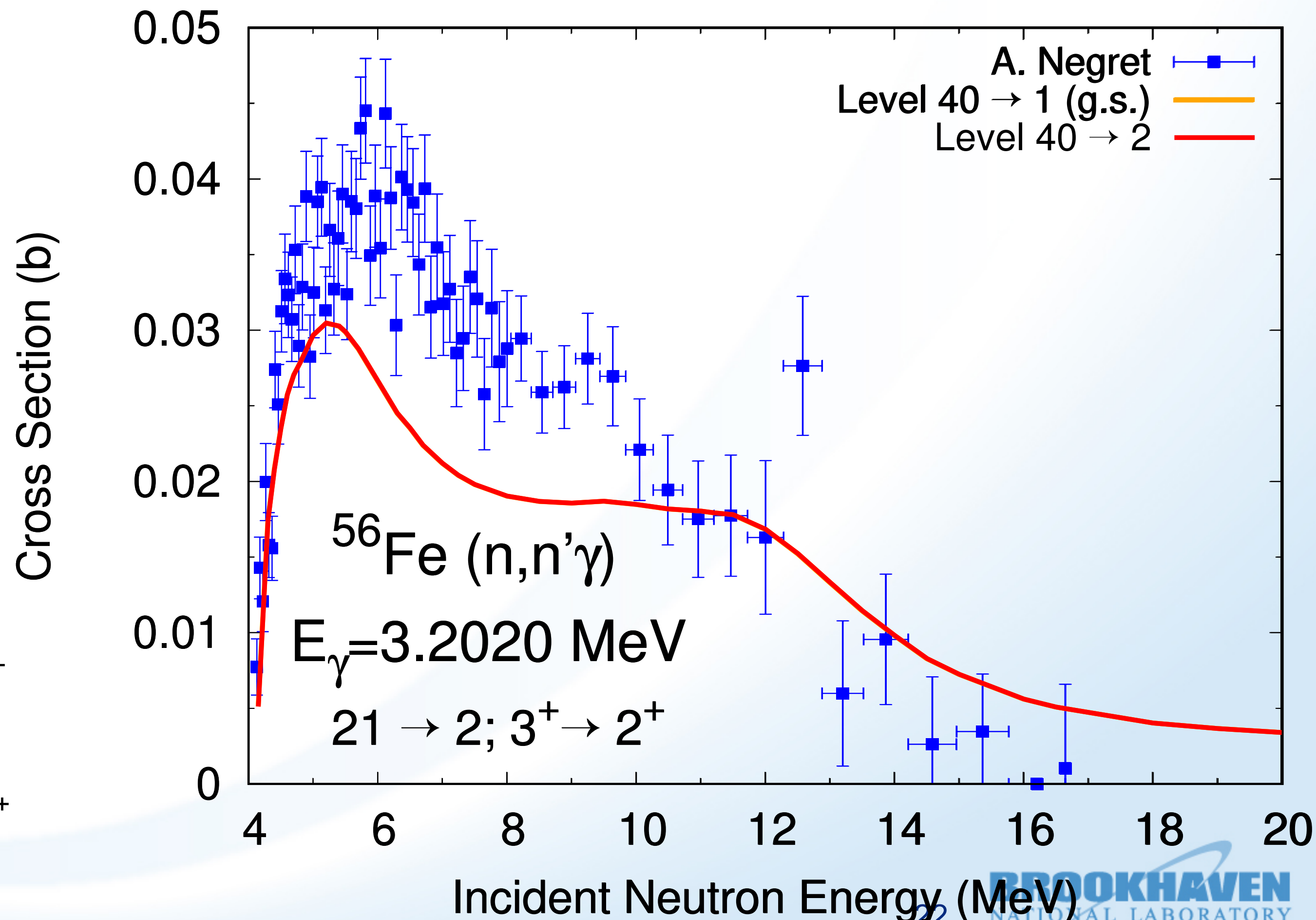

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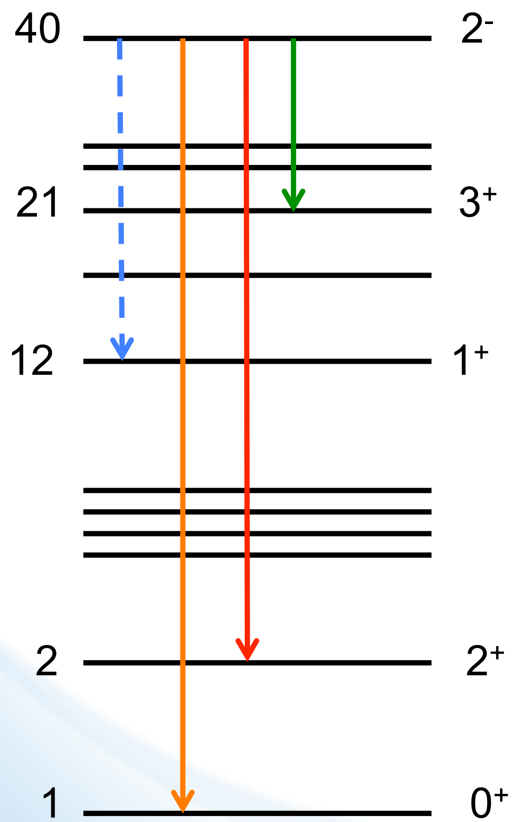

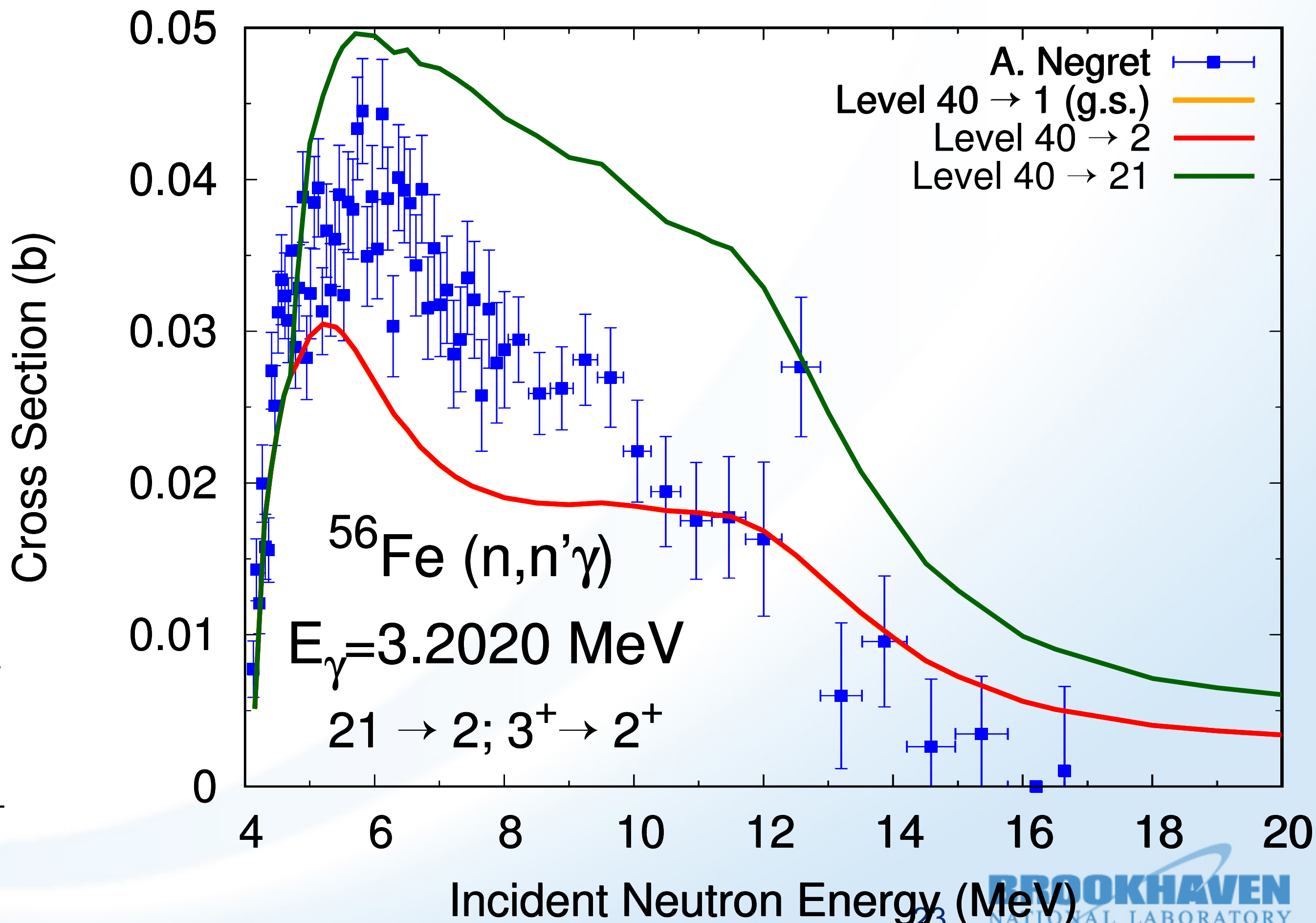

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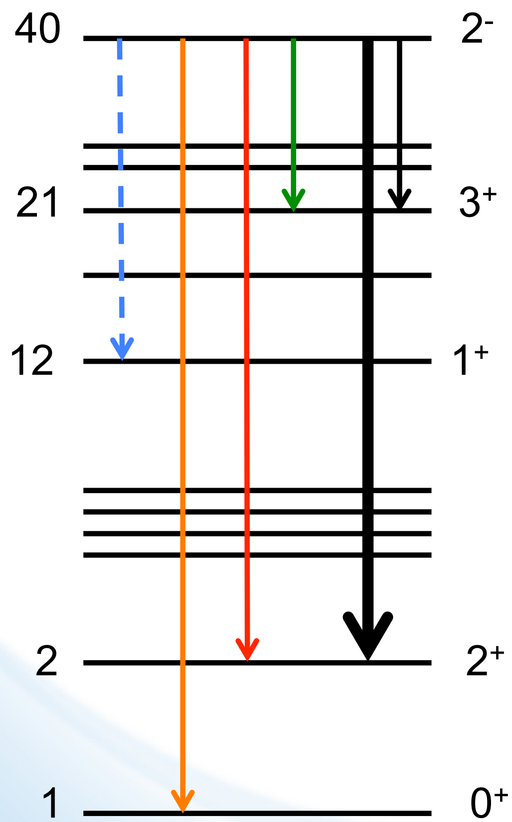

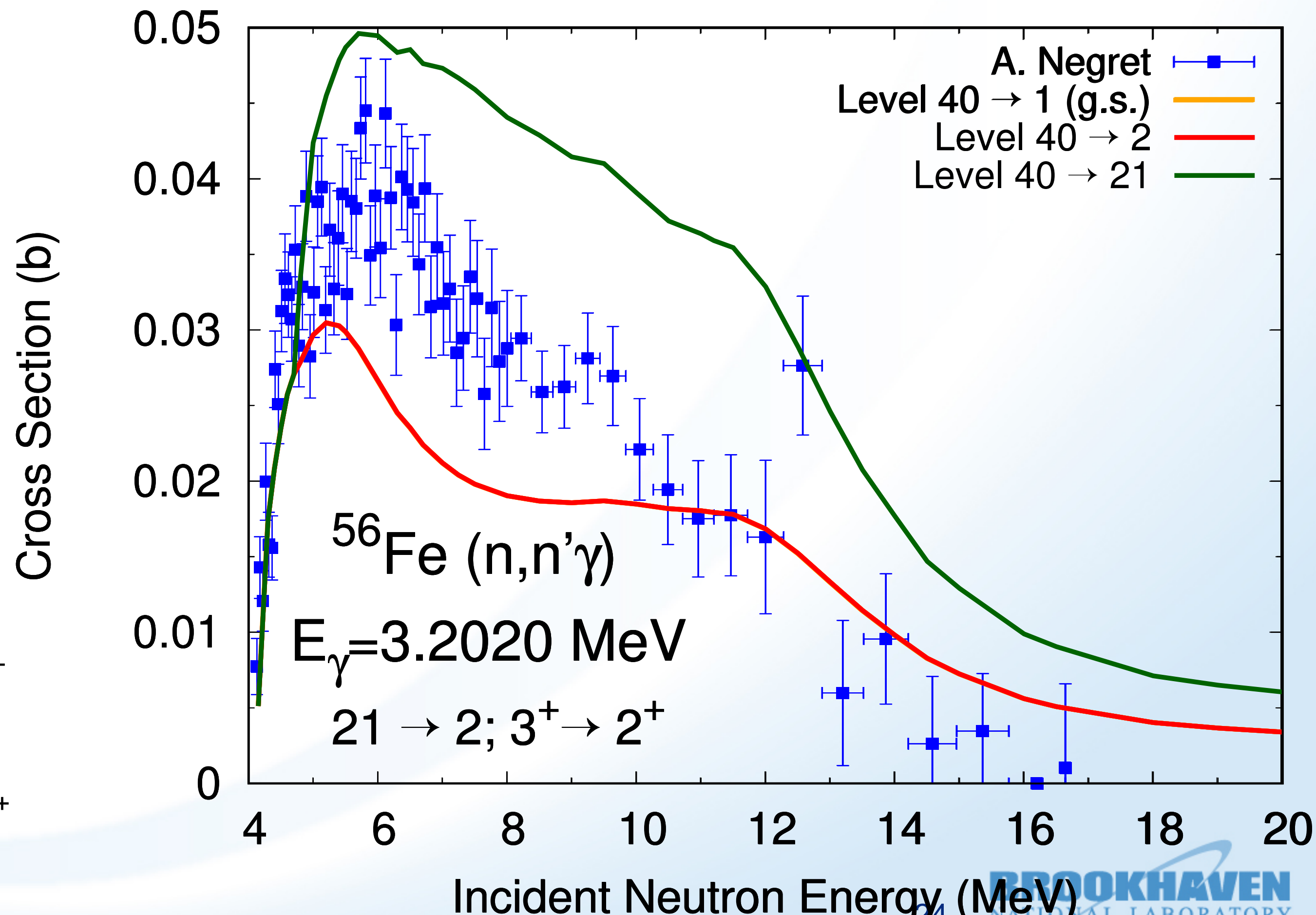

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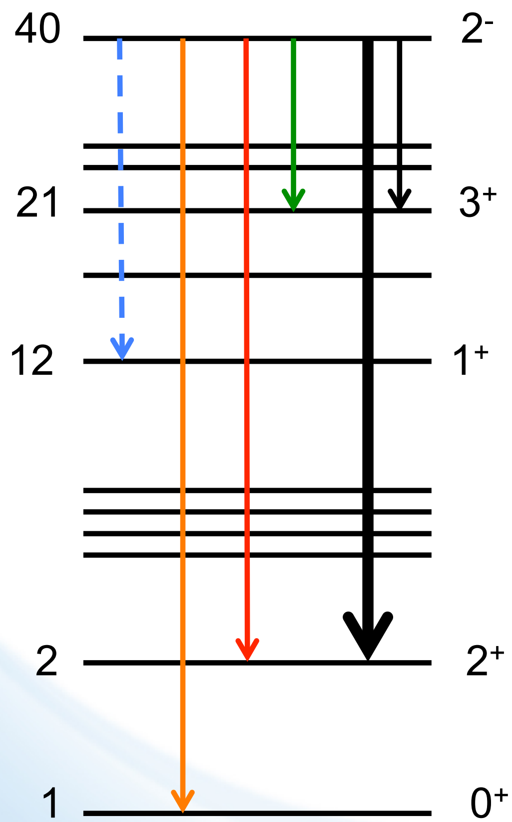
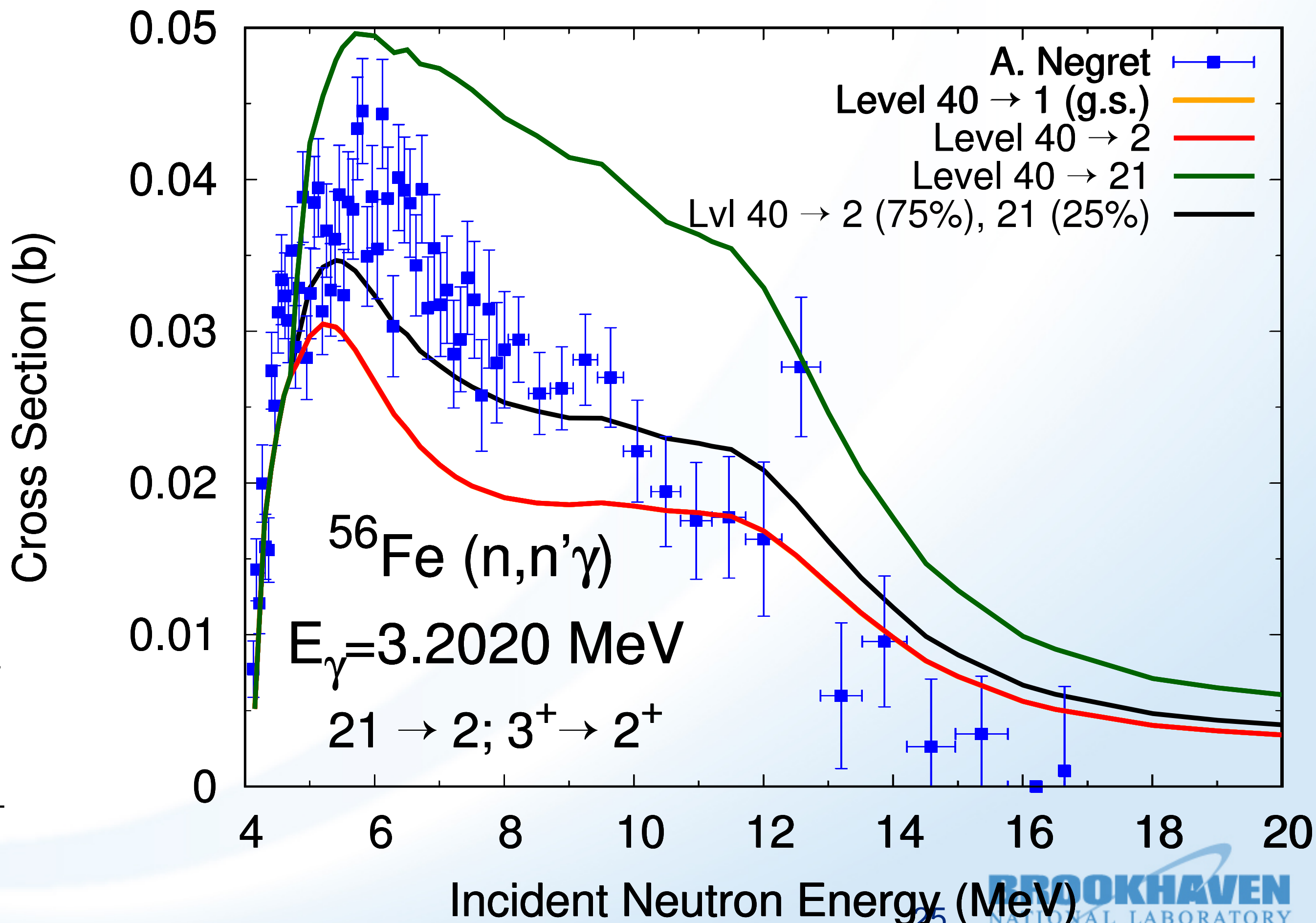
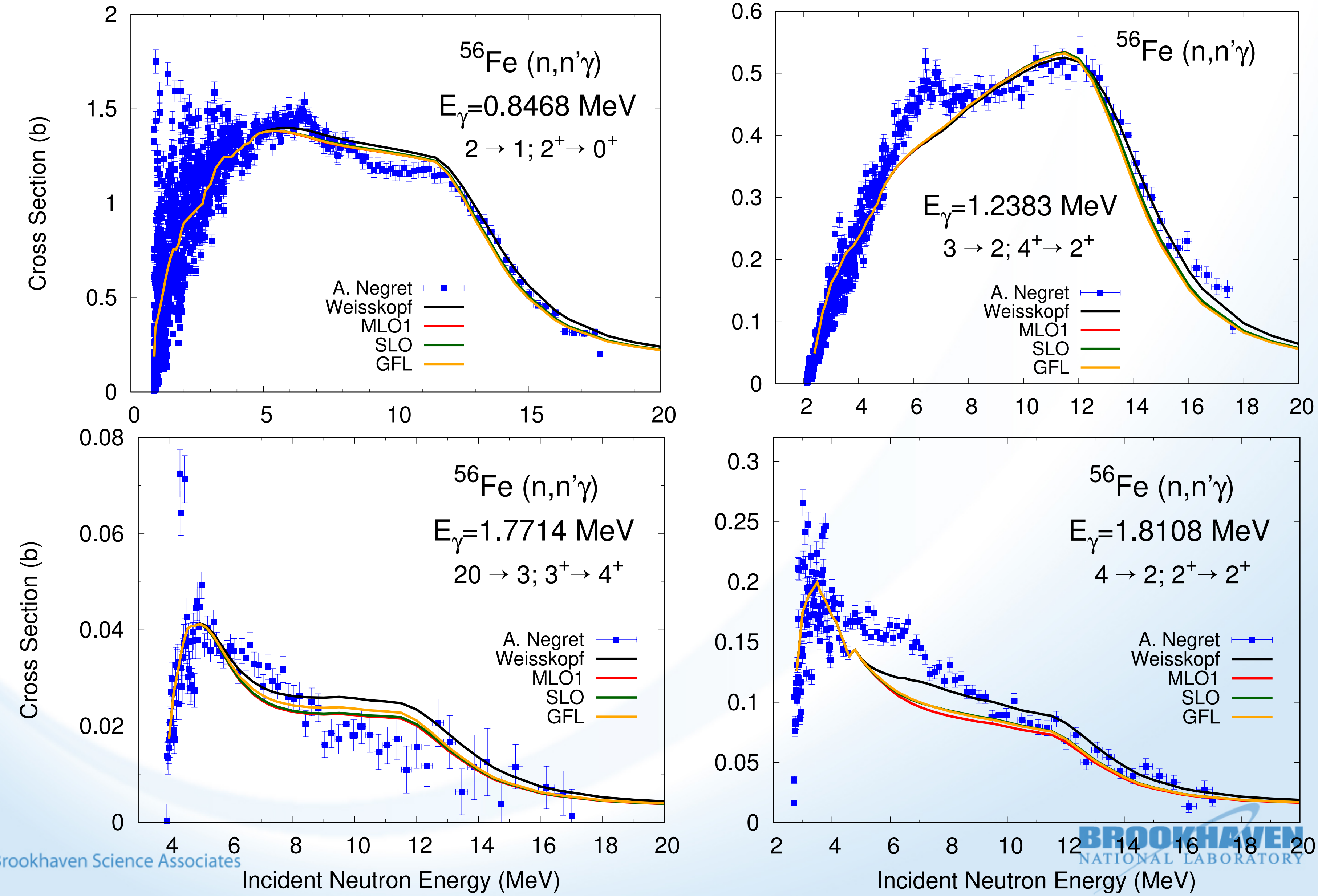


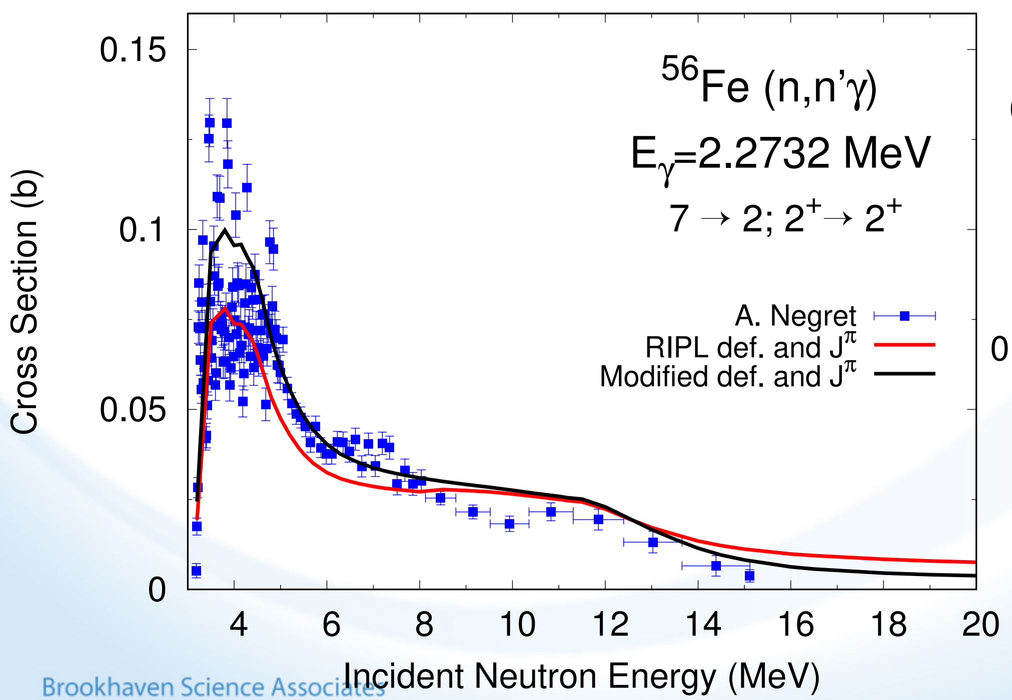


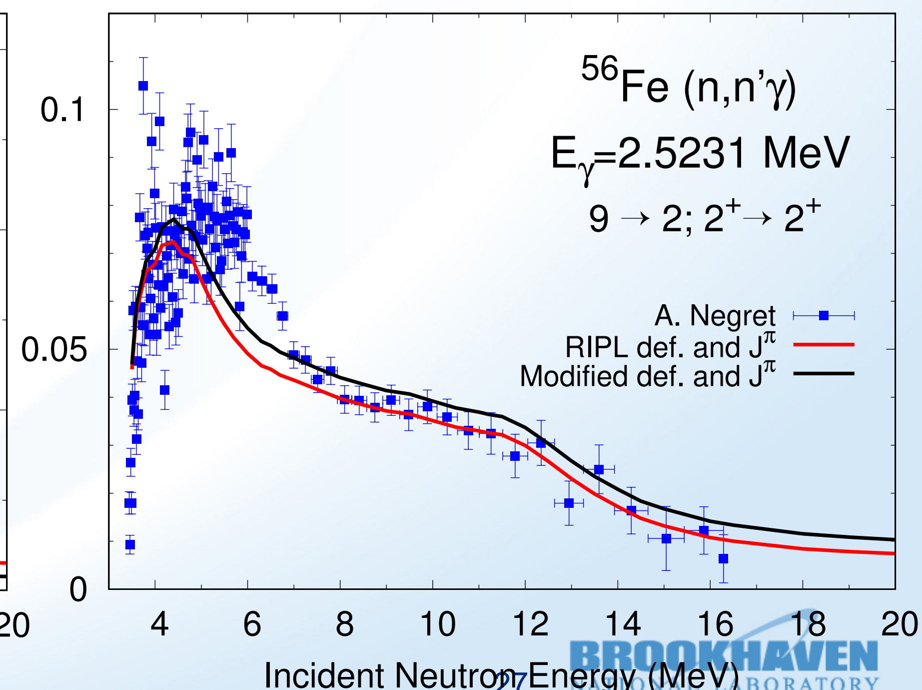
Effect of different γ strength function models



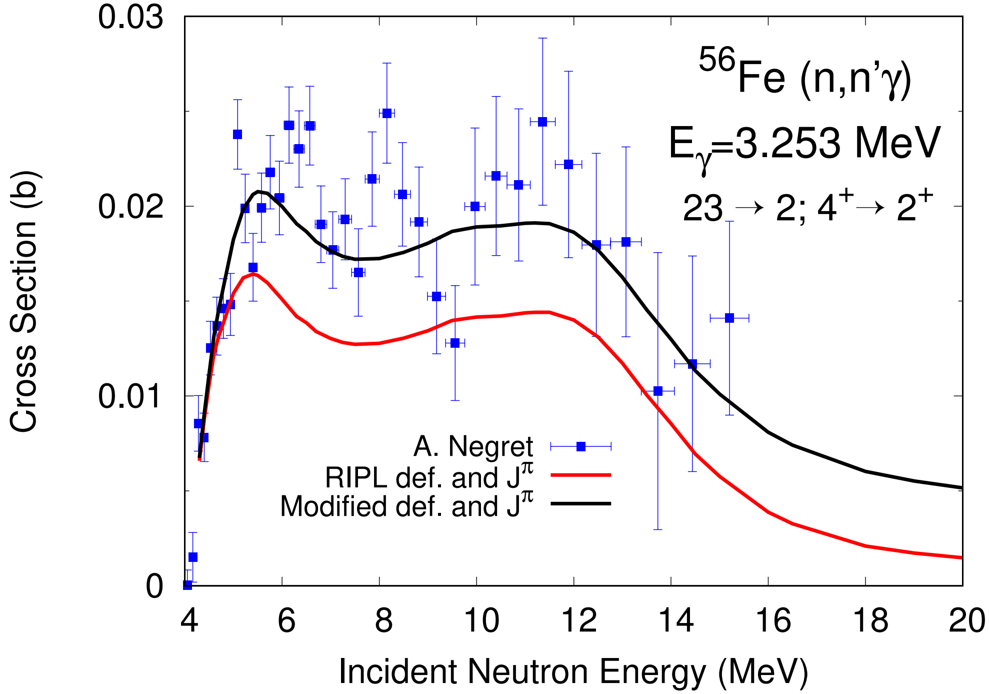
Modifying DWBA deformations and J$^{\pi}$

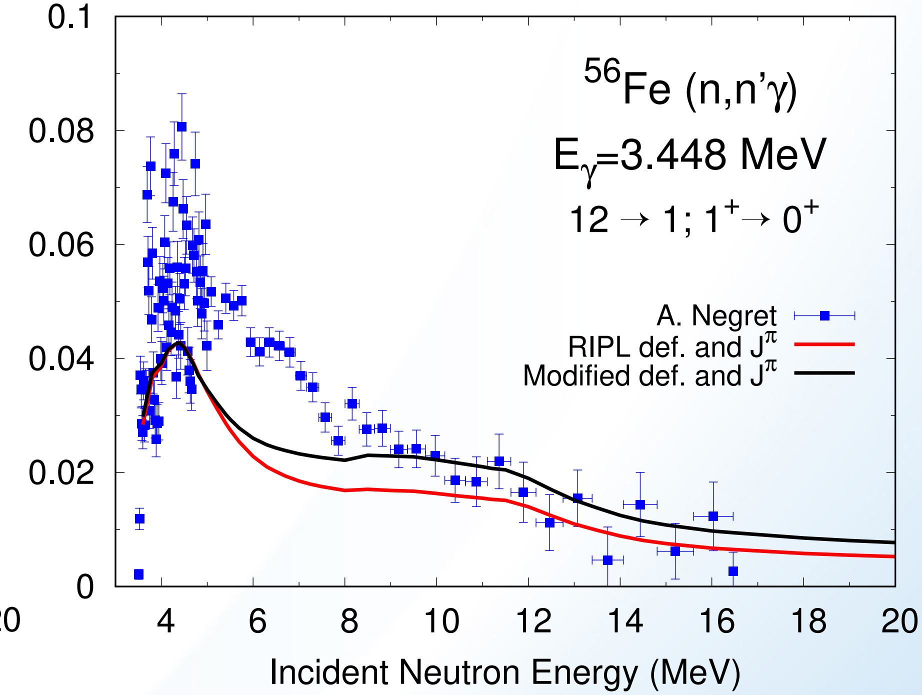
- Calculations to test sensitivity regarding uncertain J$^{\pi}$ and DWBA deformations:
  - Changed level 7 from 1^{+} to 2^{+}
  - Increased def. of level 9 from 0.05 to 0.075
  - Increased def. of level 23 from 0.03 to 0.10
  - Increased def. of level 12 from 0.039 to 0.089





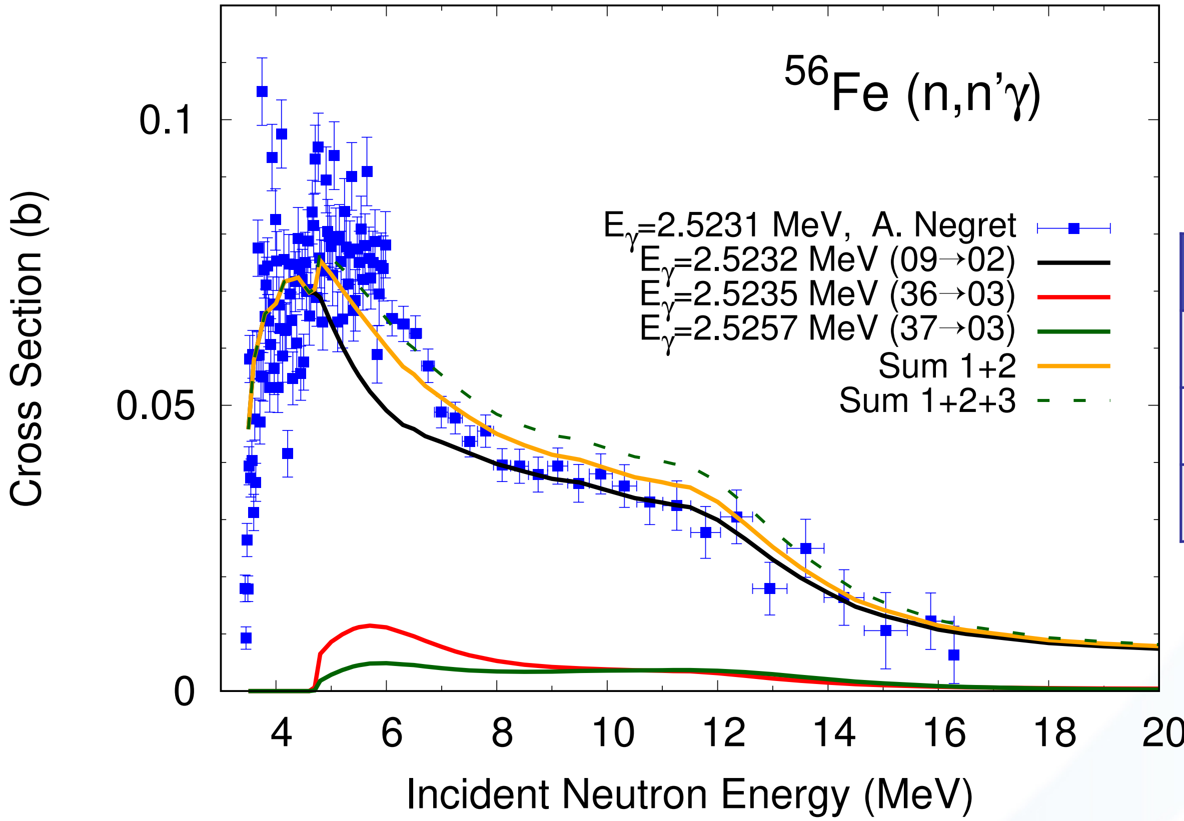
Modifying DWBA deformations and J^{π}





When there is experimental uncertainty and theoretical decisions have to be made, both DWBA deformations and spin/parity can be constrained through the inelastic gammas.

Transitions with similar Eγ

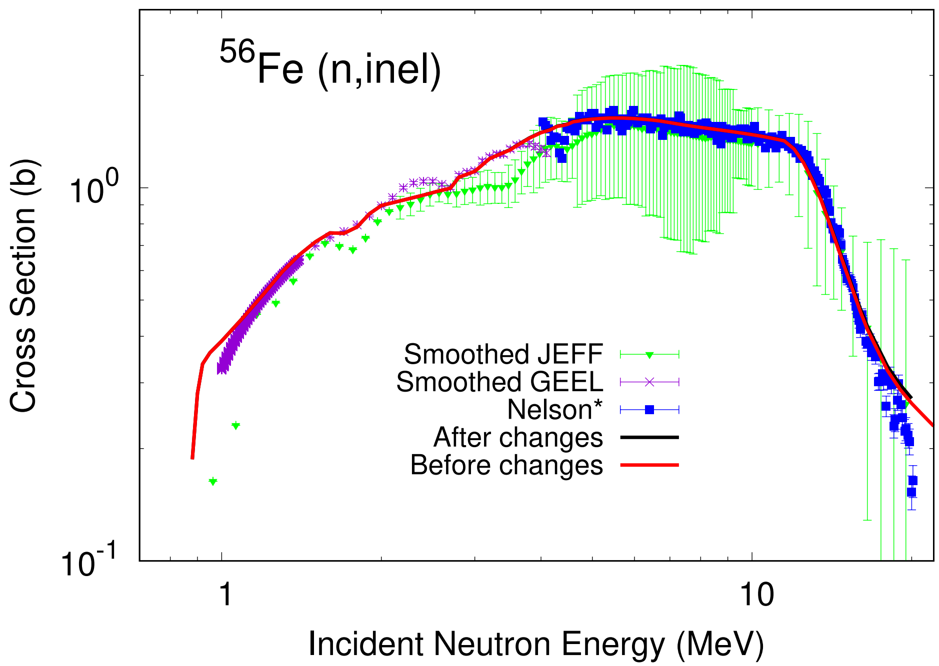


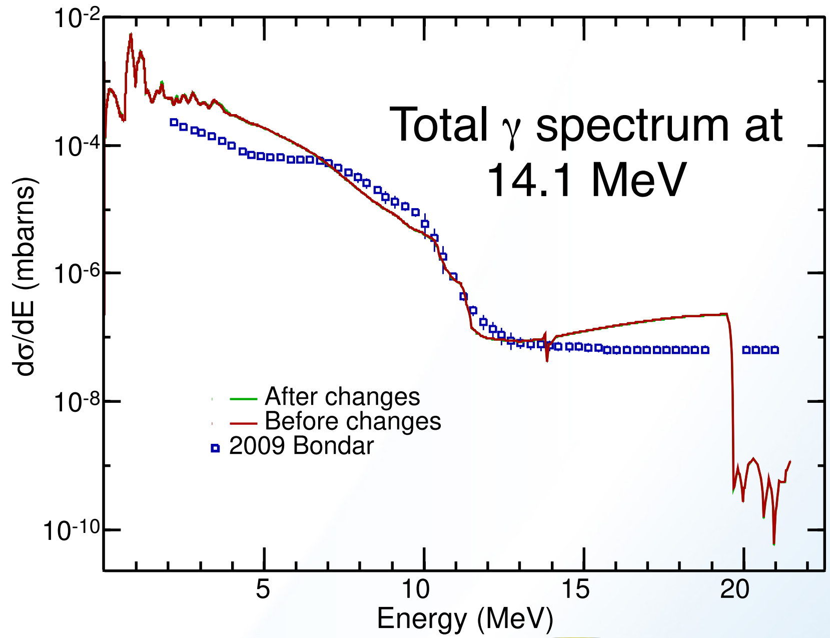
Exp. Eγ=2.5231 MeV

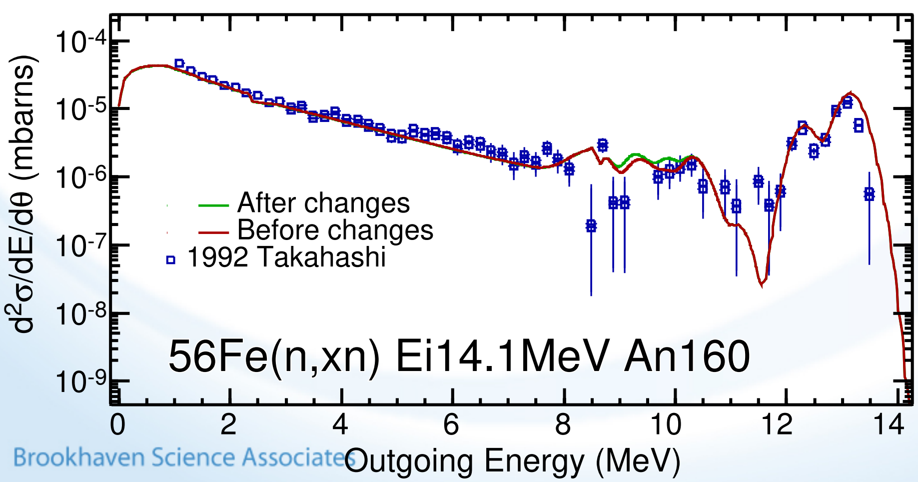
Trans.	Eγ (MeV)	Δ (keV)
Lvl 9 to 2	2.5232	0.1
Lvl 36 to 3	2.5235	0.4
Lvl 37 to 3	2.5257	2.6

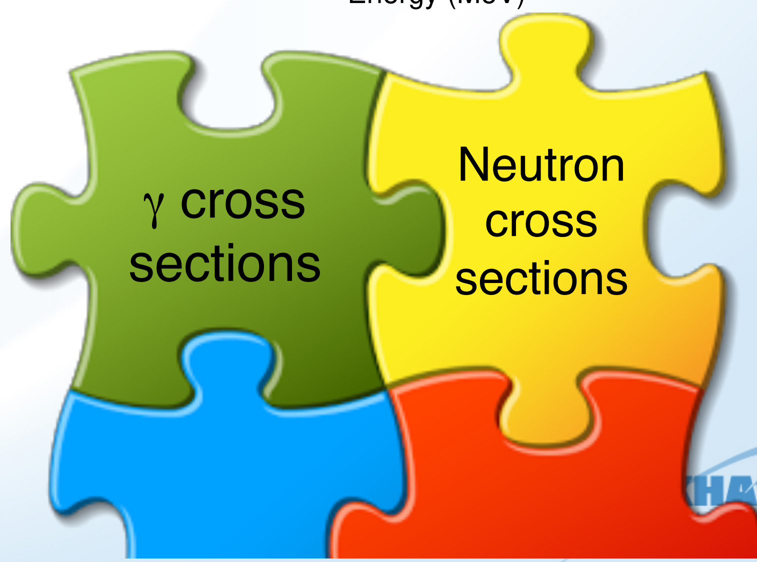
Depending on the experimental resolution and on the proximity between γ's from different transitions, those cross sections have to be added together.

Consistency with neutron cross sections

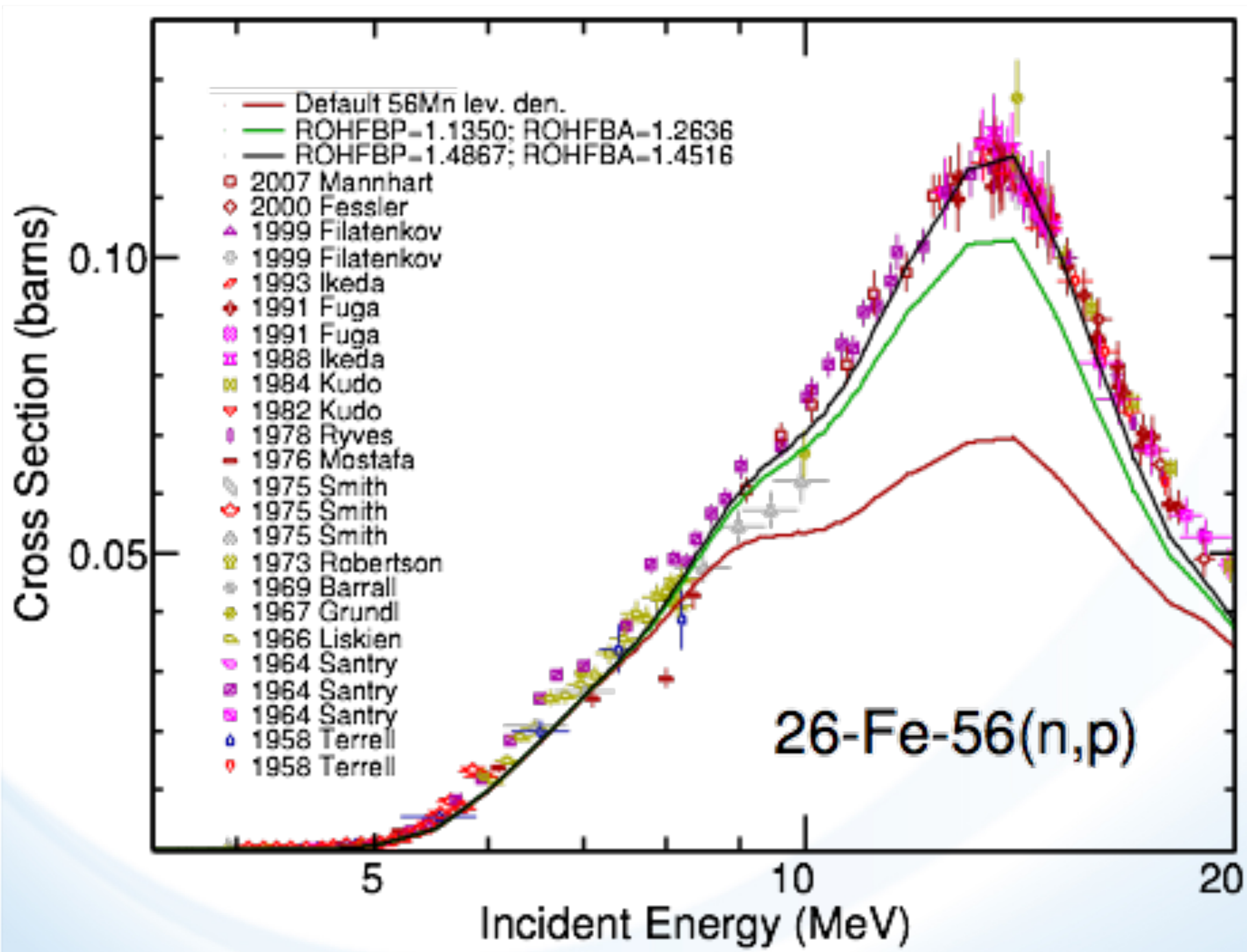








$^{56}Fe(n,p)$ sensitivity to ^{56}Mn level density



$^{56}Fe(n,p)$ is very sensitive to ^{56}Mn level-density parameters

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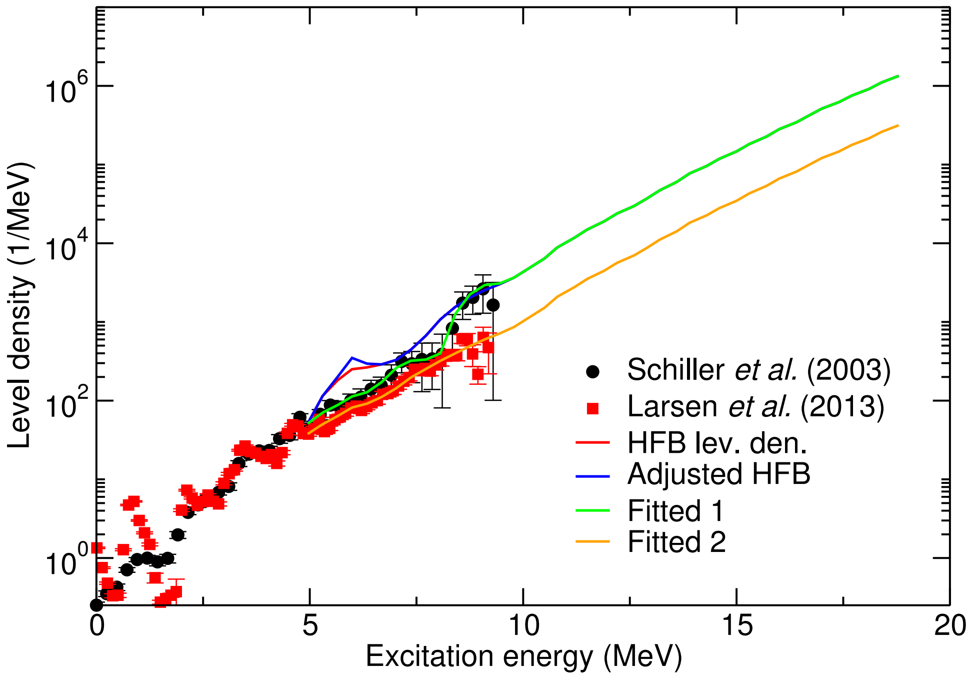
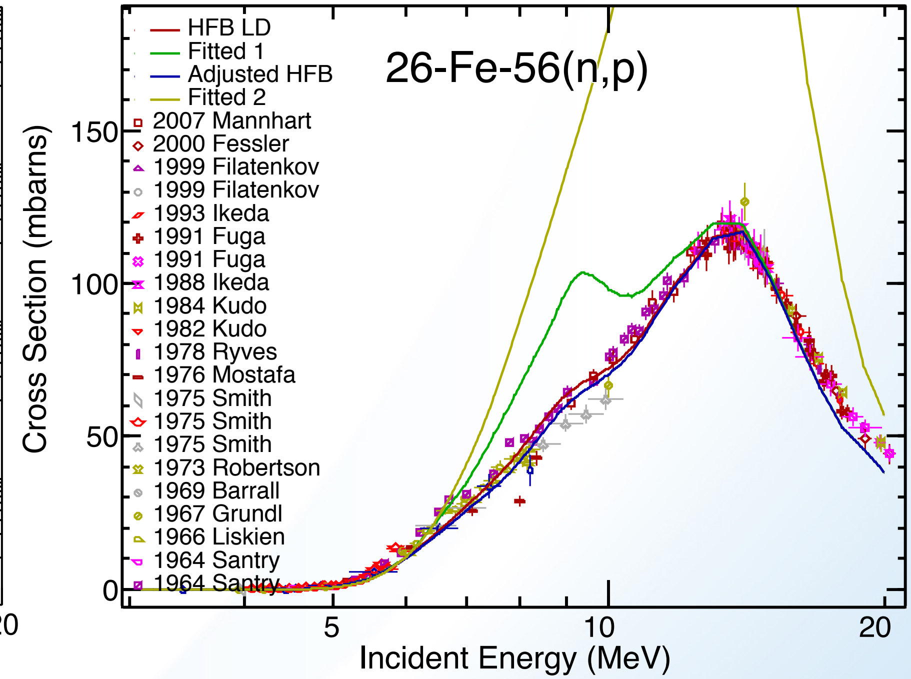
^{56}Fe(n,p) sensitivity to ^{56}Fe lev. den.





- Also incredibly sensitive to ^{56}Fe level density.
- Center of experimental LD leads to poor (n,p).
- Tweaks on LD can significantly change (n,p).

Conclusion

- Inelastic gamma cross sections are sensitive to changes in branching ratios: filling the structure gaps is important.
- When there is experimental uncertainty, this method brings additional information regarding the level spin and deformation and γ strength functions.
- Ideally, γ and *n* cross sections should be described consistently.
- Total level densities are not enough: Spin distributions, model-dependency, etc.
- Reaction calculations can serve as a complementary tool to constrain structure observables.