

# Links between nuclear structure data and cross section measurements

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**Adina Olacel**

Horia Hulubei National Institute for Physics and Nuclear Engineering (IFIN-HH), Magurele, Romania



# Introduction

Experimental physics



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Nuclear reactions



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Nuclear reactions

Cross section measurements  
(n, n' $\gamma$ ) reactions

# Introduction

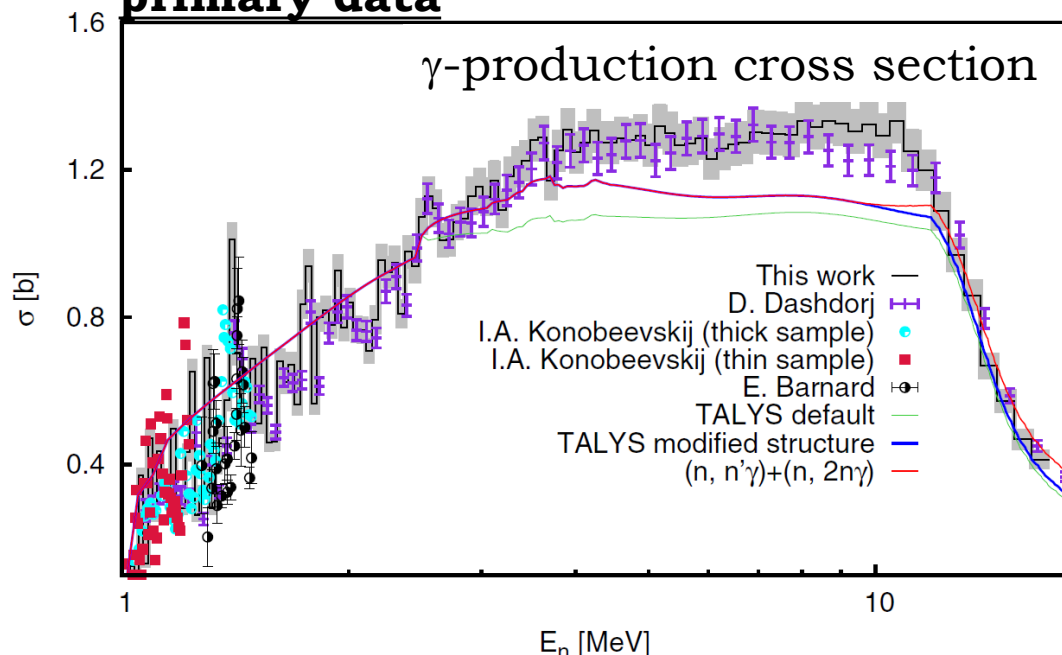
## Experimental physics

### Nuclear reactions

### Cross section measurements (n, n' $\gamma$ ) reactions

#### primary data

#### $\gamma$ -production cross section

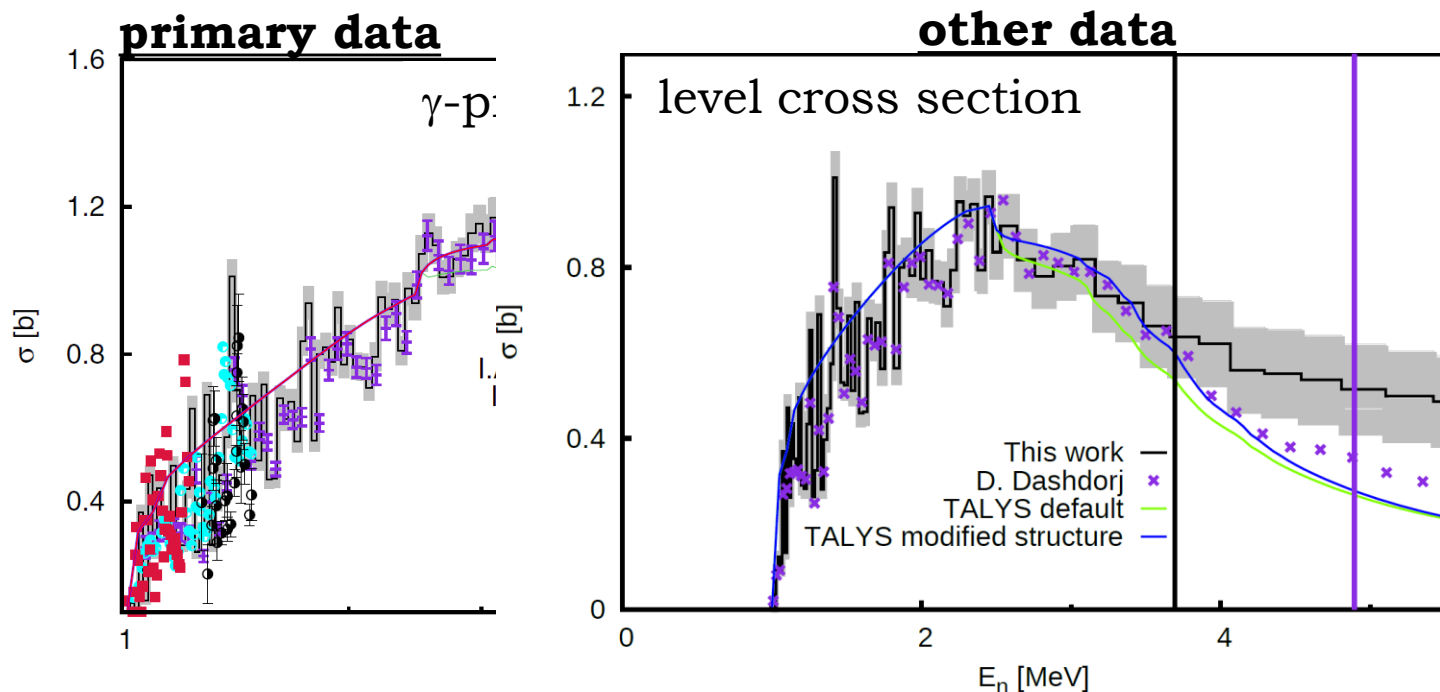


# Introduction

## Experimental physics

### Nuclear reactions

### Cross section measurements (n, n' $\gamma$ ) reactions



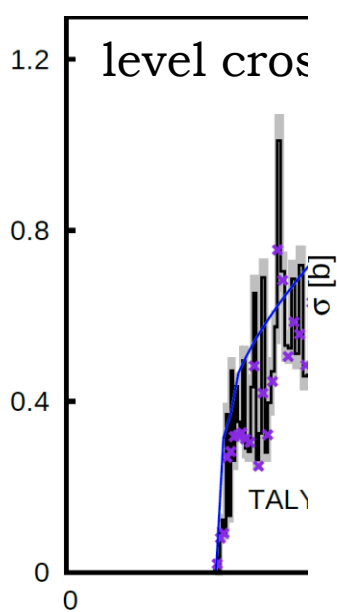
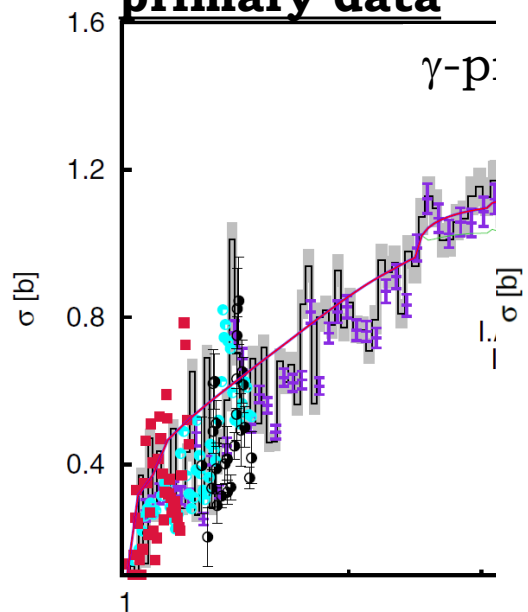
# Introduction

## Experimental physics

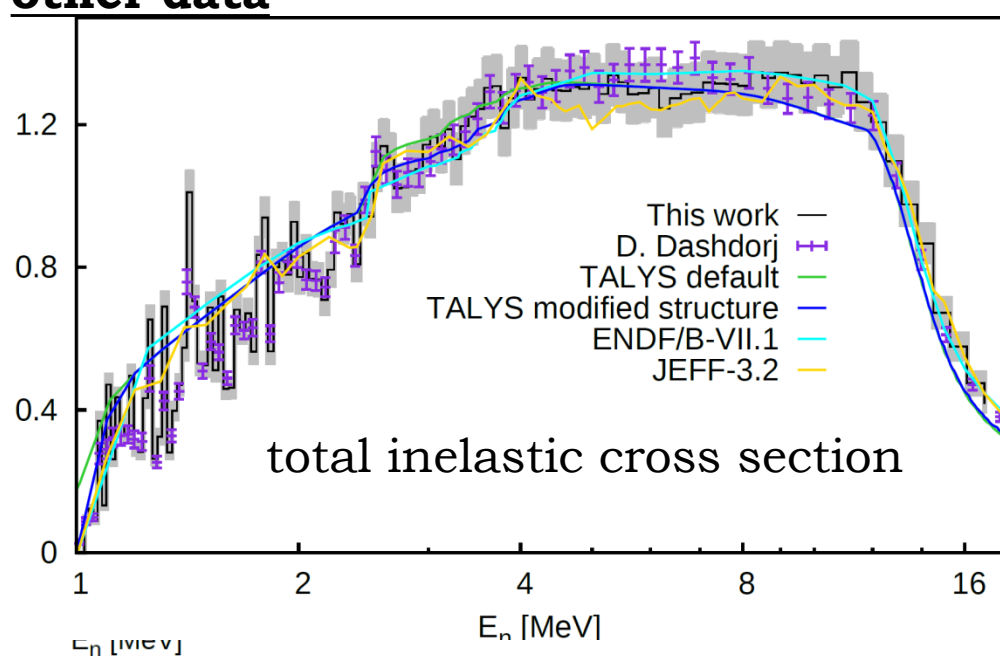
### Nuclear reactions

#### Cross section measurements (n, n' $\gamma$ ) reactions

##### primary data

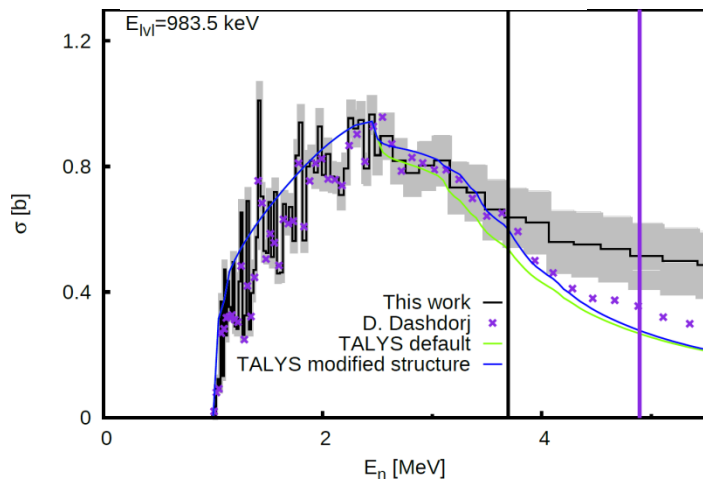


##### other data

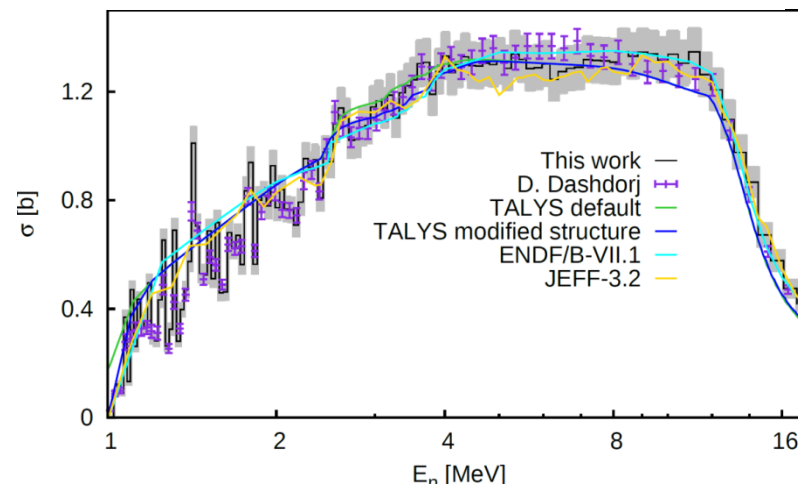


# Introduction

## level cross section



## total inelastic cross section

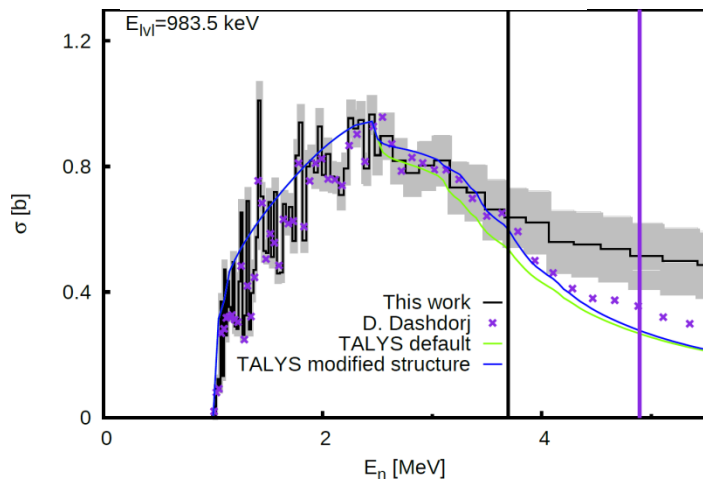


- calculated using the  $\gamma$ -production cross sections of the observed transitions and based on the feeding and the decay of each level of interest.

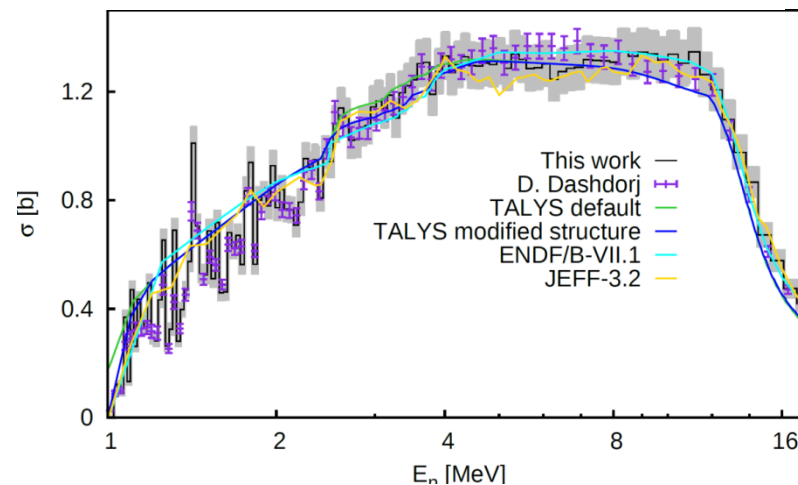


# Introduction

## level cross section



## total inelastic cross section



- calculated using the  $\gamma$ -production cross sections of the observed transitions and based on the feeding and the decay of each level of interest.

Important to have a very good knowledge of the level scheme.

Very precise experimental data with very good neutron energy resolution

Compared with theoretical calculations:

- TALYS
- EMPIRE

Very precise experimental data with very good neutron energy resolution

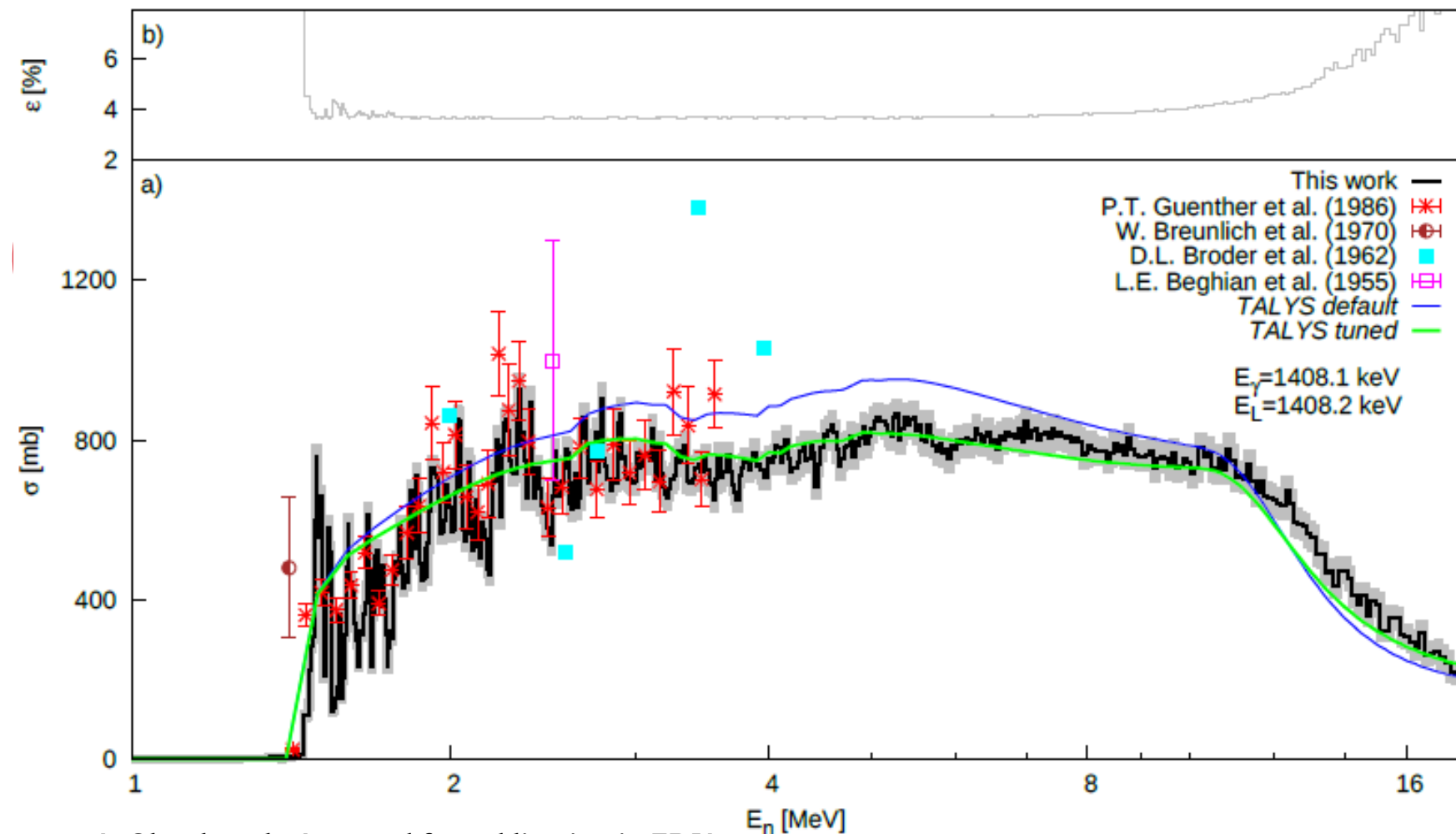
Compared with theoretical calculations:

- TALYS
- EMPIRE

Optical model potential

Two red hand-drawn ovals are present on the slide. The inner oval encloses the text "Optical model potential". The outer oval encloses the text "Optical model potential" and the list items "- TALYS" and "- EMPIRE".

Very precise experimental data with very good neutron energy resolution



Very precise experimental data with very good neutron energy resolution

Compared with theoretical calculations:

- TALYS
- EMPIRE

Optical model potential  
+  
Structure information

Very precise experimental data with very good neutron energy resolution

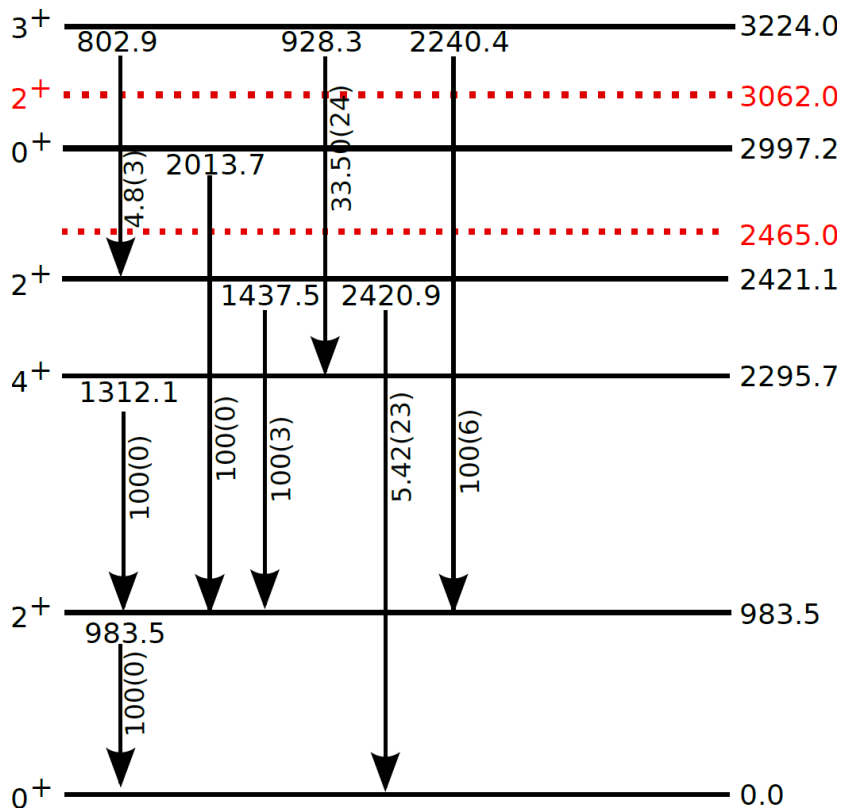
Compared with theoretical calculations:

- TALYS
- EMPIRE

Optical model potential  
+  
Structure information  
**(branching ratios,  
spin, parity...)**

# Examples - Branching ratios $^{48}\text{Ti}$

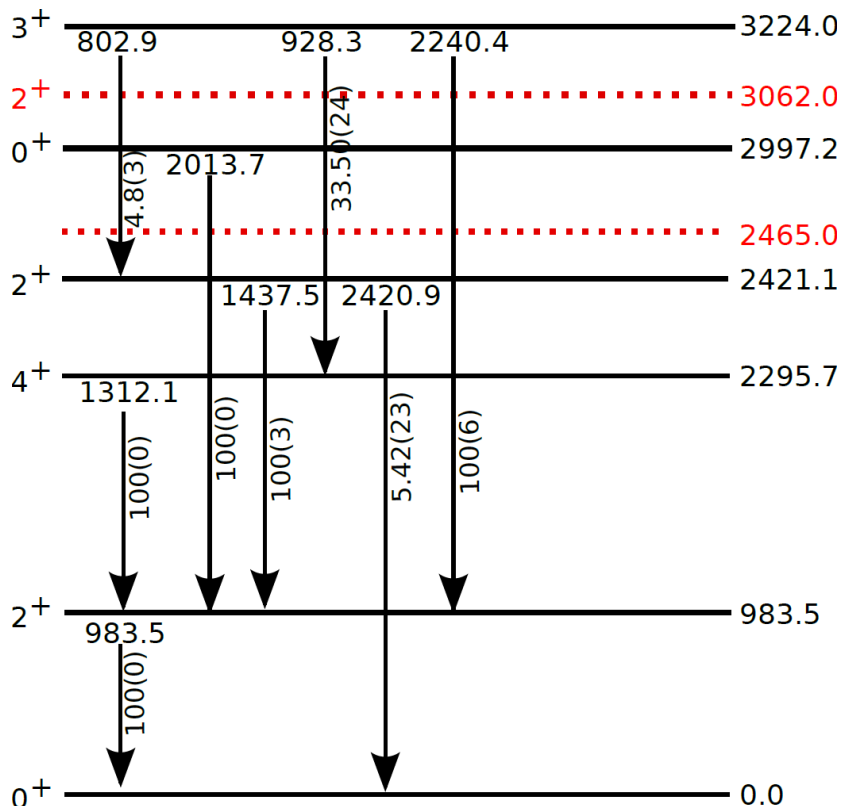
ENSDF



T. W. Burrows, Nucl. Data Sheets 107, 1747 (2006)

# Examples - Branching ratios $^{48}\text{Ti}$

ENSDF



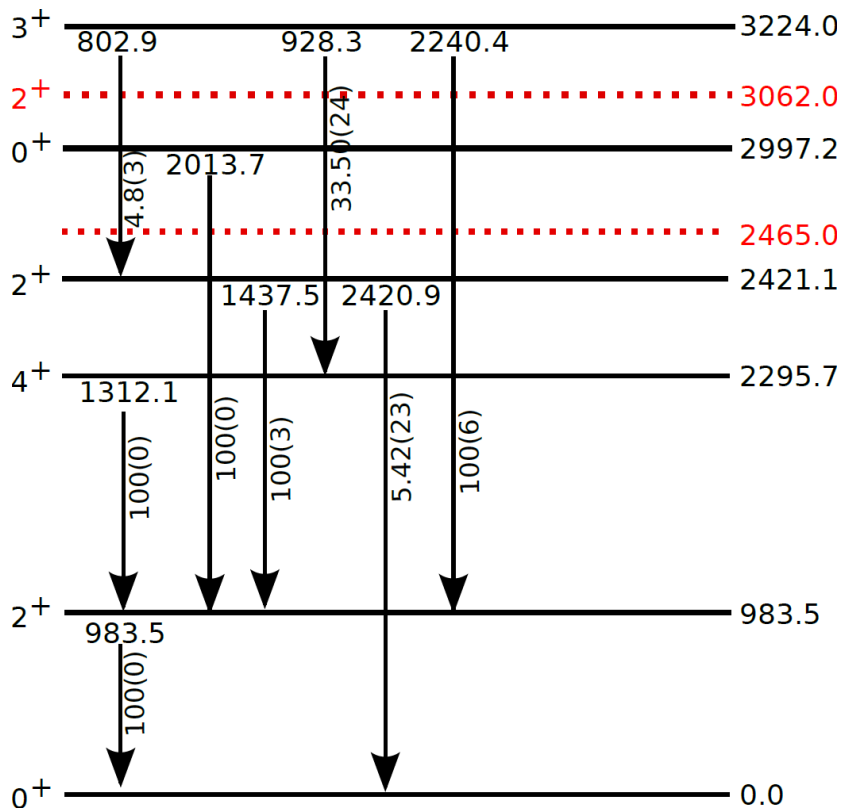
T. W. Burrows, Nucl. Data Sheets 107, 1747 (2006)

Reaction codes **must** make a decision about such decays.  
 In many codes a direct transition to the g.s. is assumed.

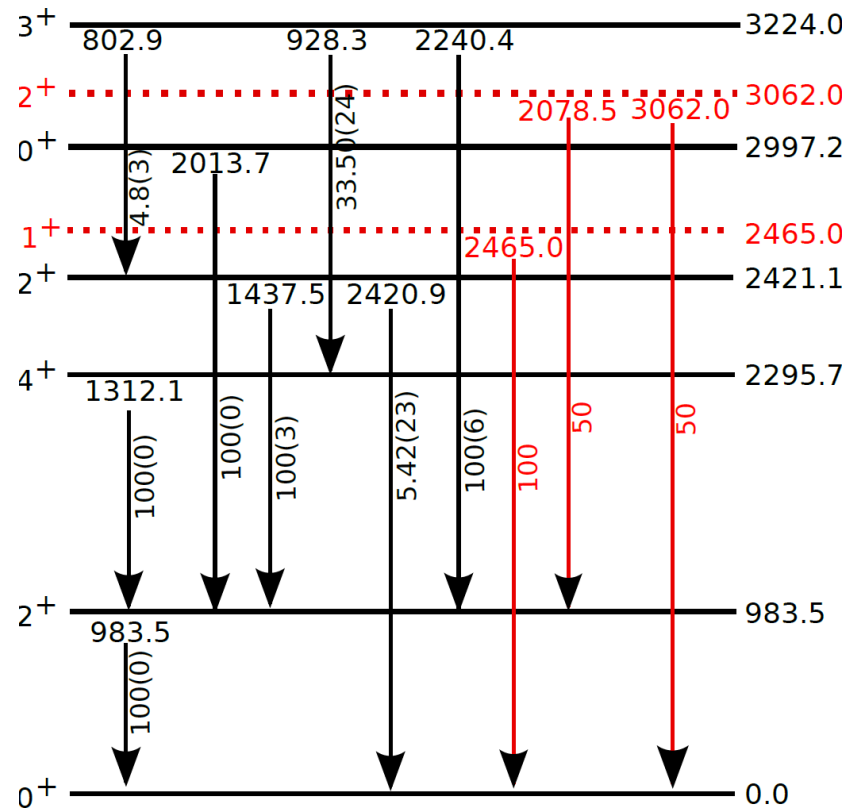


# Examples - Branching ratios $^{48}\text{Ti}$

ENSDF



TALYS 1.9 default

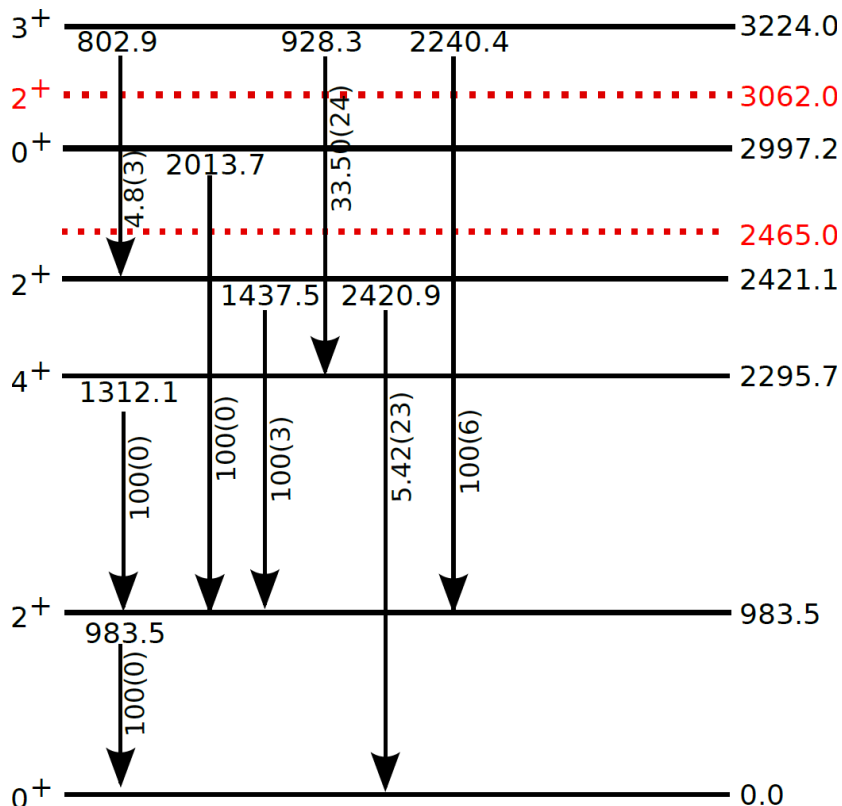


T. W. Burrows, Nucl. Data Sheets 107, 1747 (2006)

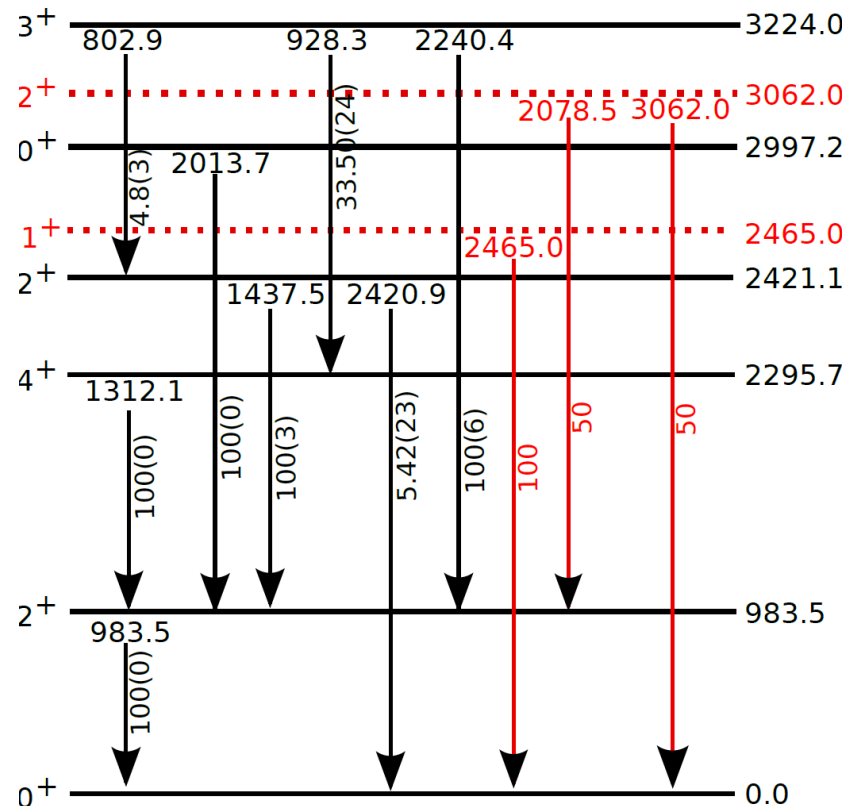
Reaction codes **must** make a decision about such decays.  
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# Examples - Branching ratios $^{48}\text{Ti}$

ENSDF



TALYS 1.9 default

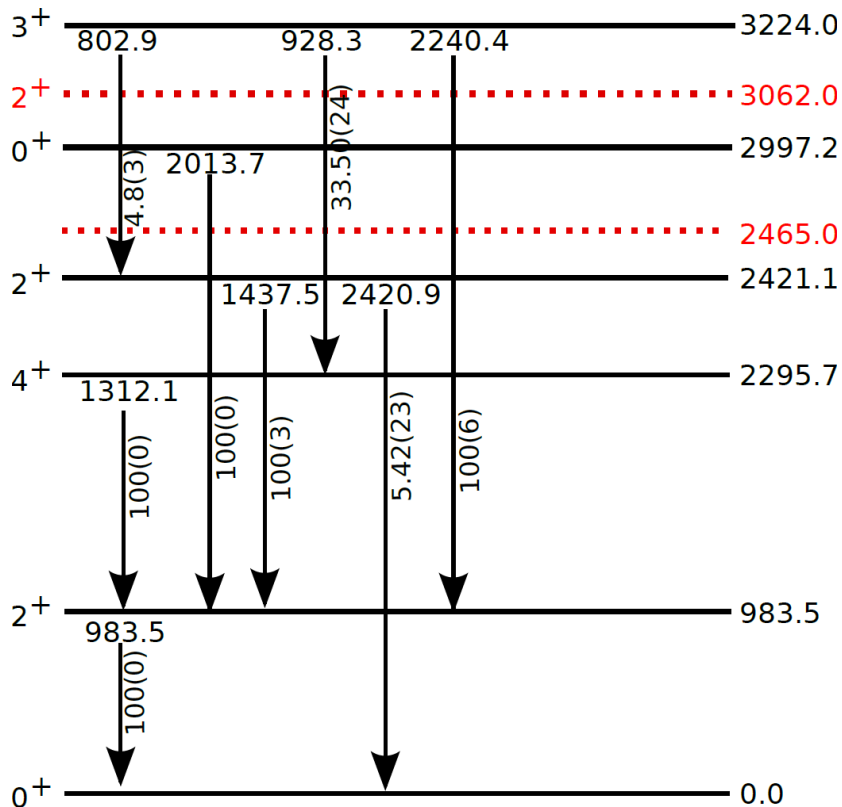


T. W. Burrows, Nucl. Data Sheets 107, 1747 (2006)

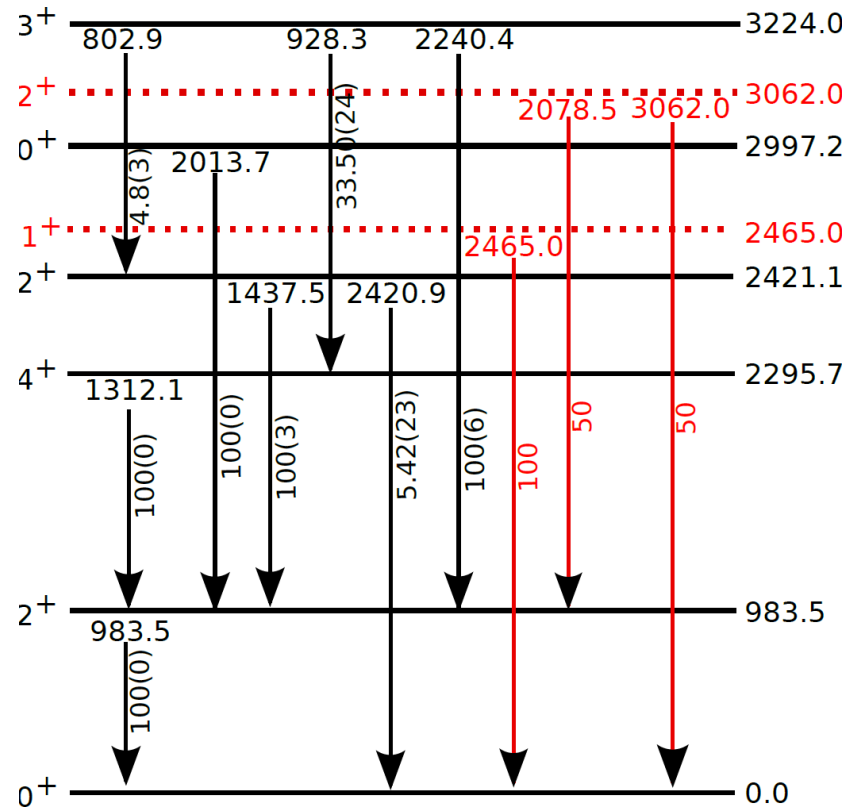
- The experimental spectra were investigated to see if:
- the TALYS-supposed  $\gamma$  rays were observed;
  - other possible de-excitations from those levels were observed.

# Examples - Branching ratios $^{48}\text{Ti}$

ENSDF



TALYS 1.9 default



T. W. Burrows, Nucl. Data Sheets 107, 1747 (2006)

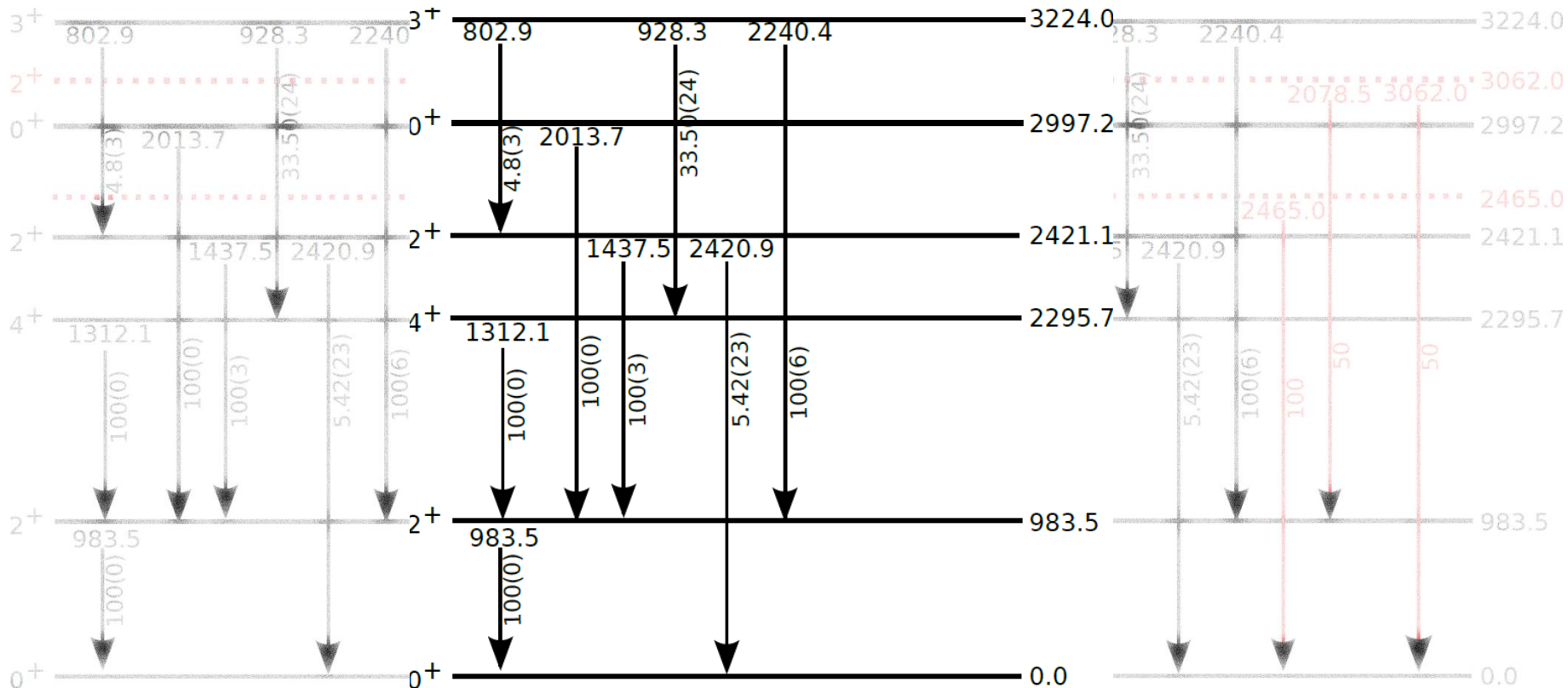
The experimental spectra were in agreement with the TALYS calculations if:  
**no  $\gamma$  rays of suitable energies were observed** if:  
 - the TALYS calculations predicted such de-excitations from those levels were observed.

# Examples - Branching ratios $^{48}\text{Ti}$

ENSDF

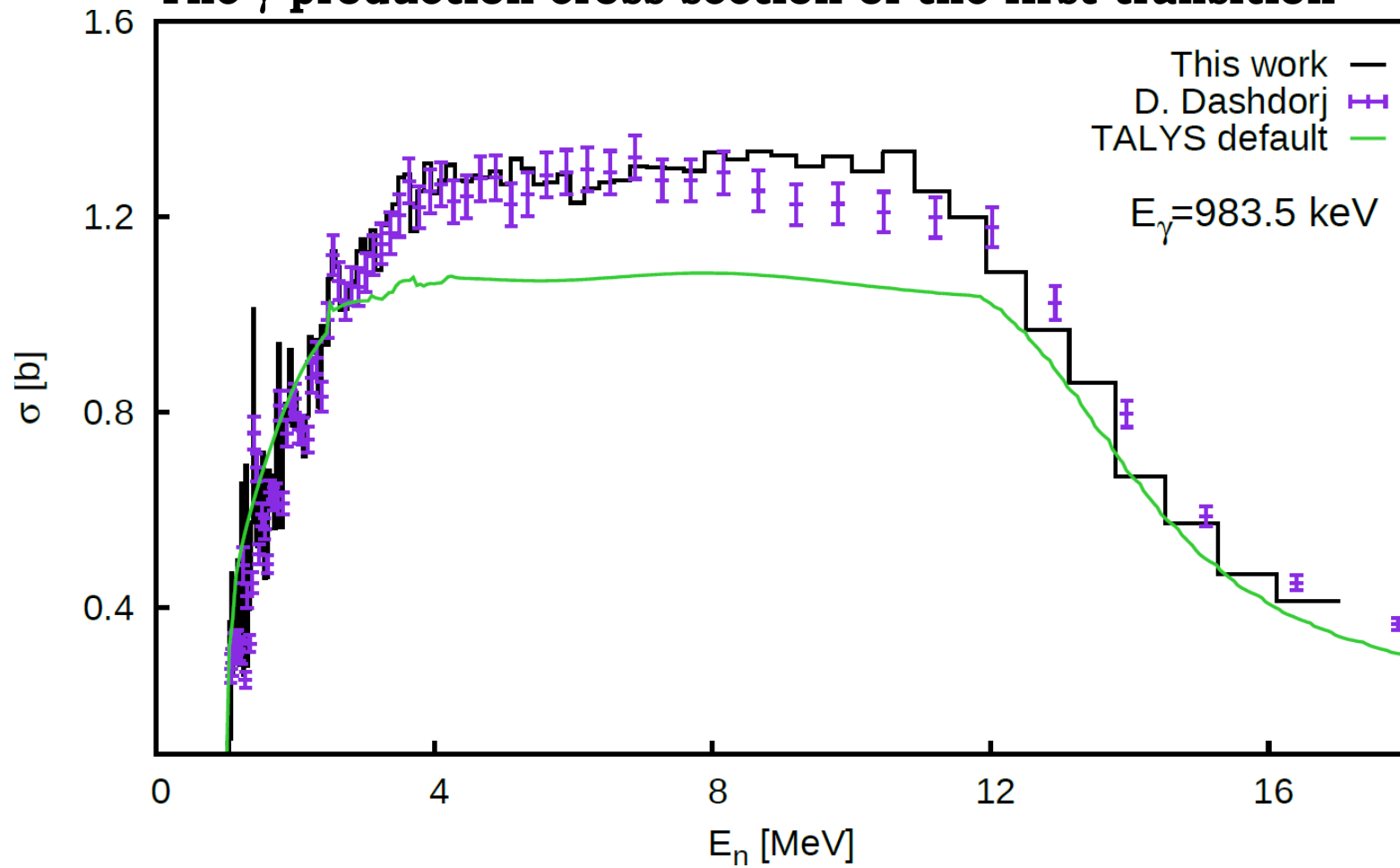
TALYS 1.9 modified

TALYS 1.9 default



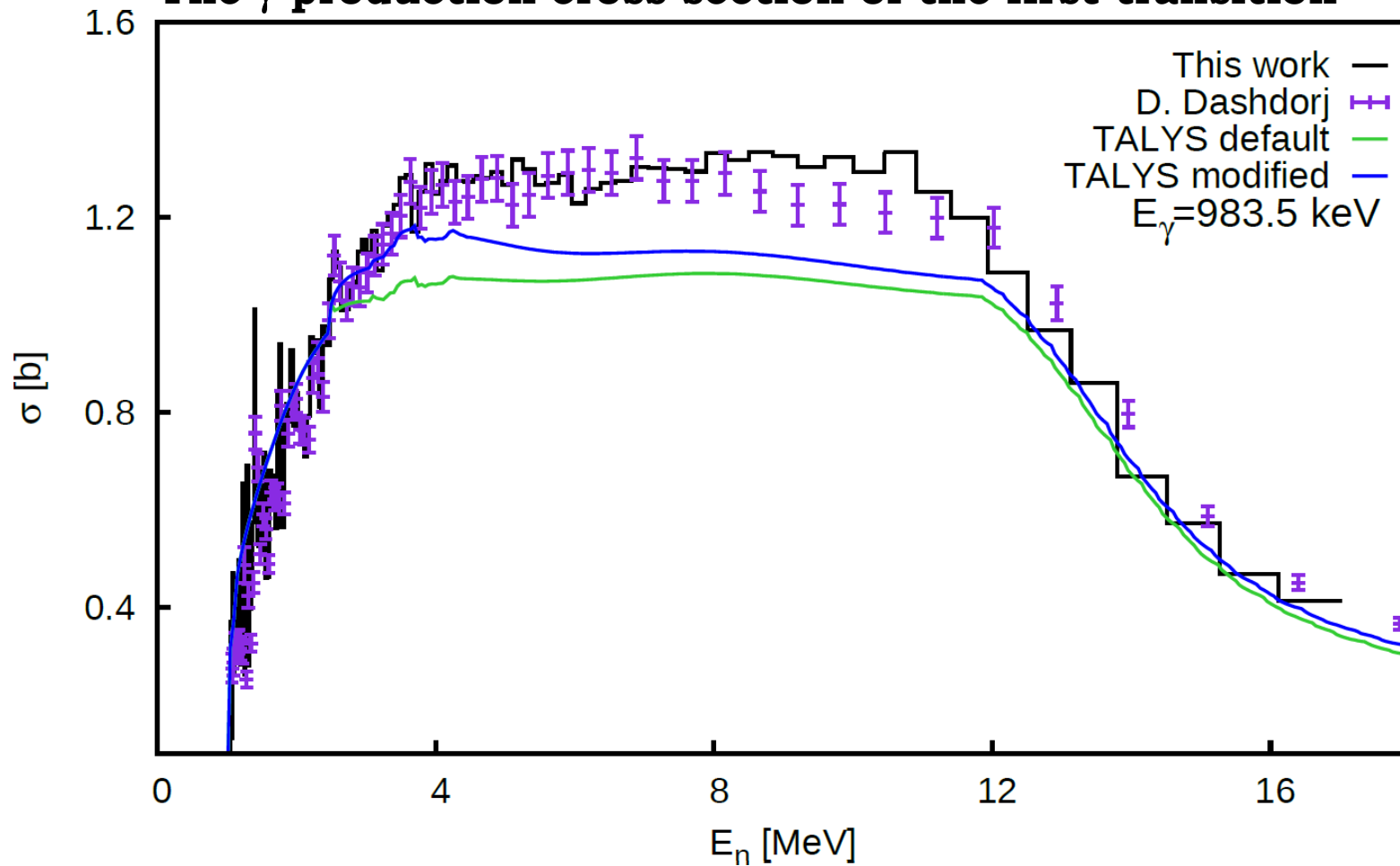
Examples - **Branching ratios**  $^{48}\text{Ti}$   
 - **Impact**

**The  $\gamma$ -production cross section of the first transition**



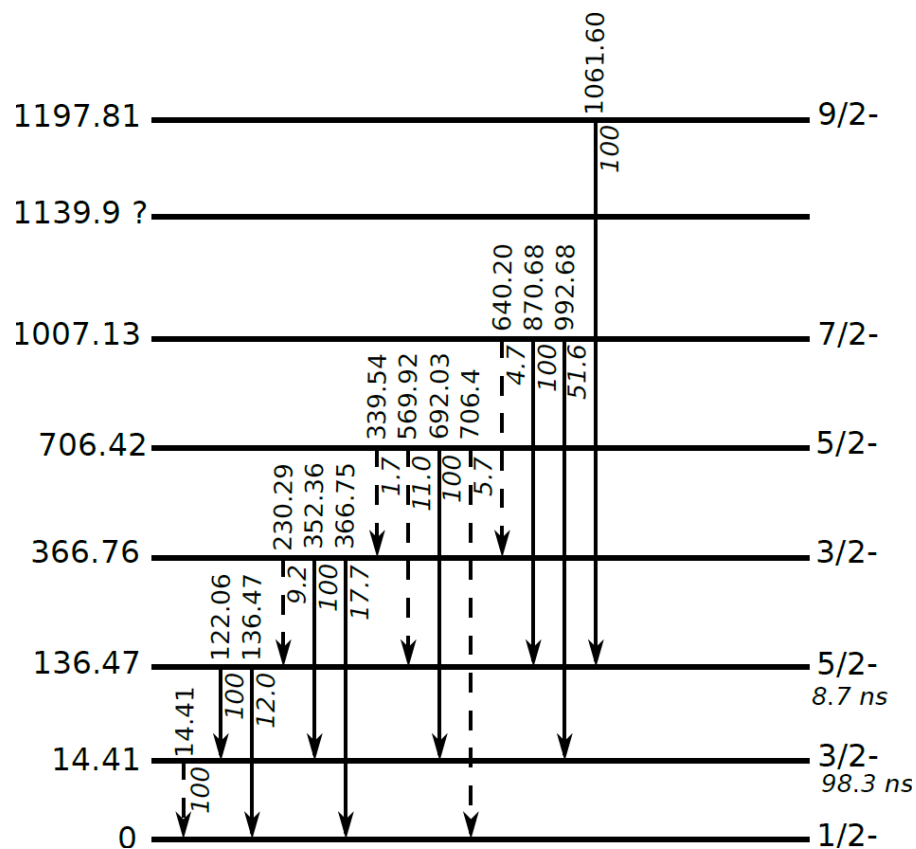
Examples - **Branching ratios**  $^{48}\text{Ti}$   
 - **Impact**

**The  $\gamma$ -production cross section of the first transition**



# Examples - Branching ratios $^{57}\text{Fe}$

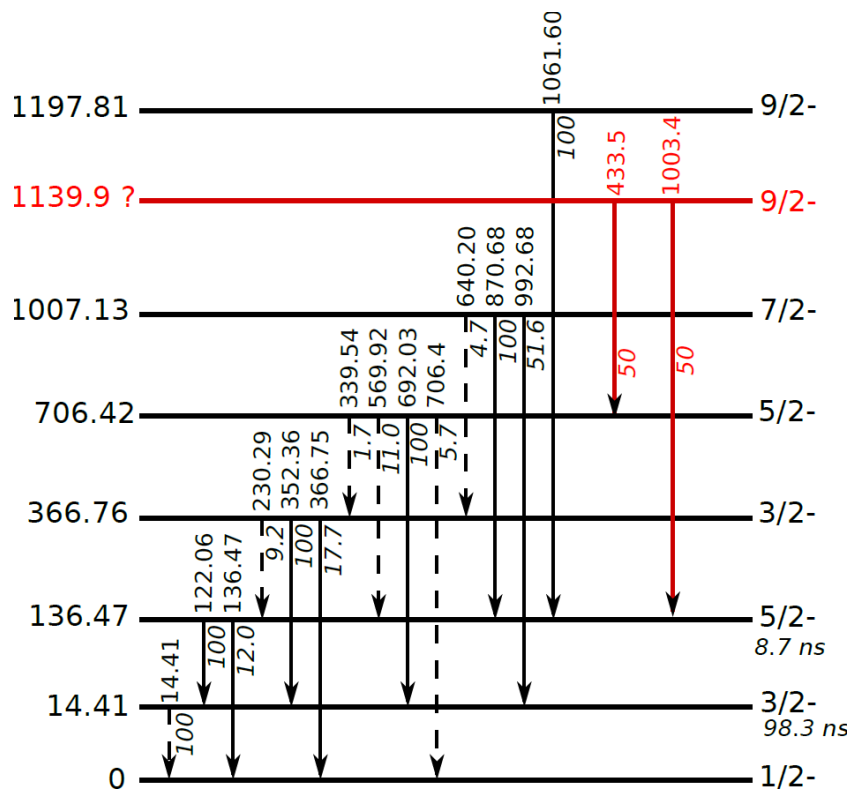
ENSDF



M. R. Bhat, Nucl. Data Sheets 85, 415 (1998)

# Examples - Branching ratios $^{57}\text{Fe}$

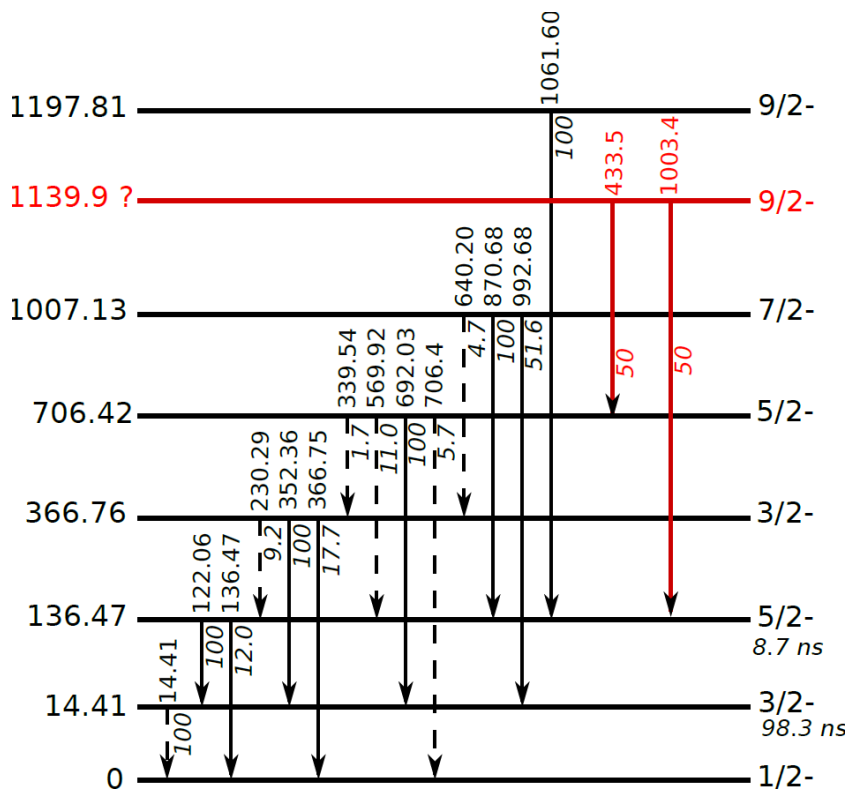
TALYS



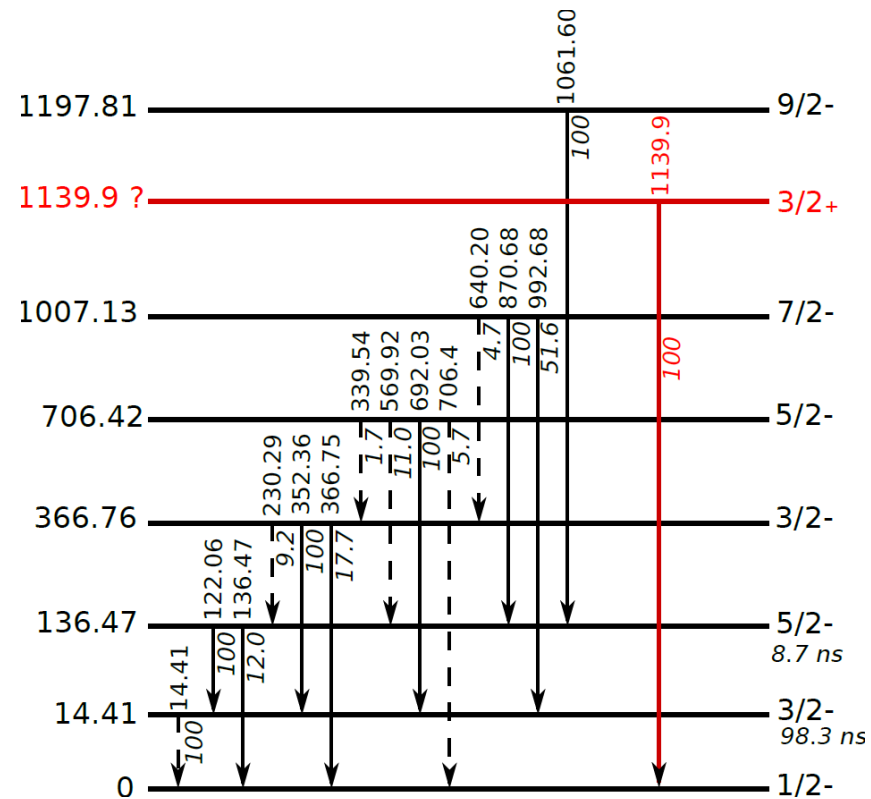


# Examples - Branching ratios $^{57}\text{Fe}$

TALYS

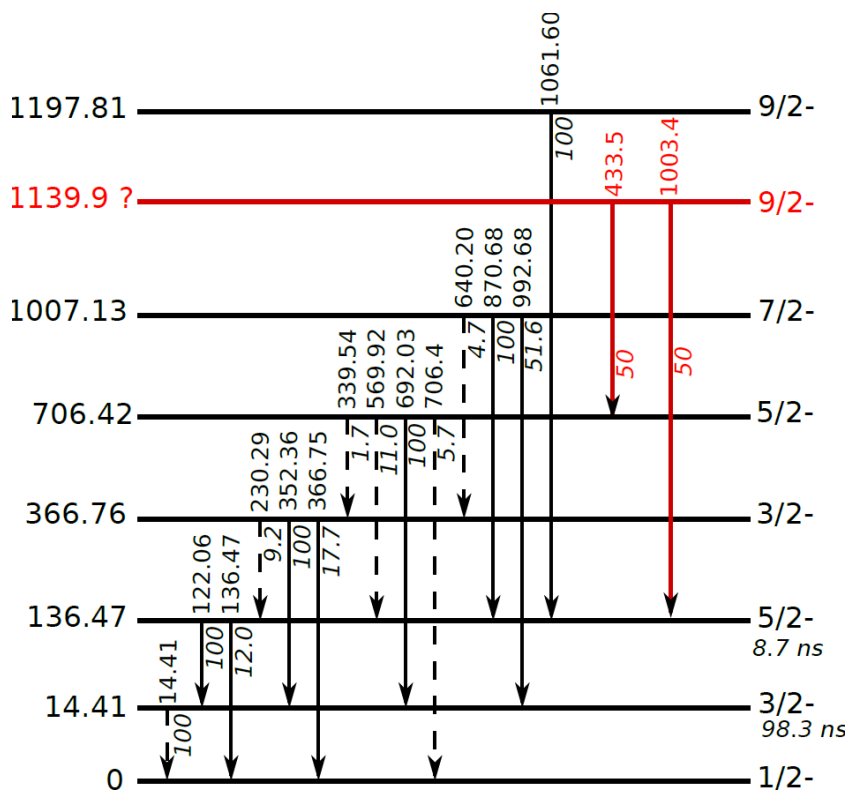


EMPIRE

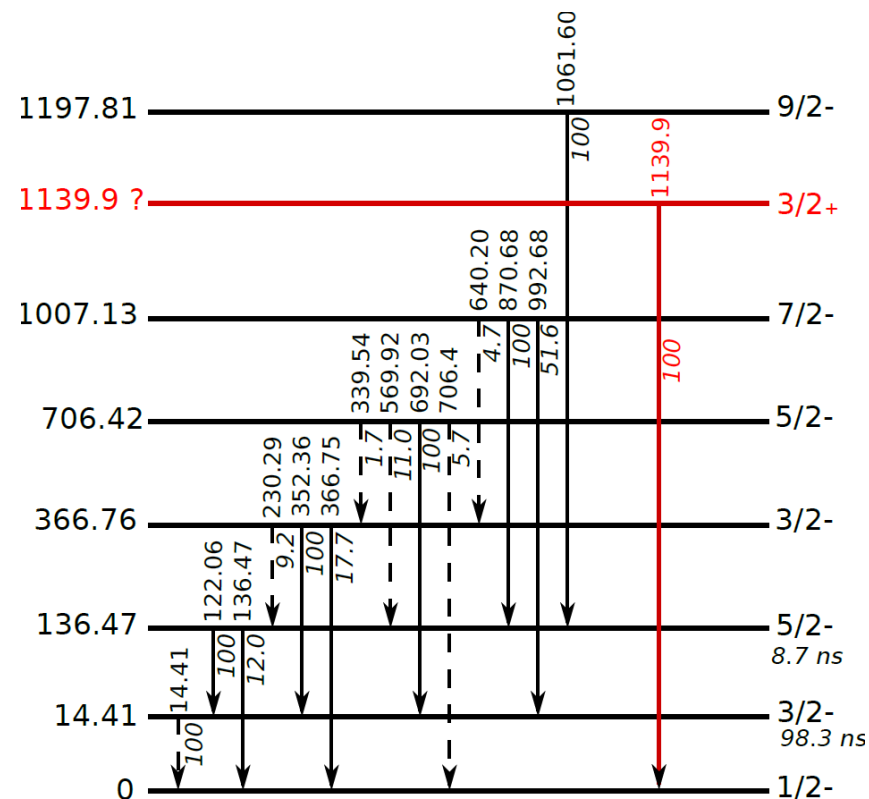


# Examples - Branching ratios $^{57}\text{Fe}$

TALYS



EMPIRE

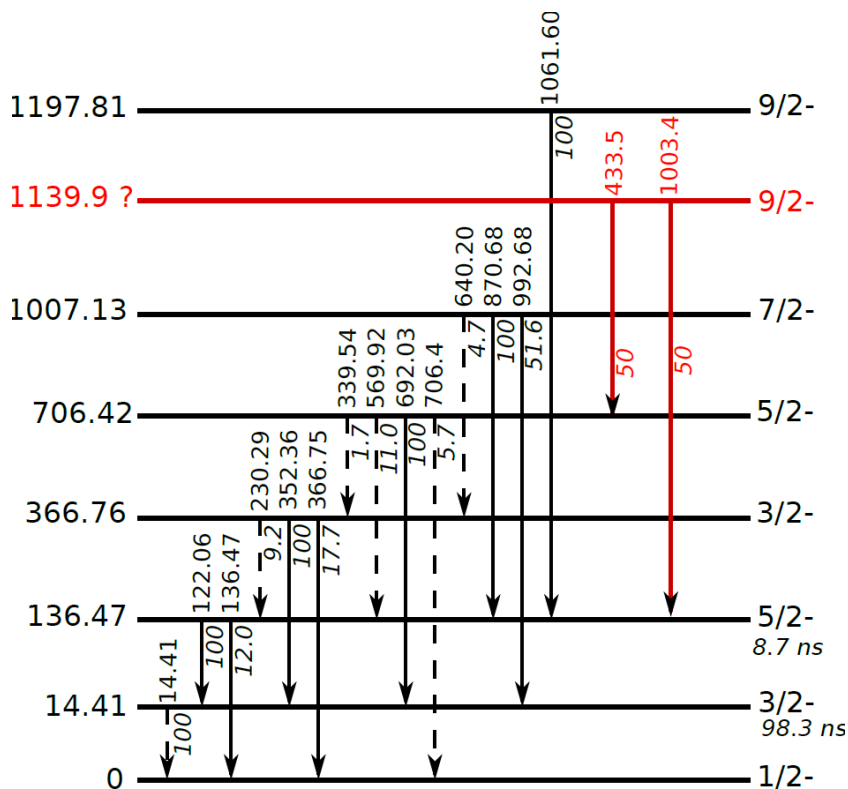


The experimental spectra were investigated to see if:

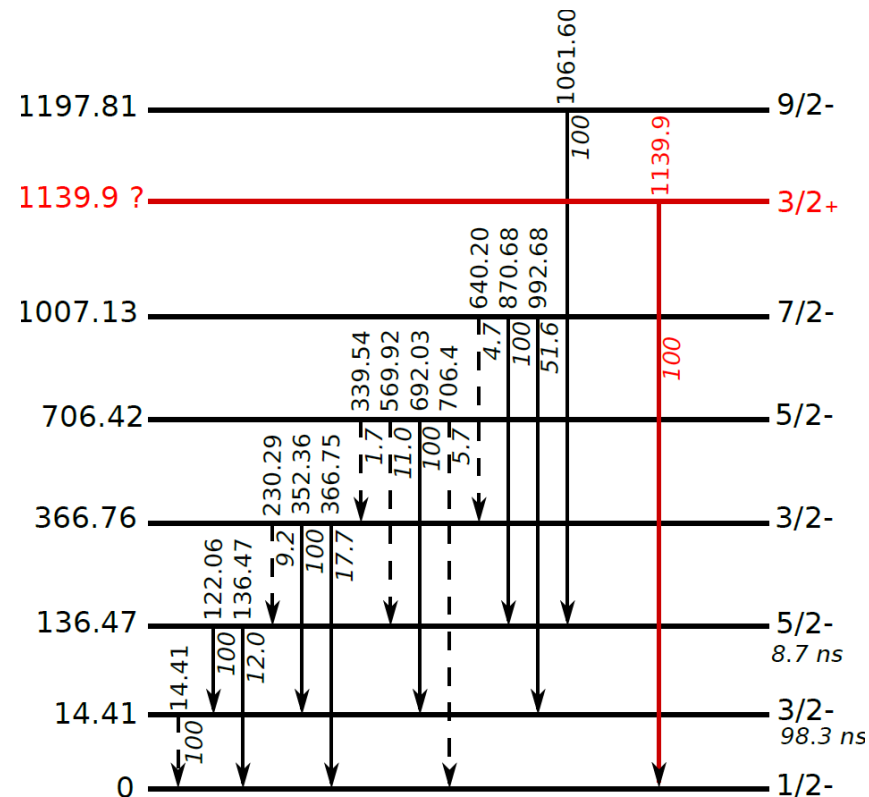
- the supposed  $\gamma$  rays were observed;
- other possible de-excitations from those levels were observed.

# Examples - Branching ratios $^{57}\text{Fe}$

## TALYS



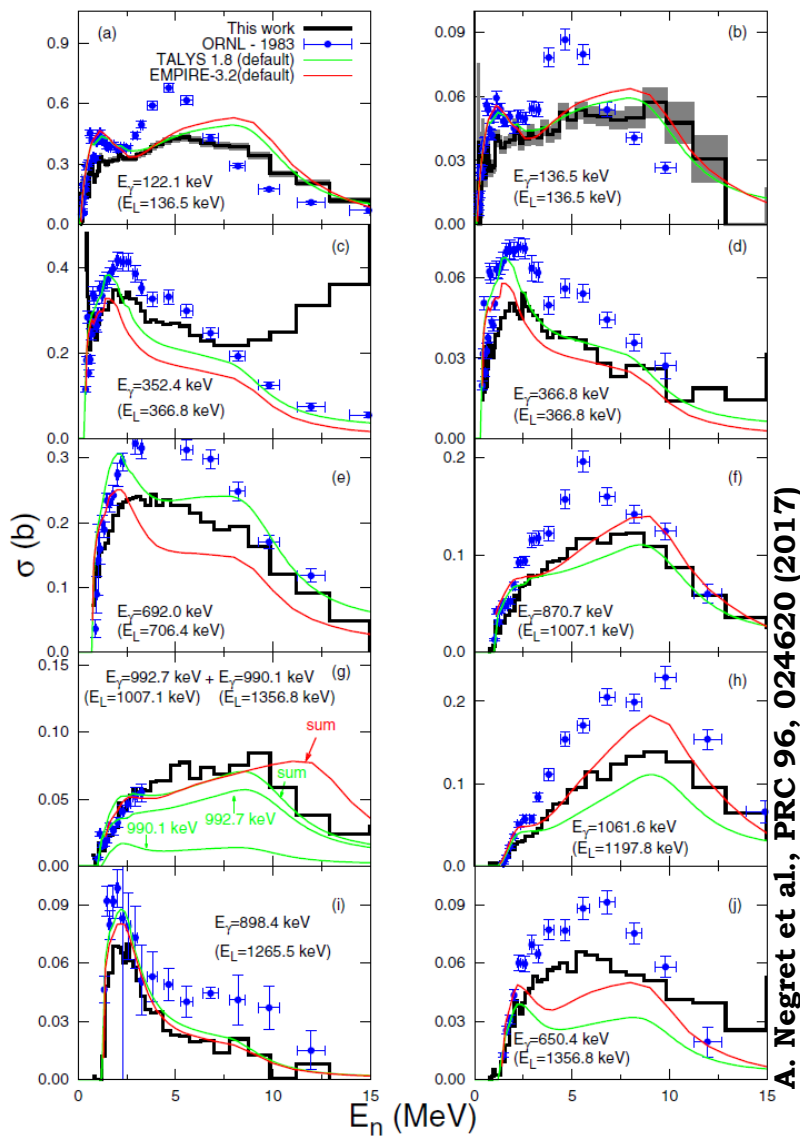
## EMPIRE



The experimental spectra were inconsistent if:  
 - the sum of branching ratios was not 100,  
 - **no  $\gamma$  rays of suitable energies were observed** if:  
 - no de-excitations from those levels were observed.

# Examples - Branching ratios $^{57}\text{Fe}$

## - Impact

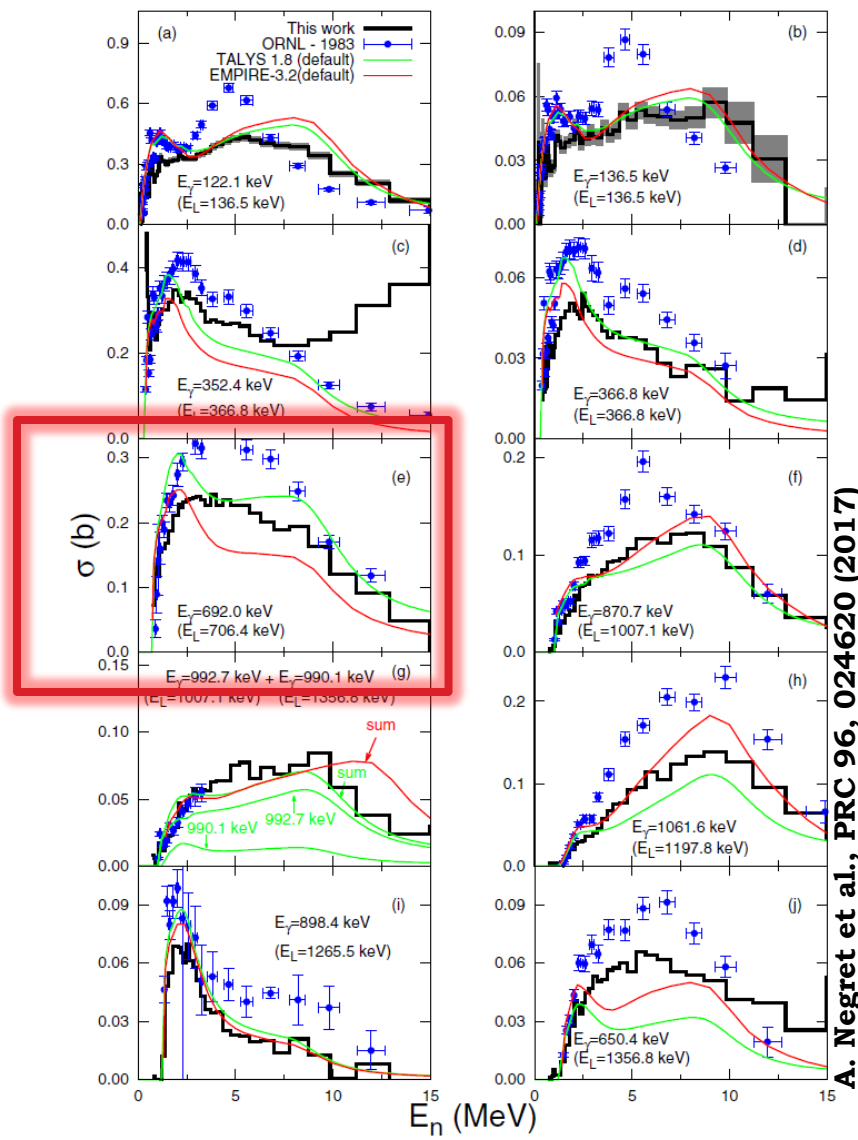


A. Negret et al., PRC 96, 024620 (2017)

# Examples - Branching ratios $^{57}\text{Fe}$

## - Impact

TALYS describes better the transition de-exciting the 706.4-keV level despite the fact that the 433.5-keV  $\gamma$  ray was not observed.



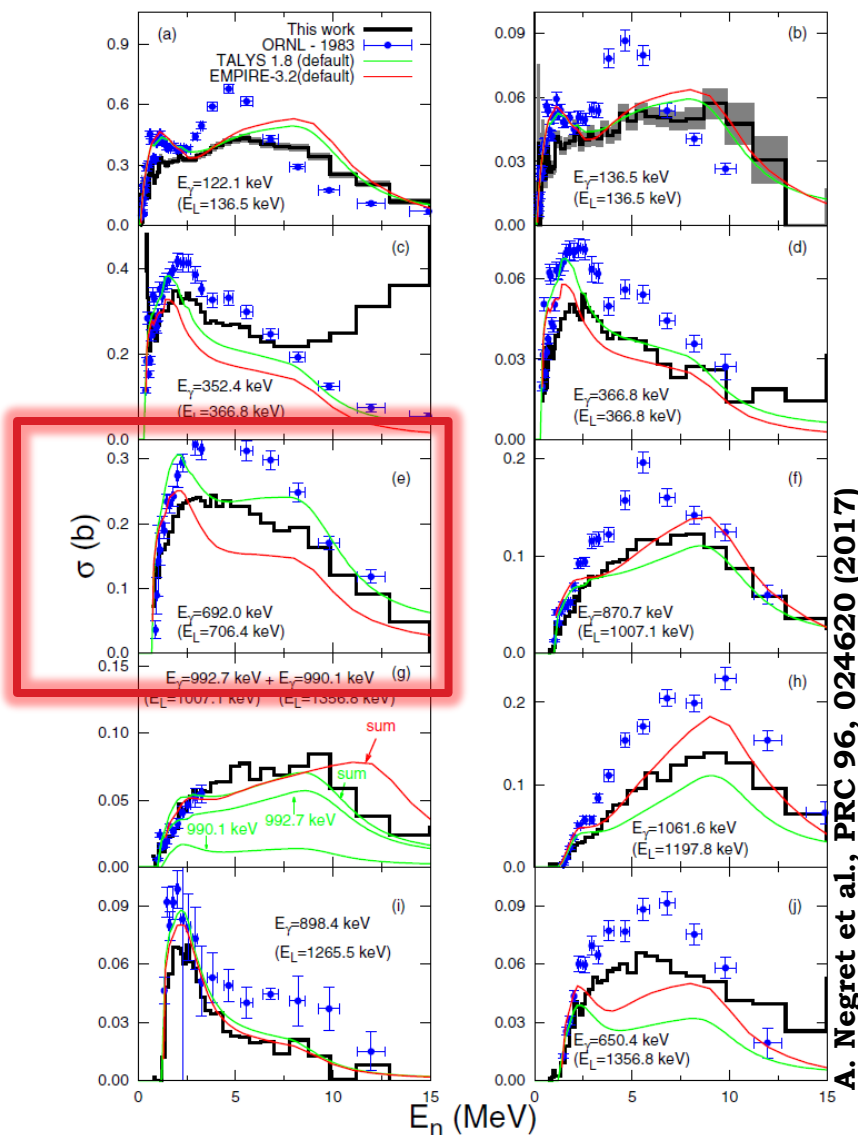
A. Negret et al., PRC 96, 024620 (2017)

# Examples - Branching ratios $^{57}\text{Fe}$

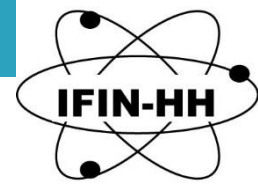
## - Impact

TALYS describes better the transition de-exciting the 706.4-keV level despite the fact that the 433.5-keV  $\gamma$  ray was not observed.

This suggests that there is a feeding of this level presently unknown.



A. Negret et al., PRC 96, 024620 (2017)



## Conclusions

- emphasize on the importance of nuclear structure data in the reaction calculations.
- present two experimental cases and the issues related to not knowing the structure of the nuclei of interest.



Thank you!