

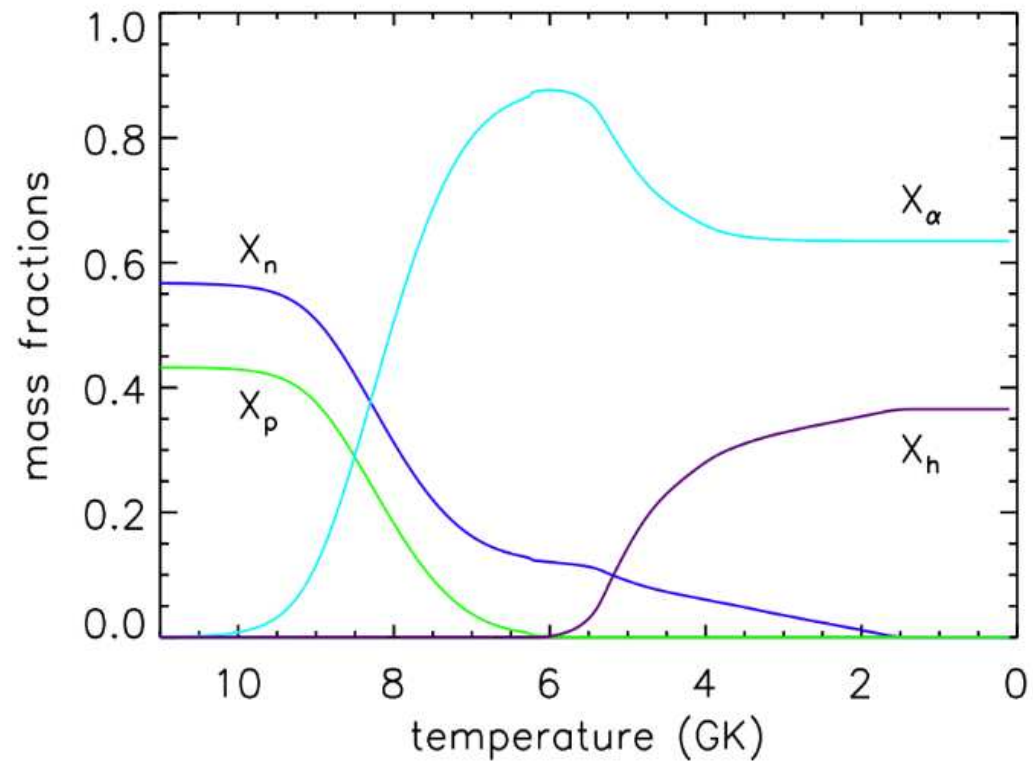
The r-process of nucleosynthesis:  
the influence of nuclear data on the  
abundance pattern

Gail McLaughlin

North Carolina State University

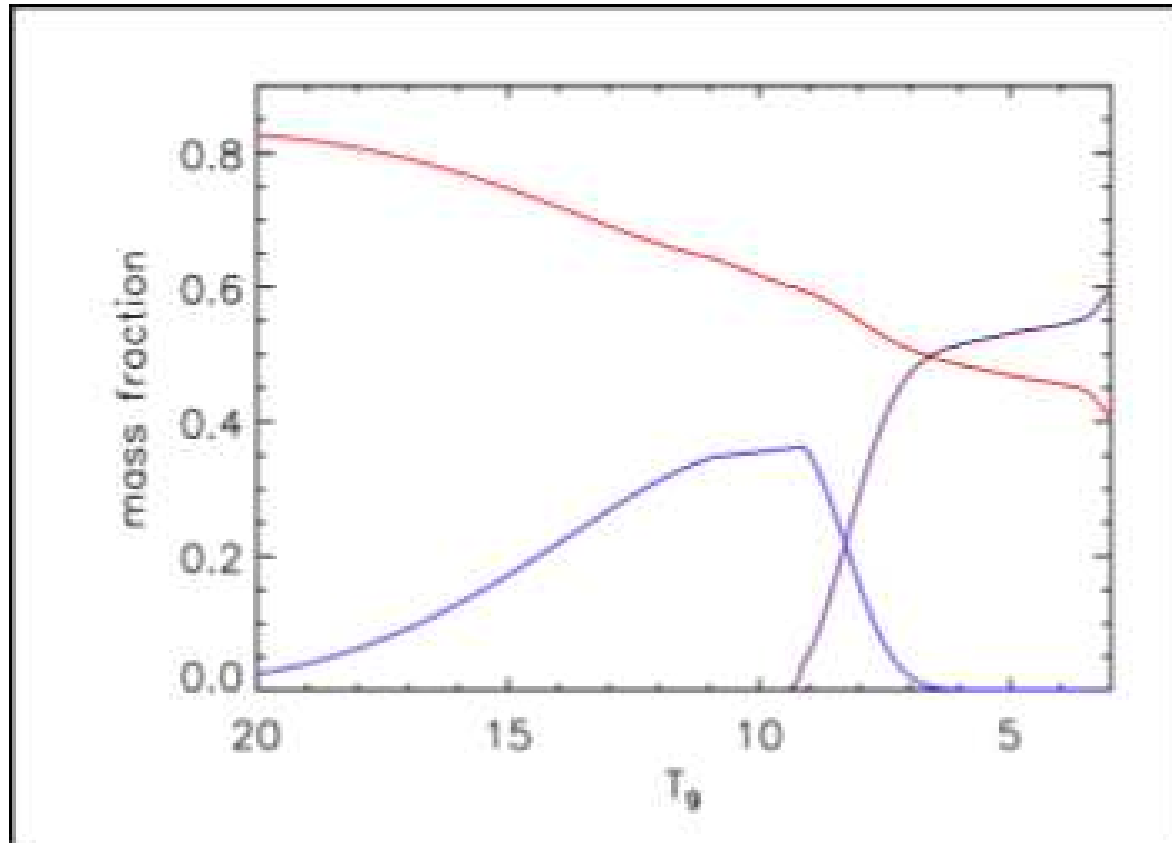
# Recall from yesterday: whats happening here?

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# Recall from yesterday: what is happening here?

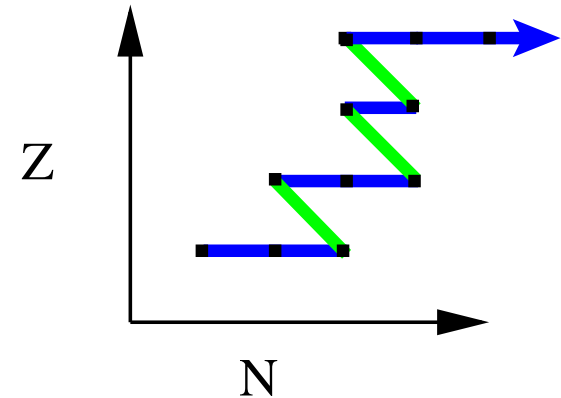
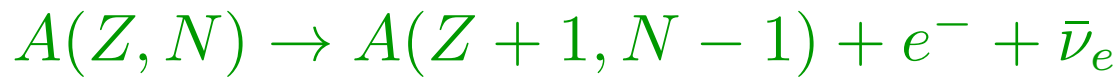
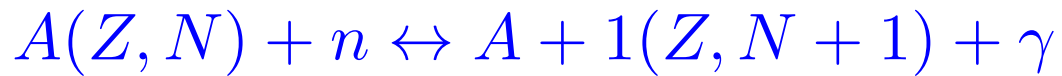
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red: neutrons, blue: protons, purple: alphas

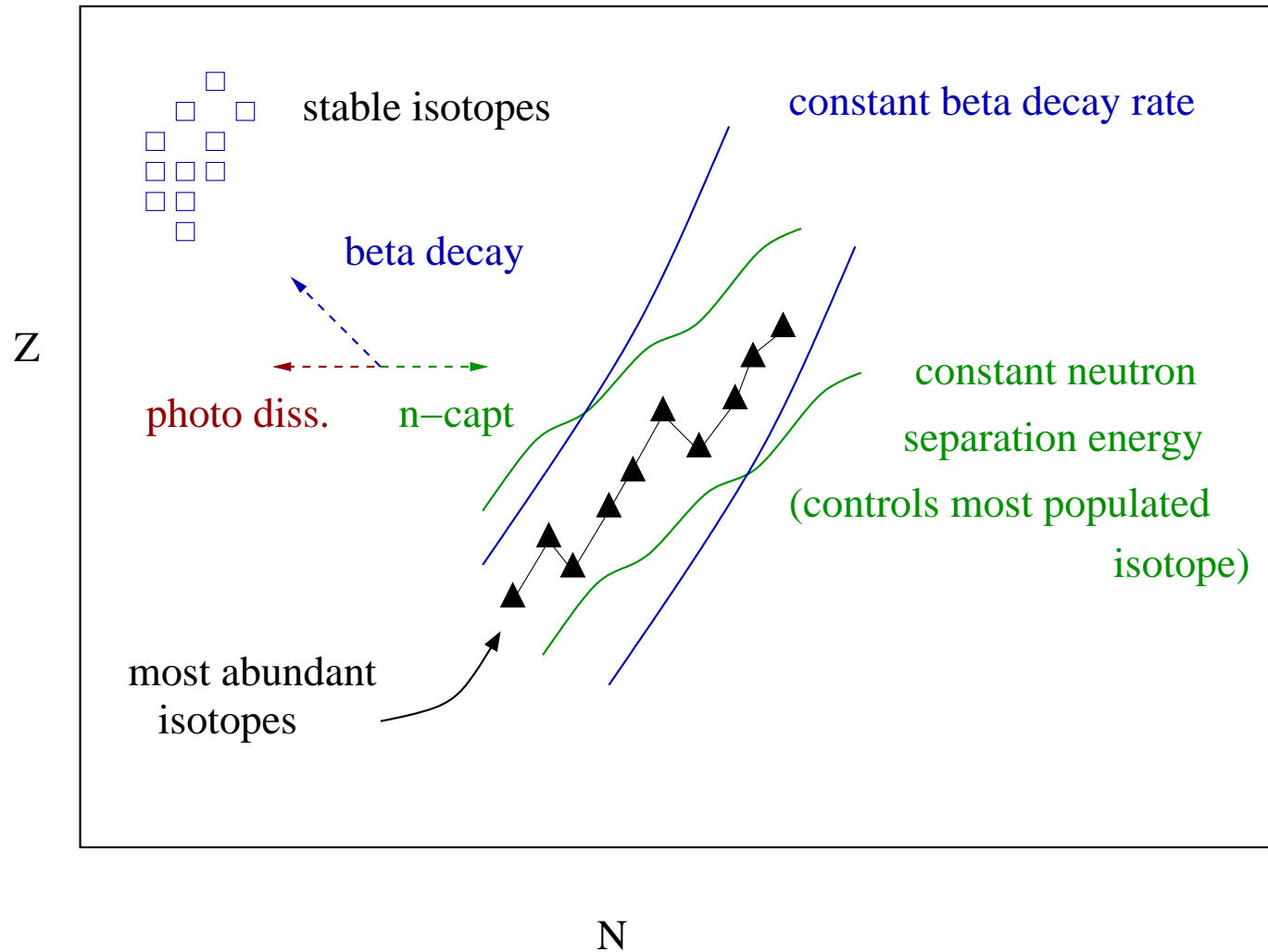
## r-process

e. g. Uranium-238  $Z=92$ ,  $N=146 \rightarrow$  need lots of neutrons

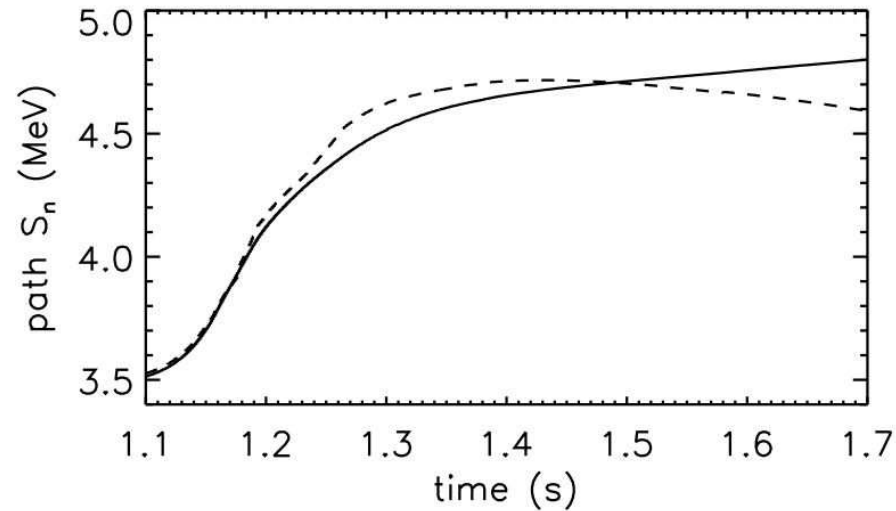


rapid neutron capture as compared with beta decay

# How to read r-process flow plots



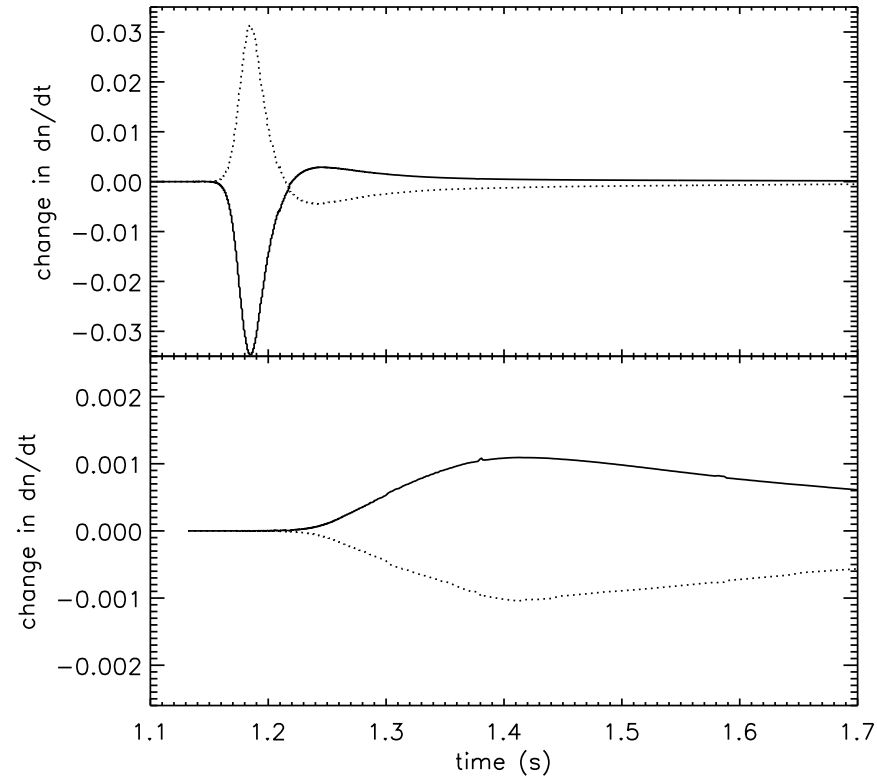
# Equilibrium and Actual Separation Energies



	80	81	82	83	84	85
50	$^{130}\text{Sn}$	$^{131}\text{Sn}$	$^{132}\text{Sn}$	$^{133}\text{Sn}$	$^{134}\text{Sn}$	$^{135}\text{Sn}$
49	$^{129}\text{In}$	$^{130}\text{In}$	$^{131}\text{In}$	$^{132}\text{In}$	$^{133}\text{In}$	$^{134}\text{In}$
48	$^{128}\text{Cd}$	$^{129}\text{Cd}$	$^{130}\text{Cd}$	$^{131}\text{Cd}$	$^{132}\text{Cd}$	$^{133}\text{Cd}$
47	$^{127}\text{Ag}$	$^{128}\text{Ag}$	$^{129}\text{Ag}$	$^{130}\text{Ag}$	$^{131}\text{Ag}$	$^{132}\text{Ag}$

Diagram illustrating the relationship between atomic number (Z) and neutron number (N) for various isotopes. The y-axis represents Z (47 to 50) and the x-axis represents N (80 to 85). The isotopes are arranged in a grid. Red shading highlights the isotopes  $^{129}\text{Ag}$ ,  $^{130}\text{Cd}$ ,  $^{131}\text{In}$ , and  $^{132}\text{Sn}$ . Arrows indicate transitions: a blue arrow points from  $^{131}\text{Sn}$  to  $^{132}\text{Sn}$ , a black arrow points from  $^{131}\text{In}$  to  $^{130}\text{Cd}$ , and red arrows point from  $^{132}\text{Cd}$  to  $^{131}\text{Cd}$  and from  $^{131}\text{Cd}$  to  $^{130}\text{Cd}$ .

# Effect of changing separation energies, capture rates

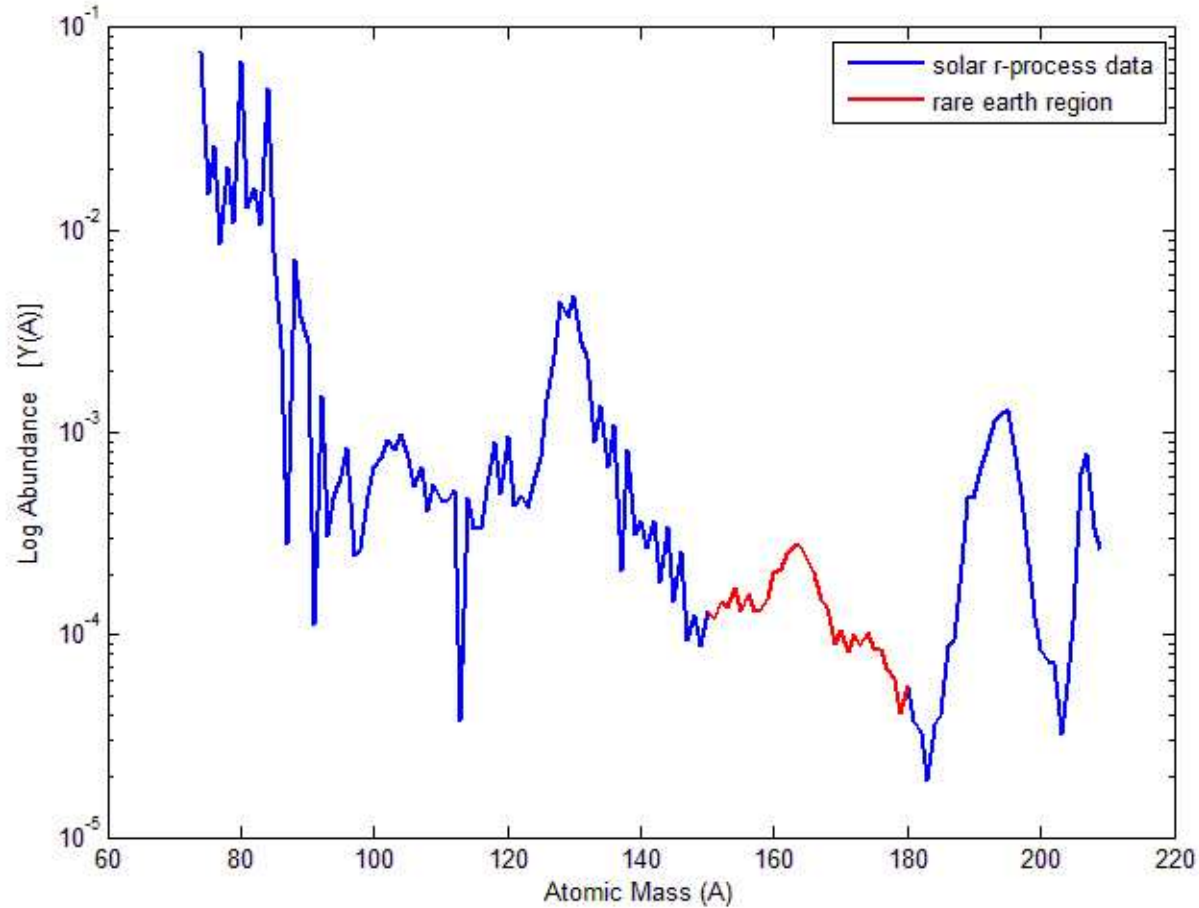


Suppose we increase photo-dissociation/capture rates

Solid - change in the 130 peak rate of “eating” neutrons

Dotted - change in the rest of the abundance patterns rate of “eating” neutrons

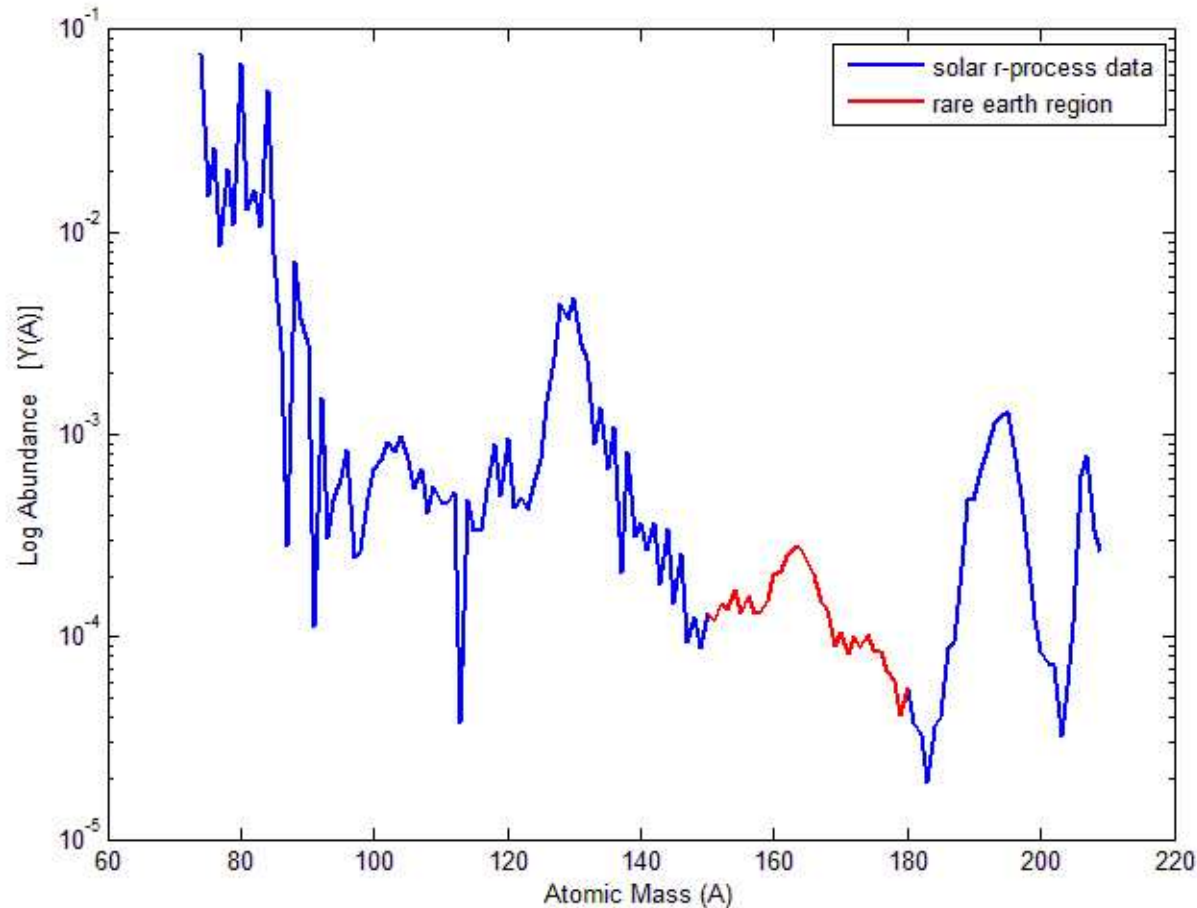
# How does the rare earth peak form?



Solar abundance data with the rare earth peak in red



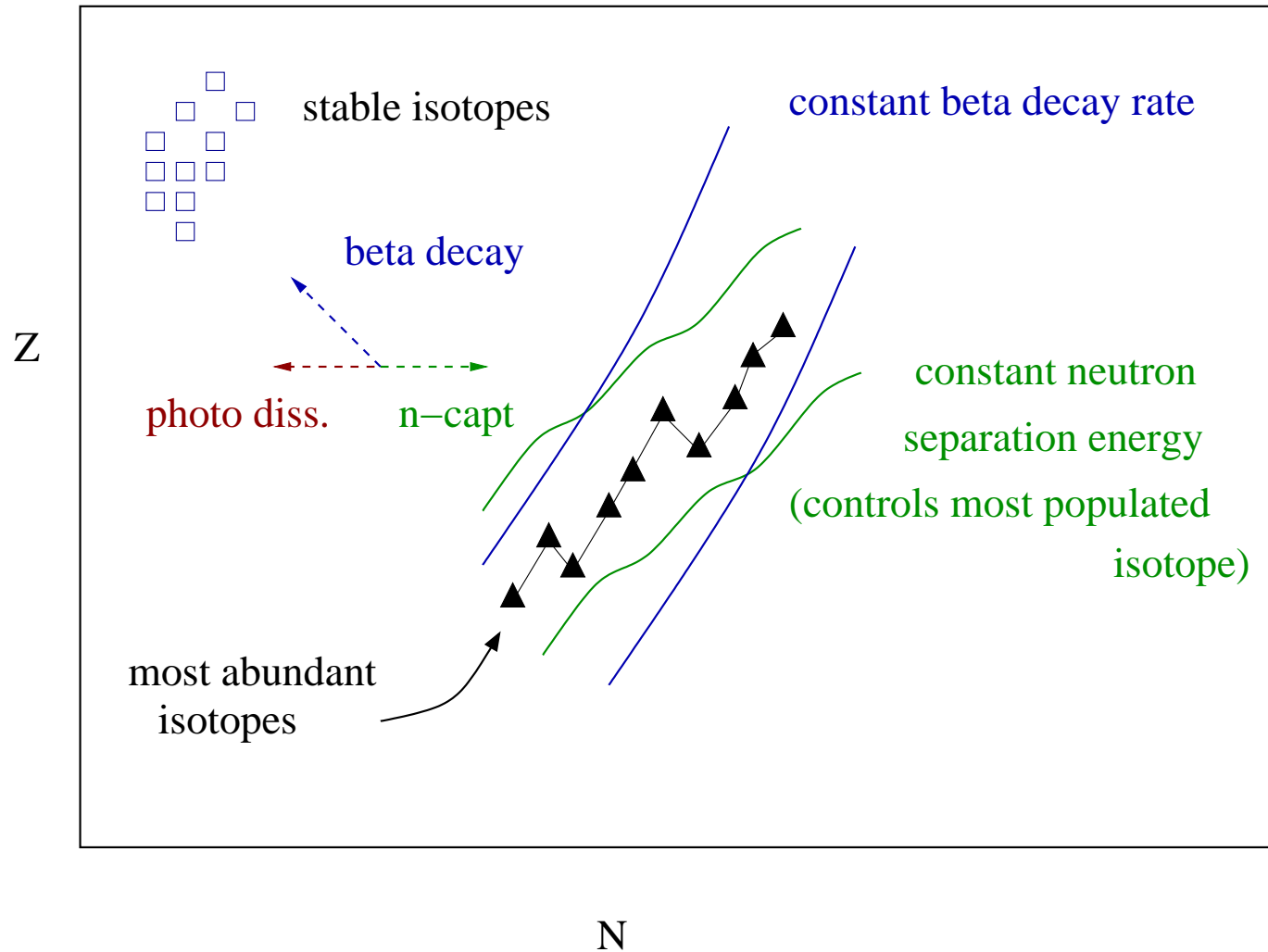
# The rare earth peak: how did it form?



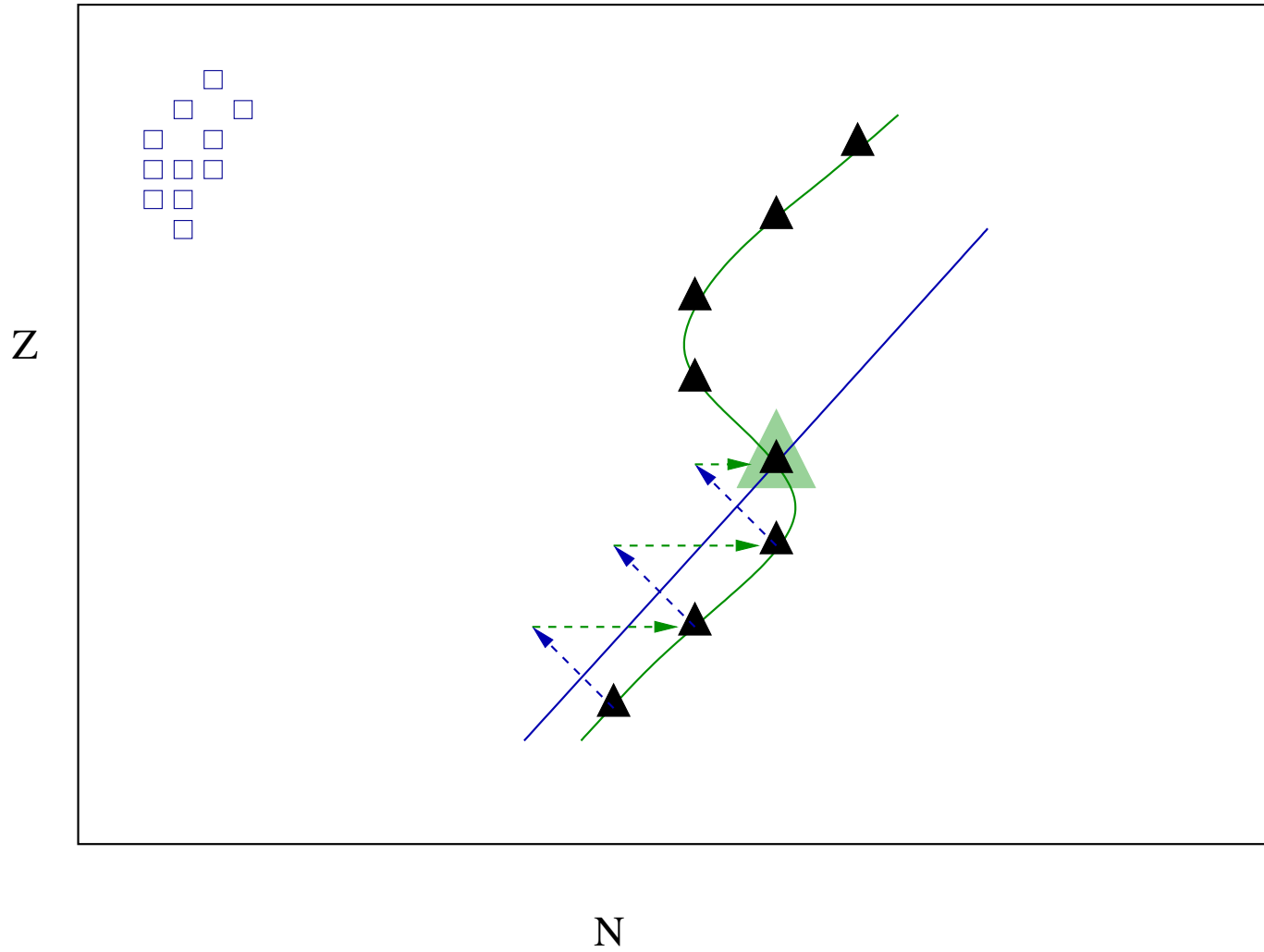
Fission cycling or neutron capture?

In most models it forms by a “pile-up” of nuclei in the slow drift back to stability, i.e. through neutron capture.

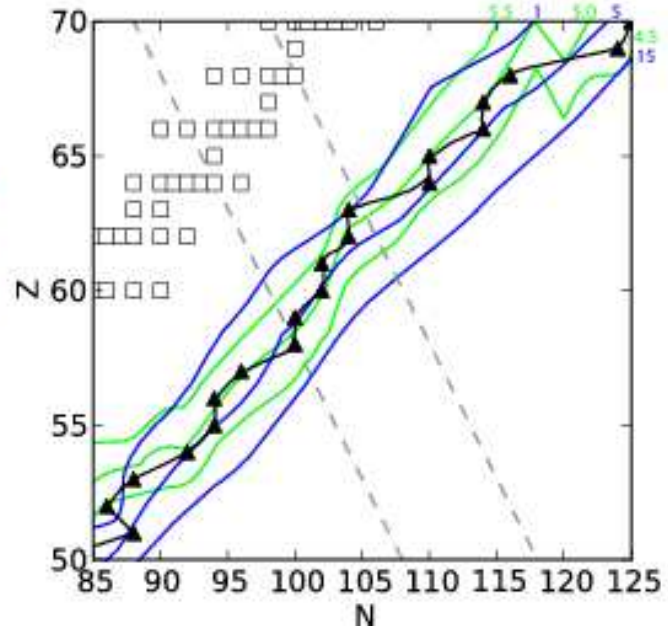
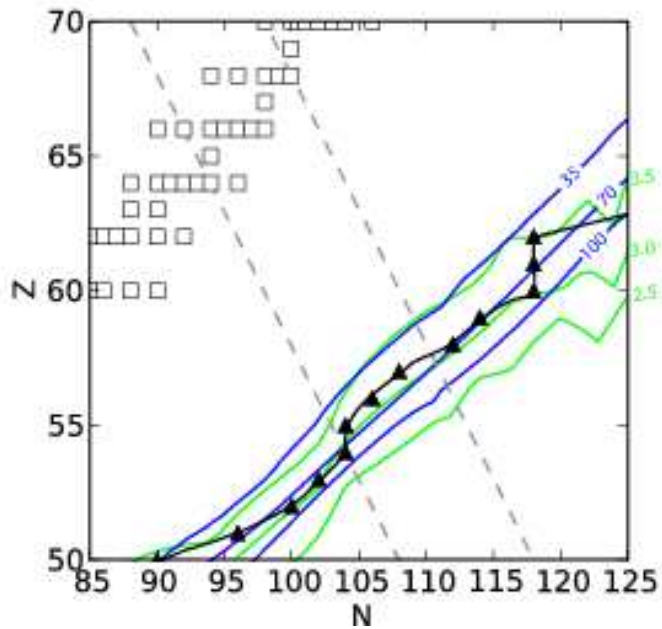
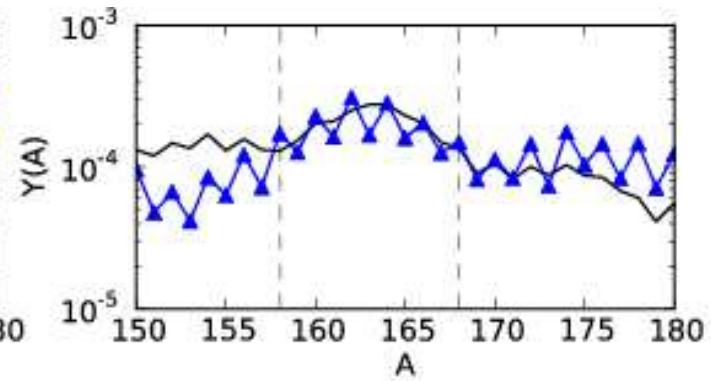
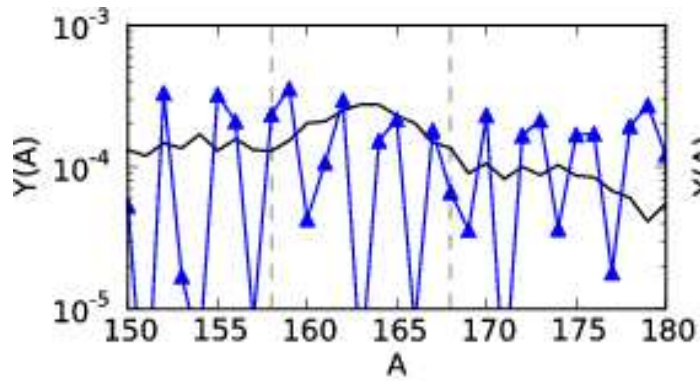
# How to read r-process flow plots



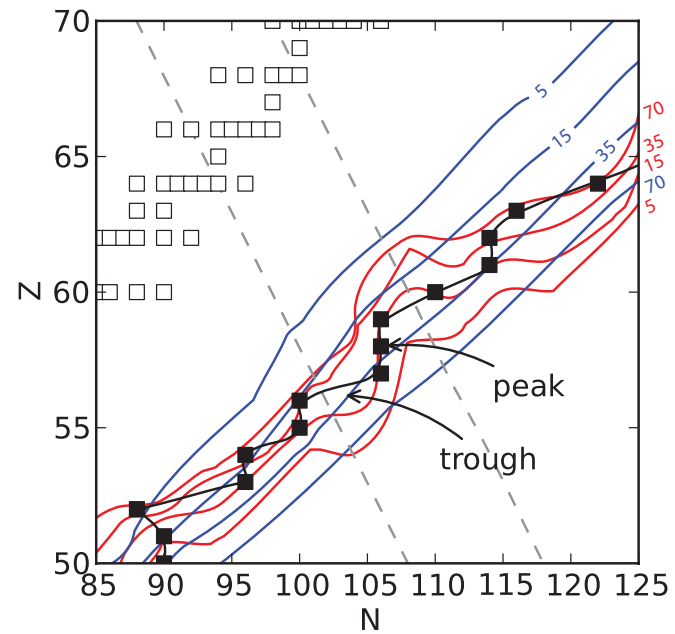
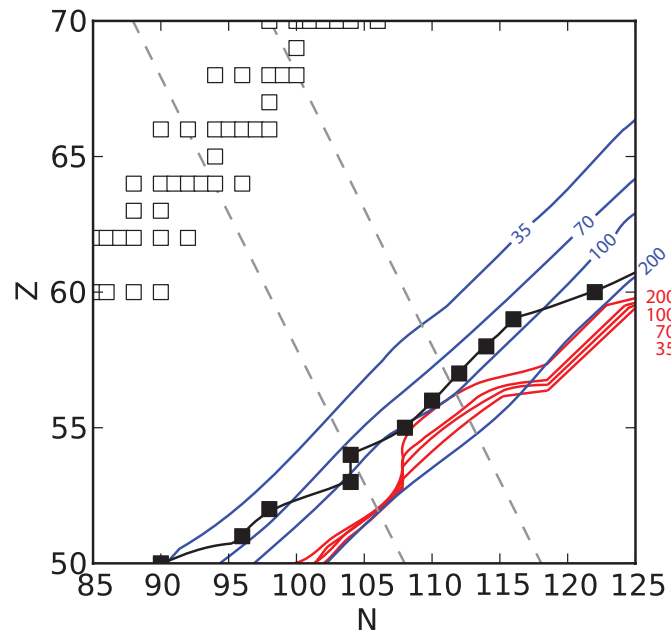
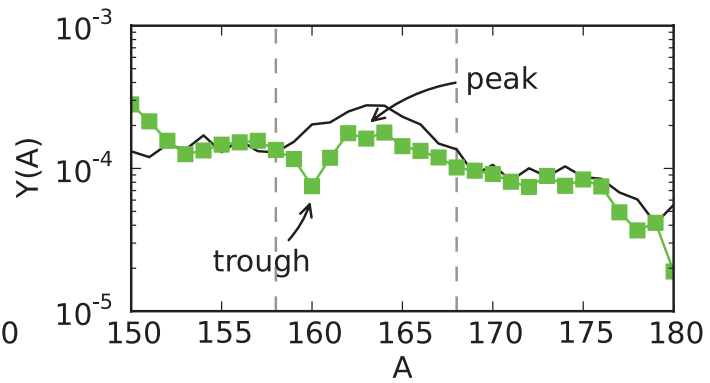
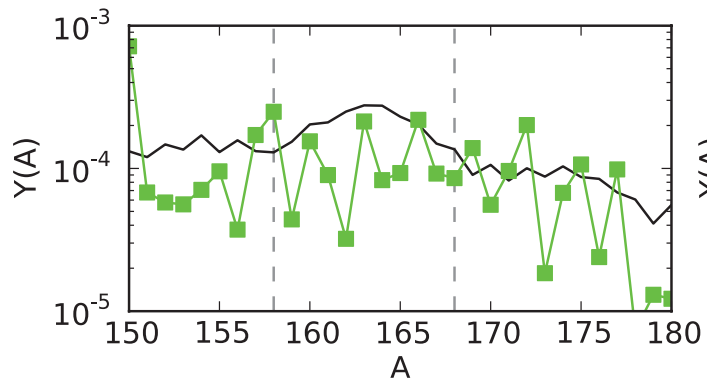
# How to form structures



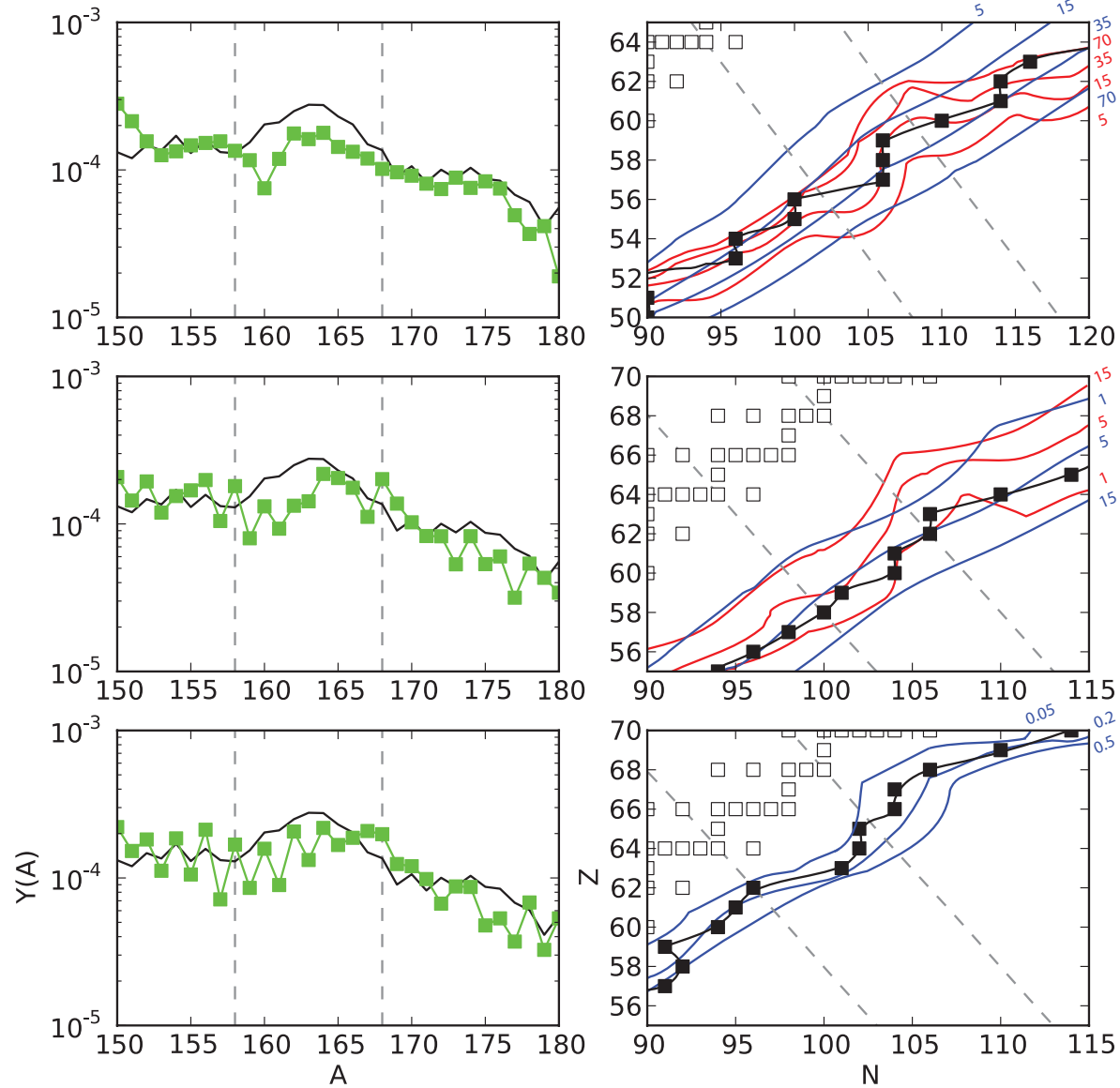
# Hot Peak Formation - FRDM Mumpower et al 2012



# Cold Peak Formation - ETFSI Mumpower et al 2012

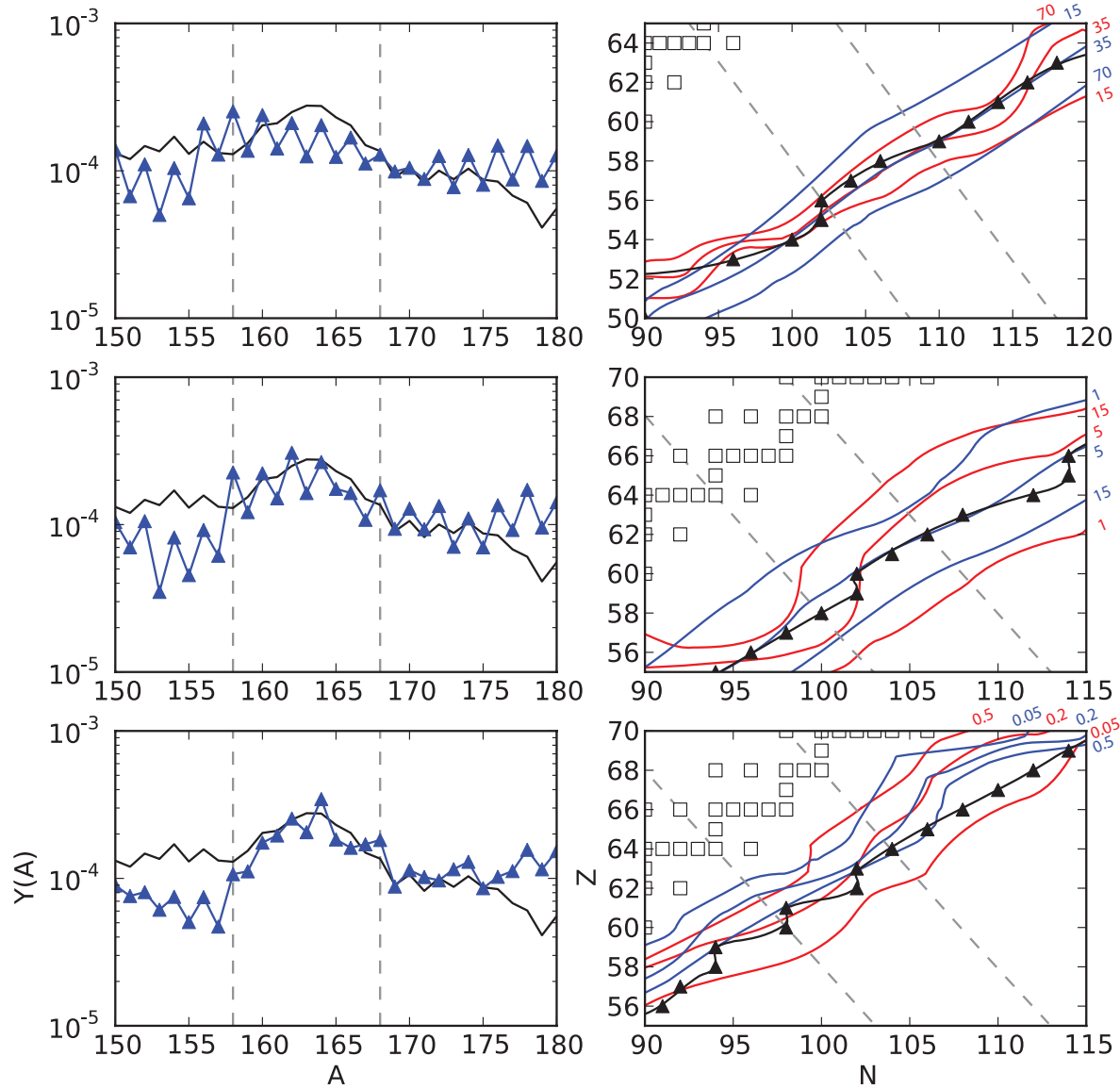


# ETFSI decay to stability



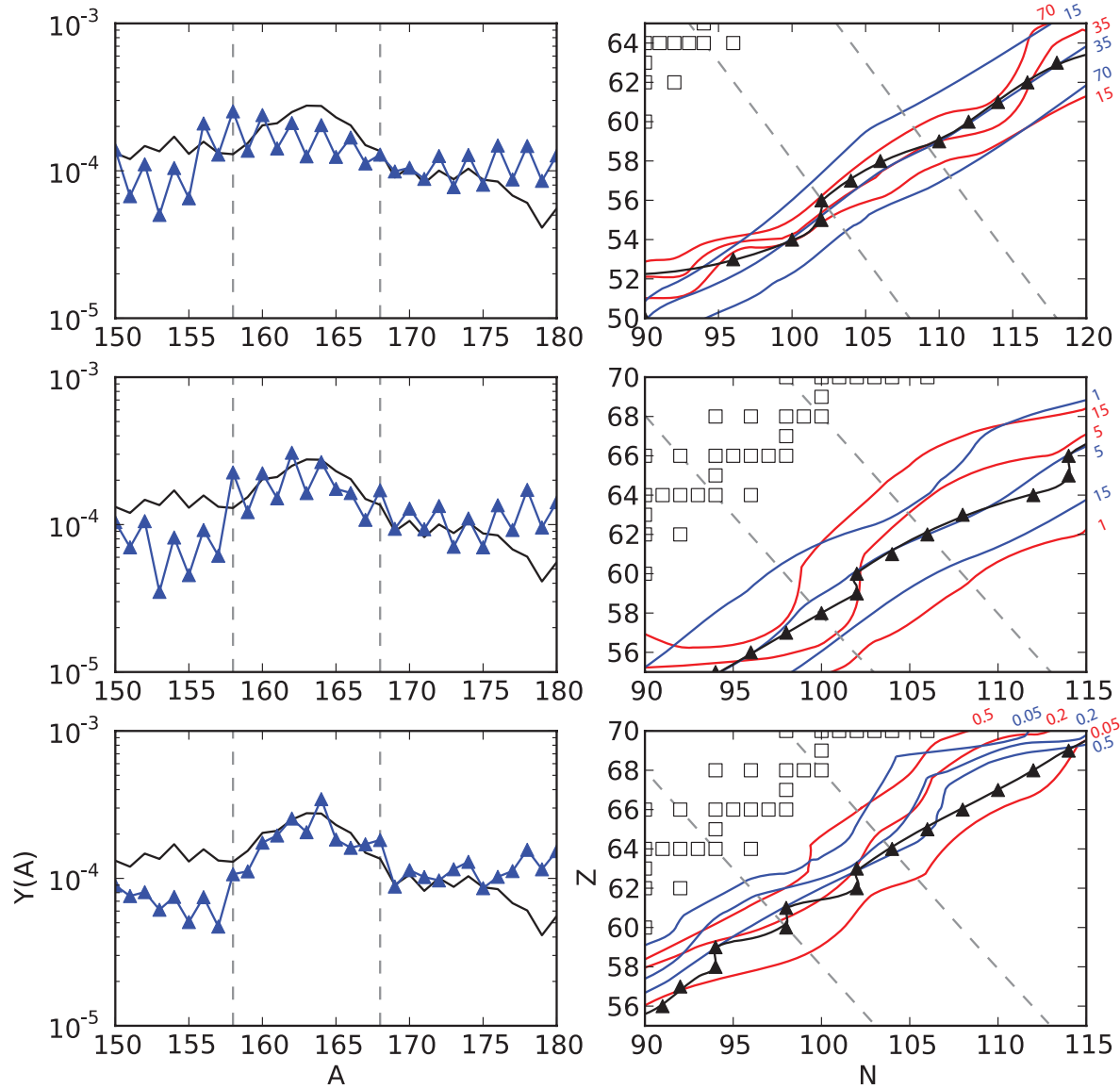
Calculation with the ETFSI model

# FRDM decay to stability



Calculation with the FRDM model

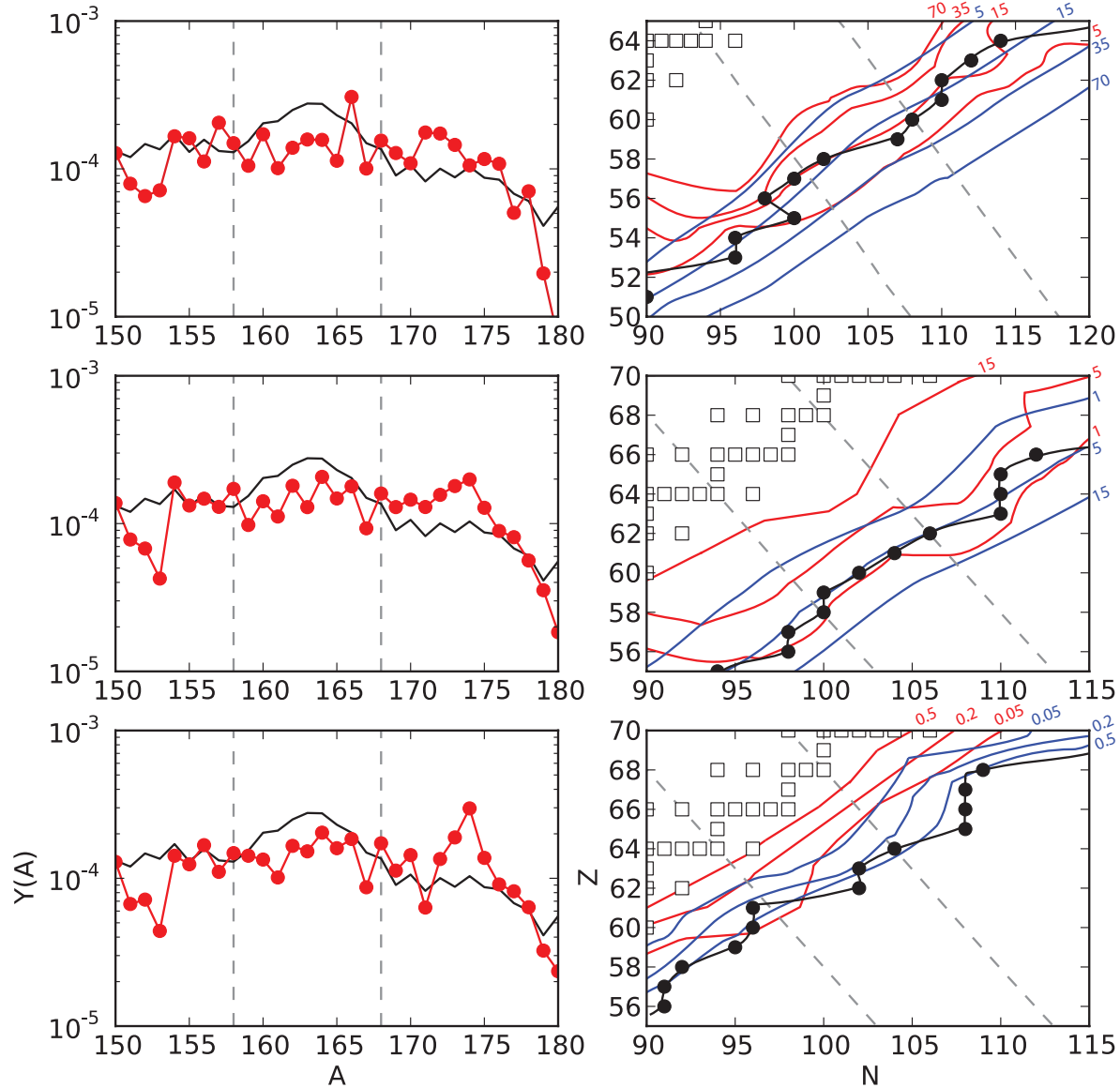
# FRDM decay to stability



Calculation with the FRDM model



# HFB-17 decay to stability



Calculation with the FRDM model