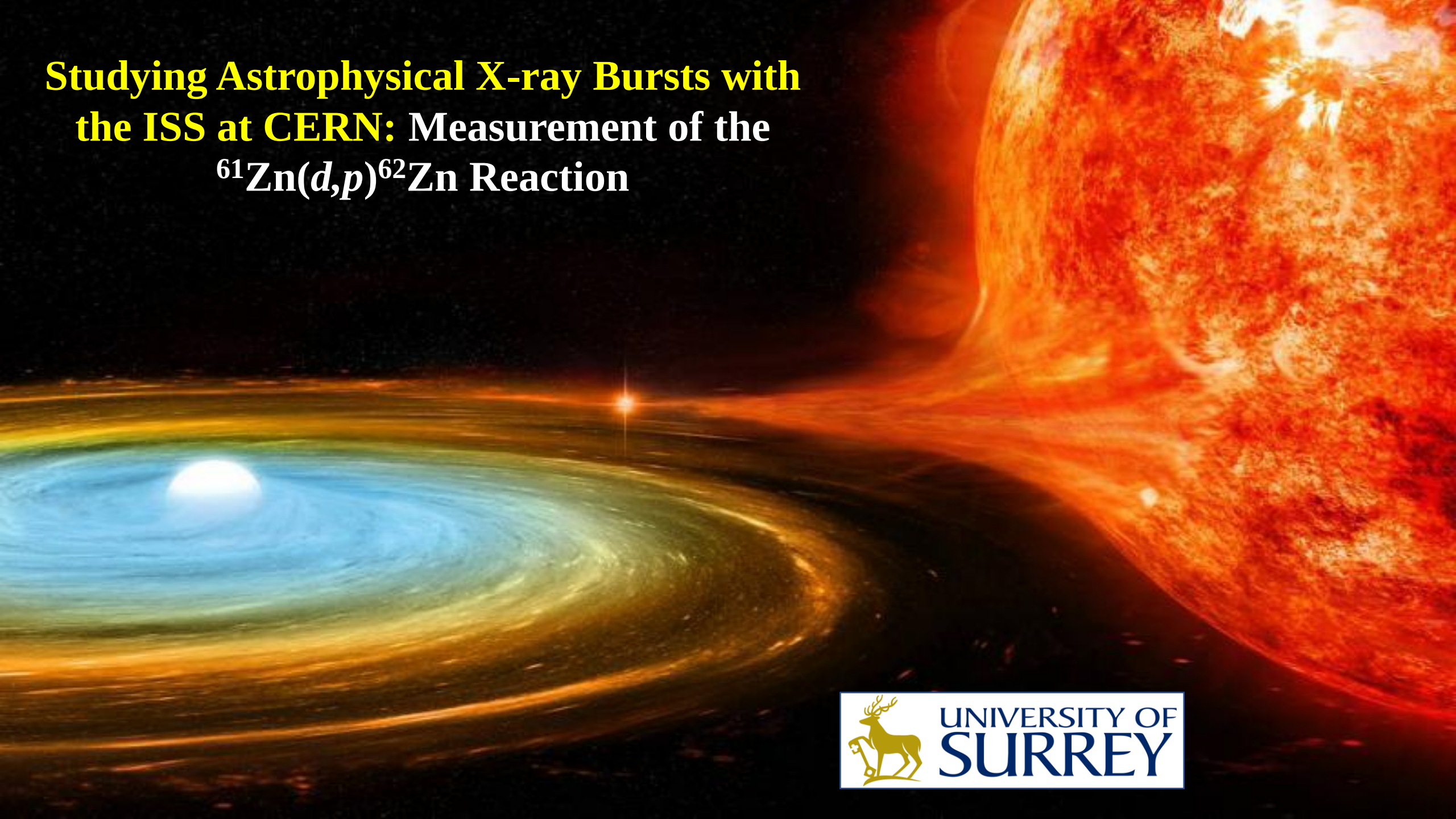
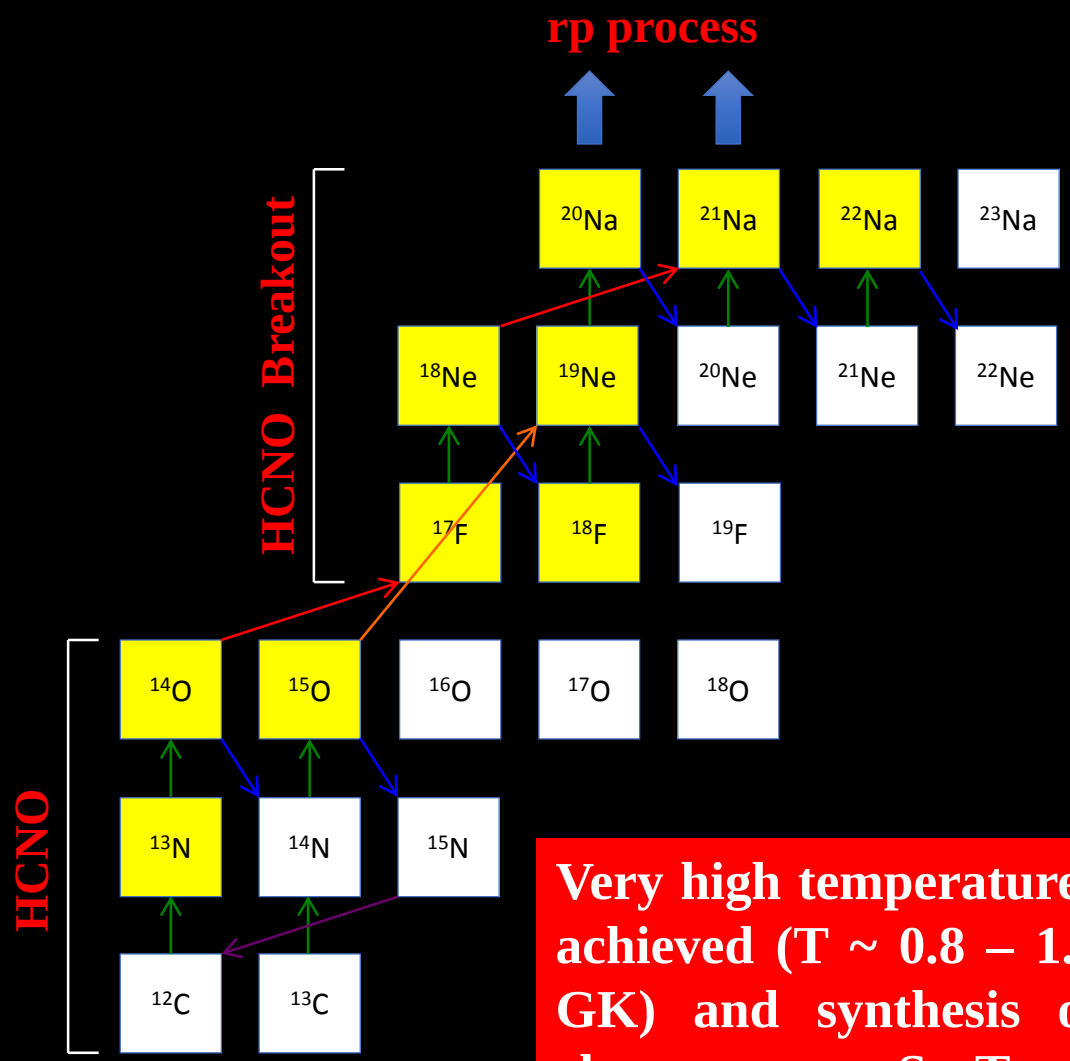
Studying Astrophysical X-ray Bursts with the ISS at CERN: Measurement of the ^{61}Zn(d,p)^{62}Zn Reaction



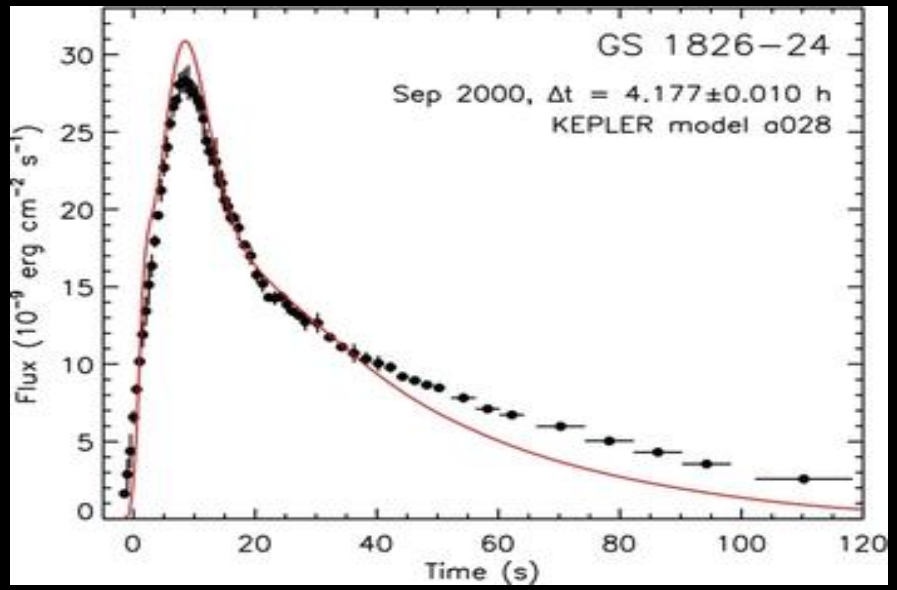
UNIVERSITY OF SURREY

Nucleosynthesis in Type-I X-ray Bursts

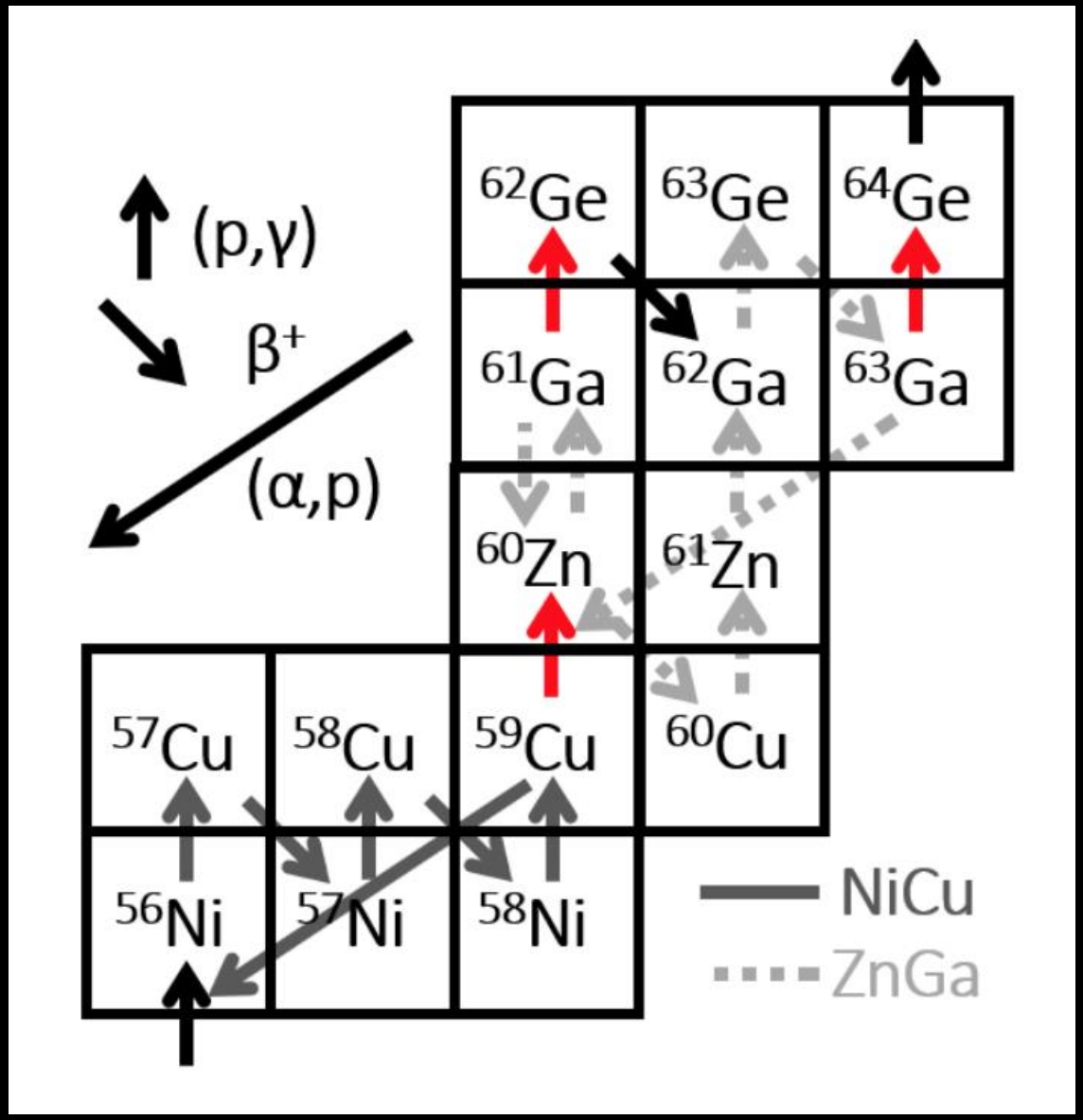


Very high temperatures achieved (T ~ 0.8 – 1.5 GK) and synthesis of elements up to Sn-Te

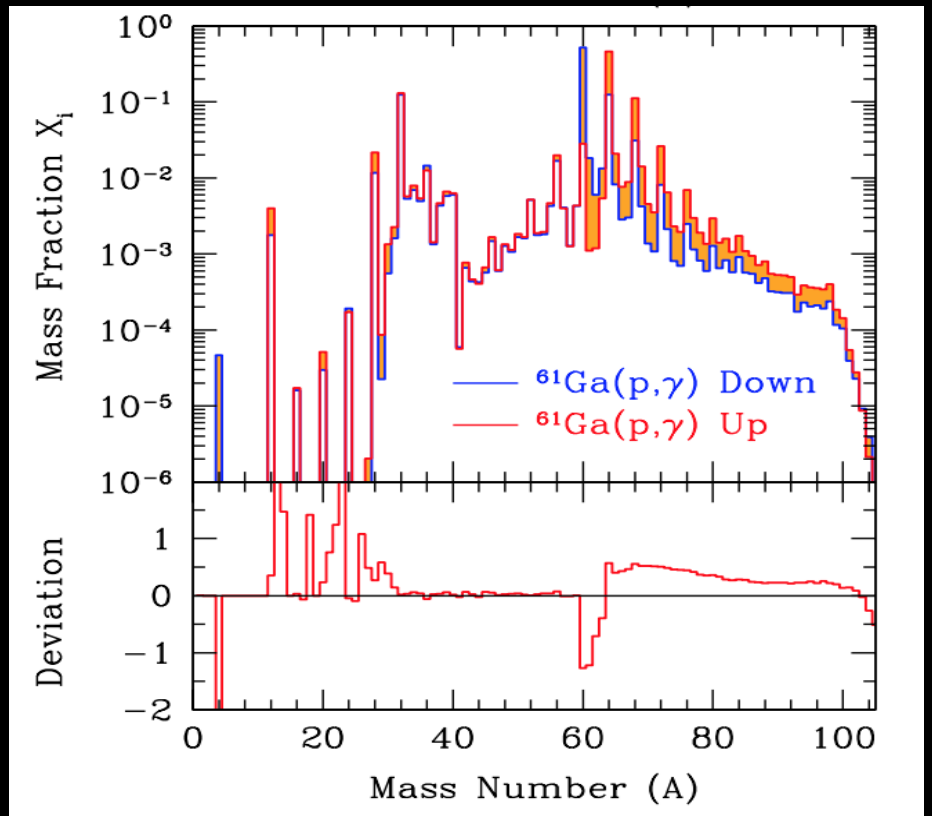
- During burst, high enough temperatures are reached to breakout of HCNO into the *rp* process



Nucleosynthesis in Type-I X-ray Bursts



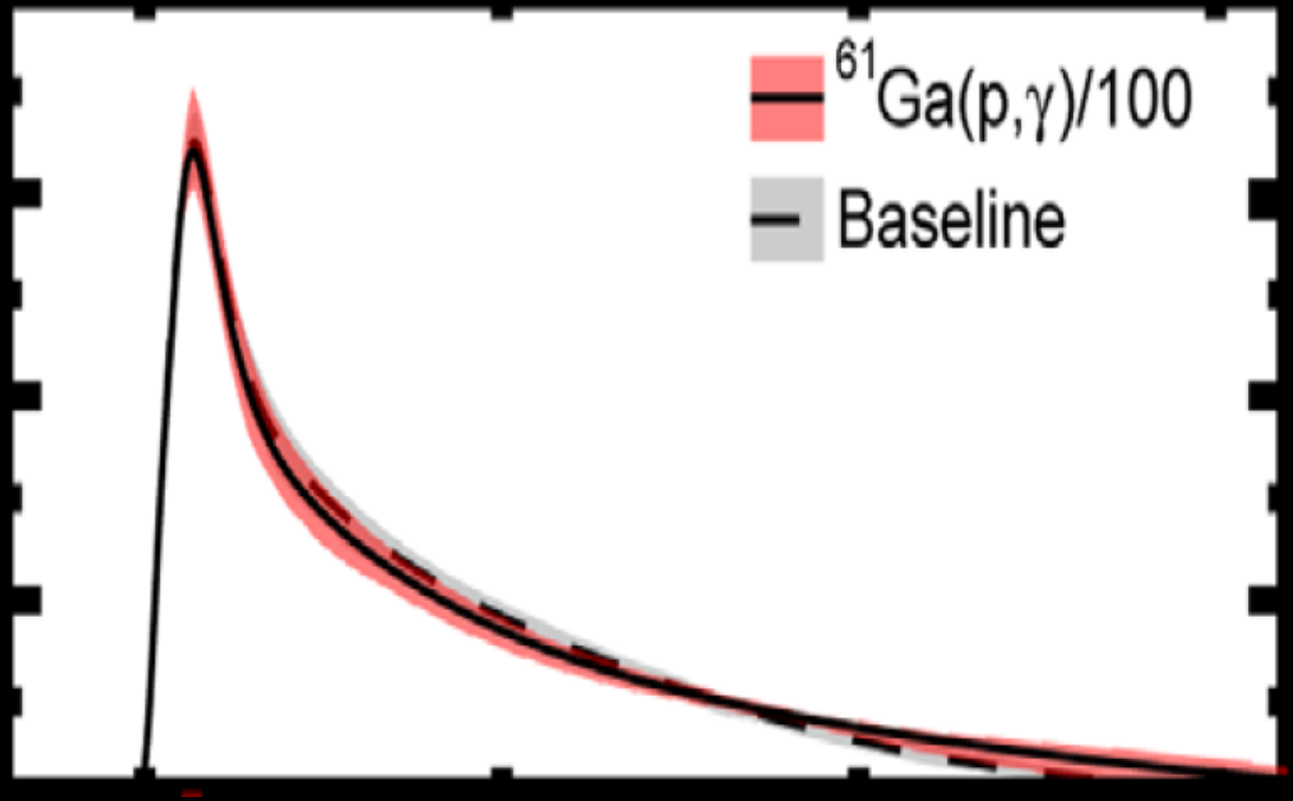
- Models have identified several key waiting points along the *rp* process path [e.g. ^{60}Zn]

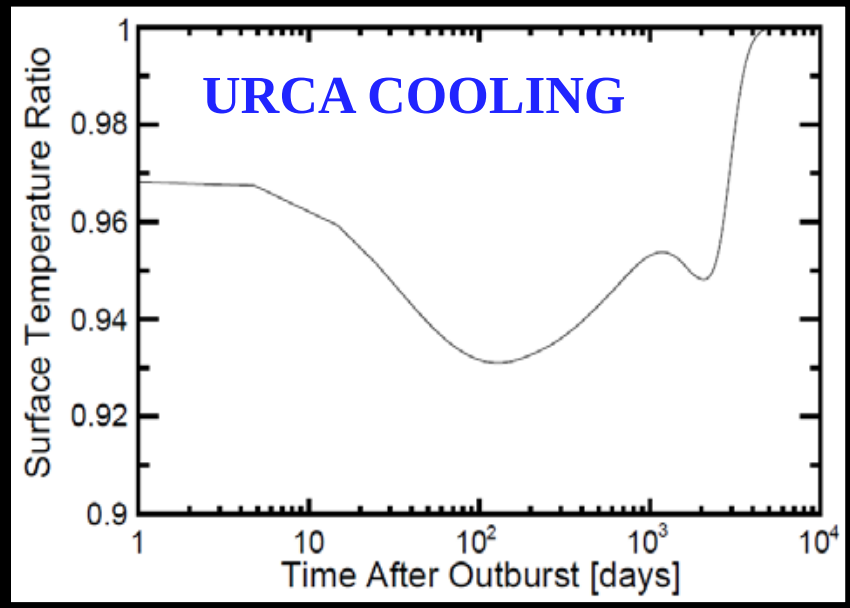


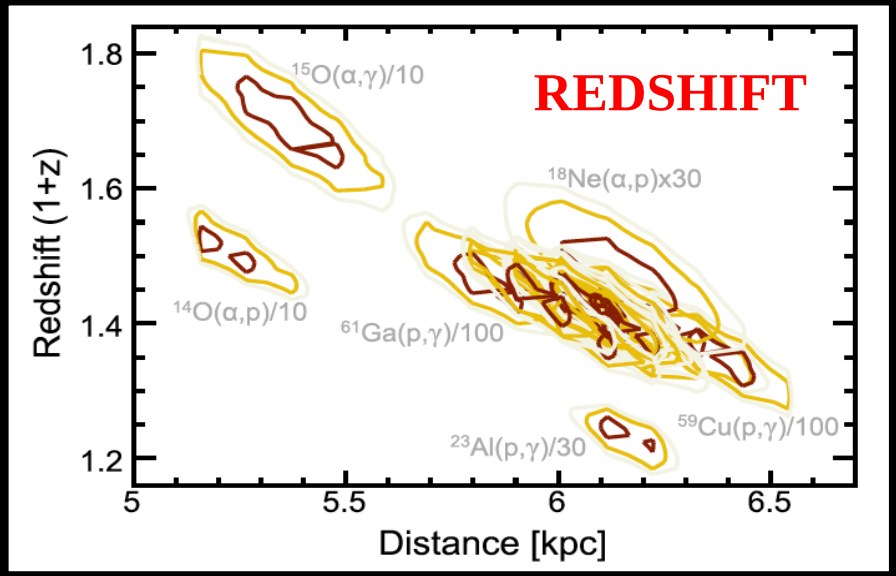
Cyburt *et al.*, ApJ **830**, 55 (2016)

Theoretical Models of Type-I X-ray Bursts

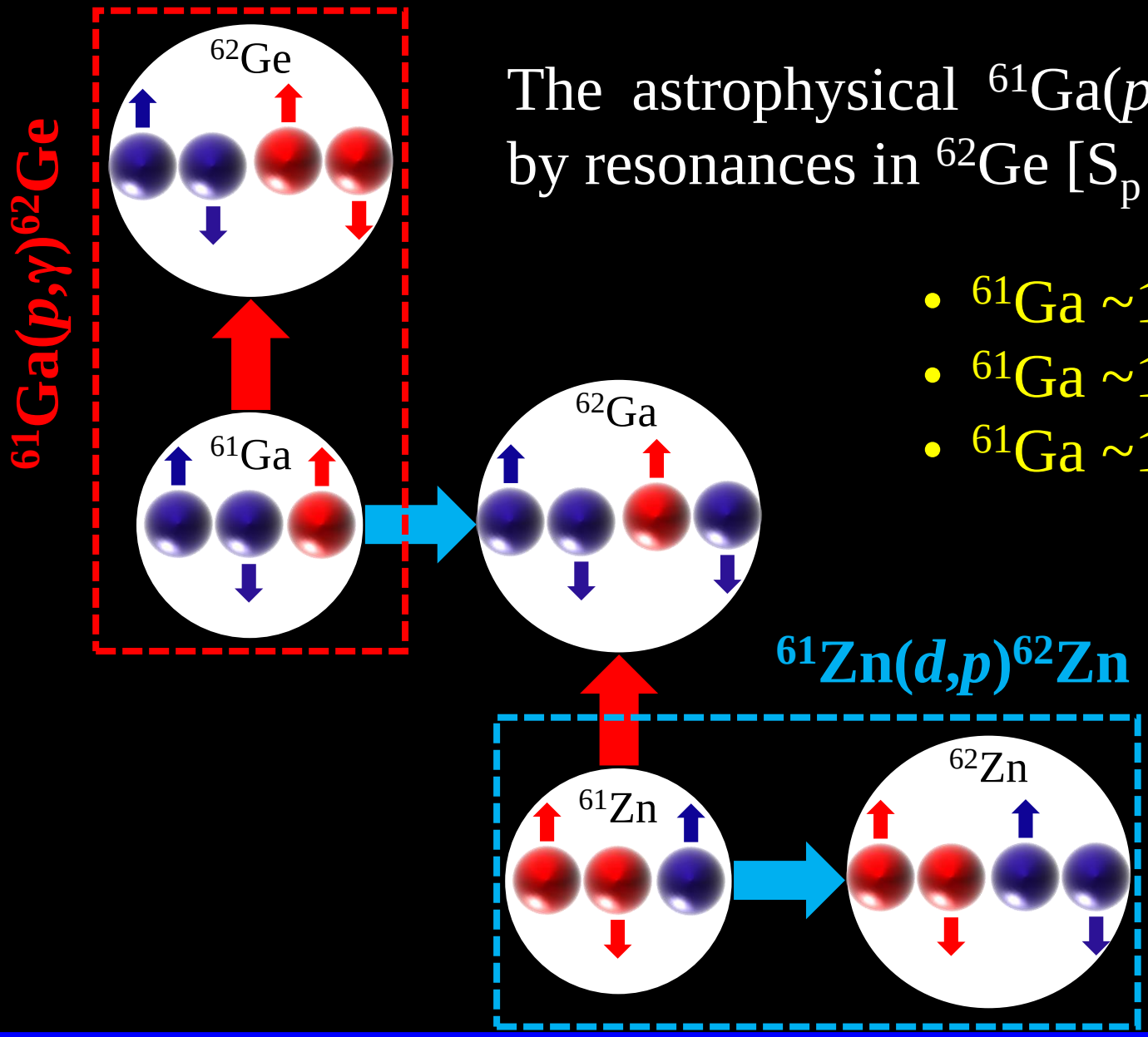
- Most recently, Meisel *et al.* [ApJ **872**, 84 (2019)] compared model parameters with astronomical observations of GS 1826-24







Studying the Astrophysical ^{61}Ga(p,γ)^{62}Ge Reaction

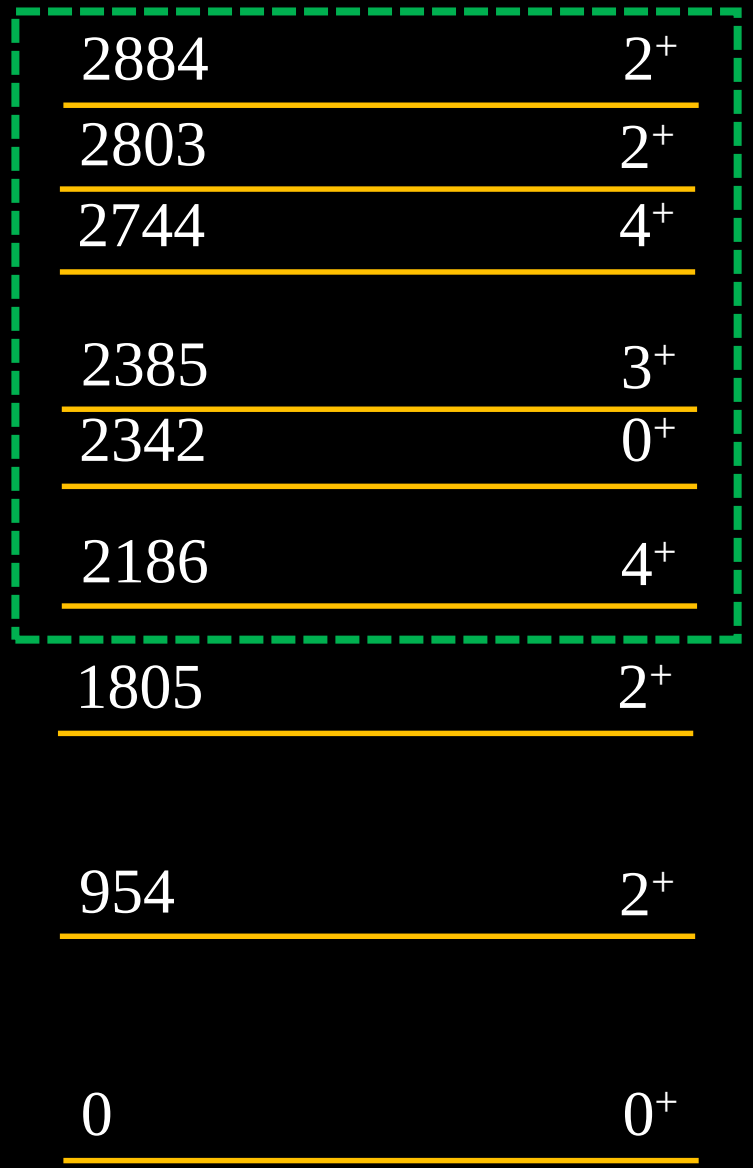


The astrophysical ^{61}Ga(p,γ)^{62}Ge reaction is dominated by resonances in ^{62}Ge [S_p = 2050(30) keV]

- ^{61}Ga ~10^2 pps – TRIUMF
- ^{61}Ga ~10^1 pps – ISOLDE
- ^{61}Ga ~10^3 pps – FRIB PAC ONE

SOLUTION: Measure the mirror reaction ^{61}Zn(d,p)^{62}Zn and determine strengths of resonances

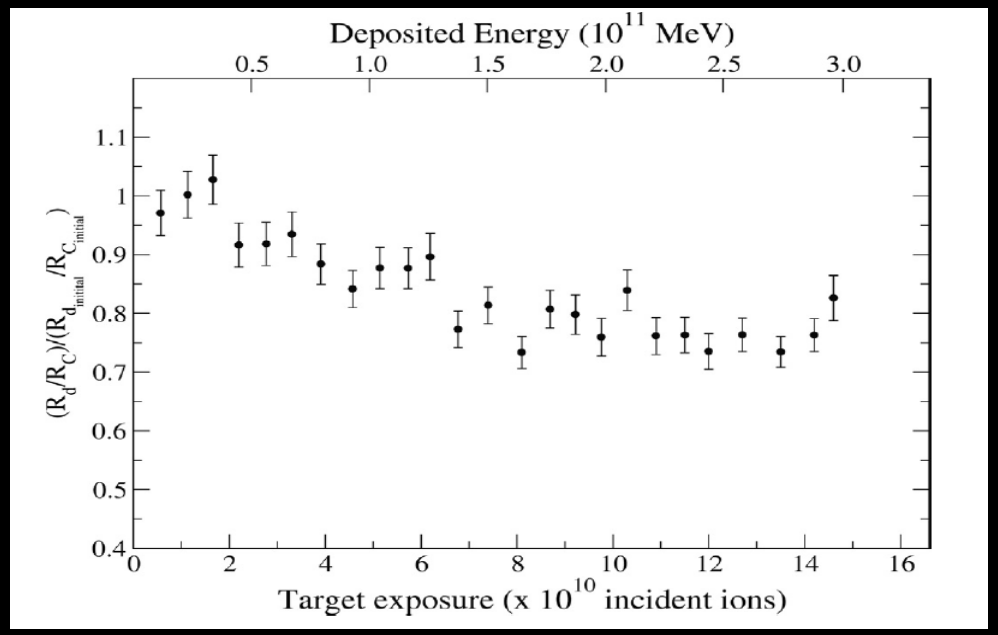
Determining the $^{61}Ga(p,\gamma)^{62}Ge$ reaction rate from ^{62}Zn

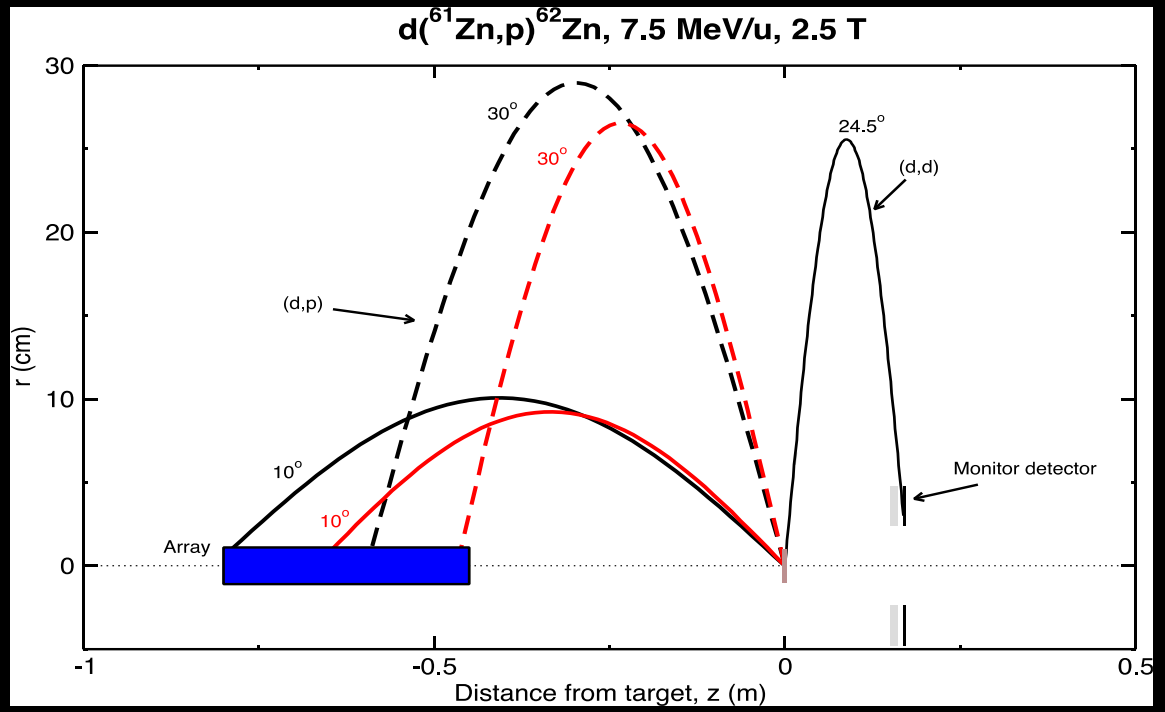


- Level structure of ^{62}Zn is well known
- Low level-density
- Measure C^2S for excited states above 2 MeV
- Utilize state-of-the-art shell model calculations

Measurement of ^{61}Zn(*d*,*p*) using the ISS

- Beam of ^{61}Zn ions at 7.5 MeV/u
- ~100$\mu g/cm^2$ thick CD_2 target
- Protons detected at backward laboratory angles (COM ~ 10º - 30º)





- low–*l* angular momentum transfer are the most important for astrophysical processes
- Elastically-scattered deuterons will be detected in a downstream annular silicon detector

Readiness and Beam Request

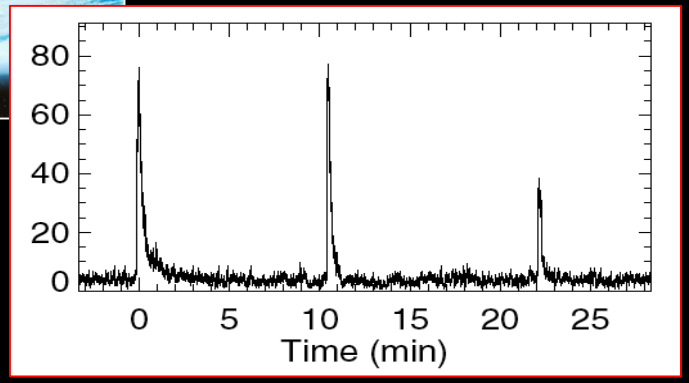
- I_{beam} ~4 x 10^6 pps reported for ^{61}Zn. Reasonably assume ~4 x 10^5 pps at ISS

- RILIS ionized neutron-deficient Zn beams largely free from contamination. [Ga suppressed by more than 7 orders of magnitude in comparison to Zn]

- Estimate ~44 counts (for C^2S ~ 0.5) in each ring of detectors per day, where each ring essentially corresponds to an angular bin.

BEAM SHIFTS = 10 (Measurement) + 4 (Background & Optimization)

Ideal nuclear astrophysics measurement for ISS



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