The rp-process in X-ray bursts

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Deepest zone of first burst (model zM of Woosley et al. 2007) Model by Heger, Woosley et al.; Similar to other groups: Fisker et al. and Jordi et al.







- Intermediate long bursts/superbursts
- Accretion rate behavior of short bursts
- ms Oscillations and their drift
- Doubly peaked bursts
- Short burst intervals

Major progress: MINBAR database (Galloway et al., 2008, ...) now 3402 bursts from 65 sources











Need reliable nuclear physics for full interpretation of observations









First sensitivity study for full 1D burst model from Heger (Cyburt, Amthor, et al.)



(see also post-processing but full Monte Carlo study by Parikh et al. 2008 --> only minor effect from correlations - single rate variation ok)





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β -decay studies at NSCL







β -decay studies at NSCL







New rate from Matic et al. from ²⁴Mg(p,t)²²Mg @ RCNP



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Z

Composition of the ashes - an observable?

 (\mathfrak{S})





Mass ejection and nucleosynthesis contribution?



Ejection of ashes? (Gravity: max few % of burned material) Weinberg et al. showed that in (some) PRE bursts convection can transport ashes close enough to surface where it could be ejected by wind

- spectral signatures predicted
- BUT: mixing occurs early no heavy ashes (p-process)



Evidence for metal enrichment in long non PRE rp-process bursts ?

Inferred NS radius depends on spectral shape:

- decreases for long bursts (expected for supersolar Fe)
- increases for short bursts (expected for no Fe)

(Bhattacharyya 2010 based on 877 bursts from Galloway)



Summary



X-ray bursts are a very active field in astronomy, modeling, and nuclear physics (stable and radioactive beam experiments and theory)

--> many open questions and observables that require nuclear physics

Nuclear physics is challenging as nuclei are very neutron deficient

- --> amazing progress
- --> but need more intense beams will be area of focus for future facilities

X-ray bursts are rich phenomenon

 astrophysics: wide range of parameters -> wide range of behaviors (accretion rates, companion composition, NS)

- complex network of nuclear reactions

Data compilations are therefore critical: (Satellite workshop in Darmstadt!)

- Astronomy: MINBAR, ...

- Nuclear:

- JINA reaclib: http://groups.nscl.msu.edu/jina/reaclib/db/
 - (R. Cyburt) (see also nucastrodata.org)
- BRUSLIB,
- MC analysis of uncertainties (Iliadis et al.)
- AME for masses