R-Process in Neutron Star Merger with a New Fission Model

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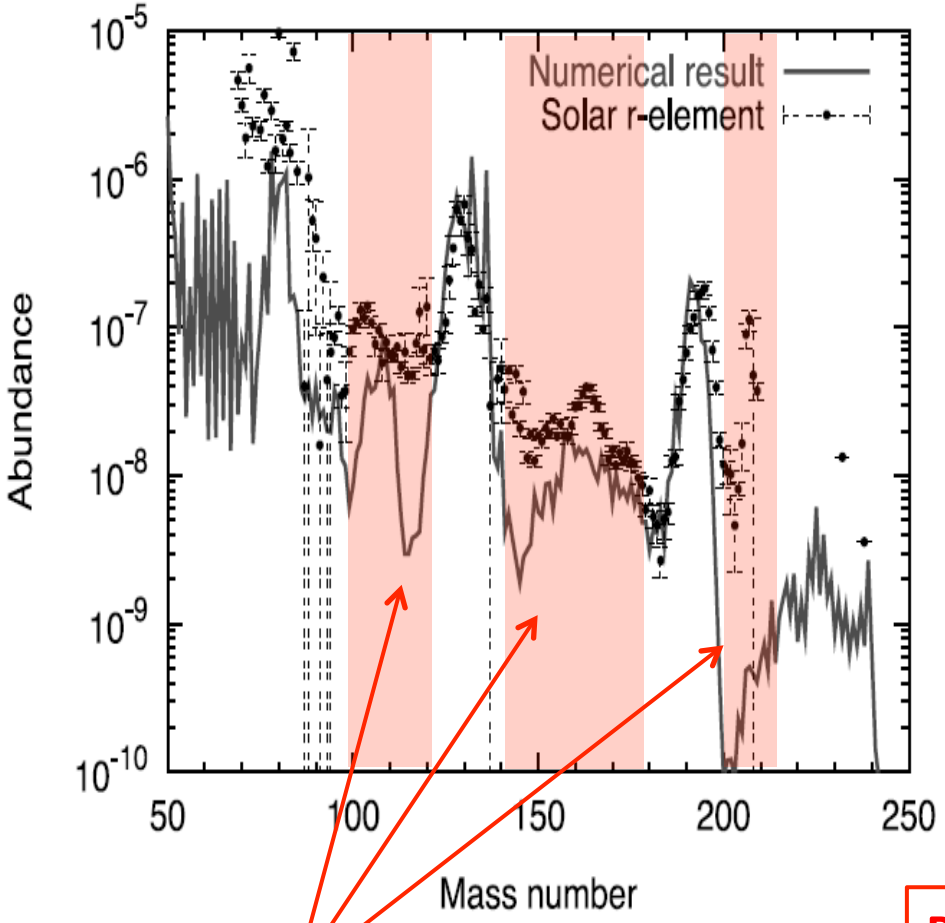
Magnetorotational Supernova

Nishimura et al.(2006)



Underproduction PROBLEM !

Winteler et al. (2012)

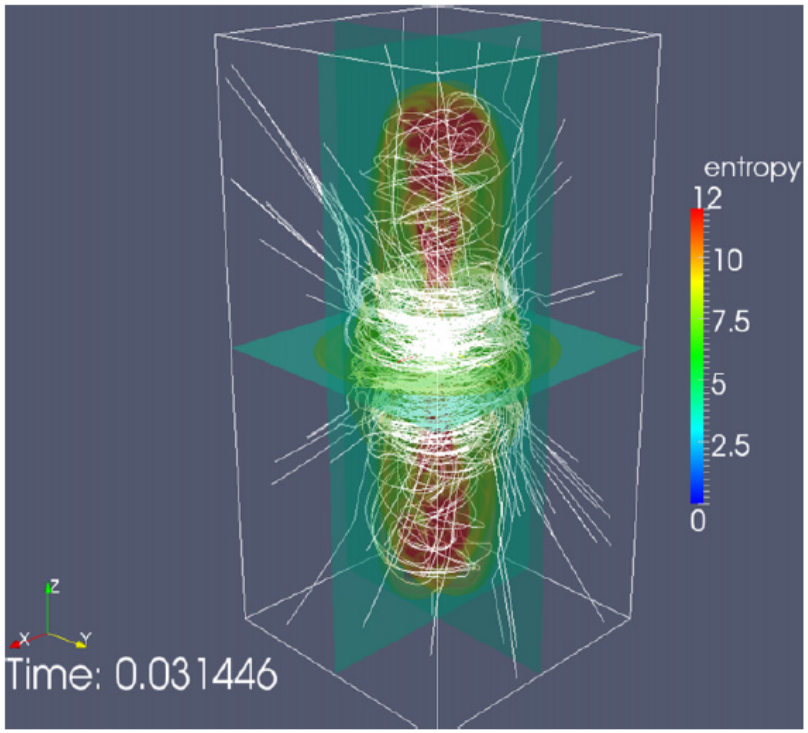


Figure 1. 3D entropy contours spanning the coordinates planes with magnetic field lines (white lines) of the MHD-CCSN simulation ~31 ms after bounce. The 3D domain size is 700 × 700 × 1400 km.

Possible Solutions

- Nuclear mass model
- Neutron Star Merger ← NEW!

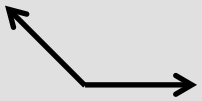
r-process Nucleosynthesis

r**apid neutron-capture **process

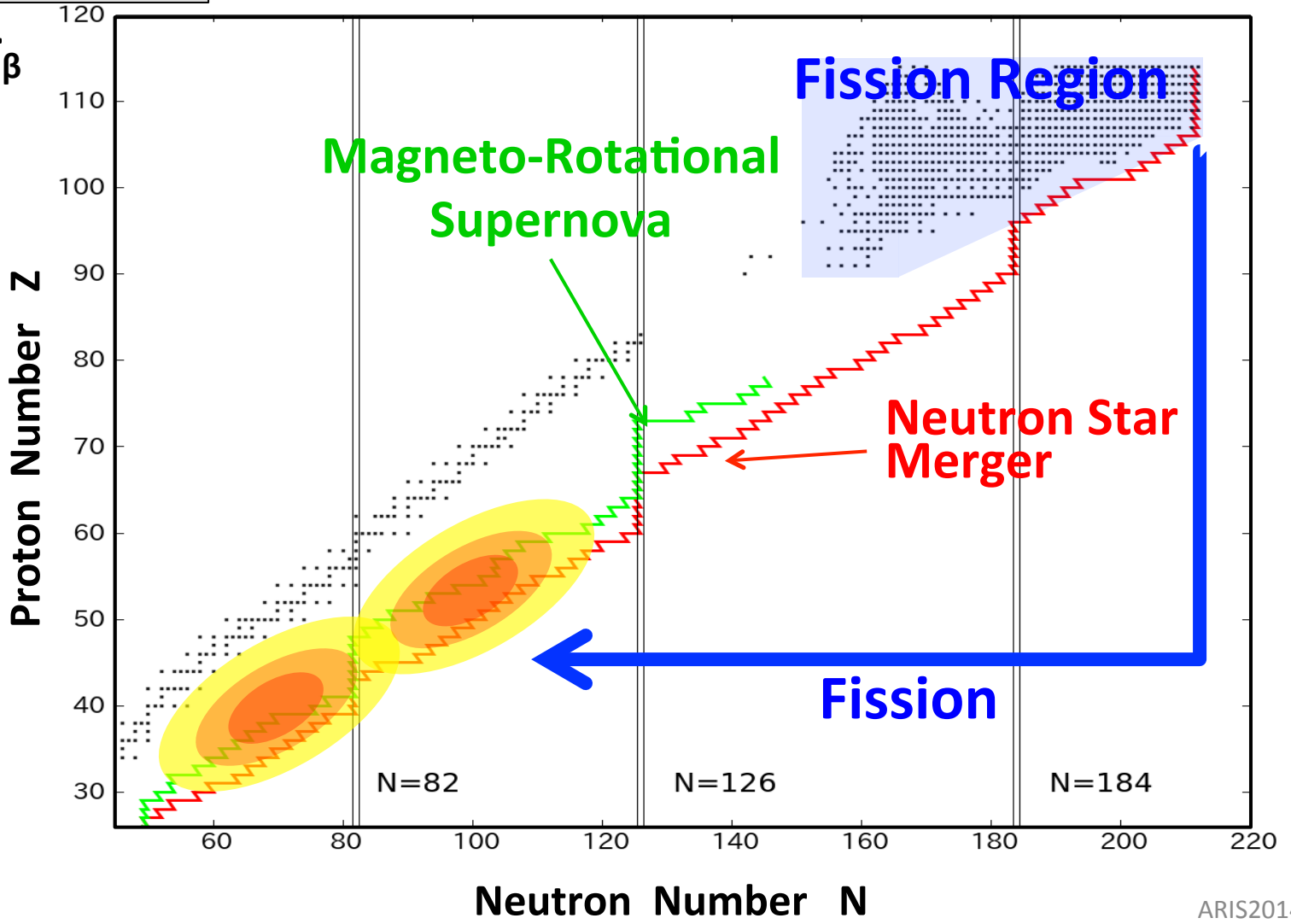
Condition for the r-process

$\tau(n,\gamma) << \tau_\beta$

β^- decay



n-capture



Important Input Data for Fission and Network Code

Sensitive to Fission !

Nuclear mass model :

Fission Barrier & Q_β, (n,γ)

KTUY model

Koura et al. (2005)

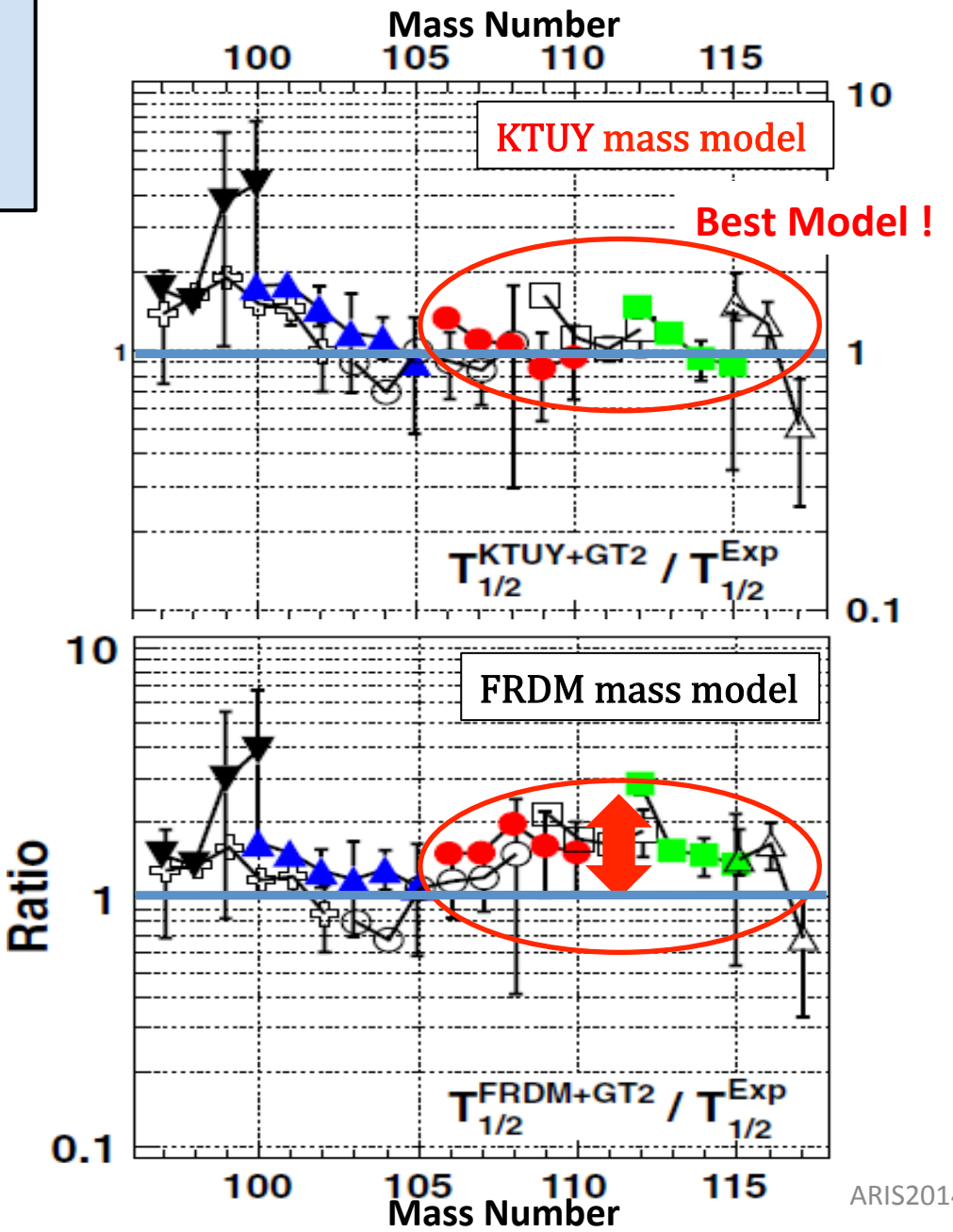
Reaction rates:

α decay, β decay, fission

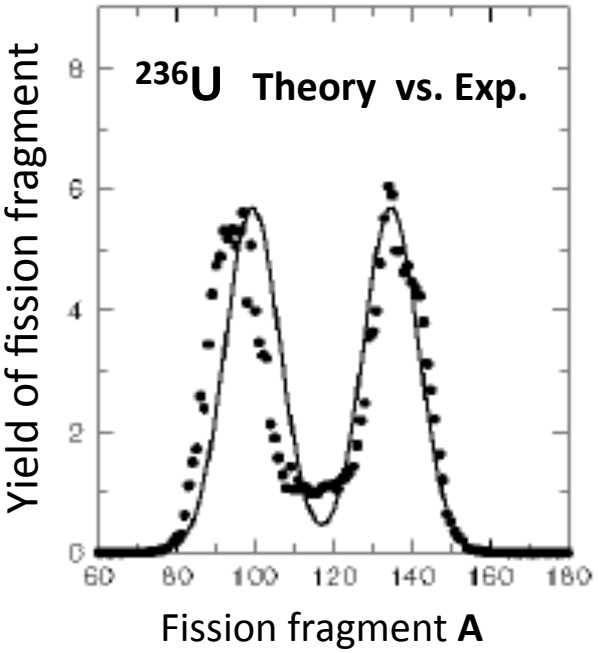
Koura et al.(2004)

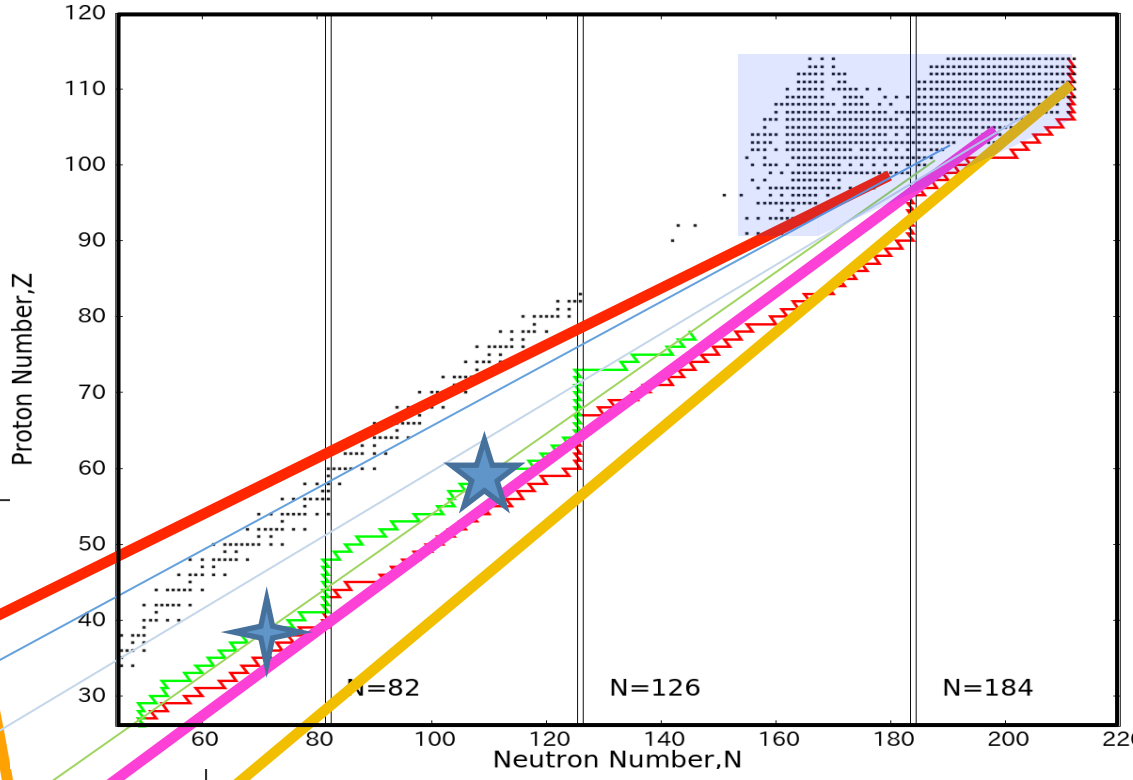
Chiba et al.(2008)

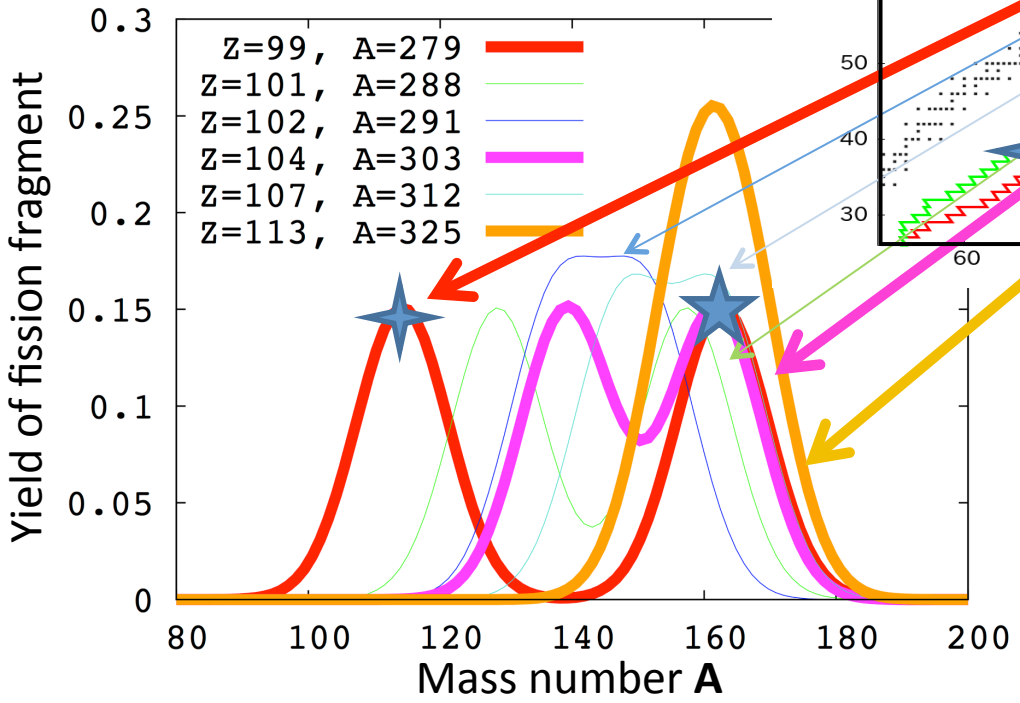
Recent RIKEN β-Decay Experiment
Nishimura et al. (2011)



Fission Fragment Mass Distribution







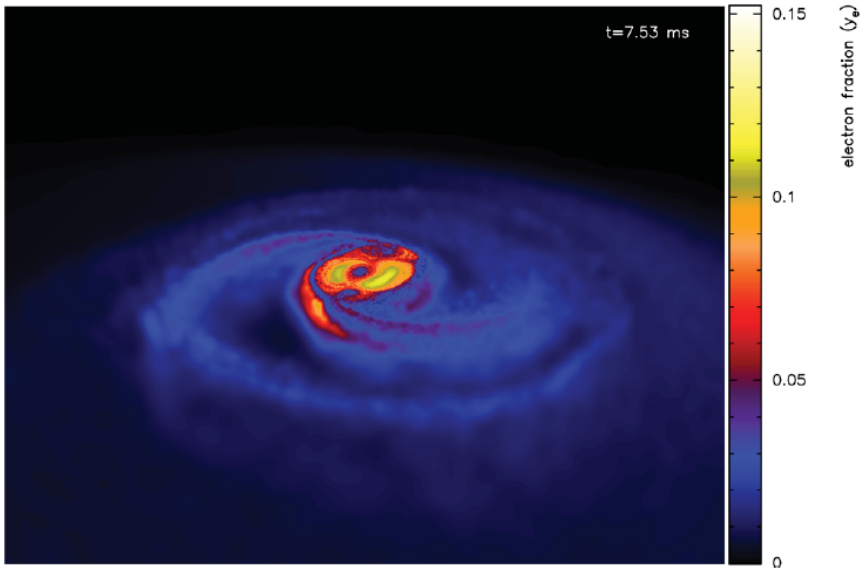
Ohta et al.(2007)
Chiba et al.(2008)

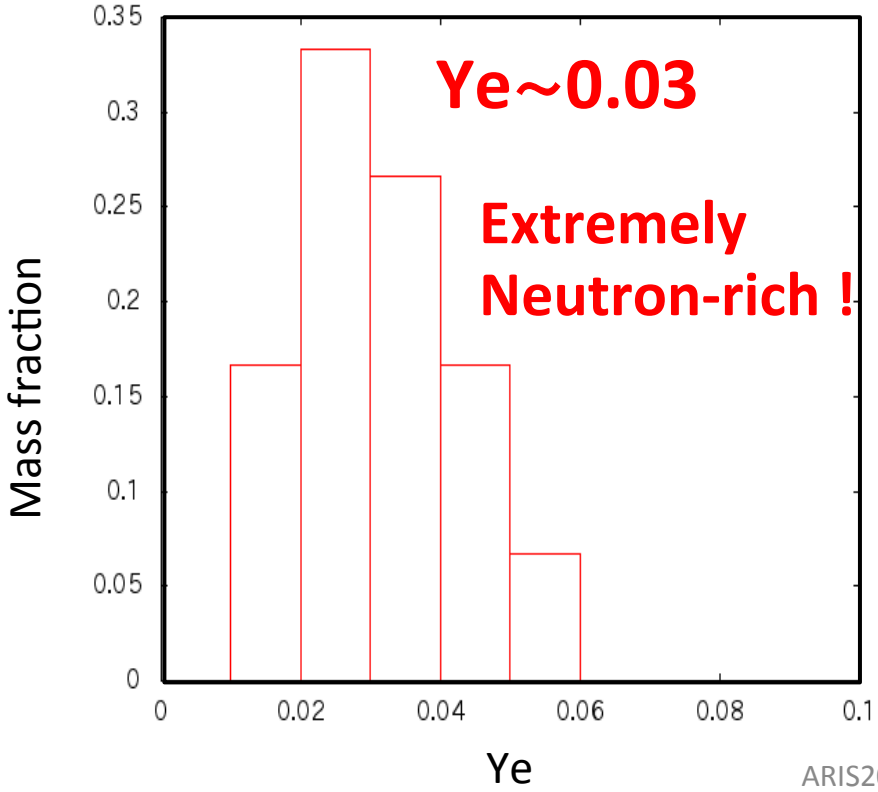
Fluid-Dynamical Data in Our Network Code for r-process Nucleosynthesis

Neutron Star Merger

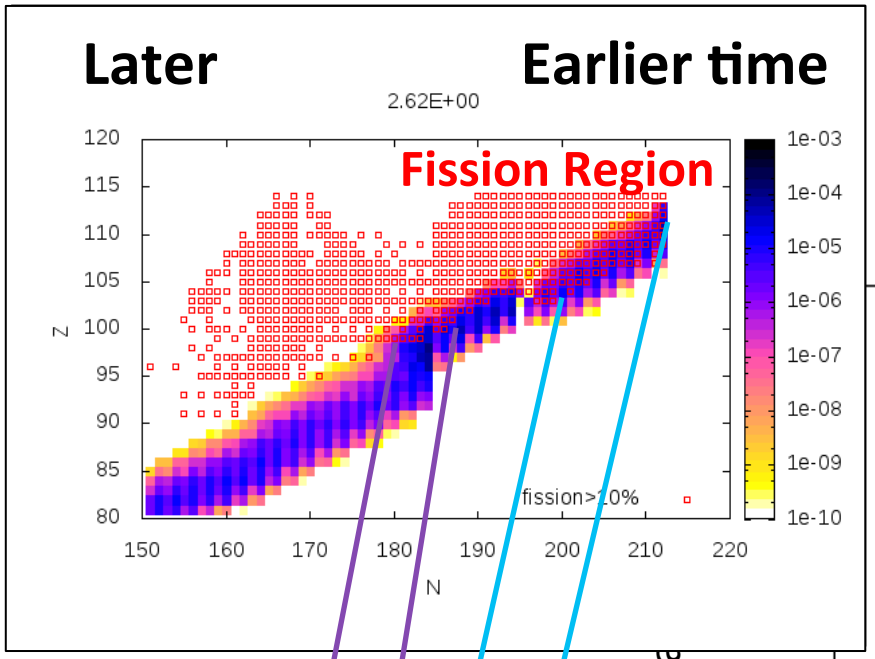
Korobkin et al.(2012), Piran et al. (2013), Rosswog et al. (2013)

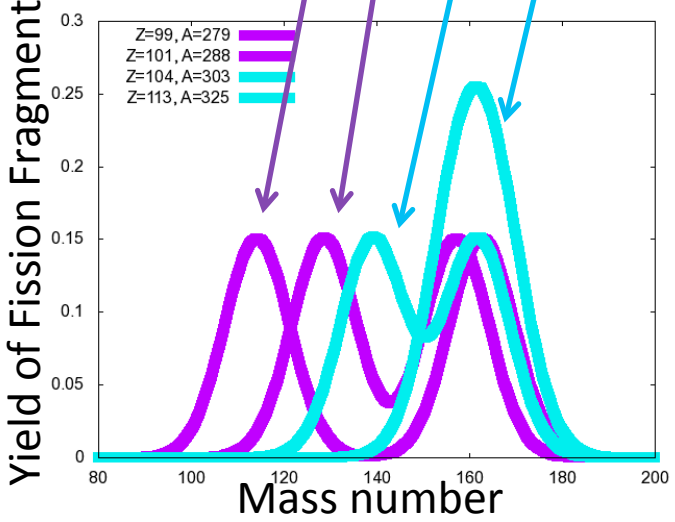
- SPH simulation
- Newtonian gravity
- Neutrino Leakage scheme

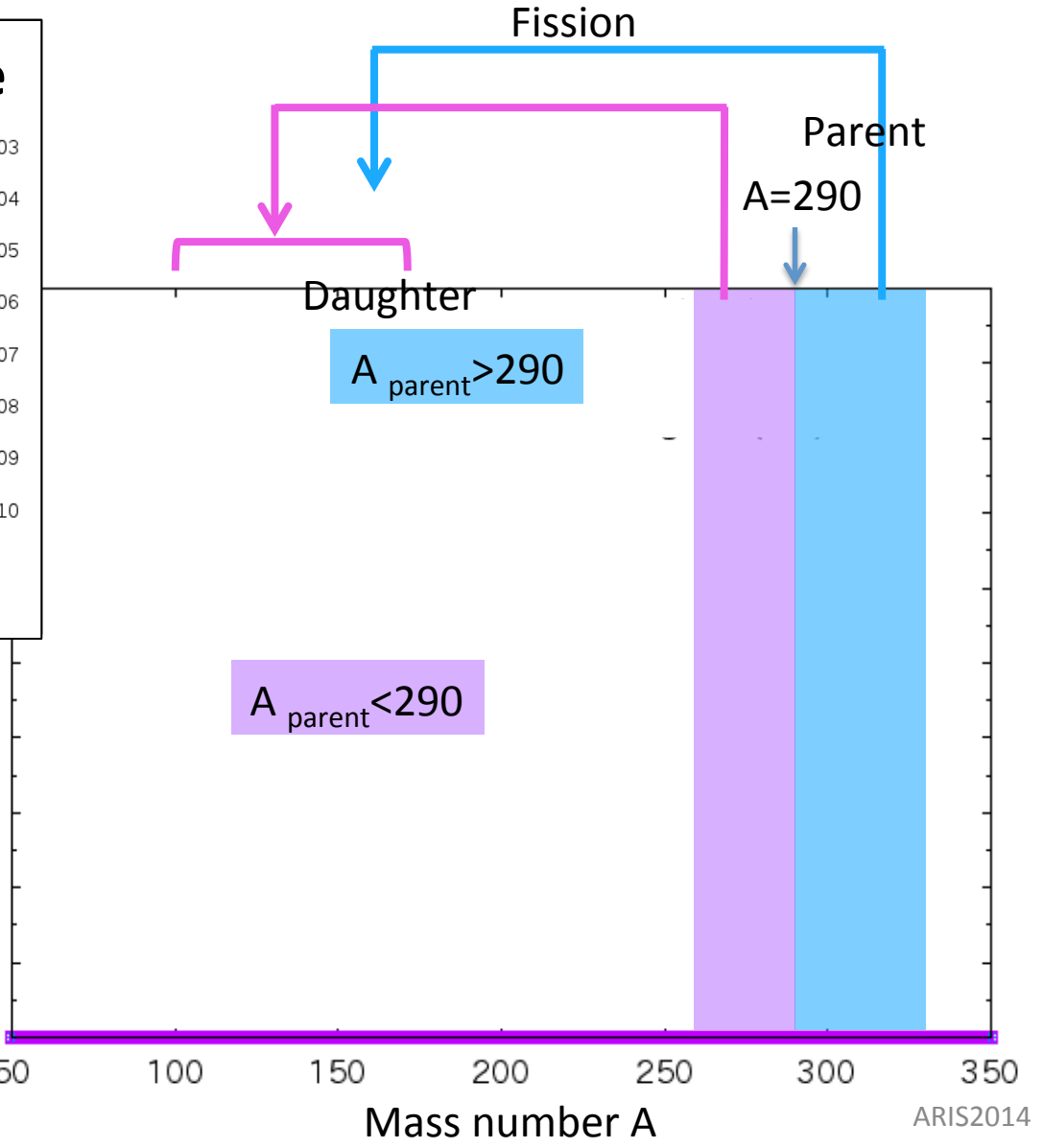




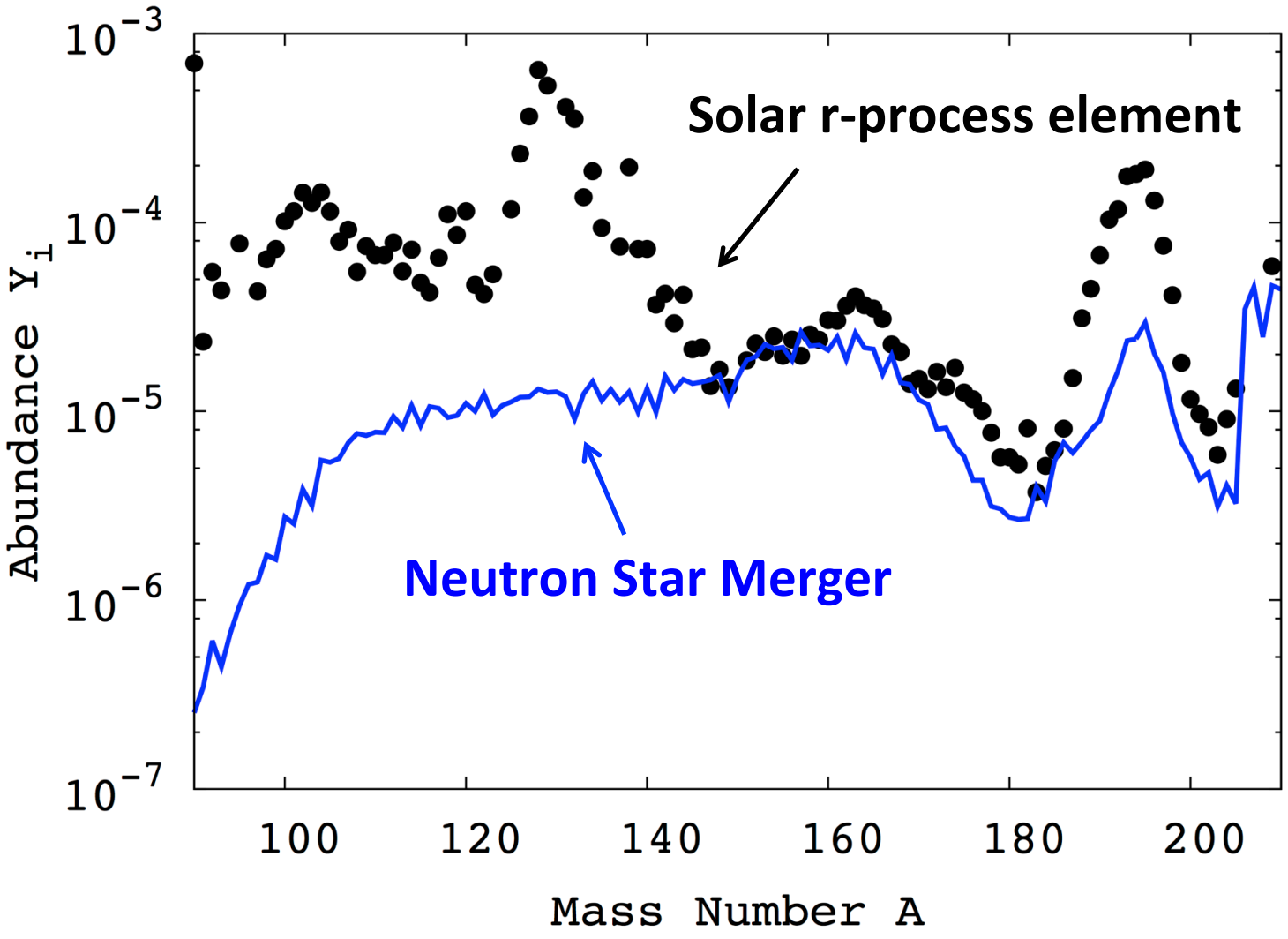
Abundance Evolution of Neutron Star Merger







Elemental Abundances of Neutron Star Merger



Summary

- We calculated r-process nucleosynthesis for the neutron star merger with new theoretical fission data.
- In the **neutron star merger**, the flat abundance pattern with 100<A<160 are produced by superposition of various **fission** fragment distributions.
- Contribution from ***Both*** **neutron star mergers** and **magnetorotational supernovae** can reproduce the abundance pattern of solar r-process elements.