# Some Future Perspectives

Anuj Parikh (TUM)

NuGrid collaboration, arXiv (NIC X proceedings, 2008)

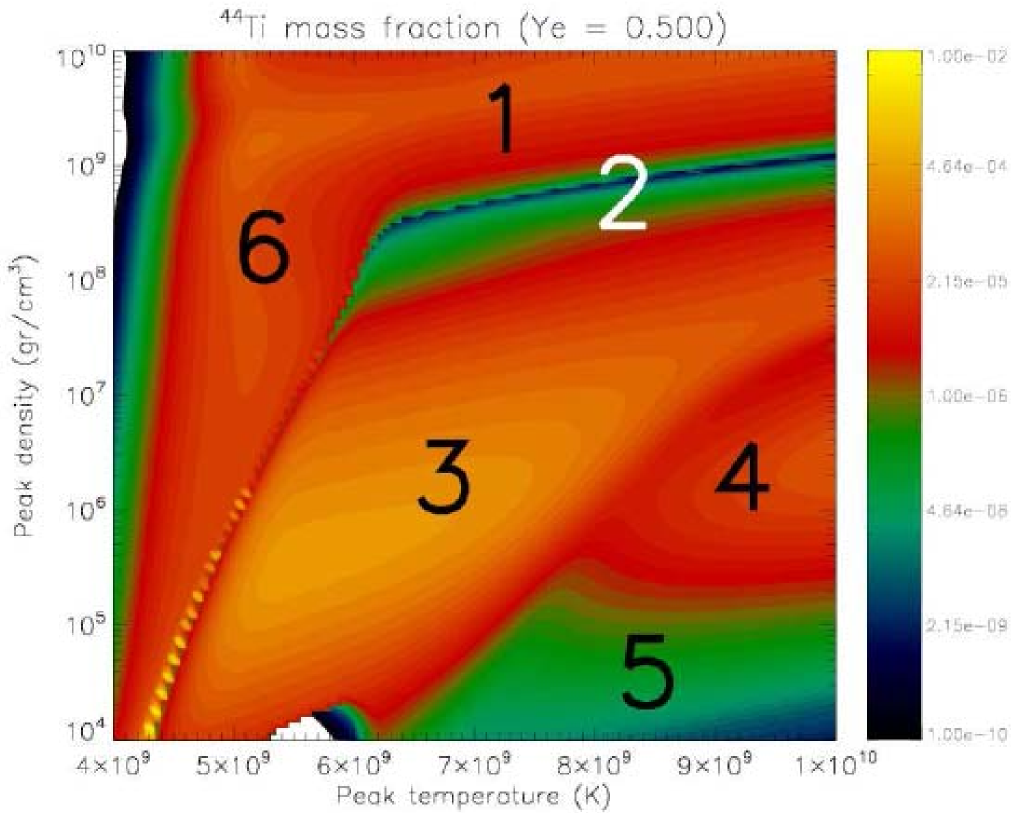


**Figure 1:** Contour plot of $^{44}$Ti final yields as a function of temperature and density for adiabatic expansions. The numbers signify the various regimes for $^{44}$Ti nucleosynthesis.

**"For each region only certain reactions affect the yields of $^{44}$Ti"**

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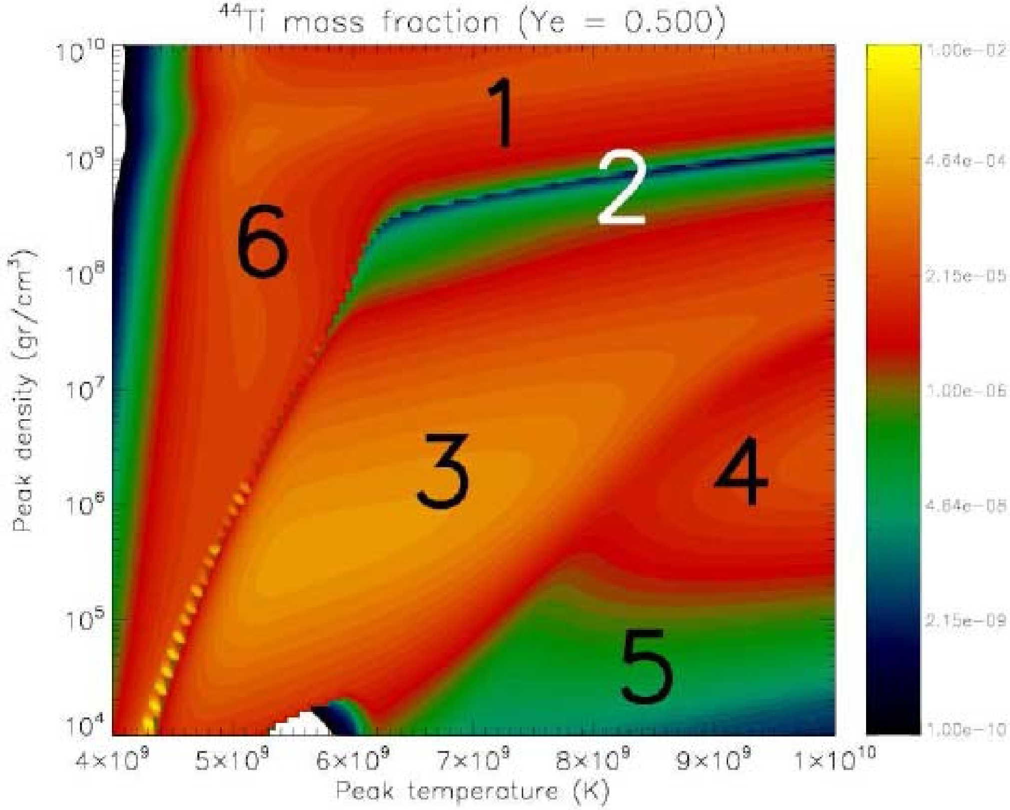


1. Fast freeze-out from NSE. Abundance largely determined from Q-values.
2. Chasm region: Passage from NSE to QSE. Reactions: $^{44}$Ti($\alpha$,p)$^{47}$V, $^{20}$Ne($\alpha$,p)$^{23}$Na, $^{21}$Na($\alpha$,p)$^{24}$Mg, $^{20}$Ne(p,$\gamma$)$^{21}$Na
3. Normal $\alpha$-rich freeze-out: $^{56}$Ni dominates. Reactions: $3\alpha \rightarrow {}^{12}$C, $^{44}$Ti($\alpha$,p)$^{47}$V, $^{20}$Ne($\alpha$,p)$^{23}$Na, $^{21}$Na($\alpha$,p)$^{24}$Mg, $^{45}$V(p,$\gamma$)$^{46}$Cr, $^{57}$Ni(p,$\gamma$)$^{58}$Cu
4. $\alpha$- and $p$-rich freeze-out. Reactions: $3\alpha \rightarrow {}^{12}$C, $^{45}$V(p,$\gamma$)$^{46}$Cr, $^{44}$Ti(p,$\gamma$)$^{45}$V, $^{41}$Sc(p,$\gamma$)$^{42}$Ti, $^{43}$Sc(p,$\gamma$)$^{44}$Ti, $^{40}$Ca(p,$\gamma$)$^{41}$Sc, $^{40}$Ca($\alpha$,p)$^{43}$Sc
5. Photodisintegration regime: n, p and $\alpha$ dominate
6. Incomplete silicon burning: $^{28}$Si rich

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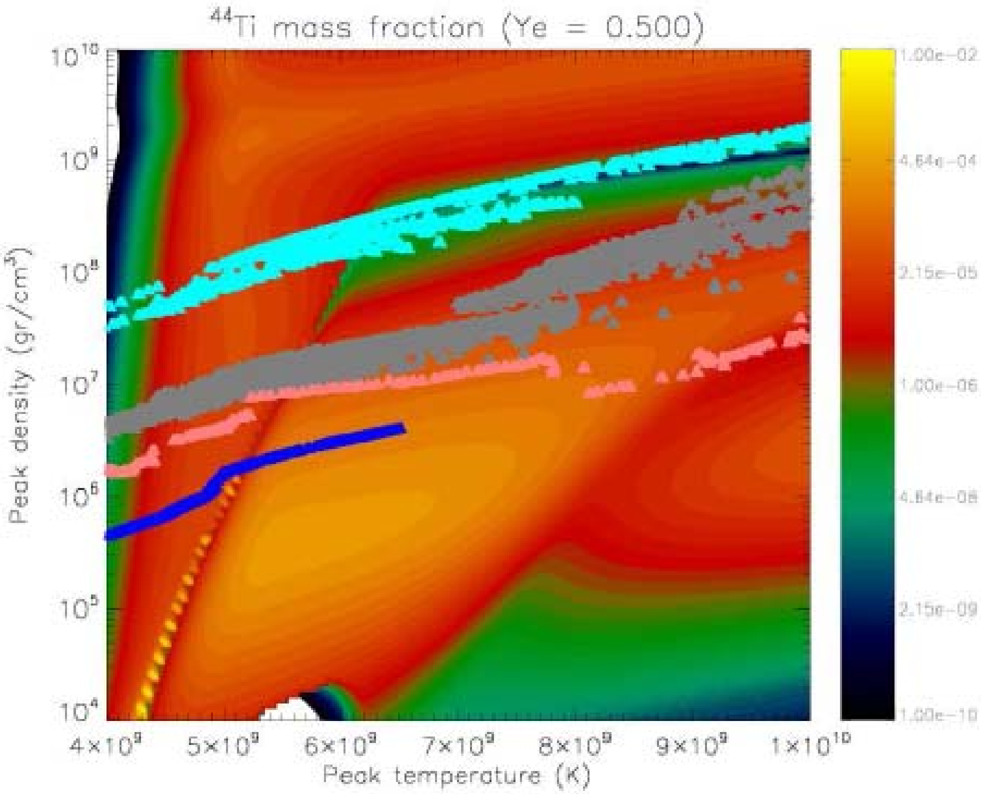


"The embedded points correspond to conditions met in supernovae simulations. The cyan ones are based on a rotating MHD star, the grey on a rotating 2D explosion model, the pink are for a gamma-ray burst model and the blue ones on a model specifically for Cassiopeia A."

"Points from multi-dimensional supernova simulations suggest that ccSN may populate the region of parameter space where very little $^{44}$Ti is produced."

The reaction that accounts for most of the "chasm's location" is **$^{44}$Ti(a,p)$^{47}$V**

(Multi-D models use artificial energy injection in the convective region until shock moves > 1000 km)

## Question: $^{44}$Ti production... solutions?

Examining **N**ucleosynthesis in **A**lpha-**R**ich **F**reeze-outs with

→ improved astrophysics

→ updated nuclear physics

→ latest observations

Excellence Cluster Universe

Visitor with the Excellence Cluster (May/June 2008)

**2008: NARF collaboration!** Diehl (MPE), Janka (MPA), Krücken (TUM), Parikh (TUM), The (Clemson)

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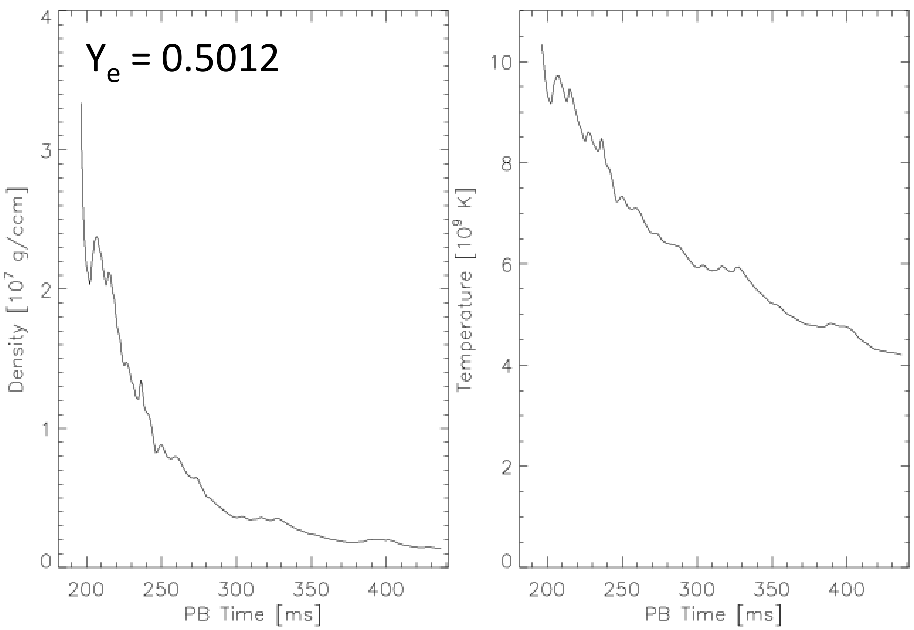


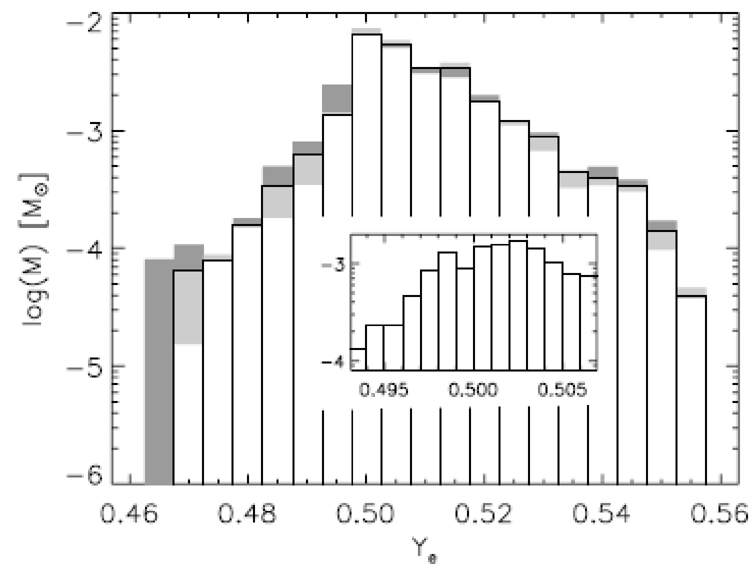


Based on 2-D 15 $M_{sol}$ $\nu$-driven explosion model

Janka et al. 2003, 2004; Pruet et al. 2005

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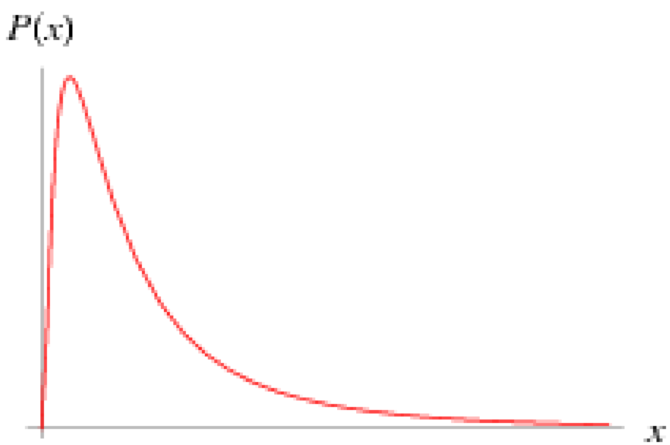


Network: H – Zr, REACLIB+ (JINA)

Updated experimental rates with T-dependent $\Delta$ when possible

Impact of correlated rate uncertainties on final ARF yields through MC treatment (log-normal distributions)

Impact of individual rates

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Excellence Cluster Universe

3000 CPU Condor cluster @ Clemson

Tests with RZG

Rechenzentrum Garching

Max-Planck-Gesellschaft & IPP

Effects of using different networks
(400 isotopes: The et al. 1998 ;
2000 isotopes: Pruet et al. 2005)

Different e- screening prescriptions

2 extrapolations of trajectories to lower T

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