PRINCETON UNIVERSITY

Nucleosynthetic Analysis of Long-term 3D CCSN Simulations

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in representation of the Princeton CCSN group

A Zoo of CCSN Progenitors

Trends + Randomness:

Low mass: steeper, weaker interfaces

High mass: shallower, stronger interfaces

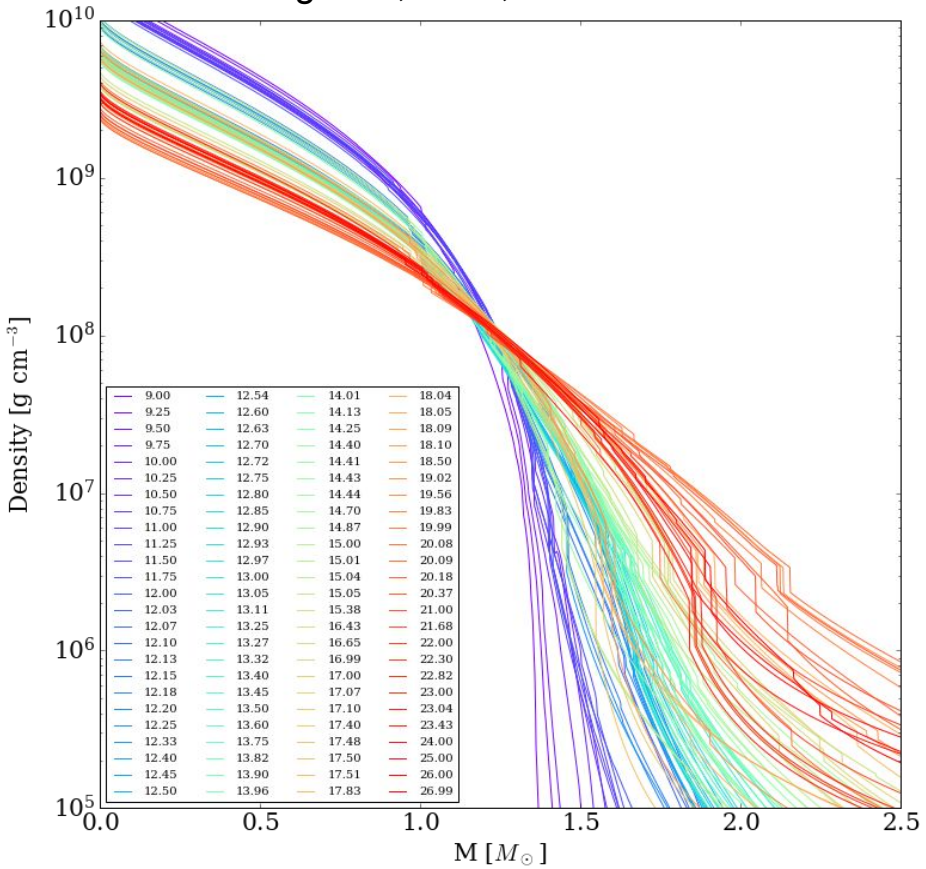
Carbon shell burning can be chaotic.

With a large variety of progenitors:

Which findings are common?

Which are model dependent?

Wang et al, 2022, arxiv:2207.02231



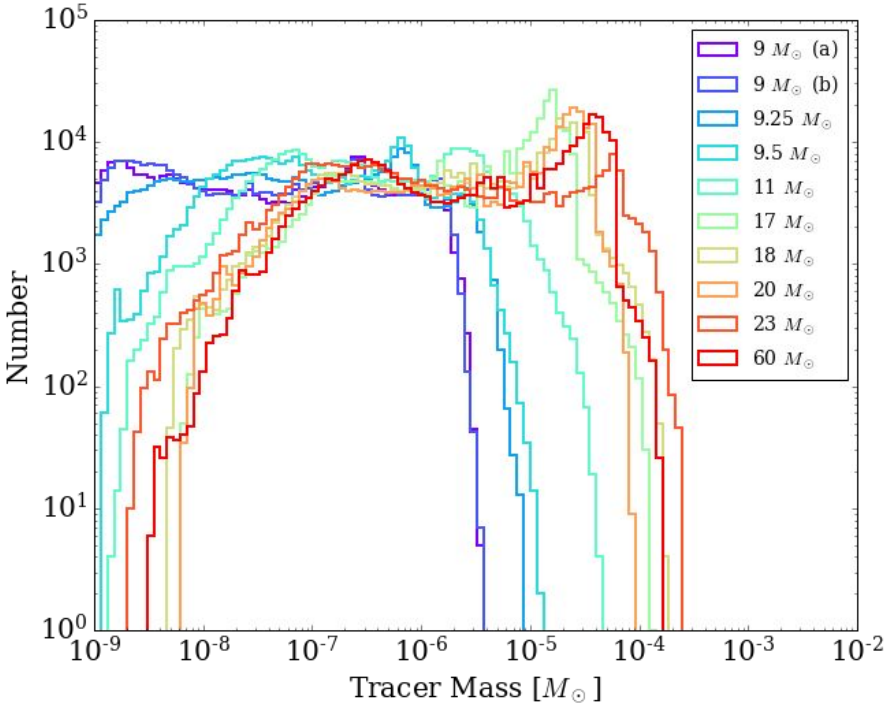
Dataset and Method

~70 3D CCSN simulations by Fornax:

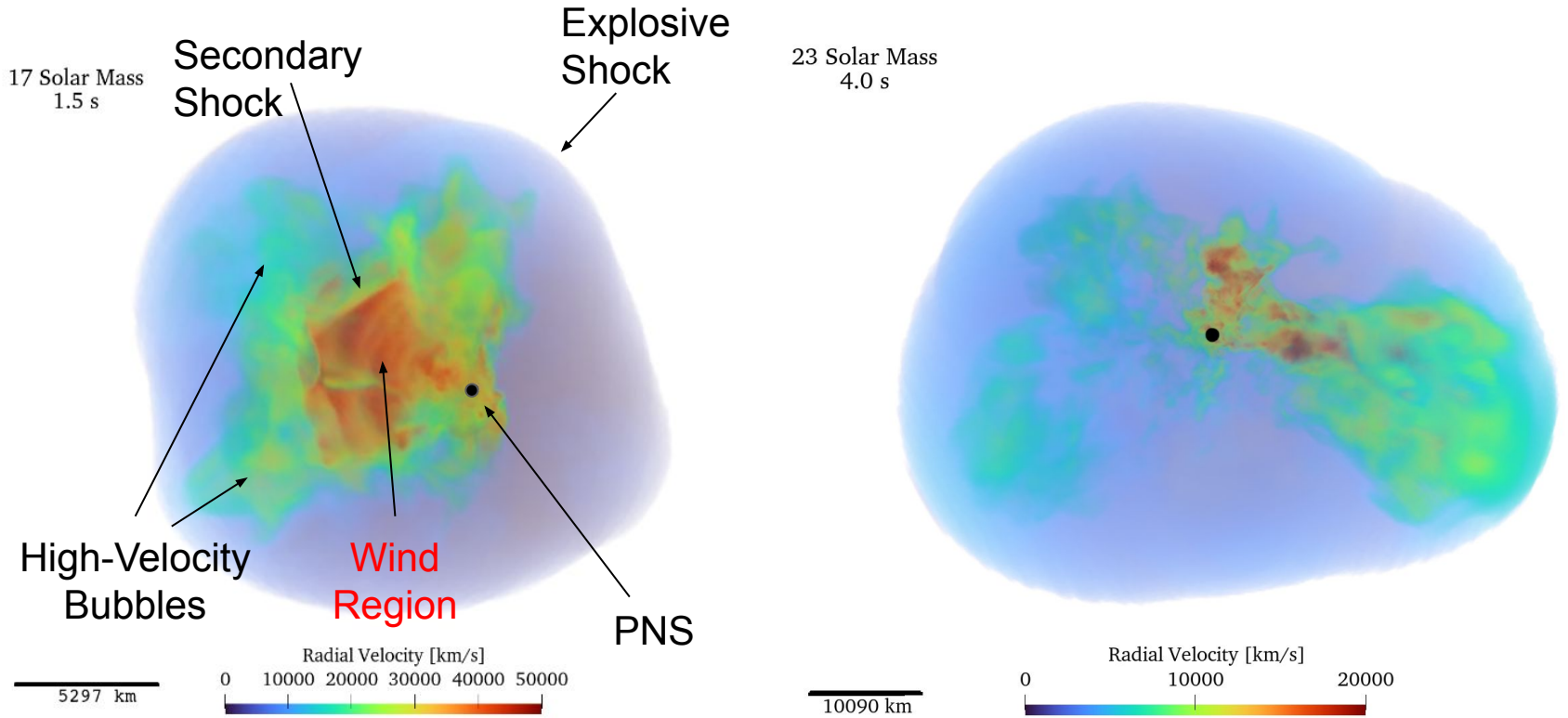
- > 2s: 20 models, > 4s: 6 models. They're still continuing.
- ~300k post-processed backward integrated tracers per model.

Nucleosynthesis:

- SkyNet.
- NSE set at T=0.6 MeV (~7GK).

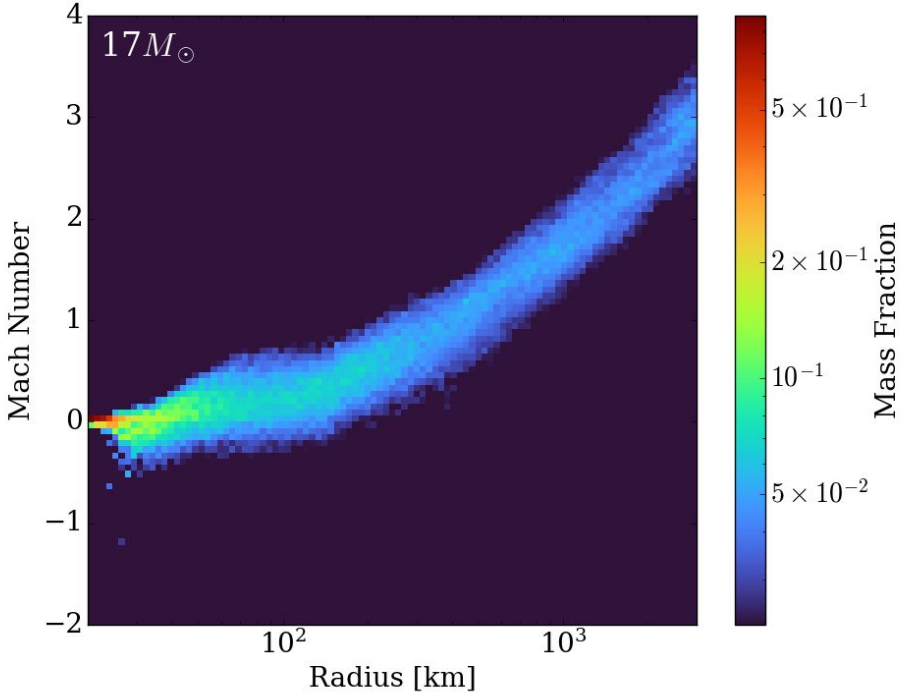


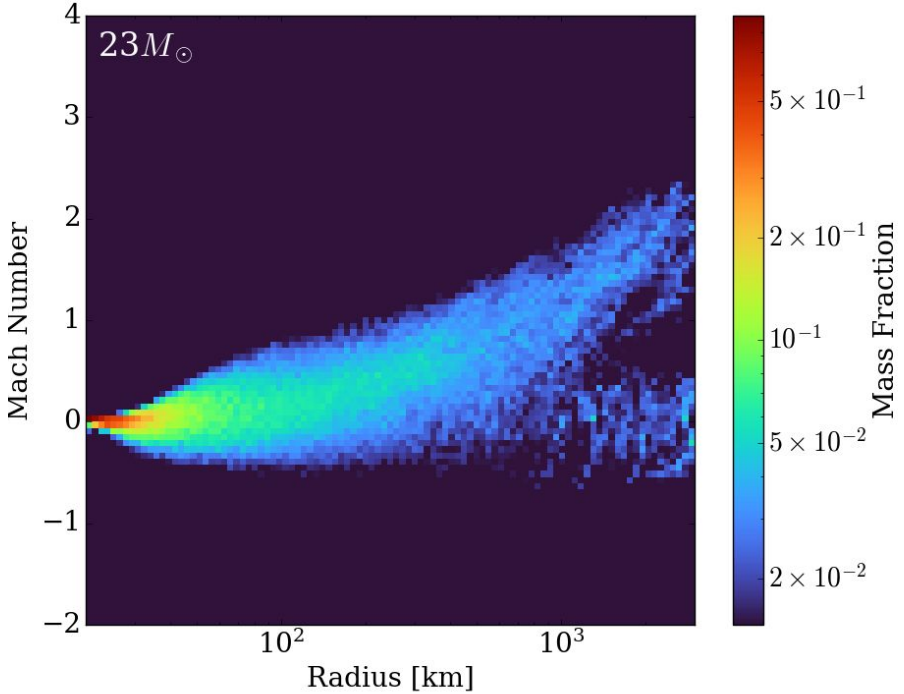
Structures in Explosion



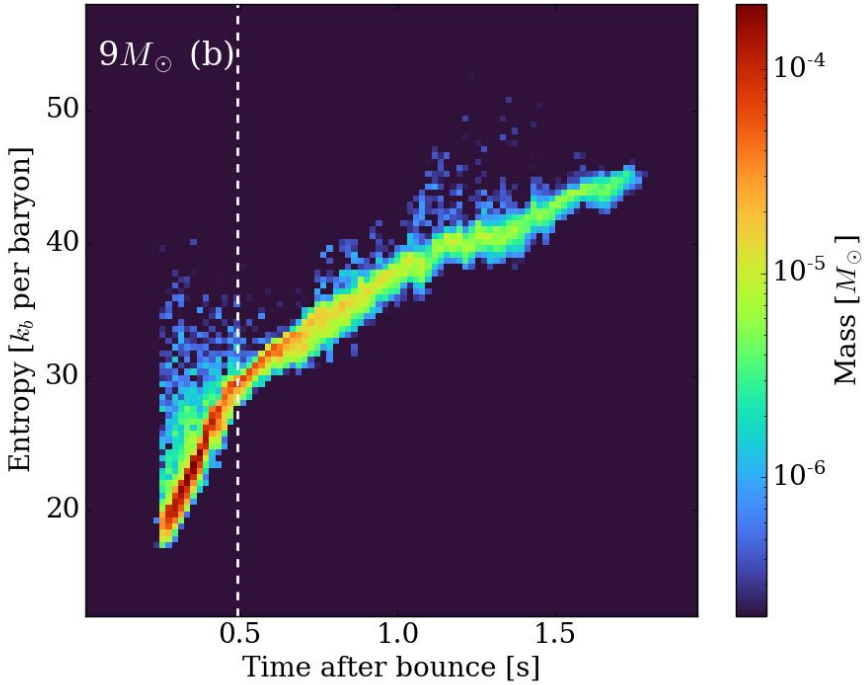
Wang et al, 2023, arxiv:2306.13712

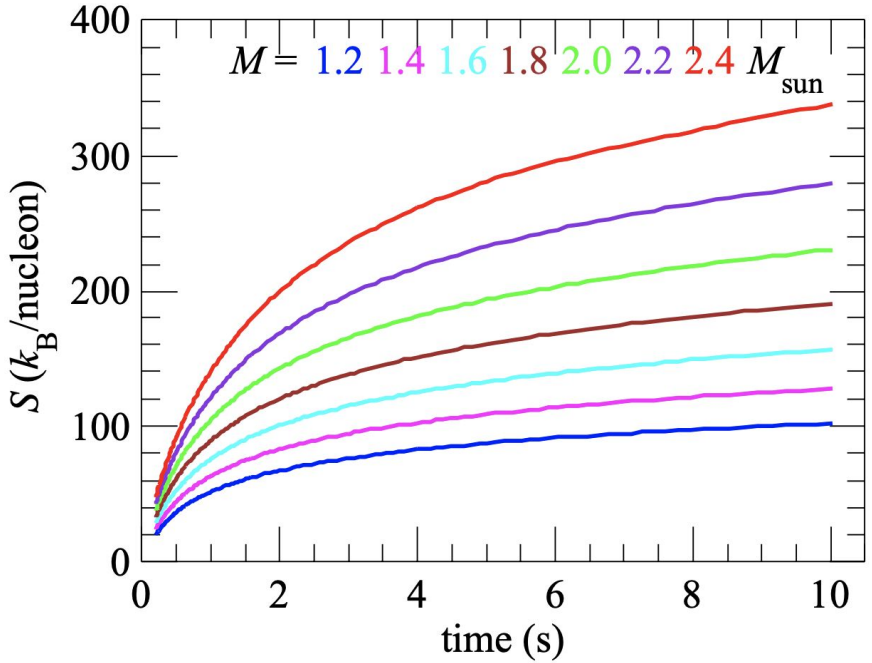
Neutrino-Driven Winds: Tracer Results





S vs Time: Explosion-Wind Transition





Wanajo 2013, Wanajo 2023

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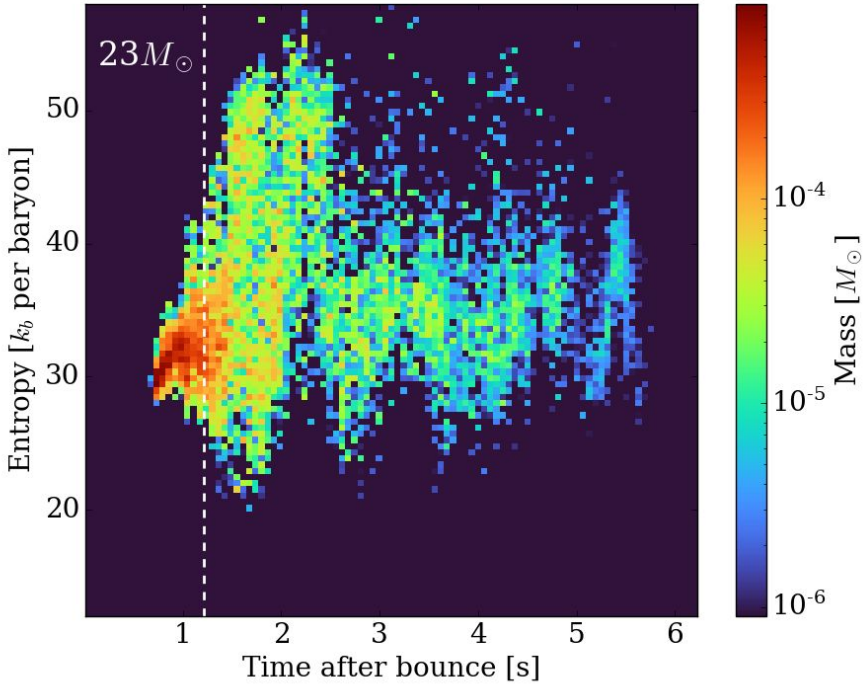
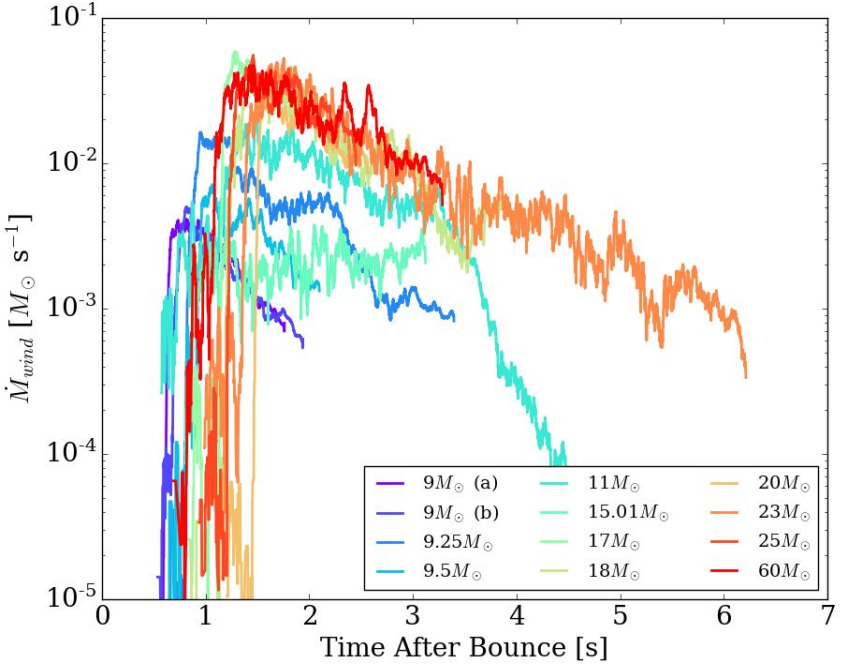
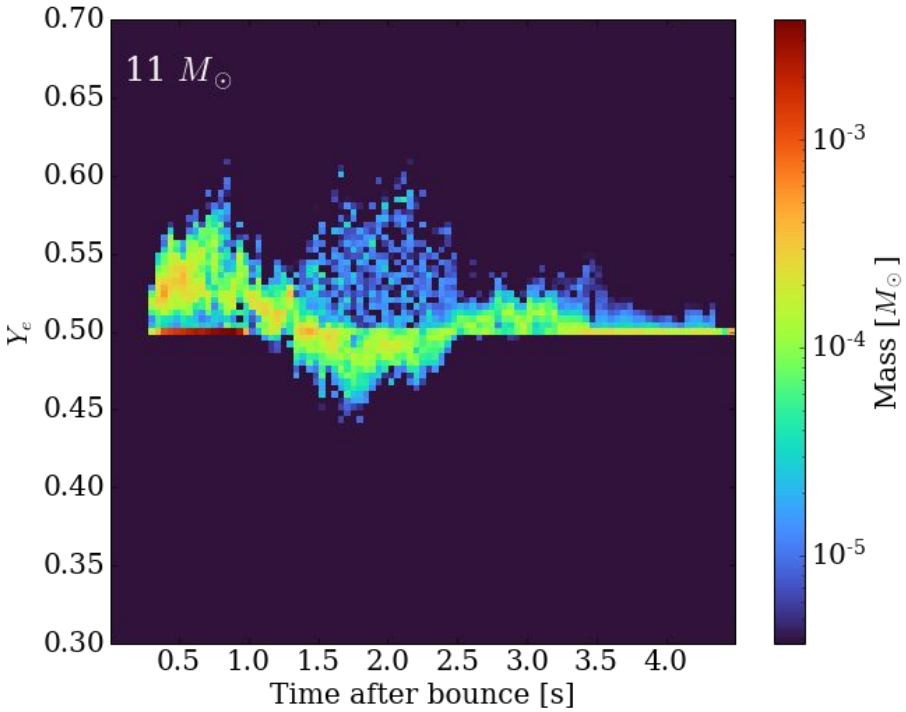
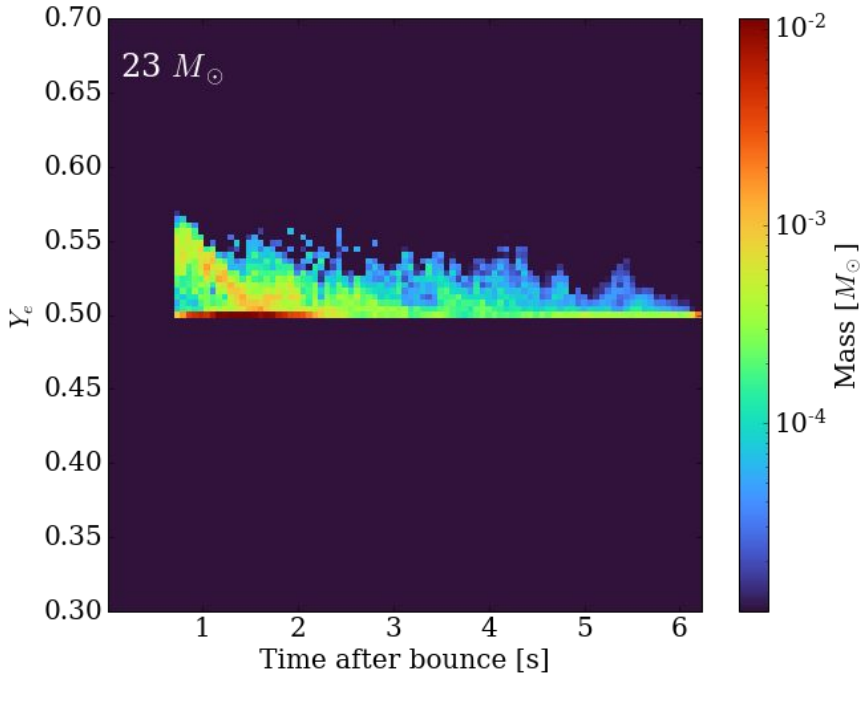




Ye vs Time (Explosion+Wind)





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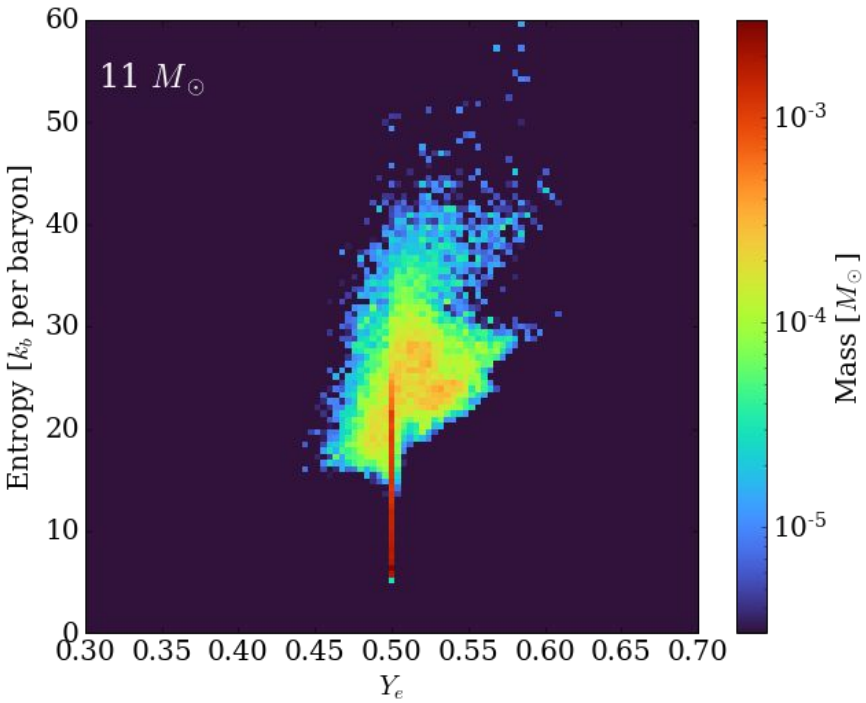
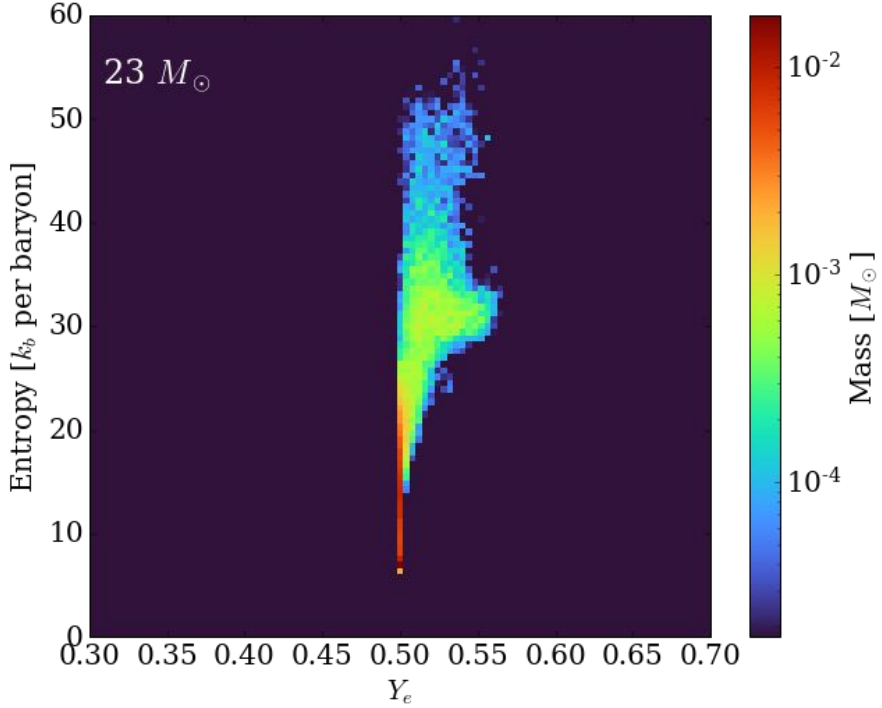
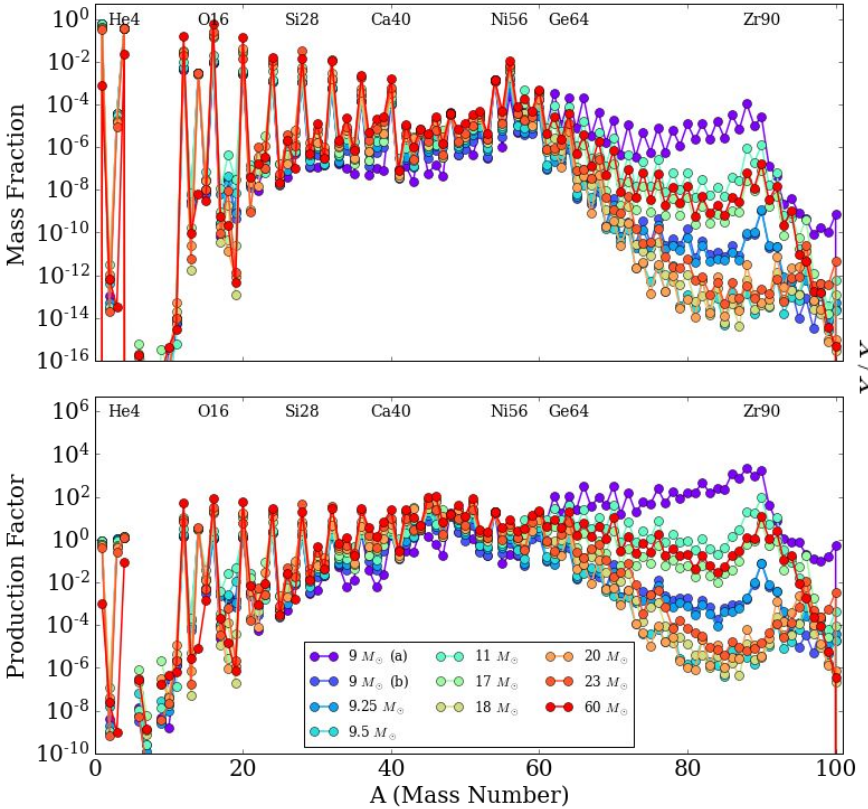
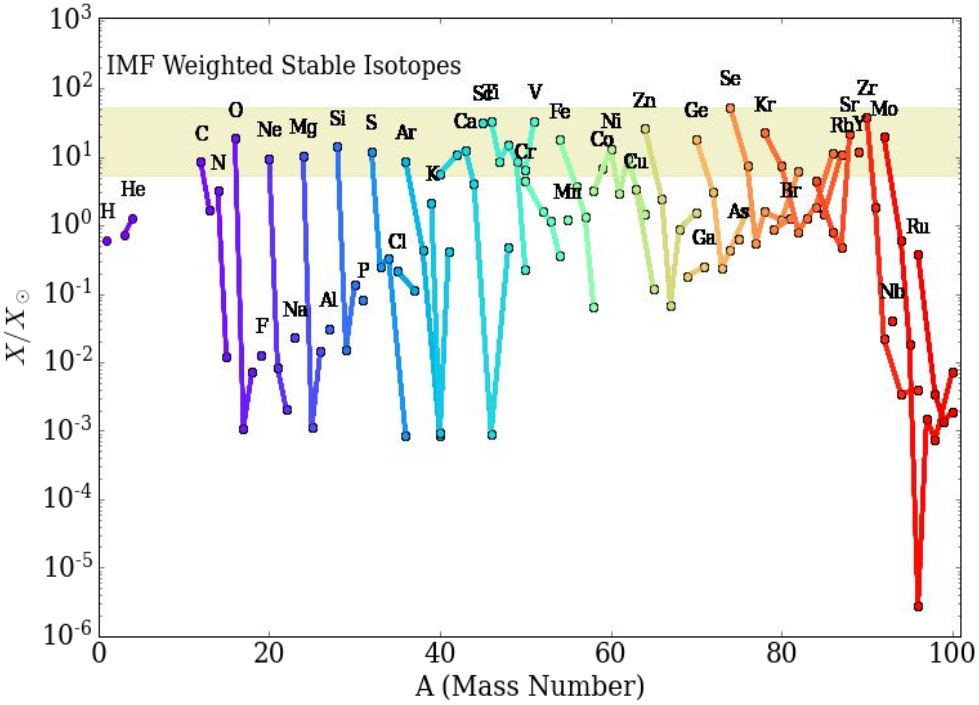


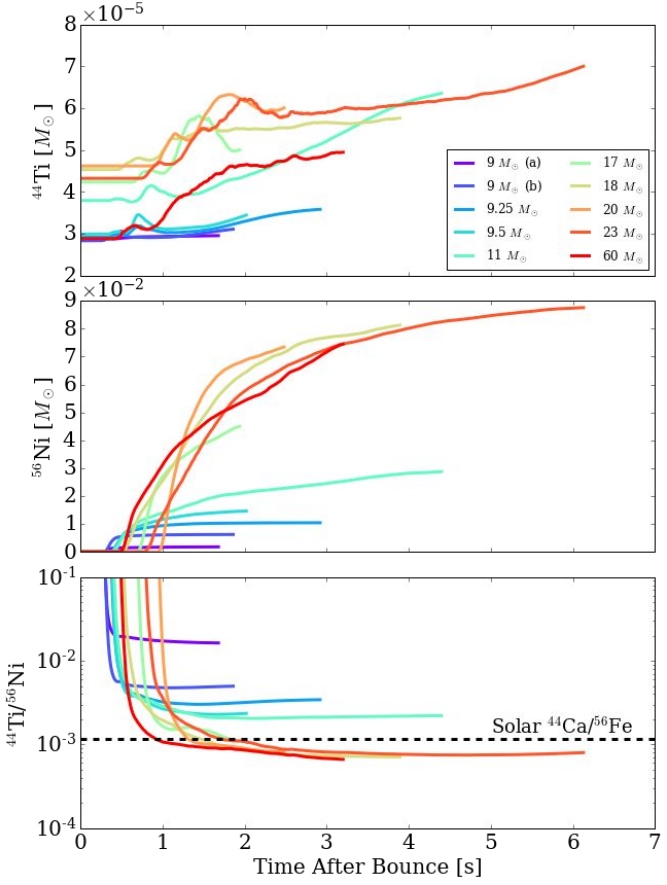


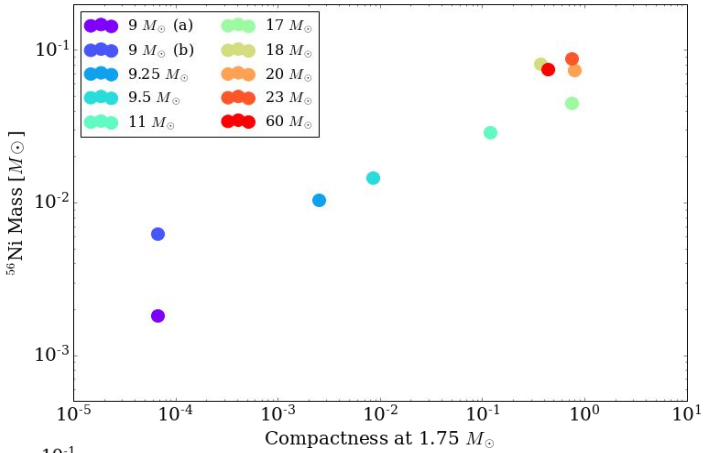
Overall Yield (With Outer Envelopes)

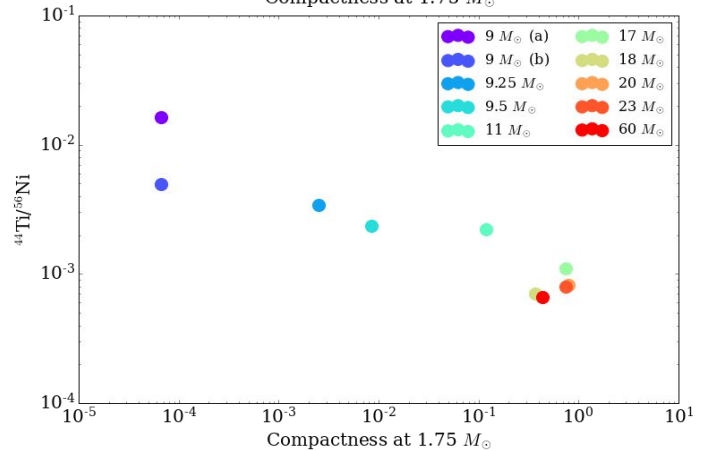




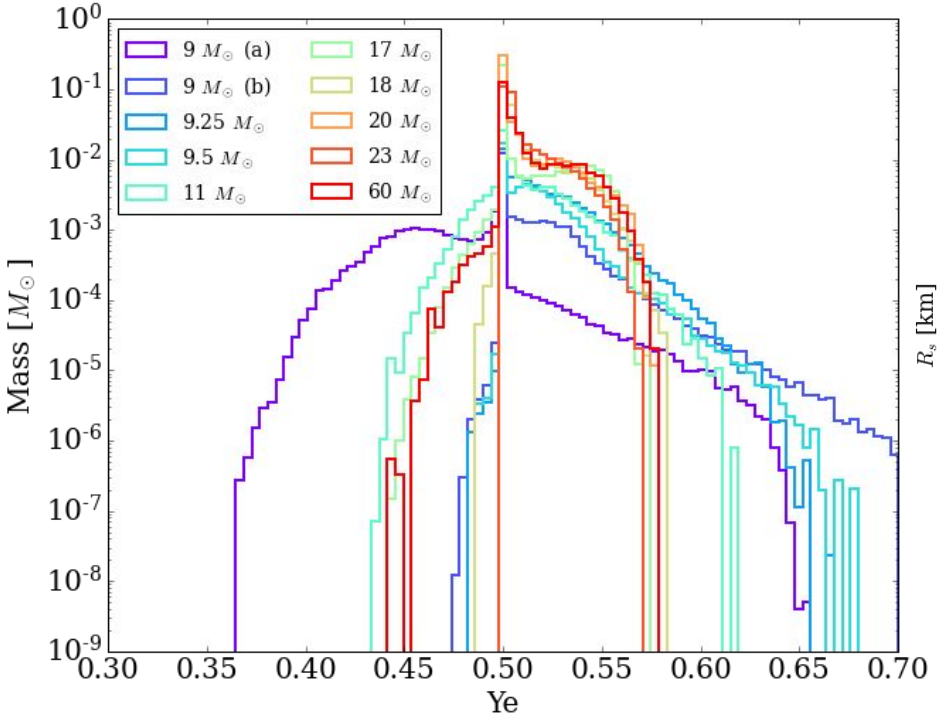
Ti44 and Ni56

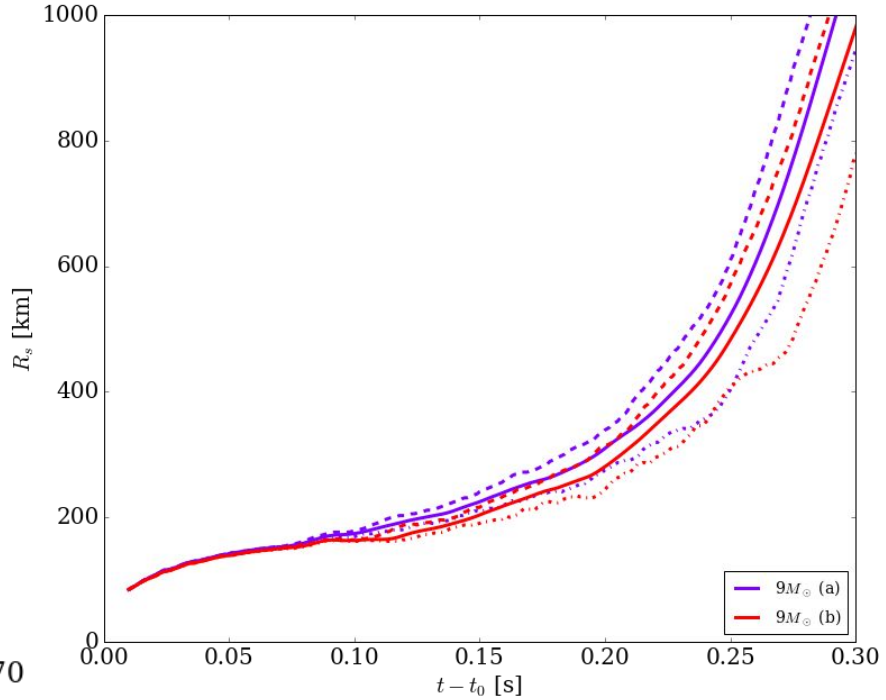






Influence of Initial Perturbation





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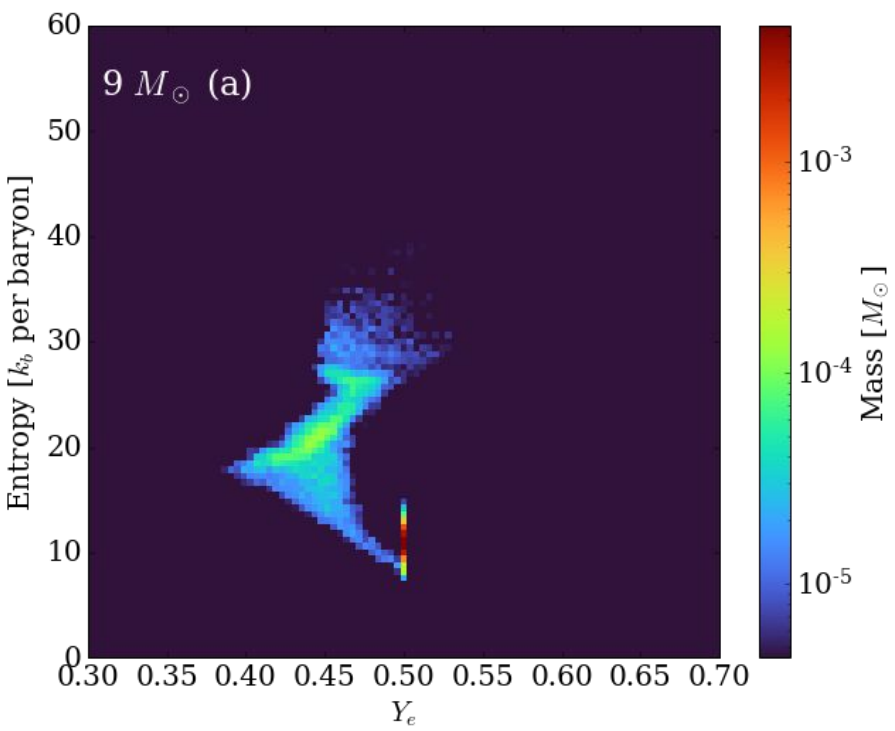

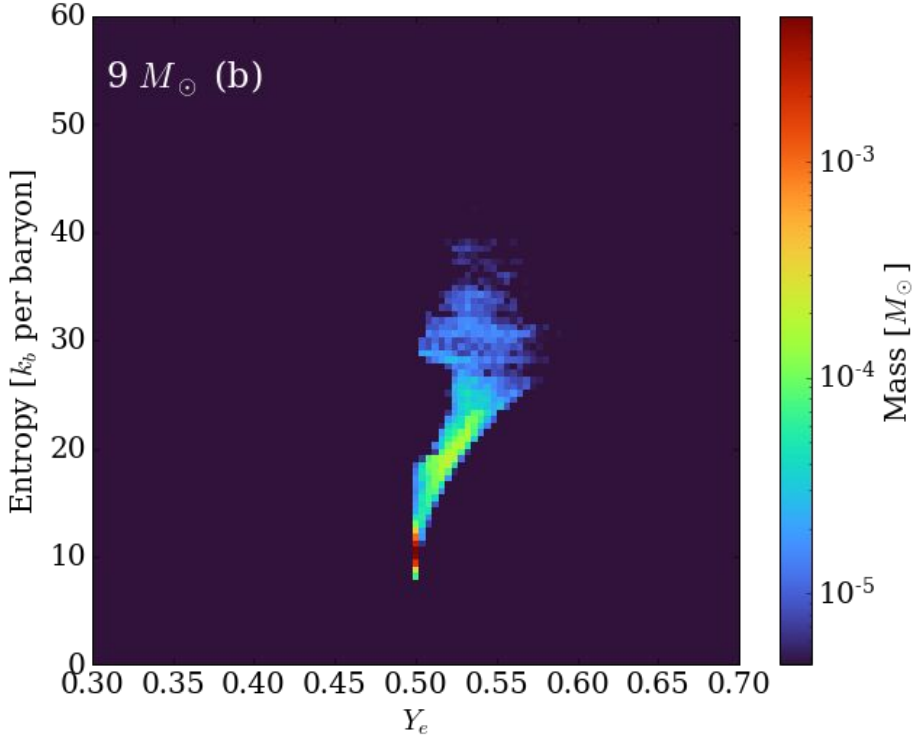

Summary

Neutrino-driven wind:

- Seen in all models, aspherical. Dynamically similar to 1D, thermally different.
- Weak r-process can occur in neutron-rich period.

Nucleosynthesis:

- Long-term simulations are required to predict yield (ti44, ni56, etc), especially more massive progenitors.
- Models explode early seem to be more sensitive to initial perturbations.