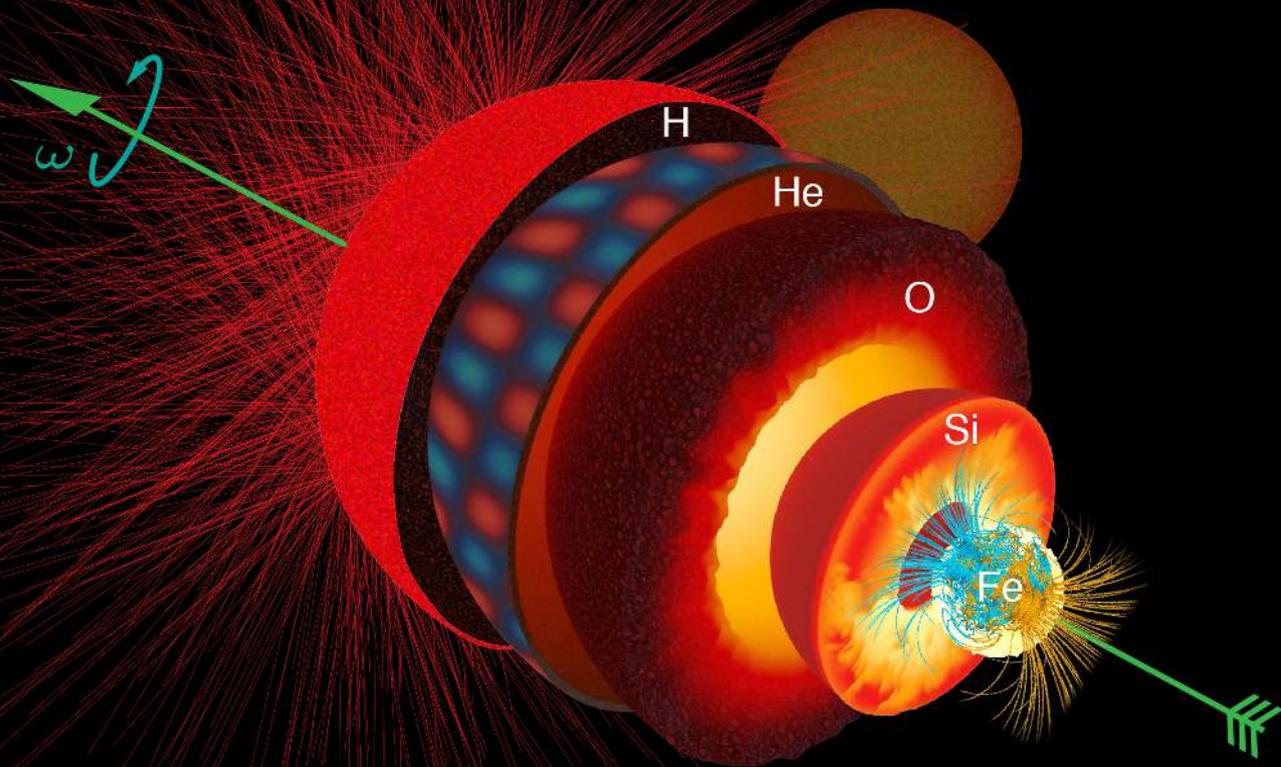
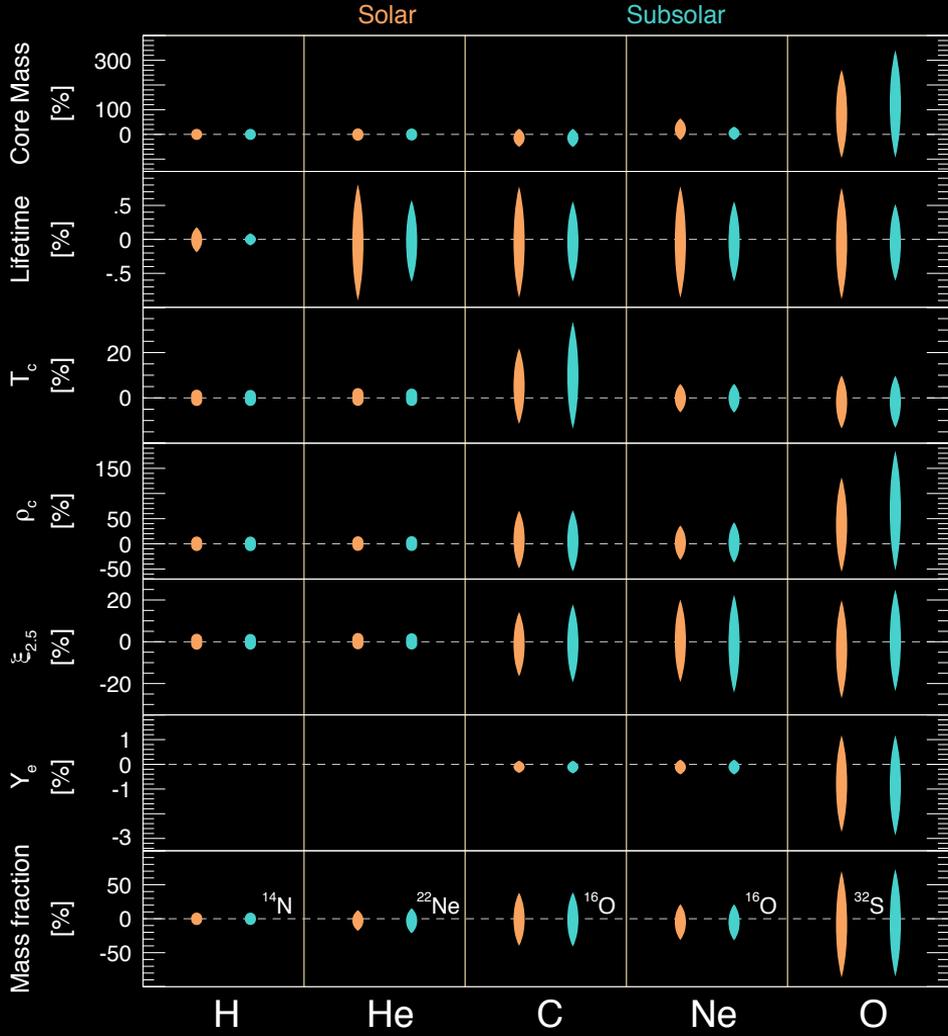


# MA1: Stars and Stellar Explosion Models







Fields et al 2018,  
1000 MESA  
Monte Carlo  
models

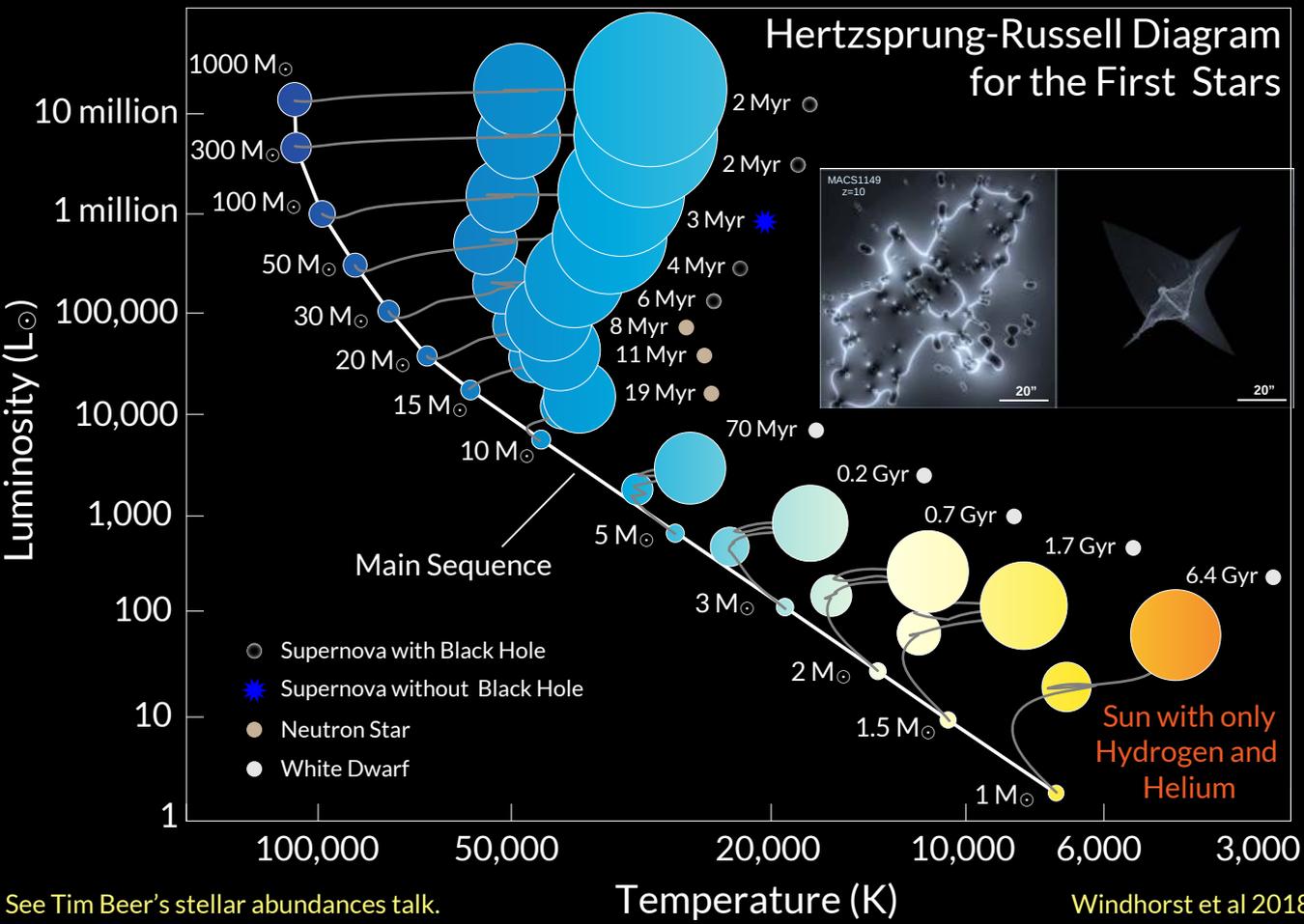
See Michael  
Wiescher's talk,  
especially on  
 $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$

See Benoit  
Côté's talk on  
chemical  
evolution.

$$\sum \delta = ?$$

Property	15 M <sub>⊙</sub>		20 M <sub>⊙</sub>	
	$\dot{M} = 0$	$\dot{M} \neq 0$	$\dot{M} = 0$	$\dot{M} \neq 0$
He <sub>core</sub> [M <sub>⊙</sub> ] <sup>a,b</sup>	2.82 <sup>2.82</sup> <sub>2.79</sub>	2.77 <sup>2.78</sup> <sub>2.72</sub>	4.67 <sup>4.70</sup> <sub>4.59</sub>	4.
C <sub>core</sub> [M <sub>⊙</sub> ]	2.51 <sup>2.58</sup> <sub>2.49</sub>	2.44 <sup>2.53</sup> <sub>2.43</sub>	4.19 <sup>4.75</sup> <sub>4.04</sub>	4.
O <sub>core</sub> [M <sub>⊙</sub> ]	1.41 <sup>1.43</sup> <sub>1.35</sub>	1.40 <sup>1.42</sup> <sub>1.32</sub>	1.54 <sup>2.47</sup> <sub>1.43</sub>	1.
Si <sub>core</sub> [M <sub>⊙</sub> ]	1.15 <sup>1.38</sup> <sub>1.02</sub>	1.15 <sup>1.39</sup> <sub>1.08</sub>	1.38 <sup>1.65</sup> <sub>1.30</sub>	1.
Y <sub>e,c,He</sub> <sup>b</sup>	0.505 <sup>0.505</sup> <sub>0.505</sub>	0.505 <sup>0.505</sup> <sub>0.505</sub>	0.505 <sup>0.505</sup> <sub>0.505</sub>	0.
Y <sub>e,c,C</sub>	0.499 <sup>0.500</sup> <sub>0.499</sub>	0.499 <sup>0.500</sup> <sub>0.499</sub>	0.499 <sup>0.500</sup> <sub>0.499</sub>	0.
Y <sub>e,c,O</sub>	0.499 <sup>0.500</sup> <sub>0.498</sub>	0.499 <sup>0.500</sup> <sub>0.498</sub>	0.499 <sup>0.500</sup> <sub>0.498</sub>	0.
Y <sub>e,c,Si</sub>	0.486 <sup>0.498</sup> <sub>0.475</sub>	0.486 <sup>0.498</sup> <sub>0.475</sub>	0.488 <sup>0.498</sup> <sub>0.483</sub>	0.

We don't know the full answer yet,  
but we have useful partial answers.

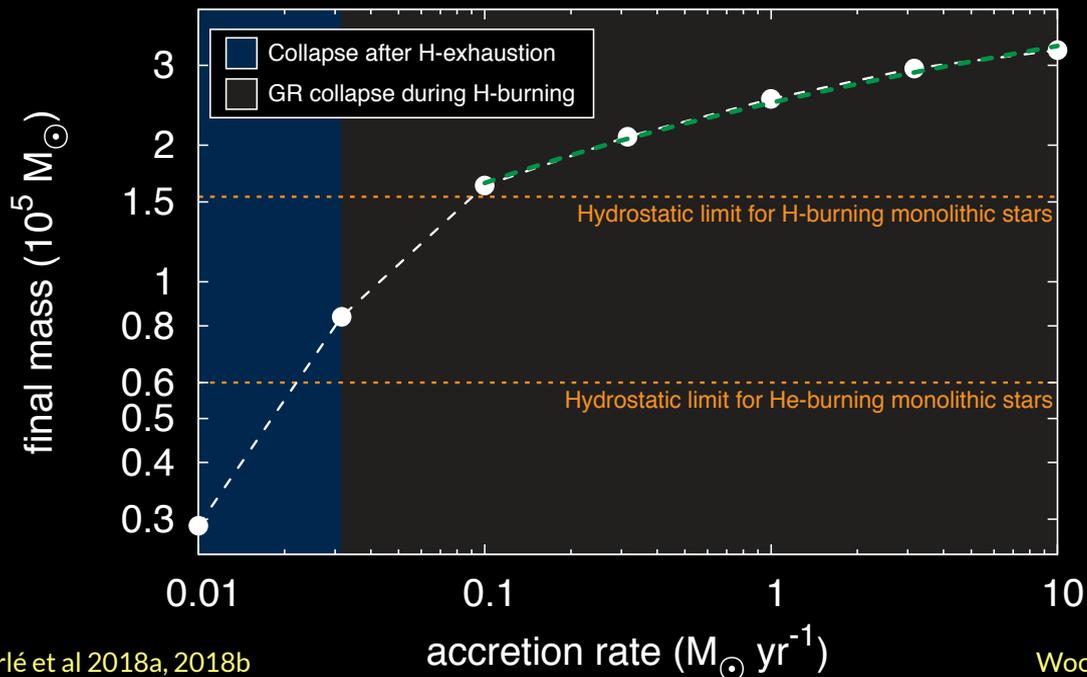


# TITANS

## OF THE EARLY UNIVERSE

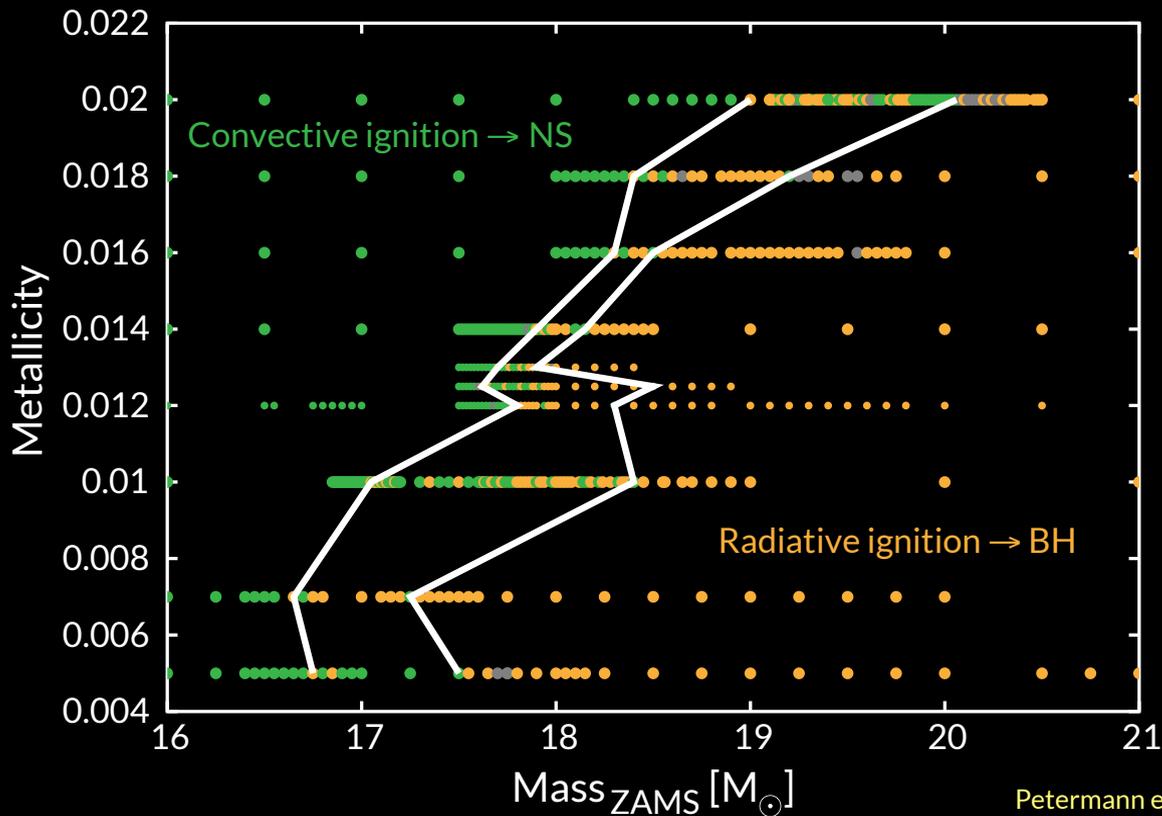
THE ORIGIN OF THE FIRST SUPERMASSIVE BLACK HOLES

MONASH UNIVERSITY PRATO CENTRE, ITALY • 20–24 NOVEMBER 2017



# Carbon ignition

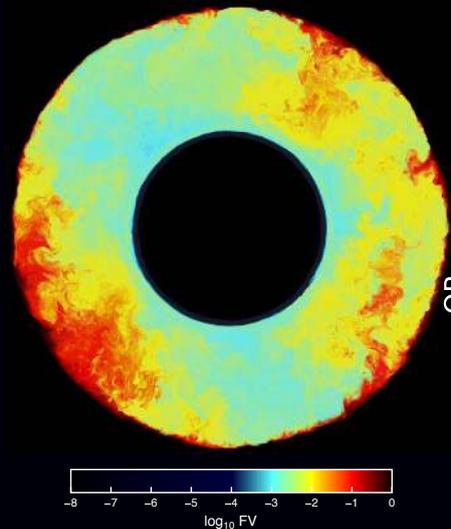
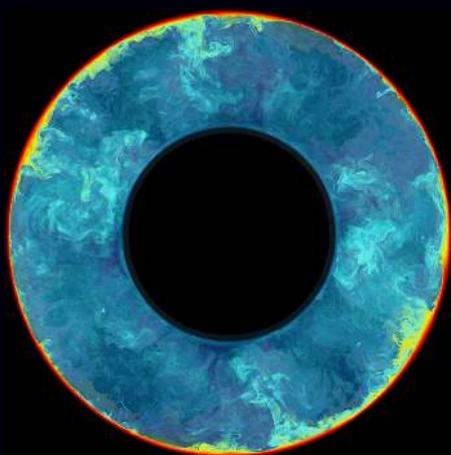
Impacts the LIGO/GAIA derived compact object initial mass function.



# Oxygen-carbon shell mergers

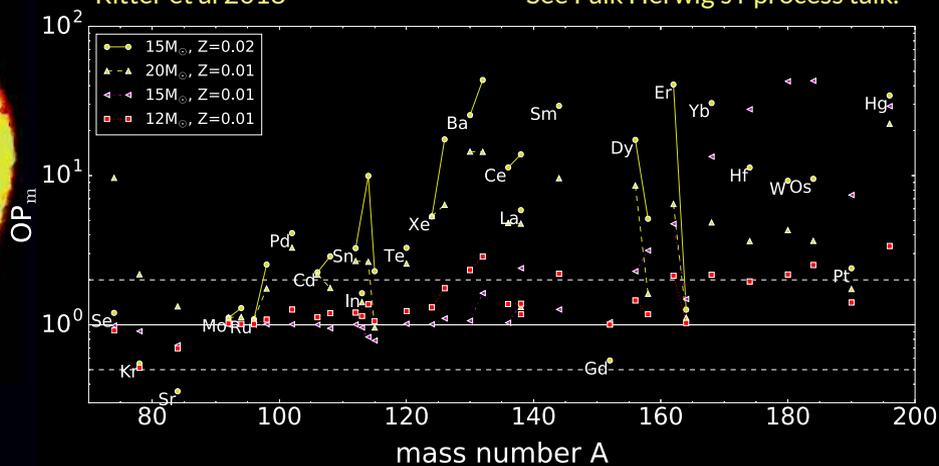
3D hydro simulation →  
1D diffusion coefficient →  
post-processing of stellar models →  
galactic chemical evolution.

O-shell ingestion events can be a robust  
site for P, Cl, K, Sc and p-process species.



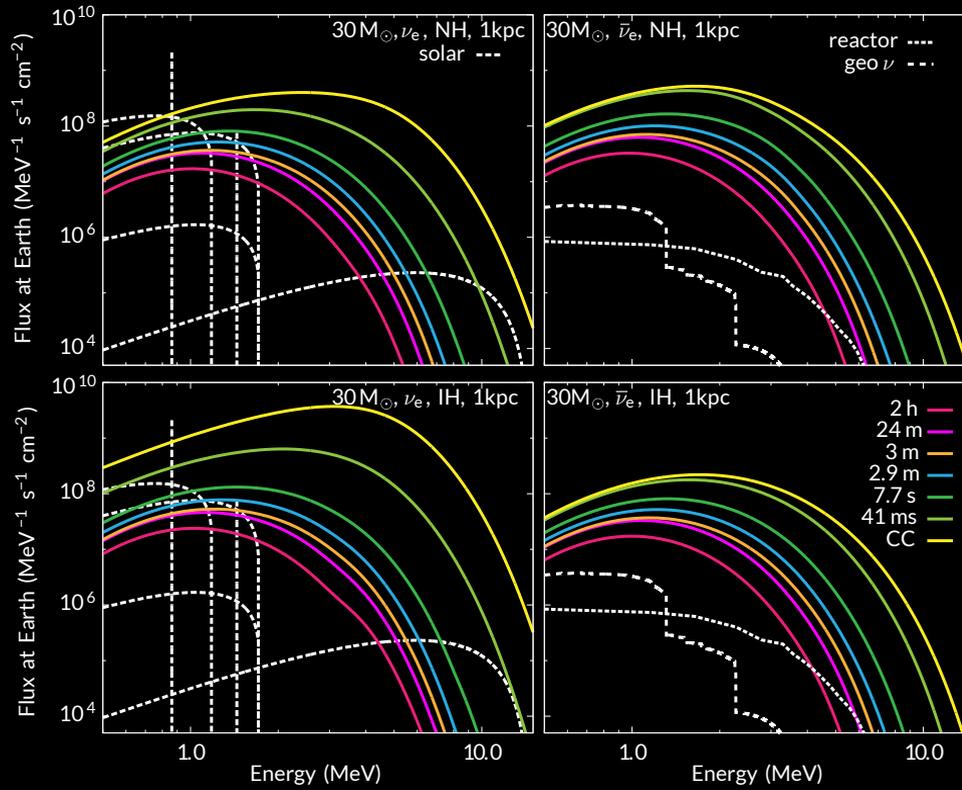
Ritter et al 2018

See Falk Herwig's i-process talk.



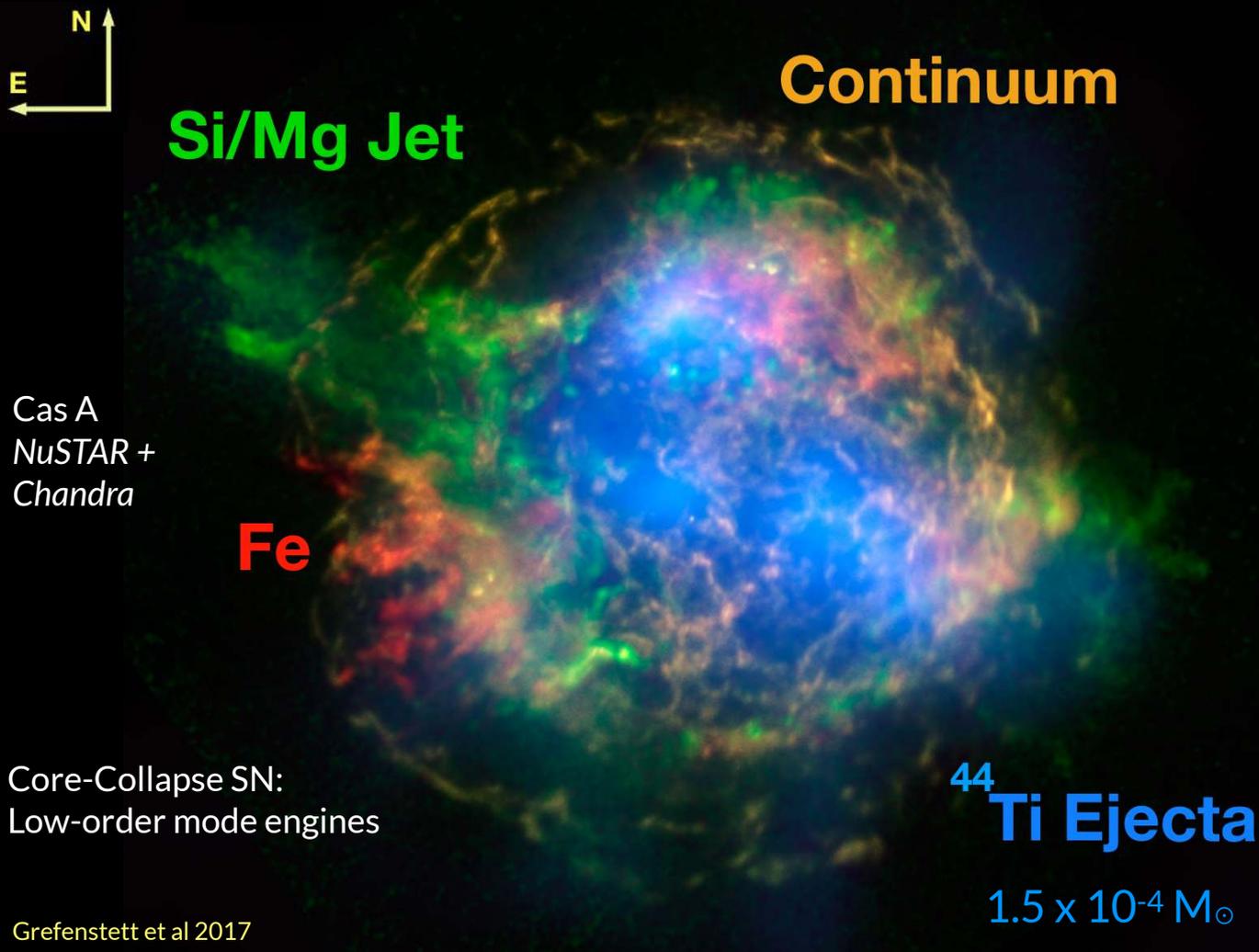
# Probing the isotopic evolution

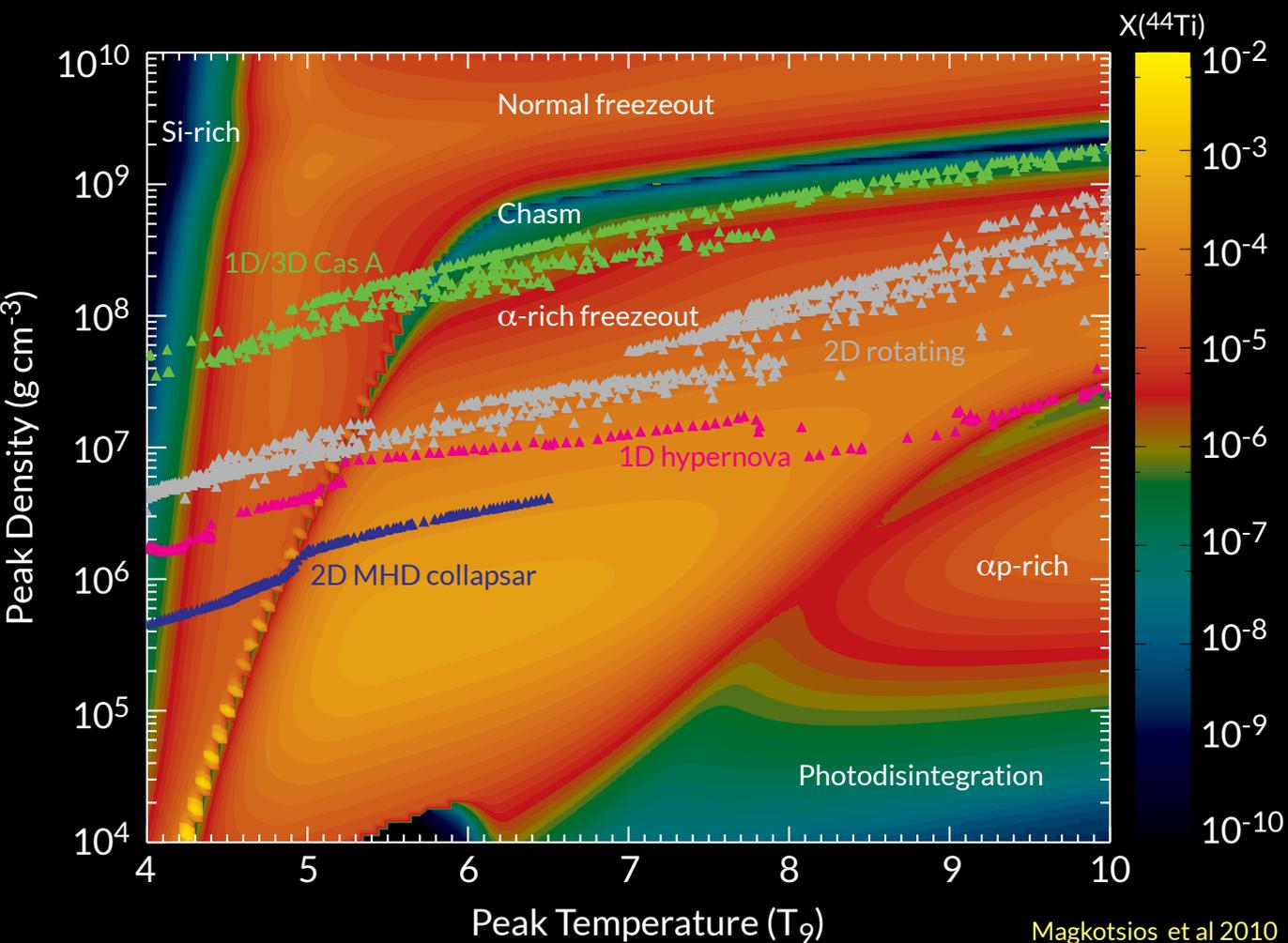
A ~20 kt liquid scintillator detector would typically observe ~10's of  $\nu$  in the final hours of a star's life at 1 kpc, with ~30% from  $\beta$  processes.



Patton et al 2017

AAS Journal  
highlight  
publication on  
20Apr2018.

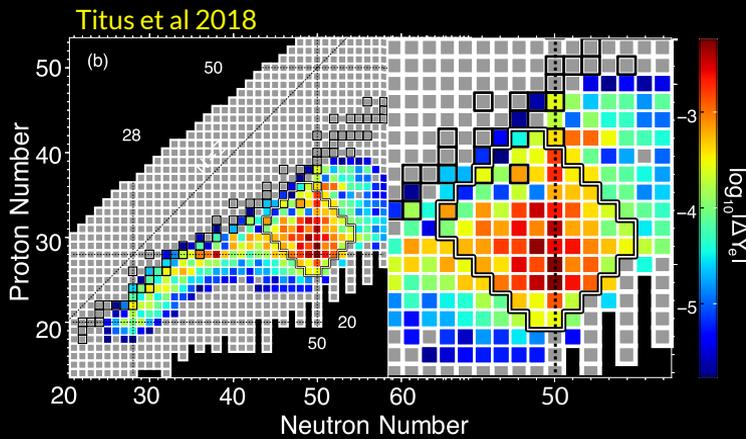
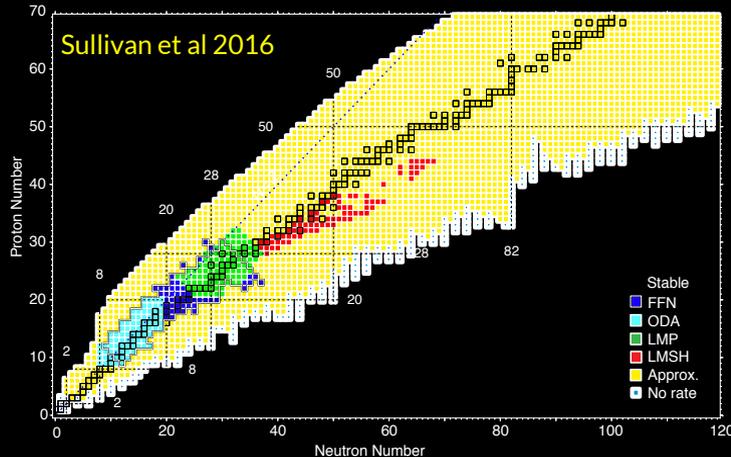




# Electron-captures in supernovae

A JINA-CEE led, comprehensive library of weak reaction rates for astrophysical models.

~70 nuclei in the diamond-shaped region at  $N \sim 50$  are drivers for changes in the  $p/n$  ratio during core-collapse. New experimental efforts are aimed at these nuclei.

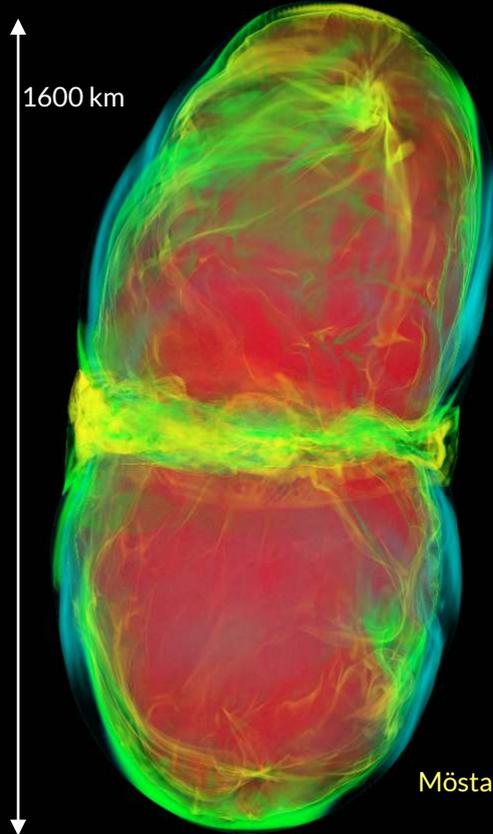


See Fernando Montes's radioactive ion beam talk.

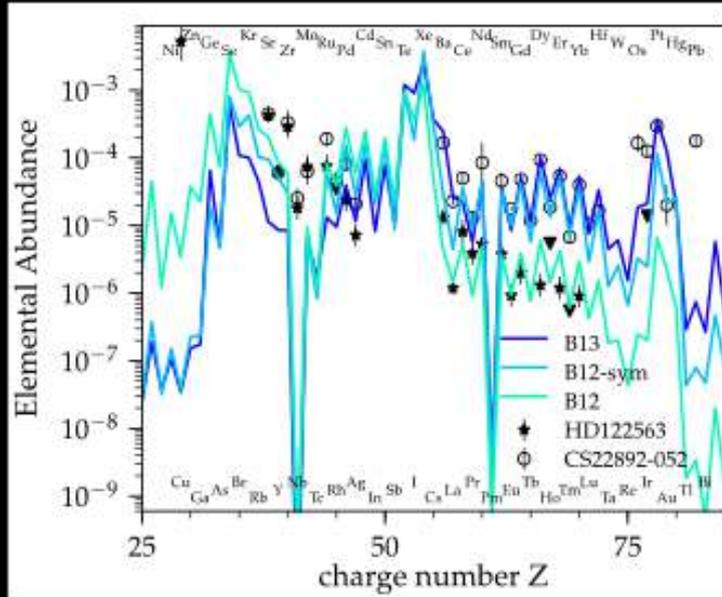
See Sanjay Reddy's dense matter physics talk.

# R-process in jet driven supernovae

Kink unstable 3D models predict the third r-process peak is under produced.



Mösta, Roberts, et al. 2018

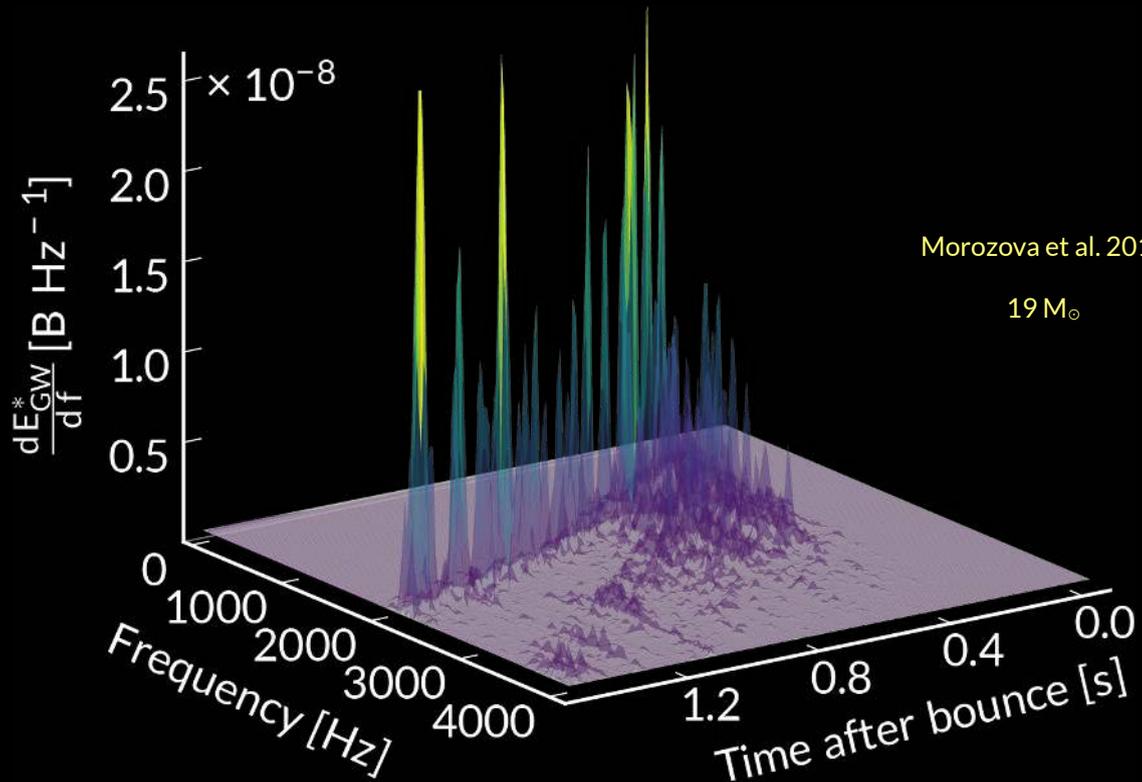


See Ani Aprahamian's r-process talk.

See Anna Frebel's r-process talk.

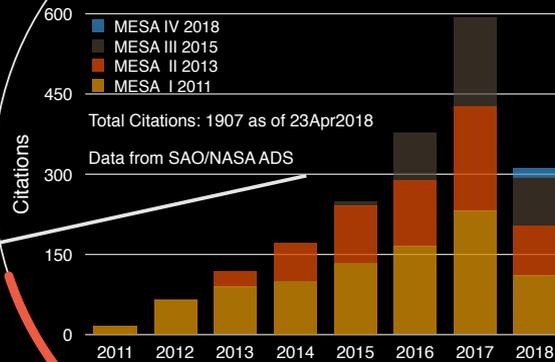
# Gravitational wave signals from supernovae

Between  $\sim 200$  and  $\sim 400$  ms after bounce, the GW signal represents a g-mode. After  $\sim 400$  ms the dominant GW signal is the quadrupole oscillation ( $l = 2$ , f-mode). High-frequency noise in GW spectrograms above the main signal are p-modes.



# Larger Science Community

## MESA



Influence  
Radius  $\approx 10$

Citations: 1,907

Citations to papers  
that cite MESA: 19,014

MESA I : Top 10 - 2011  
MESA II : Top 15 - 2013  
MESA III: Top 10 - 2015  
MESA IV: Top 50 - 2018

# Critical community-driven software and data infrastructure for NSF and NASA science.

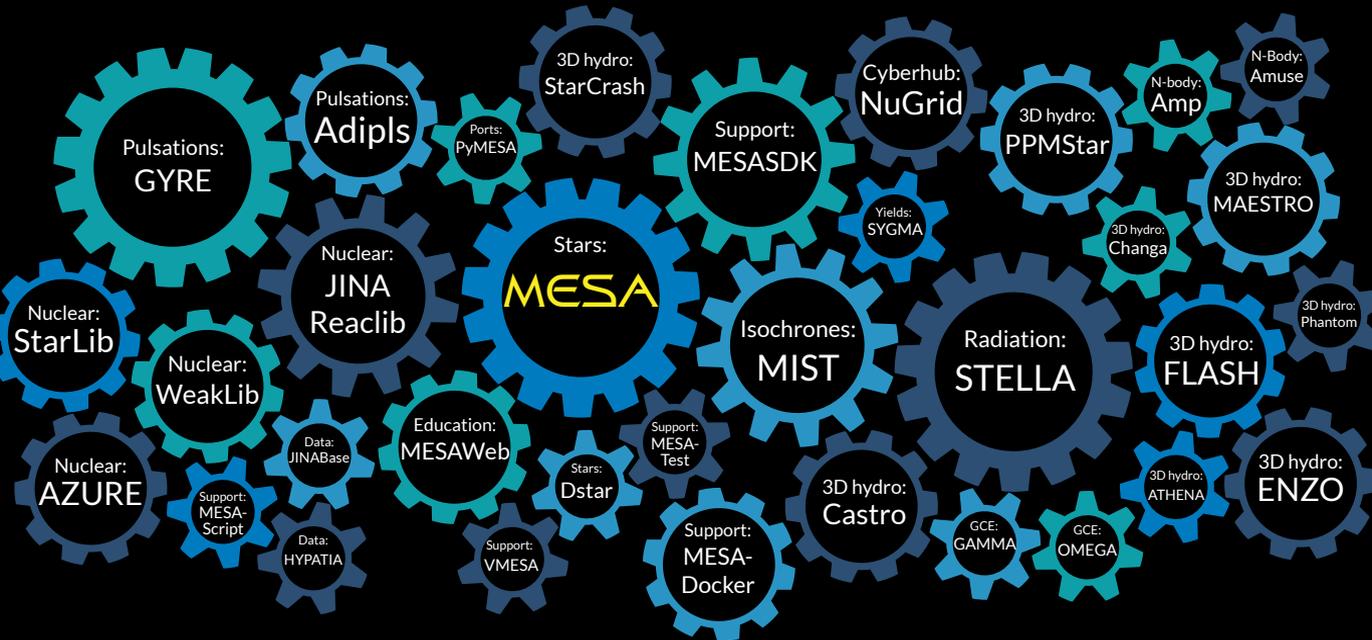
NSCL

FRIB

CASPAR

SECAR

St. George



GAIA

LSST

LCO

JWST

NuSTAR