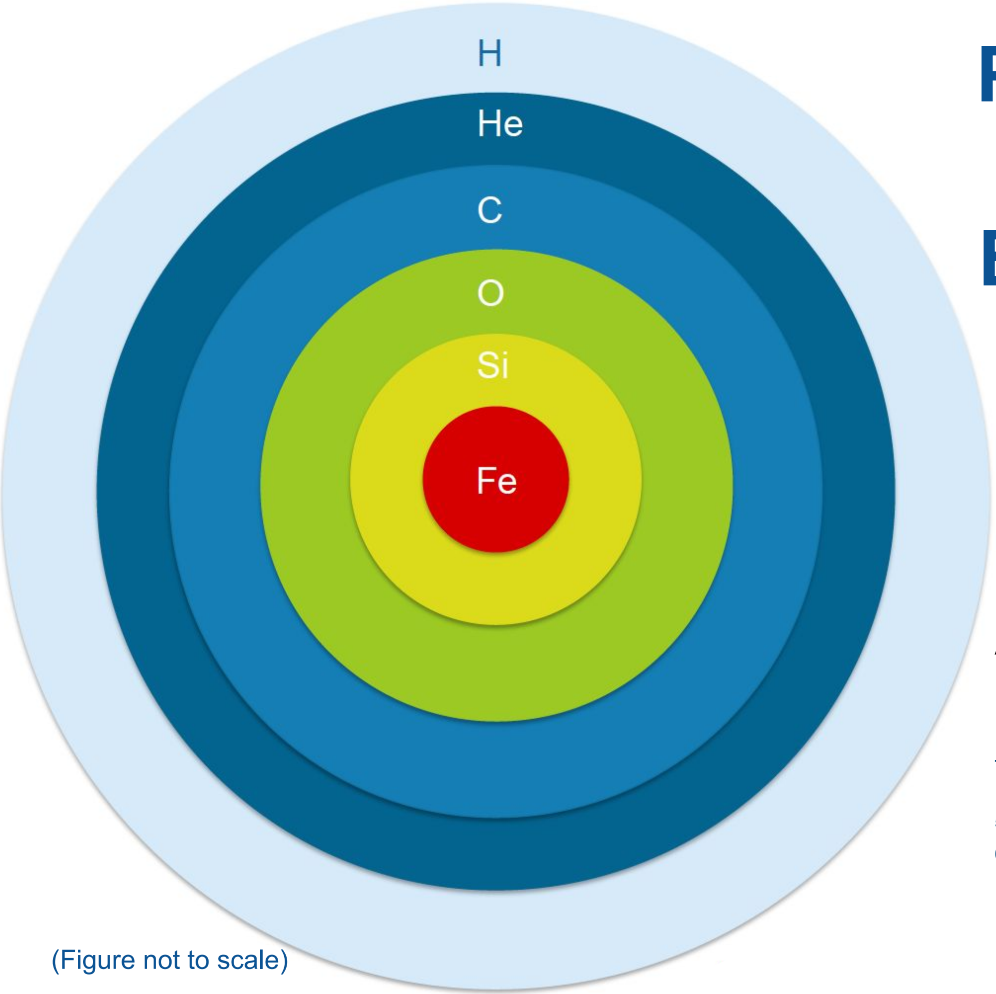

(Figure not to scale)

PUSHing Core-Collapse Supernovae to Explosions in Spherical Symmetry

Explosion Properties and Nucleosynthesis Yields

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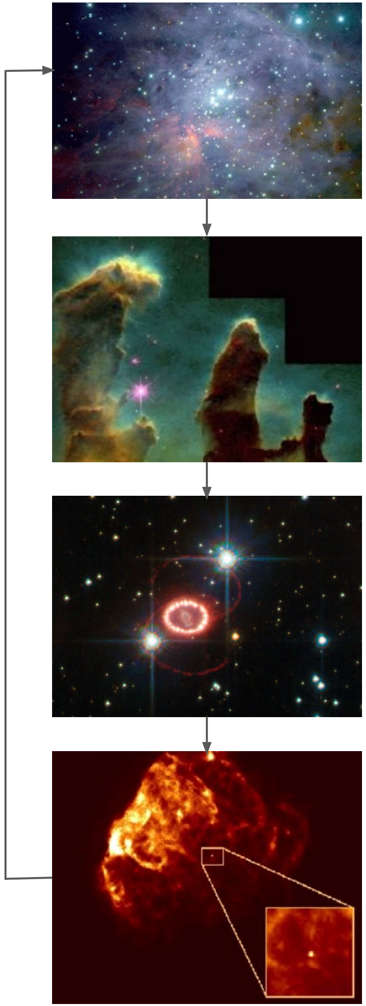


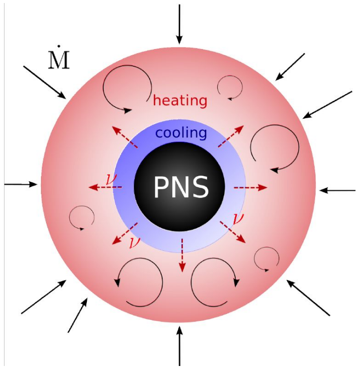
Abstract

Core-collapse supernovae (CCSNe) - the explosive deaths of massive stars - are among the most important sites of element synthesis in the universe. Not only do they drive the chemical evolution of galaxies, the nucleosynthesis yields of CCSNe are also imprinted on some of the oldest stars. Our ability to predict these yields, however, is limited by the still unsolved question of the CCSN explosion mechanism. Spherically symmetric simulations fail to explode and multi-dimensional simulations, although crucial for uncovering the explosion mechanism, are computationally too demanding to study large samples of progenitor stars. The PUSH method induces explosions in otherwise non-exploding spherically symmetric simulations via parametrized heating. It also follows the evolution of the protoneutron star and the electron fraction of the ejecta - features vital for nucleosynthesis calculations. Here, we present the explosion energies, remnant masses and nucleosynthesis yields of 111 models, with masses between 10.8 and 120 solar masses, exploded successfully using PUSH. We highlight broad trends that appear as a function of pre-explosion properties and compare predicted nucleosynthesis yields to available observational data. These yields will be extremely useful for modeling galactic chemical evolution to gain further insight into the nuclear history of our universe.

Methods

Nucleosynthesis study of models exploded with PUSH is extremely interesting for two reasons:

1. Mass cut is predicted from the hydrodynamical simulation.
2. Evolution of electron fraction is followed self-consistently.



Progenitor Models (KEPLER stellar evolution code)

Non-rotating, solar metallicity; mass range:10.8-120 M⊙

→

AGILE (GR hydrodynamics code in spherical symmetry)

EOS: HS(DD2)
***ν*-transport:** IDSA for electron flavors, ASL for heavy - lepton flavors

→

Tracer (Interpolates hydro output to produce tracer 'particles')

Tracer particle mass: 0.001 M⊙; contains T, *ϱ*,Ye information

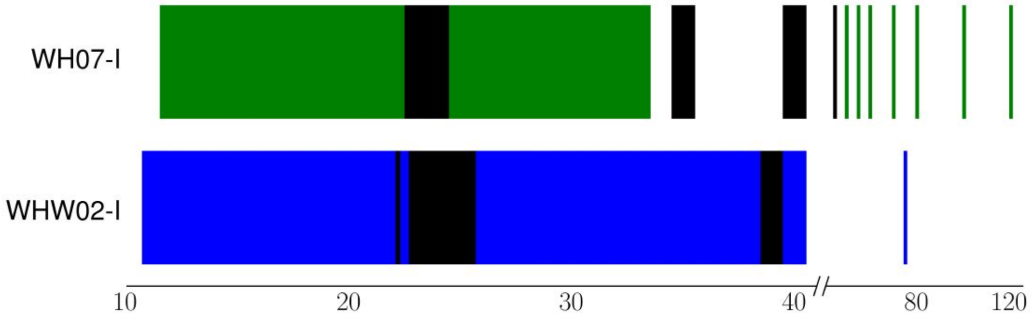
→

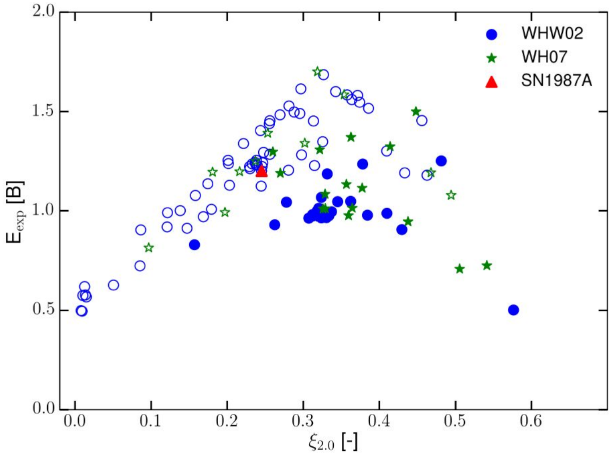
CFNET (Nuclear reaction network)

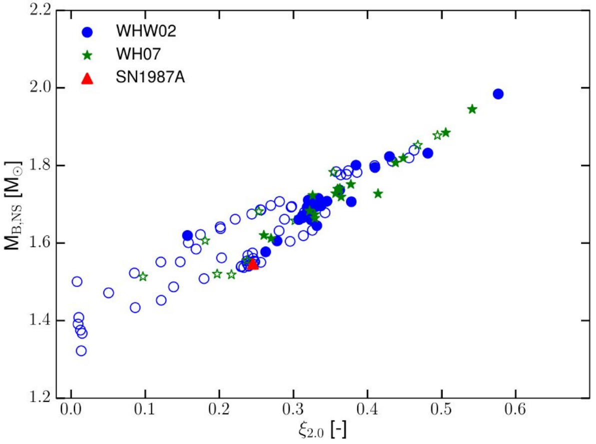
Approx. 2900 isotopes, includes weak reactions that affect Ye

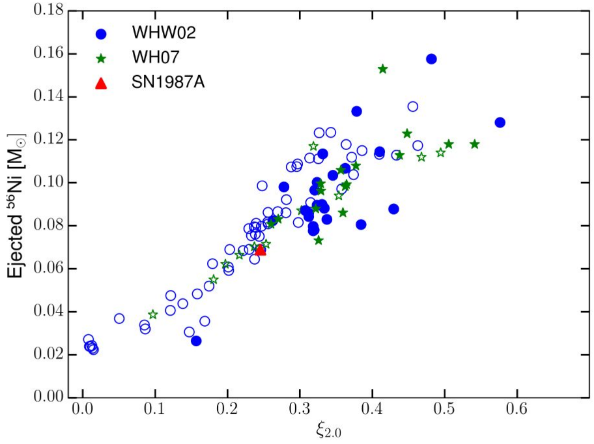
Results

1. BH formation
2. Explosion energies
3. Remnant masses
4. Detailed isotopic nucleosynthesis predictions

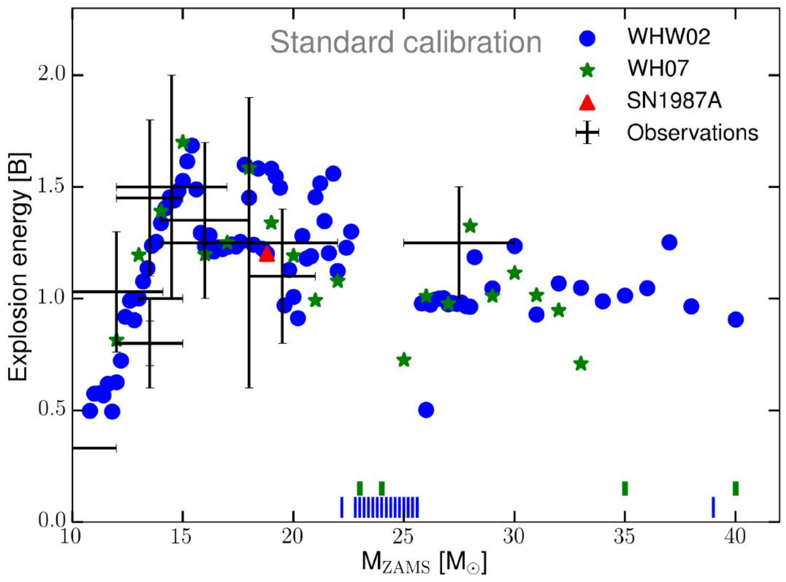


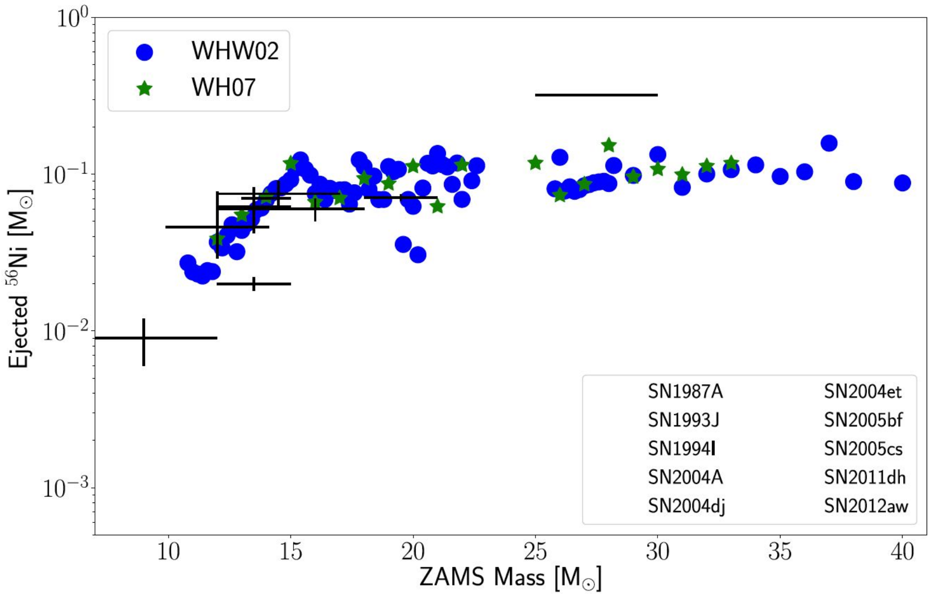






Comparison with Observations





The real test of our models is to investigate the impact of our yields on galactic chemical evolution simulations.