

# **BIDSTAR & FIFA**

**A comprehensive study of the evolution of the stars from their birth to their death in the context of the chemical and physical evolution of the Universe**

PRESENTAZIONE SCHEDE INAF - 20 may 2021

**BIDSTAR:** Blrth, evolution and final Destiny of the STARS, the architects of the chemical and biological evolution of the universe

**FIFA:** the FInal FAte of super-AGB and massive stars: remnants and nucleosynthesis

# Why study stars?

We barely need them if we want to understand:

Chemical evolution of the Universe

Compact remnant (WD – NS – BH of stellar origin)

Gravitational Waves

Exoplanets

Epoch of reionization

Stars are the *fil rouge* that connects most of has been discussed and will be discussed in these days



Erice 1979



Vittorio Castellani



Italo Mazzitelli



Alvio Renzini



Amedeo Tornambe'



Cesare Chiosi

## TEAM:

**Collaboration since the end of the 80' between Marco Limongi and Alessandro Chieffi**

**A young PhD student joined us roughly 3 years ago: Lorenzo Roberti**

This is the basic nucleus that developed from scratch and still develops and maintains  
the stellar evolutionary code **FRANEC** (Frascati RAphton Newton Evolutionary Code)  
the hydrodynamic code **HYPERION** (Hydrodynamic Ppm Explosion with Radiation diffusION)

# COLLABORATIONS:

We are members of the **PESSTO**, **GRAWITA** and **ENGRAVE** collaborations

**Salvatore Orlando**  
**Marco Miceli**

Core collapse of Supernovae and the interaction  
of the ejecta with the interstellar medium

PRIN INAF 2019 - FUNDED  
PRIN MIUR 2020

**Raffaella Schneider**

Dust production from the ejecta of the supernovae

**Gabriele Cescutti**  
**Francesca Matteucci**  
**Nikos Prantzos**  
**Carlos Abia**  
**Donatella Romano**

Chemical evolution of the Galaxies

**Michela Mapelli**

Maximum mass of BH of stellar origin

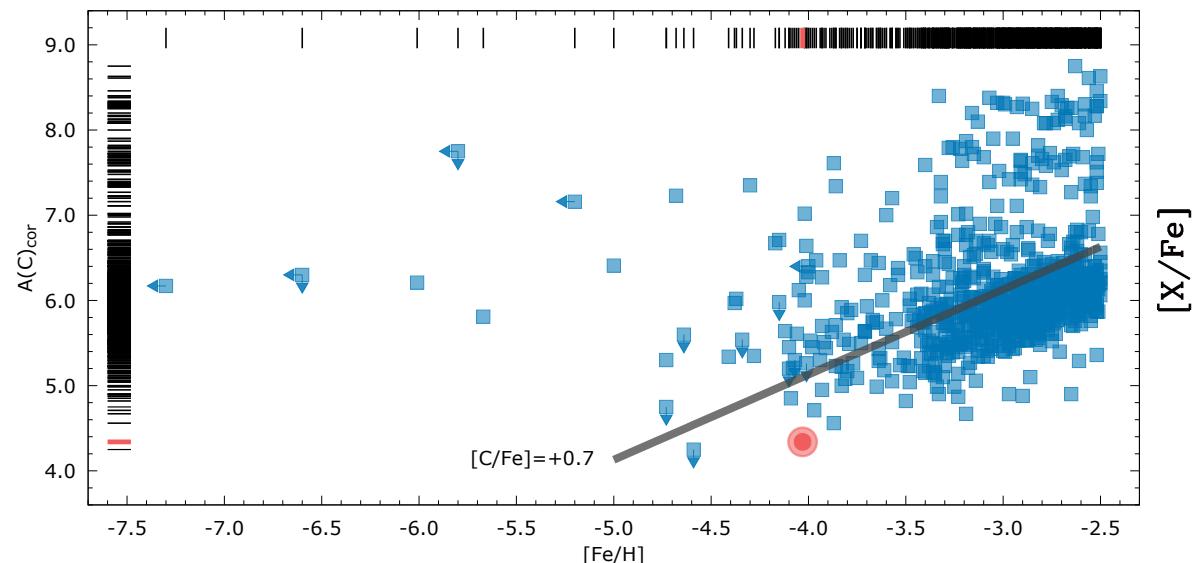
**Sara Palmerini**  
**Aurora Tumino**  
**Marco La Cognata**

Strong collaboration with the INFN in the field of the fusion cross sections

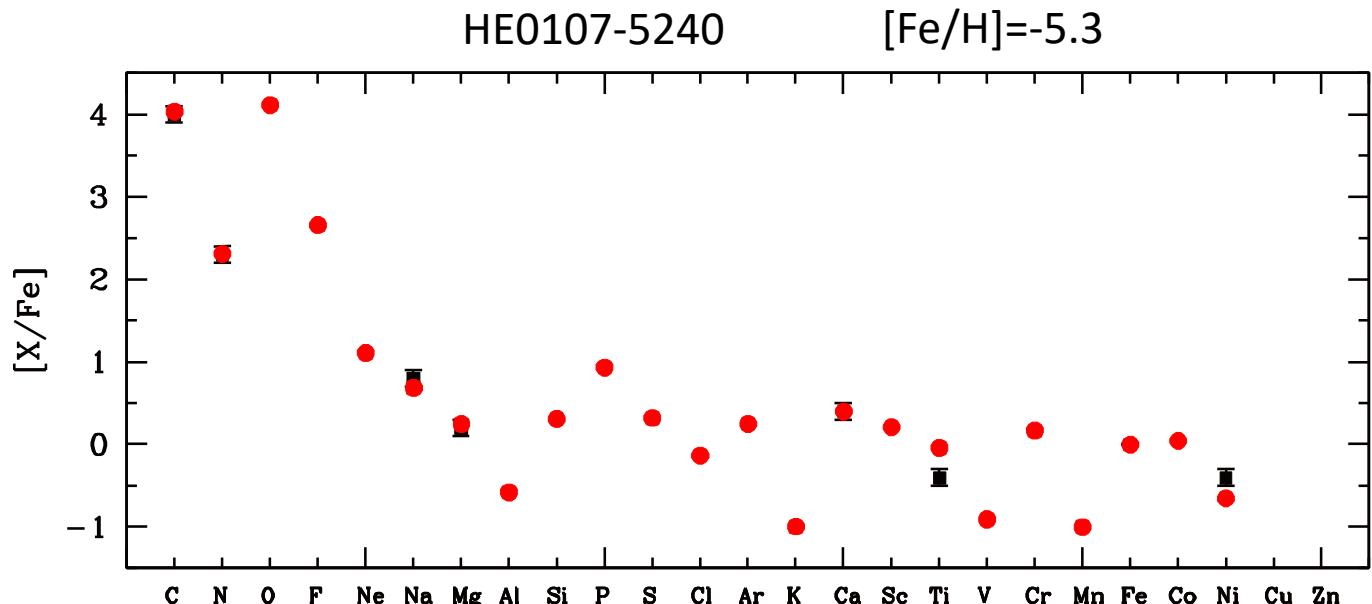
Additional collaborations

**Kenichi Nomoto – Inma Dominguez – John Lattanzio – Georges Meynet - Paolo Ventura – Sergio Cristallo**

# Ultra metal poor stars

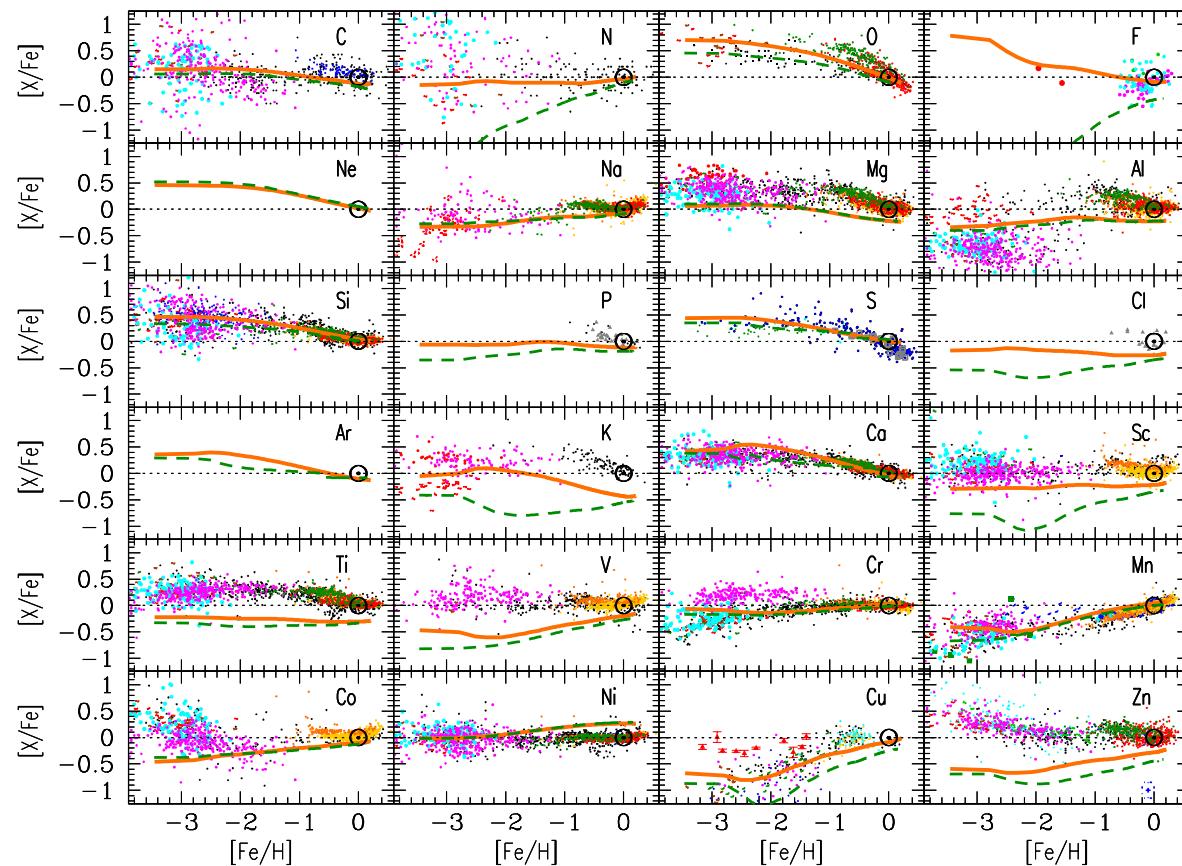


Placco et al 2021, arXiv. 2015. 04573

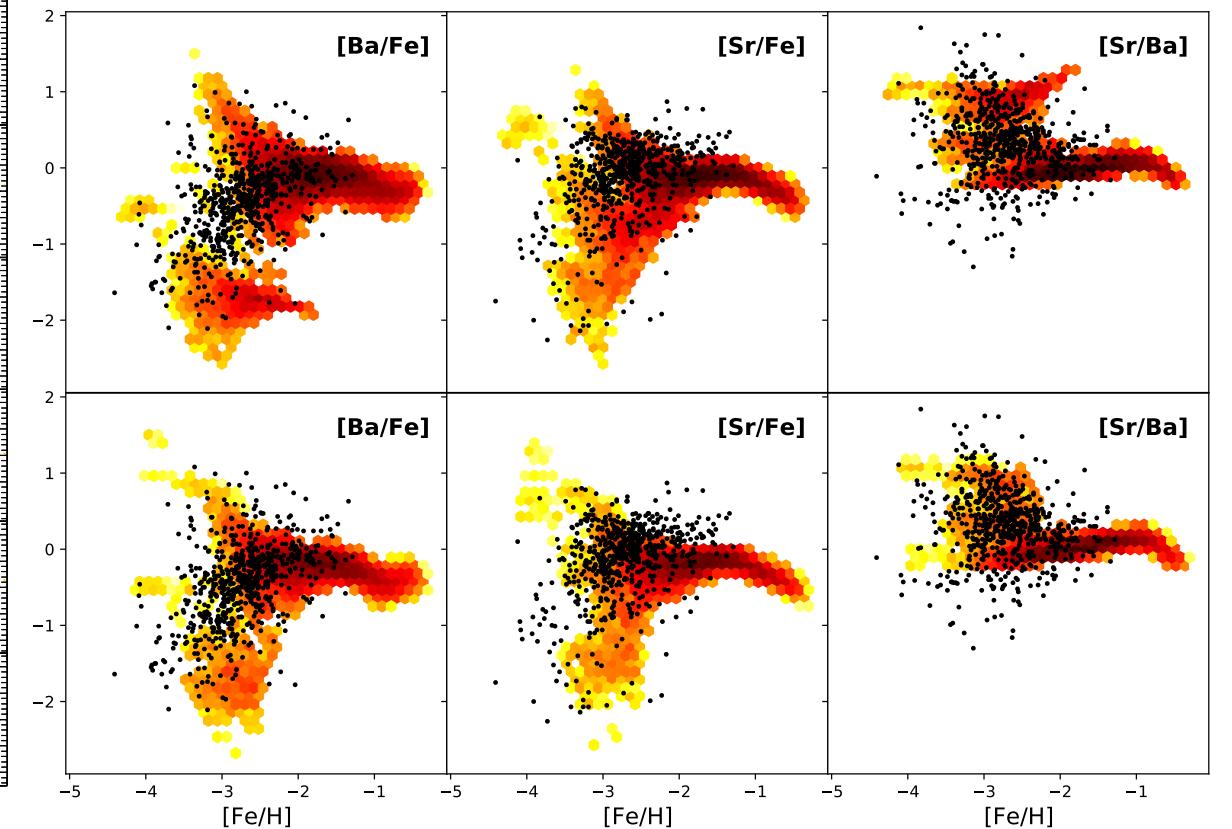


Christlieb, N. et al. *Nature* **419**, 904-906 (2002).  
Bonifacio, P., Limongi, M. & Chieffi, A. *Nature* **422**, 834 (2003).

# Chemical evolution of our galaxy



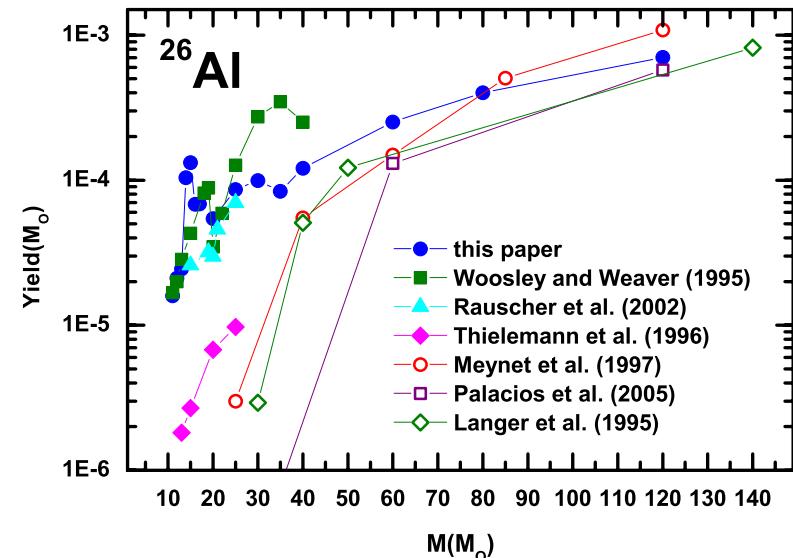
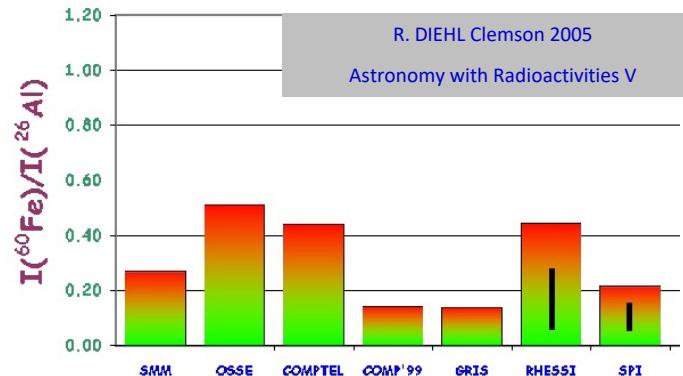
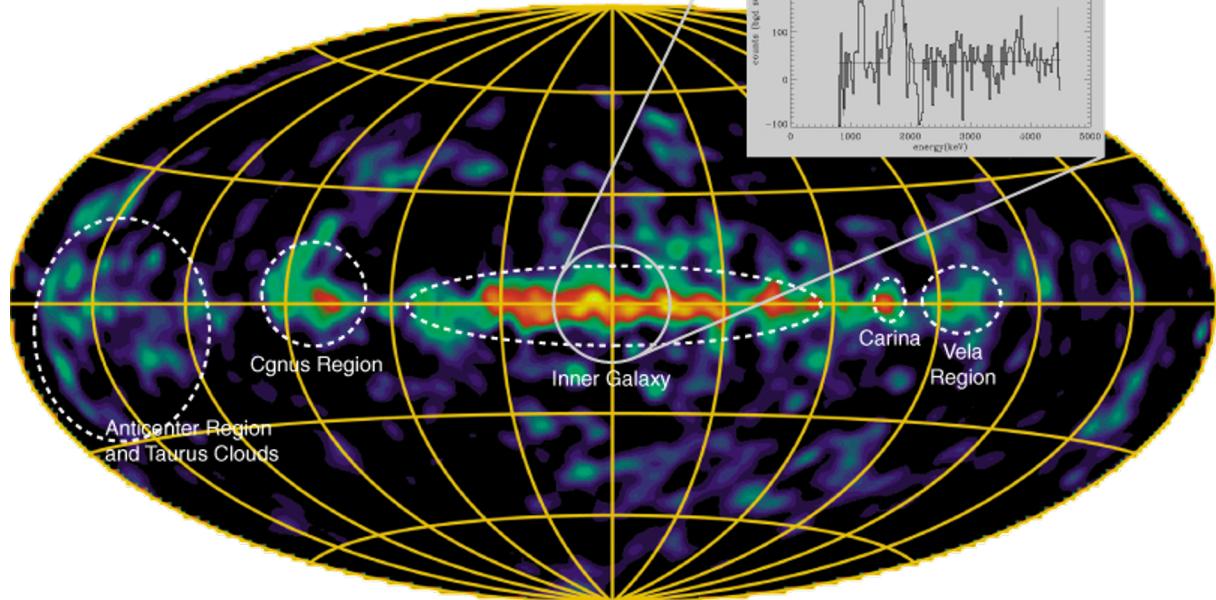
Prantzos et al. 2018 MNRAS 476, 3432



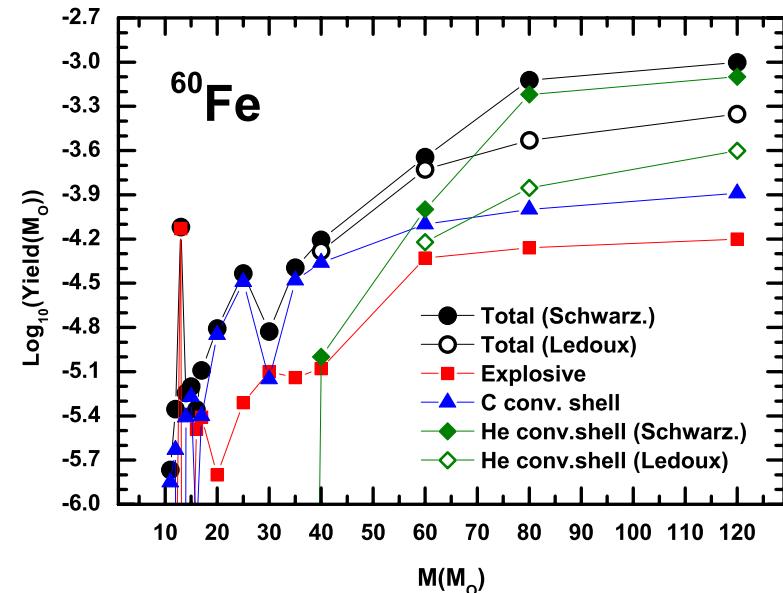
Rizzuti et al. 2021 MNRAS 502, 2495

# 1.809 MeV All Sky Map

Plüschke et al. AIP Conf. Proc. 510  
ed. M.L. McConnell & J.M. Ryan p 35-39 (2000))

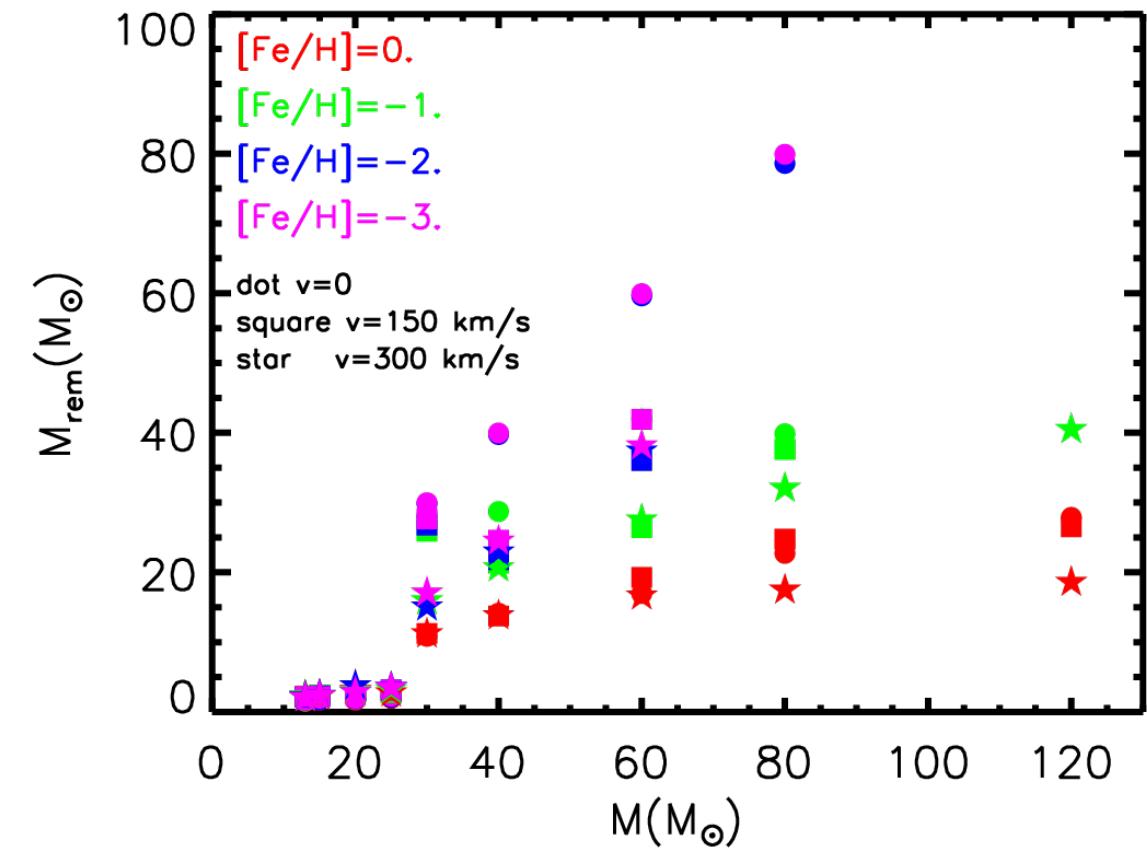
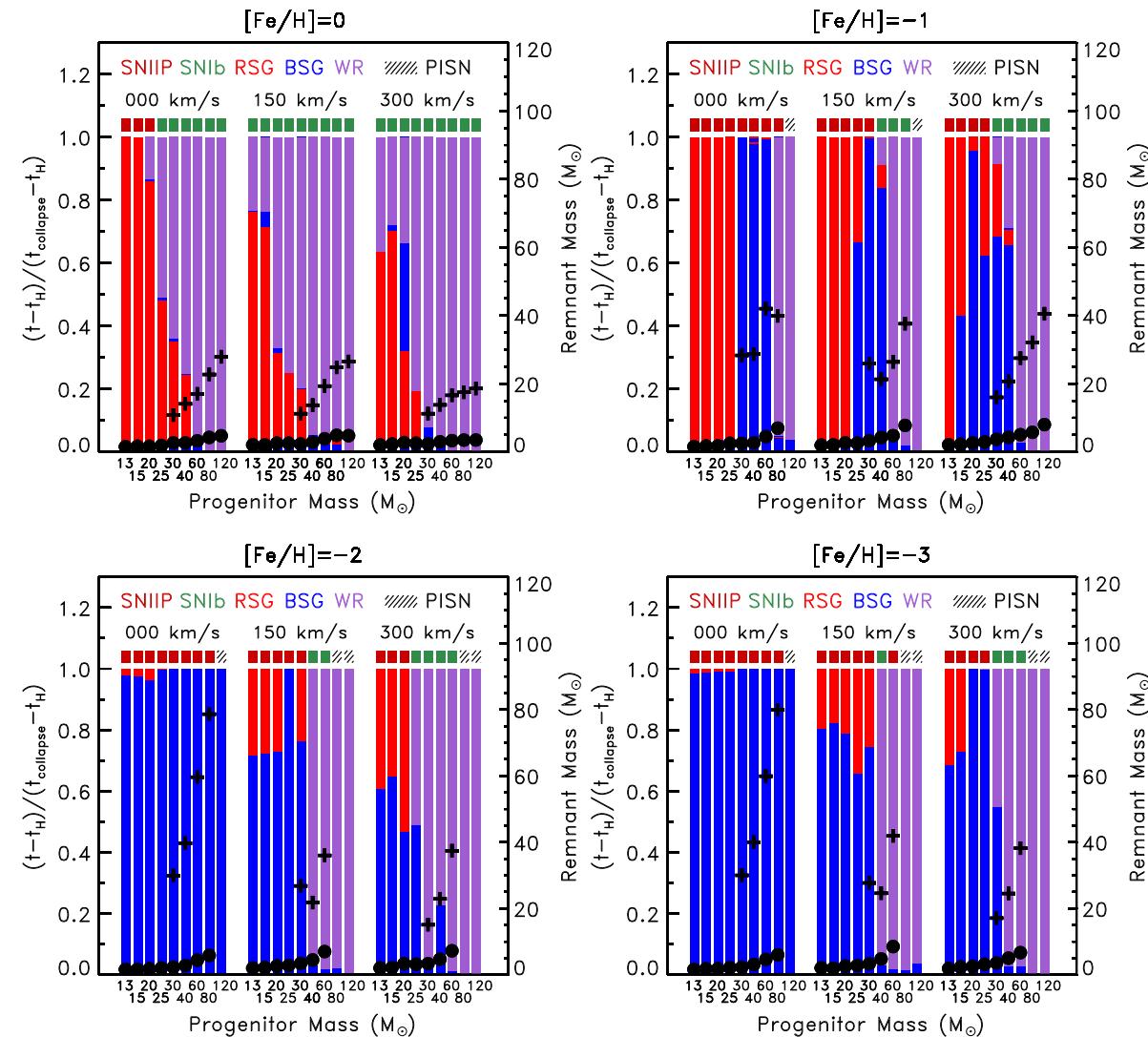


Limongi & Chieffi 2006 ApJ 647, 483



# Our latest predictions about the maximum BH mass of stellar origin

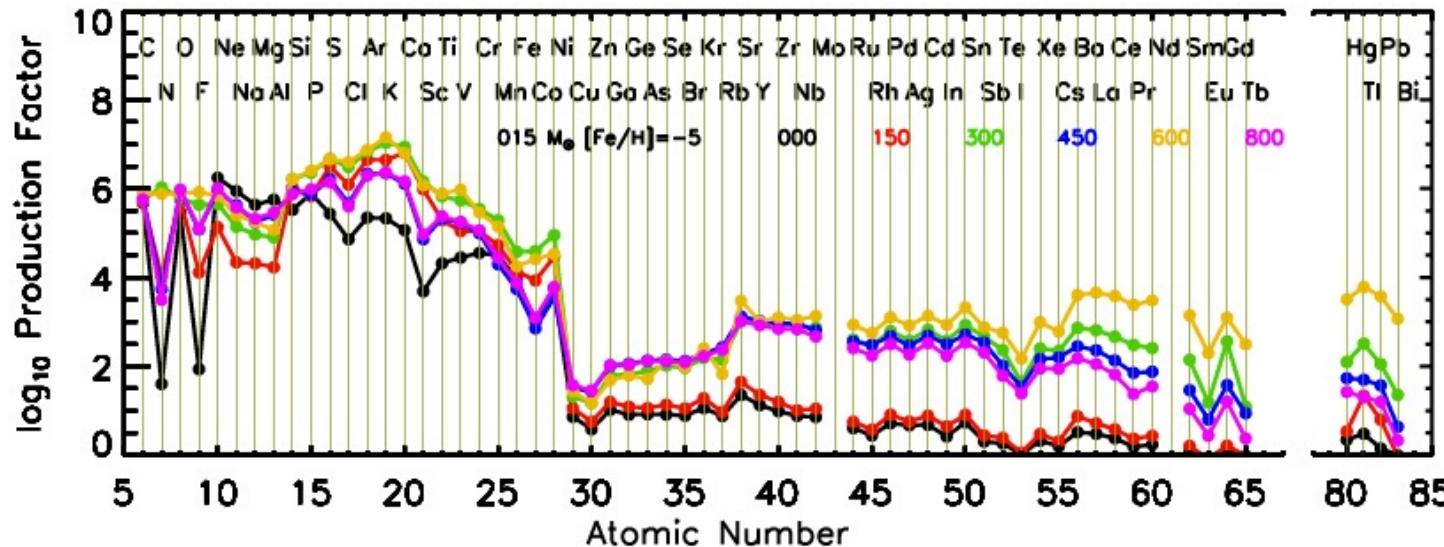
Limongi & Chieffi 2018 ApJ 237,13



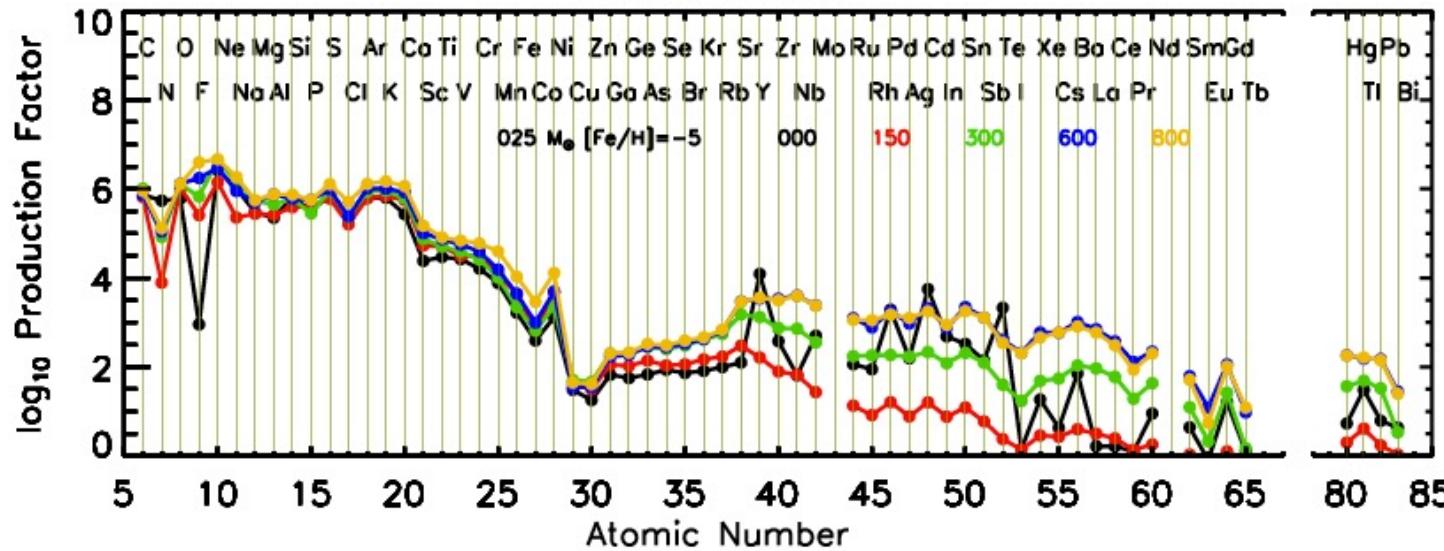
# Present and Future

The oldest generations of massive stars and the puzzling chemical composition of the oldest low mass stars.

$$[\text{Fe}/\text{H}] = -5$$



$15 \text{ M}_\odot$

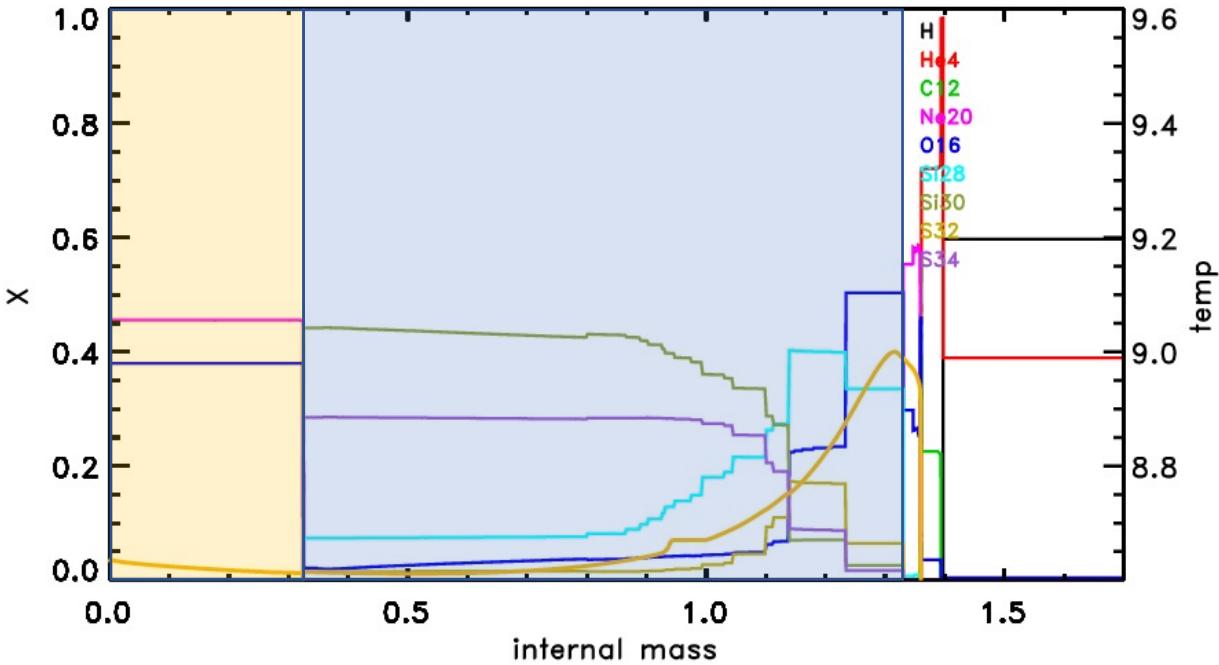


$25 \text{ M}_\odot$

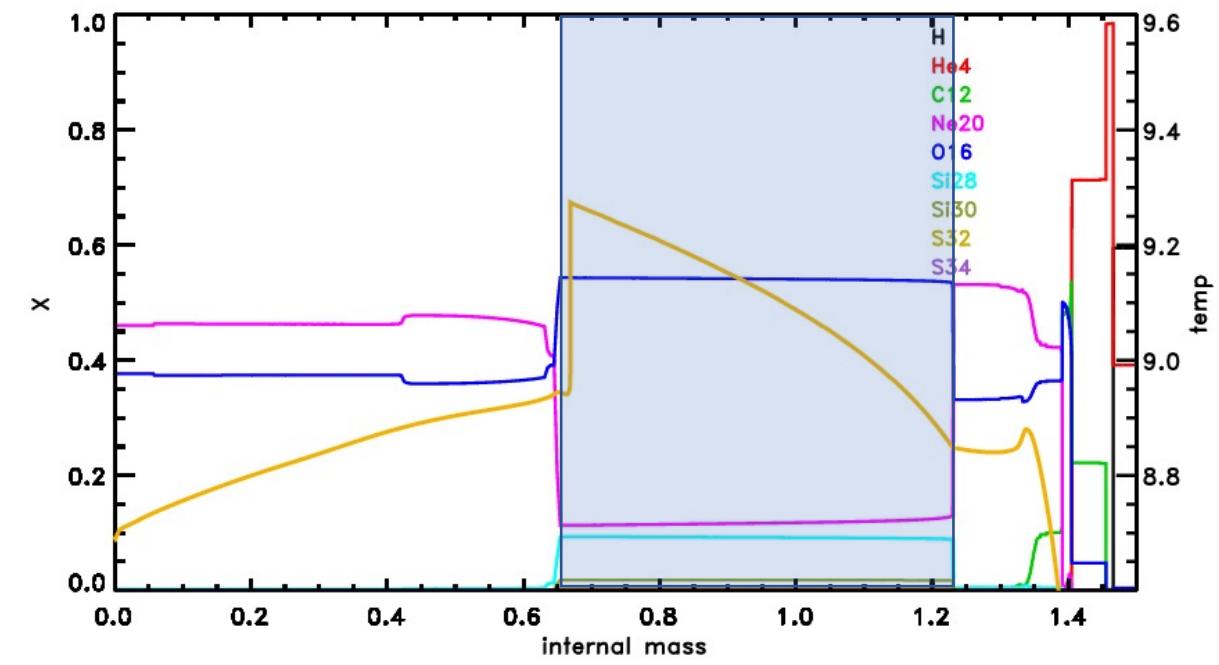
# Present and Future

The Super Asymptotic Giant Branch stars ( $7 < M(M_\odot) < 10$ )

$8.5 M_\odot$

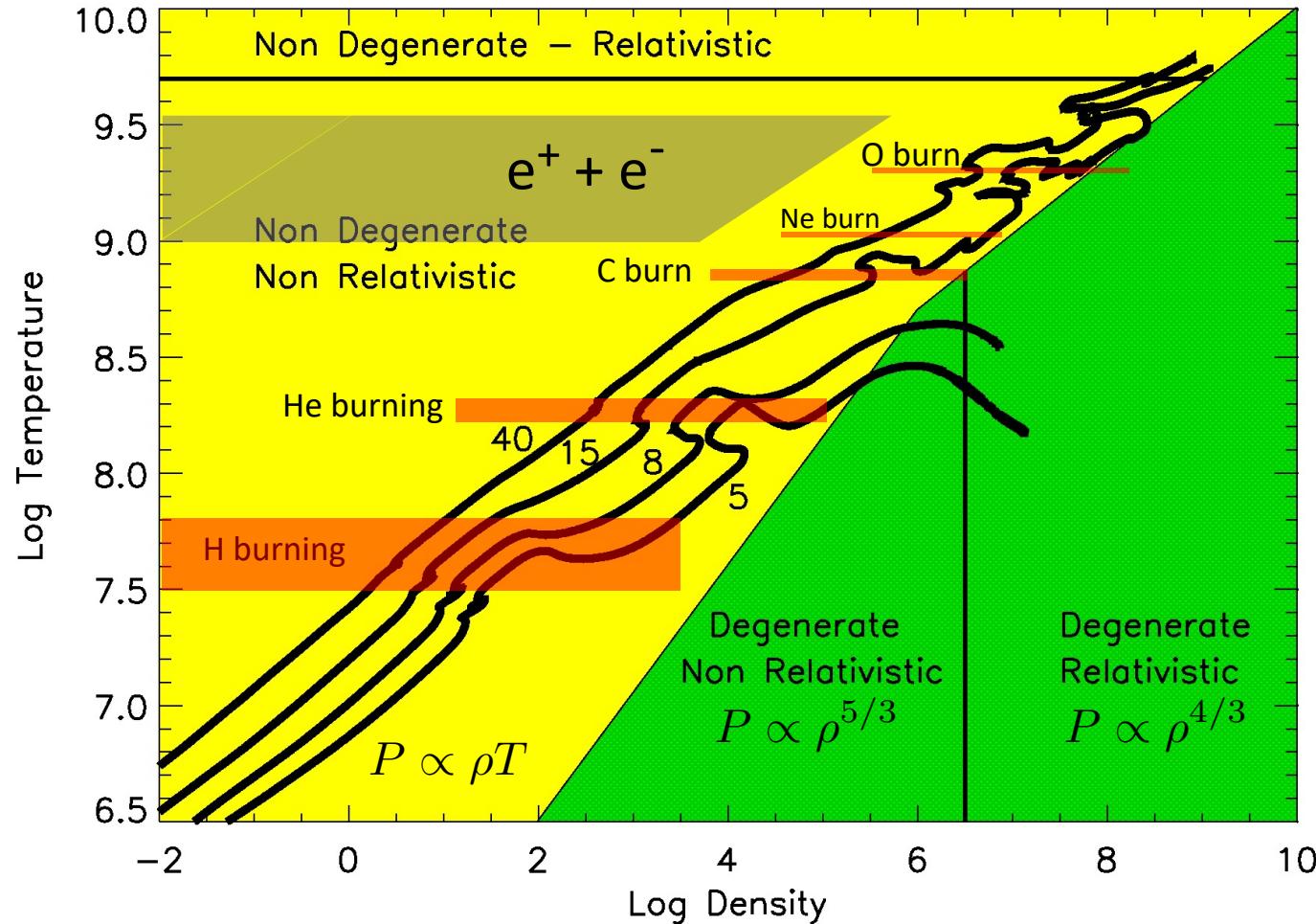


$8.8 M_\odot$



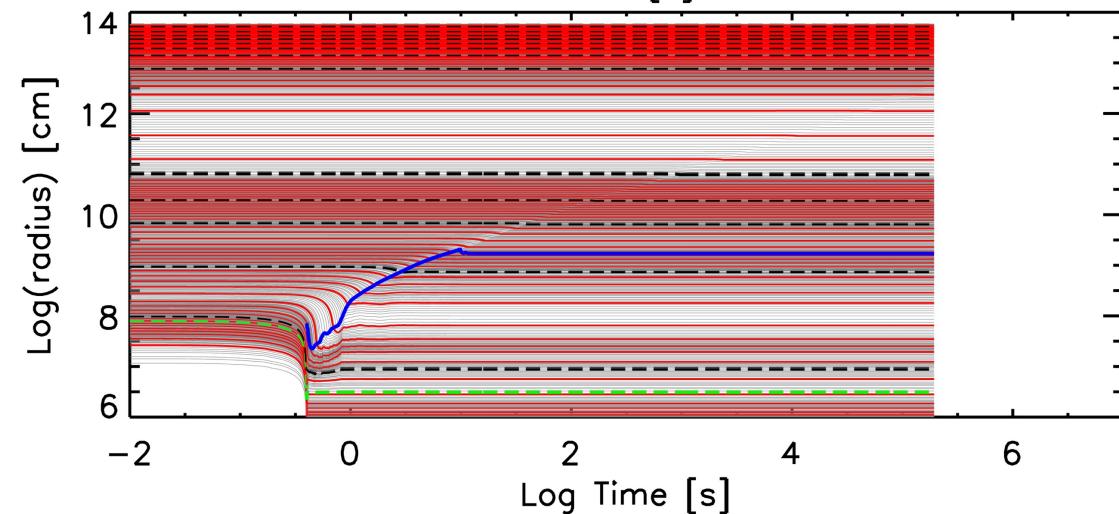
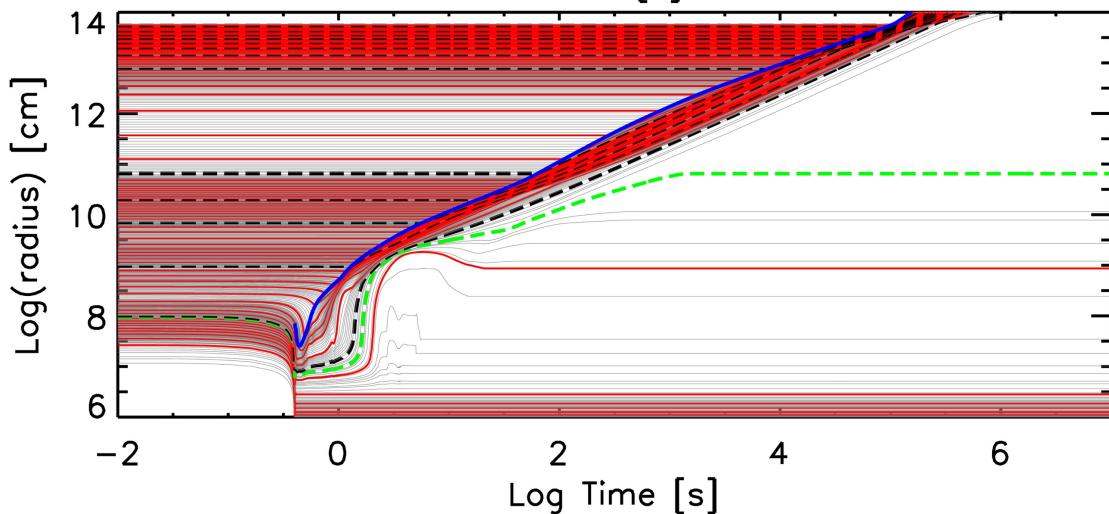
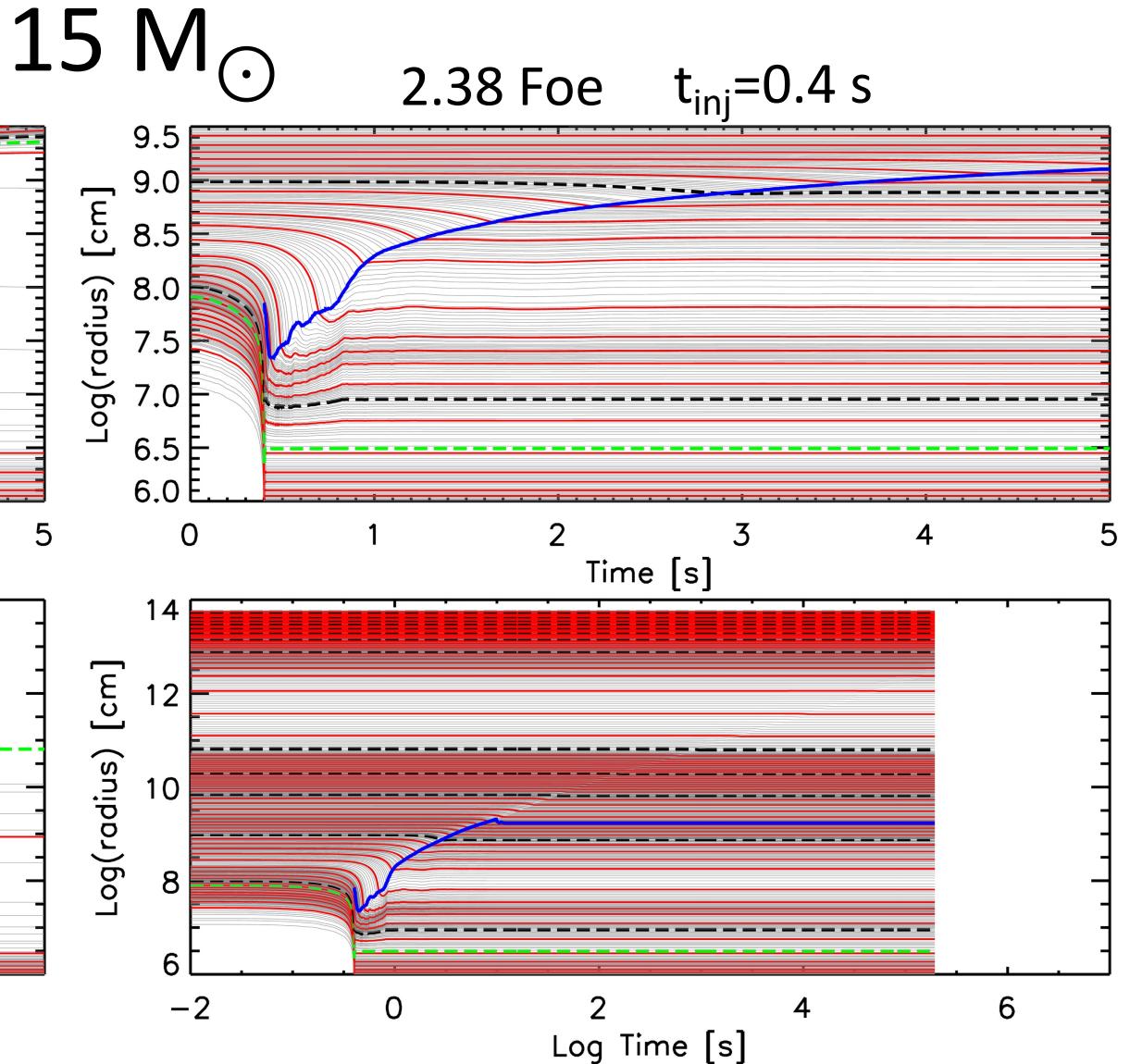
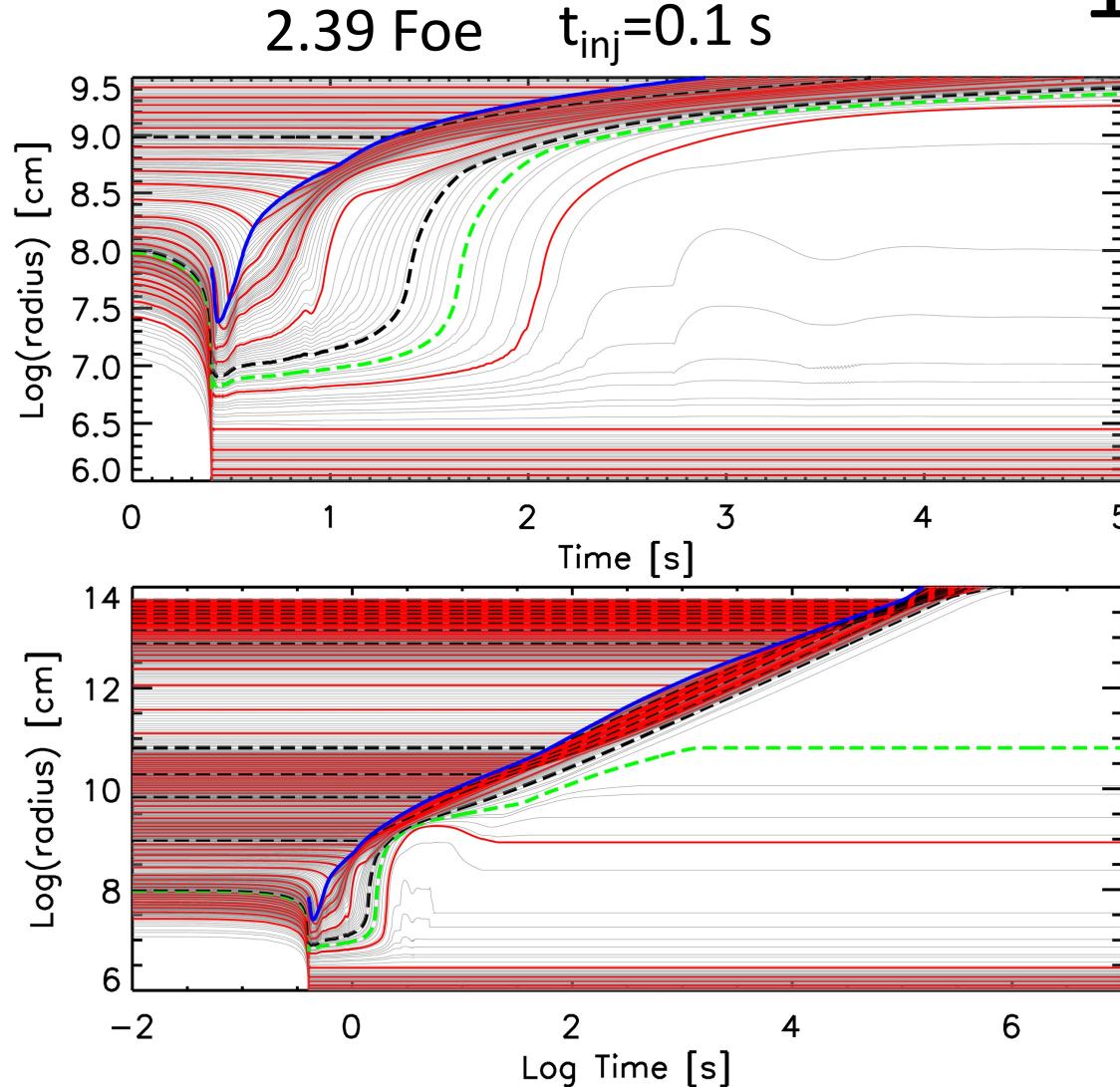
# Present and Future

(Pulsational) Pair Instability SuperNovae and the upper mass limit for the formation of BH of stellar origin



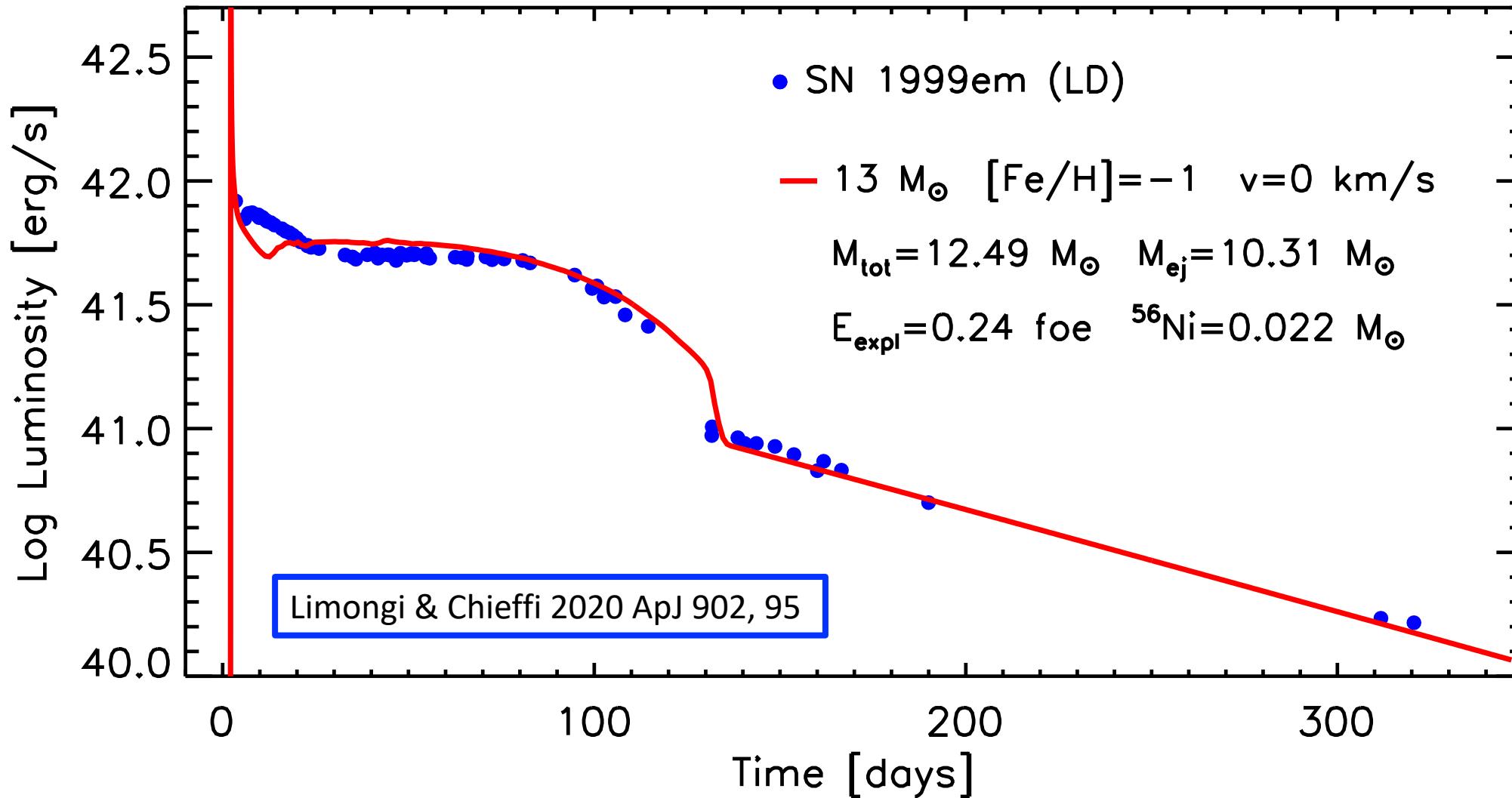
# Present and Future

HYPERION: collapse and explosion of a core collapse supernovae



# Present and Future

HYPERION: bolometric light curves



# Present and Future

The oldest generations of massive stars and the puzzling chemical composition of the oldest low mass stars.

The Super Asymptotic Giant Branch stars ( $7 < M(M_{\odot}) < 10$ )

Collapse, explosion and light curve of the core collapse supernovae

(Pulsational) Pair Instability SuperNovae

**Most of our models are available at: <http://orfeo.iaps.inaf.it>**

# Fondi

FONDI	Titolo	PI	Keuro
PRIN MIUR 2004	Fisica delle esplosioni di stelle massicce per il loro uso come traccianti dell'evoluzione dell' Universo	Cappellaro (Limongi)	59
PRIN MIUR 2006	Il mondo delle stelle massicce: formazione, evoluzione, esplosione e curve di luce	Busso (Chieffi)	7
PRIN MIUR 2010	Evoluzione chimica e dinamica della nostra galassia e delle galassie del Gruppo locale	Matteucci	6
PRIN INAF 2011	Transient Universe: from ESO Large to PESSTO	Benetti (Chieffi)	8
PRIN INAF 2014	Transient Universe: unveiling new types of stellar explosions with PESSTO	Pastorello (Chieffi)	19
PRIN INAF 2019	From massive stars to supernovae and supernova remnants: driving mass, energy and cosmic rays in our Galaxy	Orlando (Limongi)	8
PREMIALE FIGARO	Fostering Italian Leadership in the field of Gravitational Wave Astrophysics	Ghirlanda (Limongi)	13
PREMIALE MITIC	MIning The Cosmos Big Data and Innovative Italian Technology for Frontier	Garilli (Limongi)	8
PRIN MUR 2021	Life, death and afterdeath of massive stars: reconstructing the path from the pre-supernova evolution to the supernova remnant	Orlando (Chieffi)	TBD

# Criticita'

**Consolidamento e potenziamento del livello di eccellenza raggiunto con l'immissione di nuove forze**

**Finanziamenti: ordinari e straordinari**

**Potenziamento corsi di evoluzione stellare nelle Universita' italiane**

**Calcolo seriale: necessita'di CPU molto performanti, interattivita', storage, analisi dati**

**Attenzione all'uso di codici Open Source (tipo MESA) perche' l'uso di un codice di evoluzione stellare richiede una grande competenza. Non possono essere usati come una "App"**

# GRAZIE!

The image features a dark, star-filled background resembling a night sky. In the center, the words "GRAZIE!" are written in large, bold, red capital letters. The background is filled with numerous small white stars of varying sizes.