SN YIELDS AND CHEMICAL ENRICHMENT

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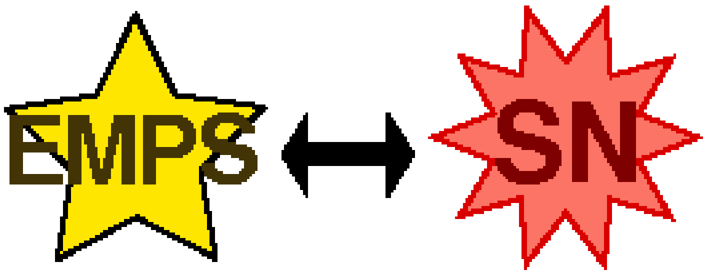
MY WORK AND MOTIVATION

◆Nucleosynthesis of CC SNe
,and compare the SN yields with the observations.



Try to understand
Galactic Chemical Enrichment,
Stellars and SNe,
Or the environment in which they are.

CONTENTS

1. Origin of Co and Zn - do we need HNe ?

   (Izutani & Umeda 2010, ApJL)

2. Massive Star ccSN contribution to Chemical Enrichment (Izutani, Kobayashi, et al. in prep.)

3. SN yields with Neutrino Processes

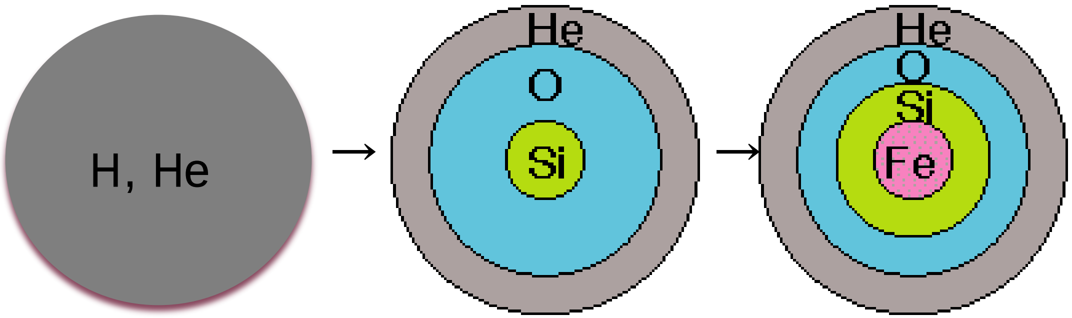
   (Kobayashi, Izutani, Amanda, Yoshida, Yong, Umeda, 2011, ApJL)

→near future! My work in this group
(Izutani, Umeda, Yoshida, Kikuchi, Suzuki, Sumiyoshi…)
complete SN yields (for database:talk of Ishizuka-san) with neutrino processes

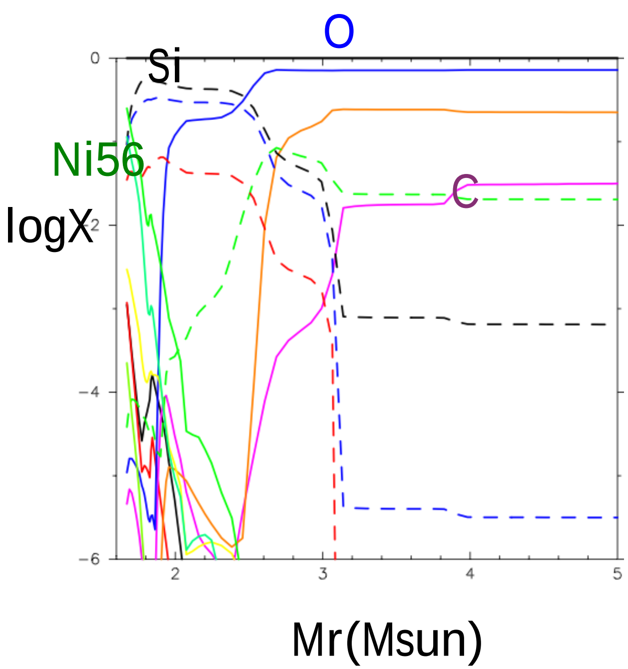
4. If I have time…Weak r-Process Star

   (Izutani, Umeda, & Tominaga 2009, ApJ)

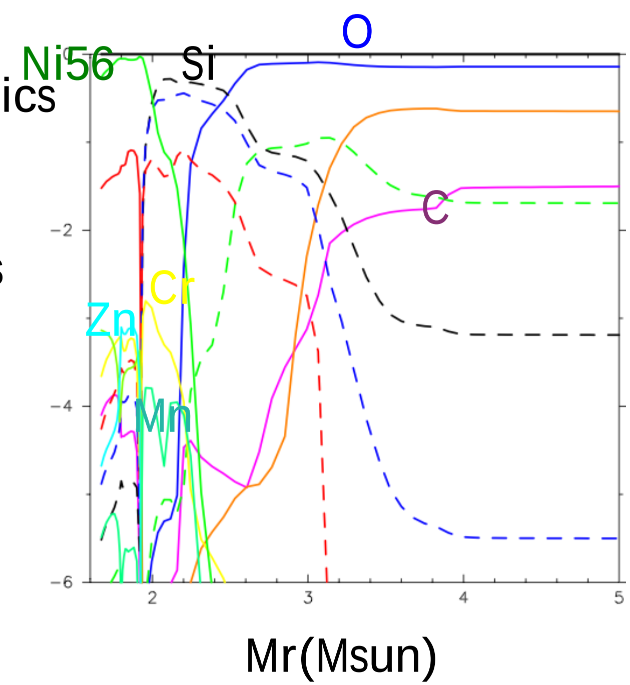
MODEL



Progenitor
(the last moment of stellar evolution)

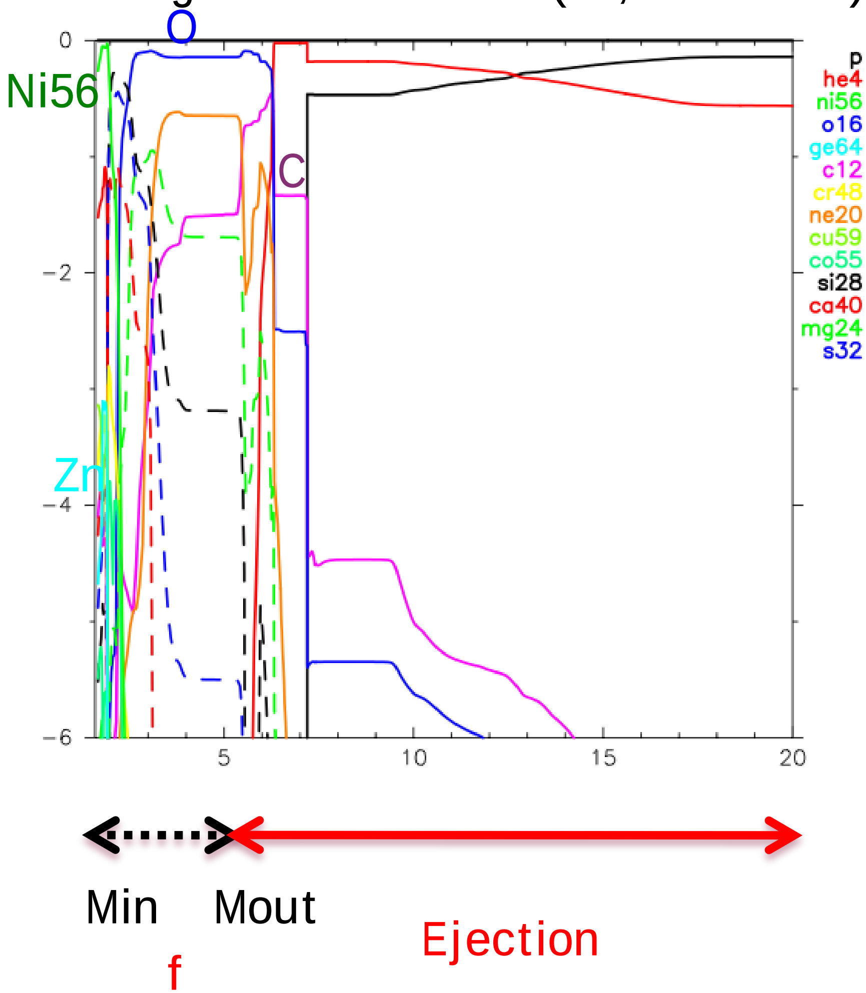


1D hydrodynamics
and
Post-process
nucleosynthesis
(shock wave)



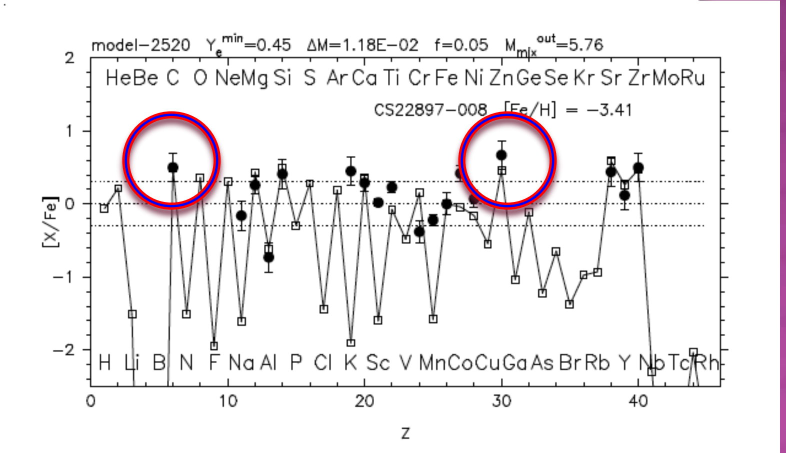
MODEL(CONTINUED)

mixing-fallback model (RT, 2D-effect)



- can produce [Zn/Fe] >~0 with reasonable M(Ni56)

- Can produce high [C,O/Fe]



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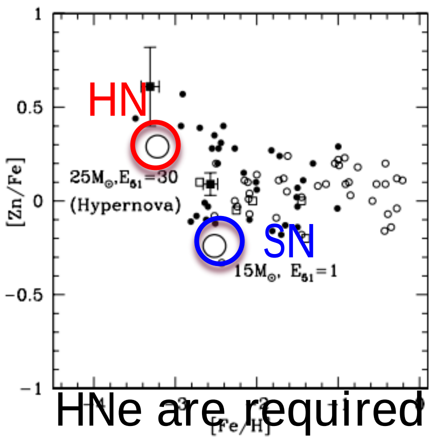
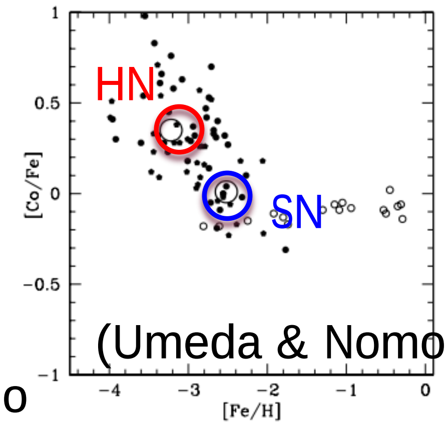
ORIGIN OF ZN AND CO



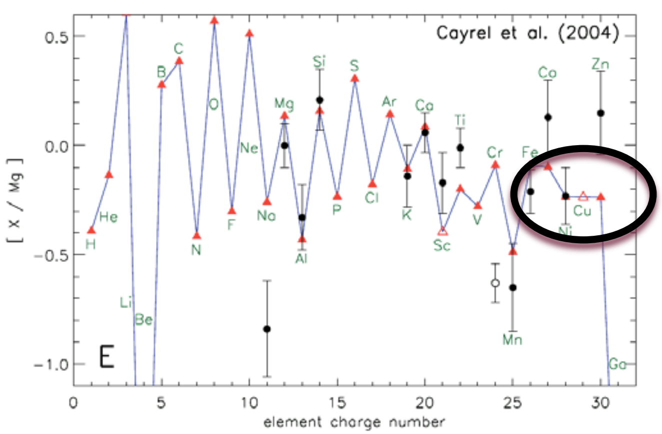


(Umeda & Nomoto '05)

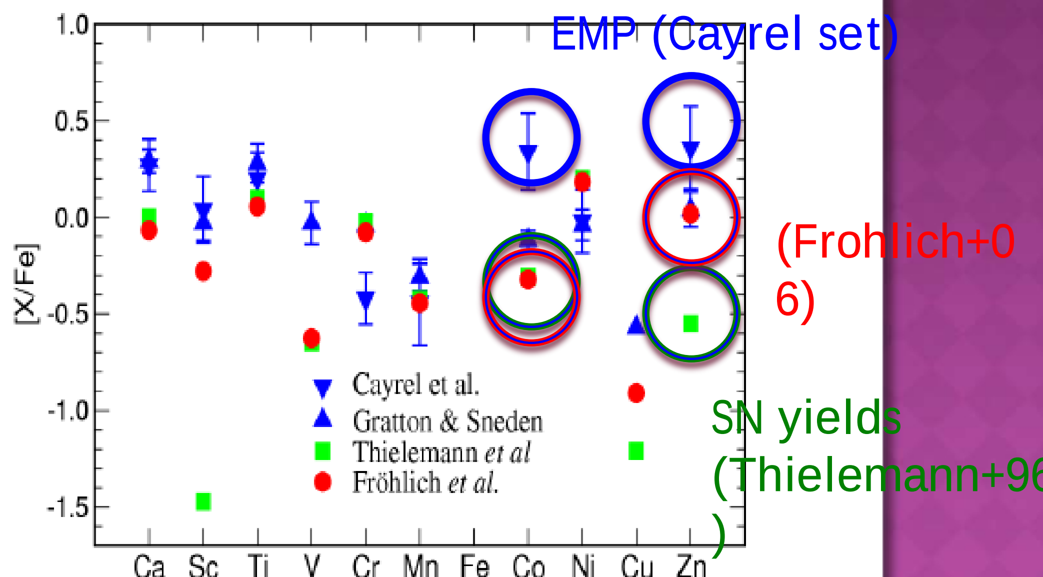
HNe are required to produce
Zn and Co in EMP stars.

Origin of Zn and Co:
Whether it's HNe or hot-bubble ?

I show HNe are required to produce Zn and Co !

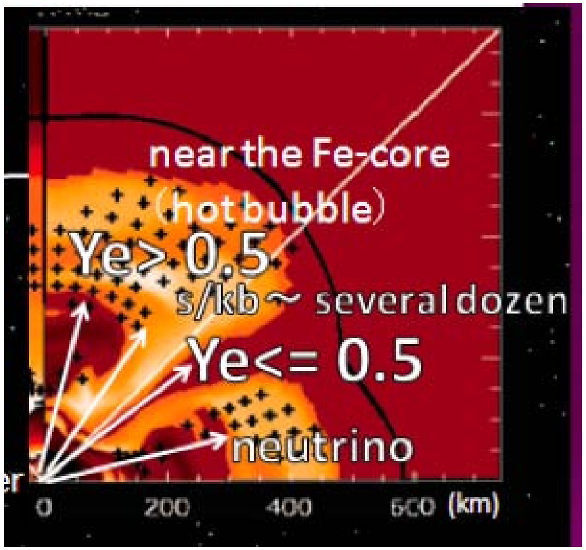


(Heger & Woosley '10)
Underproduce
Of Zn & Co



Proton-rich hot-bubbles
Improve Zn BUT NOT Co !

MODEL(CONTINUED)



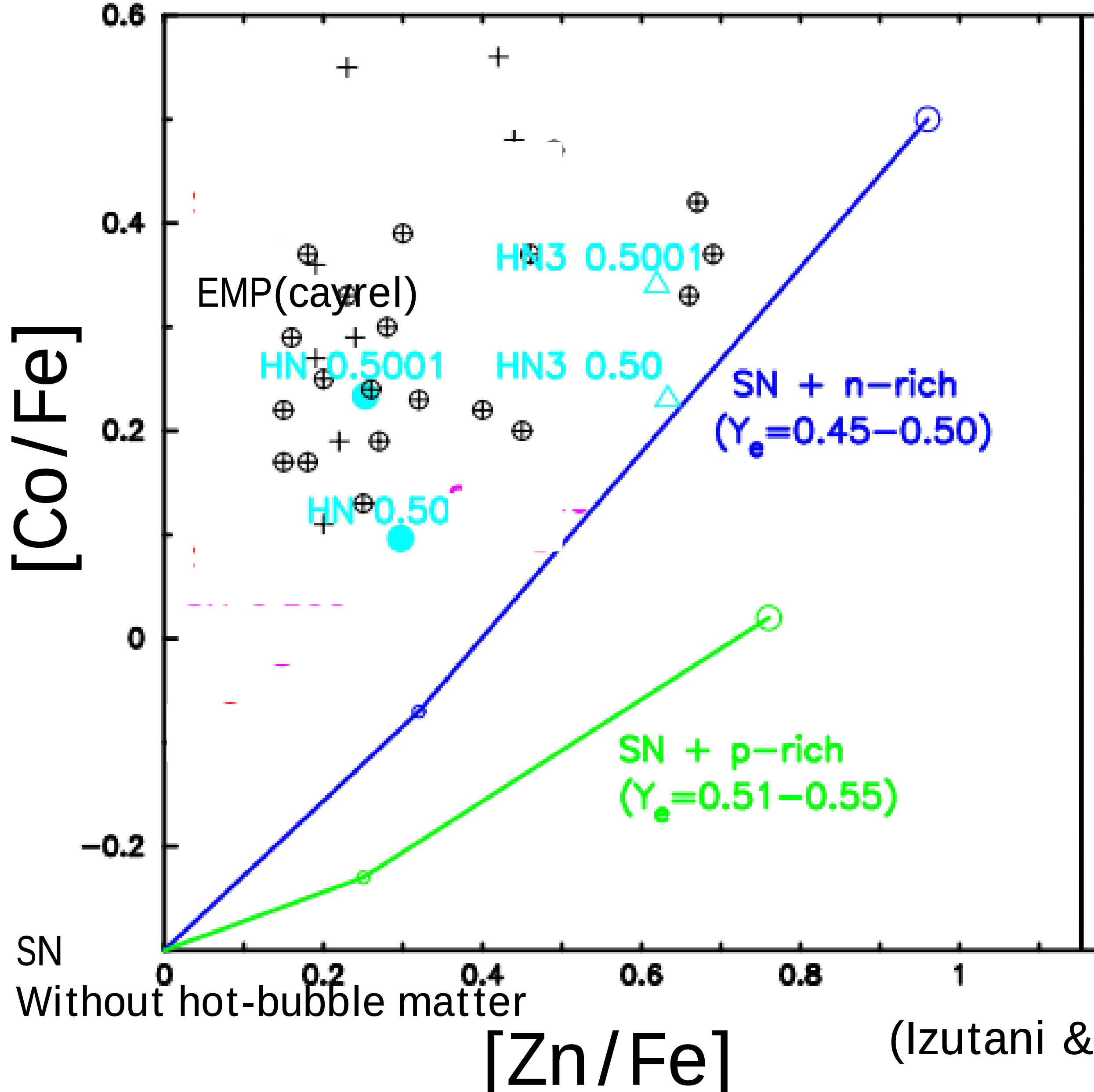
(Pruet+'06)

What is Hot-bubble ? :
Multi-dimensional phenomenon
Of the innermost region of SNe.

Include it
by changing Ye and entropy
In the wider range
Mimicking the 2D-simulation.

Add the hot-bubble matter
to the SN outer yields,
And calculate the total yields.

TOTAL EJECTA (ZN AND CO)



HNe can
reproduce
Zn and Co well

BUT

SNe with
n-rich matter
Or
p-rich matter
Cannot produce
Co !!

(Izutani & Umeda '10, ApJL)

CONCLUSION OF THE FIRST THEME

- HNe are the main origin of Zn and Co.

1. Origin of Co and Zn - do we need HNe ?
   (Izutani & Umeda 2010, ApJL)

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NEUTRINO MODEL

◆neutrino reaction in SNe

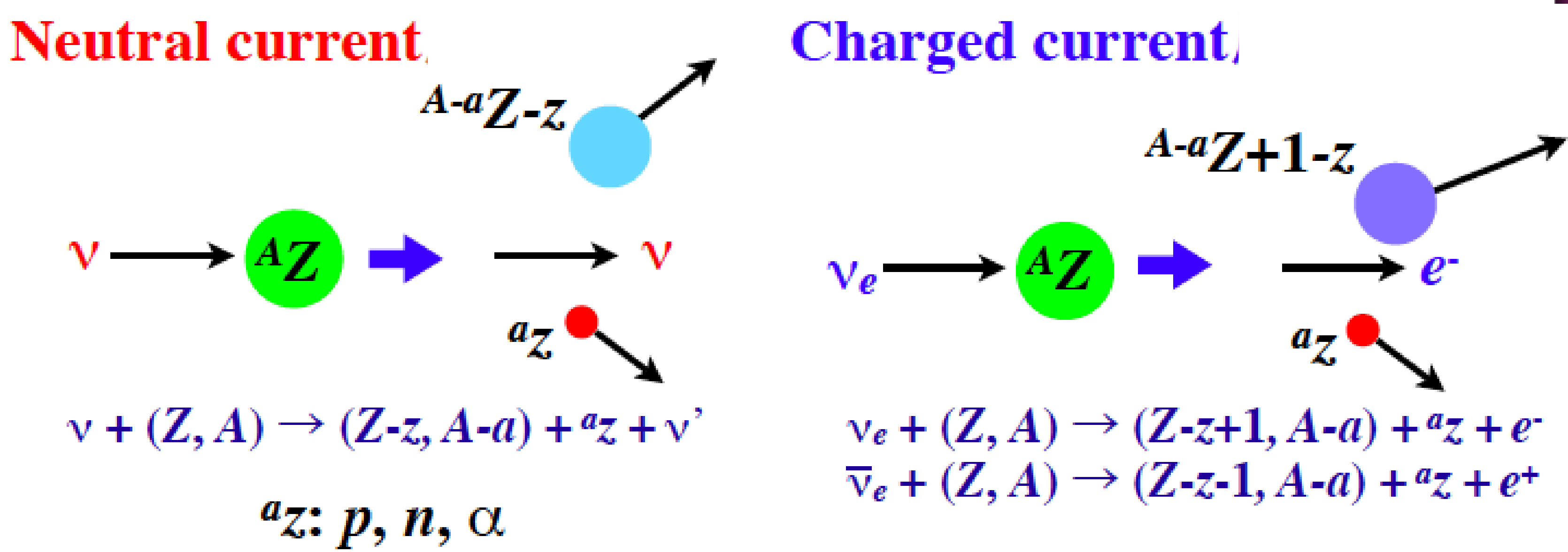


Figure from Yoshida-san’s slides

◆Reaction rate

Target	Reference
n, p	:Horowitz, C.J. (’02)
He4, C12	: Yoshida, T.+(’08)
Ni56 (neutral)	: Suzuki, T.+(’09)

The others from C13 to Kr80: Hoffman & Woosley (’92)

NEUTRINO MODEL

◆neutrino flux

$$\phi_{\nu i}(t) = \frac{1}{6}\frac{1}{4\pi r^2}\frac{E_\nu}{3.15T_{\nu i}}\frac{1}{\tau_\nu}\exp\left(-\frac{t-r/c}{\tau_\nu}\right)\Theta(t-r/c)$$

$$\nu i : \nu e\mu\tau, \bar{\nu} e\mu\tau$$

total neutrino energy : Ev, neutrino irradiation time：τv=3s (Ev= 0, 3e53, 9e53 ergs)

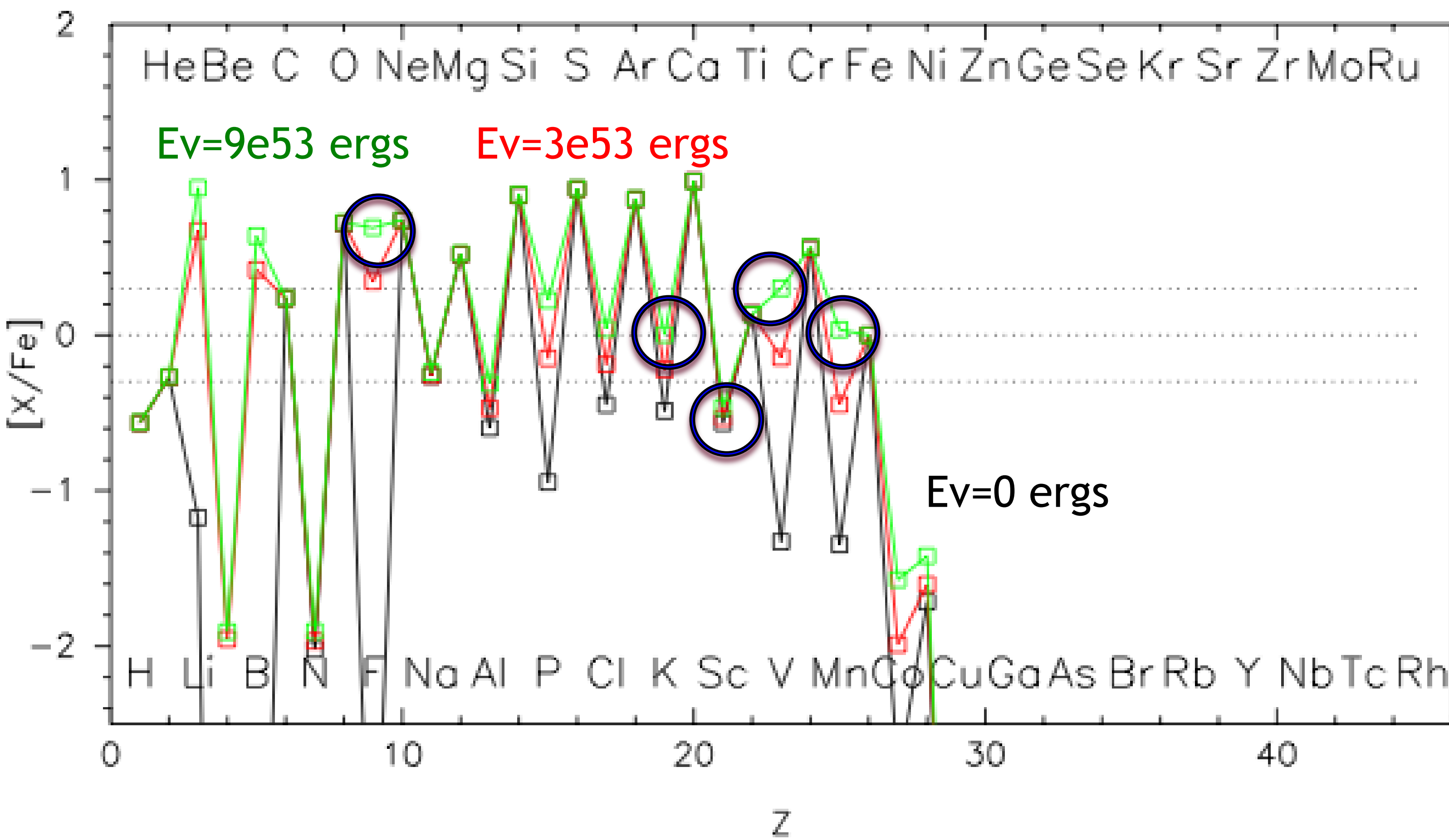
◆neutrino energy spectra

Fermi distribution $\eta_\nu = \mu_\nu / kT_\nu = 0$

$$(kT_{\nu e}, kT_{\bar{\nu} e}, kT_{\nu\mu\tau}) = (4,4,6)$$ (MeV)

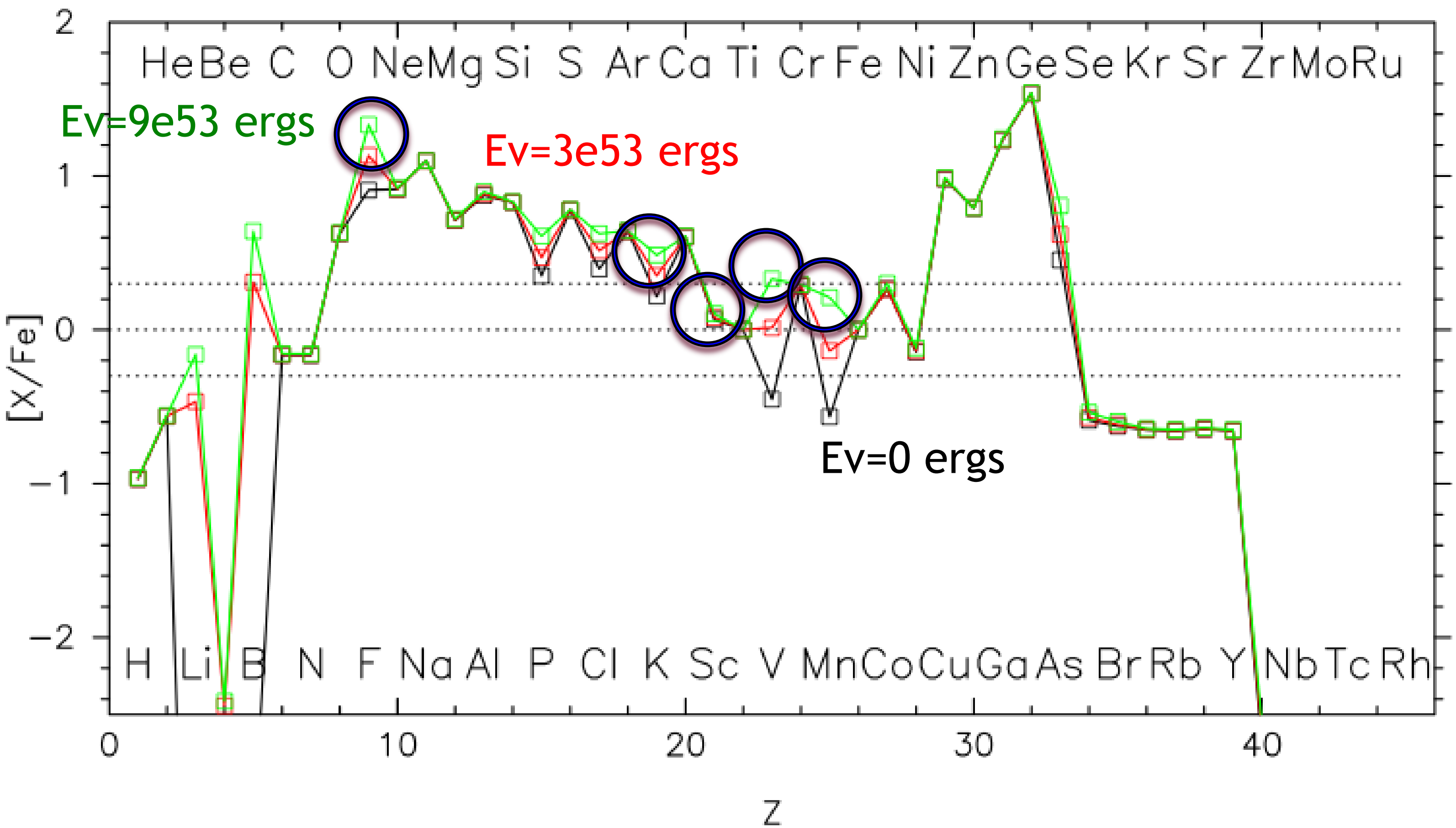
RESULT- SN YIELDS

25Msun, z= 0 , E = 1e51 ergs



RESULT- SN YIELDS

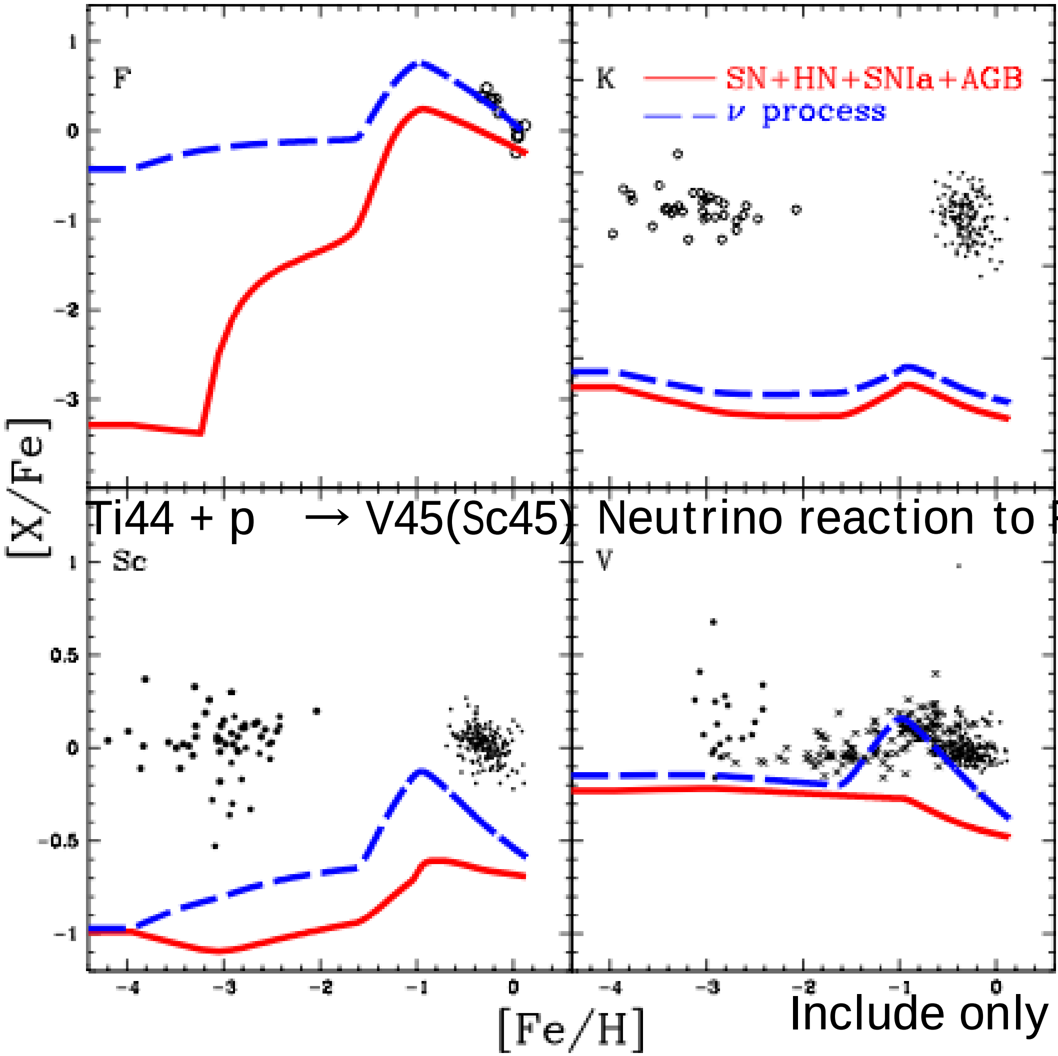
25Msun, z= 0.02 , E = 1e51 ergs



RESULT- GCE

Neutrino reaction to Ne20

Maybe neutrino reaction to Ar40



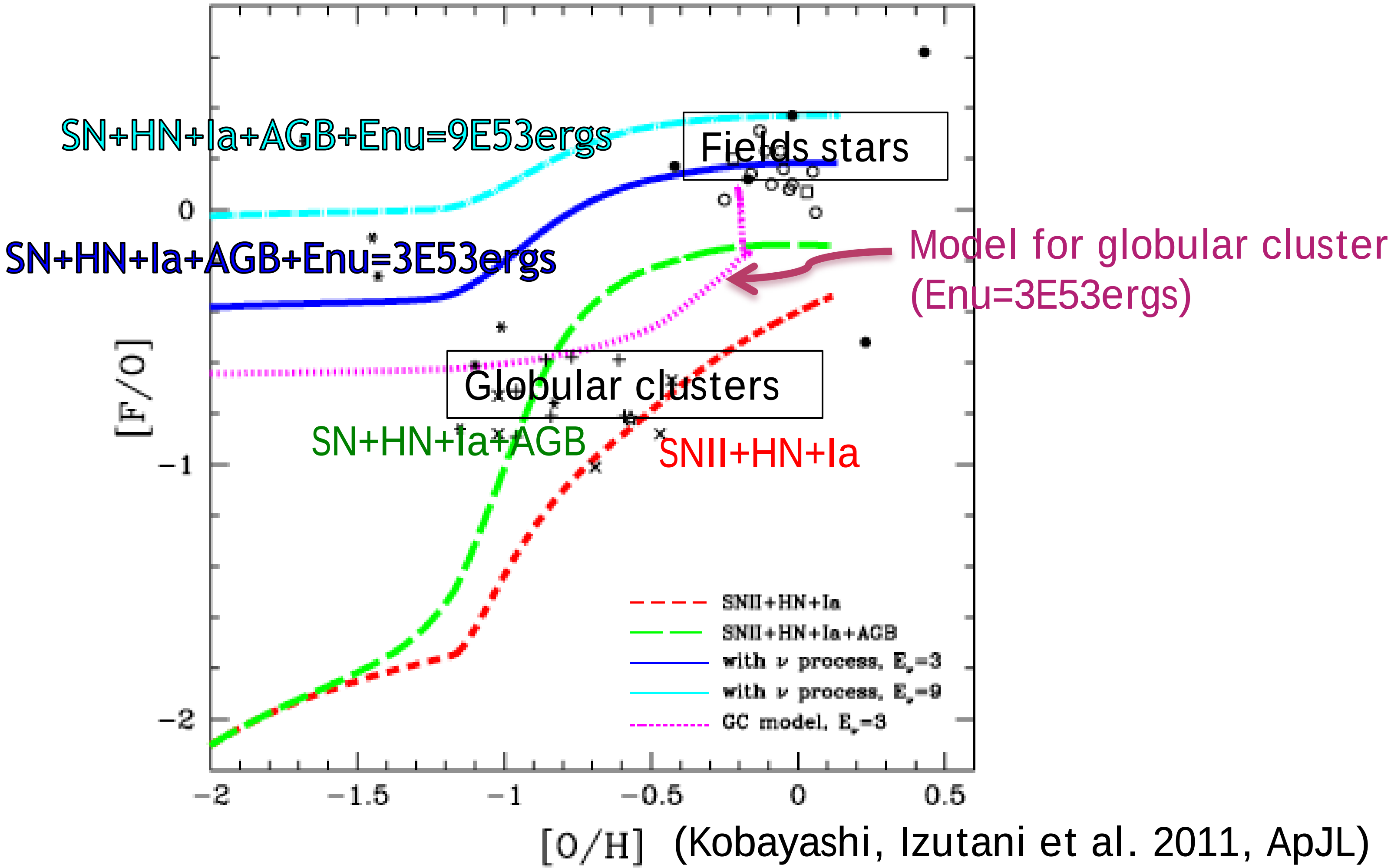
Ti44 + p → V45(Sc45)

Neutrino reaction to Fe52

The models
With
- 50Msun, E51=1,40,z=0
- 25Msun, E51=1,10,z=0
- 15Msun, E51=1,z=0
- 50Msun, E51=1,40,z=0.004
- 25Msun, E51=1,10,z=0.004
- 15Msun, E51=1,z=0.004
- 50Msun, E51=1,40,z=0.02
- 25Msun, E51=1,10,z=0.02
- 15Msun, E51=1,z=0.02

Include only 15,25,40Msun, z=0, 0.02, E51=1

RESULT- GCE 2



(Kobayashi, Izutani et al. 2011, ApJL)

CONCLUSION OF THE THIRD THEME

◆Neutrino processes improve
Sc, Mn, K,V, and especially F !