NUCLEOSYNTHESIS IN HIGH-ENTROPY HOT BUBBLES OF SNE AND ABUNDANCE PATTERNS OF EXTREMELY METAL-POOR STARS

Izutani & Umeda 2010, ApJL

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Motivation

● Extremely Metal-Poor (EMP) stars ([Fe/H]<-3) may reflect the nucleosynthetic result of Pop III supernova (SN) .

●High ratio of Zn and Co in EMP stars can be reproduced by Hypernova (HN) (Fig1) models (Umeda & Nomoto 2002; see also Izutani, Umeda & Tominaga 2009)

●EMP stars do not show the need for a HN component, and high ratio of Zn in EMP stars may reflect hot bubbles of SNe (Heger & Woosley 2008) (Fig2).

●SN model with hot bubbles can reproduce the ratios of EMP stars?

What is the origin of EMP stars? HNe or SNe?

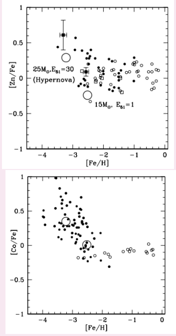


Fig1 (Umeda& Nomoto 2002)

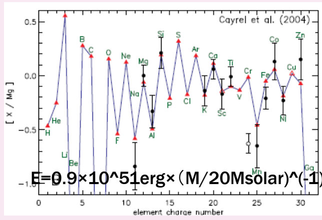
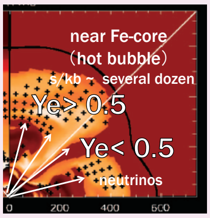


Fig2 (Heger & Woosley 2008)

Models & Method



(Janka et al. 2003)

Fig 3

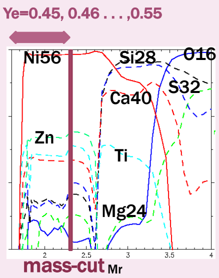


Fig 4: Illustration of our model.

●We calculate nucleosynthesis in the regions below "mass-cut" with modified Ye from 0.45 to 0.55 and modified density mimicking hot bubbles of multi-dimensional SN simulations (Fig 4) (e.g., Janka et al. 2003 (Fig 3))

●Calculate the total yield, i.e.,
matter above mass-cut + ΔM of matter in hot bubbles for the SN model ($M=15M_\odot$, $E=1\times10^{51}$erg)
matter above mass-cut for the HN model ($M=25M_\odot$, $E=20\times10^{51}$erg)

Results

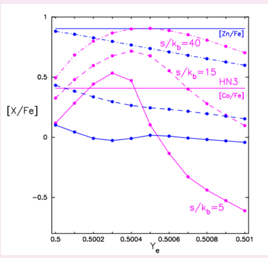


Fig 5: [Co,Zn/Fe] in "hot bubbles" of SNe.

(Izutani & Umeda 2010)

●Matter with 0.50<=Ye<=0.501 shows better fitting to the abundance of EMP stars than n-rich (0.45-0.49) and p-rich (0.51-0.55) matter. [Co/Fe] once increases as Ye increases, but decreases for larger Ye (Fig 5).

●N-rich matter (0.45-0.49) and p-rich (0.51-0.55) matter also produce Co and Zn, but at the same time, tend to overproduce Ni and Cu. (Fig6)

●If slightly p-rich matter with 0.50 <= Ye < 0.501 of s/kb ~ 15-40 is ejected as mush as 0.06 $M_\odot$, even normal SNe can reproduce the abundance of EMP stars, though it requires fine-tuning of Ye. On the other hand, HNe can more easily reproduce the observations of EMP stars (Fig6).

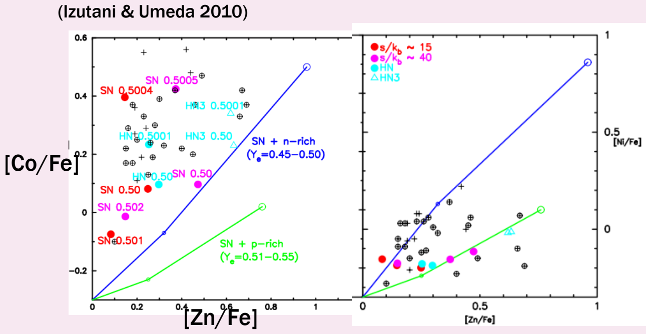


Fig 6: Comparison between observed abundance ratios and those in our models. (Izutani & Umeda 2010)

Left panel: [Co/Fe] vs. [Zn/Fe]. Right panel: [Ni/Fe] vs [Zn/Fe].

HNe are the most possible origin of EMP stars!!

Please read Izutani & Umeda 2010, ApJL !!!