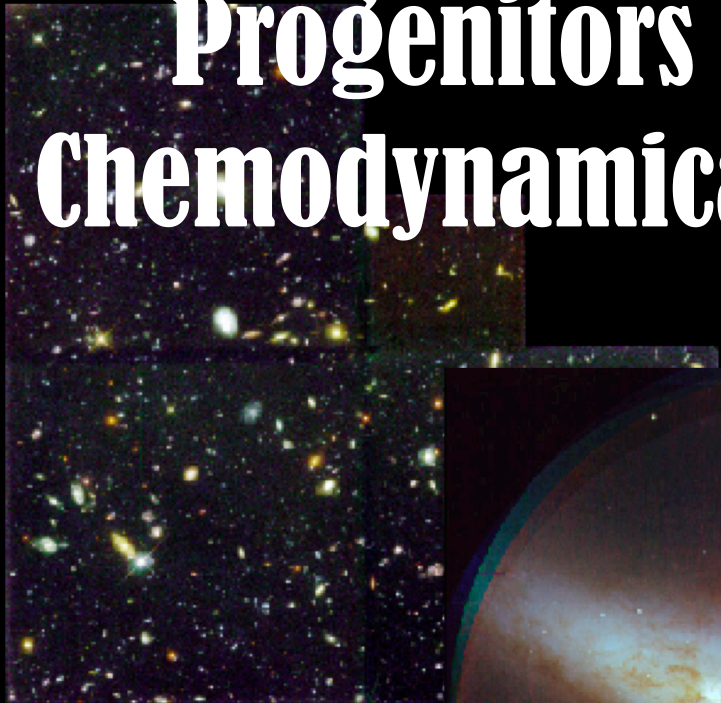
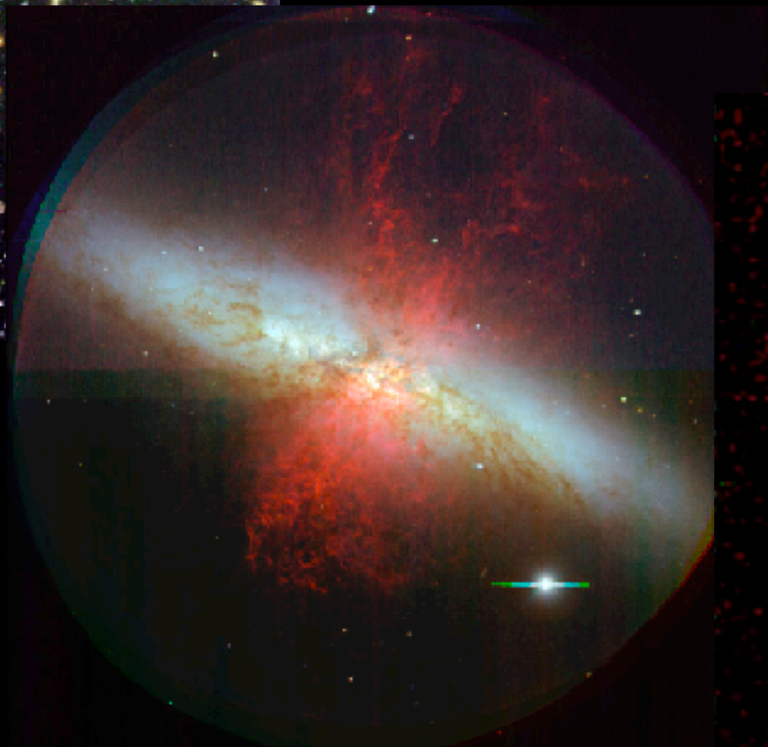
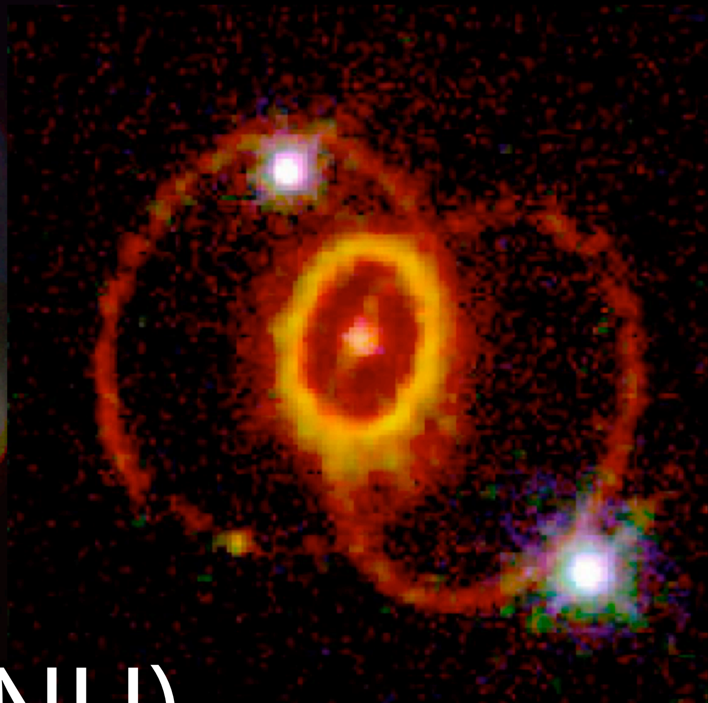
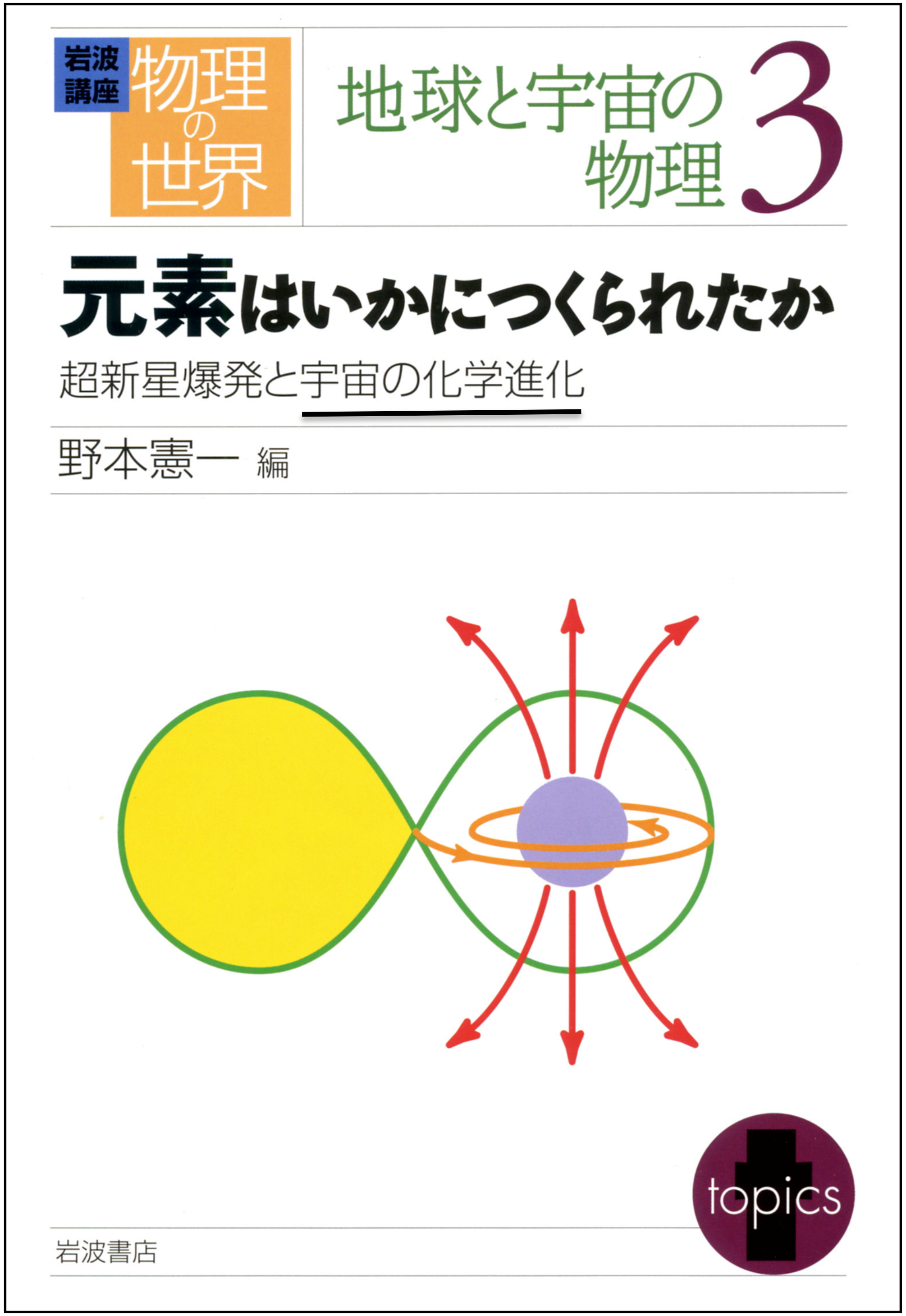
Progenitors of Type Ia Supernova and Chemodynamical Simulations of Galaxies







Chiaki Kobayashi (ANU)



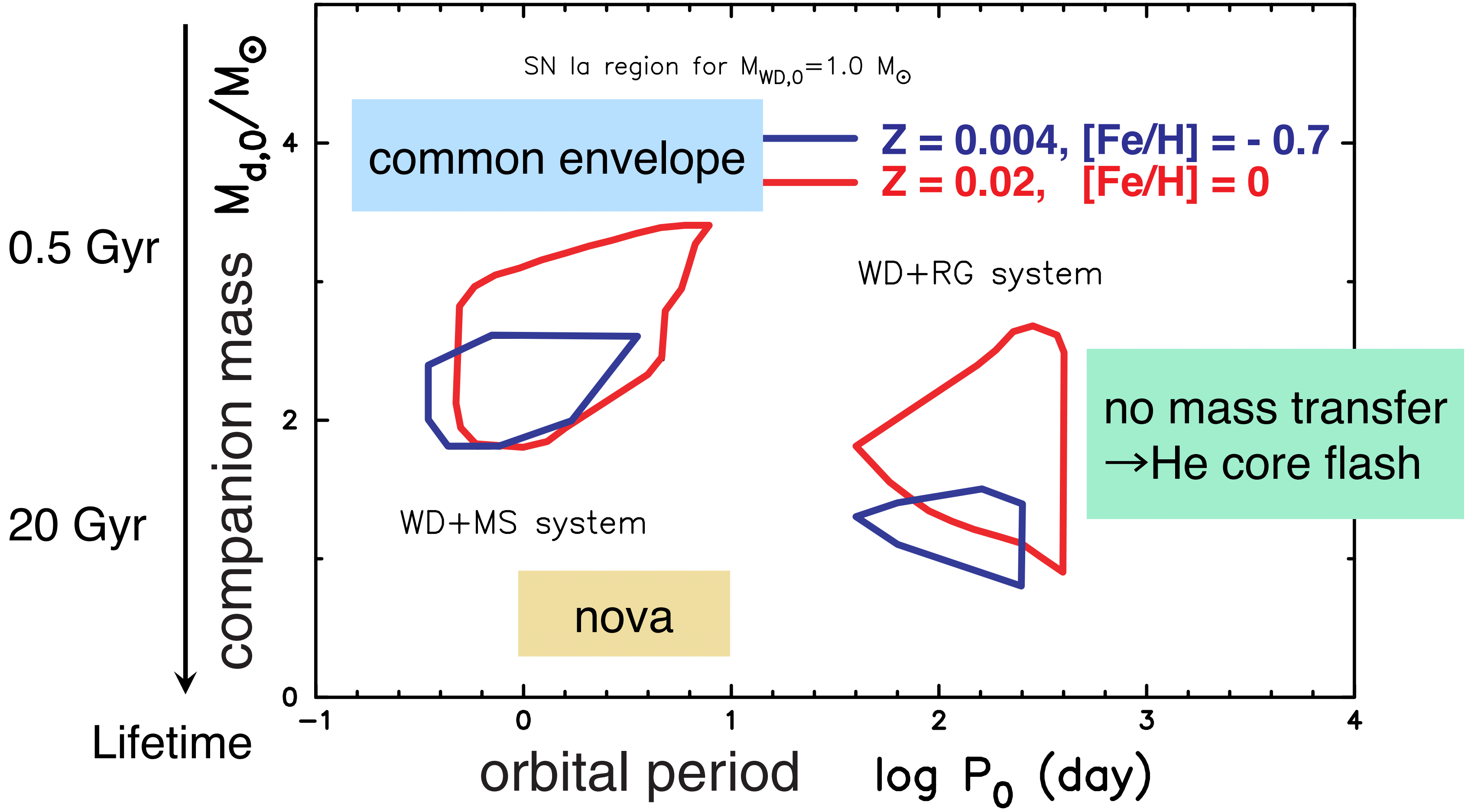
Origin of Elements

Supernova explosion and
Cosmic chemical evolution
Edited by Ken'ichi Nomoto

- SD scenario
- HKN (96) wind model
  - WD+MS & WD+RG systems
- Accretion of H-rich matter
- → **Optically thick winds from WD**
  - $M_{2,RG} \sim 1 M_\odot$, $M_{2,MS} \sim 3 M_\odot$
- → **Stripping Effect**(HKN08)
  - max $M_{2,MS} \sim 5\text{-}7 M_\odot$

Metallicity Effect on SNe Ia

- No SNIa at [Fe/H]<-1.1 (Kobayashi, Tsujimoto, Nomoto, Hachisu, Kato 1998)

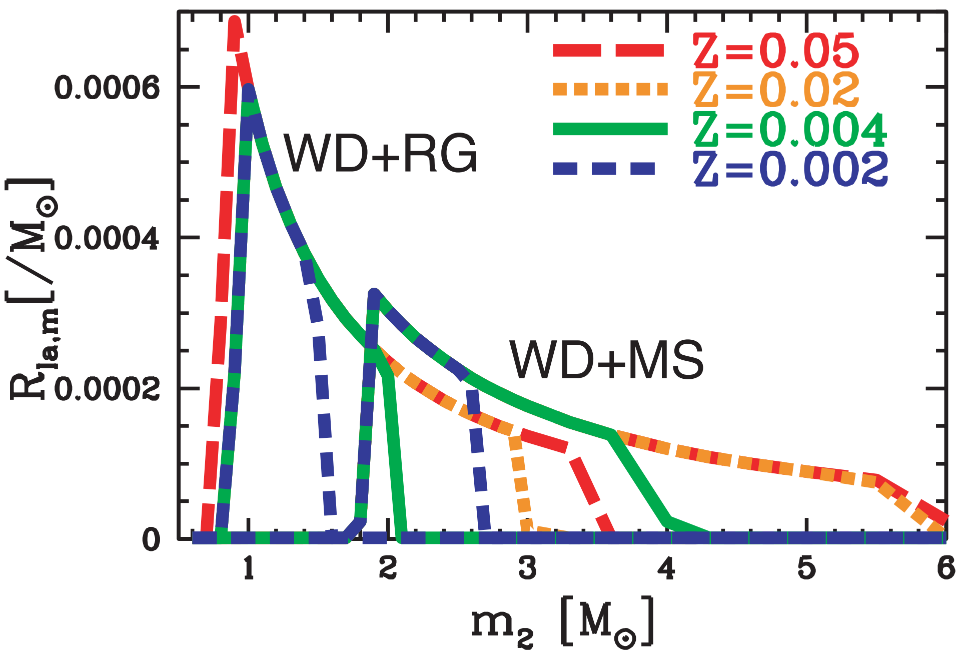


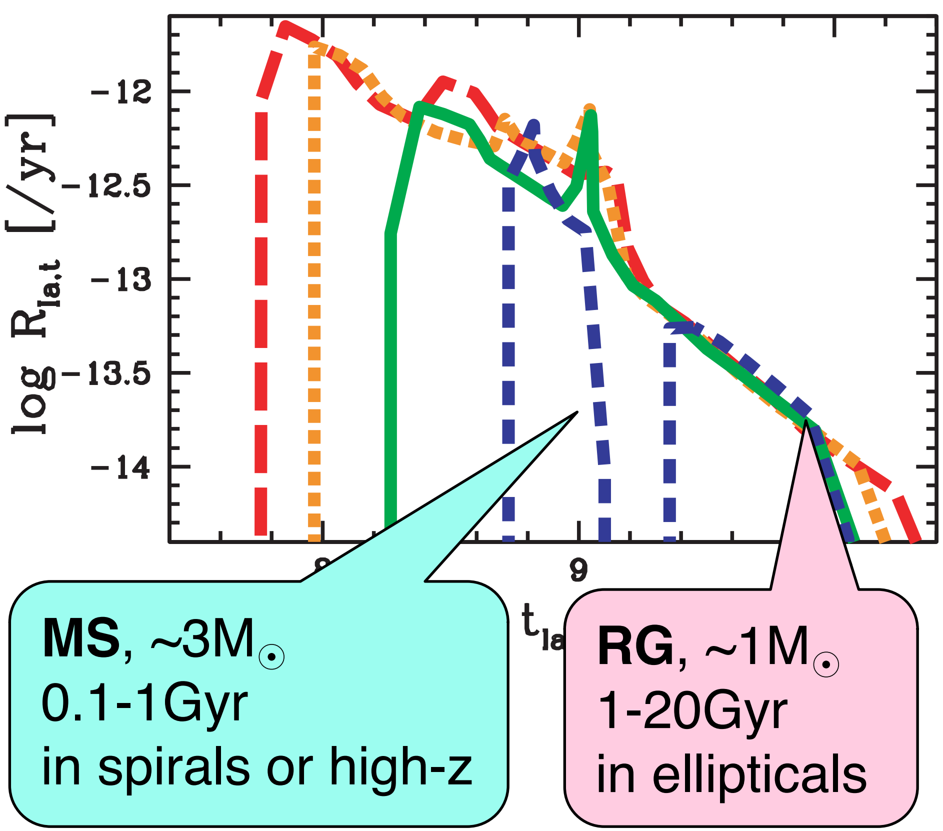
Lifetime Distribution (KN09)

- SN Ia Lifetime ~ lifetime of companion star
- Companion mass ranges from HKN's binary calculation

$$\mathcal{R}_{\rm Ia} = b \int_{\max[m_{\rm 1p,\ell}, m_t]}^{m_{\rm 1p,u}} \frac{1}{m}\phi(m)\,{\rm d}m \int_{\max[m_{\rm 1d,\ell}, m_t]}^{m_{\rm 1d,u}} \frac{1}{m}\phi_{\rm d}(m)\,{\rm d}m .$$

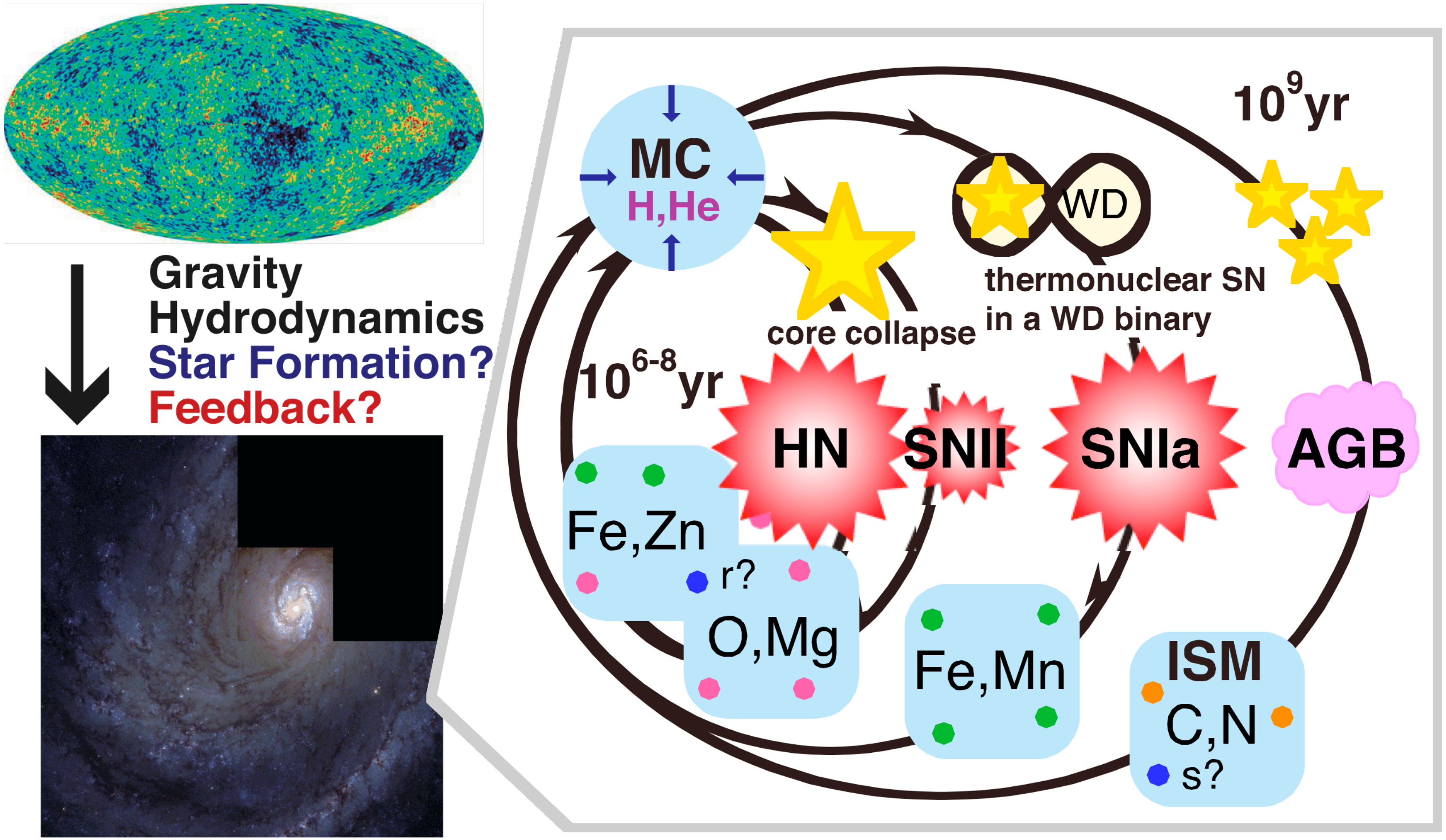
primary WD   secondary star





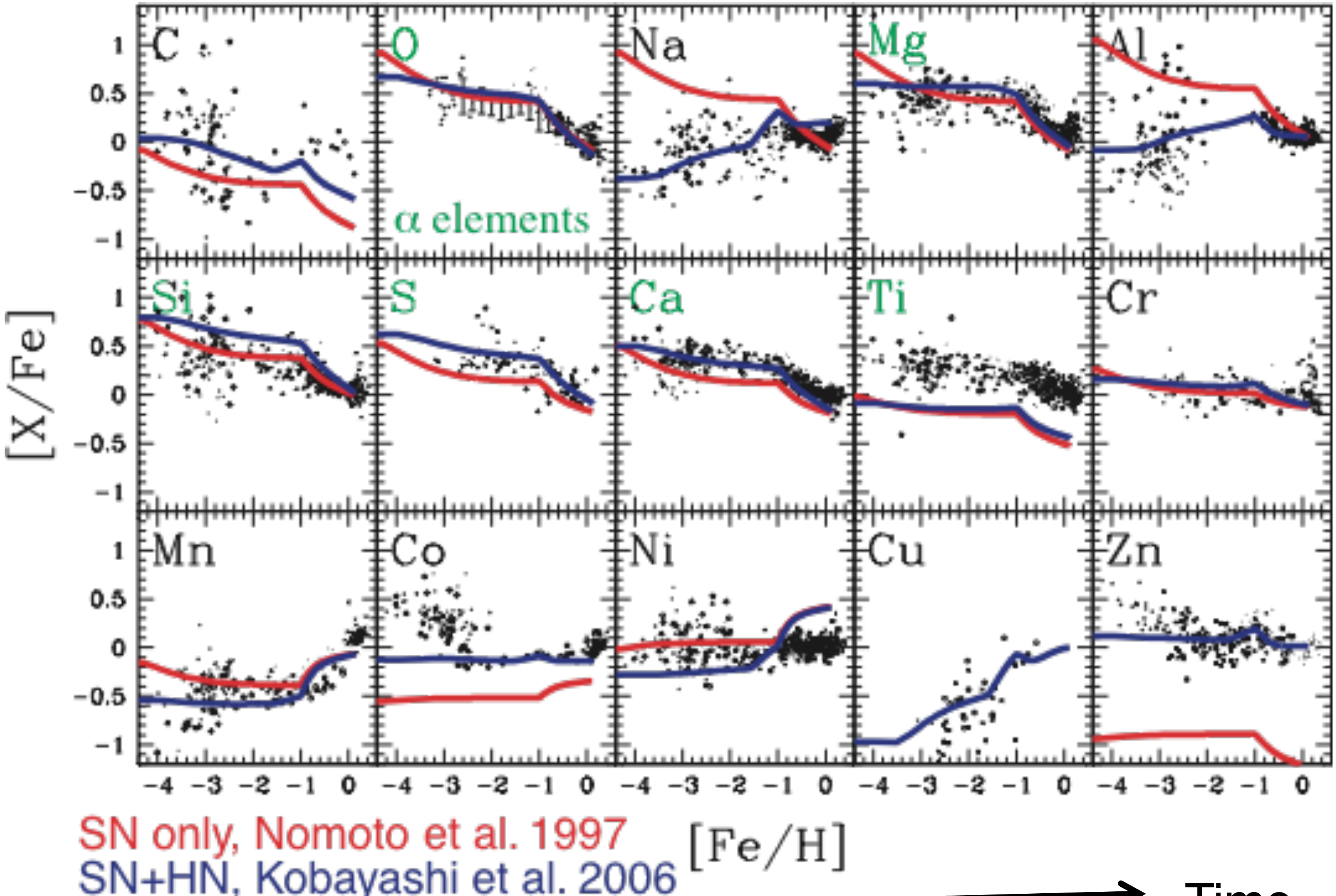
Chemical Evolution of galaxies

Chemical Evolution



- [Fe/H] and [X/Fe] evolve in a galaxy: fossils to trace the evolution history of the galaxy → **Galactic Archaeology**

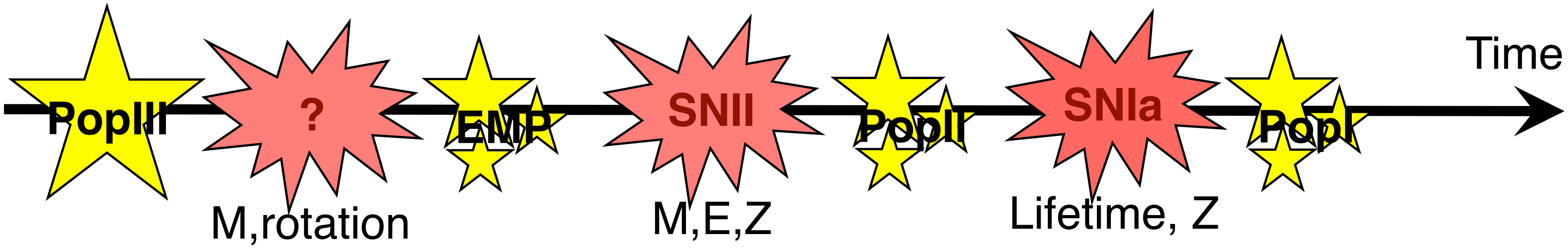
[X/Fe]-[Fe/H] relations

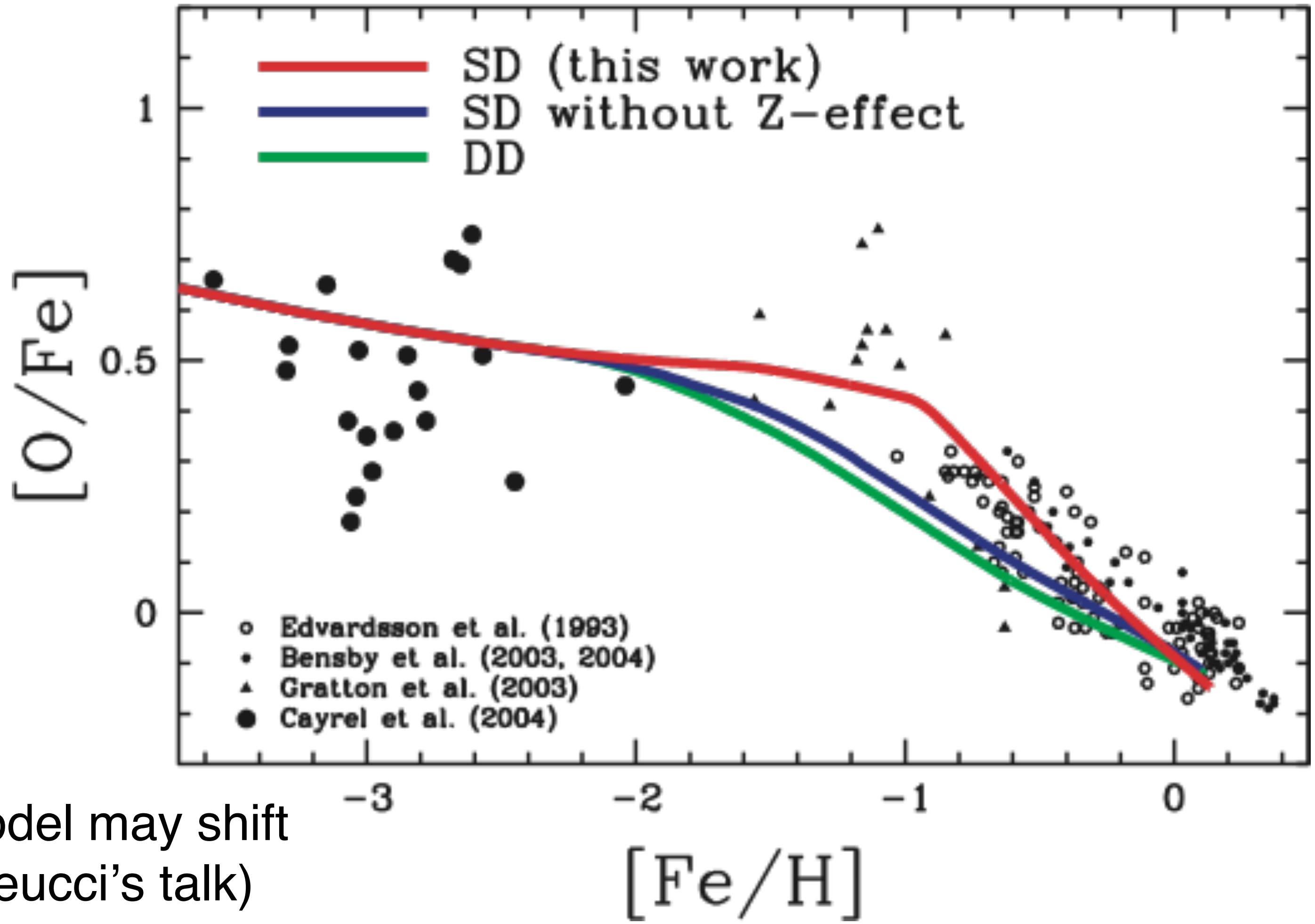


HN fraction =0.5 for M>20$M_{\odot}$

Time

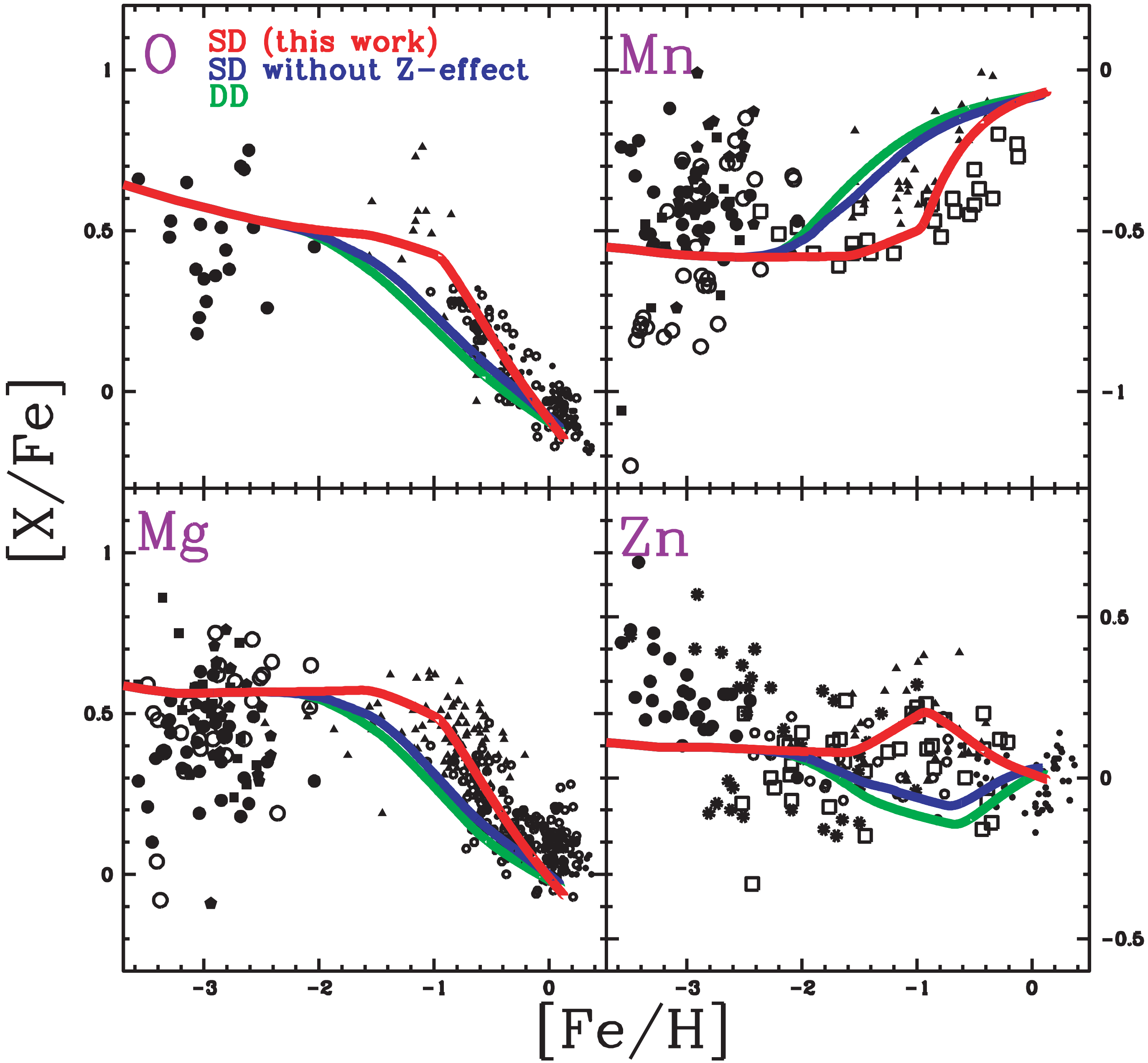
[α/Fe]-[Fe/H] relation



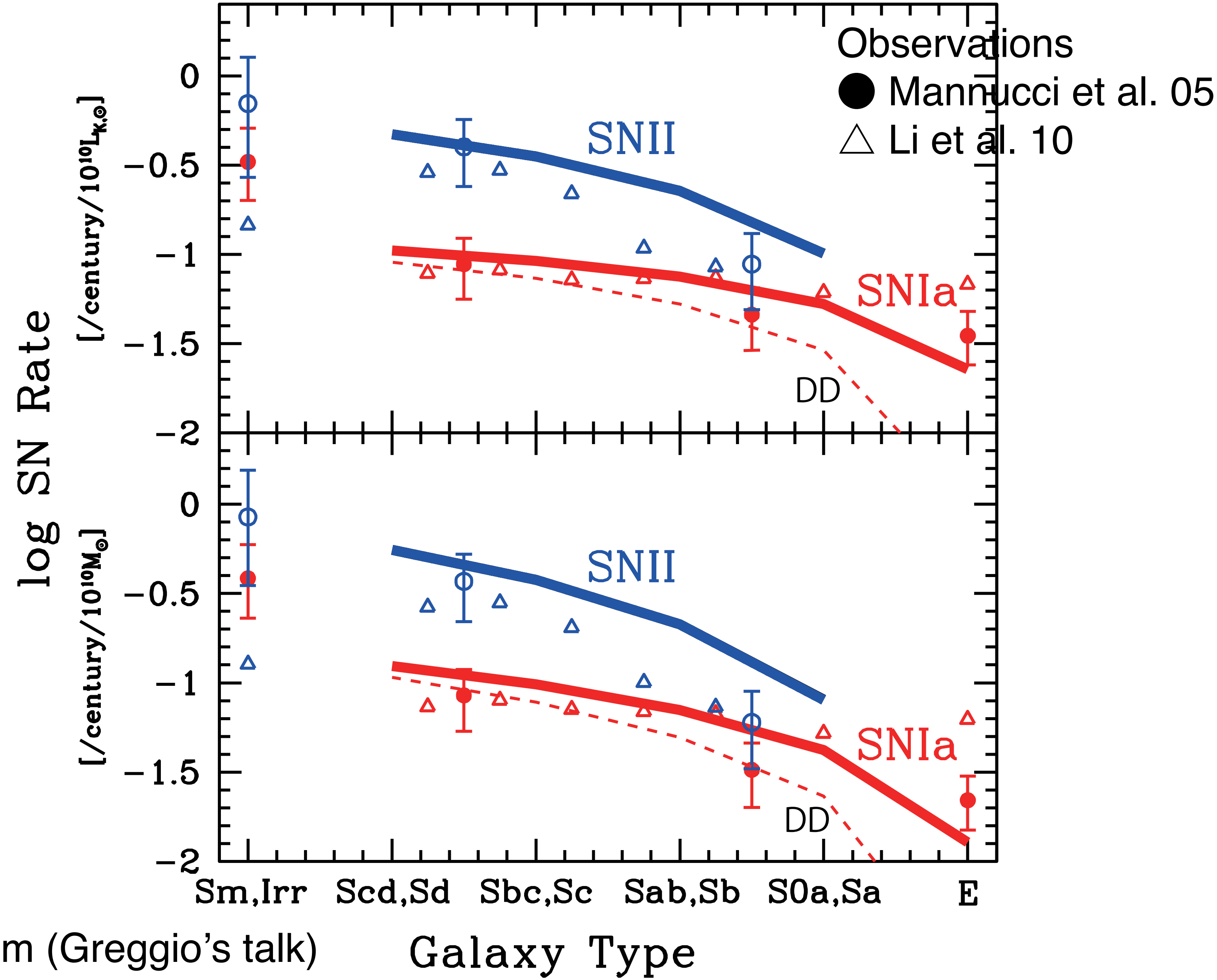


※Dual Infall model may shift the knee (Matteucci's talk)

[X/Fe]-[Fe/H] relations



Galactic SN Rates

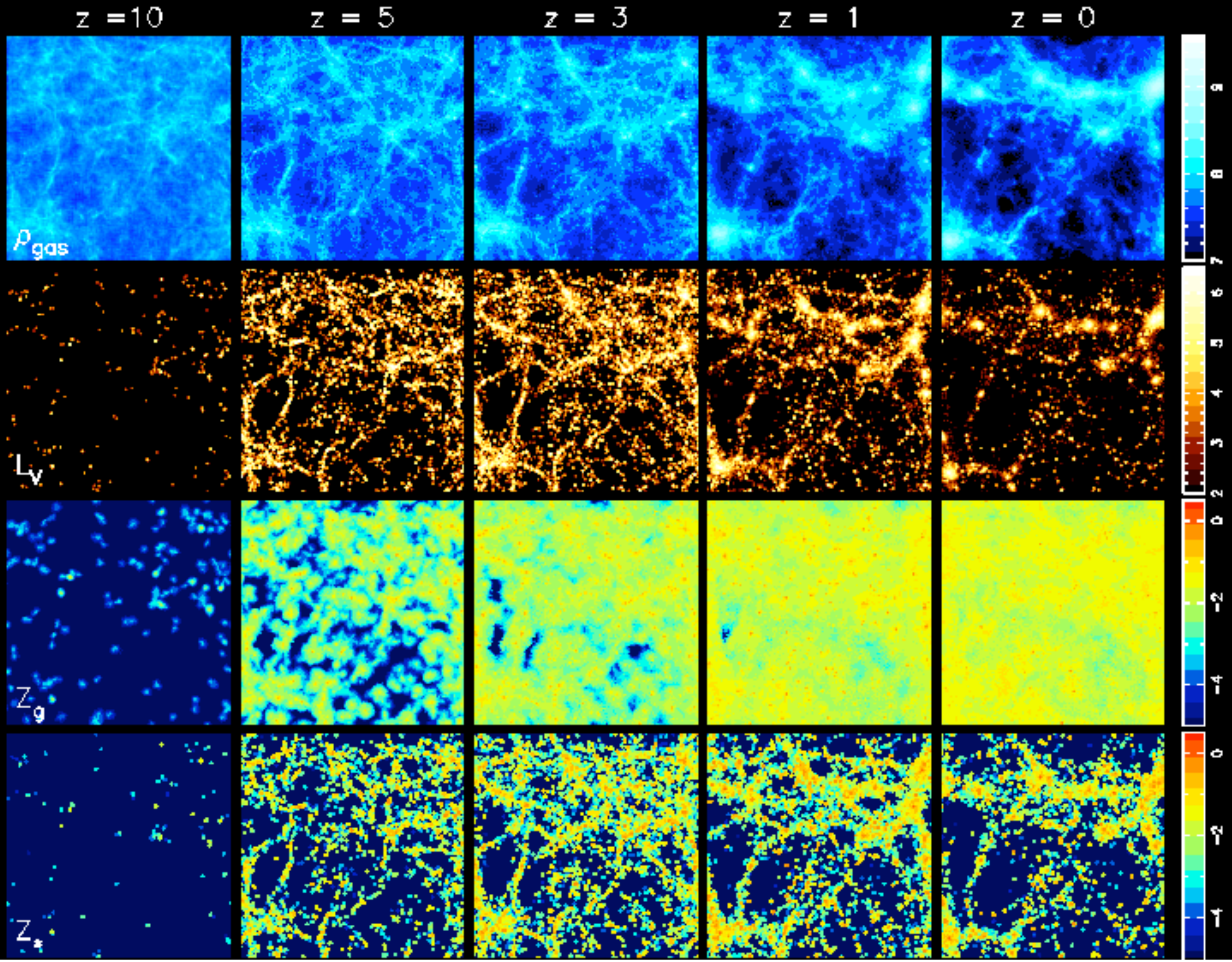


※No Problem (Greggio's talk)

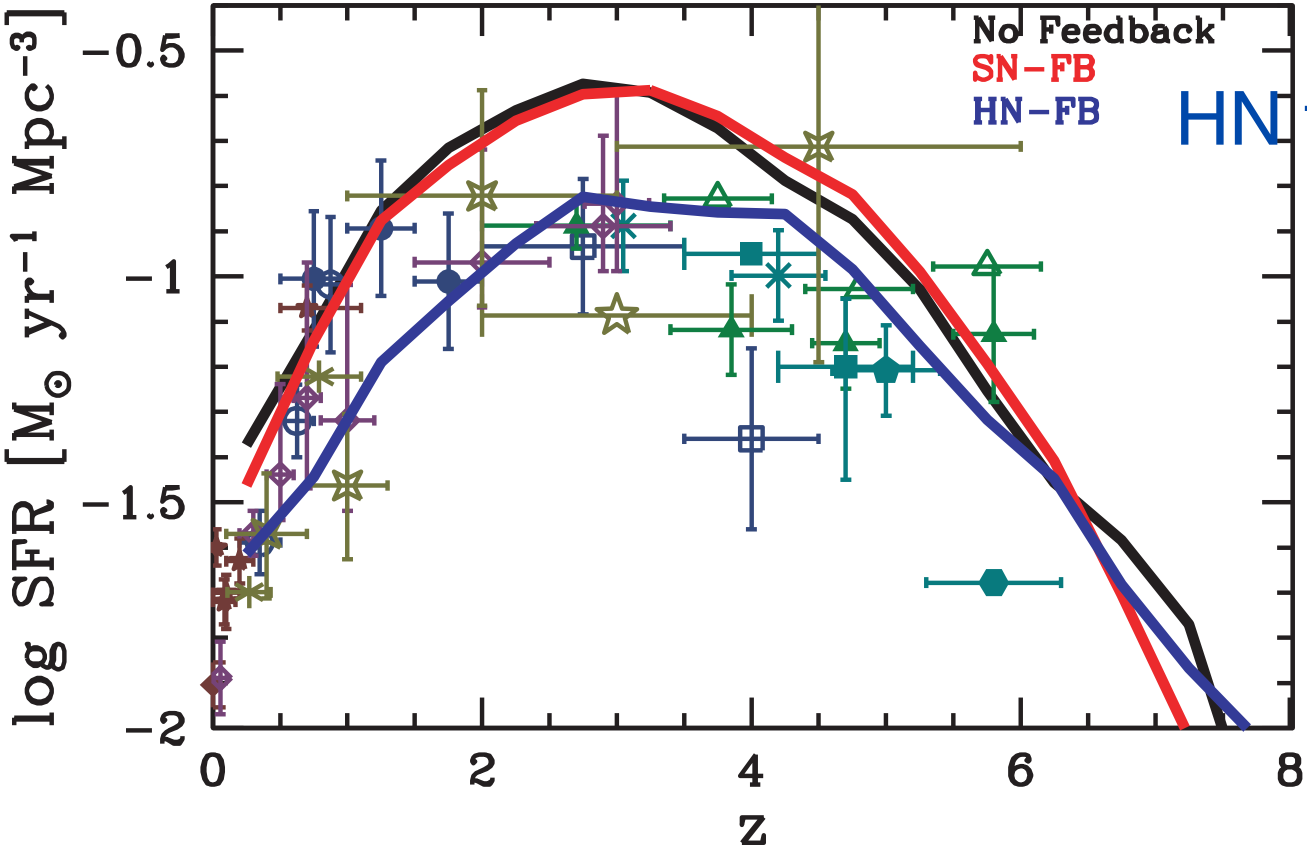
Chemodynamical Simulations of galaxies

Cosmological Simulation

See http://www.mso.anu.edu.au/~chiaki/works/ for the movie



Cosmic Star Formation Rate



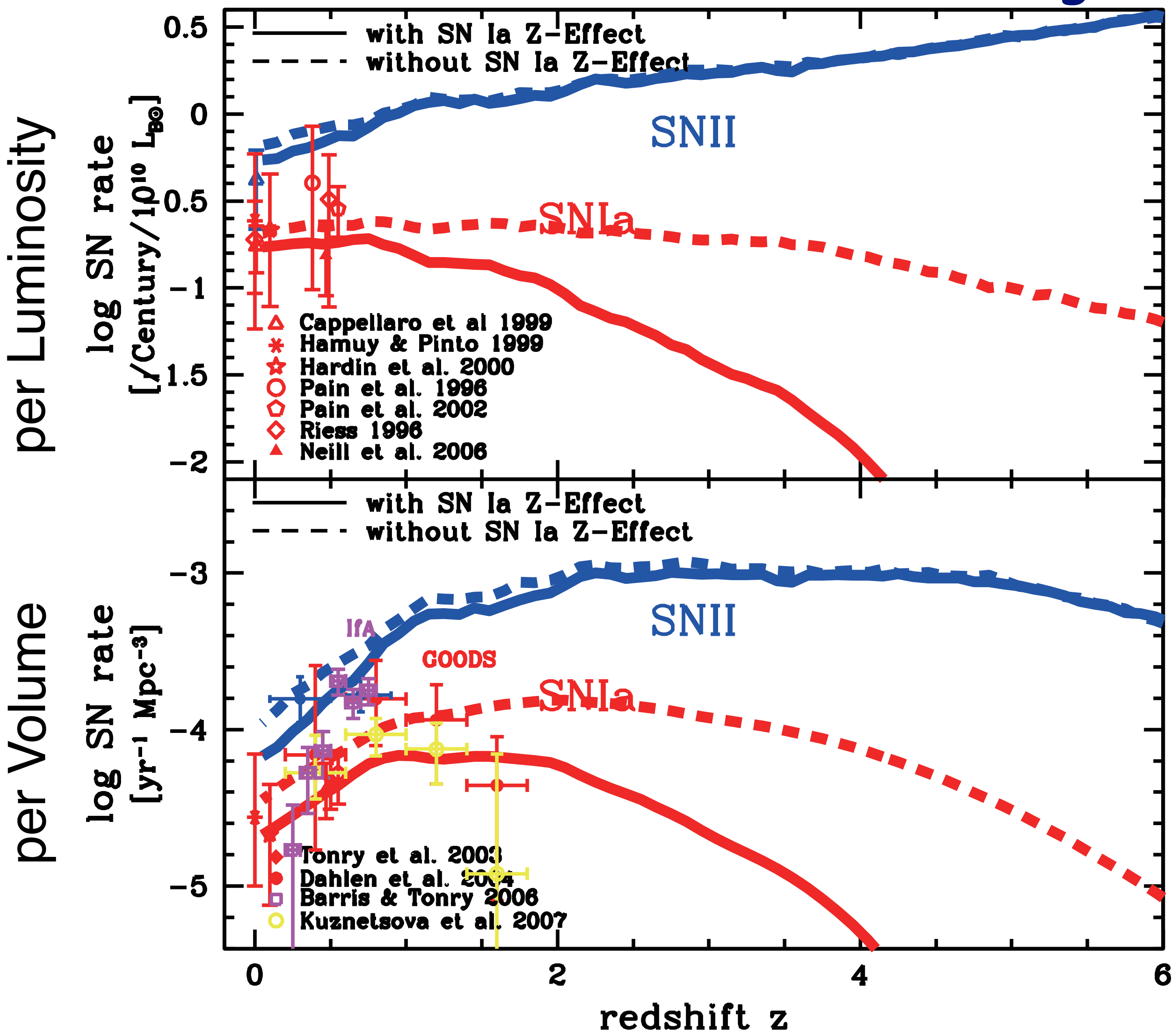
HN feedback

UV: Lilly+ 95, Connolly+ 97, Madau+ 98, Steidel+ 99, Bouwens+ 03, Giavalisco+ 04, Ouchi+ 04, Iwata+ 03, Bunker+ 04, Schiminovich+ 05,
Hα: Gallego+ 95, Perez-Gonzalez+ 03, Gronwall 99, Brinchmann+ 04, Tresse & Maddoz 98, Tresse+ 02,
X-ray: Norman+ 04, radio: Barger+ 00, Submilli: Hughes+ 98.

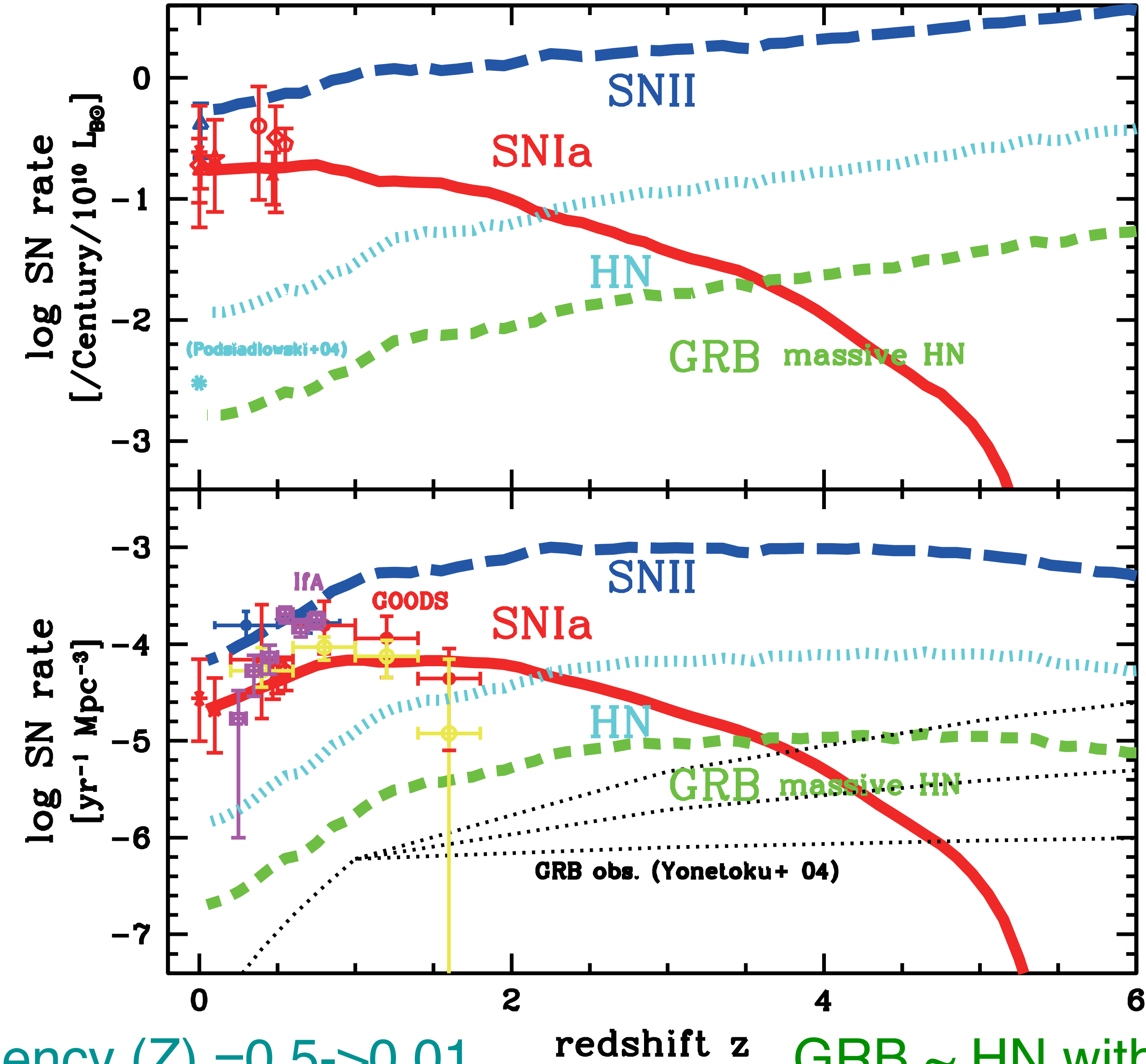
With dust correction

CK, Springel, White 2007

Cosmic SN rate history



Cosmic SN/GRB rate history



HN efficiency (Z) =0.5->0.01

GRB ~ HN with $M>40M_{\odot}$

Summary

- Chemical Evolution with SD scenario + HKN wind model

Low Z	1 (MS) to 10 (RG) Gyr
High Z	0.1 (MS) to 20(RG) Gyr

  - prompt: 10% (<0.1Gyr), 50% (<1Gyr) in MW-type galaxy
- A large fraction of HNe is required (50% of $M>20M_\odot$ @$Z<Z_\odot$, 1% @$Z=Z_\odot$) from
  - [(Zn,Co)/Fe]-[Fe/H] relation in the solar neighborhood
  - Cosmic Star Formation History as feedback sources
- The metallicity effect (few SNe Ia@[Fe/H]<-1.1)
  - more strongly required from [(α,Mn)/Fe]-[Fe/H] relation in the presence of young population of SNe Ia
  - Cosmic SN Ia rate rapidly decreases from z~2
- Properties of Host Galaxies from cosmological chemodynamical simulations
  - Metal-rich for SNIa, metal-poor for GRB, smaller difference@high-z