Detailed chemical evolution in the Munich semi-analytic model

Rob Yates
with Bruno Henriques and Peter Thomas

MPA

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Outline

- **Our GCE set-up**
  - Supernova yields and rates
  - Storing star formation histories
  - SN-Ia DTDs
- **Comparison with Milky Way disc stars**
  - [Fe/H] and [O/Fe] distributions
- **Comparison with local ellipticals**
  - The M_*-[O/Fe] relation

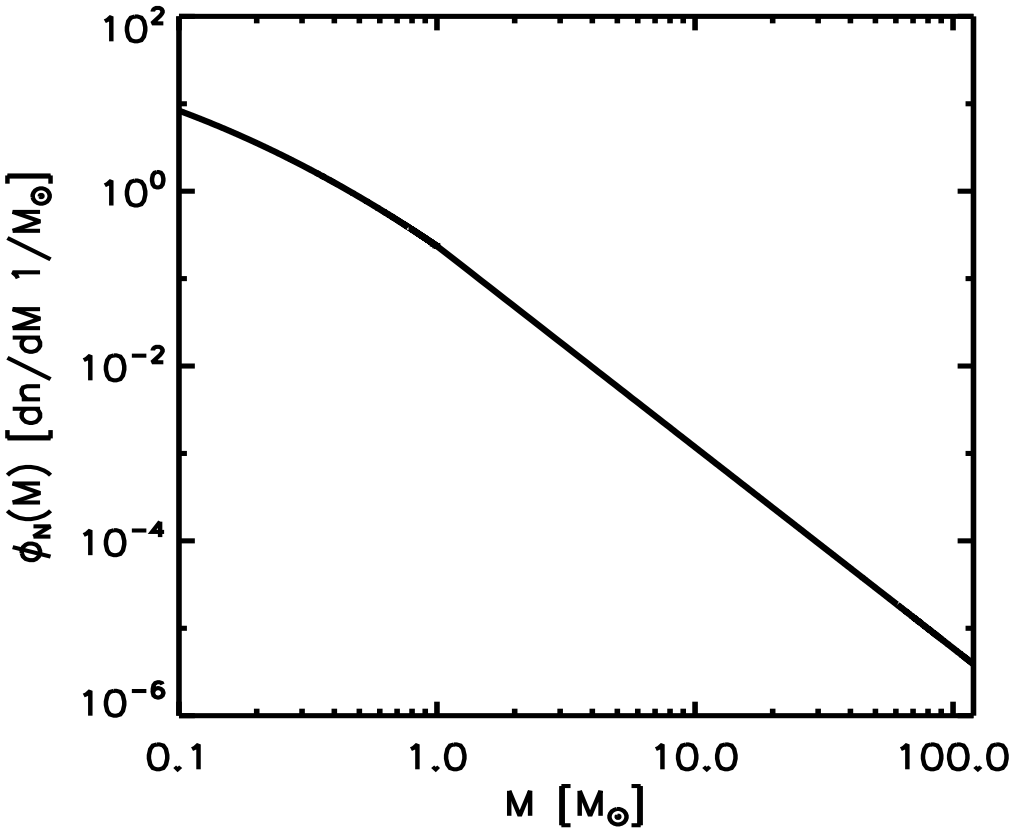
Dependence on SFH resolution

The GCE equation

$$e_Z(t) = \int_{M_L}^{M_U} M_Z(M, Z_0)\ \psi(t - \tau_M)\ \phi(M)\ \mathrm{dM}$$

Chabrier IMF

$$e_Z(t) = \int_{M_L}^{M_U} M_Z(M, Z_0)\ \psi(t - \tau_M)\ \phi(M)\ \mathrm{dM}$$



Yield tables

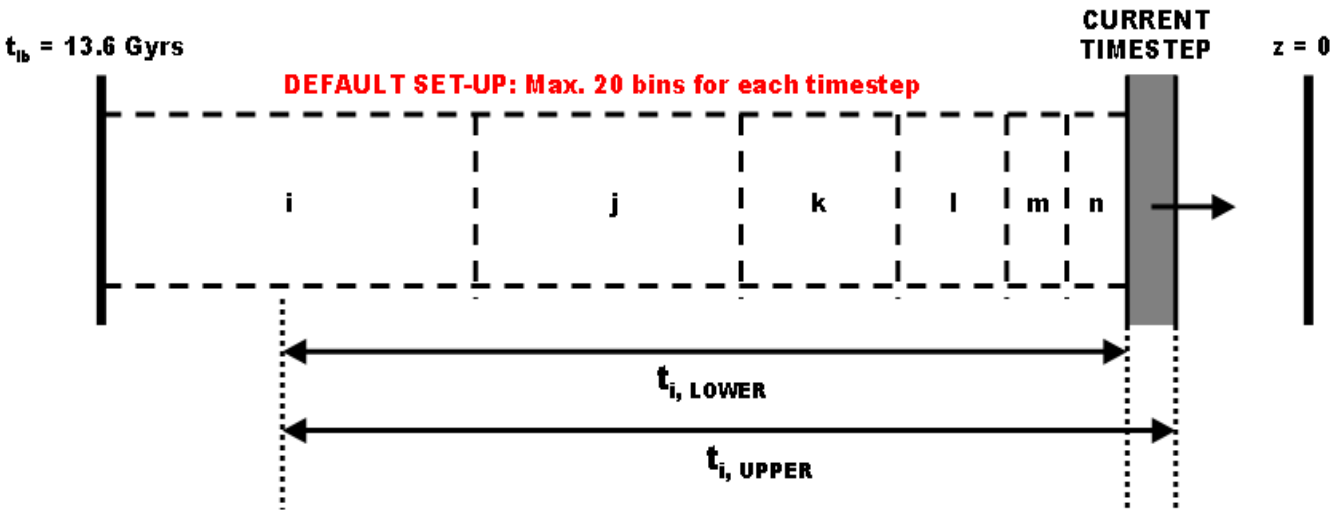
$$e_Z(t) = \int_{M_L}^{M_U} M_Z(M, Z_0)\ \psi(t - \tau_M)\ \phi(M)\ \mathrm{dM}$$

We track: H, He, C, N, O, Ne, Mg, Si, S, Ca & Fe

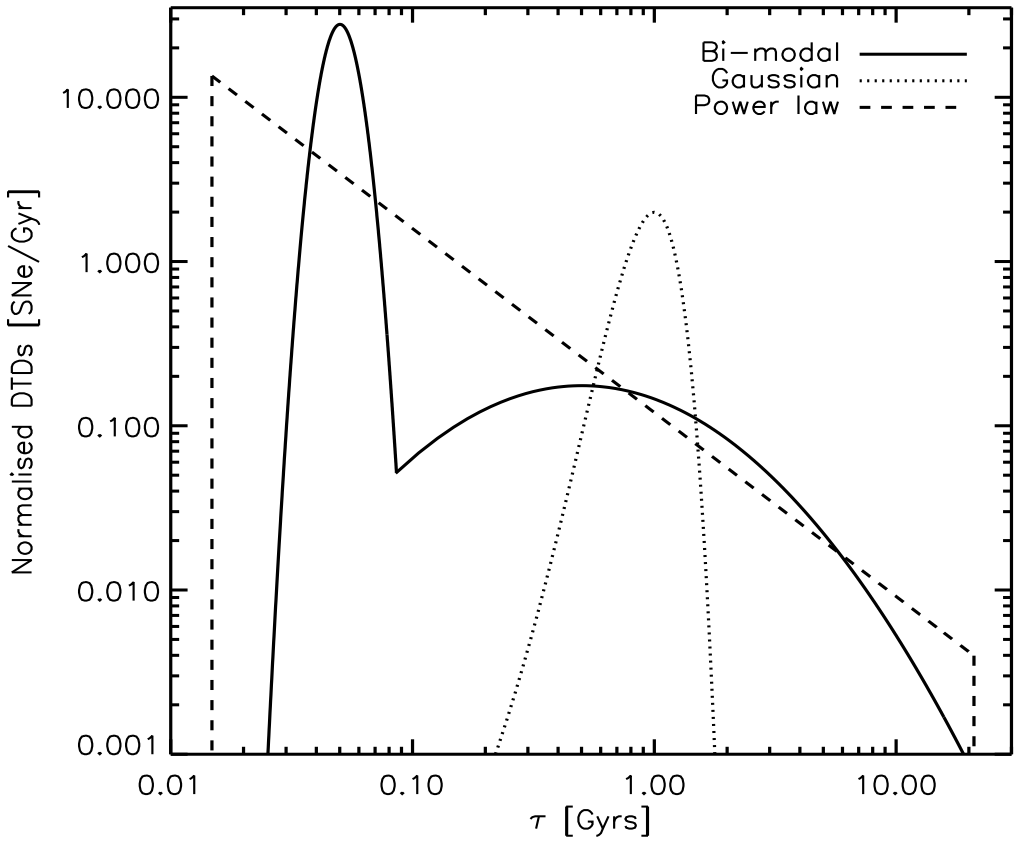
Table type	Reference	Masses ($M_\odot$)	Metallicities (M_Z/M)
Stellar lifetimes	Portinari et al. (1998)	30 [0.6 $\leqslant M \leqslant$ 120.0]	6 [0.0004 $\leqslant Z \leqslant$ 1.0]
AGB winds	Marigo (2001)	21 [0.85 $\leqslant M \leqslant$ 5]	3 [0.004 $\leqslant Z \leqslant$ 0.019]
SNe-Ia	Thielemann et al. (2003)	–	–
SNe-II	Portinari et al. (1998)	15 [6 $\leqslant M \leqslant$ 120]	5 [0.0004 $\leqslant Z \leqslant$ 0.05]
SNe-II	Chieffi & Limongi (2001)	15 [13 $\leqslant M \leqslant$ 35]	6 [0.0 $\leqslant Z \leqslant$ 0.02]

SFH bins

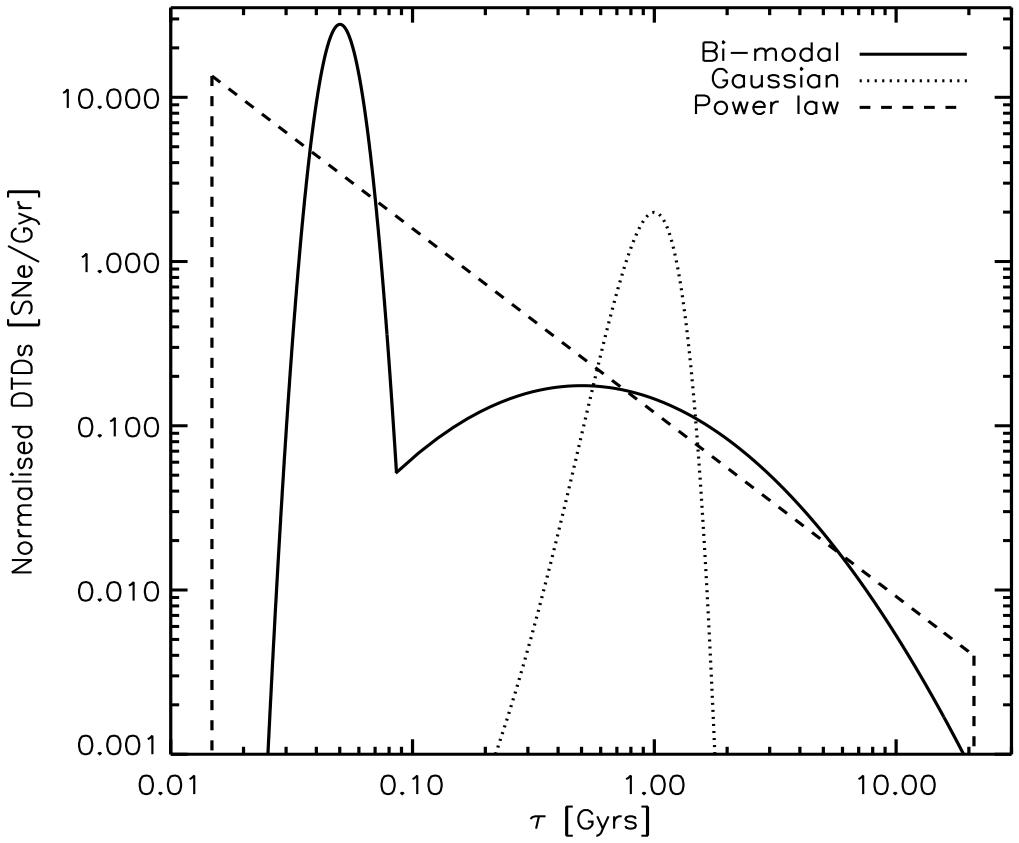
$$e_Z(t) = \int_{M_L}^{M_U} M_Z(M, Z_0)\ \psi(t - \tau_M)\ \phi(M)\ \mathrm{dM}$$



Supernova Ia rates



Fiducial GCE parameters



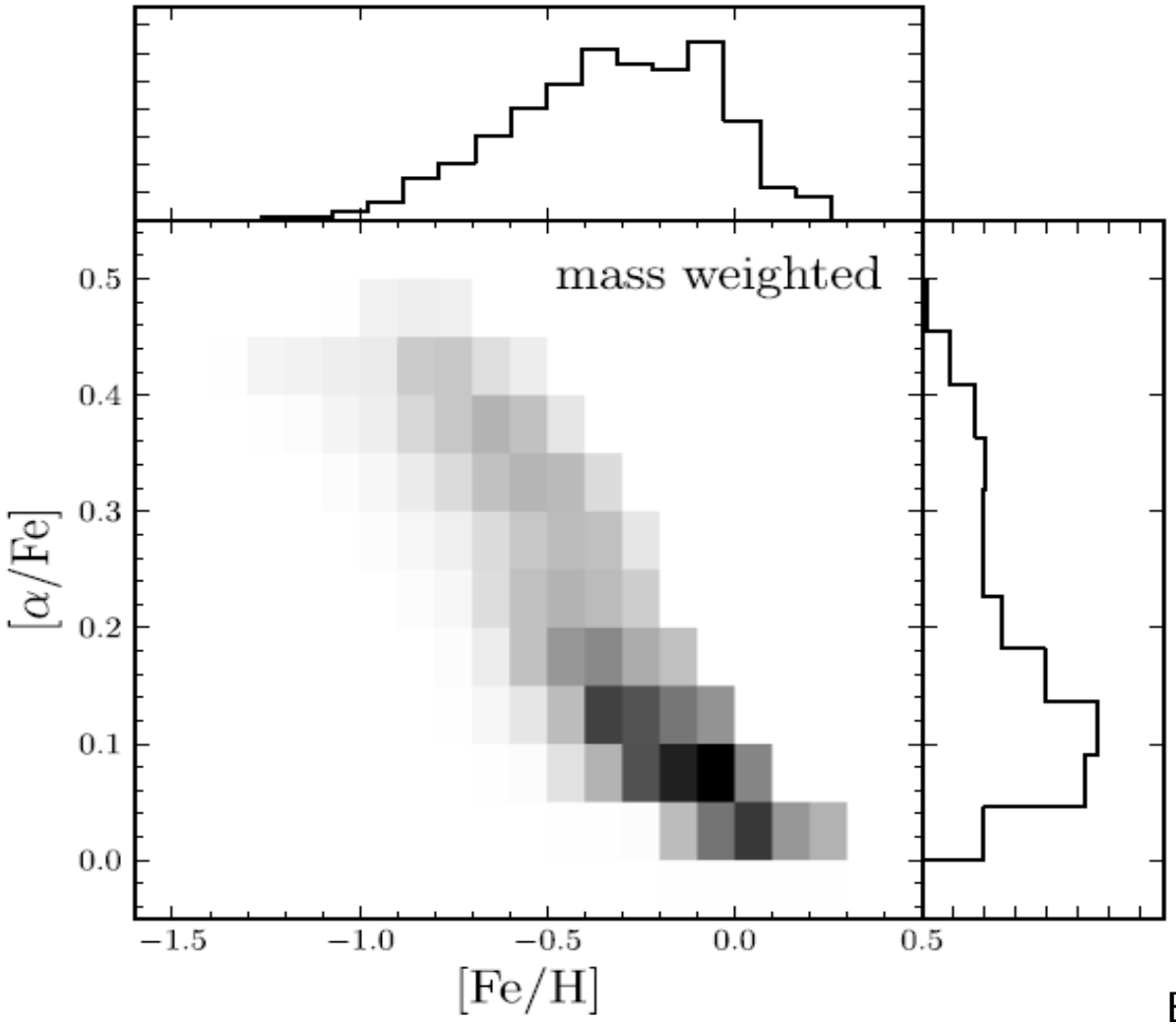
SN-II yields	SN-Ia DTD	A	M_{max}
P98	Bi-modal	0.08	120 $M_{\odot}$

Composition of MW disc G-dwarfs

MW-type galaxy sample ($z = 0$)

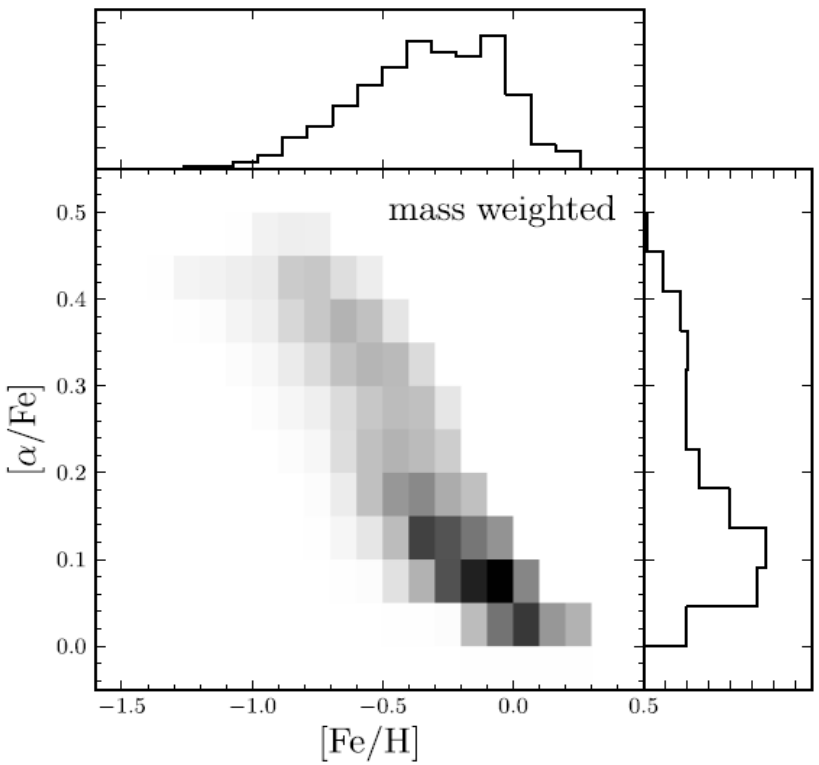
- $11.5 \leq \log(M_{\text{DM halo}}) \leq 12.5$
- Type 0 (central) galaxy
- $M_{\text{bulge}}/M_{*} < 0.5$
- $1.0 \leq \text{SFR}[M_{\odot}/\text{yr}] \leq 10.0$, in the last ~ 3.5 Gyrs

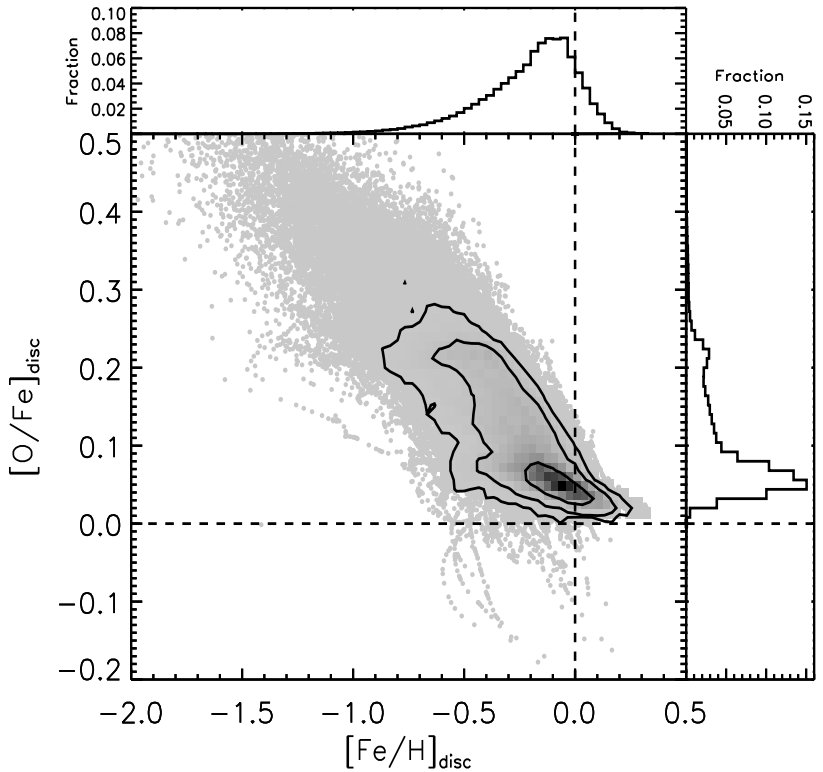
Observations



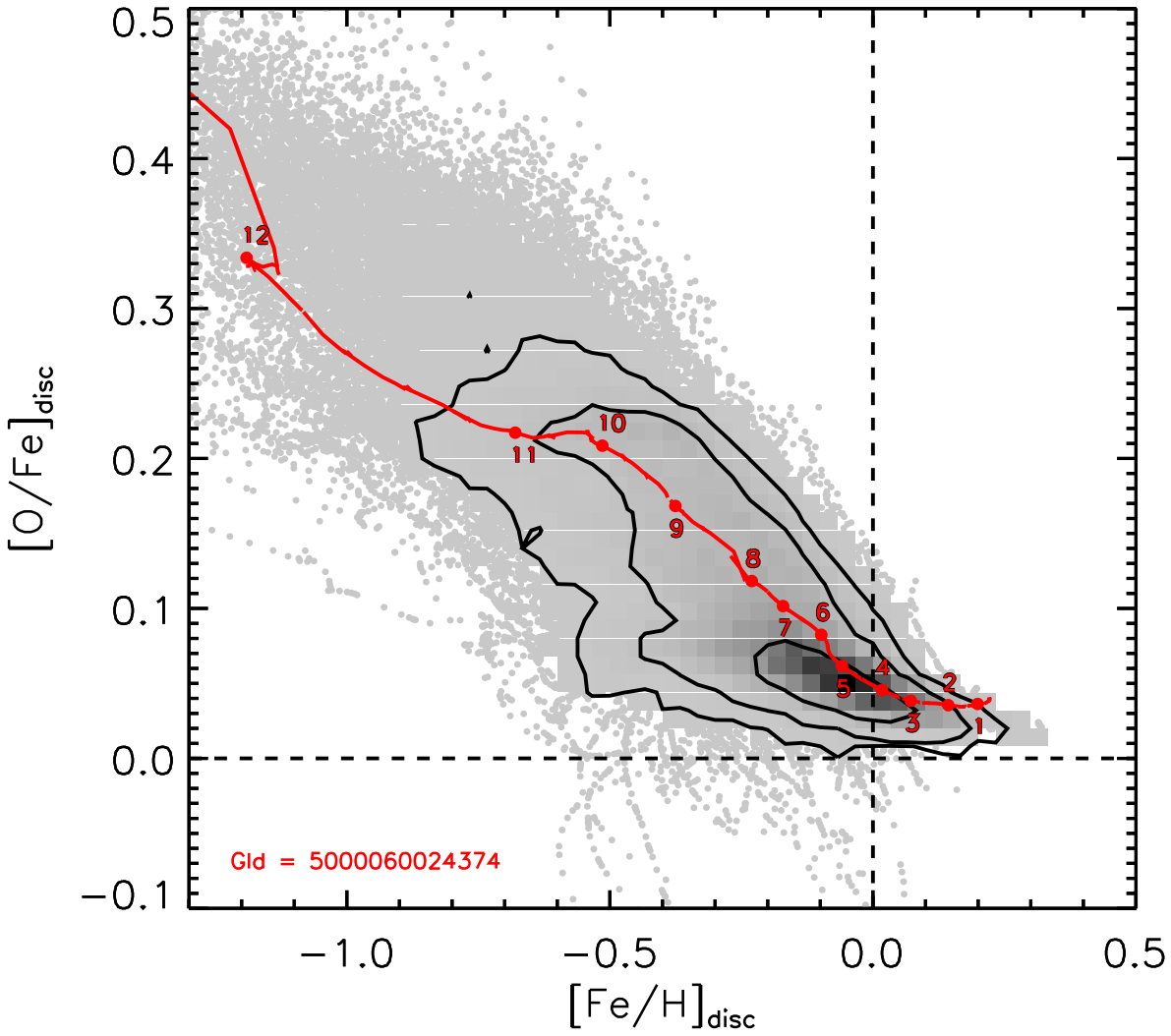
Bovy et al. (2012a)

Comparison

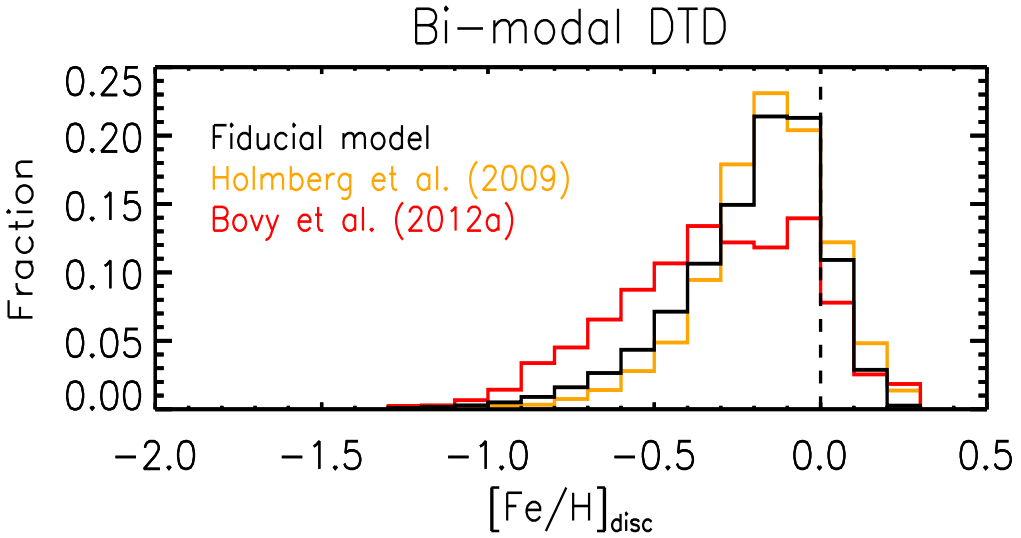

mass weighted
[α/Fe]
[Fe/H]
0.5
0.4
0.3
0.2
0.1
0.0
−1.5
−1.0
−0.5
0.0
0.5

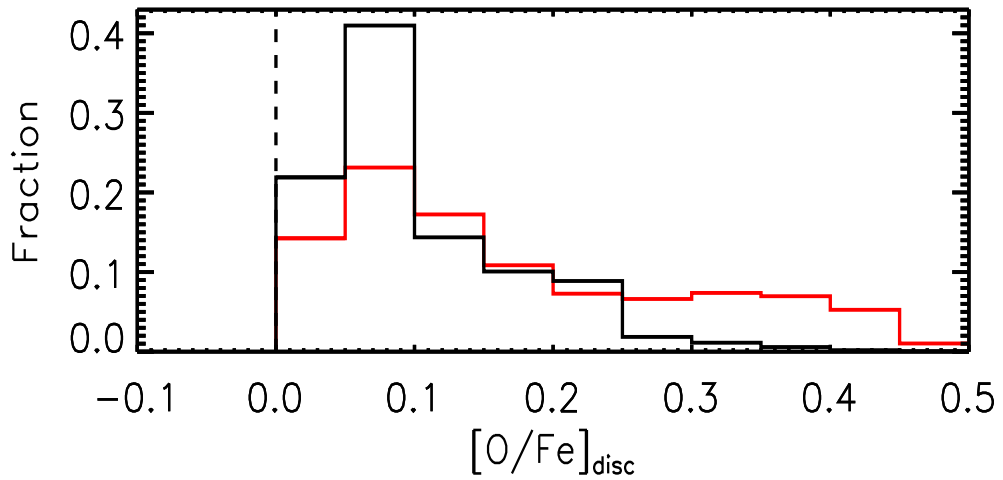

Fraction
0.10
0.08
0.06
0.04
0.02
Fraction
0.05
0.10
0.15
[O/Fe]disc
[Fe/H]disc
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−2.0
−1.5
−1.0
−0.5
0.0
0.5

Model MW disc tracks

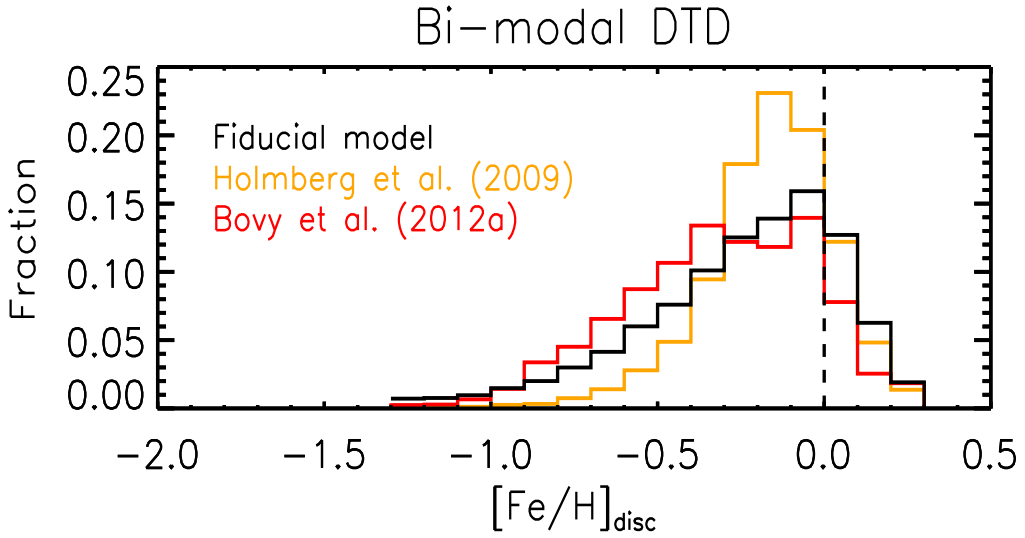


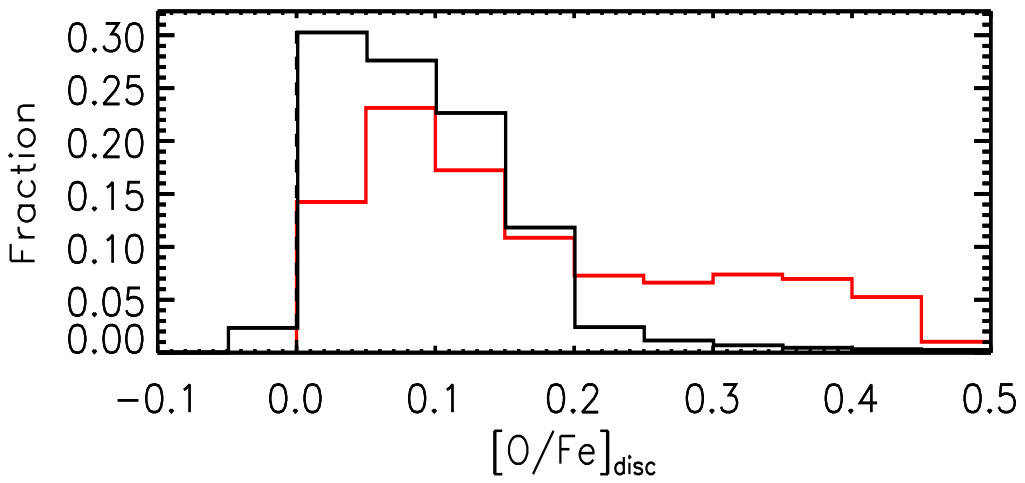
[Fe/H] and [O/Fe] distributions



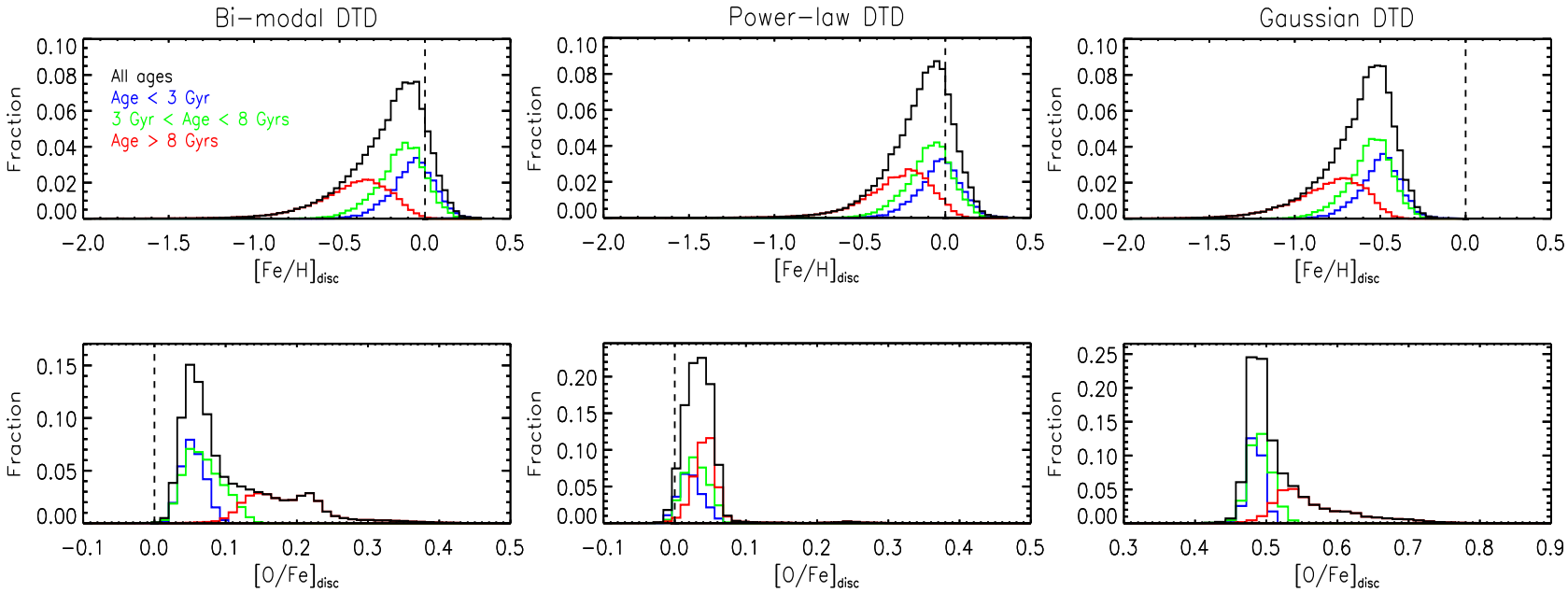


[Fe/H] and [O/Fe] distributions (full resolution)





Results for different SN-Ia DTDs

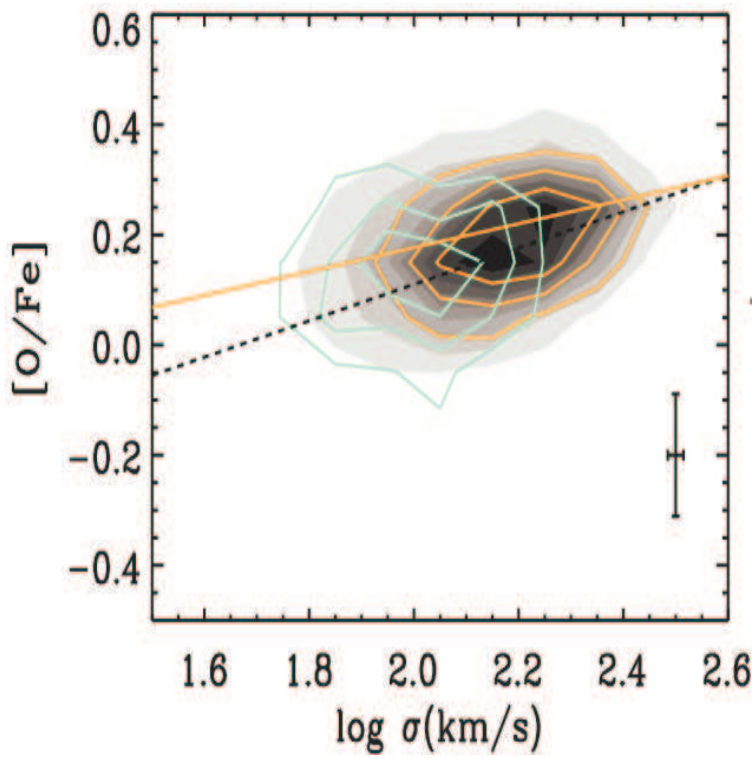


Local elliptical galaxies

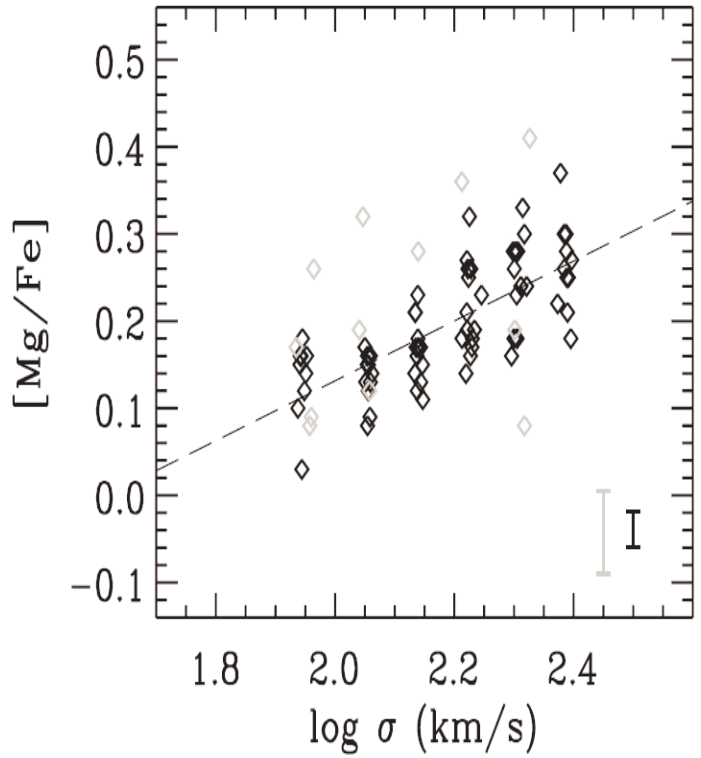
Elliptical galaxy sample $(z = 0)$

- $M_{\text{bulge}}/M_* > 0.7$

Observed mass-[α/Fe] relations

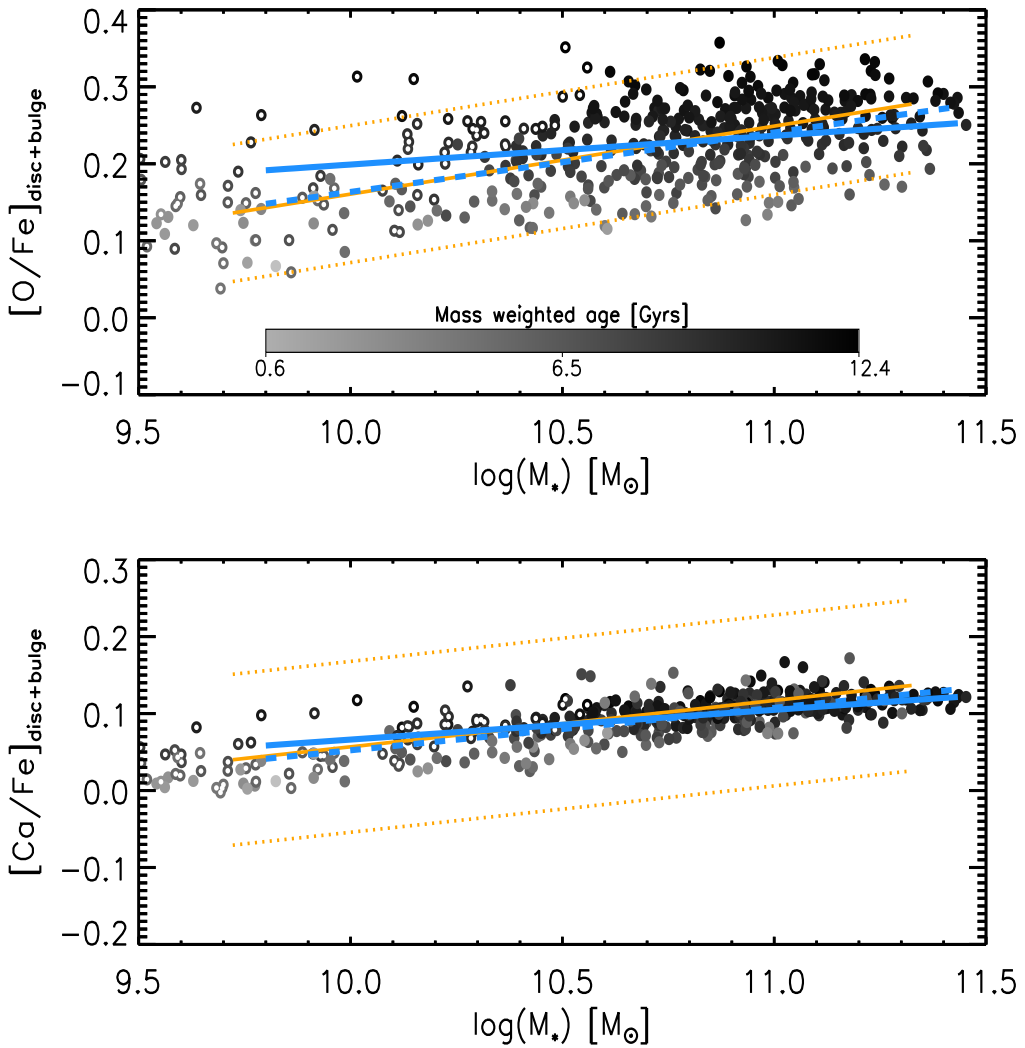


Johansson, Thomas & Maraston (2011)

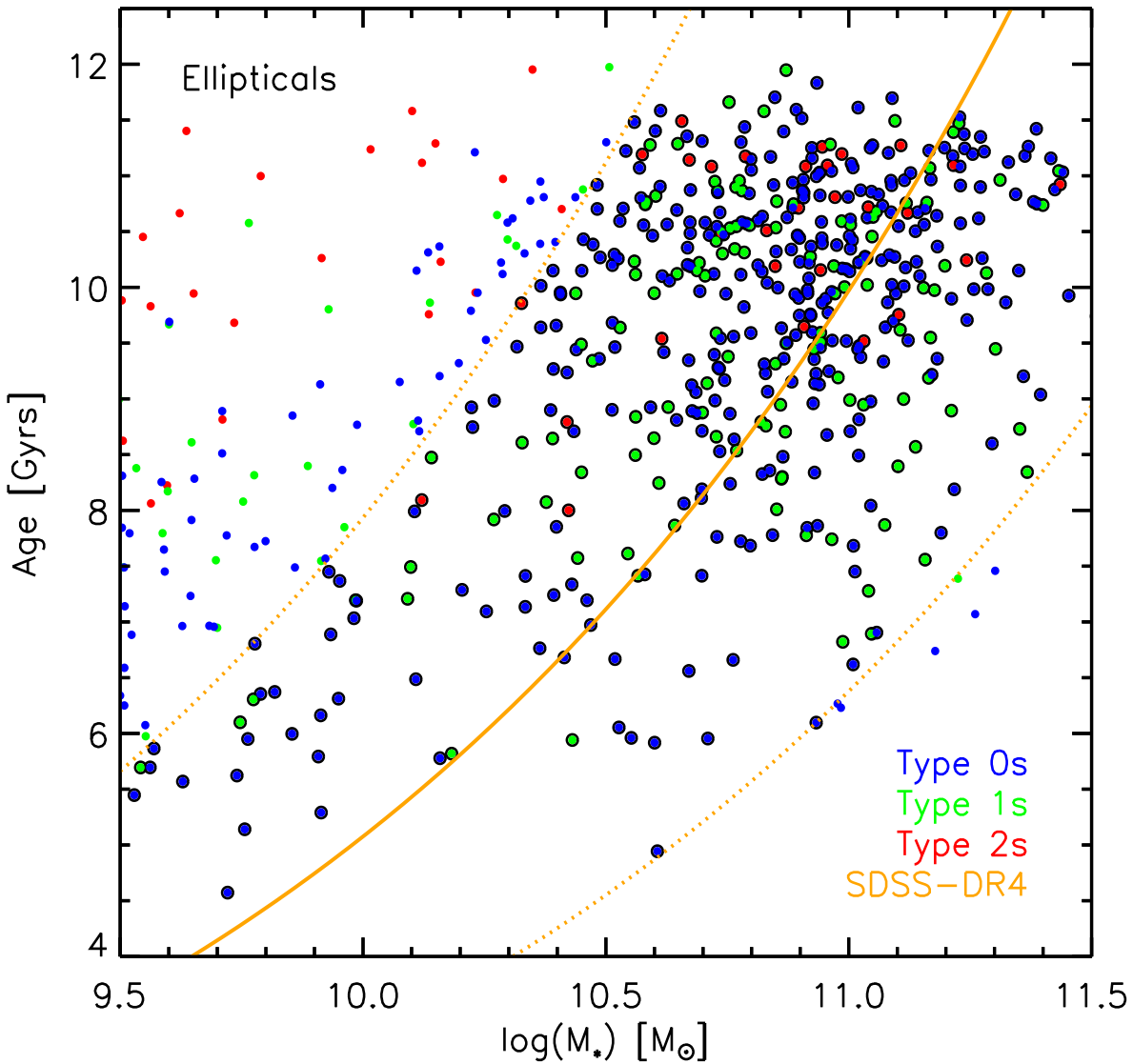


Graves et al. (2010b)

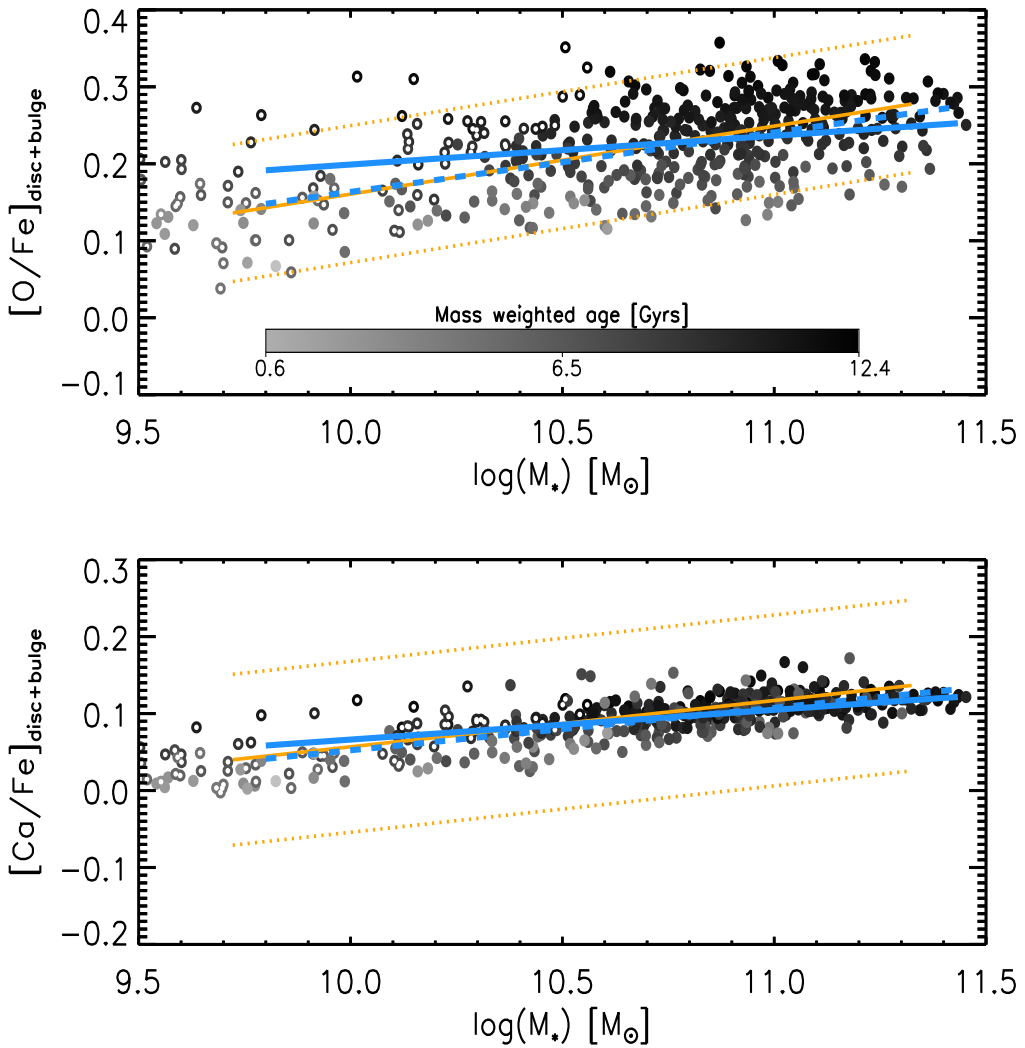
Model mass-[O/Fe] relation



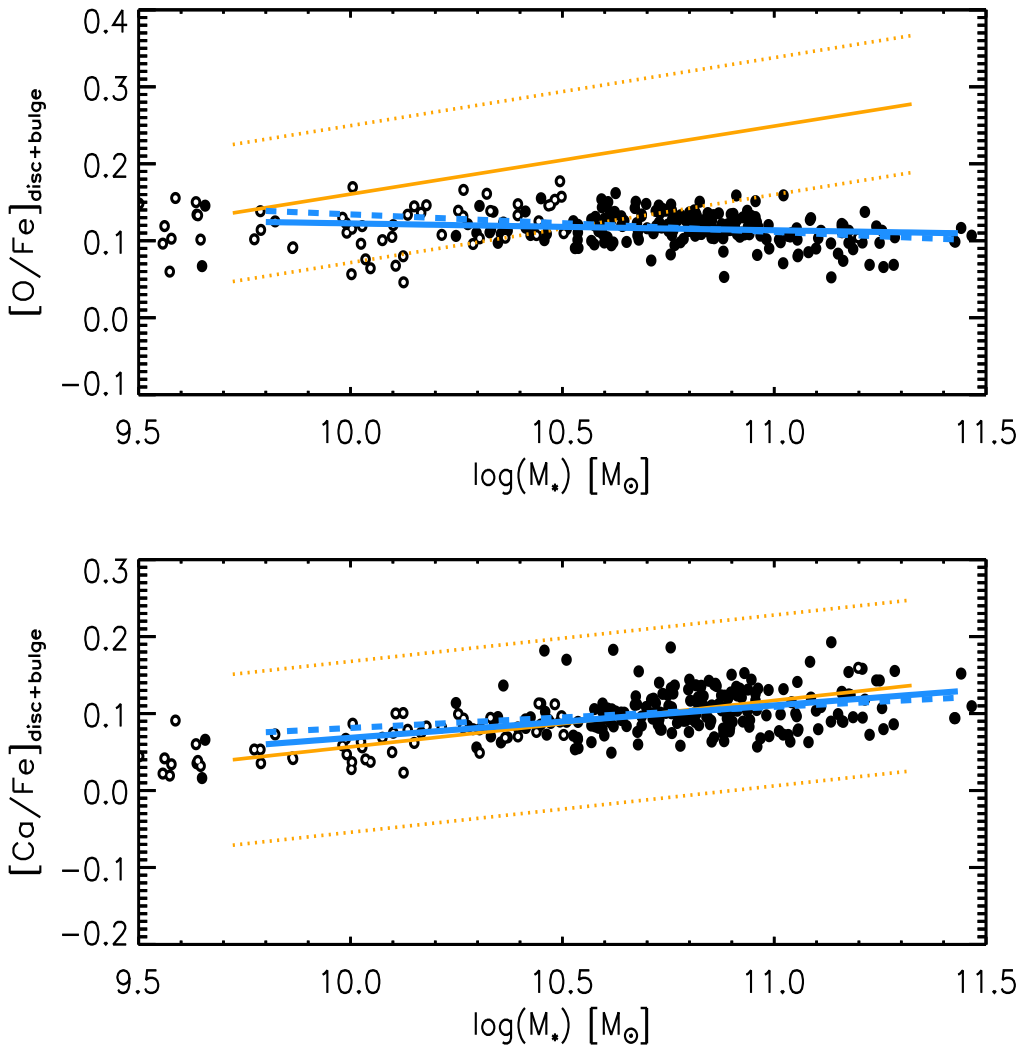
Mass-Age relation



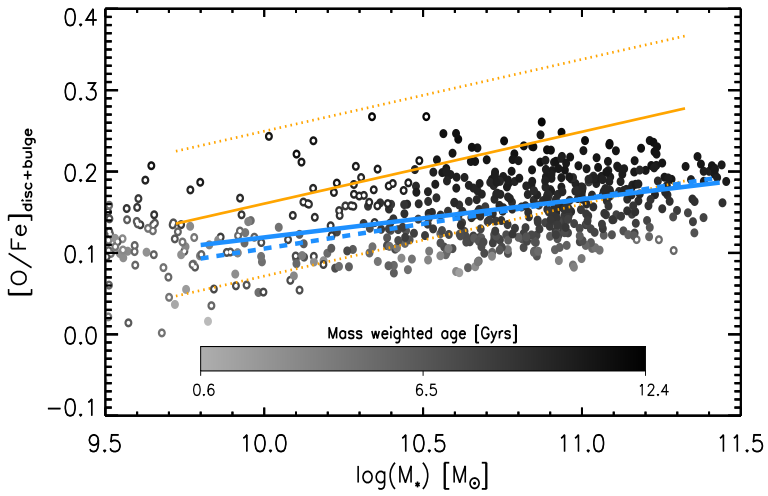
Model mass-[O/Fe] relation



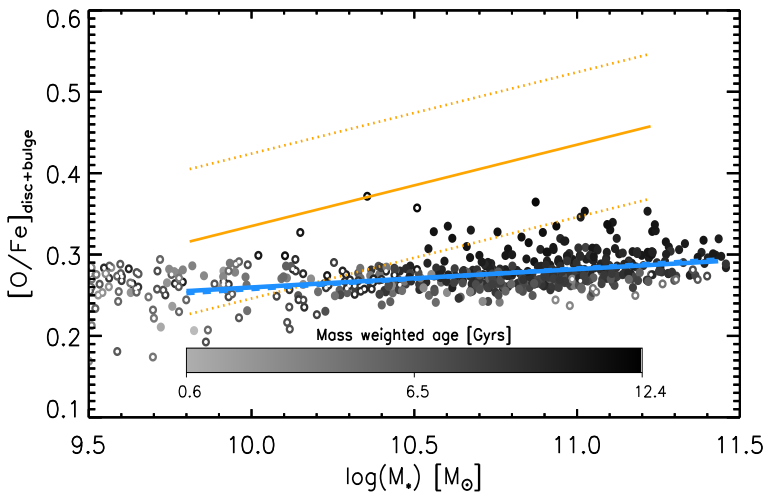
Model mass-[O/Fe] relation (full resolution)



Model mass-[O/Fe] relations (other set-ups)



CL04 SN-II yields



Power law SN-Ia DTD

Summary

- We have implemented **delayed enrichment** into the Munich semi-analytic model
- We can reproduce the chemical composition of **MW-type galaxy discs**
- We can reproduce **positive slopes** in the M_*-[α/Fe] relations of local ellipticals, **except for O and Mg . . .**
- We find a **bi-modal DTD** and SN-II yields that account for **prior stellar mass loss** give the best results
- Further SFH resolution tests required. . .