CNO abundances in open clusters and field stars

Radial abundance gradients in the Galactic disc

Grazina Tautvaisiene

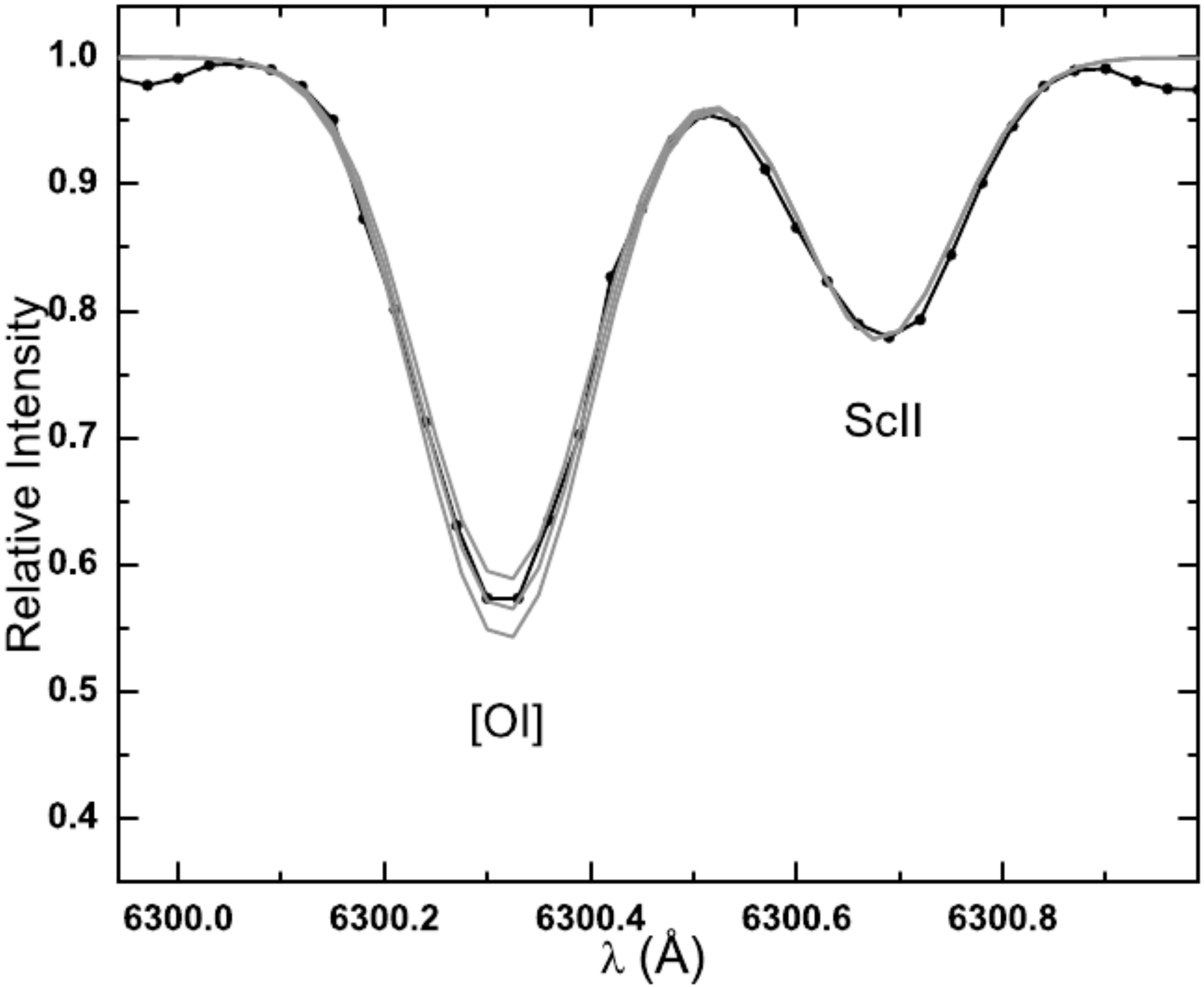
Vilnius University

Open clusters

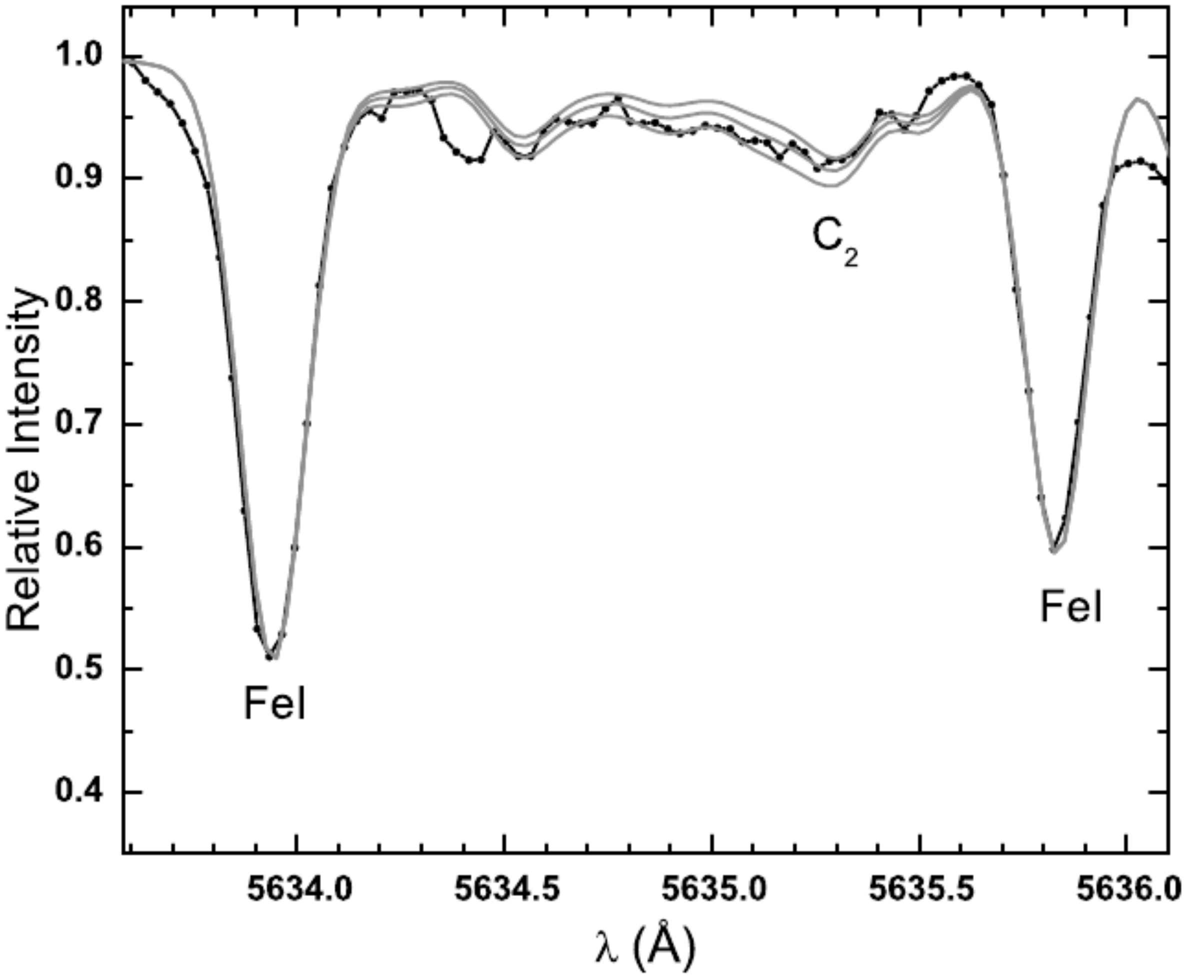
- Due to faintness C, N and O in the main sequence stars are analysed for rather few clusters
- Gradients of oxygen can be investigated using both dwarfs and giants
- Carbon and nitrogen in giants are effected by evolutionary changes

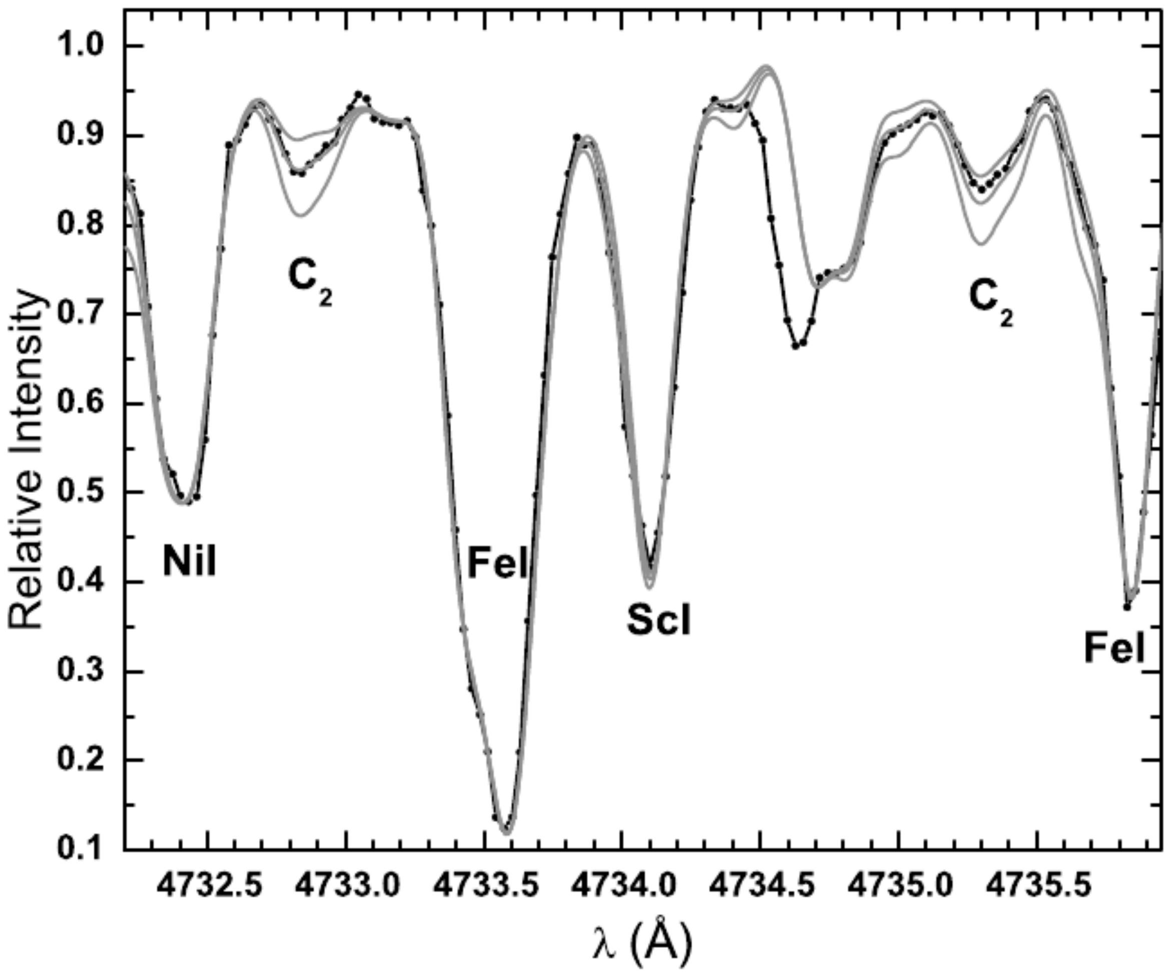
Spectral lines according to siutability

- Oxygen – [O I], IR OH, O I, UV OH
- Carbon – [C I], C_2, CH, C I
- Nitrogen – CN, N I, NH

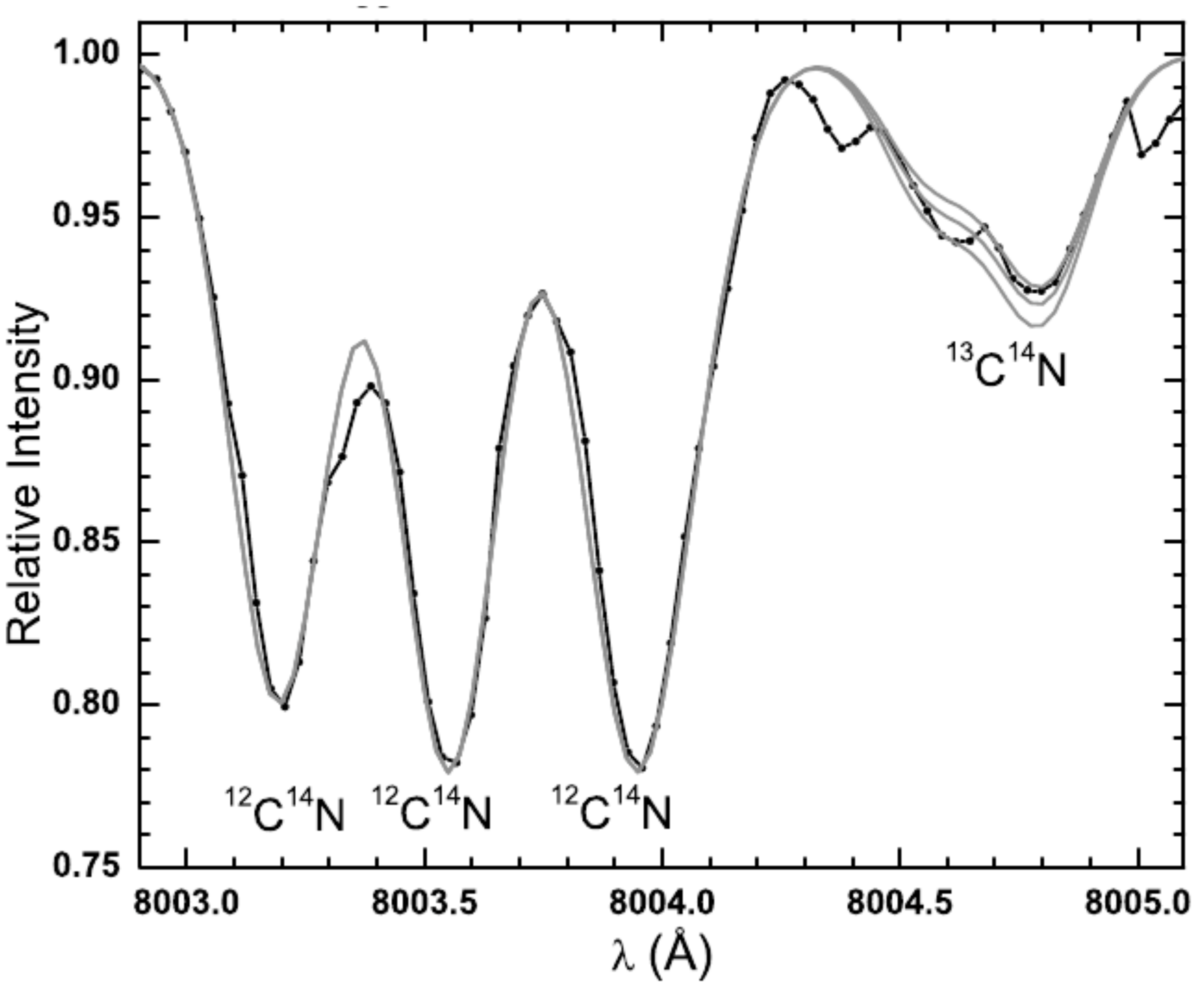


Relative Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
6300.0
6300.2
6300.4
6300.6
6300.8
λ (Å)
ScII
[OI]


Relative Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
FeI
C2
FeI
5634.0
5634.5
5635.0
5635.5
5636.0
λ (Å)



Relative Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
4732.5
4733.0
4733.5
4734.0
4734.5
4735.0
4735.5
λ (Å)
C2
C2
NiI
FeI
ScI
FeI


1.00
0.95
0.90
0.85
0.80
0.75
Relative Intensity
8003.0
8003.5
8004.0
8004.5
8005.0
λ (Å)
12C14N
12C14N
12C14N
13C14N

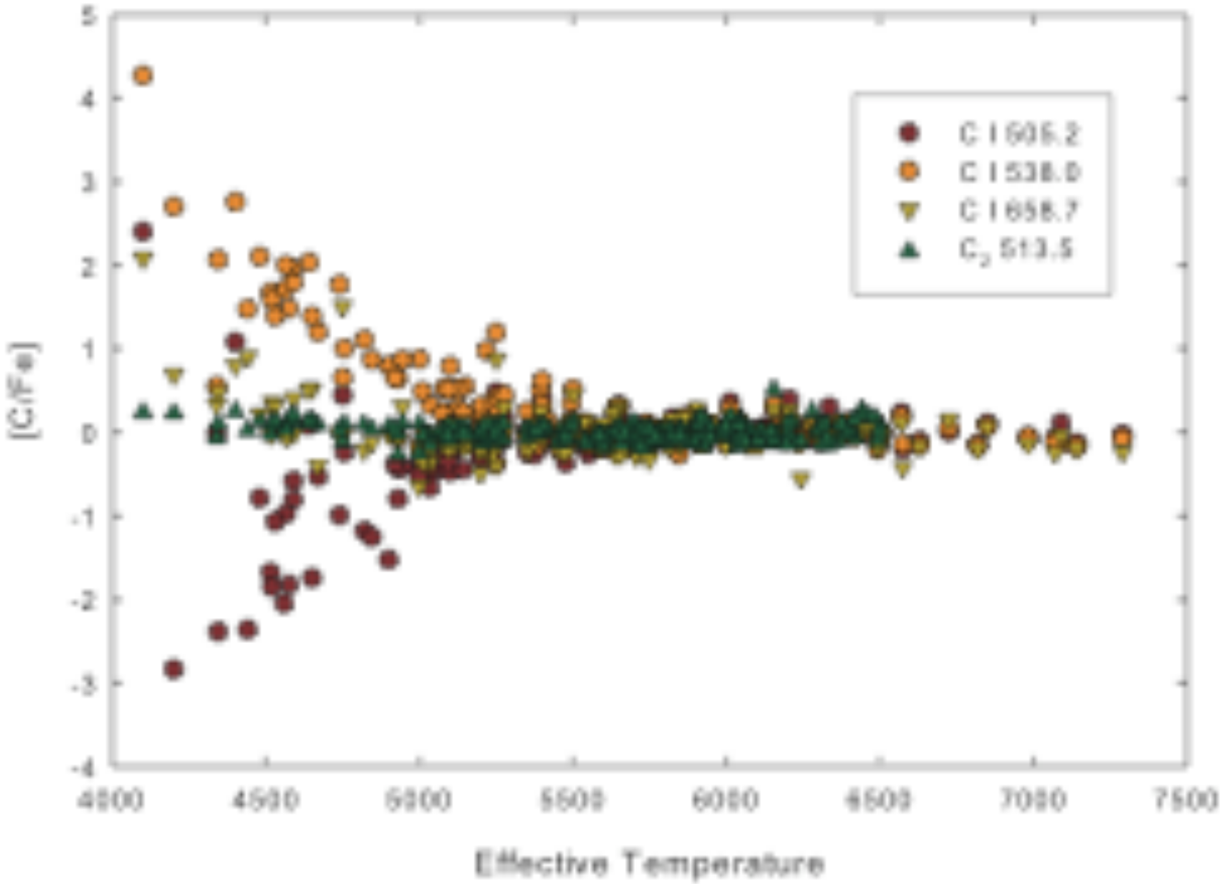
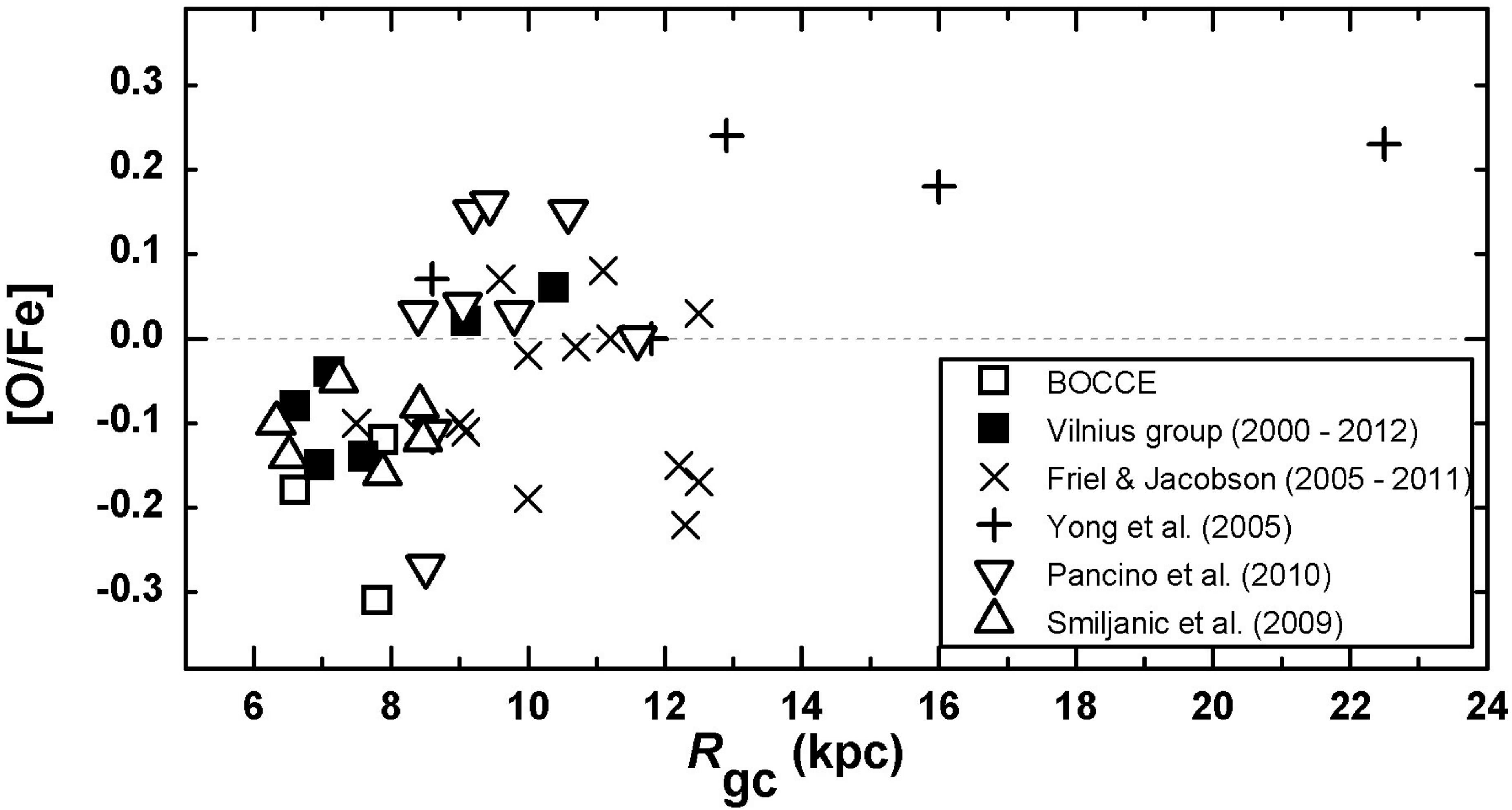
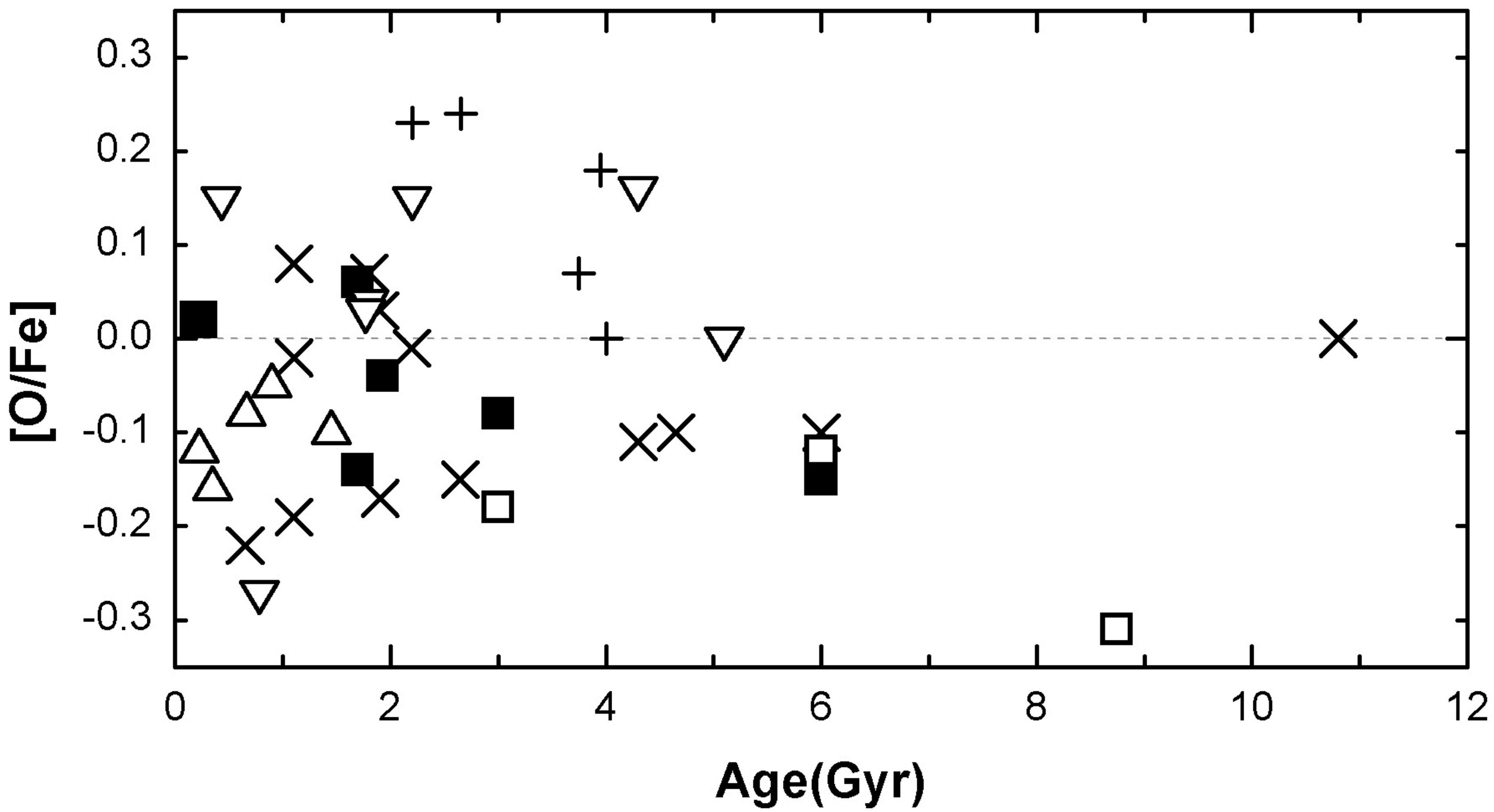


FIG. 3.—Behavior of the carbon abundance indicators (normalized to iron) as a function of temperature. The behavior of C I 505.2 nm is due to the presence of a strong Fe I line that increasingly perturbs the C I feature as the temperature decreases. The explanation of the behavior of C I 538.0 nm is most likely the presence of a blend that strengthens with decreasing temperature.

Luck & Heiter 2006

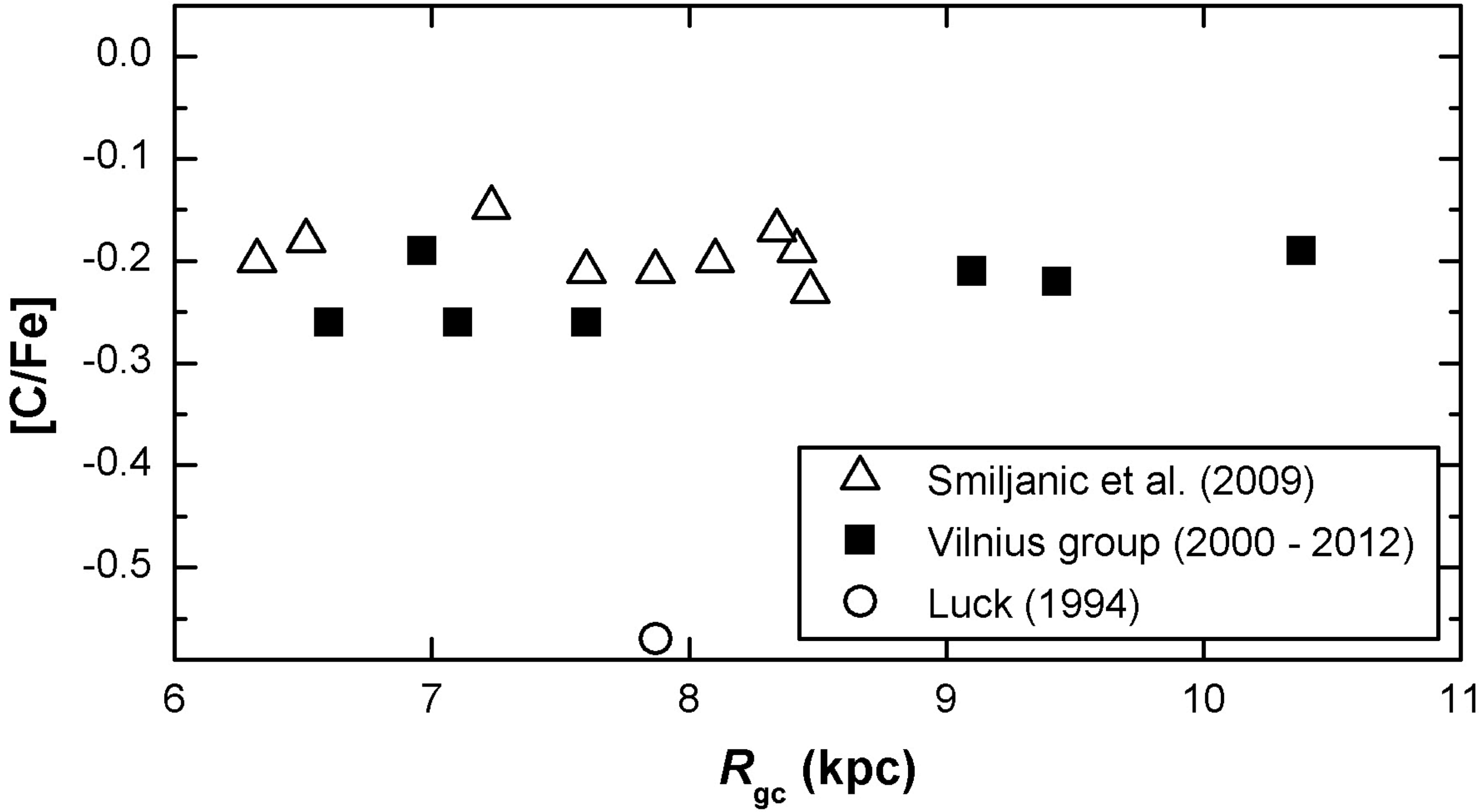
Oxygen in open clusters

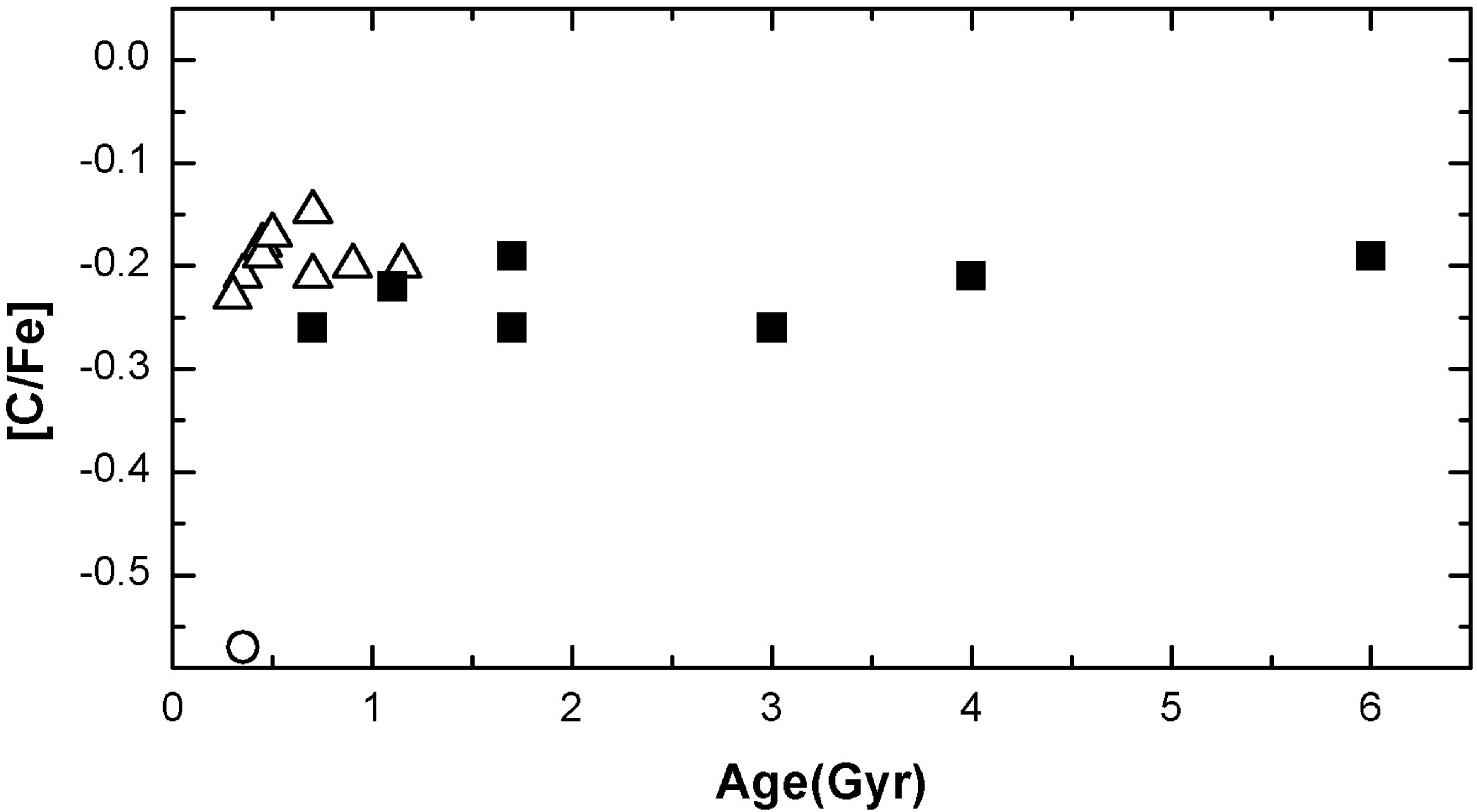




0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
[O/Fe]
0
2
4
6
8
10
12
Age(Gyr)

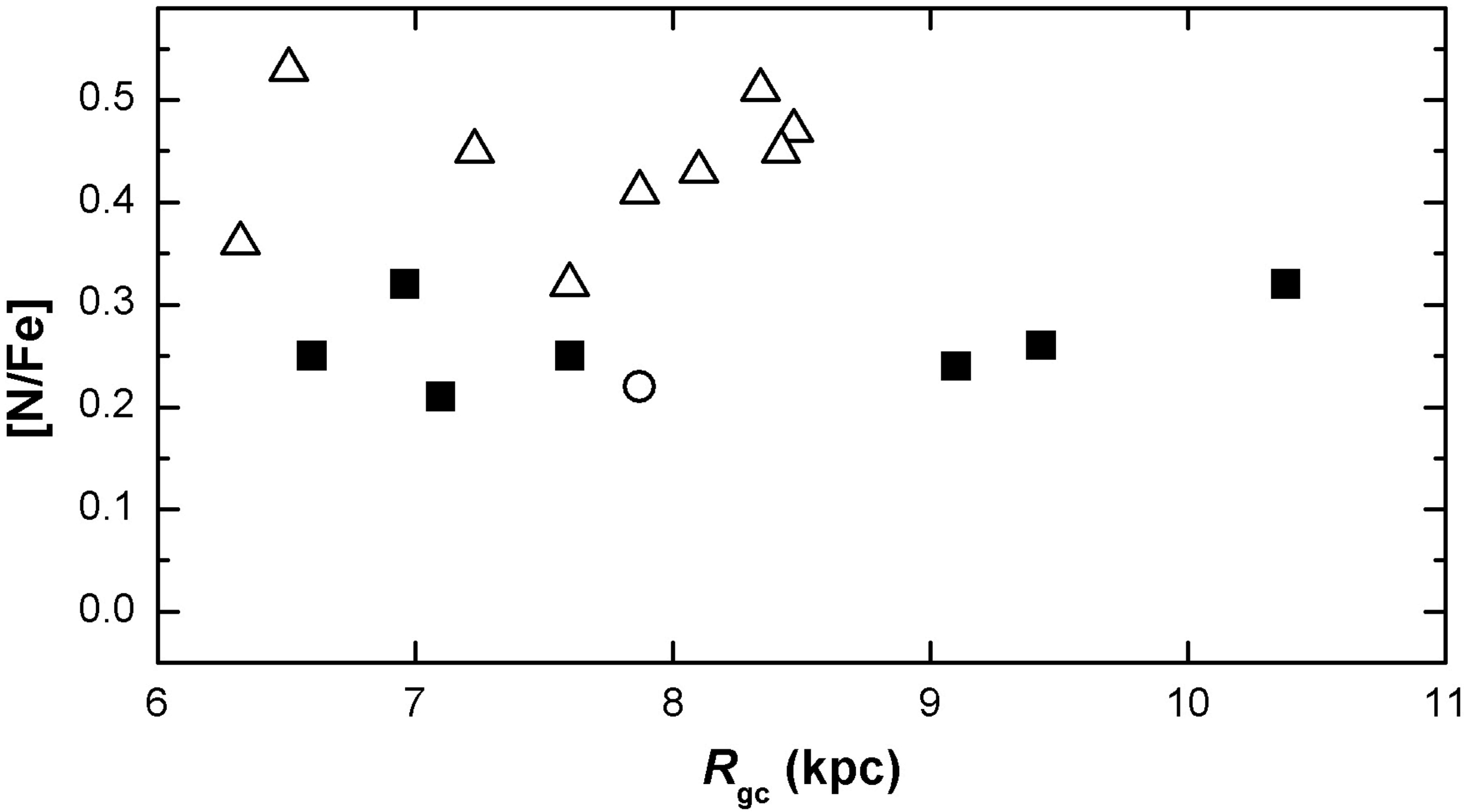
Carbon in open clusters: red clump stars

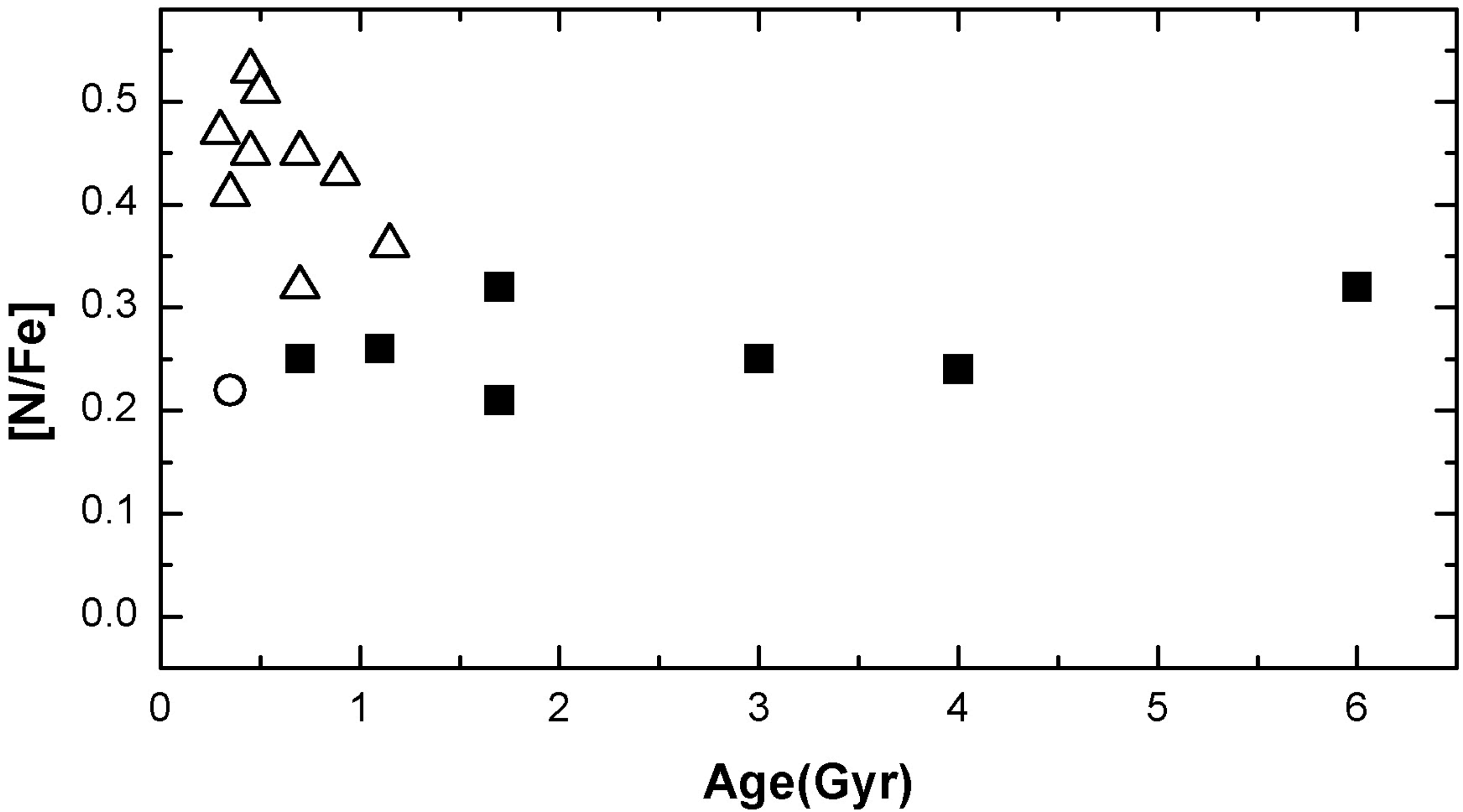




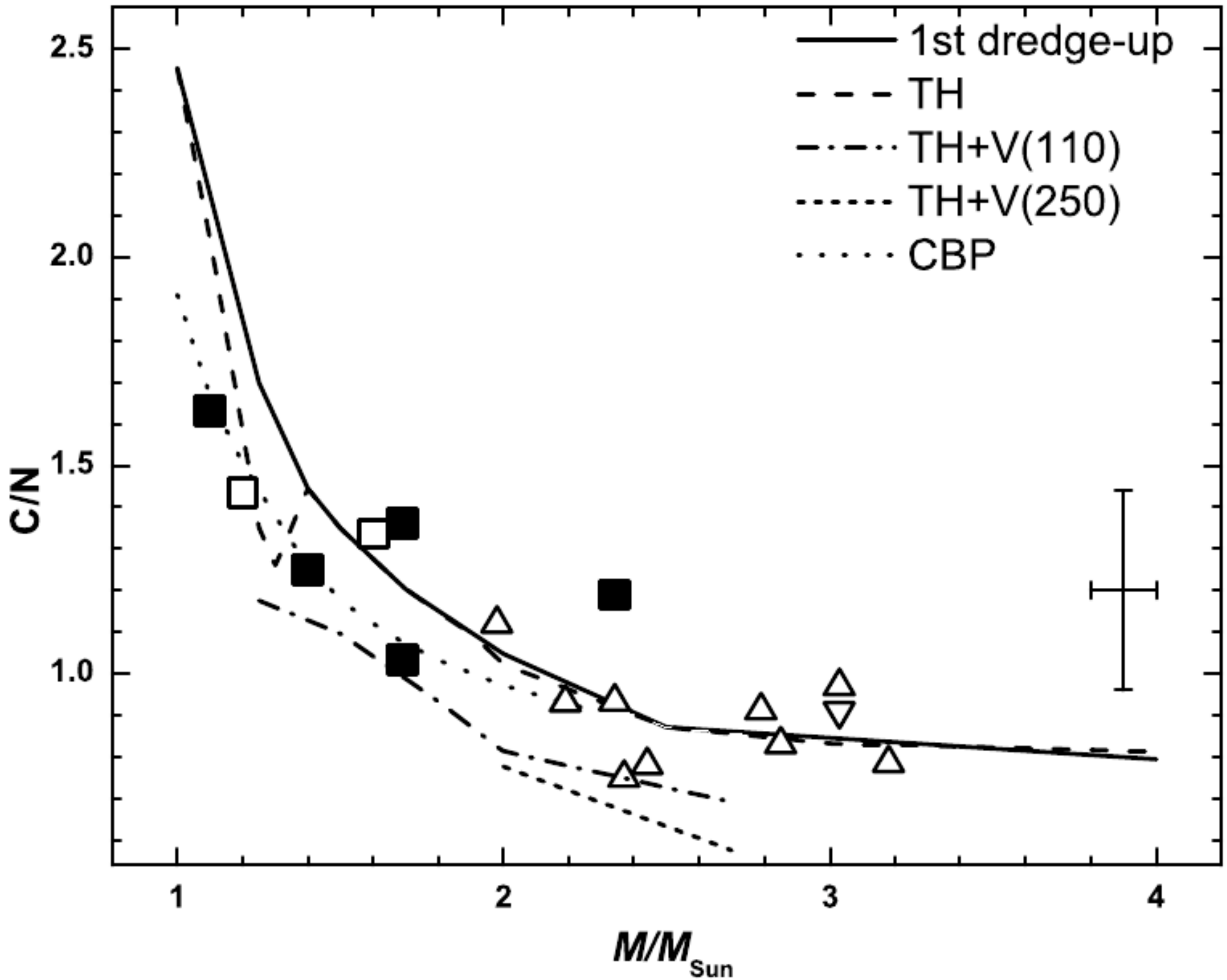
[C/Fe]
Age(Gyr)
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
0
1
2
3
4
5
6

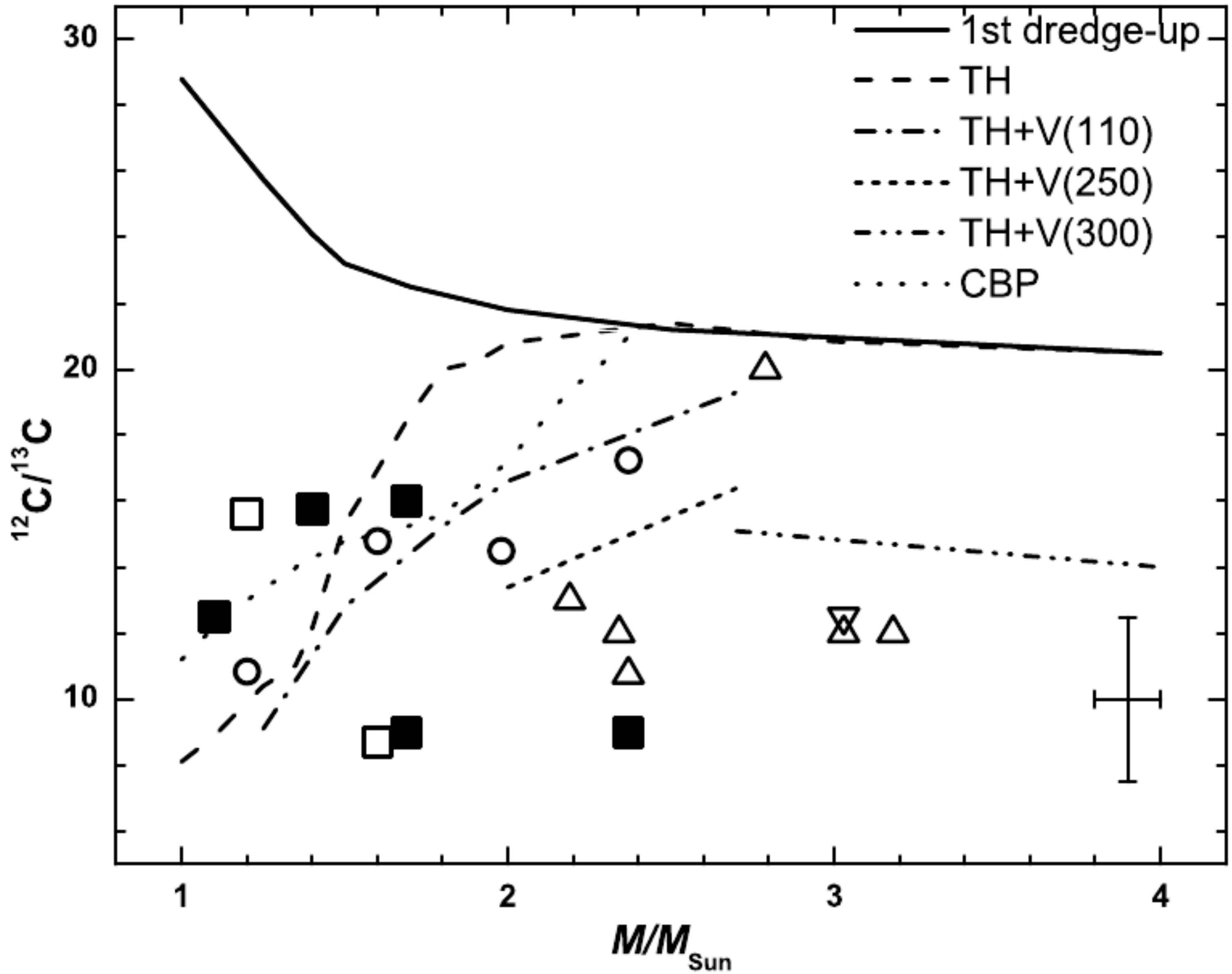
Nitrogen in open clusters

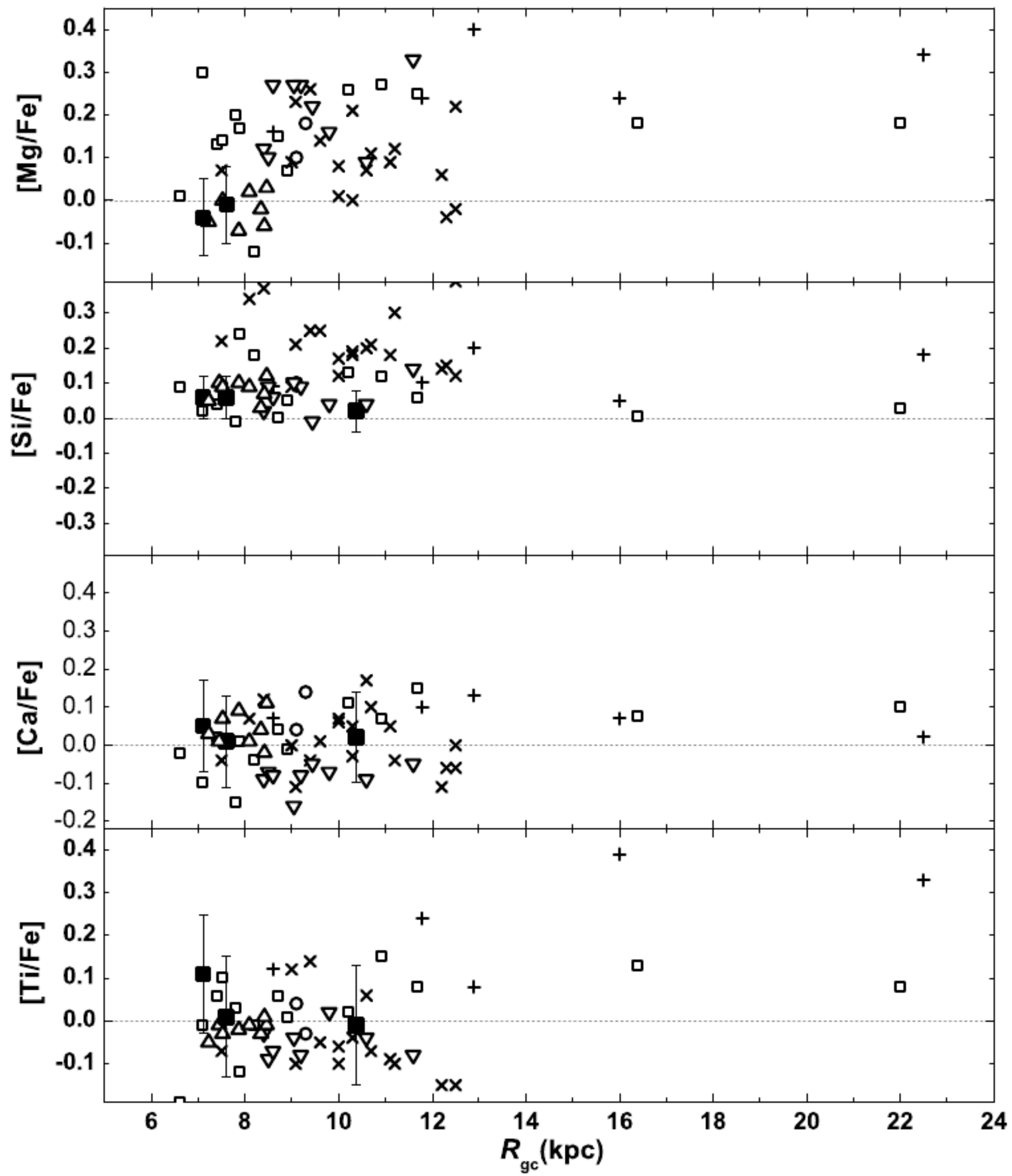


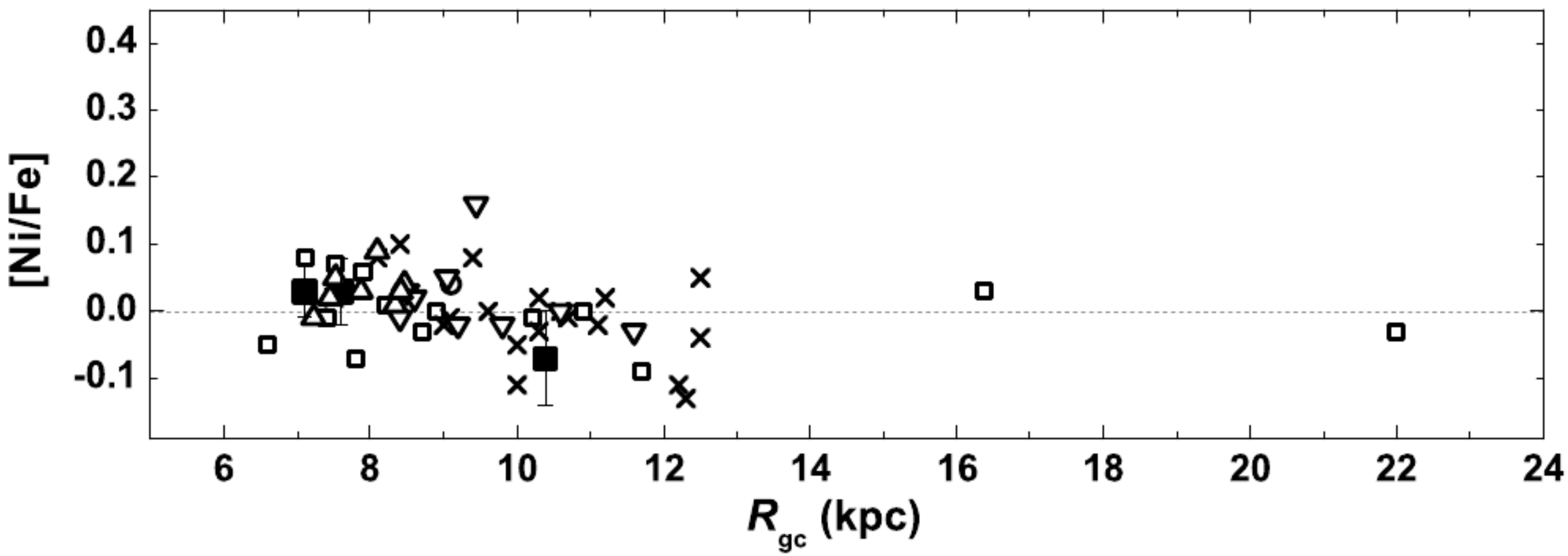


[N/Fe]
0.0
0.1
0.2
0.3
0.4
0.5
0
1
2
3
4
5
6
Age(Gyr)


1st dredge-up
TH
TH+V(110)
TH+V(250)
CBP
C/N
2.5
2.0
1.5
1.0
1
2
3
4
M/M_Sun


1st dredge-up
TH
TH+V(110)
TH+V(250)
TH+V(300)
CBP
30
20
10
1
2
3
4
$^{12}C/^{13}C$
M/M_{Sun}


[Mg/Fe]
[Si/Fe]
[Ca/Fe]
[Ti/Fe]
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
6
8
10
12
14
16
18
20
22
24
R_{gc}(kpc)



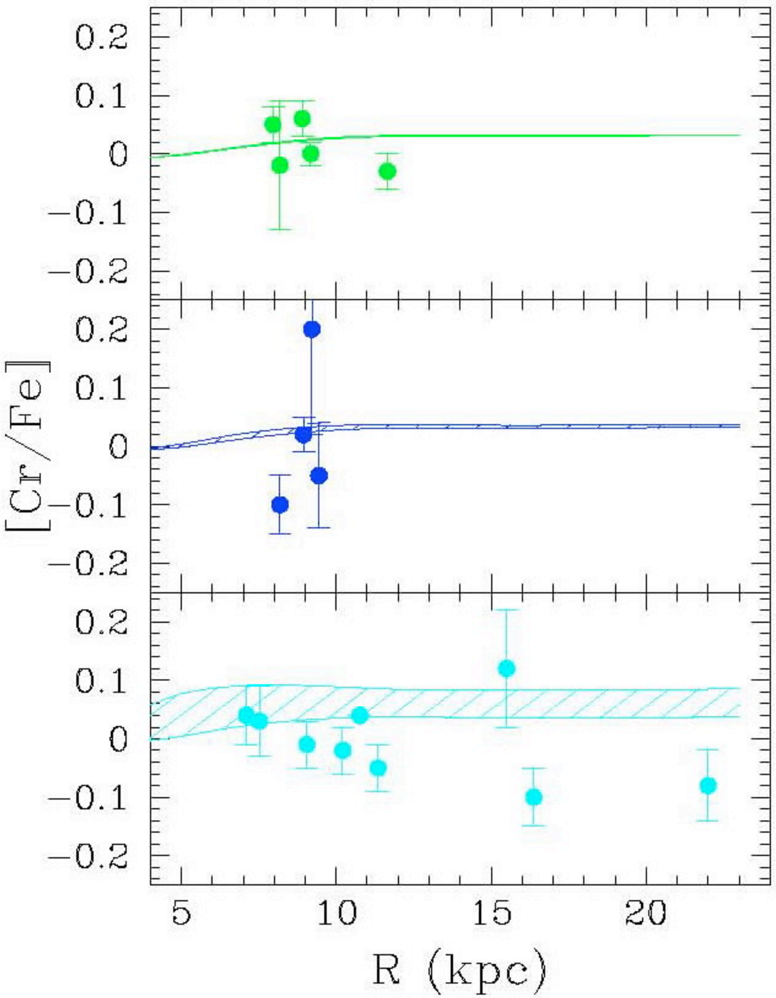
[Ni/Fe]
0.4
0.3
0.2
0.1
0.0
-0.1
6
8
10
12
14
16
18
20
22
24
R_gc (kpc)

A&A 494, 95–108 (2009)
DOI: 10.1051/0004-6361:200810634

Astronomy & Astrophysics

The evolution of the Galactic metallicity gradient from high-resolution spectroscopy of open clusters

L. Magrini, P. Sestito, S. Randich, and D. Galli



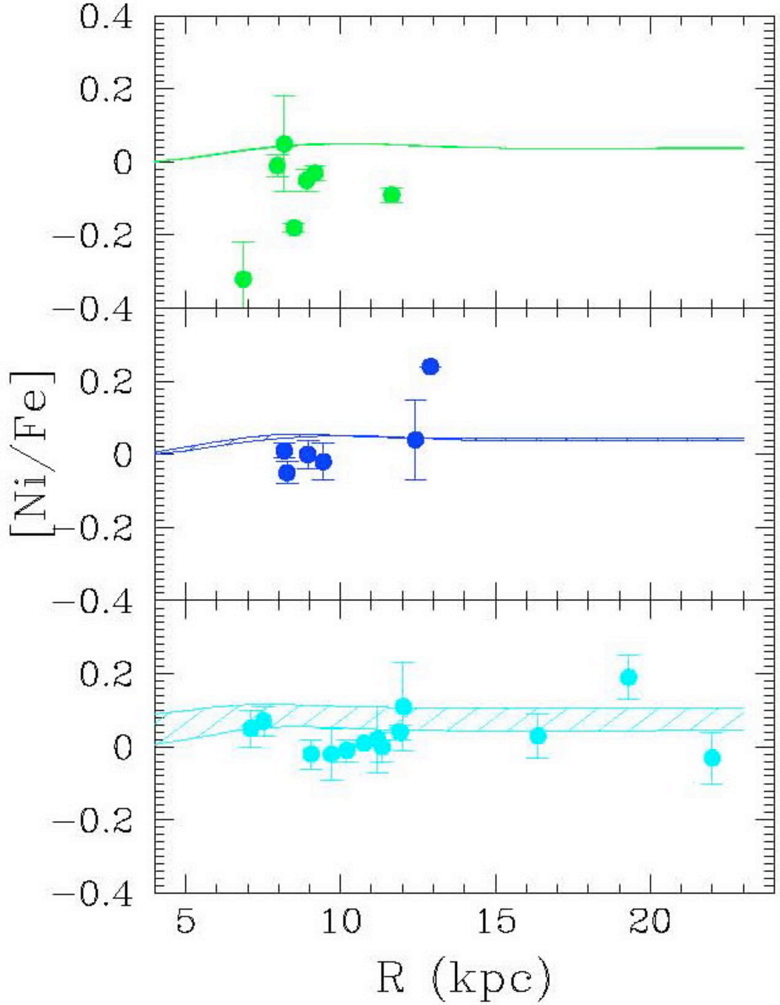
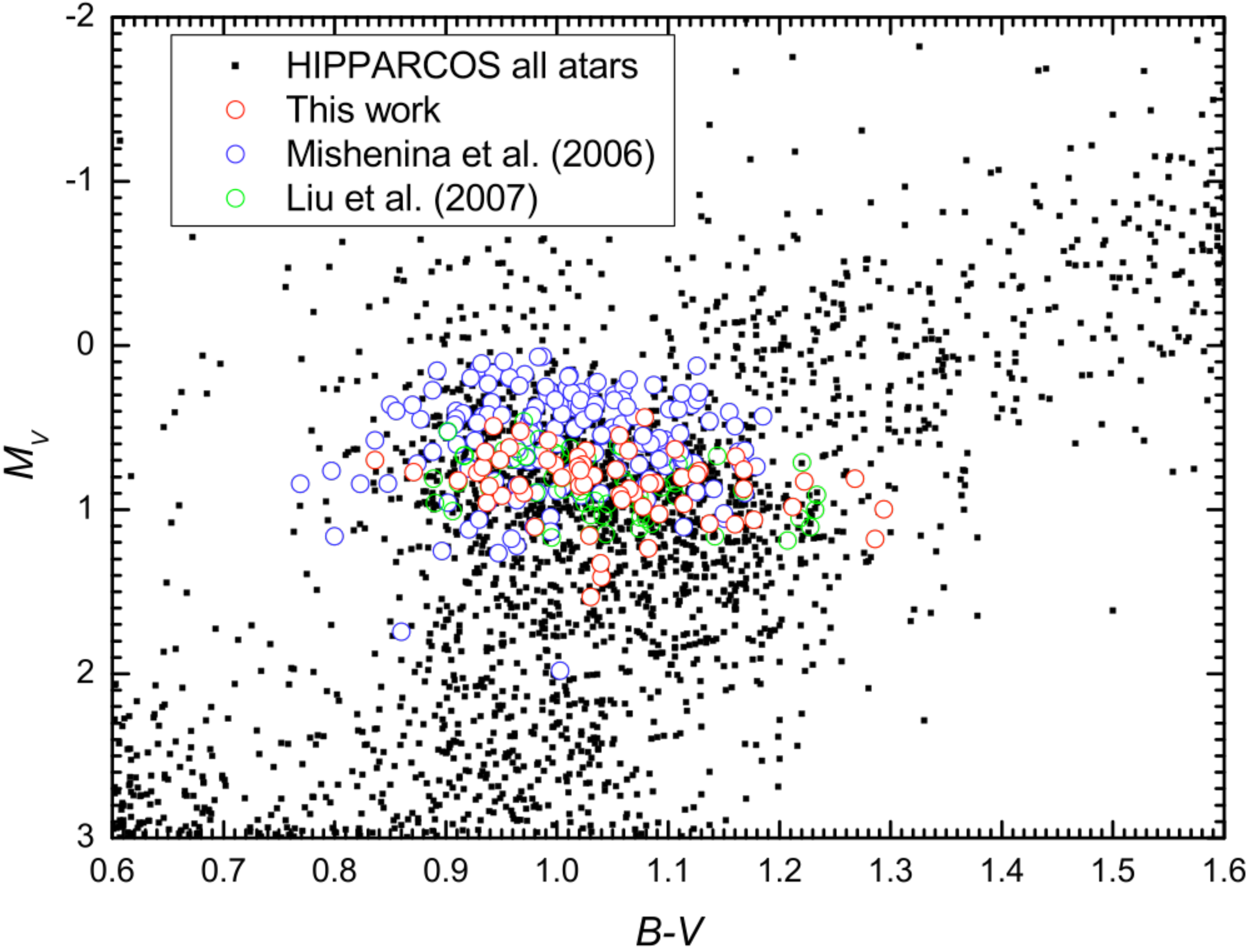


Fig. 6. Radial gradients of [Ni/Fe] and [Cr/Fe]: comparison between high-resolution data of OCs with our model. Different panels show abundances for different age bins: *top* (panel 1), ages ≤0.8 Gyr; *middle* (panel 2), ages 0.8 Gyr < age ≤ 4 Gyr; *bottom* (panel 3), ages 4 Gyr < age ≤ 11 Gyr. The models adopted to compare with observations are for 0 and 1 Gyr ago (panel 1), 1 and 4 Gyr ago (panel 2), and 4, 11 Gyr ago (panel 3). The shaded regions indicate the area between the two models shown in each panel.

Field red clump giants



Local stellar kinematics from RAVE data: III. Radial and Vertical Metallicity Gradients based on Red Clump Stars

S. Bilir [1]*, S. Karaali[1]†, S. Ak[1], Ö. Önal[1], N. D. Dağtekin[1], T. Yontan[1], G. Gilmore[2,3], G. M. Seabroke[4]

ABSTRACT

We investigate radial and vertical metallicity gradients for a sample of red clump stars from the RAdial Velocity Experiment (RAVE) Data Release 3. We select a total of 6781 stars, using a selection of colour, surface gravity and uncertainty in the derived space motion, and calculate for each star a probabilistic (kinematic) population assignment to a thin or thick disc using space motion and additionally another (dynamical) assignment using stellar vertical orbital eccentricity. We derive almost equal metallicity gradients as a function of Galactocentric distance for the high probability thin disc stars and for stars with vertical orbital eccentricities consistent with being dynamically young, $e_v \leqslant 0.07$, i.e. $d[M/H]/dR_m = -0.041 \pm 0.003$ and $d[M/H]/dR_m = -0.041 \pm 0.007$ dex kpc^{-1}. Metallicity gradients as a function of distance from the Galactic plane for the same populations are steeper, i.e. $d[M/H]/dz_{max} = -0.109 \pm 0.008$ and $d[M/H]/dz_{max} = -0.260 \pm 0.031$ dex kpc^{-1}, respectively. R_m and z_{max} are the arithmetic mean of the perigalactic and apogalactic distances, and the maximum distance to the Galactic plane, respectively. Samples including more thick disc red clump giant stars show systematically shallower abundance gradients. These findings can be used to distinguish between different formation scenarios of the thick and thin discs.

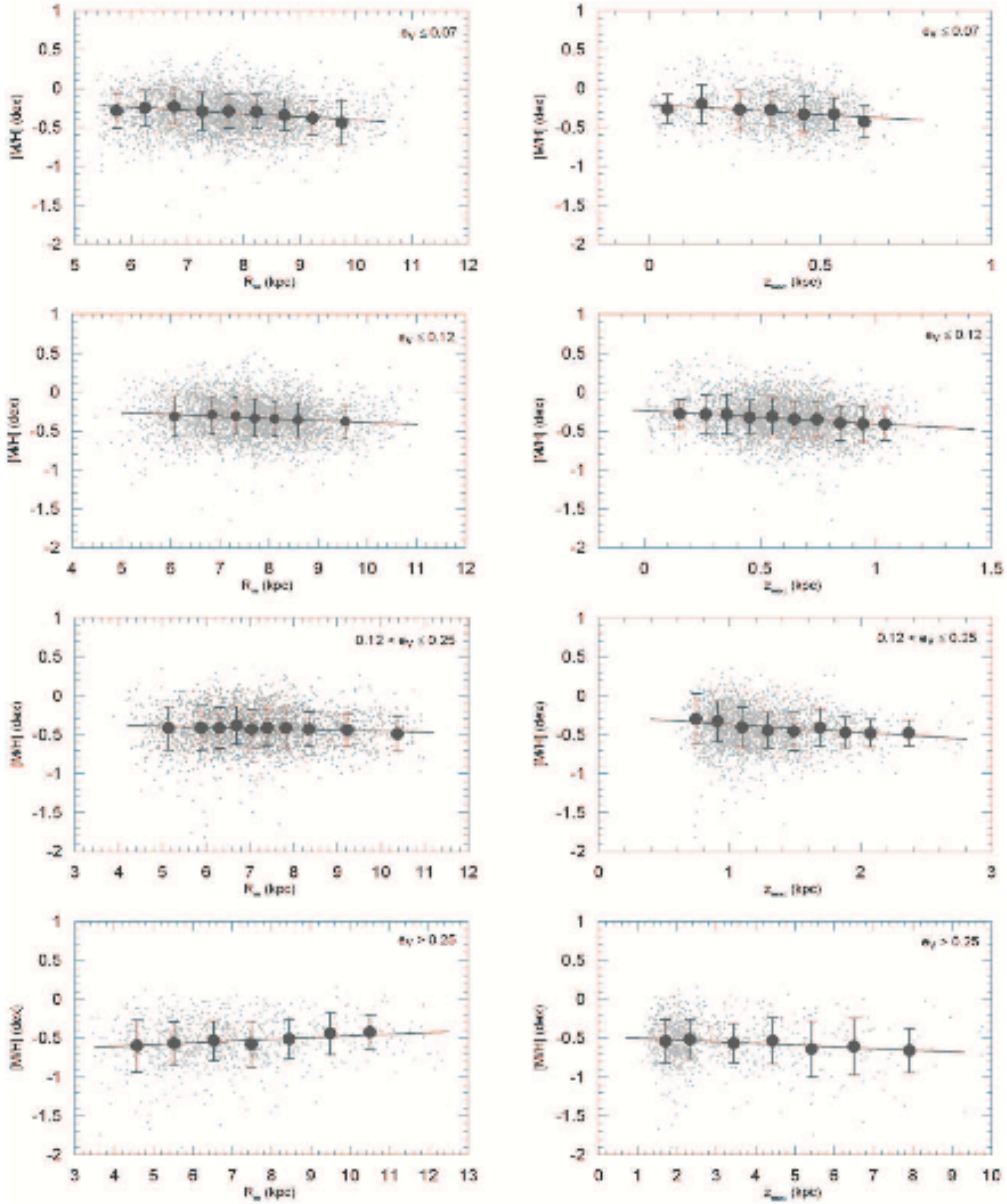
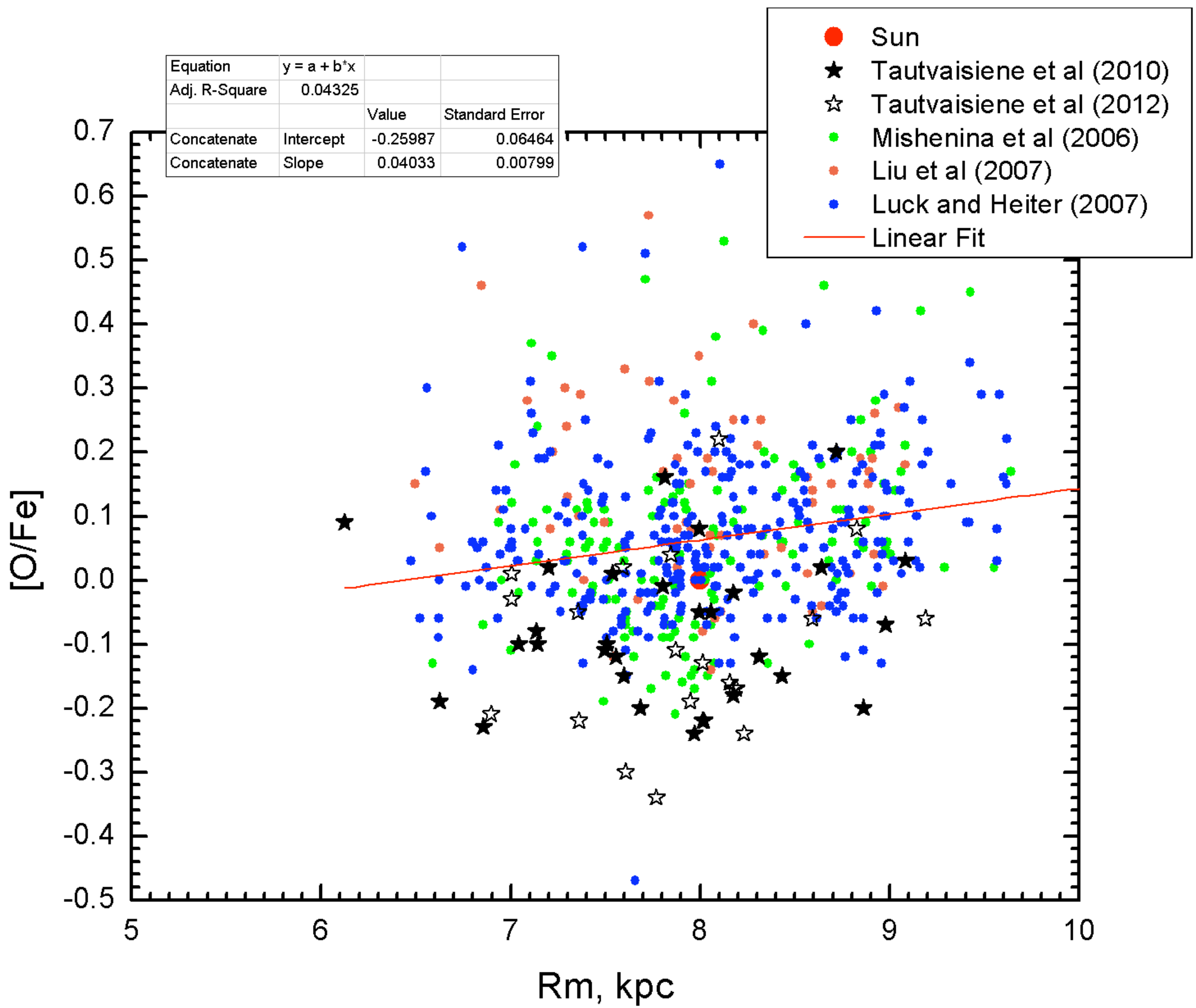
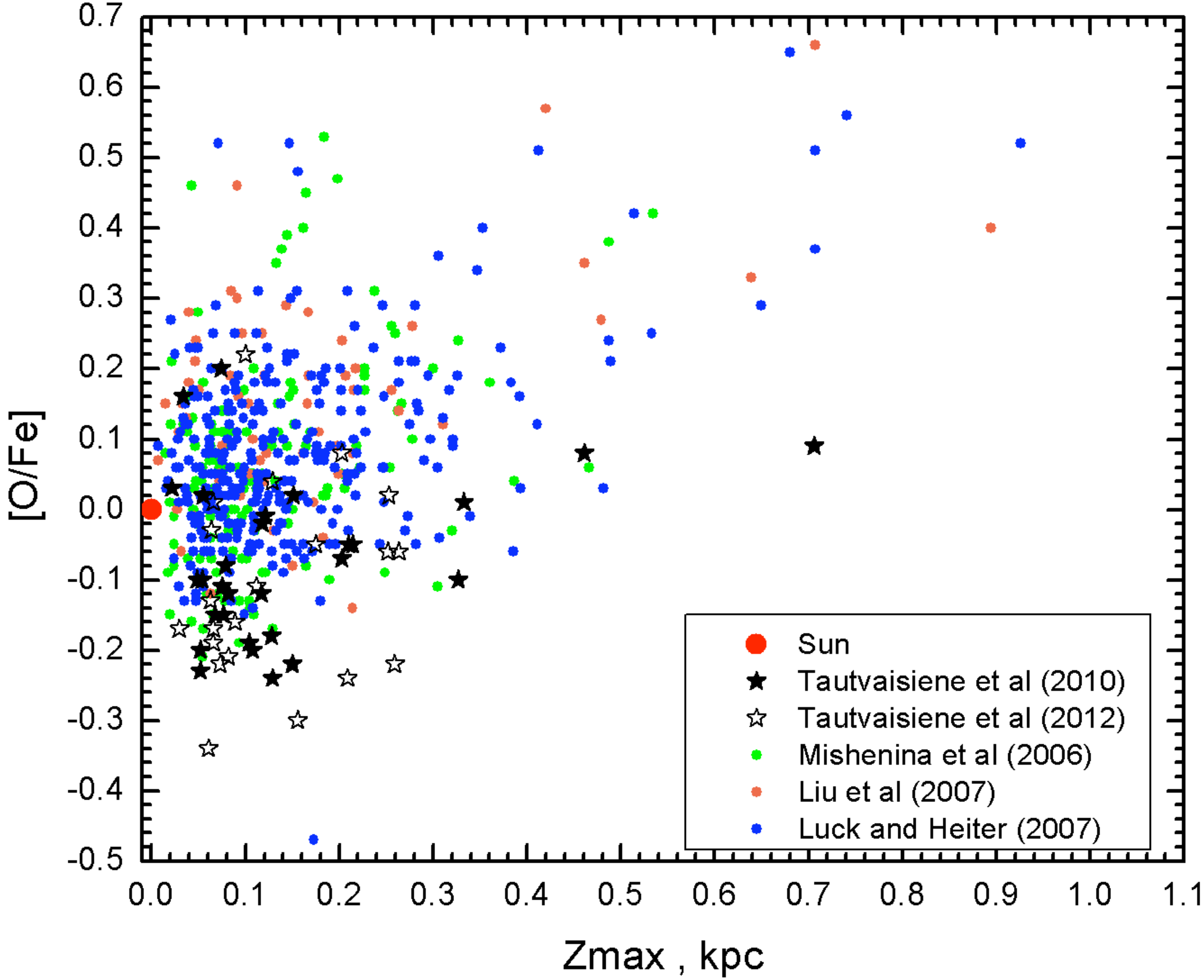
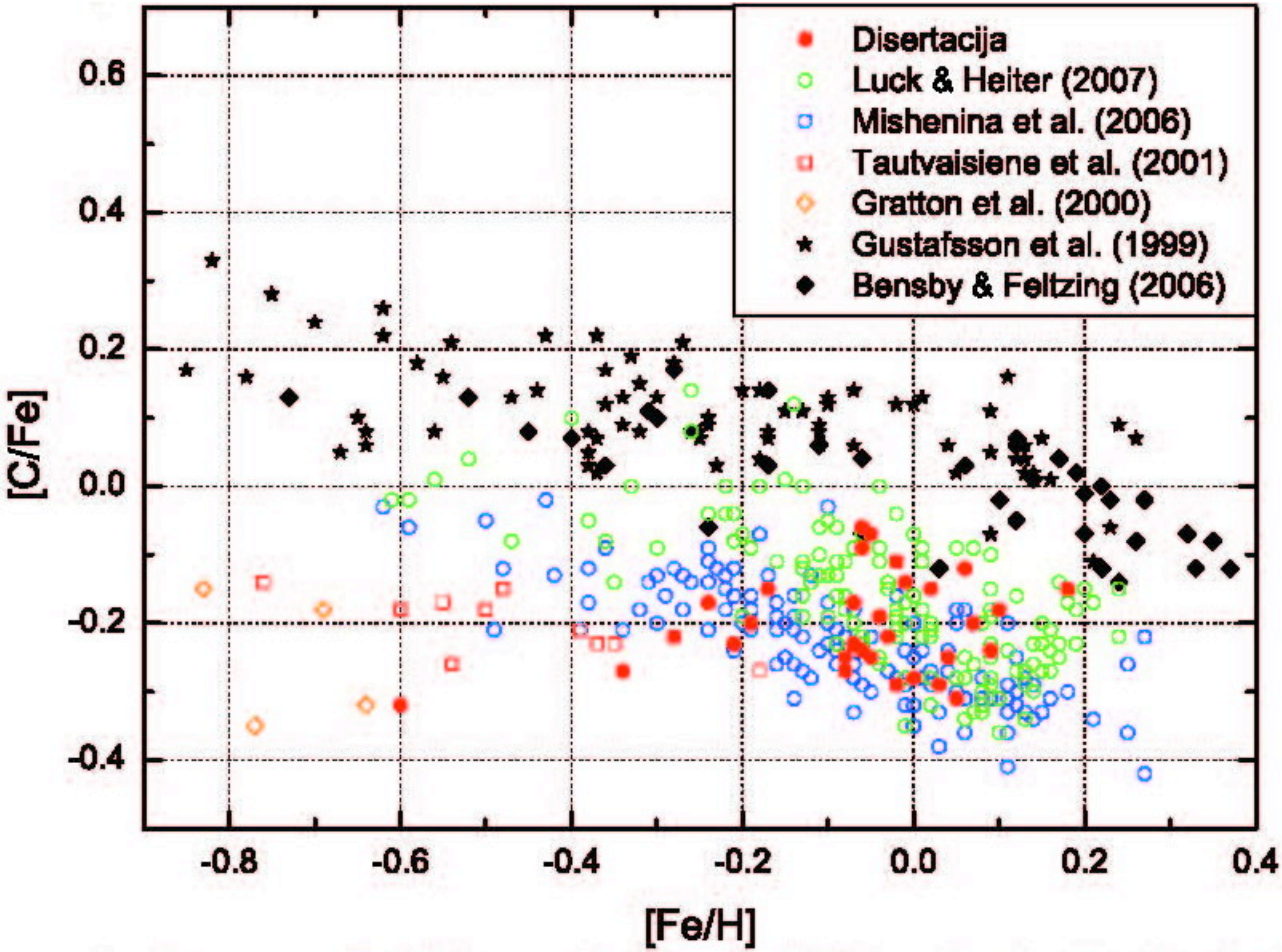


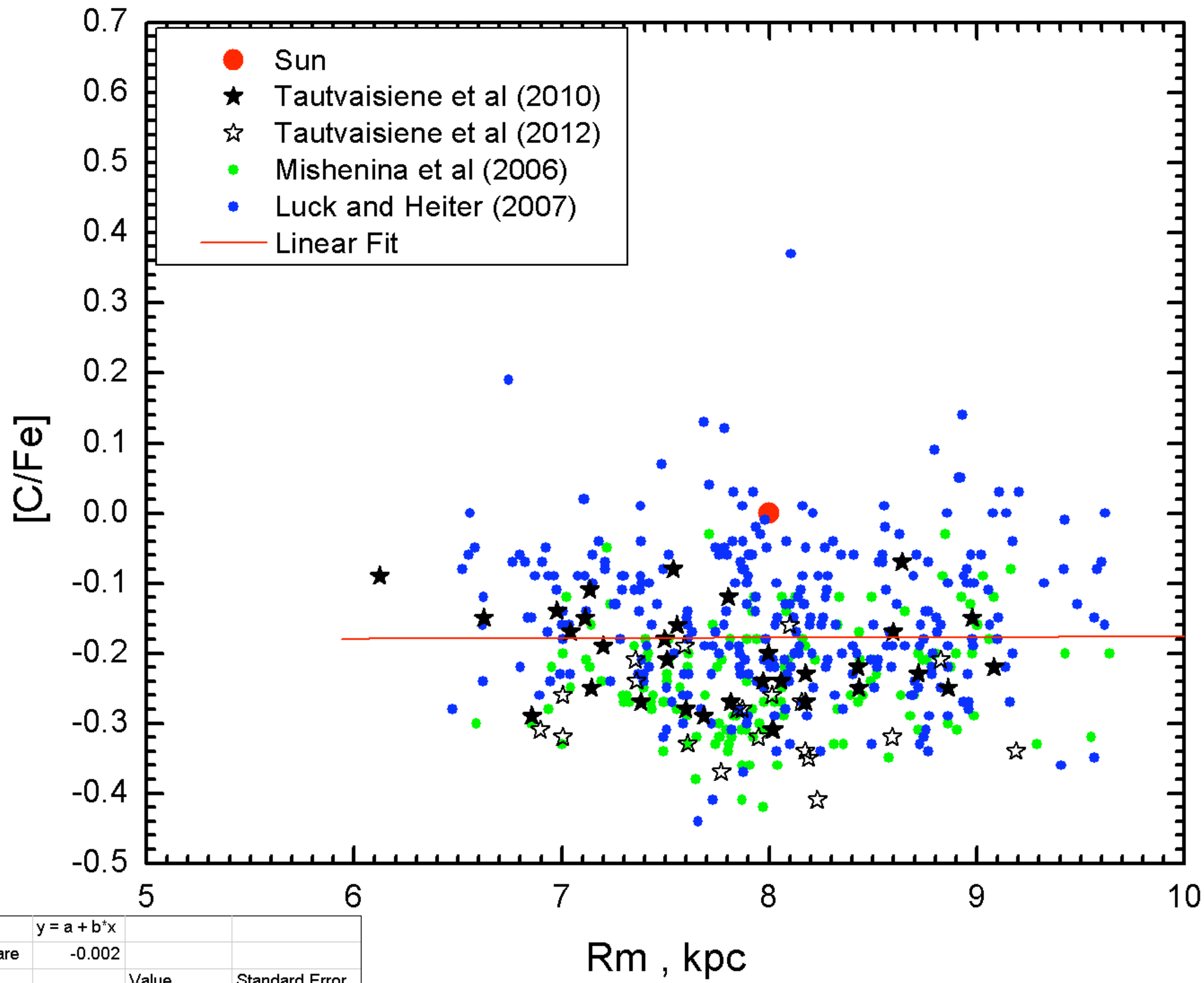
Figure 15. Radial (R_m-$[M/H]$) and vertical (z_{max}-$[M/H]$) metallicity gradients for the red clump sub-samples, subdivided by vertical orbital eccentricity.


Equation | y = a + b*x
Adj. R-Square | 0.04325
Value | Standard Error
Concatenate | Intercept | -0.25987 | 0.06464
Concatenate | Slope | 0.04033 | 0.00799
Sun
Tautvaisiene et al (2010)
Tautvaisiene et al (2012)
Mishenina et al (2006)
Liu et al (2007)
Luck and Heiter (2007)
Linear Fit
[O/Fe]
Rm, kpc

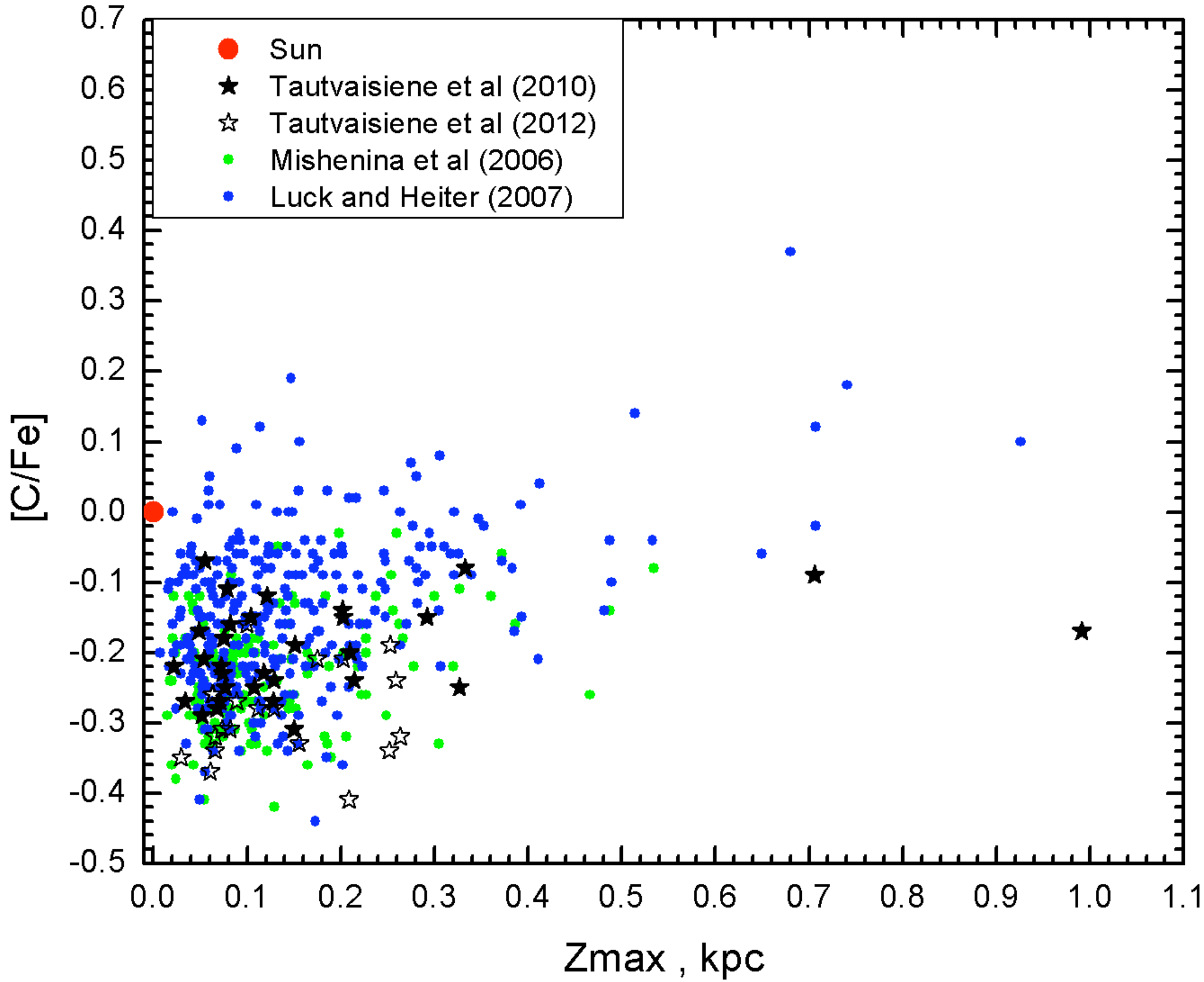


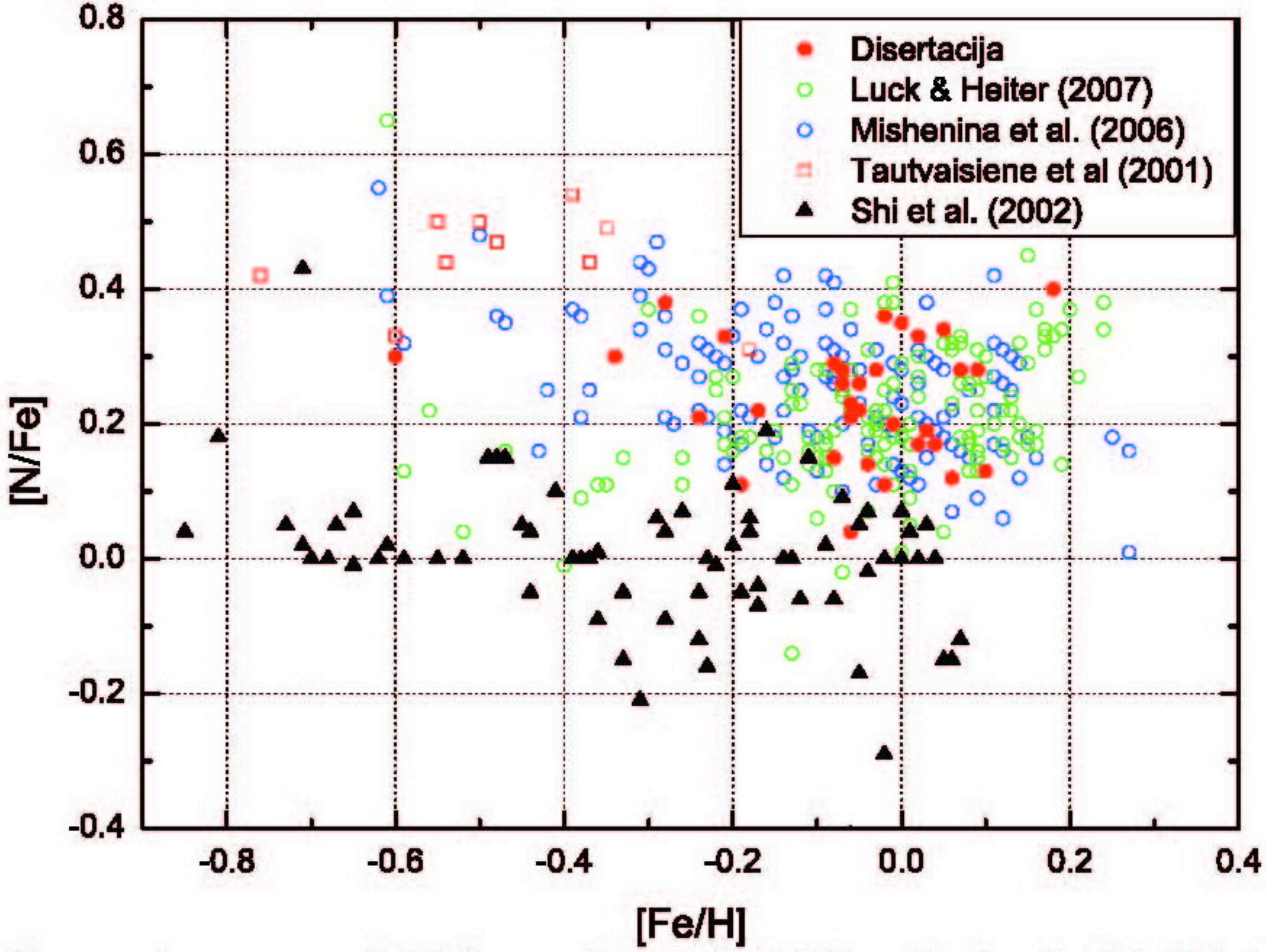
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
[O/Fe]
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
Zmax , kpc
Sun
Tautvaisiene et al (2010)
Tautvaisiene et al (2012)
Mishenina et al (2006)
Liu et al (2007)
Luck and Heiter (2007)


Disertacija
Luck & Heiter (2007)
Mishenina et al. (2006)
Tautvaisiene et al. (2001)
Gratton et al. (2000)
Gustafsson et al. (1999)
Bensby & Feltzing (2006)
[C/Fe]
[Fe/H]
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4

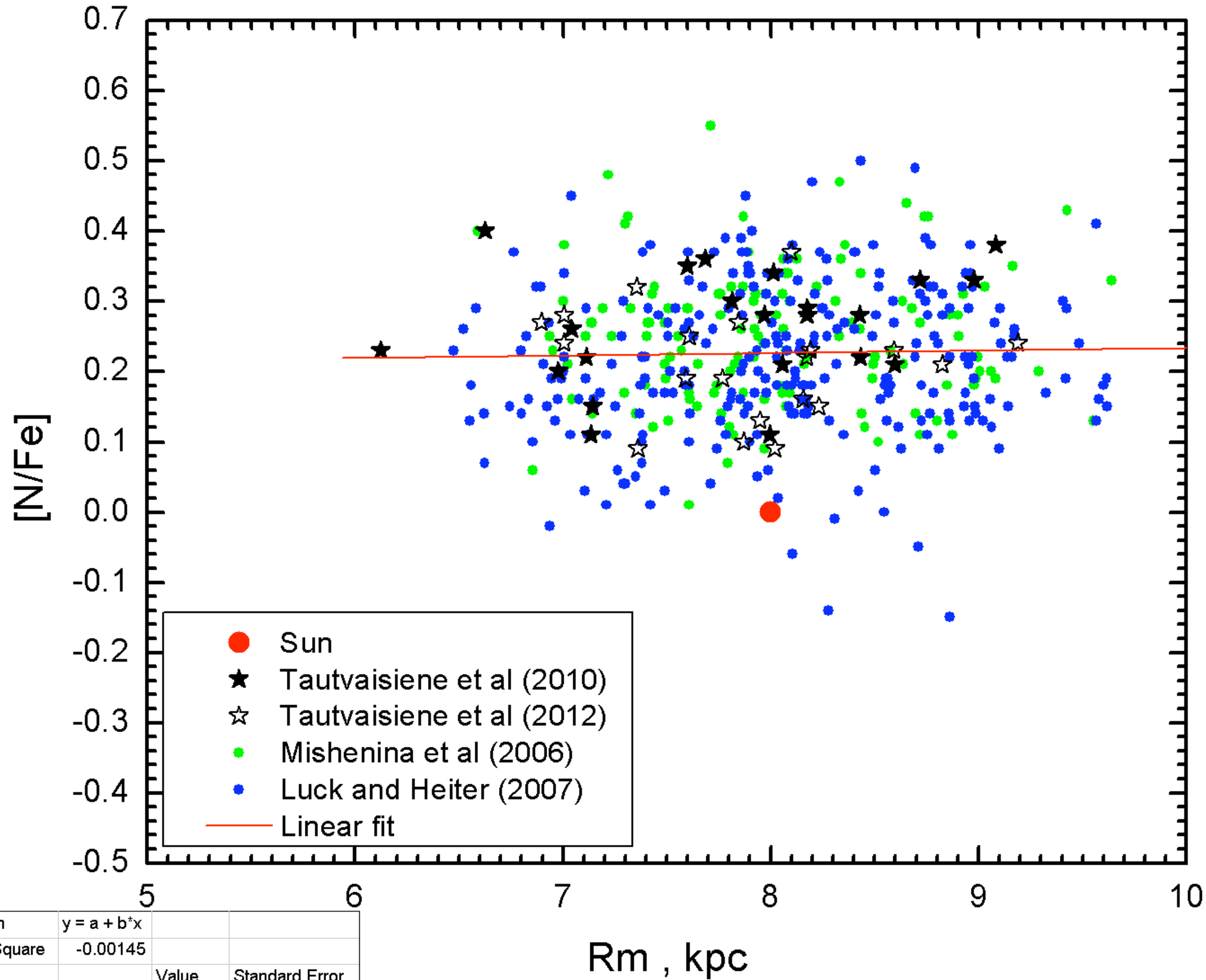


Equation	y = a + b*x		
Adj. R-Square	-0.002		
		Value	Standard Error
Concatenate	Intercept	-0.18482	0.04968
Concatenate	Slope	8.25468E-4	0.00616

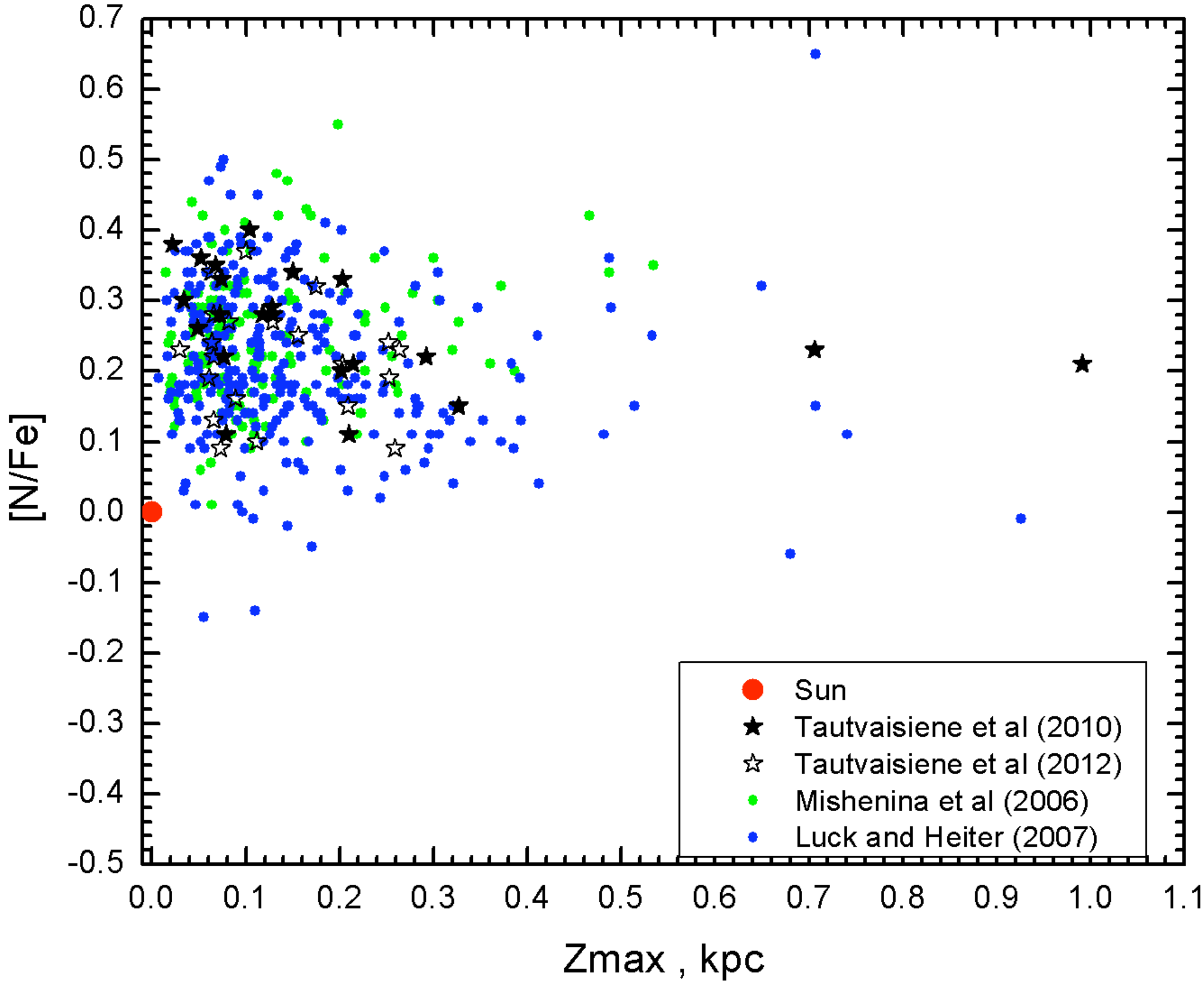

Sun
Tautvaisiene et al (2010)
Tautvaisiene et al (2012)
Mishenina et al (2006)
Luck and Heiter (2007)
[C/Fe]
Zmax , kpc
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1



Disertacija
Luck & Heiter (2007)
Mishenina et al. (2006)
Tautvaisiene et al (2001)
Shi et al. (2002)
[N/Fe]
[Fe/H]
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4



Equation	y = a + b*x		
Adj. R-Square	-0.00145		
		Value	Standard Error
Concatenate	Intercept	0.1976	0.04908
Concatenate	Slope	0.00355	0.00609



0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
[N/Fe]
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
Zmax , kpc
Sun
Tautvaisiene et al (2010)
Tautvaisiene et al (2012)
Mishenina et al (2006)
Luck and Heiter (2007)

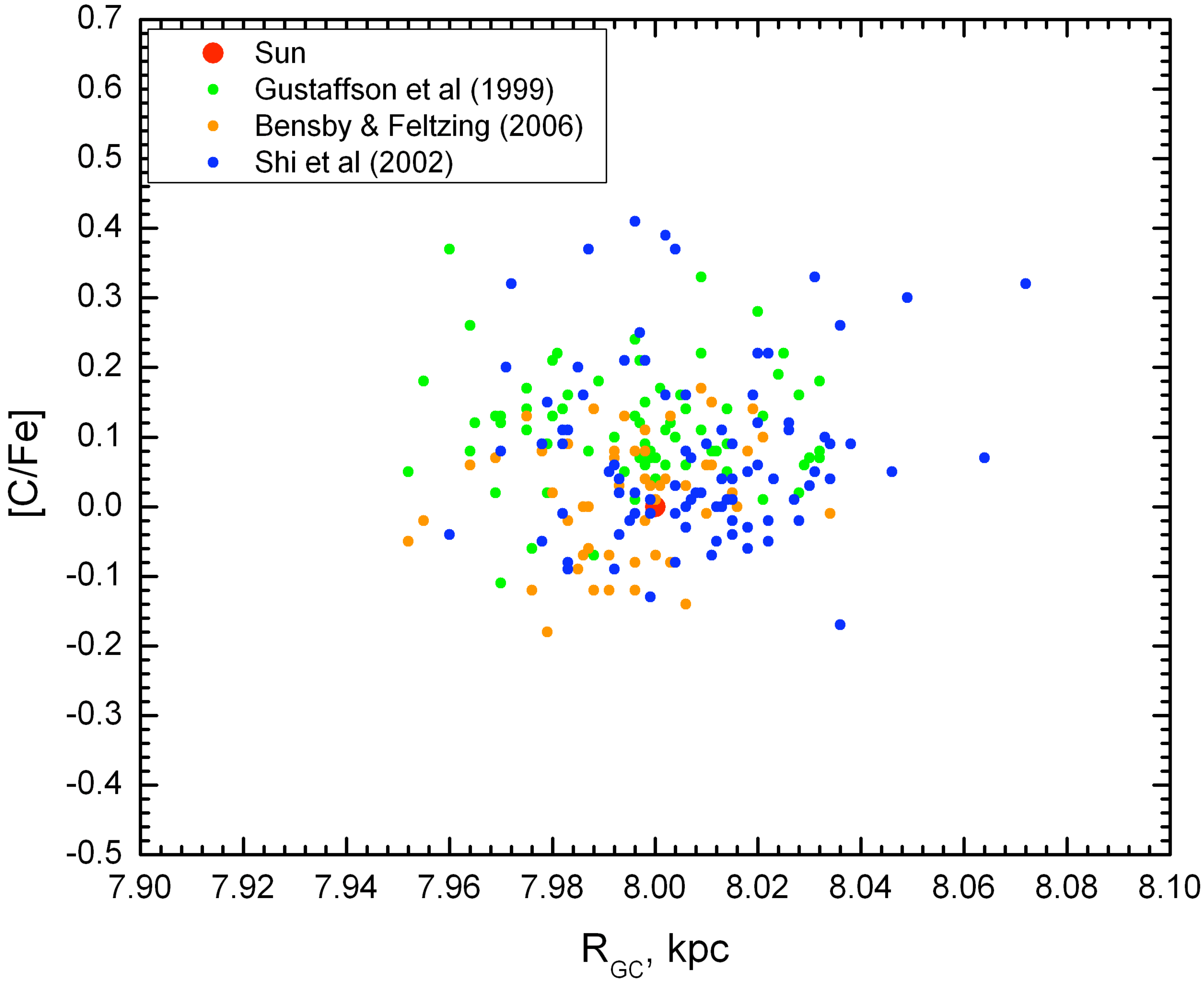
F-G-K dwarfs

- Petigura E. A. & Marcy G. W. 2011, ApJ 735, 41 ([O I] – 694 stars, C I 6587.6 – 704 stars)
- Delgado Mena et al. (2010) HARPS

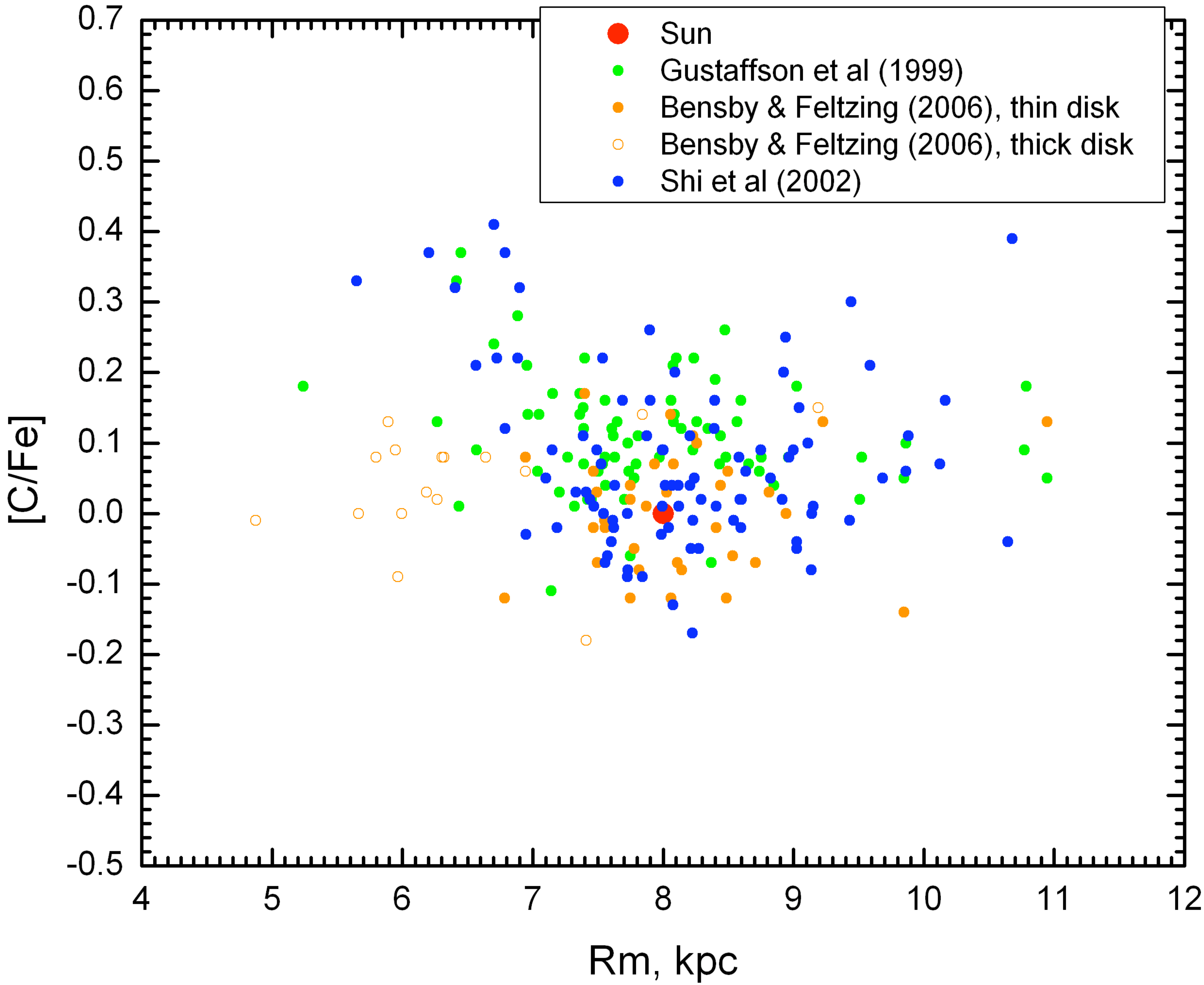
  (C I 5380.3, 5052.2; [OI] 6300, 6363; 370 stars)
- Luck R. E. & Heiter U. 2006, AJ, 131, 3069

  ([O I] and O I; C I and C_2; about 50 stars)

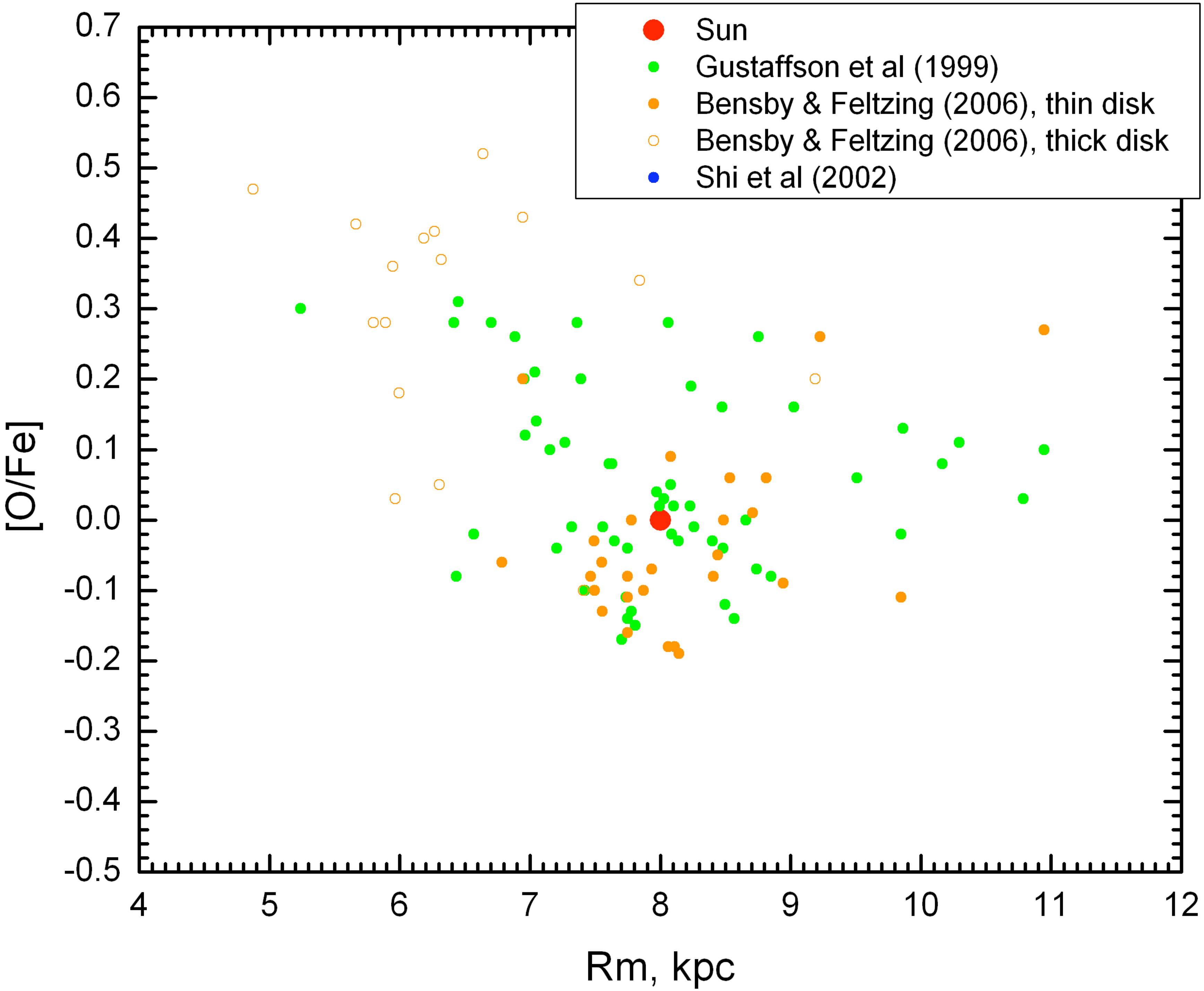
Dwarfs

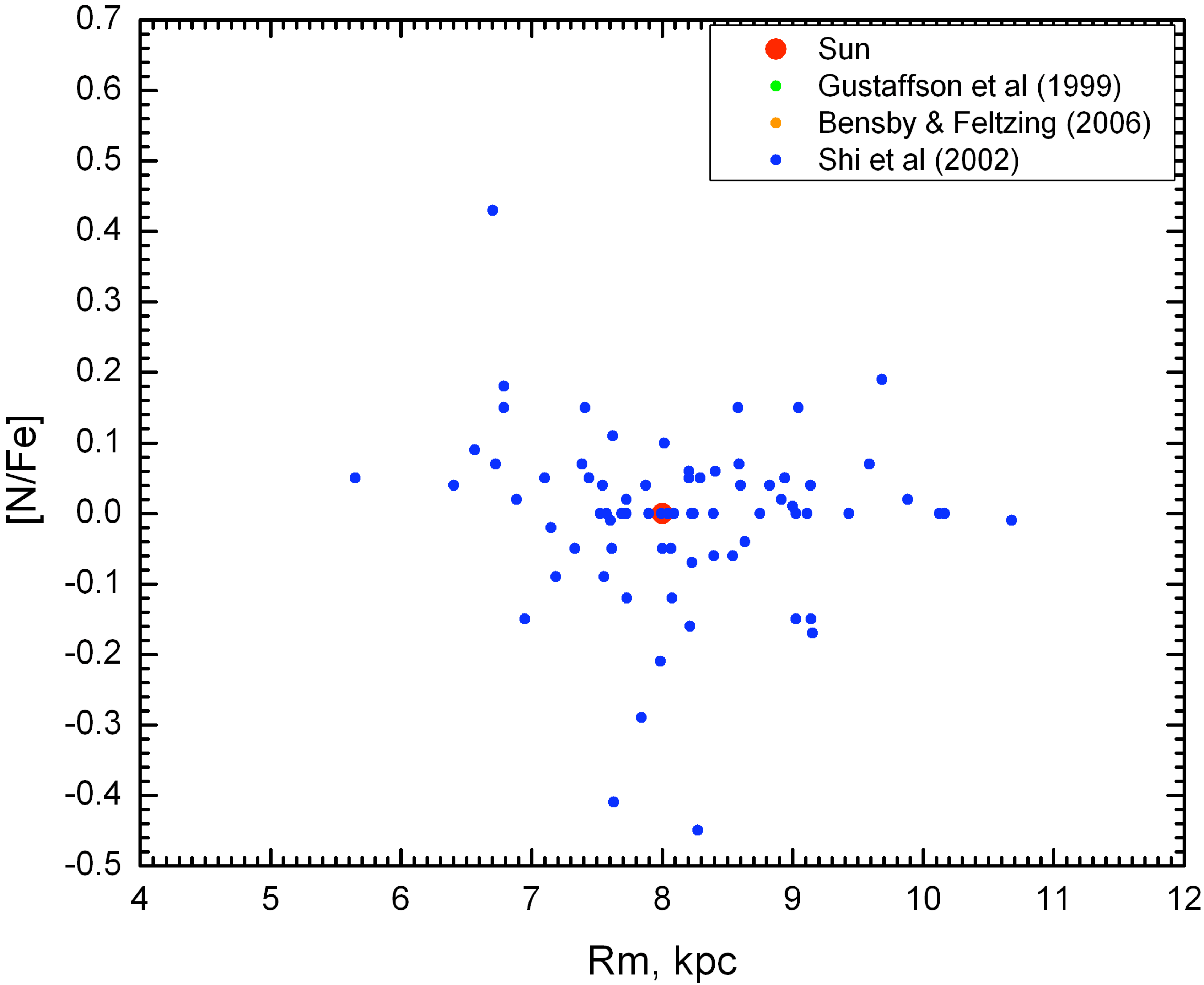


Sun
Gustaffson et al (1999)
Bensby & Feltzing (2006)
Shi et al (2002)
[C/Fe]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
7.90
7.92
7.94
7.96
7.98
8.00
8.02
8.04
8.06
8.08
8.10
R_{GC}, kpc



Sun
Gustaffson et al (1999)
Bensby & Feltzing (2006), thin disk
Bensby & Feltzing (2006), thick disk
Shi et al (2002)
[C/Fe]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
4
5
6
7
8
9
10
11
12
Rm, kpc


Sun
Gustaffson et al (1999)
Bensby & Feltzing (2006), thin disk
Bensby & Feltzing (2006), thick disk
Shi et al (2002)
[O/Fe]
Rm, kpc
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
4
5
6
7
8
9
10
11
12



0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
[N/Fe]
4
5
6
7
8
9
10
11
12
Rm, kpc
Sun
Gustaffson et al (1999)
Bensby & Feltzing (2006)
Shi et al (2002)

Planetary nebula and H II regions

The Galaxy Disk in Cosmological Context
Proceedings IAU Symposium No. 254, 2008
J. Andersen, J. Bland-Hawthorn & B. Nordström, eds.

DOI: 00.0000/X000000000000000X

Abundance gradients in the galactic disk: space and time variations

Walter J. Maciel and Roberto D. D. Costa

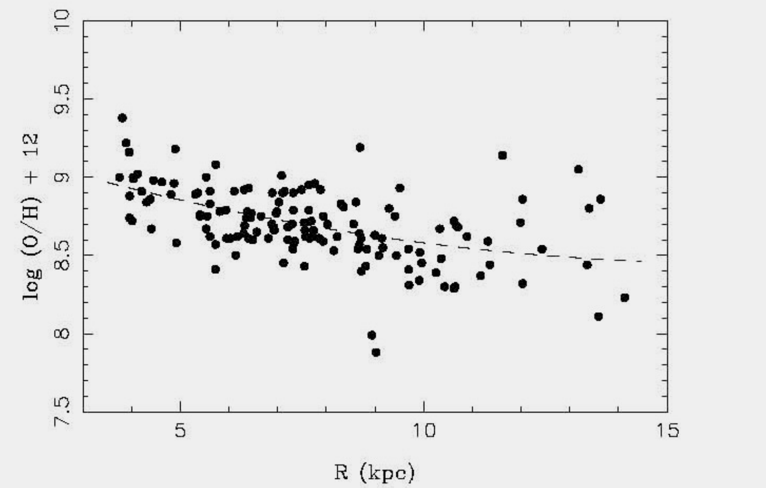


Figure 1. The O/H radial abundance gradient in the galactic disk.

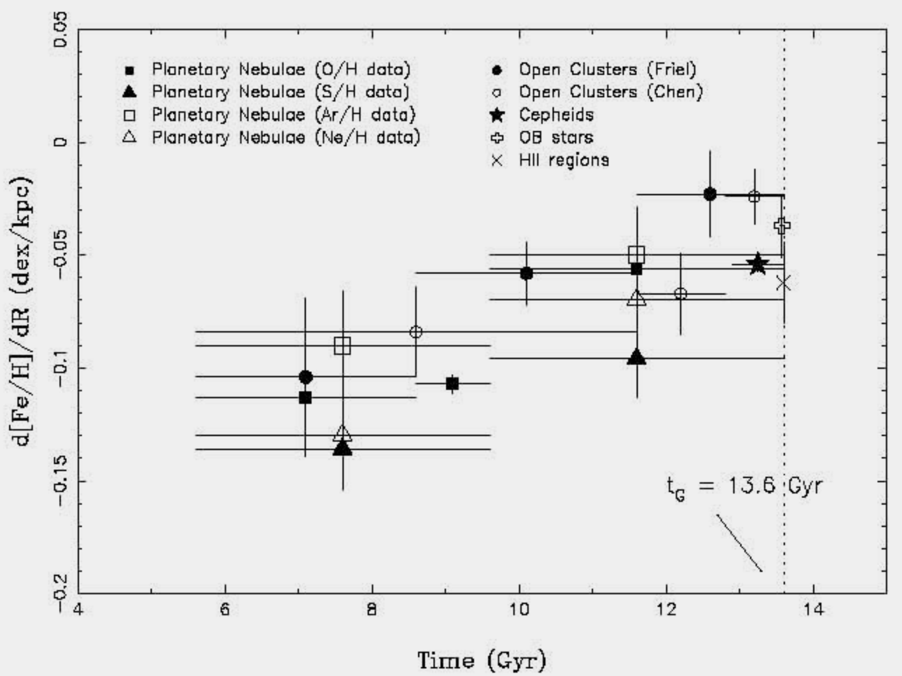


Figure 3. Time variation of the converted [Fe/H] radial gradient from PN and other objects.

Conclusions

- Work on stellar CNO abundance radial gradients in the Galactic disk is on its initial stage
- Stars of the thin and thick discs should be analysed separately
- Giants of the same evolutionary stage also may be useful
- Most trustful spectral features should be used
- Promising results to come from AMBRE, APOGEE, Gaia-ESO Spectroscopic Survey, Gaia, etc.