Magnesium isotopic abundance ratios in dwarf stars of the galactic halo

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PRECISION SPECTROSCOPY 2016

Introduction

- The study of the chemical composition of stars is crucial to understanding the formation history of our Galaxy.
- Main sequence stars provide the chemical composition at the time and place that they were formed.
- So, the study of dwarf stars in different populations, metallicities and ages, can provide clues about the different components of our galaxy and also how it was formed and how it evolved.

The Mg stable isotopes:

- The magnesium isotope, ^{24}Mg, is produced inside massive stars in their carbon and neon burning layers before the supernova explosion.
- The production of the isotopes ^{25}Mg and ^{26}Mg can occur in stars with intermediate mass through the reactions :
  - $^{22}Ne(\alpha,n)^{25}Mg$
  - $^{25}Mg(n,\gamma)^{26}Mg$
- Since the Mg isotopes are produced in different sites (i.e., different stars), they track different stellar (and Galactic) evolution over short and longer timescales.

Sample

- The sample consist of 8 K dwarf stars from the galactic halo (in this talk – 3 stars are shown).
- The stars were observed with the HIRES spectrograph at the Keck observatory.
- $R{\sim}10^5$ and $191 \leq S/N \leq 312$.

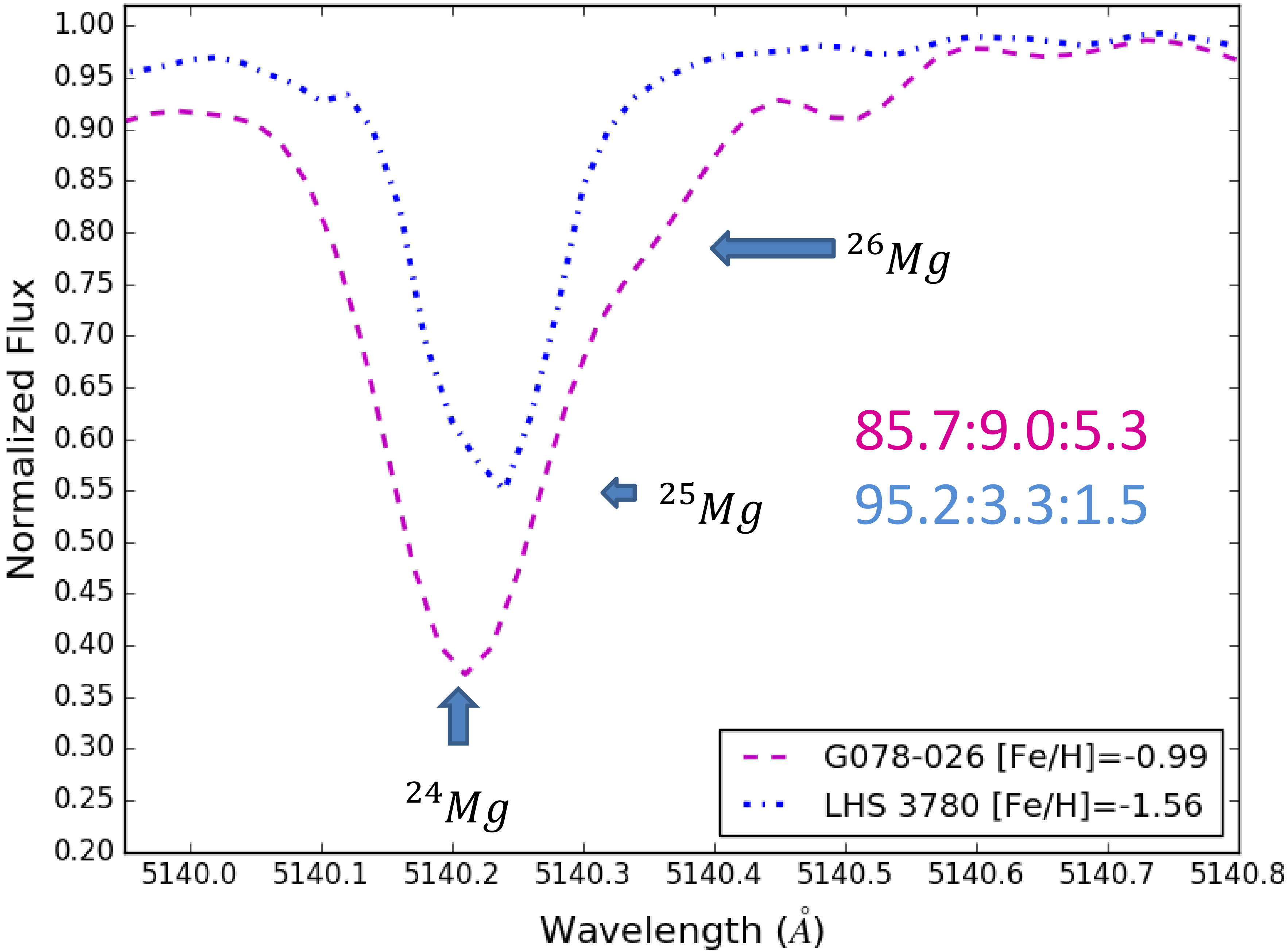
Analysis

- We adopted $vsini = 0$ km/s.

- The macroturbulence velocity was calculated analyzing the line profiles of the Fe I 6056.0 Å, 6078.5 Å, 6096.7 Å and 6151.6 Å lines.

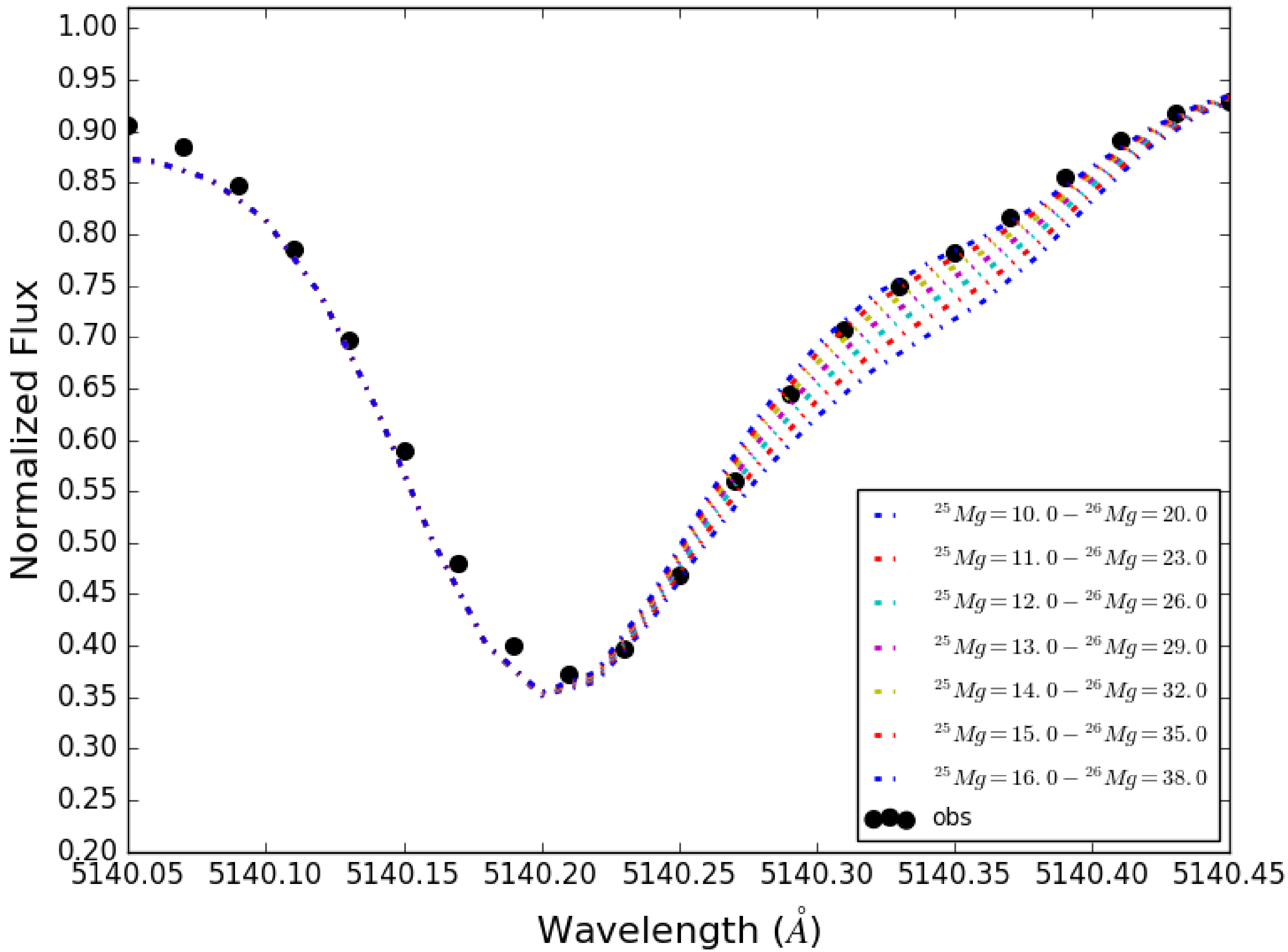
- Magnesium abundance was measured by spectral synthesis via MOOG code at the regions:

  - 5134.6 Å
  - 5138.7 Å
  - 5140.2 Å

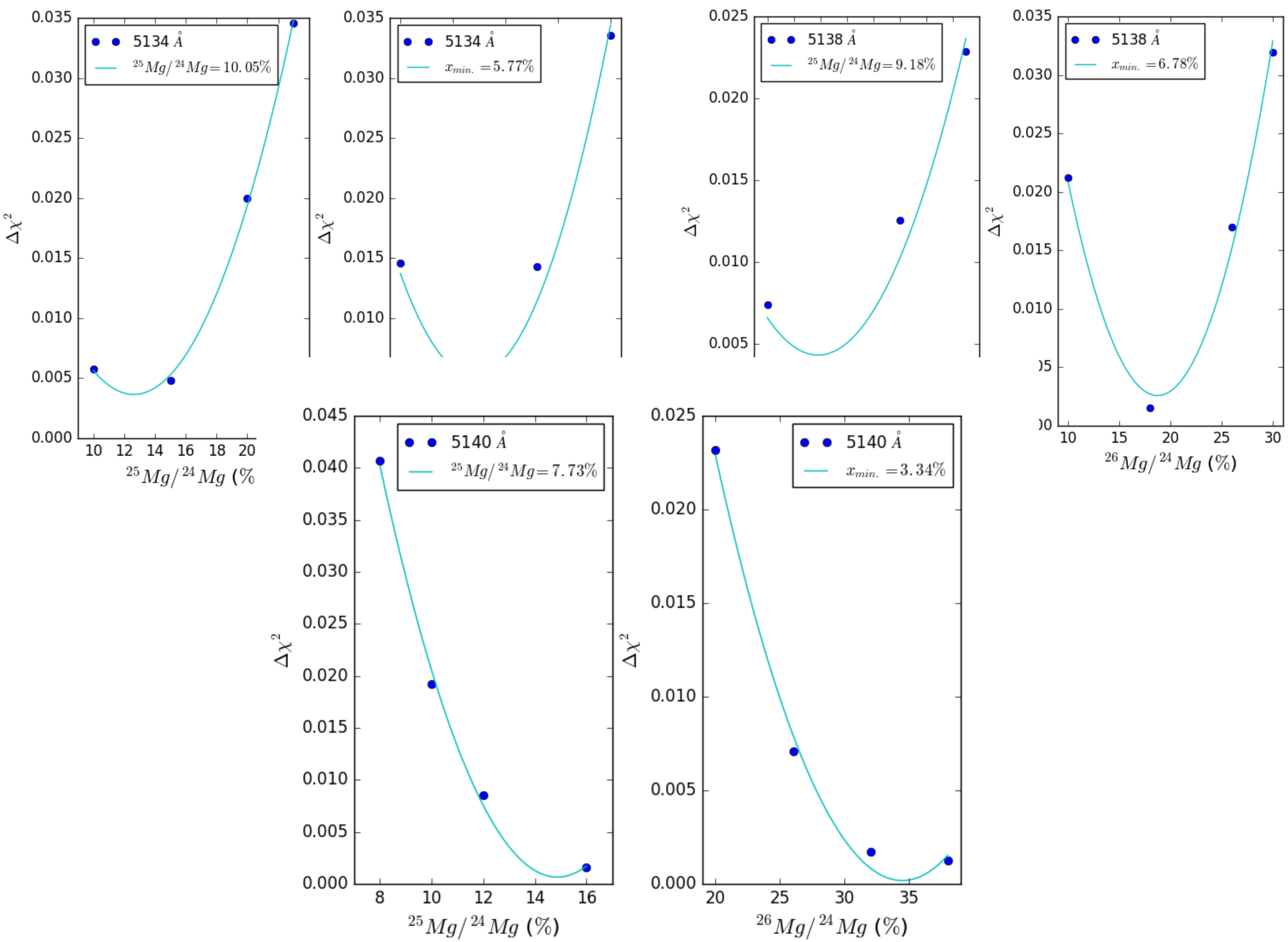


Normalized Flux
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
5140.0
5140.1
5140.2
5140.3
5140.4
5140.5
5140.6
5140.7
5140.8
Wavelength (Å)
^{26}Mg
^{25}Mg
^{24}Mg
85.7:9.0:5.3
95.2:3.3:1.5
G078-026 [Fe/H]=-0.99
LHS 3780 [Fe/H]=-1.56

○ 5140.2 Å – G078-026

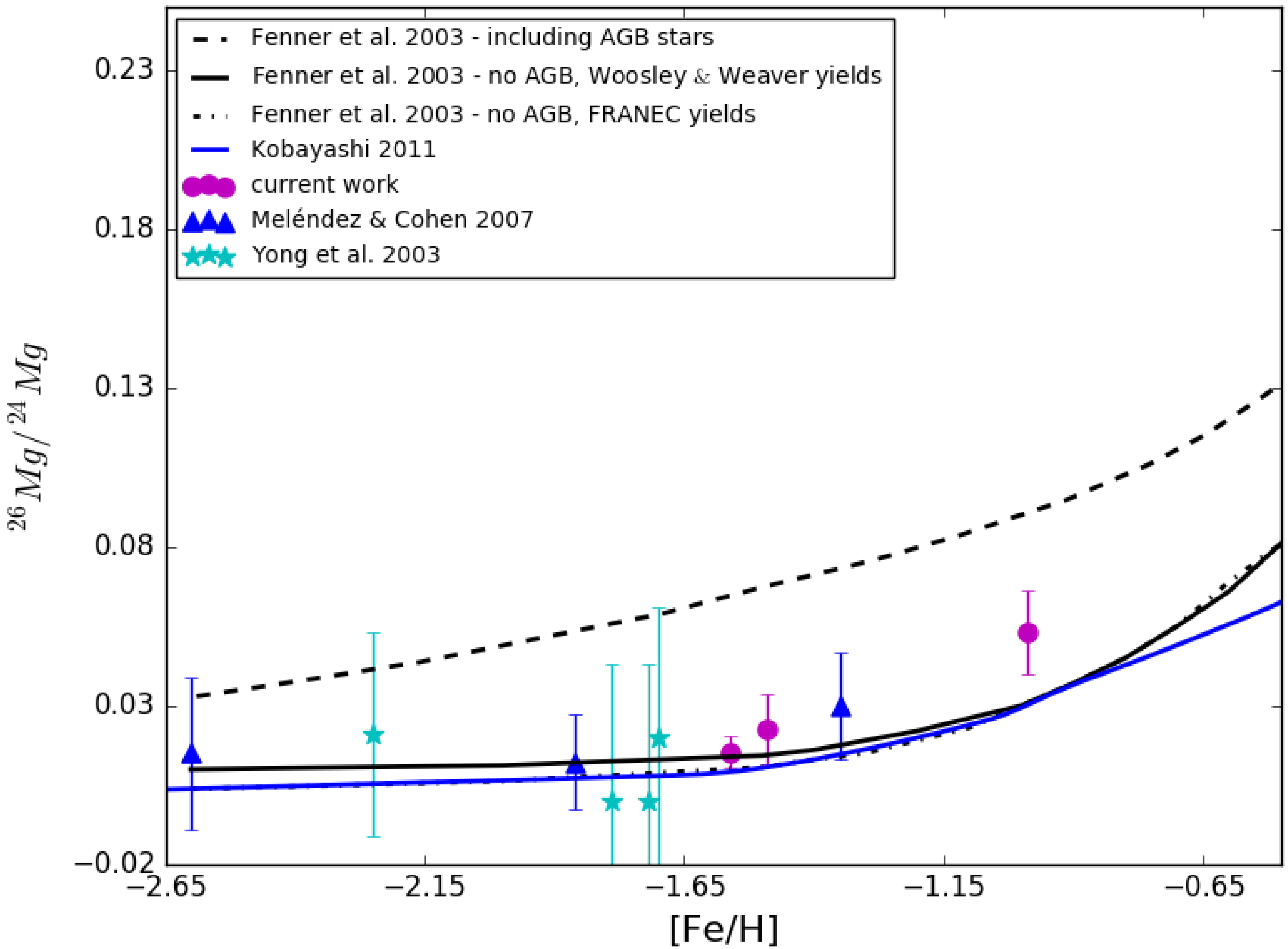


○ χ^2



5134 Å
$^{25}Mg/^{24}Mg$=10.05%
$\Delta\chi^2$
$^{25}Mg/^{24}Mg$ (%
5134 Å
$x_{min.}$ =5.77%
$\Delta\chi^2$
5138 Å
$^{25}Mg/^{24}Mg$=9.18%
$\Delta\chi^2$
5138 Å
$x_{min.}$ =6.78%
$\Delta\chi^2$
$^{26}Mg/^{24}Mg$ (%)
5140 Å
$^{25}Mg/^{24}Mg$=7.73%
$\Delta\chi^2$
$^{25}Mg/^{24}Mg$ (%)
5140 Å
$x_{min.}$ =3.34%
$\Delta\chi^2$
$^{26}Mg/^{24}Mg$ (%)

Results



Fenner et al. 2003 - including AGB stars
Fenner et al. 2003 - no AGB, Woosley & Weaver yields
Fenner et al. 2003 - no AGB, FRANEC yields
Kobayashi 2011
current work
Meléndez & Cohen 2007
Yong et al. 2003
$^{26}Mg/^{24}Mg$
0.23
0.18
0.13
0.08
0.03
−0.02
−2.65
−2.15
−1.65
−1.15
−0.65
[Fe/H]

Conclusions (so far)

- There is no need to invoke the contribution of intermediate-mass AGB stars at low metallicities.

- The contribution from AGB stars begins at $[Fe/H] \sim -1.5$ (in agreement with Melendez & Cohen 2007).

- The calculations of Karakas & Lattanzio (2003) show that the AGB stars that contribute significant amounts of $^{25,26}Mg$ are stars with initial masses of 3–6 $M_{\odot}$.

- Since these stars have lifetimes considerably shorter than the age of the universe, they can be used to constrain the timescale for the formation of the Galactic halo.

Thank you!