Chemical diversity at low metallicities

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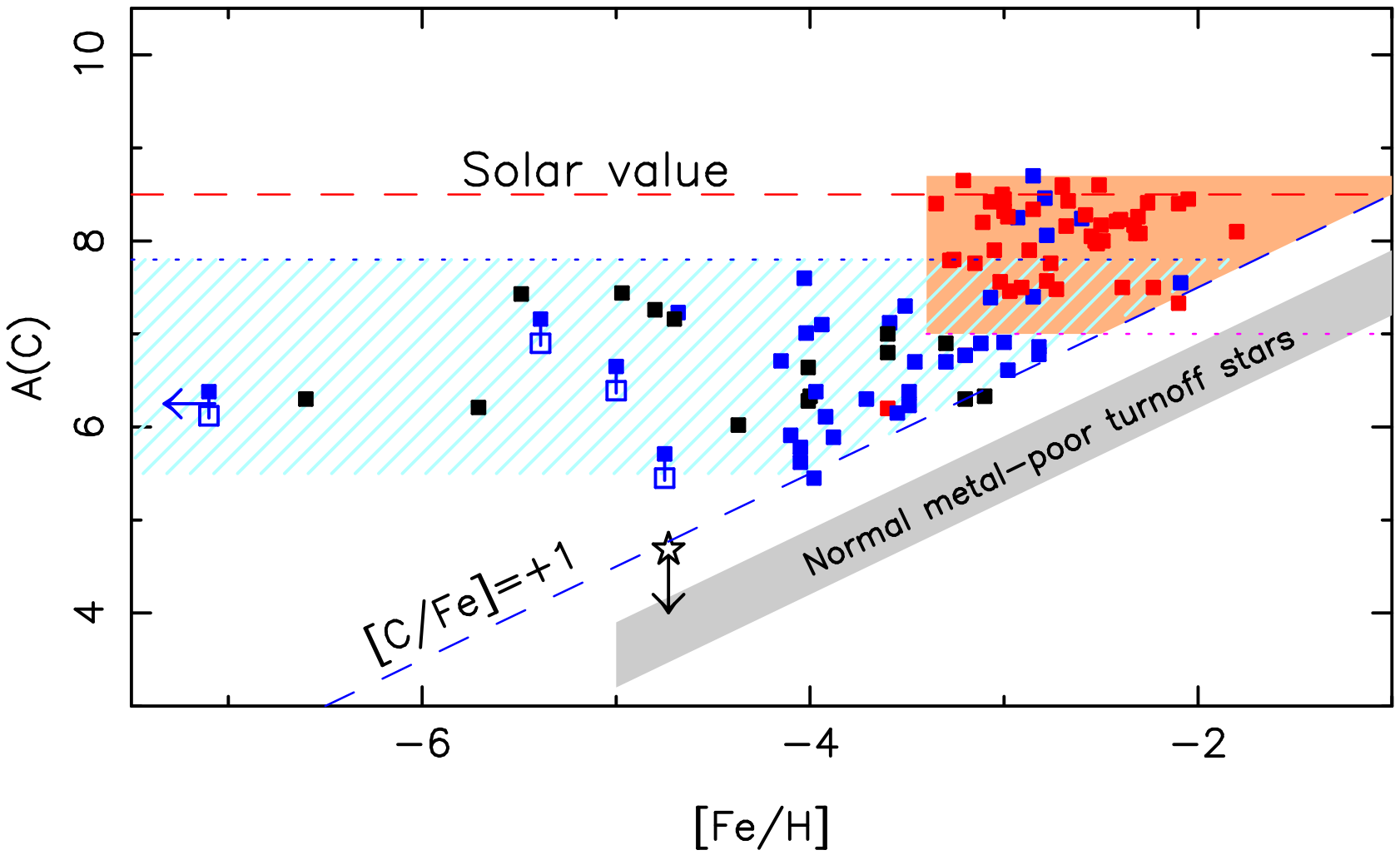
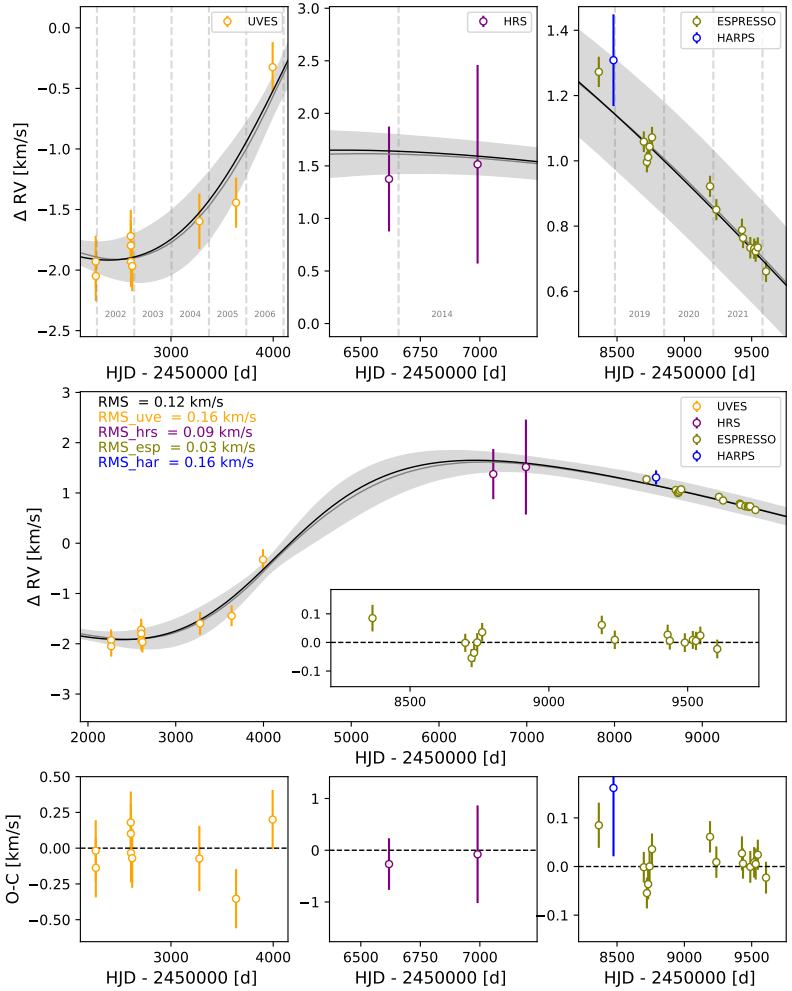
The most Fe-poor stars



HE0107–5240: the first star known with $[\mathrm{Fe/H}] < -5$

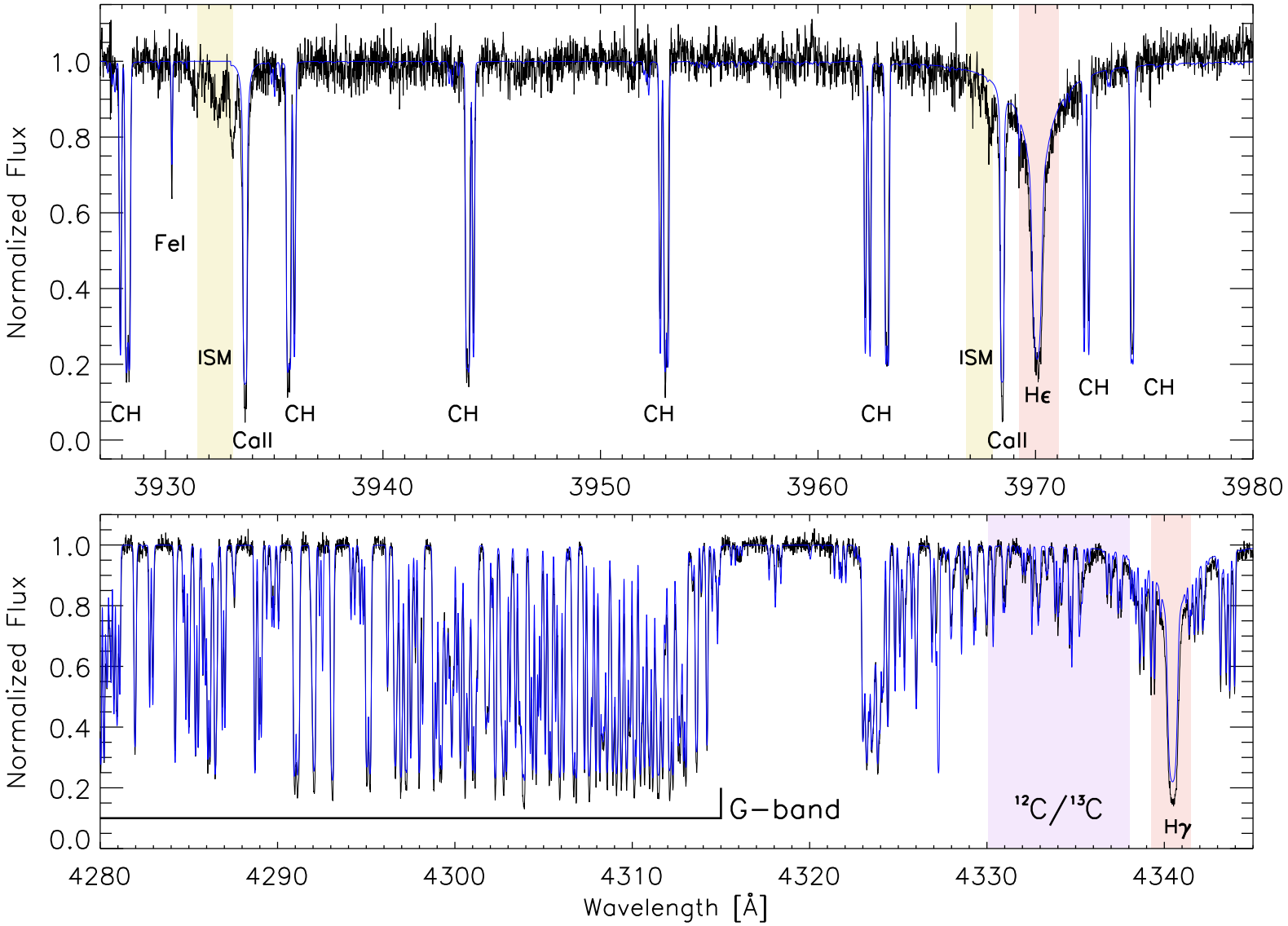
Christlieb's star (Christlieb et al. 2002) belongs to a binary system



Bonifacio et al. (2020) and Aguado et al. (2022) - ESPRESSO GTO (PI Paolo Molaro)
binarity already depicted by Arentsen et al. (2019)

HE0107–5240: ESPRESSO spectrum

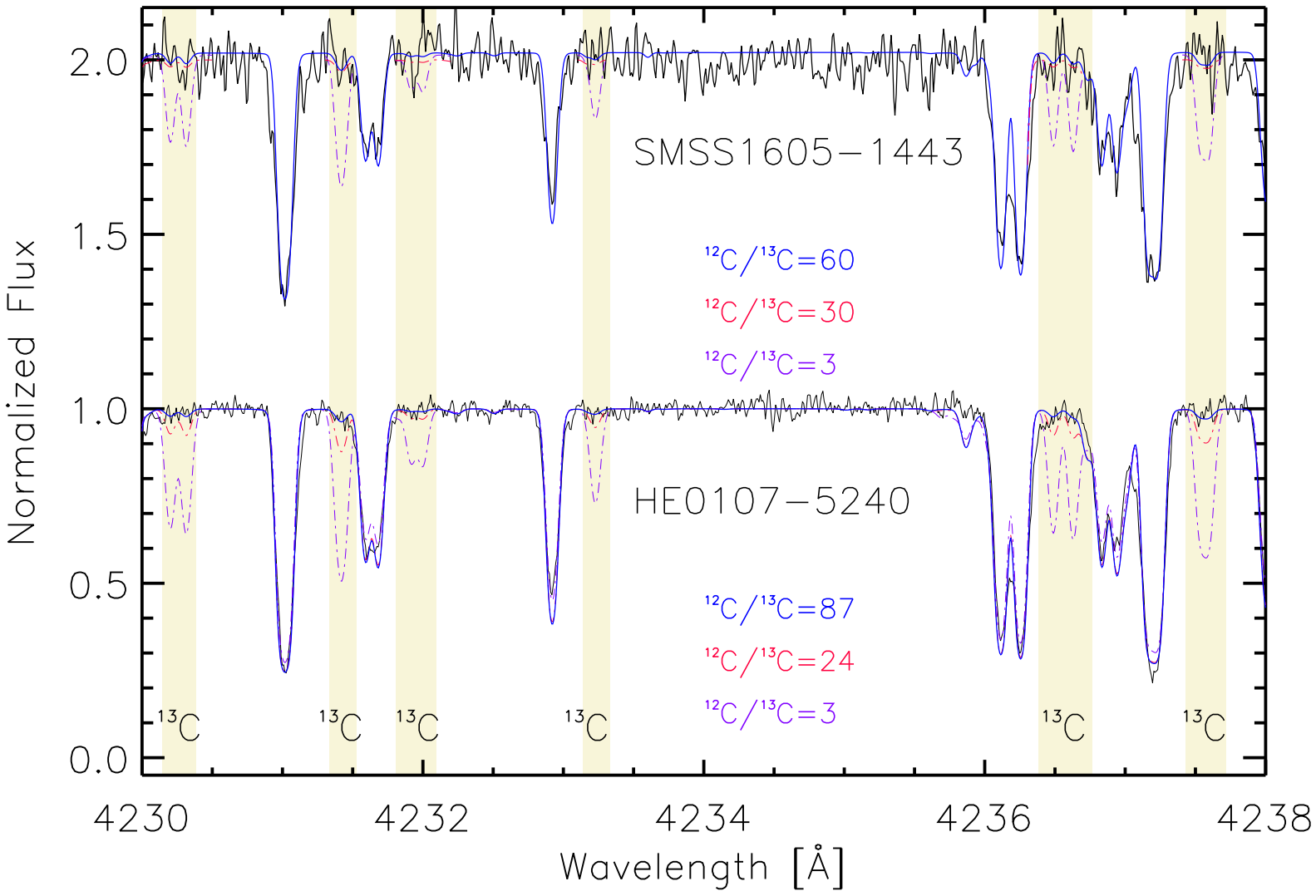
Christlieb's star: a strong G-band, A(C)=6.7, [C/Fe]=+3.5



Aguado et al. (2022) - ESPRESSO GTO

HE0107–5240: C isotopic ratio

Christlieb's star: high $^{13}C/^{12}C$ ratio



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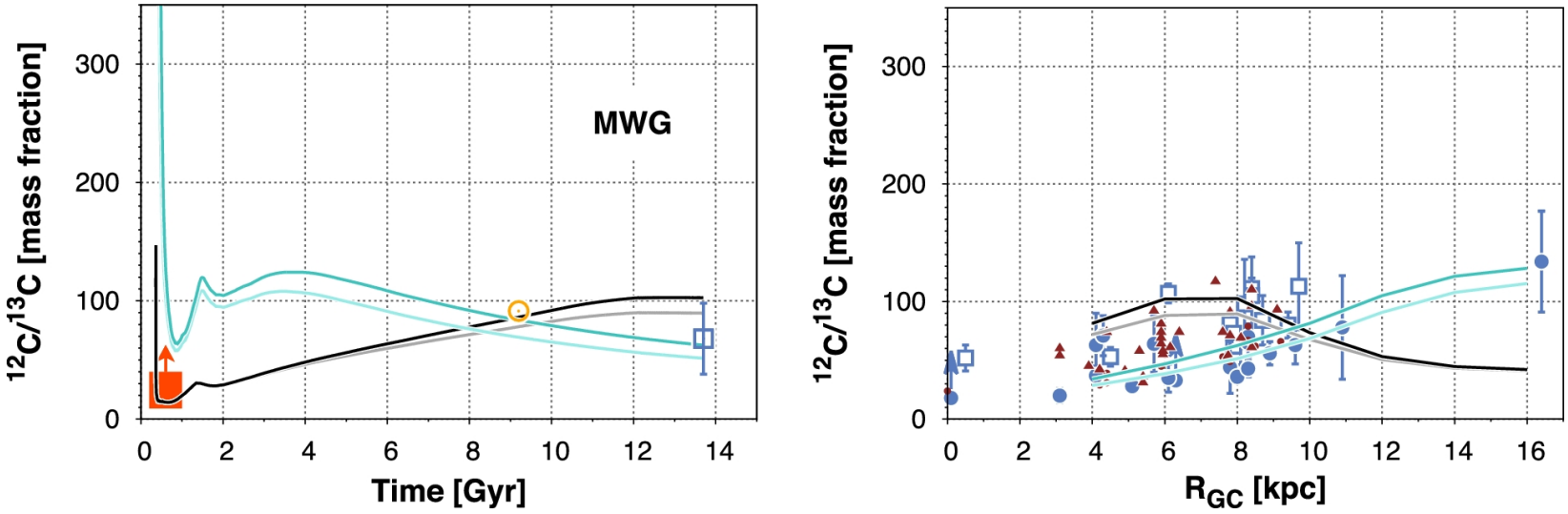
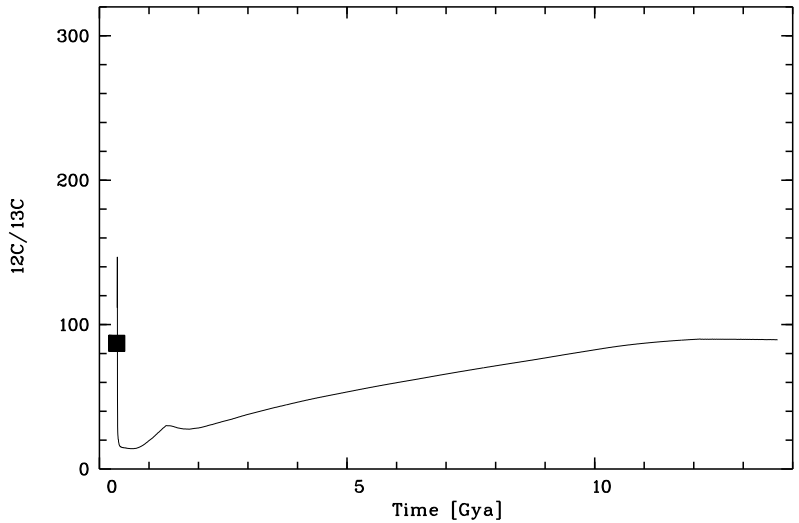


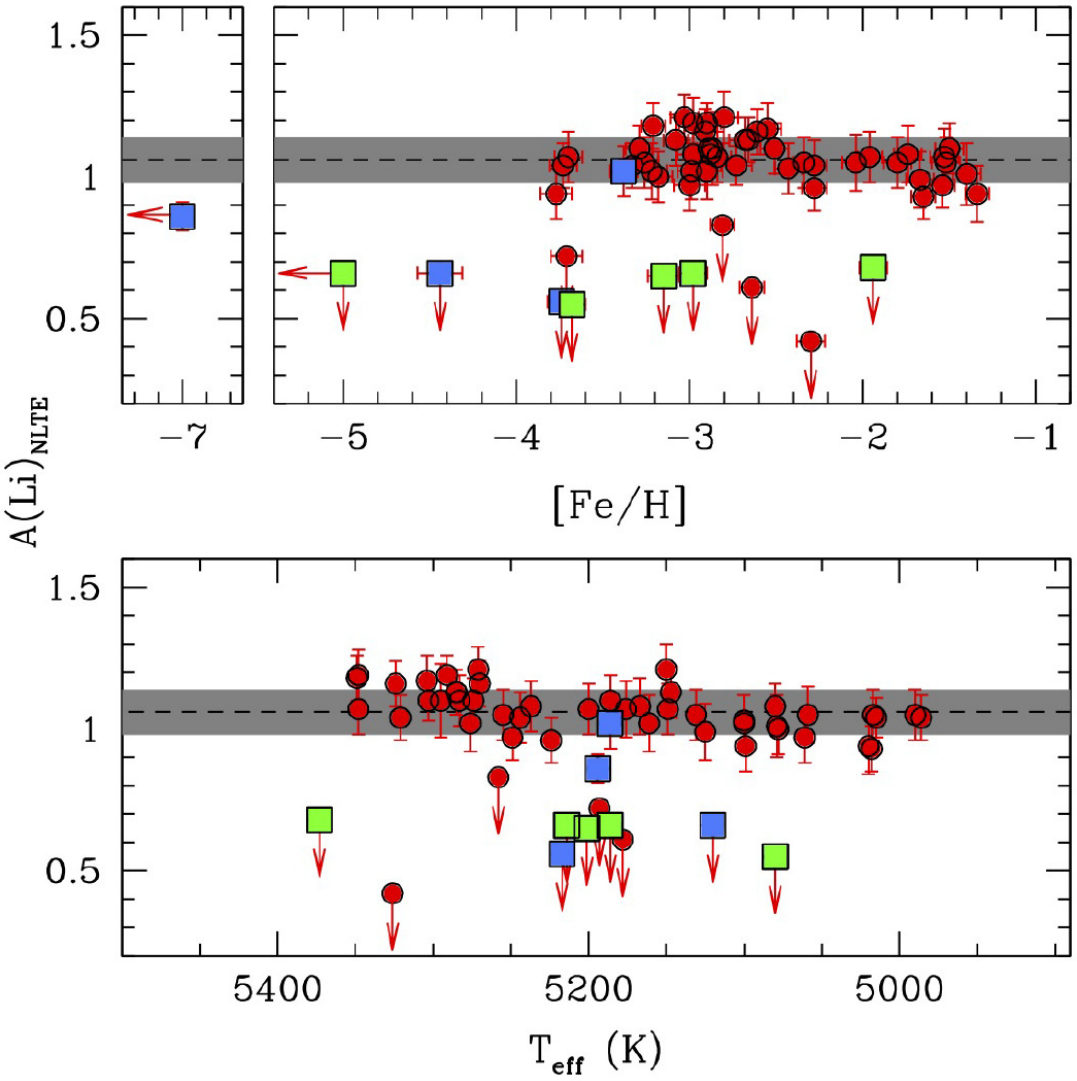
Romano et al. (2017)

Spite et al. (2006) – Sun, Ayres et al. (2013) – ISM, Milam et al. (2005)



Christlieb's star

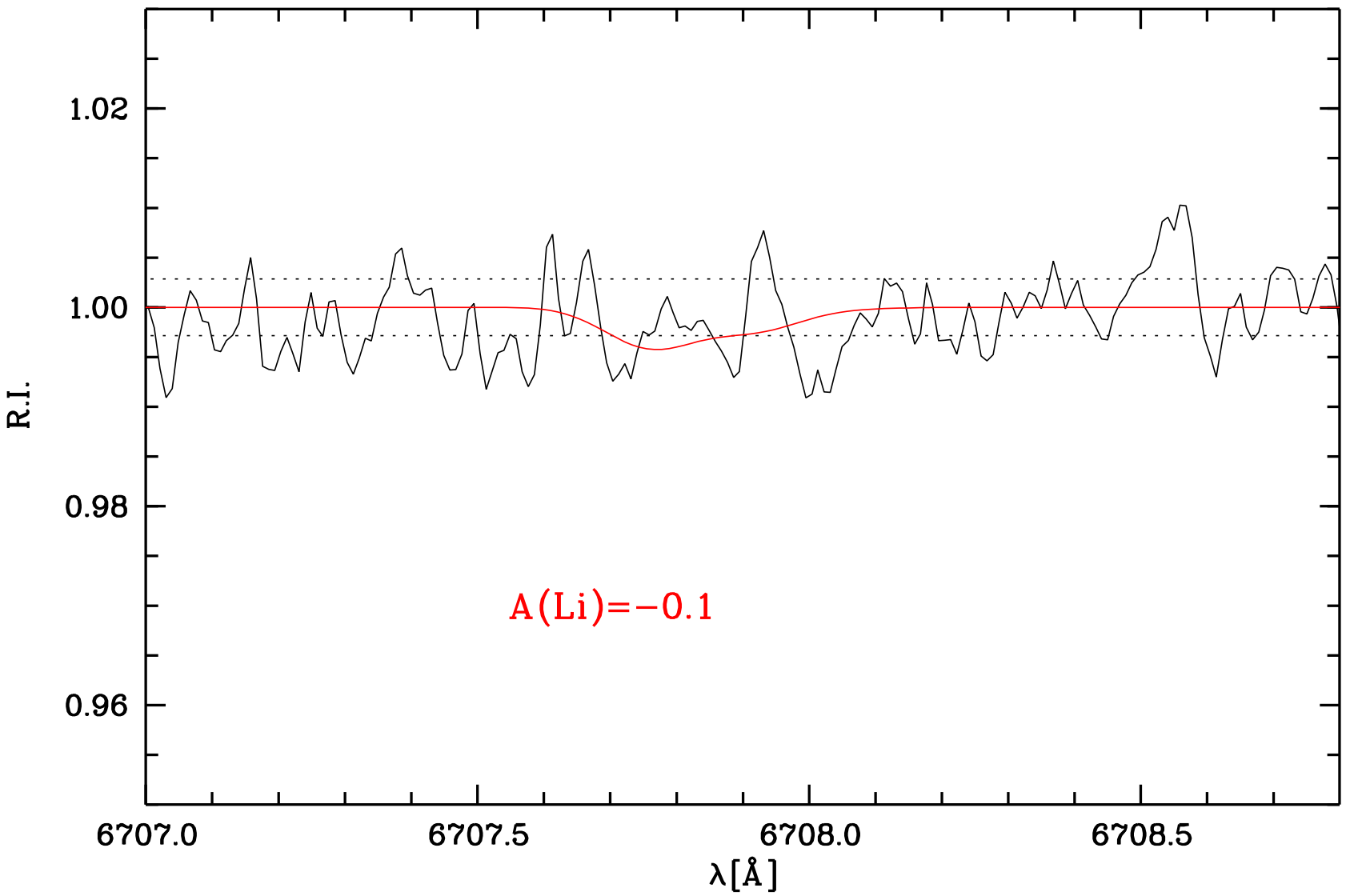
Lithium in lower RGB stars



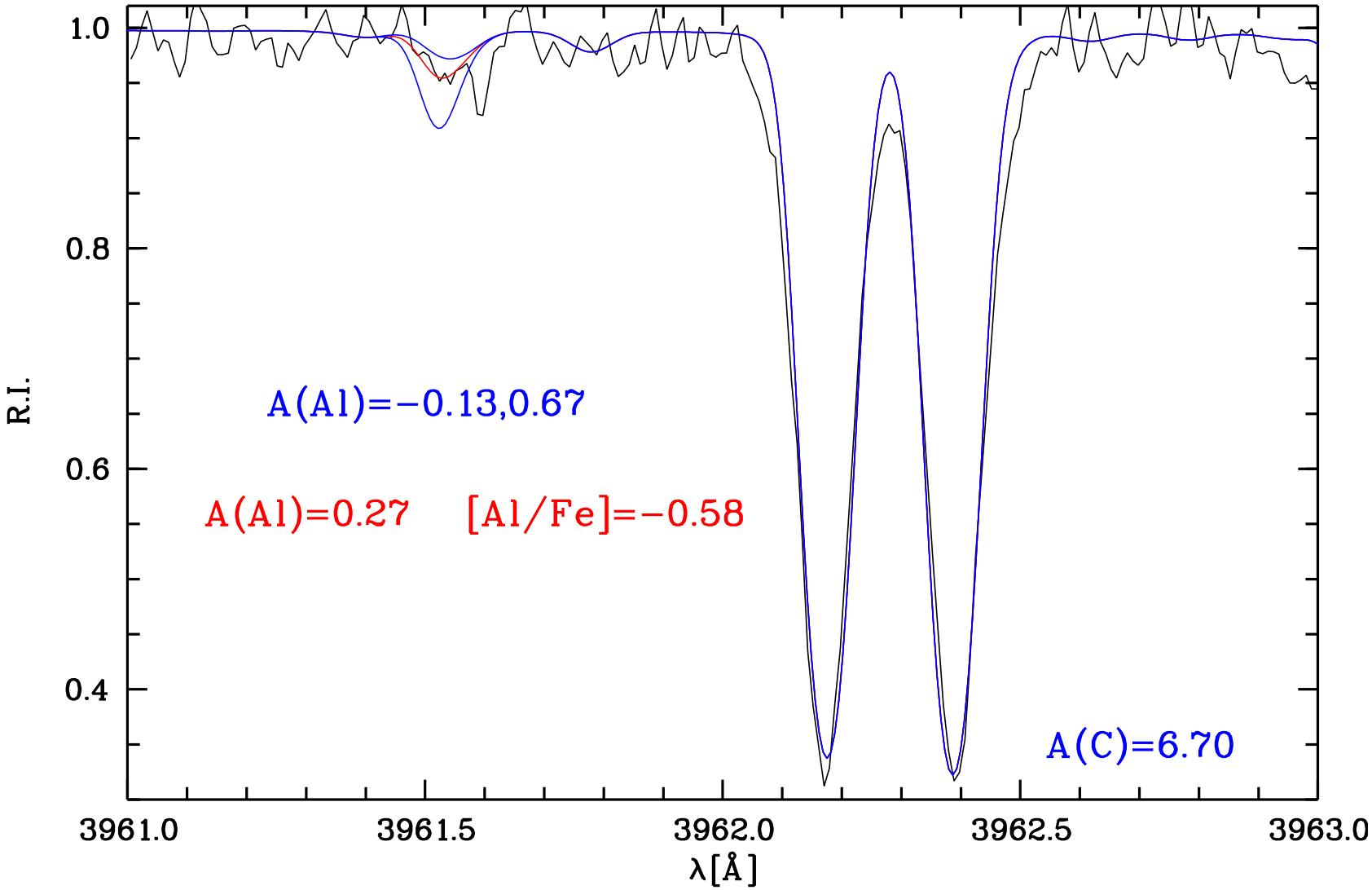
From Mucciarelli et al. (2023, A&A 661, 153): EMP, CEMP low C-band and CEMP high C-band stars

HE0107–5240: lithium

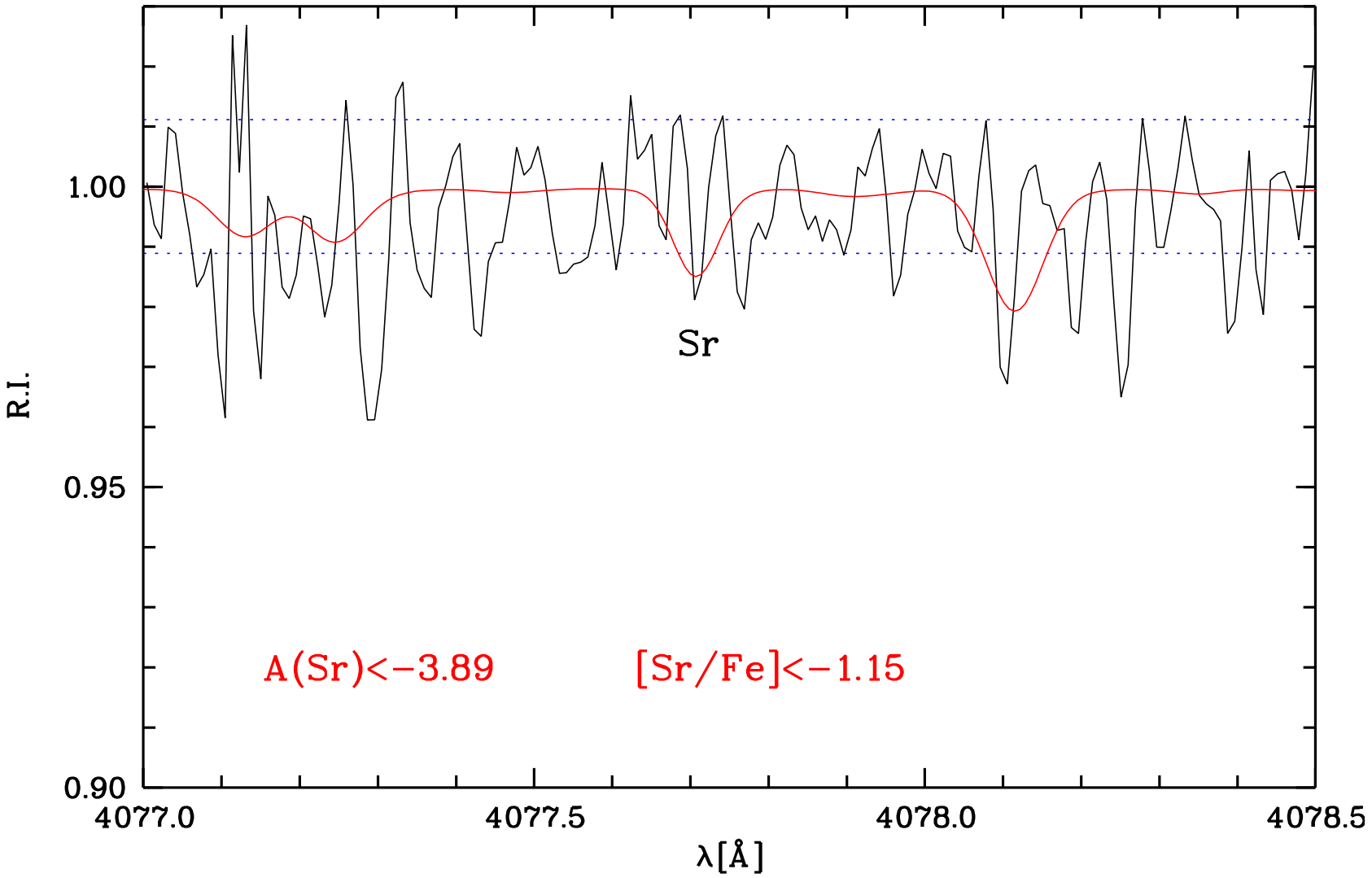
$T_{\rm eff} = 5100\,\mathbf{K}$, $\log g = 2.2$, $[{\rm Fe/H}] = -5.62\,\mathbf{dex}$ $\quad A({\rm Li}) < -0.1$



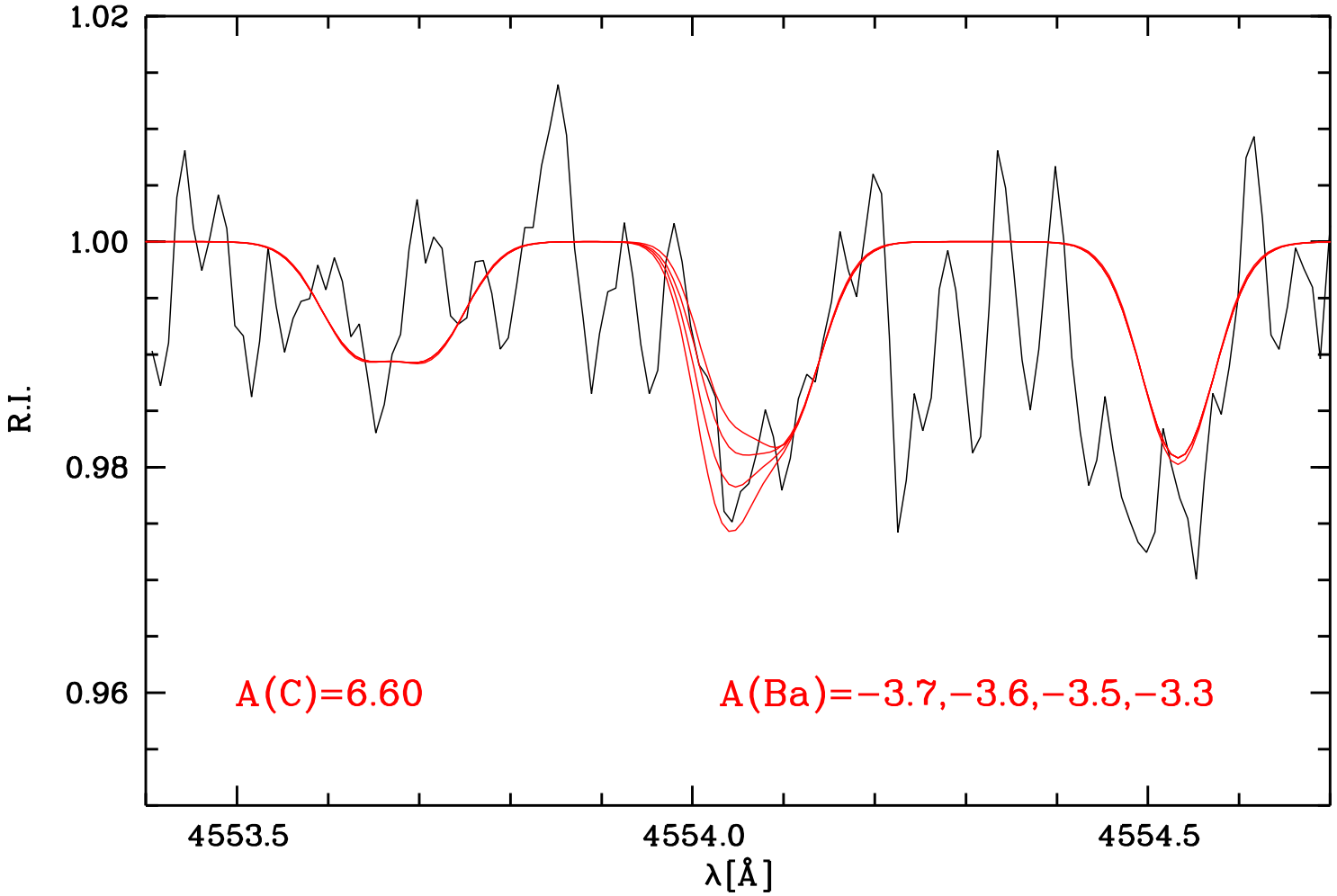
HE0107–5240: Al, tentative detection



HE0107–5240: Sr upper-limit



HE0107–5240: Ba tentative detection

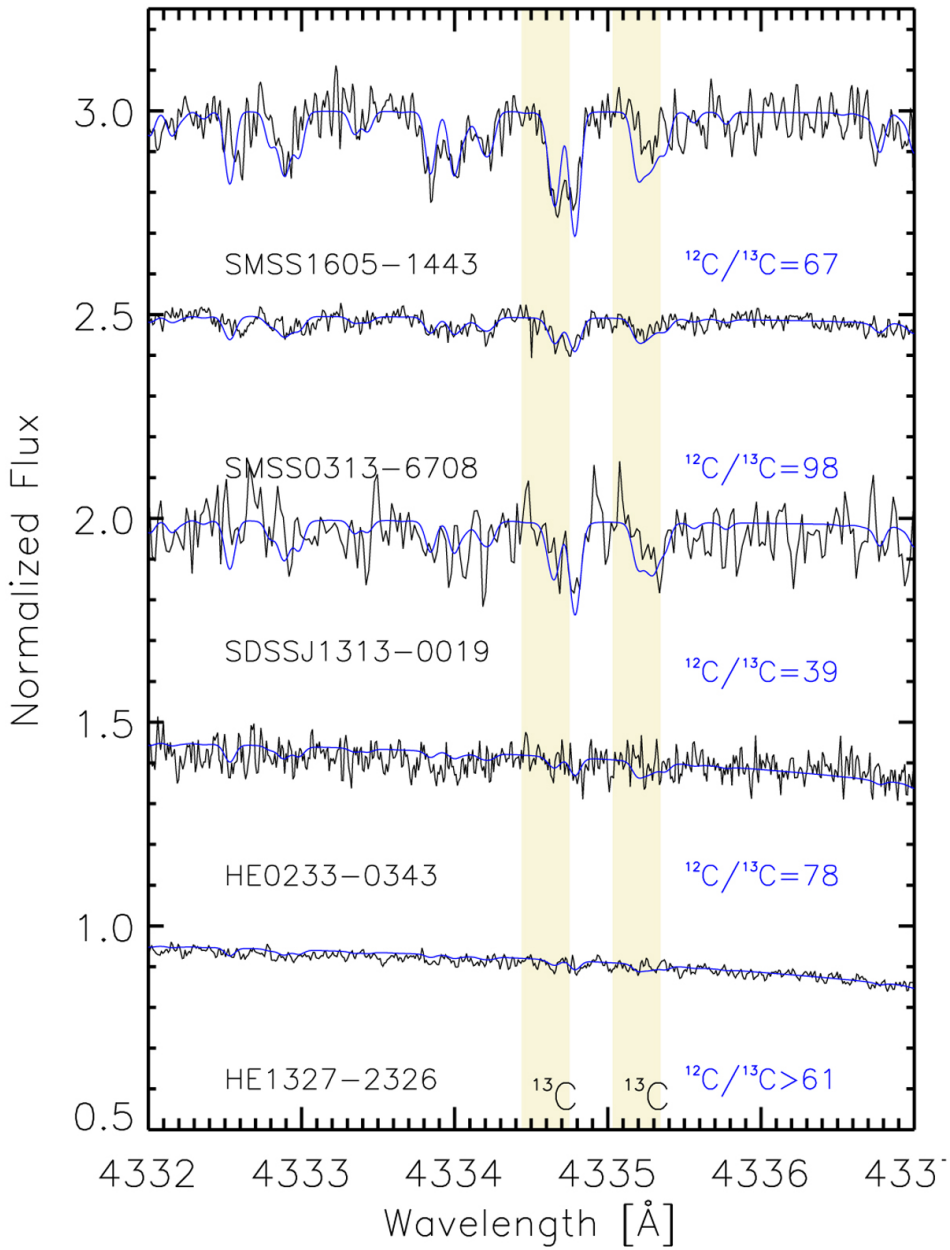


$$[\mathrm{Ba/Fe}] \sim -0.15$$

HE0107–5240

- **Member of a double system**
- **Chemical composition not affected by the more evolved compantion in its AGB phase:**
  - $^{12}\mathrm{C}/^{13}\mathrm{C}$ **too high**
  - **[Ba/Fe] too low**
  - **[Sr/Fe] too low**
- $\Longrightarrow$ **chemical composition of the cloud from where the star formed**

$^{13}C/^{12}C$ ratio in ultra Fe-poor stars



$T_{\rm eff}/\log g/[{\rm Fe/H}]$

4850/2.0/-6.21

5125/2.3/< -7.1

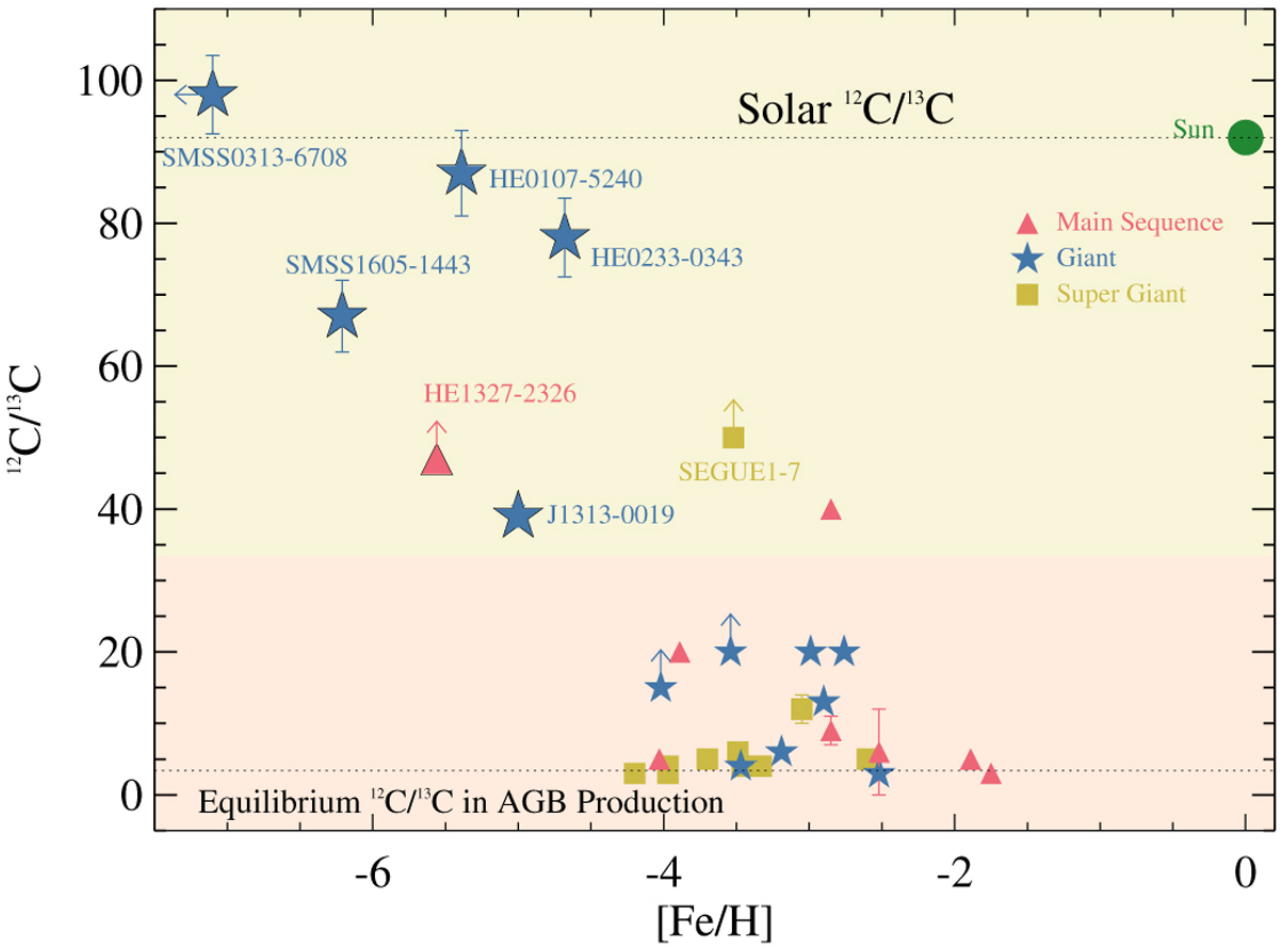
5200/2.6/-5.0

6230/4.43/-4.70

6180/3.7/-5.76

Molaro et al. (2023) - ESPRESSO GTO

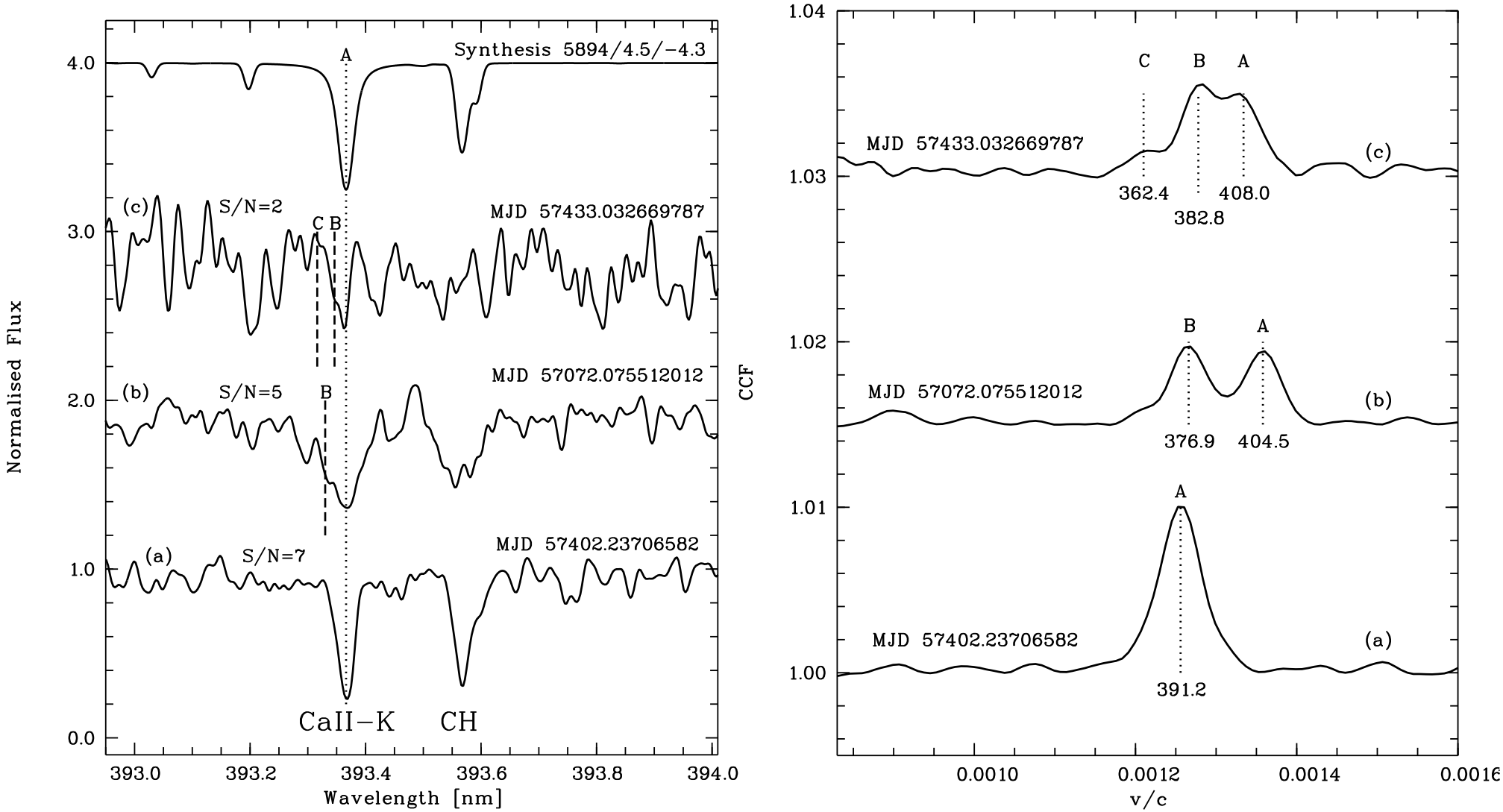
$^{13}C/^{12}C$ ratio in ultra Fe-poor stars



A monotonic decrease, with the lowest values at metallicities in the range $-4 < [\mathrm{Fe/H}] < -3$.
A real difference between the progenitor?
The decrease is an increase in ^{13}C production by less massive star?
A relation to the time formation of each star?
Molaro et al. (2023) - ESPRESSO GTO

Hydra: SB2 CEMP star

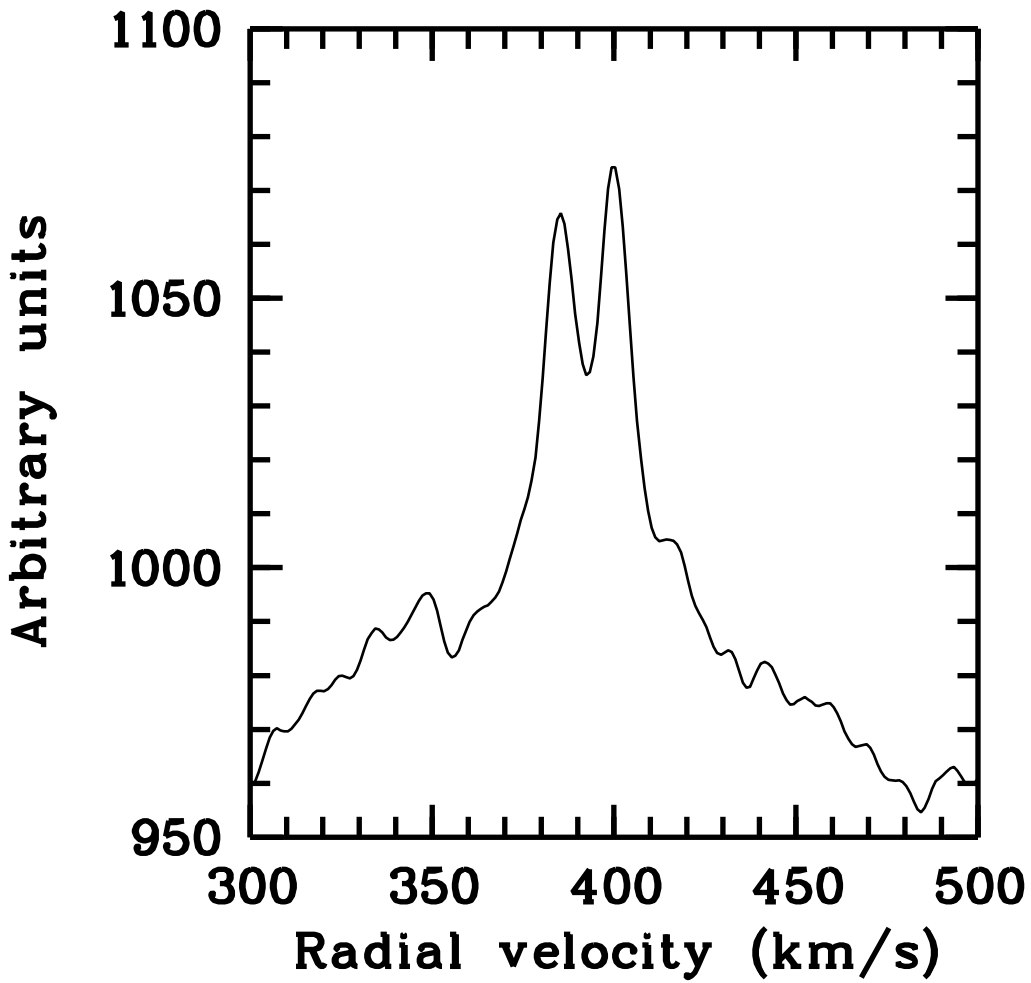
UVES spectra



Caffau et al. (2016)

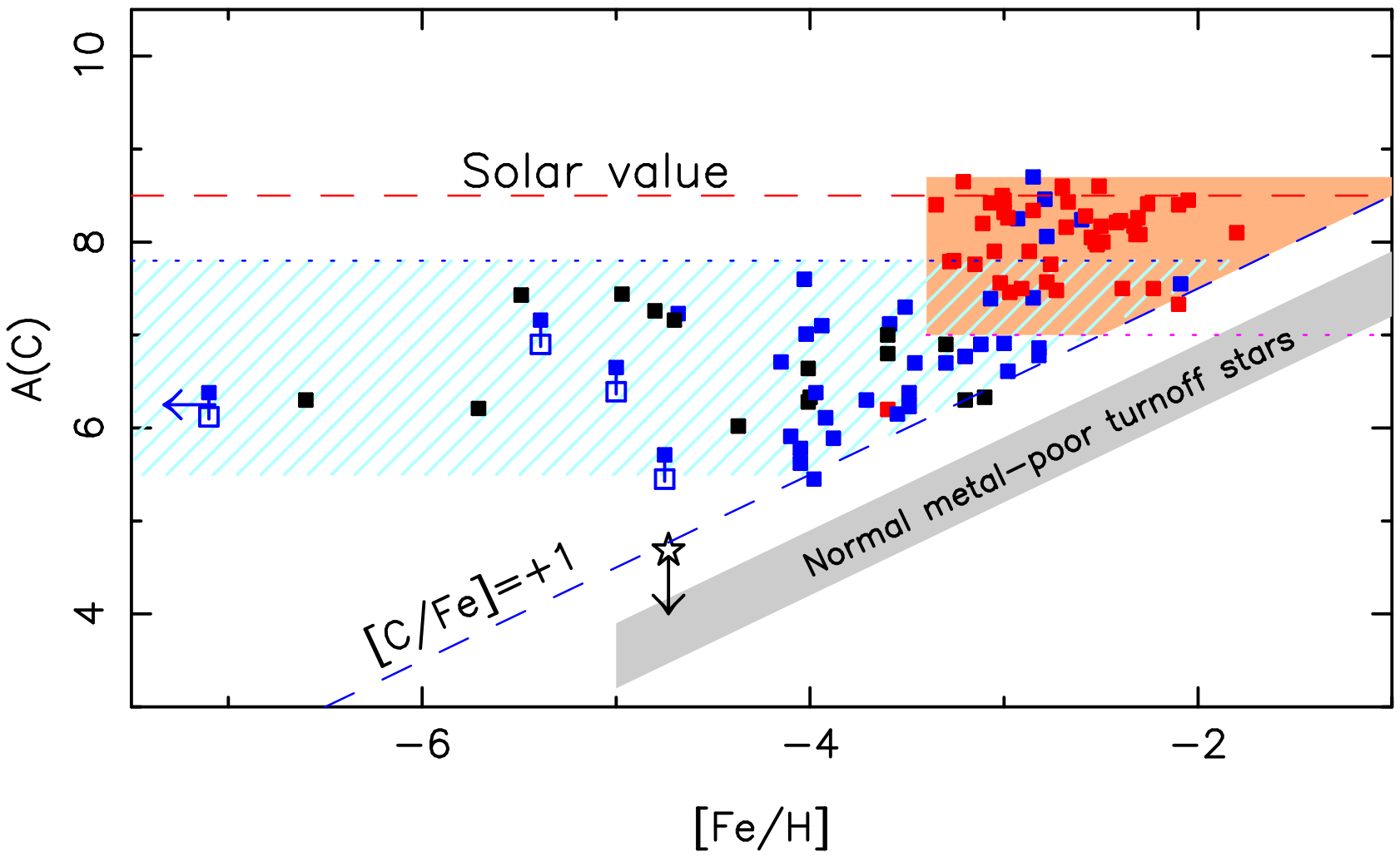
Hydra: SB2 CEMP star

ESPRESSO spectra

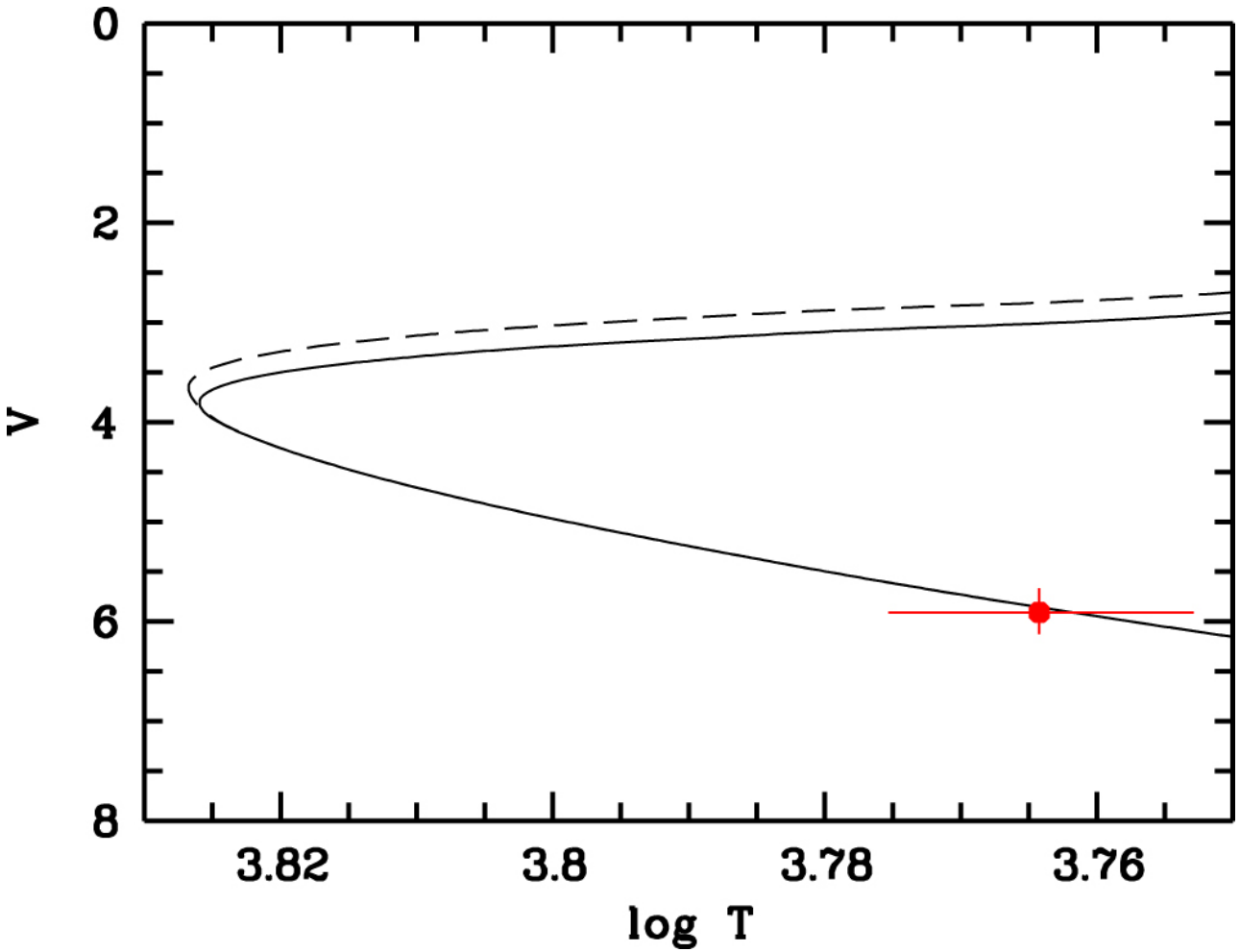


CCF of an ESPRESSO spectrum taken from the ESO archive, with S/N=2 in the G-band, error on the position of each peak 0.09 $\mathrm{km\,s^{-1}}$

The most Fe-poor stars

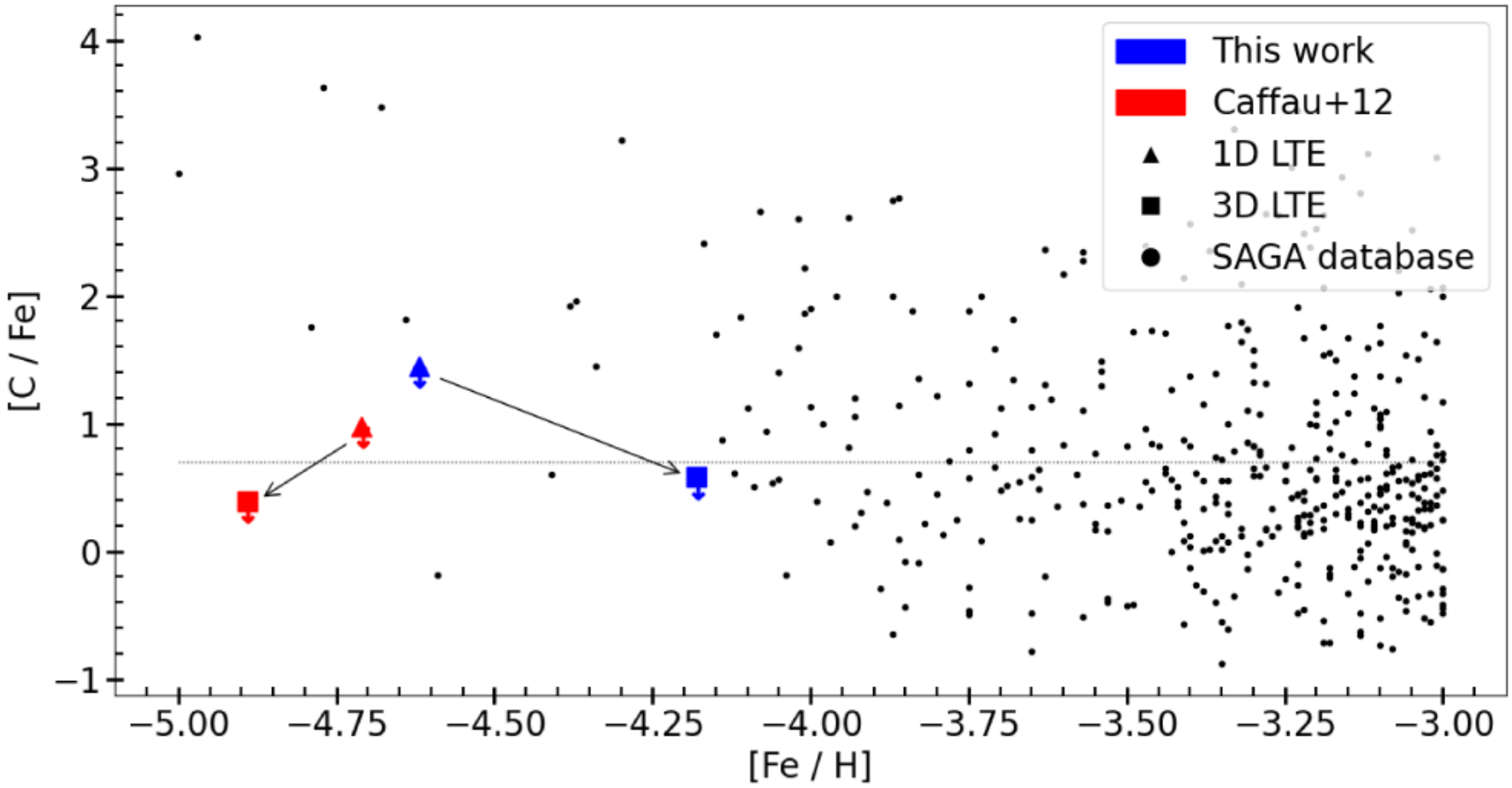


SDSS J102915.14+172927.9: an almost 'normal' star at $[\mathrm{Fe/H}] < -4.5$ Caffau et al. (2011)



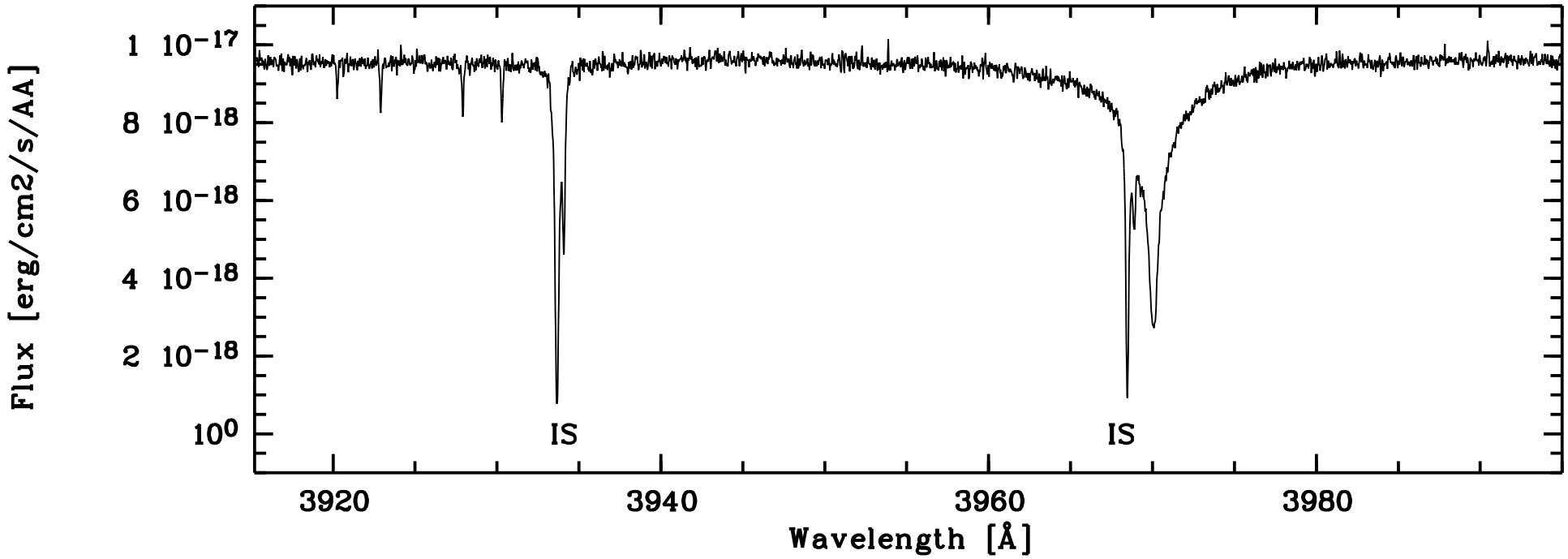
Bonifacio et al. (2018)
The absolute magnitude derived from the Gaia parallax and the Gaia photometry compared to two isochrones FRANEC (Chieffi 2018) for 14 Gyr and $\mathrm{Z} = 2 \times 10^{-6}$ (dashed line) and $\mathrm{Z} = 2 \times 10^{-5}$ (solid line).

SDSS J102915.14+172927.9: an almost 'normal' star at $[\mathrm{Fe/H}] < -4.5$

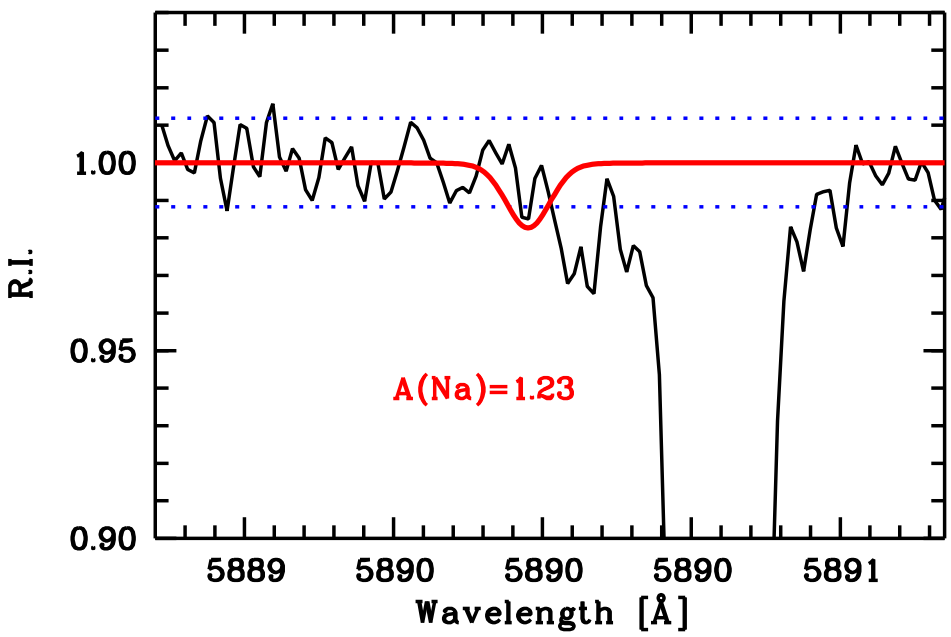


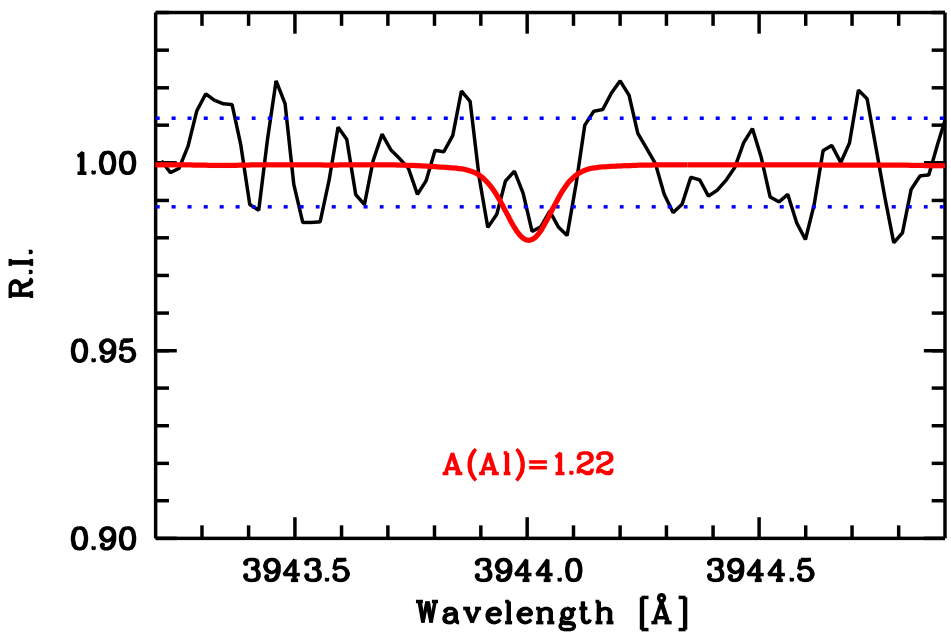
From Lagae et al. (2023)
1D-LTE: A(Fe)=2.79 ± 0.13 2.80 ± 0.22

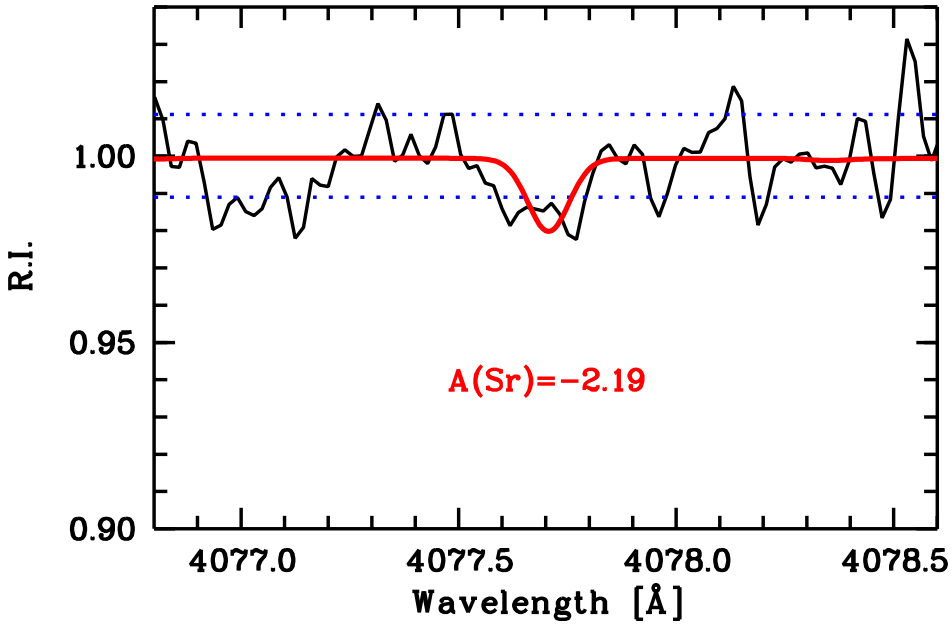
SDSS J102915.14+172927.9: a good UVES spectrum

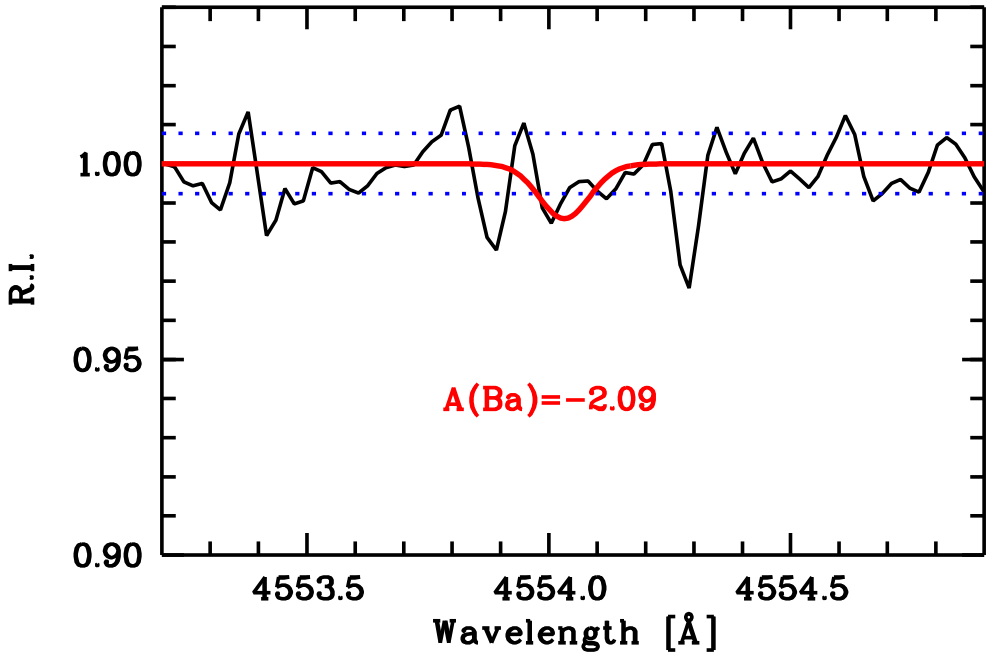


SDSS J102915.14+172927.9









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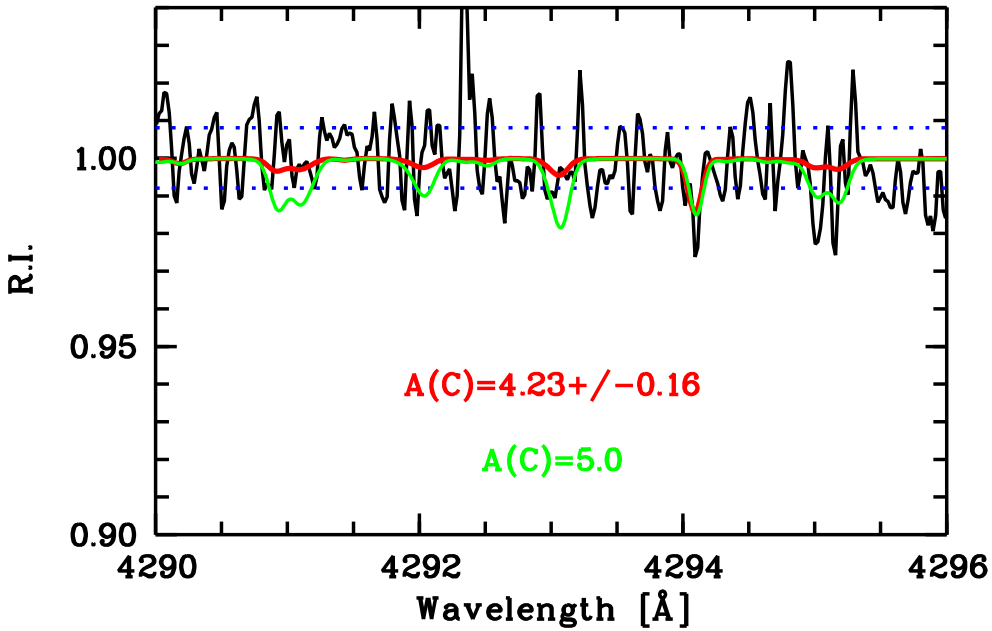
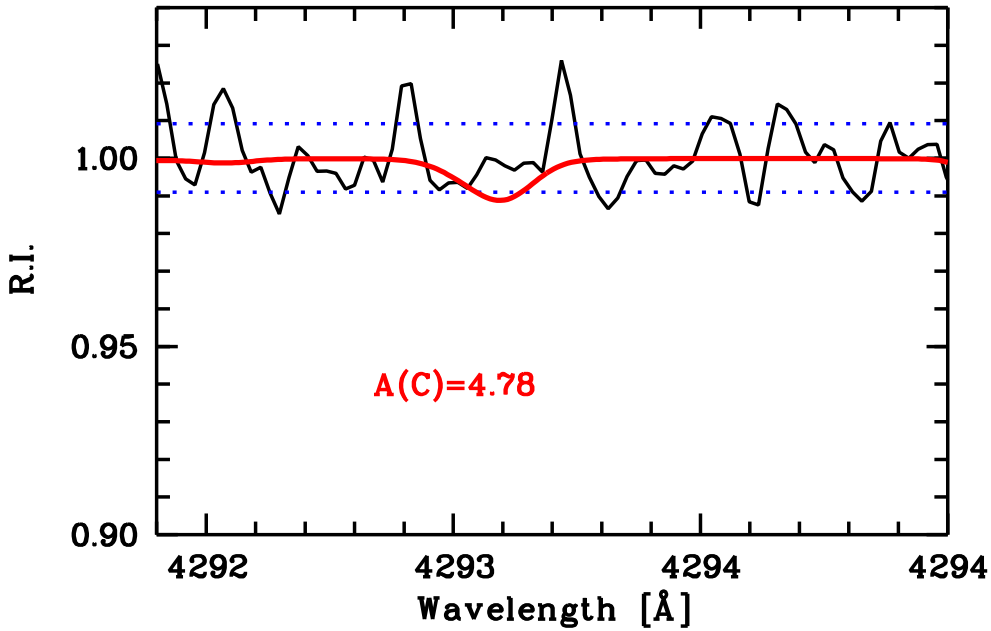
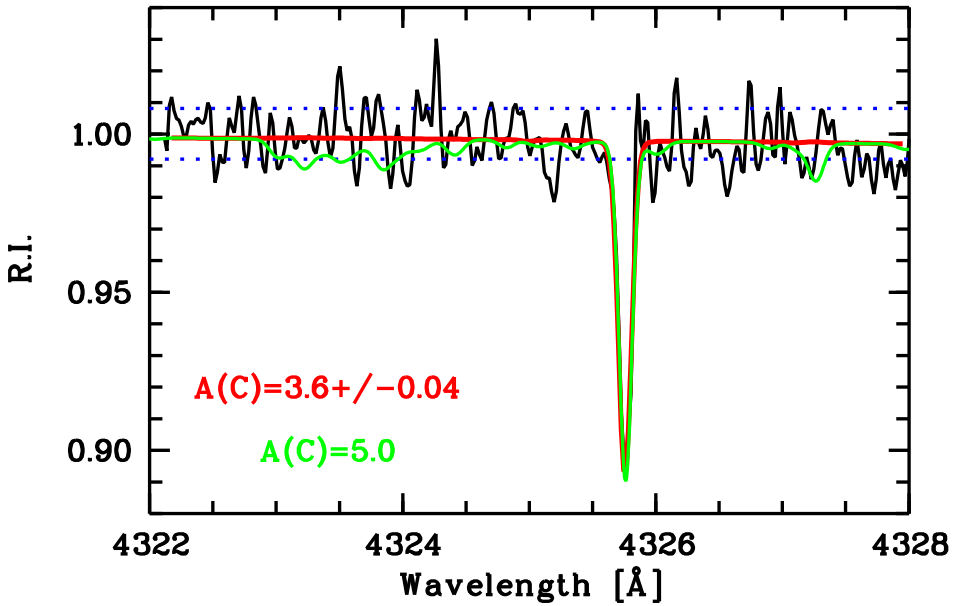
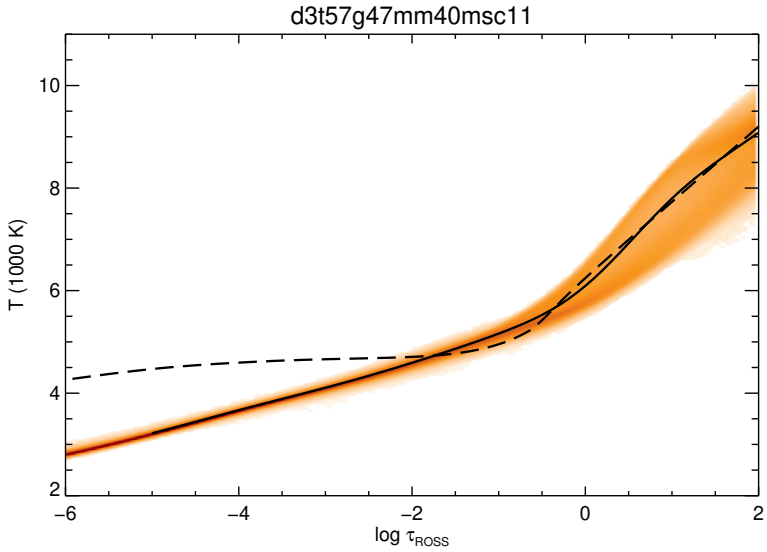


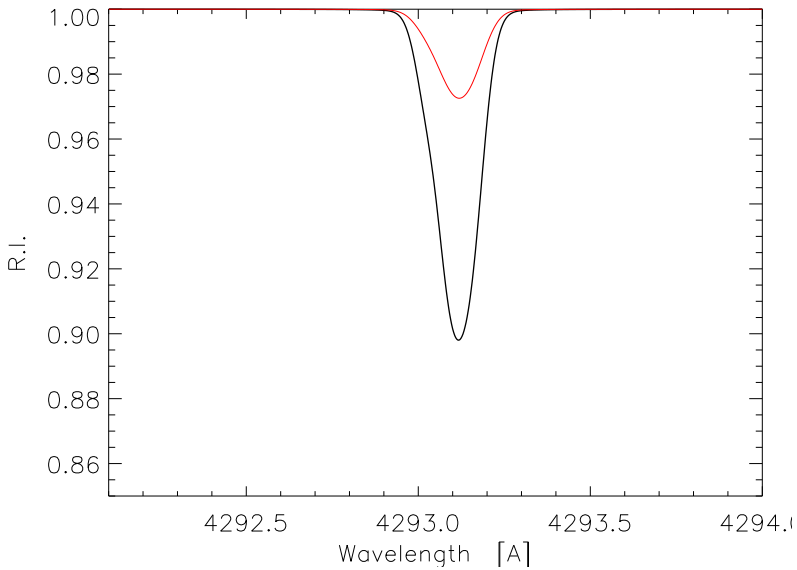


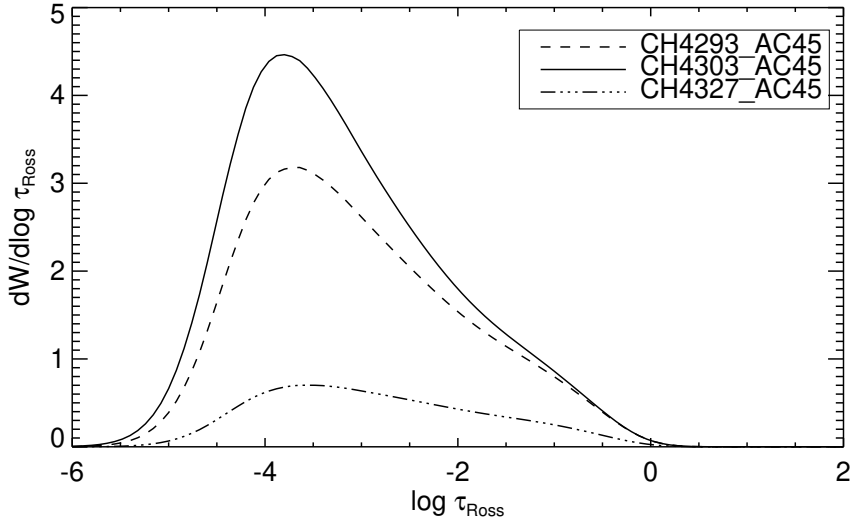


S/N=100
$[\mathrm{C/Fe}] < 0.91$ **in 1D-LTE**
with 3D correction on G-band and taking into account NLTE for Fe the upper limit is lower

SDSS J102915.14+172927.9







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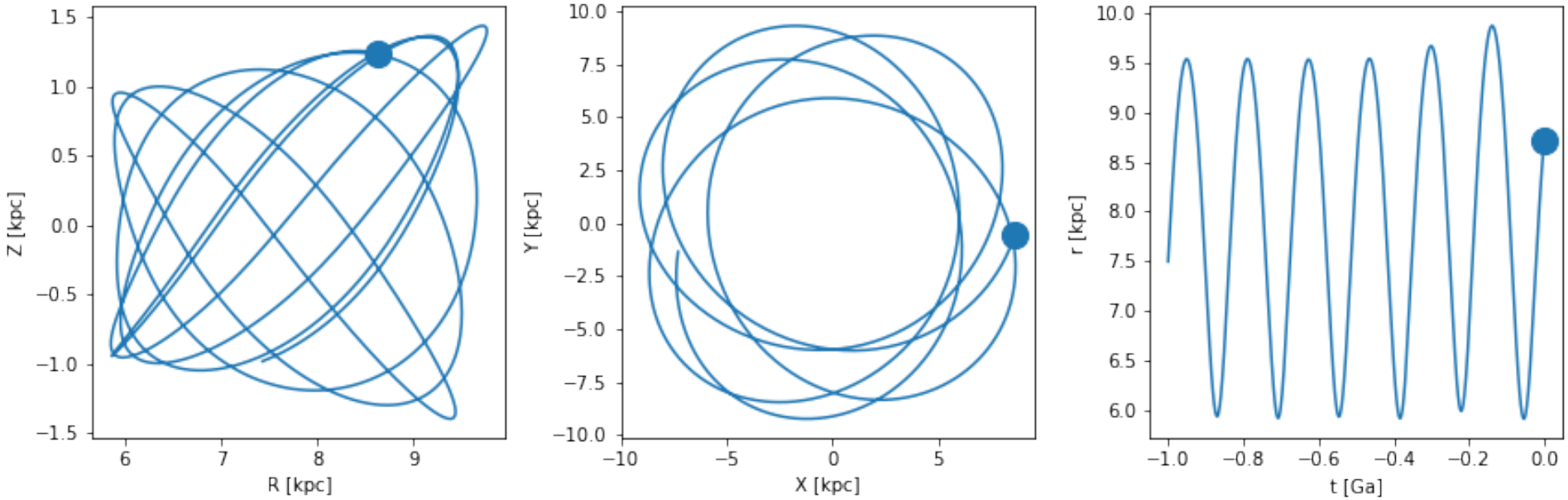

- low C supports its formation through dust cooling
- poor in α-elements, Na, Al and Sr
- not enhanced in C (not a CEMP star)
- Galactic disc orbit
- with the 3 points above we cannot exclude that this is a Pop III stars polluted in the Galactic disc

Danke!