FLUORINE IN A CARBON-ENHANCED METAL-POOR STAR: HE 1305+0132

Simon C. Schuler

NOAO/CTIO

Notation

N(X) – number abundance

→ log N(H) = 12

A(X) = log N(X/H) + 12 = log N(X)

$[X/H] = A(X)_{star} - A(H)_{\odot} = \log N(X)_{star} - \log N(X)_{\odot}$

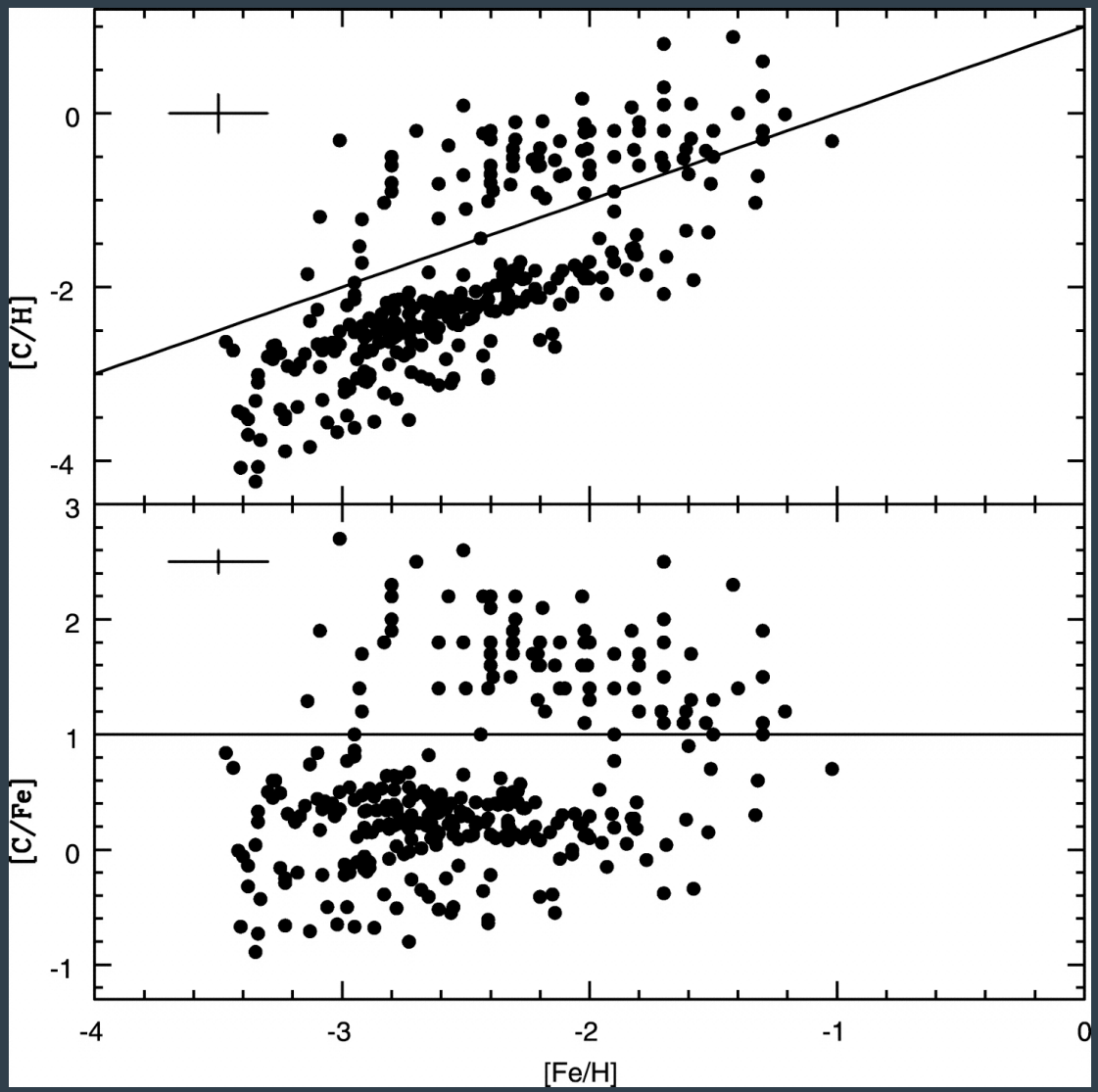
→ [X/Fe] = [X/H] - [Fe/H]

*Logarithmic units: dex

CEMP Stars

- [C/Fe] ≥ +1.0
- CEMP-s, CEMP-no, CEMP-r, CEMP-r/s, CEMP-α
- Frequency ≤ 25% at [Fe/H] ≤ -2.0
  ≤ 40% at [Fe/H] ≤ -3.5
  → 100% at [Fe/H] ≤ -4.0

CEMP Stars



Lucatello et al. 2006

CEMP Stars- Nucleosynthetic Histories

- Mass Transfer from AGB Companion
  → CEMP-s

- Formation from Enriched Cloud
  → CEMP-no

^{19}F- A Rare Nuclide

- Rarest of Light Nuclei ($6 \leq Z \leq 20$)
- No ^{19}F in Main Nuclear Reactions
- Limited Number of Spectral Lines

^{19}F Nucleosynthesis

1. Type II Supernovae: $^{20}\mathrm{Ne}(\nu,\nu' p)^{19}\mathrm{F}$

2. TP-AGB Stars:

   $^{14}\mathrm{N}(\alpha,\gamma)^{18}\mathrm{F}(\beta^{+})^{18}\mathrm{O}(p,\alpha)^{15}\mathrm{N}(\alpha,\gamma)^{19}\mathrm{F}$

   $\rightarrow$ $^{14}\mathrm{N}(n,p)^{14}\mathrm{C}$, $^{13}\mathrm{C}(\alpha,n)^{16}\mathrm{O}$

3. Wolf-Rayet Stars

^{19}F and CEMP Stars

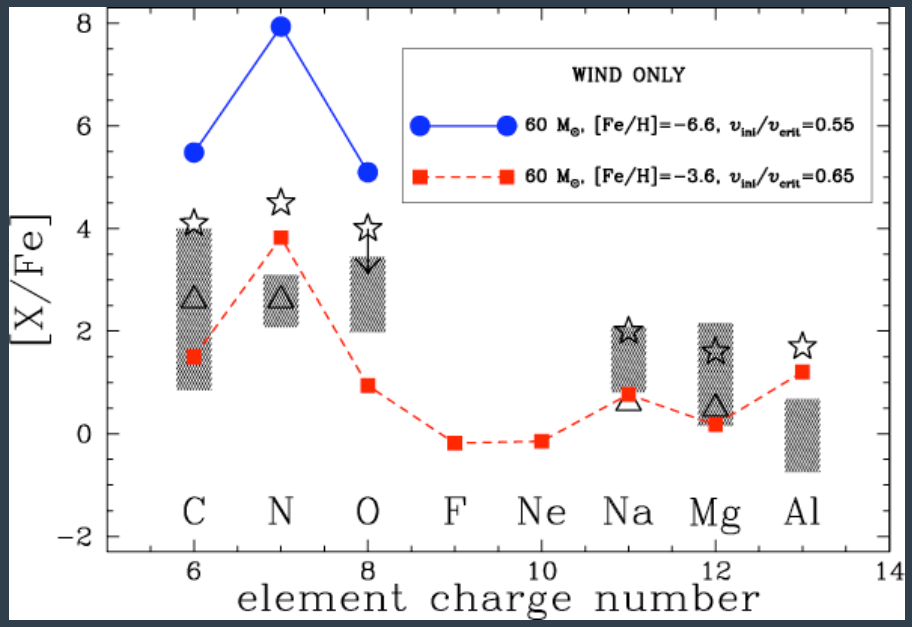
Stellar Evolution Models of Meynet, Ekström, & Maeder (2006):

- Rapidly Rotating: v_{ini} = 800 km s^{-1}
- [m/H] = -3.6

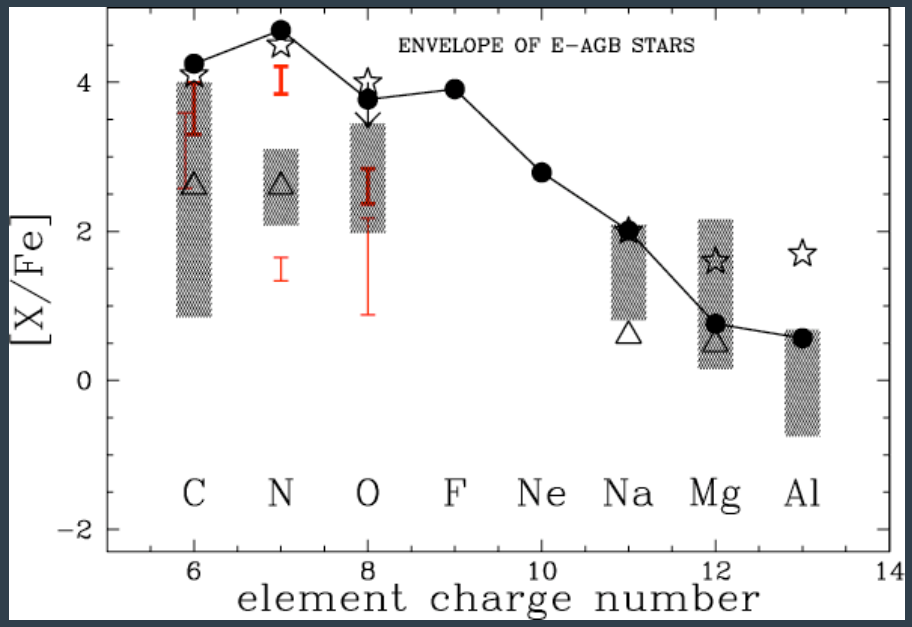
→ Massive Star (60 $M_\odot$): [F/Fe] ~ 0

→ AGB Star (7 $M_\odot$) : [F/Fe] ~ +4.0

^{19}F and CEMP Stars



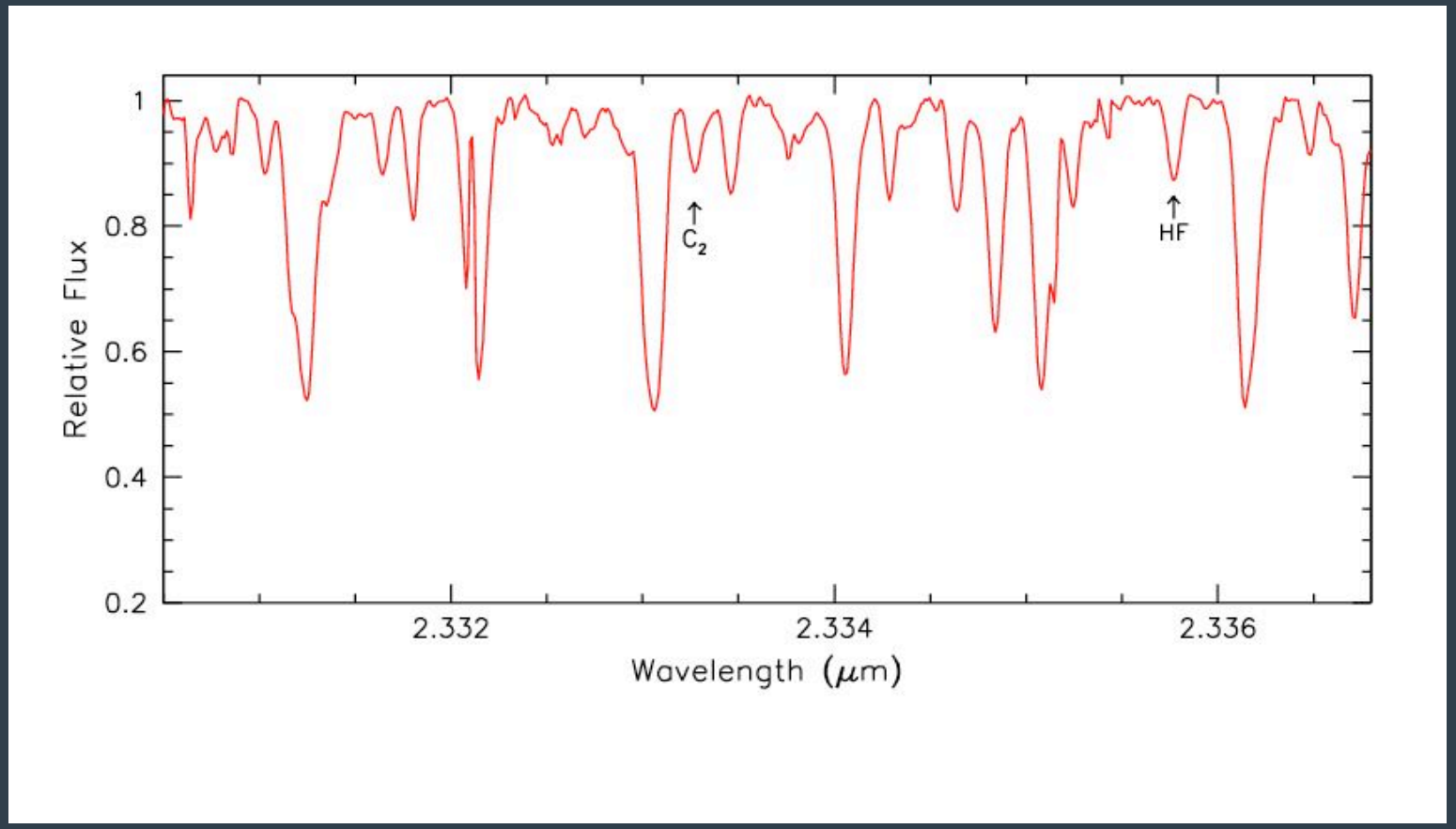
60 $M_\odot$ Star



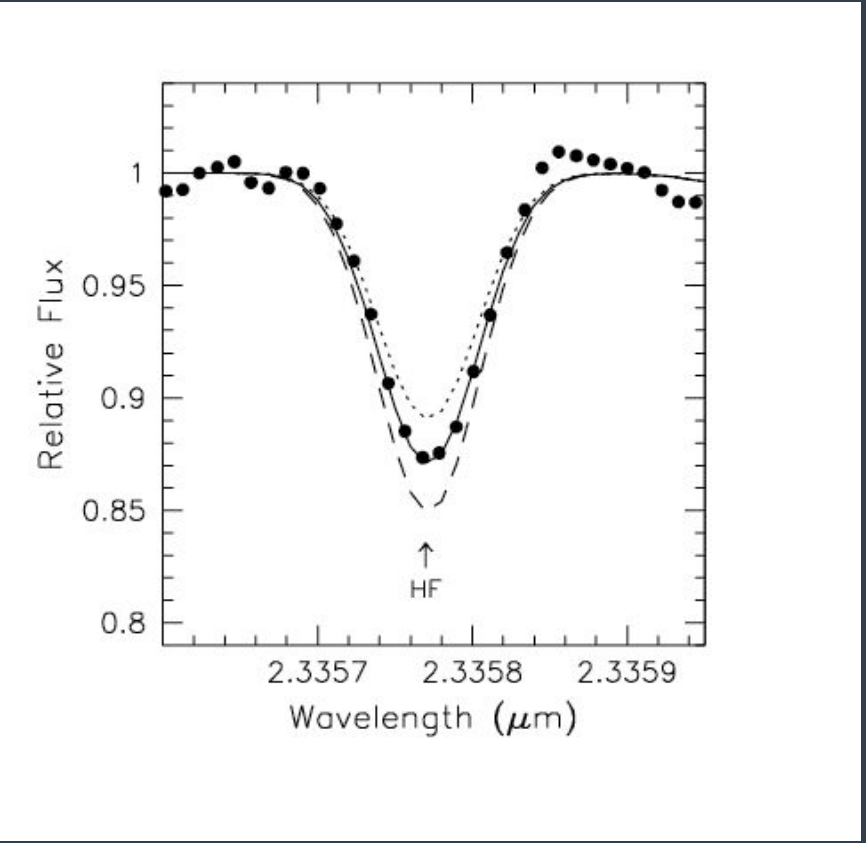
7 $M_\odot$ AGB Star

Meynet, Ekström, & Maeder 2006

Gemini-S/Phoenix Spectrum: HE 1305+0132



Observed & Synthetic Spectra: HF



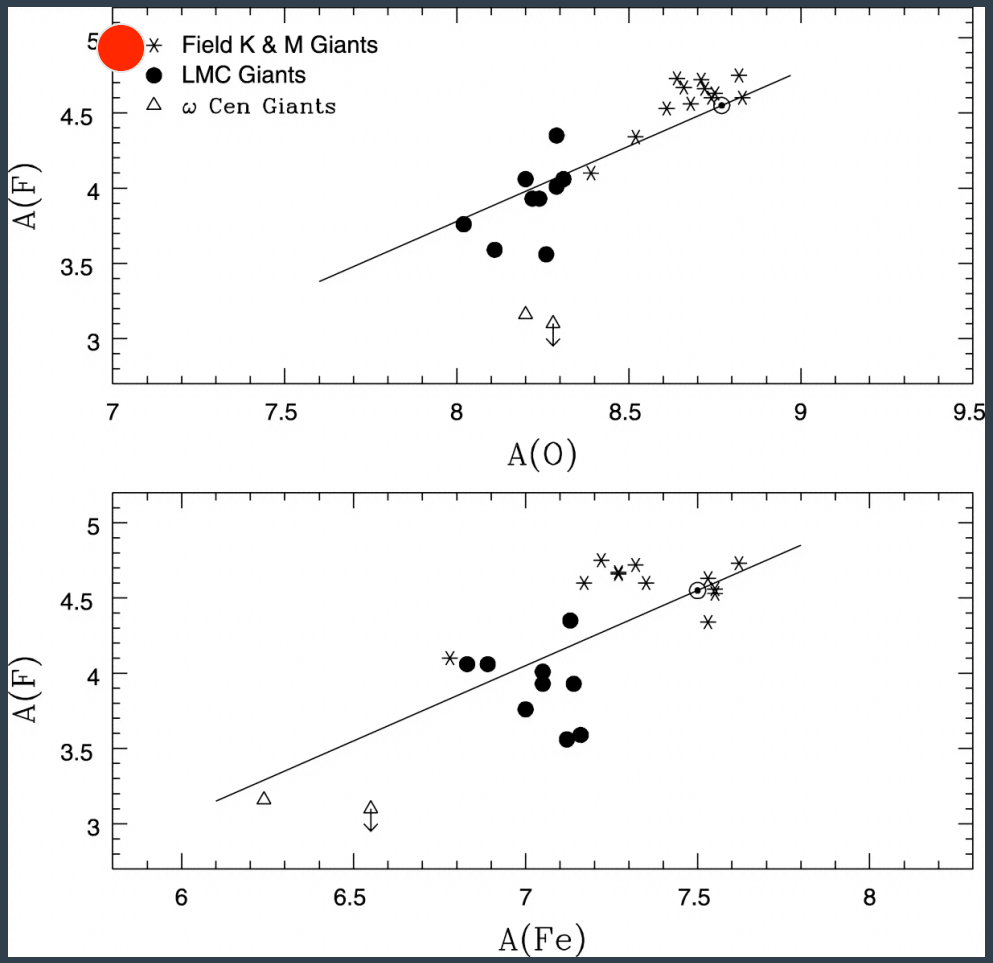
HE 1305+0132: Abundances

[Fe/H] = -2.5 ± 0.50

$A(^{12}C) = 8.57 \pm 0.11 \rightarrow [C/Fe] = +2.68$
$A(^{16}O) = 7.04 \pm 0.14 \rightarrow [O/Fe] = +0.88$

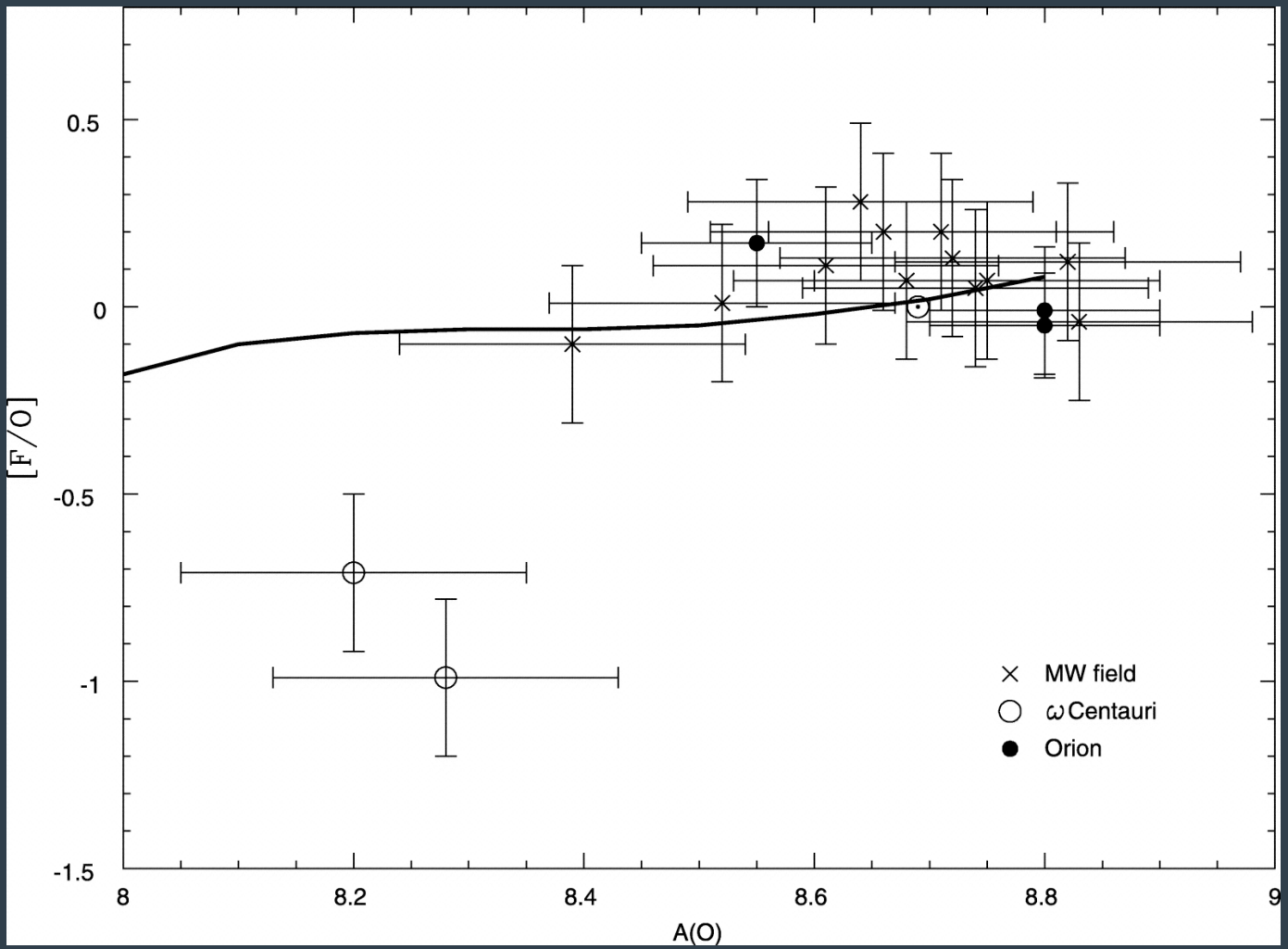
$A(^{19}F) = 4.96 \pm 0.21 \rightarrow [F/Fe] = +2.90$
$\rightarrow [F/O] = +2.02$

^{19}F and Galactic Evolution



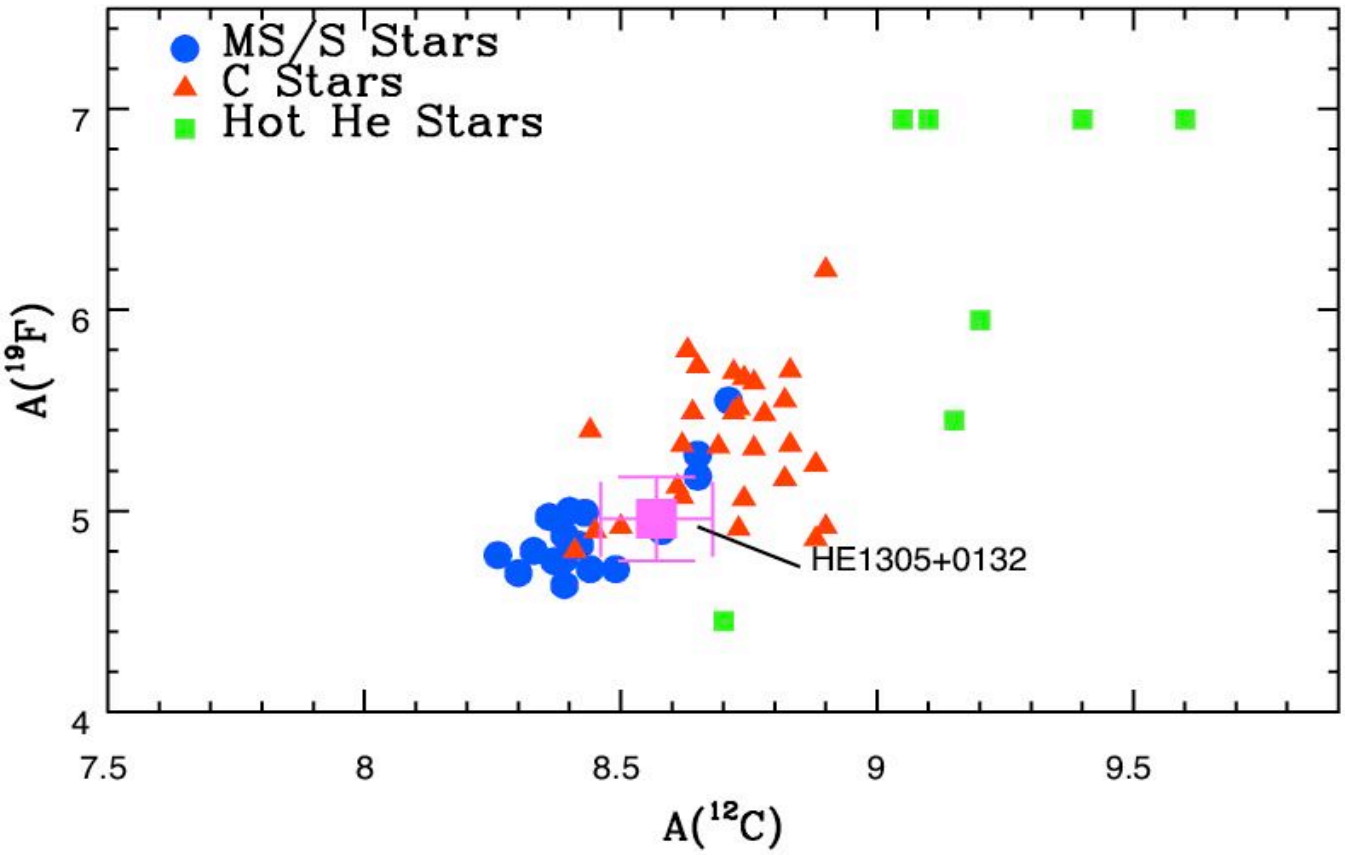
Cunha et al. 2003

^{19}F and Galactic Evolution



Cunha & Smith 2005

Galactic ^{19}F vs ^{12}C



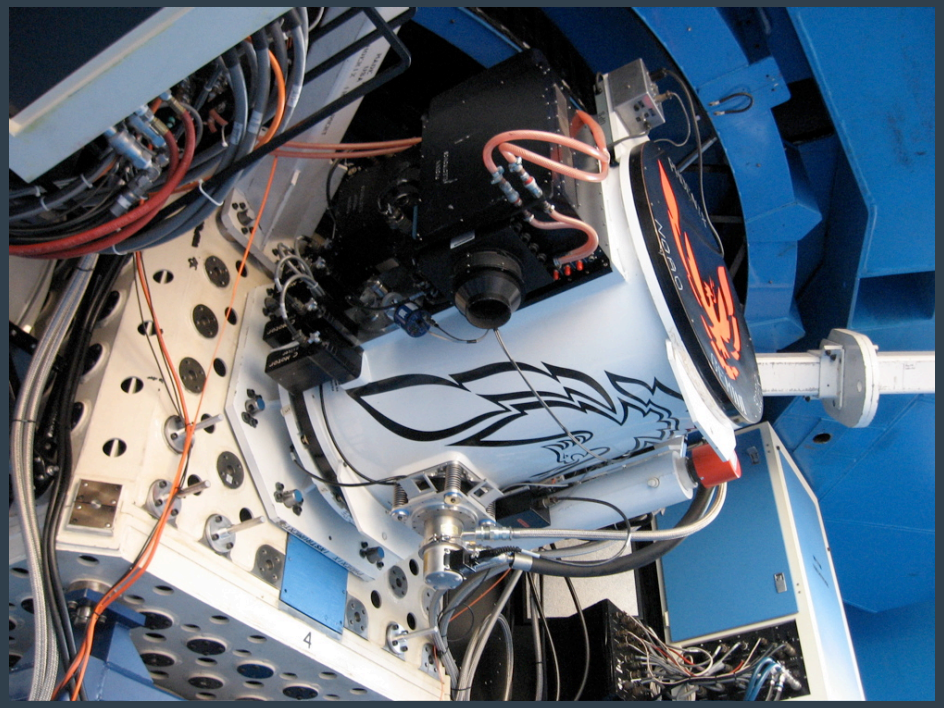
Nucleosynthetic History of HE 1305+0132

- Pollution from AGB Companion

- Binarity?
  - Radial Velocity Variations?

- *s*-process Element Enhancements?
  - Identified as a CH star
  - High-Res Spectrum

Phoenix near-IR High-Res Spectrometer



ACKNOWLEDGEMENTS

Collaborators: K. Cunha (NOAO), V.Smith (NOAO), T.Beers (MSU/JINA), T.Silvarani (MSU/JINA)

Support for this work has been provided by the NOAO Leo Goldberg Fellowship; NOAO is operated by the Association of Universities for Research Astronomy, Inc., under a cooperative agreement with the National Science Foundation.