Carbon-rich metal-poor stars: witnesses of the first AGB stars

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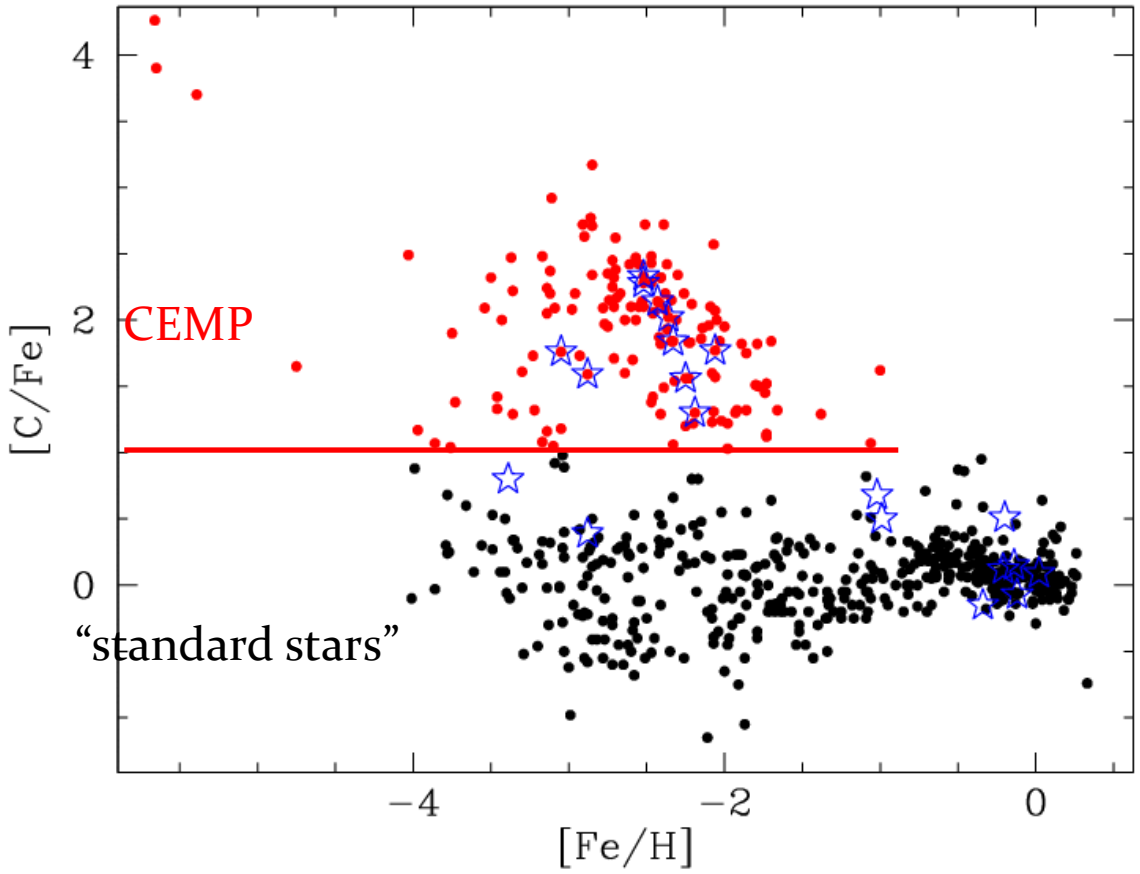
The Carbon Enhanced Metal-Poor (CEMP) stars phenomenon

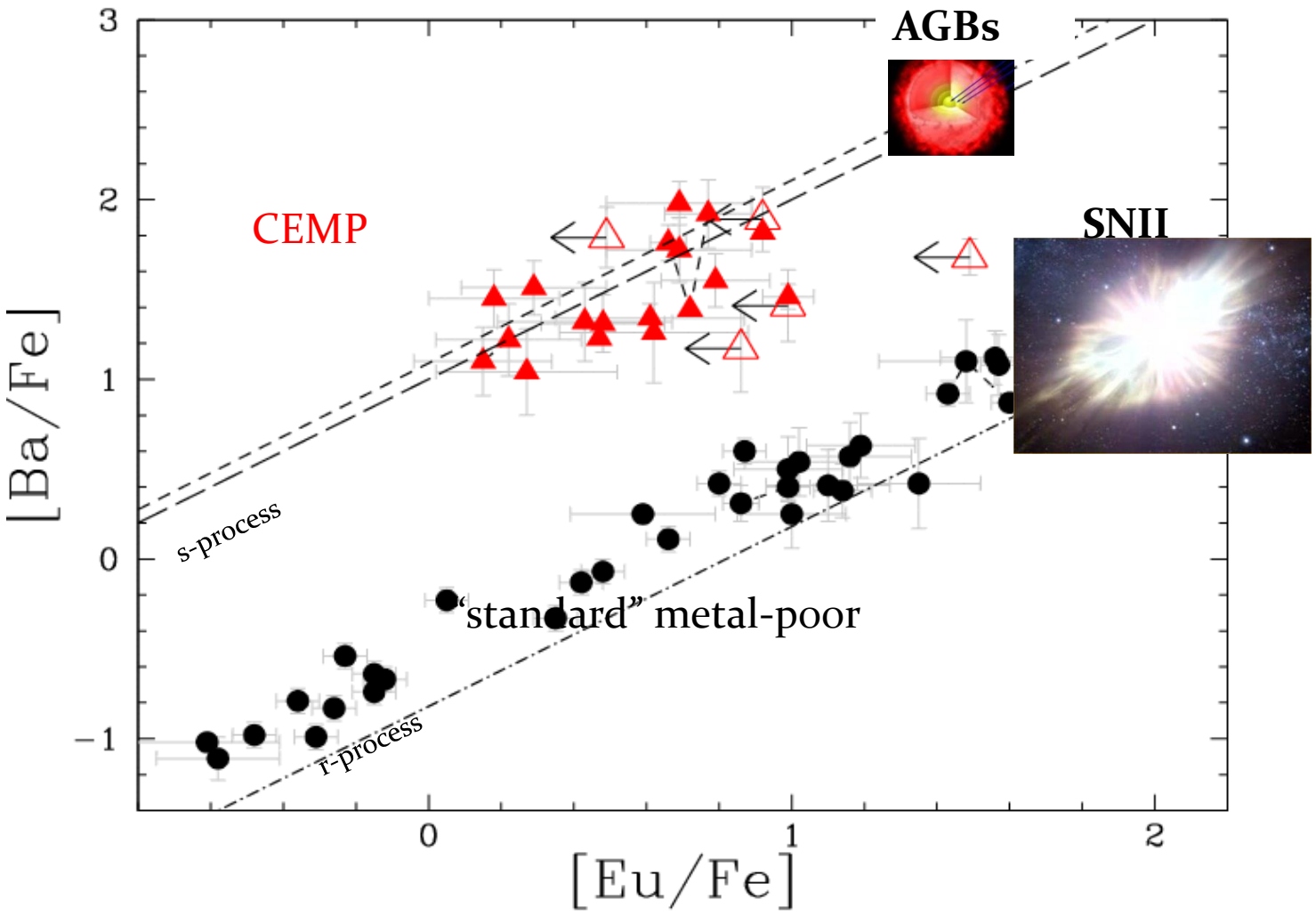


(Masseron 2006)

-> Looking for first generation of stars in the Galactic halo but no stars with M > 0.8$M_{\odot}$ have survived to the present day

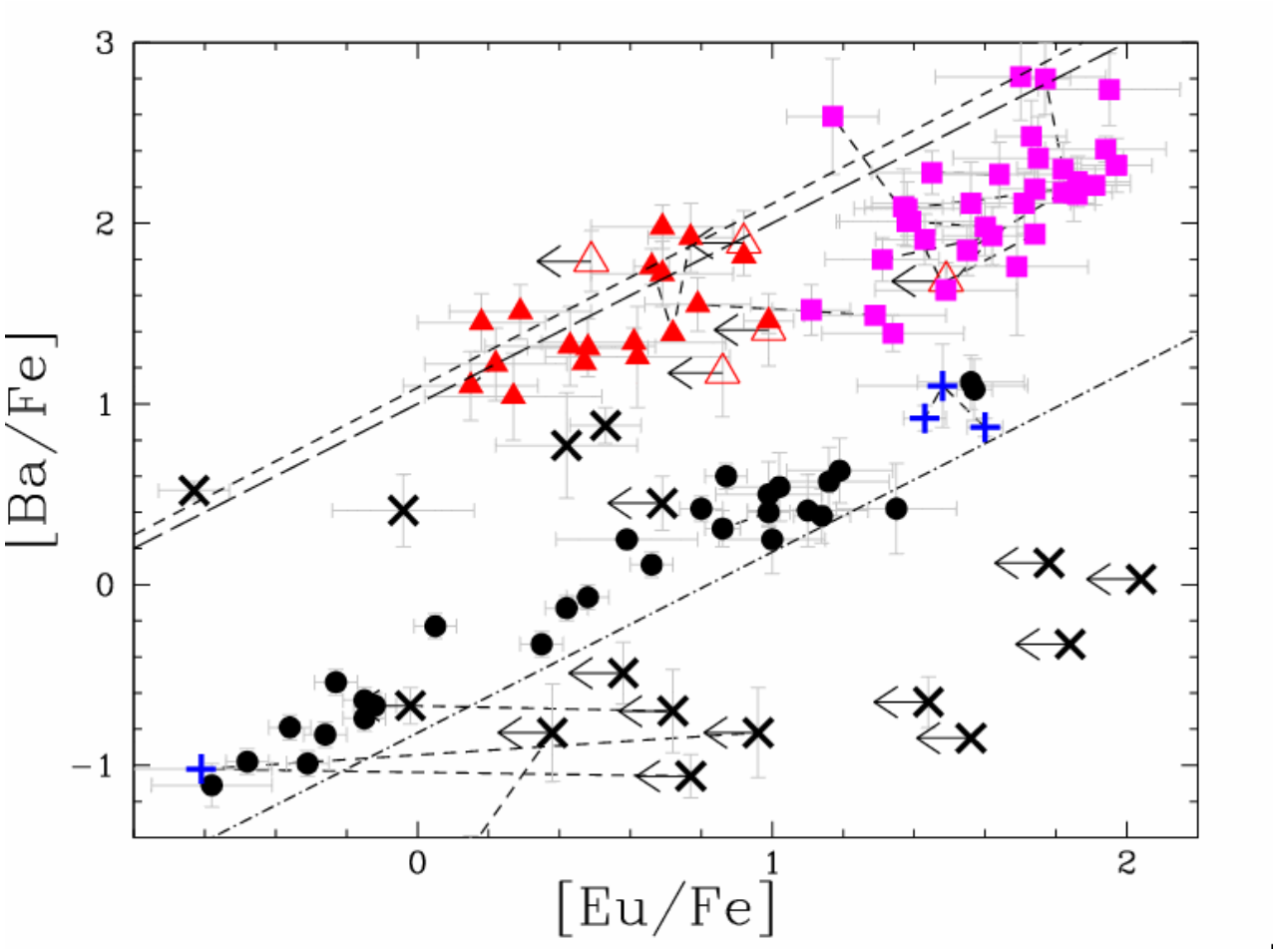
AGB vs SNII

Properties of progenitors can be inferred via abundances (mass, etc…)



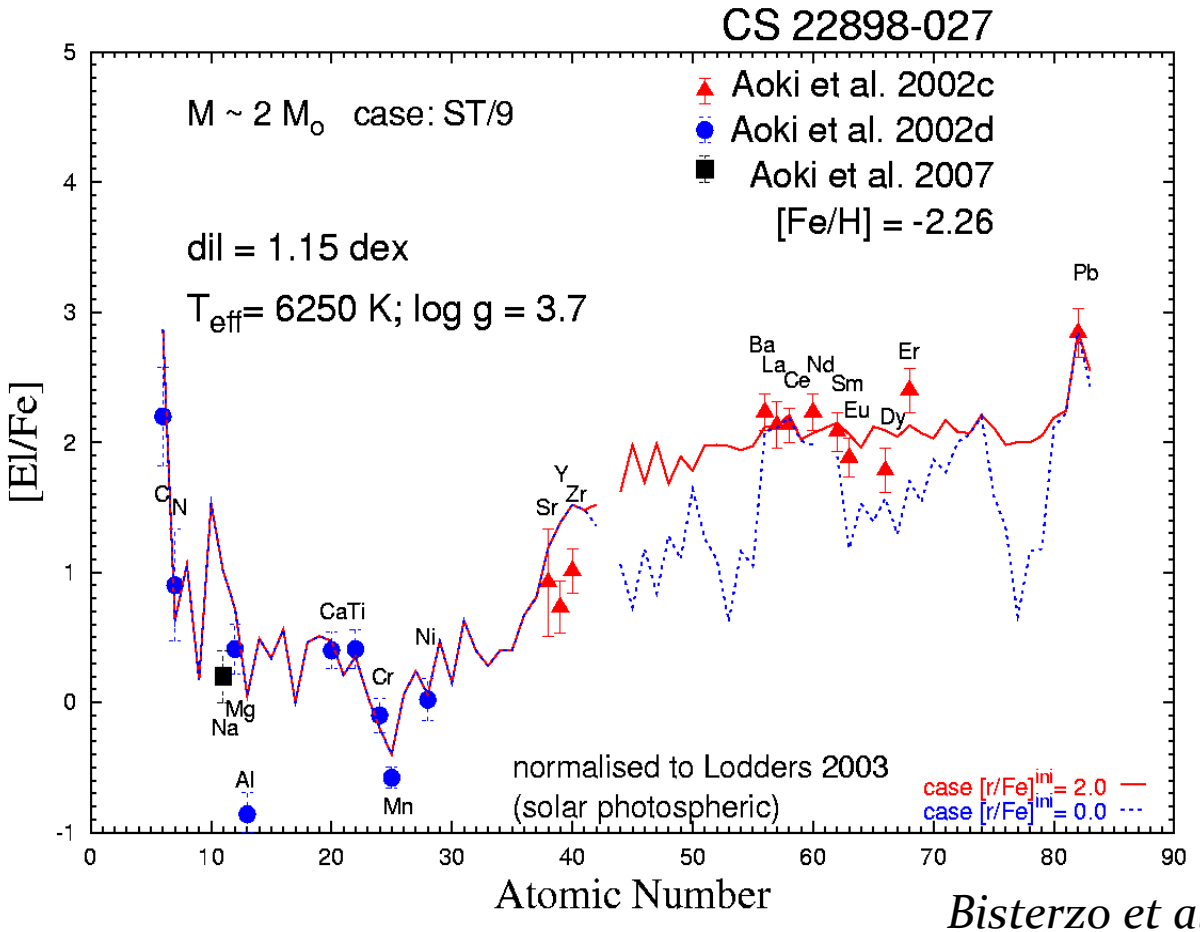
But large dispersion in heavy element abundances

But different CEMP stars…



Masseron et al. 2010

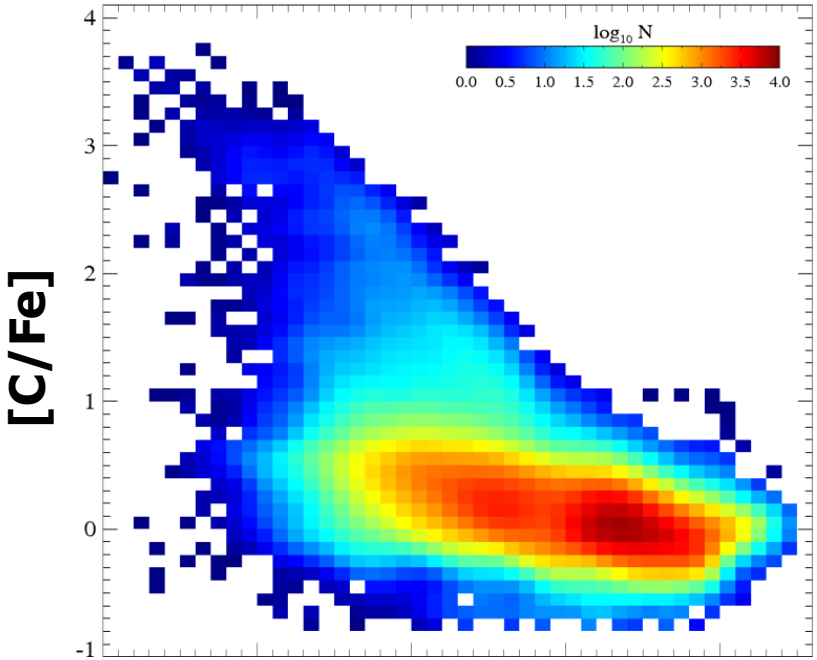
Double pollution

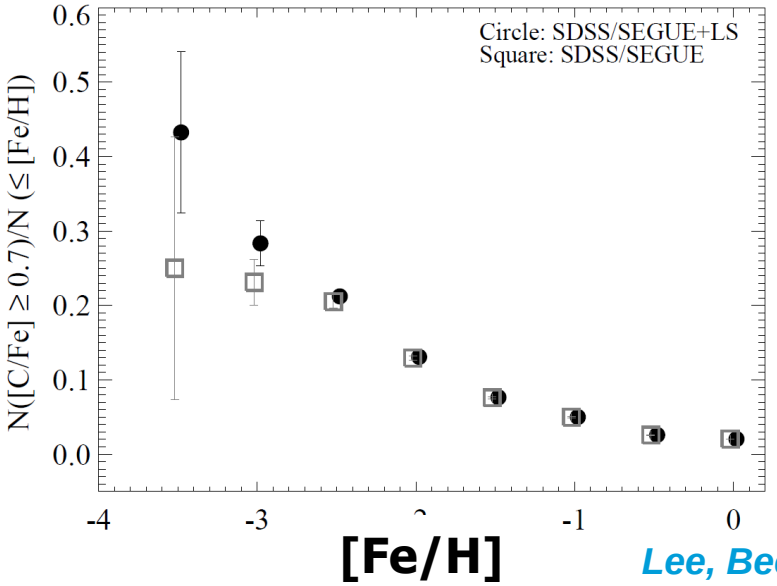


Bisterzo et al. (2012)

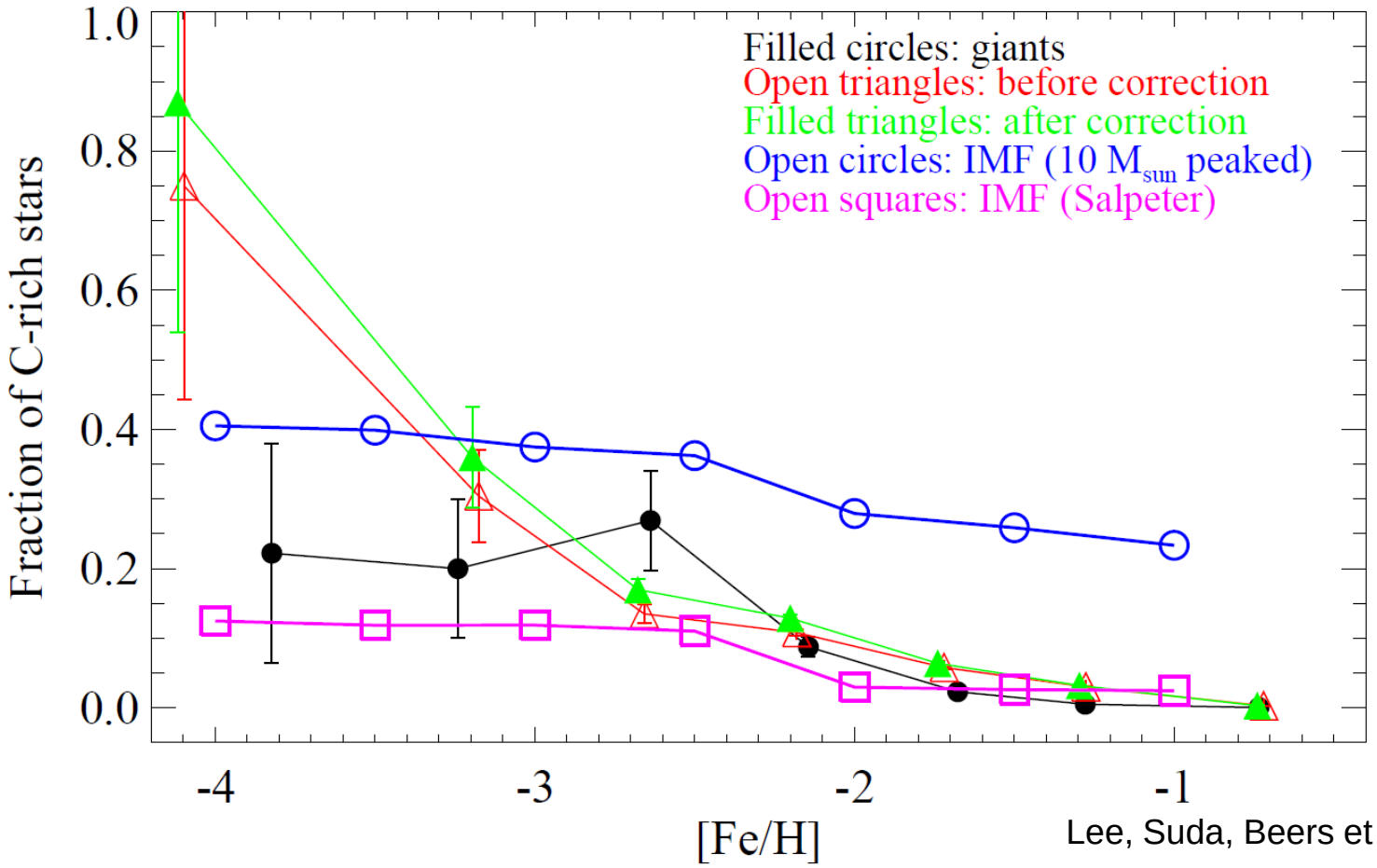
Existence of multiple systems (SNII + AGB + 0.8M) at low metallicity

Carbon enhanced metal-poor stars distribution in the Galaxy





Lee, Beers, Masseron, Plez et al. (2013)



Lee, Suda, Beers et al. (2013)

Early IMF peak towards high metallicity
But still require another source for C (massive rotating SNII)

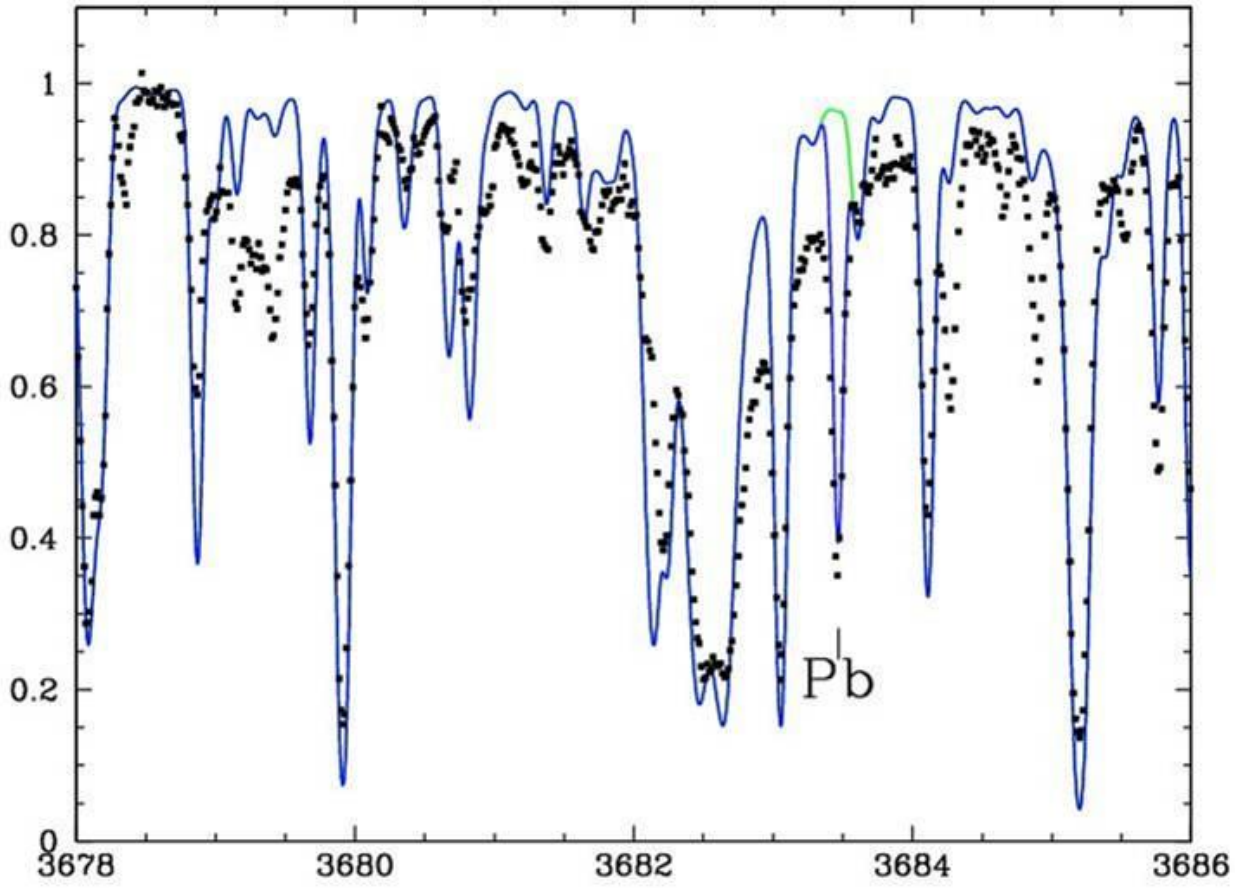
Main picture:

From high resolution spectroscopic study, one can infer early Galactic & stellar physics:

- neutron source in AGBs is variable
- Existence of double-polluted stars
- Early IMF seems to be peak towards higher masses

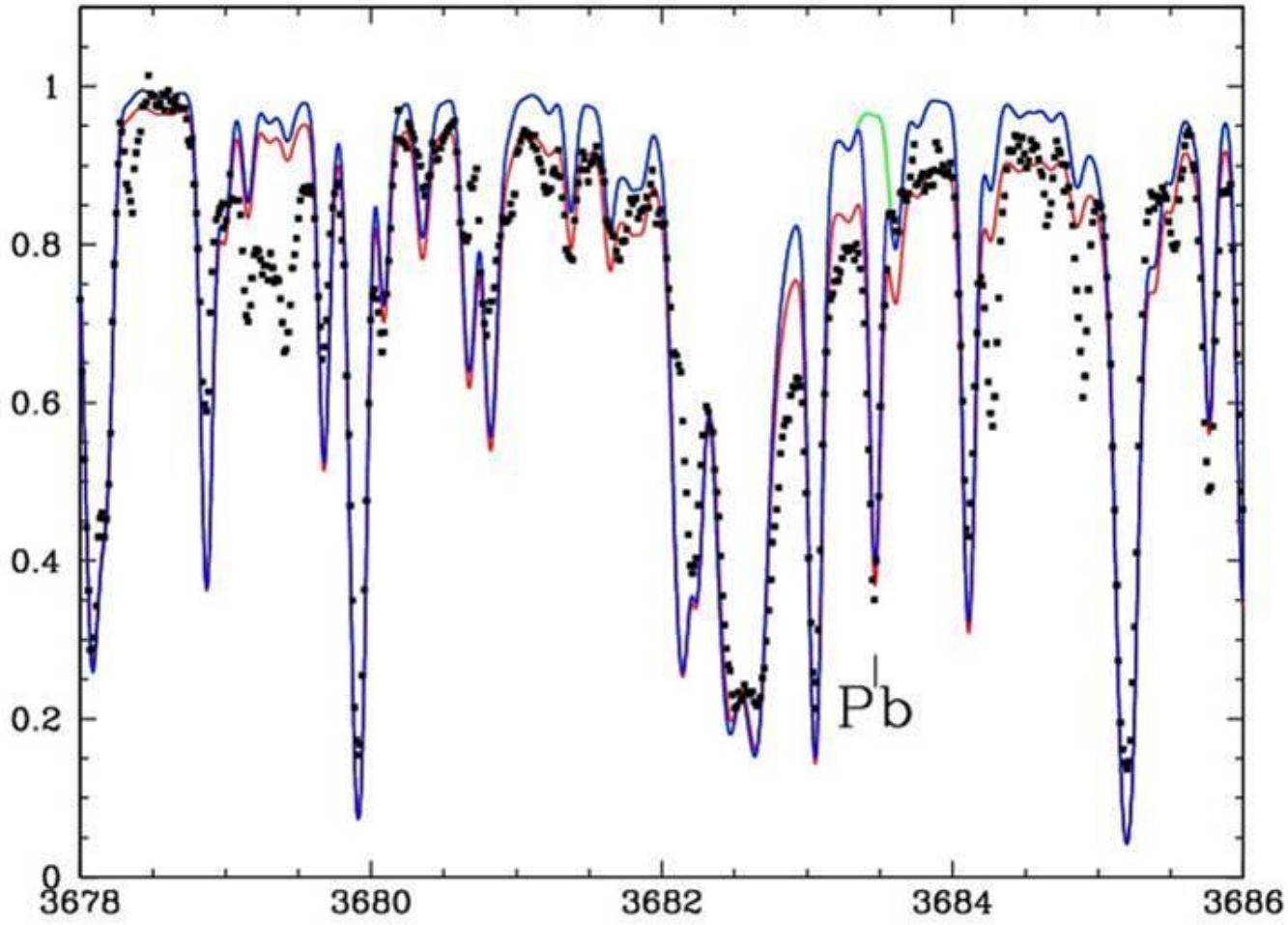
Just one more thing…

Analysis Technique

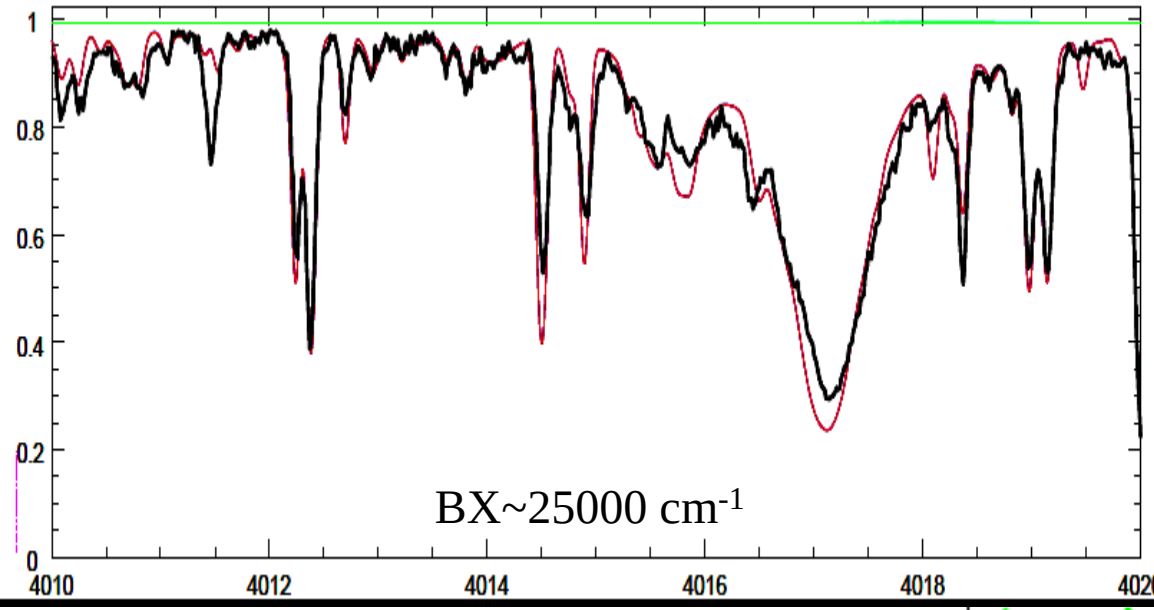


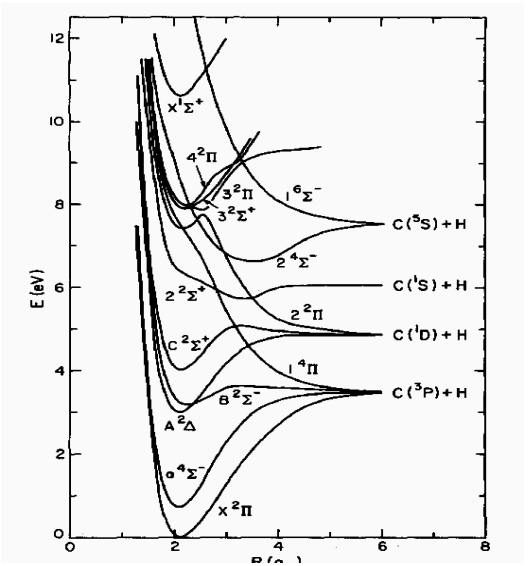
Derive abundances by comparing synthetic spectrum synthesis with observation (Turbospectrum, Alvarez & Plez 1998, Plez 2012)

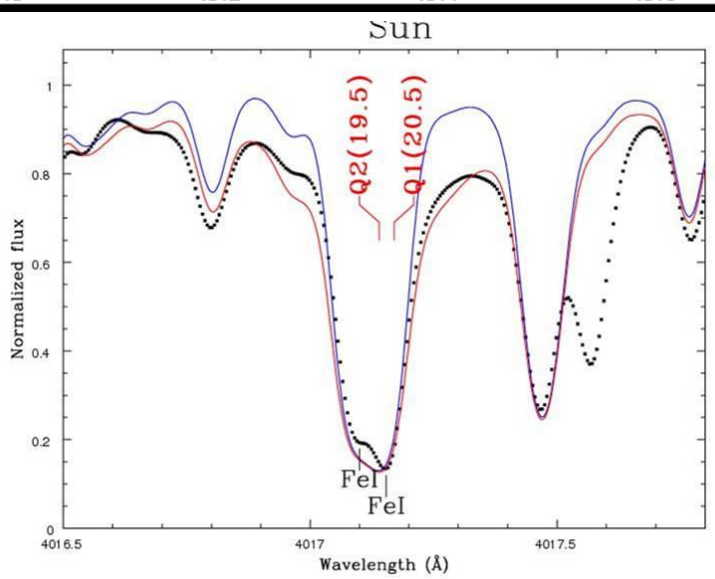
CH (predissociation)

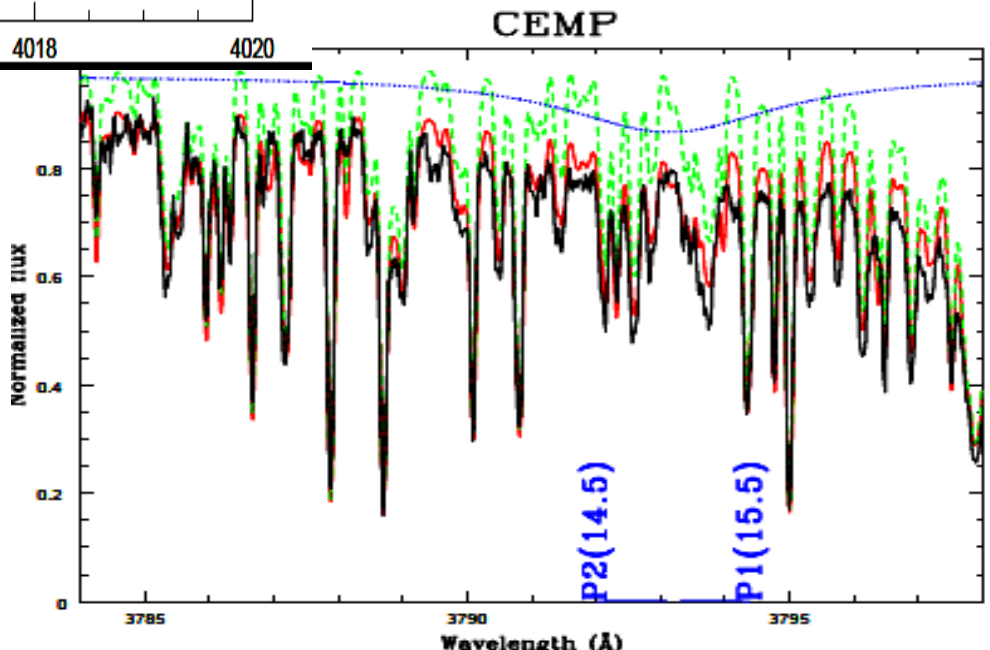


CH: predissociation lines

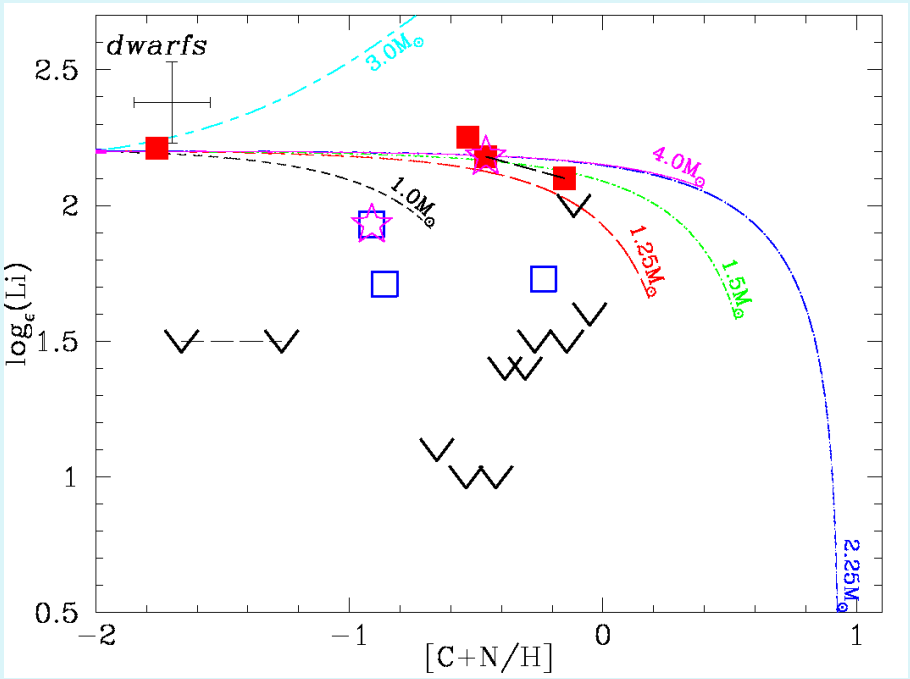




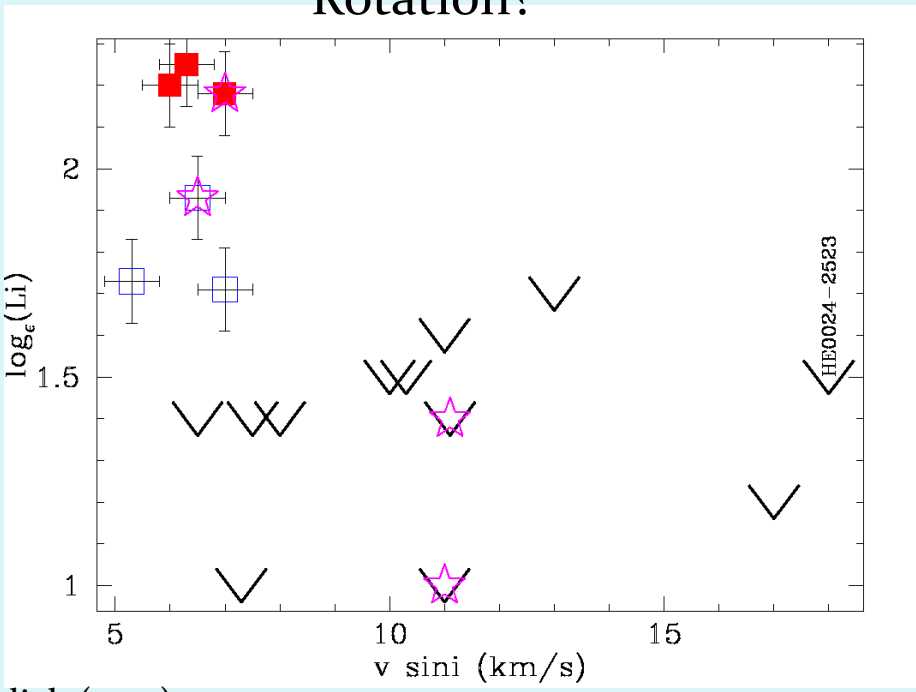




Lithium

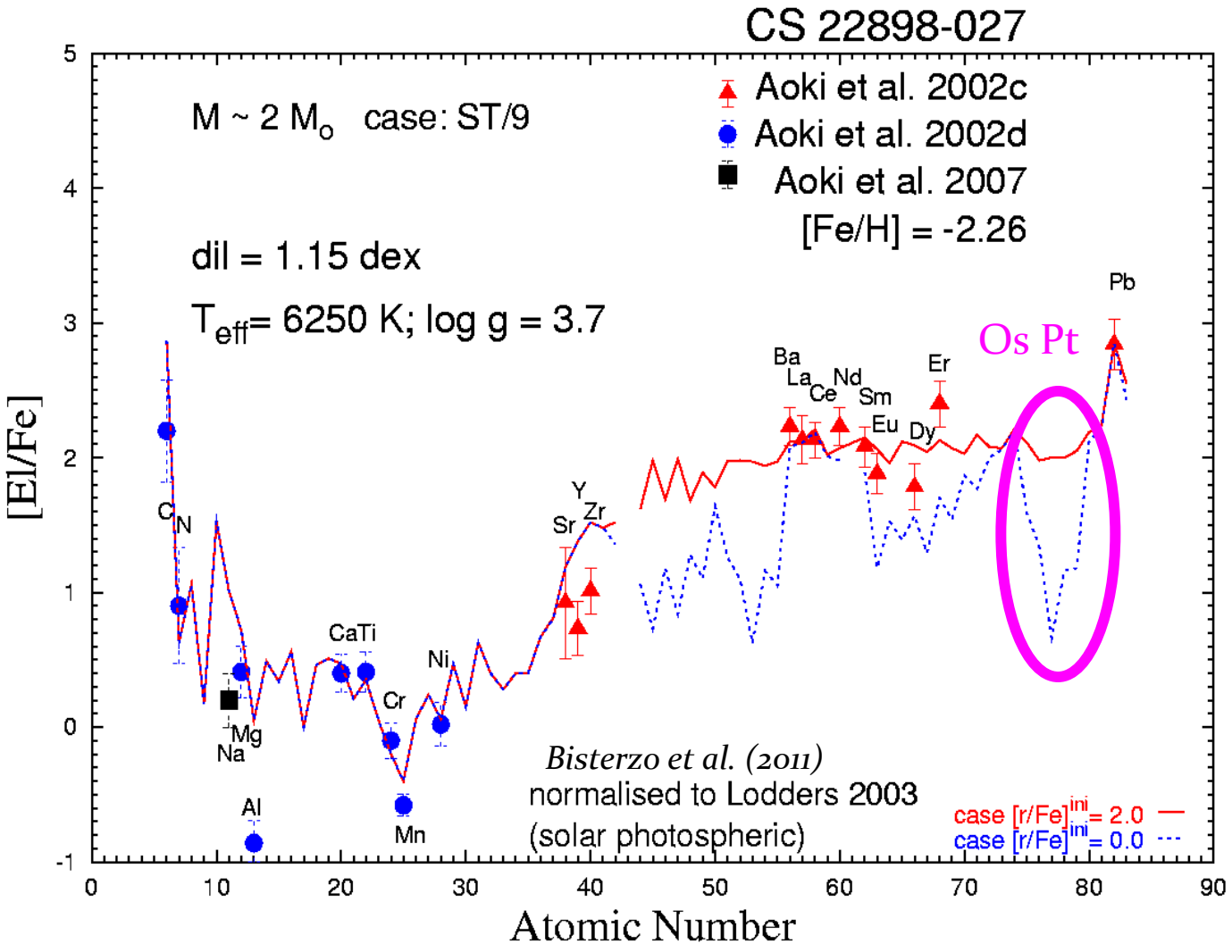


Rotation?

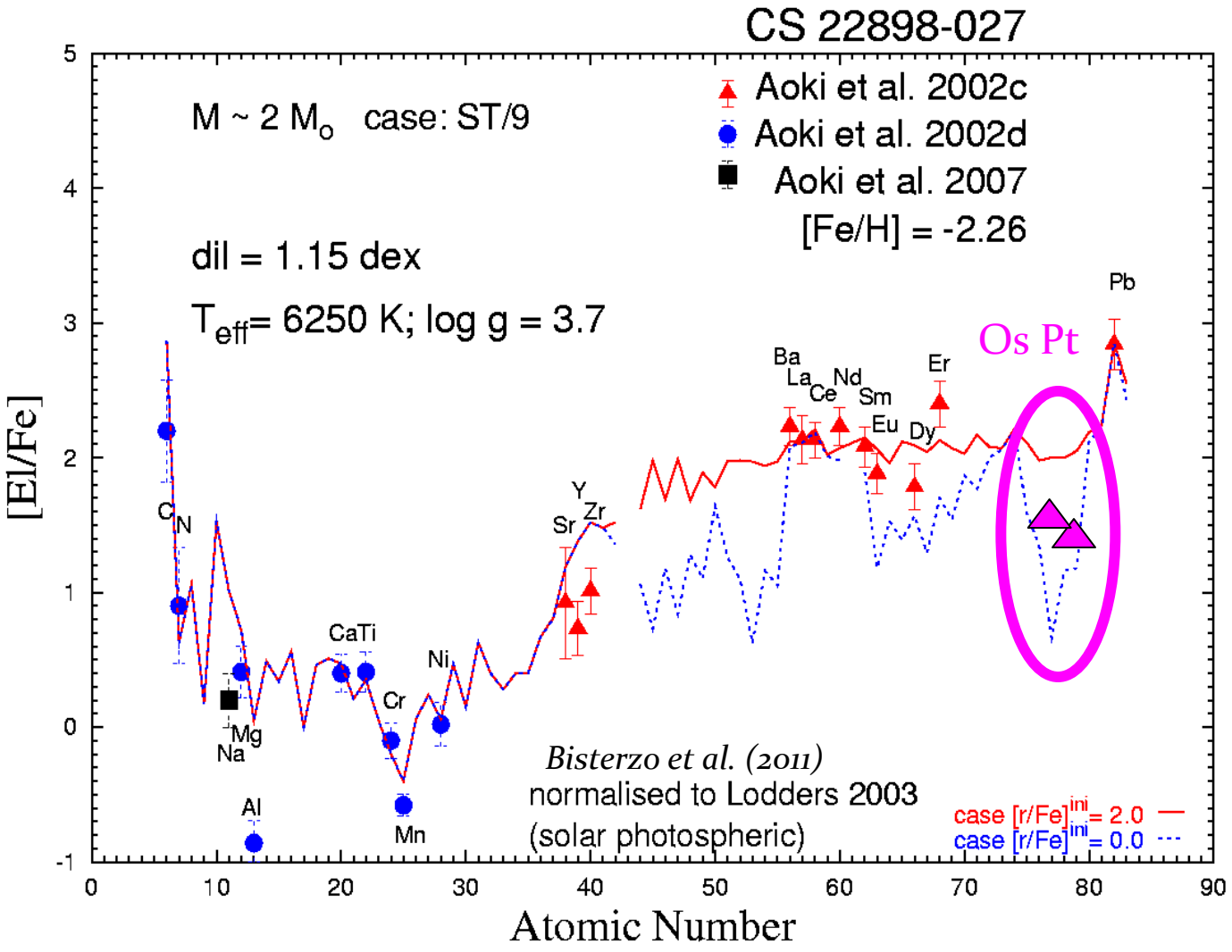


Masseron, Johnson, Lucatello,Karakas, Plez, Beers & Christlieb (2012)

Double pollution scenario



Double pollution?

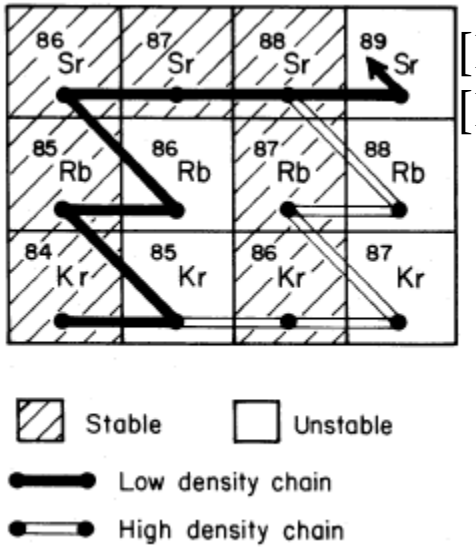


In collaboration with Stephane Goriely

Different s-processes ?

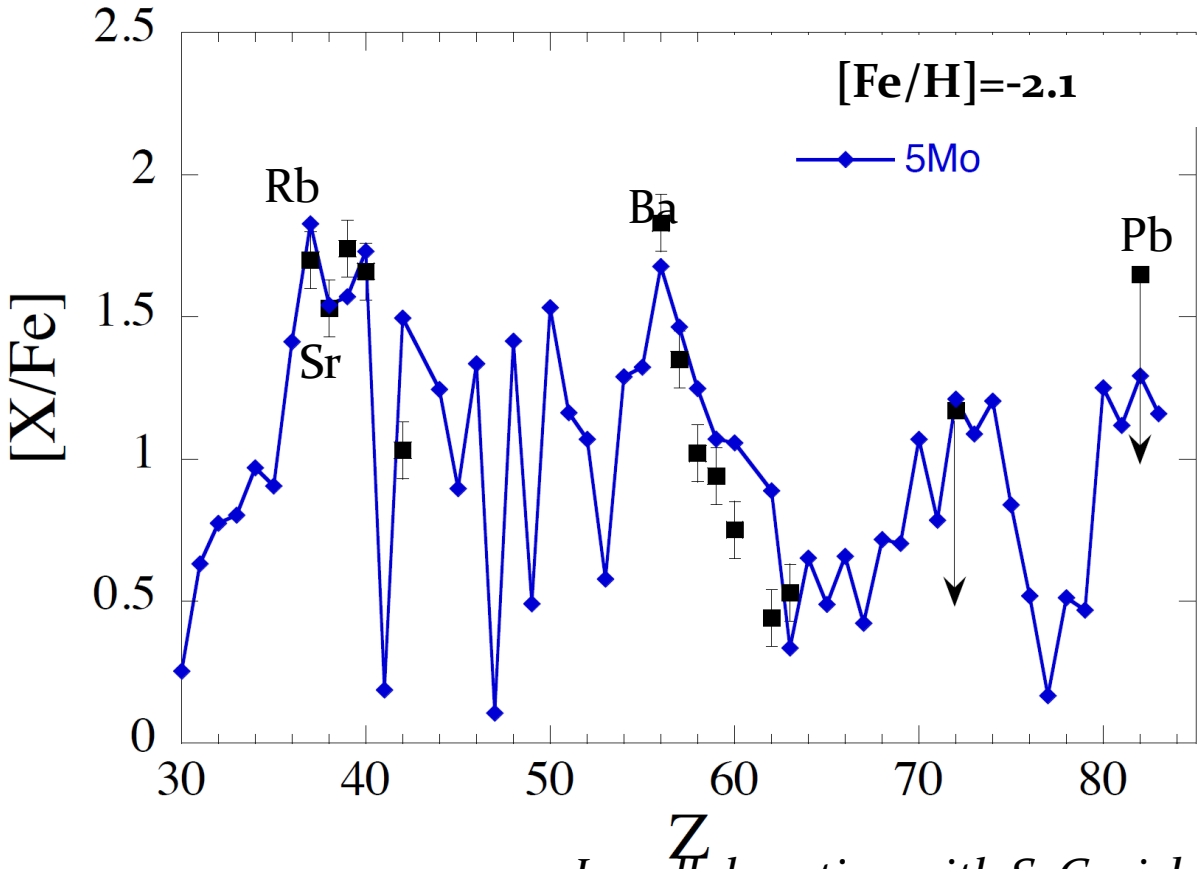
$^{14}N(\alpha,\gamma)^{18}O(\alpha,\gamma)^{22}Ne(\alpha,n)^{25}Mg$ **-> very efficient source of neutron**

(Goriely & Siess 2005)



[Rb/Sr]>o => high neutron density

[Rb/Sr]<o => low neutron density



In collaboration with S. Goriely

Summary

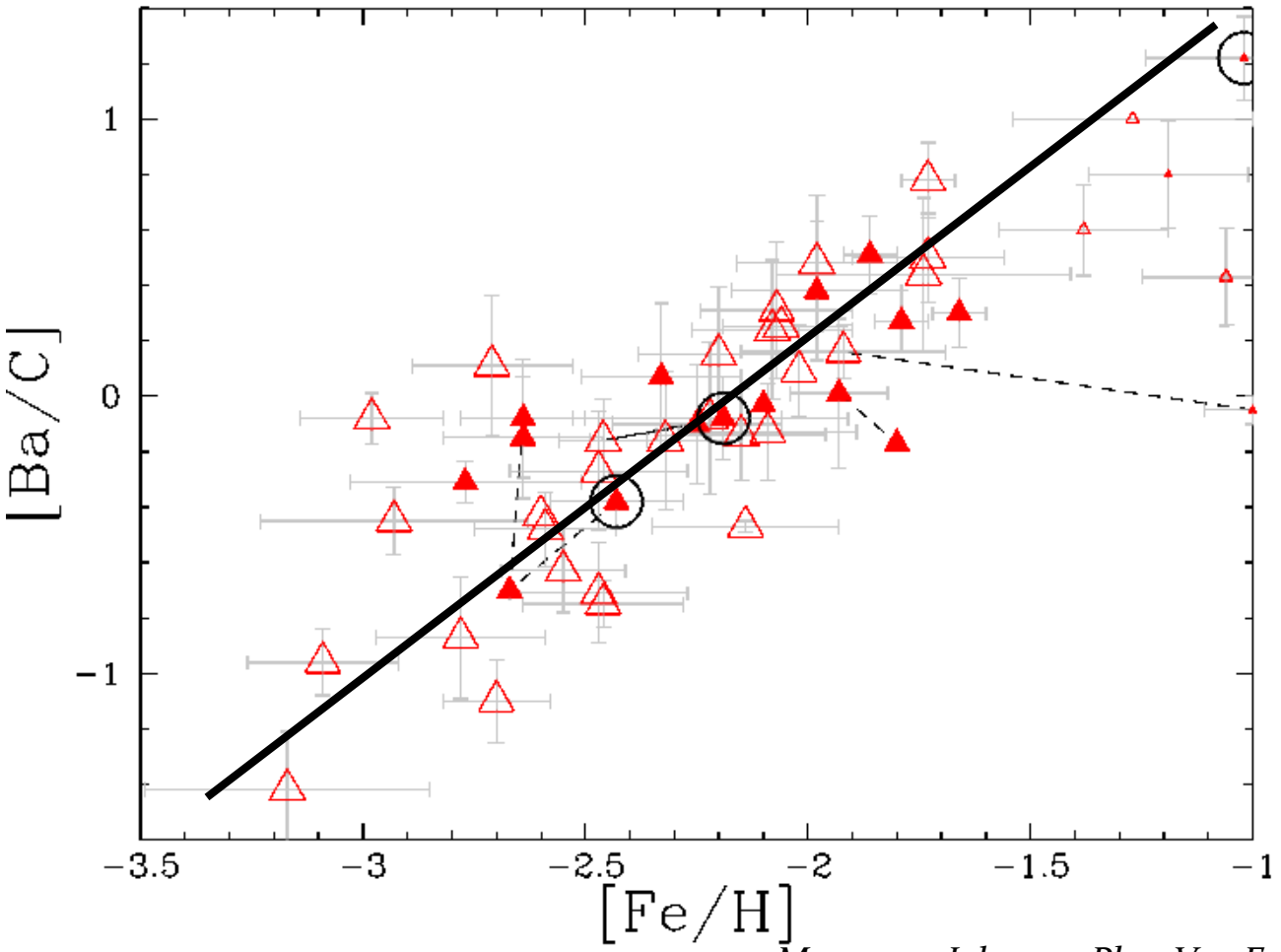
-> one must be careful with observations of CEMP stars

-> do not forget other effects such as rotation

-> call for a different s-process

Unfortunately I am not inspector Columbo, and there are more questions than answers are raised:

Ba vs C in CEMP stars

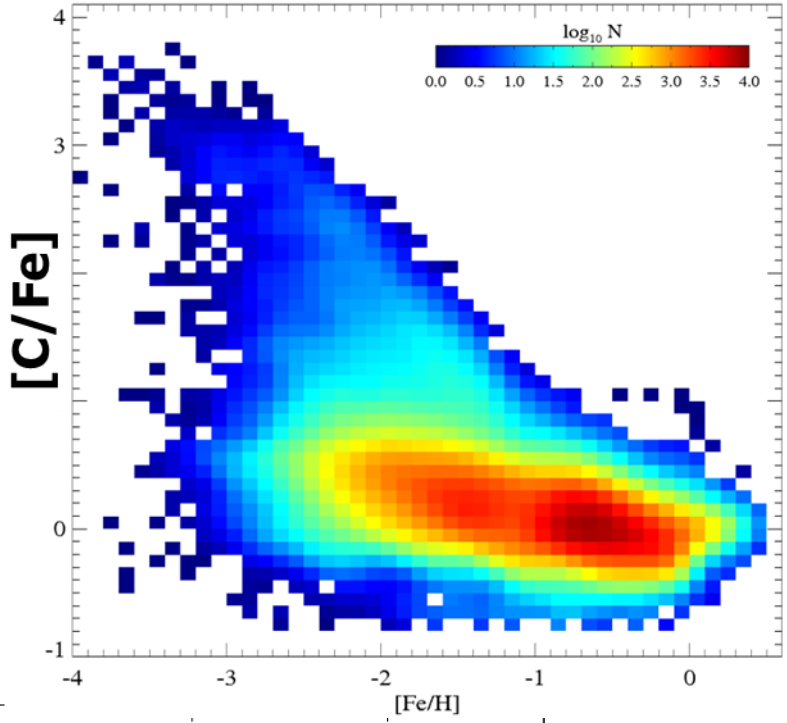


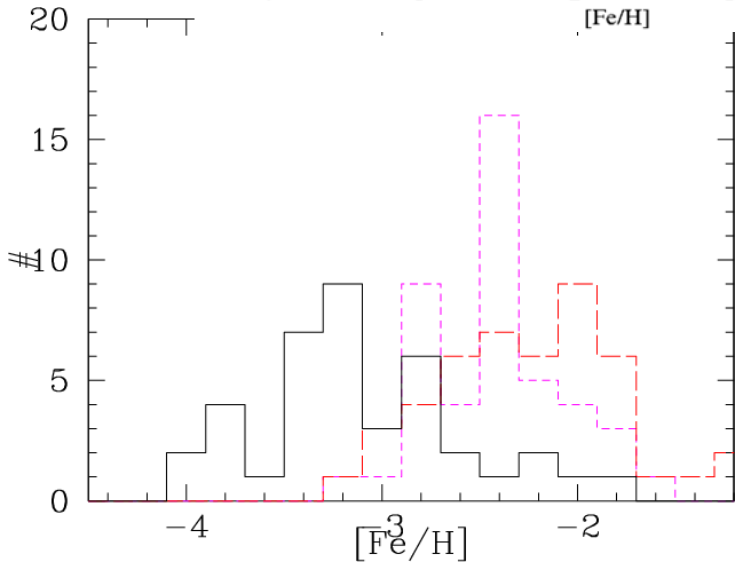
[Ba/Fe] α [C/H]
<=>
[Ba/C] α [Fe/H]

Masseron, Johnson, Plez, Van Eck, Primas, Goriely & Jorissen(2010)

Ba and C are correlated in CEMP stars

->qualitatively consistent with standard AGB nucleosynthesis but not quantitatively!





✓SNII exists for [Fe/H] < -3.0
✓0.8M exists as well
what about AGBs?
-> **where are the first AGBs?**

Metallicity effect on AGB nucleosynthesis?....