Follow-up observations of EMP stars identified in SDSS and LAMOST

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2º LAMOST-KEPLER WORSHOP
ROYAL OBSERVATORY of BELGIUM
BRUSSELS, 1st AUGUST 2017

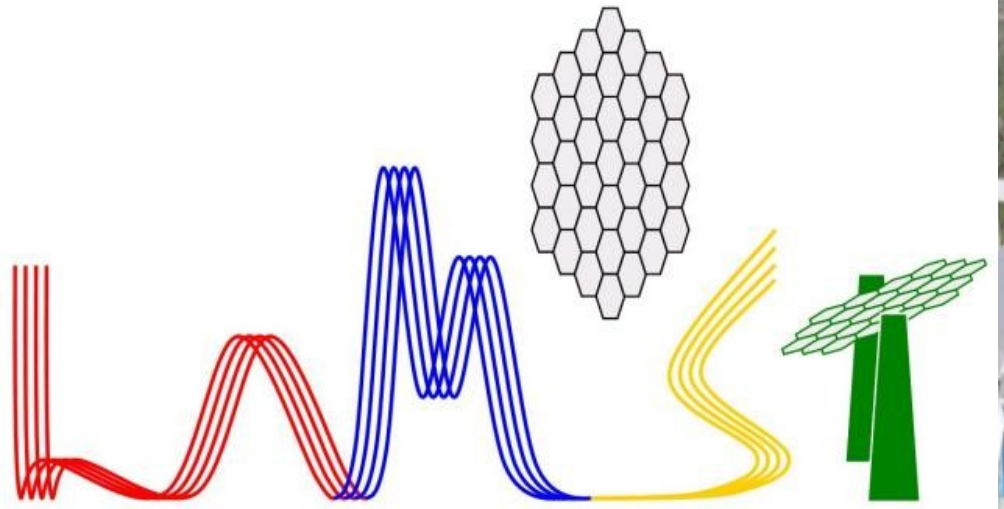
The most iron-poor stars known

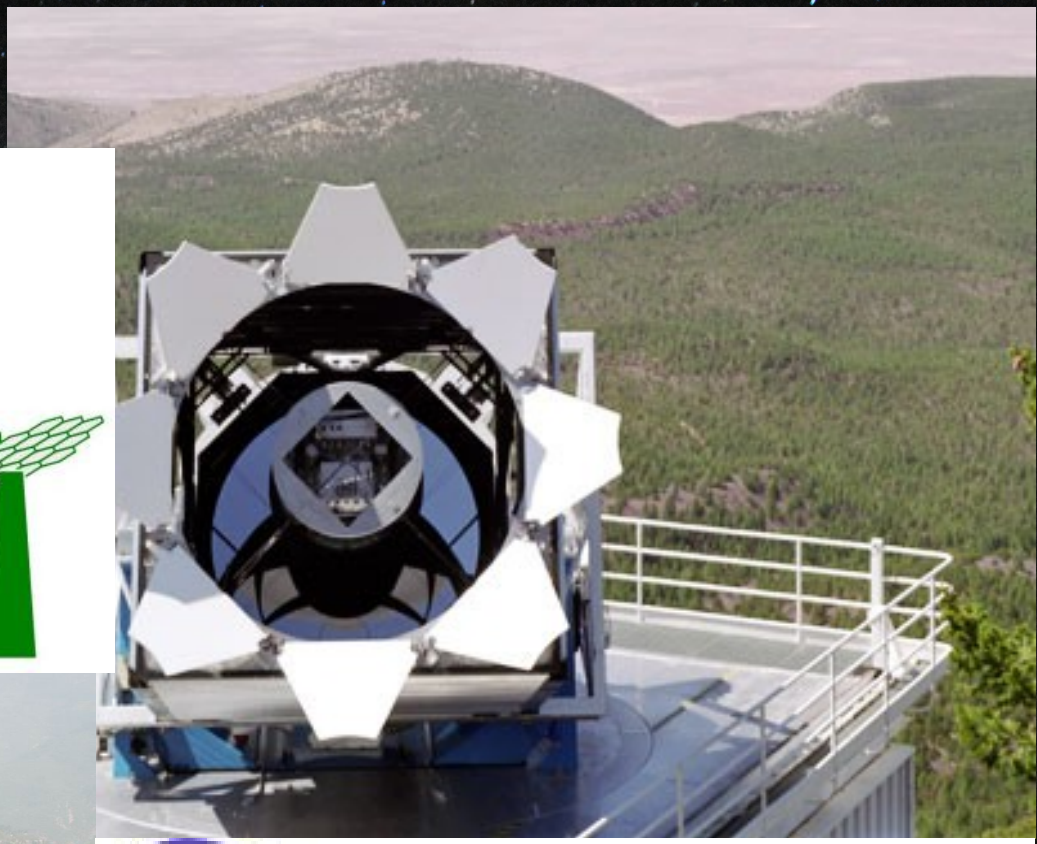
Starname	[Fe/H]	[C/Fe]	References
HE 0233-0343	-4.68	+3.32	Hansen et al. (2014)
HE 0557-4840	-4.75	+1.66	Norris et al. (2007, 2012); Masseron et al. (2012)
SDSS J1742+2531	-4.80	+3.63	Bonifacio et al. (2015)
SDSS J1029+1729	-4.99	<+0.70	Caffau et al. (2011, 2012)
SDSS J1313-0019	-5.00	+2.96	Allende Prieto et al. (2015); Frebel et al. (2015)
SDSS J1035+0641	<-5.07	>+3.55	Bonifacio et al. (2015)
HE 0107-5240	-5.54	+2.69	Christlieb et al. (2002, 2004)
HE 1327-2326	-5.65	+3.48	Frebel et al. (2005, 2008); Aoki et al. (2006)
SMSS J0313-6708	<-7.80	>+5.39	Keller et al. (2014); Bessel et al. (2015)

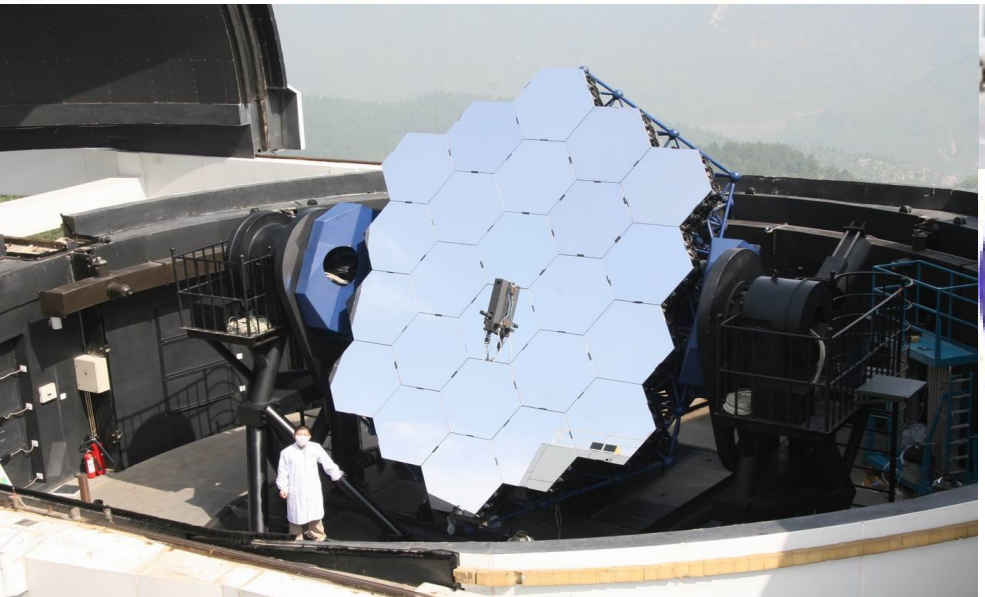
2 < logg < 3
3 < logg < 4
logg > 4

Only 9 stars at [Fe/H] < - 4.5!!

Searching for candidates





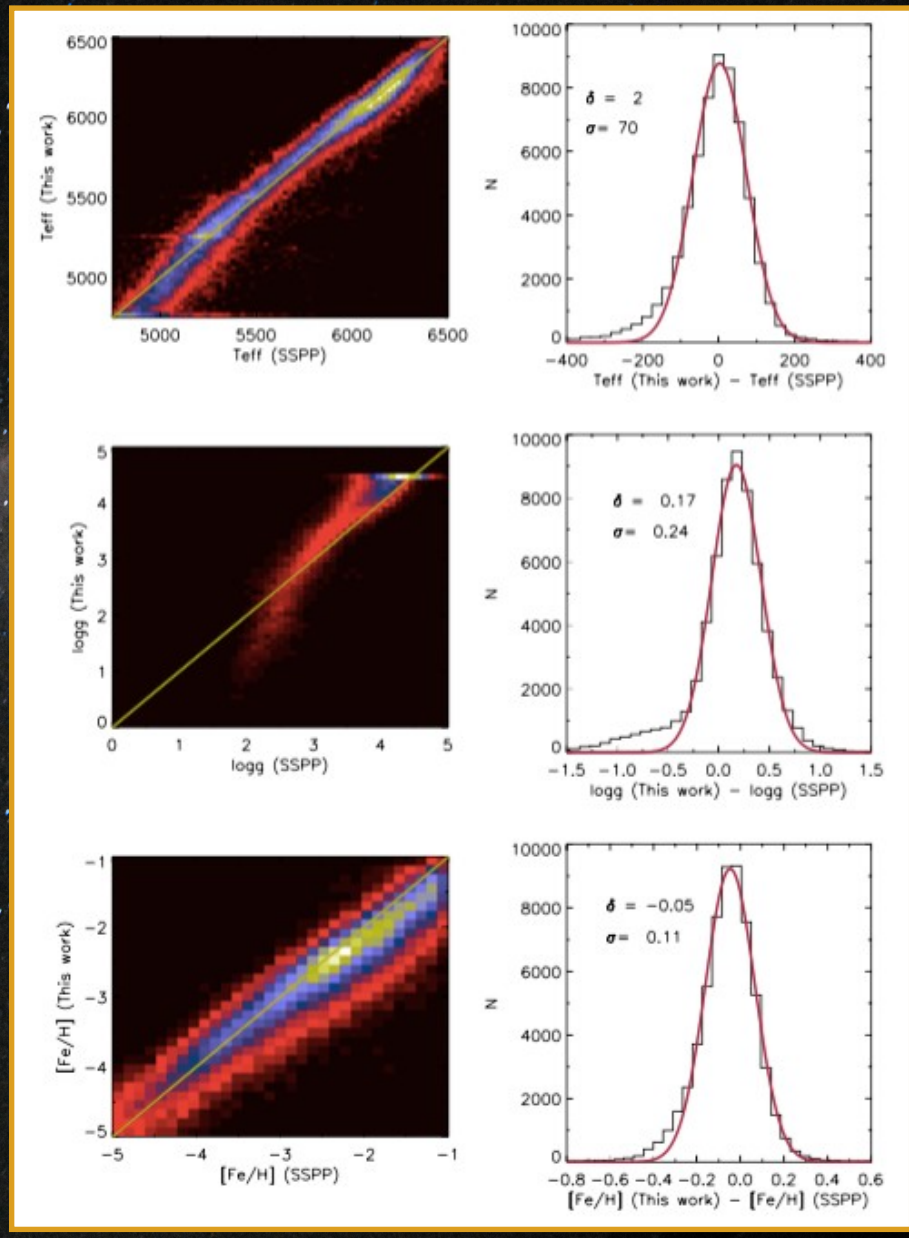


Searching for candidates

FERRE code

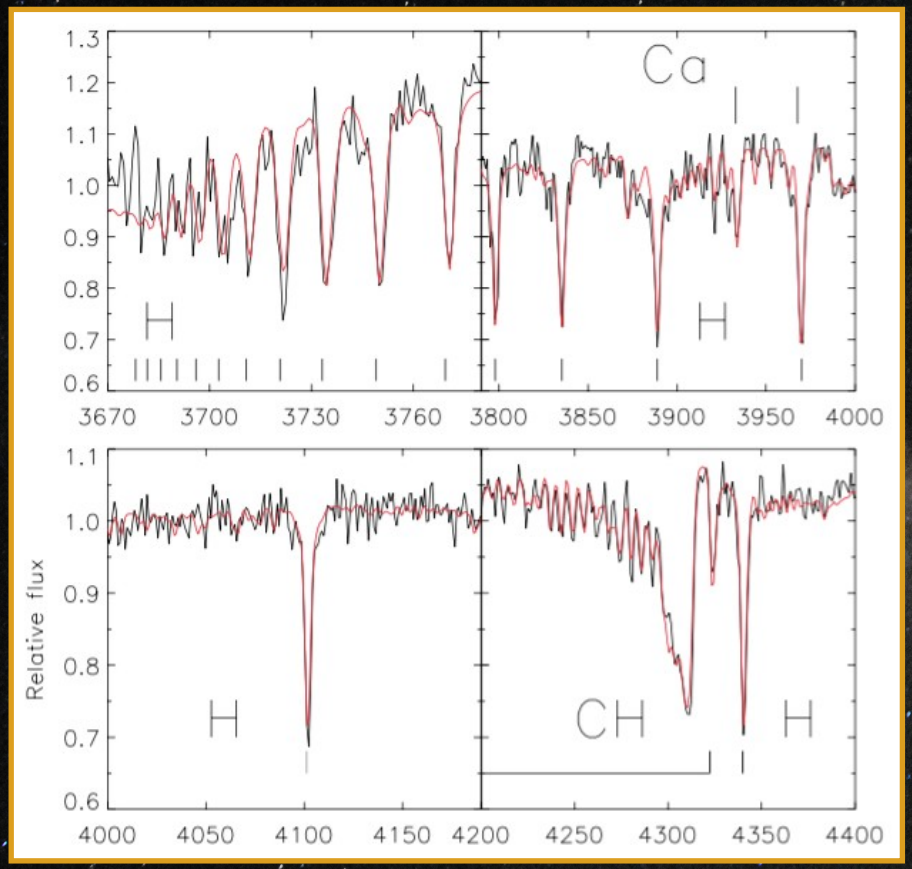
NOW AVAILABLE!

http://github.com/callendeprieto/ferre



Allende Prieto et al. (2014)

First Important Result: J1313-0019



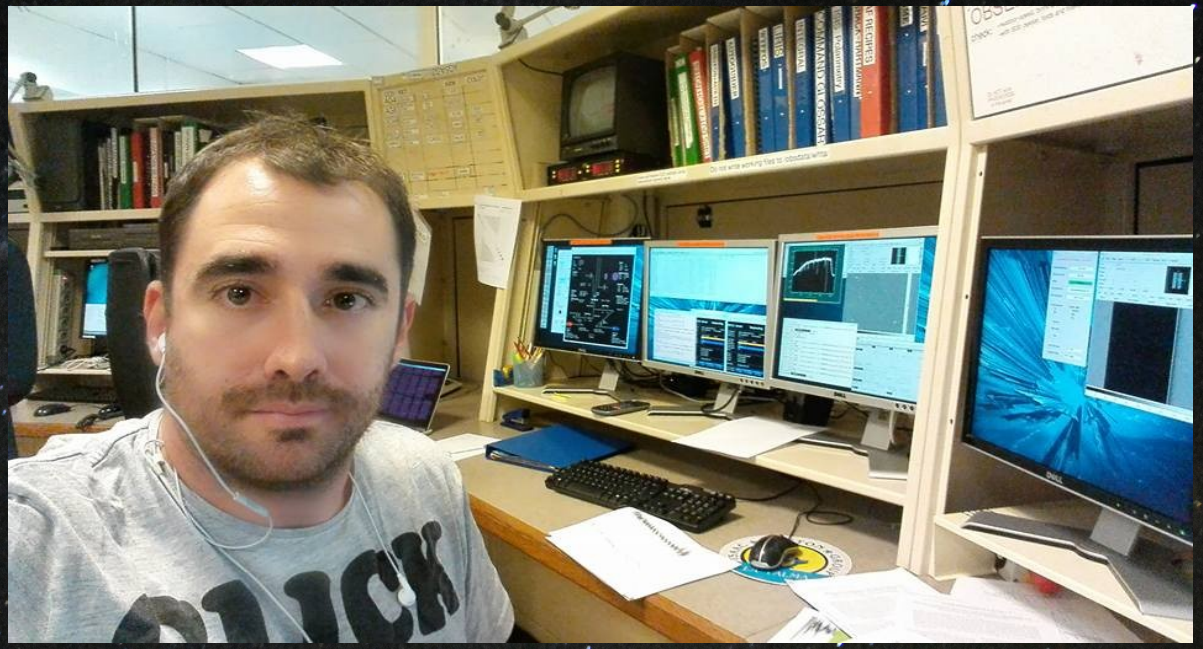
Allende Prieto et al. (2015)

BOSS spectra (R~2000) (Allende Prieto et al. 2015)
*T*eff = 5300K, logg = 2.50, and [Fe/H] = −4.3

High resolution result:

***T*eff = 5200+-150 K, logg = 2.6+-0.5 [Fe/H] = −5.0+-0.1 (Frebel et al. 2015)**

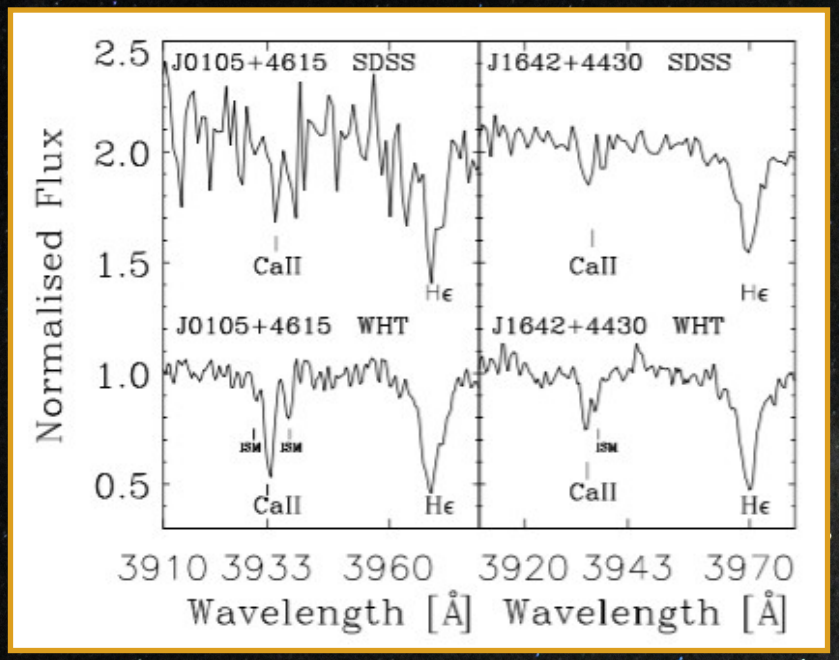
The methodology: medium resolution with ISIS at William Herschel Telescope (WHT)



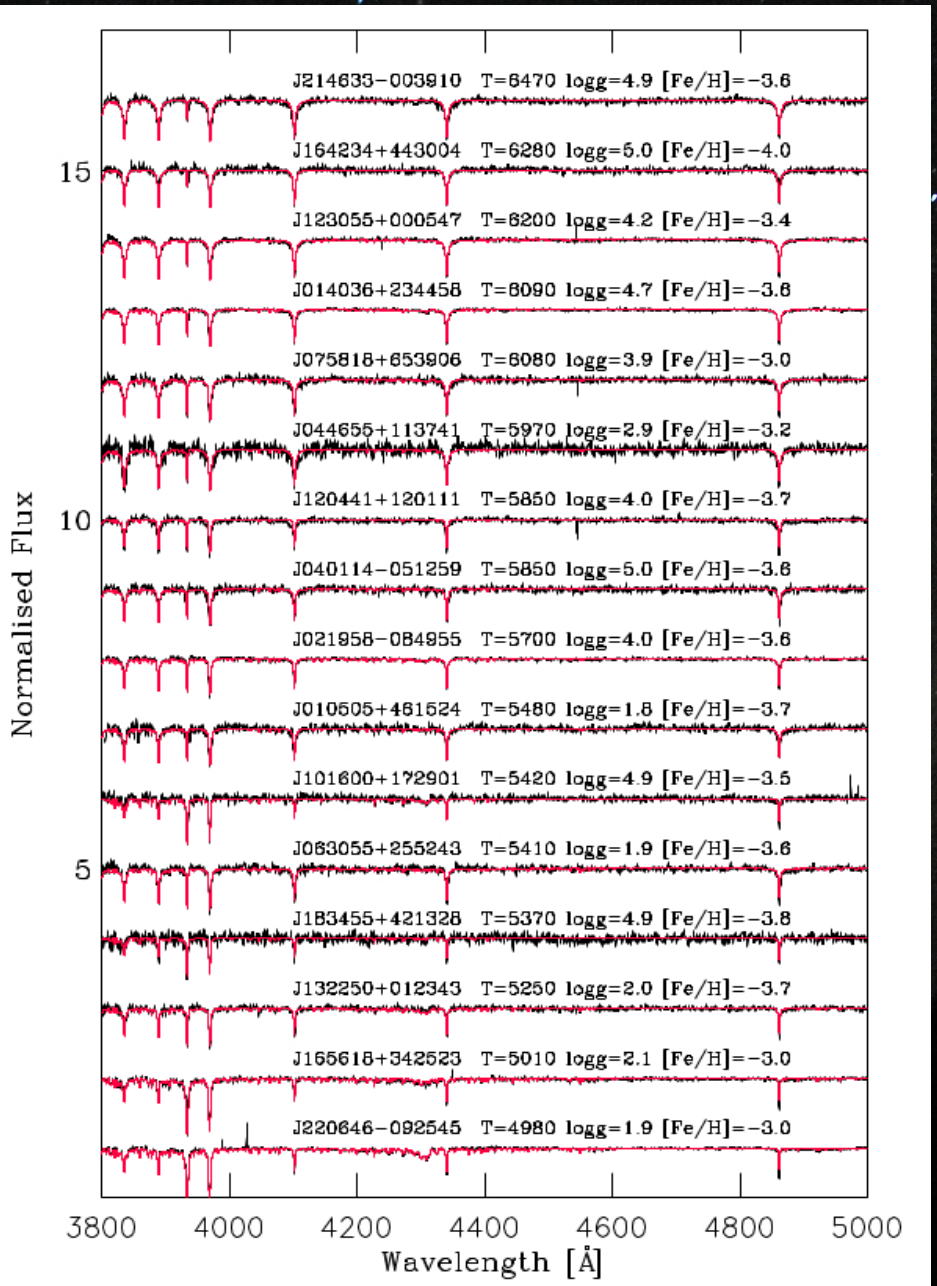
La Palma observatory in Canary Islands!

-8 observing runs: 27 nights - >65 objects
-Reduction: IRAF
-Stellar models: ATLAS9
- Analysis: MOOG, SYNTHE and FERRE

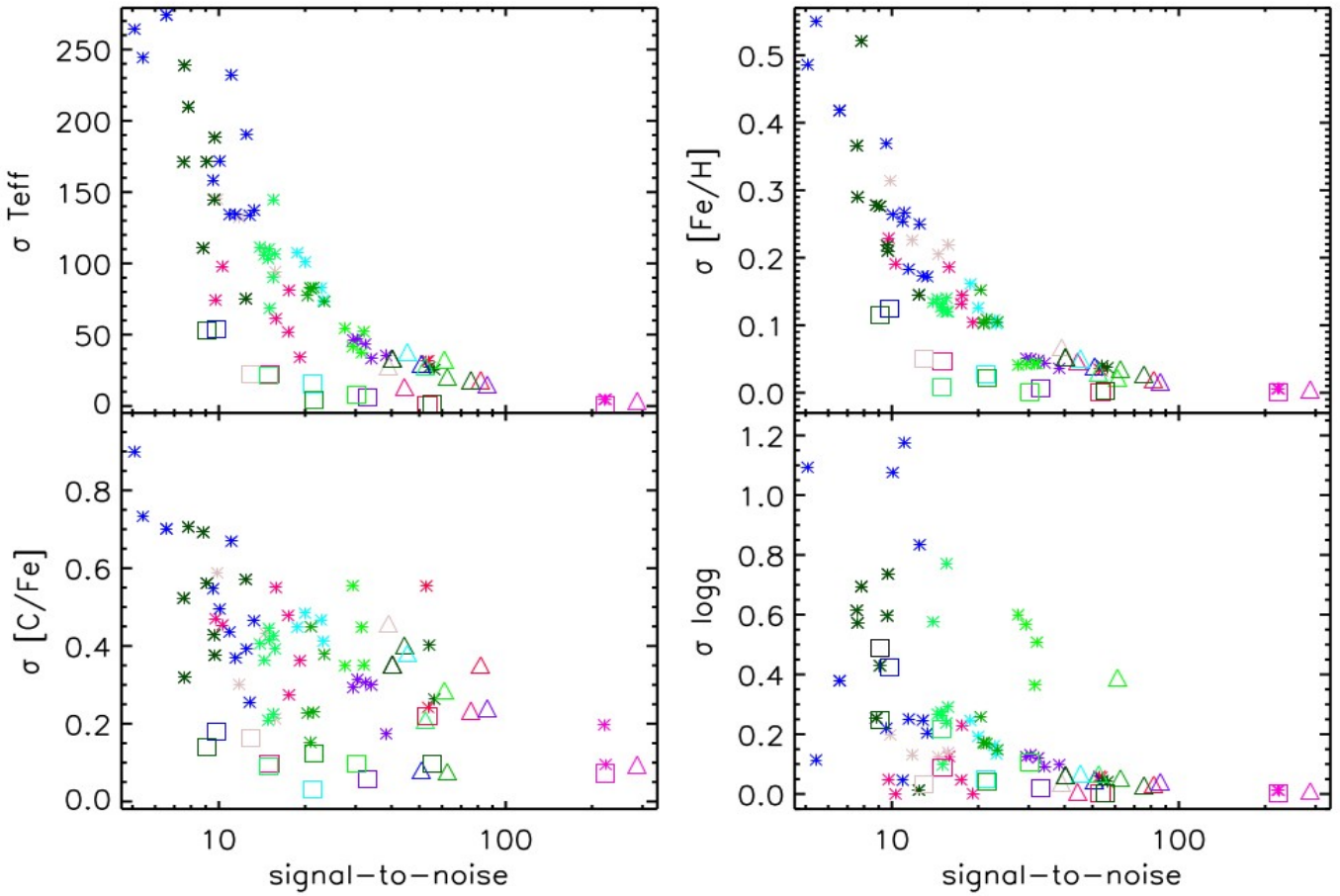
The methodology: medium resolution



Aguado et al. (2016)



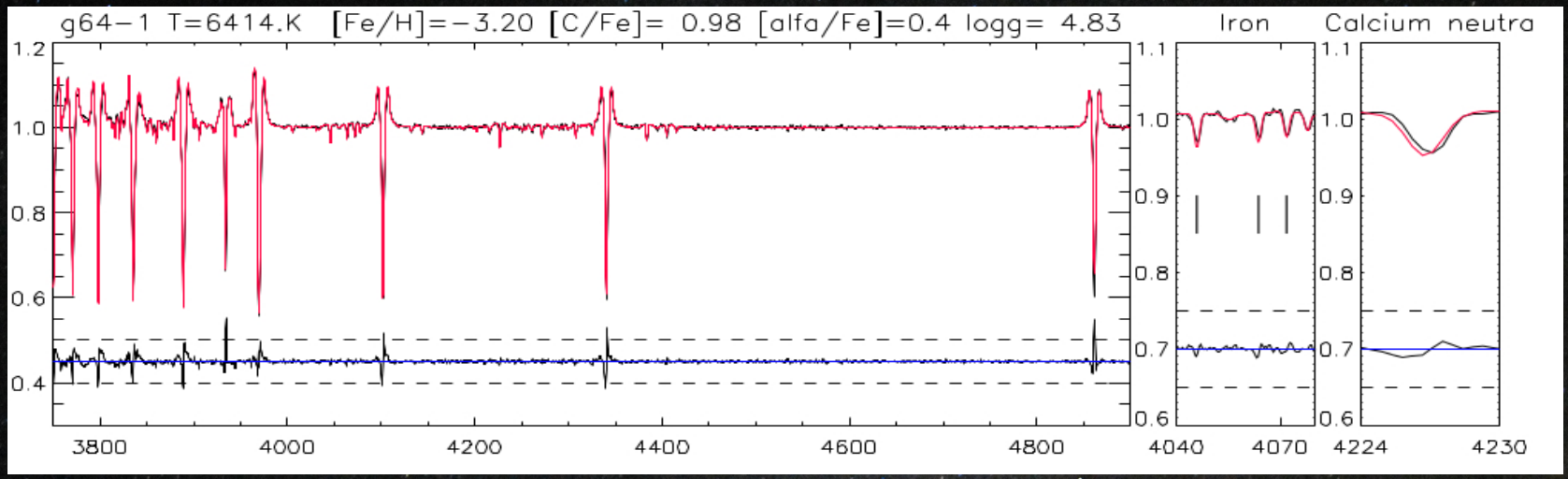
The methodology: FERRE performance

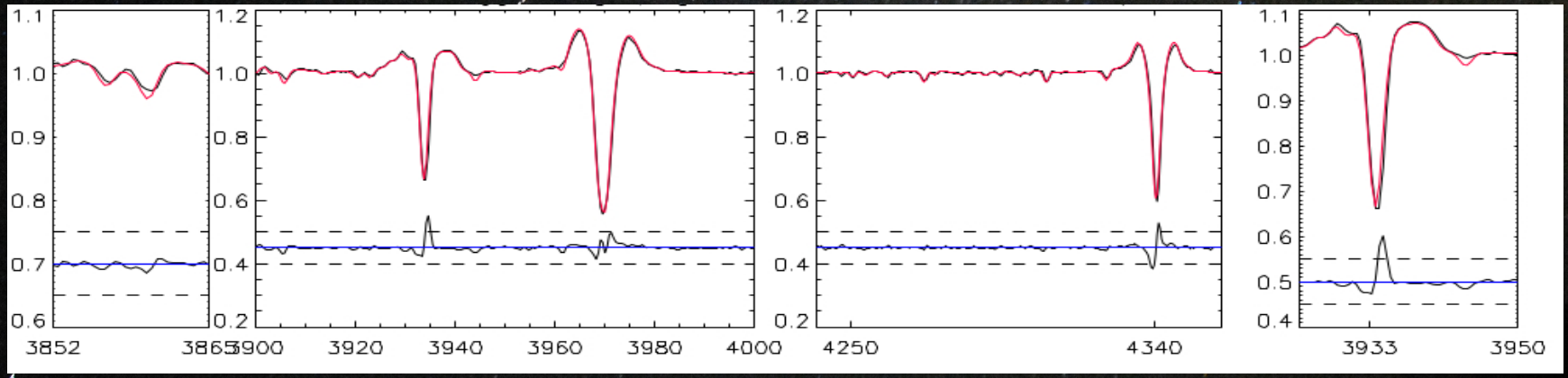


Aguado et al. (2017a)

The methodology: comparing

G64-12 [Fe/H]=-3.25





Aguado et al. (2017a)

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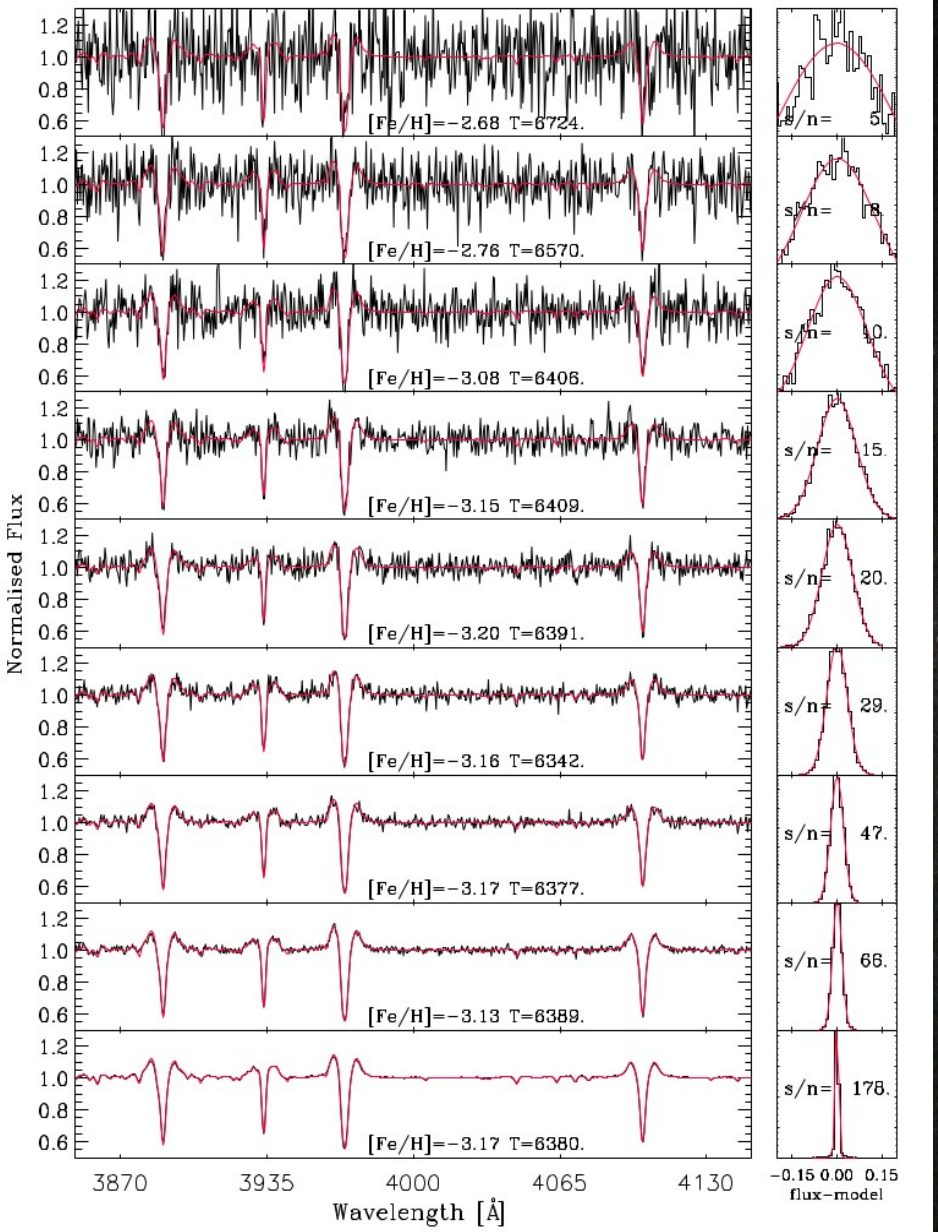


J1313 Allende Prieto et al. (2015); Frebel et al. (2015)

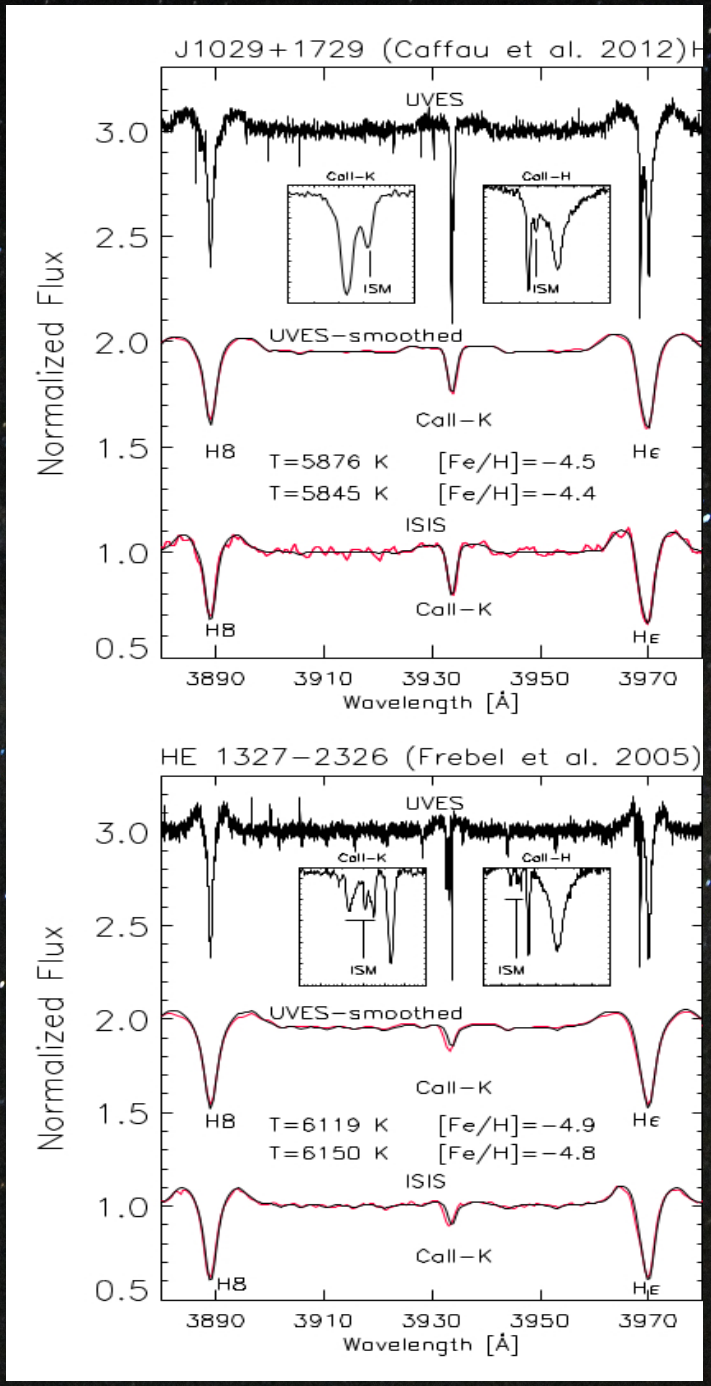
[Fe/H]=-5.0 [Fe/H]=-4.6
[C/Fe]=2.96 [C/Fe]=2.8
FERRE

J1029 Caffau et al. (2011, 2012)

[Fe/H]=-4.99 [Fe/H]=-4.4
[C/Fe]<+0.7 [C/H]=-0.3
FERRE

HE 1327 Frebel et al. (2005, 2008); Aoki et al. (2006)

[Fe/H]=-5.65 [Fe/H]=-5.0
[C/Fe]=+3.48 [C/Fe]=+3.0
FERRE



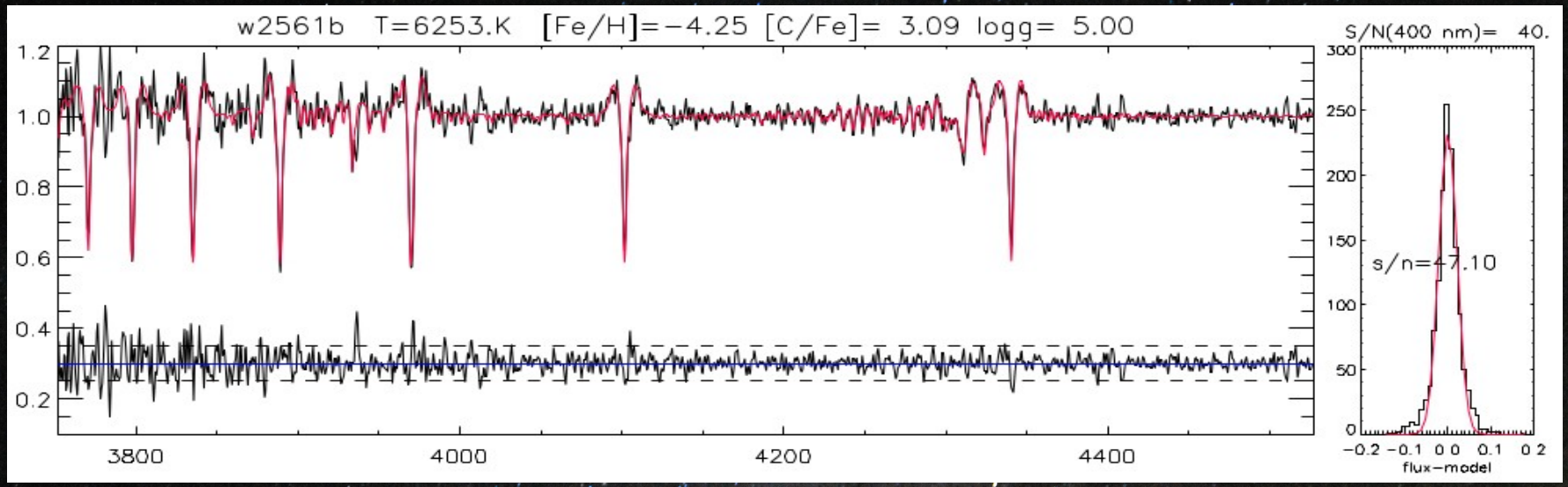
Aguado et al. (2017a)

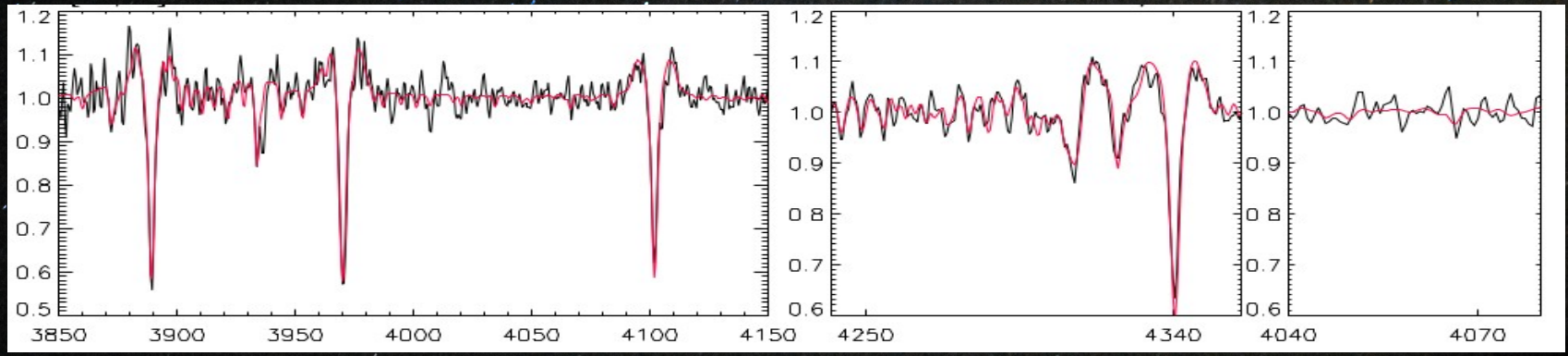
OSIRIS at 10.4 m GTC

-Faint objects (g>19) or very interesting ones

-OSIRIS med-resolution spectrograph

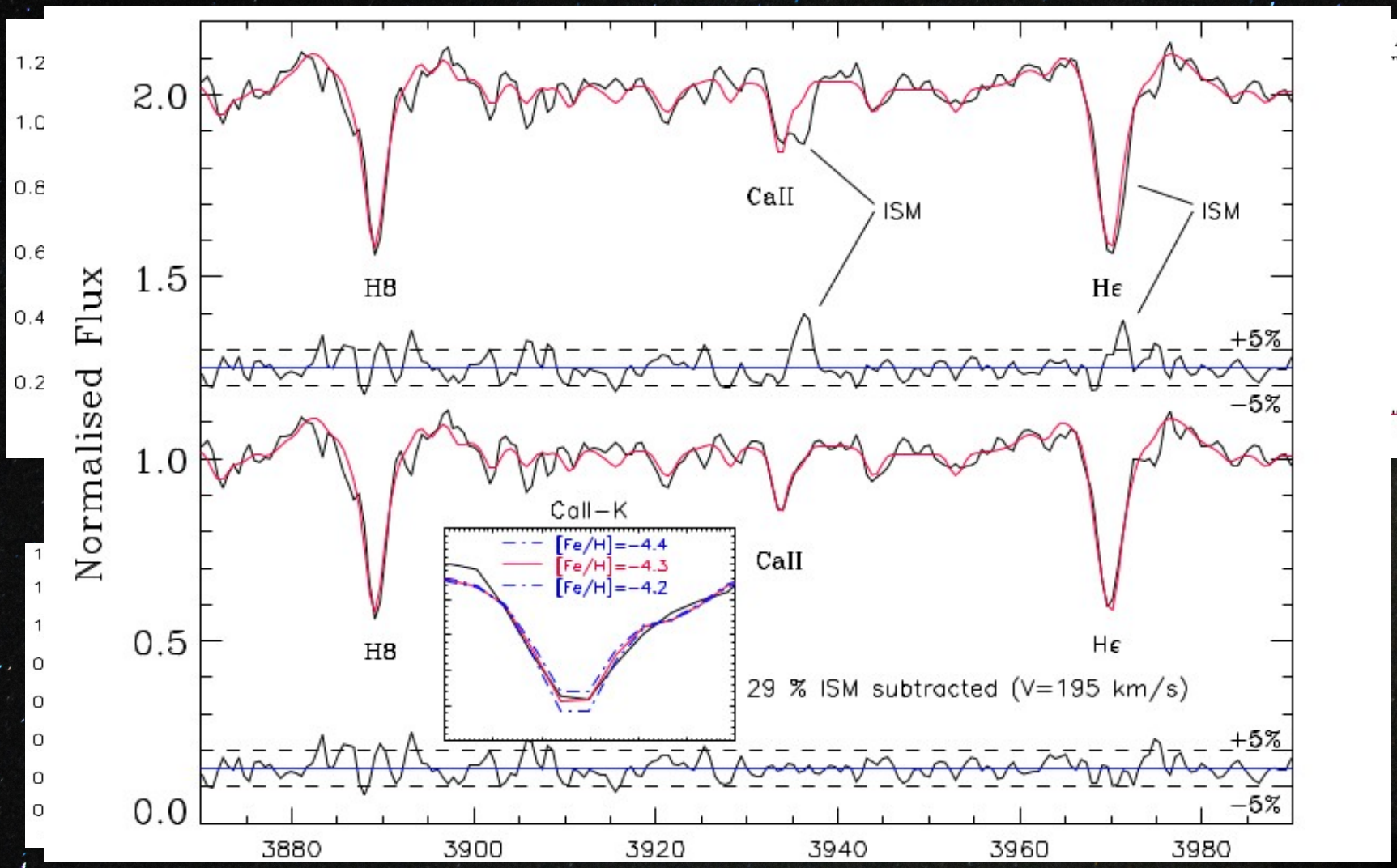
OSIRIS at GTC: J1734+6446





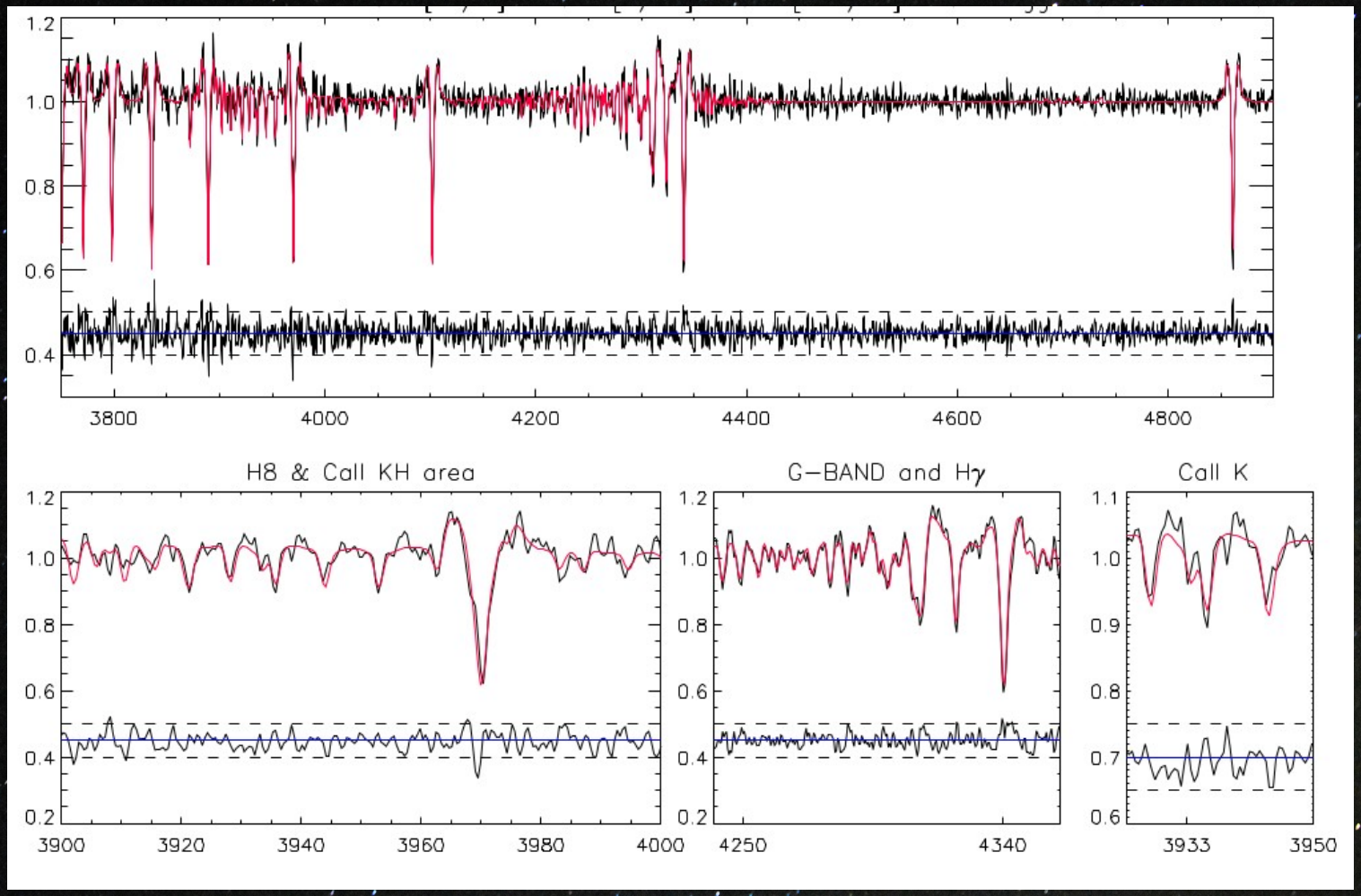
Aguado et al. (2017b)

OSIRIS at GTC: J1734+6446



Aguado et al. (2017b)

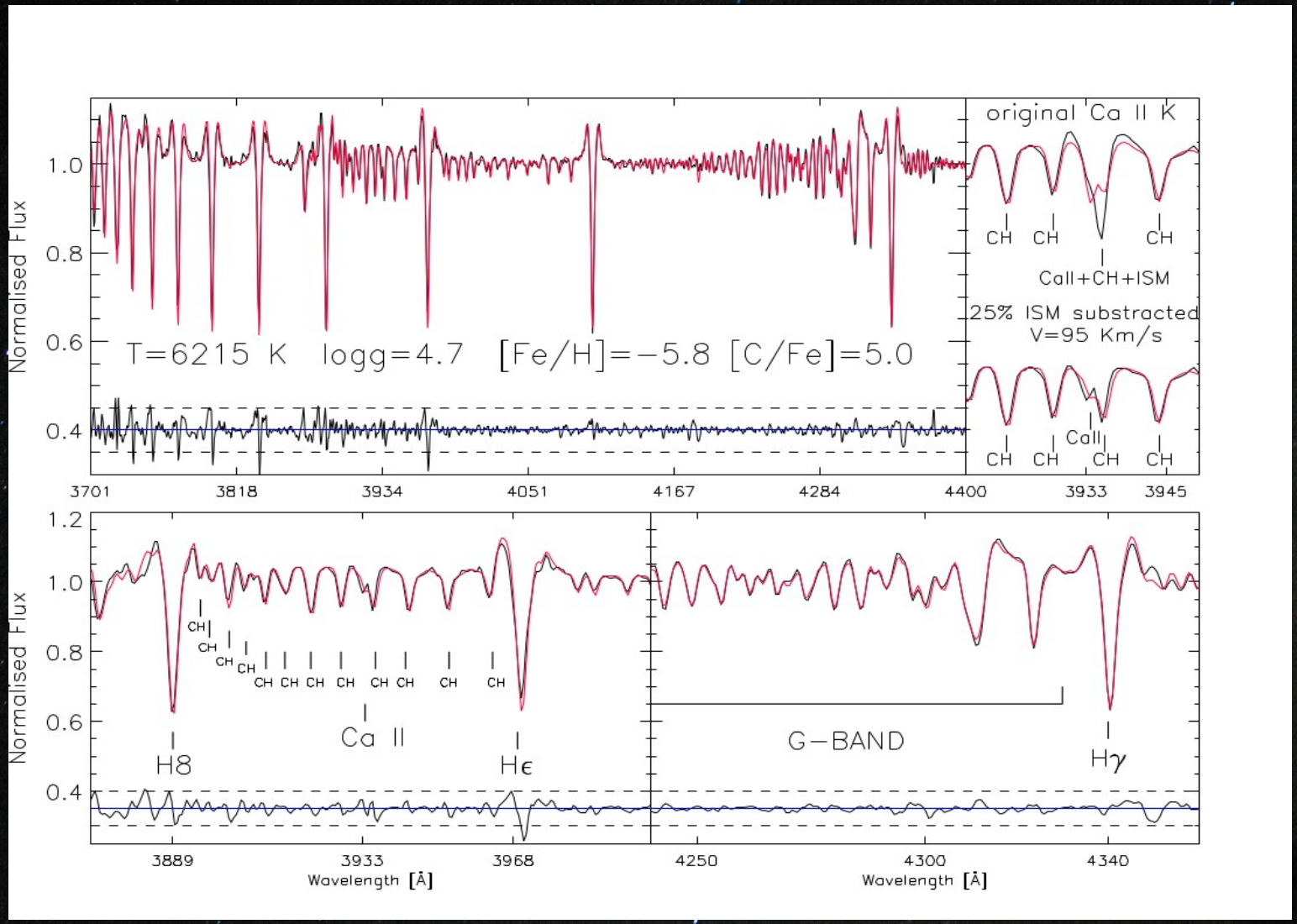
A interesting candidate from SDSS



ISIS at 4.2m WHT

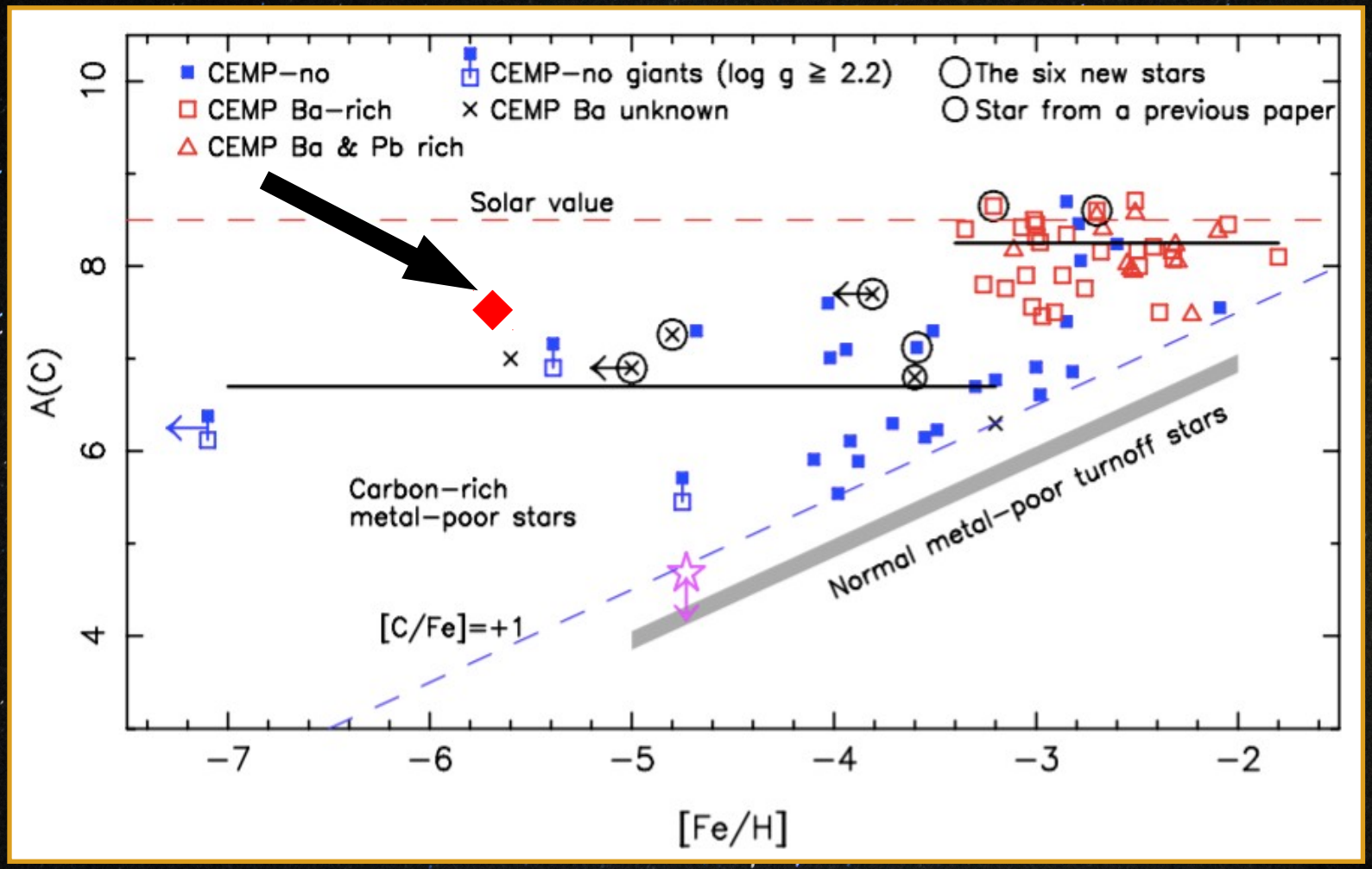
Aguado et al. (2017c) In preparation.

OSIRIS at GTC



Aguado et al. (2017c) In preparation.

A new HMP star with [Fe/H]=-5.8

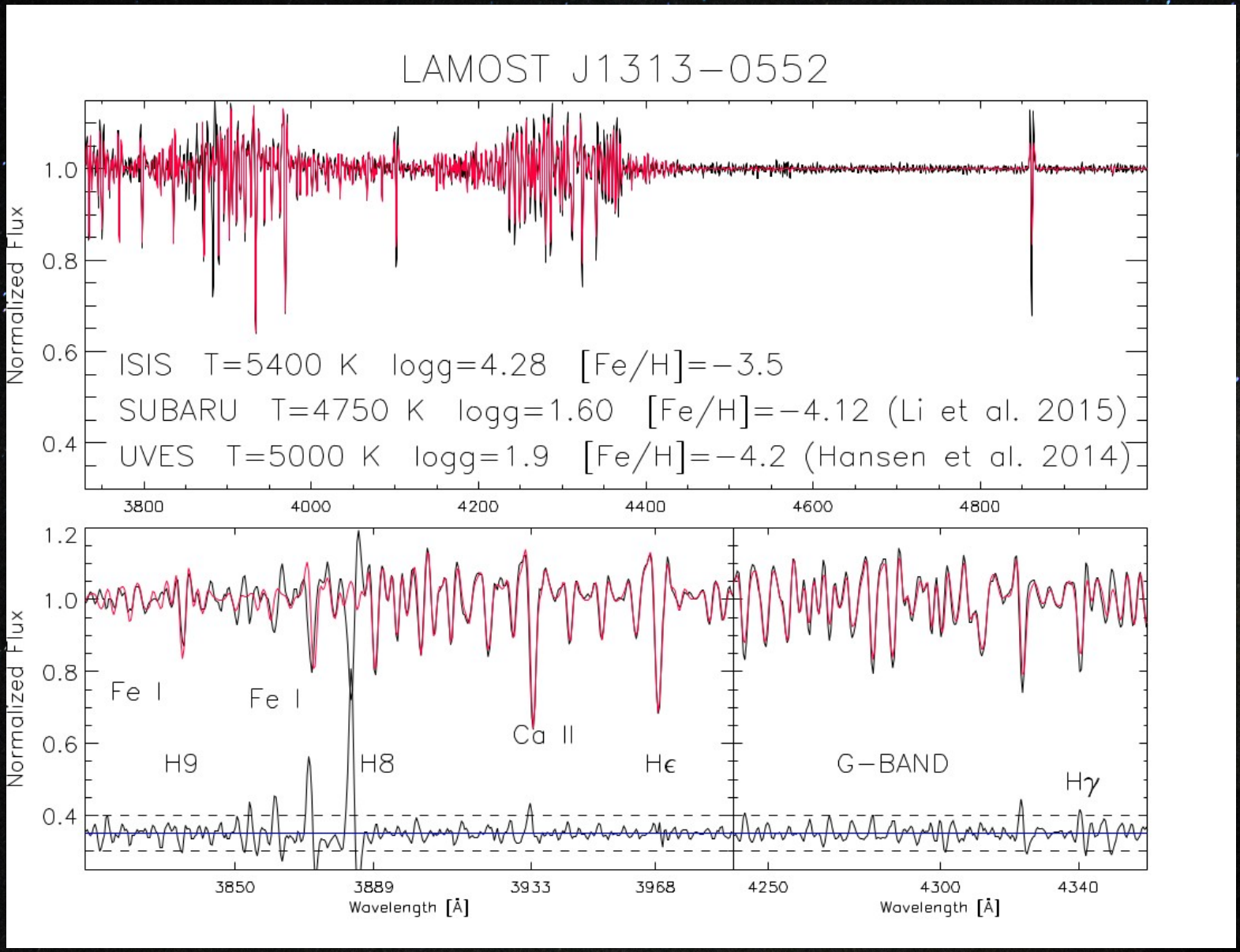


Bonifacio et al. (2015); Spite et al. (2013)

Candidates from LAMOST

-First attempt: 12 candidates observed with ISIS in 2016
- All DR2 re-analyzed with FERRE in 2017
- About 30 candidates selected for ISIS/LRS2 observations

Candidates from LAMOST



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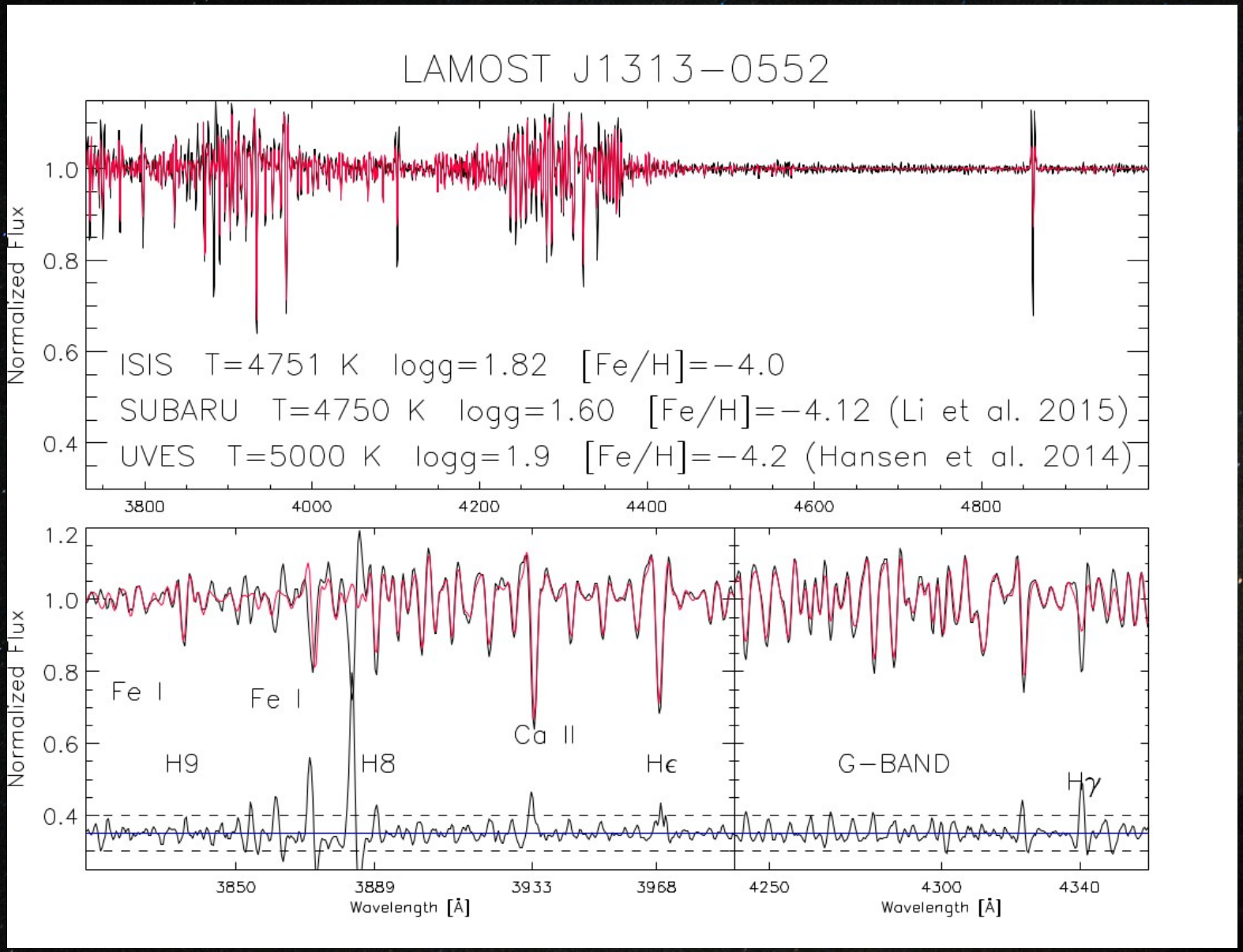
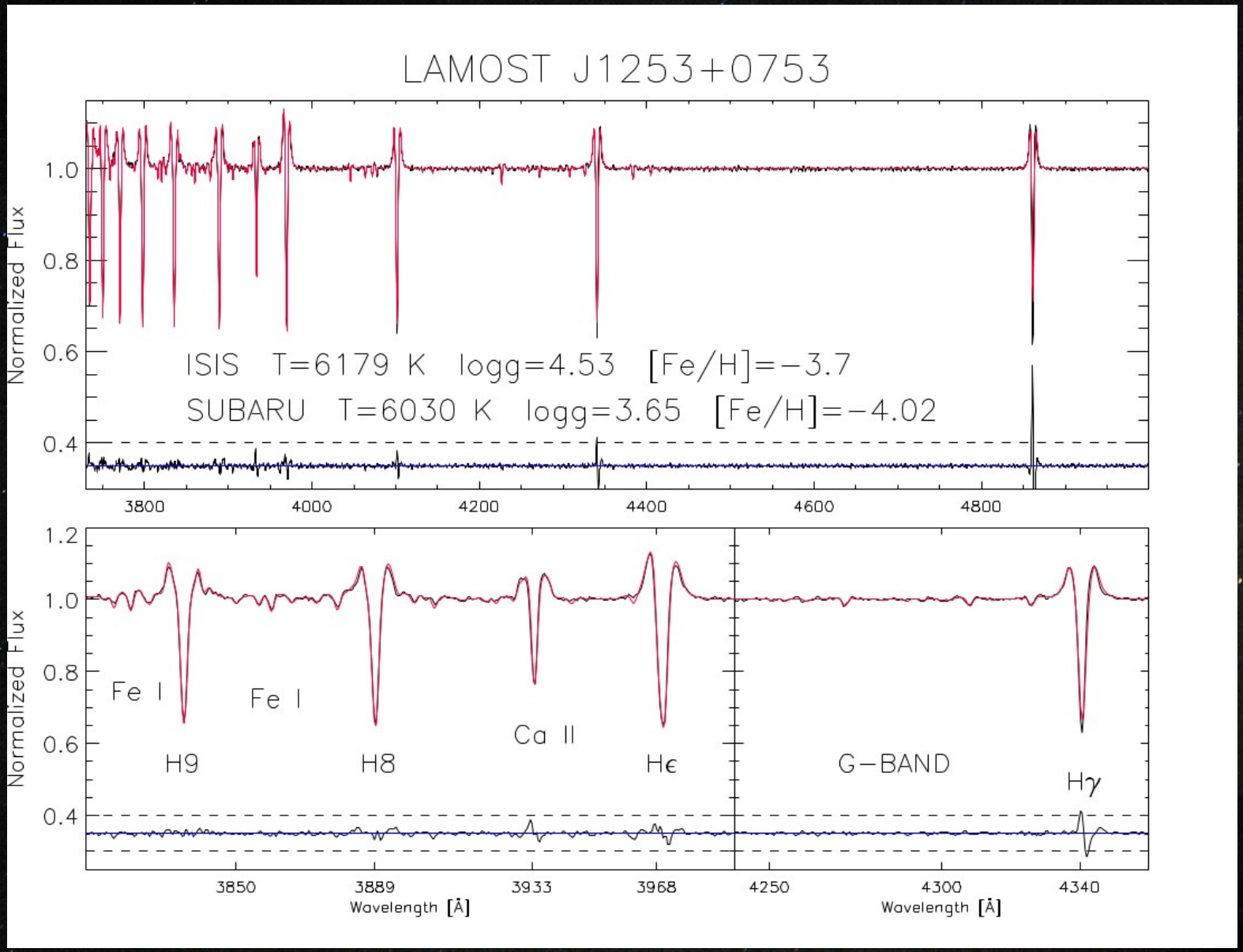


Candidates from LAMOST



But we could go further...

Let's go to McDonald Observatory in Texas!

LRS2 at HET: LAMOST FOLLOW-UP

-Resolution ~2200 and ~900 in blue and orange channel

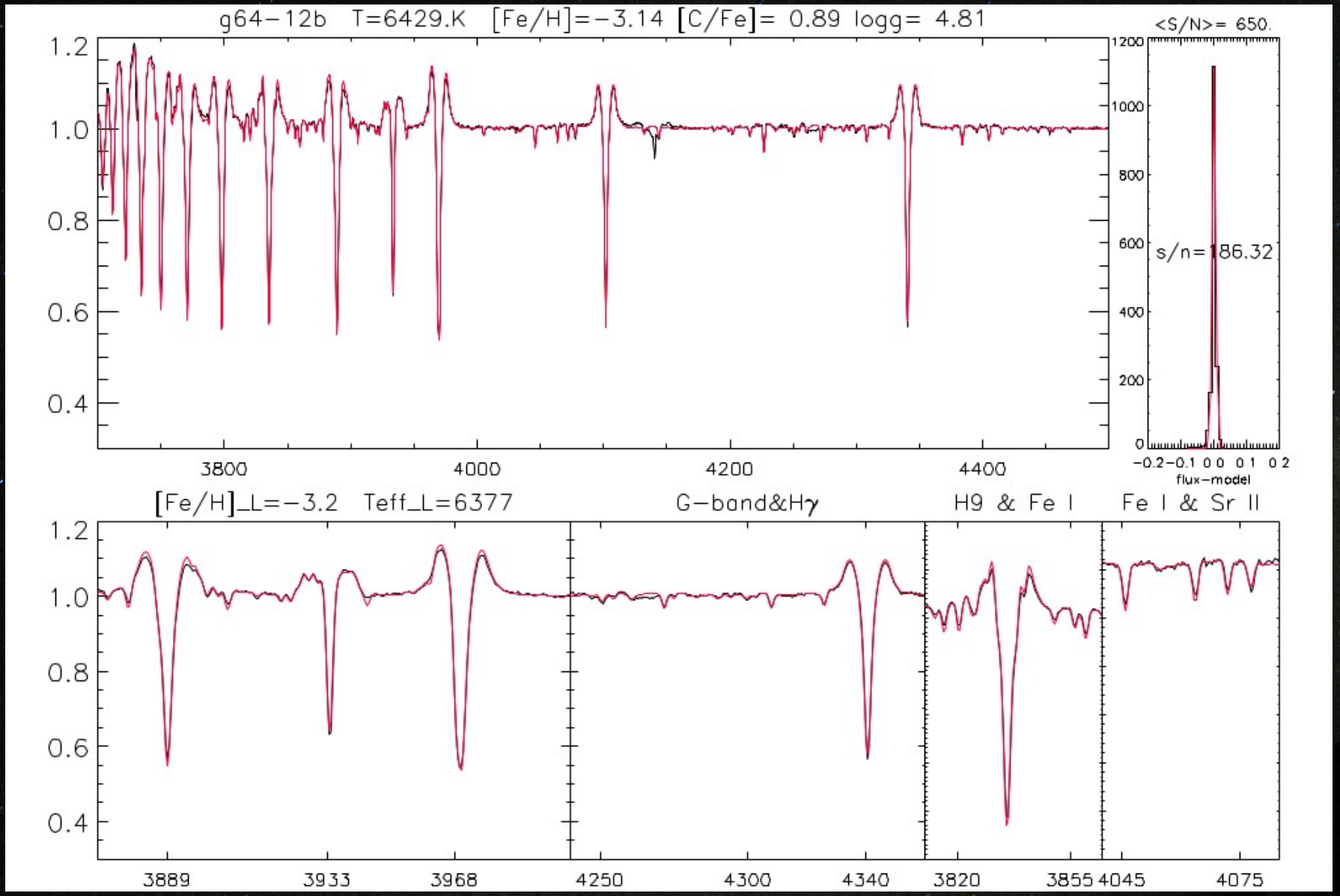
-3700-7500 A coverage

-High quality espectra (S/N>100)

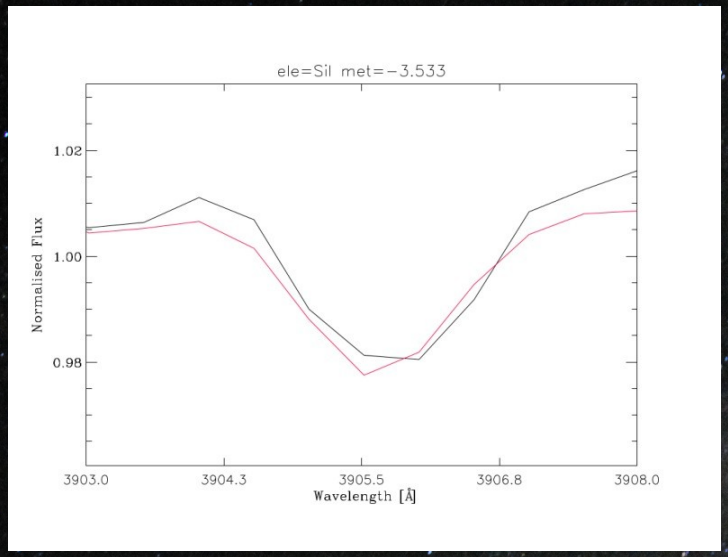
-16 hours in P3 and P4

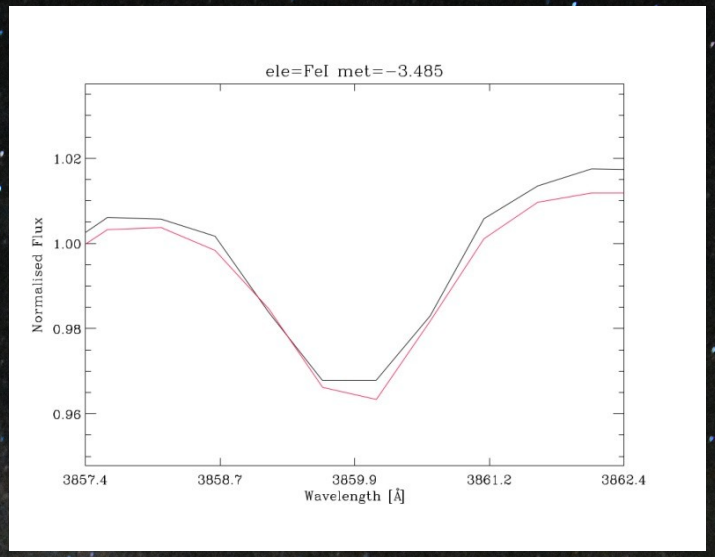
-14 observed LAMOST candidates

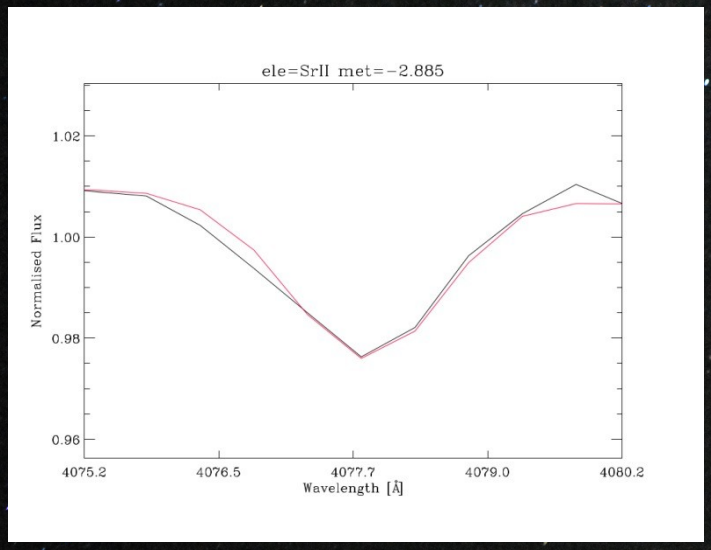
LRS2 at HET: LAMOST FOLLOW-UP

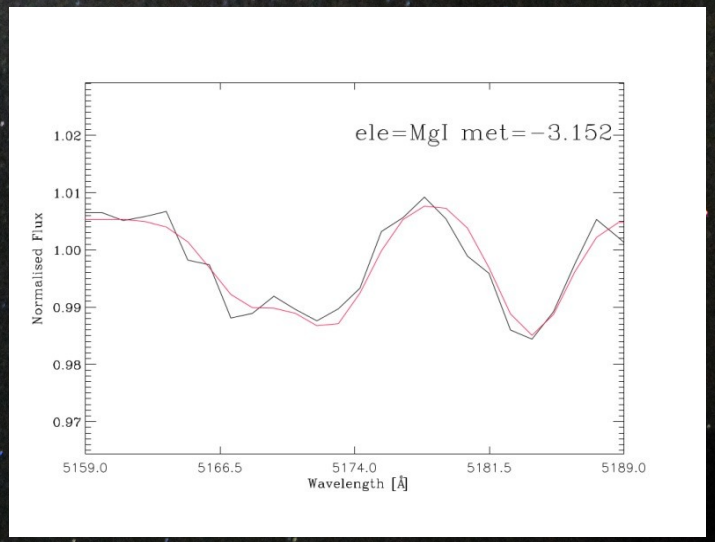


LRS2 at HET: LAMOST FOLLOW-UP









LRS2 at HET: LAMOST FOLLOW-UP

LRS2 at HET program: EMP candidates from LAMOST survey.

Table .1. Abundances for individual species.

Species	$\log \epsilon_{\odot}$ (X)	G64-12 [X/Fe]	L06-241 [X/Fe]	L15-114 [X/Fe]	L16-177 [X/Fe]	L16-196 [X/Fe]	L14-056 [X/Fe]	L16-061 [X/Fe]	L16-179 [X/Fe]	L16-233 [X/FE]
[Fe I/H]		−3.25(16)	−2.75(15)	−2.60(14)	−3.22(15)	−2.97(14)	−2.99(16)	−3.70(10)	−2.35(15)	−3.19(10)
CH	8.43	+0.98	−0.06	−1.00	+0.87	+0.04	+0.09	+1.53	−0.13	−0.31
Mg I	7.60	+0.50(3)	+0.77(3)	+0.63(3)	+0.45(3)	+0.28(3)	+0.55(3)	+0.50(3)	+0.38(3)	+0.17(3)
Si I	7.51	+0.12	+0.49	+0.31	+0.26	+0.13	+0.37	+0.32	–	−0.21
Ca I	6.34	+0.26	+0.48	+0.19	+0.07	+0.07	+0.32	–	+0.14	−0.11
Ca II	6.34	+0.57	+0.73	+0.71	+0.64	+0.67	+0.81	+0.53	+0.75	+0.14
Ti II	4.95	+0.80(2)	+0.81(2)	+0.84(2)	+0.75(2)	+0.74(2)	+0.92(2)	–	+0.59(2)	−0.02(1)
Sr II	2.87	+0.22(2)	−0.02(2)	+0.33(2)	+0.22(2)	+0.09(2)	−0.02(2)	–	−0.06(2)	–

Notes. In bracket number of detected lines

What we can offer to LAMOST community?

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-Crossing check LAMOST LSSPP stellar parameters using FERRE.

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-A catalogue of confirmed extremely/ultra metal-poor stars with reliable metallicity with ISIS.

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-Interesting UMP candidates from s/n~10 LAMOST spectra using LRS2 and/or ISIS.

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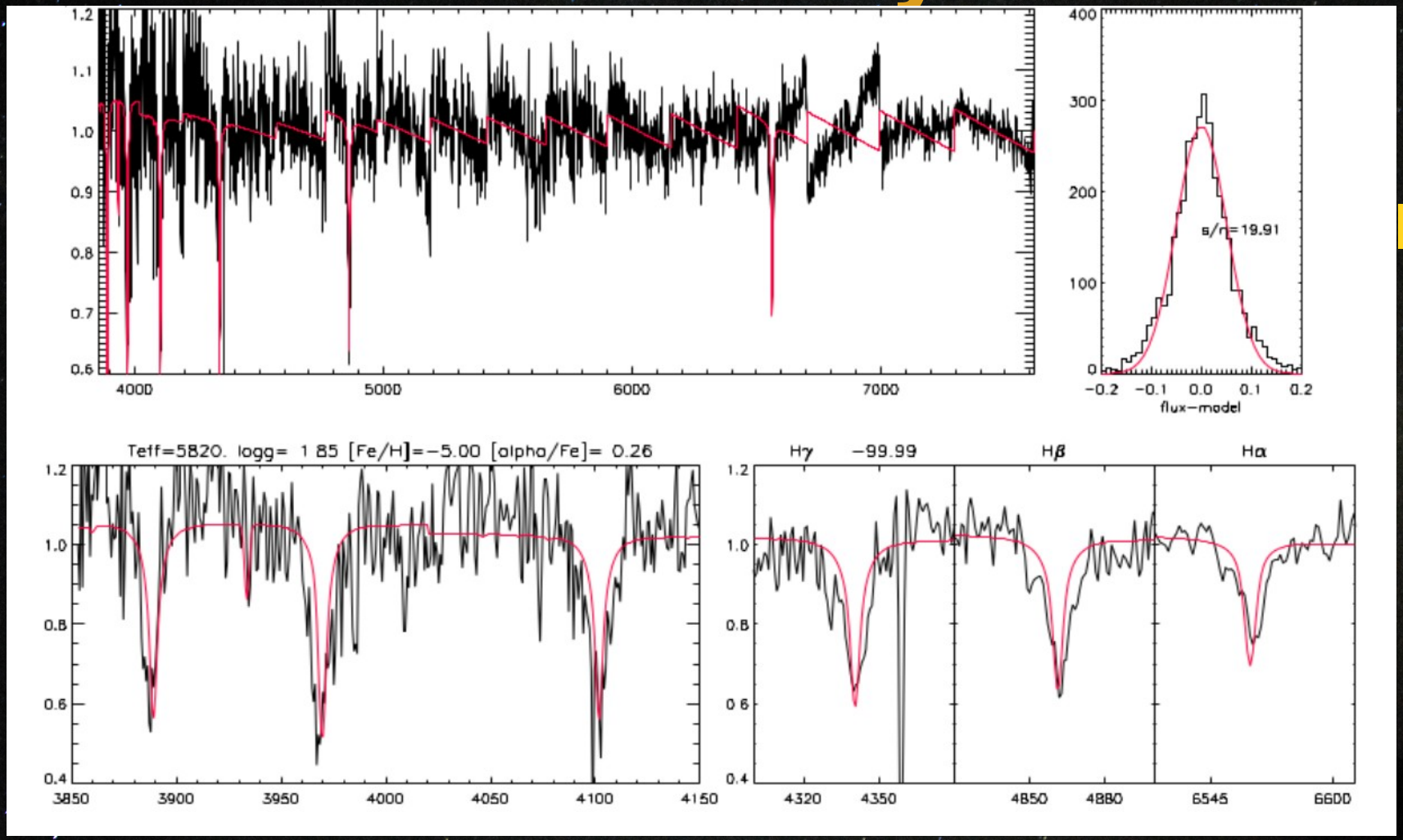
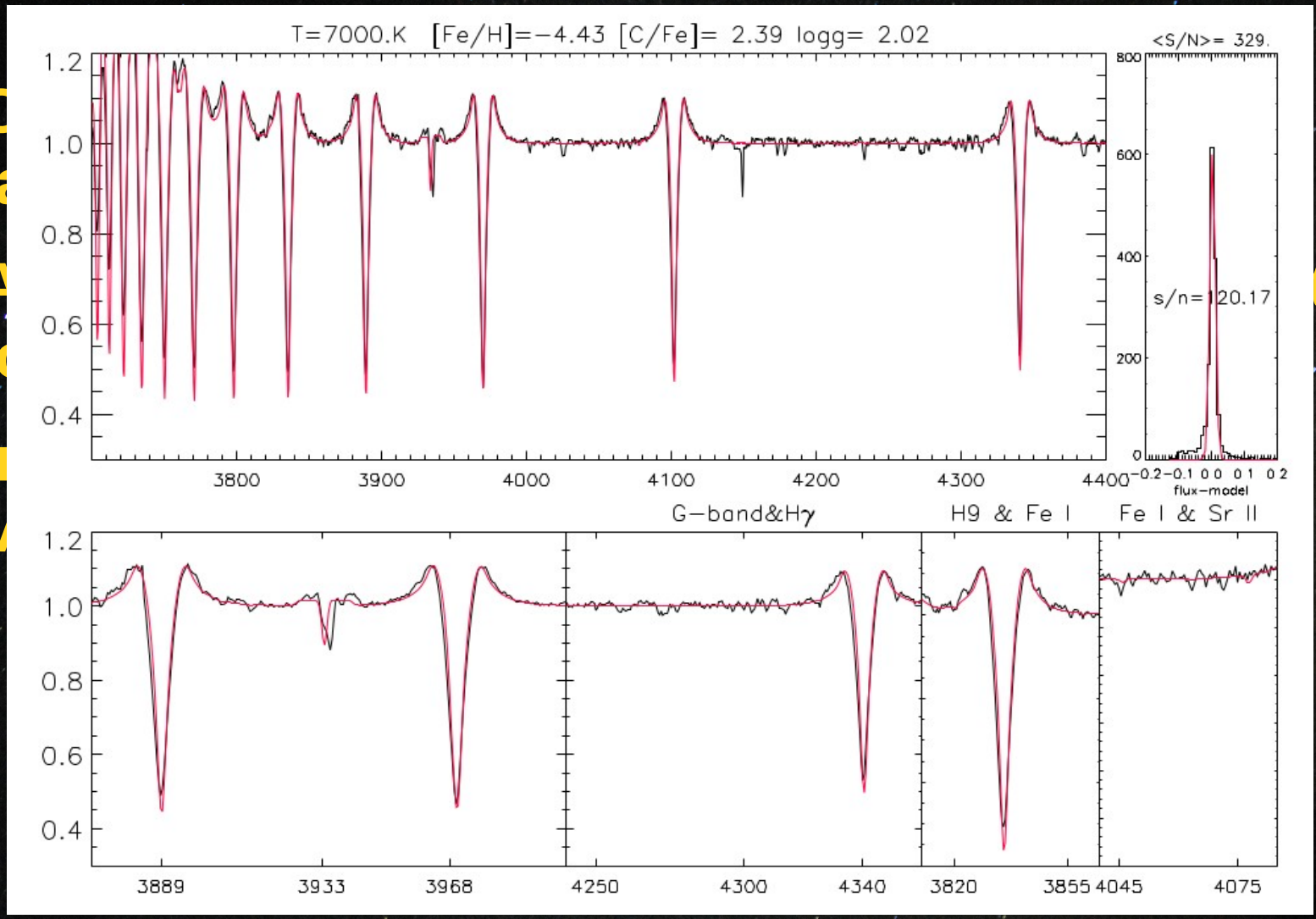


A HB star with [Fe/H]~-5??



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-Crossing check LAMOST SSPP stellar parameters using FERRE.

-A catalogue of confirmed extremely/ultra metal-poor stars with reliable metallicity using ISIS

-Interesting UMP candidates from s/n~10 LAMOST spectra.

-A first chemical abundance pattern of several alpha-elements, iron and strontium using LRS2 at HET.


THANKS!
ASPEN VALLEY