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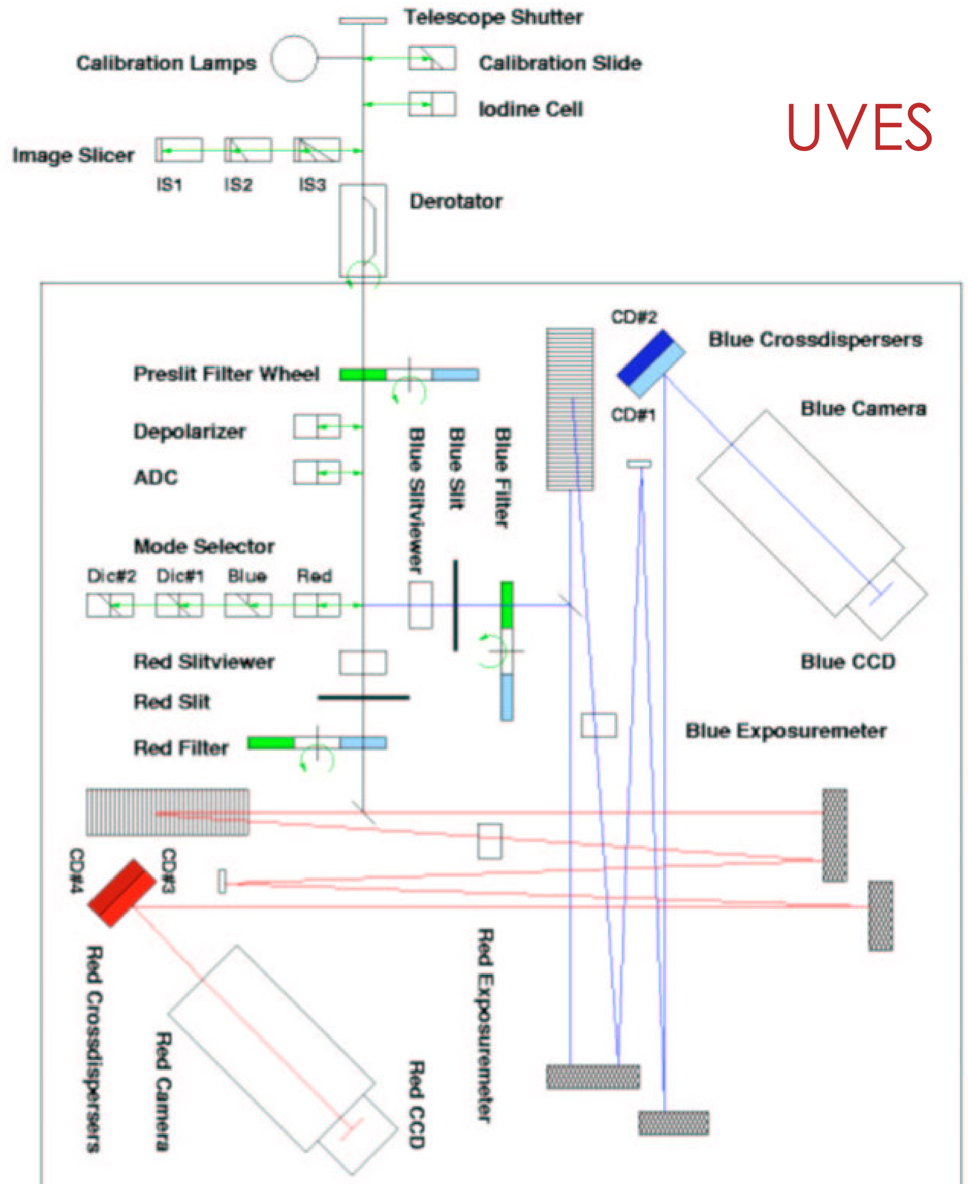
Mining solar-type stars with UVES

UVES



Telescope Shutter
Calibration Lamps
Calibration Slide
Iodine Cell
Image Slicer
IS1
IS2
IS3
Derotator
CD#2
Blue Crossdispersers
Preslit Filter Wheel
CD#1
Blue Camera
Depolarizer
ADC
Blue Slitviewer
Blue Slit
Blue Filter
Mode Selector
Dic#2
Dic#1
Blue
Red
Red Slitviewer
Blue CCD
Red Slit
Blue Exposuremeter
Red Filter
CD#4
CD#3
Red Crossdispersers
Red Camera
Red CCD
Red Exposuremeter

Table 1.1: UVES characteristics and observing capabilities

	Blue Arm	**Red Arm**
Wavelength range	300–500 nm	420–1100 nm
Resolving power-slit product **nm/pixel**	41,400 0.0019 nm at 450 nm	38,700 0.0025 nm at 600 nm
Max. Resolving power (2-pixel sampling)	~80,000	~110,000
Throughput at blaze (TEL+UVES, no slit, no atm.)	12% at 400 nm	14% at 600 nm
Limiting magnitude (90m exp. time, S/N=10, 0.7 arcsec slit,seeing 0.7)	18 R=58,000 at 360 nm	19.5 R=62,000 at 600 nm
CCDs	2048 × 4096 (windowed to 2048 × 3000)	two 2048 × 4096 (mosaic of different types)
Pixel (15μm) scale disp. dir. (varying along order) along slit (dep. on cross-disp.)	 0.215″ ± 20% 0.25"(CD1 and CD2)	 0.155″ ± 20% 0.18"(CD3),0.17 (CD4)
Echelle (R4 mosaic)	41.59 g/mm	31.6 g/mm
Cross dispersers Blaze wavelength Blaze wavelength	CD1: 1000 g/mm 430 nm CD2: 660 g/mm 460 nm	CD3: 600 g/mm 560 nm CD4: 312 g/mm 770 nm
Typ. wavel. cov. CD1 and CD3 (CD2 and CD4 in parenthesis)	85 (126) nm in 33 (31) orders	200 (403) nm in 37 (33) orders
Min. order separation (standard setup)	10 arcsec (40 pixels)	9 arcsec (51 pixels)

Table 2.3: Measured properties of UVES scientific CCDs

	Blue, EEV	Red Mosaic
Quantum efficiency	49% at 320 nm 56% at 350 nm 82% at 400 nm 88% at 500 nm	89% at 450 nm (EEV) 89% at 600 nm (EEV) 84% at 800 nm (MIT-LL) 64% at 900 nm (MIT-LL) 18% at 1000 nm (MIT-LL)
Number of pixels	2048×3000 (2048×4096, used in windowed readout)	4096×4096 (2048×4096 2×1 mosaic)
Pixel size	15 μm	15 μm
Gain (MIT-LL values in brackets)	low: 1.84 e^-/ADU high: 0.54 e^-/ADU	low: 1.5(1.4) e^-/ADU high: 0.52(0.46) e^-/ADU
Read-out noise fast read-out, low gain (slow read-out, high gain) Ultrafast readout, low gain	4.1 (2.1) e^- rms	EEV 4.2 (2.8) e^- rms MIT 3.7 (2.1) e^- rms EEV 4.3 e^- rms MIT 4.7 e^- rms
Saturation low gain (MIT-LL in brackets)	~65000 ADU	~65000 ADU (~65000 ADU)
Full frame readout (s) at 50 kpix, 2x2 bin at 225 kpix, unbinned at 625 kpix, unbinned	34 (1-port) 30 (1-port) 6.4 (2-ports)	45 (2-ports) 40 (2-ports) 10 (4-ports)
Dark current levels	0.4 e^-/pix/h at -120°C	EEV 0.5,MIT 1.5 e^-/pix/h at -120°C
Fringing amplitude at 850nm	-	EEV: up to 40% MIT: up to 10%
CTE	> 0.99993	> 0.99995
Read-out direction	in disp. dir.	in disp. dir.
Prescan, Overscan areas	Pix. 1-50 and 2098-2148	MIT: pix 40-50,2098-3008 EEV: pix 1-50,2098-2148
Flatness	$< 15\mu$m peak to peak	$< 60\mu$m peak to peak

Table 2.2: UVES echelle and cross-disperser gratings

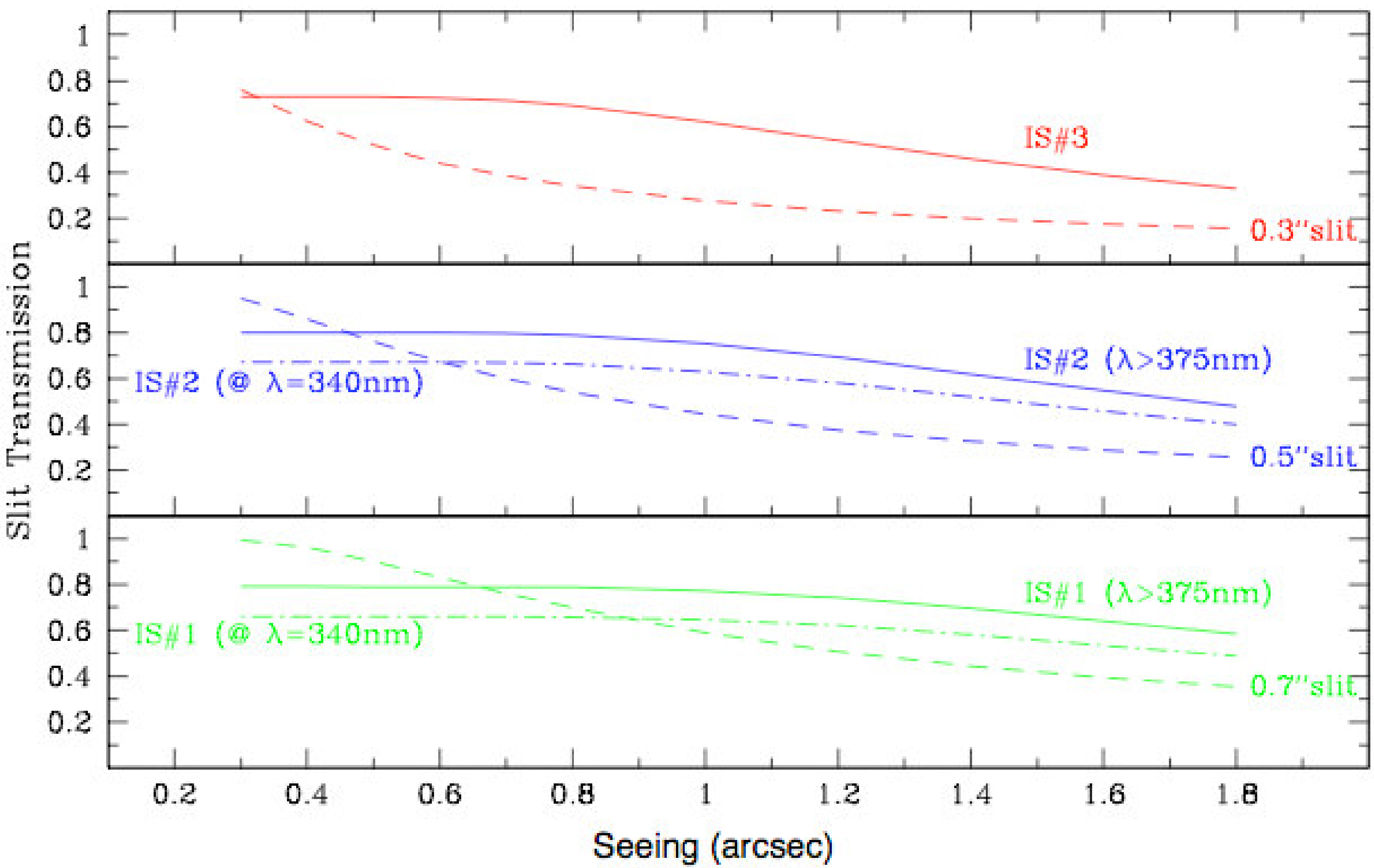
Echelle gratings					
	g/mm	Resolving Power	Spatial resolution	Blaze angle	Blaze Eff. (%)
Blue	41.59	1.900.000	$0.1''$	76.0°	67
Red	31.6	2.100.000	$0.09''$	75.04°	63

Cross-disperser gratings					
	g/mm	Wav. range (nm)	Average Eff. (%)	Wav of Peak Eff. (nm)	Blaze Eff. (%)
CD1-prot	1000	$300 - 390$	> 55	430	60
CD2	660	$370 - 500$	> 60	460	65
CD3	600	$420 - 680$	> 60	520	68
CD4	312	$660 - 1100$	> 70	770	80

UVES standard settings							
Mode	Cross Disp.	Below slit filter	Min. Wav.	Central Wav. (nm)	Max. Wav.	Decker Height	Gap (nm)
Using dichroic							
DIC1	CD#1	HER_5	303	**346**	388	10."	=
	CD#3	SHP700	476	**580**	684	12."	5
DIC1	CD#2	HER_5	326	**390**	445	8."	=
	CD#3	SHP700	458	**564**	668	11."	2
DIC1	CD#1	HER_5	303	**346**	388	10."	=
	CD#3	SHP700	458	**564**	668	11."	2
DIC1	CD#2	HER_5	326	**390**	445	8."	=
	CD#3	SHP700	476	**580**	684	12."	5
DIC2	CD#1	HER_5	303	**346**	388	10."	=
	CD#4	BK7_5	565	**760**	946	8."	7
DIC2	CD#2	HER_5	326	**390**	445	8."	=
	CD#4	BK7_5	565	**760**	946	8."	7
DIC2	CD#2	HER_5	373	**437**	499	10."	=
	CD#4	BK7_5	565	**760**	946	8."	7
DIC2	CD#2	HER_5	373	**437**	499	10."	=
	CD#4	OG590	660	**860**	1060	12."	10
DIC2	CD#1	HER_5	303	**346**	388	10."	=
	CD#4	OG590	660	**860**	1060	12."	10
DIC2	CD#2	HER_5	326	**390**	445	8."	=
	CD#4	OG590	660	**860**	1060	12."	10
Using blue arm only							
BLUE	CD#1	HER_5	303	**346**	388	10."	=
BLUE	CD#2	HER_5	373	**437**	499	10."	=
Using red arm only							
RED	CD#3	SHP700	414	**520**	621	8.9"	1
RED	CD#3	SHP700	476	**580**	684	12."	5
RED	CD#3	SHP700	500	**600**	705	12."	5
RED	CD#4	OG590	660	**860**	1060	12."	10

Table 2.1: UVES image slicers

Slicer number	Entrance Opening	Slit width	Slit length	Number of slices	Resolving power	Efficiency [%]
1	2.1″ × 2.6″	0.68″	7.9″	3	∼ 60,000	70 @ 350, 78 @ 450, 80 > 650 nm
2	1.8″ × 2″	0.44″	7.9″	4	∼ 75,000	73 @ 350, 82 @ 450, 83 > 500 nm
3	1.5″ × 2″	0.30″	10.0″	5	∼ 110,000	73 @ 400 − 1000 nm



Fringing Problem

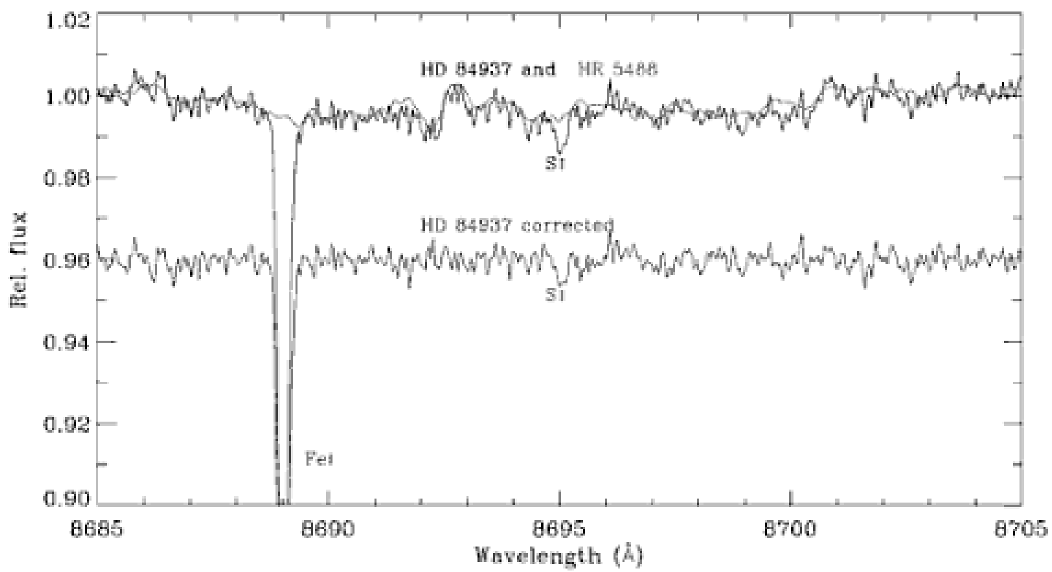


Fig. 1. Residual fringing problem in a UVES spectrum of the metal-poor turnoff star HD 84937 around the S I line at 8695 Å [15]. After flat-fielding, the extracted spectrum of HD 84937 has residual fringes with an amplitude of about ±0.5%. A 5-pixel smoothed spectrum of the B2III star HR 5488 observed in the same way as HD 84937 is overplotted. Below is the spectrum of HD 84937 (shifted to a continuum level of 0.96) after division with the spectrum of HR 5488

P. Nissen ESO Conf. Proc. (2005)

Fringing Problem

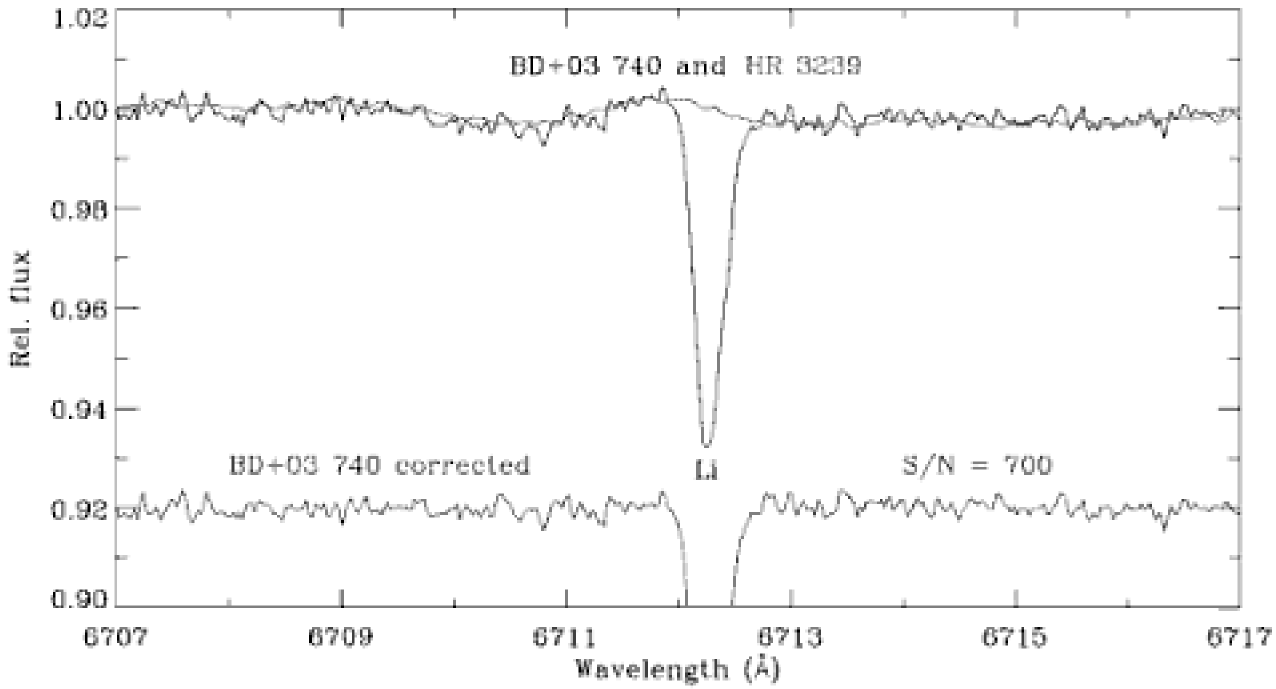
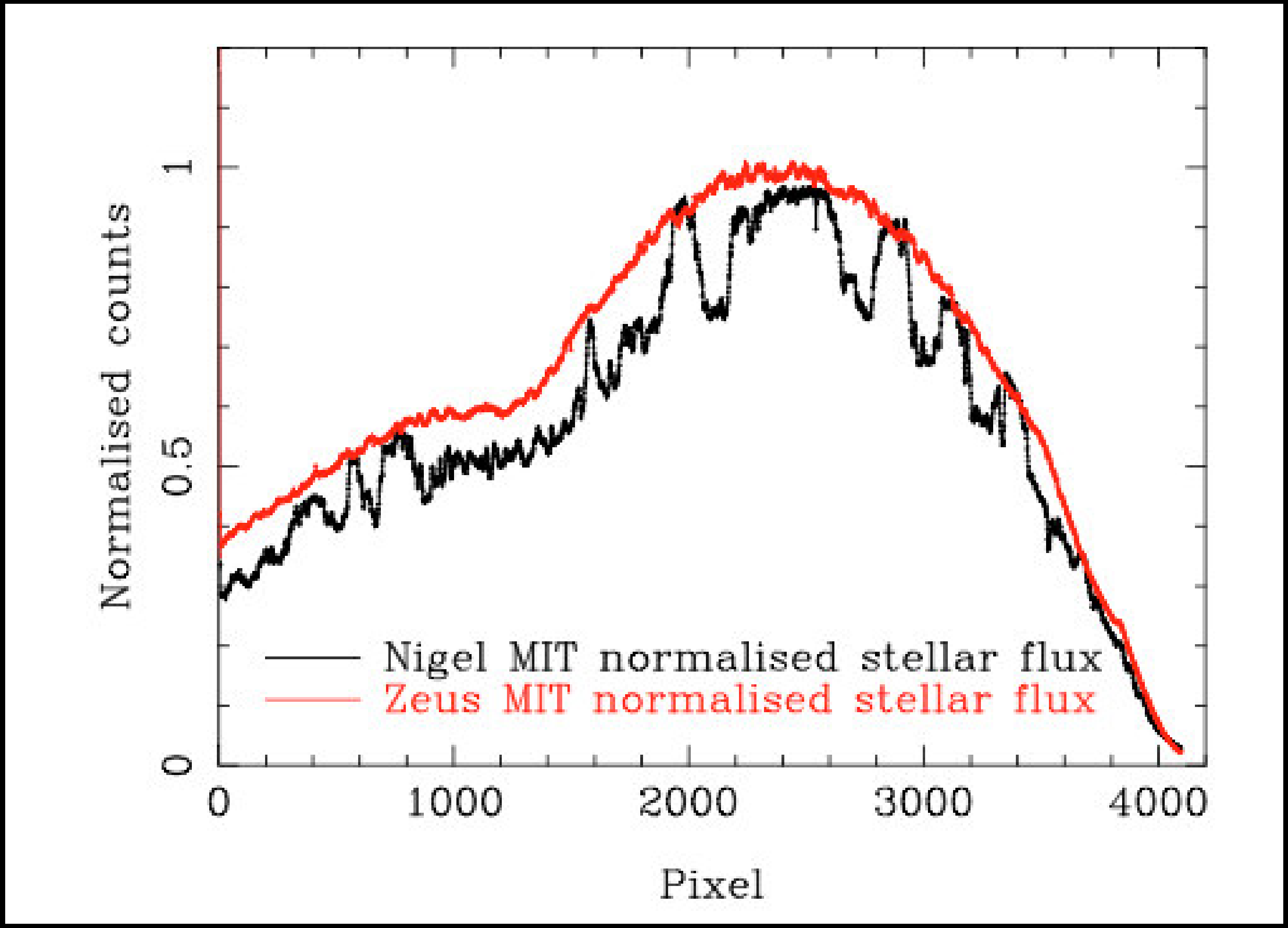


Fig. 2. Residual fringing problem in a UVES spectrum of the metal-poor turnoff star BD +03 740. After division with a 5-pixel smoothed spectrum of the B1.5V star HR 3239 observed on the same night as BD +03 740, a corrected spectrum (shifted to a continuum level of 0.92) is obtained. Note that the Li line in BD +03 740 is radial-velocity shifted by $+200\,\mathrm{km\,s^{-1}}$

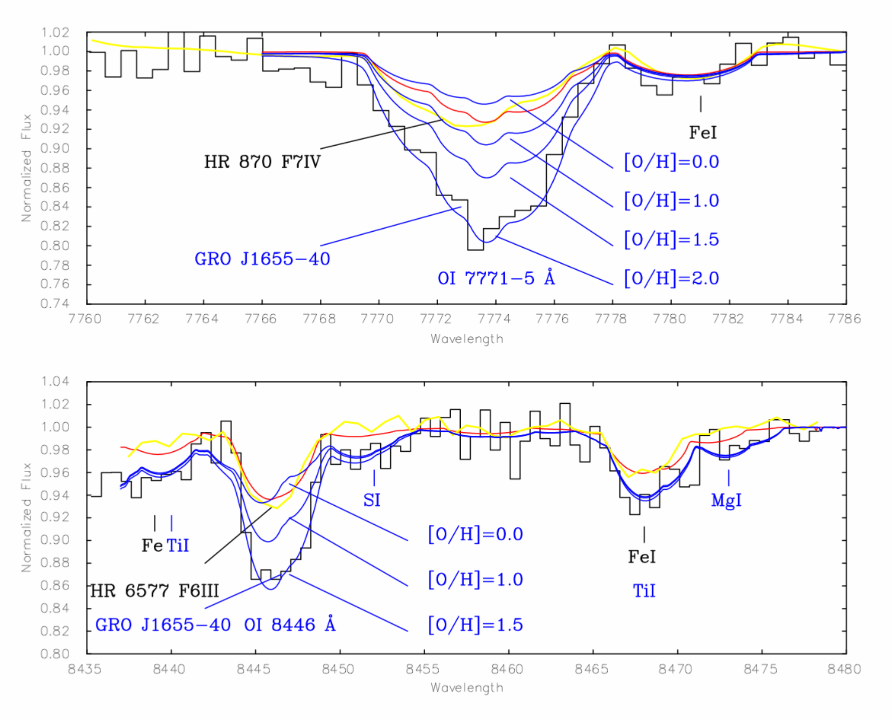
P. Nissen ESO Conf. Proc. (2005)



Normalised counts
0
0.5
1
0
1000
2000
3000
4000
Pixel
Nigel MIT normalised stellar flux
Zeus MIT normalised stellar flux

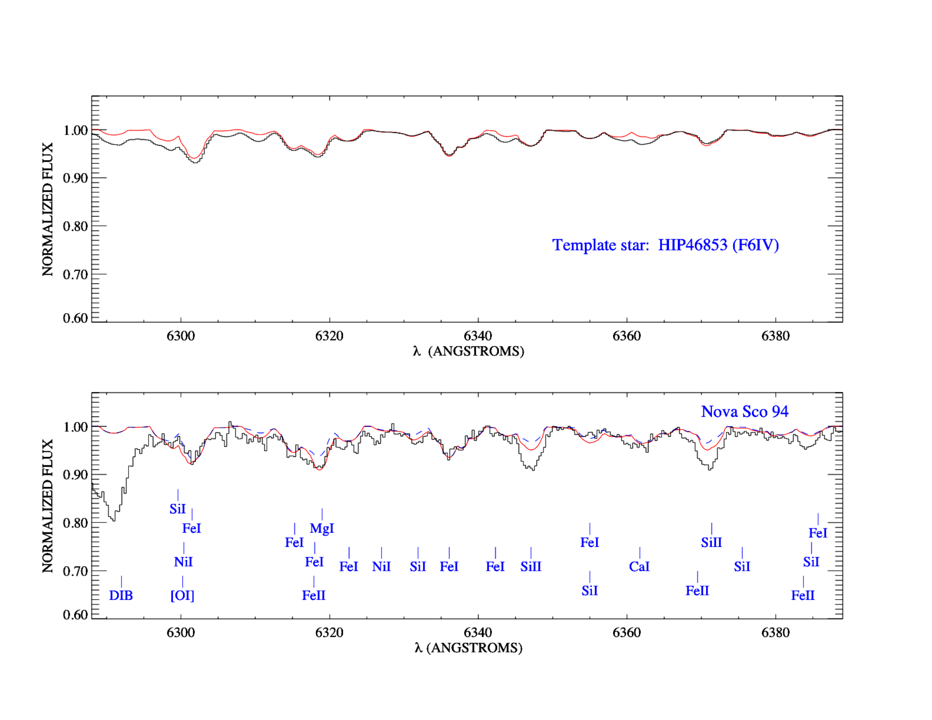
These stars in black hole double star systems were "polluted" by products of Supernova explosion !

Nova Sco 1994: Keck/HIRES



Israelian et al. , *Nature,* 1999

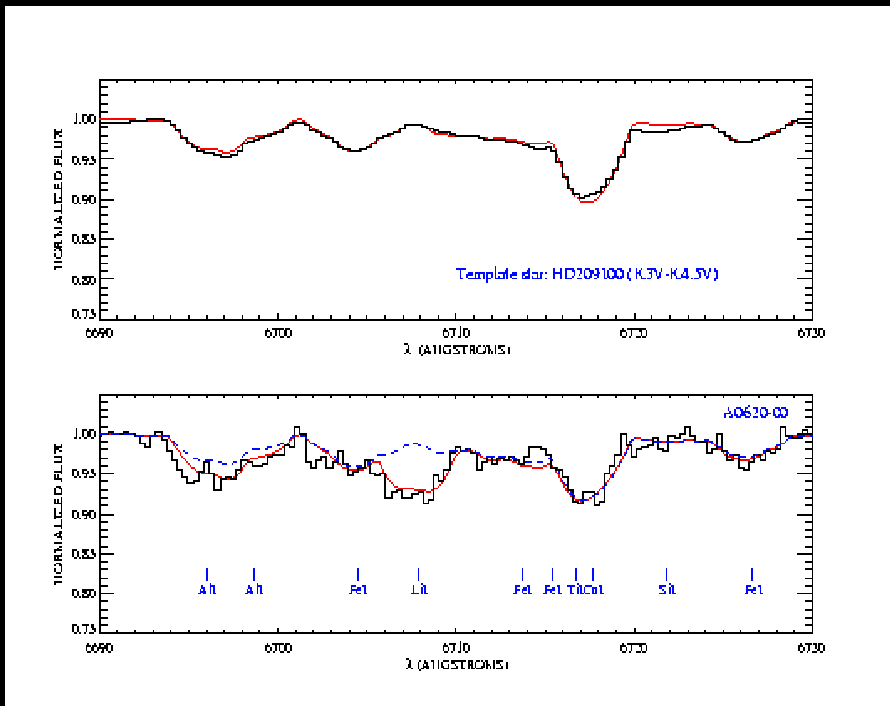
Nova Sco 1994: VLT/UVES

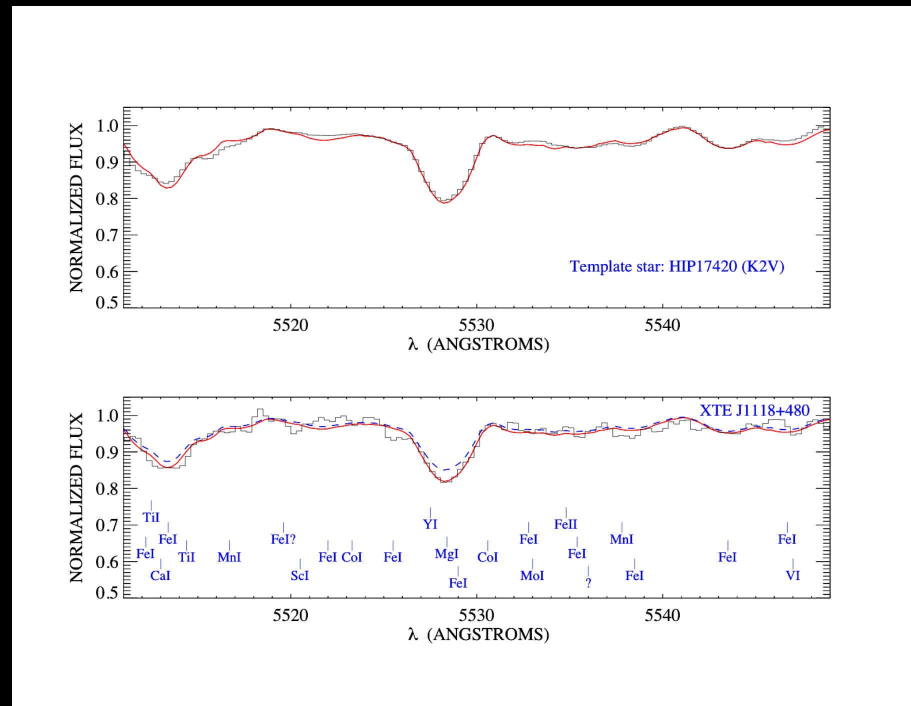


Gonzalez Hernandez et al. A&A, 2008

A0620-00 VLT/UVES

XTEJ1118+480 Keck/HIRES

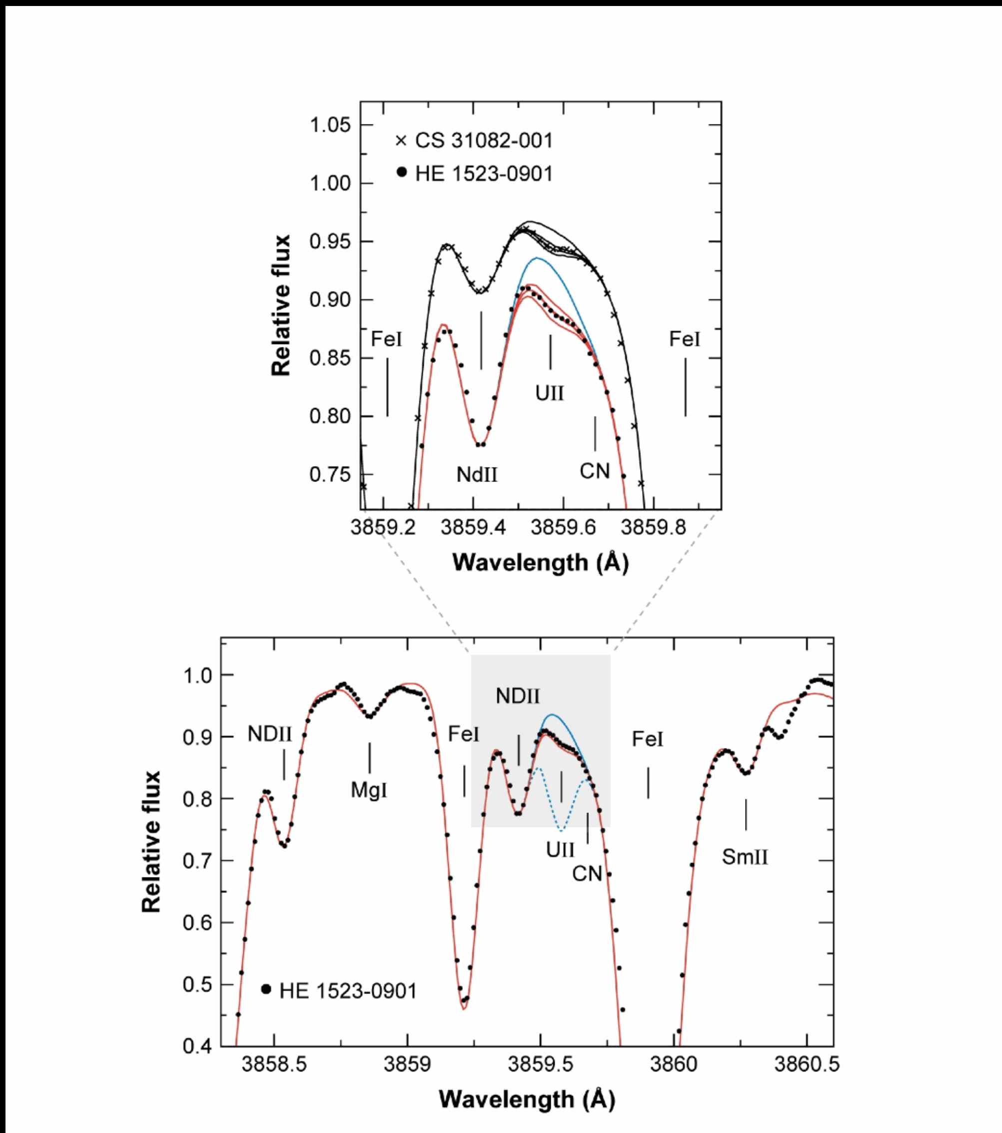




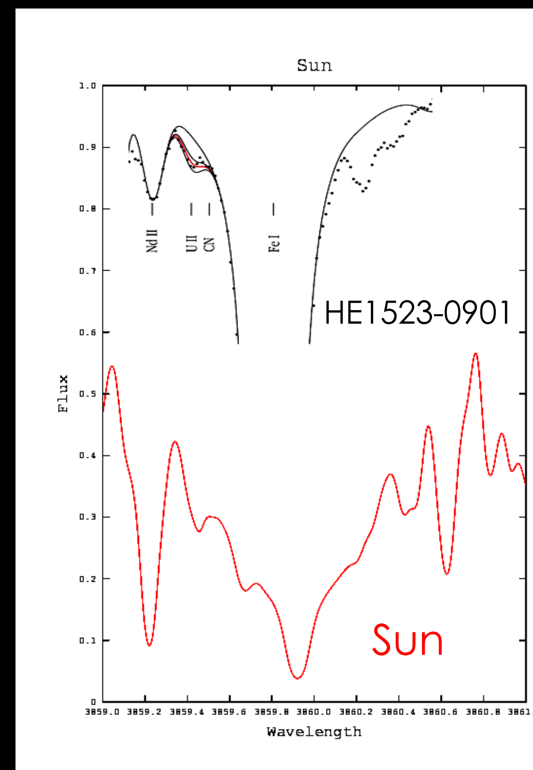
Gonzalez Hernandez et al. A&A, 2005

Gonzalez Hernandez et al. ApJ 2008

First detection of Uranium

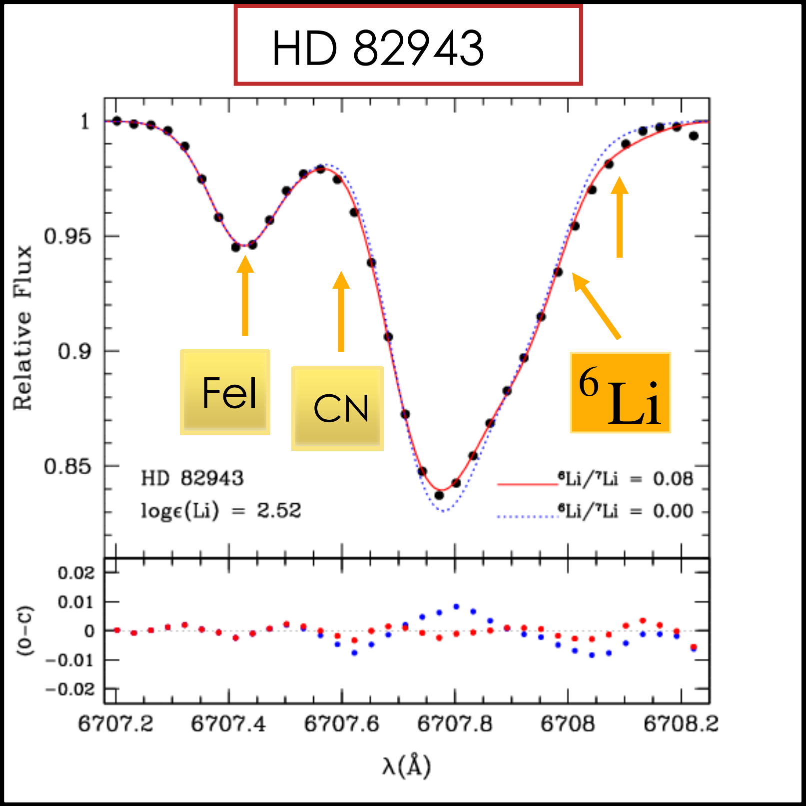


Uranium cannot be measured in the Sun



Cayrel et al. *Nature*, 2001

Li^6 in solar-type stars

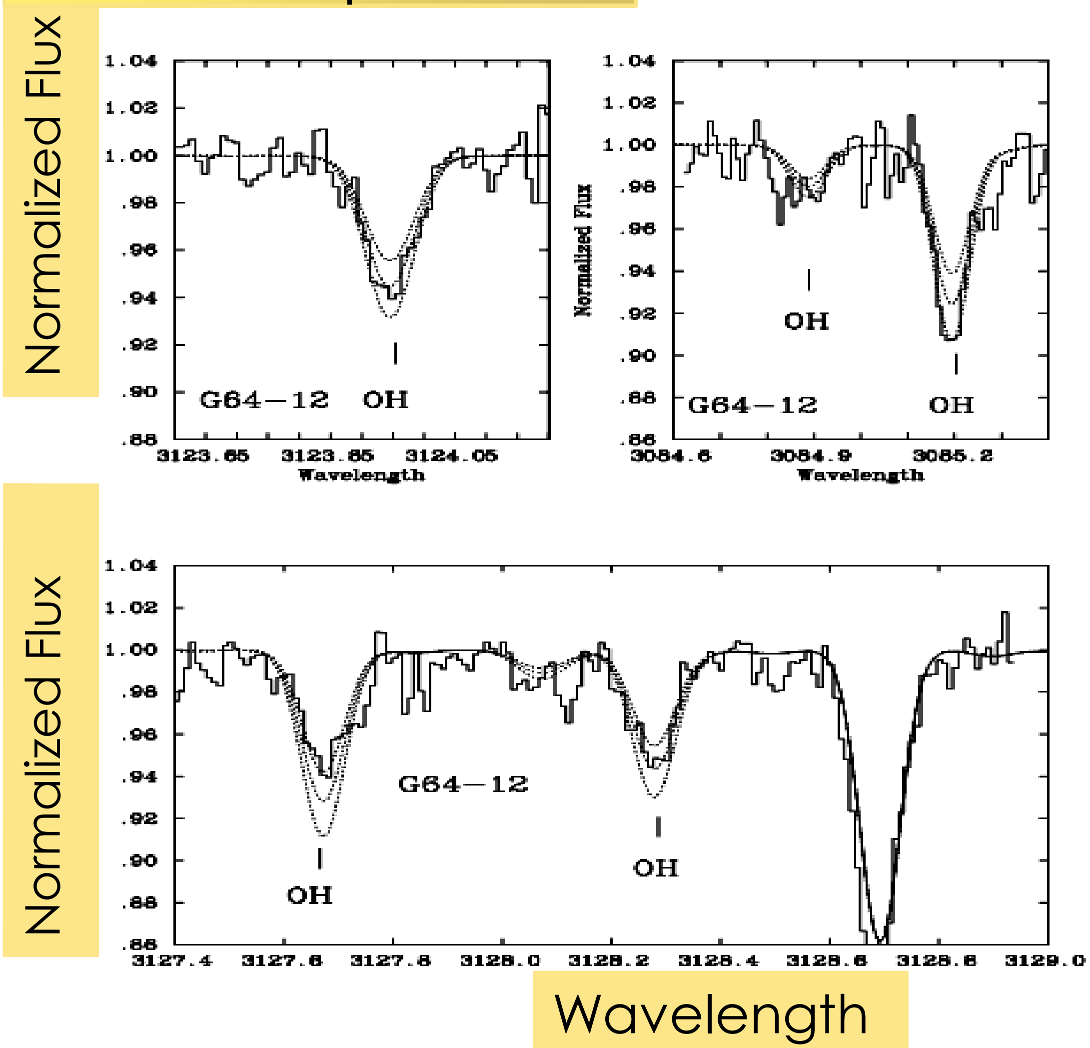


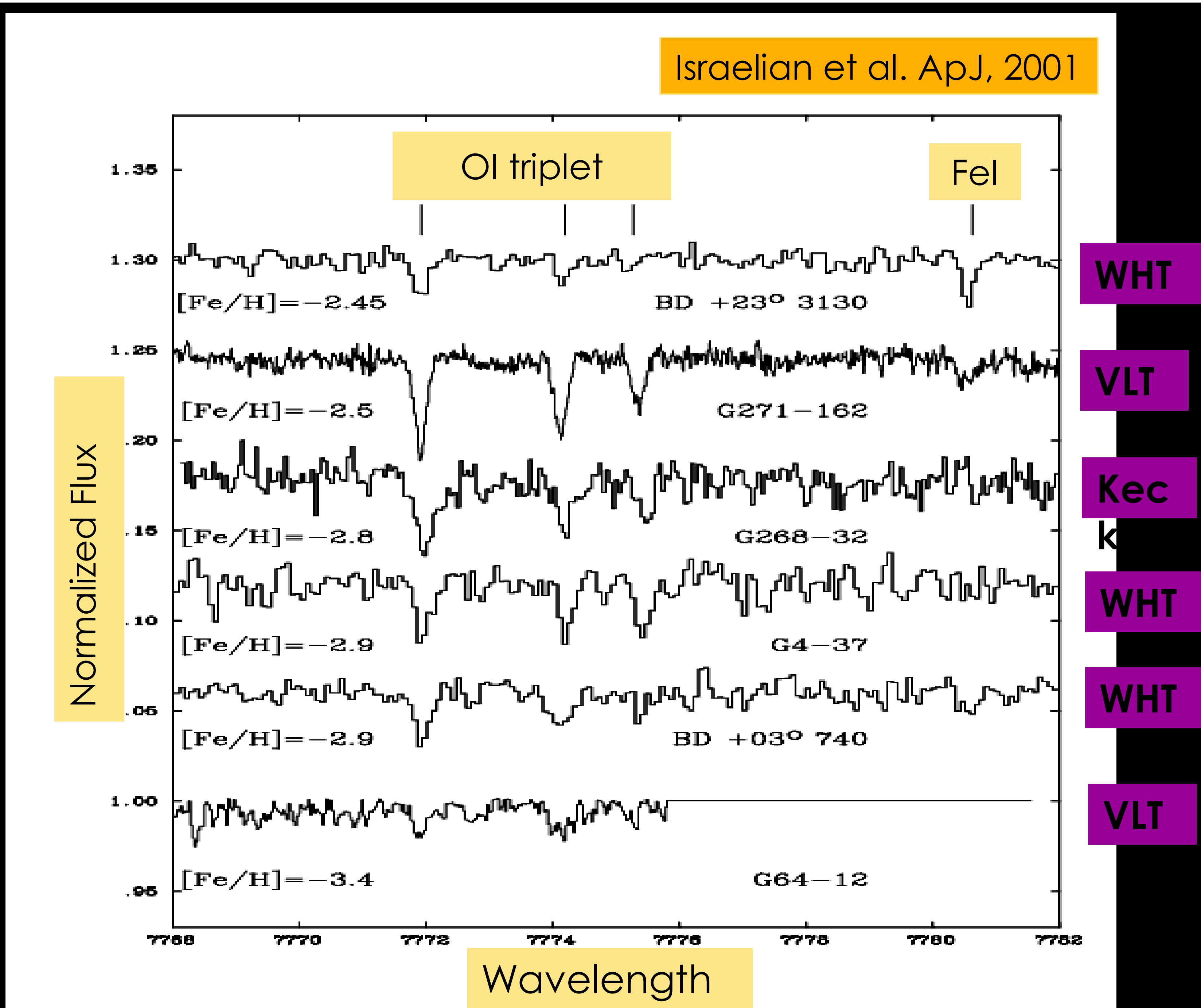
Israelian et al. *Nature*, 2001

Oxygen in ultra metal-poor dwarfs

VLT/UVES: t_{exp} ~ 6 hours

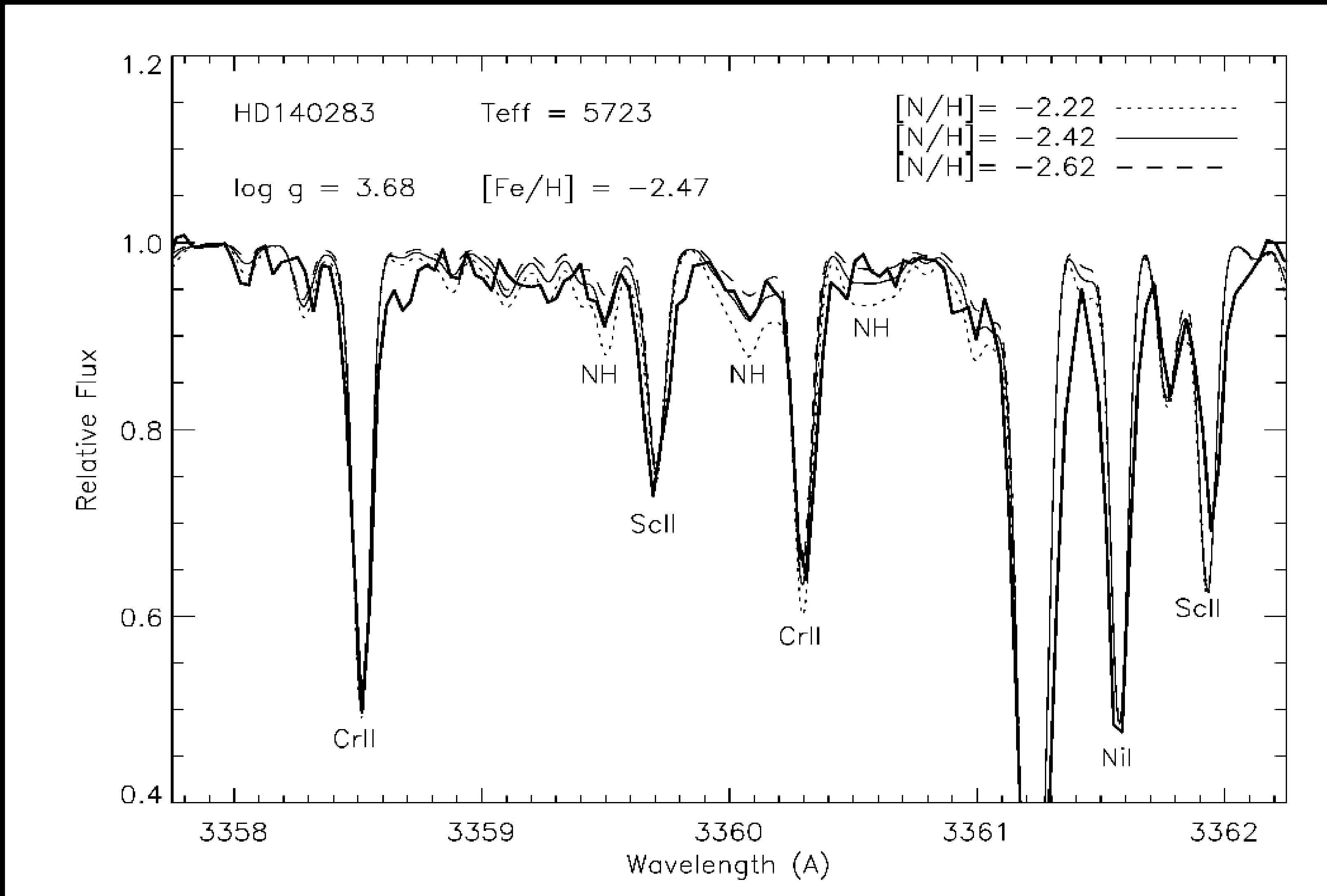
Israelian et al. ApJ, 2001





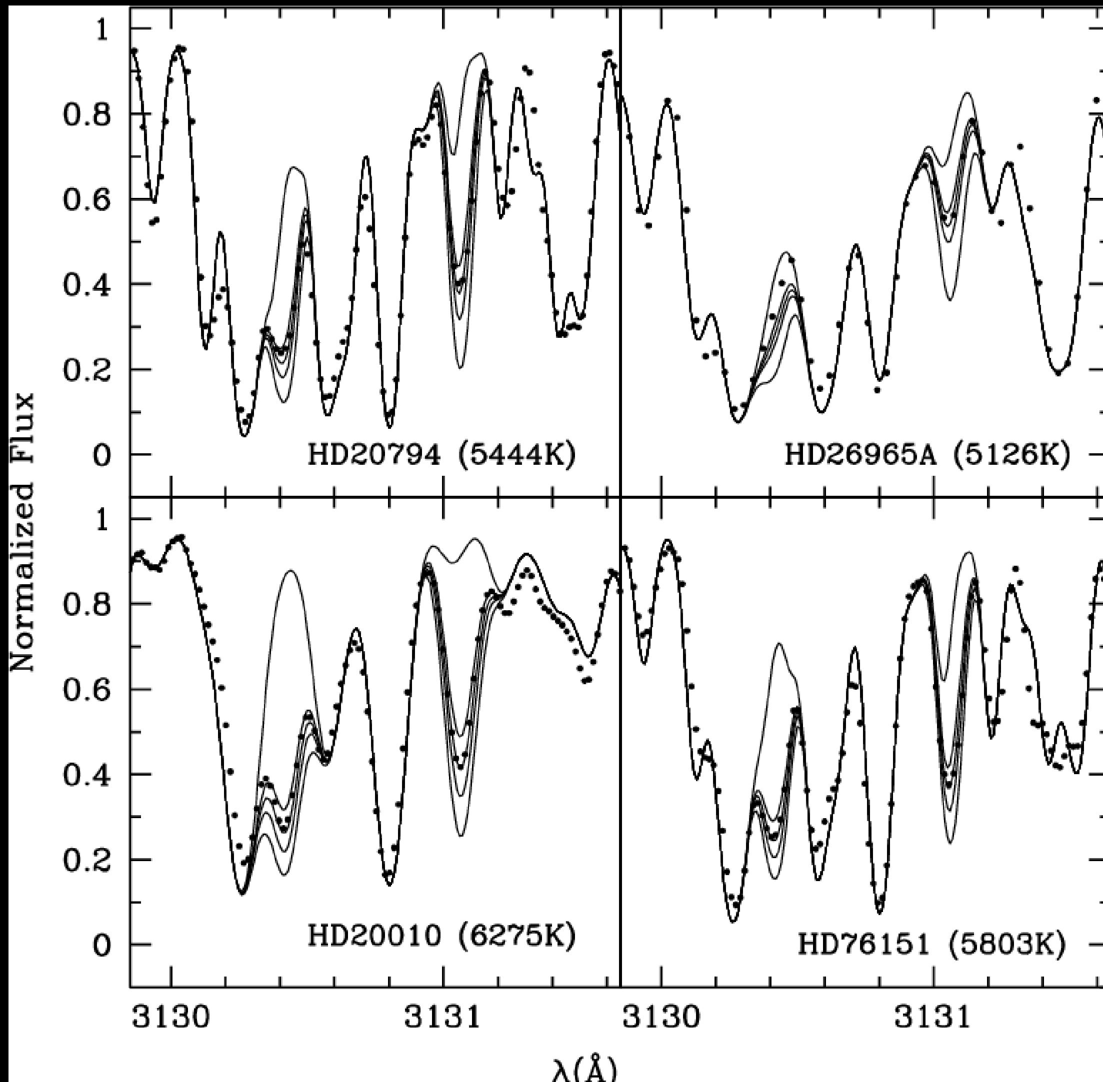
Israelian et al. ApJ, 2001
OI triplet
FeI
Normalized Flux
Wavelength
1.35
1.30
1.25
.20
.15
.10
.05
1.00
.95
7768
7770
7772
7774
7776
7778
7780
7782
[Fe/H]=−2.45
BD +23° 3130
[Fe/H]=−2.5
G271−162
[Fe/H]=−2.8
G268−32
[Fe/H]=−2.9
G4−37
[Fe/H]=−2.9
BD +03° 740
[Fe/H]=−3.4
G64−12
WHT
VLT
Kec
k
WHT
WHT
VLT

Primary Nitrogen in metal poor dwarfs

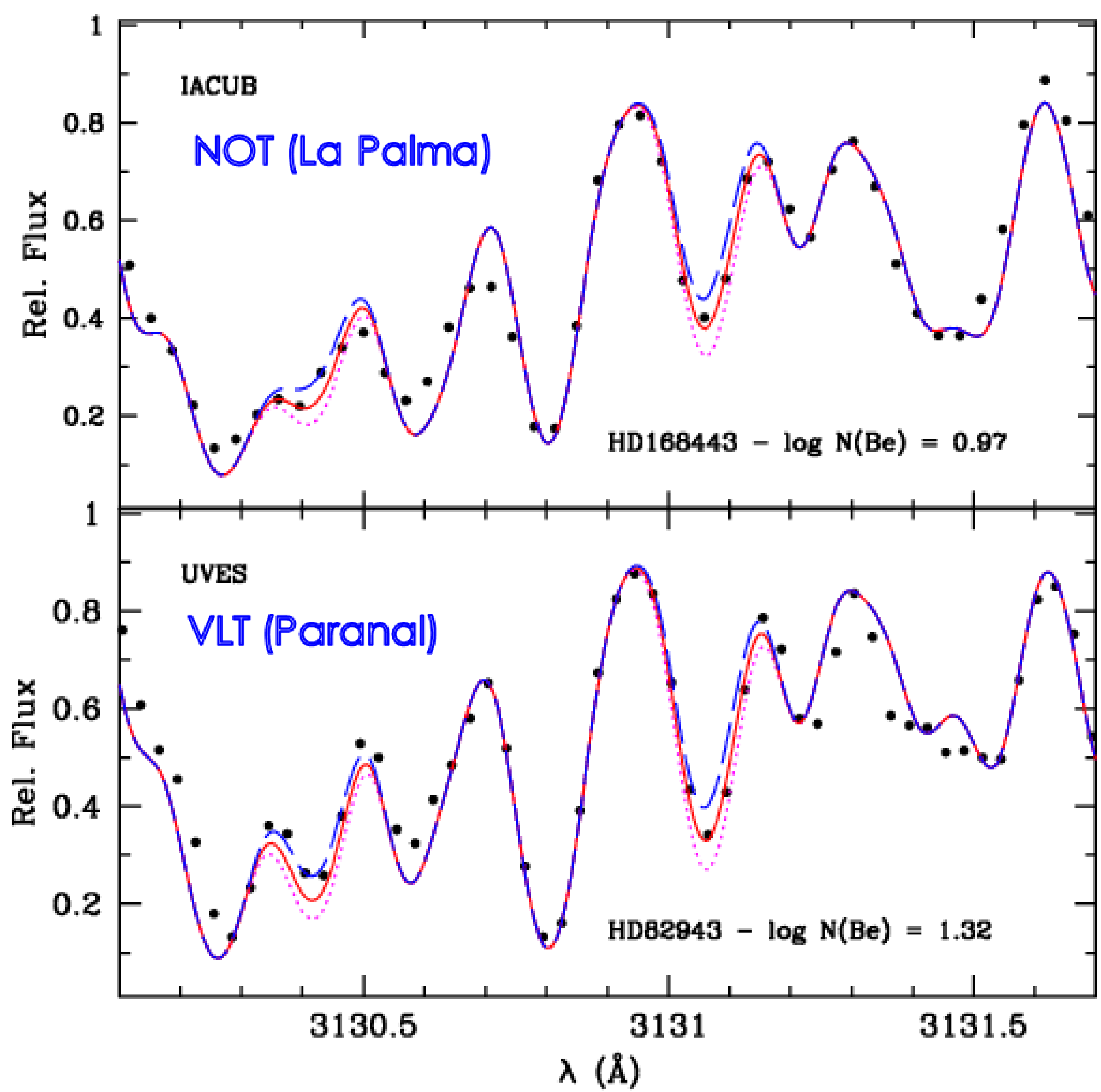


Israelian et al. A&A 2004

Be in stars with exoplanets

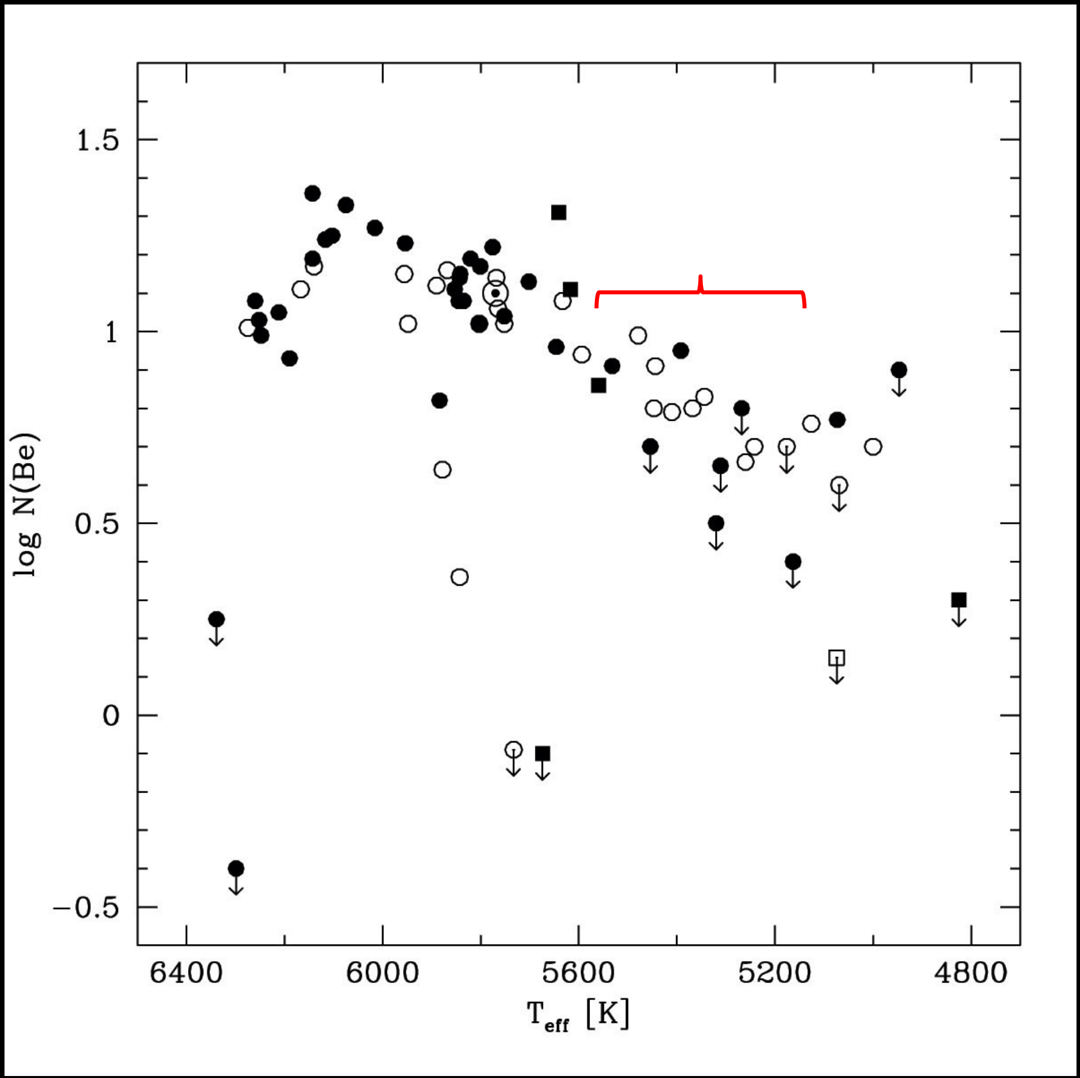


Santos et al. *A&A* 2002, 2004



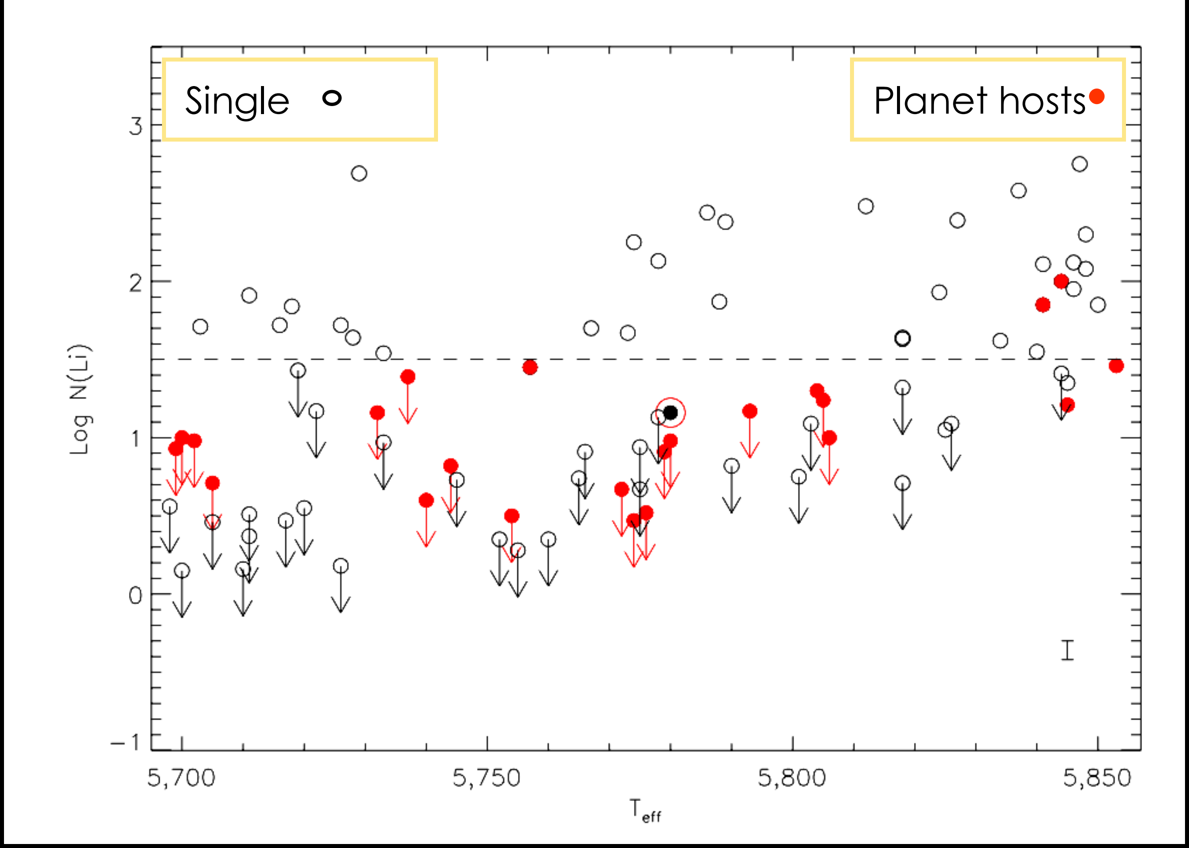
IACUB
NOT (La Palma)
HD168443 – log N(Be) = 0.97
UVES
VLT (Paranal)
HD82943 – log N(Be) = 1.32
Rel. Flux
λ (Å)
3130.5
3131
3131.5

Be in stars with exoplanets



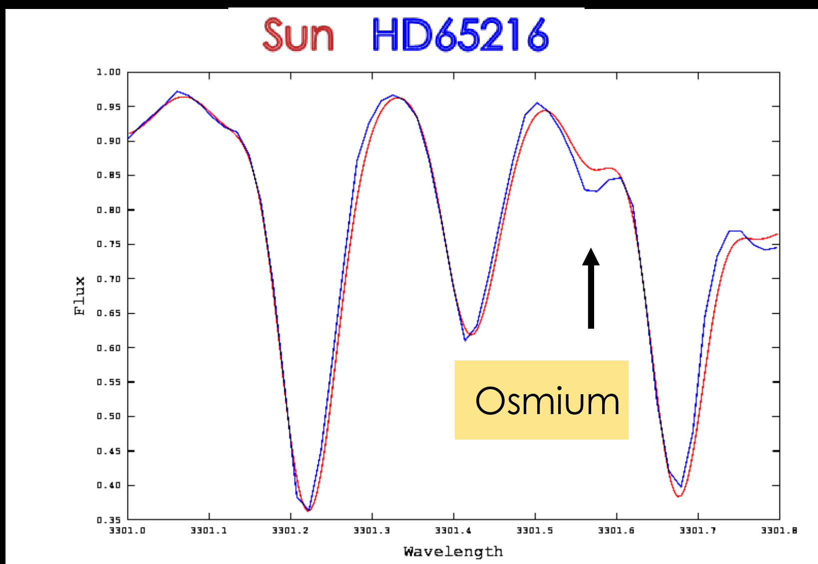
Santos et al. *A&A* 2004

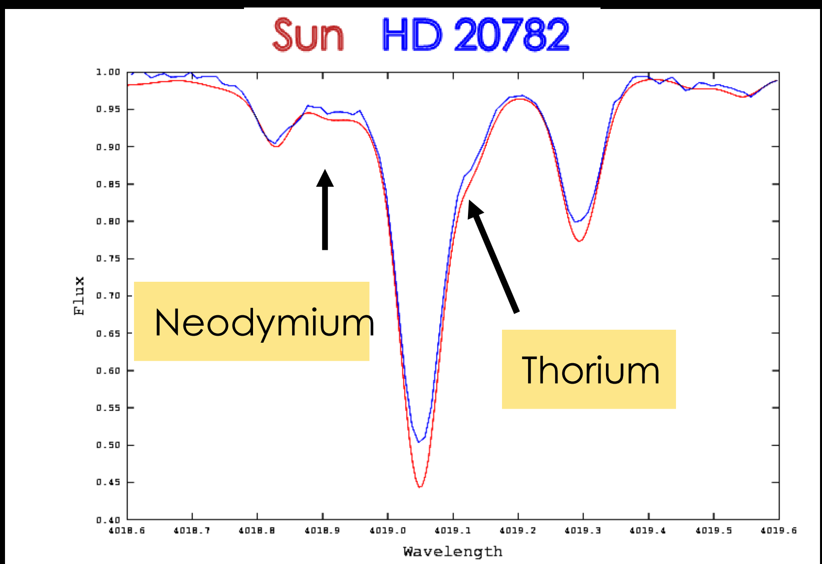
Li in stars with exoplanets



Israelian et al. *Nature* (in press, 2009)

Heavy elements in stars with exoplanets





Work in progress

[redacted]