CENTRO DE ASTROBIOLOGÍA
Laboratorio de Astrofísica Estelar y Exoplanetas

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Spectroscopic observations of WTS planet-host candidates

under supervision of: David Barrado

RoPACS – 2nd end of year network workshop, Lisbon, September 8th 2010

Aims

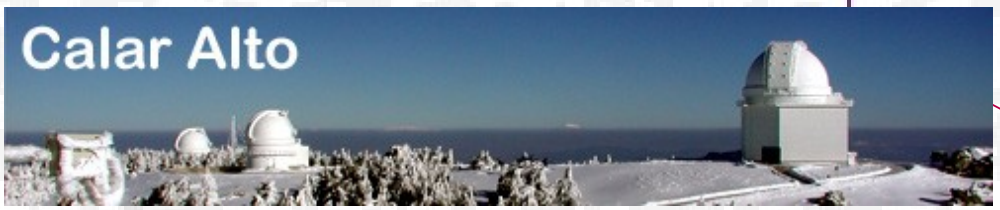
Spectroscopic follow-up of the most exciting candidates:

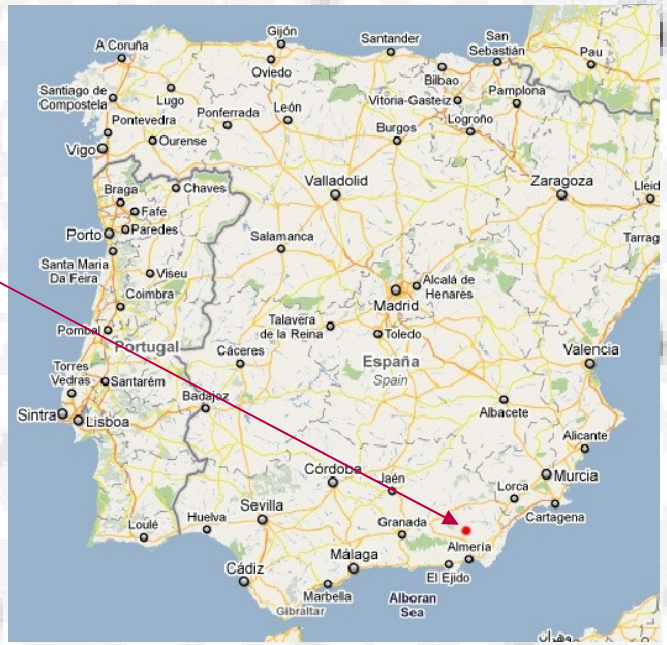
- Phase I: classify the spectral type;
- Phase II: estimate radial velocity variations with ~km/s-precision:

  establish the real planet-transit systems

  identify and solve the lowest-mass stellar/substellar binaries

Calar Alto Observatory





- German-Spanish Astronomical Centre (CAHA)
- Sierra de los Filambres, Andalucía, Southern Spain
- 3 telescopes: 1.23m, 2.2m and 3.5m

Fase I – June 19-21

- 3 nights at 3.5m telescope
- 24 candidates of 19.5h field
- I-mag between 14 and 19

- TWIN spectrograph:

  low-resolution: R ~ 2000 (1.63 Å/pix)

  wavelength range: 5673-8922 Å

- Goal :

  derive the spectral types of the targets

3.5m telescope

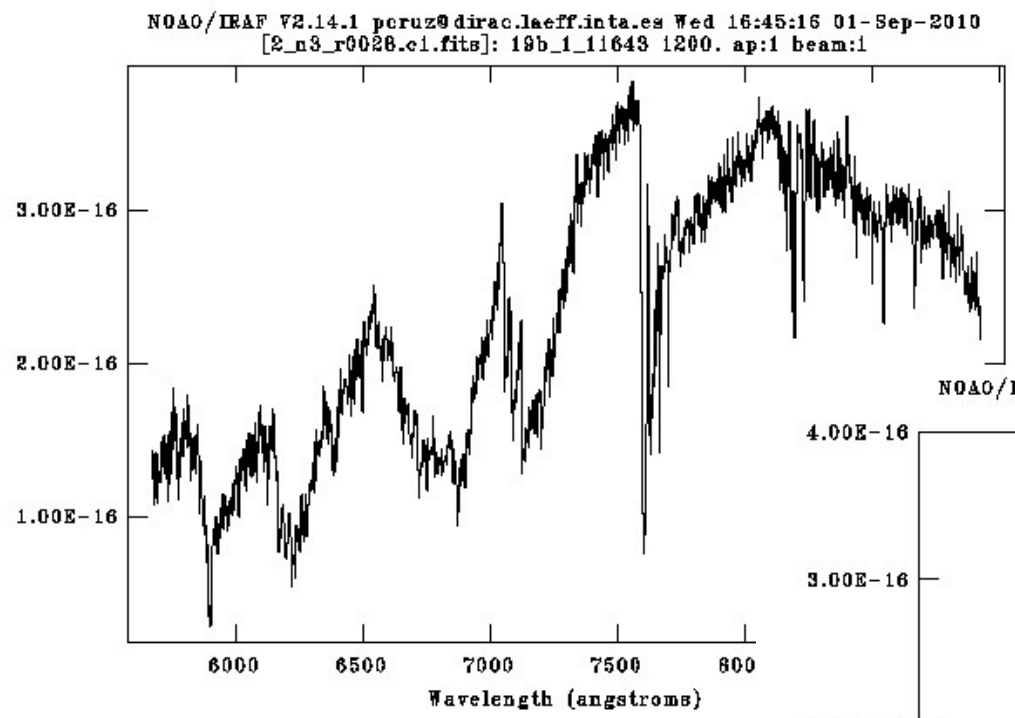
Fase I – June 19-21

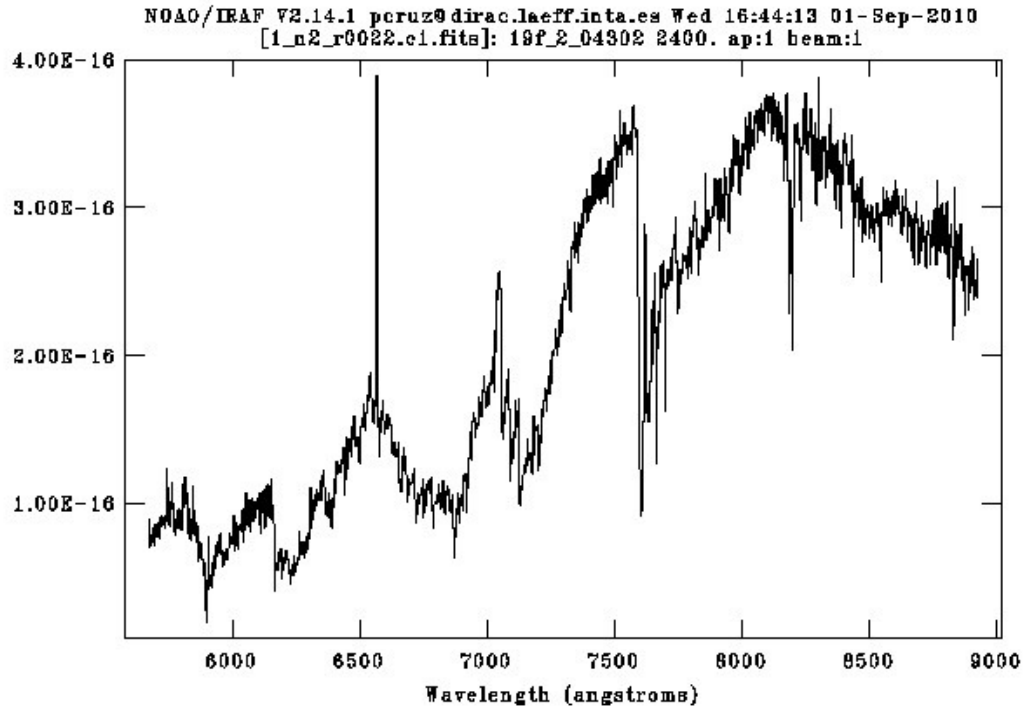
Observing log

Object	RA	Dec	Exp. Time	Date	I mag	SNR
19a_1_03509	19:30:47.84	36:22:38.95	1800	2010-06-19	16.61	28.70
19a_1_07679	19:30:22.57	36:27:22.58	900	2010-06-19	14.98	31.34
19a_4_07025	19:30:44.27	36:51:48.63	600	2010-06-20	15.02	23.95
19b_1_11643	19:31:10.07	36:25:40.36	1200	2010-06-20	17.02	25.08
19b_3_12432	19:34:22.82	36:53:37.25	600	2010-06-20	15.45	22.77
19c_1_09991	19:34:46.14	36:19:10.53	600	2010-06-20	14.40	21.84
19c_2_07252	19:36:54.91	36:23:31.50	600	2010-06-20	15.35	35.16
19d_2_12626	19:38:27.61	36:18:51.23	1800	2010-06-19	16.16	27.96
19d_3_00550	19:37:43.46	36:44:14.25	600	2010-06-19	14.07	34.16
19e_2_02883	19:33:18.75	36:14:28.72	1800	2010-06-21	17.64	14.90
19e_2_05273	19:32:33.27	36:12:35.13	600	2010-06-21	14.77	25.40
19e_2_07143	19:32:19.04	36:10:53.77	800	2010-06-21	15.45	23.87
19e_2_07873	19:32:51.50	36:10:23.27	300	2010-06-21	13.64	32.99
19e_2_15829	19:32:45.43	36:04:11.62	2400	2010-06-21	18.24	23.51
19f_1_01229	19:32:08.55	36:03:36.04	600	2010-06-19	14.85	28.29
19f_1_06048	19:31:41.90	36:15:58.96	600	2010-06-19	14.40	29.14
19f_2_02883	19:33:48.41	36:13:51.45	600	2010-06-19	13.92	31.73
19f_2_04302	19:33:29.39	36:12:13.75	2400	2010-06-19	17.23	23.26
19f_2_04637	19:33:25.50	36:11:50.53	2400	2010-06-19	16.89	28.98
19f_2_05453	19:33:45.08	36:10:56.58	1800	2010-06-19	16.07	43.77
19f_2_05853	19:33:55.44	36:10:33.65	600	2010-06-21	16.40	25.74
19f_2_11738	19:33:43.85	36:04:12.98	1800	2010-06-20	16.87	17.58
19f_4_05585	19:31:41.03	36:35:50.21	600	2010-06-19	13.74	29.80
19f_4_06903	19:31:06.52	36:37:19.22	600	2010-06-21	15.38	27.23

Fase I – June 19-21

Spectra





19b_1_11643

19f_2_04302

Process:

- flat-fielding and bias;
- extraction: 1D spectra;
- wavelength calibration and instrumental response correction.

Spectral Typing

VOSA: VO Sed Analyzer is a tool designed to perform several tasks in an automatic manner, based on Virtual Observatory standards (Bayo et al. 2008).

- Photometrical catalogs accessible through VO services, and theoretical models (spectra) used to calculate a synthetic photometry.
- Input: photometry-table (SDSS, 2MASS, and UKIDSS).

http://svo.cab.inta-csic.es/svo/theory/vosa/

The Hammer: is a spectral typing algorithm designed to classify spectra, for the MK spectral sequence (Covey et al. 2007).

- One can perform a visual comparison with a set of templates.
- Input: FITS files.

https://www.cfa.harvard.edu/~kcovey/thehammer.html

Spectral Typing

VOSA

Sessions | Files | Coordinates | VO Phot. | Objects | Model Fit | Template fit | HR Diag. | Save Results | Help | Logout

Stars and brown dwarfs (Change) **Session:** (info) (Change) **File: 6th** (info) (Change)

Model fit

Bestfit
19a_1_03509
19a_1_07679
19a_2_03515
19a_4_07025
19b_1_11643
19b_3_12432
19c_1_09991
19c_2_07252
19d_2_12626
19d_3_00550
19e_2_02883
19e_2_05273
19e_2_07143
19e_2_07873
19e_2_15829
19f_1_01229
19f_1_06048
19f_2_02883
19f_2_04302
19f_2_04637
19f_2_05453

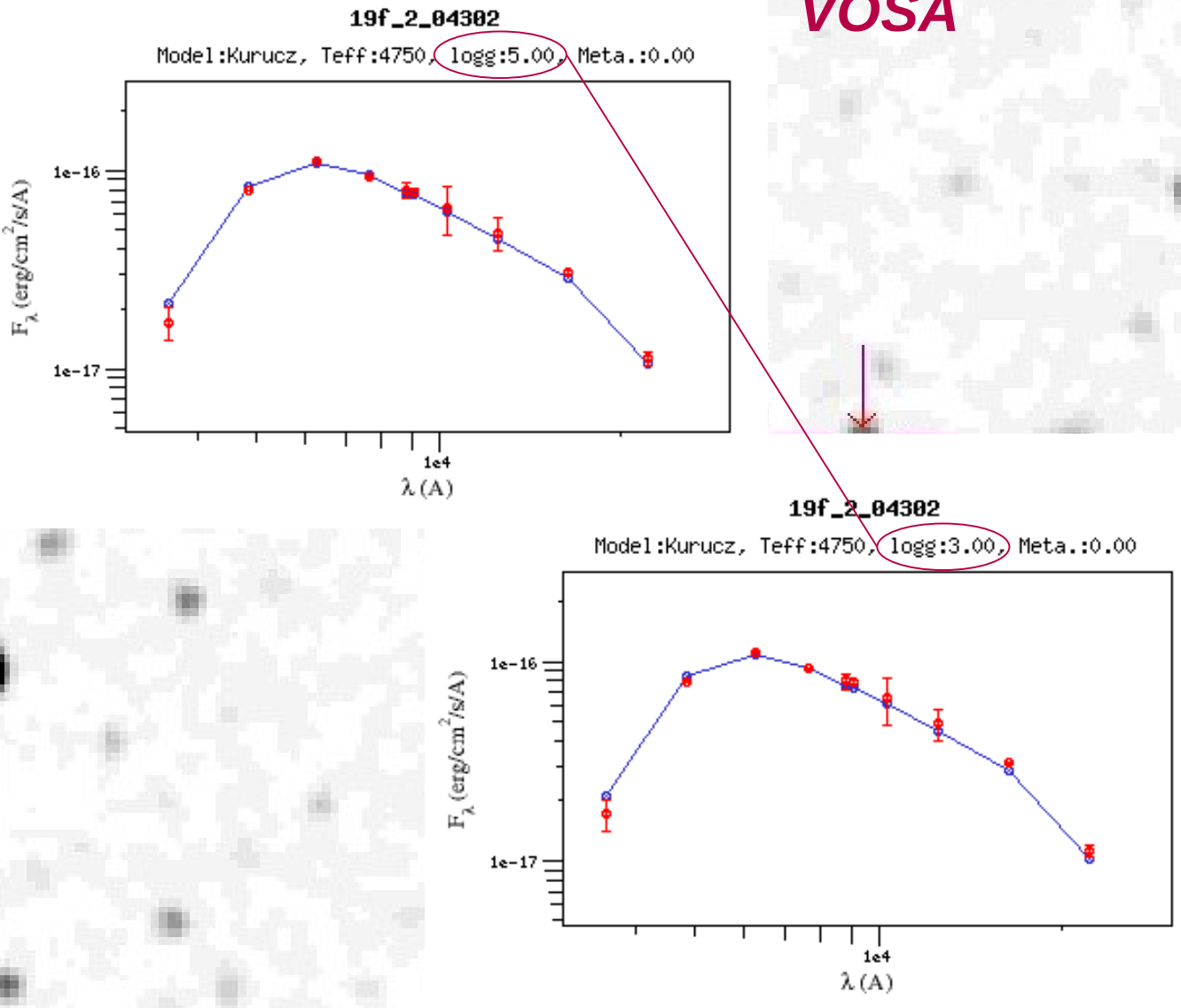
19f_2_04302

Here you can see the best fits for this object.
By default, the one with a smaller Chi2 is selected as **"Best"**.
To select a fitting different from that chosen by default, just click in the link **"Best"**.

Model	T_{eff}	logg	Meta.	χ^2	M_d	F_{tot}	ΔF_{tot}	F_{obs}/F_{tot}	L_{bol}/L_{sun}	$\Delta L_{bol}/L_{sun}$	λ_{max}	N_{fit}/N_{tot}	Action
Kurucz	4750	5.00	0.00	7.60e+0	1.06e-3	1.03e-12	4.20e-14	0.45	3.21e-6	1.31e-7	22084	10/10	Best | See |
Kurucz	4750	1.00	0.00	9.52e+0	1.04e-3	1.02e-12	4.20e-14	0.46	3.17e-6	1.31e-7	22084	10/10	Best | See |
Kurucz	4750	1.50	0.00	9.99e+0	1.04e-3	1.02e-12	4.20e-14	0.46	3.18e-6	1.31e-7	22084	10/10	Best | See |
Kurucz	4750	4.50	0.00	1.01e+1	1.05e-3	1.03e-12	4.20e-14	0.45	3.21e-6	1.31e-7	22084	10/10	Best | See |
Kurucz	4750	0.50	0.00	1.03e+1	1.04e-3	1.01e-12	4.20e-14	0.46	3.16e-6	1.31e-7	22084	10/10	Best | See |
NextGen	3400	5.5	0.0	2.26e+3	1.77e-22	1.17e-12	4.20e-14	0.40	3.63e-6	1.31e-7	22084	10/10	Best | See |
NextGen	3400	5.0	0.0	2.34e+3	1.77e-22	1.17e-12	4.20e-14	0.40	3.64e-6	1.31e-7	22084	10/10	Best | See |
NextGen	3400	4.5	0.0	2.62e+3	1.73e-22	1.15e-12	4.20e-14	0.40	3.59e-6	1.31e-7	22084	10/10	Best | See |
NextGen	3300	5.5	0.0	2.72e+3	1.92e-22	1.14e-12	4.20e-14	0.41	3.55e-6	1.31e-7	22084	10/10	Best | See |
NextGen	3300	5.0	0.0	2.76e+3	1.94e-22	1.14e-12	4.20e-14	0.41	3.57e-6	1.31e-7	22084	10/10	Best | See |
COND00	2200	4.0	0.0	5.14e+3	6.26e-22	8.66e-13	4.20e-14	0.54	2.70e-6	1.31e-7	22084	10/10	Best | See |
COND00	2200	3.5	0.0	5.14e+3	6.36e-22	8.73e-13	4.20e-14	0.53	2.72e-6	1.31e-7	22084	10/10	Best | See |
COND00	2200	4.5	0.0	5.15e+3	6.13e-22	8.51e-13	4.20e-14	0.55	2.65e-6	1.31e-7	22084	10/10	Best | See |
COND00	2100	3.5	0.0	5.23e+3	7.37e-22	8.51e-13	4.20e-14	0.55	2.65e-6	1.31e-7	22084	10/10	Best | See |
COND00	2200	5.0	0.0	5.23e+3	5.95e-22	8.33e-13	4.20e-14	0.56	2.60e-6	1.31e-7	22084	10/10	Best | See |
DUSTY00	2100	4.5	0.0	5.37e+3	6.46e-22	8.48e-13	4.20e-14	0.55	2.64e-6	1.31e-7	22084	10/10	Best | See |
DUSTY00	2000	4.0	0.0	5.46e+3	7.68e-22	8.49e-13	4.20e-14	0.55	2.65e-6	1.31e-7	22084	10/10	Best | See |
DUSTY00	2100	3.5	0.0	5.48e+3	7.04e-22	8.47e-13	4.20e-14	0.55	2.64e-6	1.31e-7	22084	10/10	Best | See |

Spectral Typing

Low sensitivity to gravity.



VOSA

19a_1_03509	5000	5.0
19a_1_07679	4000	3.5
19a_4_07025	4750	3.5
19b_1_11643	3750	5.0
19b_3_12432	5000	4.5
19c_1_09991	4000	5.0
19c_2_07252	3500	3.5
19d_2_12626	4750	3.5
19e_2_02883	4500	3.5
19e_2_05273	3750	5.0
19e_2_07143	3500	4.5
19e_2_07873	5500	4.5
19e_2_15829	5500	3.5
19f_1_01229	4000	4.5
19f_1_06048	5750	5.0
19f_2_02883	5250	5.0
19f_2_04302	4750	5.0
19f_2_04637	3500	3.0
19f_2_05453	5250	5.0
19f_2_05853	5250	4.0
19f_2_11738	5000	4.5
19f_4_05585	3750	4.0
19f_4_06903	5000	5.0

Spectral Typing

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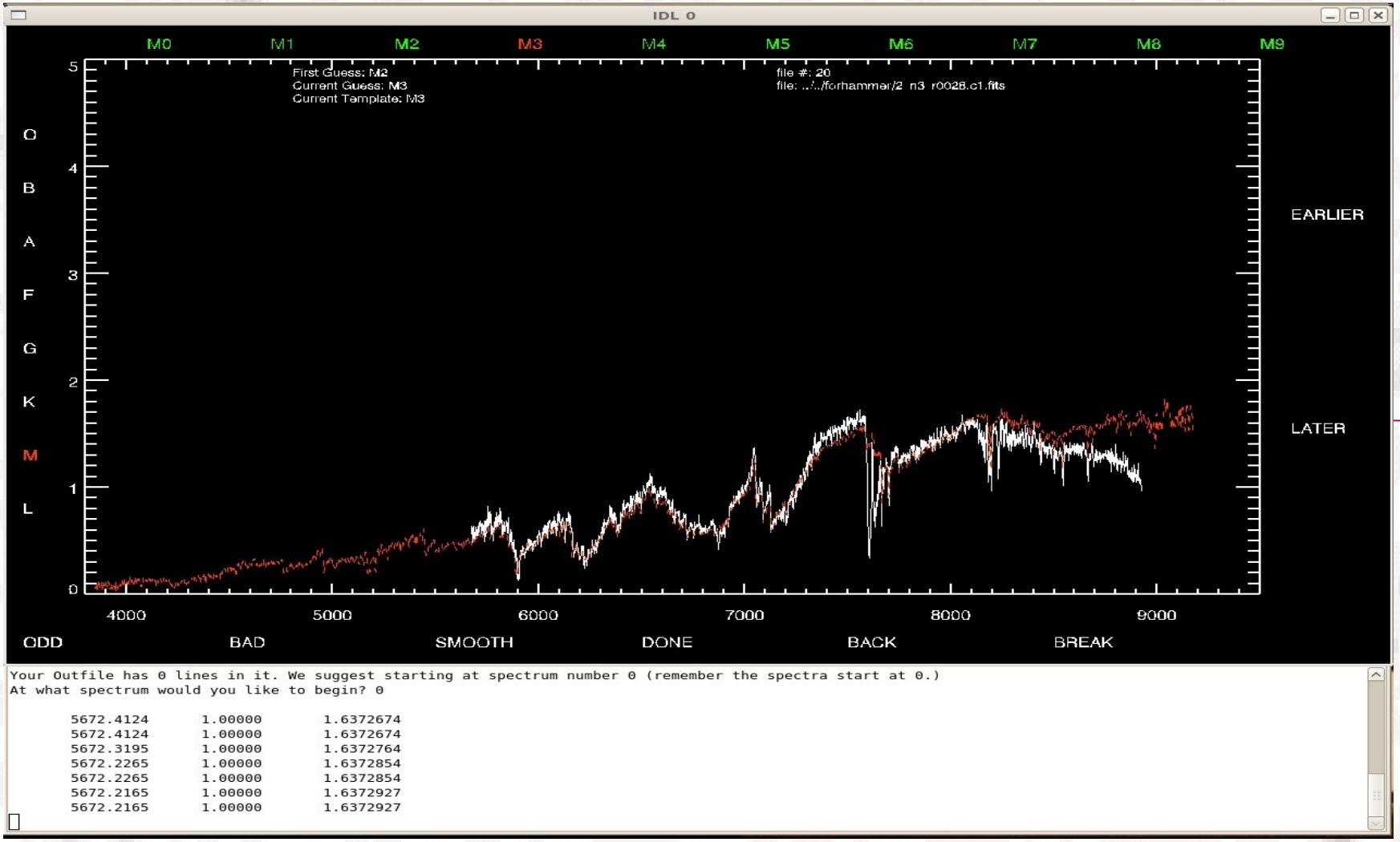
Spectral Typing

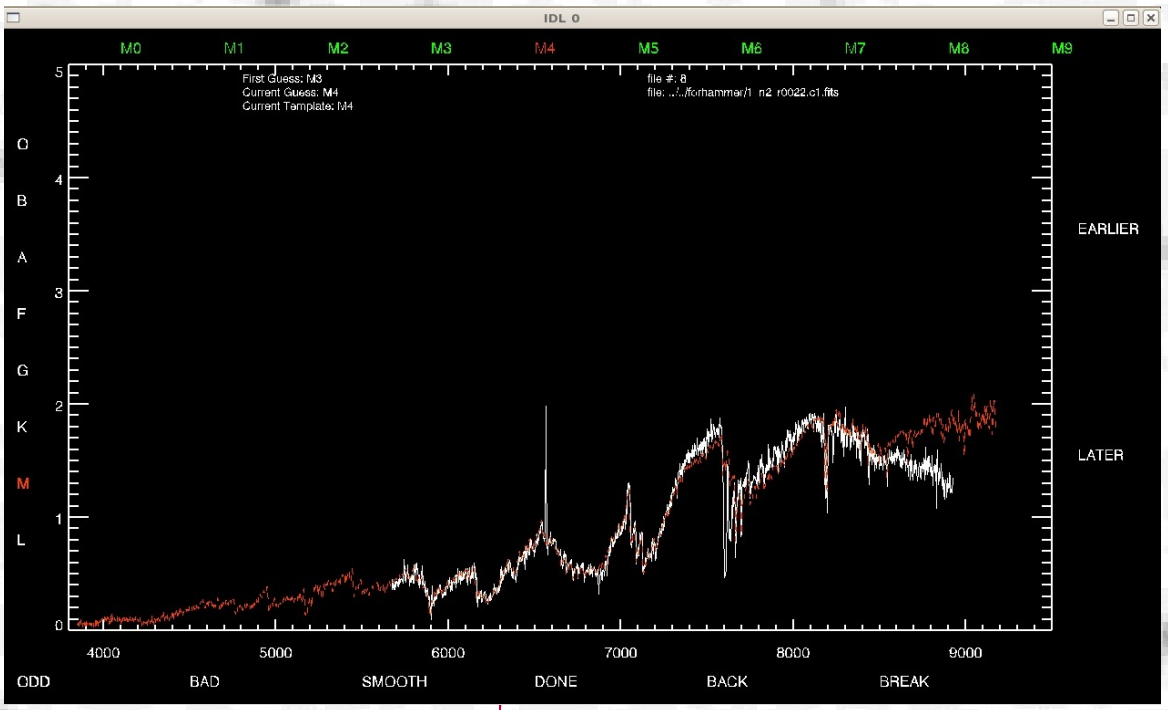
Hammer

19b_1_11643



Spectral Typing

Hammer



19f_2_04302

Only for main-sequence!

???

19a_1_03509	G7
19a_1_07679	G6
19a_4_07025	G6
19b_1_11643	M3
19b_3_12432	K1
19c_1_09991	K1
19c_2_07252	G6
19d_2_12626	M4
19d_3_00550	G9
19e_2_02883	K7
19e_2_05273	K1
19e_2_07143	M3
19e_2_07873	K1
19e_2_15829	M1
19f_1_01229	K1
19f_1_06048	G8
19f_2_02883	K0
19f_2_04302	M4
19f_2_04637	K1
19f_2_05453	G7
19f_2_05853	G9
19f_2_11738	K7
19f_4_05585	G9
19f_4_06903	G7

Without the luminosity class of the candidates, the spectral type assigned could not be reliable.

To come...

Spectral Classification

Comparison method:

1) Library of synthetic spectra (Coelho et al. 2005):

– Teff: 3500-7000 K

– log g: 0.5-5.0 dex

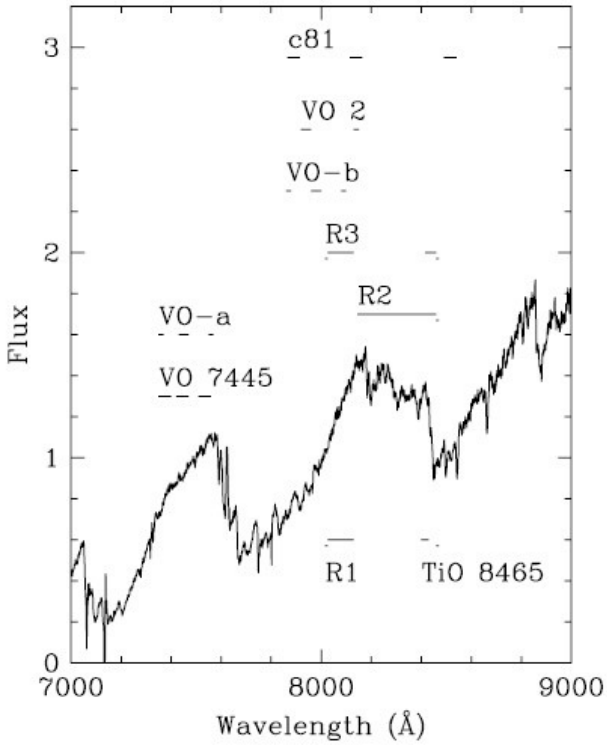
► Adapting the program.

2) Own template (Calar Alto):

SpT: K7, M0, M2, M4, M5, M6, M7, M8 some luminosity class coverage.

Color indices:

For a more precise classification of M-type stars (Riddick et al. 2007).



Riddick et al. 2007 (Fig.2)

To come...

Future Observations: Calar Alto Observatory

Second proposal already approved for 2 nights in November:

- around 12 candidates;
- Phase II: intermediate resolution spectroscopy.

Calar Alto's new instrument: CAFE – echelle spectrograph:

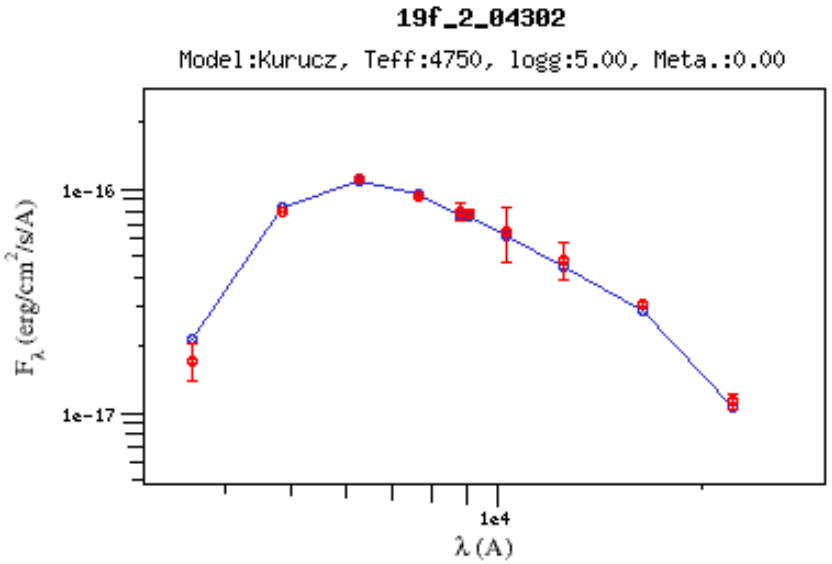
- to obtain accurate RV for late-K to early-M candidates.

Important: deadline for the spring semester 2011 of Calar Alto

September 15th !!!


Thank you all!

Spectral Typing



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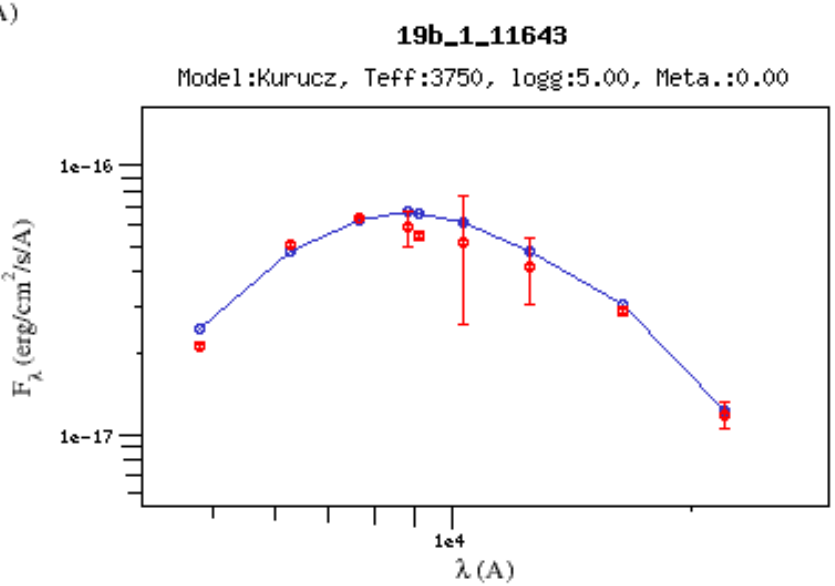

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19f_2_05453	5250	5.0
19f_2_05853	5250	4.0
19f_2_11738	5000	4.5
19f_4_05585	3750	4.0
19f_4_06903	5000	5.0