CENTRO DE ASTROBIOLOGÍA
Laboratorio de Astrofísica Estelar y Exoplanetas

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Classifying M-dwarfs hosts and detecting planetary light

under supervision of: David Barrado

Overview

Planet-host candidates:

- Spectral typing via low-resolution spectroscopy
- M-dwarfs: indices from molecular bands
- Intermediate resolution: identify and solve the lowest-mass stellar/substellar binaries

Detecting planetary light:

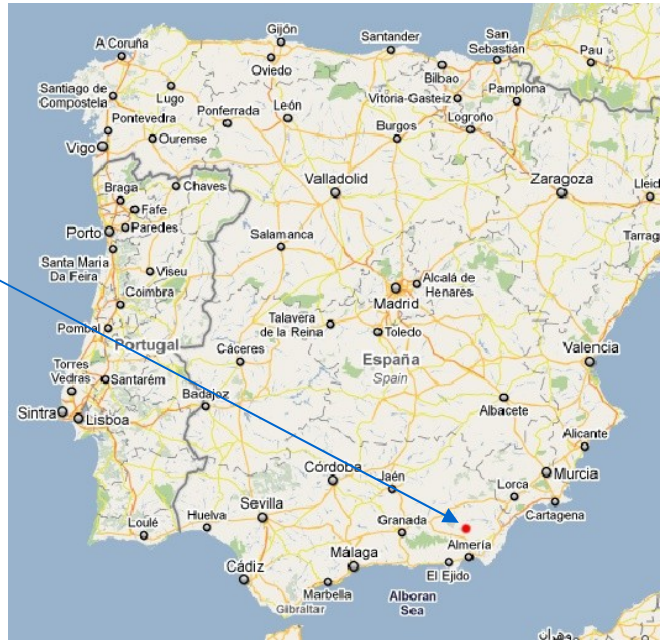
- Secondary transit
- Proposals for known exoplanets

Spectroscopic observations

Spectroscopic follow-up of the most exciting candidates:

- low-resolution: obtain their spectral type;
- mid-resolution: estimate radial velocity variations with ~km/s-precision to identify low-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

Observing run – June 19-21 +22

- 3+1 nights at 3.5m telescope
- 32 candidates of 19.5h field
- Goal :

  derive the spectral types of the targets
- TWIN spectrograph:

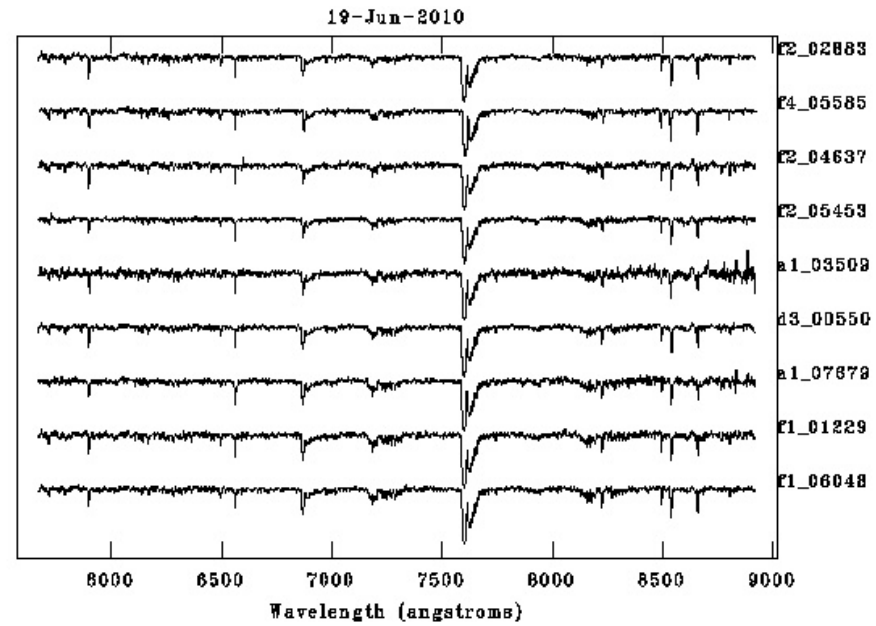
  low-resolution: R ~ 2000 (1.63 Å/pix)

  wavelength range: 5673-8922 Å

Reduction: IRAF
- flat-fielding and bias subtraction
- extraction: 1D spectra
- wavelength calibration
- spectrum normalization

3.5m telescope

Spectra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6500
7000
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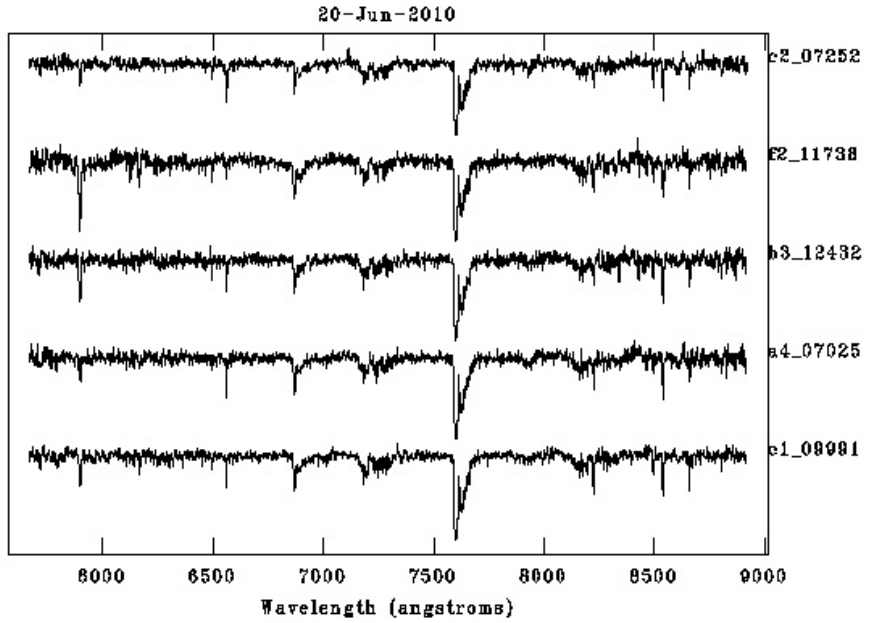
8000
8500
9000
Wavelength (angstroms)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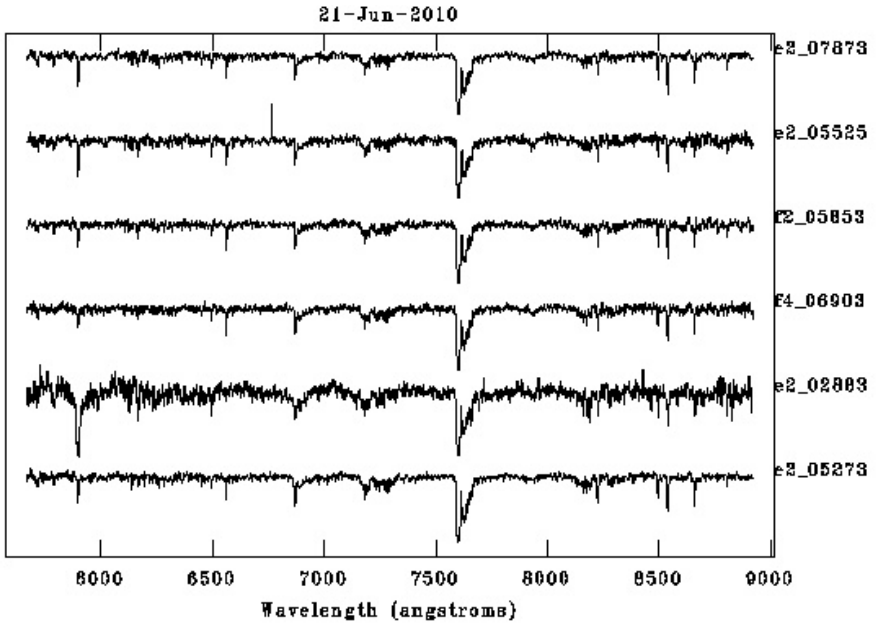
9000
Wavelength (angstroms)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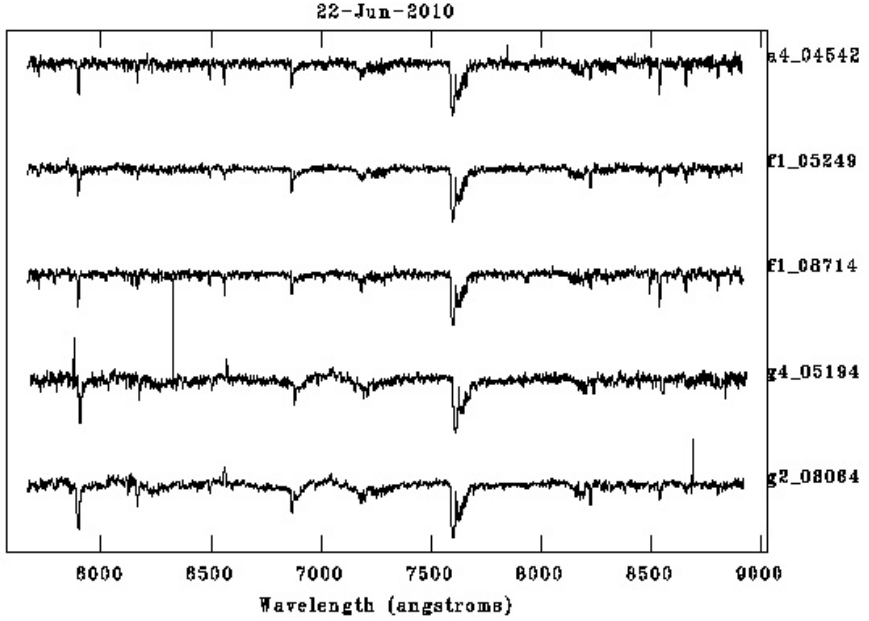
Wavelength (angstroms)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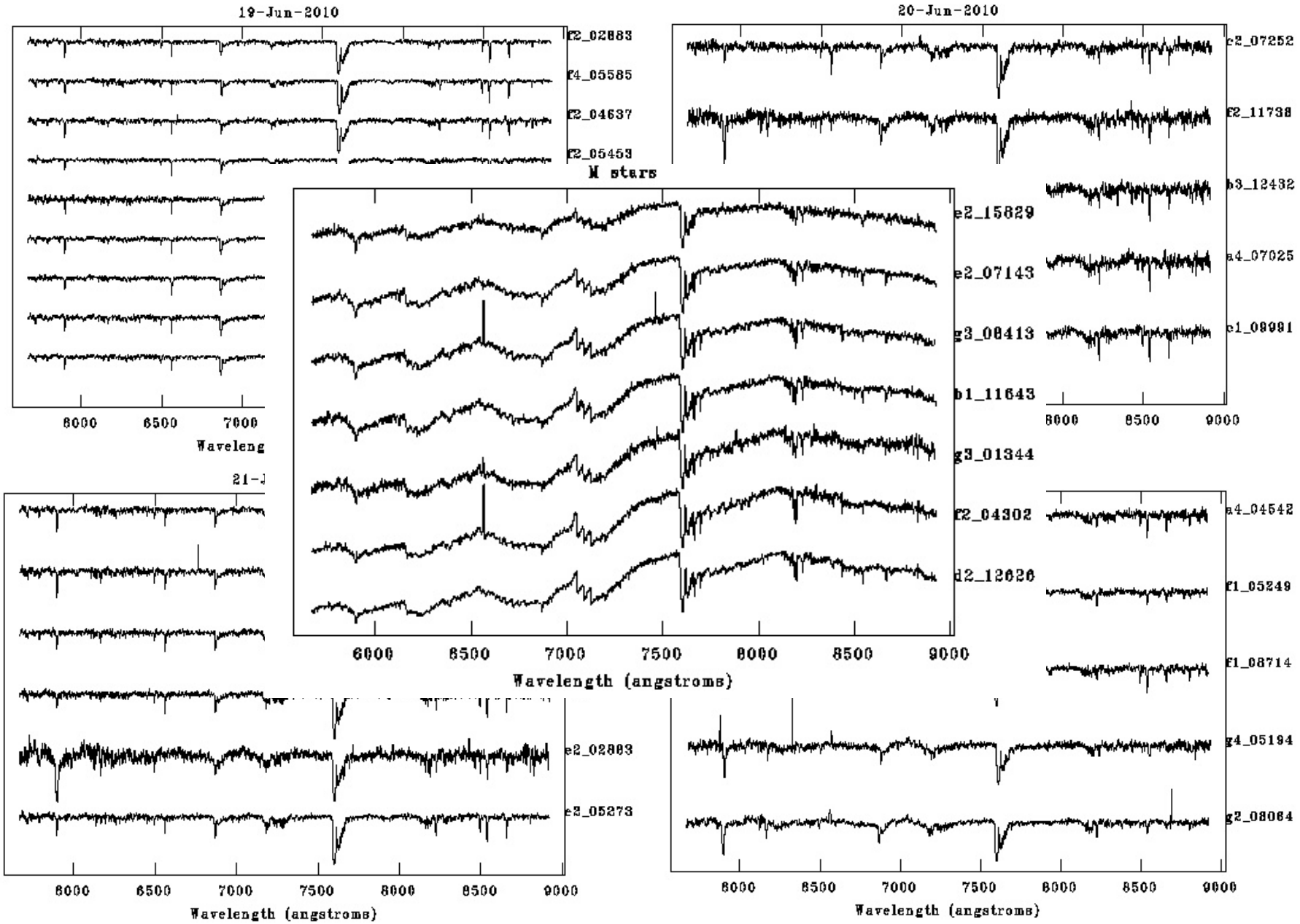
Wavelength (angstroms)

Spectra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f2_11738
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a4_07025
e1_08981
M stars
e2_15829
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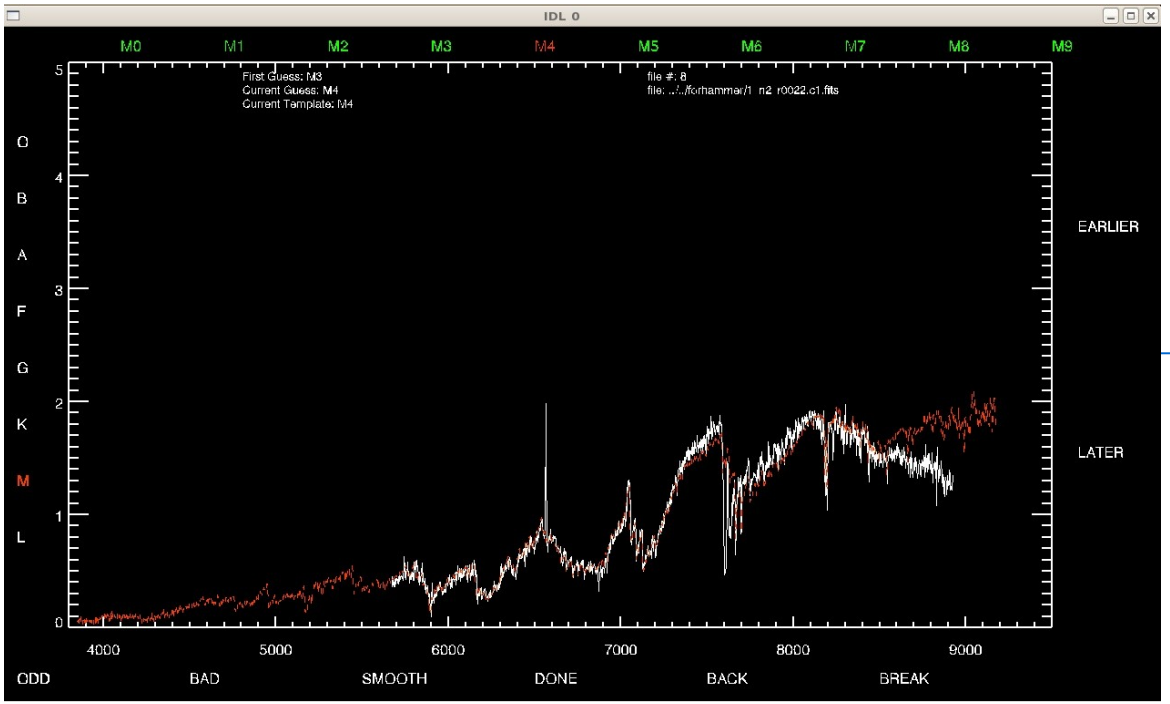
g3_08413
b1_11643
g3_01344
f2_04302
d2_12626
6000
6500
7000
7500
8000
8500
9000
Wavelength (angstroms)
21-J
e2_02883
e2_05273
a4_04542
f1_05249
f1_08714
g4_05194
g2_08064

Spectral Typing: first approach

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.



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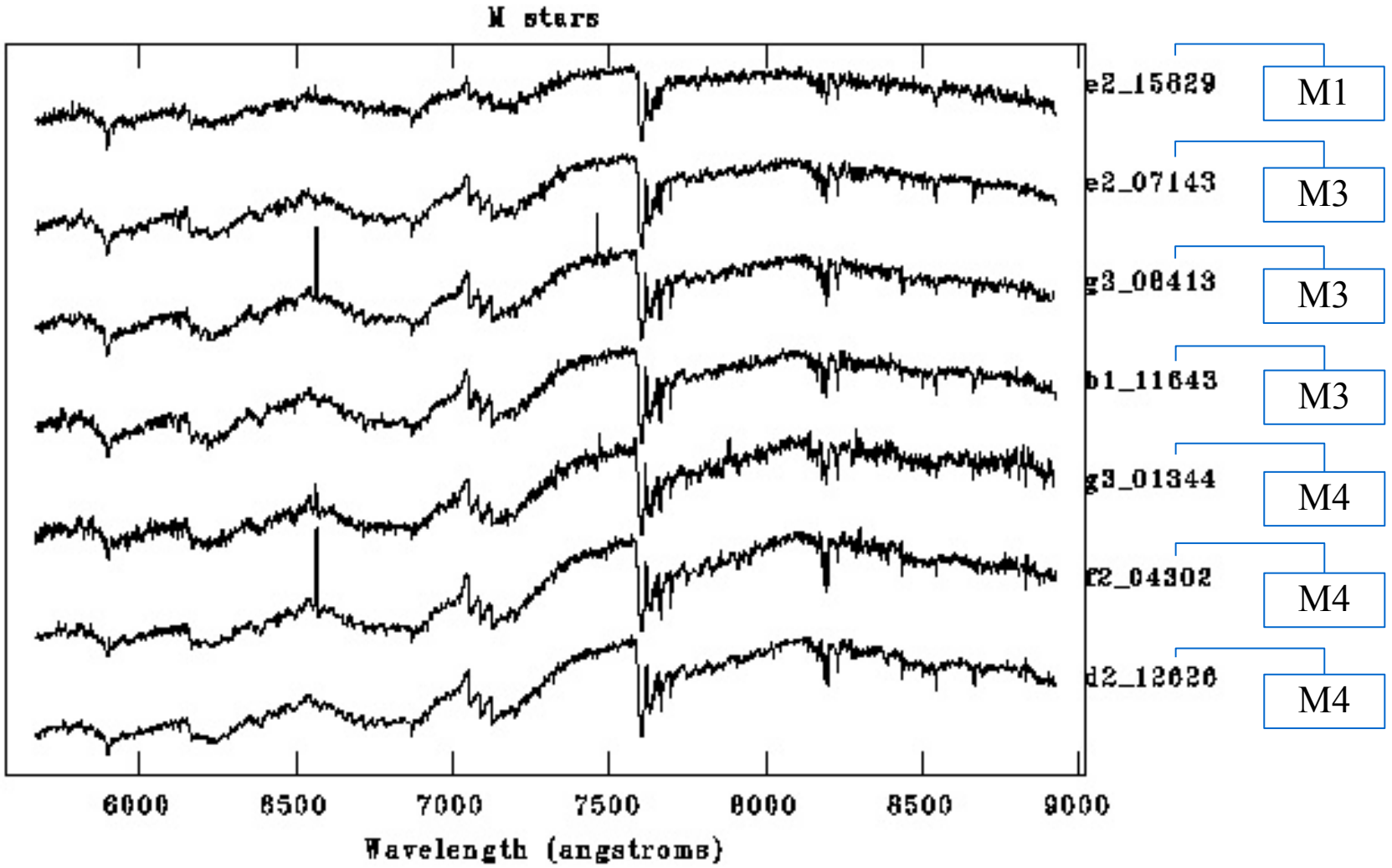
Spectral Typing: first approach - M-types



Spectral Typing: accurate method

Comparison to a template of spectra observed at Calar Alto:

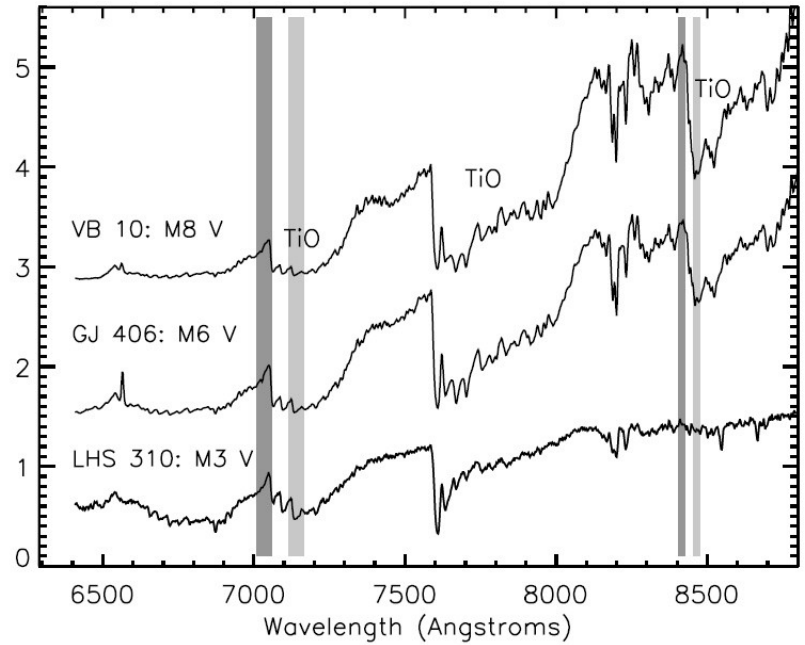
- G-type: G0V, G1V, G2II, G3V, G5V, G8V, G9V
- K-type: K0II, K0V, K2V, K3I, K3II, K3III, K4V, K5II, K6II, K7III, K7V
- M-type: M0V, M2V, M3V, M4V, M5V, M6V, M7V, M8V

Utilization of spectral lines and molecular bands:

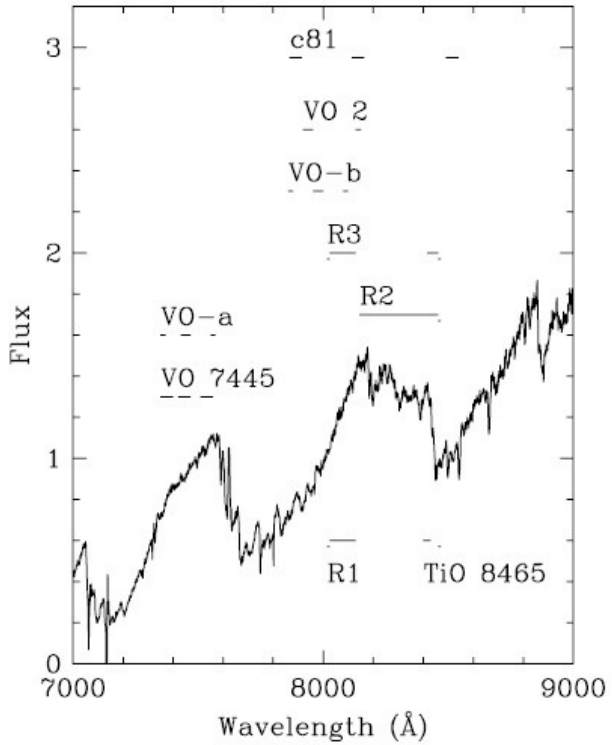
- lines: NaI doublet (λ5890, 5896), Hα λ6563, CaII triplet (λ8498, 8542, 8662), MgI λ8807
- bands: TiO (λ6651, 7750), CaH (λ6346), VO (λ7851)

Spectral Typing: accurate method - M-types

Slesnick et al. 2006 (Fig.8)



Riddick et al. 2007 (Fig.2)

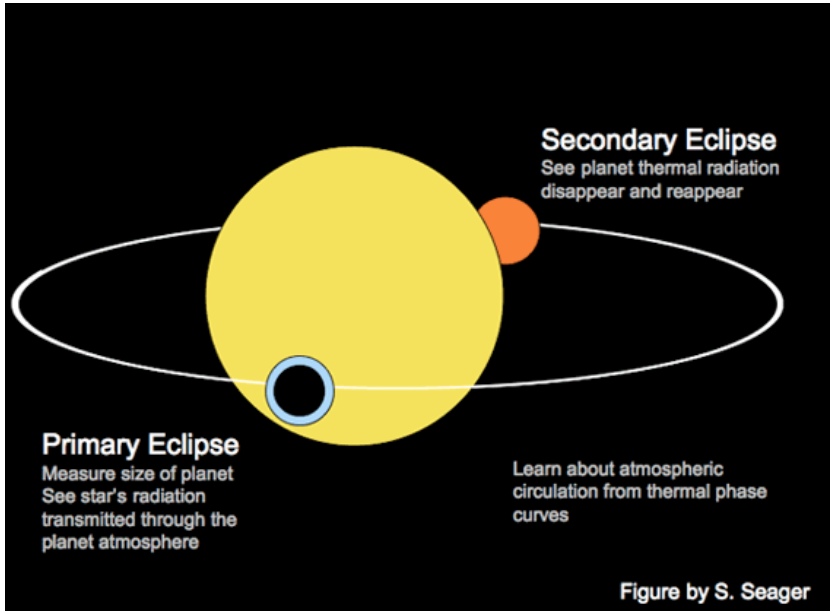


Color indices:

TiO bands: F(λ7035)/F(λ7140), F(λ8415)/F(λ8465) – Slesnick et al. (2006).

Around 30 indices more described in Riddick et al. (2007).

Detecting planetary light

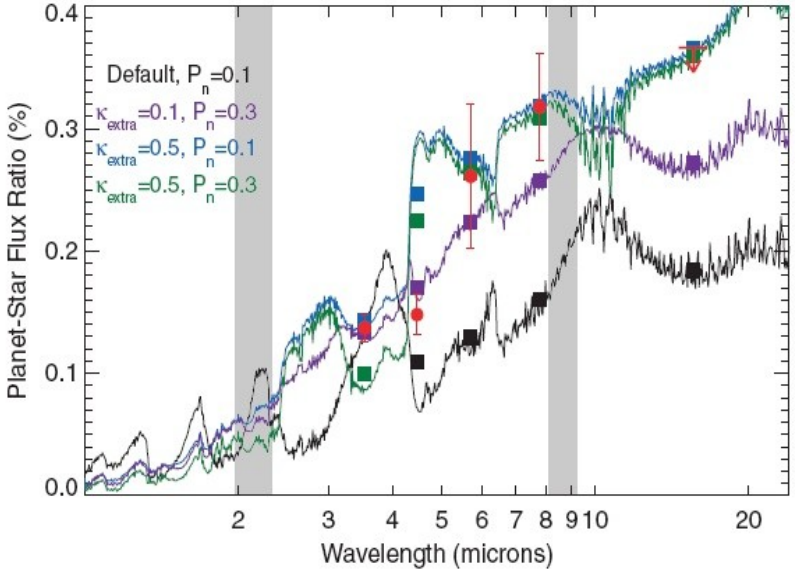


Observations of secondary transits to detect IR emission of known close-orbiting planets.

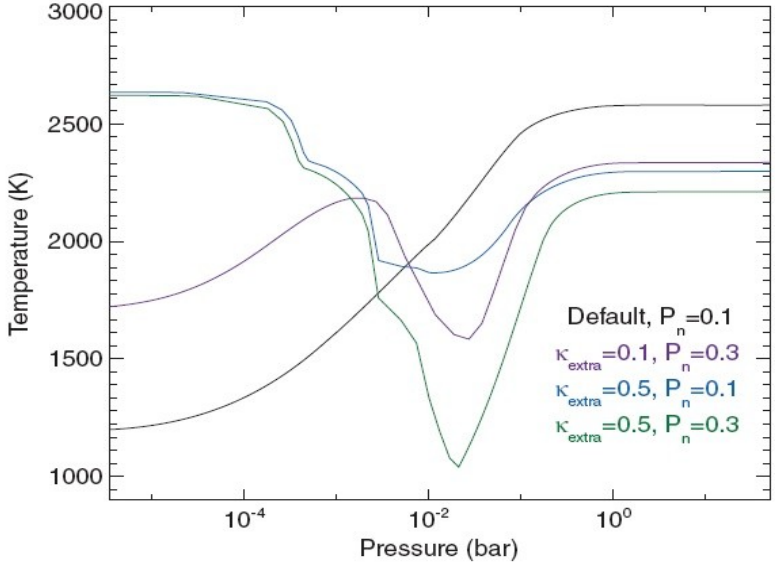
- Planet-to-Star flux ratio
- Temperature inversion driven by molecules in the atmosphere

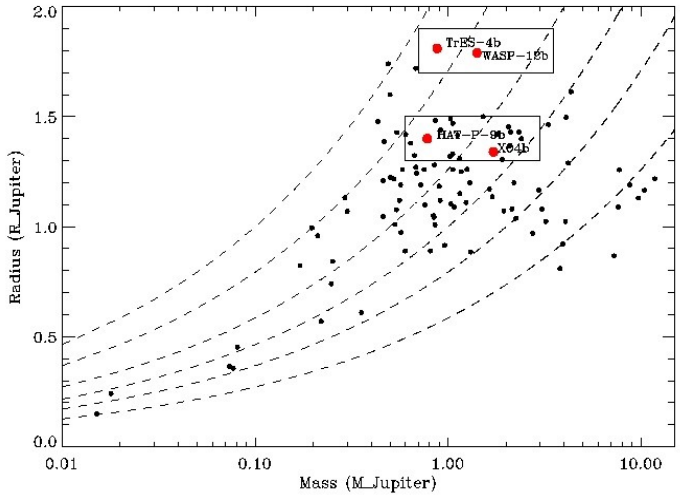
GTC and WHT proposals

Knutson et al. 2009 (Fig.6 - modified)



Knutson et al. 2009 (Fig.7)





Inflated exoplanets to be studied:

- WHT: XO-4b and TrES-4b
- GTC: XO-4b and HAT-P-9b

To come...

Next observing run of 5 nights approved for 2011A at Calar Alto:

- around 15 candidates from 7h-field;
- start intermediate resolution spectroscopy.

Calar Alto's new instrument:

CAFE – Calar Alto Fiber-fed Echelle spectrograph.

- obtain accurate RV for early-M candidates.

Planetary light detection:

- GTC and WHT for 2011A ???
- new proposals for 2011B.

Thank you