A large astronomical telescope is shown in a dark, outdoor setting at night. The telescope is mounted on a tripod and is equipped with various accessories for spectroscopy. A prominent feature is a blue circular component, likely a spectrograph or filter, attached to the side of the telescope tube. A white cable is connected to this component. Other visible accessories include a red cylindrical part at the bottom, a white cylindrical part, and a yellow component near the top. The background shows a dark sky with some clouds and the silhouettes of trees and mountains.

***Why to do  
Astronomical  
Spectroscopy ?***

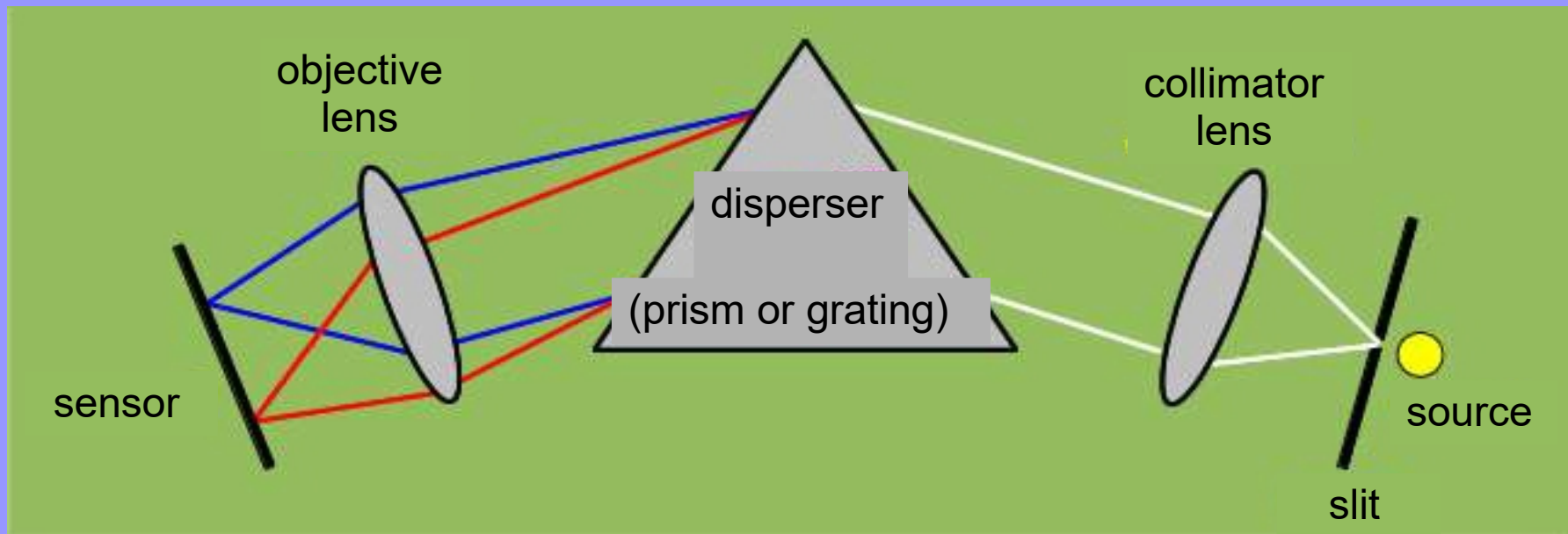
***Olivier THIZY  
BAA Spectroscopy Workshop  
Norman Lockyer Observatory, 10 june 2015***

# Agenda

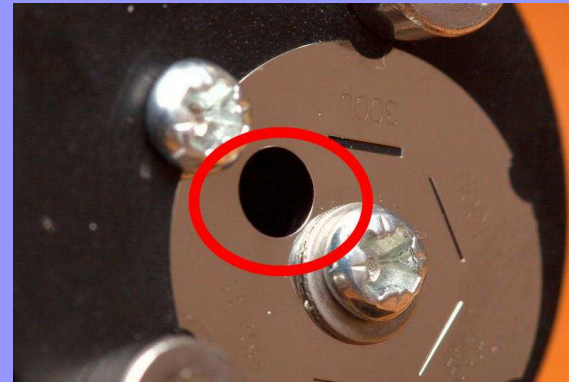
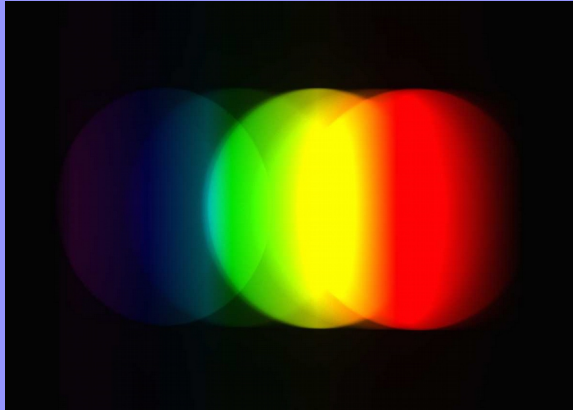
- **because it's FUN to learn Optics !**
- **Because it's FUN to learn (Astro)Physics**
- **because it's FUN to share & teach !**
- **because it's FUN to contribute !**

# Inside the Alpy 600 spectroscope

*...or how it is FUN to learn Optics*



# Importance of the slit



3mm slit (hole)



300µm slit



25µm slit

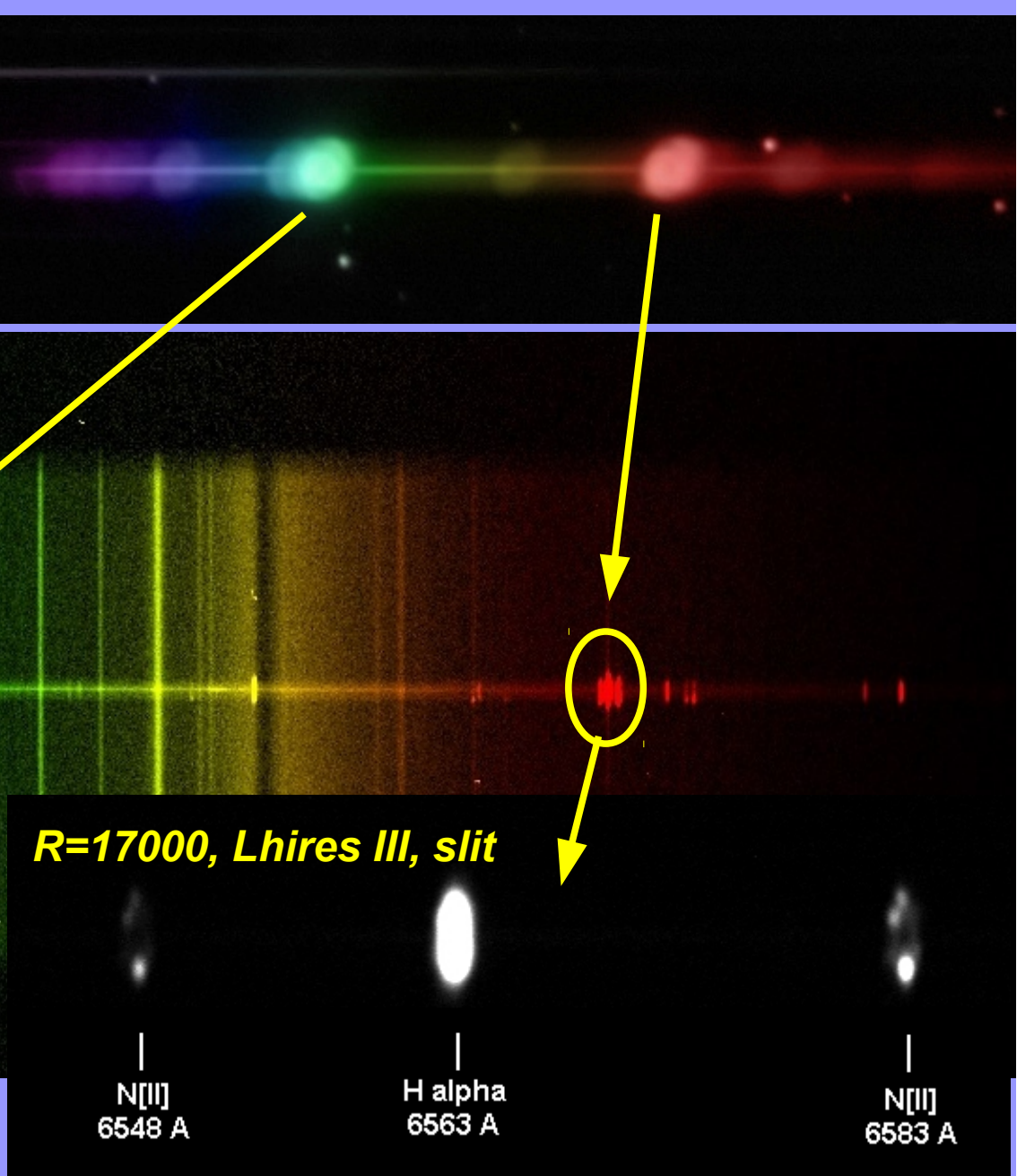
# Cat's eye nebula / no slit Vs slit



## Slit:

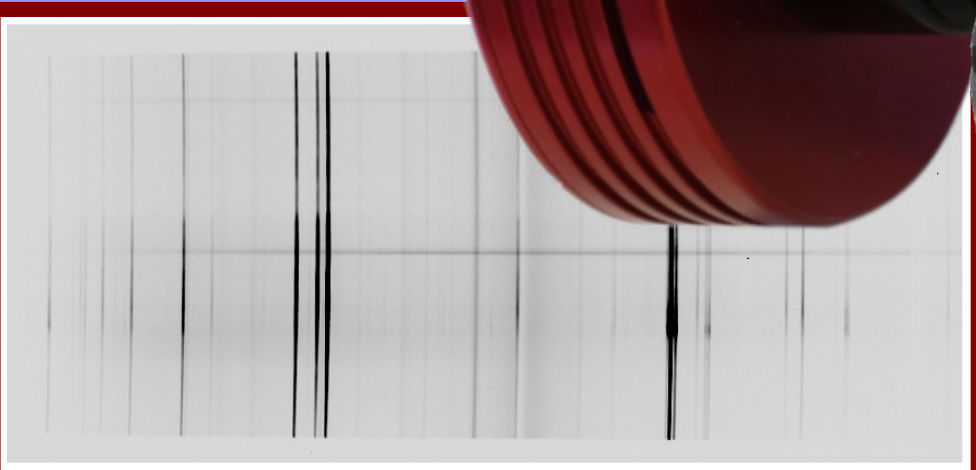
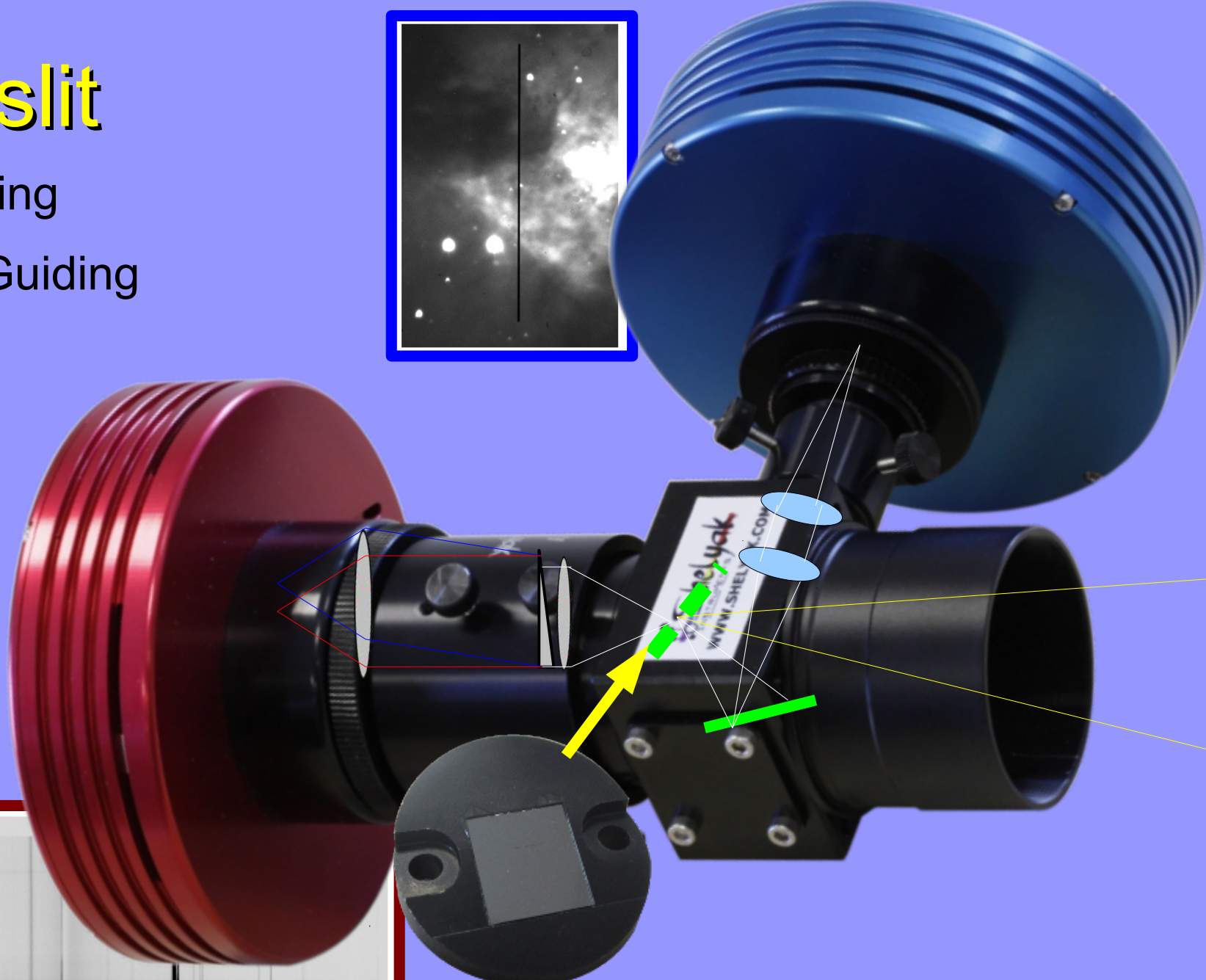
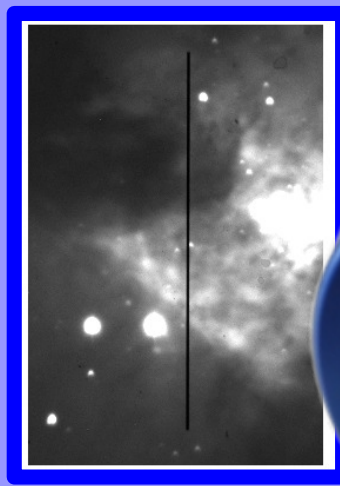
- helps for resolution
- isolates target
- allows light pollution removal

*R=1000, LISA, 23 $\mu$ m slit*

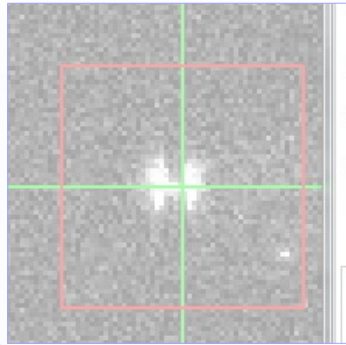


# Mirror slit

- Centering
- (auto)Guiding



# The Alpy 600 system on a scope



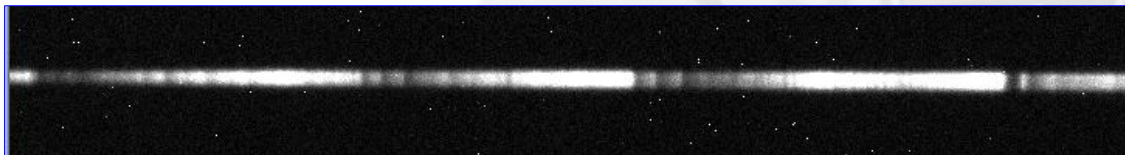
Guiding camera

a *spectrum* is an *image* that can be also displayed as a spectral *profile*

Alpy 600 spectrograph



Acquisition camera



# Astronomical Spectroscopy

...or how it is *FUN* to learn from the stars

beta Cygni  
(Albireo)

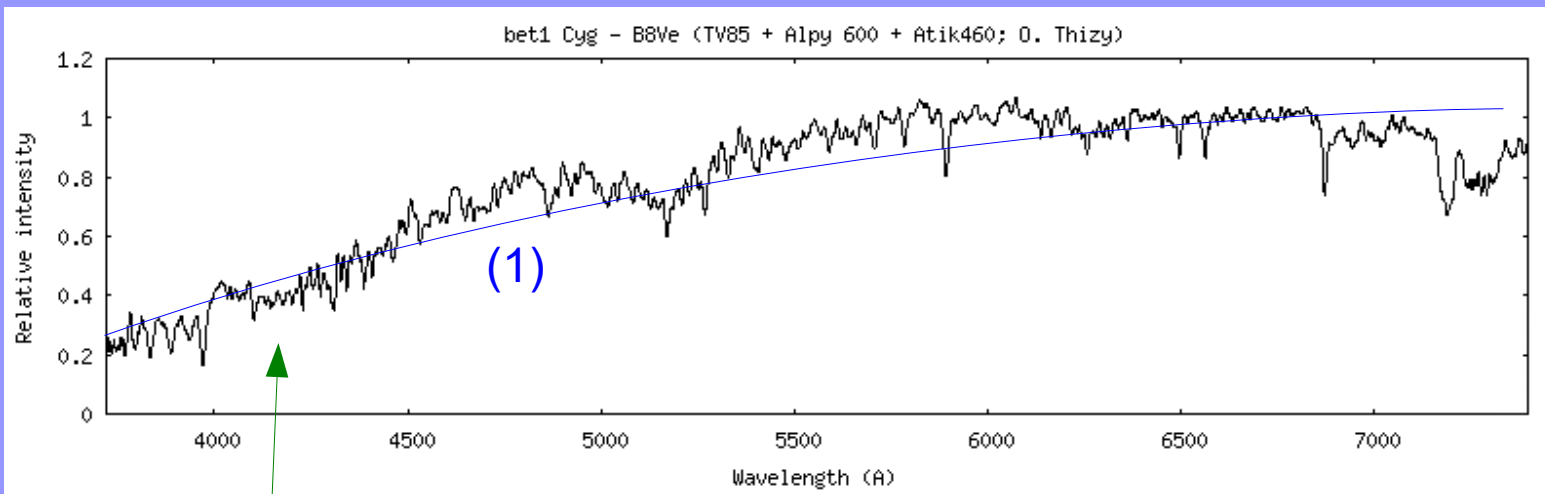


Stars won't  
look the same!

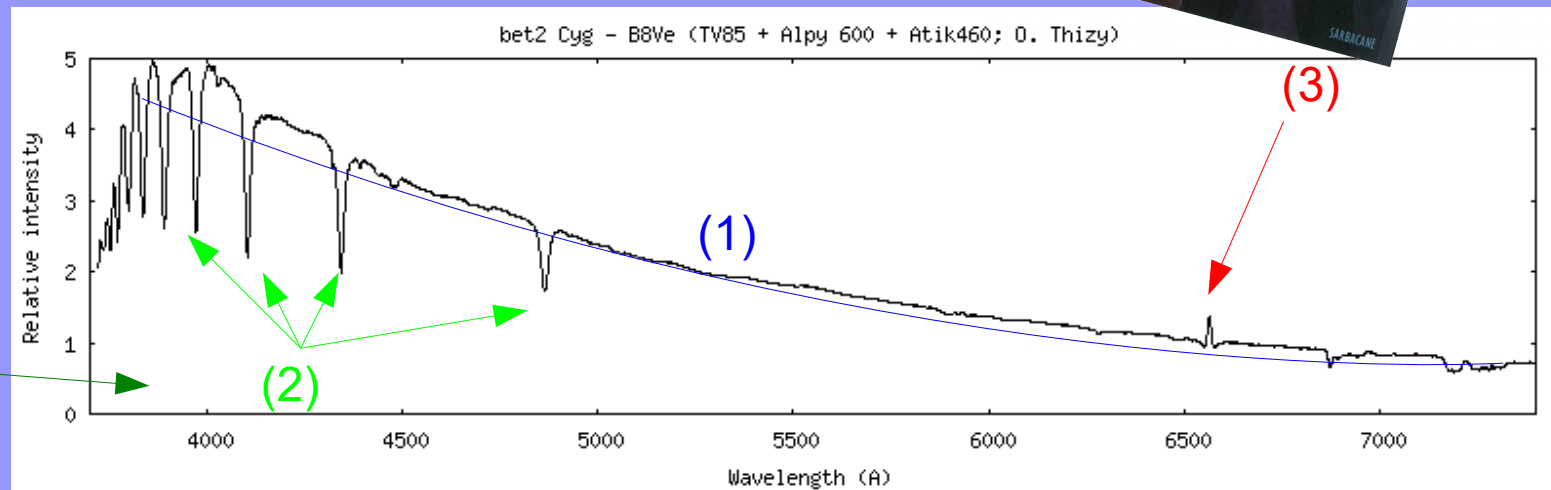
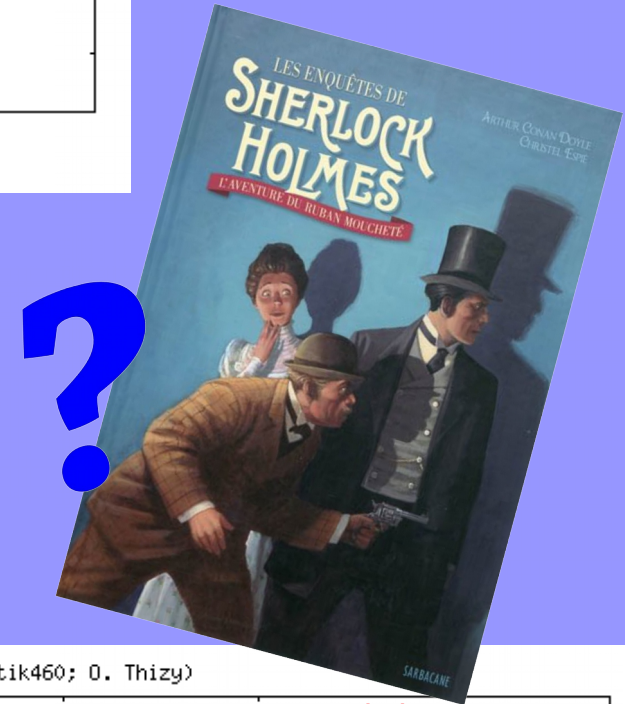




# Albireo A vs B



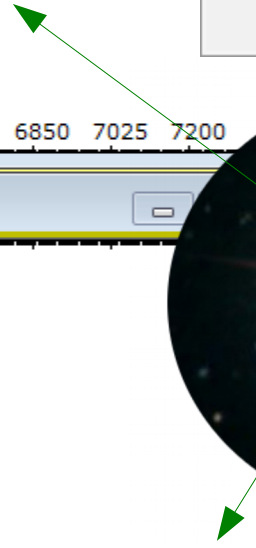
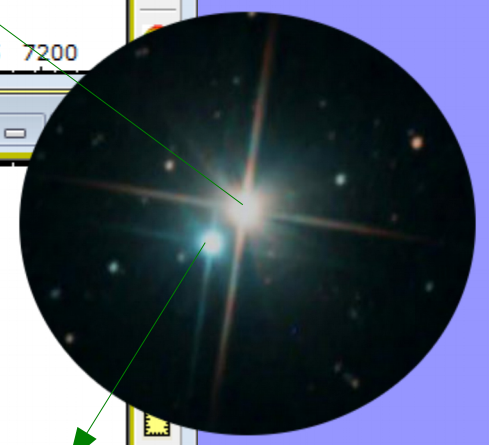
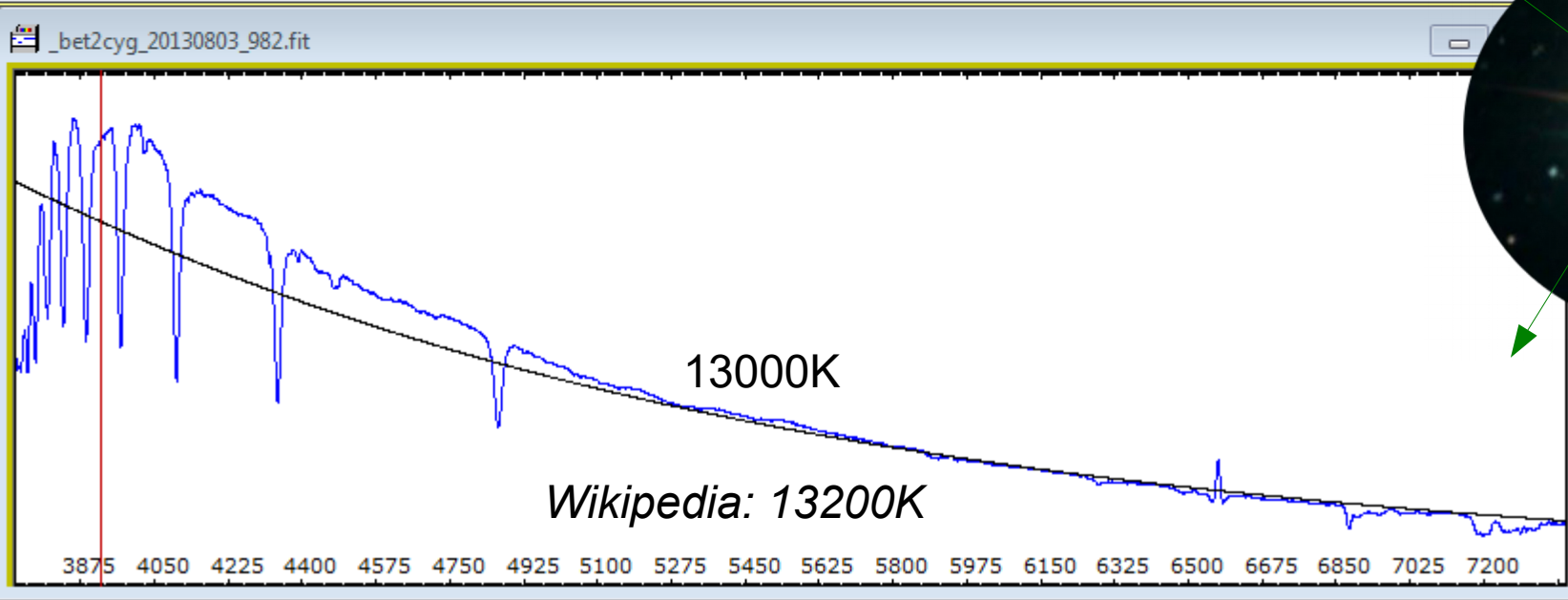
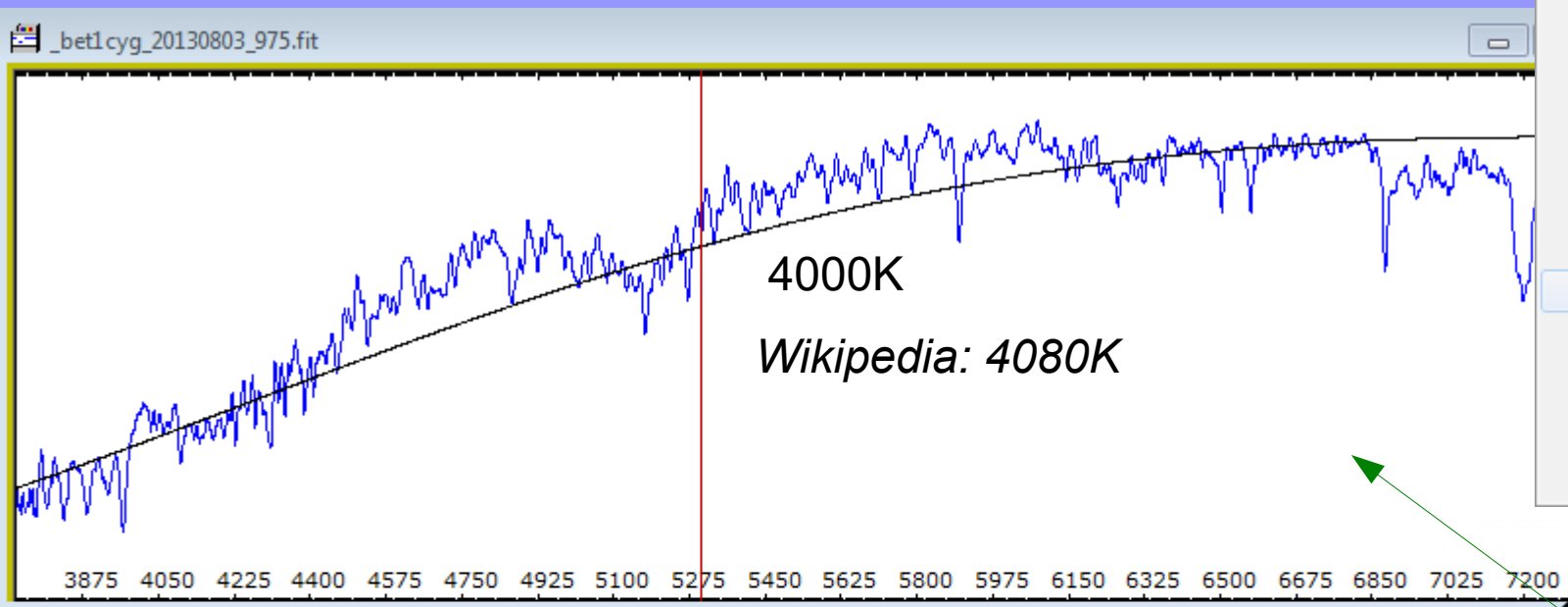
- (1) Overshape profile
- (2) Absorption lines
- (3) Emission line



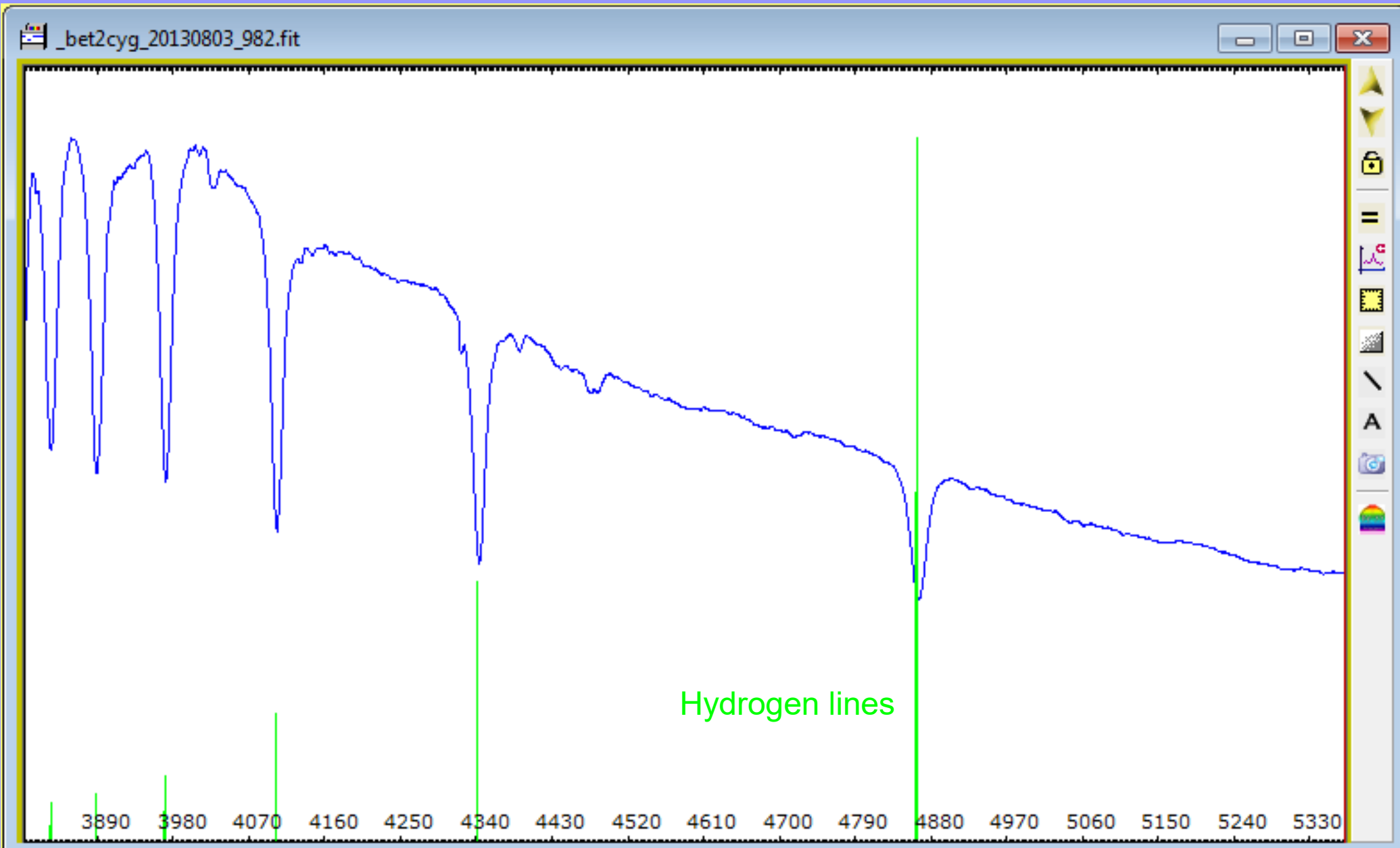
*Perfect exemple of Kirchhoff's laws...*

# 1: overall profile --> Temp.

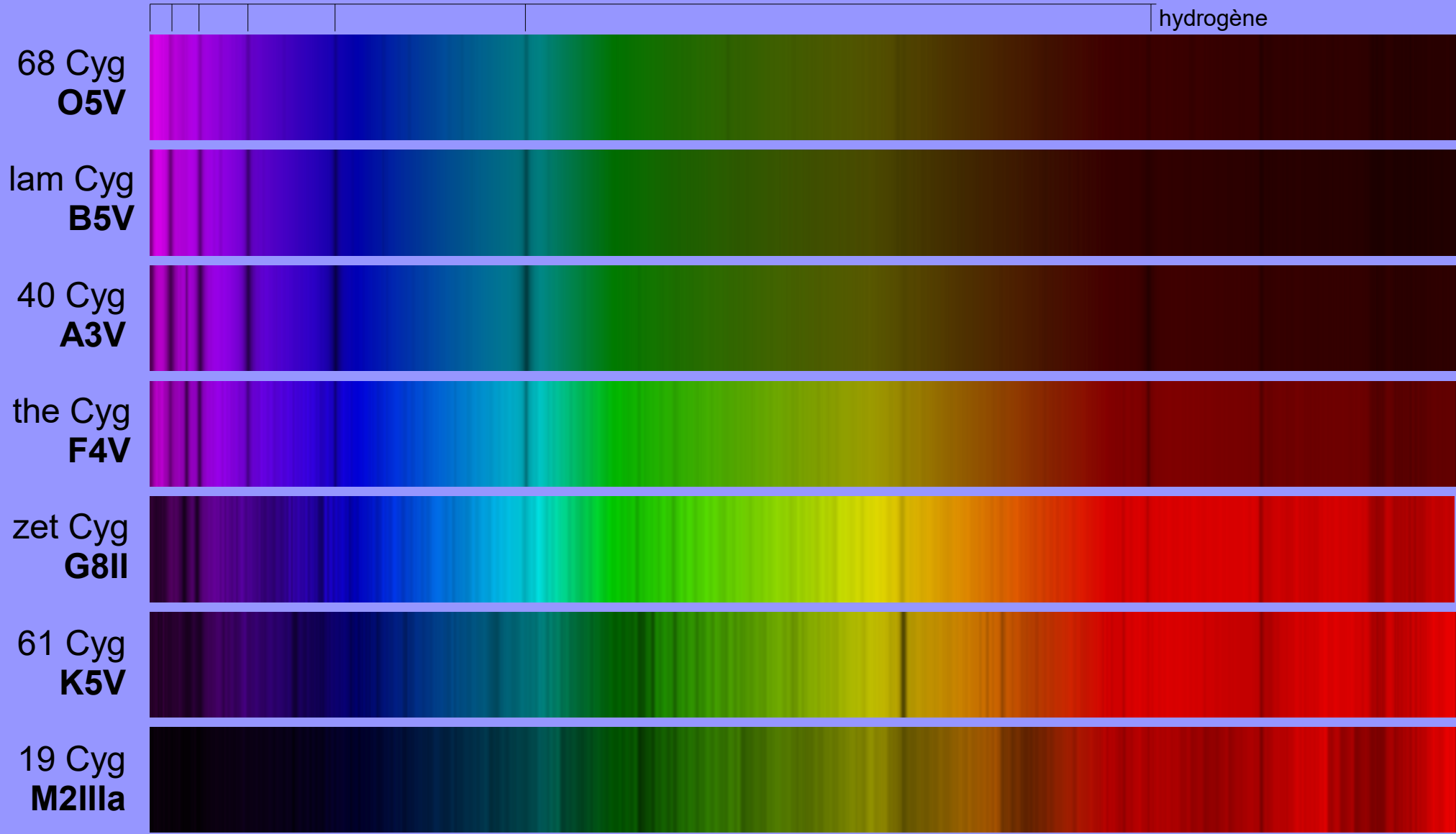
- Radiometry
  - Tools
  - Assistant
  - Window
  - Op
- Compute Continuum...
  - Extract...
  - Extract from zone list
  - Automatic continuum
  - Continuum Division
  - Continuum Subtraction
  - H2O correction...
  - H2O correction real spectrum...
  - Auto H2O correction
  - Verif Cal Atm
  - Auto Planck...**
  - Planck...
  - Extinction...
  - Compute flux of reference star...
  - Compute absolute flux..



# 2: stellar atmosphere

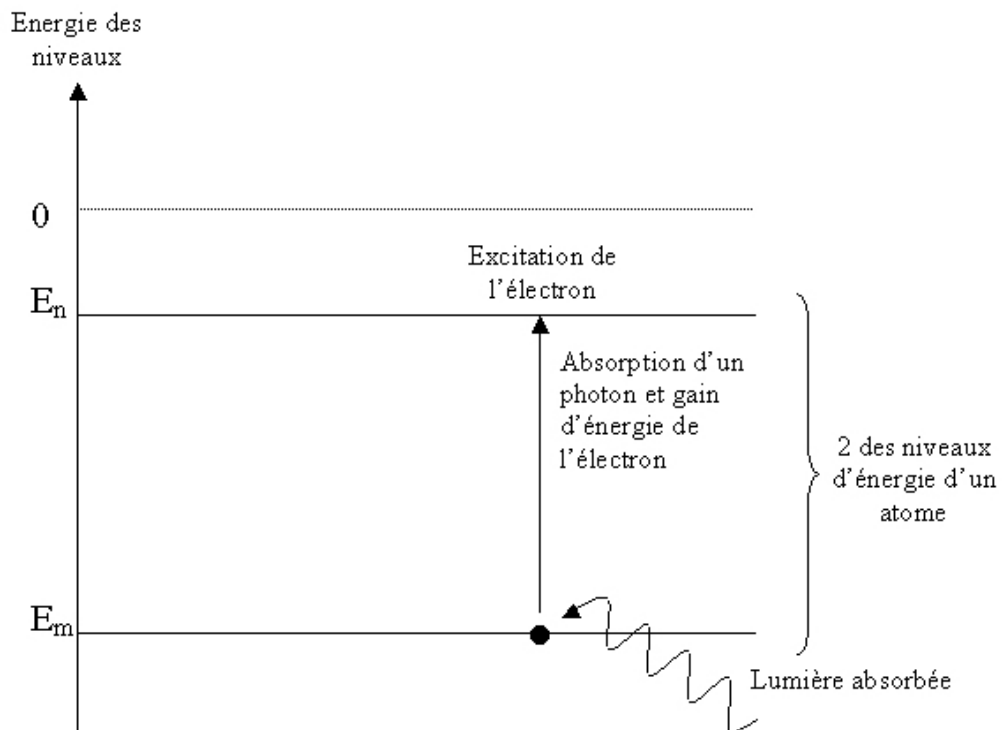
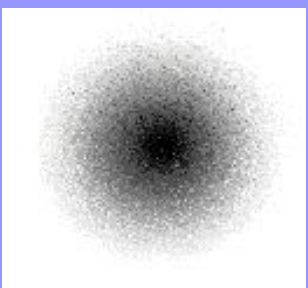


# Spectral classification

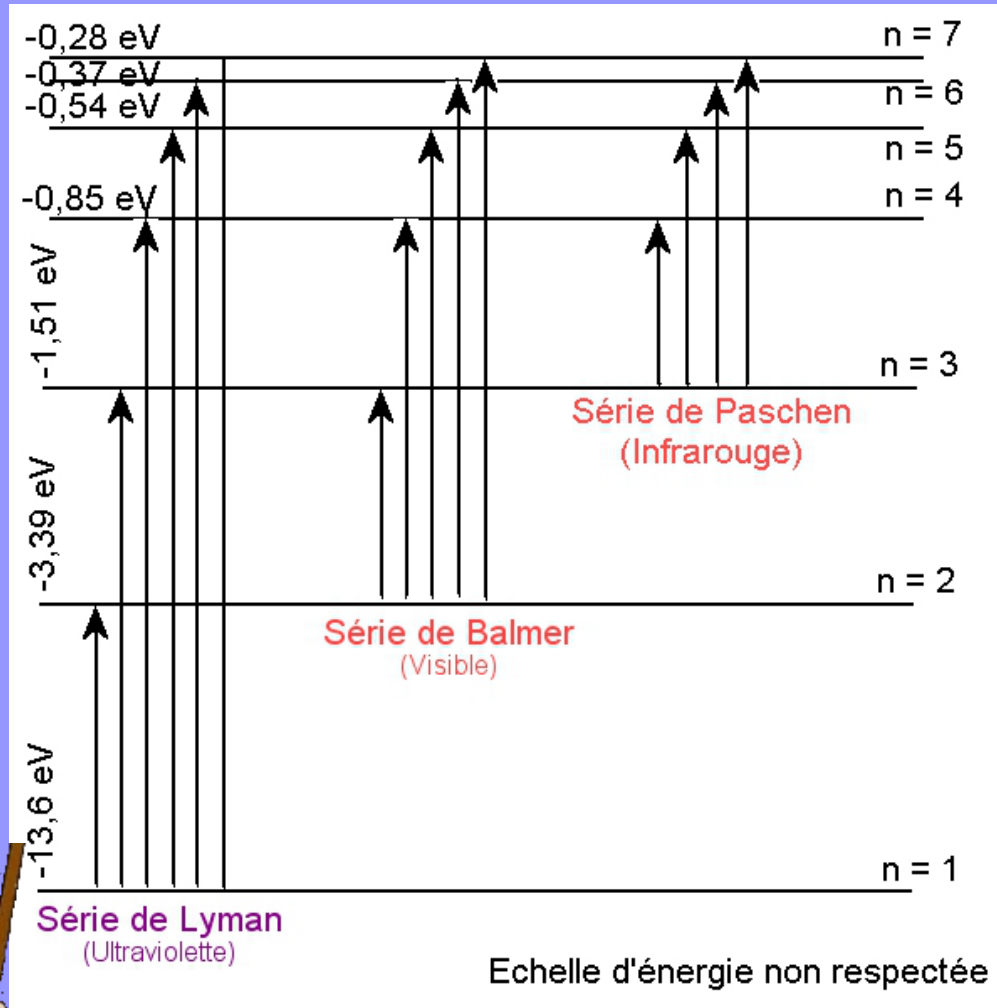


**O**<sub>h</sub>, **B**<sub>e</sub> **A****F**<sub>ine</sub> **G**<sub>irl</sub>/**G**<sub>uy</sub>... **K**<sub>iss</sub> **M**<sub>e</sub>!

# Absorption lines physics



$$\Delta E = |E_n - E_m| = h\nu = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{\Delta E}$$



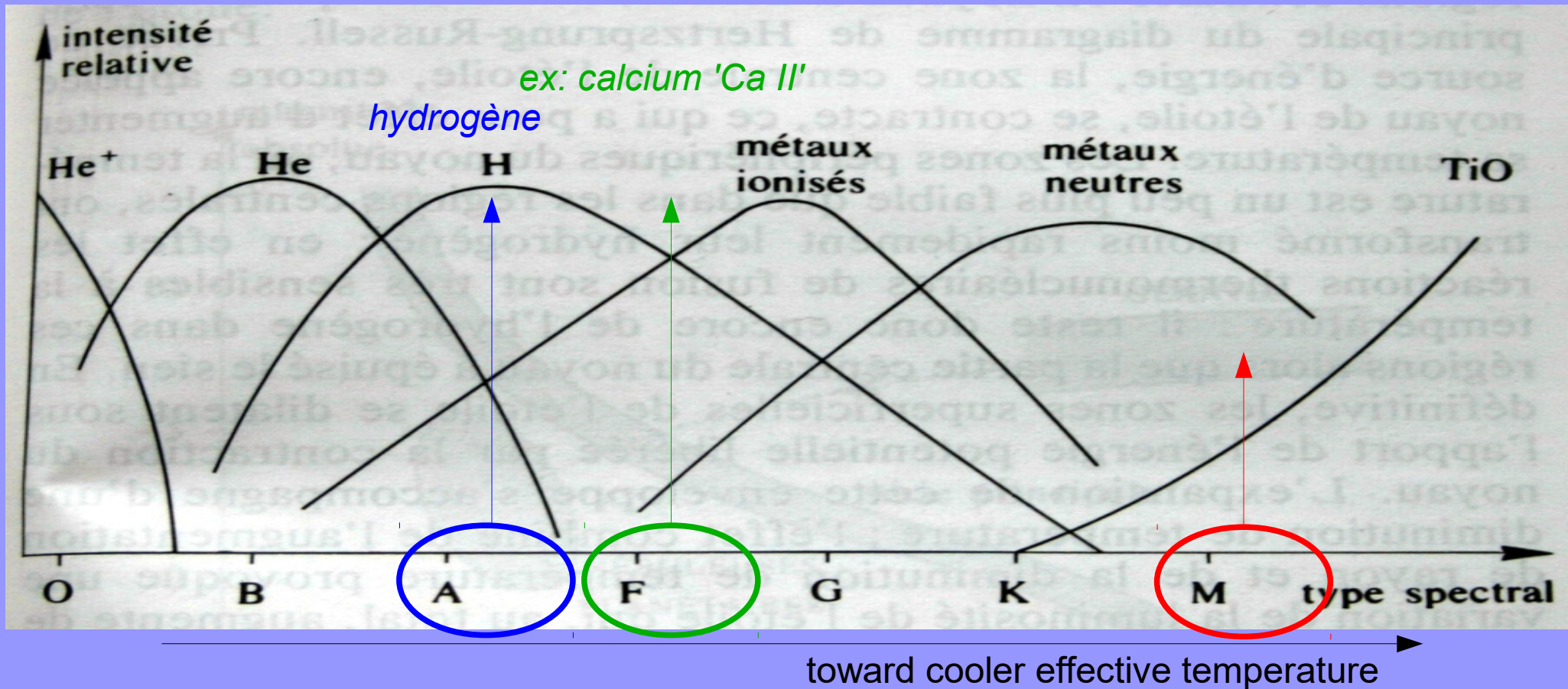
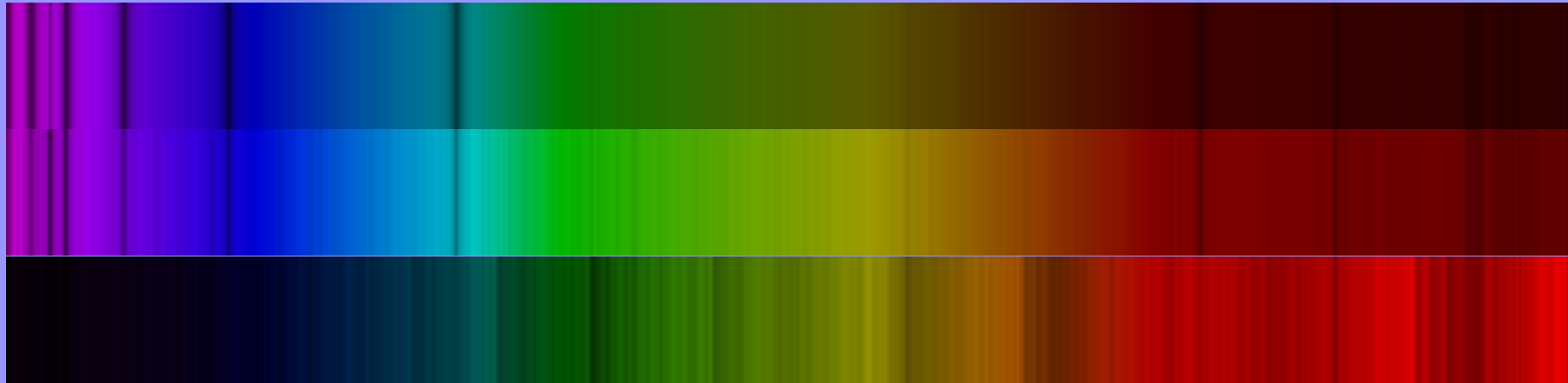
Exemple for the hydrogen atom

# Temperature Vs line strength

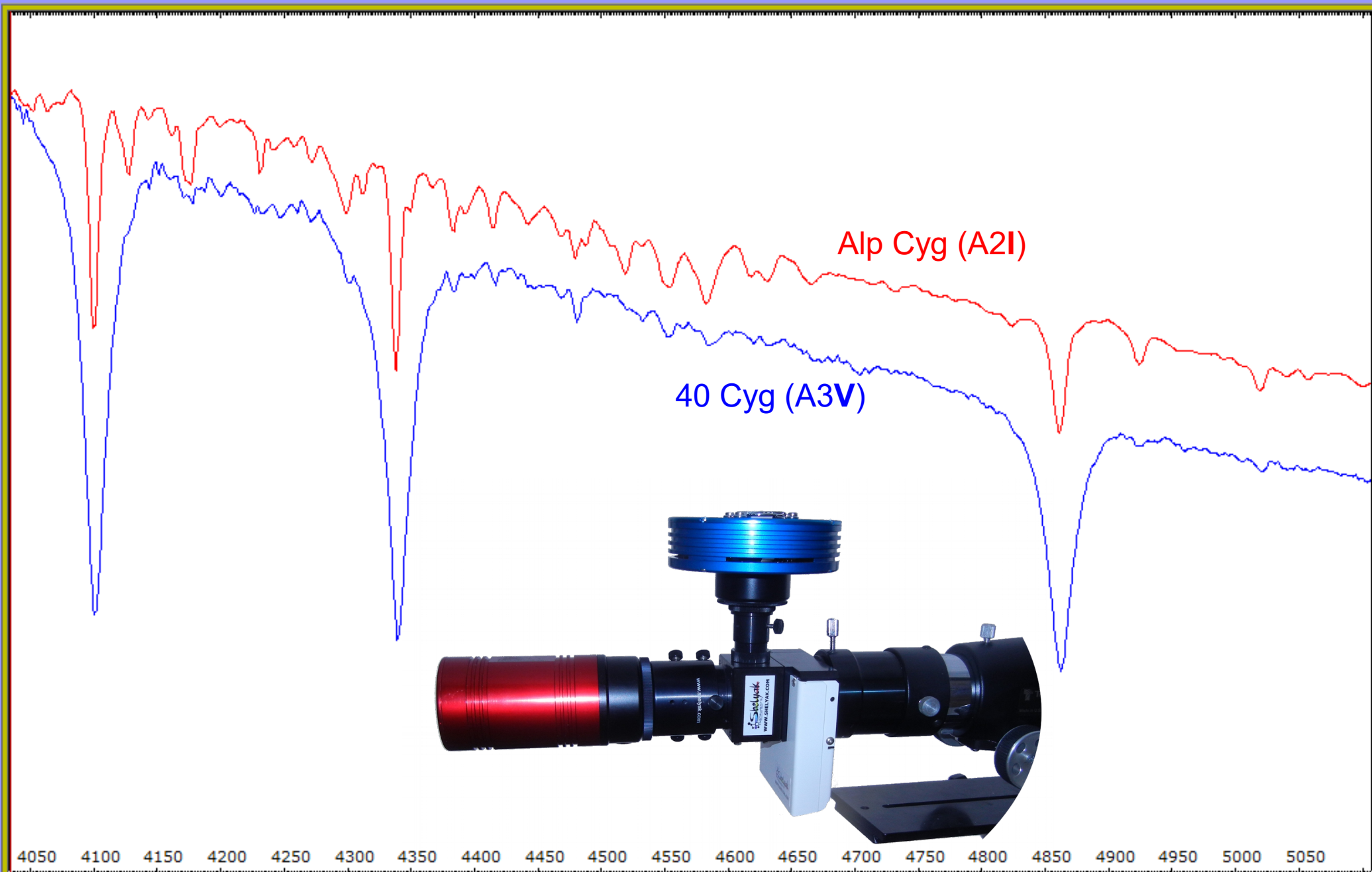
40 Cyg  
A3V

the Cyg  
F4V

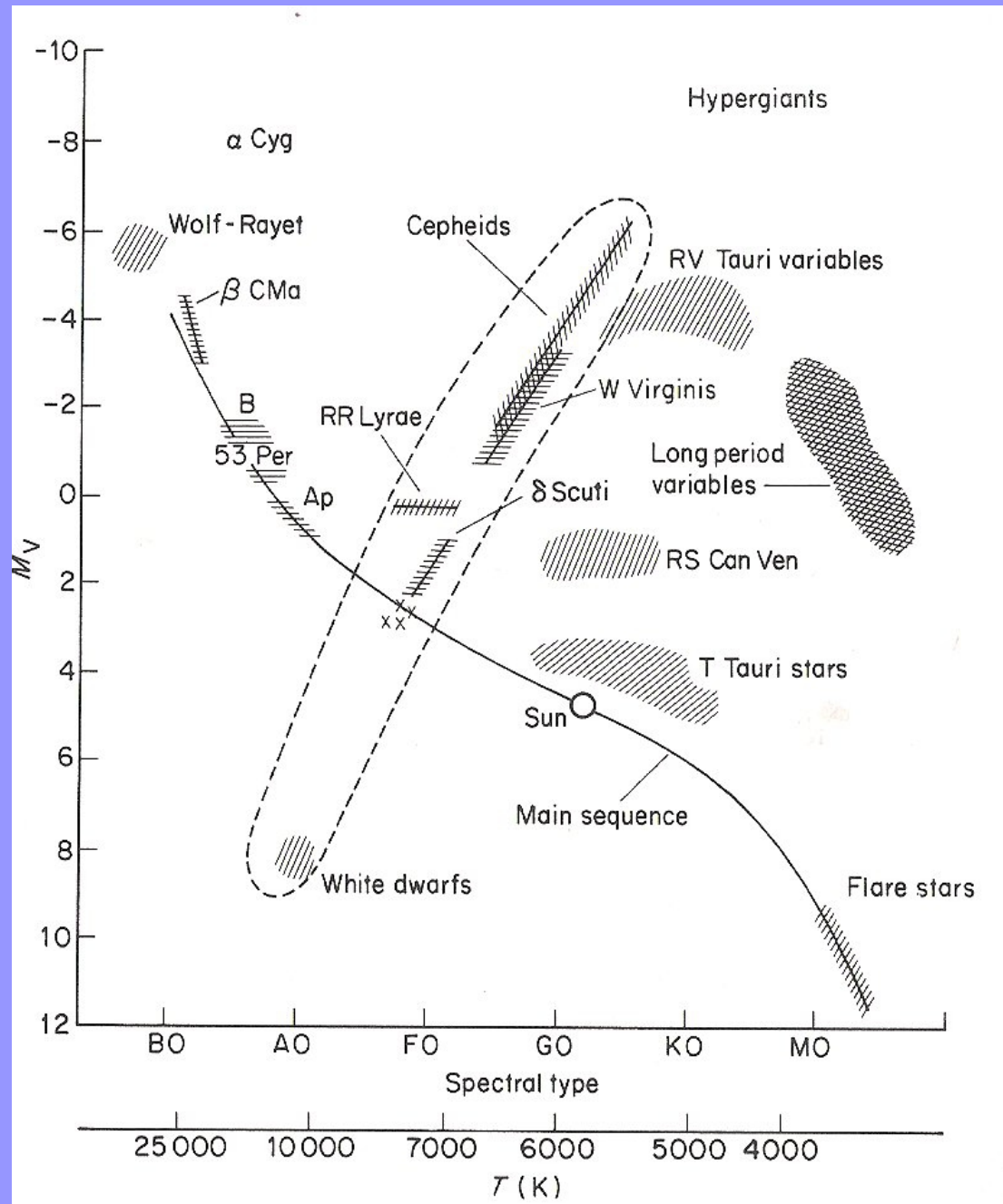
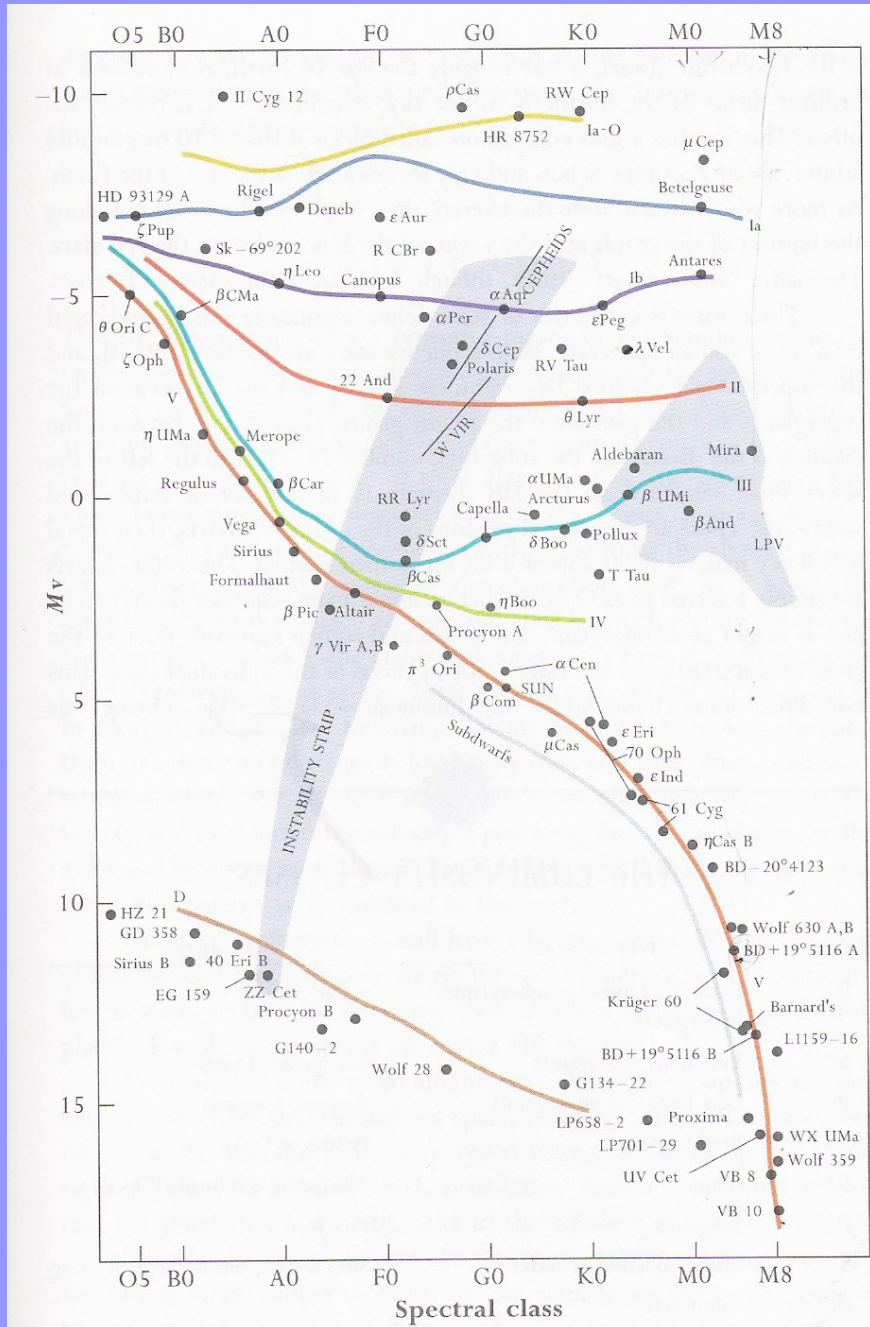
19 Cyg  
M2IIIa



# Luminosity class

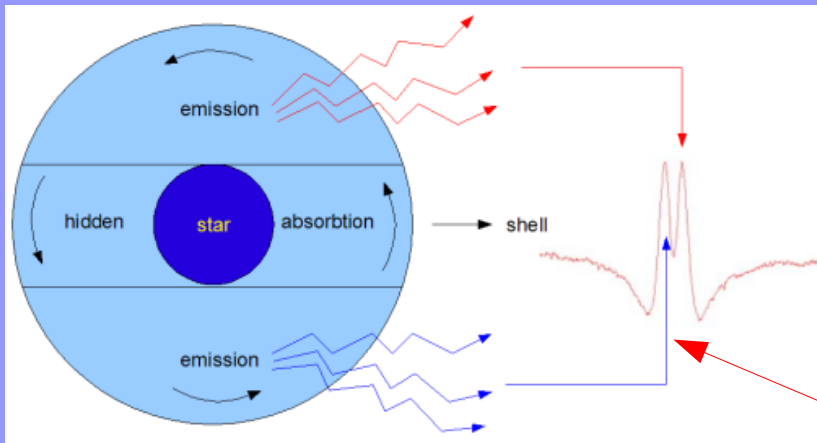
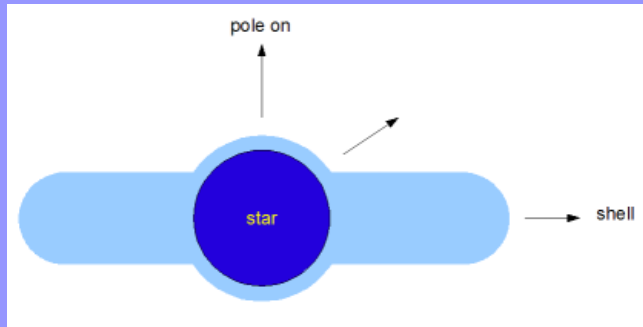


# Hertzspring-Russell diagram

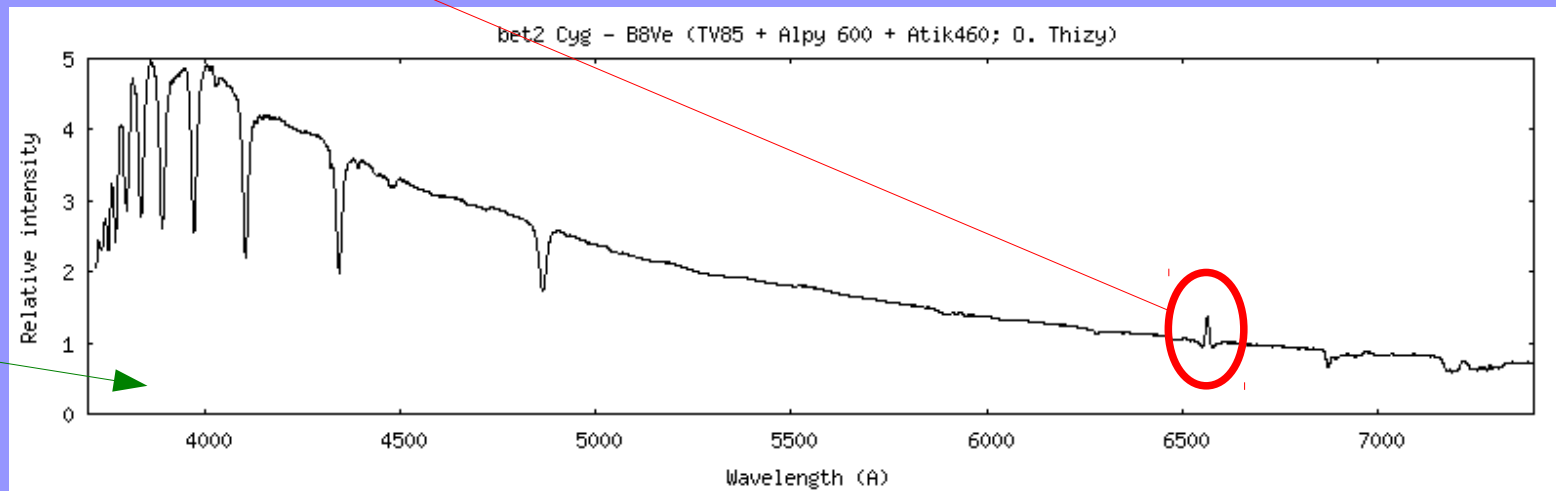




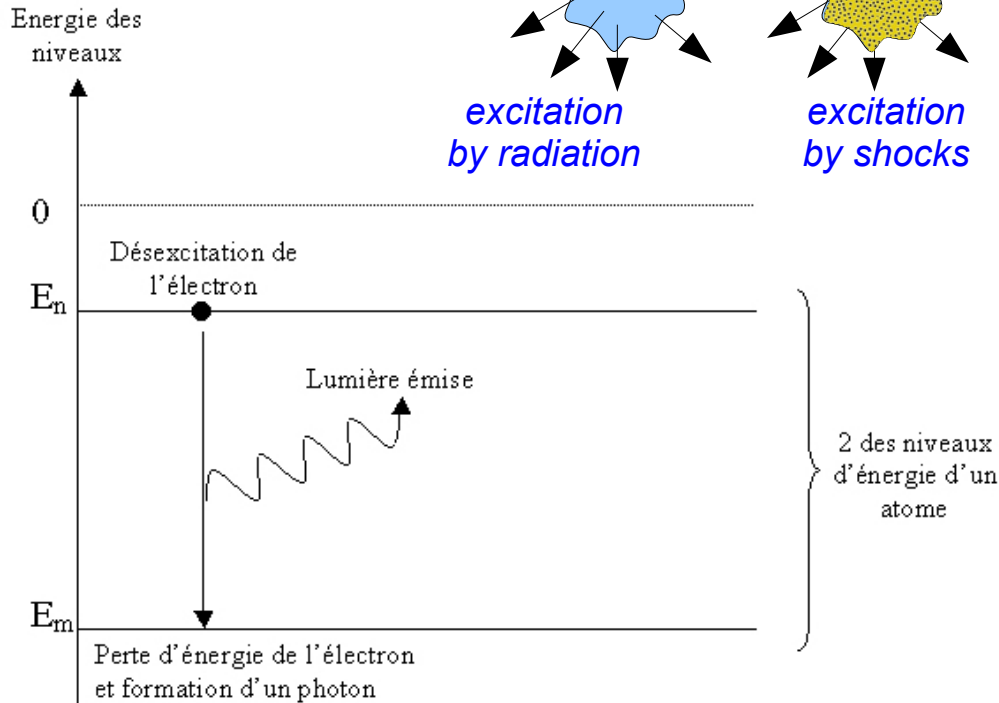
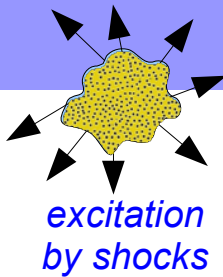
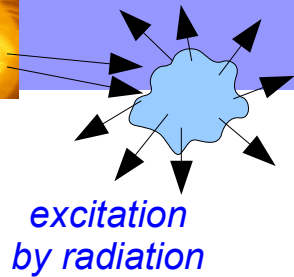
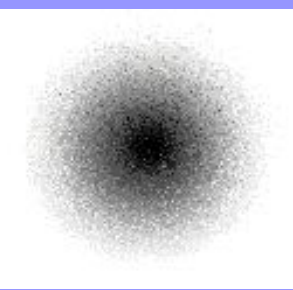
# 3: emission lines



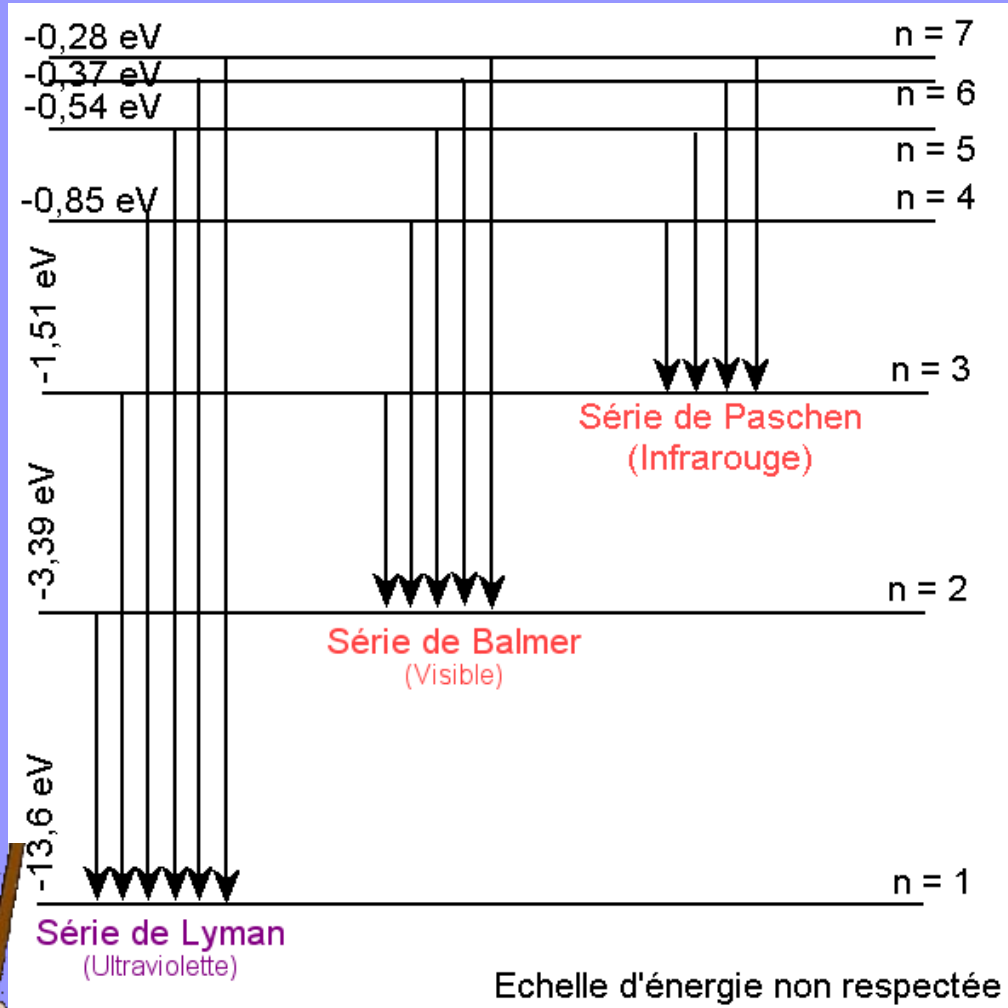
- non super-giant B type star showing or having shown a Balmer line in emission
- Discovered in 1866 by father Secchi: gamma Cas, beta Lyrae...
- Disk of matter ejected from the star and re-emitting energy through emission line



# Emission lines physics

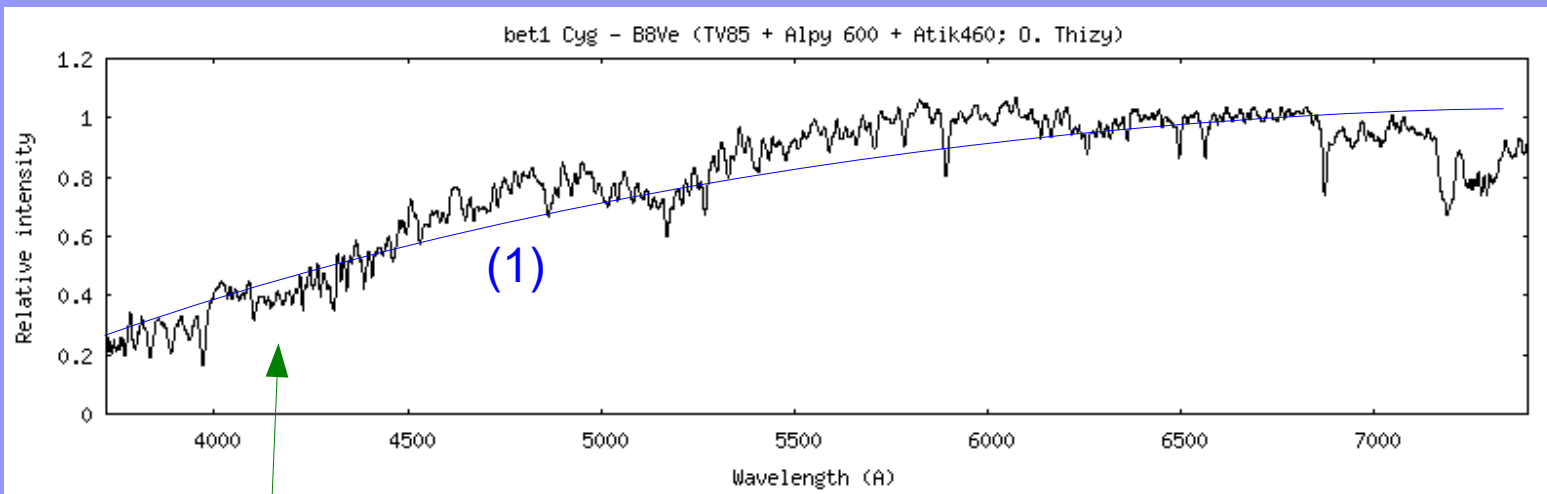


$$\Delta E = |E_n - E_m| = h\nu = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{\Delta E}$$

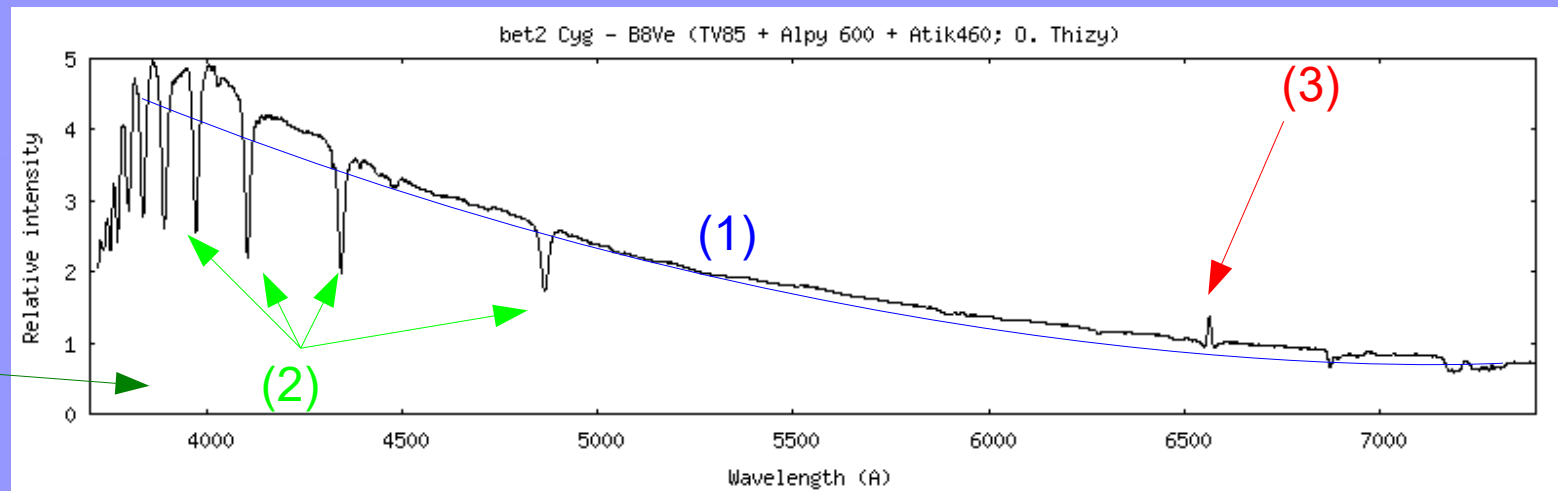


*Exemple for the hydrogen atom*

# Summary

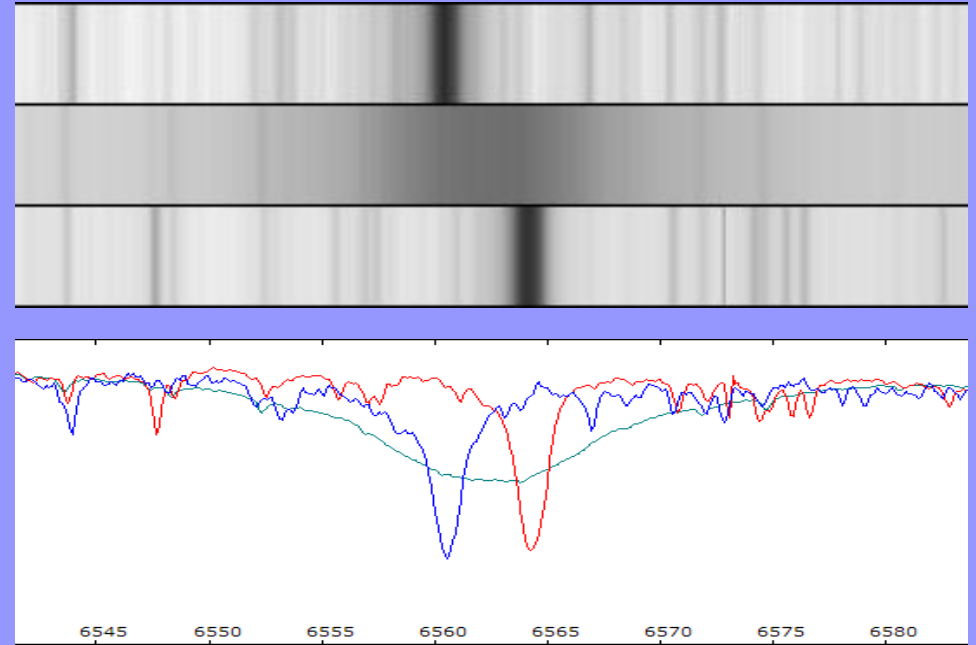
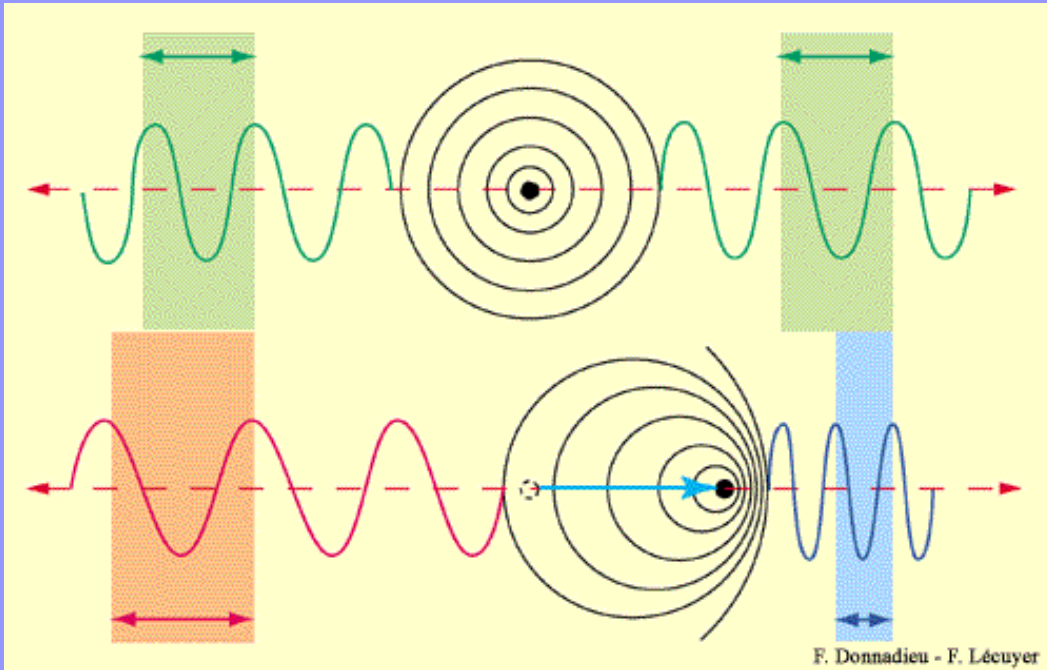


- (1) Overall profile = effective Planck temperature
- (2) Energy absorption = stellar atmosphere
- (3) Energy emission = circumstellar disk



...thanks Mr Kirchhoff !

# Doppler-Fizeau effect:

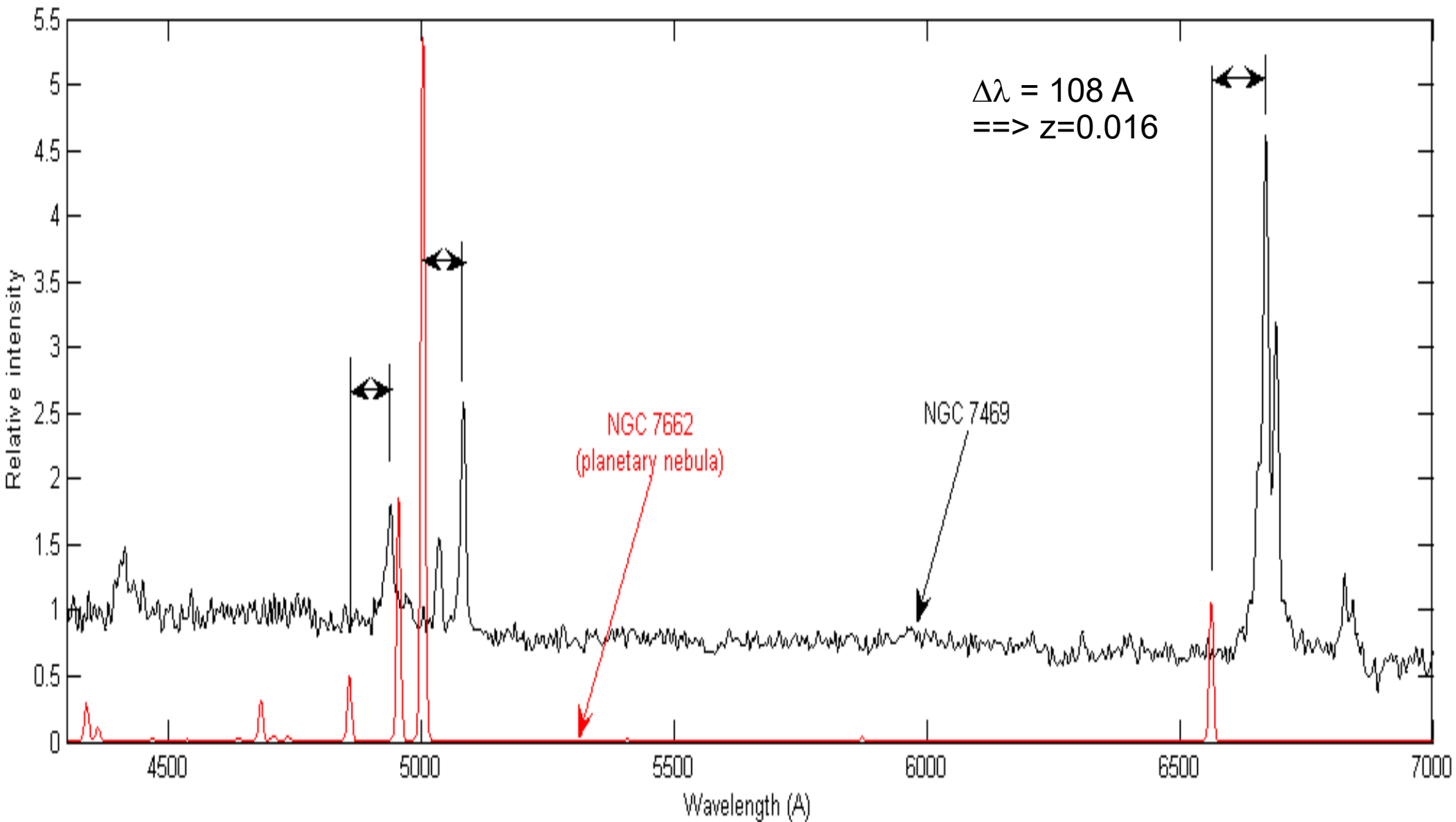


$$\frac{(\Delta \lambda)}{\lambda} = \frac{v}{c}$$

Galaxies redshift  
=  
Expansion of our Universe !

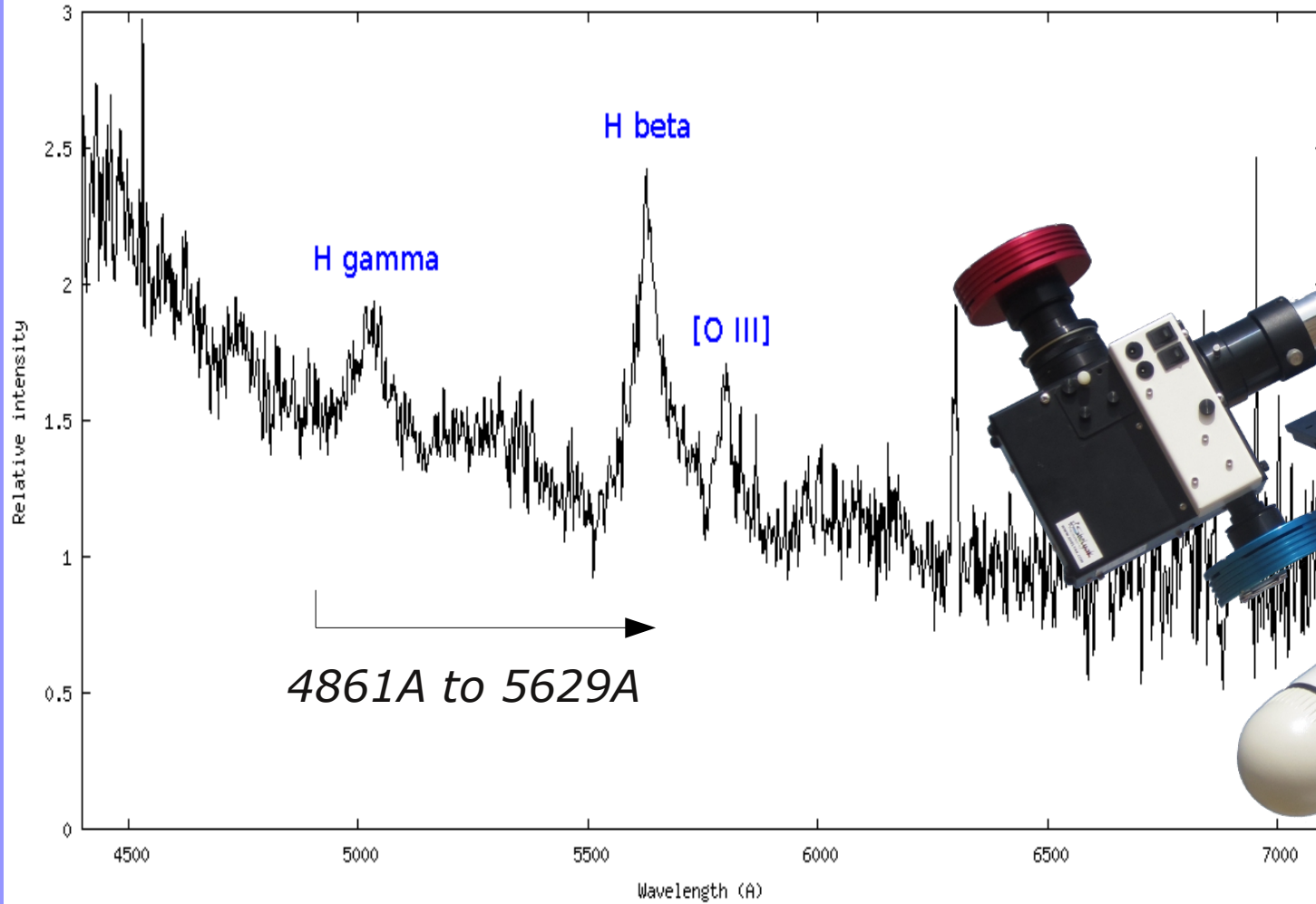


# Galaxies redshift



# 3C273 quasar

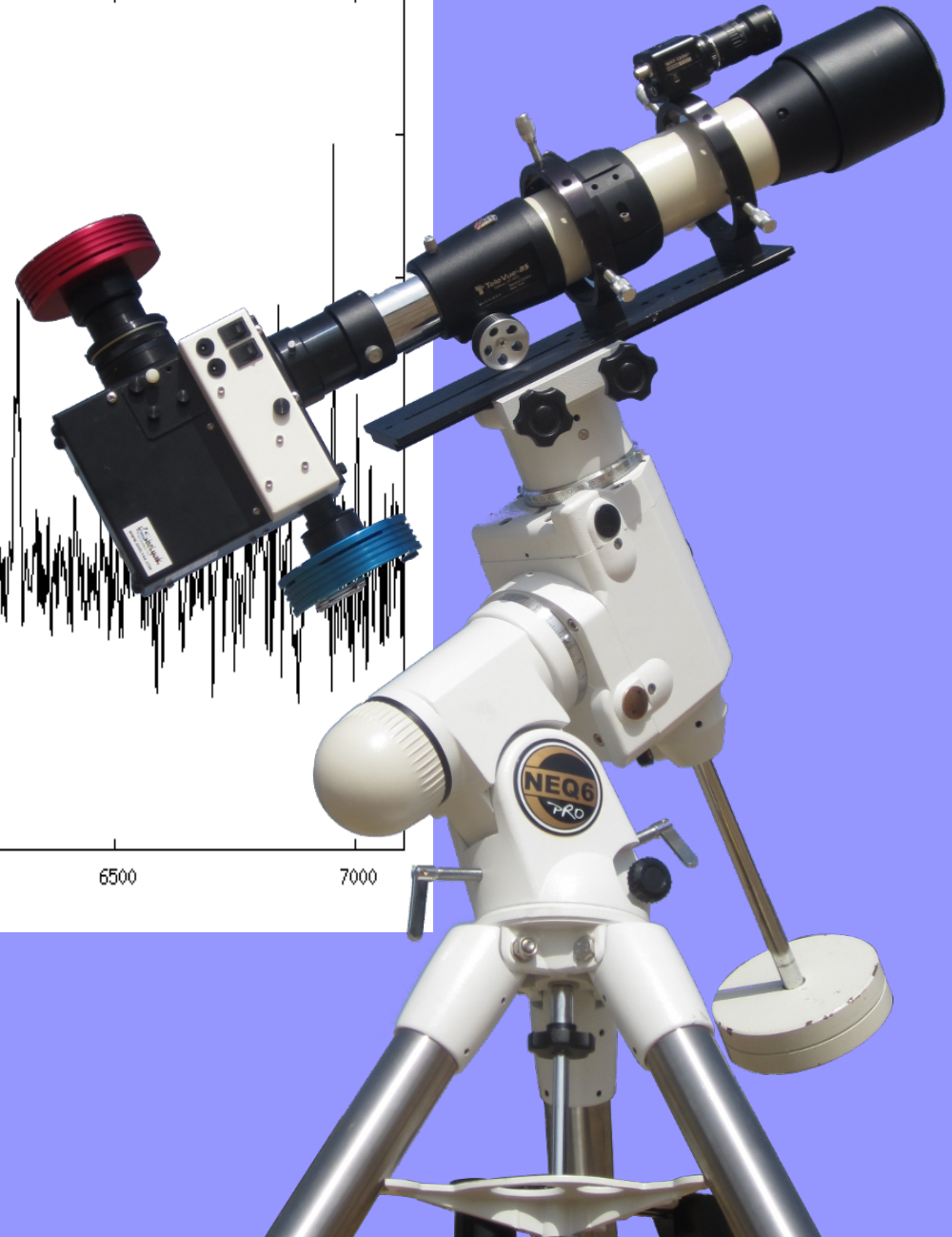
3C273 [O. Thizy / TV85+LISA R=1000 / 2h exposure]



*Hbeta red-shifted from 4861Å to 5629Å :*

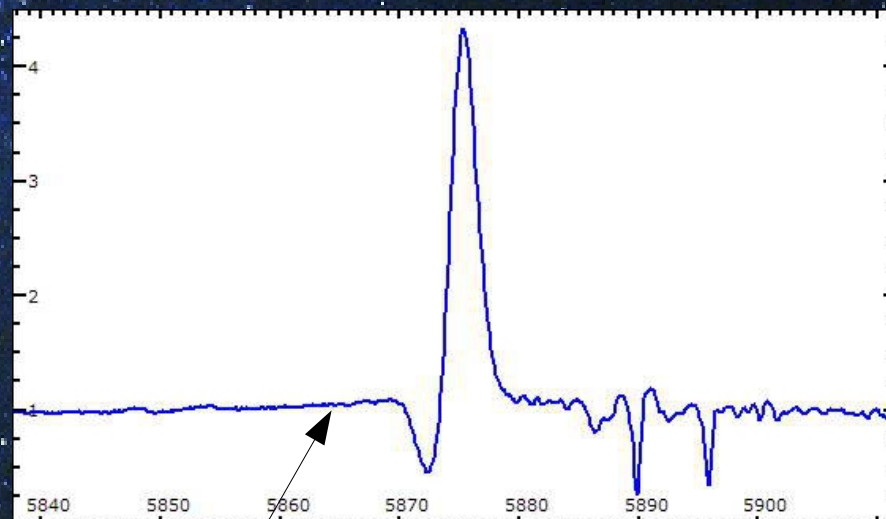
$$z = (5629.27/4861.32) - 1$$

$$z = 0.158$$

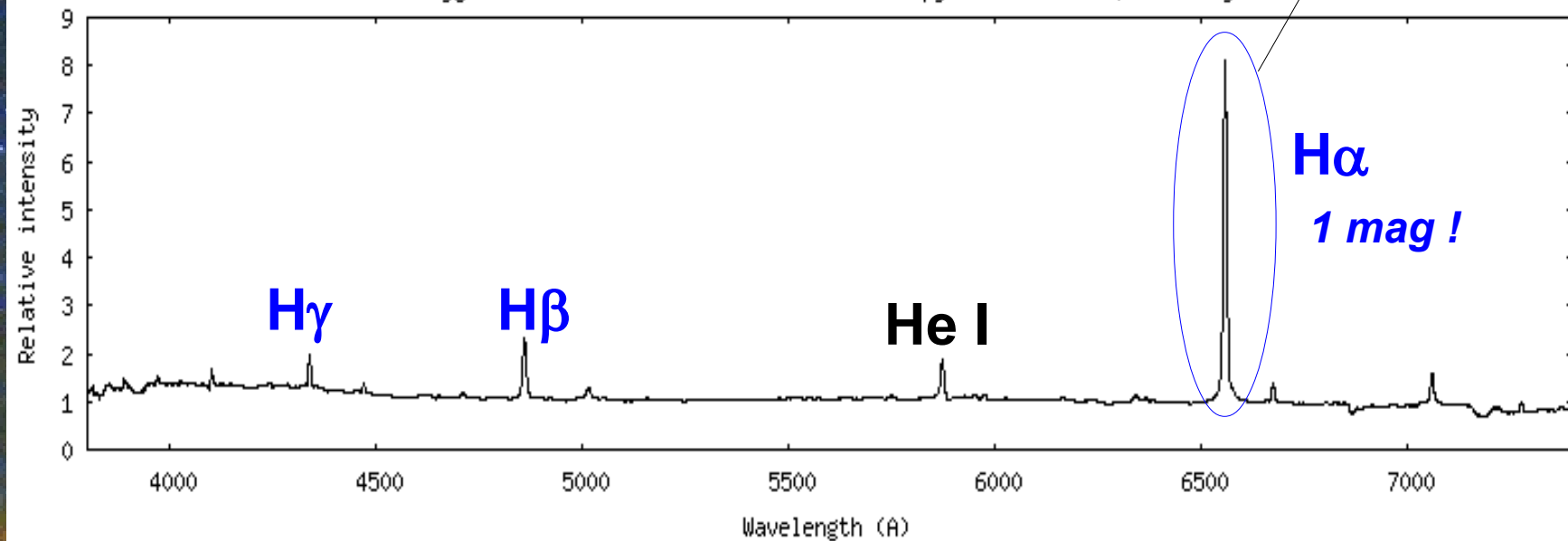


# P Cygni Luminous Blue Variable

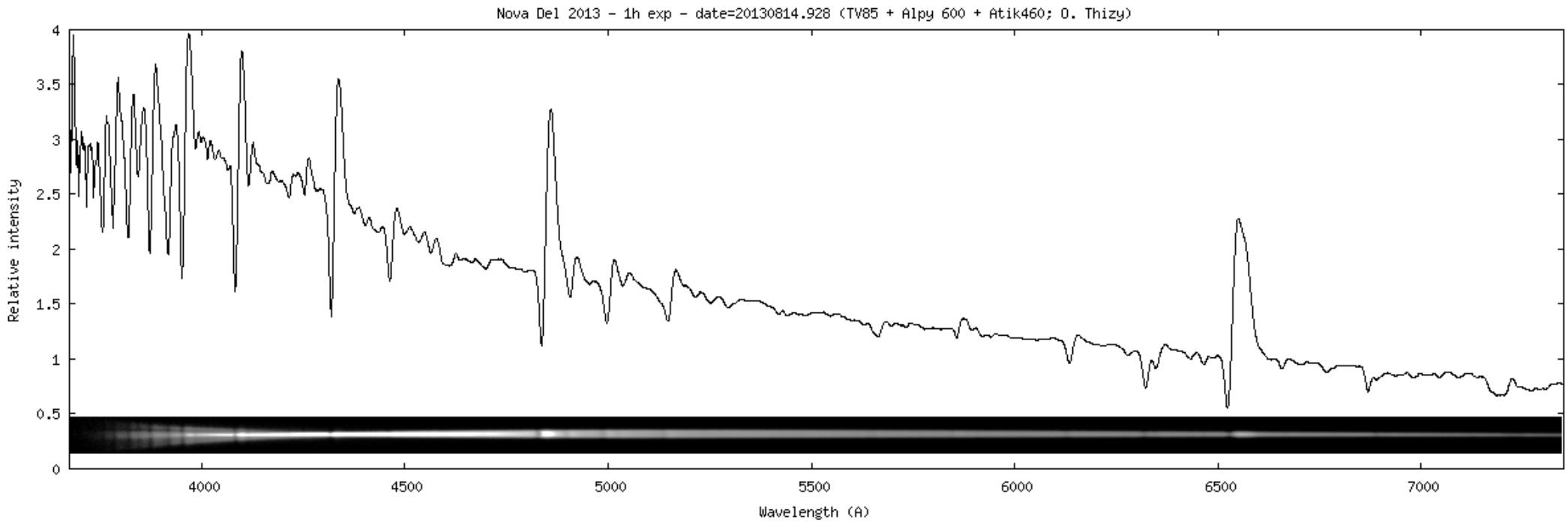
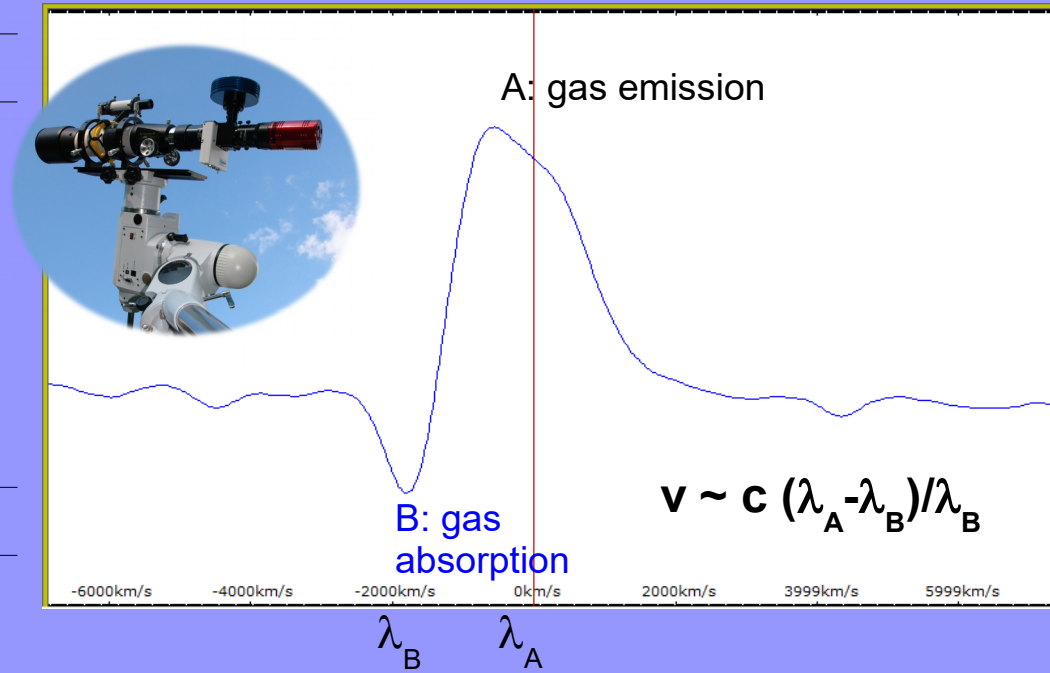
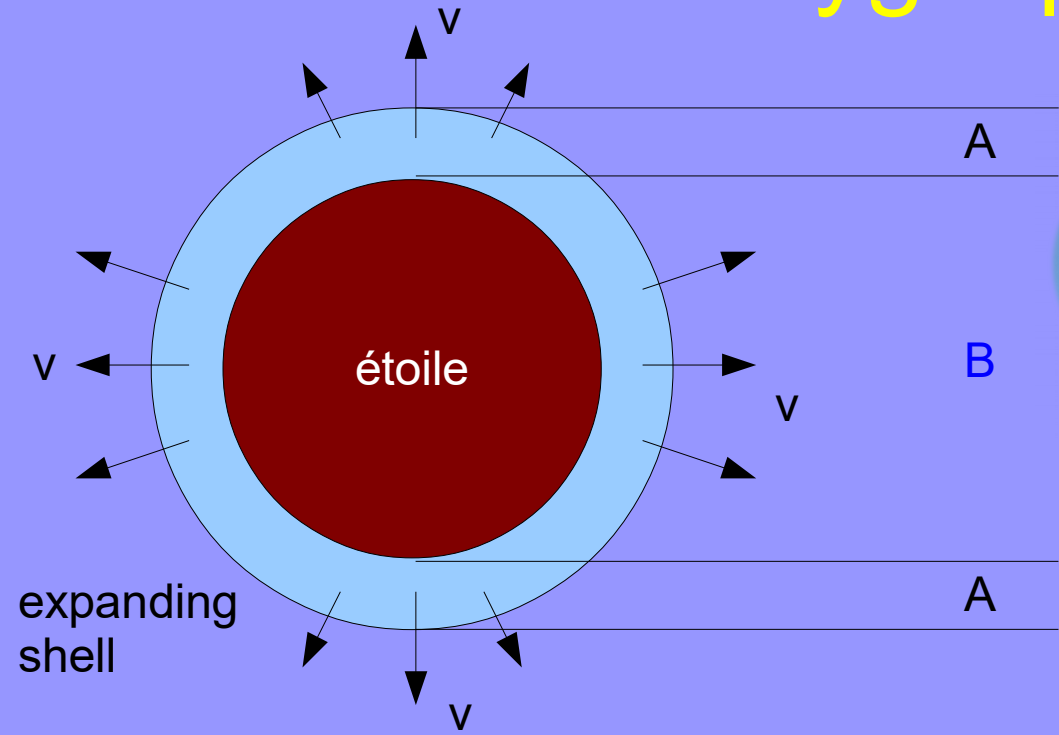
P Cygni



P Cygni - Luminous Blue Variable (TV85 + Alpy 600 + Atik460; O. Thizy)

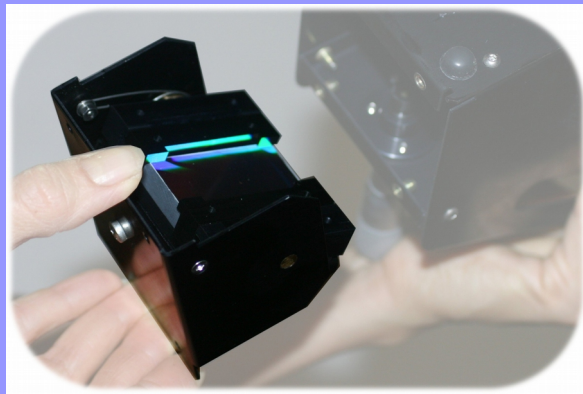


# P Cygni profile / Doppler effect

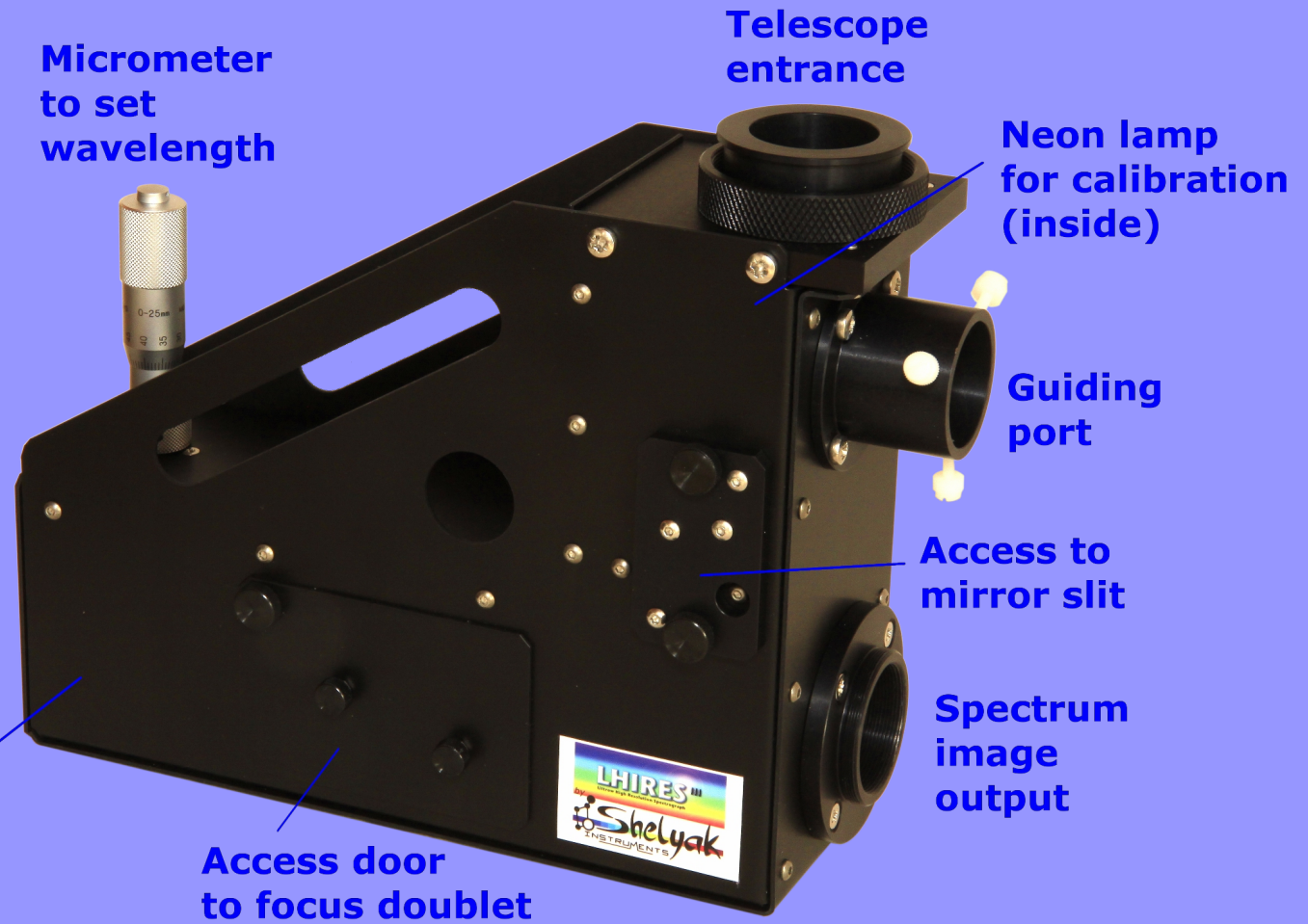




# L hires III high-resolution spectrogr.

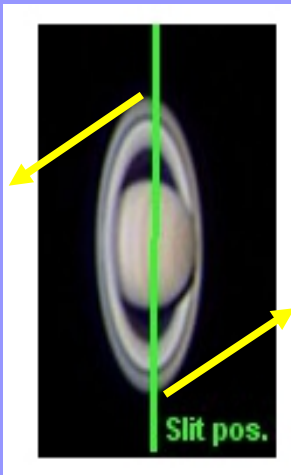
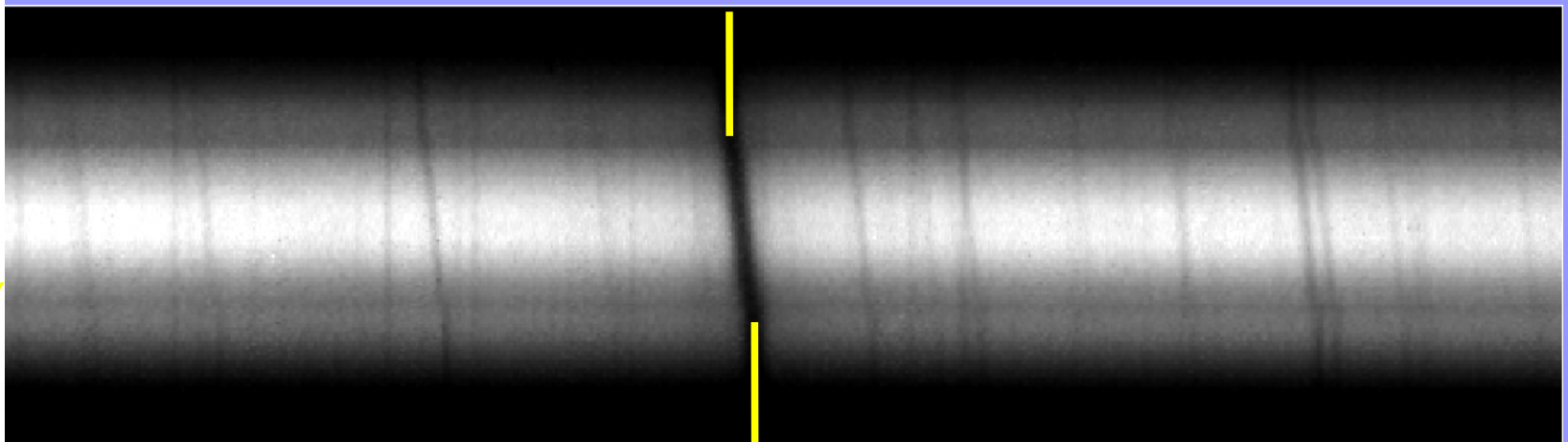
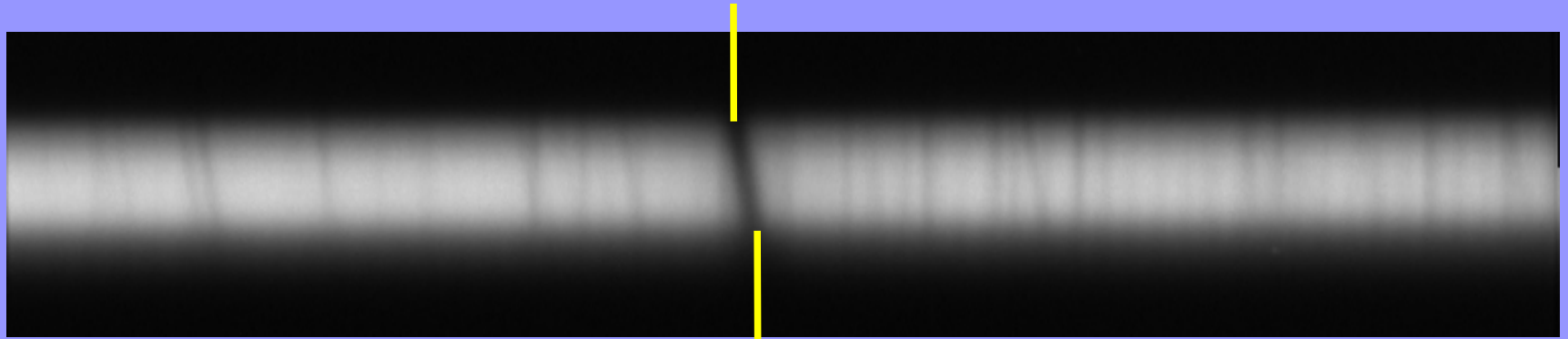


Interchangeable gratings



		2400	1200	600	300	150
Resolution	Å	0,3	1	2,5	5	11
	km/s	18	50	110	230	500
Power of Resolution (R)		17000	6000	2700	1300	600
Spectral domain	Å	85	250	550	1100	2300
Limiting magnitude		5	6	7	8	9

# Planet's rotation



Saturn:

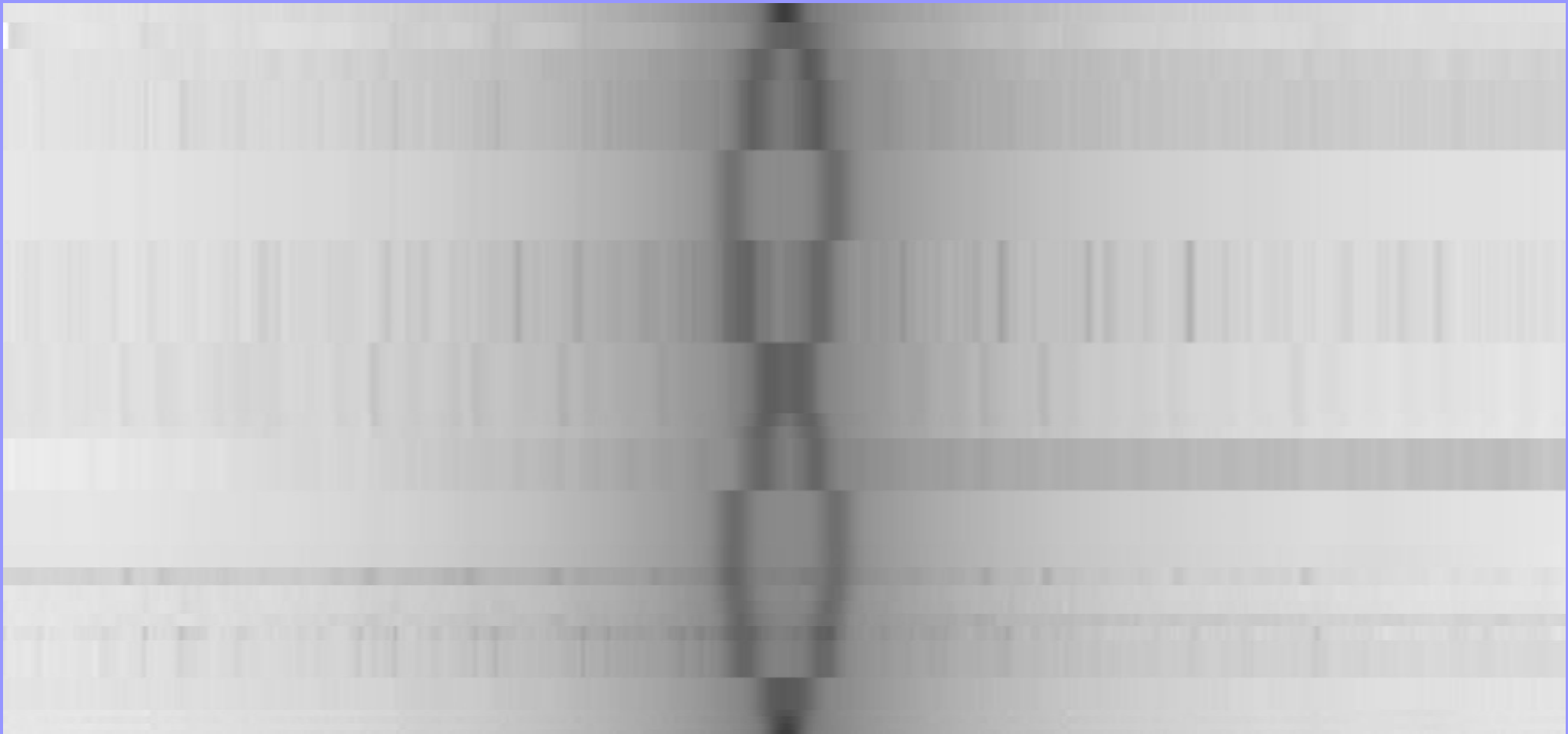
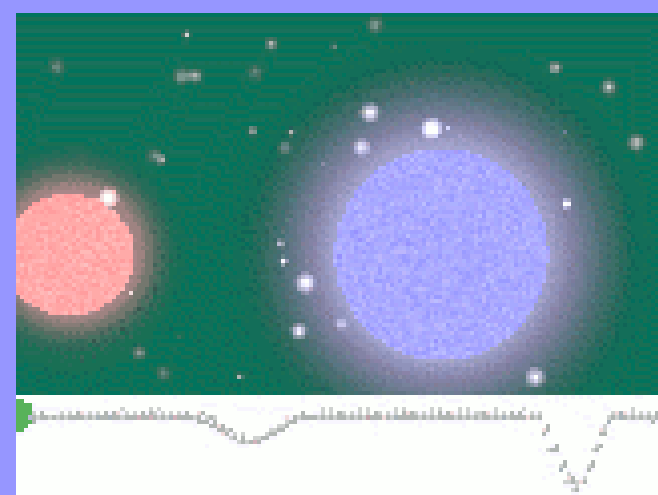
Shift = 7 pixels = 8,8 km/s

Period of 10,6 h  $\gg$  R = 107511 km

$$T^2 = \frac{(4\pi^2)}{(G(m_1 + m_2))} a^3$$

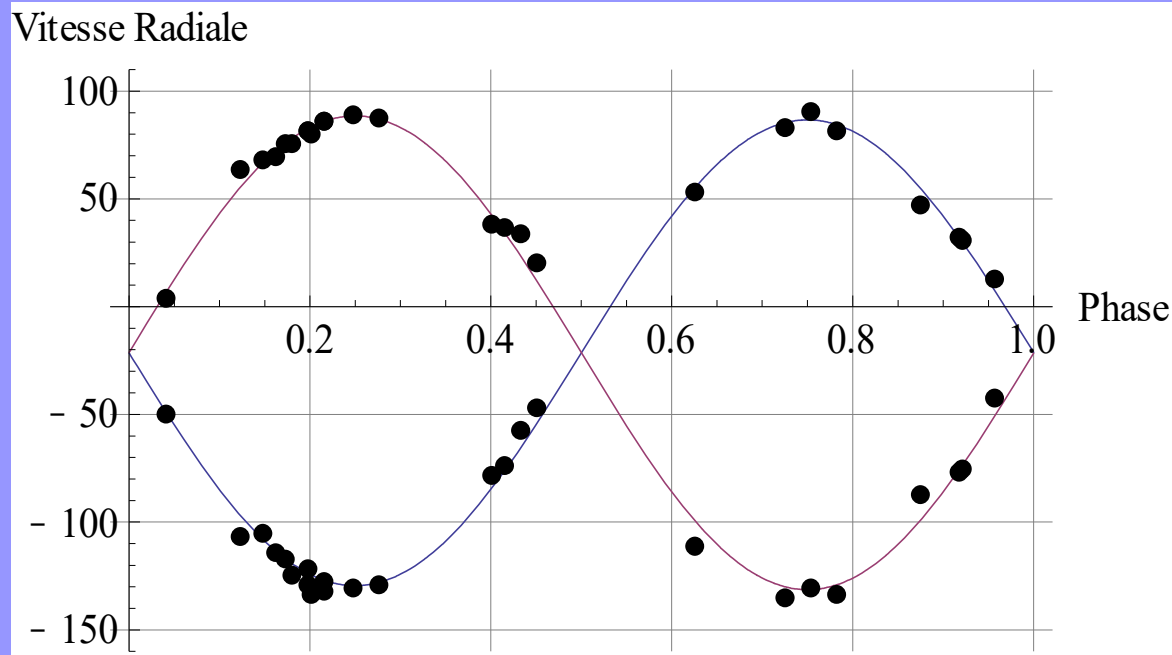
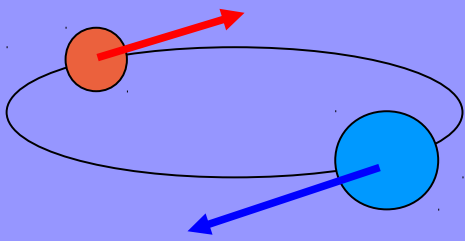
$$\frac{(\Delta\lambda)}{\lambda} = \frac{v}{c}$$

# Spectroscopic binaries



*Spectrogrammes de Beta Auriga (30 spectres sur 2006/2007) / O. Thizy et al.*

# Spectroscopic binaries



Paramètres orbitaux	Cette étude (VSpec)	Cette étude (PeakFit)	Nordström (1994)
$K_1$ (km.s <sup>-1</sup> )	$106 \pm 3$	$108 \pm 3$	$107.75 \pm 0.40$
$K_2$ (km.s <sup>-1</sup> )	$108 \pm 3$	$110 \pm 3$	$111.25 \pm 0.40$
$M_1/M_2$	$0.98 \pm 0.06$	$0.98 \pm 0.06$	$0.97 \pm 0.01$
$V_\gamma$ (km.s <sup>-1</sup> )	$-20 \pm 2$	$-21 \pm 2$	$-17.0 \pm 0.4$
$a.\sin(i)$ ( $R_{\text{sol}}$ )	$16.7 \pm 0.5$	$17.1 \pm 0.6$	$17.13 \pm 0.04$
$m_1.\sin^3(i)$ ( $M_{\text{sol}}$ )	$2.02 \pm 0.06$	$2.15 \pm 0.06$	$2.19 \pm 0.02$
$m_2.\sin^3(i)$ ( $M_{\text{sol}}$ )	$1.99 \pm 0.06$	$2.11 \pm 0.06$	$2.12 \pm 0.02$

Share your passion

...or how it is FUN to share & teach



# Visual solar spectrum



# Charlie Bates Solar Project (Steve Ramsden)

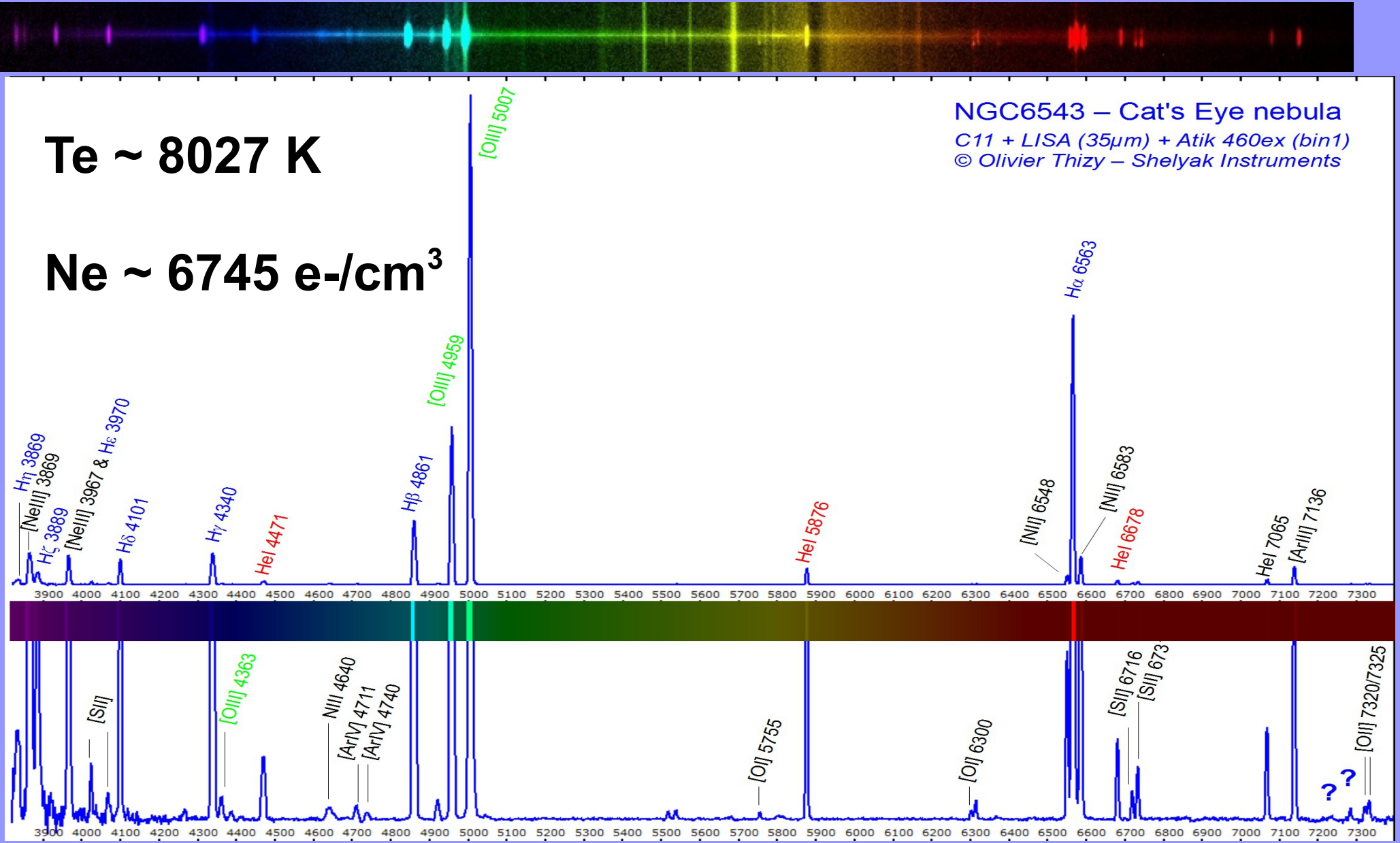


Tunisia



Costa Rica

# High School level projects



Cf: [http://www.shelyak.com/dossier.php?id\\_dossier=77](http://www.shelyak.com/dossier.php?id_dossier=77)

...and all the „learning“ observation shown before !

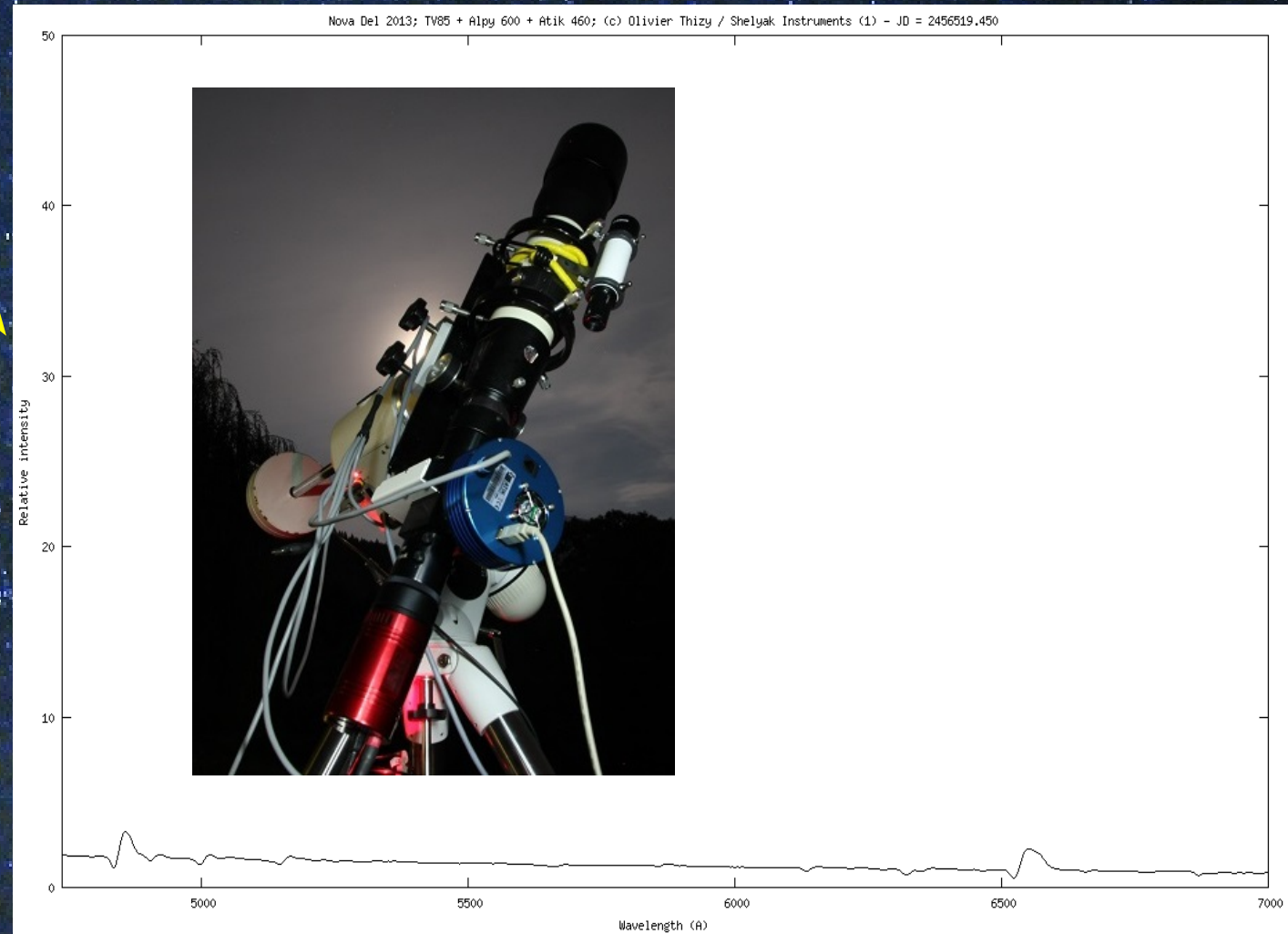
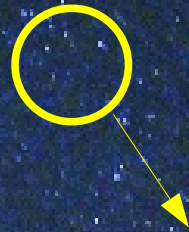


# Nova Del 2013

*...or how it is FUN to contribute  
with a professional astronomer*

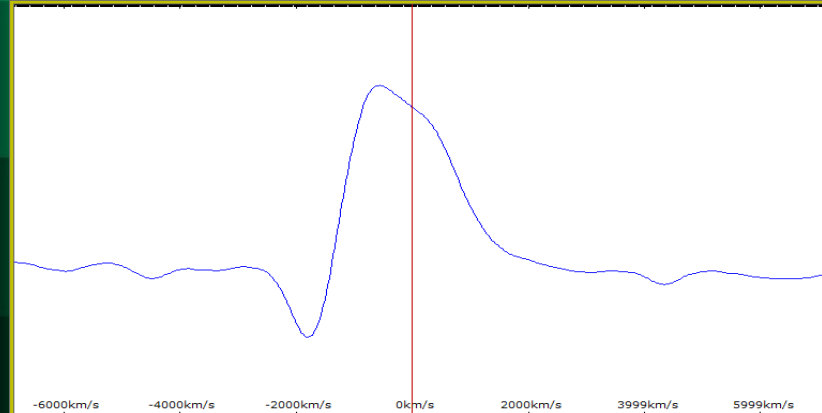


# Nova Del 2013



# Nova Del 2013

„P Cygni“ profile



20130814.928

20130815.865

20130816.862

20130817.838

20130818.874

20130819.985

20130820.829

20130821.814

20130822.848

20130823.806

# Nova Del 2013: Pro-Am campaign




- Over 1100 spectra, 40 people active for the nova spectral follow up
- An excellent collaboration with a professional astronomer - Steve Shore
- A structured campaign: <http://www.astrosurf.com/aras/novae/Nova2013Del.html>

# Nova Del 2013: Pro-Am campaign

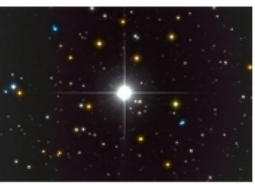
**Nova Del 2013**

www.astrosurf.com/aras/novae/Nova2013Del.html

**NOVA Del 2013 = V339 Del**  
An amateur spectroscopic survey of a bright classical CO Nova



Coordinates: R.A. 20 23 40.74 Dec. +00 46 04.1



August 16th, 08 star credit: Mike Mosby/Sloan Observatory

http://www.a...el-2013.htm

www.astrosurf.com/aras/Aras\_DataBase/Novae/Nova-Del-2013.t


Number of spectra 1096  
First Spectrum 14/08/2013  
Last Spectrum 07/01/2014

#	Date	Start		Observer	Site
		Time (UT)	J.D.		
1	14/08/2013	19:45:16	2456519.344	OlivierGarde	Observato
2	14/08/2013	20:45	2456519.385	OlivierGarde	Observato
3	14/08/2013	21:12:32	2456519.396	TdeFrance	MEZI
4	14/08/2013	21:12:32	2456519.396	ThibaultdeFrance	Mez
5	14/08/2013	21:38:09	2456519.405	J.Guarro	STAMARIAD
6	14/08/2013	21:48:03	2456519.419	TdeFrance	MEZI
7	14/08/2013	21:48:35	2456519.412	J.Guarro	STAMARIAD
8	14/08/2013	21:58:59	2456519.427	J.Guarro	STAMARIAD
9	14/08/2013	22:07	2456519.443	OlivierGarde	Observato
10	14/08/2013	22:09:26	2456519.427	J.Guarro	STAMARIAD
11	14/08/2013	22:15	2456519.449	OlivierThizy	Revel38
12	14/08/2013	22:19:50	2456519.434	J.Guarro	STAMARIAD
13	14/08/2013	22:40:24		P.J.H.Gerlach	HoutenThe
14	14/08/2013	22:54:54	2456519.458	J.Guarro	STAMARIAD
15	14/08/2013	22:59:49	2456519.474	TdeFrance	MEZI
16	14/08/2013	23:06:27	2456519.466	J.Guarro	STAMARIAD
17	14/08/2013	23:07	2456519.485	OlivierGarde	Observatoirede
18	14/08/2013	23:15:12	2456519.472	J.Guarro	STAMARIADEMONT
19	14/08/2013	23:24:02	2456519.479	J.GUARRO	STAMARIADEMONT
20	14/08/2013	23:40:22	2456519.489	J.GUARRO	STAMARIADEMONT
21	14/08/2013	23:45:07	2456519.507	TdeFrance	MEZE
22	14/08/2013	23:49	2456519.514	OlivierThizy	Revel38420
23	15/08/2013	00:02:34	2456519.504	J.GUARRO	STAMARIADEMONT
24	15/08/2013	0:09	2456519.527	OlivierGarde	Observatoirede
25	15/08/2013	00:09:40	2456519.509	J.GUARRO	STAMARIADEMONT
26	15/08/2013	00:16:45	2456519.514	J.GUARRO	STAMARIADEMONT
27	15/08/2013	00:23:54	2456519.519	J.GUARRO	STAMARIADEMONT

**Novae Amateur Spectrosc...**

www.astrosurf.com/aras/novae/InformationLetter/InformationLetter.html

**Eruptive Stars Spectroscopy**  
Novae, Symbiotics, Cataclysmics, Supernovae



**Information letter Supp n° 2 15-03-2015**

- Compilation of Steve Shore's notes for ARAS group in 2013 & 2014

**2015**

**Information letter n° 2015-06 06-09-2015**

- Eclipsing systems as probes of atmospheric structure by Steve Shore

**Information letter n° 2015-05 19-07-2015**

- Nova Sgr 2015 No. 2 forms dust: the event and the physics by Steve Shore  
- A photo-ionized nebula observed around the dwarf nova PNW J03093063+2638031 by Paolo Berardi

**Information letter n° 2015-04 31-04-2015**

- A note on applicability of low-resolution spectra of CH Cyg by Augustin Skopal  
- Some comments on the currents beasts (Nova Sgr 2015B, Nova Sco 2015, ...) by Steve Shore  
- Now back to the discussions of winds and lines by Steve Shore

**Information letter n° 2015-03 31-03-2015**

- A comment on the recent evolution in the line spectrum of CH Cygni by Dr Augustin Skopal  
- The events during the optically thick stage by Dr Steve Shore  
- Spectroscopy of comet C/2014 Q2 (Lovejoy) by Paolo Berardi

**Information letter n° 2015-02 28-02-2015**

- More on Plasma Diagnostics and Line Formation - ionization freeze-out in more detail (Dr Steve Shore)  
- Spectroscopy of planetary nebulae - 150 years later... Olivier Thizy, François Teysseier

**Information letter n° 2015-01 31-01-2015**

- Introduction to CH Cygni campaign (Dr Augustin Skopal)

#	Date	Time (UT)	J.D.	Observer	Site	Wavelength (Å)	Flux	Wavelength (Å)	Flux	Wavelength (Å)	Flux	
1	14/08/2013	19:45:16	2456519.344	OlivierGarde	Observatoirede	C14-Eshel-ATIK460EX	10000	4185 - 7318	3683	novadel2013_20130814_964_full.fit	zip4	v
18	14/08/2013	23:15:12	2456519.472	J.Guarro	STAMARIADEMONT	M6REMOTATIK460EX	755	3715 - 7431	528	novadel2013_20130814_969_J.GUARRO.fit		v
19	14/08/2013	23:24:02	2456519.479	J.GUARRO	STAMARIADEMONT	M6REMOTATIK460EX	755	3715 - 7431	688	novadel2013_20130814_975_J.GUARRO.fit		v
20	14/08/2013	23:40:22	2456519.489	J.GUARRO	STAMARIADEMONT	M6REMOTATIK460EX	772	3715 - 7431	421	novadel2013_20130814_986_J.GUARRO.fit		v
21	14/08/2013	23:45:07	2456519.507	TdeFrance	MEZE	C9_2SLISAATIKTTITA	614	4868 - 6798	2959.001	novadel2013_20130814_4897_TdeFrance.fit		v
22	14/08/2013	23:49	2456519.514	OlivierThizy	Revel38420	TV85Alpy600Atik460E	607	3676 - 7350	3695	novadel2013_20130814_993.fit		v
23	15/08/2013	00:02:34	2456519.504	J.GUARRO	STAMARIADEMONT	M6REMOTATIK460EX	741	3715 - 7431	423	novadel2013_20130815_002_J.GUARRO.fit		v
24	15/08/2013	0:09	2456519.527	OlivierGarde	Observatoirede	C14-Eshel-ATIK460EX	10000	4266 - 7318	3624	novadel2013_20130815_006_full.fit	zip5	v
25	15/08/2013	00:09:40	2456519.509	J.GUARRO	STAMARIADEMONT	M6REMOTATIK460EX	772	3715 - 7431	422	novadel2013_20130815_007_J.GUARRO.fit		v
26	15/08/2013	00:16:45	2456519.514	J.GUARRO	STAMARIADEMONT	M6REMOTATIK460EX	769	3715 - 7431	426	novadel2013_20130815_012_J.GUARRO.fit		v
27	15/08/2013	00:23:54	2456519.519	J.GUARRO	STAMARIADEMONT	M6REMOTATIK460EX	734	3715 - 7431	421	novadel2013_20130815_017_J.GUARRO.fit		v

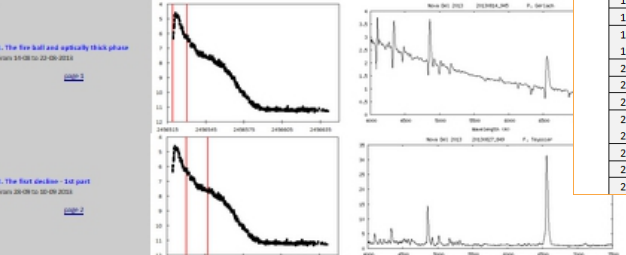
The sort of program I have in mind could not be accomplished by one person, or even one observatory... I would require co-operation between two or more observatories, and would involve the use of a CCD camera.

From the direct observation, I have not been able to get a good idea of the nature of the event... I have not been able to get a good idea of the nature of the event... I have not been able to get a good idea of the nature of the event...

Dr. B. MacLaughlin, Problems in the spectra of Nova, 1960, MNRAS

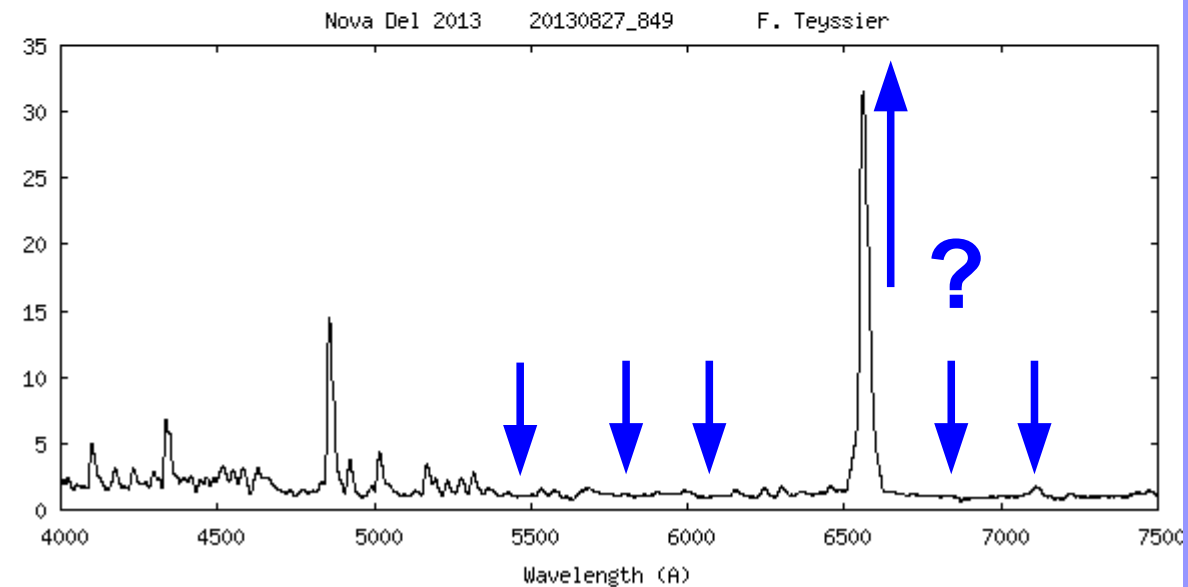
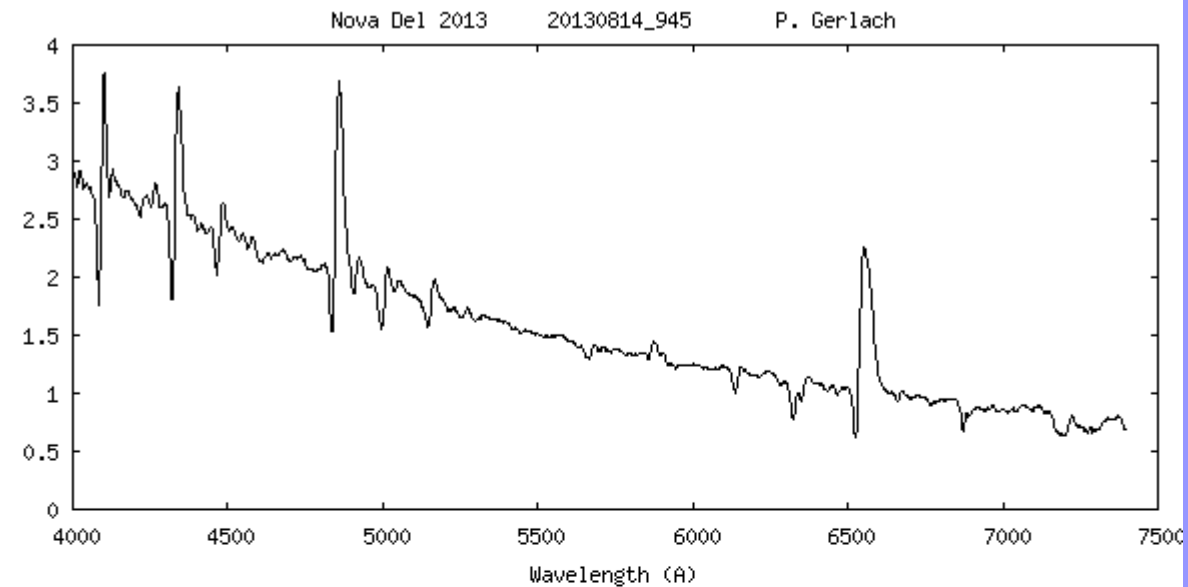
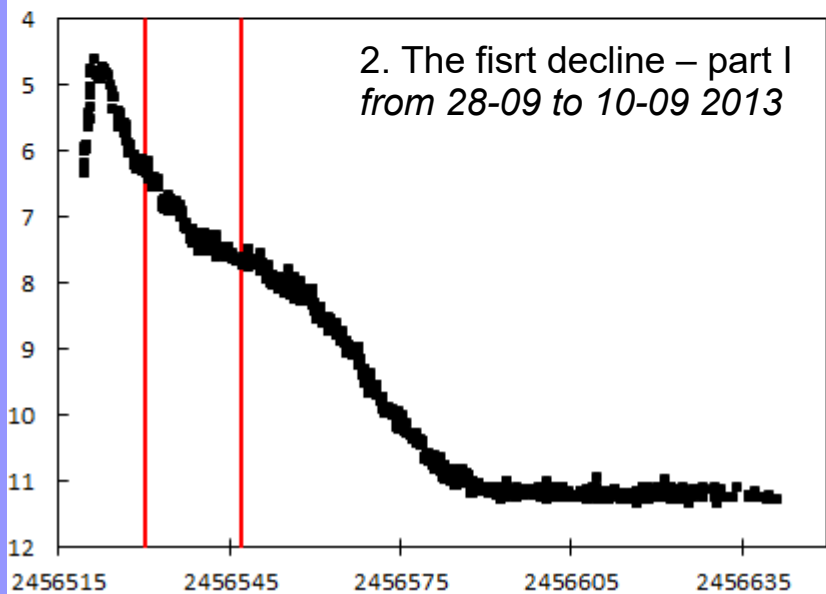
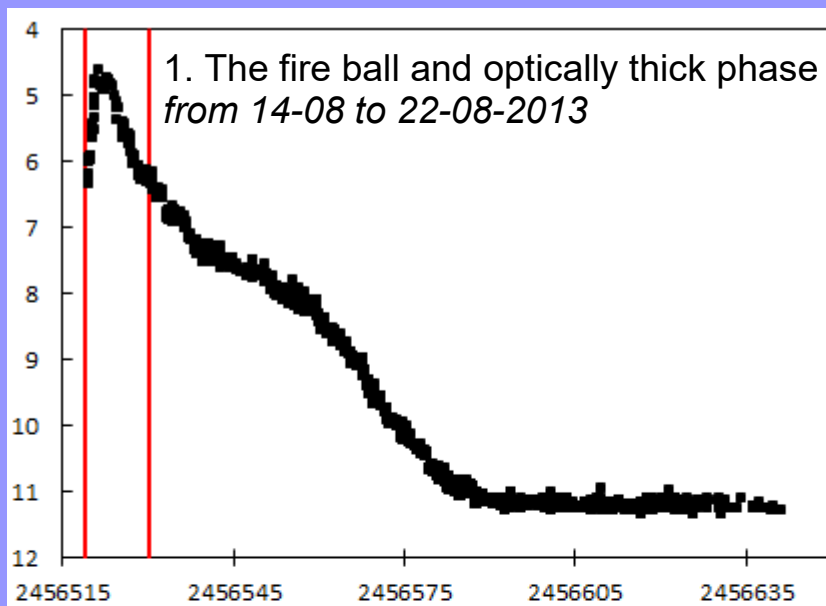


The development of the nova is described on 6 pages with Steve Shore's comment



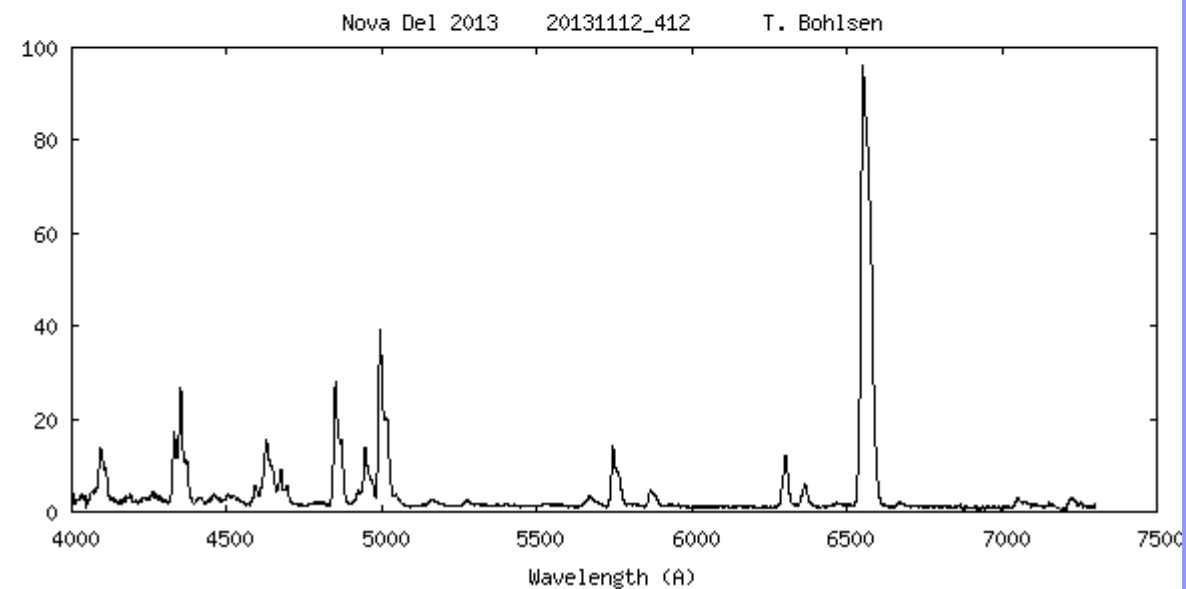
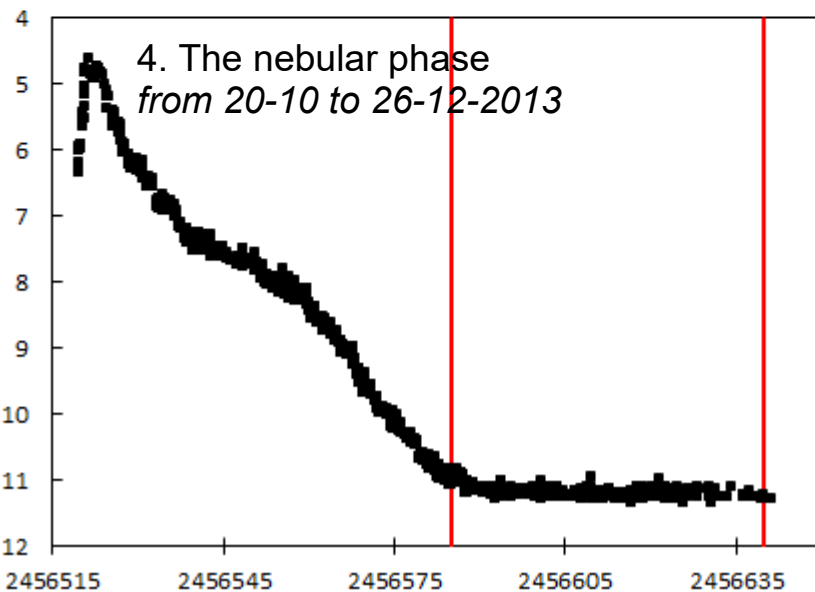
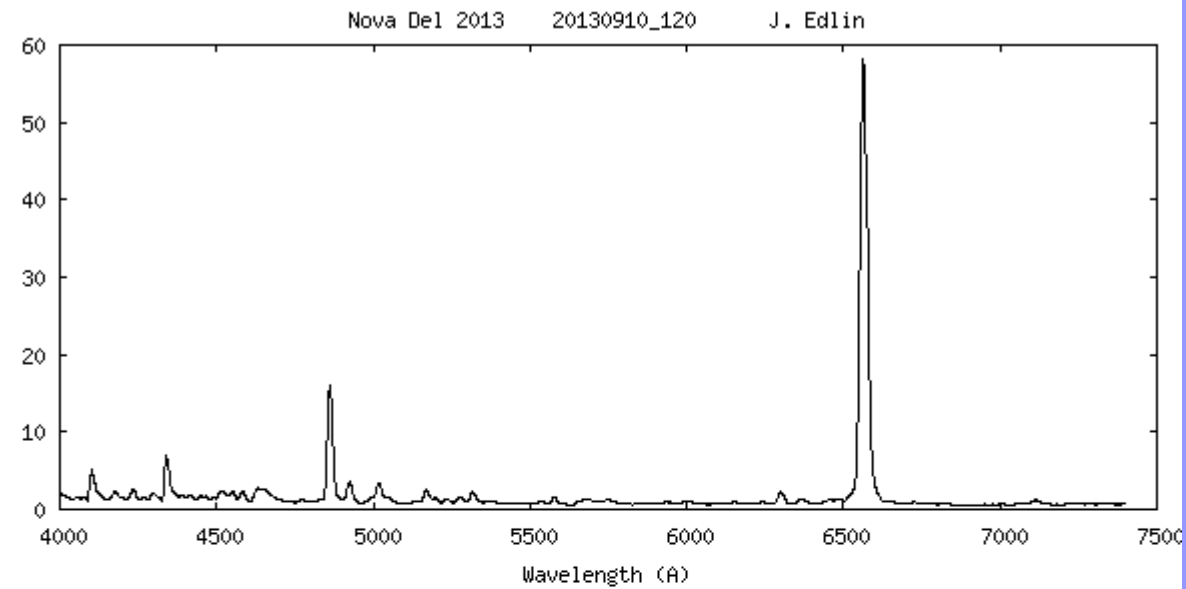
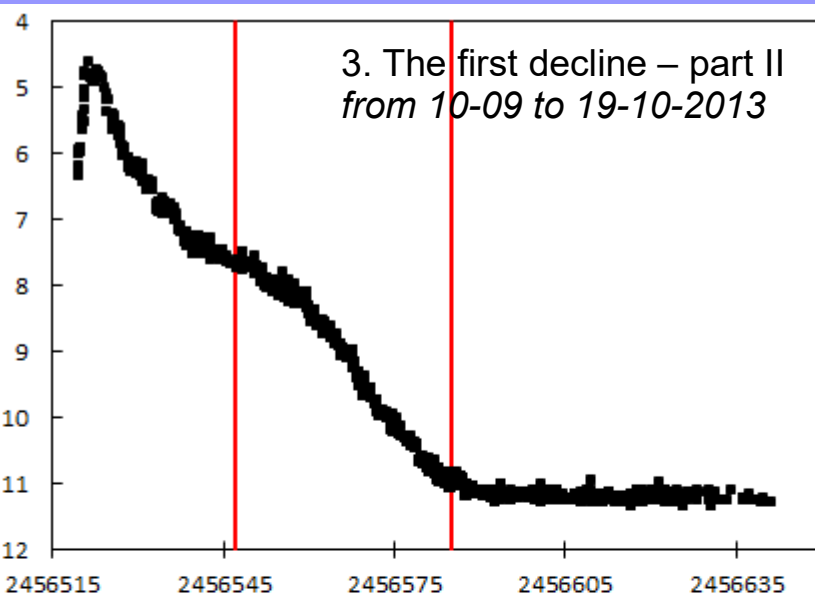
1. The first half and applying thick plate  
2. The first quarter - 1st part

# Photometry or Spectroscopy?

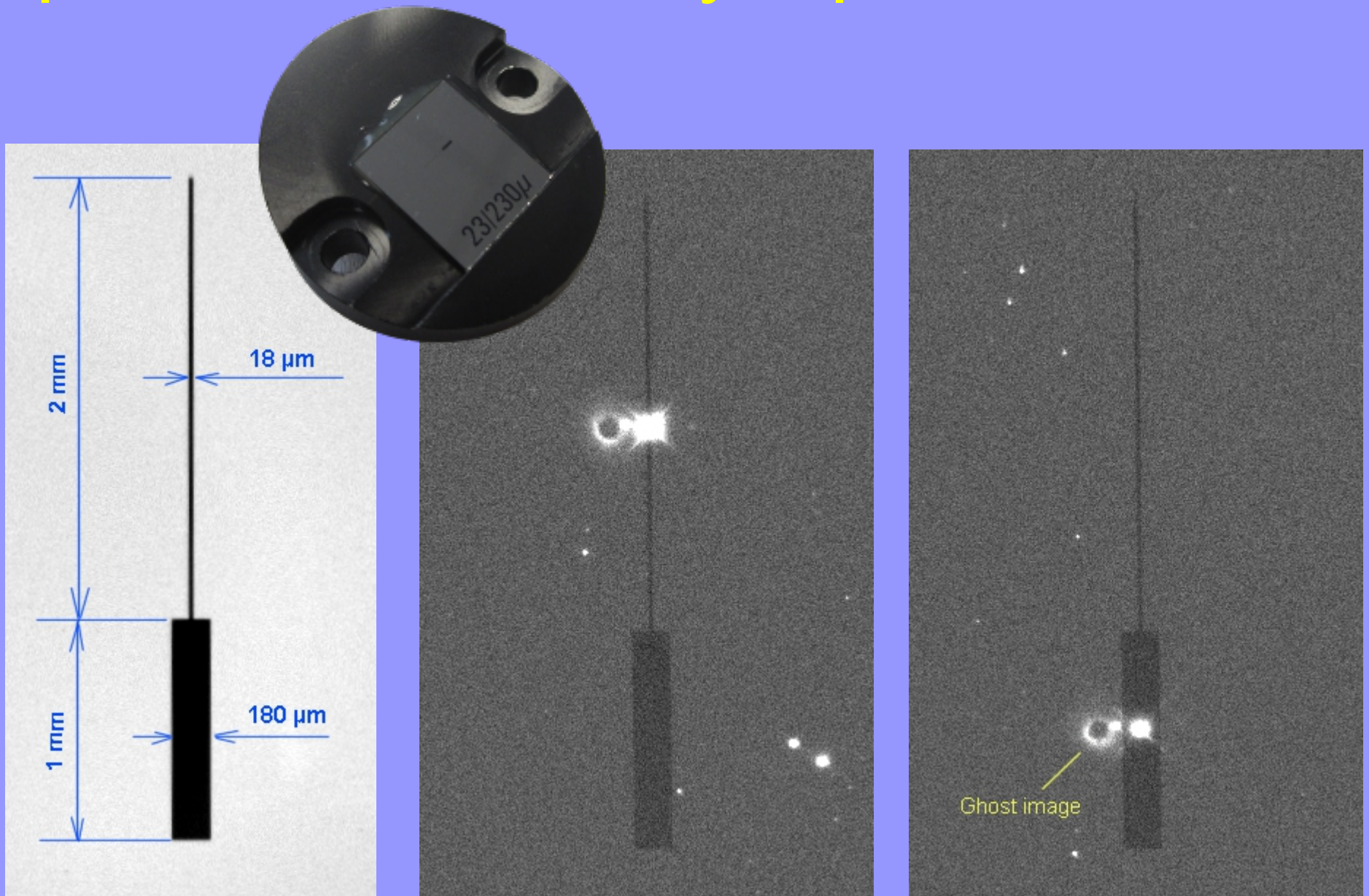


⇒ BOTH ARE IMPORTANT AND COMPLEMENTARY !!!

# Photometry or Spectroscopy?



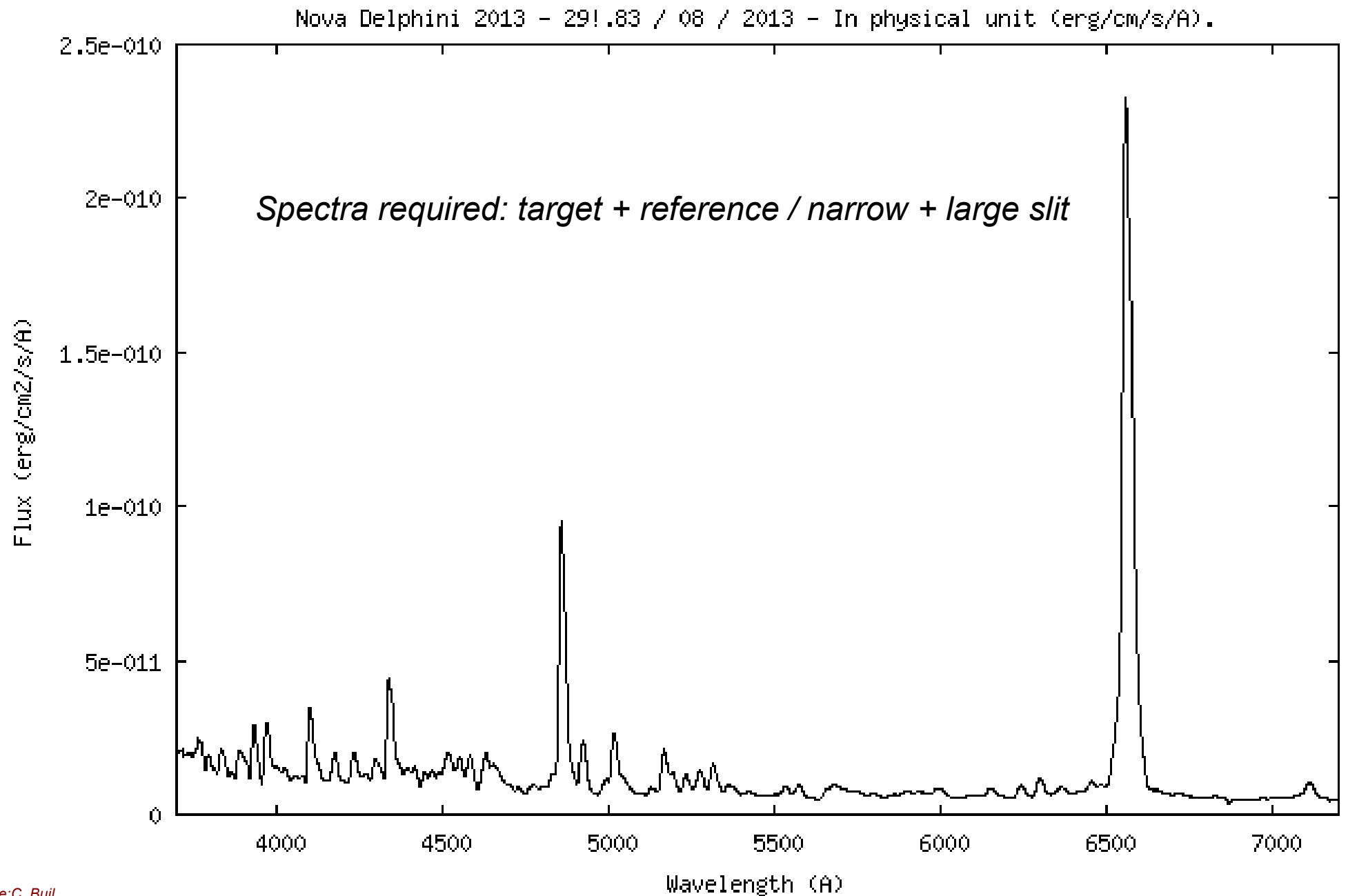
# Spectro-Photometry: special slit



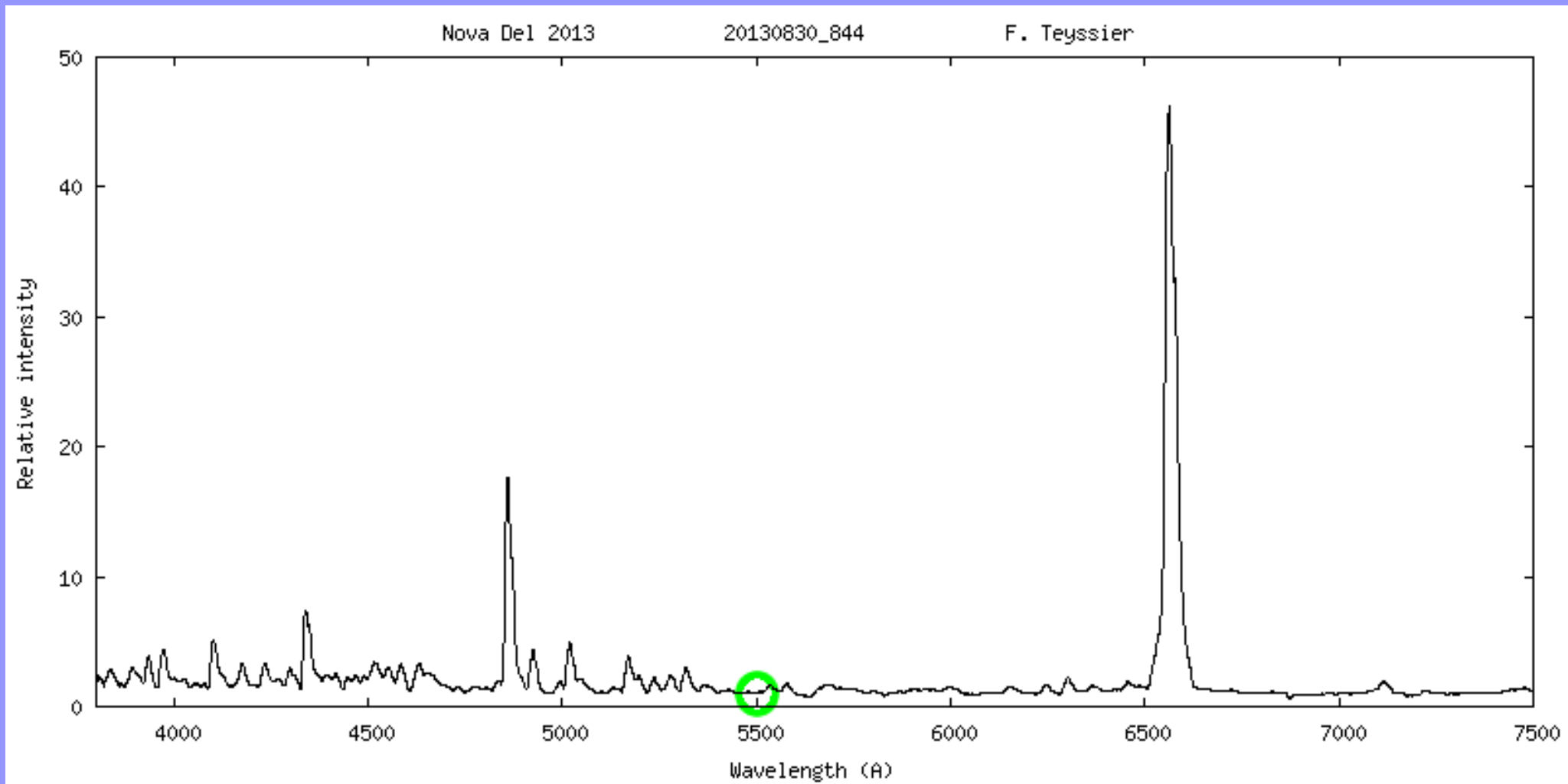
HD180163



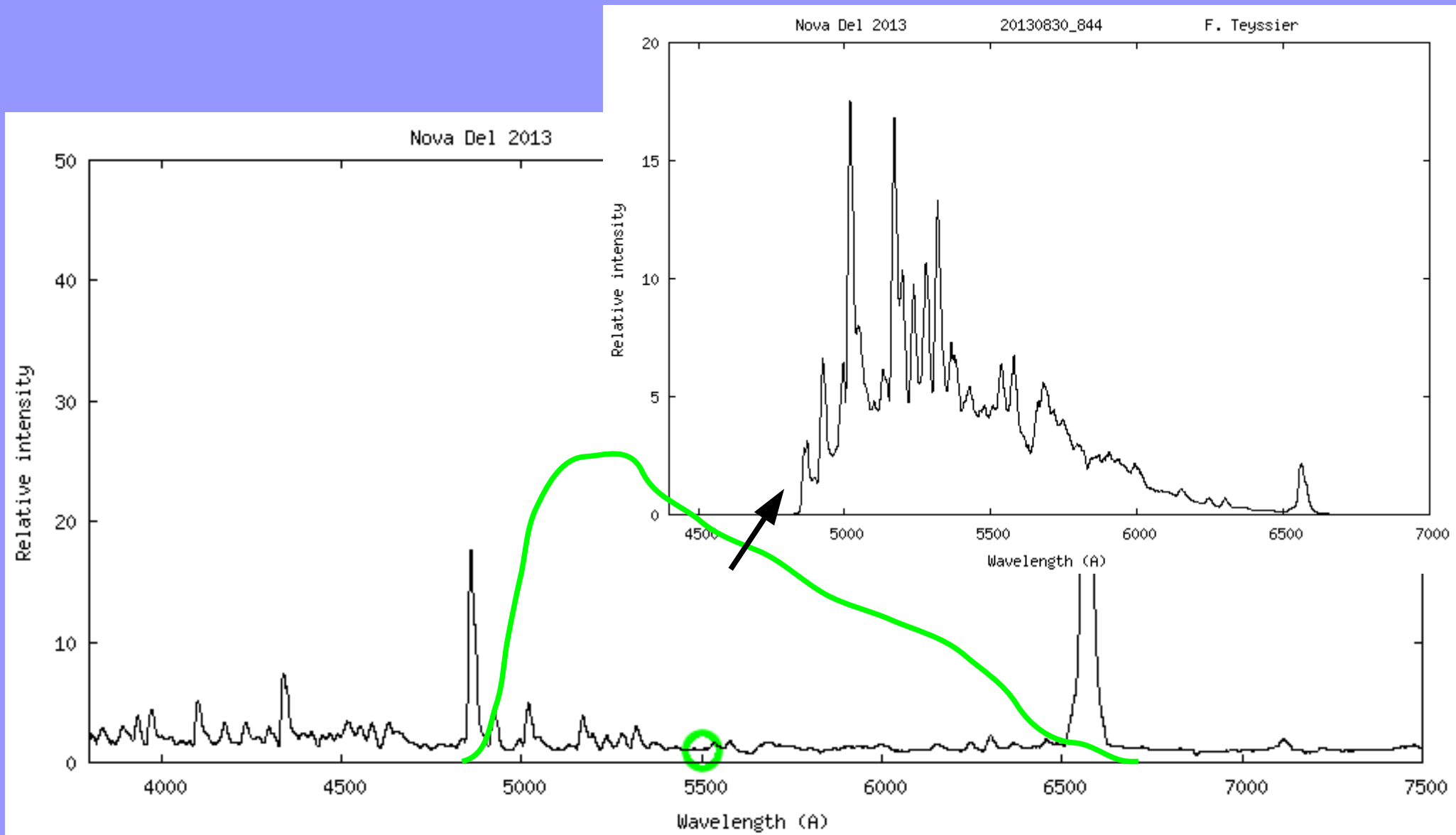
# Absolute spectrophotometry #1



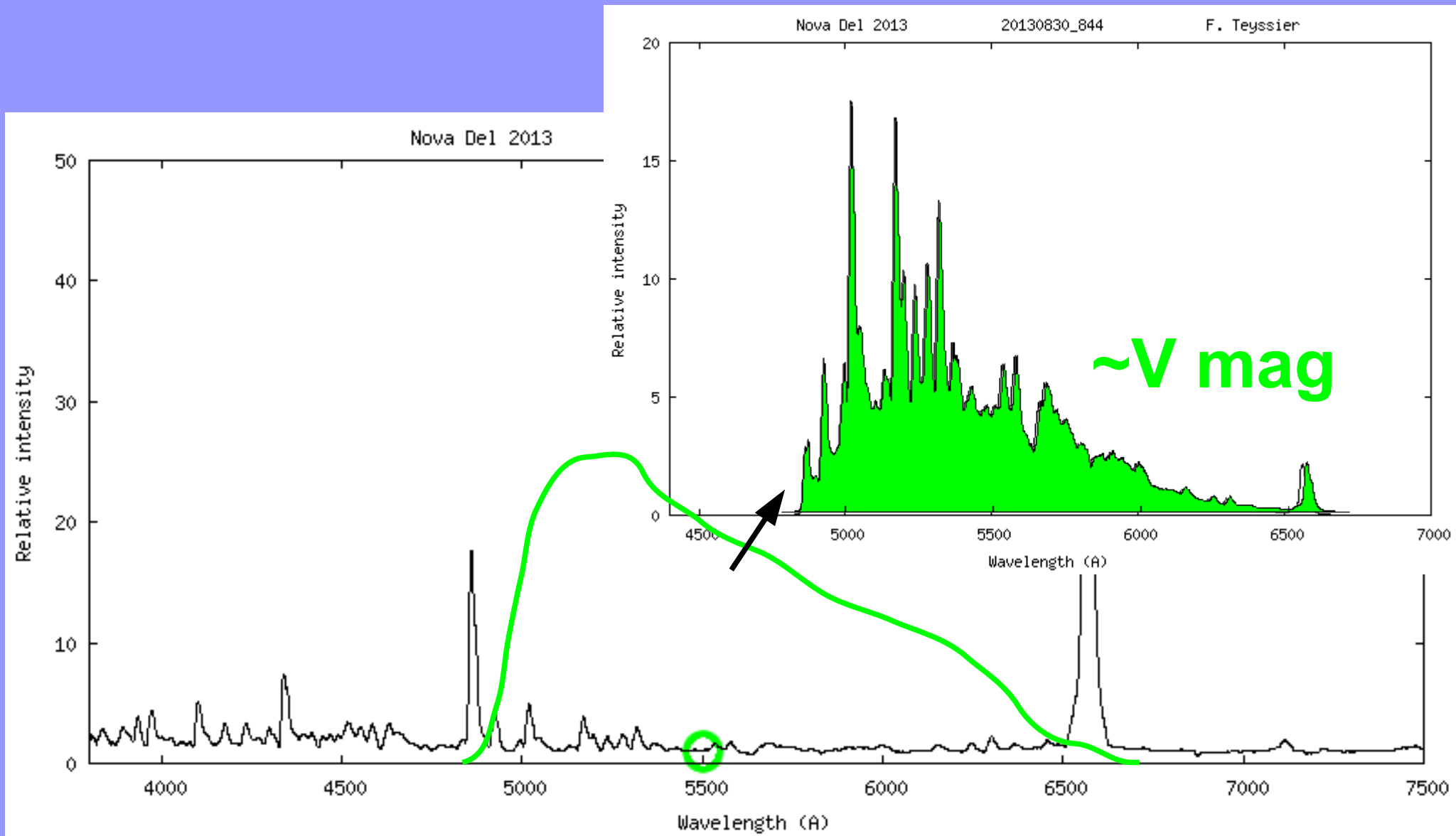
# Absolute spectrophotometry #2



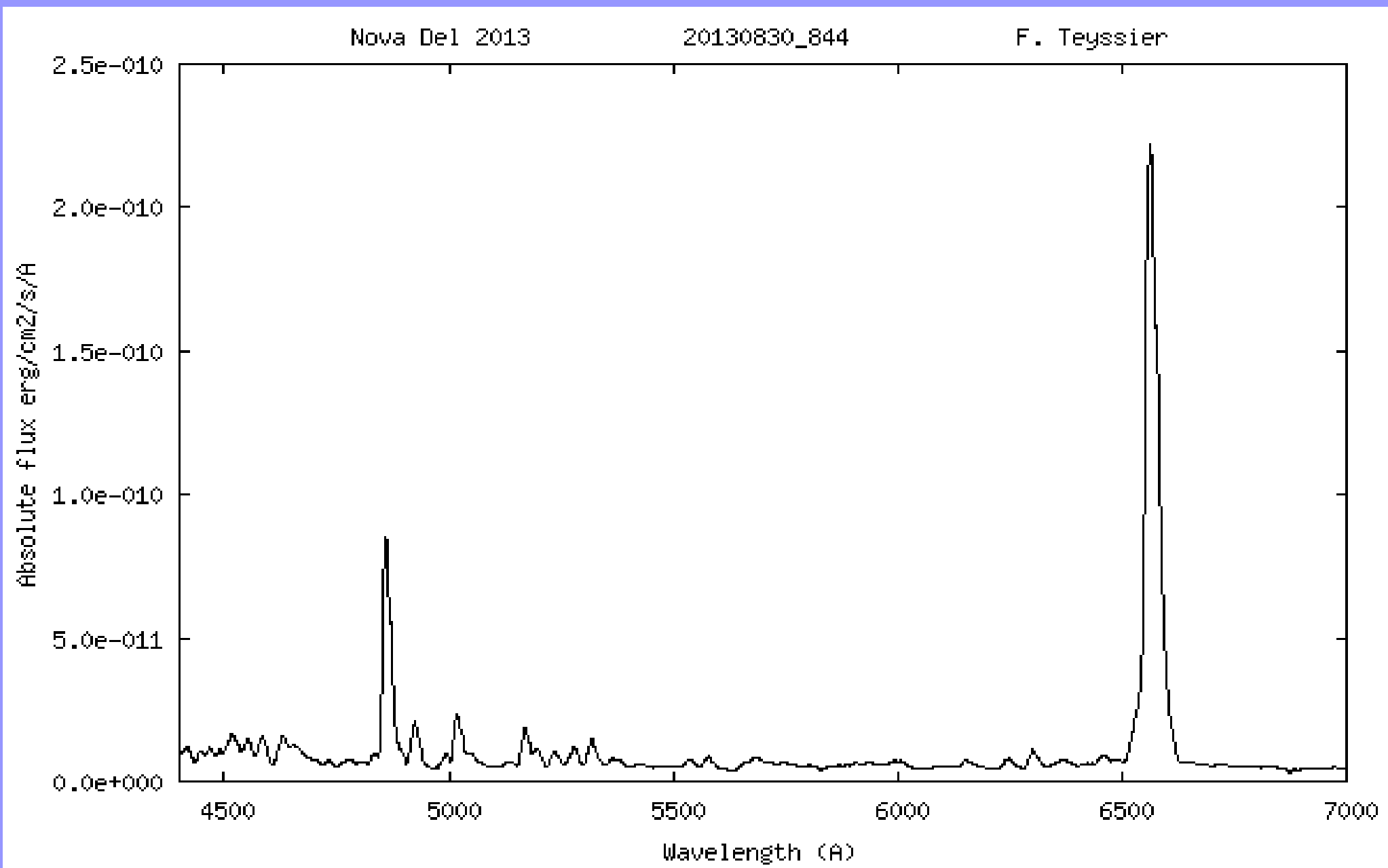
# Absolute spectrophotometry #2



# Absolute spectrophotometry #2



# Absolute spectrophotometry #2

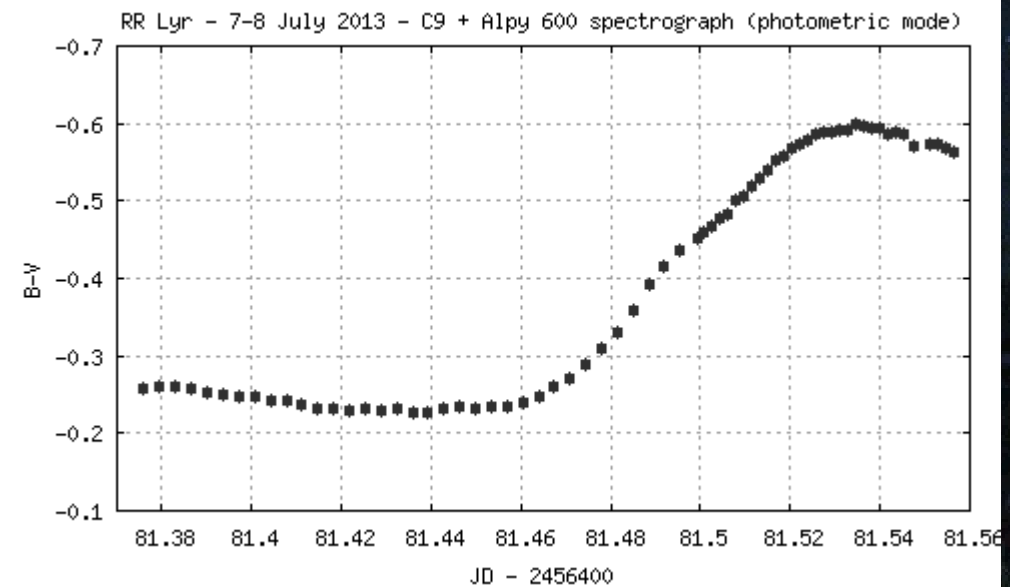
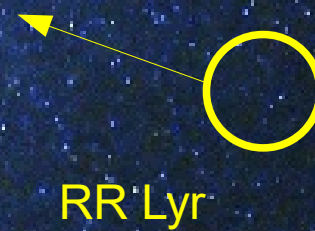
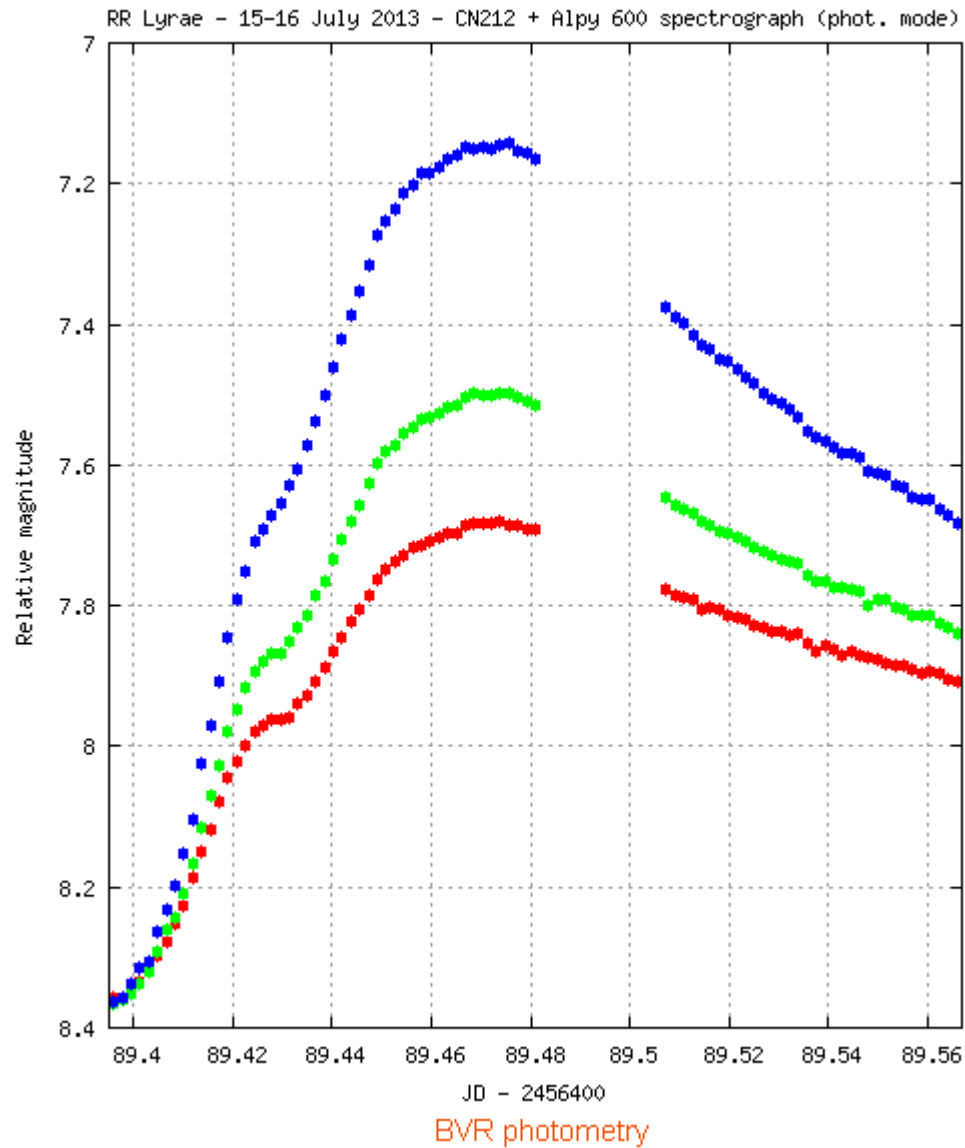


# The Sky is our Playground

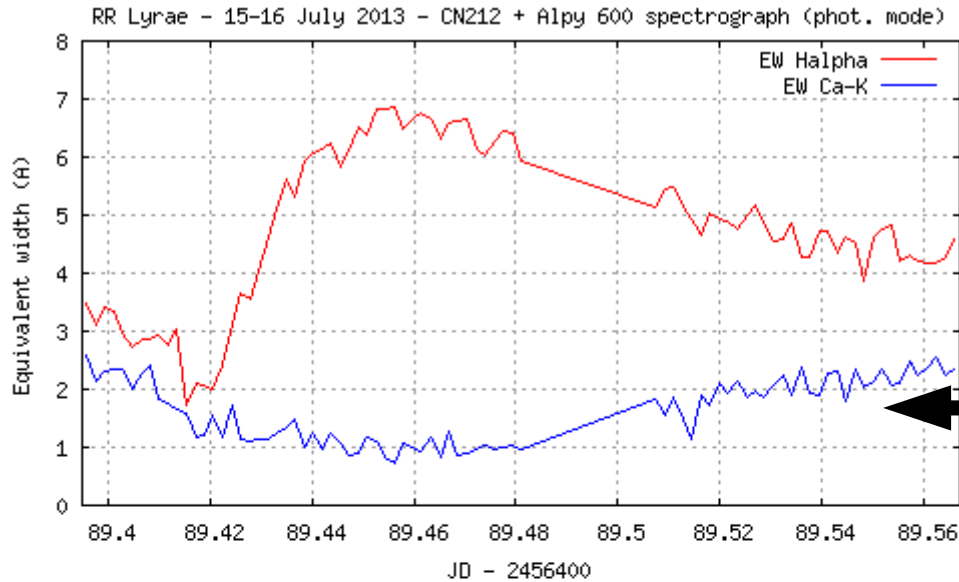
*...or how it is FUN to contribute  
with more professional astronomers !*



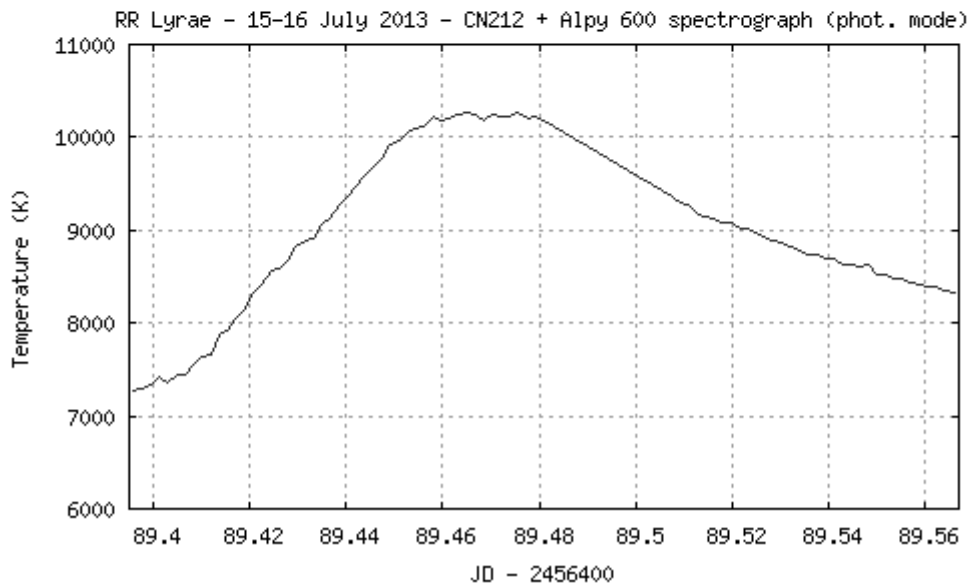
# Pulsating stars: RR Lyrae



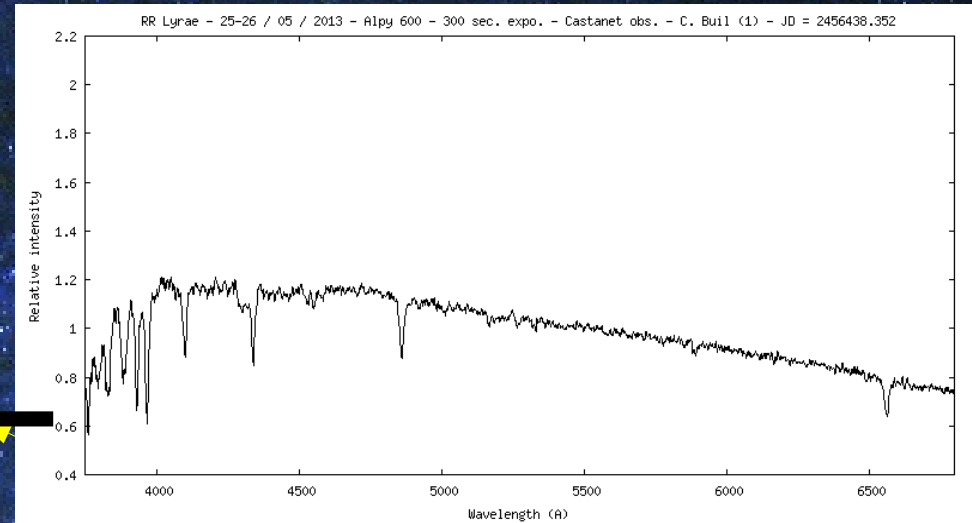
# Pulsating stars: RR Lyrae



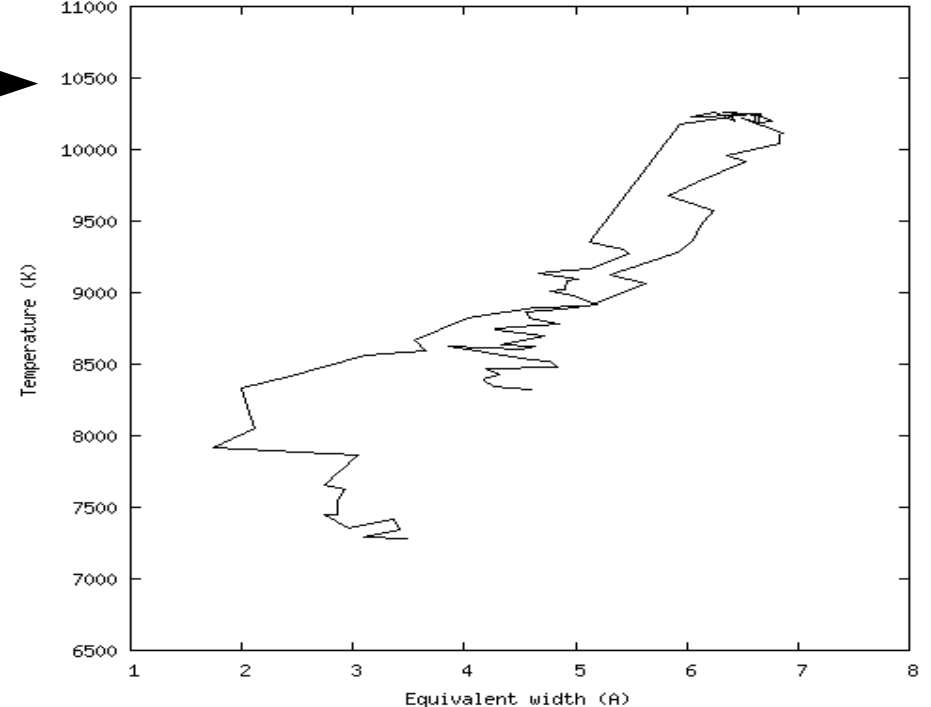
Halpa and Ca K lines equivalent width in Angstroms



Photospheric temperature (K)



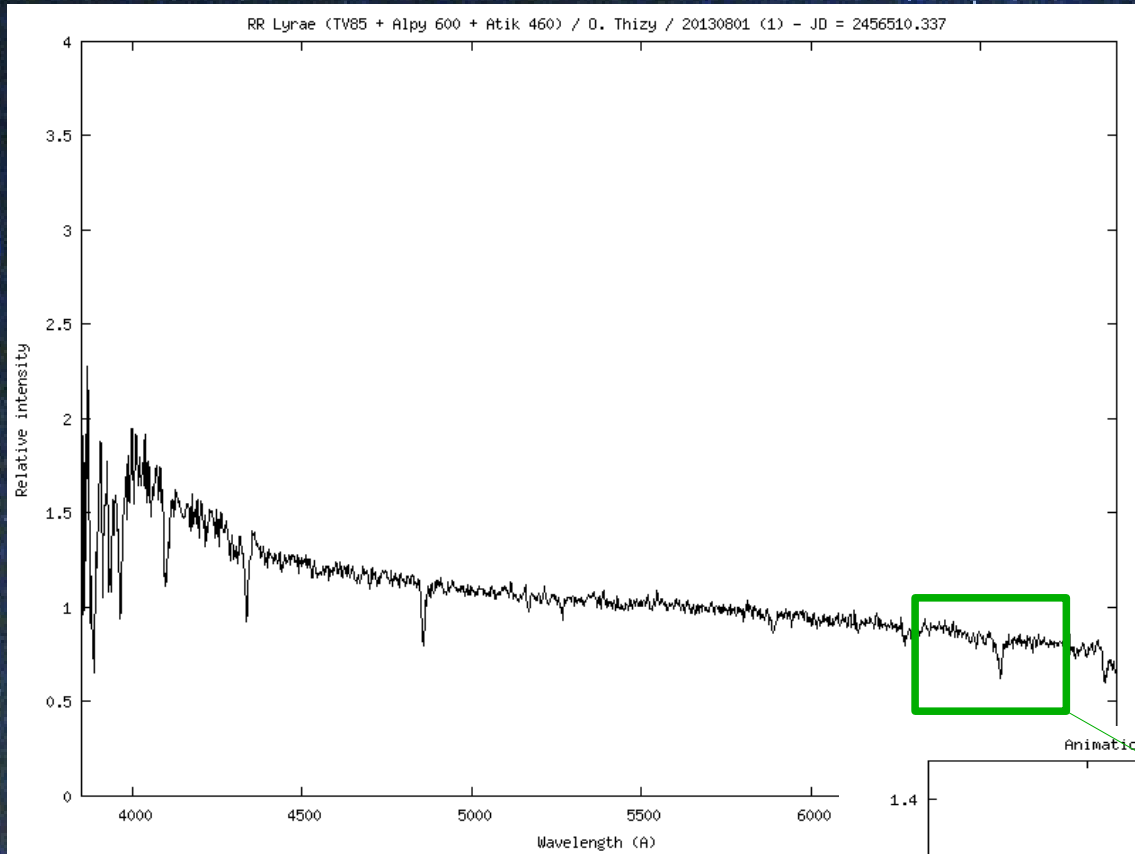
RR Lyrae - 15-16 July 2013 - CN212 + Alpy 600 spectrograph (phot. mode)



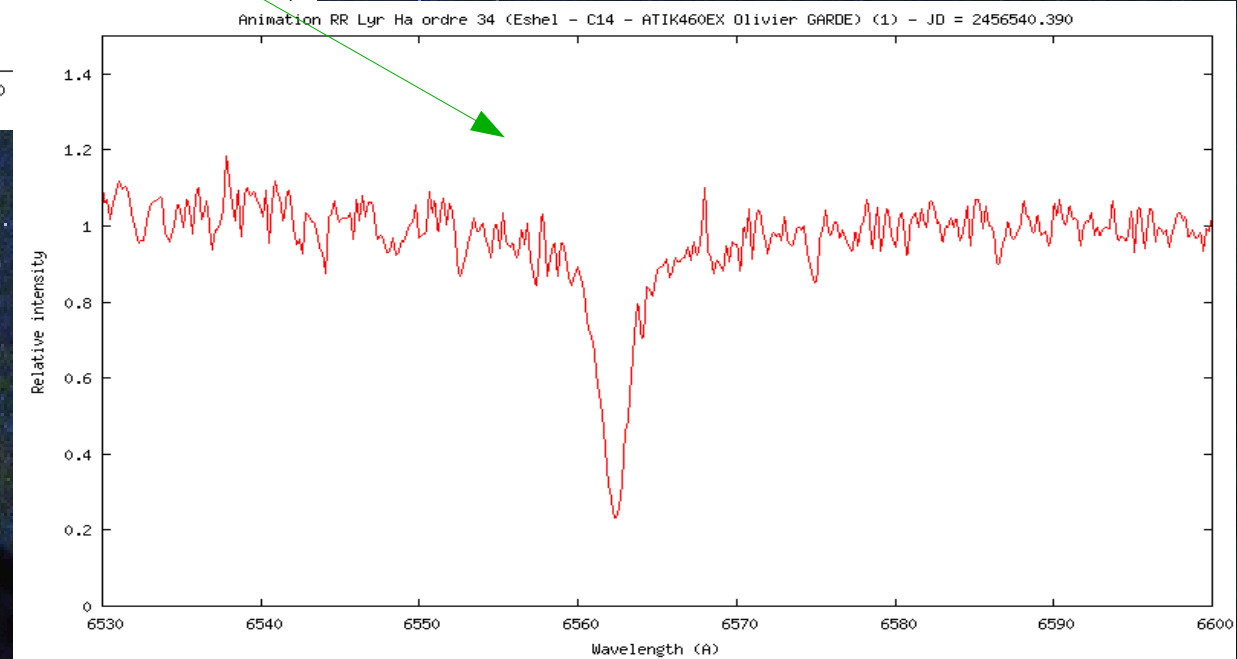
Halpa equivalent width vs Temperature diagram



# Pulsating stars: RR Lyrae

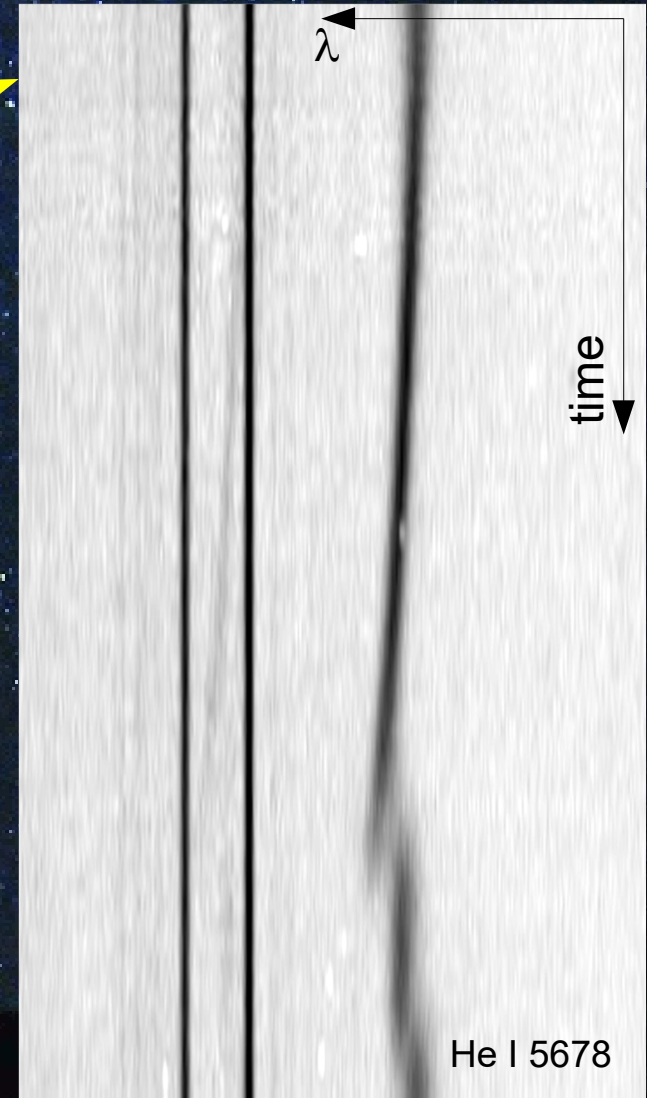
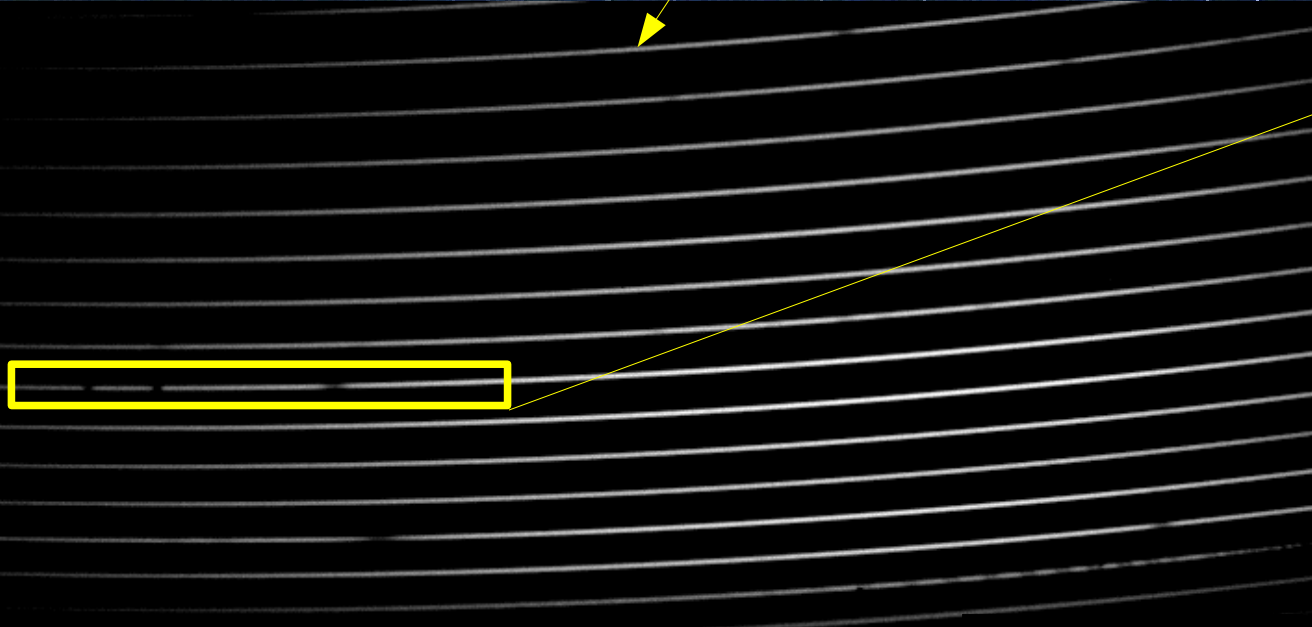


RR Lyr



# Pulsating stars: quest for higher resolution

BW Vul



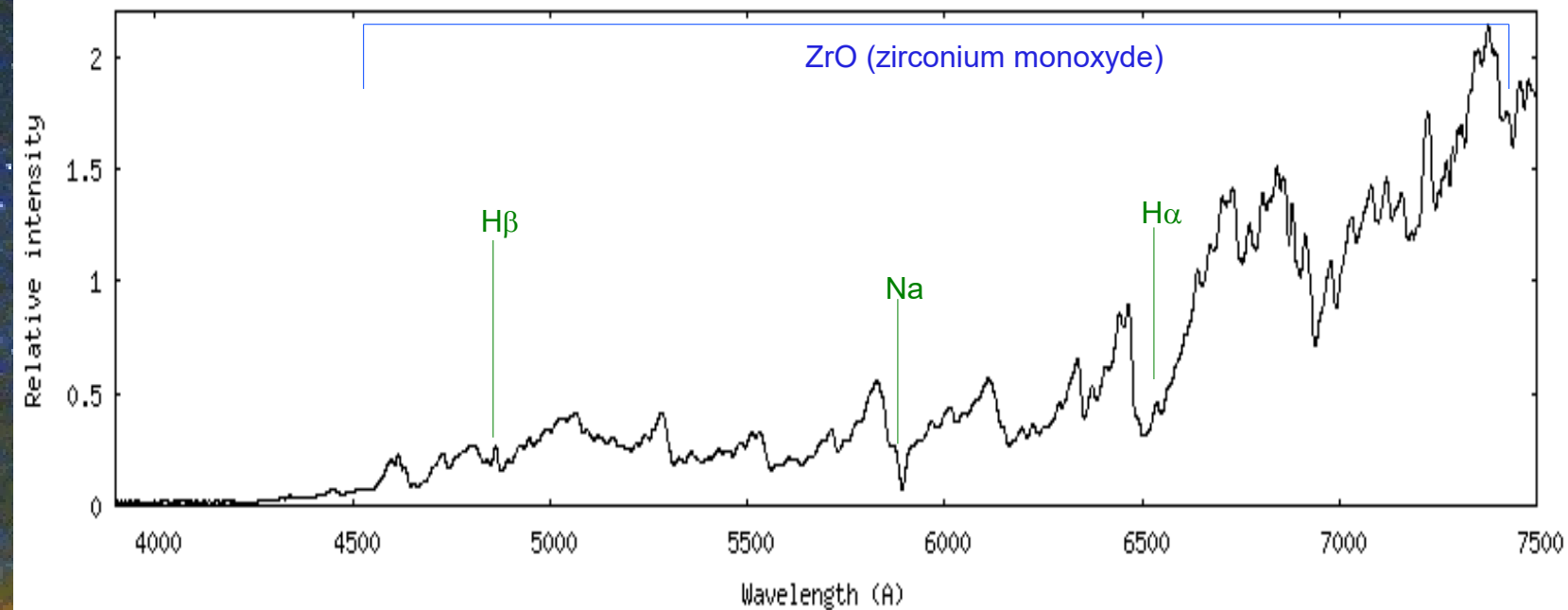
Christian Buil  
Valérie Desnoux  
Michel Pujol  
Olivier Thizy

# R Cyg: S type, near maximum

- S-type: red giant at end of life, between M-type and Carbon stars
- Mira variable stars

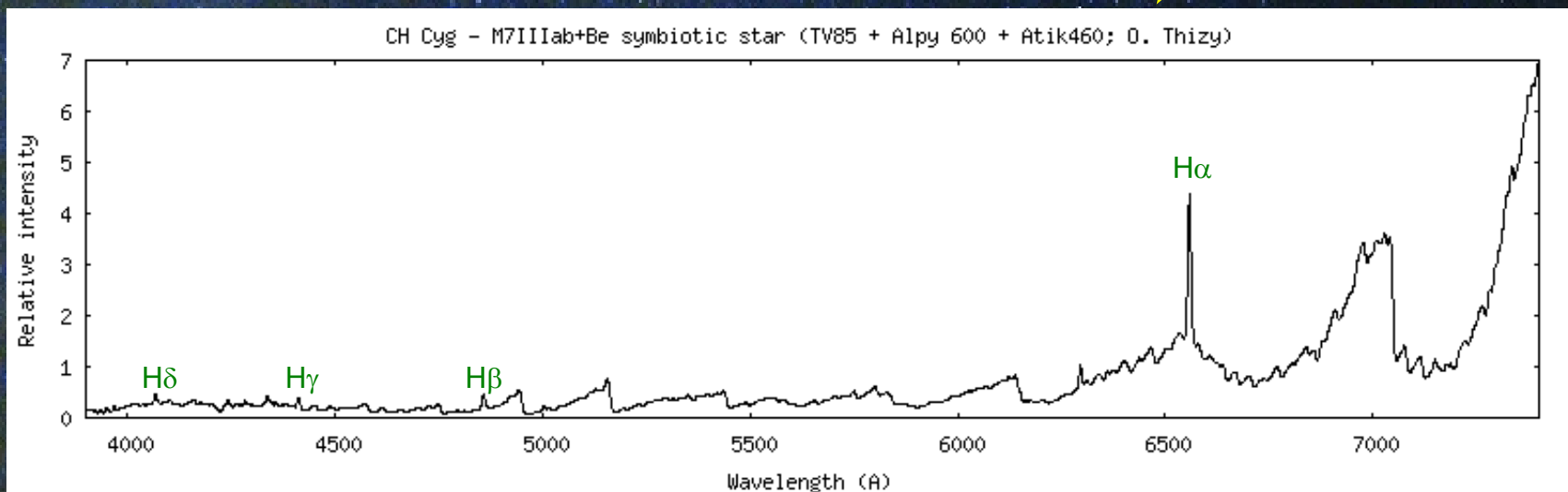
R Cyg

R Cyg - S type star; Mira variable star close to maximum (TV85 + Alpy 600 + Atik460; O. Thizy)



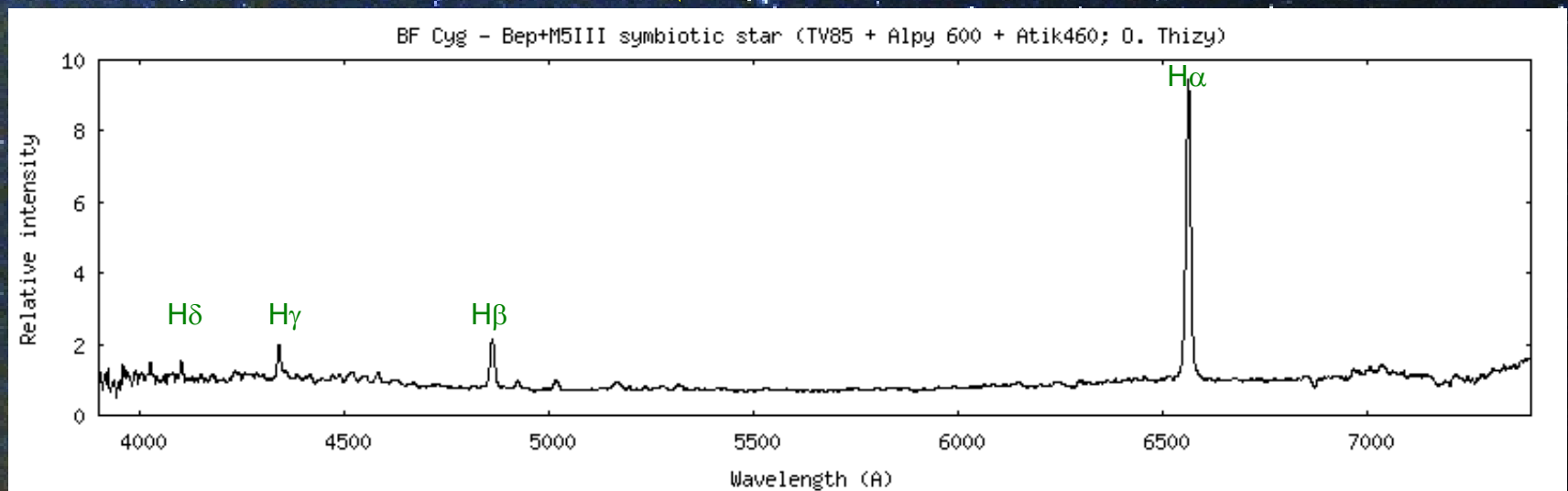
# Symbiotic star: CH Cyg

- Red Giant + white dwarf
- Mass transfer



# another Symbiotic star: BF Cyg

BF Cyg



# VV Cep – a zeta Aur type star

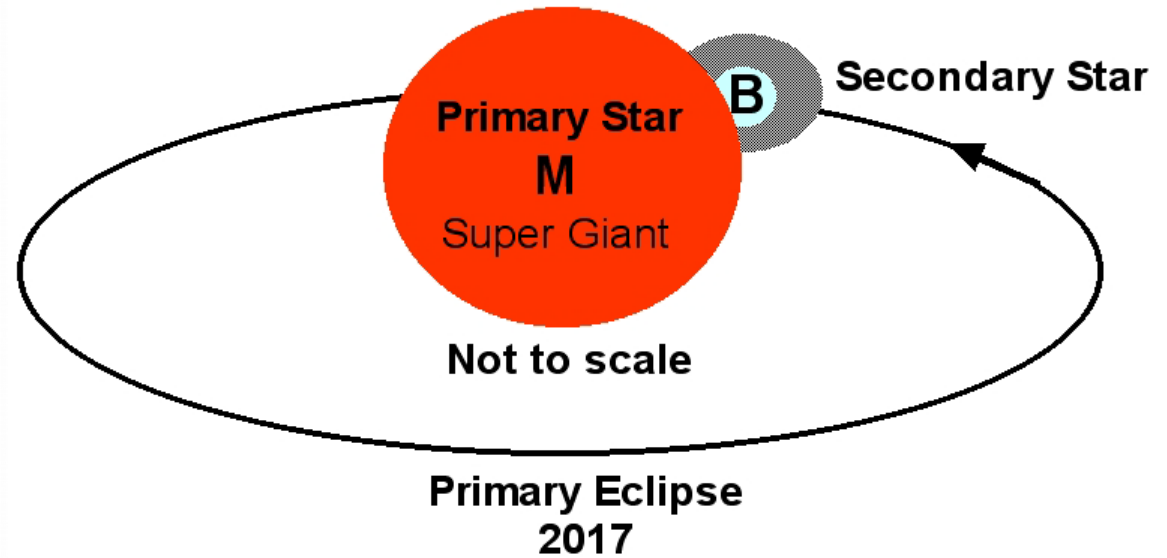
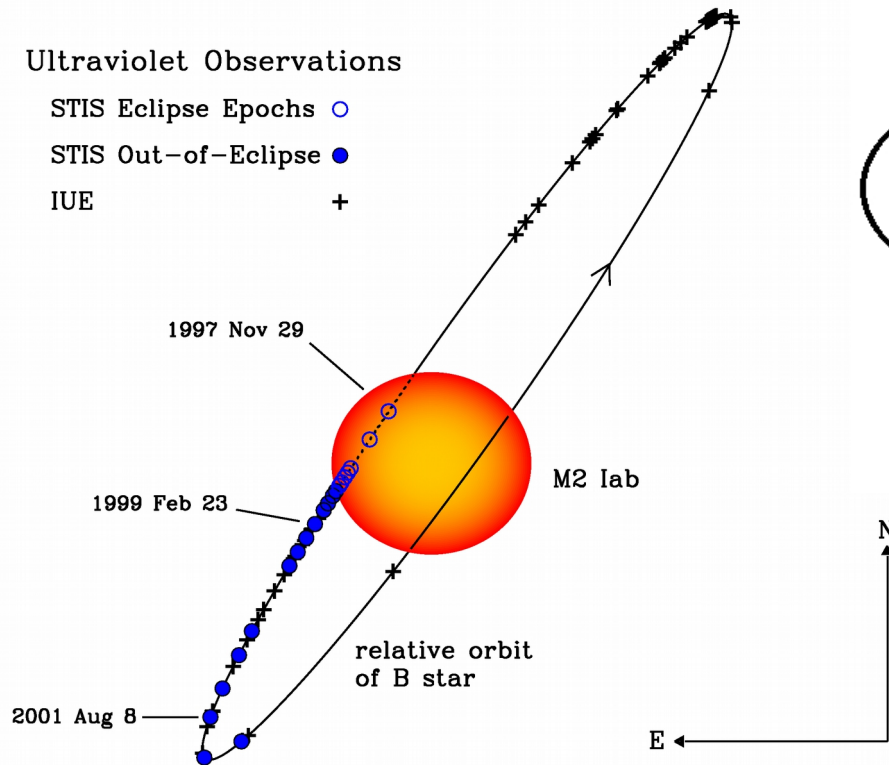
## VV Cephei

Ultraviolet Observations

STIS Eclipse Epochs ○

STIS Out-of-Eclipse ●

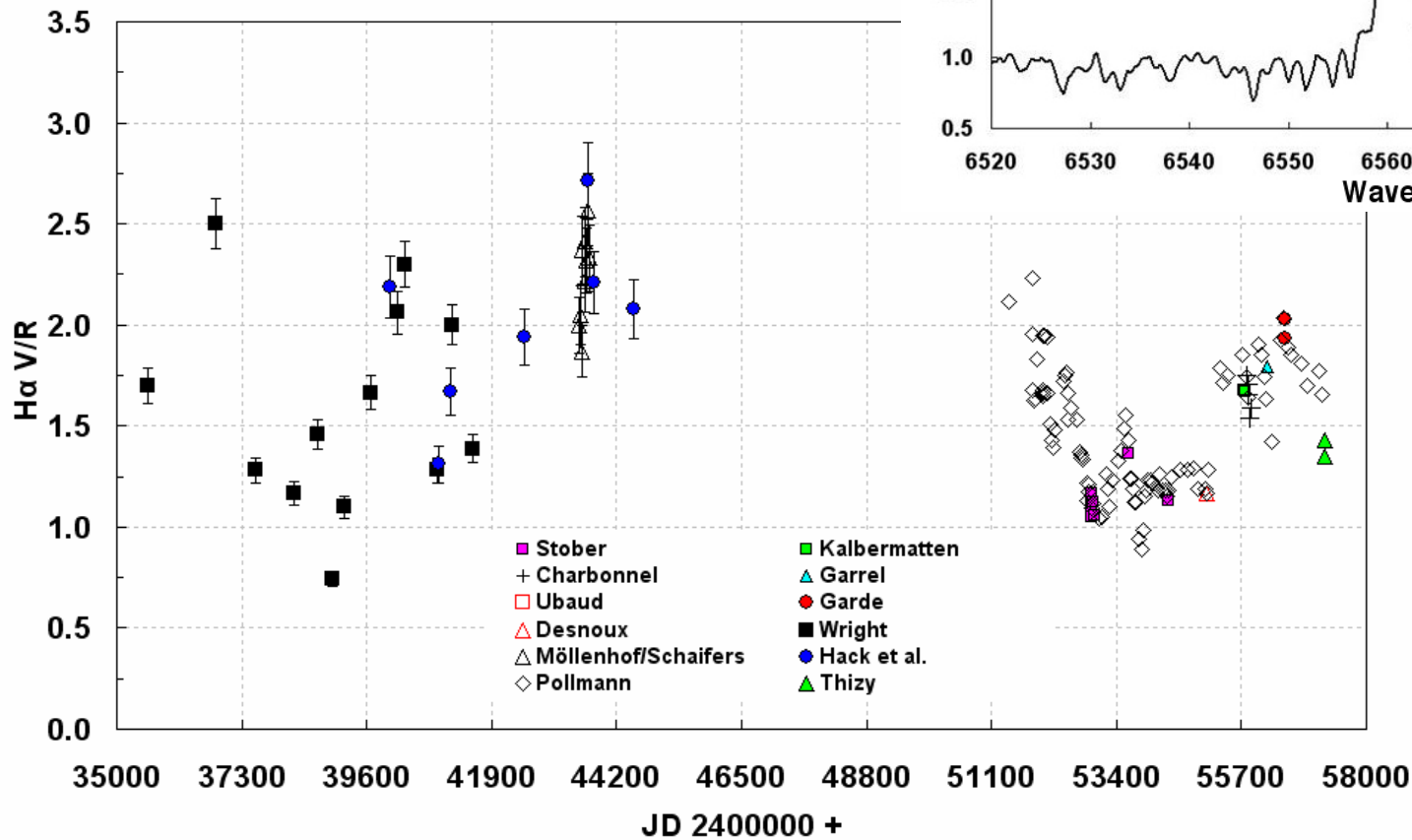
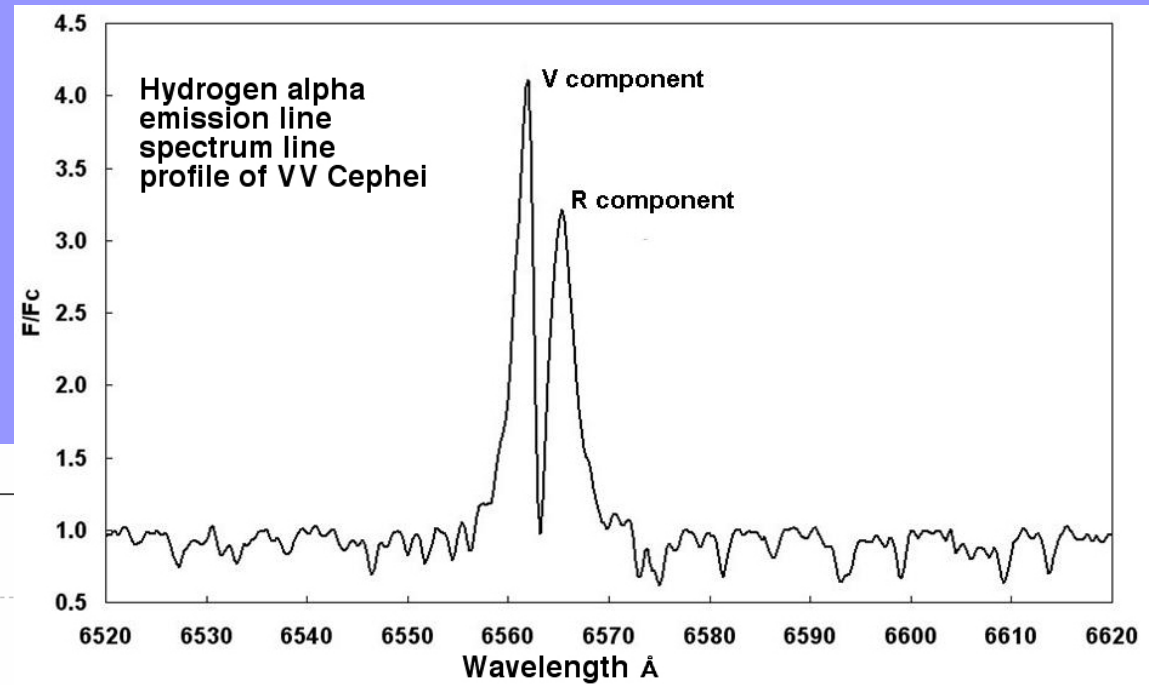
IUE +



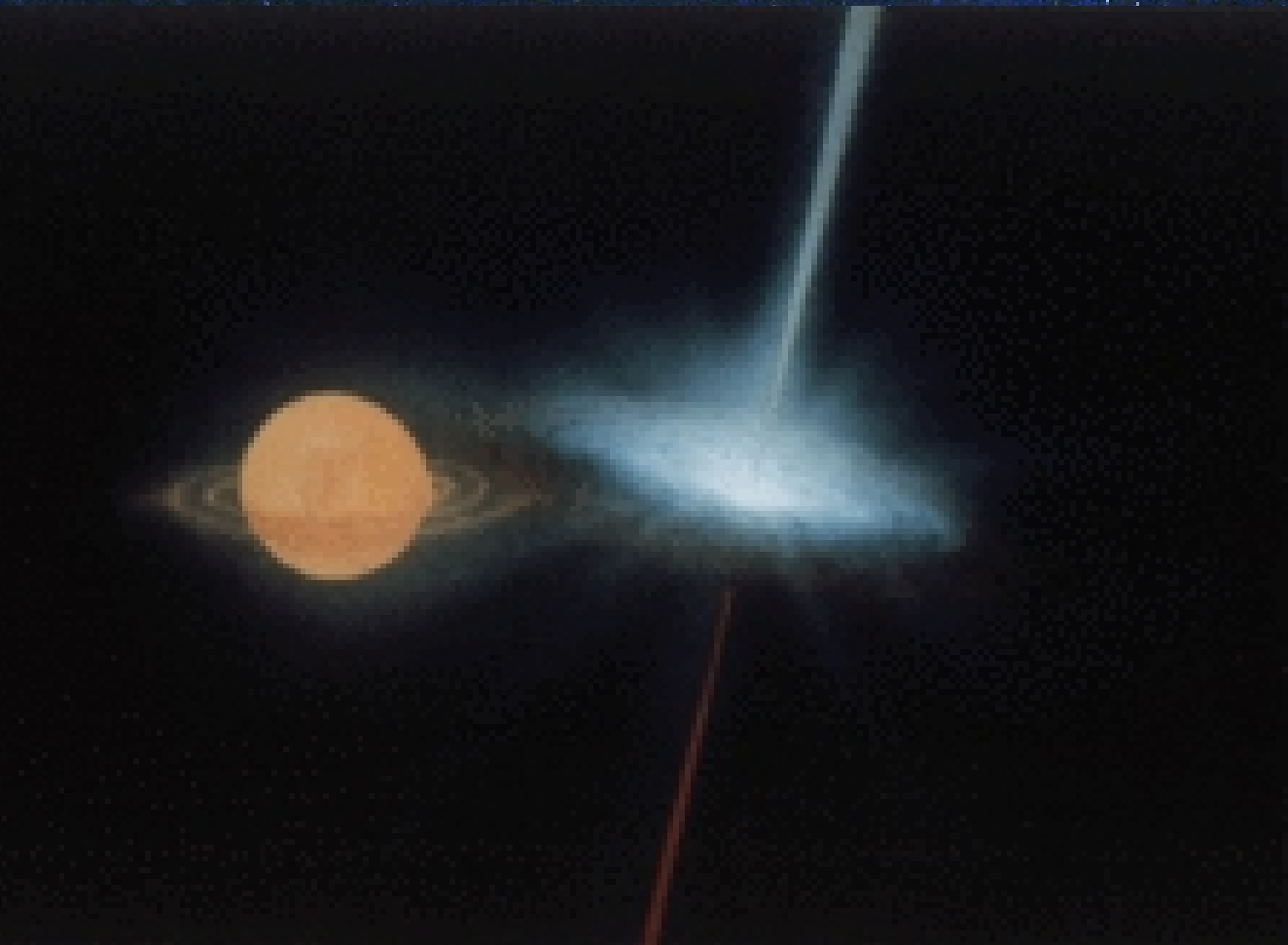
Source: Ernst Pollmann / Phil Bennett

20.3 years period !  
Next eclipse: 2016-2018  
(eclipse lasts for 1000 days)  
(totality ~300-500 days)

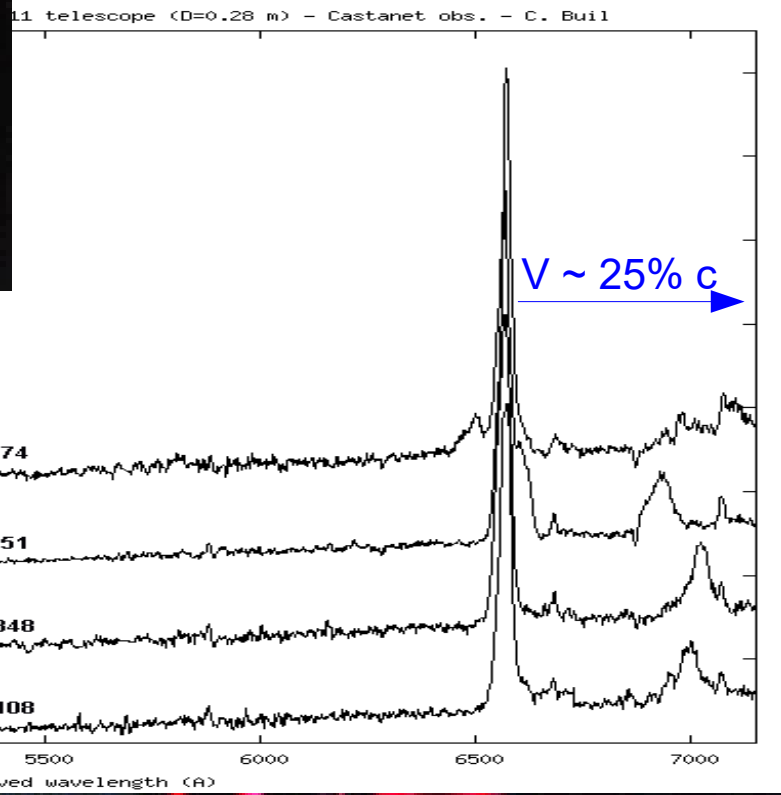
# VV Cep – a zeta Aur type star



# Microquasars



-1



SS 433



# The future: robotic observations!

The screenshot displays a web application interface for robotic observations. The browser window shows the URL `192.168.0.103`. The interface includes a navigation bar with **PLAYBACK**, **SETUP**, and **LOG OUT** options. The main area is divided into four camera channels:

- CH1**: Shows a close-up of a robotic arm with a timestamp of `12/09/2014 22:40:46`.
- CH2**: Shows a different angle of the robotic arm with a timestamp of `12/09/2014 22:40:46`.
- CH3**: Shows a dark view with a timestamp of `12/09/2014 22:40:46`.
- CH4**: Shows a dark view with a timestamp of `12/09/2014 22:40:45`.

On the right side, there are control panels:

- PLAY CONTROL**: Includes icons for play, stop, and volume, along with a volume slider.
- PTZ CONTROL**: Features a circular PTZ control panel with a starburst icon and directional arrows, and buttons for **ZOOM**, **FOCUS**, and **IRIS** (each with minus and plus buttons). Below these are buttons for **START**, **STOP**, **RECALL**, **LOAD**, **SAVE**, and **CLEAR**.

The Windows taskbar at the bottom shows the system tray with the time `23:44` and date `12/09/2014`.

# The future: robotic observations!

The screenshot displays the PRISM software interface, version 9.0.2, running on a Windows operating system. The main window shows a monochrome astronomical image of a star field, with a dark, curved object (possibly a shadow or a specific feature) visible. The image is labeled "SX-LODESTAR [1] | 752x580 - Monochrome - Réels(32bits) [Zoom = 1]".

Below the main image, there are several control panels and data displays:

- Graphiques:** A panel with "Reset" and "Sauver" buttons, showing a small green square on a dark background.
- Positions Axe DEC:** -0.53 Pix, +46ms
- Décalage [Pixels, angle]:** 0.56 -70.75°
- Champ:** 180°00'00" x 180°00'00"
- Az / Z Tpc:** A small diagram showing a telescope's orientation.

On the right side, there are several control panels for different CCD cameras:

- ARTEMIS CCD ATIK-460ex:** Includes buttons for "DEMARRER" and "ABANDONNER", and a "Temps:" field.
- ARTEMIS CCD ATIK-314L:** Similar controls to the ATIK-460ex.
- SX-LODESTAR:** Includes buttons for "DEMARRER" and "ABANDONNER", and a "Temps:" field.

At the bottom right, there are buttons for "Exp Longue", "Fichier", "Fenêtrage", "Cam", "Sauver", and "S". A "Contrôle Dome" button is also visible.

The bottom status bar shows "Format 695x519x1 [Réels 32bits] Zoom = 1" and "23:46 12/09/2014".

The terminal window in the center-right displays the output of the "SPECTROAUTO.PGM" program, showing observation logs for various stars and telescope configurations. The logs include details such as elevation, visibility, angle, and height for different targets, along with instructions for telescope pointing and camera operation.

# The future: robotic observations!

The screenshot displays the PRISM software interface, version 9.0.2, running on a Windows operating system. The main window shows a monochrome astronomical image of HD 162365, with a zoom level of 1. The image is split into two panels, showing the star and its surrounding field. A status bar at the bottom of the image window indicates a 18-second exposure, a binning of 2x2, a temperature of -10.0°C, and a focal length of 2153.5 mm.

Overlaid on the image is a 'Run: SPECTROAUTO.PGM' window, which displays a log of the observation process. The log includes details such as the telescope's orientation (WEST and EAST), the target star's coordinates, and the results of the astrometric measurements. A 'Seuils' (Thresholds) dialog box is also open, showing a histogram of the image data with a red cursor pointing to a threshold value of 9522.643. The dialog also shows a 'Seuil Bas' of 327.6262 and a 'Palettes' section with 'Max, Min' values of 65535 and 213.

At the bottom of the interface, there is a 'Contrôle Dome' (Dome Control) panel and a system tray showing the time as 23:47 on 12/09/2014. The PRISM software interface includes a menu bar with options like 'Fichier', 'Edition', 'Prétraitement', 'Visualisation', 'Transformations', 'Trichromie (imagerie couleur)', 'Traitements', 'Analyse', 'Caméras', 'Télescope/observatoire', 'Fenêtre', 'Options', and 'Aide'. The status bar at the bottom indicates the format as 695x519x1 [Réels 32bits] Zoom = 1.

# The future: robotic observations!

The screenshot displays the PRISM software interface, version 9.0.2, running on a Windows operating system. The main window shows a CCD image of a star field with a zoom level of 1. The image is labeled "ARTEMIS CCD ATIK-314L | 695x519 - Monochrome - Réels(32bits) [Zoom = 1]". Below the image, technical parameters are displayed: 90.0 ms, Bin:2x2, -10.0°C, MX=0 MY=0, Fil=, and Foc=2147.8 mm sca=1.24".

On the right side, a log window titled "Run: SPECTROAUTO.PGM" displays the following text:

```
Repertoire de travail : Z:\2014-9-12 19h12m15 LISA_RACINE\2014-9-12 21
pointe le telescope sur 19h22m49.160s +45°00'00.00''
Pointage termine
pointe le telescope sur 17h50m07.610s +15°29'43.31''
Pointage termine
Orientation des cameras suivant position du telescope
Telescope côté EAST
attente 1 minute max que le dome arrive
Fin d attente: duree: 1 sec
Extinction de toutes les lampes.
c est le premier pointage ou on vient de se retourner
Chercheur: Procedure Astrometrie allsky
- Pose d astrometrie sur le ciel pendant 10 secondes
- debut astrometrie ALLSKY
- reconnaissance reussie, recalage telescope
pointe le telescope sur 17h50m07.557s +15°29'43.97''
Pointage termine
Champ: Procedure Astrometrie
Premiere Astrometrie precise
- Pose sur le ciel pendant 10 secondes
- debut calcul astrometrie precise:
- resultat_astrometrie_absoelue=1
- position fente: 17h50m11.103s +15°32'03.72'' X=348 Y=233
- position aux coordonnes de la cible: 17h50m07.61s +15°29'43.31''
- distance fente-cible dX=40 dY=114
- deplace cible sur la fente
attente rattrage entrainement horaire
Deuxieme Astrometrie precise
- Pose sur le ciel pendant 10 secondes
- debut calcul astrometrie precise:
- resultat_astrometrie_absoelue=1
- position fente: 17h50m06.990s +15°29'45.78'' X=348 Y=233
- position aux coordonnes de la cible: 17h50m07.61s +15°29'43.31''
- distance fente-cible dX=-7 dY=2
demi taille de la fenetre de recherche de l'etoile guide= 30
La cible est l'etoile de guidage on va guider doucement
Determine le temps de pose pour le guidage
pose de 0.01 secondes donne un max ADU etoile=543
pose de 0.03 secondes donne un max ADU etoile=1423
pose de 0.05 secondes donne un max ADU etoile=3583
On choisit un temps de pose de guidage de =0.05 secondes
autoguidage
lance centrage
```

At the bottom of the interface, there are control panels for "Positions Axe RA" (set to -1.46 Pix, +61ms) and "Positions Axe DEC" (set to -0.64 Pix, -54ms). A "Réparation" panel includes "Lier", "Graphiques", "Reset", and "Sauver" buttons. A "Décalage (Pixel, angle)" panel shows "1.60 -155.47". The bottom status bar indicates "Format 695x519x1 [Réels 32bits] Zoom = 1".

# The future: robotic observations!

The screenshot displays the PRISM software interface, version 9.0.2, running on a Windows system. The main window shows a dark astronomical image with a bright horizontal line and a vertical crosshair. A terminal window titled 'Run: SPECTROAUTO.PGM' displays the following text:

```
Run: SPECTROAUTO.PGM
PARAMETRES PREDEFINIS
-Pose sur le ciel pendant 18 secondes
-debut calcul astrometrie precise:
-resultat_astrometrie_absoelue=1
-position fente: 17h50m11.103s +15°32'03.72'' X=348 Y=233
-position aux coordonnes de la cible: 17h50m07.61s +15°29'43.31''
-distance fente-cible dX=40 dY=114
-deplace cible sur la fente
attente rattrage entrainement horaire
Deuxieme Astrometrie precise
-Pose sur le ciel pendant 18 secondes
-debut calcul astrometrie precise:
-resultat_astrometrie_absoelue=1
-position fente: 17h50m06.990s +15°29'45.78'' X=348 Y=233
-position aux coordonnes de la cible: 17h50m07.61s +15°29'43.31''
-distance fente-cible dX=-7 dY=2
demi taille de la fenetre de recherche de l'etoile guide= 30
La cible est l'etoile de guidage on va guider doucement
Determine le temps de pose pour le guidage
pose de 0.01 secondes donne un max ADU etoile=543
pose de 0.03 secondes donne un max ADU etoile=1423
pose de 0.09 secondes donne un max ADU etoile=3583
On choisit un temps de pose de guidage de =0.09 secondes
autoguidage
lance centrage
centrage OK
centrage stop
Pose sur le champ pour sauvegarde
lance autoguidage final Agressivite RA=0.2 DEC=1
autoguidage definitif en cours
determination du temps de pose et nb de pose optimum
pose evaluation spectre dure:1 secondes
Flux= 362
pose evaluation spectre dure:10 secondes
Flux= 2776
La pose unitaire choisie est de 60 secondes
Temps total exposition necessaire 109 secondes, pour obtenir un flux
La pose d evaluation de 10 secondes donne un max ADU=2776
On choisit de realiser 3 poses unitaires exposees pendant 36.333333
Soit un total de 109 secondes
Pose Photometrie au Chercheur
commence l acquisition de 1 objet=HD 162365
Extinction de toutes les lampes.
spectre de HD 162365 ,debut de la pose 1/3 duree 36.333333 secondes
```

The interface also includes a control panel on the right with buttons for 'DEMARRER' and 'ABANDONNER', and a status bar at the bottom showing 'Format 695x519x1 [Réels 32bits] Zoom = 1'.

# The future: robotic observations!

PRISM Version 9.0.2 build 2717 27/06/2014 (TU: 12/09/2014 21:51:24) Alloué > 37 722 176 -> Log désactivé, Processus 0x0000E60 [39,20]

Fichier Edition Prétraitement Visualisation Transformations Trichromie (imagerie couleur) Traitements Caméras Telescope/observatoire Fenêtre Options Aide

ARTEMIS CCD ATIK-460ex [1] | 1374x1099 - Monochrome - Réels(32bits) [Zoom = 1/2]

Run: SPECTROAUTO.PGM

```

ATTENTE RATTRAGE ENTRAINEMENT HORS-HEURE
Deuxieme Astrometrie precise
- Pose sur le ciel pendant 10 secondes
- debut calcul astrometrie precise:
- resultat_astrometrie_absolue=1
- position_fente: 17h50m04.990s +15°29'45.78'' X=348 Y=233
- position aux coordonnees de la cible: 17h50m07.61s +15°29'43.31''
- distance_fente-cible dX=-7 dY=2
Demi taille de la fenetre de recherche de l'etoile guide= 30
La cible est l'etoile de guidage on va guider doucement
Determine le temps de pose pour le guidage
pose de 0.01 secondes donne un max ADU etoile=543
pose de 0.03 secondes donne un max ADU etoile=1423
pose de 0.05 secondes donne un max ADU etoile=3683
On choisit un temps de pose de guidage de =0.05 secondes
autoguidage
lance centrage
centrage OK
centrage stop
Pose sur le champ pour sauvegarde
lance autoguidage final Agressivite RA=0.2 DEC=1
autoguidage definitif en cours
determination du temps de pose et nb de pose optimum
pose evaluation spectre dure:1 secondes
Flux= 362
pose evaluation spectre dure:10 secondes
Flux= 2776
La pose unitaire choisie est de 60 secondes
Temps total exposition necessaire 109 secondes, pour obtenir un flux
La pose d evaluation de 10 secondes donne un max ADU=2776
On choisit de realiser 3 poses unitaires exposees pendant 36.333333
Soit un total de 109 secondes
Pose Photometrie au Chercheur
commence l acquisition de l objet=HD 162365
Extinction de toutes les lampes.
spectre de HD 162365 ,debut de la pose 1/3 duree 36.333333 secondes
spectre de HD 162365 ,debut de la pose 2/3 duree 36.333333 secondes
spectre de HD 162365 ,debut de la pose 3/3 duree 36.333333 secondes
Arrêt de l'autoguidage sur Consigne
Allume la lampe Neon
attente apres manipulation lampe 5 secondes
Neon de HD 162365 ,debut de la pose 1/1 duree 5 secondes

```

Positions Axe RA : -0.95 Pix +16ms Répartition

Positions Axe DEC : 0.25 Pix +22ms

Décalage (Pixels,angle) 0.00 100.50°

Champ=180°00'00"x180°00'00" Az/El Tpc

ARTEMIS CCD ATIK-460ex

ARTEMIS CCD ATIK-314L

SX-LODESTAR

23:51 12/09/2014

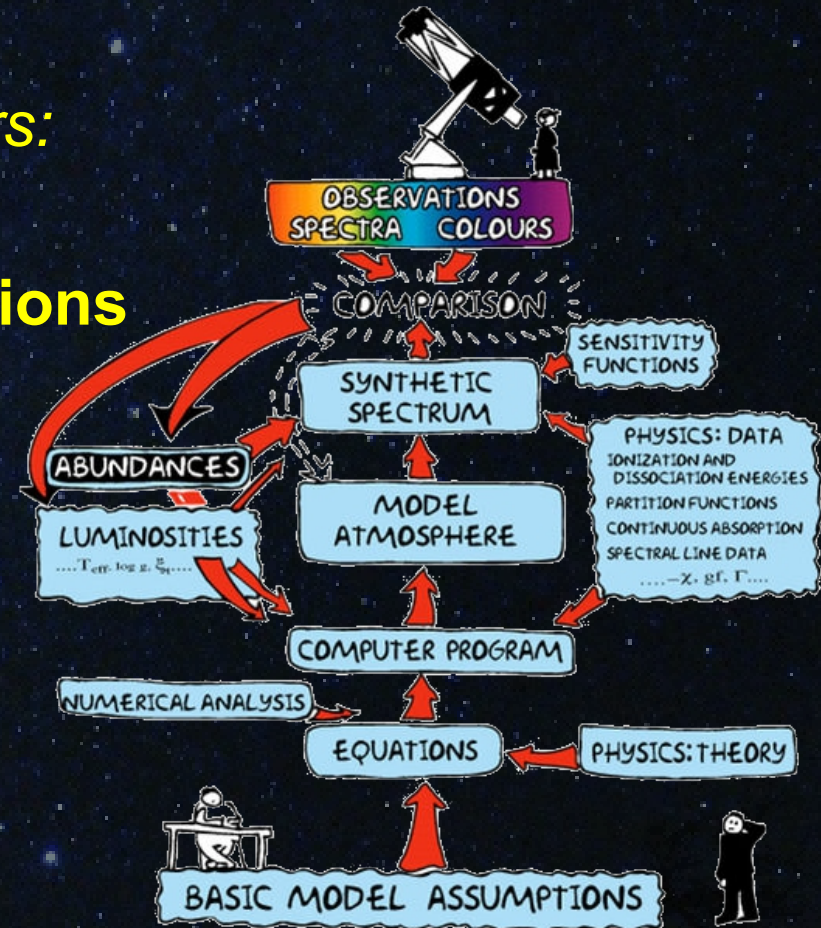
# Conclusions

*Spectroscopy is FUN to learn from the stars:*

- their **temperature** [overall profile]
- their **composition and physical conditions**
- **abundance, pressure, gravity**
- their **movements** [Doppler effect]

*Spectroscopy is also FUN for variable stars study*

- complementary to photometry
- main tool for professional astronomers
- off-the-shelf equipment & software now available
- more and more amateur are doing spectroscopy
- active Pro/Am community – **Join Us**





Merci...

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