# Eruptive stars spectroscopy
## Cataclysmics, Symbiotics, Novae, Supernovae

**ARAS Eruptive Stars**
**Information letter n° 19 #2015-07 09-10-2015**
**Observations of September 2015**

## News

A third nova in Sagittarius discovered independly by Koichi Itagaki, Akira Takao Yuji Nakamura (2015, 27th september) at mag ~ 10
First high resolution spectra was obtained by Olivier Garde

**Contents**



**Acknowledgements to AAVSO Observers for the invaluable photometric data**

Next issue : November

## ARAS Spectroscopy

**ARAS Web page**
http://www.astrosurf.com/aras/

**ARAS Forum**
http://www.spectro-aras.com/forum/

**ARAS list**
https://groups.yahoo.com/neo/groups/spectro-l/info

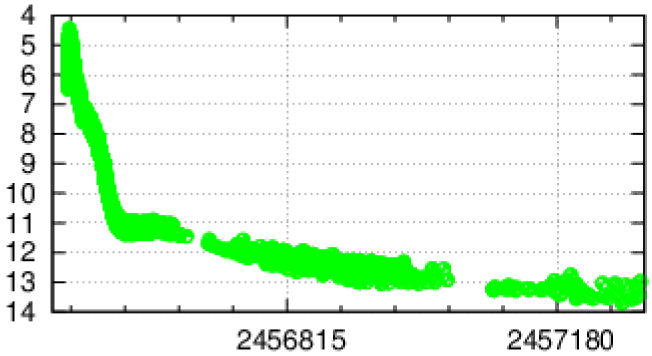
**ARAS preliminary data base**
http://www.astrosurf.com/aras/Aras_DataBase/DataBase.htm

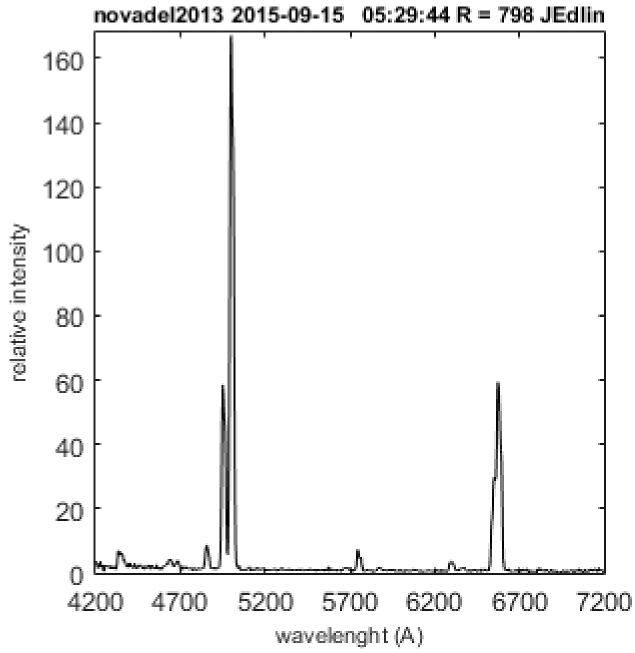
**ARAS BeAM**
http://arasbeam.free.fr/?lang=en

**Authors :**
F. Teyssier, A. Skopal, S. Shore, C. Buil, O. Thizy, O.Garde, D. Li, J. Montier, T.Lester, K. Graham, P. Somogyi, T. Bohlsen, D. Boyd, J. Edlin, J. Guarro, U. Sollecchia, L. Franco, T. Lemoult

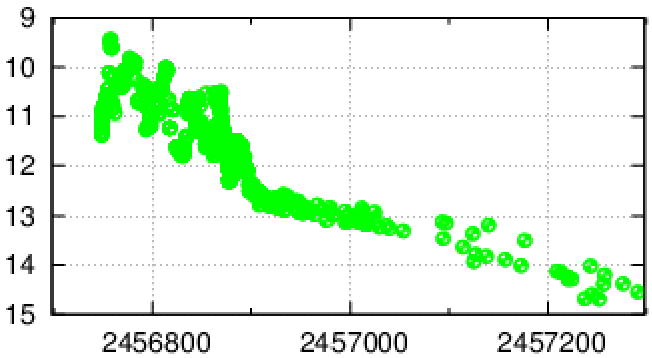
# Status of current novae 1/2

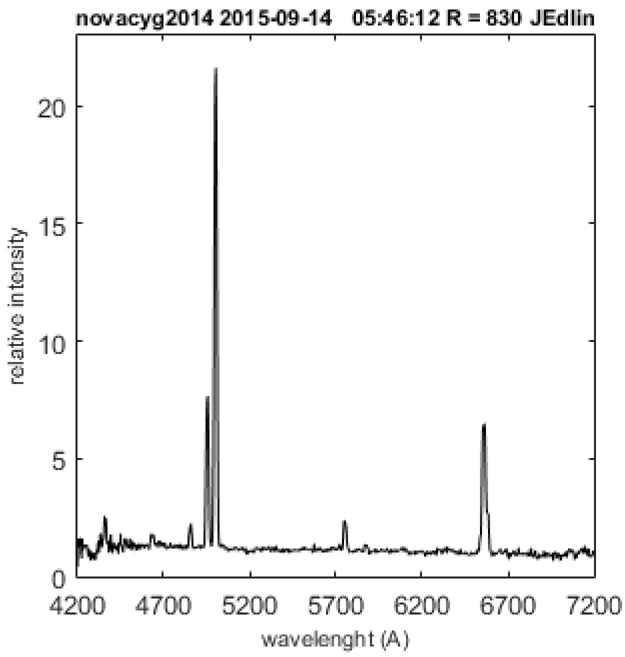
| Nova Del 2013 | V339 Del |
|---|---|
| Maximum | 14-08-2013 |
| Days after maximum | 747 |
| Current mag V | 13.5 |
| Delta mag V | 9.1 |



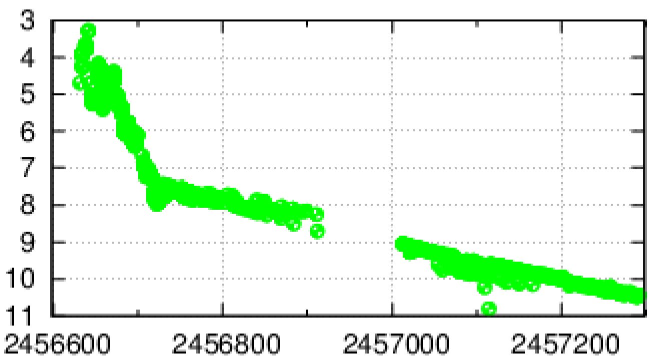




| Nova Cyg 2014 | V2659 Cyg |
|---|---|
| Maximum | 09-04-2014 |
| Days after maximum | 509 |
| Current mag V | 14.5 |
| Delta mag V | 5 |



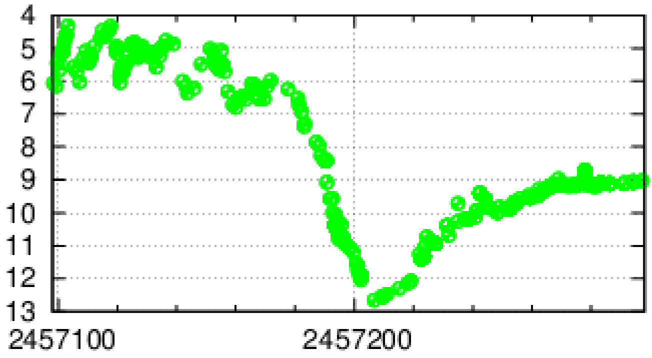



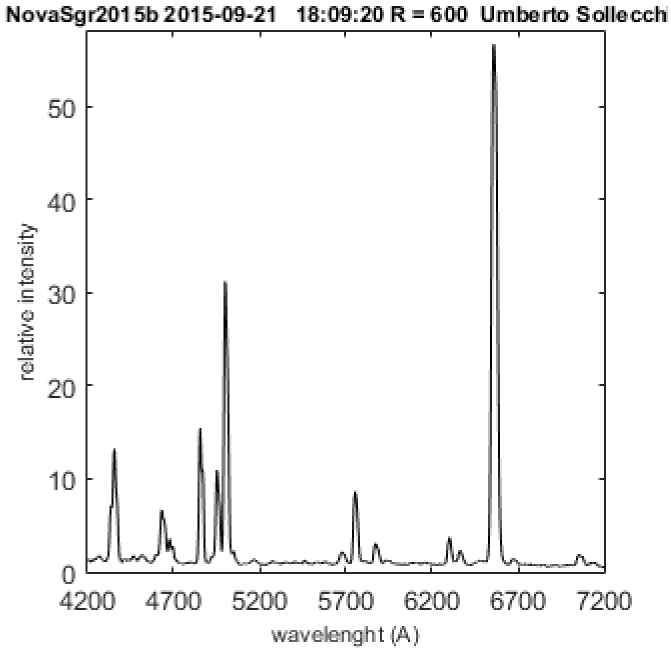

| Nova Cen 2013 | V1369 Cen |
|---|---|
| Maximum | 14-12-2013 |
| Days after maximum | 625 |
| Current mag V | 10.3 |
| Delta mag V | 7 |



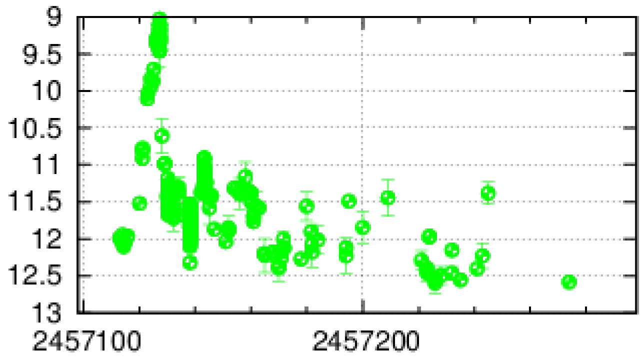
# Status of current novae 2/2

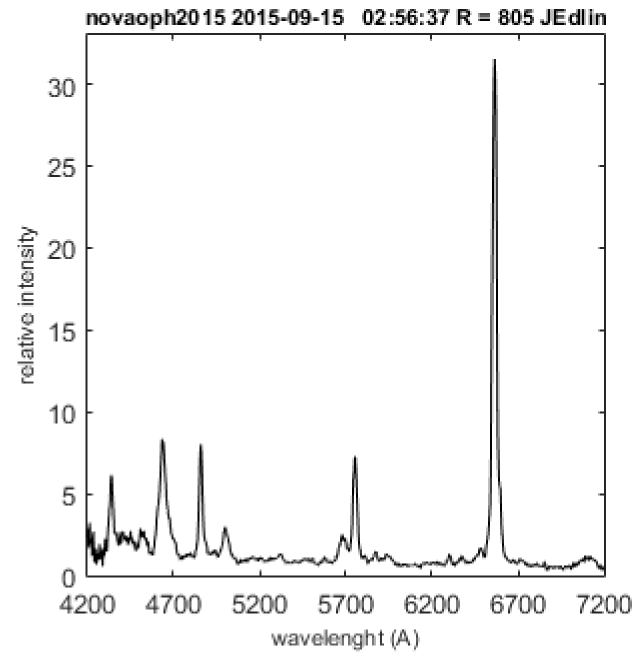
| NovaSgr 2015 #2 | |
|---|---|
| Maximum | 21-03-2015 |
| Days after maximum | 165 |
| Current mag V | 9.3 |
| Delta mag V | |



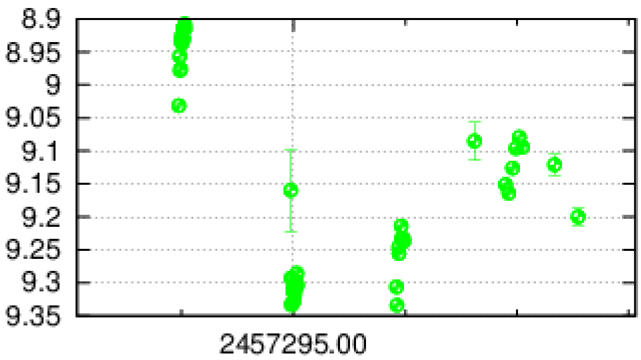



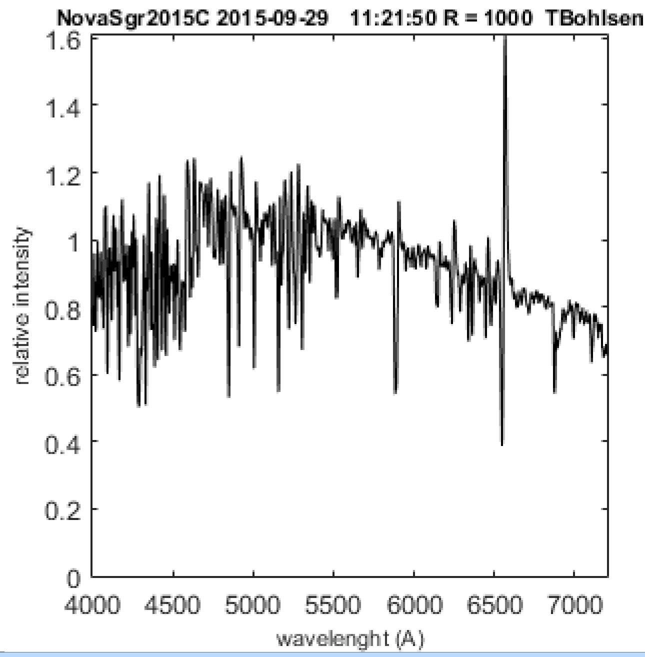

| Nova Oph 2015 | |
|---|---|
| Maximum | 01-04-2015 |
| Days after maximum | 152 |
| Current mag V | 12 |
| Delta mag V | 3 |



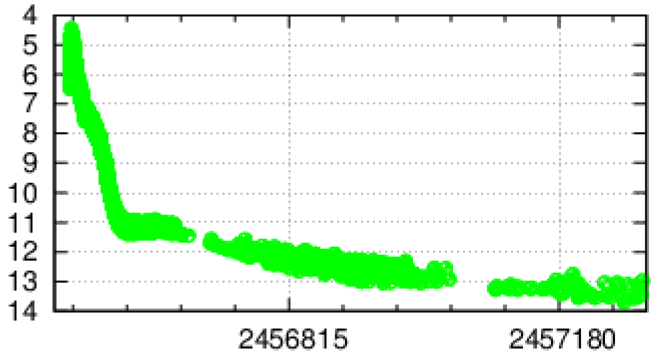

| NovaSgr 2015 #3 | |
|---|---|
| Maximum | |
| Days after maximum | |
| Current mag V | |
| Delta mag V | |

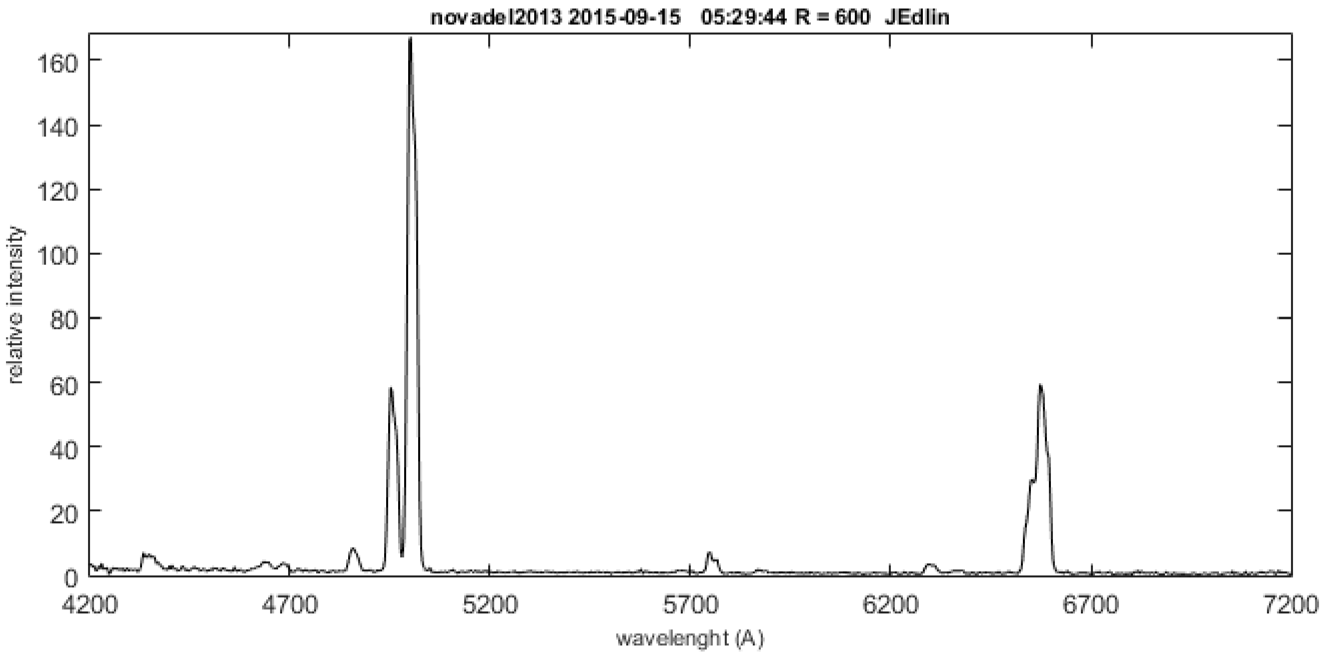


## Nova Del 2013 = V 339 Del

The nova continues its slow decline (Mag V = 13.5 , but remains observable



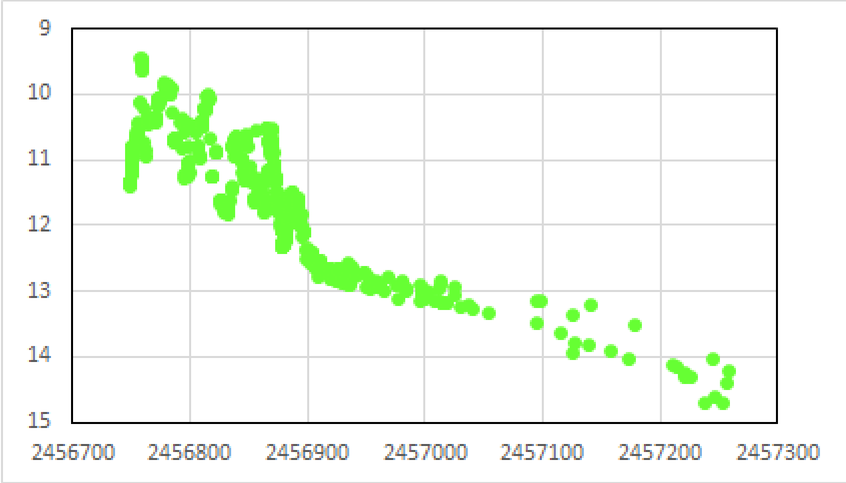

A spectrum obtained by Stéphane Charbonnel at OHP, two years after the discovery (LISA R= 1000)

# Nova Cyg 2014

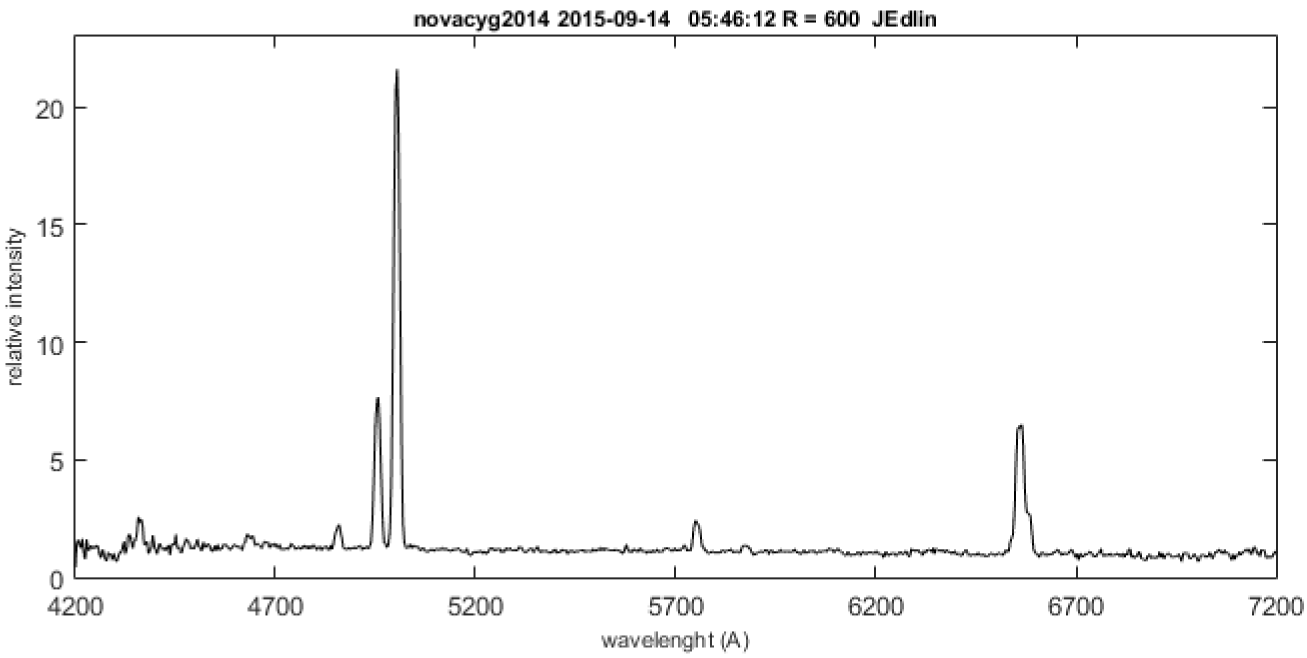
**Luminosity**
**Mag V = 14.8 (30-09-2015)**

**Spectroscopy**
**Nova Cyg in nebular phase**
**Rapid decline in september**

**Jim Edlin got a spectrum at mag V ~14.5**



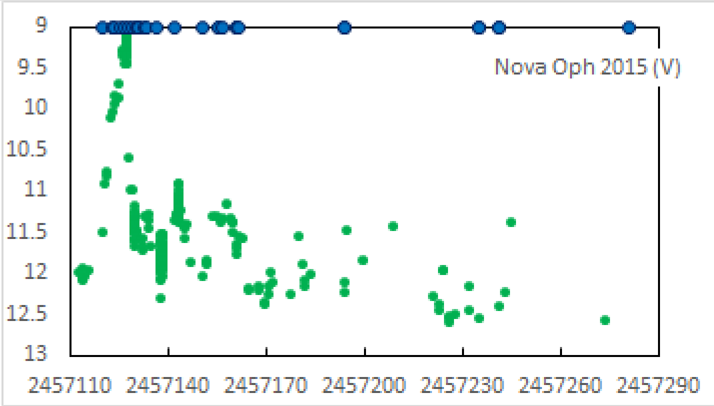

AAVSO Light Curve (V band)



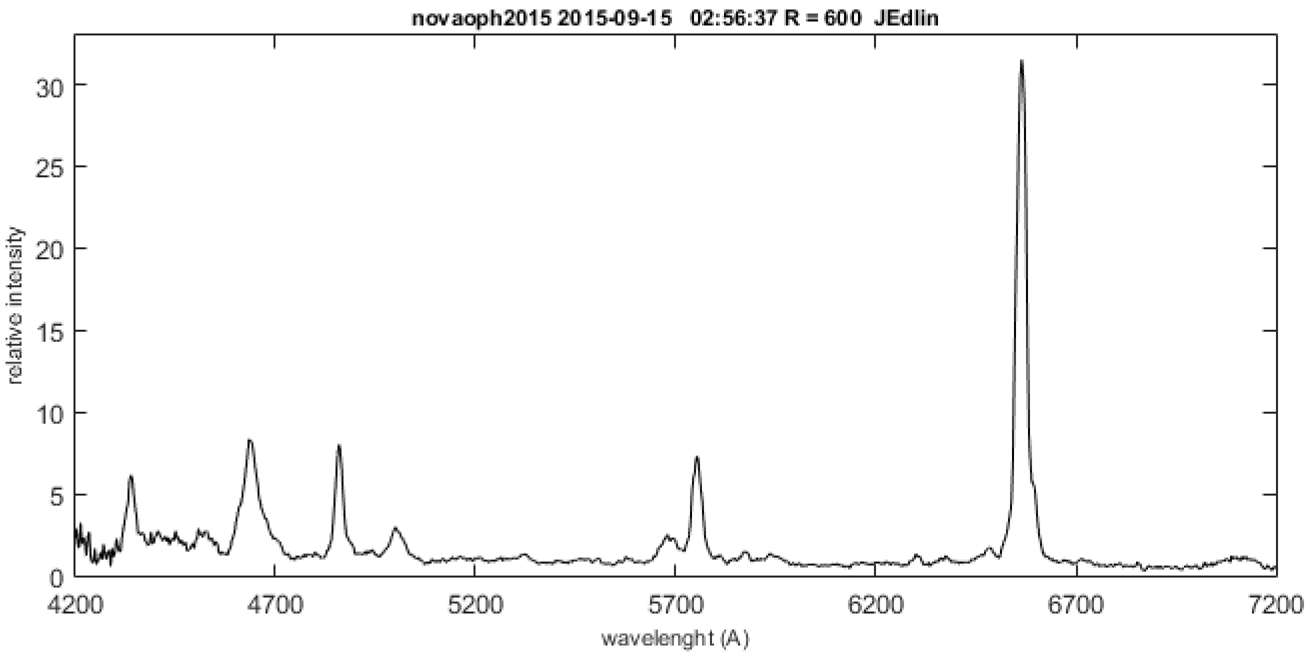
## Nova Oph 2015 (PNV J17291350-1846120)

| Coordinates (2000.0) | |
|---|---|
| **R.A.** | **17 29 13.5** |
| **Dec.** | **- 18 46 12** |

Note the strong NIII/CIII 4640-4660 blend




The AAVSO light curve sine 30th of march, 2015
Spectra of ARAS database : blue points



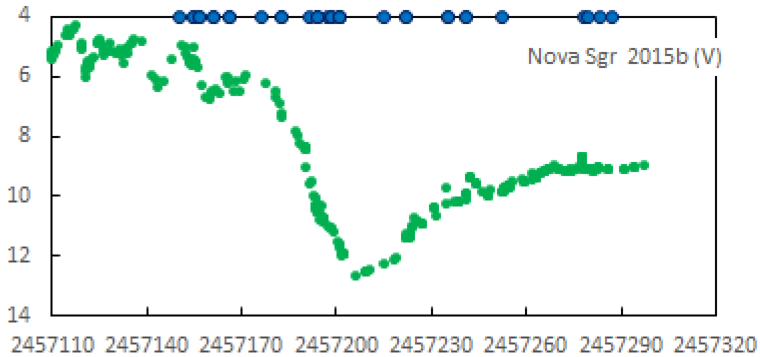

ARAS Data Base : 26 spectra : http://www.astrosurf.com/aras/Aras_DataBase/Novae/2015_NovaOph2015.htm

# Nova Sgr 2015b = V5668 Sgr

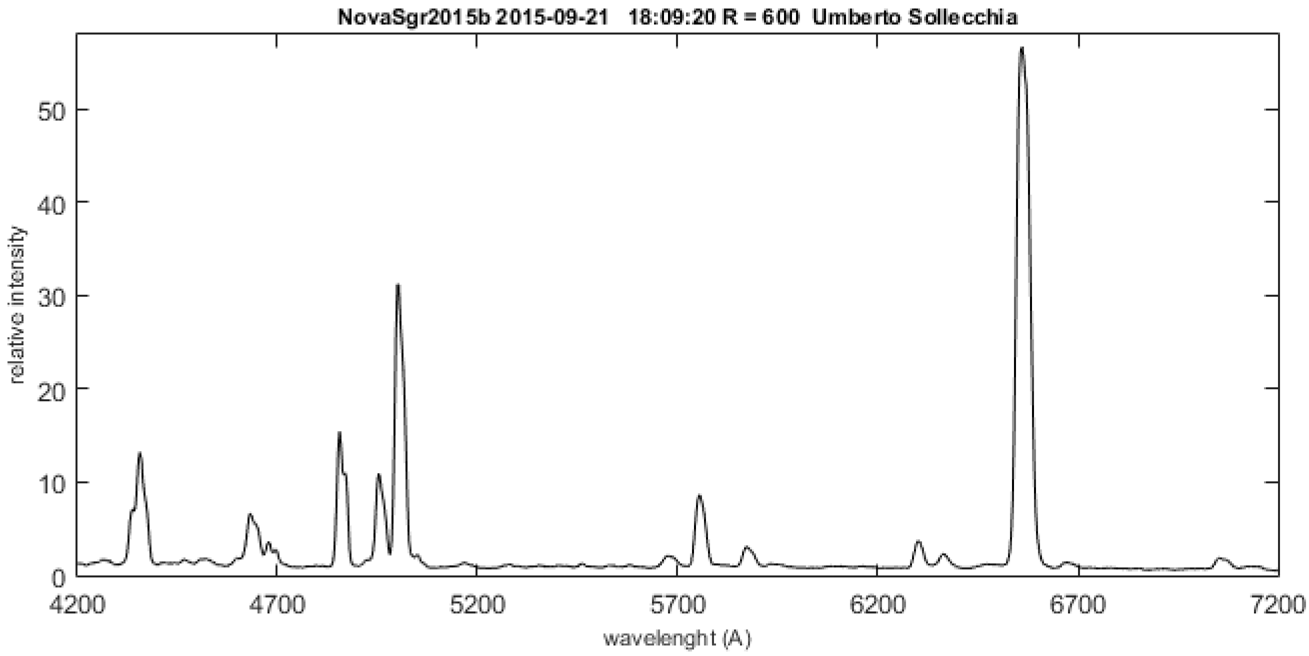
| Coordinates (2000.0) | |
|---|---|
| R.A. | 18 36 56.8 |
| Dec. | -28 55 39.8 |

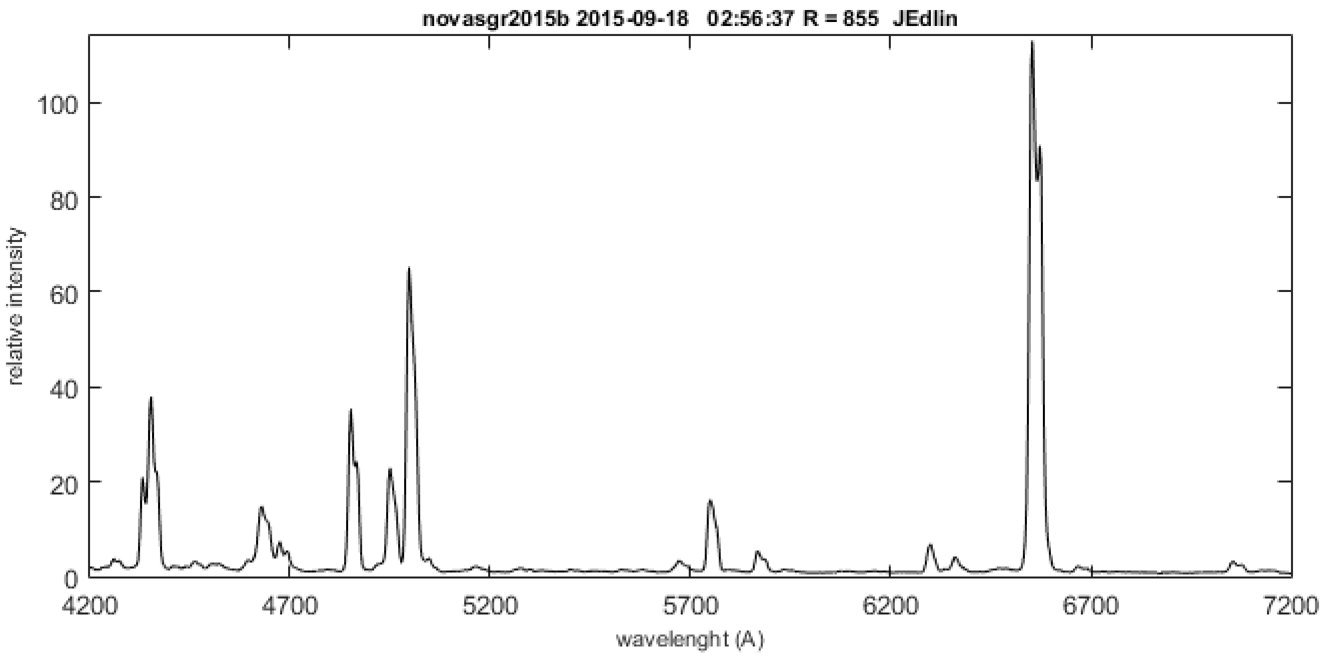
The nova is now in nebular stage
New spectra from Umberto Sollecchia and Jim Edlin

Note He II 4686




AAVSO light curve (V band)
ARAS Spectra : blue dots

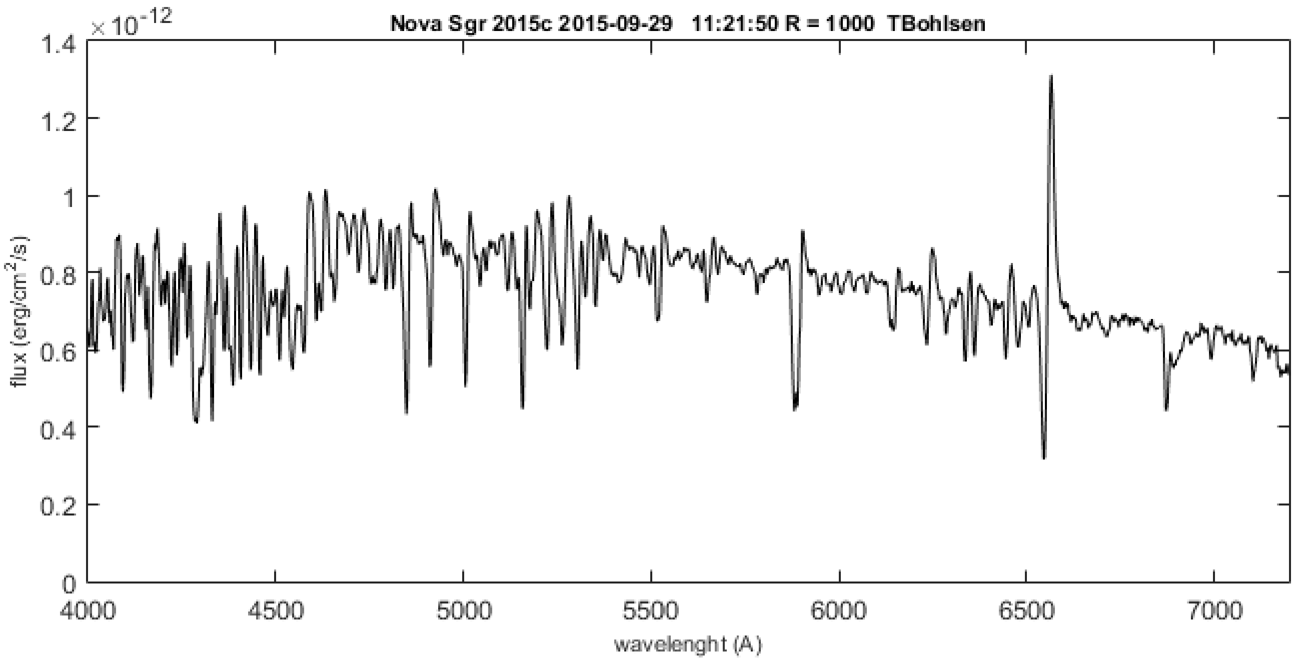


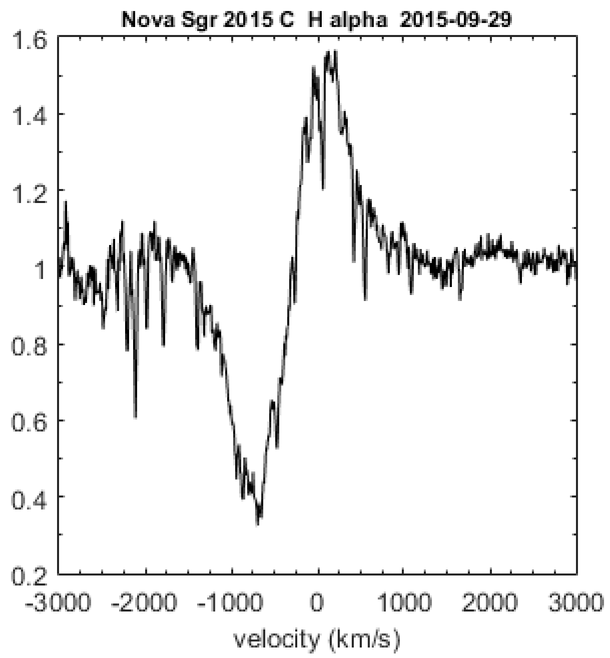



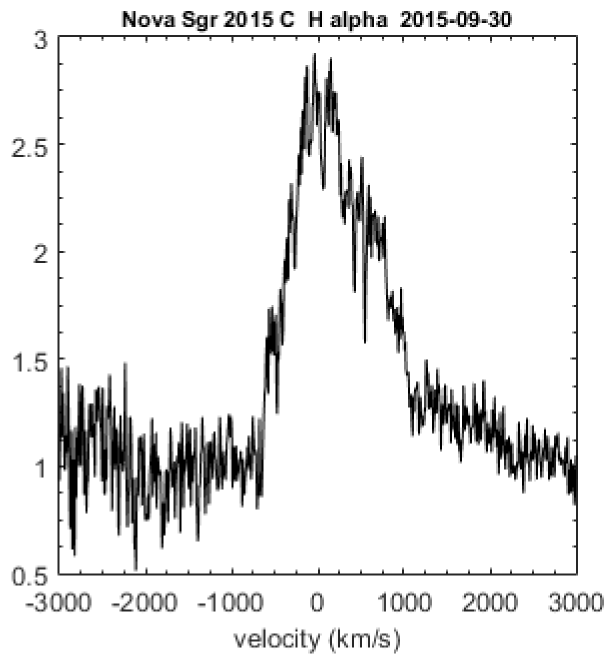
## Nova Sgr 2015c = V5669 Sgr

| Coordinates (2000.0) | |
|---|---|
| R.A. | 18 03 32.7 |
| Dec. | -28 16 05 |

The third nova of the year in Sagittarius
Spectra acquired one day after dicovery by Terry Bolhsen and Olivier Garde




Hα profile obtained by Olivier Garde at R = 11 000 (eShel)

Electronic Telegram No. 4145
Central Bureau for Astronomical Telegrams

**NOVA SAGITTARII 2015 No. 3 = PNV J18033275-2816054**

S. Nakano, Sumoto, Japan, reports the discovery by K. Itagaki (Teppo-cho, Yamagata, Japan) of an apparent nova (mag 9.9) on an unfiltered CCD frame taken on Sept. 27.429 UT using a 180-mm-focal-length camera lens; unfiltered confirming CCD images taken by Itagaki at the same time with a 0.50-m f/6 reflector yield the following position: R.A. = 18h03m32s.75, Decl. = -28d16'05".4 (equinox 2000.0; reference stars from UCAC4 catalogue). The discovery image was posted at URL http://www.kitagaki.jp/images/pn-sgr.jpg.
The variable was designated PNV J18033275-2816054 when it was posted at the Central Bureau's TOCP webpage.

Additional CCD magnitudes for the variable: Sept. 20.438 UT, [13.0 ](Itagaki); 23.420, [12.5 (Y. Nakamura, Kameyama, Mie, Japan; camera apparently with a 135-mm-f.l. f/4 lens; communicated by H. Yamaoka, Kyushu University); 27.404, 9.5 (T. Kojima, Tsumagoi, Gunma-ken, Japan; pre-discovery image; Canon EOS 60 camera + 135-mm-f.l. f/2.8 lens + infrared filter; image posted at website URL http://www.oaa.gr.jp/~oaacs/image/Pnova_Sgr_Kojima.jpg; communicated by Nakano); 27.418, 27.420, 9.7 (Y. Sakurai, Mito, Ibaraki-ken, Japan; pre-discovery image; Nikon D7100 + 180-mm-f.l. f/2.8 lens; communicated by Nakano); 27.441, 9.3 (K. Nishiyama, Kurume, Japan; 0.50-m f/6.8 reflector + FLI 1001E camera; limiting mag 16.5; position end figures 32s.74, 05".6; star of mag 20 noted at position end figures 32s.70, 05".7 in VizieR catalogue); 27.447, 10.5 (A. Takao, Kitakyushu, Japan; independent discovery reported after posting on TOCP webpage; position end figures 33s.6, 10"; image posted at URL https://sites.google.com/site/akitakao001/); 27.483, 9.6 (R. Kaufman, Bright, Victoria, Australia; digital SLR camera + 200-mm-f.l. lens in strong moonlight; image posted via URL http://tinyurl.com/nr4xfw4); 27.483, 9.8 (T. Noguchi, Chiba-ken, Japan; 0.23-m f/6.3 Schmidt-Cassegrain reflector; position end figures 32s.75, 05".4; communicated by Nakano; image posted at URL http://park8.wakwak.com/~ngc/images/PNVinSgr_20150927.jpg); 28.082, B = 9.77, V = 9.18, R_c = 8.83 and I_c = 8.48 (S. Kiyota, Kamagaya, Japan; remotely with a 0.43-m f/4.5 CDK astrograph + FLI-PL6303E camera near Mayhill, NM, USA); 28.4, 9.5 (E. Guido; remotely with an iTelescope 0.43-m f/6.8 astrograph at Siding Spring; position end figures 32s.77, 05".3; UCAC-4 catalogue; image posted at website URL http://bit.ly/1FwPd8O; animated comparison with Palomar Sky Survey blue plate from 1958 Apr. 18 posted at URL http://bit.ly/1NXp7wN). Yamaoka adds that Y. Nakamura also reported an independent discovery of this variable on CCD images taken on Sept. 27.419 with a 135-mm-f.l. camera lens (no magnitude or position provided).

**K. Ayani, Bisei Astronomical Observatory, reports that a spectrogram (resolution about 500 at H-beta) taken of PNV J18033275-2816054 by M. Fujii (Kurashiki, Okayama, Japan) with a 0.4-m telescope on Sept. 27.487 UT shows Balmer emission lines, with the H-beta line having a P-Cyg profile that indicates an expansion velocity of about 1100 km/s. Emission lines of Fe II (37), (42), and (49) also have P-Cyg profiles. The Na D absorption is remarkable. The spectrogram can be viewed at the following website URL:**
**http://otobs.sakura.ne.jp/FBO/fko/nova/pnv_j18033275-2816054.htm**

**O. Garde, Chabons, France, writes that he obtained nine 600-s echelle spectrograms (resolution R = 11000) of PNV J18033275-2816054 with a 40-cm Ritchey-Chretien telescope (+ ATIK 460EX CCD camera) on Sept. 29.768 UT.**
**H-alpha shows a P-Cyg profile with an indicated radial velocity of about 870 km/s. The spectrogram can be viewed at the following website URL:**
**http://www.spectro-aras.com/forum/viewtopic.php?f=5&t=1264**

See also : https://www.aavso.org/aavso-alert-notice-528

# Selected list of bright symbiotics stars of interest

| Target | | | | | | Refrence Star | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Name | AD (2000) | DE (2000) | Mag V * | Interest | Name | AD (2000) | DE (2000) | Mag V | E(B-V) | Sp Type |
| 1 | AX Per | 1 36 22.7 | 54 15 2.5 | 11.6 | ++ | HD 6961 | 01 11 06.2 | +55 08 59.6 | 4.33 | 0 | A7V |
| 2 | UV Aur | 5 21 48.8 | 32 30 43.1 | 10 | | HD 39357 | 05 53 19.6 | +27 36 44.1 | 4.557 | | A0V |
| 3 | ZZ CMi | 7 24 13.9 | 8 53 51.7 | 10.2 | | HD 61887 | 07 41 35.2 | +03 37 29.2 | 5.955 | | A0V |
| 4 | BX Mon | 7 25 24 | -3 36 0 | 10.4 | + | HD 55185 | 07 11 51.9 | - 00 29 34.0 | 4.15 | | A2V |
| 5 | V694 Mon | 7 25 51.2 | -7 44 8 | 10.5 | ++ | HD 55185 | 07 11 51.9 | - 00 29 34.0 | 4.15 | | A2V |
| 6 | NQ Gem | 7 31 54.5 | 24 30 12.5 | 8.2 | | HD 64145 | 07 53 29.8 | +26 45 56.8 | 4.977 | | A3V |
| 7 | T CrB | 15 59 30.1 | 25 55 12.6 | 10.4 | ++ | HD 143894 | 16 02 17.7 | +22 48 16.0 | 4.817 | 0 | A3V |
| 8 | AG Dra | 16 1 40.5 | 66 48 9.5 | 9.7 | ++ | HD 145454 | 16 06 19.7 | +67 48 36.5 | 5.439 | 0 | A0Vn |
| 9 | RS Oph | 17 50 13.2 | -6 42 28.4 | 10.4 | ++ | HD 164577 | 18 01 45.2 | +01 18 18.3 | 4.439 | 0 | A2Vn |
| 10 | YY Her | 18 14 34.3 | 20 59 20 | 12.9 | ++ | HD 166014 | 18 07 32.6 | +28 45 45.0 | 3.837 | 0.02 | B9.5V |
| 11 | V443 Her | 18 22 8.4 | 23 27 20 | 11.3 | ++ | HD 171623 | 18 35 12.6 | +18 12 12.3 | 5.79 | 0 | A0Vn |
| 12 | BF Cyg | 19 23 53.4 | 29 40 25.1 | 10.8 | ++ | HD 180317 | 19 15 17.4 | +21 13 55.6 | 5.654 | 0 | A4V |
| 13 | CH Cyg | 19 24 33 | 50 14 29.1 | 7 | + | HD 184006 | 19 29 42.4 | +51 43 47.2 | 3.769 | 0 | A5V |
| 14 | CI Cyg | 19 50 11.8 | 35 41 3.2 | 10.5 | ++ | HD 187235 | 19 47 27.8 | +38 24 27.4 | 5.826 | 0.02 | B8Vn |
| 15 | StHA 190 | 21 41 44.8 | 2 43 54.4 | 10.3 | + | HD 207203 | 21 47 14.0 | +02 41 10.0 | 5.631 | 0 | A1V |
| 16 | AG Peg | 21 51 1.9 | 12 37 29.4 | 8.6 | ++ | HD 208565 | 21 56 56.4 | +12 04 35.4 | 5.544 | 0 | A2Vnn |
| 18 | Z And | 23 33 39.5 | 48 49 5.4 | 9.65 | ++ | HD 222439 | 23 40 24.5 | +44 20 02.2 | 4.137 | 0 | A0V |
| 19 | R Aqr | 23 43 49.4 | -15 17 4.2 | 9.9 | ++ | HD 222847 | 23 44 12.1 | - 18 16 37.0 | 5.235 | 0 | B9V |

Mag V * : 01-04-2014

## Observing

**CH Cygni campaign**
**Especially high resolution H alpha**
**CH Cygni remains at a high level of activity.**

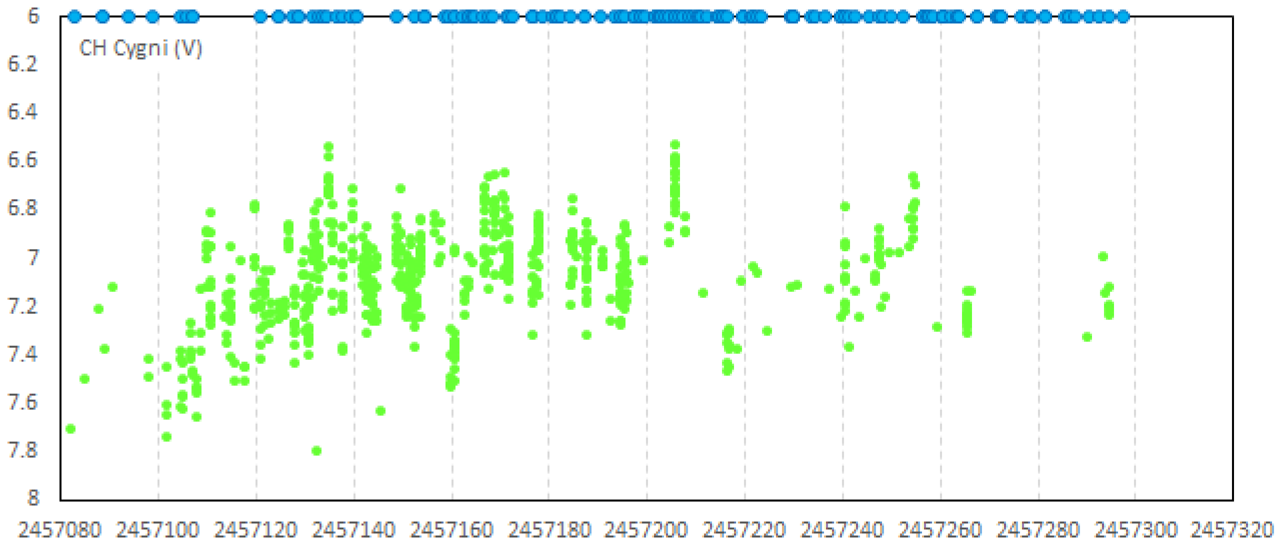
**AG Peg : historical outburst**

ARAS DATA BASE | http://www.astrosurf.com/aras/Aras_DataBase/Symbiotics.htm

# CH Cygni campaign

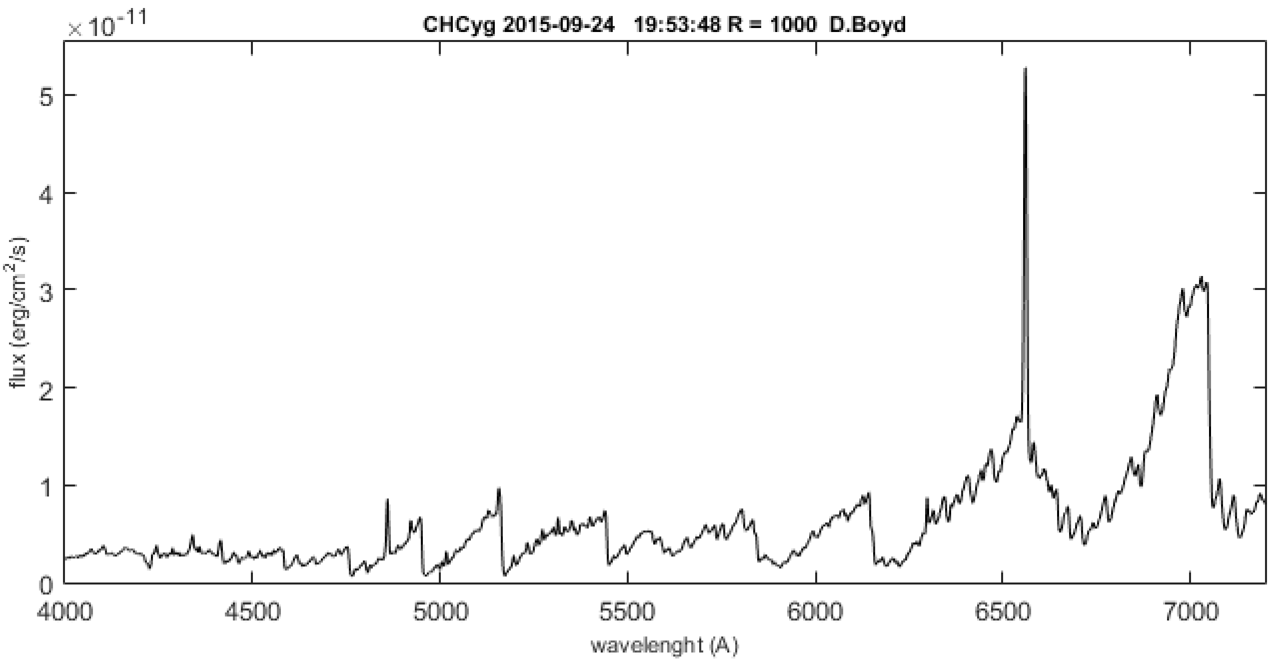
| Coordinates (2000.0) | |
|---|---|
| R.A. | 19 24 33.0 |
| Dec. | +50 14 29.1 |

**23 spectra + time series in September 2015**

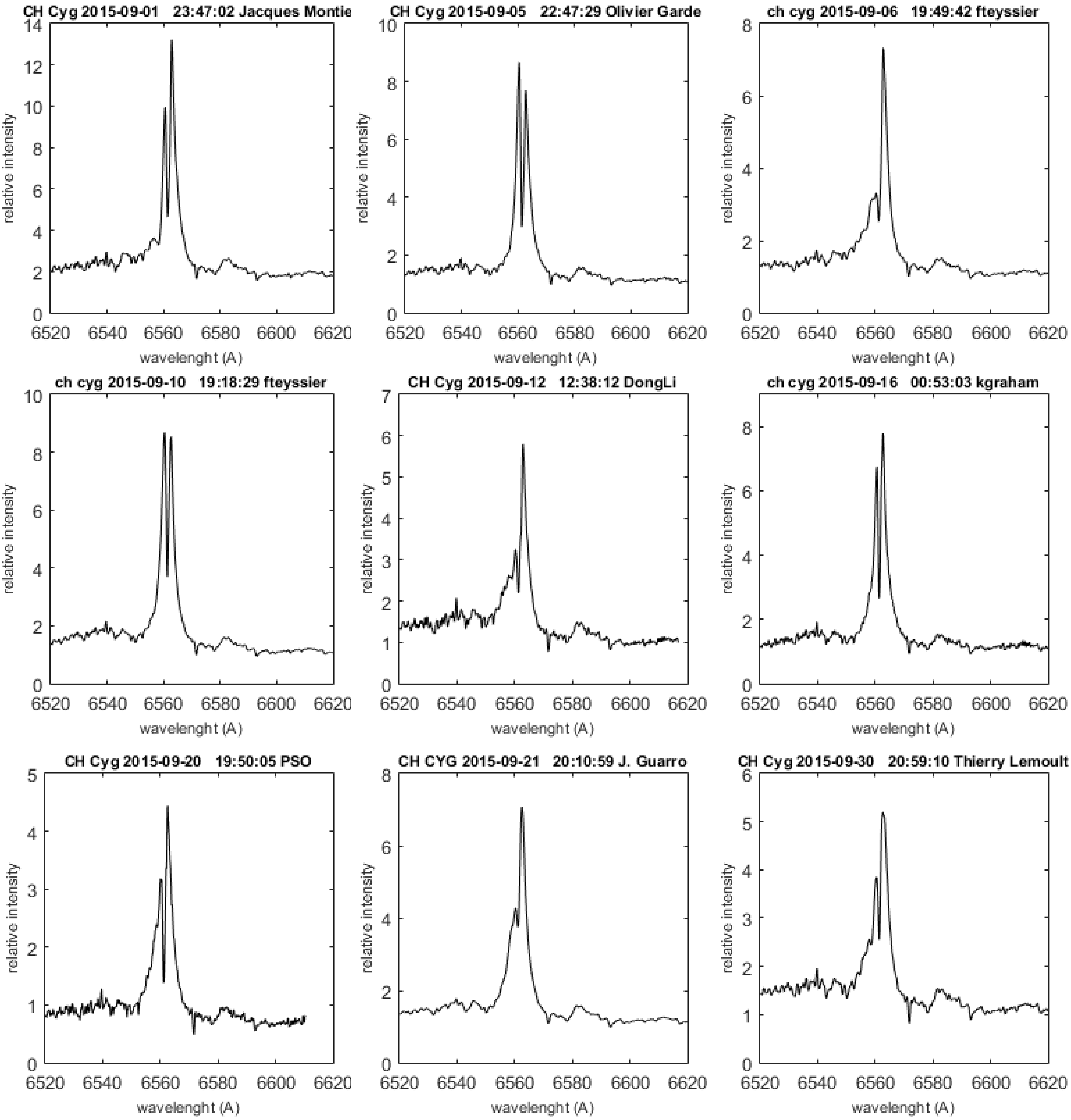



AAVSO V band light curve in 2015
CH Cyg remains in high state with a flickering of about 0.3-0.4 mag
ARAS observations : blue dots

**CH Cygni ARAS campaign : see page 16 and previous issues**



# CH Cygni campaign : various H alpha profiles in september, 2015

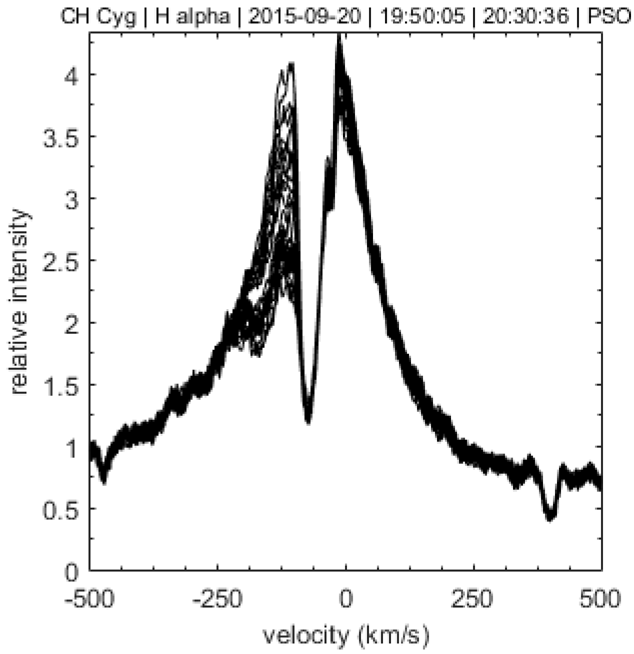


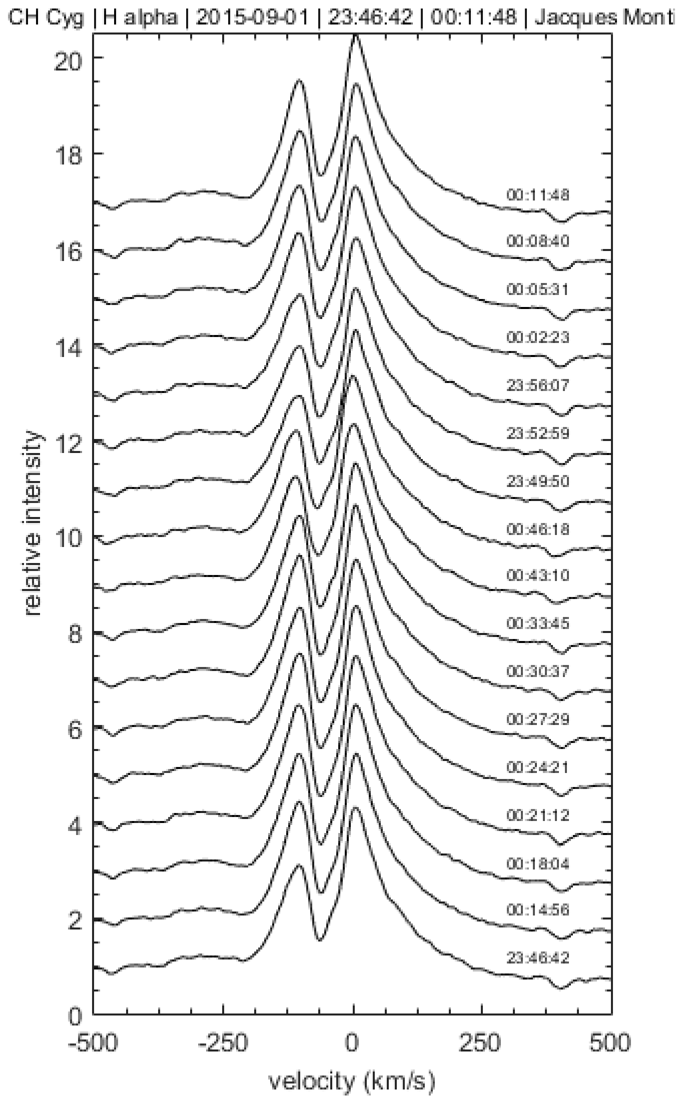

J. Montier, D. Li, P. Somogyi (PSO), K Grakam: LHIRES III, 2400 l/mm, R = 15000
T. Lemoult, F. Teyssier : eShel, R = 11000
J. Guarro : home built spectroscop, R = 6500

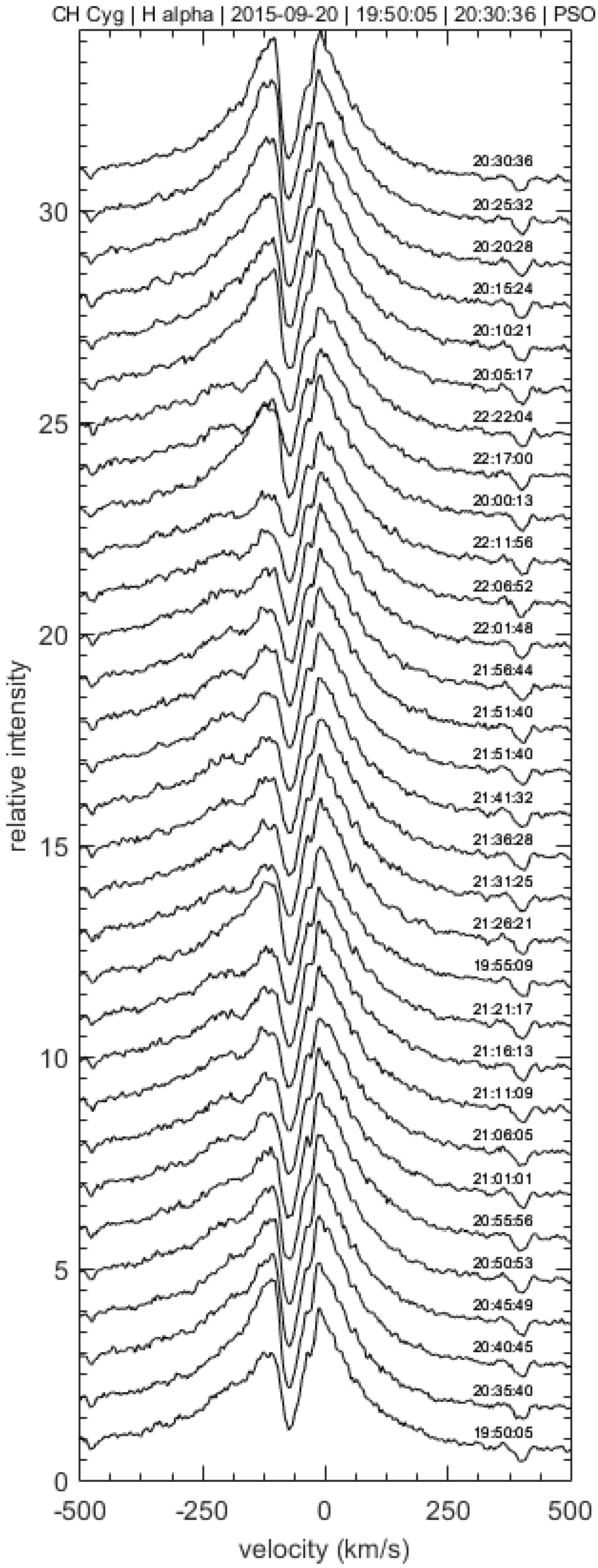
Spectra from China, Europe, USA

# CH Cygni campaign : time series

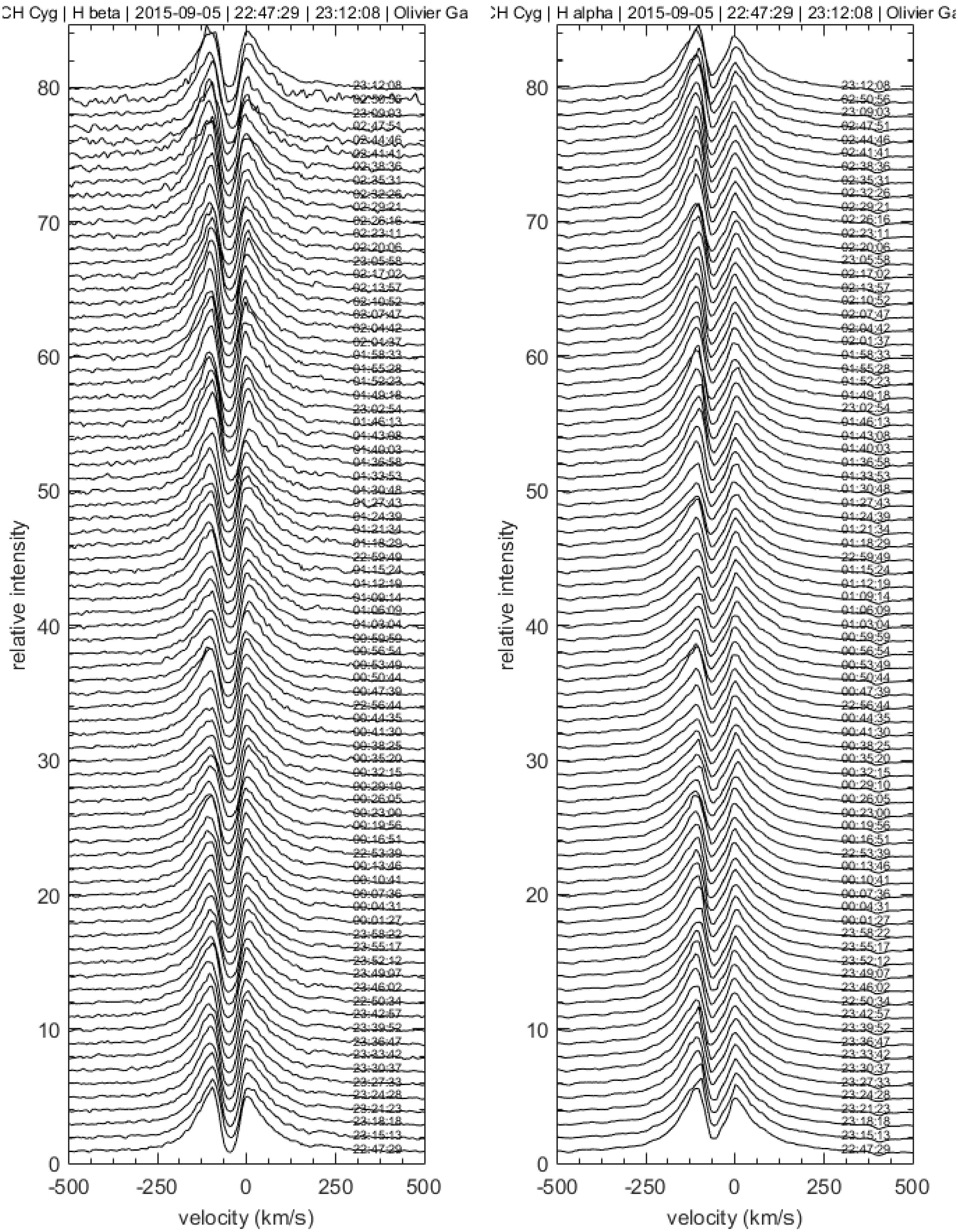
Two examples of time series at R = 15000
Profile almost constant in Jacques Montier's series
Fast and strong changers in Peter's Series (PSO)



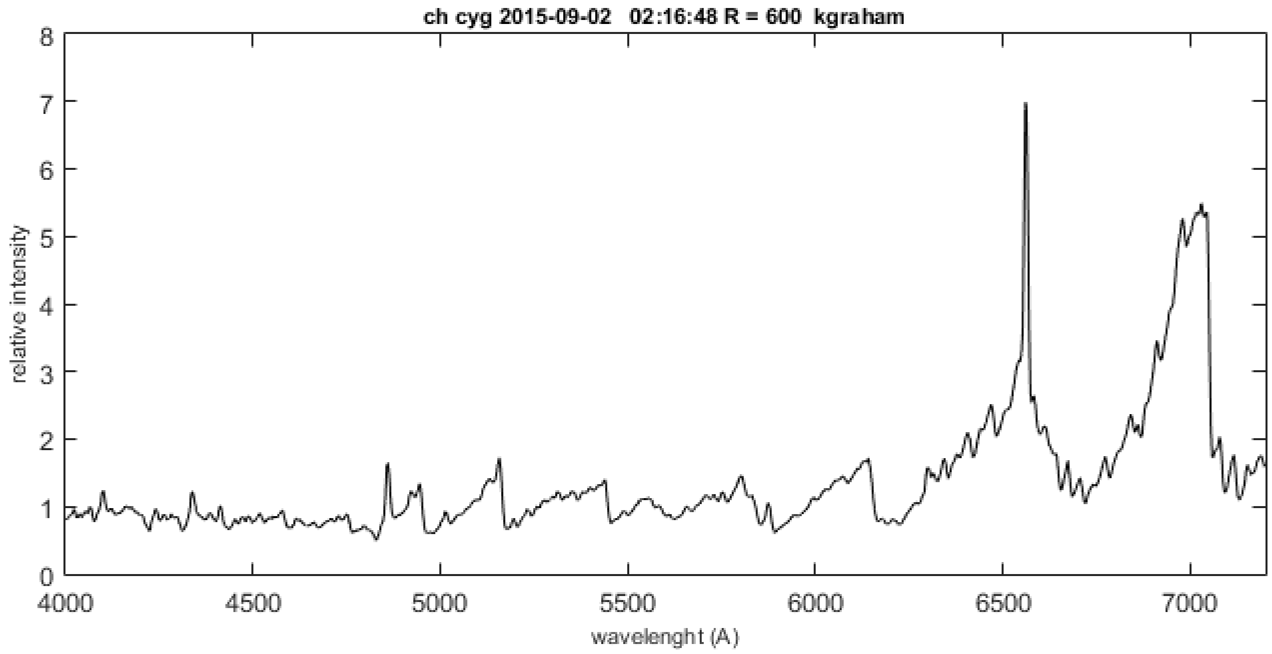



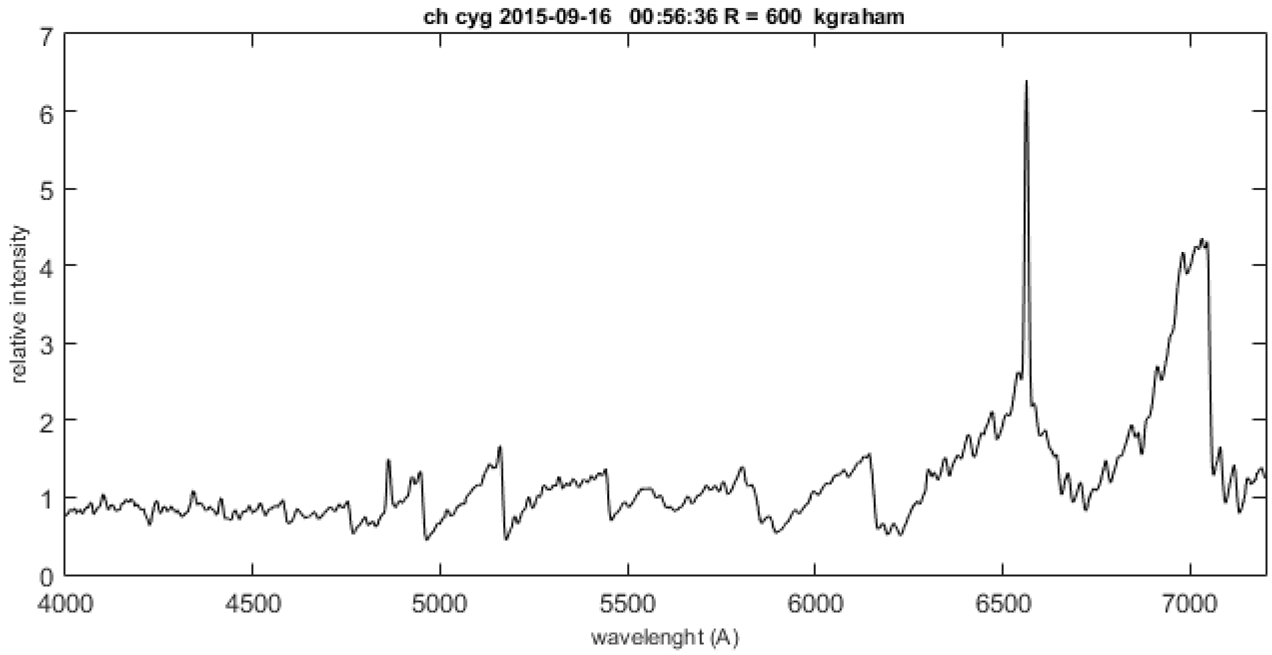



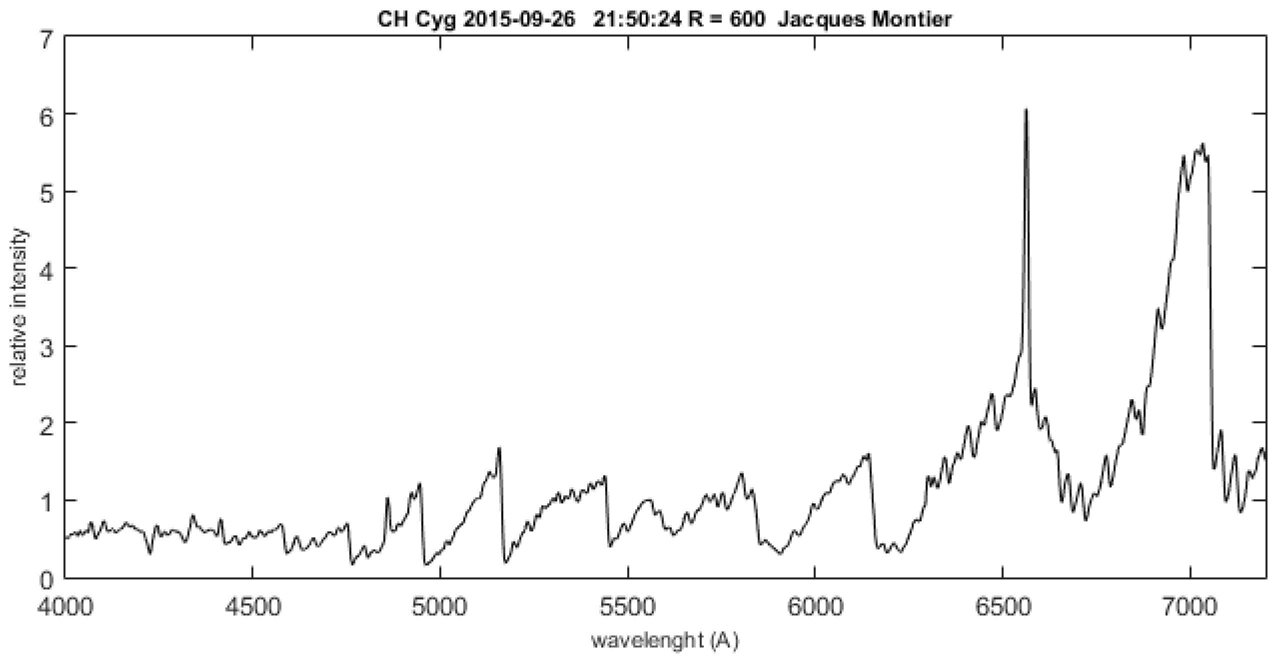
## CH Cygni campaign




H beta and H alpha time series by O. Garde with an eShel


ch cyg 2015-09-02 02:16:48 R = 600 kgraham
relative intensity
wavelenght (A)
0
1
2
3
4
5
6
7
8
4000
4500
5000
5500
6000
6500
7000


ch cyg 2015-09-16 00:56:36 R = 600 kgraham
relative intensity
wavelenght (A)
0
1
2
3
4
5
6
7
4000
4500
5000
5500
6000
6500
7000


CH Cyg 2015-09-26 21:50:24 R = 600 Jacques Montier
relative intensity
wavelenght (A)
0
1
2
3
4
5
6
7
4000
4500
5000
5500
6000
6500
7000

# Request for observations of the symbiotic star CH Cygni (Dr A. Skopal)


Field of CH Cygni - Christian Buil - 15-03-2012

### CH Cygni

| Coordinates (2000.0) | |
|---|---|
| R.A. | 19 24 33 |
| Dec. | +54 14 29.1 |

Current magnitude V = 7.4 to 7.6
(Flickering)

### Reference stars

MILES Standart for high resolution spectra

| Name | RA (2000) | Dec (20002) | Sp. Type | Mag. V | $E_{B-V}$ |
|---|---|---|---|---|---|
| HD 192640 | 20:14:31.9 | +36:48:22.7 | A2V | 4.96 | 0.026 |

Reference for low resolution spectra

| Name | RA (2000) | Dec (20002) | Sp. Type | Mag. V | $E_{B-V}$ |
|---|---|---|---|---|---|
| HD 183534 | 19:27:42 | +52:19:14 | A1V | 5.7 | 0 |

### Observing

**High resolution spectra**
Eshel
LHIRES III 2400 l/mm ( H alpha)
**Spectra should be corrected for heliocentric velocity**

**Low resolution spectra (minimum R = 600)**
**With an excellent correction of atmospheric/intrumental response for computation of the SED**

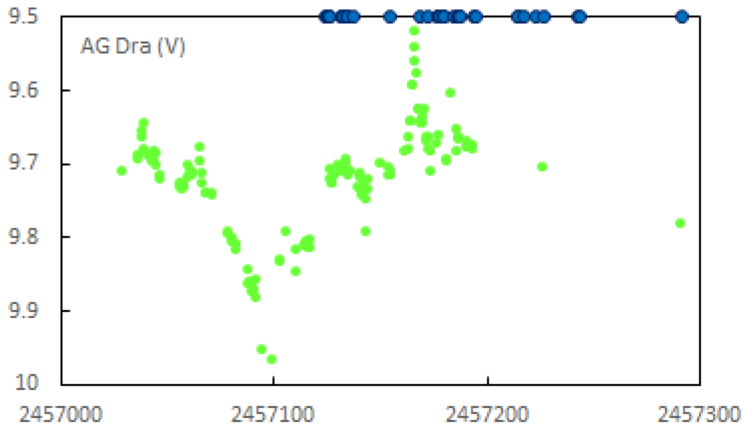
**Send spectra**
**To francoismathieu.teyssier at bbox.fr**

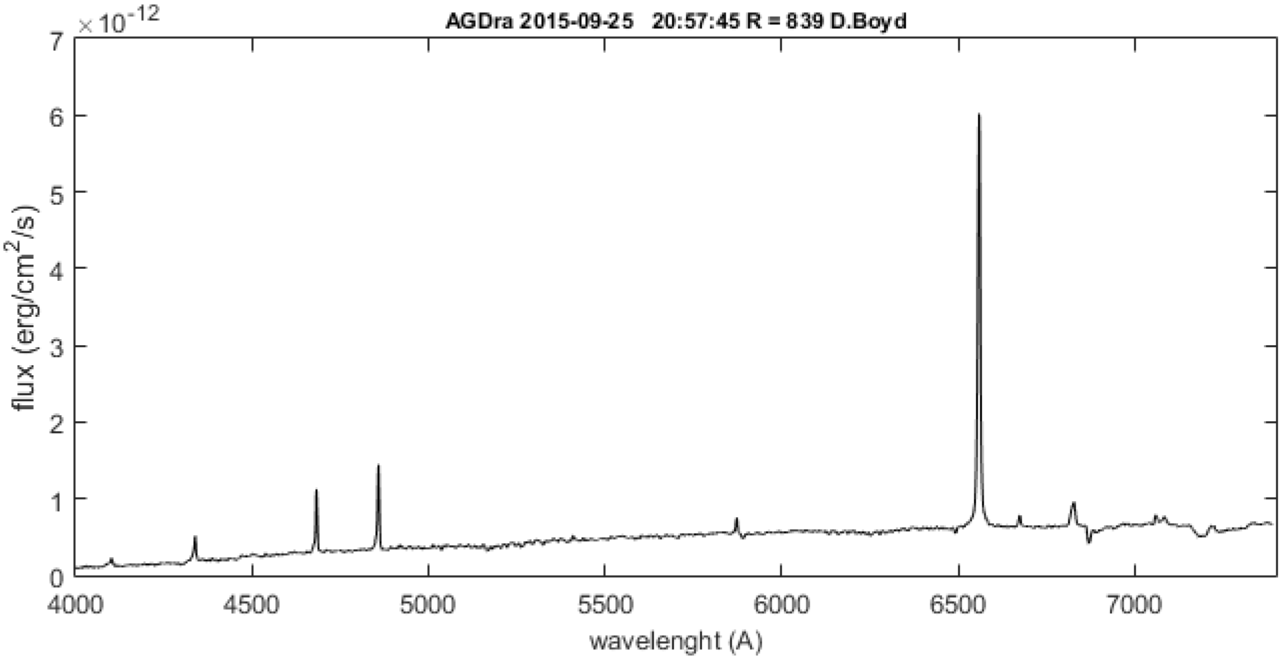
**File name : _chcygni_aaaammdd_hhh.fit**
**And _chcygni_aaaammdd_hhh.zip for eShel and Time series**

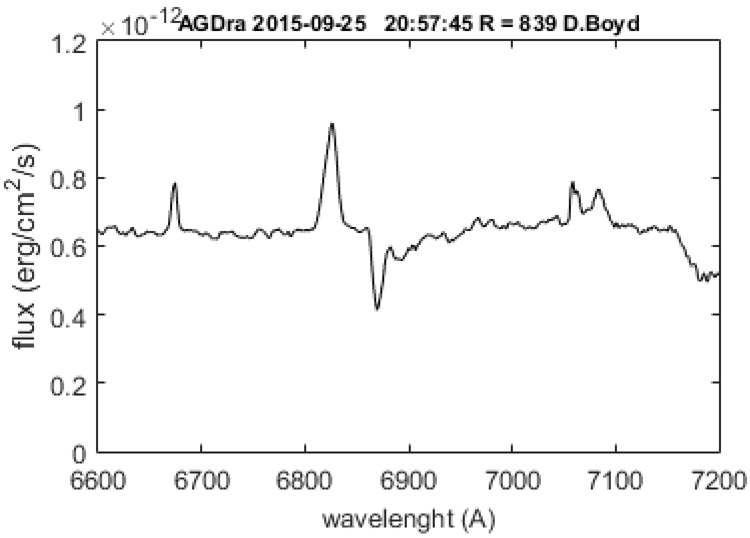
**ARAS Data Base for CH Cygni**
http://www.astrosurf.com/aras/Aras_DataBase/Symbiotics/CHCyg.htm

AG Dra

| Coordinates (2000.0) | |
|---|---|
| R.A. | 16 01 41.0 |
| Dec. | +66 48 10.1 |
| Mag V | 9.7 |



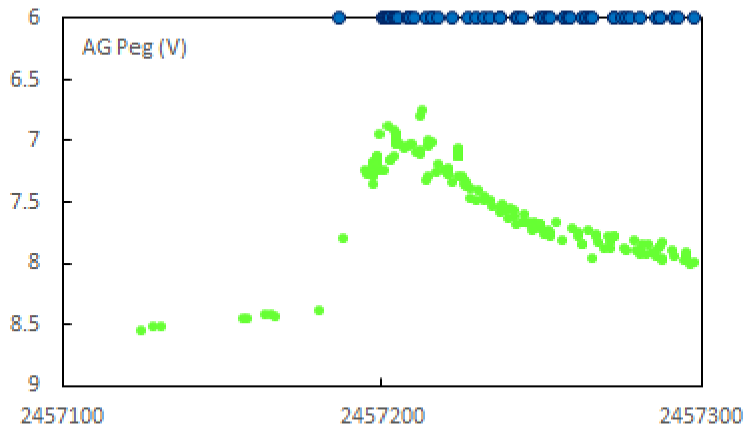

Raman OVI lines

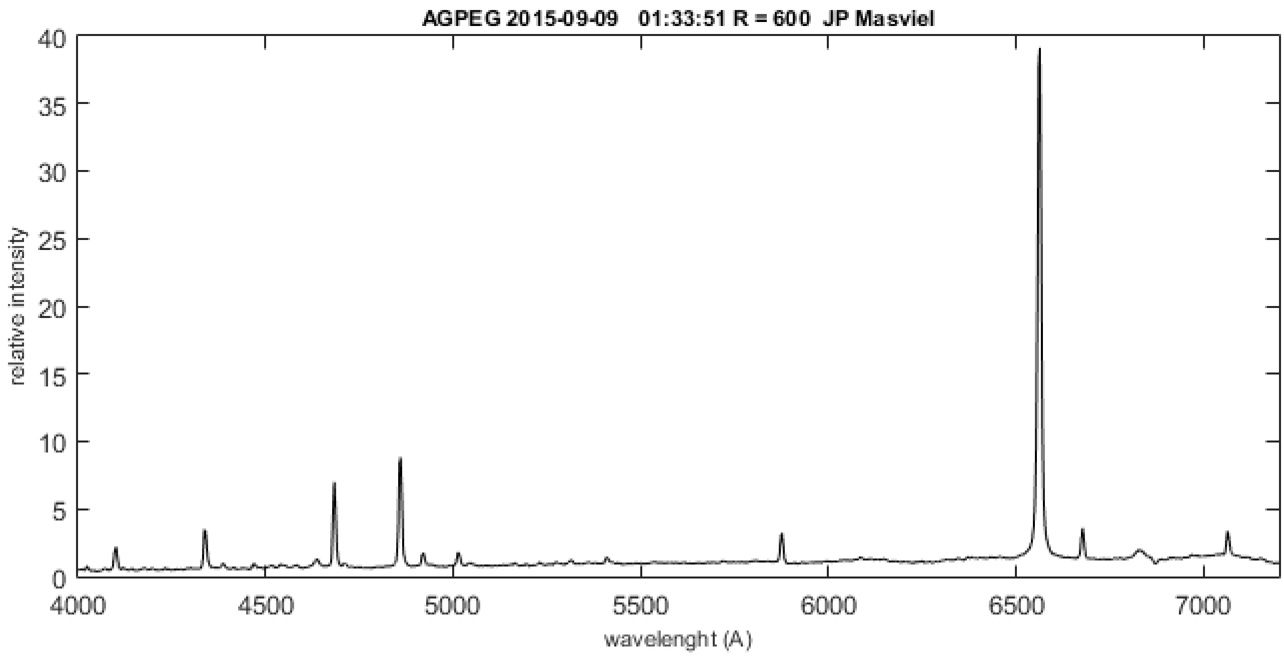
# AG Peg in outburst : an historical event

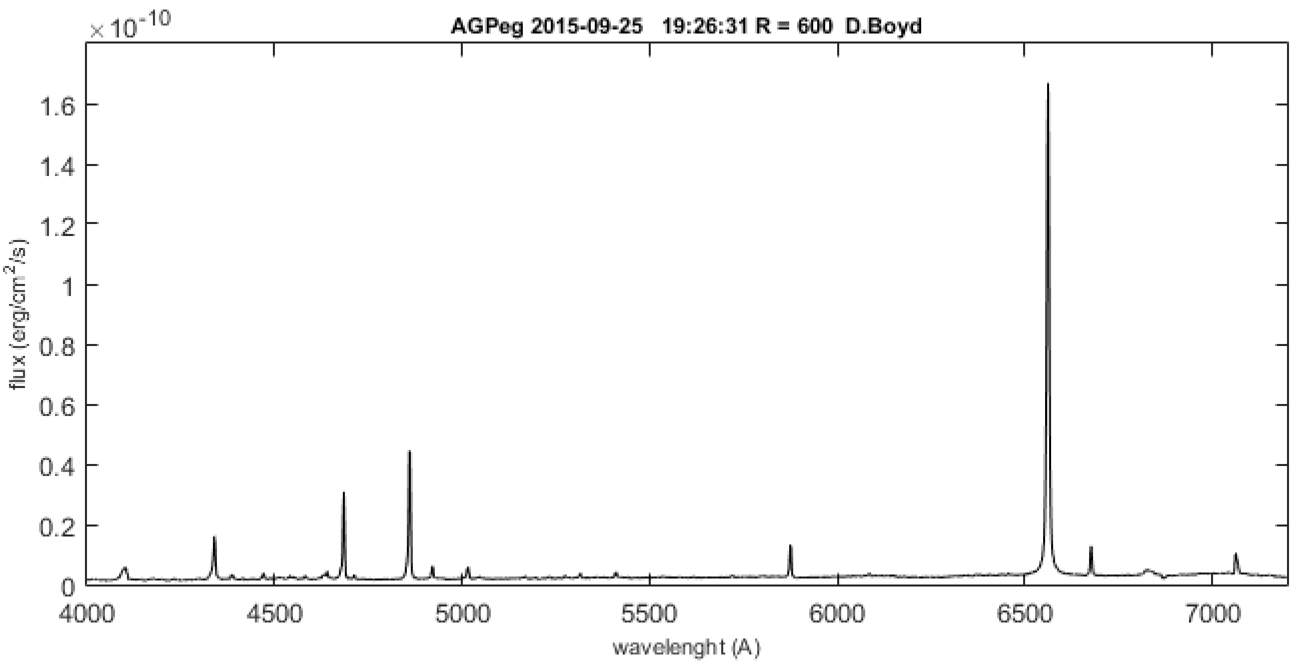
| Coordinates (2000.0) | |
|---|---|
| R.A. | 19 23 53.5 |
| Dec. | +29 40 29.2 |

The V luminosity is declining during this historical symbiotic outburst, V = 8.0 at the end of september

The event is well covered in spectroscopy with 57 spectra in ARAS Data base since June



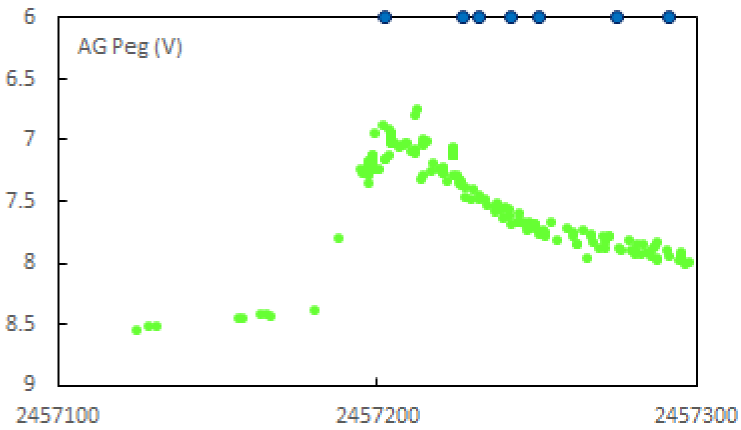



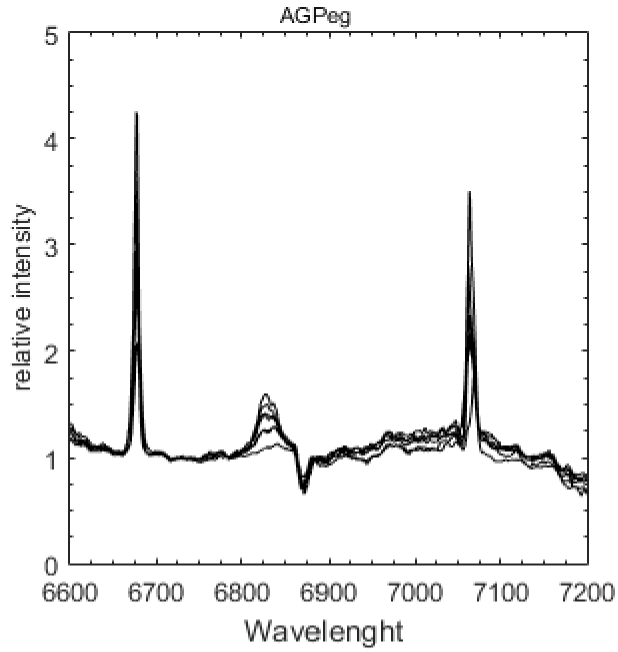



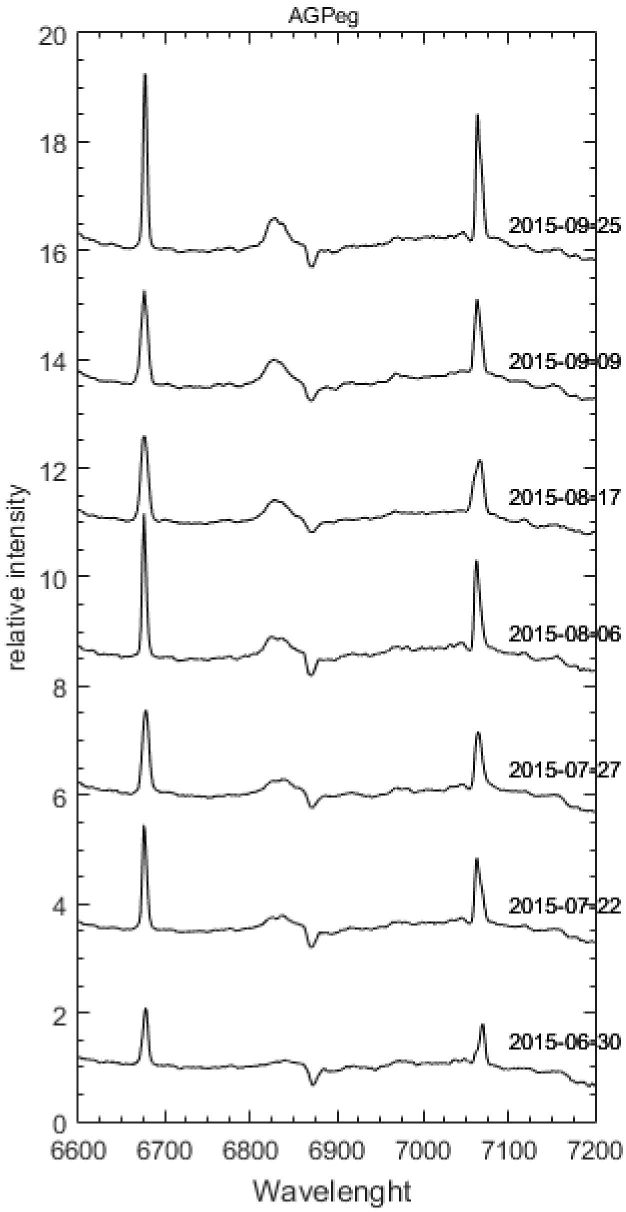
## AG Peg : Raman OVI during the decline throw low resolution spectra

Strenghtening of Raman OVI 6828

Spectra from D. Boyd, J. Montier, JP Masviel, J. Guarro, V. Bouttard

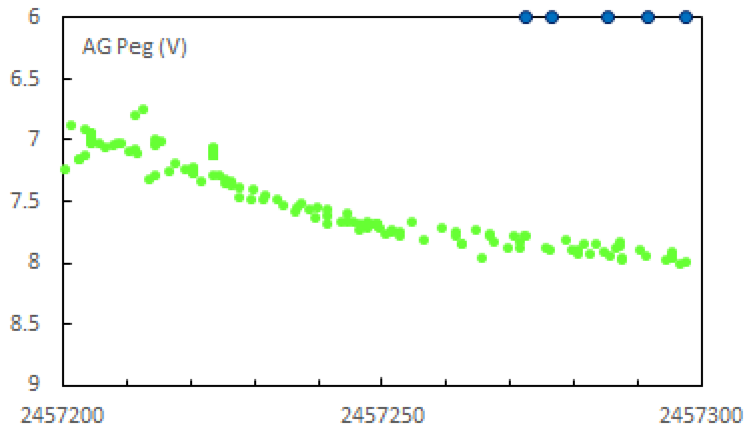


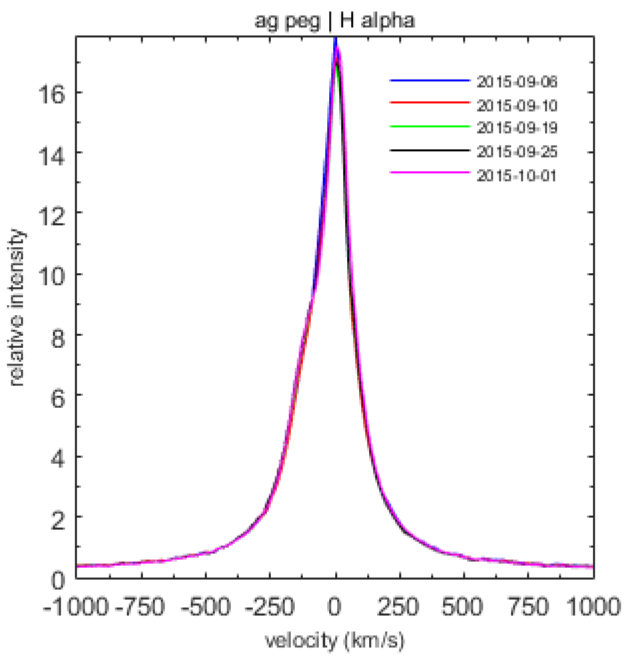



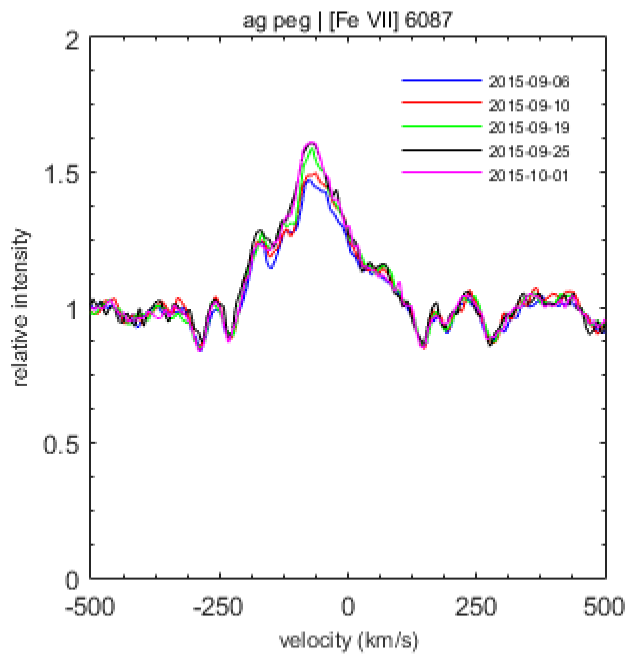



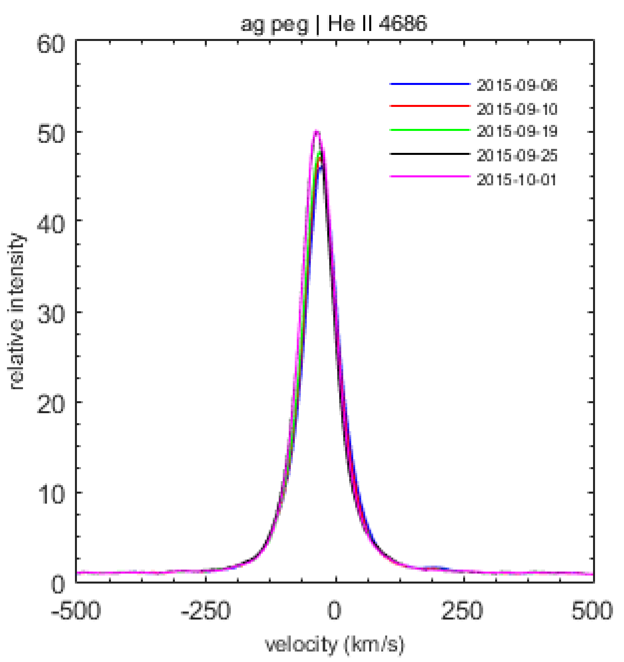
## AG Peg

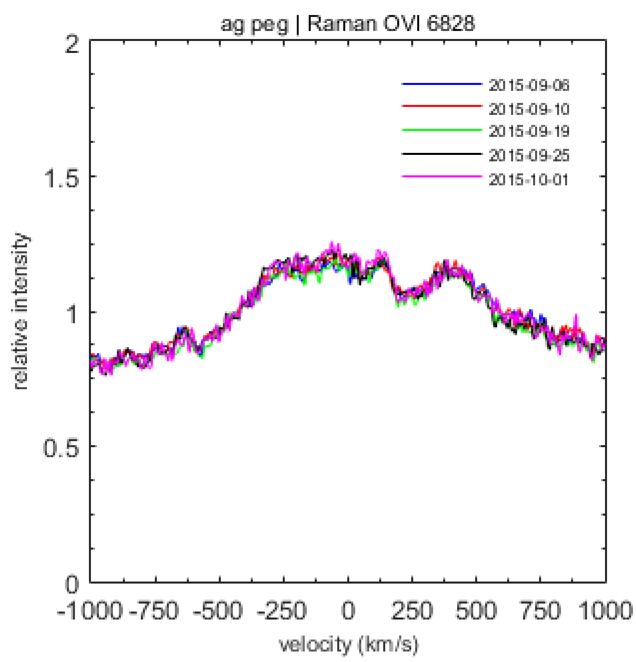
Evolution of a few lines in september with Eshel spectra at R = 11000 (F. Teyssier)
A faint, broad, shoulder appears in the blue edge of H alpha line between the 10th and the 19th of september.
Raman OVI constant.



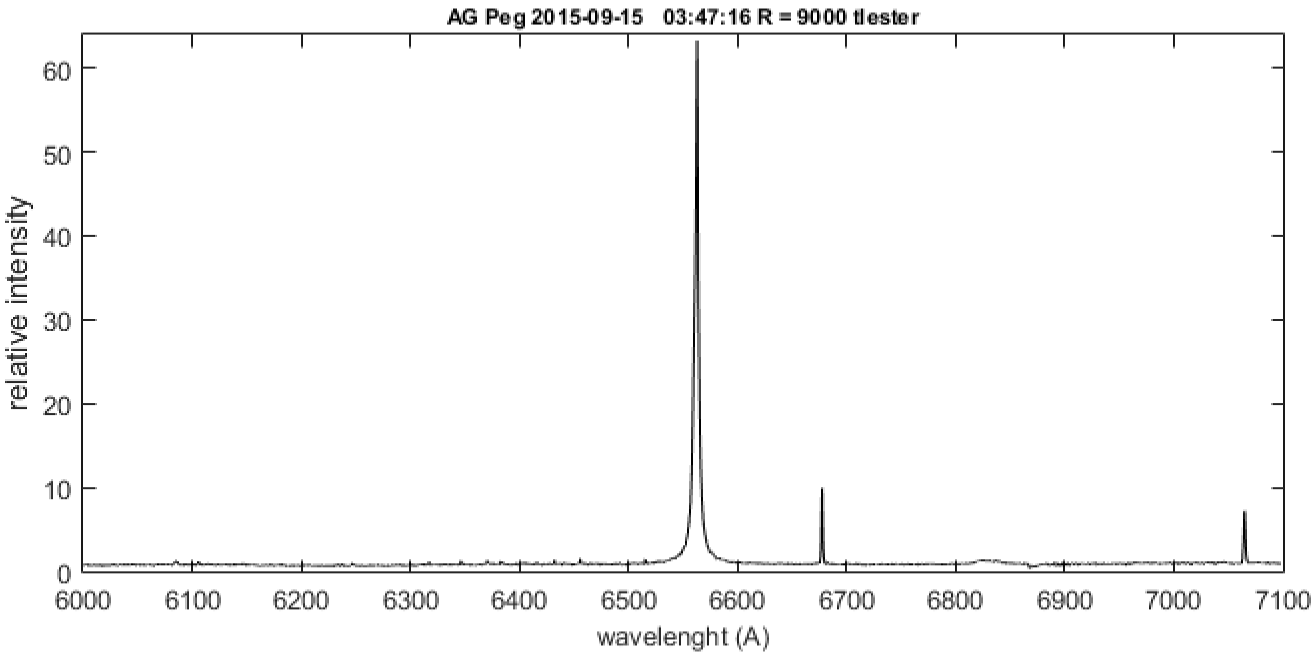



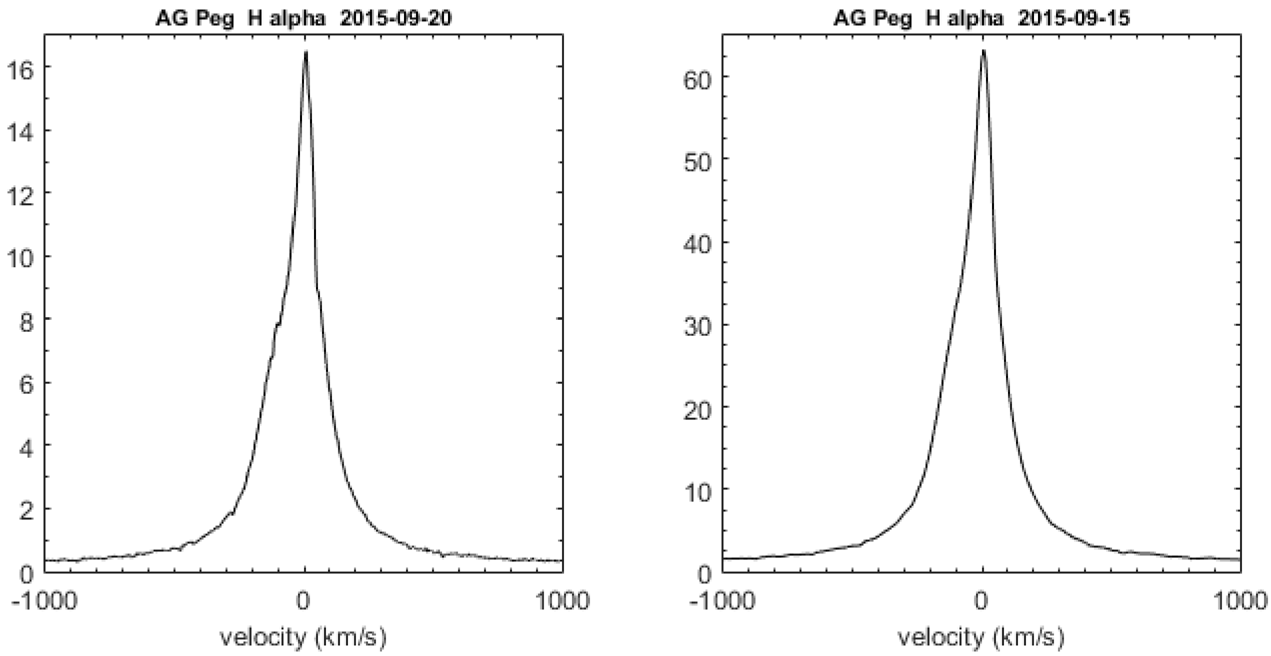



## AG Peg in september



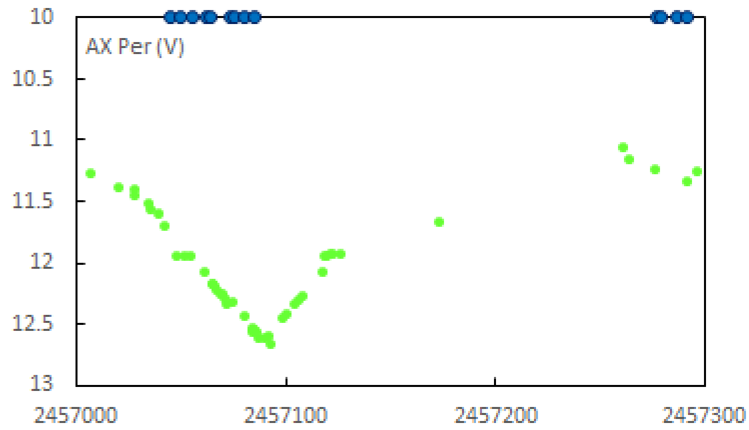

Hα region by T. Lester at R = 9000

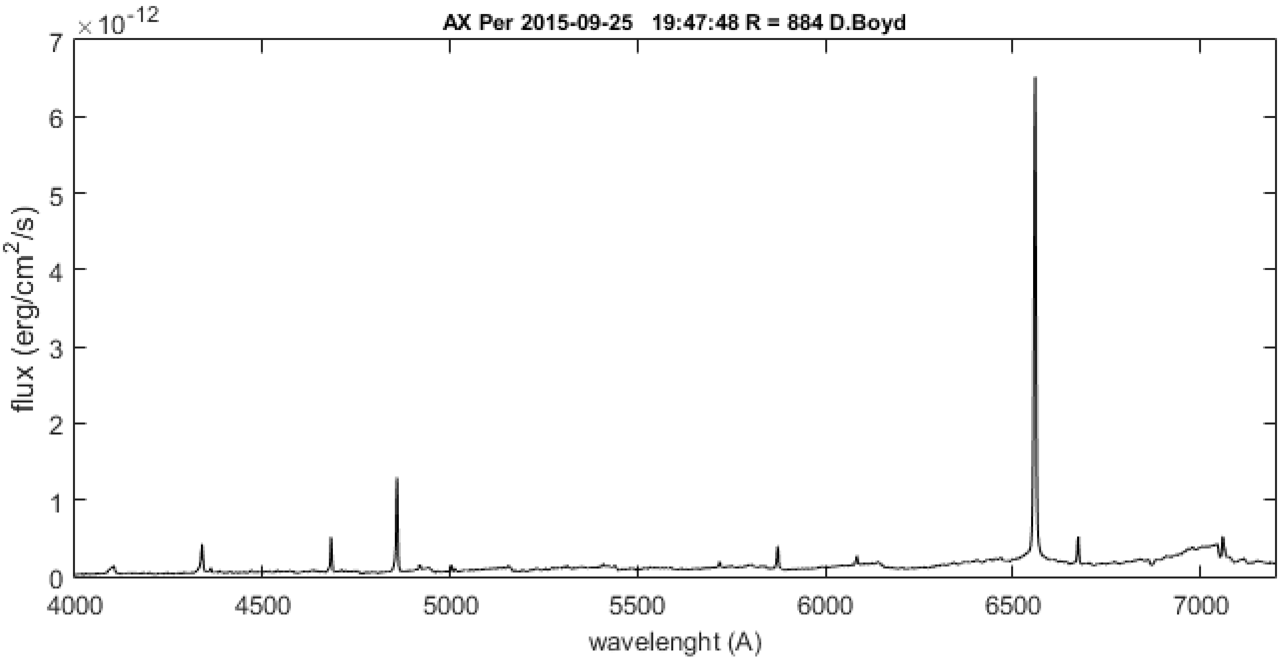


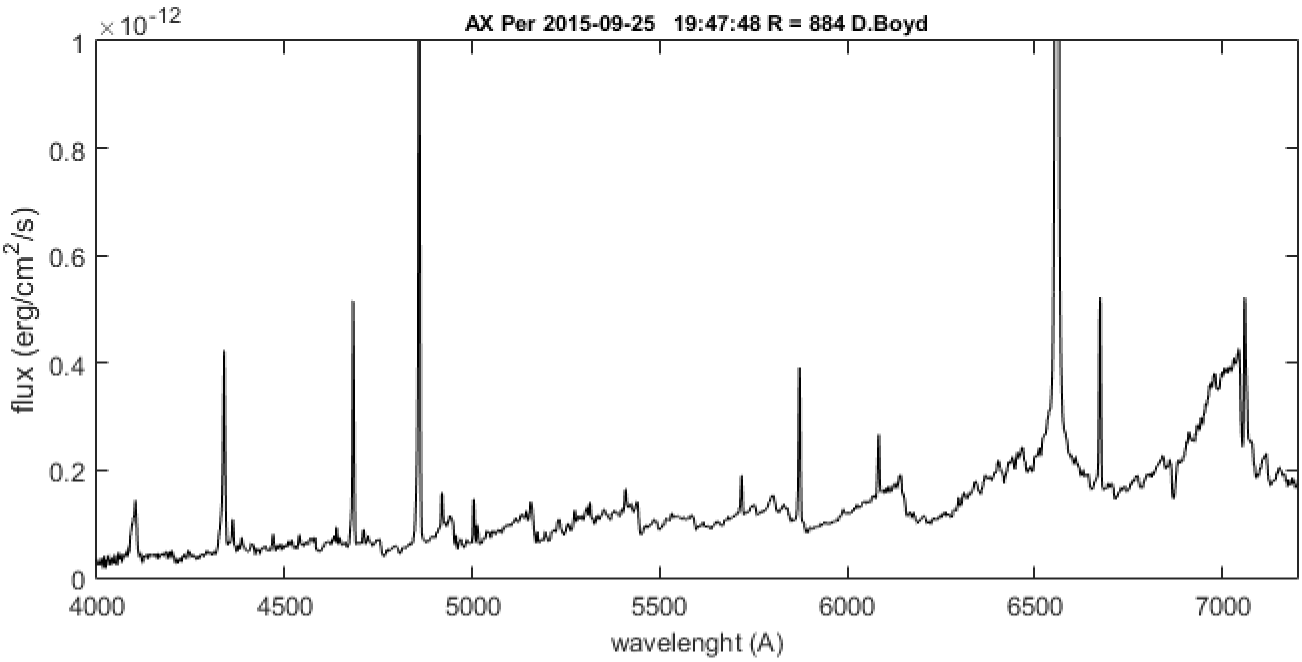

Hα profiles
Right : Peter Somogyi Lhires III 2400 l/mm R = 24000
Left : Tim Lester R = 900

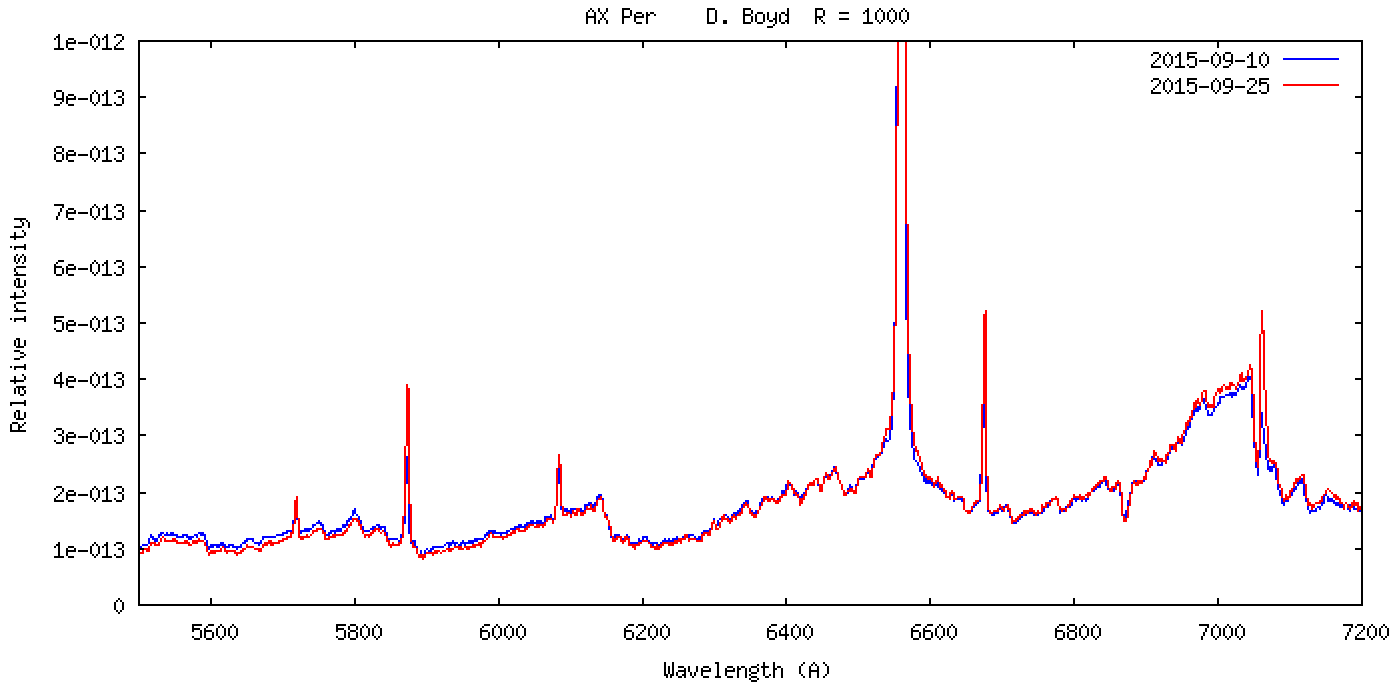
**AX Per**

| Coordinates (2000.0) | |
|---|---|
| R.A. | |
| Dec. | |
| Mag V | 11.2 |

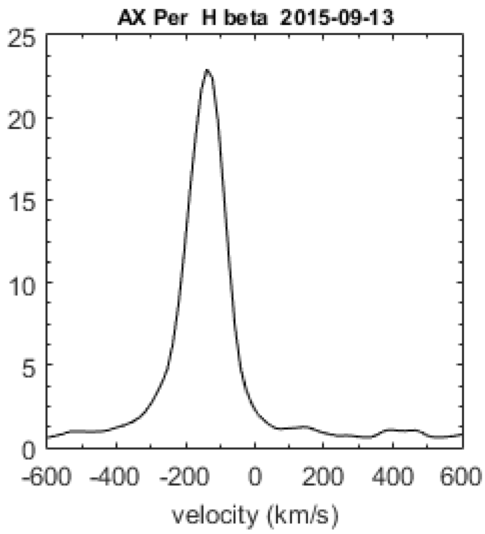


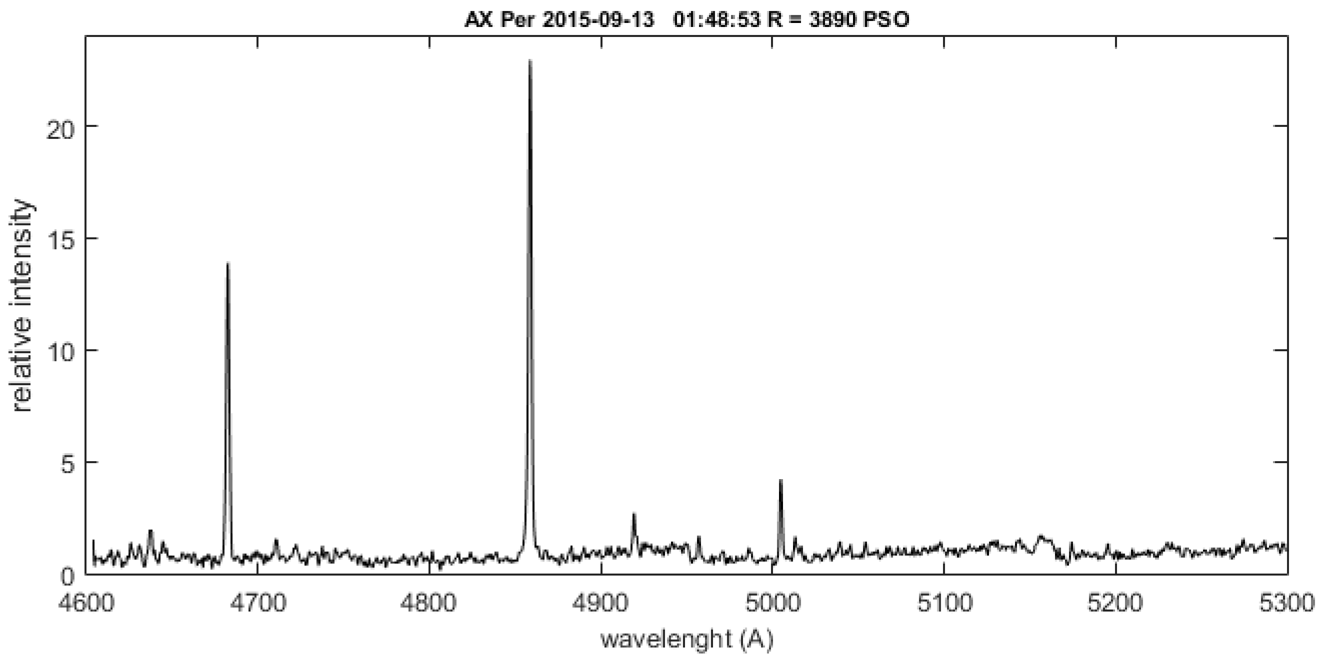



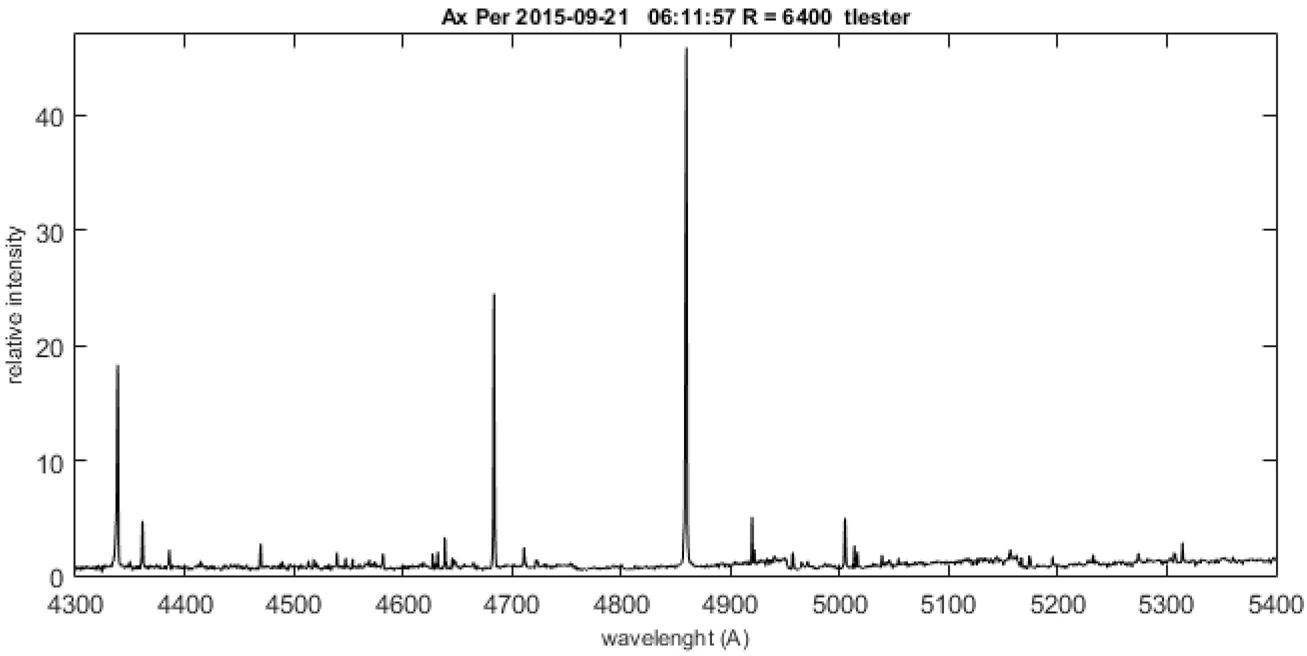



Evolution of AX Per in september - D. Boyd _ LISA R = 1000
Note the increase of He I lines while [Fe VII] remains almost constant

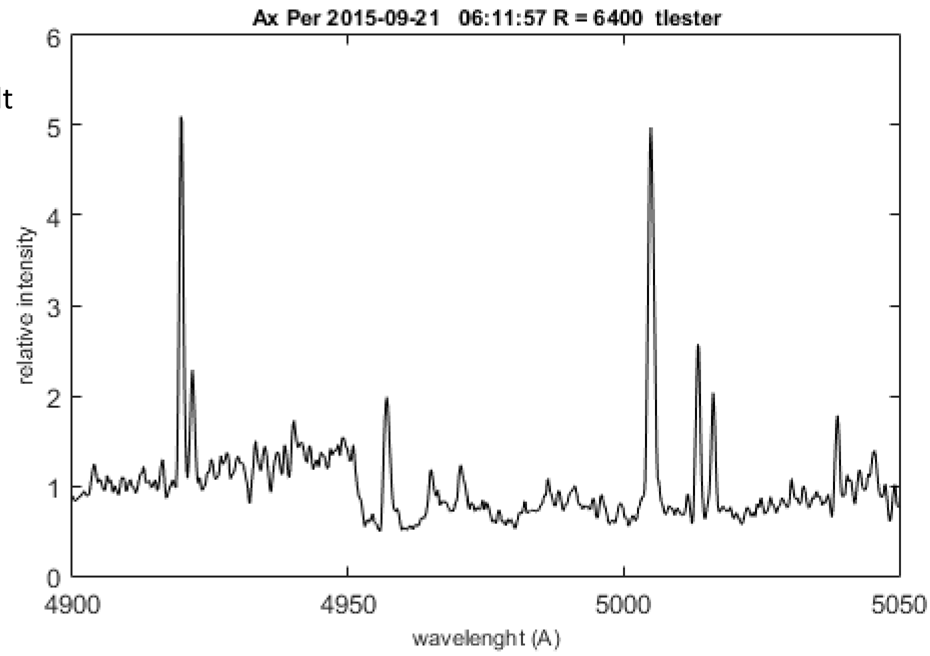



The Hb region by Peter Somogyi at R = 4000
By Peter Somogyi with a Lhires III (600 l/mm)
Left : Crop on Hb line in radial velocity






The Hβ range by Tim Lester at R = 9000 with a home built spectroscope




On this crop, He I 4922, 5016 and Fe II 4924 and 5018 are well detached
Note also the nebular lines [O III] 4959 and 5007

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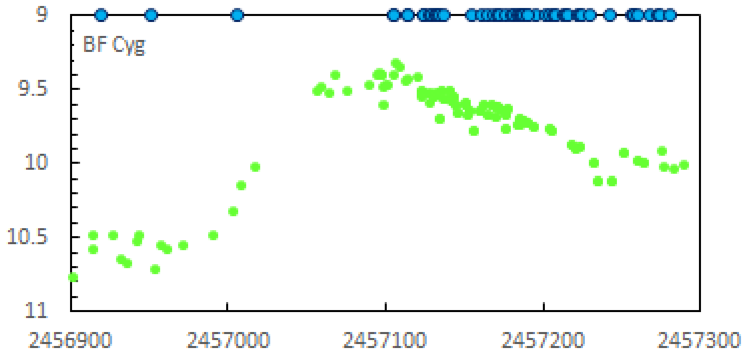
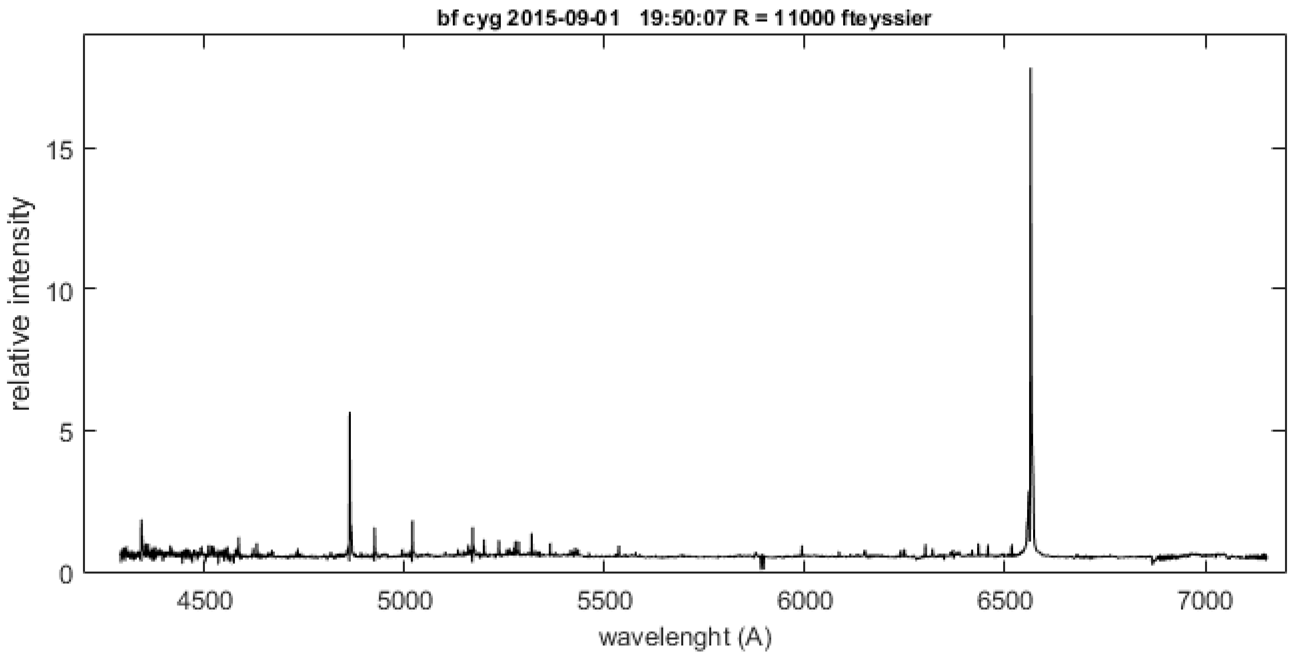
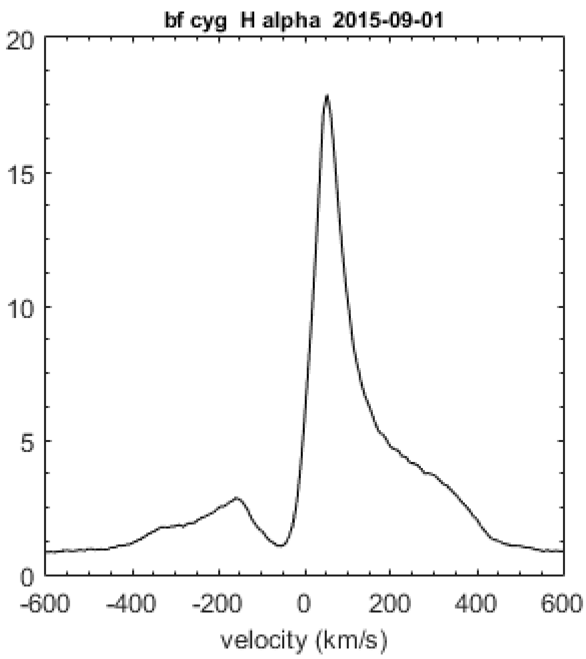
## BF Cygni

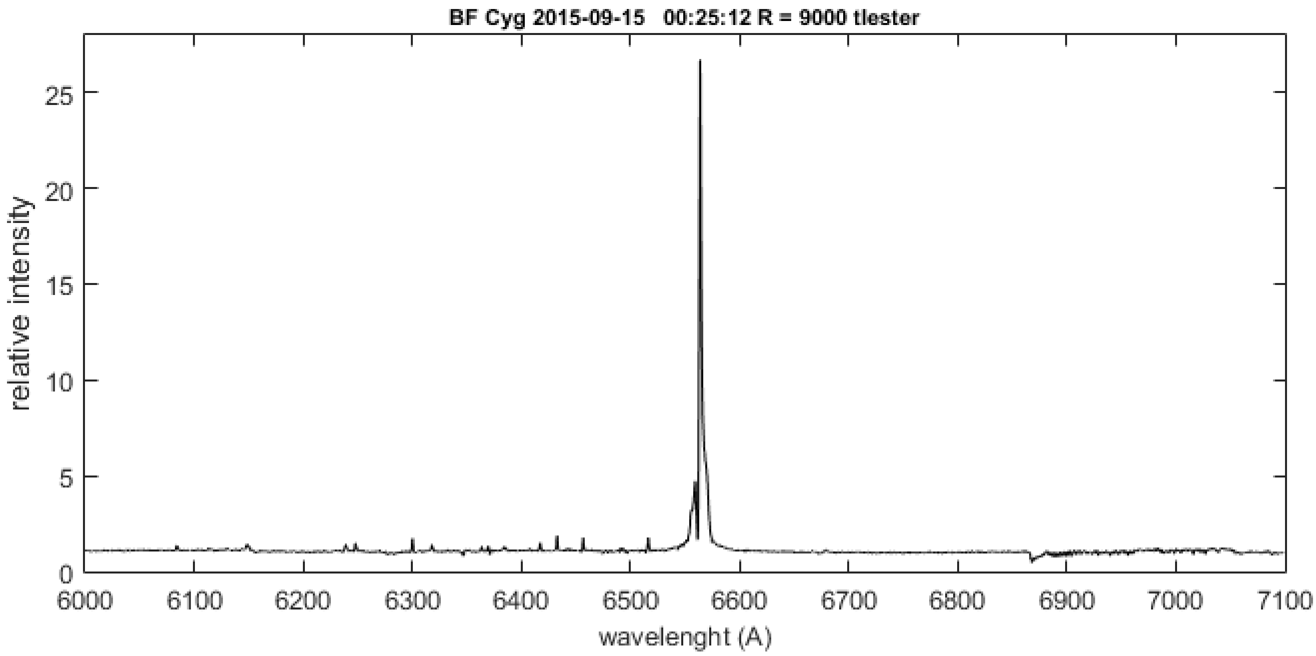
| Coordinates (2000.0) | |
|---|---|
| **R.A.** | **19 23 53.5** |
| **Dec.** | **+29 40 29.2** |

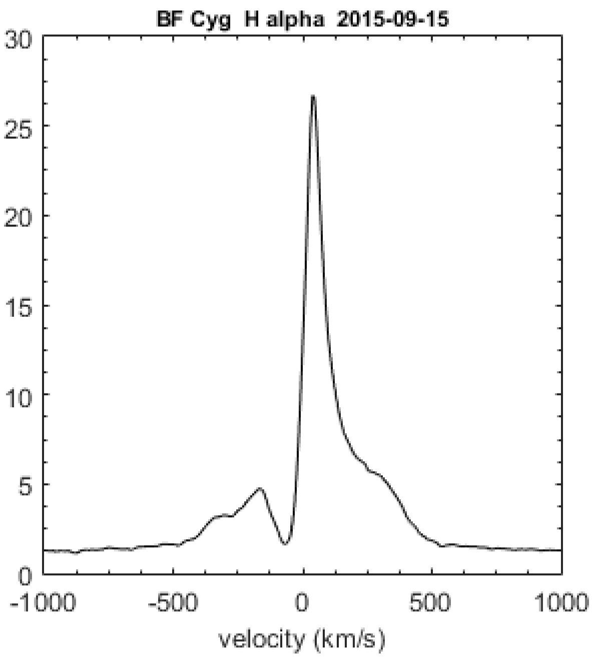



Luminosity almost constant in September (V ~ 10).
Monitoring of this interesting target to go on.



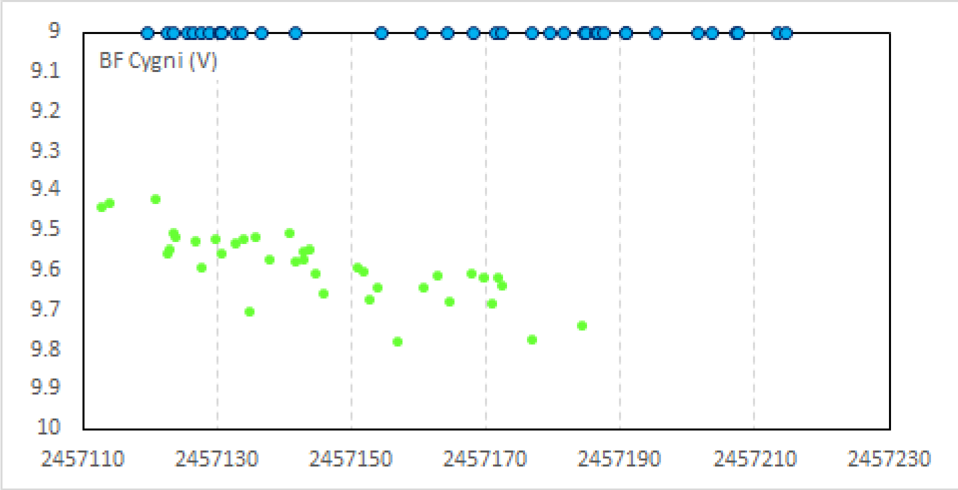




BF Cyg 2015-09-15 00:25:12 R = 9000 tlester
relative intensity
wavelenght (A)
0
5
10
15
20
25
6000
6100
6200
6300
6400
6500
6600
6700
6800
6900
7000
7100


BF Cyg H alpha 2015-09-15
velocity (km/s)
0
5
10
15
20
25
30
-1000
-500
0
500
1000

## BF Cygni

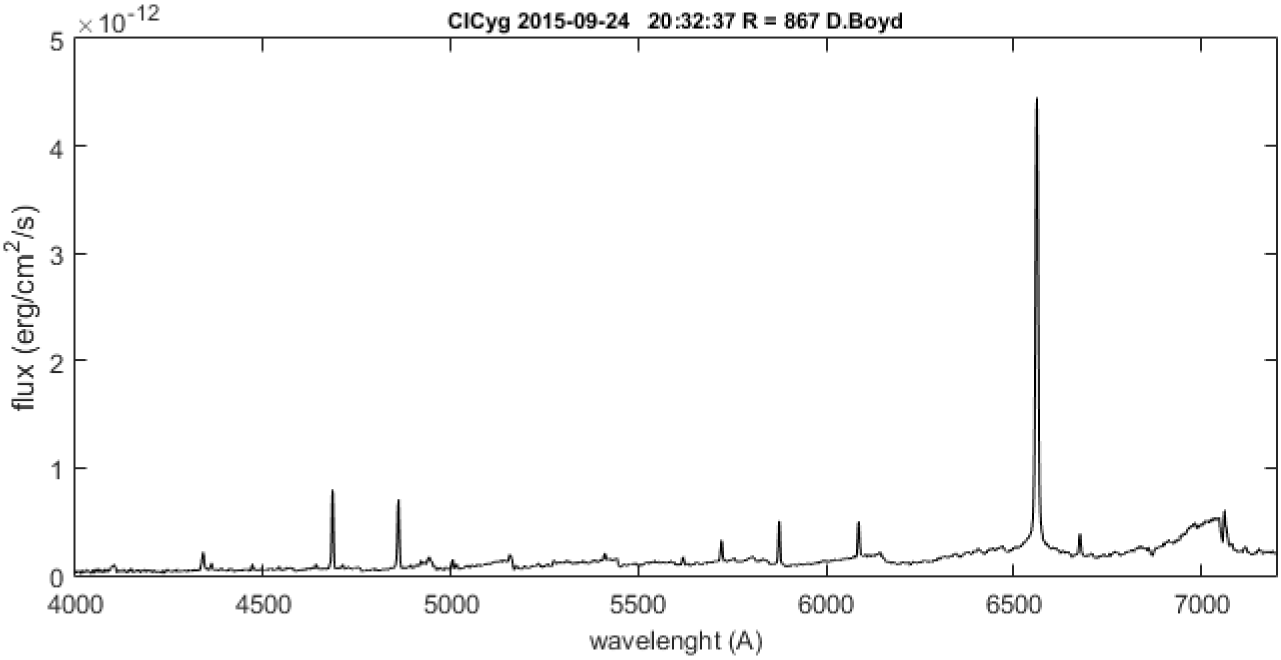
| Coordinates (2000.0) | |
|---|---|
| R.A. | 19 23 53.5 |
| Dec. | +29 40 29.2 |



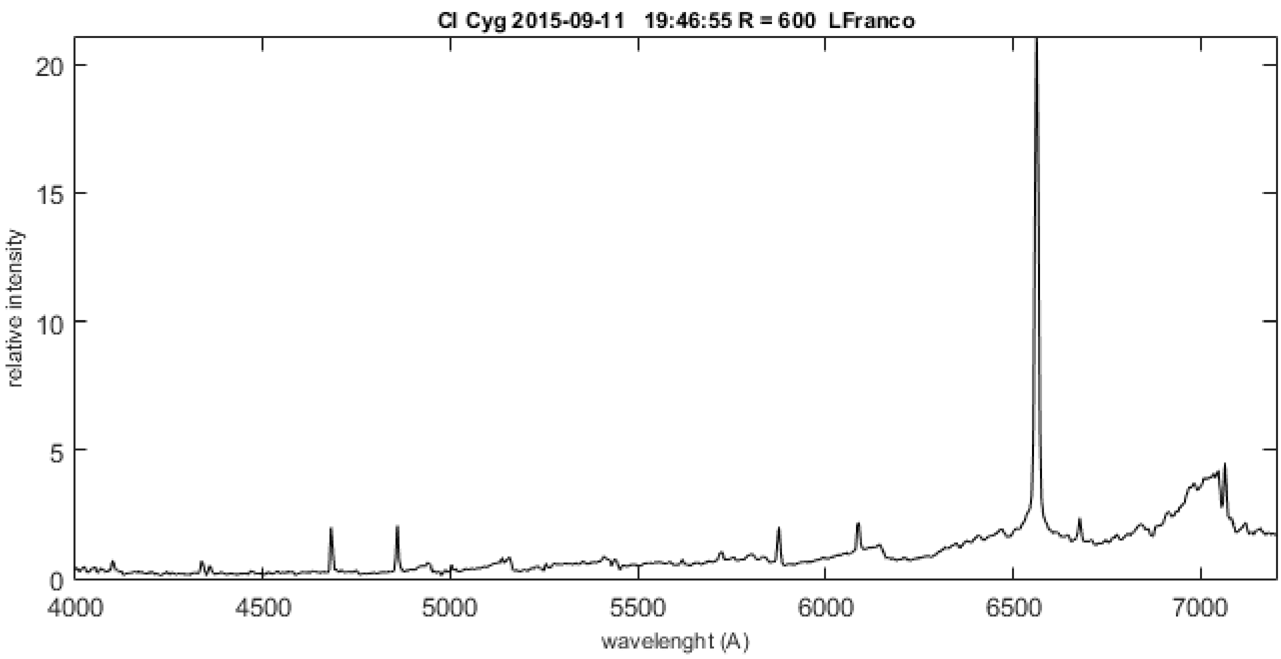

Crop on Hβ, Fe II (42) 4924, 5018

CI Cyg

| Coordinates (2000.0) | |
|---|---|
| R.A. | 19 50 11.8 |
| Dec. | +35 41 03.0 |
| Mag V | 11 |




D. Boyd, LISA, R =1000

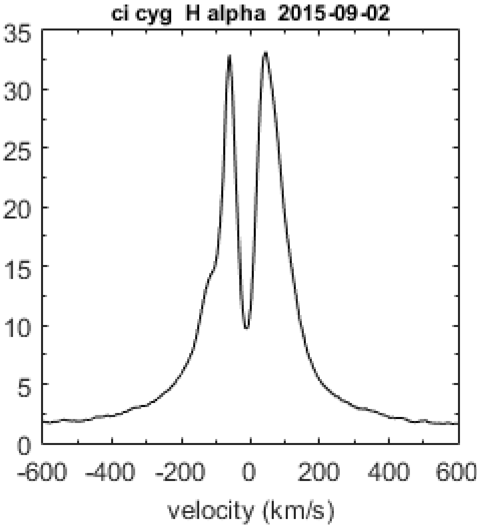


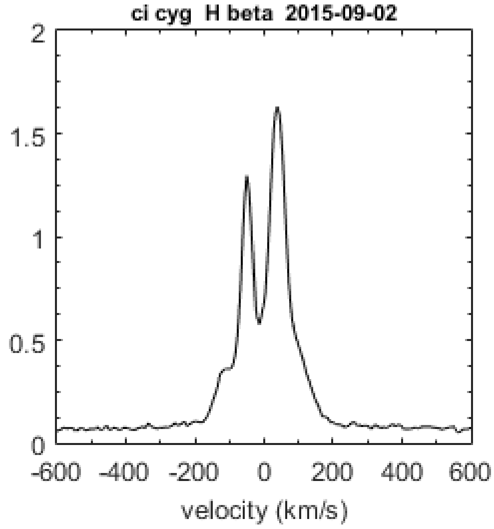

L. Franco, Alpy600, R = 600

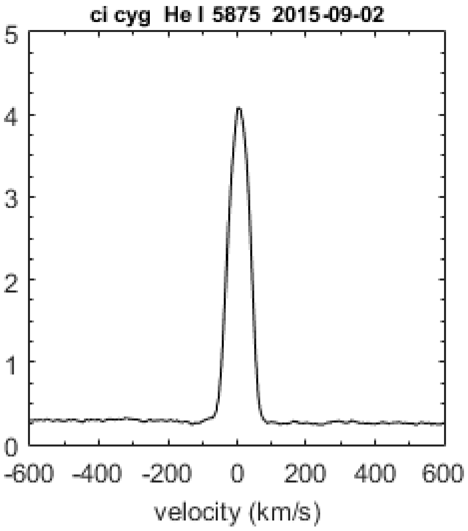
**CI Cyg**

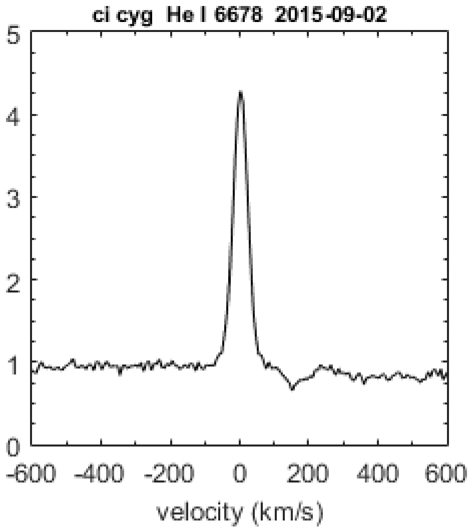
Profile of the main lines with Eshel R = 11000
F. Teyssier

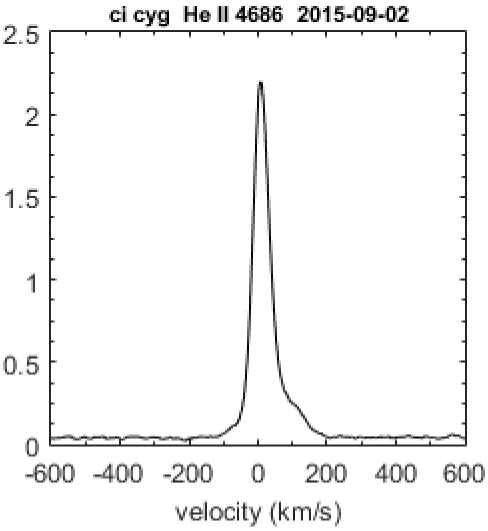
Note the double peaked [OIII] lines

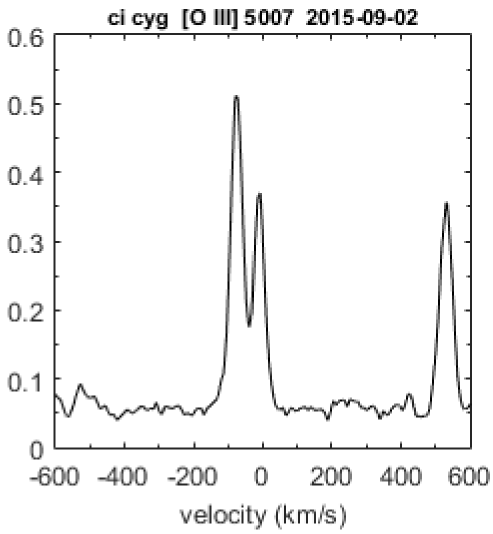


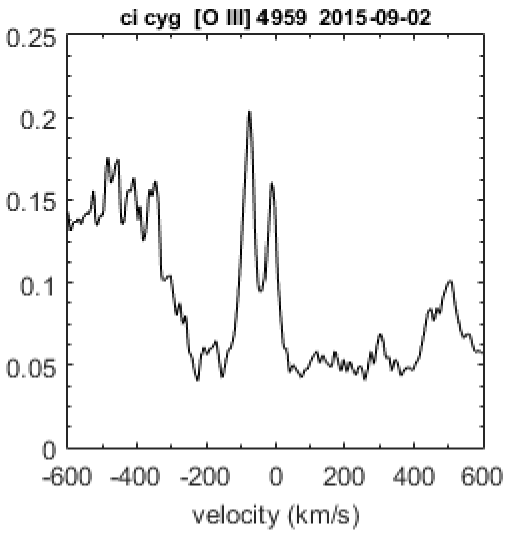



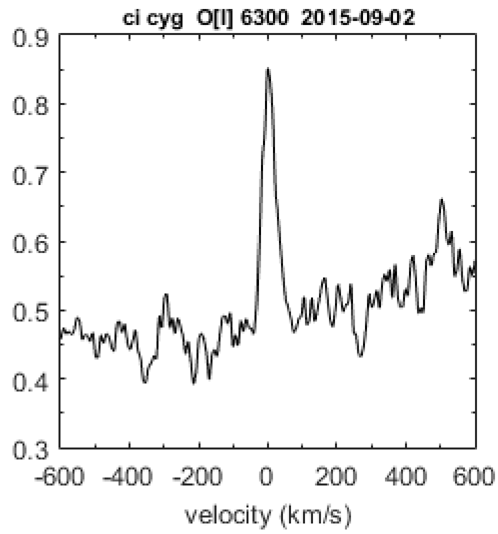



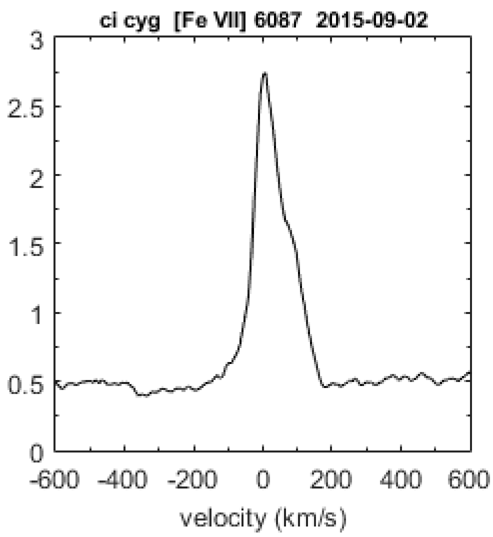



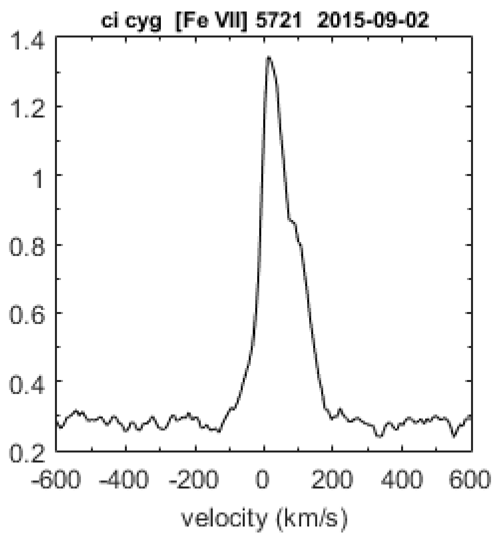



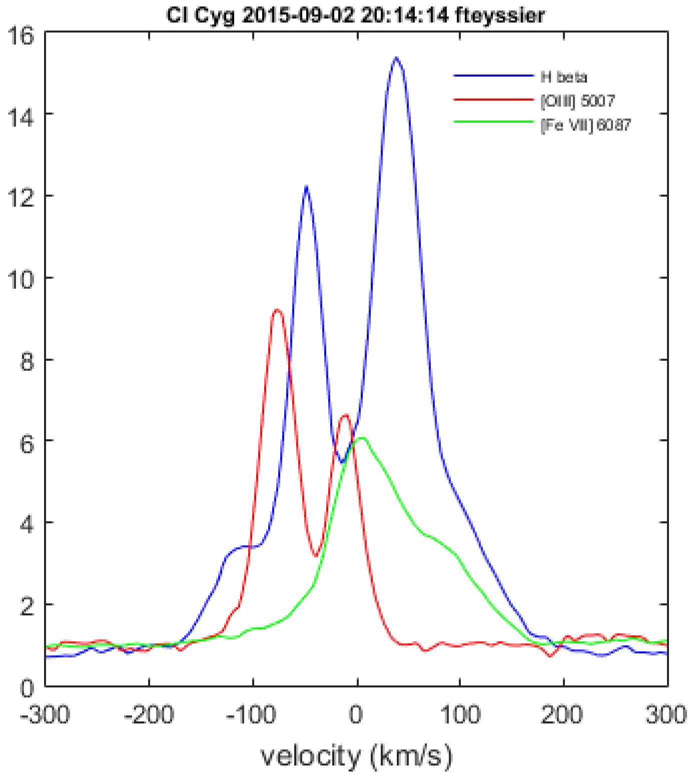



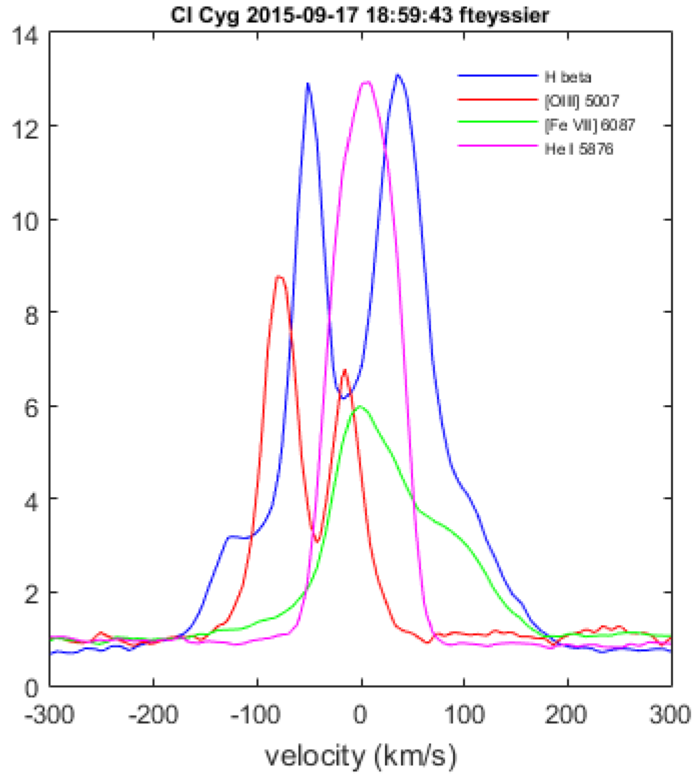



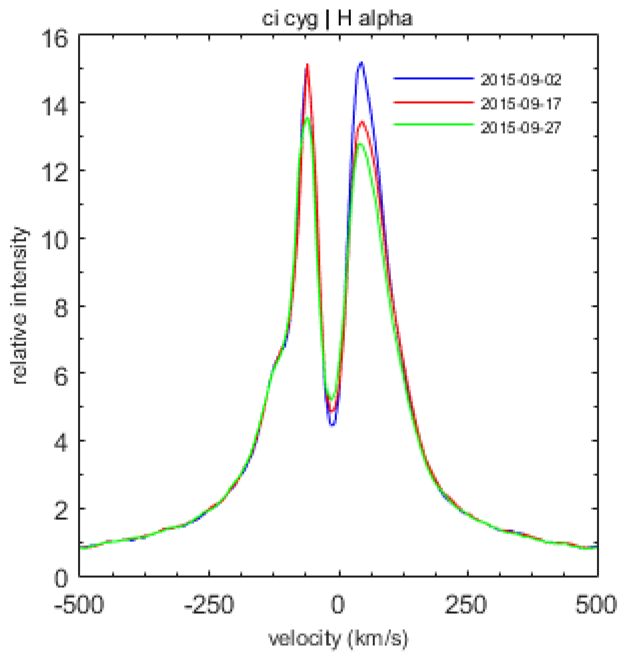



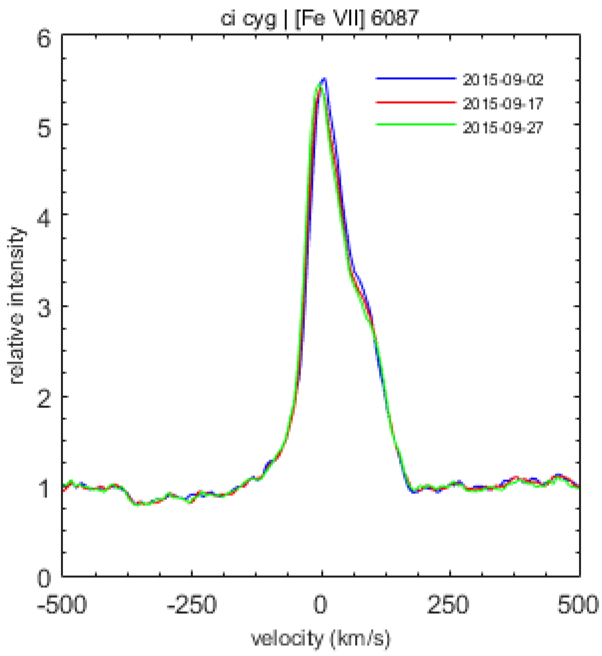






The complex structuration of the nebula

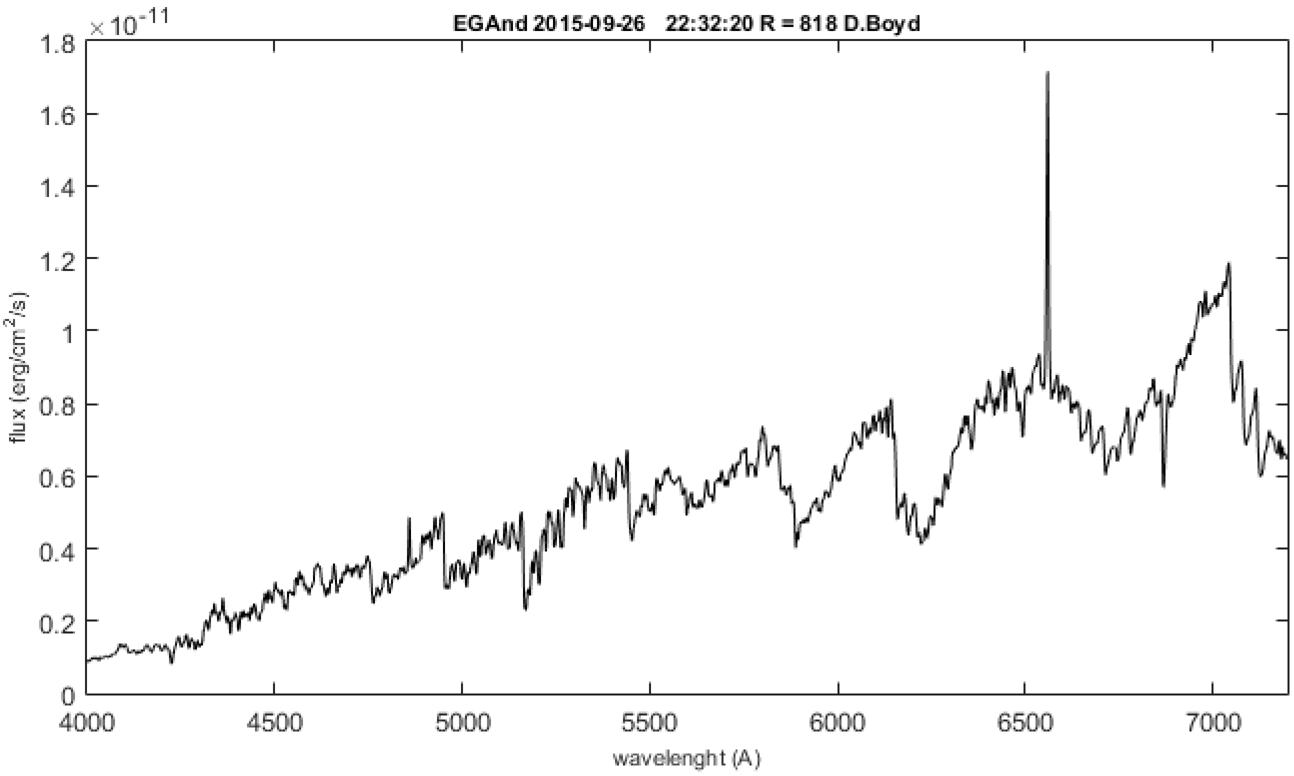


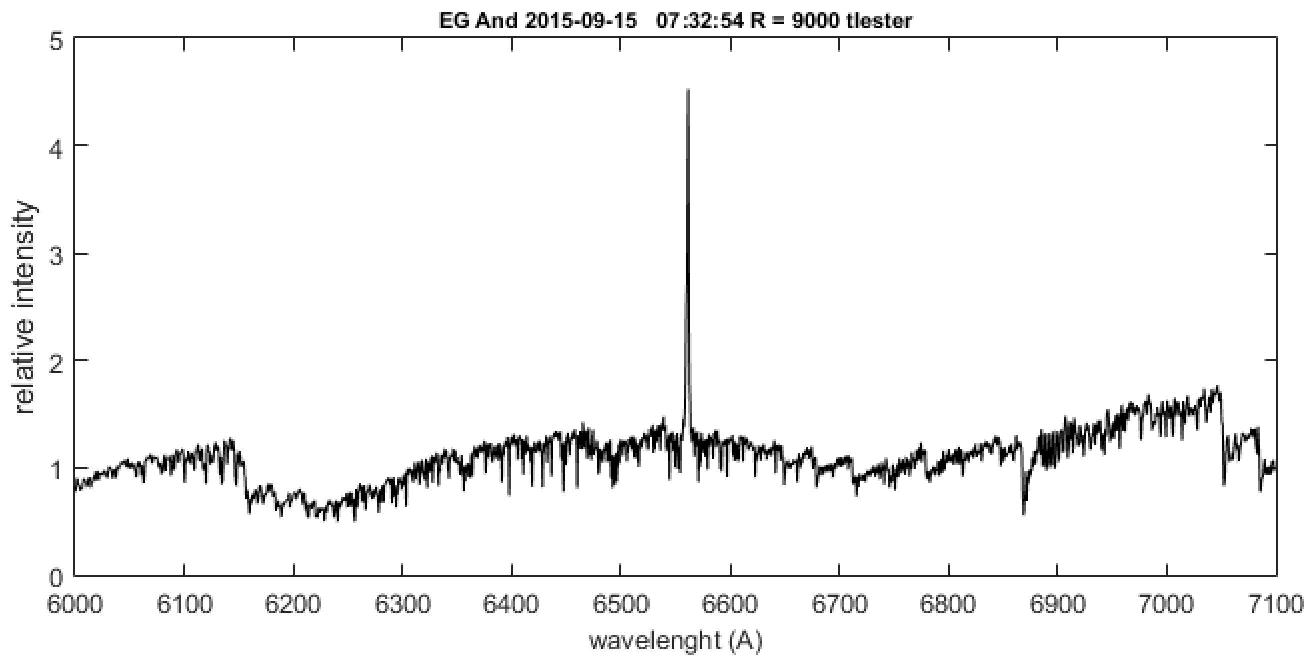




Variation of lines in september
Small change of Ha emission profile The broad component in the blue part of the line reamains un unchanged
[Fe VII] very stable

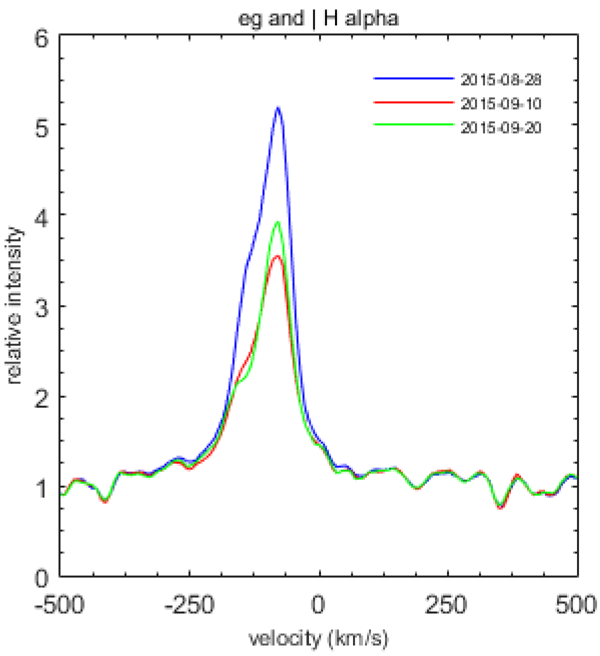
EG And

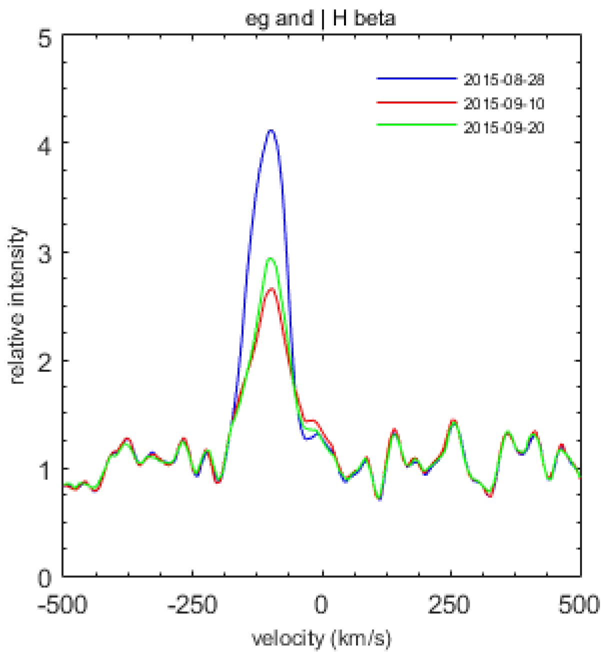
| Coordinates (2000.0) | |
|---|---|
| R.A. | 00 44 3701 |
| Dec. | +40 40 45.7 |
| Mag | 7.0 - 7.4 |



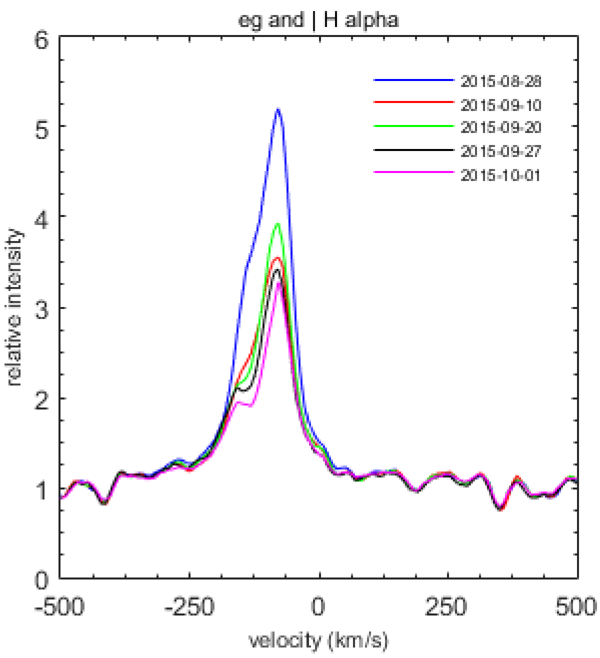



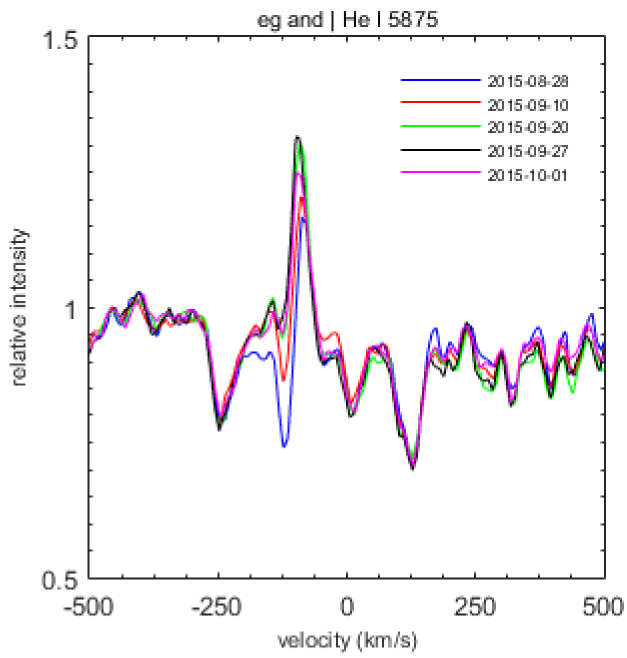
## EG And




EShel spectra in september. F. Teyssier R = 11 000
The intensity of Balmer lines decreases quickly between 28-08 and 10-09. Then, the main evolution is the formation of an absorption in the blue edge of Hα .
The behaviour of He 5876 is opposite : increasing intensity and weakening of the absorption




| Date | Phase |
|---|---|
| 28/08/2015 | 0.384 |
| 10/09/2015 | 0.411 |
| 20/09/2015 | 0.431 |
| 27/09/2015 | 0.446 |
| 01/10/2015 | 0.454 |

**Ephemeris of the spectra**

JD0 = 2450804
P = 482.6 d

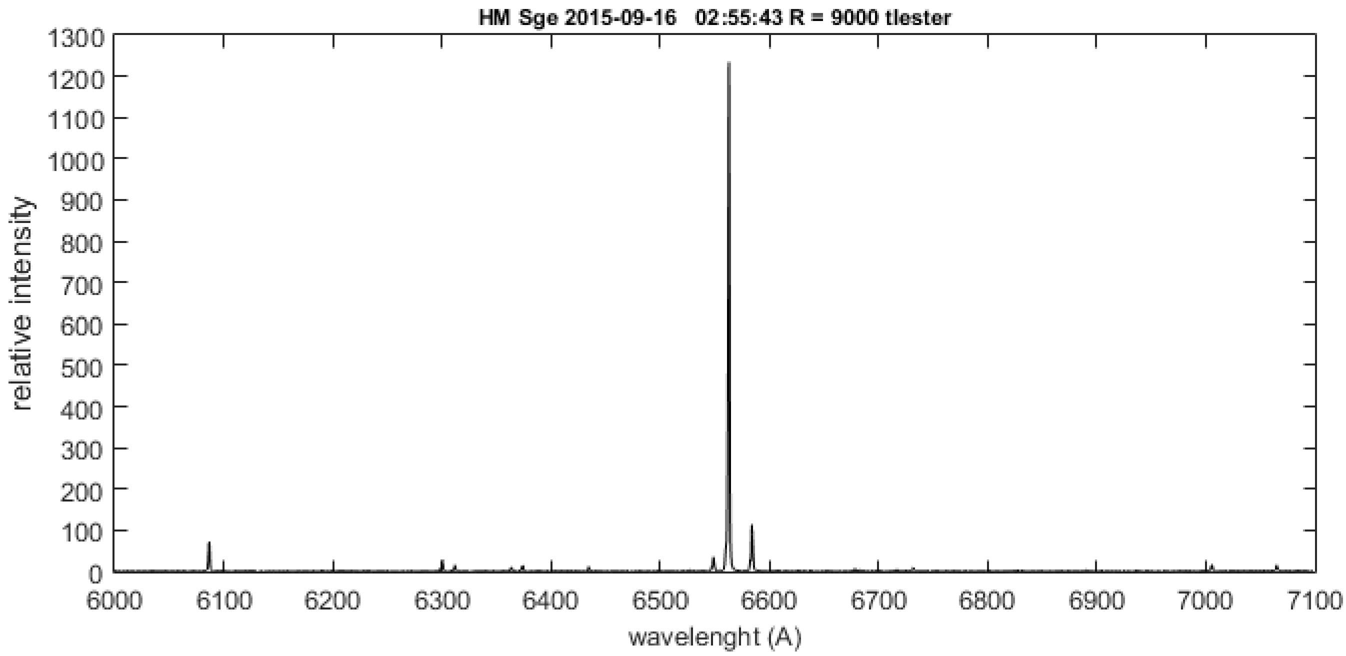
Fekel F.C., Joyce R.R., Hinkle K.H., Skrutskie M.F., 2000, AJ 119, 1375

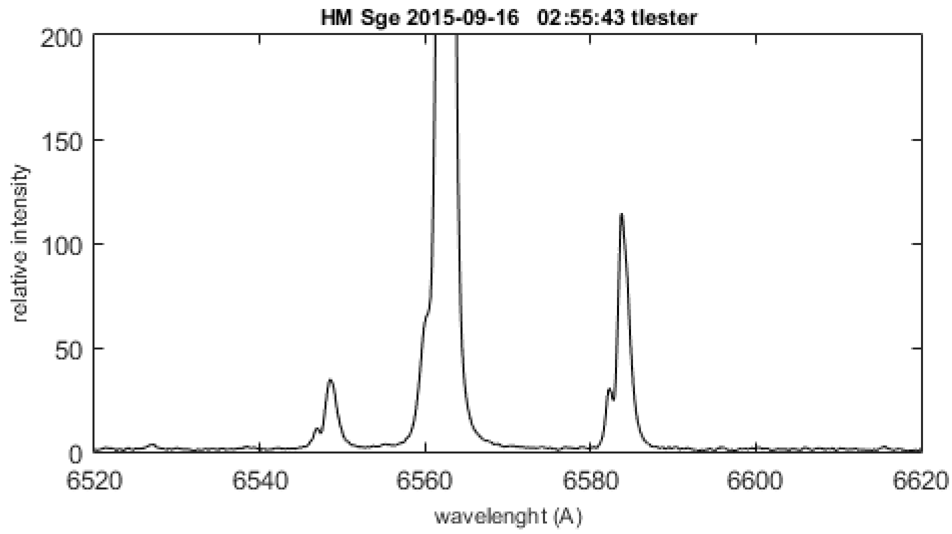
EG And

# HM Sge

| Coordinates (2000.0) | |
|---|---|
| R.A. | 19 41 57.0 |
| Dec. | +16 44 39.9 |
| Mag V | ~ 12.3 |

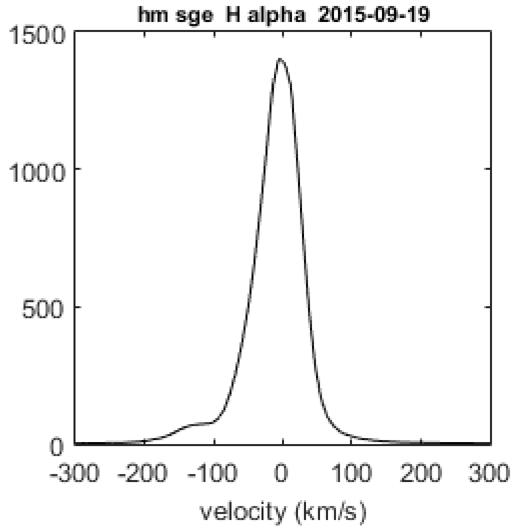
The symbiotic nova (Nova Sge 1975) HM Sge

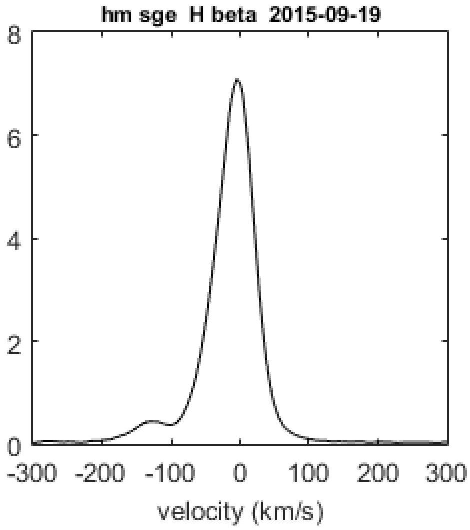


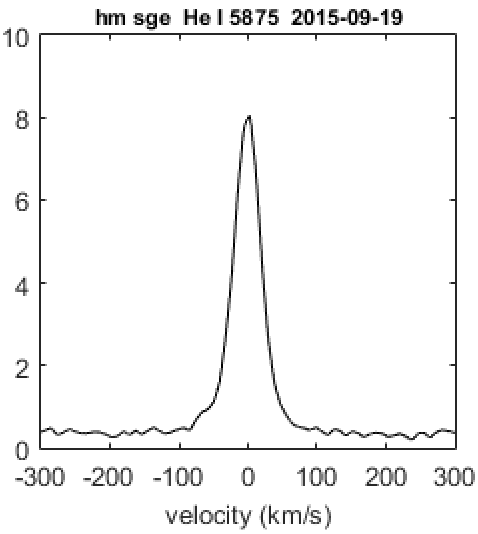



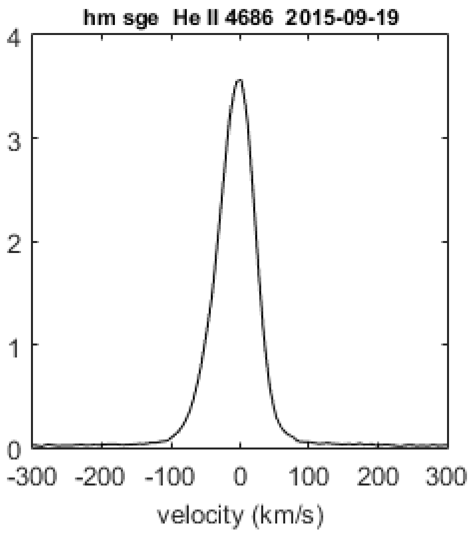

Hα and [N II] 6548 6584

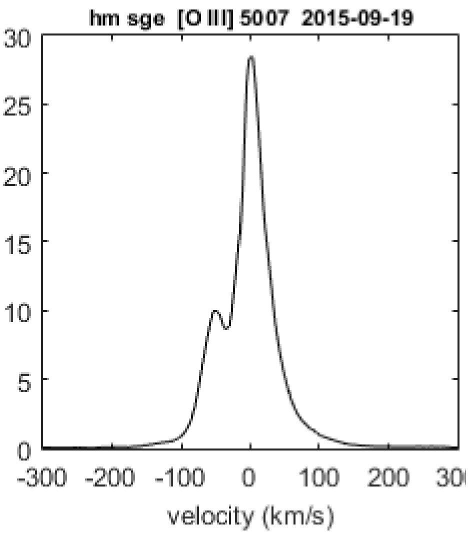
Other emission lines with Eshel
R = 11 000
F. Teyssier

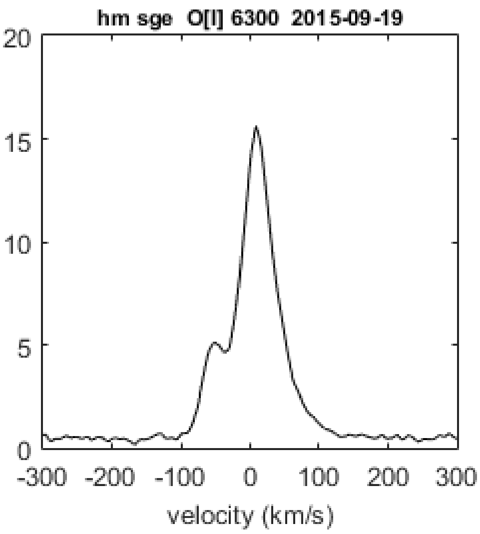


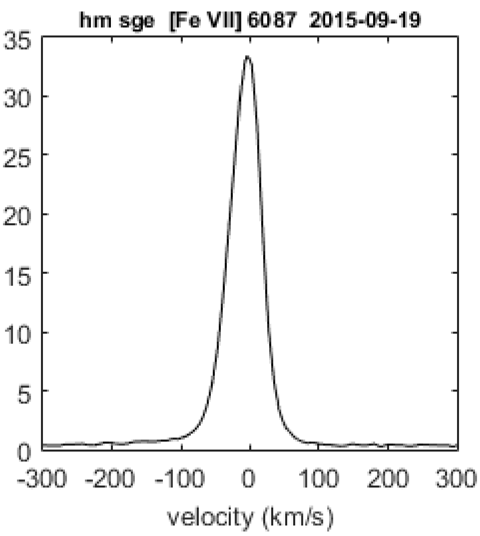



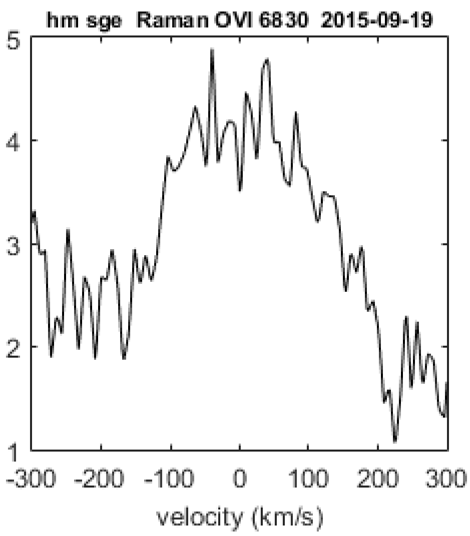



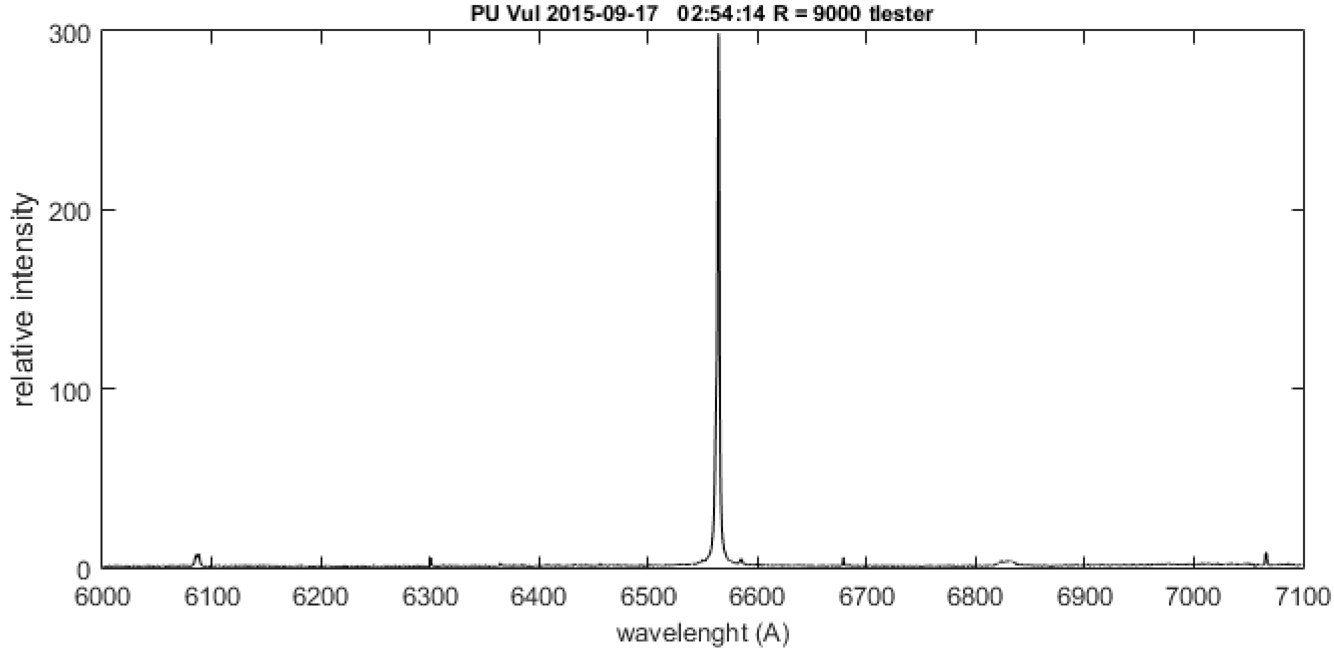



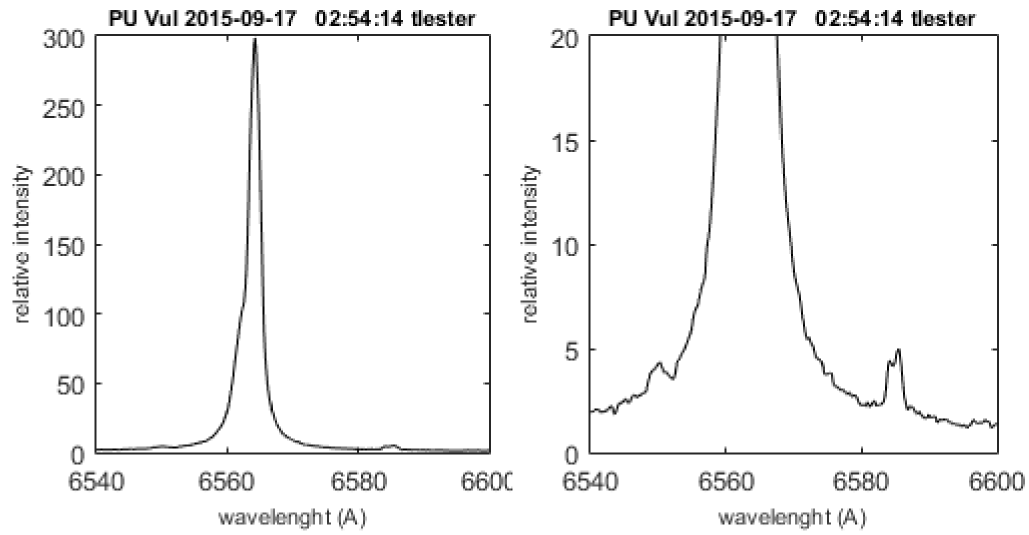



# PU Vul

| Coordinates (2000.0) | |
|---|---|
| R.A. | 20 21 13.3 |
| Dec. | +21 34 18. |
| Mag V | 11/01/1900 |

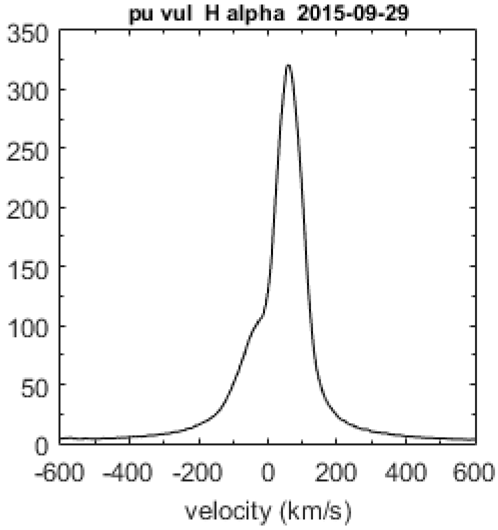


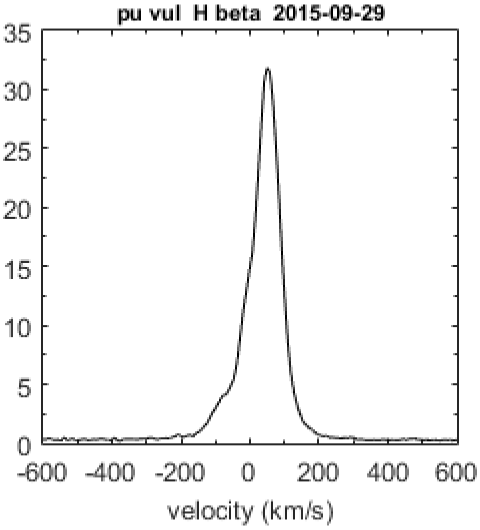



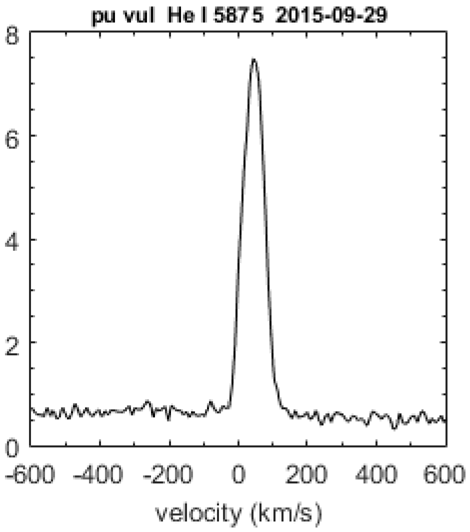

Crop on H alpha
Note [NII] (Right)

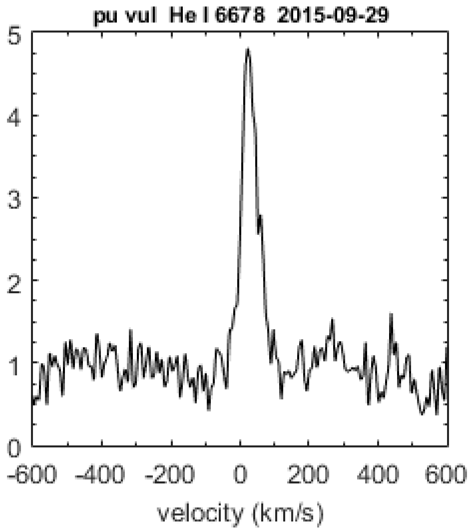
## PU Vul

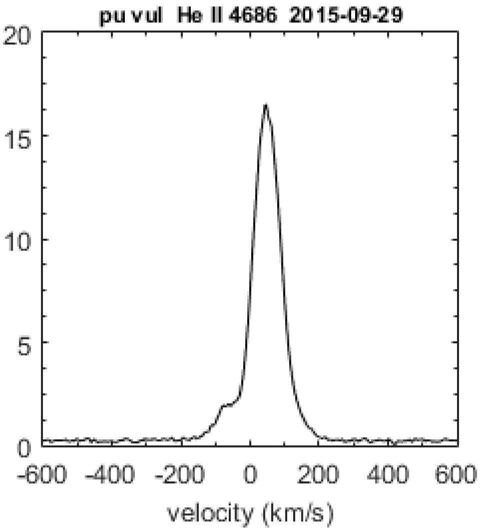
Other emission lines with Eshel
R = 11 000
F. Teyssier

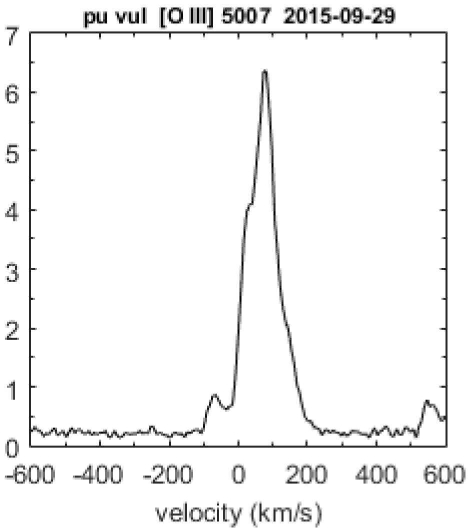


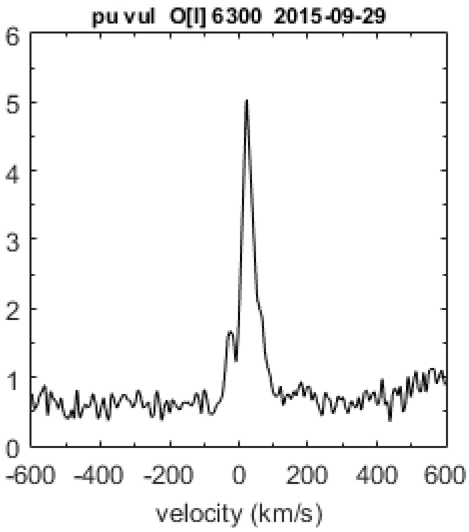



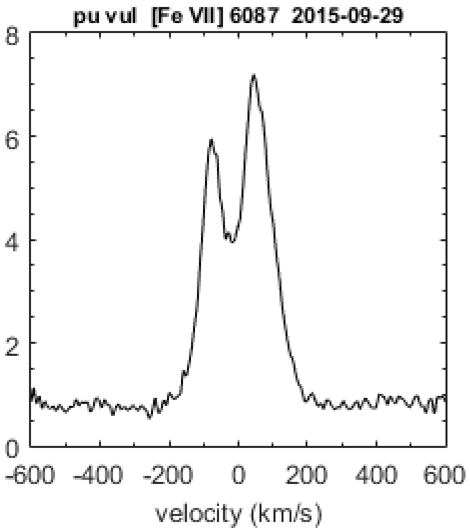



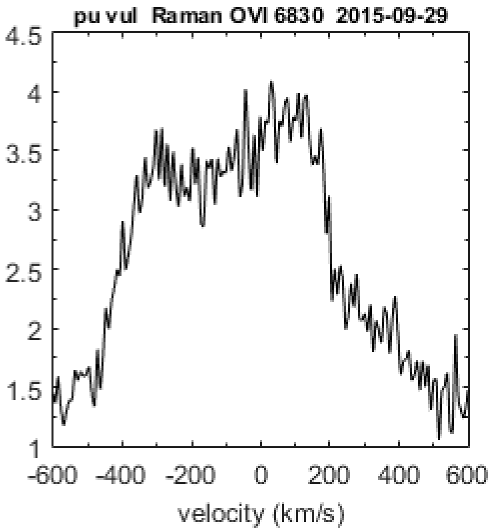



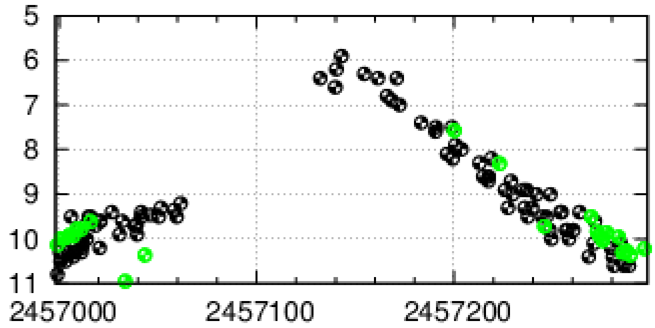



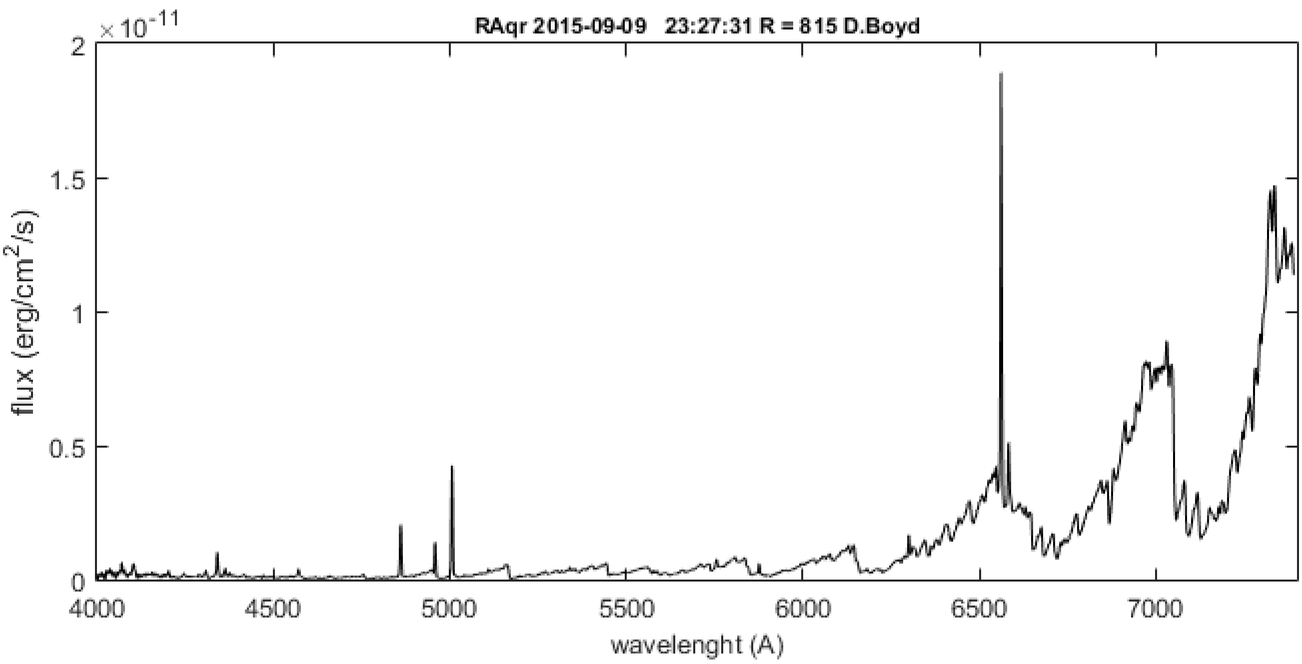



## R AQr

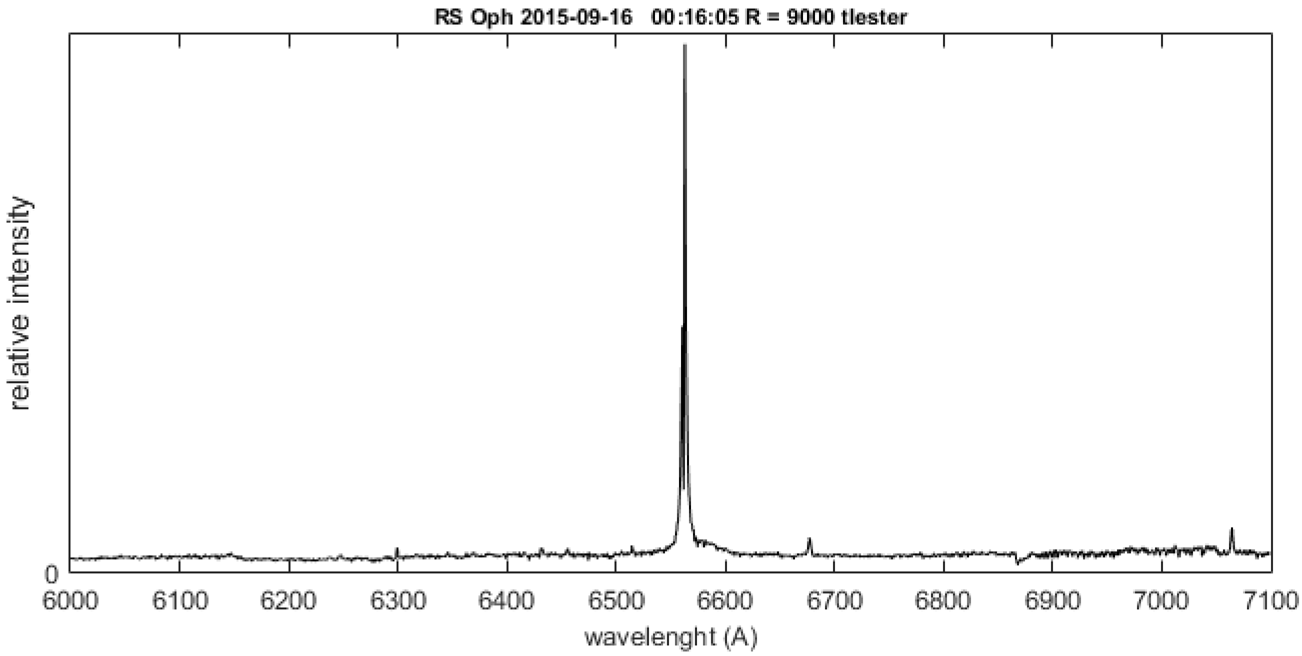
| Coordinates (2000.0) | |
|---|---|
| R.A. | 23 43 49.4 |
| Dec. | -15 17 04.1 |
| Mag V | 6 - 11 |



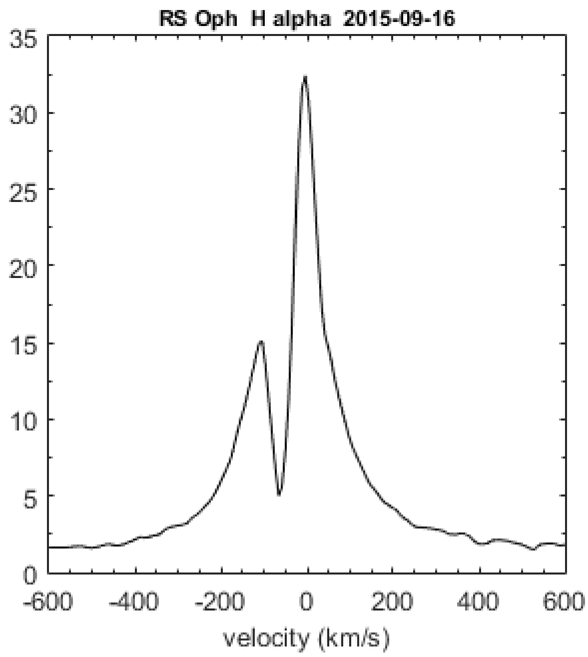

The symbiotic mira R Aqr near minimum luminosity
Note the strong [O III]
Other spectra around minimum are welcome



| Coordinates (2000.0) | |
|---|---|
| R.A. | 17 50 13.2 |
| Dec. | -06 42 28 |
| Mag V | |



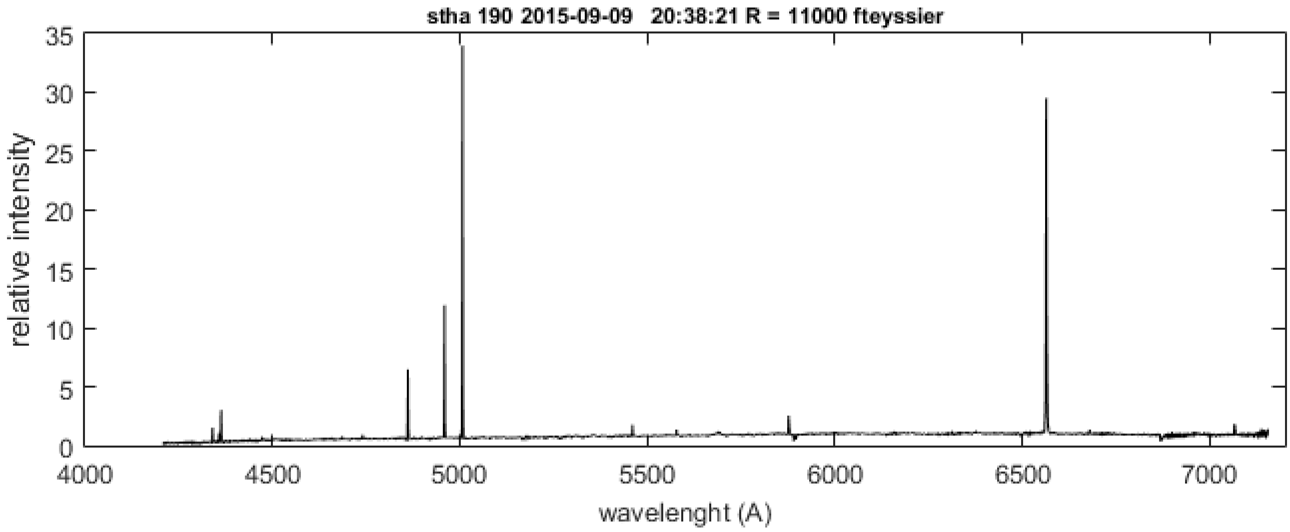

Tim Lester
Home Built Spectrograph
R = 9000

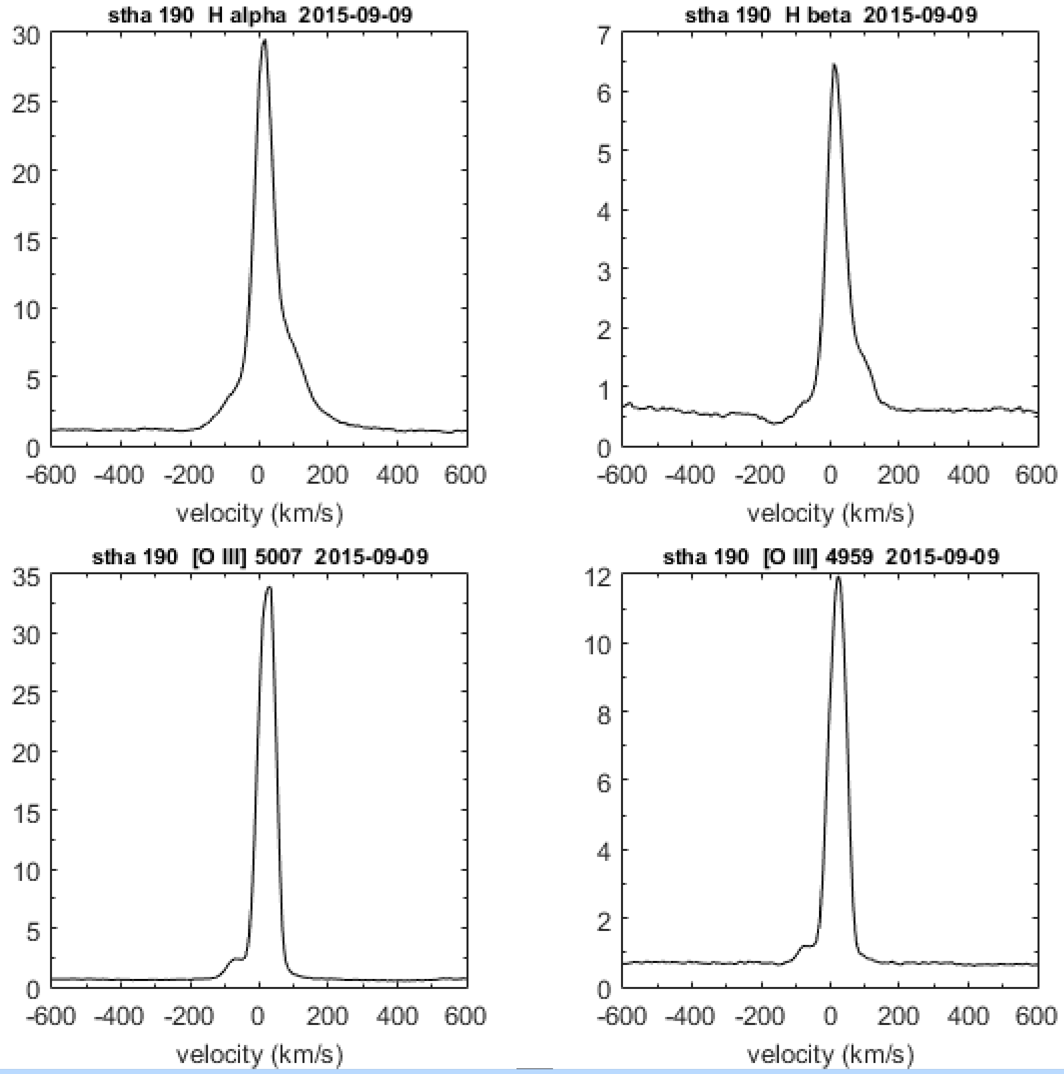


## StHa 190

| Coordinates (2000.0) | |
|---|---|
| R.A. | 21 41 44.89 |
| Dec. | +02 43 54.4 |
| Mag | ~ 10.5 |

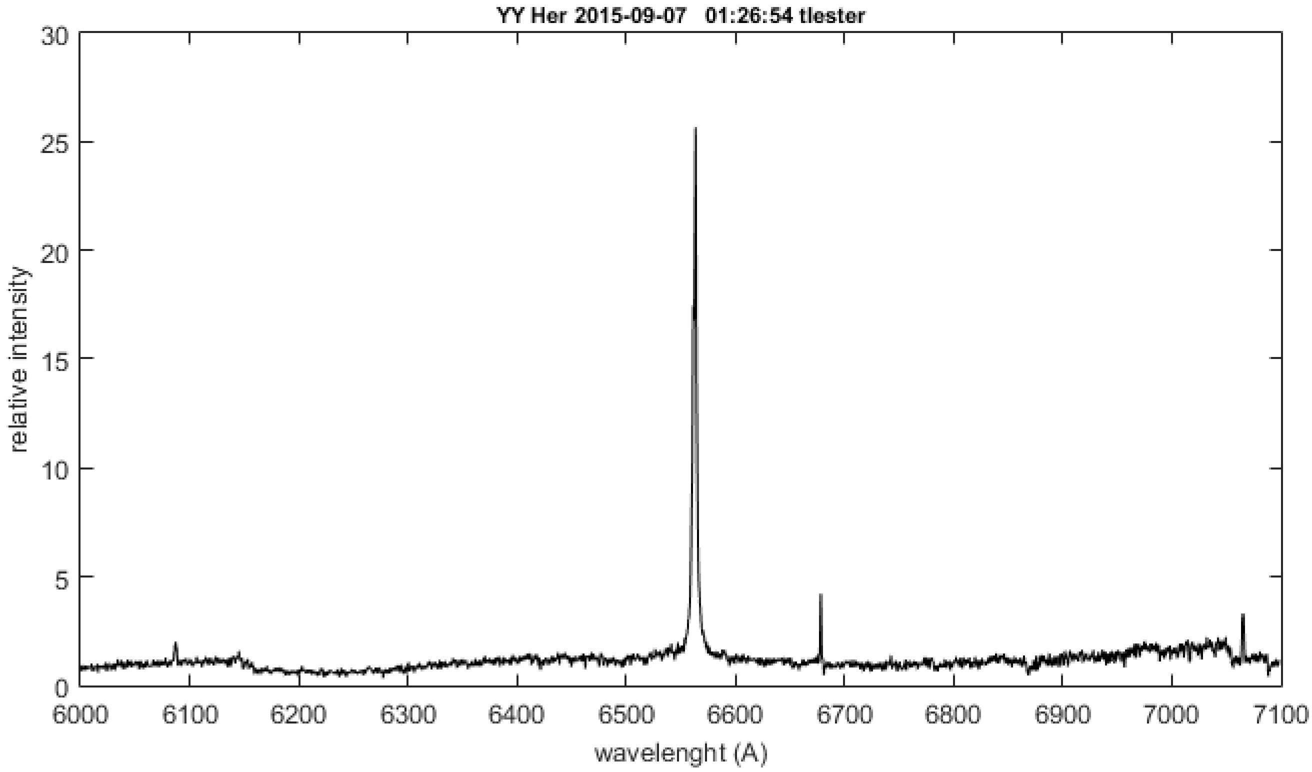
The yellow symbiotic StHa 190 at R = 11000
Note the faint shoulder in the blue edge of [O III] lines

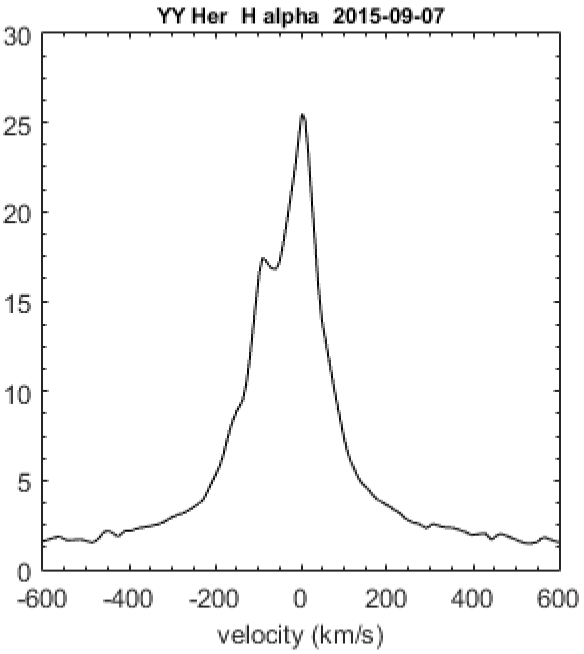


| Coordinates (2000.0) | |
|---|---|
| R.A. | 18 14 34.2 |
| Dec. | +20 59 21.3 |
| Mag V | 12.8 |

A new spectrum of this faint target at R = 9000 by T. Lester

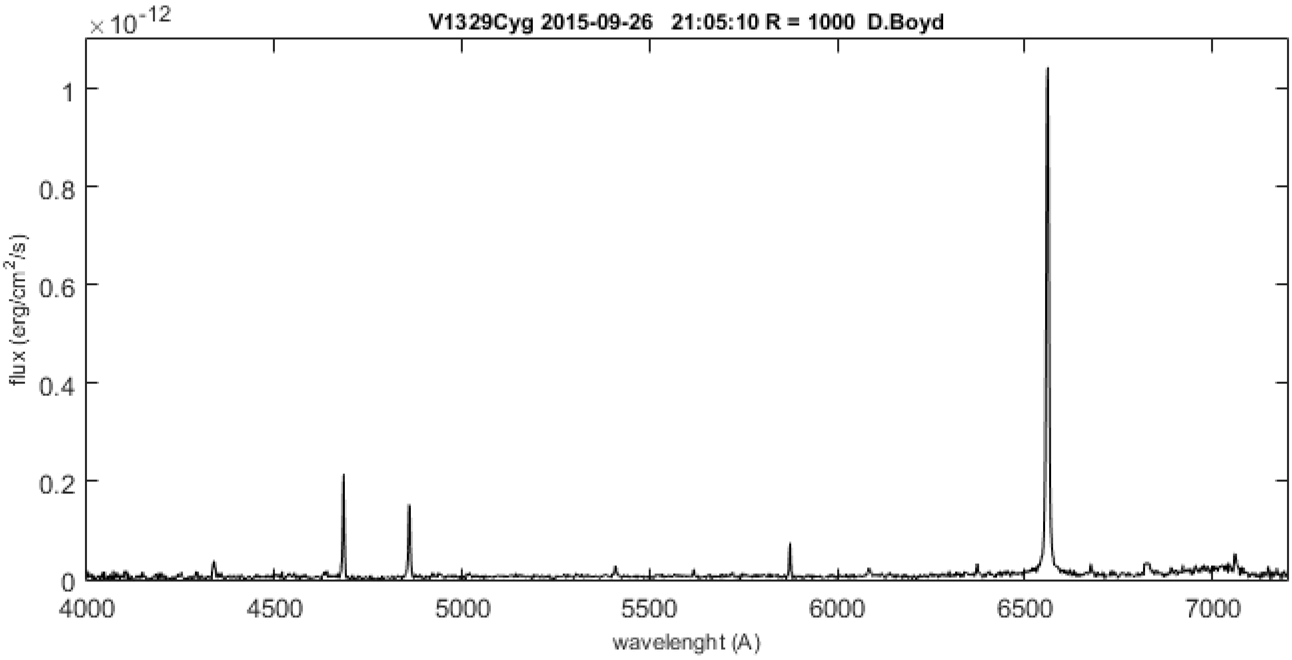


# V1329 Cyg

| Coordinates (2000.0) | |
|---|---|
| R.A. | 20 51 01.2 |
| Dec. | +35 34 54.0 |
| Mag V | |

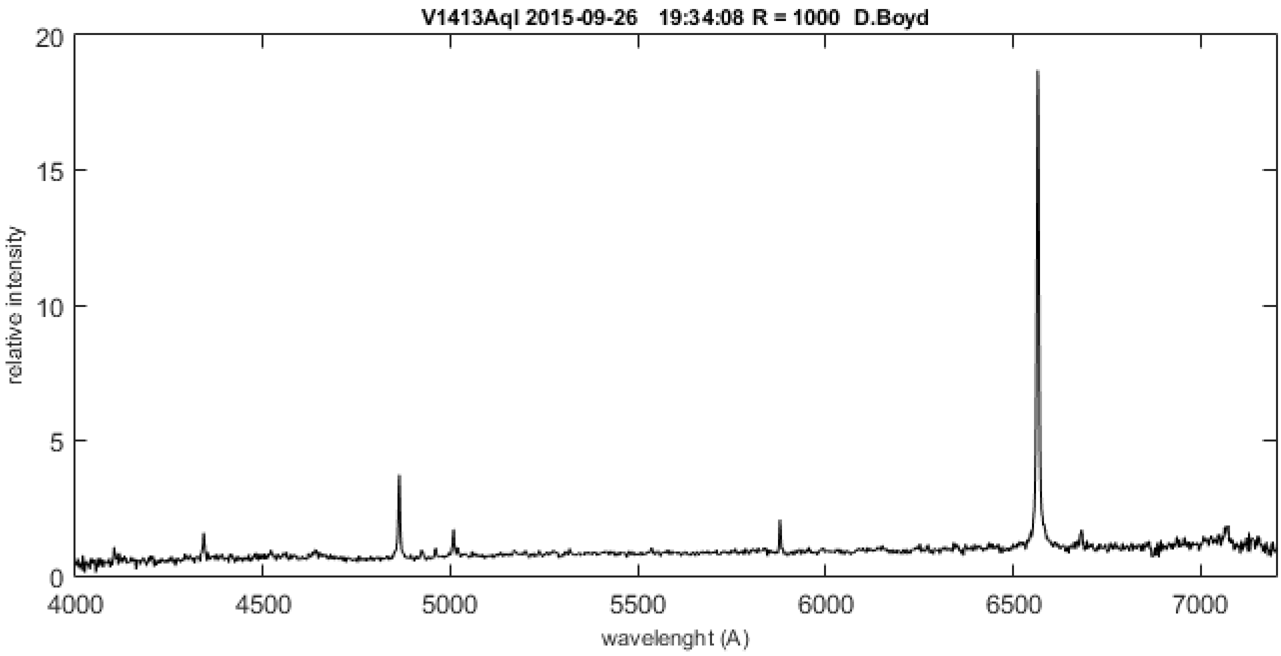
A spectrum at R = 1000 at Mag V = 14.3
obtained by David Boyd



## V1413 Aql

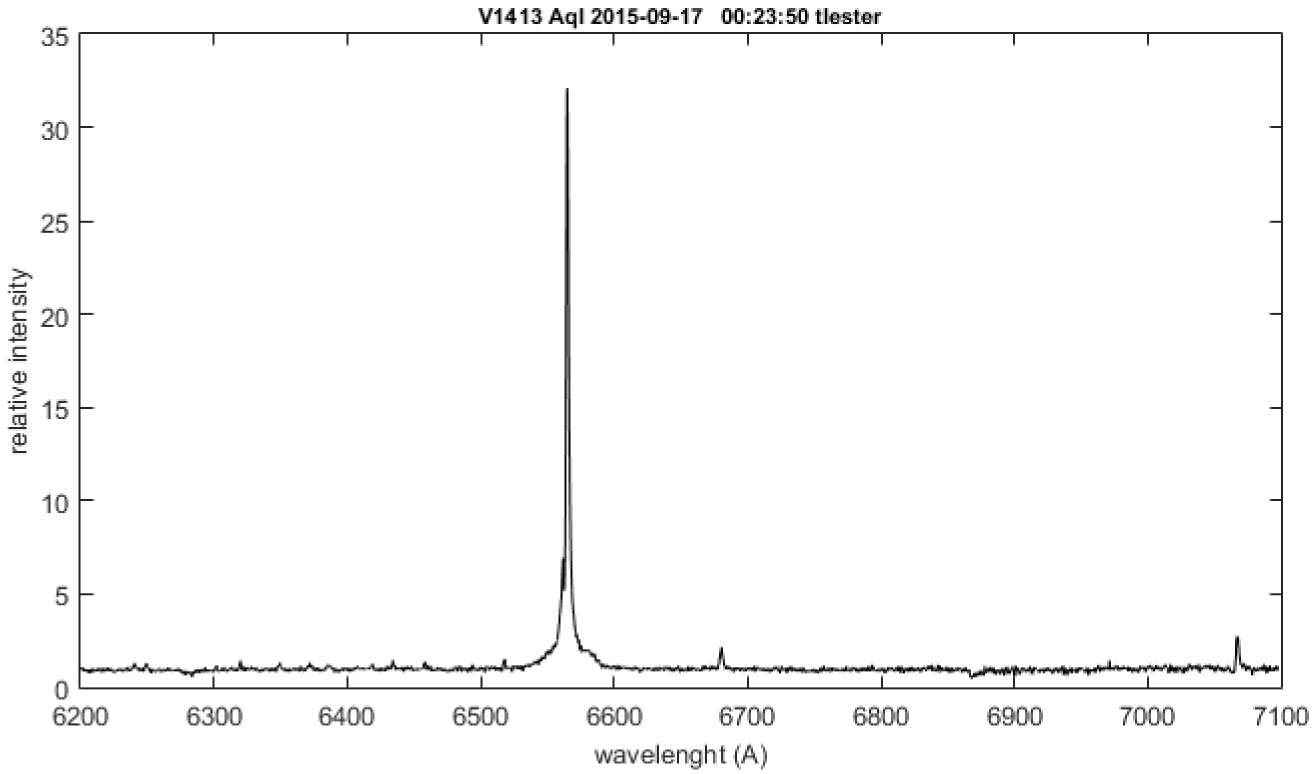
| Coordinates (2000.0) | |
|---|---|
| R.A. | 19 03 46.8 |
| Dec. | +16 26 17 |
| Mag V | 10.5-15.5 |

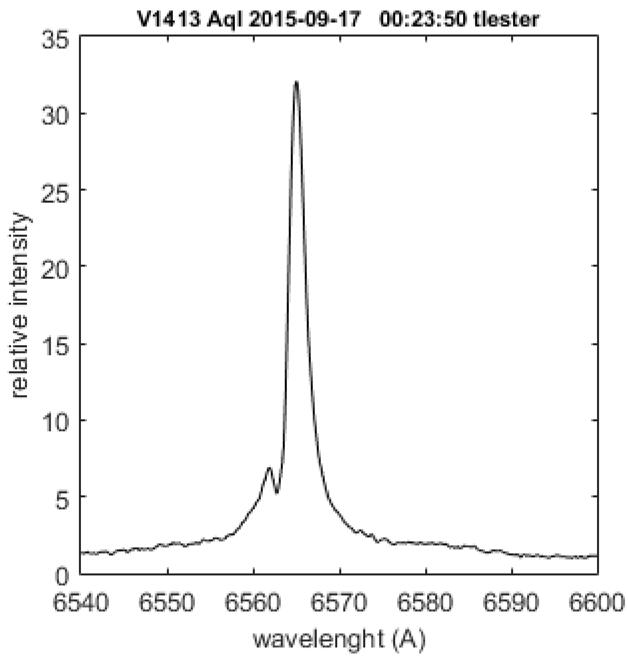
Another symbiotic nova, currently Mag V ~ 12.2



# V1413 Aql

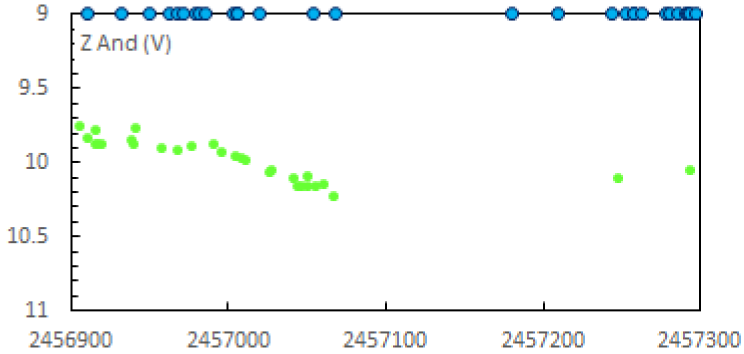
| Coordinates (2000.0) | |
|---|---|
| R.A. | 19 03 46.8 |
| Dec. | +16 26 17 |
| Mag V | 10.5-15.5 |



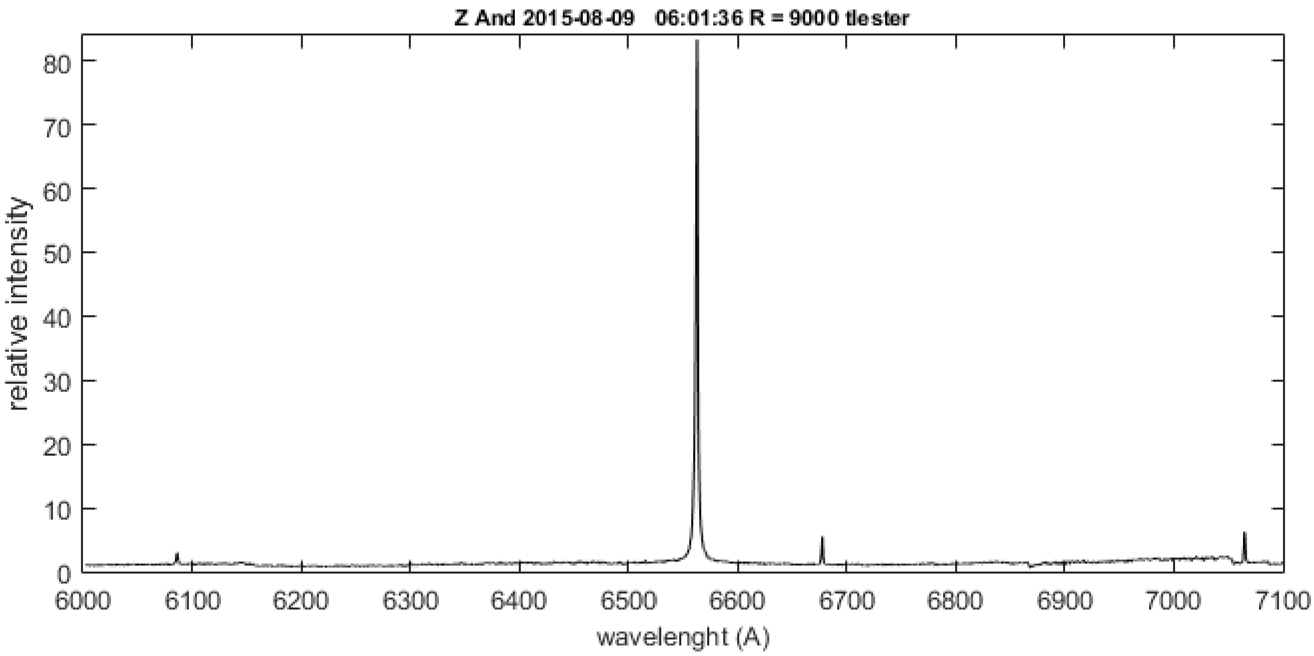



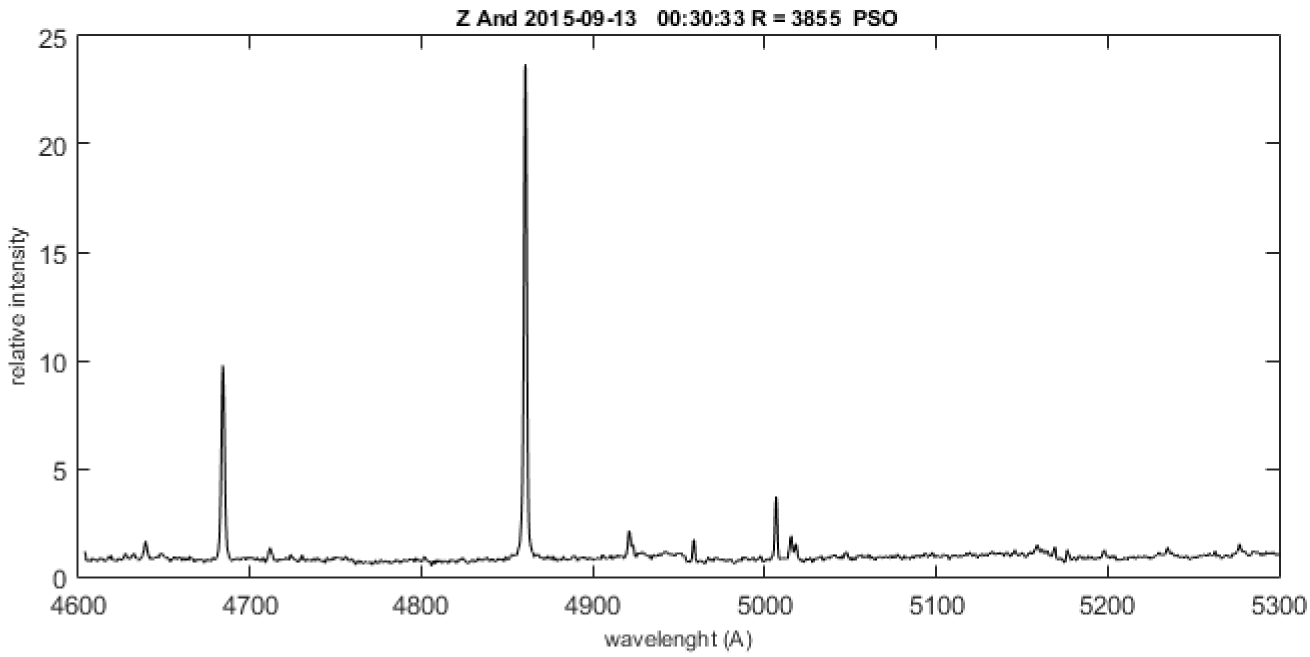
## Z And

| Coordinates (2000.0) | |
|---|---|
| R.A. | 23 33 40 |
| Dec. | 48 49 06 |
| Mag V | 10.1 |




H alpha and H beta region by Tim Lester and Peter Somogyi

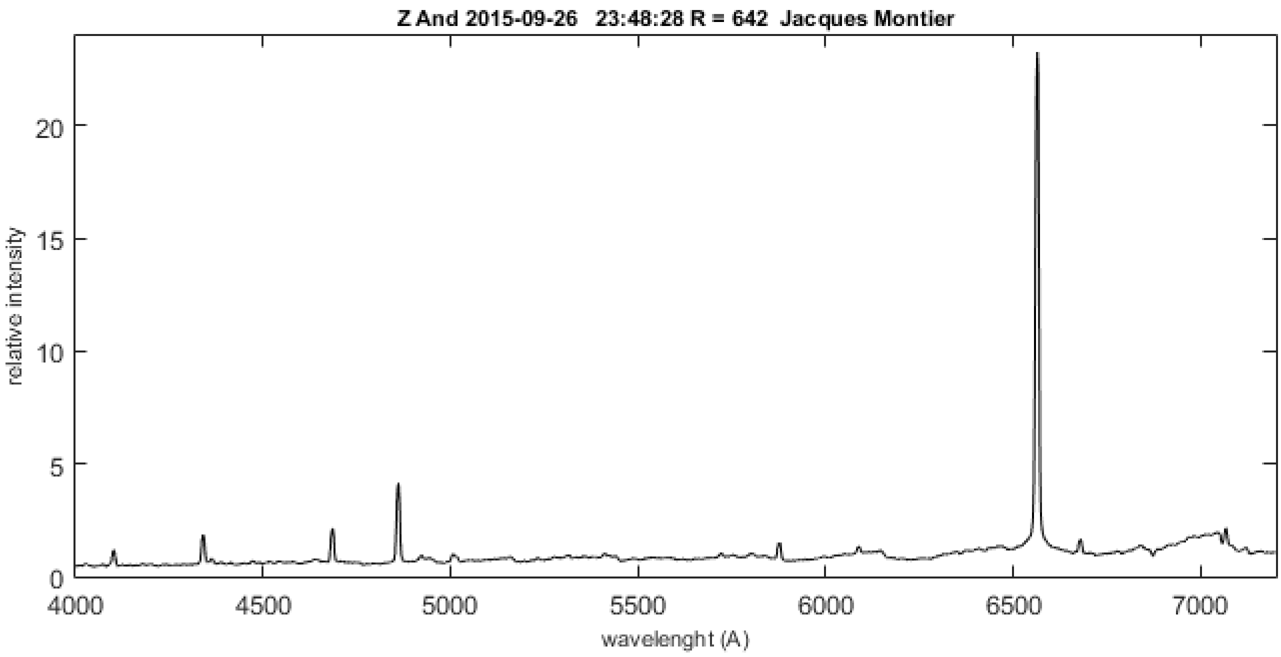



Hβ range by Peter Somogyi at R = 4000 with a Lhires III (600 l/mm)

# Z And

| Coordinates (2000.0) | |
|---|---|
| R.A. | 23 33 40 |
| Dec. | 48 49 06 |
| Mag V | 10.1 |



# The current CH Cygni active phase
# Emergence of unforseen hydrogen line profiles.

## A. Skopal



*During the current, 2014-15, active phase of CH Cygni we are observing very complex and highly-variable profiles of hydrogen lines that suggest high-velocity (+/-2000-2500 km/s) jet-like mass-outflow. Such type of the profiles has been observed in the CH Cyg spectrum for the first time!*
*To get an imagination of their possible origin, first I introduce a qualitative explanation of P Cygni profiles. In the second part, I briefly describe two examples of the H-alpha and H-beta profiles you observed on May 20 and July 26, 2015.*

## 1. P Cygni profiles

As it is well known, the most convincing indicator of mass loss from_hot stars is the presence of the so-called `P-Cygni profiles'.
The name of such type of the profile is historically connected with the outburst of a star in the constellation Cygnus in 1600, when this star (later named as P Cygni) reached brightness of 3 mag.
At the end of 19-th century, the prismatic spectra of this star revealed the presence of a special type of line profiles consisting of a red-shifted emission component changing continuously to a violet-shifted absorption component. This type of line profiles appeared to be a common feature for mainly very luminous hot stars and has been observed during outbursts of classical novae and symbiotic stars. According to its representative, it was called as P-Cygni type of the profile.

Such type of the profile is a result of the radiation transfer in the continuum, produced by the photosphere of the central star, throughout an expanding medium around it, for example, the stellar wind. A scheme of how the P Cygni profile can be created in a spherically symmetric outflowing wind, in which the velocity increases outward, is shown in Fig. 1.
An outer observer can recognize four regions contributing to the formation of a spectral line.

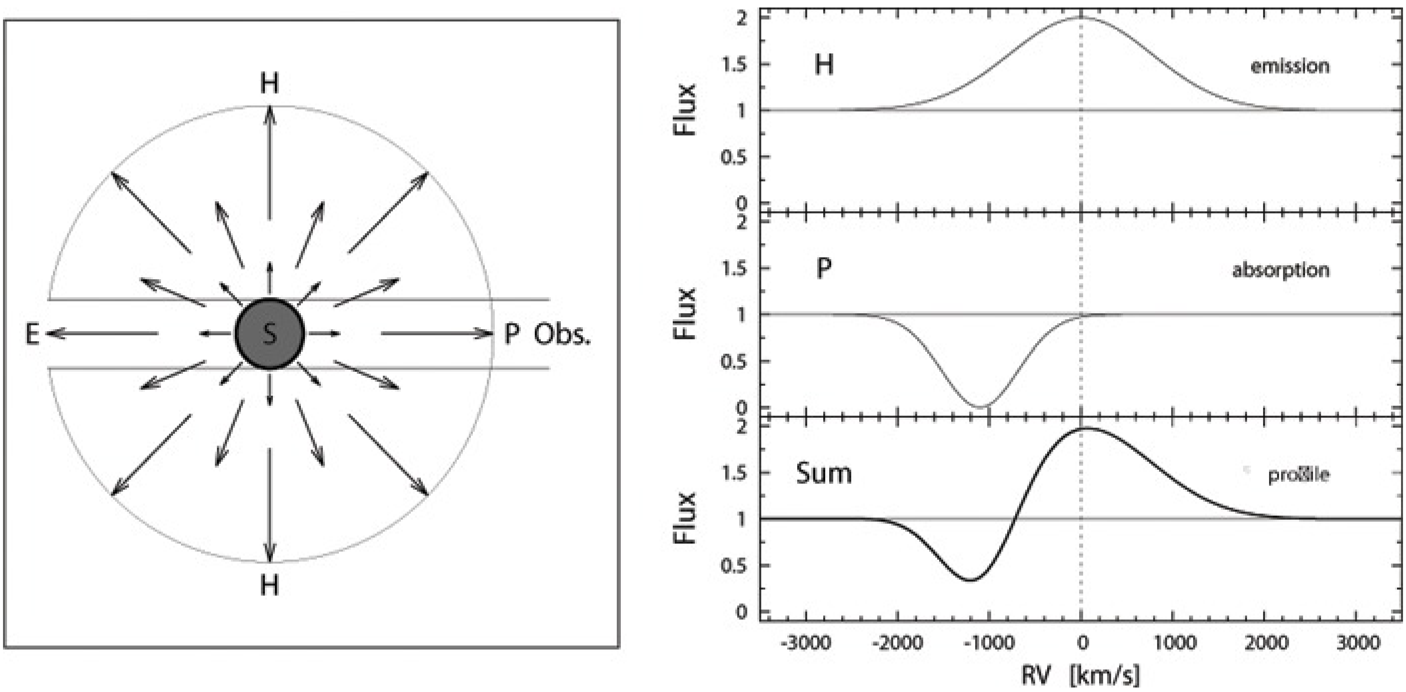



Figure 1.
A sketch of the origin of P Cygni profile. The left panel shows a geometry of the stellar wind with an increasing velocity from the central star S. Direction of the observer is denoted by P. The emission component is created in the halo region H, while the blue-shifted absorption component originates in the tube P. P Cygni type of the profile results from the superposition of both the emission and absorption components (right panel).

(i) The central star which emits a continuum (possibly) with a photospheric absorption line.

(ii) The halo H at the sides of the star, where the gas has both positive and negative velocity components along the line
of sight, limited by the wind terminal velocity. It scatters radiation from the photosphere in all directions, in part also in the direction of the observer.
As a result, an additional line emission to that from the stellar photosphere is measured. According to the Doppler effect, contributions of this emission come from different parts of the emitting hemispheres, and therefore will be redistributed between the positive and negative terminal velocity of the wind. This produces a broad emission component added to the continuum level (see the top right panel of Fig. 1).

(iii) The `tube' P in front of the stellar disk, where the gas is moving to the observer with velocities between 0 and the terminal velocity. In this region the gas scatters the photospheric radiation in specific transitions of its atoms (i.e. spectral lines) that leads to a removal of corresponding photons in the direction to the observer, producing thus a violet shifted absorption with a Doppler broadening between 0 and the negative terminal velocity (the mid panel of Fig. 1 top). In more detail, an original photon is absorbed by an atom, excites its electron to a higher energetic level which returns back during an extremely short time of 1E-9 - 1E-10 s, re-radiating a photon with the same energy, but to a different direction. In this way the photospheric radiation at/around a given line transition is attenuated in the line of sight, but does not reach zero flux because a fraction of photons is scattered also to the observer.
The process is repeatable and its final result depends mainly on the number of scatterers on the line of sight (i.e. on the column density of given element), probability of the line transition (its so-called oscillator strength), the temperature of the gas and its velocity distribution.
For example, absorptions of the hydrogen Balmer lines are strongest at the temperature of around 10000 Kelvins, because at this temperature the second level of HI atom is most populated by electrons which then can be excited to higher levels and be scattered to different directions when being stabilized at the same level.
This creates an absorption at Balmer line wavelengths. At the H-alpha by scattering between 2nd and 3rd level of HI atom, H-beta (2 <--> 4), H-gamma (2 <--> 5), etc.

(iv) The `tube' E that is eclipsed by the star, so the radiation from_this region cannot reach the observer.

Finally, the net result, which is simple addition of the contributions from the halo H, the region in front of the star and its photospheric continuum, is a P Cygni profile (see the right bottom panel of Fig. 1).
However, a particular P Cygni profile depends on the mass-loss rate and the geometry of the outflowing emitting/absorbing material. The latter need not to be spherically symmetric as in the case of single stars. Also the driving mechanism can differ from a radiatively driven stellar wind. This is usual case for erupting stars.

## 2. On the origin of HI line profiles during the current outburst of CH Cygni

First glance on the CH Cyg hydrogen line profiles, you are observing during its current active phase, suggests some similarities with the P Cygni type of the profile.
Omitting the fact that the profiles are highly variable, we always observe an absorption on the blue side of the profile, while the red part of a strong emission persists relatively stable. Second glance, however, shows a large difference between the observed and typical P Cygni profile, suggesting thus their different origin. Nevertheless, the shape and the origin of P Cygni profile, as described above, provides us at least a template in qualitative understanding the origin of CH Cyg profiles. As an example, I selected two spectra, from your around 200 measurements during 2015. First was made by Francois Teyssier on May

20.983 (see Fig. 2) and the second one by Olivier Garde on July 26.025, 2015 (see Fig. 3).

Below I briefly describe the observed profiles and their origin as follows:

1. A common feature of all spectra is the presence of a sharp central absorption cutting the emission of H-gamma, H-beta and H-alpha at/around the systemic velocity of ~ -58 km/s. These properties imply the presence of neutral hydrogen in the system, located in front of the warm white dwarf (WD) pseudophotosphere (7000-10000 K, the blue line in figures) that is relatively stable during the whole active phase.

What can be its origin? Its position simulates the absorption component in the P Cygni profile. However, with respect to abrupt and dramatic variability of absorption/emission features at the blue side of the profile, the corresponding absorbing material cannot be connected with that ejected by the active WD. The only possibility, I can see, is the neutral wind from the giant that engulfs the whole system during active phases of symbiotic stars, because the warm pseudophotosphere around the WD is not capable of ionizing it. Thus the WD is embedded in the giant's wind.

2. The emission core (in between approx. -500 and +500 km/s), that is comparable with a standard double-peaked emission profile observed in other active symbiotic stars. However, in the case of CH Cyg its blue part is often highly variable as documented by series of your H-alpha observations made during one night. Such profiles, mainly its broad wings, can be produced by the ionized hydrogen in the bipolar stellar wind from the hot component. This requires the presence of an ionizing source with temperature of ~ > 50000 K to generate a flux of a few times $10^{45}$ of ionizing photons per second which is adequate to the rate of recombinations producing the observed line emission. CH Cyg is accretion powered object, so the ionizing source can be connected with the hotter inner parts of the accreting material and the boundary layer at the WD surface.

3. The absorption feature located around -2000 km/s (see Fig. 3) originates in the material absorbing the continuum radiation of the WD pseudophotosphere. An analogy of the `tube' P in front of the stellar disk in Fig. 1. However, separation of the absorption component from the core line implies that the absorbing material cannot be spread continuously from the WD, but represents an isolated parcel of matter moving fast to the observer.

Figure 2 shows a more complicated case, where the ouflowing material absorbs also a part of a strong emission in the blue wing of the line. The presence of another absorbing material having radial velocity of around -500 km/s is better seen in the H-alpha profile, because it is superposed with already strong emission wing.

This absorption seems to be much stronger (deeper) than the level of the WD continuum (in the figure represented by the blue line).

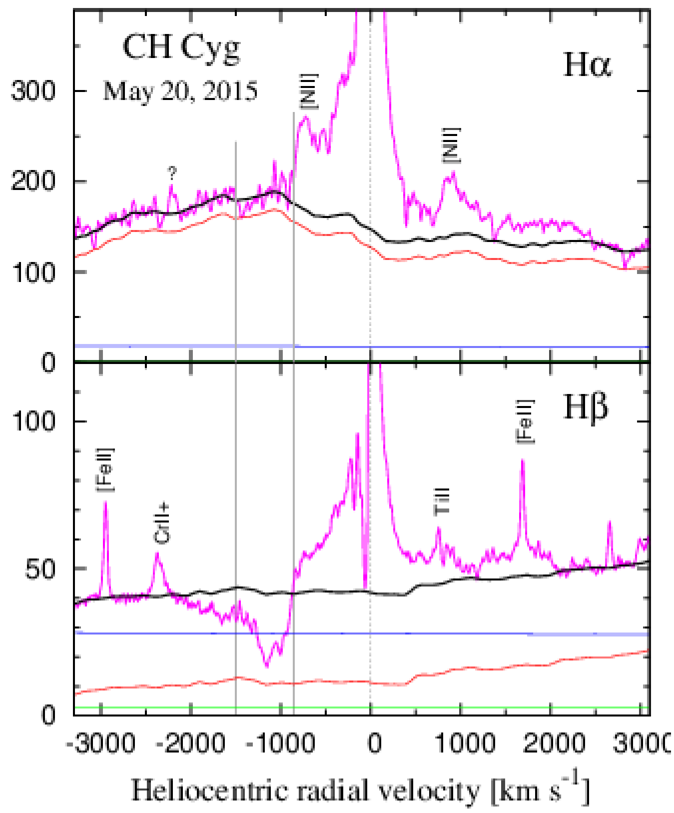



**Figure 2.**
Example of the H-alpha and H-beta profiles in the radial velocity scale as observed by Francois Teyssier on May 20.983, 2015. The model of the underlying continuum is denoted by the black line. The red, blue and green lines denote continuum contributions from the giant, WD pseudophotosphere and the nebula, respectively.

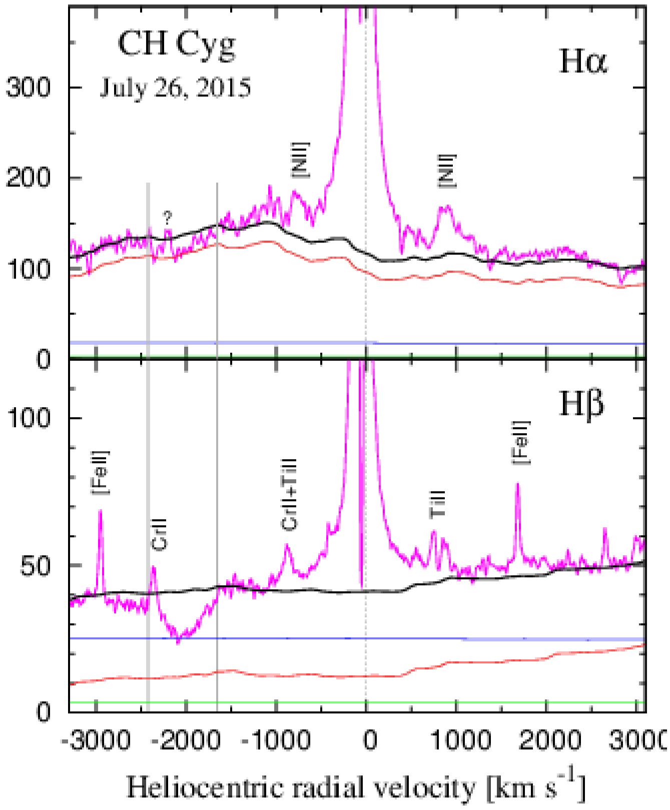



**Figure 3.**
As in Fig. 2, but for the spectrum made by Olivier Garde on July 26.025, 2015.

This implies that the ejected dense material is spread also beyond the source of the warm continuum, and thus absorbs a fraction of the 'halo' emission.

4. The emission features extended to around 2000 to 2500 km/s (here best seen in the H-alpha profile in Fig. 2) that seem to represent a counterpart to the most blue-shifted absorptions.
In principle, their origin is the same as the `halo' emission in the P Cygni profile as described above. However, the velocity field and the structure of the outflow cannot be compared with a spherically symmetric stellar wind.
Note also that absorption features are more pronounced in the H-beta region, because the level of the WD continuum here is significantly higher than that of the cool giant, whereas in the H-alpha region this ratio is inverse (see the blue and red lines in the figures).

These main characteristics of the hydrogen line profiles in the current spectrum of CH Cyg can be interpreted as due to the pulsed bipolarly driven jets from the accreting WD.
Absorption features are very similar to those observed in a unique jet source MWC 560, where the line of sight lies practically parallel to the jet axis so that the outflowing gas absorbs the underlying emission regions. This interpretation requires the line of sight to be practically parallel to the jet axis that is assumed to be perpendicular to the orbital plane, i.e. implying a low orbital inclination. However, this is in conflict with the current basic CH Cyg configuration, being understood as an eclipsing system (binary or triple-star system; see my contribution in the ARAS Letter #13).

The orbital inclination problem could be possible to avoid by pulsed ejection of (more axially than spherically [because of a disk-like structure]) symmetric and optically thick bubbles by the WD caused by unstable accretion at rates near to the critical value igniting thermonuclear fusion. This could give rise to repetitive hydrogen shell flashes accompanied with variable mass outflow in a form of blobs or bubbles. Rapid photometric variability is consistent with this view.

However, for now we do not know what is the true. We still need more multiwavelength observations and theoretical modelling.

**Augustin Skopal**

**October 8, 2015**

# Absorption lines, abundances, and atmospheres

## Steve Shore



Winds and ejecta have been our main discussion in these pages but now it's time to turn to the more mundane, and essential, type of spectroscopy, the observation of stellar and planetary atmospheres.

Unlike the diffuse interstellar medium, dynamic media, or circumstellar environments, atmospheres are hydrostatic structures whose transparency varies with temperature and density. It is the essential property of those environments we call atmospheres that their density and temperature gradients result from the balance of internal pressure against the compression induced by an external gravitational field, that of the bulk of the mass of which they form a peripheral layer. Whether the region is very extended, as in giants (especially red giants), or compact (as in white dwarfs), the main feature of the transfer of radiation through this layer is dominated by a systematic, uniform decrease in the optical depth and an almost uniformly smooth gradient in the physical quantities.

### Seeing through an atmosphere: stellar spectra

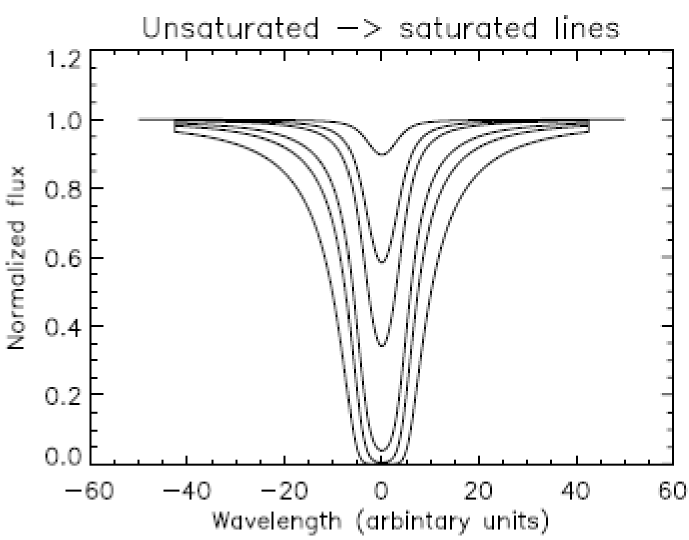
OK, now that I've frightened you with the technicality, let me restate this in more everyday language. An atmosphere is whatever lies above the photosphere, the surface through which we can't see. But that depends on wavelength, since the opacity of the gas -- of a specific composition -- depends on wavelength. For the moment, we'll take a reference value for the opacity as that in the middle visual range, at 5500 Å (an old convention from photographic days). Where we see a completely opaque surface, that is the reference photosphere. As in the Earth's atmosphere, this occurs at some pressure -- hence geometric depth -- in the layer and the mechanical equilibrium insures that the pressure decreases with geometric height above this layer. So we see through the atmosphere. But not quite without obstruction. Consider a thermal problem (scattering is a bit more complicated) where a perfect gas has a pressure depending on density, temperature, and composition (the mean atomic/molecular mass of the constituents). In thermal equilibrium, ass species have the same temperature (collisions among the particles guarantees that) so we can talk about a single temperature-pressure-density relation. This atmosphere is the continuation of the gas distribution, called for want of a better word, the *star,* whose luminosity is generated somewhere far below the layer we see through thermonuclear reactions. The radiation diffuses outward; one says ``diffuses'' instead of ``streams'' because of the high density and opacity (although it may be only electron scattering the optical depth is enormous), The photons random walk with no chance of not undergoing scattering, absorption, and/or re-emission before exiting any layer. The density decreases outward as does the pressure, to have otherwise -- a density inversion -- would be as unstable as hot air supporting cold air in a room. In fact, if this happens, as in a convective region, the heat transport is dominated by physical motion of turbulent gas that buoyantly transport the energy outward until they too cool and sink. Convection, which we see in the photosphere of the Sun and solar-type stars, is the result of this gravitational structuring o the atmosphere. If too much energy needs to be transported by radiation, the layer heats until -- because of a decreasing density -- it becomes buoyantly unstable. You see this easily when the bottom of a pot of water is above some temperature difference relative to the top of the pot, it boils. OK, this isn't a competition between radiation and fluid motion but the heat transport within the liquid is diffusive (conductive) and the analogy holds well. In an atmosphere, when the surface is reached, any further decrease in density reduces the opacity within the convective elements and they cool and contract, hence sink. But they send waves into the upper layers and disturb the otherwise quiet, cooling gas., This broad spectrum of waves knocks the atoms and molecules of the atmosphere about at the sound speed, or even higher and broadens the lines. We'll return to this in a moment.

Now in equilibrium, that is to say in the absence of a net outward acceleration, the atmosphere develops a temperature gradient just like the pot. It is hotter in its base and also denser. Hotter means the ionization is higher than the outer parts, due to collisions and irradiation, and the atoms (let's concentrate on those for now) are also more excited. Collisions establish a balance between transition rates that sets the level populations in fixed ratios that depend on temperature. The lower level of any pair is always more populated. Remember, we're discussing a thermal problem, not what we talked about with nova ejecta or winds where the densities are so low that emission can occur before downward collisions happen. The atom is, therefore, able to *absorb* a photon coming from below, an upward transition is induced at a frequency that depends only on the difference between the energies of the two levels. Any photons that correspond to such differences will produce an upward transition. But because this gas is in thermal equilibrium, collisions occur faster than the downward radiative rates so a photon does not re-emerge from the event. The energy absorbed is redistributed into the gas, heating the particles and maintaining the internal pressure. So a photon that emerged from the photosphere now disappears and the more atoms that lie along the line of sight, the darker that frequency will be. This means that the lines have a higher optical depth than the adjacent continuum and that is why we see them (!!). Were everything to have about the same opacity, you would see the merger of all transitions. That is another way of saying you're above the photosphere, you see individual lines (or overlapping lines) because the medium is overall more transparent than the gas below except at specific frequencies.

### The line profile and broadening

The individual atomic transitions have a characteristic spectral response, much like the filter of a circuit. There's a fuzziness to the levels because they have finite lifetimes and a probability of decaying into a lower state. This is another expression of the fundamental quantum mechanical property of any microsystem, the shorter the statistical lifetime of a level the broader it is. So the photons are not absorbed by a perfect oscillator, they can be absorbed in a spread of energy around the central frequency. The so-called Lorentz profile, has a very specific form (see Fig. 1) and the higher the transition probability the broader the line. The wings vary as $1/\Delta\lambda^2$ and have the peculiar property that the dispersion (width) of the profile grows without limit as the interval in wavelength increases. But that's a separate issue. The main thing is that this is what a cold atom, or molecule, shows when there is no other microscopic - or macroscale - motion.

When an absorbing atom is moving radially relative to the radiation source the frequency it ``sees'' is shifted by the Doppler effect along the line of sight so for a speed along some direction v, the frequency shift $\Delta\nu/\nu_0 = \Delta\lambda/\lambda_0 = v/c$. This is one dimensional, toward or away from the source. Whatever the intrinsic line profile, its center is shifted relative to the source by this $\Delta \nu$. For thermal broadening, the assumption is that the random motions are distributed as a gaussian profile (also called a normal distribution, remember the ``bell curve''?) so there are relatively few atoms shifted by a large amount and most see a frequency shift of zero. Every point in the profile is affected so the resulting profile is a combination -- a convolution -- of the gaussian with the intrinsic profile. The larger the velocity dispersion, the broader the core of the profile relative to the wings. In other words, you've spread the absorption over a broader velocity interval so over a broader frequency interval.




This is where turbulent motions enter. If in addition to thermal motion the gas is turbulent, depending on the spectrum of the fluctuations, the profile is further broadened. This reduces the absorption at line center but increases it in the wings relative to what the medium would have had were it quiet.

The optical depth at each frequency depends on the absorption coefficient, -- the profile function -- and the amount of material that lies between the observer and the radiation source. The latter is independent of frequency, the former is the ``efficiency of absorption at any frequency relative to line center''. So the line is weakened at its center and increased, proportionally, in the wings as the broadening increases. Saturation is when the line center is as dark as it can get, in other words when all of the light that can be absorbed at the center is absorbed. For a completely covered source, what you would see in an atmosphere, the residual flux at line center will be very nearly zero (in fact it never really is but it's close enough to seem so). A further increase in the column density of gas increases the visibility of the wings of the profile that absorb intrinsically less. That is the meaning of the ``curve of growth'', the saturation is compensated by further absorption from the wings of the profile and the line appears broader. But keep in mind that you are merely seeing what was previously too weak to detect as the amount of matter increases. The more you have along the line of sight, the stronger the absorption line so the strength of the line is proportional to the number of atoms in the state that's absorbing.

This is the basis of abundance studies. Were the atmosphere isothermal -- having only a single temperature throughout the layer -- the absorption would depend only on the number density. Since the base of the layer is usually hotter, since the pressure is higher near the photosphere, the line may be more excited where the density is higher even if the actual elemental abundance is the same. This is why you need to know the run of temperature and density throughout the line of sight, and why it is harder to interpret a stellar absorption spectrum than, say, an interstellar cloud or an isothermal stellar wind. A layer can also be screened from below, a strong absorber in a hot layer can remove so much light that the overlying, possibly less excited or ionized, layer is invisible and the absorption is dominated only by the lower part. The same holds for a planetary atmosphere. For a disk it's different because the radial structure of the disk is not pressure supported, an accretion disk is ``centrifugally supported'' because of orbital motion and only the radial drift of matter controls the density and temperature profile. The outer portions will be lower temperature because the internal heating from viscosity is lower an because the illumination of the central source is also diluted by distance. When the disk passes in front of a source, during n eclipse, the light traverses an optical depth that depends on the disk structure but this depends on the angle it makes relative to the center of the disk and the inclination of the disk across the source.

# Absorption lines, abundances, and atmospheres

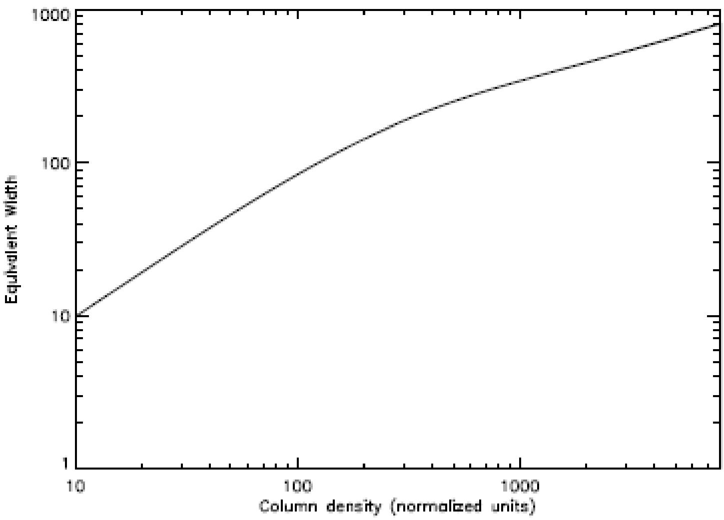
## Steve Shore

3/4

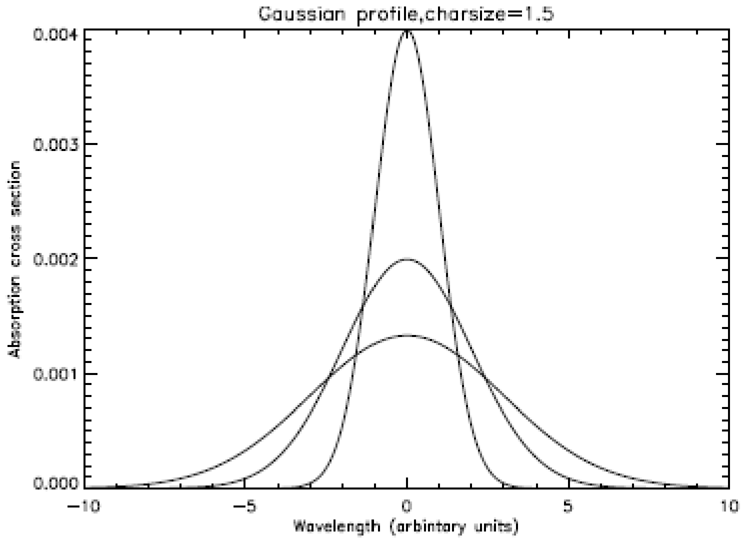
### Equivalent width and the line profiles

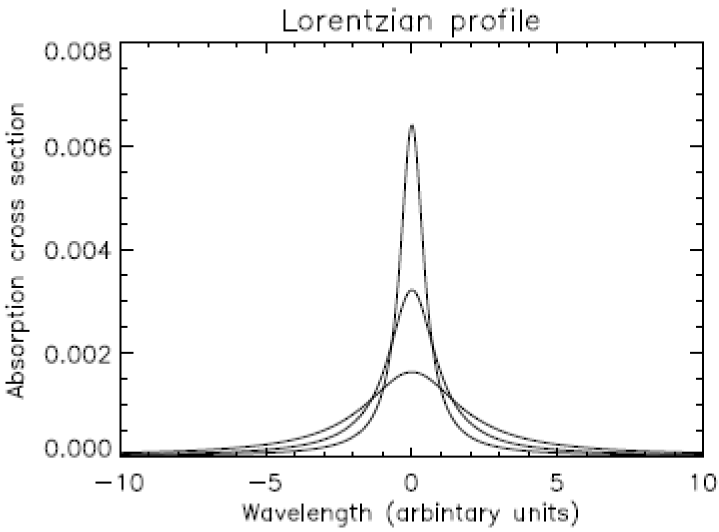
Now we finally come to an observable quantity that serves as a line strength measurement. In the ``stone tool days'' of photographic plates and microcomparators, intensity and profiles couldn't be directly obtained. But looking through a microscope, you can say that the line has some photographic density-averaged apparent width, that the fuzzy wings and the dark core would be roughly equivalent to a saturated line (rectangular profile) of some width in Å This *equivalent width* became the standard way to discuss the absorption (or emission, the same problem of uncalibrated data) so is the fractional of energy within some spectral range that has been removed. Now, with digital spectra, the profiles are obtained directly so this measure is really an anachronism, but it is convenient as a measure of the optical depth of the transition.

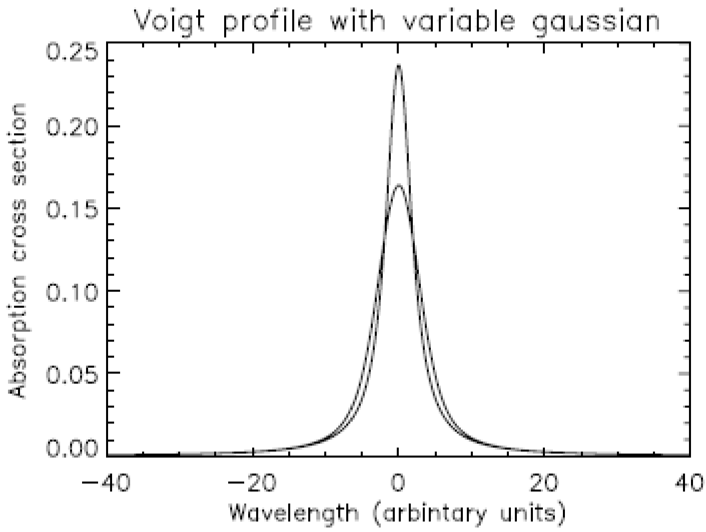
When the core dominates the profile, when the line is weak so the intrinsic wings are not detected, as the amount of material increases so does the amount of energy removed. The two are linearly related so this, the weak line limit (meaning that the residual intensity at line center is a few percent of the continuum or greater) , the $EW \sim \tau \sim N$ where N is the column density along the line of sight. Increasing the amount of matter in the column eventually saturates the core but,. since the wings are always unsaturated, leaves the line to increase in ``blackness'' but more slowly, as $EW \sim N^{1/2}$ (*The equivalent width is proportional to the column density for small optical depth and proportional to the square root in the hih optical depth case*). This, the so-called *damped phase*, is the rate of change with column density of a line dominated by the wings of the intrinsic profile (assumed to be a Lorentzian form but it's not that important for the basic argument). The graph describing this dependence is called the ``curve of growth'' and is just a pictorial way of understanding the calibration between the amount of absorbing material and the profile changes.




Variation of the equivalent width of a line with the column density for that line



For a turbulent medium, the gaussian is broader and the saturation is delayed, the line remains in the linear growth stage for longer but it must eventually saturate. Since the amount of energy removed will always be a function of the intrinsic opacity (not just the profile but the atomic strength of the transition) each line has an identical formal curve of growth but the specific column densities at which saturation begins or the damped part begins depends on the strength of the individual line (think again of the difference between forbidden and permitted lines, the forbidden saturate at only very high column densities).

Don't make the mistake of confusing column density with volume density. The latter is the density around any point, any atom, it is local. It governs the collision rate, for instance. The column density depends on the local values but along a line of sight and the longer the sight line the greater the column density -- and the larger the optical depth. Should there be a temperature and density change along the line of sight, this enters the curve of growth -- a line formed over a range of densities does not behave like an isothermal line (one formed over a single temperature range). All atmospheres have both density and temperature gradients so the analysis of the column density cannot use a simple method of this type. But it *does* work for lines in interstellar clouds that are very close to single temperature and have internal turbulent motions. The same holds for galaxies and, likely, for the clouds seen in absorption by neutral species -- especially the Lyman series of hydrogen -- against distant galaxies, the so-called ``Lyman alpha forest'' because of the density of the lines and the number of sampled clouds along the enormous cosmological sight lines.

### Abundances and ionization

A hot atmosphere, for example a B star with a temperature of, say, 20000 K, is more ionized than an F star with a temperature of 8500 K. In the B star you see weaker Balmer lines than the F star and no Ca II while the F star will show a strong pair of lines at Ca II H and K (3933, 3964 Å). This does not mean there is more Ca in one and less in the other but that the Ca is in the form Ca+2 in the B star and Ca+ in the F star. The same for He I, you see it in the B star and not in the F star because the lower levels (that absorb) are not sufficiently excited at 8500 K to produce a sufficient column density of the ion. Knowing the temperature and the pressure structure of the layer you can correct for this lack of presence to recover the amount of the element along the line of sight to the photosphere. But looking just at the line strength and equating it with the abundance measure is dead wrong. This is the same problem in novae, for instance. If you see the Fe II absorption lines at the start, when the gas dramatically cools because of the expansion, the strength of the lines only says there is sufficient optical depth to produce the absorption. Lower column density means weaker lines. This is why I kept emphasizing in earlier discussions that the so-called ``Fe II novae'' only indicate the amount of absorbing matter and the temperature and not the abundance or anything else fundamental. If there is less gas, the matter is more transparent and, therefore, more ionized and you may lose the Fe II absorbers altogether. In that case, the gas may display only emission lines even at a very early stage of e.g., He I, He II, and N III. Increasing the velocity gradient decreases the relative opacity of the gas because the absorption is now spread over a broader velocity range so you see emission sooner for the same amount of mass.

### A closing comment on spectral classification

Because stellar atmospheres are the outer layers of stars, having negligible masses, the gravitational force is produced from the bulk of the mass. Since the star is hydrostatic there is a systematic change of the lines in the spectrum with increasing luminosity and extension. If the gravity is lower, meaning the atmosphere and the star are more extended, the temperature and density will be lower in the atmosphere since the pressure is lower. For a structure like the main sequence, where all stars have the same nuclear source, the higher the luminosity the hotter the atmosphere and you see the systematic shift from metallic lines to Balmer lines to Helium lines. Lowering the gravity, for a giant, the ionization is higher at the same temperature because there are fewer recombinations for each ionization. This is in the base of all spectral classifications. This doesn't hold for a moving medium, such as a stellar wind or ejecta, where the radiation source is dynamically detached from the medium through which it passes.

I hope this makes sense. It's pretty dense but really, even with all these words, it's not hard at all. Keep that sunset or dawn in mind, and the analogy of an eclipse. You see the light of any astronomical source altered by everything through which it passes, only free space is transparent (hence optical depth approximately zero) and lines are just added opacity sources. Whatever absorbs or scatters in the lines adds to that in the continuum and that produces the spectrum you see.

**Steve Shore**
**29-08-2015**

*A good reference :*
Gray, R. O. and Corbally, C. J. 2009, **Stellar Spectral Classification** (Princeton Univ. Press)

# ARAS Spectroscopic data base

**François Teyssier, Christian Buil, Olivier Thizy**

ARAS team is at the initiative of the PRO/AM data base for Be Stars

http://basebe.obspm.fr/basebe/

For other objects, spectra have been gathered by Christian Buil for specific campaigns such as

http://www.astrosurf.com/aras/V407Cyg/v407cyg.htm

Since 2013 a preliminary data base allows to gather the spectra of various types of objects, especially eruptive stars, novae, symbiotics, cataclysmics, supernovae. For specific campaigns, at the request of professionnal astronomers, or special events, sporadic pages are built (For example T Tauri Stars, Comets …).

http://www.astrosurf.com/aras/Aras_DataBase/DataBase.htm

**Requirements for spectra**

The spectra submitted to ARAS spectroscopic data base (ASDB) **must** respect the following guide lines :

- minimum resolution 500
- dark substracted, flat divided
- corrected by atmospheric and instrumental response
- acurate wavelenght calibration
- fit format (and suffixe = "fit")
- header according to "BESS" format
- the object name **must** be the name of ARAS Data base without any special symbol, such as "_", "-" … Upper, Low case, spaces are accepted
- the observer name **must** remain unchanged, idem for Observatory

**Quality check**

There's only a a first level validation check prior to adding spectra to this table (validation "v"). A few spectra which doesn't respect the guidelines are exceptionally accepted and are marked "~".

**Improvments**

Following the suggestion of Steve Shore the following changes have been (or are) introduced :

- The name of observer is replaced by an observer code (3 letters)
- The observatory or site is replaced by a site code (3 letters + country code in 2 letters)
- The range (wavelenght) is replaced by minimum and maximum wavelenght in two columns (l_min and l_max)
- The most important change is the normalisation of the file name. Since August, 2015 the file name is constructed according to :

**asdb_object_aaaammdd_hhh.fit**

*Example : asdb_agpeg_20150926_950.fit*

with asdb = Aras Spectroscopic Data Base.
object is a unique identifier for a star

**New categories**

Since August, two news categories are opened :
VV Cep stars (for the VV Cep campaign)
And LBV (for P Cygni spectra)

http://www.astrosurf.com/aras/Aras_DataBase/VVCepStars/VVCep.htm
http://www.astrosurf.com/aras/Aras_DataBase/LBV/PCyg.htm

The spectra must be sent to :

- François Teyssier (Novae, Symbiotics)
- Olivier Thizy (VV Cep stars, P Cygni)

List of observers (to be completed)
http://www.astrosurf.com/aras/Aras_DataBase/ObserversCodes.htm

List of Observatories and Sites (Idem)
http://www.astrosurf.com/aras/Aras_DataBase/SitesCodes.htm

**Next steps**

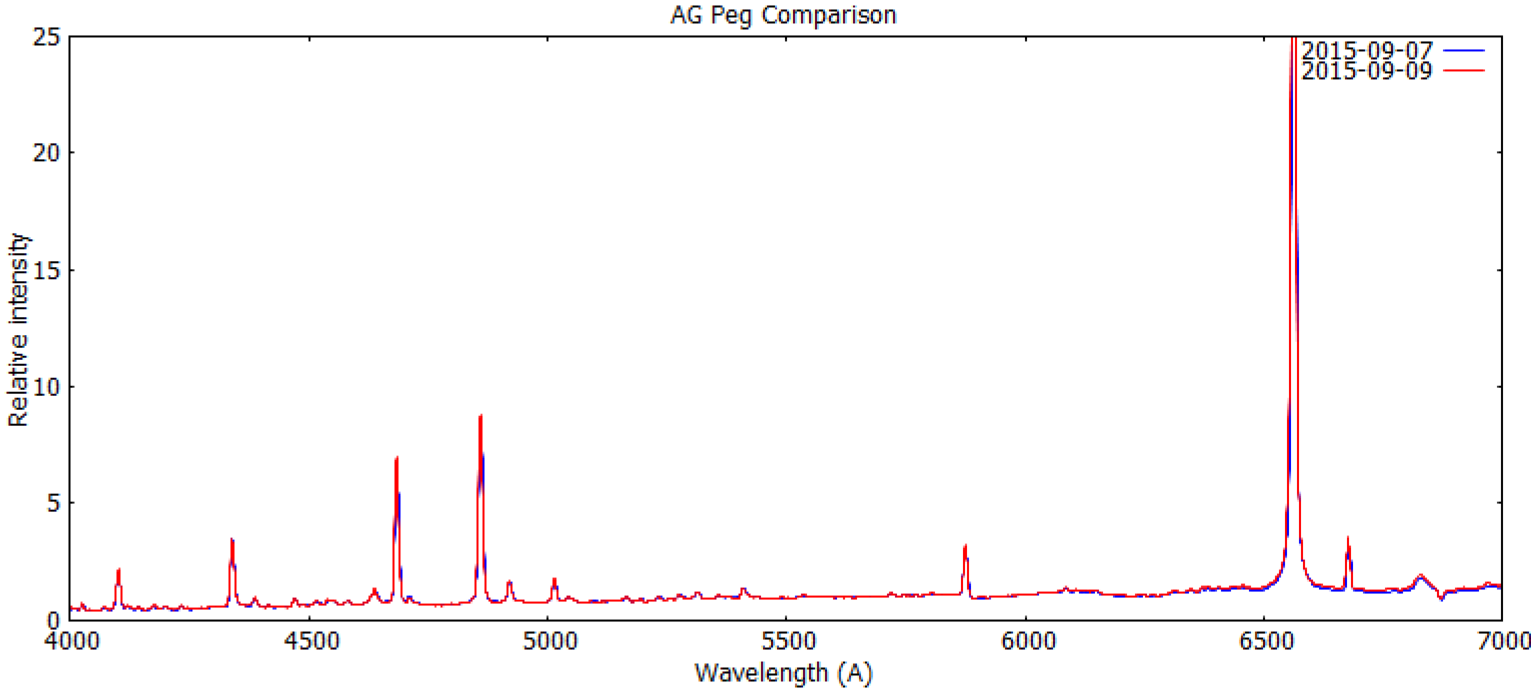
- finalisation of the improvements for all categories of stars

**Ungoing**

A project of an automated data base is under construction.

*Many thanks to all the observers who contribute to the construction of this high level data base.*

Two spectra of AG Peg have been acquired and reduced independently by Jacques Montier and Jean-Pierre Masviel with a ALPY 600 (two days between the two spectra)
The accordance of the spectra is almost perfect. This is the target level for ARAS data base.




Short description of the set-up, acquisition procedure, reduction
Right : J.P. Masviel
Bottom : J. Montier

Télescope Maksutov Cassegrain Intes: diamètre 150 mm, focale 1500 mm ramenée à 1050 mm (F/D=7) via un RF Celestron 6.3 + bagues allonges

Caméra ATIK 314 L

Spectrographe ALPY 600: à noter que je n'utiise pas le module Shelyak de calibration/flat. Calibration en longueur d'onde sur les raies de Balmer de l'étoile de référence et, pour la partie droite du spectre, calibration au moyen d'une lampe néon "Filly" orange (commercialisée chez Habitat il y a quelques années).

Etoile de référence: HD 208565 Hauteur: 36°
Etoile cible (Ag Peg) Hauteur: 35 °

3 poses de 600 secondes

9 flats de 3 secondes réalisés avec une ampoule d'éclairage à filament placé devant un diffuseur en papier calque monté directement à l'entrée du spectro (ADU max = 51000)

Traitement: ISIS V5.5.0

Telescope : MEADE ACF 355mm F/D10
Spectrograph : Alpy600 600t/mm
Imaging camera : ATIK460EX

Reference star : HD 208565 Date Obs : 2015-09-07T01:27:01 Altitude : 42.85°
Exposure : 4x60s (total time exposure 269s)

Target : AG Peg Date obs : 2015-09-07T01:42:14
Altitude : 40.35°
Exposure : 4x180s (total time exposure : 818s)

Bias : 7
Darks : 7x600s
Flats : 15x5s
Final flat : Max 34159 Min 2594 Mean 21027.77

Processing software ISIS-v5.5.2

**Same spectrograph,**
**Same reference star**
**Low difference of altitude between target and reference**
**Complete reduction with bias, dark, flat**
**Process with ISIS**
**= some keys for an excellent result**

## About ARAS initiative

**Astronomical Ring for Access to Spectroscopy (ARAS)** is an informal group of volunteers who aim to promote cooperation between professional and amateur astronomers in the field of spectroscopy.

To this end, ARAS has prepared the following roadmap:

• Identify centers of interest for spectroscopic observation which could lead to useful, effective and motivating cooperation between professional and amateur astronomers.
• Help develop the tools required to transform this cooperation into action (i.e. by publishing spectrograph building plans, organizing group purchasing to reduce costs, developing and validating observation protocols, managing a data base, identifying available resources in professional observatories (hardware, observation time), etc.
•Develop an awareness and education policy for amateur astronomers through training sessions, the organization of pro/am seminars, by publishing documents (web pages), managing a forum, etc.
• Encourage observers to use the spectrographs available in mission observatories and promote collaboration between experts, particularly variable star experts.
• Create a global observation network.

By decoding what light says to us, spectroscopy is the most productive field in astronomy. It is now entering the amateur world, enabling amateurs to open the doors of astrophysics. Why not join us and be one of the pioneers!

**Be Newsletter**

Previous issues :

**http://www.astrosurf.com/aras/surveys/beactu/index.htm**

**See also : VV Cep campaign**

http://www.spectro-aras.com/forum/viewforum.php?f=19

**Submit your spectra**

Please :
- respect the procedure
- check your spectra BEFORE sending them

Resolution should be at least R = 500
For new transcients, supernovae and poorly observed objects,
SA spectra at R = 100 are welcomed

1/ reduce your data into BeSS file format
2/ name your file with: _novadel2013_yyyymmdd_hhh_Observer
novadel2013: name of the nova, fixed for this object

Exemple: _chcyg_20130802_886_toto.fit

3/ send you spectra to
Novae, Symbiotics : François Teyssier
Supernovae : Christian Buil
to be included in the ARAS database

Download previous issues :

**http://www.astrosurf.com/aras/novae/InformationLetter/InformationLetter.html**

Further information :
Email francoismathieu.teyssier at bbox.fr