Eruptive stars spectroscopy
Cataclysmics, Symbiotics, Novae, Supernovae

ARAS Eruptive Stars
Information letter n° 12   31-12-2014
Observations of December 2014

.

NEWS

Symbiotic star Hen 2-468
(= V2428 Cyg)
detected in ouburst at mag 13
by U. Munari & al. (Atel # 6841)

Contents

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

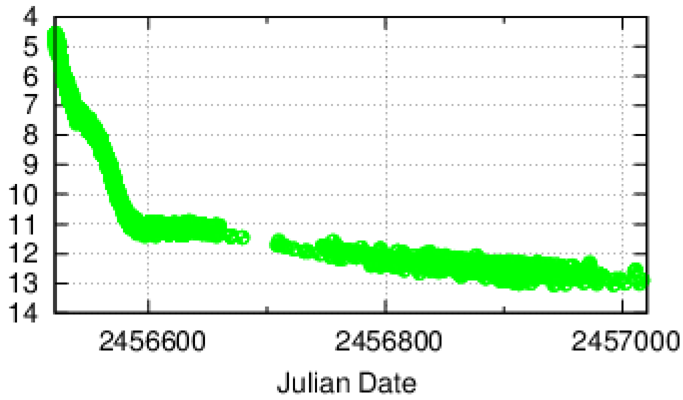
ARAS BeAM
http://arasbeam.free.fr/?lang=en

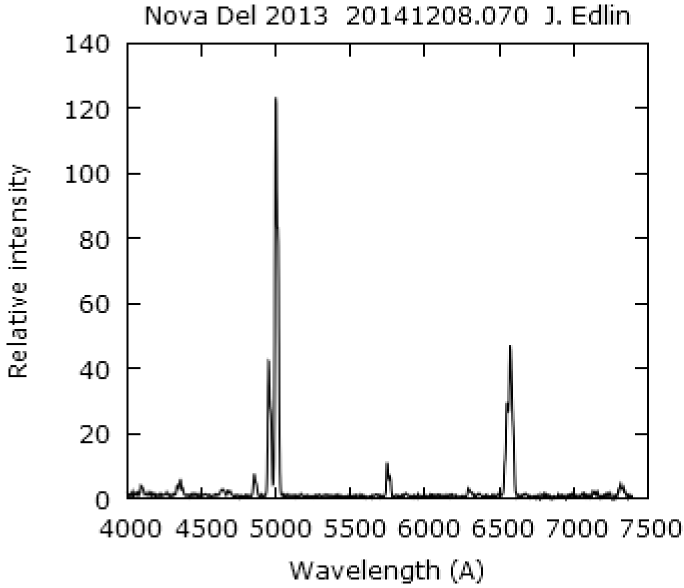
Acknowledgements :
V band light curves from AAVSO photometric data base

Authors :
F. Teyssier, P. Somogyi, P. Berardi, D. Boyd, J. Edlin,
J. Guarro, T. Lester, J. Montier

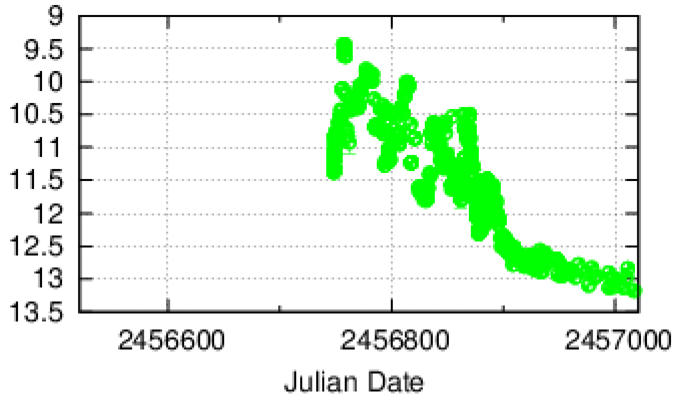
Status of current novae

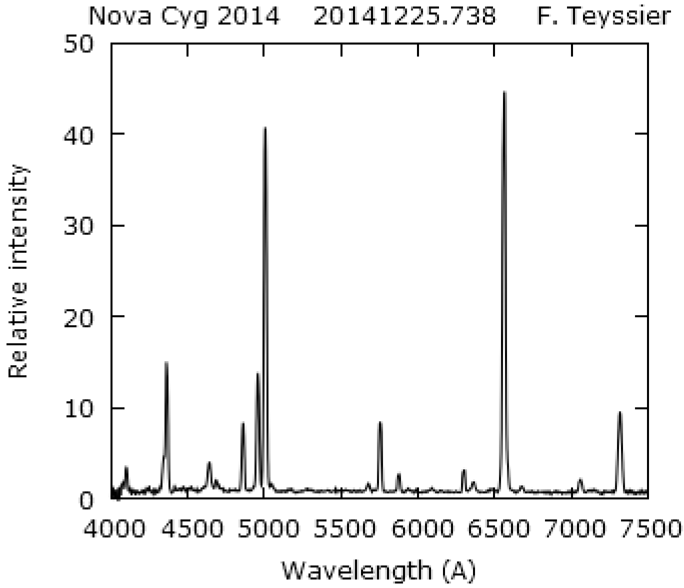
Nova Del 2013	V339 Del
Maximum	14-08-2013
Days after maximum	504
Current mag V	12.9
Delta mag V	8.5



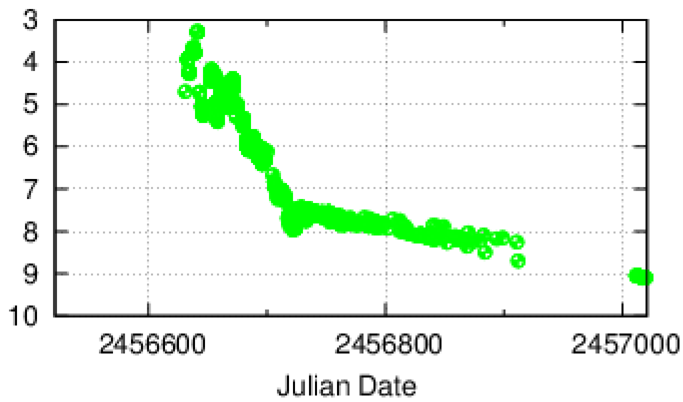


Nova Cyg 2014	V2659 Del
Maximum	09-04-2014
Days after maximum	266
Current mag V	13.2
Delta mag V	3.8





Nova Cen 2013	V1369 Cen
Maximum	14-12-2013
Days after maximum	382
Current mag V	9.1
Delta mag V	5.8

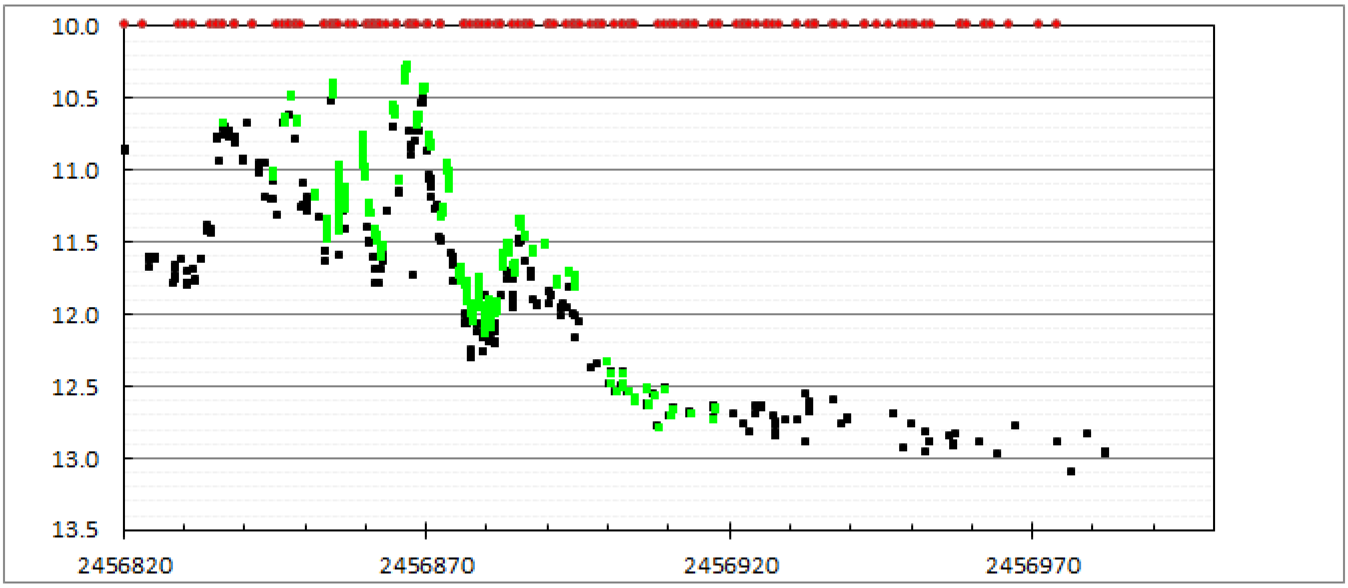


Luminosity
Mag V = 12.9 (30-12-2014)
Slow decline

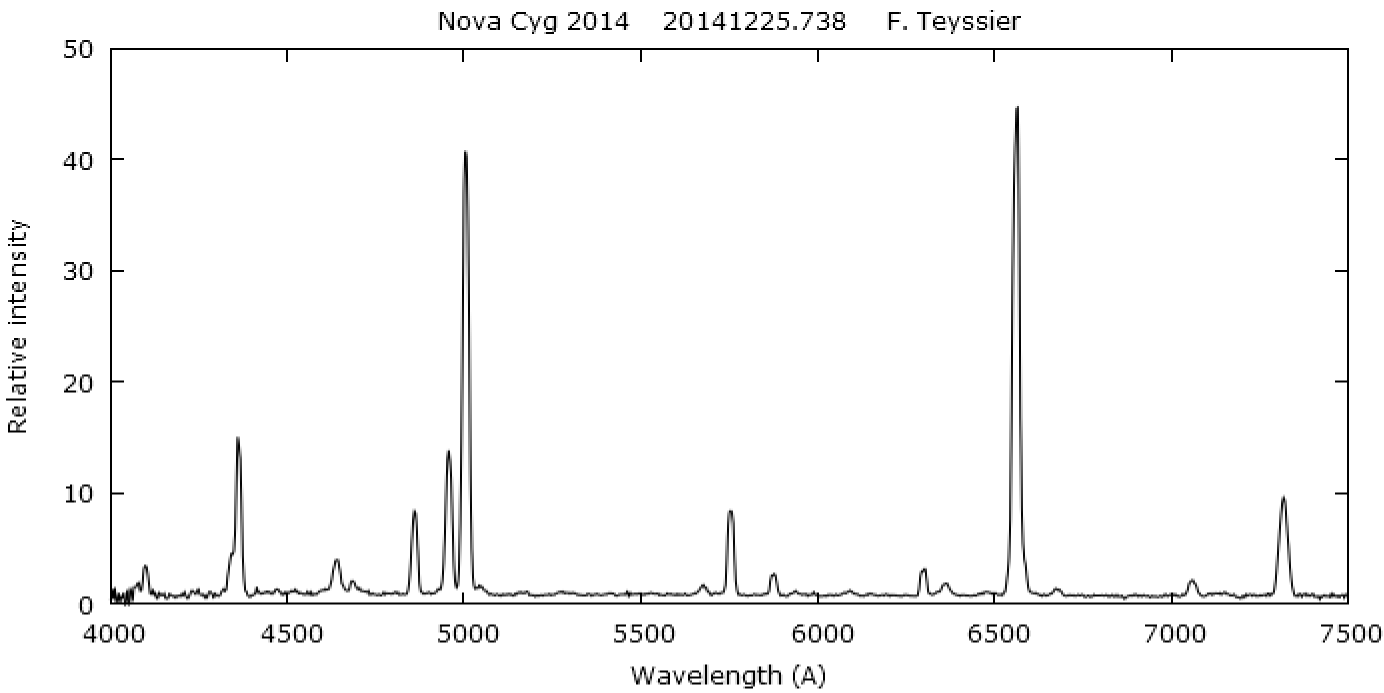
Spectroscopy
Nova Cyg in nebular phase

Observing : ungoing observations during nebular phase

Photometry
Slow decline during the nebular phase (0.4 mag / 100 days)
Dark squares : AAVSO
Green squares : Antonio Garcia and Joan Guarro



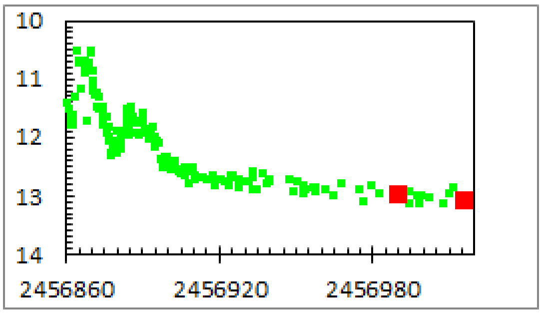
Spectroscopy
Nebular spectrum with noticelly [OII] intense

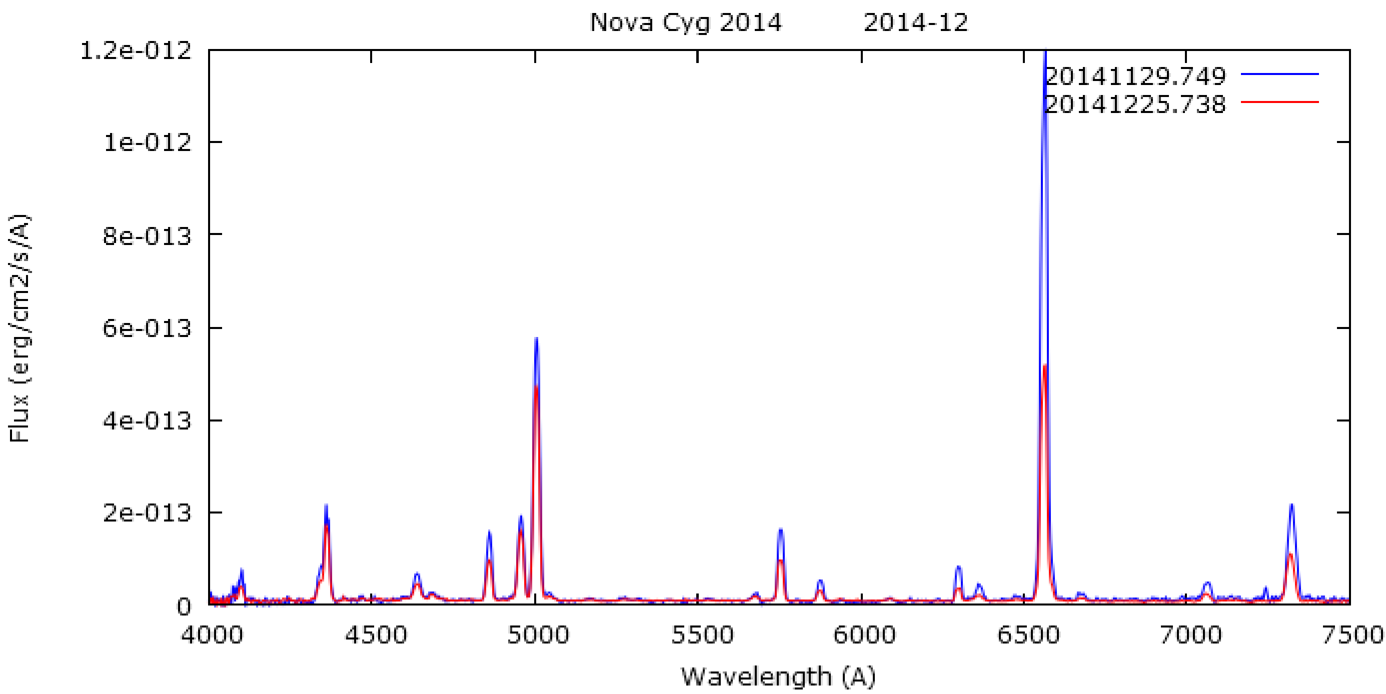


Observers : Tim Lester | Christian Buil | Paul Gerlach | Olivier Garde | François Teyssier | Jacques Montier | Antonio Garcia | Joan Guarro
Paolo Berardi | Franck Boubault | Peter Somogyi | Miguel Rodriguez | F. Boubault | O. Thizy

ARAS DATA BASE : 209 spectra http://www.astrosurf.com/aras/Aras_DataBase/Novae/Nova-Cyg-2014.htm
Web Page : http://www.astrosurf.com/aras/novae/NovaCyg2014.html

Nova Cyg 2014 evolution in December 2014





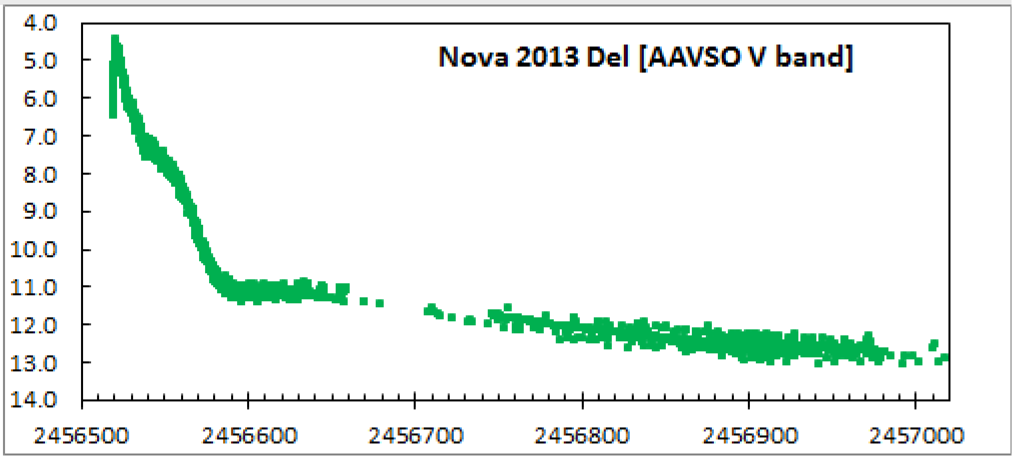
F. Teyssier LISA R=1000
Evolution of the nova during december
Ha alpha intensity decline more than other lines. [O III] as strong as H alpha which declined more than other lines.

Nova Del 2013 = V339 Del

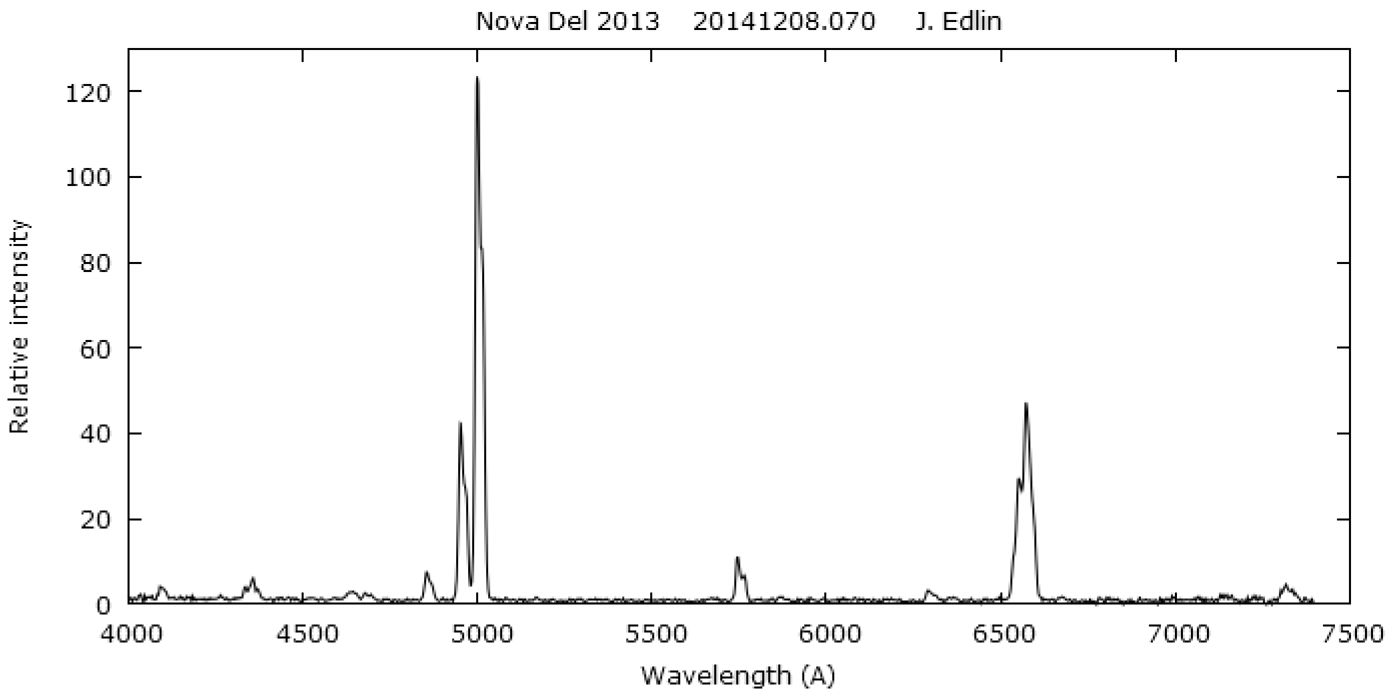
Luminosity
Mag V ~ 12.8 (31-12-2014)
Slowly declining

Observing
Spectra required (one a week)

Ungoing observations,
500 days after its outburst



Very slow evolution during the nebular phase (1 year)

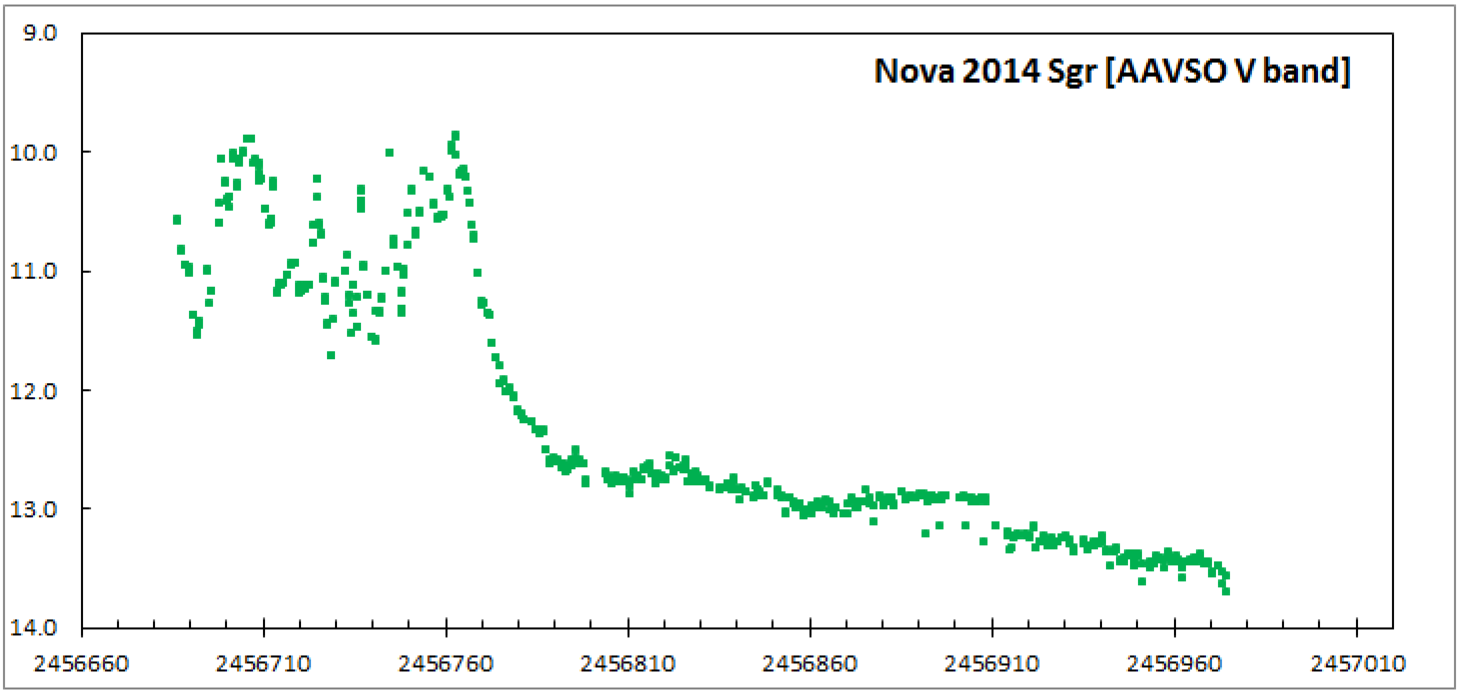


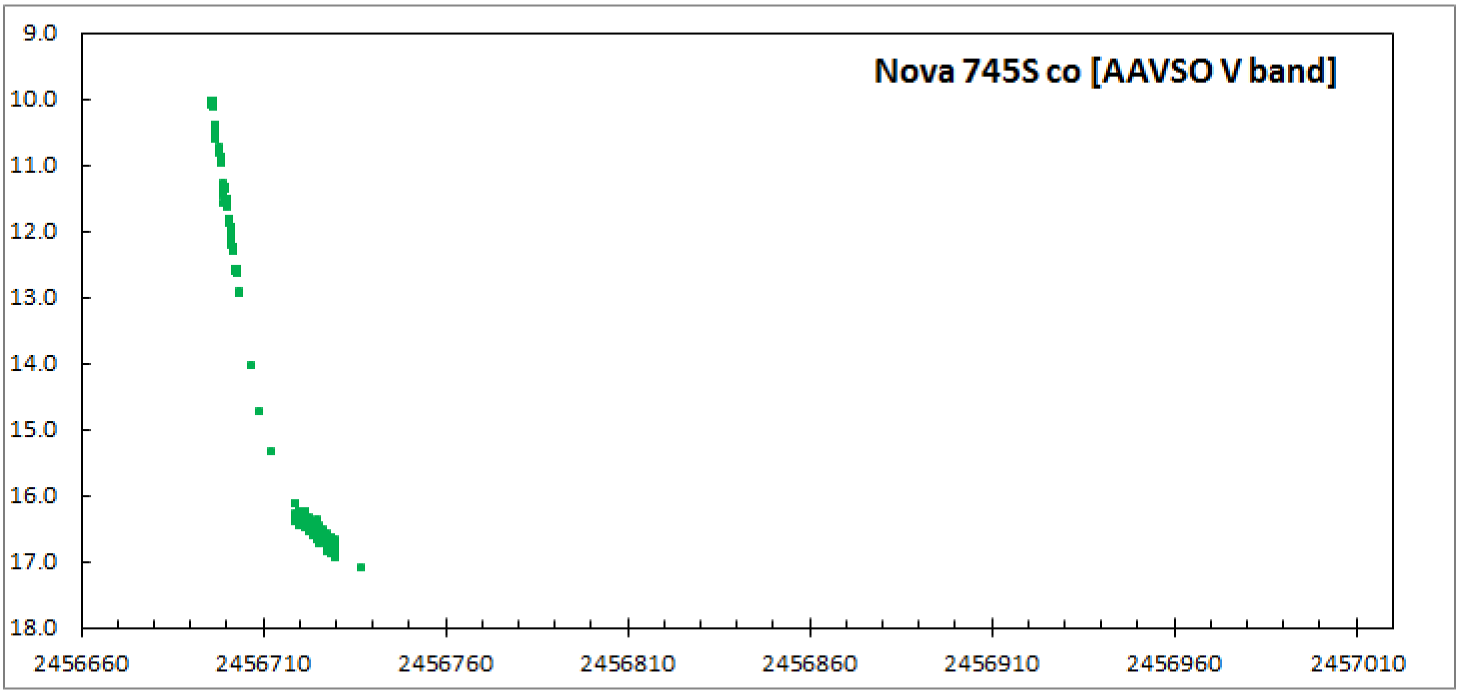
Observers (2014) : C. Buil - T. Lester - F. Teyssier - D. Boyd - A. Garcia O. Garde - T. Bohlsen - P. Berardi - M. Dubs - P. Dubreuil - J. Edlin - T. Bohlsen

ARAS DATA BASE 2014 | 34 spectra | http://www.astrosurf.com/aras/Aras_DataBase/Novae/Nova-Del-2013_2.htm
ARAS Web Page for Nova Del 2013 : http://www.astrosurf.com/aras/novae/Nova2013Del.html

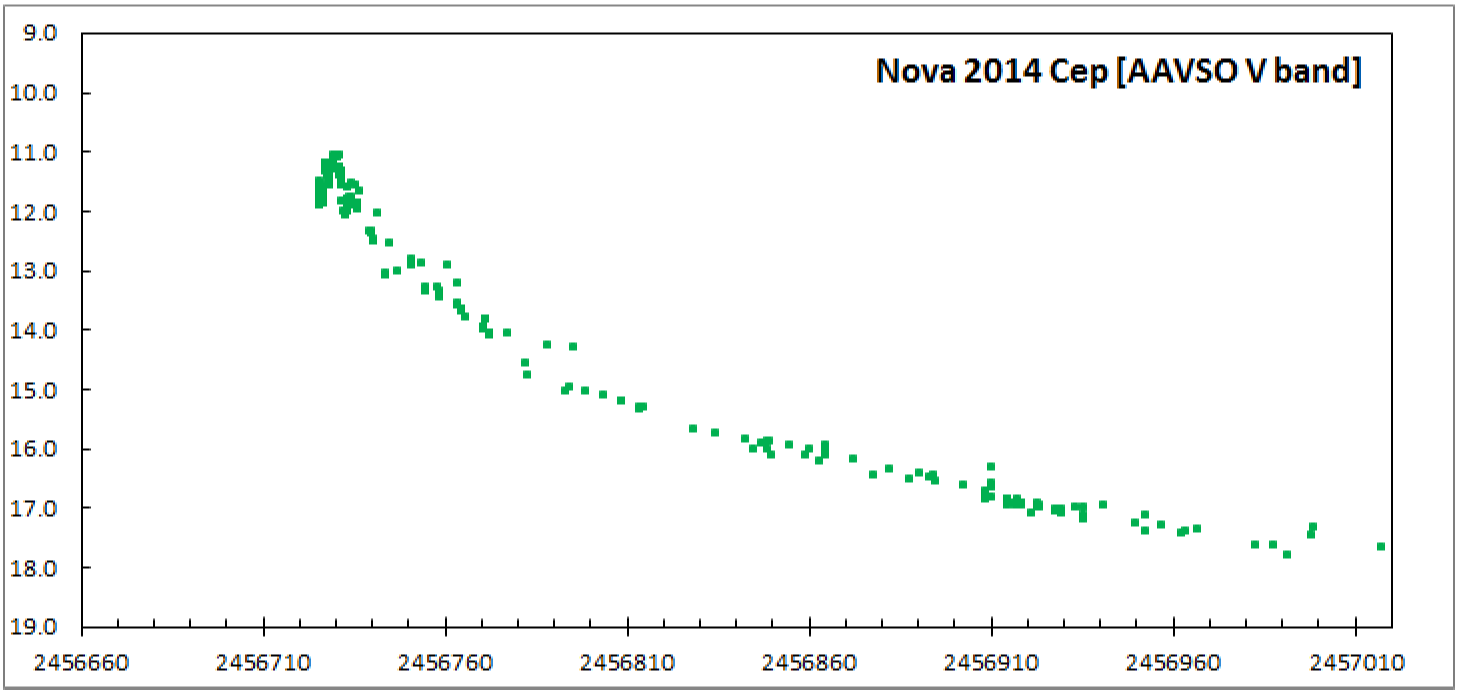
2014 Novae

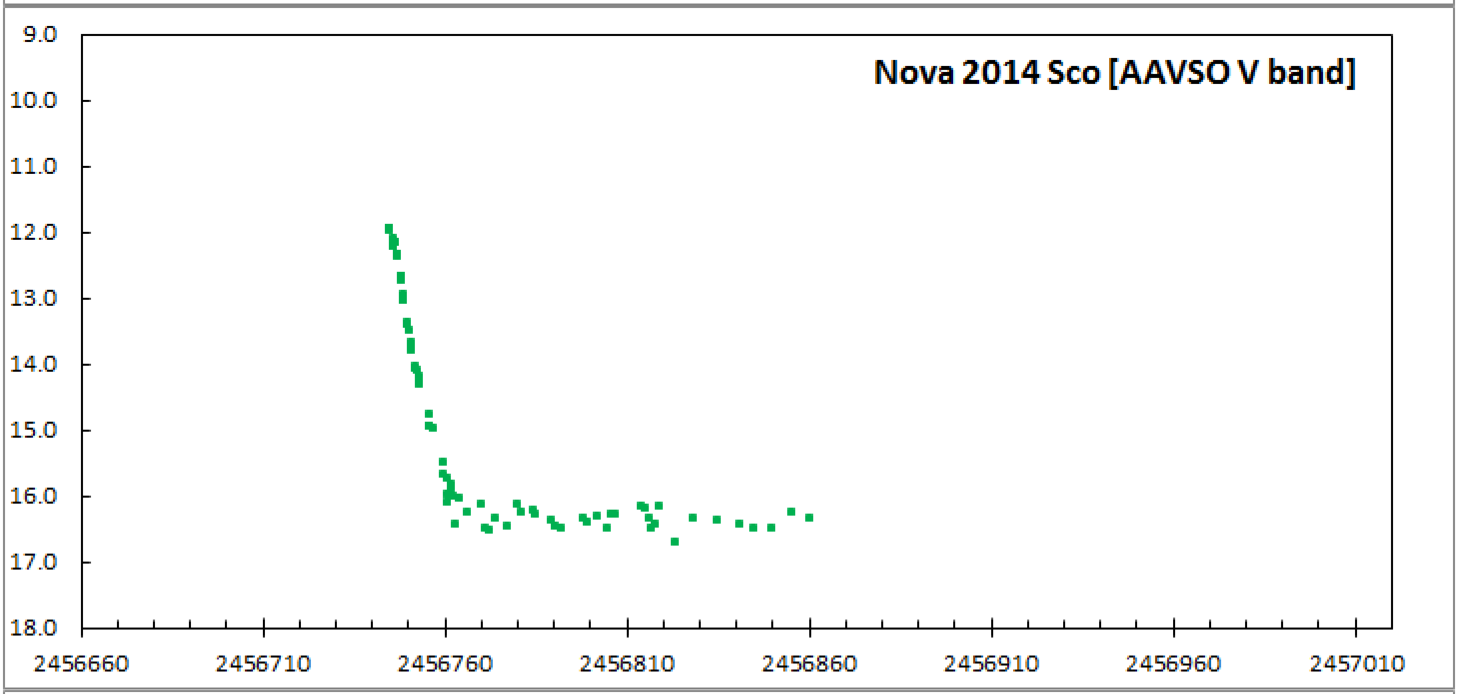
#	Nova	Name	GCVS	A.D.	Dec.	Discovery Date	Mag Max (V)	ARAS Spectra
1	Nova Sgr 2014	PNV J18250860-2236024	V5666 Sgr	18 25 08.60	-22 36 02.4	26/01/2014	9.9	2
2	V745 Sco	RN	V745 Sco	17 55 22.27	-33 14 58.5	06/02/2014	10	
3	Nova Cep 2014	TCP J20542386+6017077	V962 Cep	20 54 23.86	+60 17 07.7	08/03/2014	11.1	15
4	Nova Sco 2014	TCP J17154683-3128303		17 15 46.83	-31 28 30.3	26/03/2014	12.1	
5	Nova Cyg 2014	PNV J20214234+3103296	V2659 Cyg	20 21 42.34	+31 03 29.6	31/03/2014	9.4	210

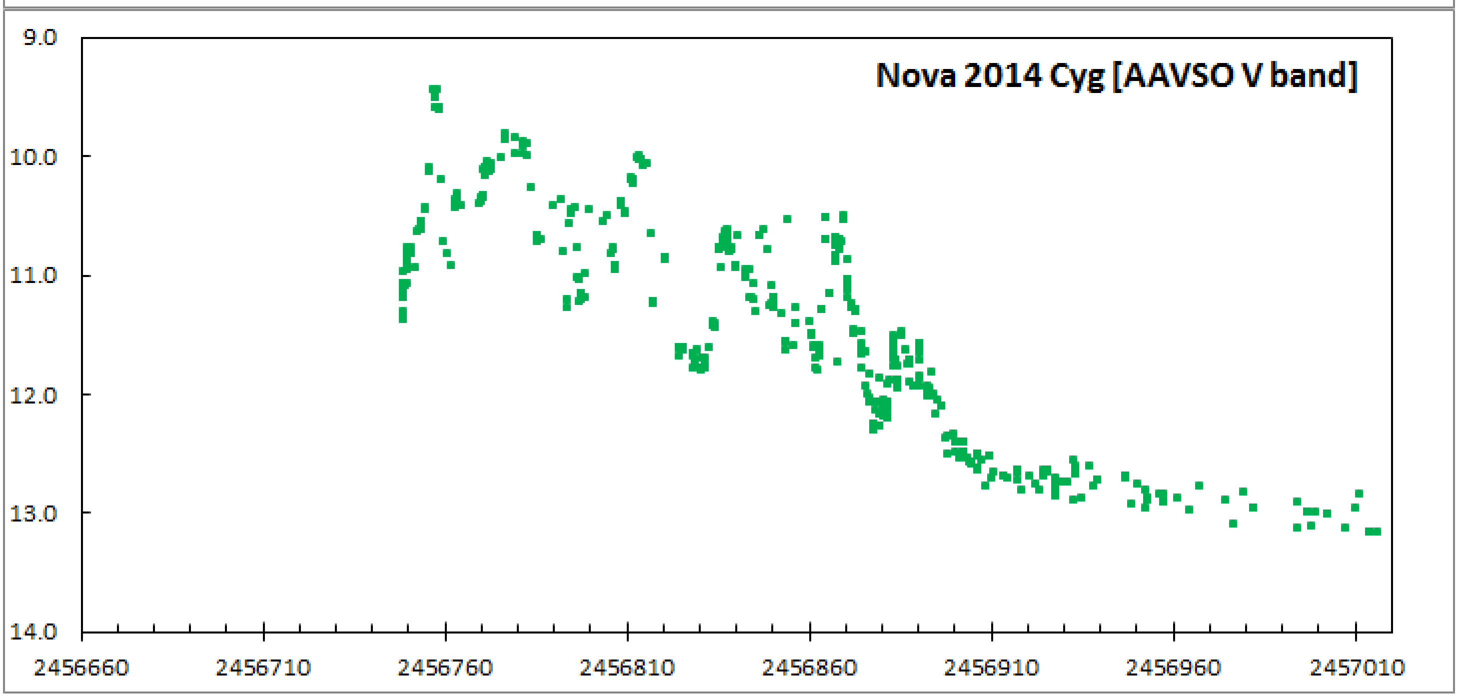




ARAS DATA BASE 2014 | 34 spectra | http://www.astrosurf.com/aras/Aras_DataBase/Novae/Nova-Del-2013_2.htm
ARAS Web Page for Nova Del 2013 : http://www.astrosurf.com/aras/novae/Nova2013Del.html


Nova 2014 Cep [AAVSO V band]
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
2456660
2456710
2456760
2456810
2456860
2456910
2456960
2457010


Nova 2014 Sco [AAVSO V band]
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
2456660
2456710
2456760
2456810
2456860
2456910
2456960
2457010


Nova 2014 Cyg [AAVSO V band]
9.0
10.0
11.0
12.0
13.0
14.0
2456660
2456710
2456760
2456810
2456860
2456910
2456960
2457010

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

Observations from 01-12 to 31-12

New spectra	
AG Dra	1
AG Peg	7
AX Per	9
BD Cam	3
BF Cyg	1
BX Mon	2
CH Cyg	5
CI Cyg	5
EG And	1
NQ Gem	1
o Cet	2
R Aqr	4
UV Aur	3
V694 Mon	4
Z And	5

Observing

CH Cygni campaign
See Information Letter #11

AX Per returning to quiescent state

Detect high state of V694 Mon in the morning sky

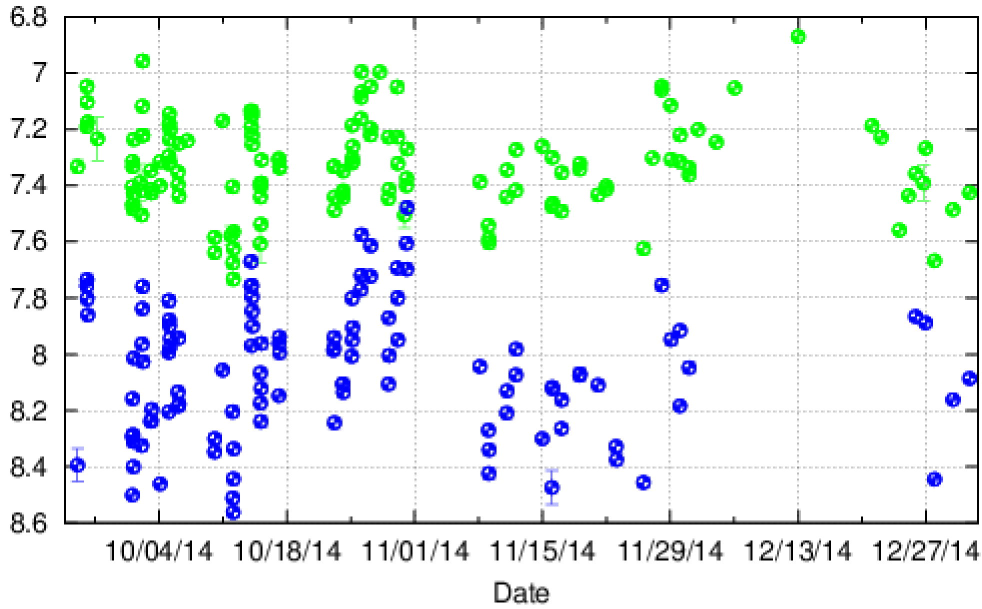
Follow R Aqr during a pulse period of the Mira

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

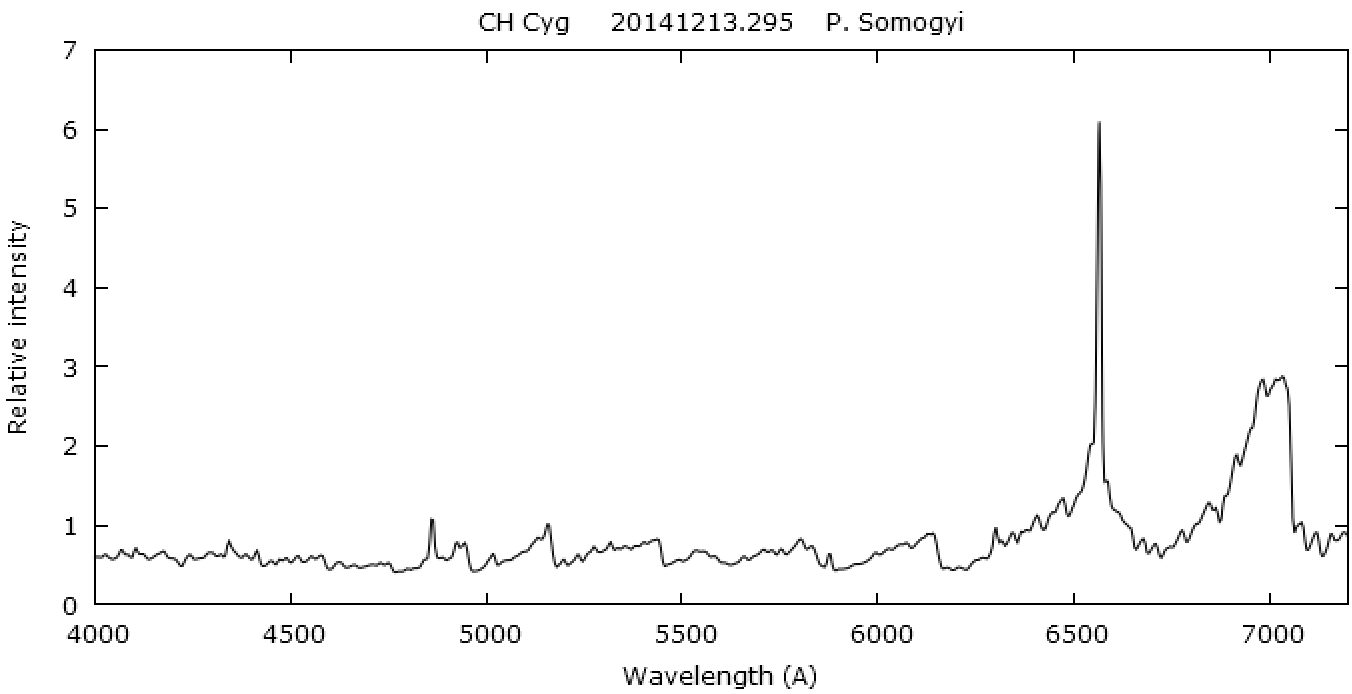
CH Cygni campaign

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

See details for the campaign page

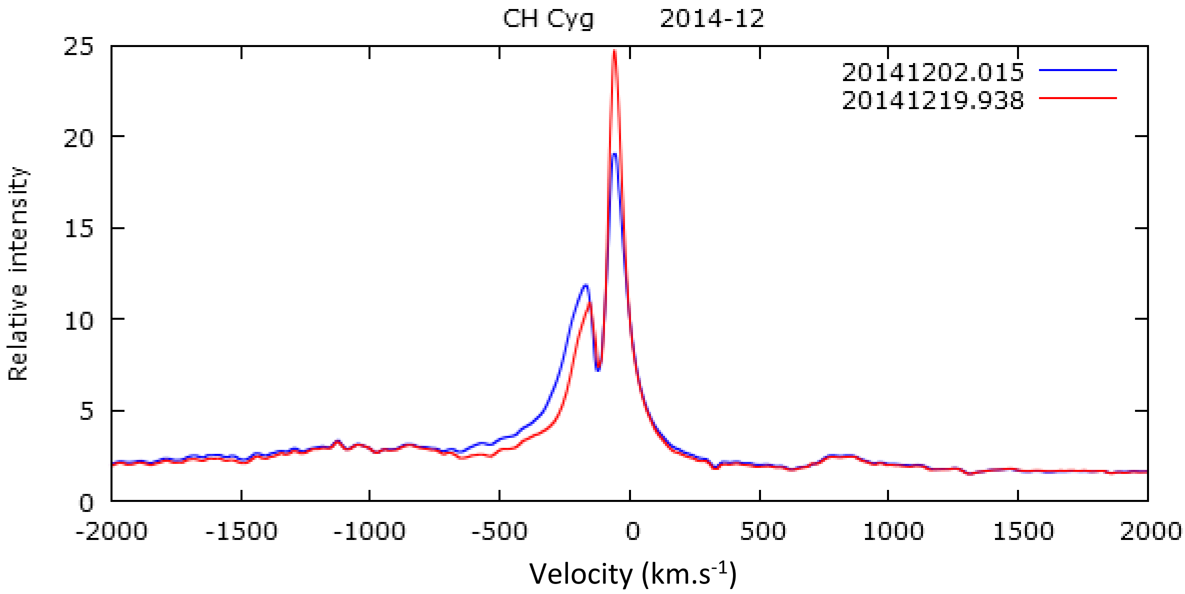


B and V light curves in AAVSO database



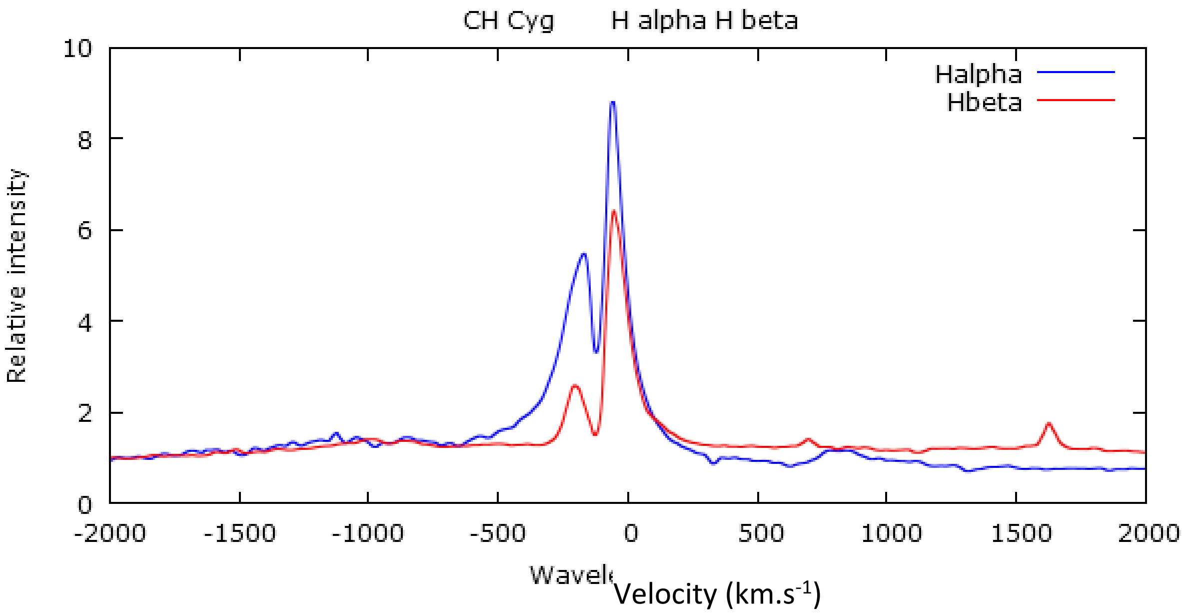
CH Cyg at low resolution - P. Somogyi - Alpy600 - R = 100 - 13-12-2014

Tim Lester's spectra at R ~ 9000

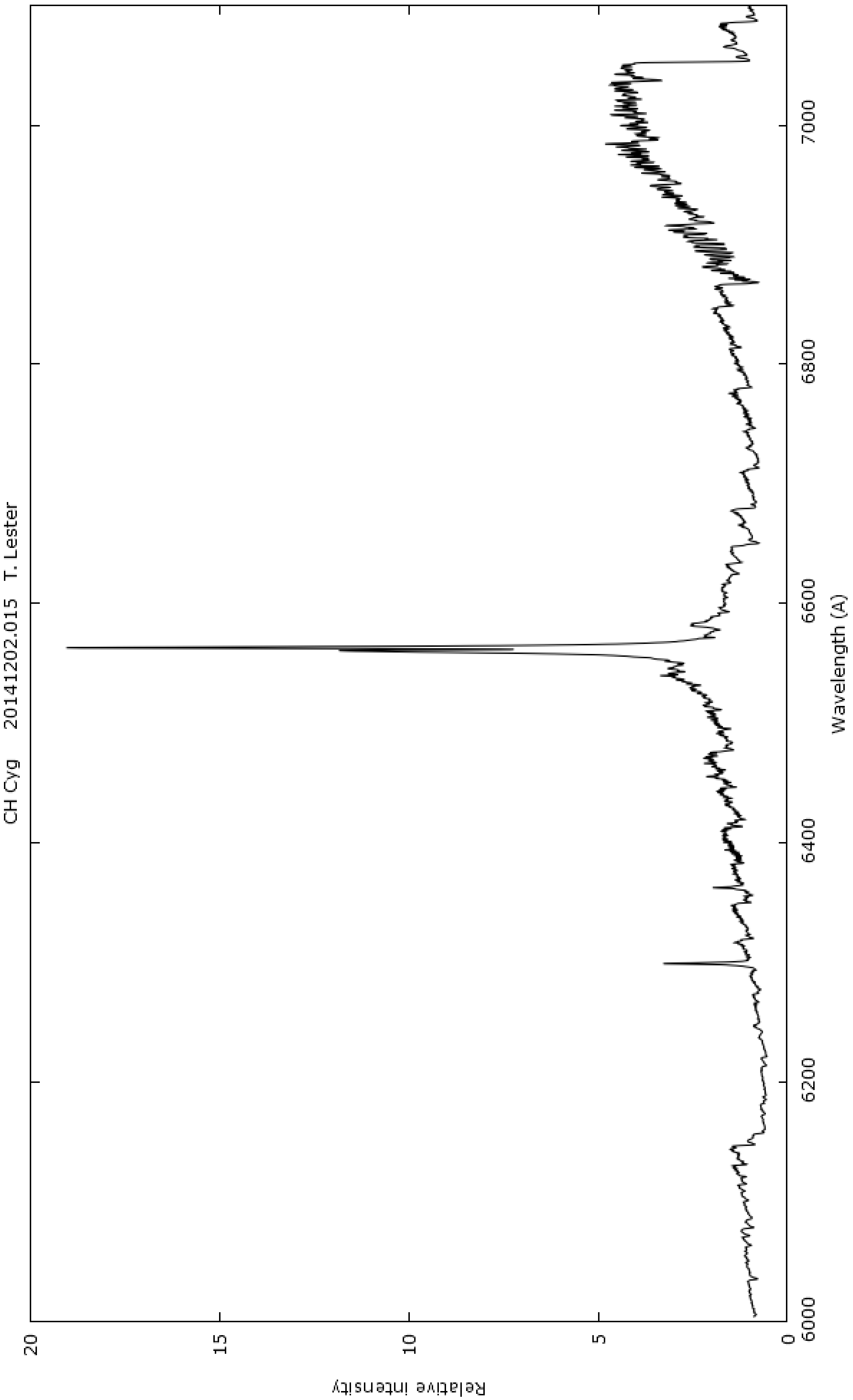


Hα profile on 2d and 19th of december, 2014

The spectra are corrected for radial velocity of the star (-59.9 km.s^{-1}) according to Hinckle & al. (2009) and heliocentric velocity (resp. -9.2 and -7.4 km.s^{-1})

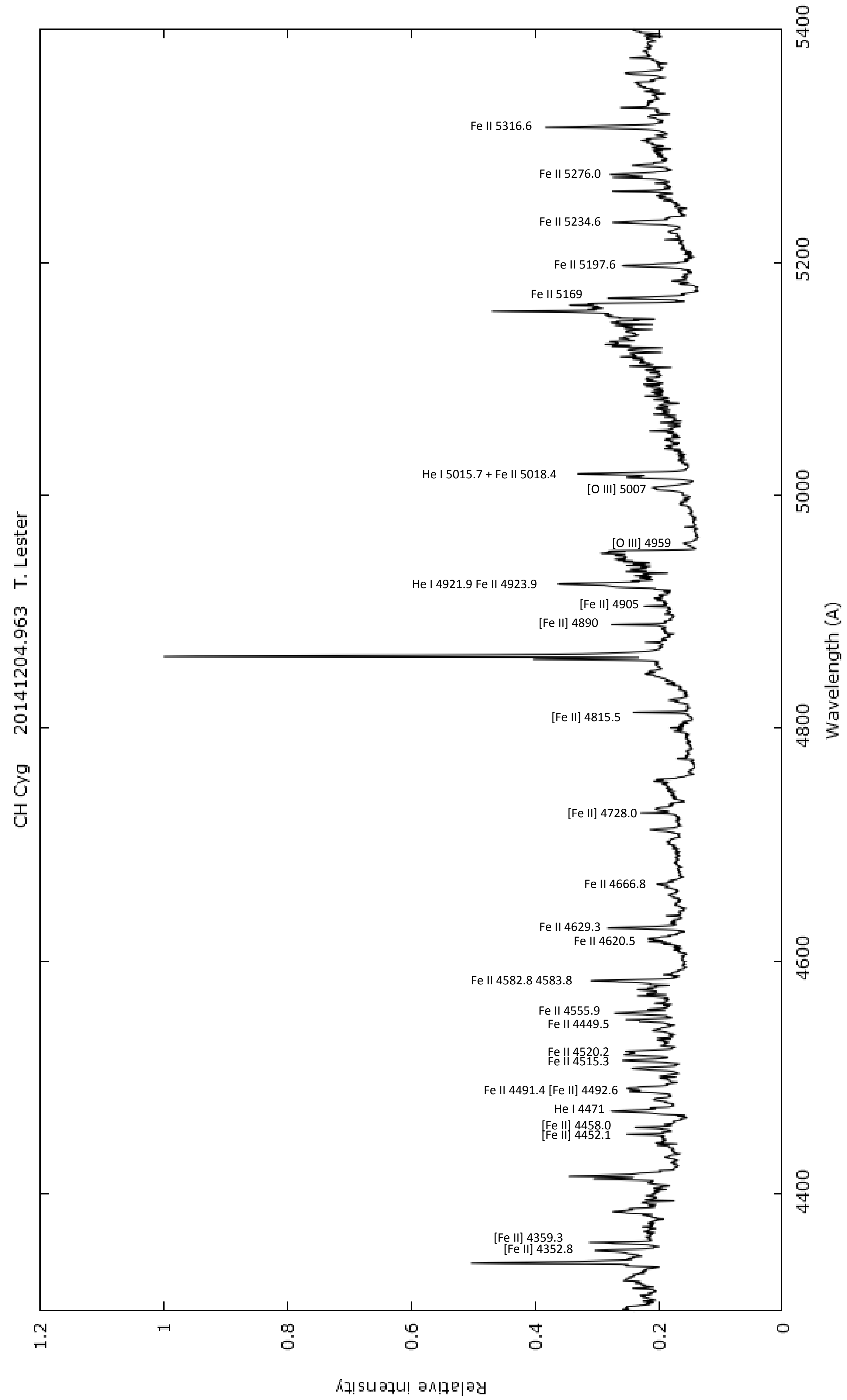


Comparison of Hα and Hβ profiles (resp. 4th and 2d of december, 2014)



H alpha - Tim Lester -02-12-2014 - R ~ 9000

[O I] λλ 6300, 6363 and weak [N II]



H béta - Tim Lester -04-12-2014 - R ~ 9000

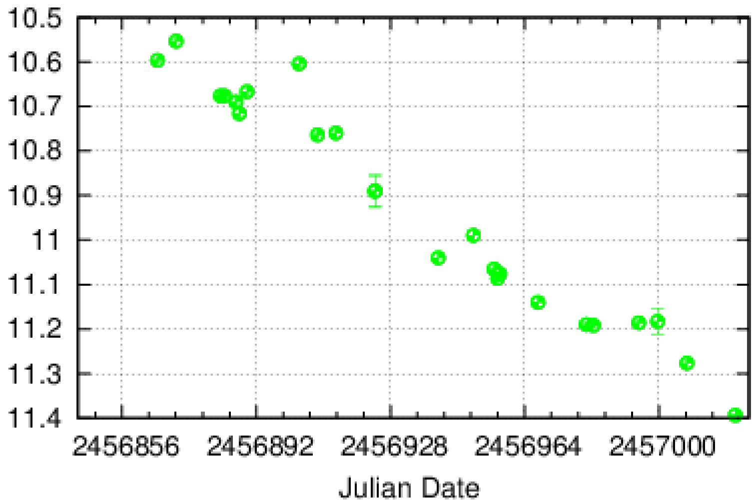
Numerous Fe II and [Fe II] lines - Identification following Kaler & al. (983) and Hack (1988)

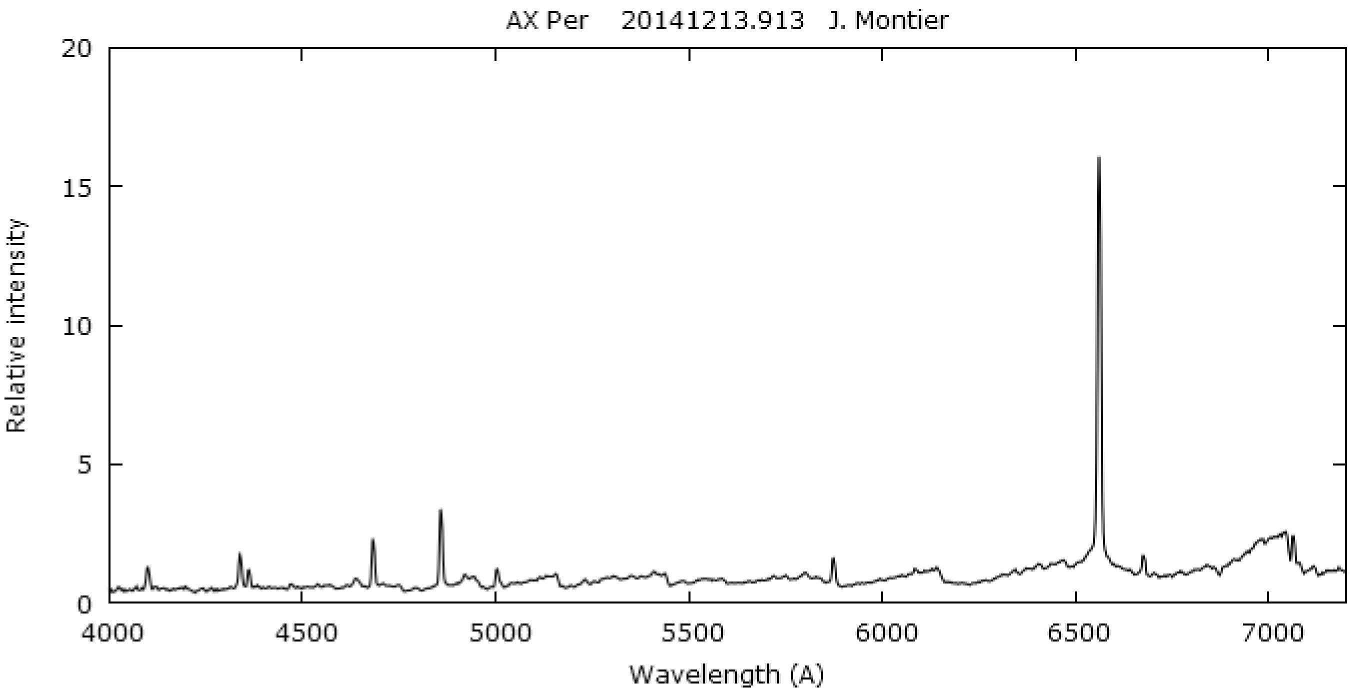
AX Per Outburst

The prototype Symbiotic **AX Per** has been detected in outburst in august 2014 by ANS collaboration See ATel #6382
The current mag is about 10.9 (declining)
Spectra of this event are welcome for ARAS data base Data Base AX Per
Aras topic for exchanges Forum

Coordinates (2000.0)	
R.A.	**01 h 36 m 22.7 s**
Dec.	**+54° 15' 2.5"**

Mag ~ 11.4 31-12-2014





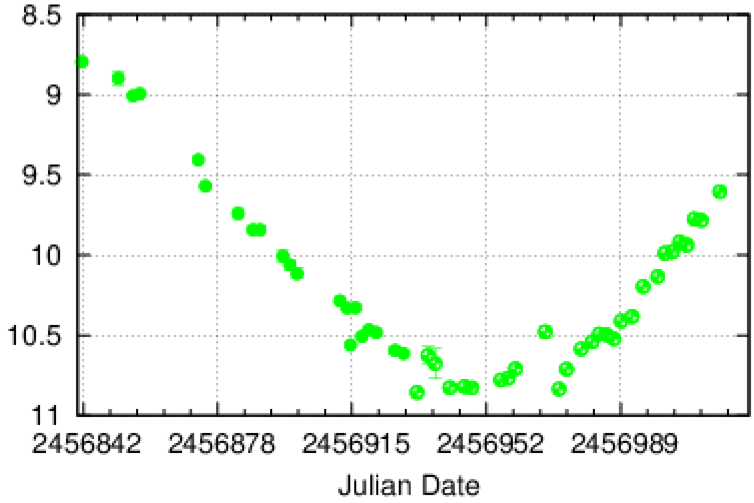
R Aqr

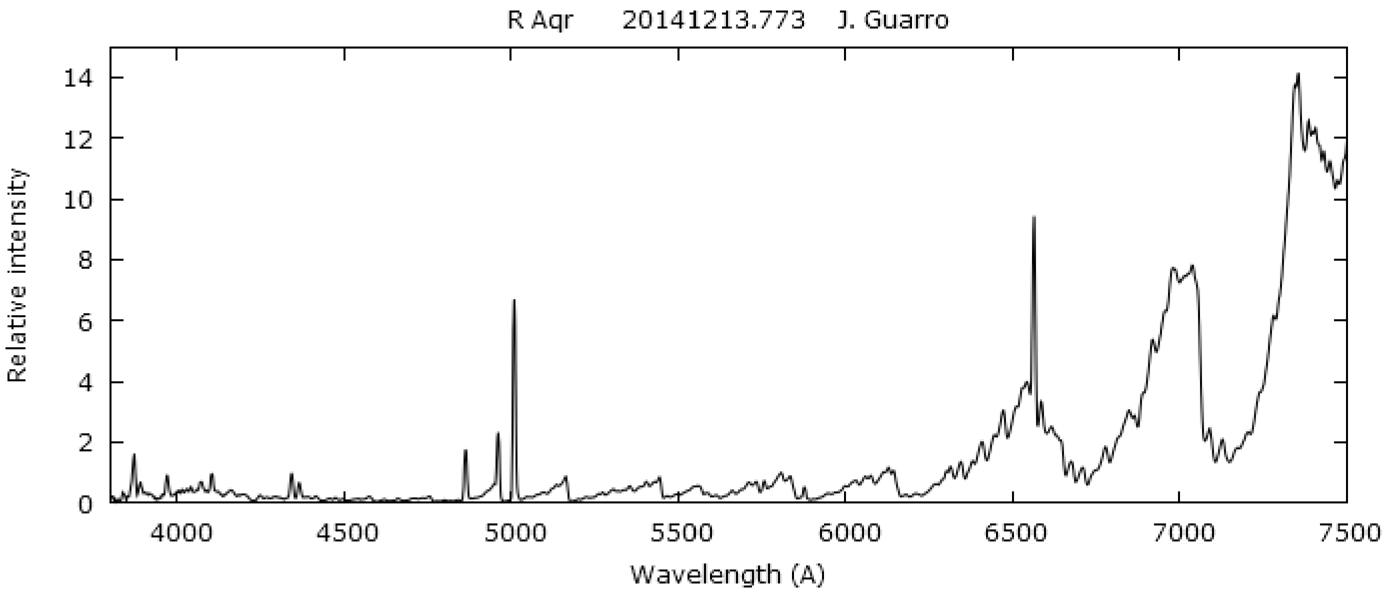
Coordinates (2000.0)	
R.A.	07 h 25 m 51.2 s
Dec.	-07° 44' 08"

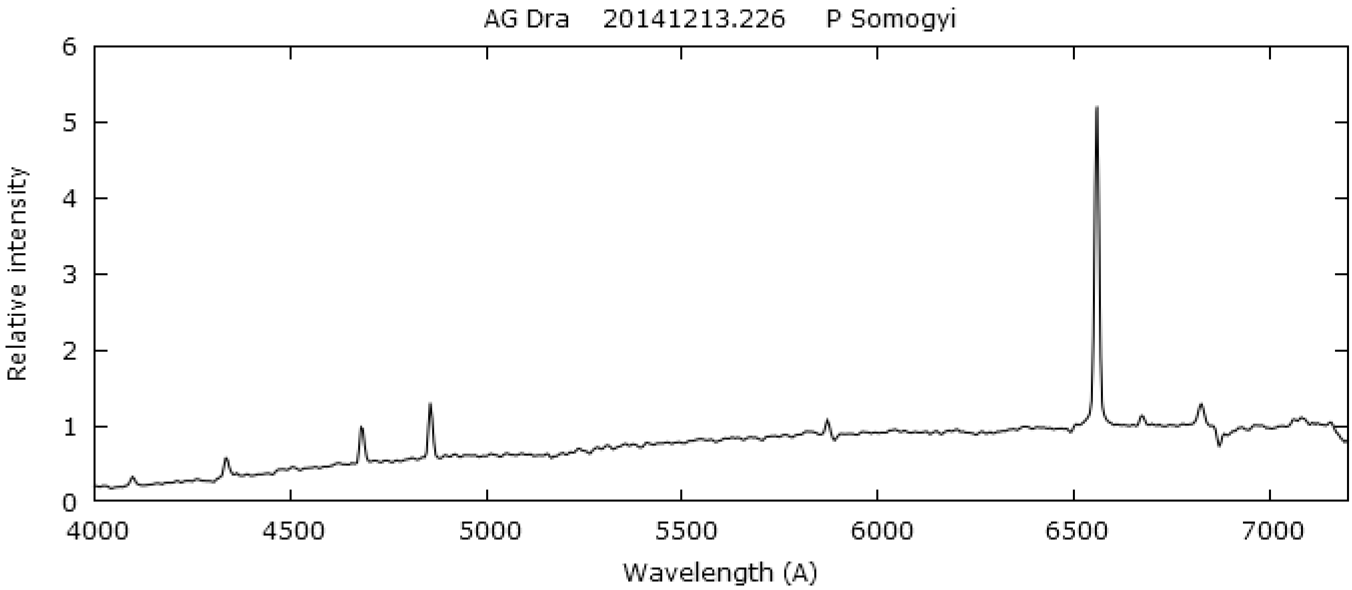
Mag V = 7 to 11
Period (Mira) = 387 d

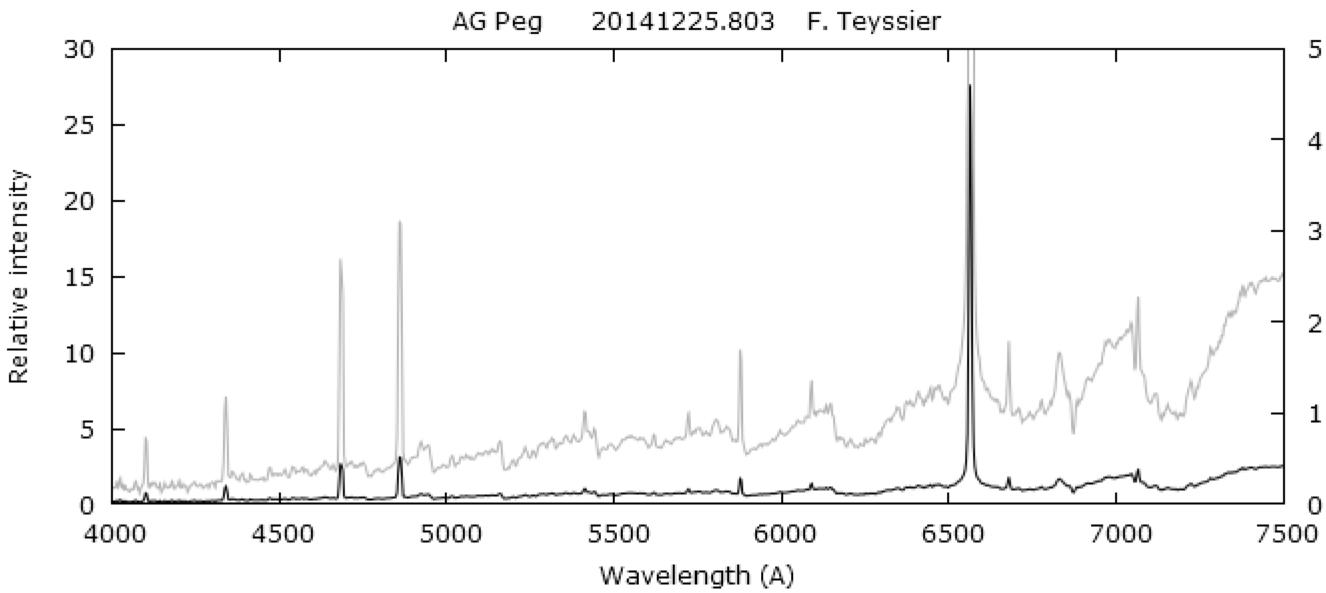
Current V mag = 9.5

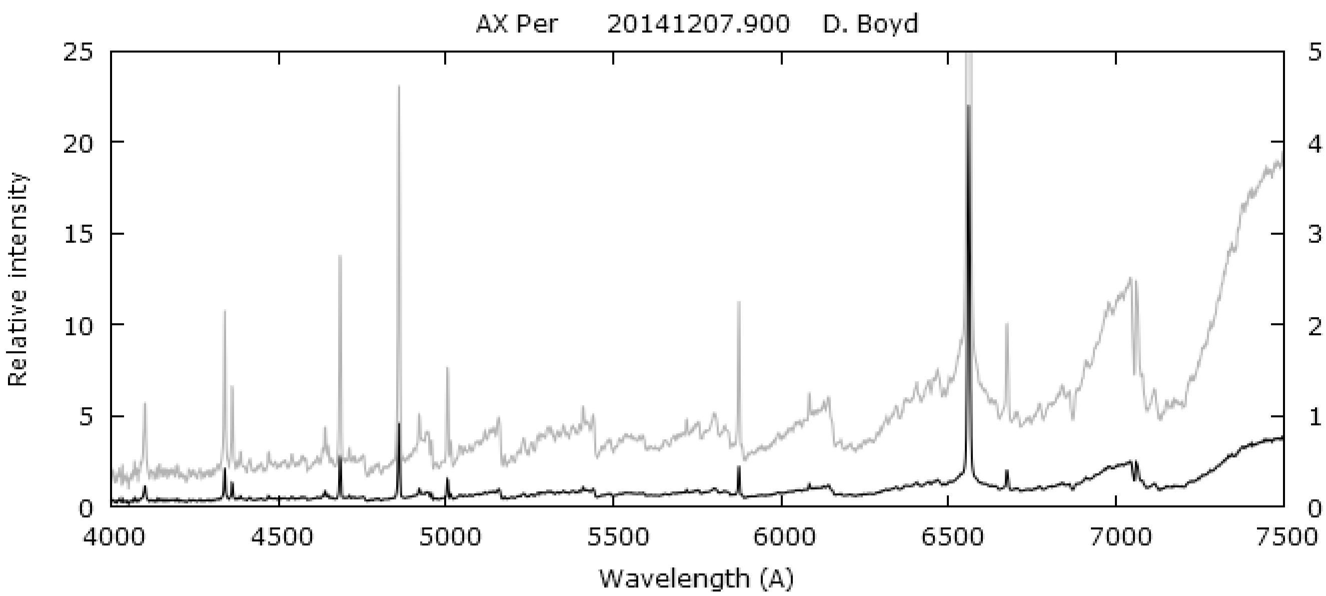
Observing : along a Mira pulsation



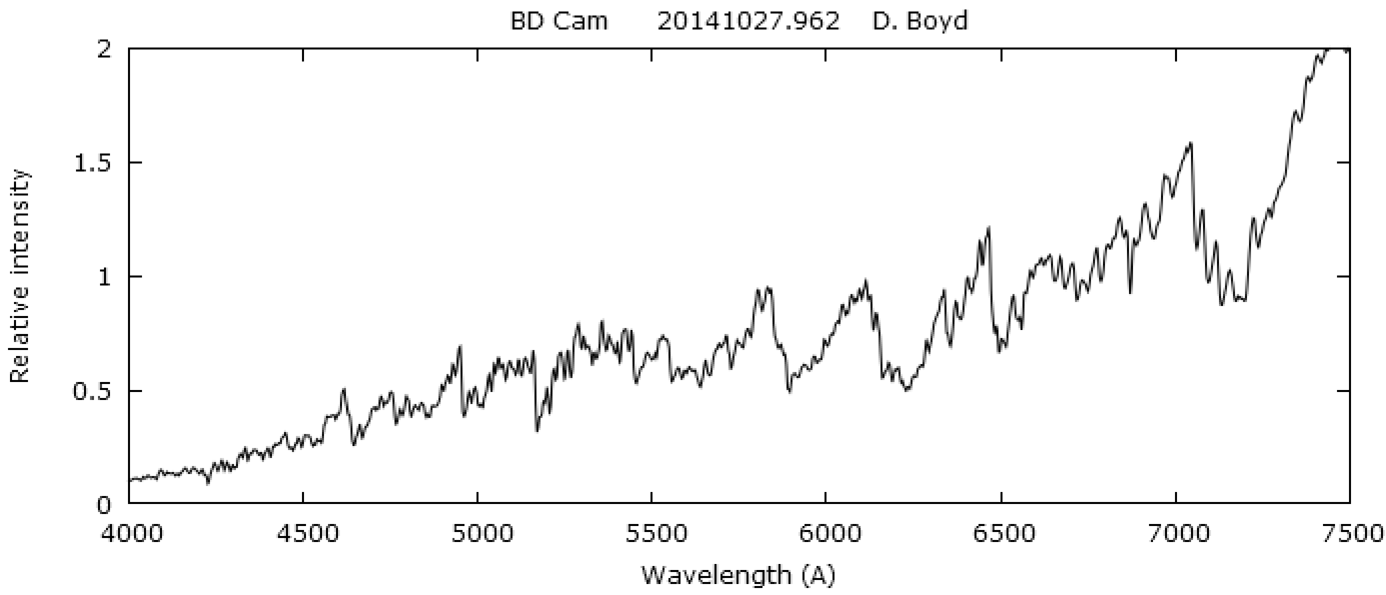


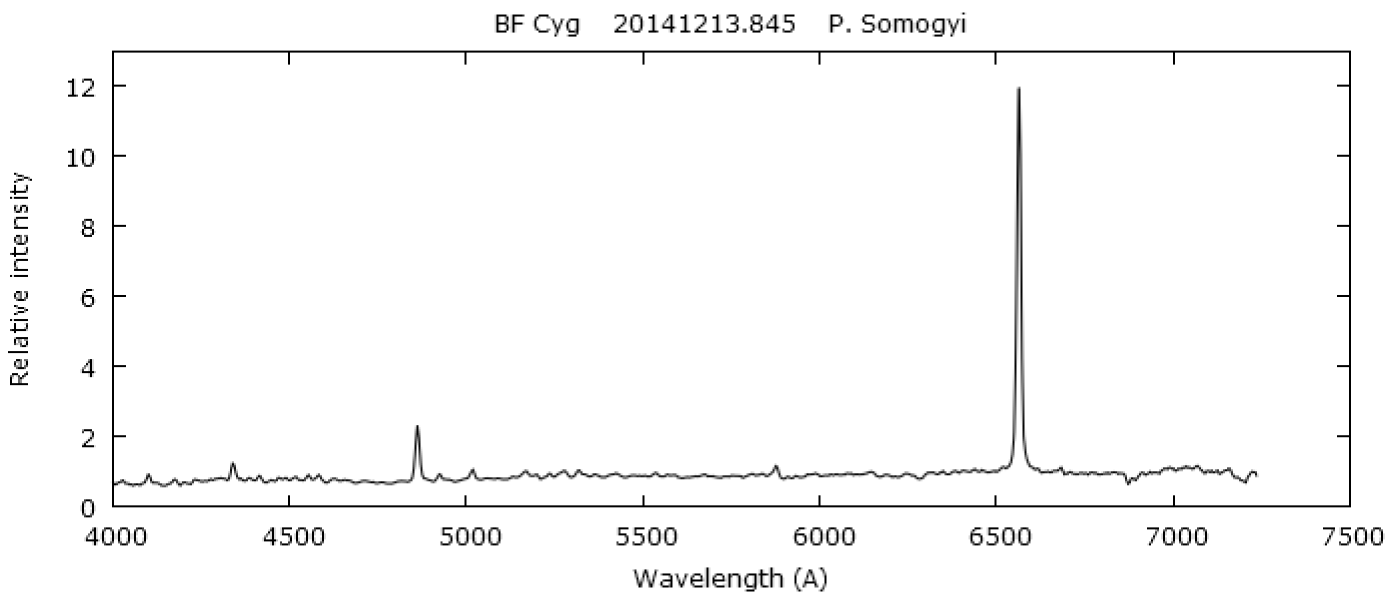


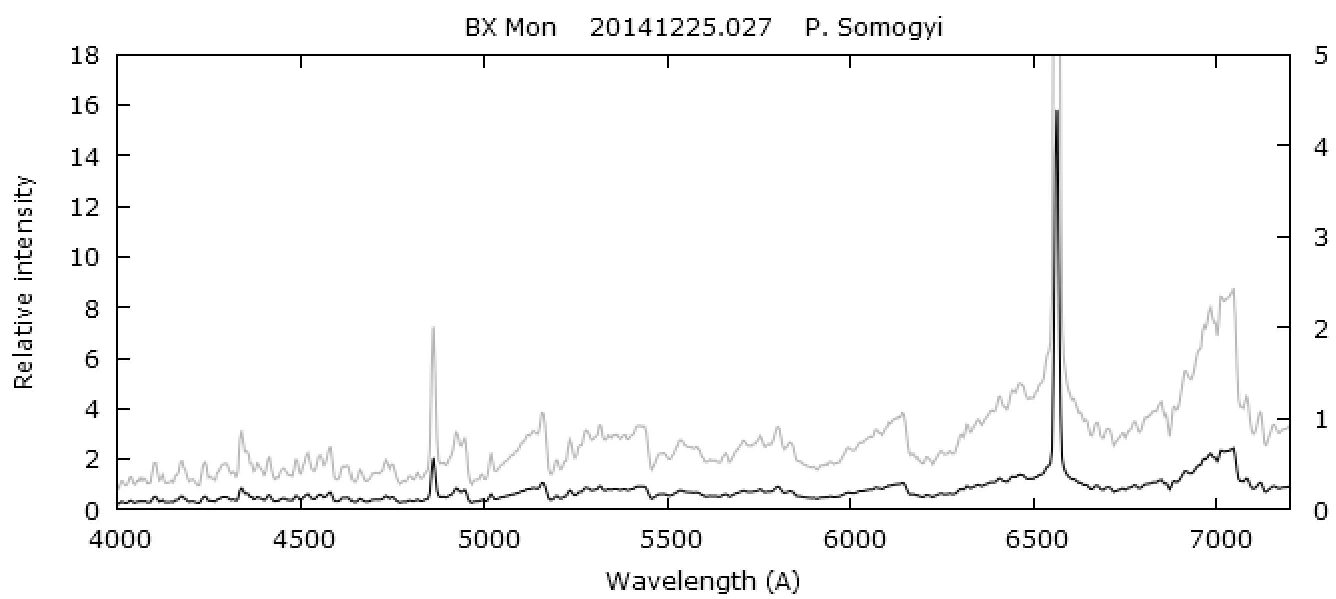


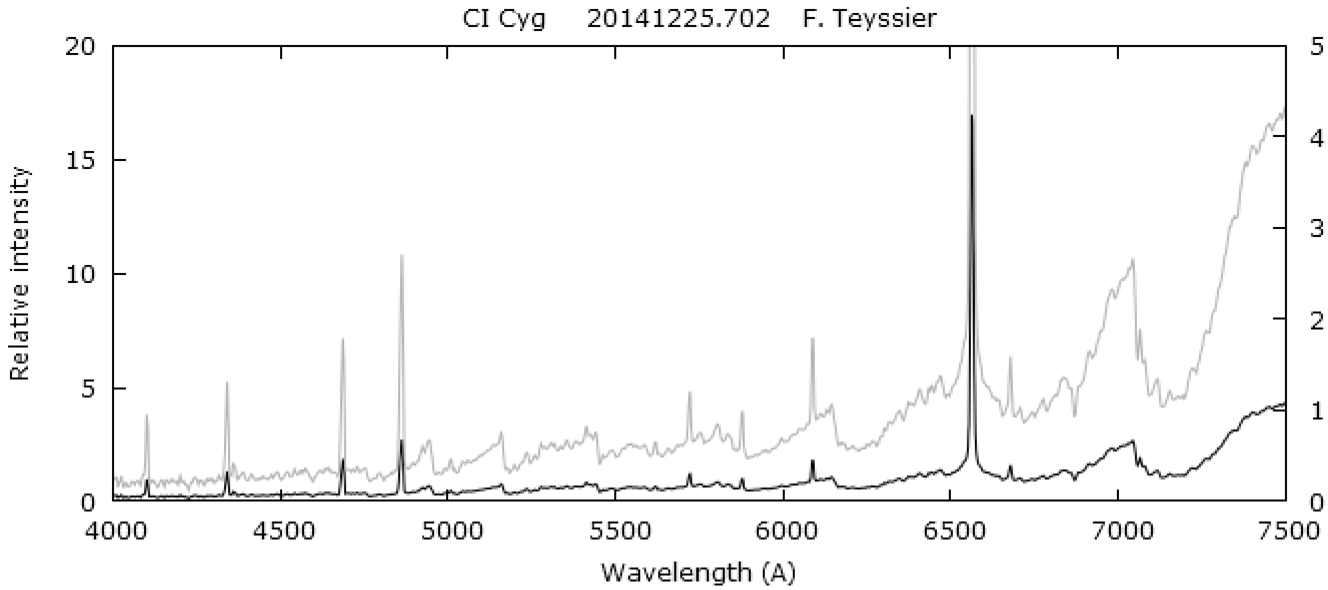


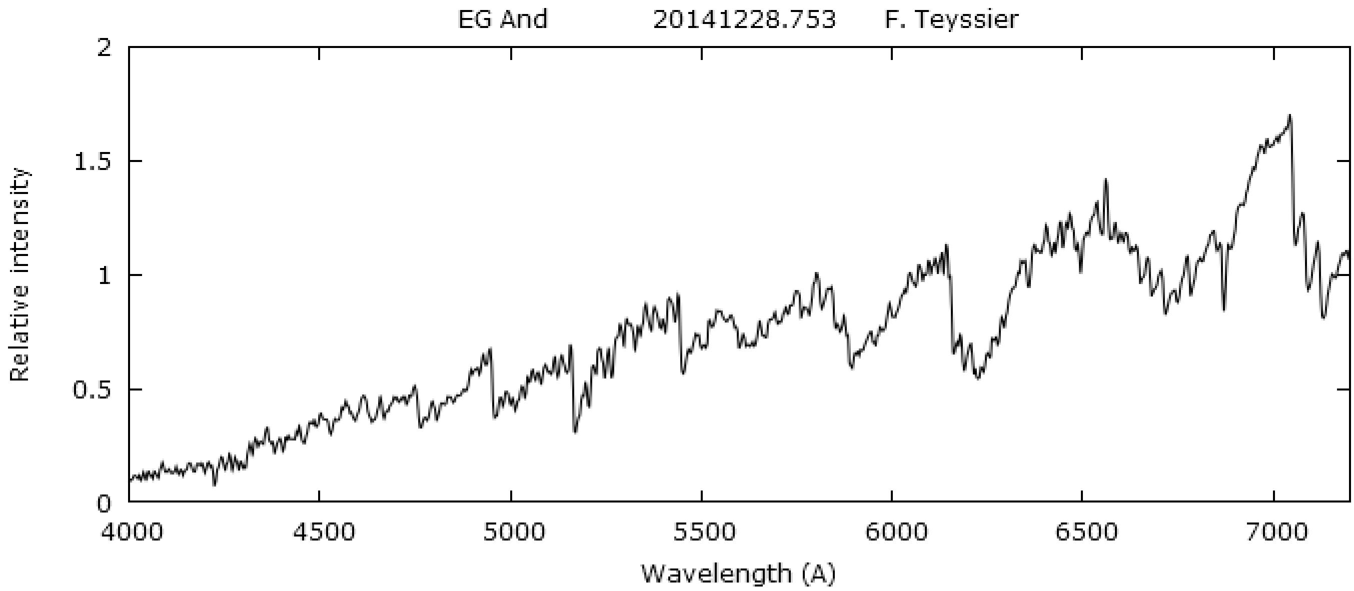
ARAS DATA BASE | http://www.astrosurf.com/aras/Aras_DataBase/Symbiotics.htm

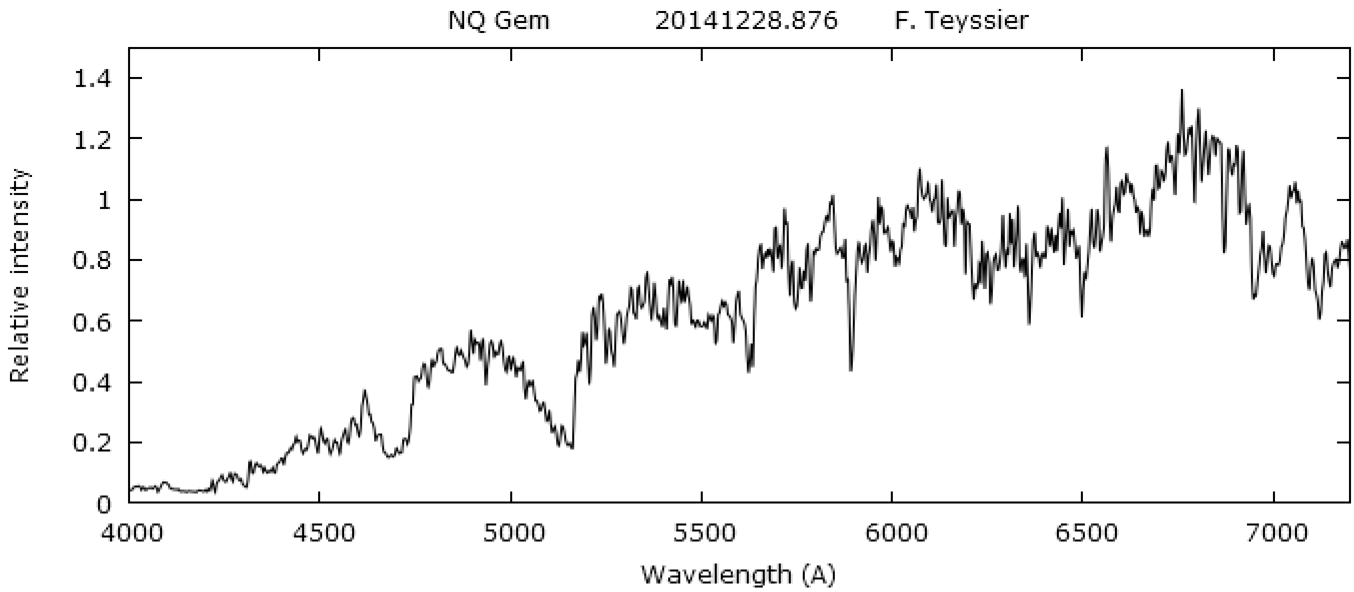

BD Cam 20141027.962 D. Boyd
Relative intensity
Wavelength (A)
0
0.5
1
1.5
2
4000
4500
5000
5500
6000
6500
7000
7500

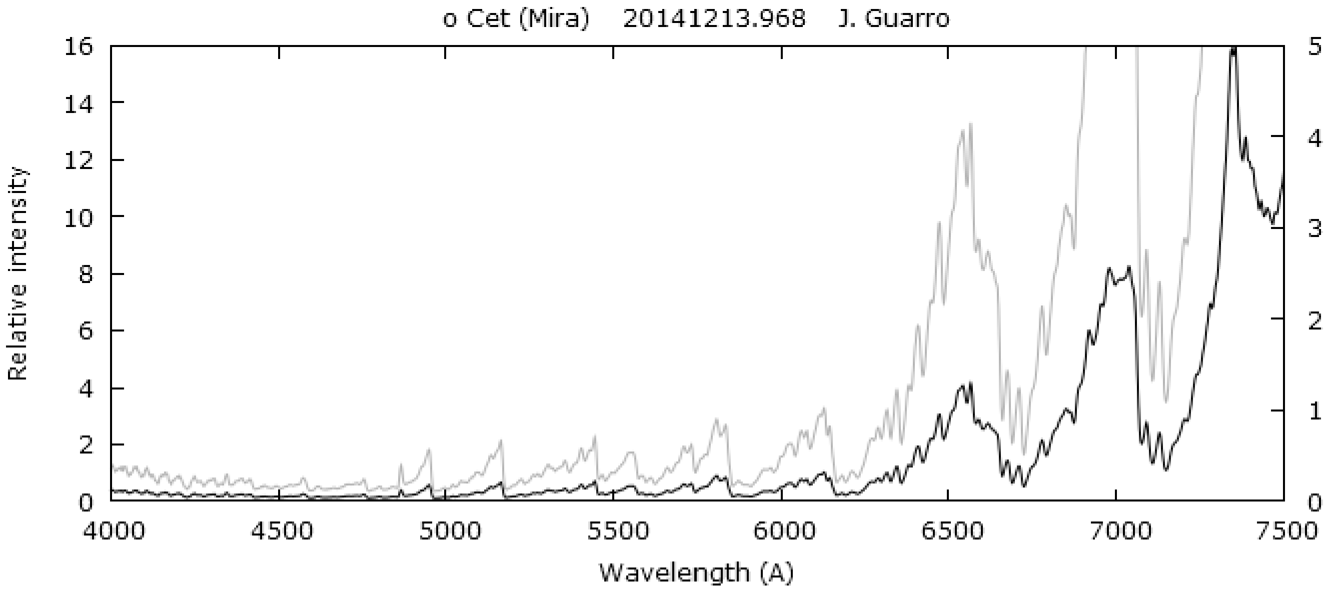

BF Cyg 20141213.845 P. Somogyi
Relative intensity
Wavelength (A)
0
2
4
6
8
10
12
4000
4500
5000
5500
6000
6500
7000
7500

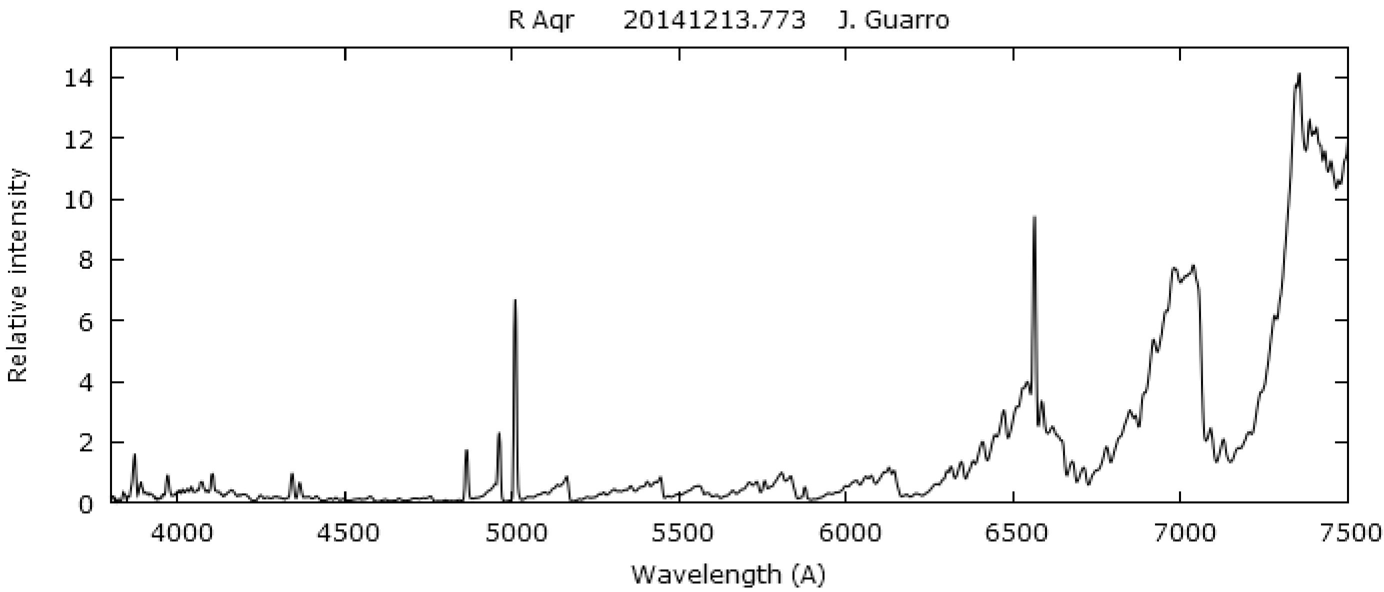

BX Mon 20141225.027 P. Somogyi
Relative intensity
Wavelength (A)
0
2
4
6
8
10
12
14
16
18
0
1
2
3
4
5
4000
4500
5000
5500
6000
6500
7000

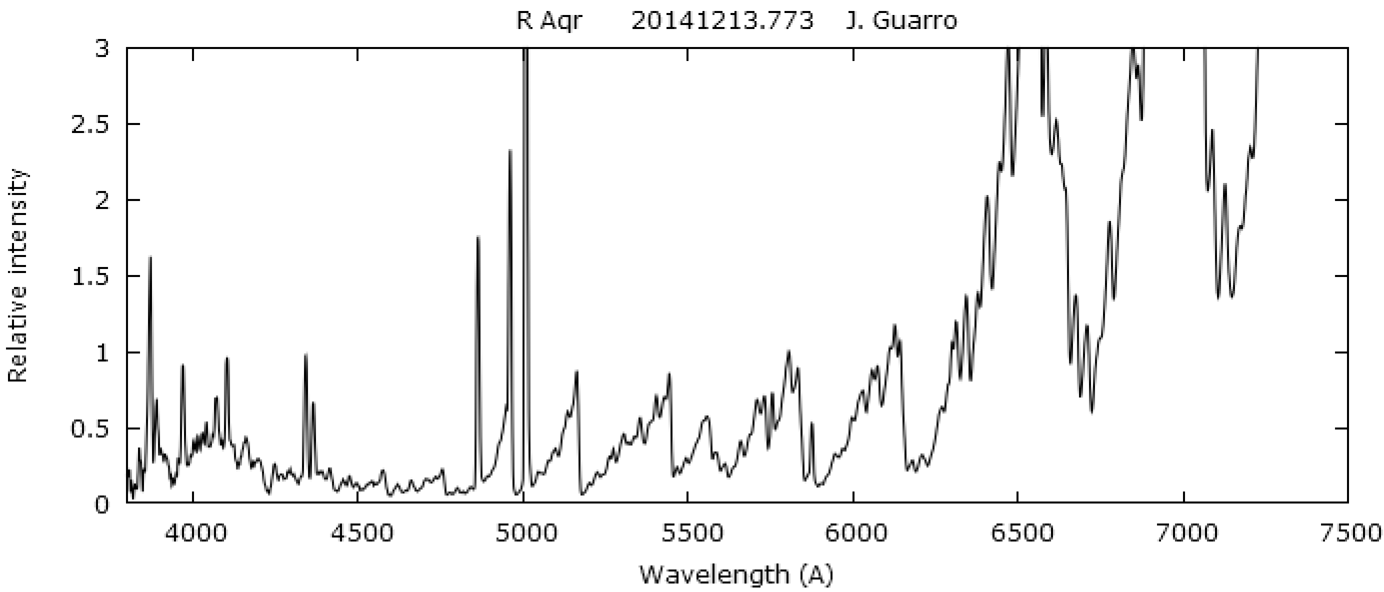

CI Cyg 20141225.702 F. Teyssier
Relative intensity
Wavelength (A)
0
5
10
15
20
4000
4500
5000
5500
6000
6500
7000
7500
0
1
2
3
4
5

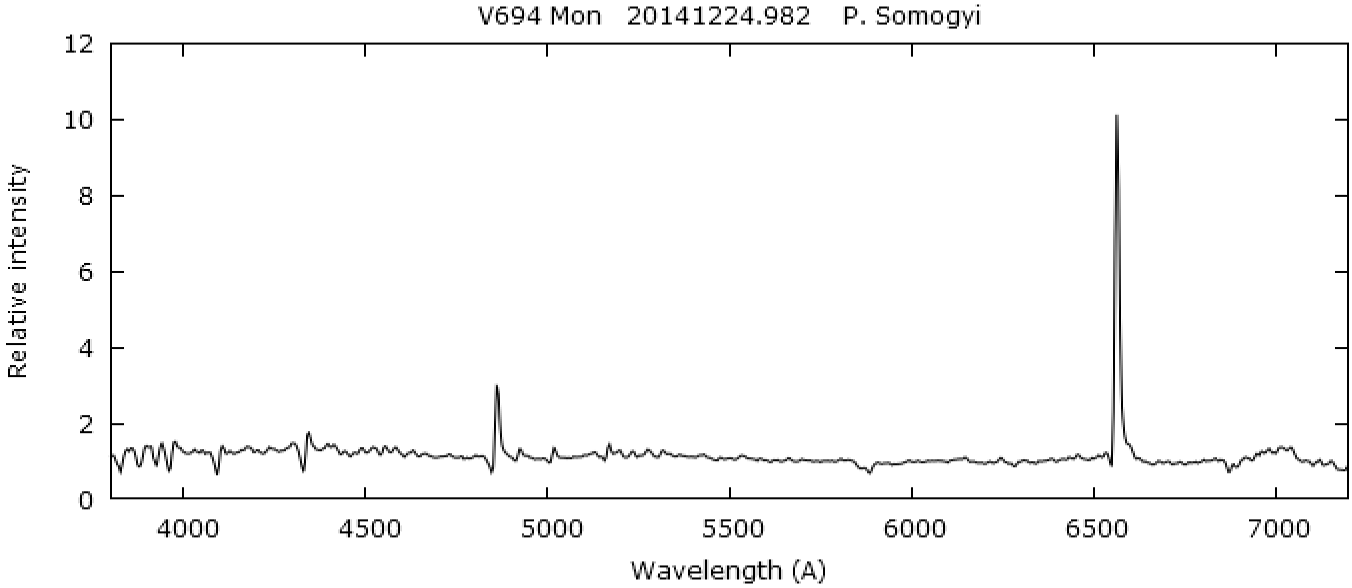

EG And 20141228.753 F. Teyssier
Relative intensity
Wavelength (A)
0
0.5
1
1.5
2
4000
4500
5000
5500
6000
6500
7000


NQ Gem 20141228.876 F. Teyssier
Relative intensity
Wavelength (A)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
4000
4500
5000
5500
6000
6500
7000


o Cet (Mira) 20141213.968 J. Guarro
Relative intensity
Wavelength (A)
0
2
4
6
8
10
12
14
16
0
1
2
3
4
5
4000
4500
5000
5500
6000
6500
7000
7500


R Aqr 20141213.773 J. Guarro
Relative intensity
Wavelength (A)
0
2
4
6
8
10
12
14
4000
4500
5000
5500
6000
6500
7000
7500


R Aqr 20141213.773 J. Guarro
Relative intensity
Wavelength (A)
0
0.5
1
1.5
2
2.5
3
4000
4500
5000
5500
6000
6500
7000
7500


V694 Mon 20141224.982 P. Somogyi
Relative intensity
Wavelength (A)
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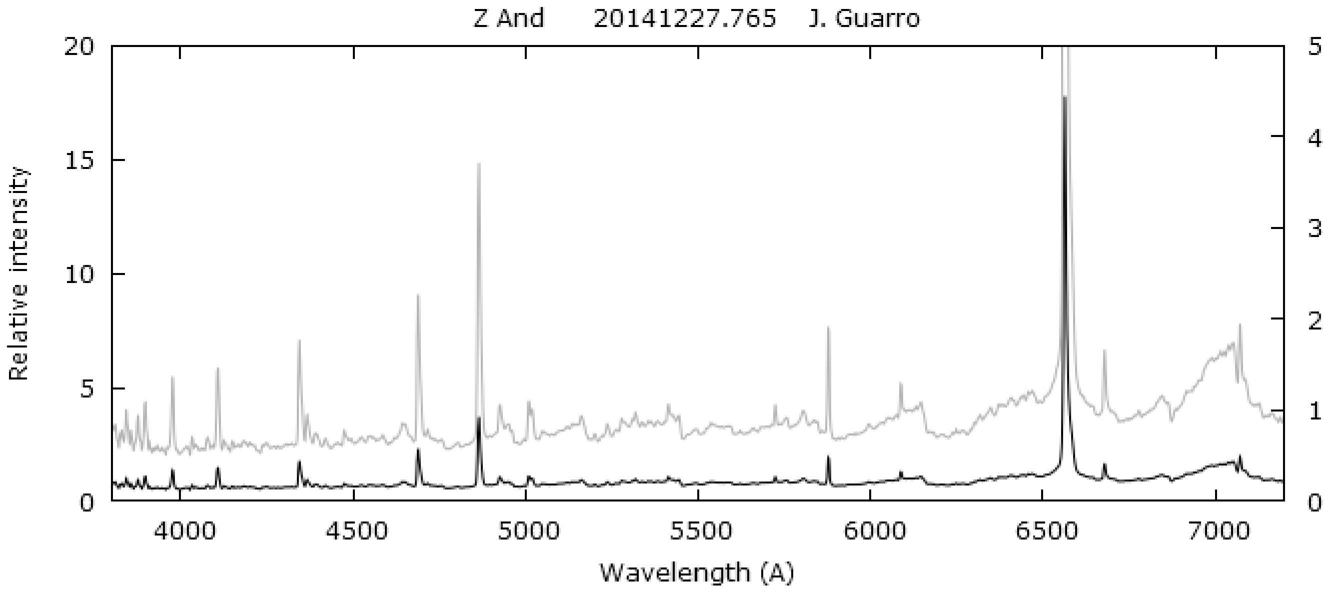
Z And 20141227.765 J. Guarro
Relative intensity
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5500
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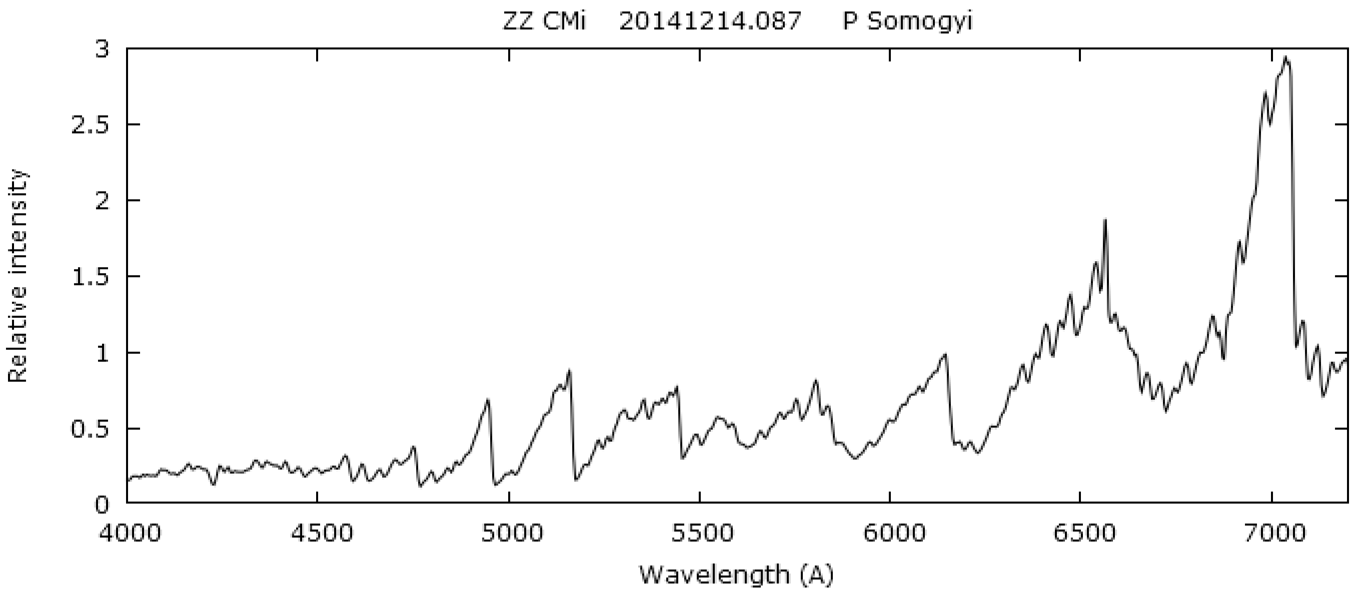
ZZ CMi 20141214.087 P Somogyi
Relative intensity
Wavelength (A)
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1.5
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2.5
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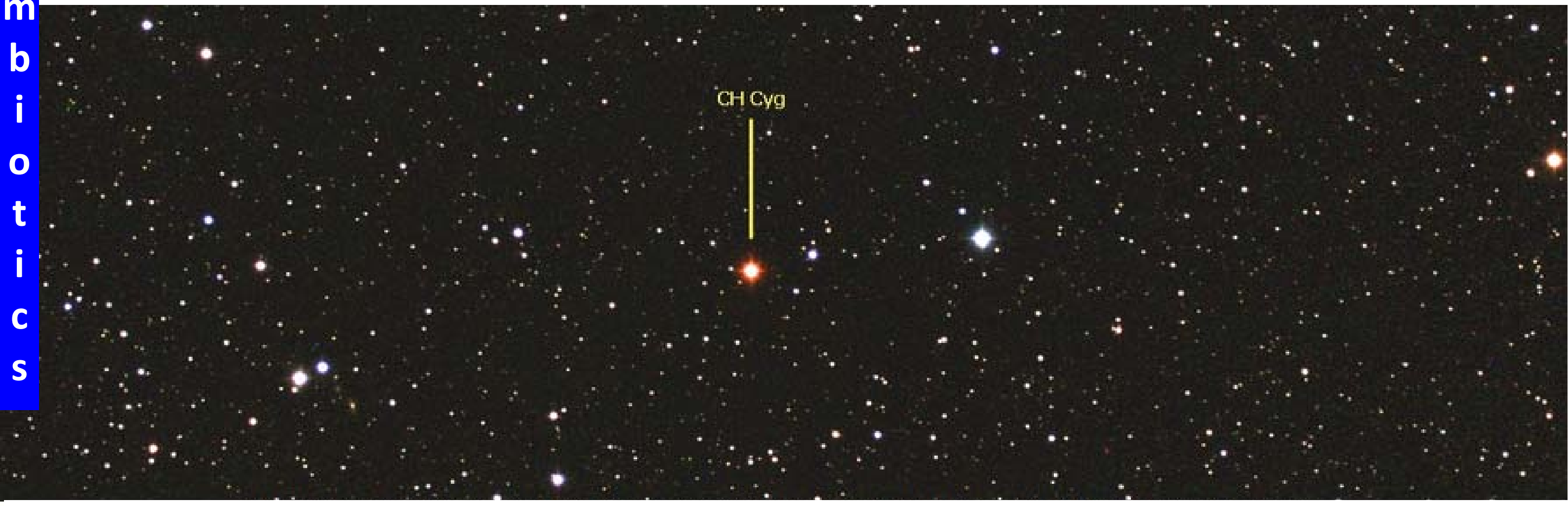
4000
4500
5000
5500
6000
6500
7000

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)

Low resolution spectra (minimum R = 600)

Send spectra

To francoismathieu.teyssier at bbox.fr

File name : _chcygni_aaaammdd_hhh.fit
And _chcygni_aaaammdd_hhh.zip for eShel

ARAS Data Base for CH Cygni
http://www.astrosurf.com/aras/Aras_DataBase/Symbiotics/CHCyg.htm
See also former campaign :
www.astrosurf.com/aras/surveys/chcyg/index.html

Balmer line formation and variations and a comment on abundance determinations

by Steve Shore

1 The hydrogen lines in symbiotic spectra

When discussing symbiotic stars, the overwhelming impression is that they are a sort of nebula superimposed on a red giant that has to be ionized by some other source than the visible star.

For most of the emission lines this is actually not a bad picture, especially the higher ionization transitions such as [O III] and He II. Those clearly, as we've discussed, require a strong UV and EUV continuum source to produce sufficient ionization while not so completely ionizing the medium that lower ions, [N II] for example, are not observed. The region surrounding the WD must therefore be sufficiently dense that each zone is ionization bounded within the nebular spectrum-forming region.

The forbidden lines require low density so the highest ionization stages must also be low density. This precludes the formation of such lines within the wind of the WD,if there is one, since the densities for reasonable mass loss rates exceed the threshold for the forbidden transitions (about 10^6 cm^{-3}). But this ignores what happens outside the ionized region, at lest outside that producing the He^+. Hydrogen will be both neutral (outside of the ionized region, within the outer wind of the red giant) and also present in the Heo zone, even in the region where ionized Fe-peak transitions and C^+ form. Remember these all have lower ionization potentials than H. But the wind of the red giant isn't low density near its photosphere, at the base of the wind. For mass loss rates typical of this stage of evolution, $10^{-7} M_{\odot}.yr^{-1}$ or so (the so-called thermal rate, what the star would lose if it were to be at its limit of thermal stability or at the Kelvin-Helmholtz timescale for the star's luminosity and mass) the densities are rather high (chromospheric), about 10^{10} cm^{-3} and the gas is largely neutral. The emission lines surrounding the WD are therefore seen through this denser gas and, well, like any photons encountering an opacity source they can be scattered and absorbed.

A way to see this is to recall the discussion, for novae, of what happens during the Fe-curtain stage. Absorption from resonance transitions in the UV populates the excited levels that are the lower levels of optical Fe-peak lines. This leads to absorption in transitions that, based on the density and temperature, would be thought optically thin. As long as the lower states can be populated because the photons radiated in then UV are trapped and scatter many times before escaping, the optical lines will show P Cyg-like absorption (the upper states of these transitions are also populated and this produces both emission, from radiative de-excitations, and additional population of the lower states). Just recall how to think like a photon and you'll see why this doesn't depend on the local number density. Collisional de-excitation have to be comparatively important if the lines observed are forbidden transitions. Now pass to hydrogen. The UV transitions are the strongest in the spectrum, the Lyman series, of which Lyα 1215 Å is the absolute strongest. The upper state of this line is $2p^2P$ – transitions of 1s –>2s are strictly forbidden and produce a two-photon continuum in the blue part of the spectrum. This is the lower state of Hα and the rest of the Balmer lines. Therefore, if the Lyman series is opaque, and at low temperatures (<10^4 K, like a red giant wind) and high column densities (of order 10^{22} cm^{-2} or more) it will be, then the Balmer lines can be absorbed.

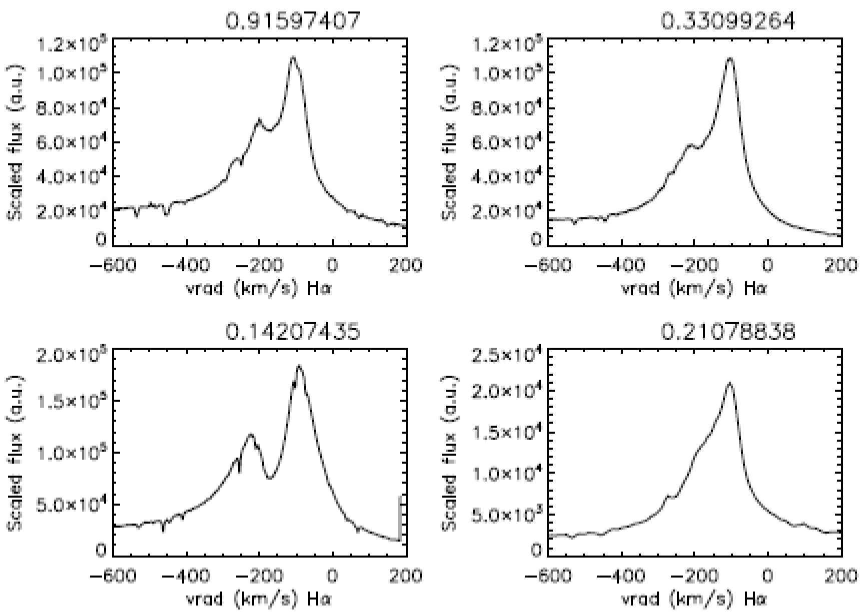


Figure 1: AG Dra: Asiago spectra showing Hα variations phased on the known binary orbital period.

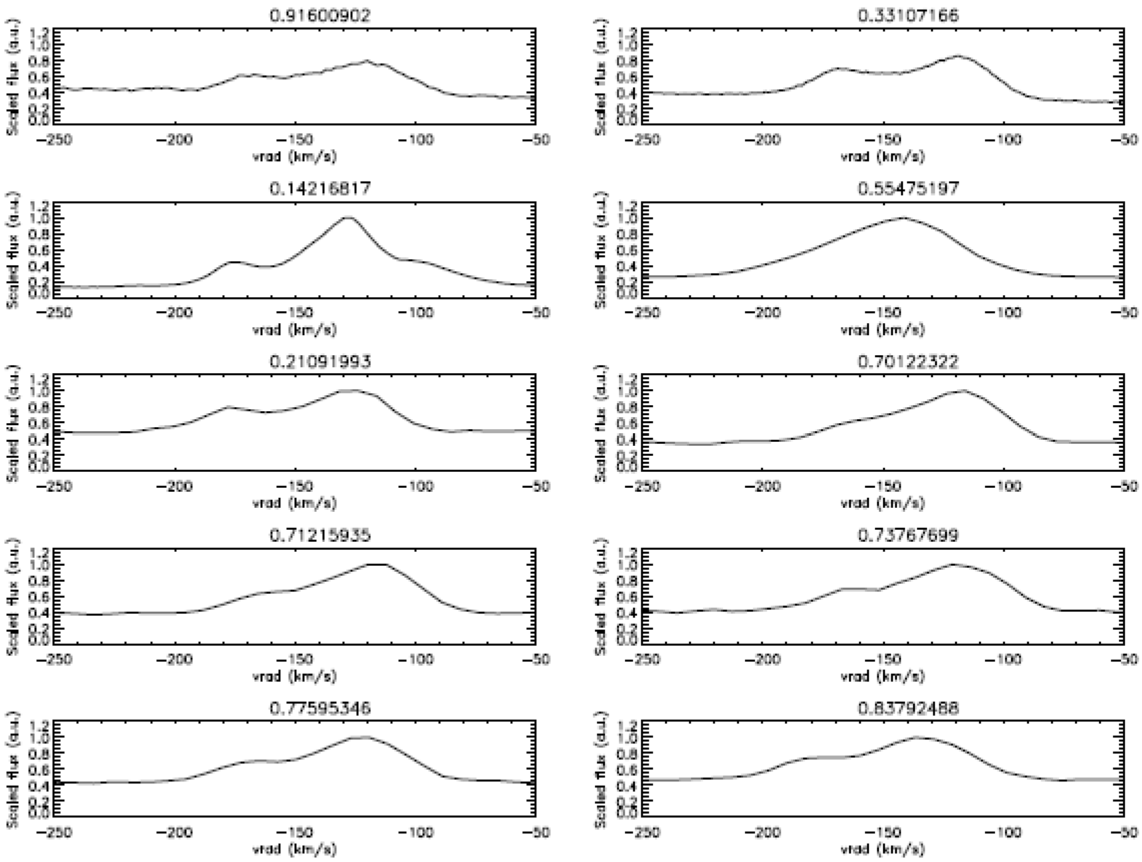


Figure 2: AG Dra, from Ondrejov spectra showing the phased variations of He I 5876 Å

The WD is a negligible continuum source at these wavelengths relative to the giant, but the emission isn't. So seen through the red giant, the Balmer lines will show absorption profiles with characteristic velocities of the red giant wind (a few tens of km.s^{-1}). These absorption lines can be very strong, depending on the orbital phase and inclination of the system, and will vary with phase angle as you sample different lines of sight. An example is the orbital modulation of the Balmer and He I 5876 Å lines in AG Dra (an old favorite).

To show what happens along the line of sight, taking a sample Balmer line (in this case with no absorption intrinsic to the profile and only observing through the wind at steps of 0.1 in phase (assuming a broad gaussian for the H II region and the orbital motions in AG Dra) you see the variations produced by the orbital modulation. Depending on the mass ratio and orbital period, the line of sight through the giant wind can also produce a redshift of the absorption (since the H II region around the WD has the same orbital motion as that star.

But this isn't the only type of variation shown by the Balmer lines and, as you've seen from your observations, things can happen far more quickly than the hundreds of days (or more) required for the orbit. Changes on even nightly bases are seen, your data show this and it has been especially well observed in some extreme systems such as MWC 560 by Tomov and collaborators. These changes are clearly dynamical, features move within the absorption line profiles in a way hat indicates optical depth changes at different velocities while the line of sight is at a fixed phase. What these are is not clear and your observations, taken with higher cadence than usually followed in the literature (always that damned nagging issue of telescope time) will be key to understanding this in a broad range of systems. Notice that the He I lines also show this feature (and that He II doesn't, there isn't any He^{+} in the surrounding wind at sufficient opacity to absorb, remember?). Coordination of the various Balmer line measurements is very important since the opacity of the line depends on the intrinsic strength of the transition. Hoping you recall the discussion of the Balmer decrement, the sequence of terminal velocities for the different lines of the Balmer series, you can dissect the wind structure by seeing how the different lines vary at the same time. The higher series members are formed deeper so they will reveal what the Hα line is "hiding" because of its extremely strong absorption. Then the timing of line variations, both short term and orbital (and longer) will separate the contribution of the smooth wind and individual structures.

How these might arise is another question. Red giants likely have some magnetic fields, although these stars are not strong X-ray sources and show only weak chromospheres and coronae. The giants in many symbiotics are, however, Mira variables and pulsate. So the winds are likely time variable as pulses of mass loss move outward. It may be possible to separate these contributions over timescales of days and weeks. Magnetic structuring of the winds is another possibility, this has been seem as sector structures in the solar wind but also likely present in massive, hot star winds. And there is always the structuring of the wind because of the orbital modulation, the formation of equatorially flattened structure and standing shocks within the flows. In other words, the shorter the timescale the closer it has to be to the dynamics of the wind and/or the accretion zone around the WD. I don't know any studies that look for disk-outflow interactions around the WD although the extreme variations of MWC 560 require jets (Z And and CH Cyg also likely show this, there are discrete emission events in these that don't show the extreme velocities or mass loss changes of MWC 560).

Finally, the Lyα line shows its presence in another, important way – aside from the Raman features we've already discussed. When talking about the O VI 6825, 7890 Å doublet, I mentioned Rayleigh scattering. This is produced by the elastic scattering (no change in the energy, unlike the Raman effect) of photons from the far wing of the Lyman line, much more separated in energy from Lyα than that required for the O VI transitions. This produces a continuum, strongly peaking toward the blue, that has been noted in these stars. And it will be highly polarized (yet another plug for that capability, sorry!).

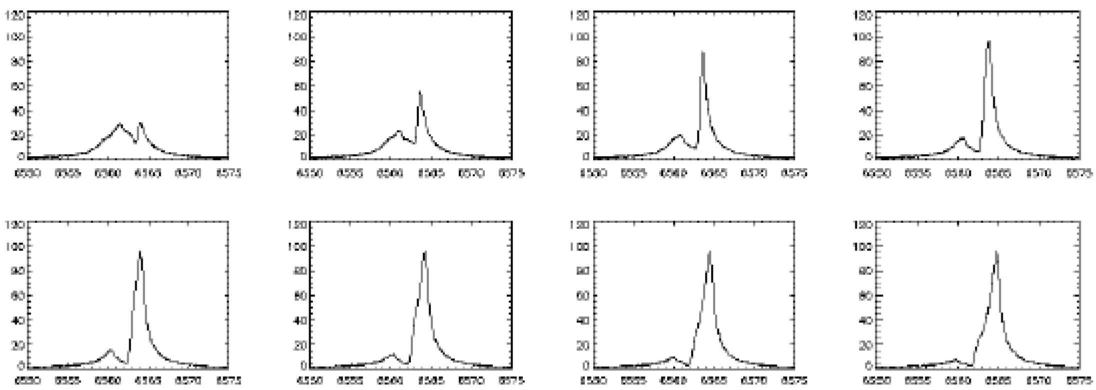


Figure 3: Model simulation of the Balmer line variations for a symbiotic-like wind. The relative motion of the two stars is important, the amplitude of the orbital motion suffices to produce both blue and redshifts of the two components relative to each other around the center of mass. Thus, the absorption can also fall on the red side of the emission line. This is *not* accretion.

2. A start on abundance determinations, a start

In the discussions to this point, I've been concentrating on the processes produce spectra but we haven't yet discussed what forms the spectrum of a run-of-the-mill star, one without strong outflows or other dynamics in its atmosphere. In the hope that this doesn't get too detailed, I'll try this time to explain something about the origin of stellar types and how abundances are determined.

We can assume the whole star is, more or less, static and the internal pressure gradient balances the weight of the overlying gas, hydrostatic equilibrium. In a medium that is sufficiently compact, and opaque, the photosphere will occur in that part of the outer layers that are still sufficiently dense that collisions dominate the population of the atomic levels. In other words, we can assume that the ionization and recombination, and the excitation and de-excitation, of the atoms is due to environmental electrons that collide with the atoms. Although this can't hold for the entire atmosphere out to its farthest portions, it can apply near the surface if the radiative decay times are longer than the mean time between collisions. Then the rate of knocking the atom into an excited state has a threshold – the excitation energy of the lower or upper state of a transition – and if this is of the same order as the thermal (kinetic) energy of the electrons the upward transitions will be effective and the level will be populated. The greater the difference between the thermal energy and that of the levels, the lower the population. This is the main reason why resonance (ground state) lines are the strongest in any ion's spectrum.

We've already discussed the extreme case where the collisions are not important, such as the symbiotic stars or planetary nebulae of very low density. But in stars, especially those on the main sequence that are at relatively low luminosity, the atmospheres are compact (a few percent of the stellar radius in thickness). Unlike symbiotic binaries, where the source that ionizes and excites the giant's wind is external, the nuclear source within stars is central and the radiation emerges from the atmosphere. As you'd expect, this means the deep layers are not only denser but also hotter. The overlying mass produces a greater pressure and this leads to the more extreme thermal conditions than father out. All this is intuitive. What may not be is that the higher temperature can mean that the opacity of the deeper layers is actually lower than the outer parts so radiation passes more easily from those layers. In the center, the temperatures are high enough in stars more massive than, say, an M main sequence star that electron scattering – not absorption – dominates the opacity and impedes the radiation passage. This is independent of wavelength and, since a free electron cannot absorb, the only other opacity source is thermal bremsstrahlung (the absorption and/or emission of photons when electrons are scattered by positive ions such as protons). This all happens within the envelope so is hidden from view. Remember, the spectrum you see is formed by the escaping photons, not those that are still diffusing through the envelope and our problem is to start from that deeper portion and ask how the lower density gas – in emitting and absorbing light – leaves its signature on the emerging photospheric distribution because of the wavelength dependence of line opacities.

This is where the link comes between spectrum and structure. The flux of radiation from below diffuses rather than "streams". When the density is low, the distance a photon can travel before encountering a target is comparable to the scale over which the density changes. Since that decreases outward, the atmosphere (the escape zone), will be comparatively cool since it is through the absorption and collisions that the gas is heated. Diffusion is a gradient process, by which I mean that the differences in temperature drive the flux. The greater the temperature gradient, the greater the flux. But opacity reduces this radiative conductivity, serving as a bottleneck to the photon passage, thus reducing the flux. The only problem is that the interior is the source of the light and that sets the rate at which the atmosphere must pass the light. So the decrease in temperature and increase in the opacity can only be balanced by increasing then temperature gradient. Since the radius of the star is set by the hydrostatic condition, and the gas pressure depends on both density and temperature, the change in the run of temperature also alters the pressure and density. In equilibrium, this establishes a spectral energy distribution.

When you look into the atmosphere, as you do whenever you take a spectrum, the lines are formed at different depths. Those from the highest ions and/or atomic levels are formed deeper than lower excitation or ionization. So He I, for instance, is formed deeper than Fe II and at a higher density.

This also samples a stronger pressure broadening effect, the Stark effect. The wings of the strongest lines are far broader, in general, than thermal velocities would indicate. This is because the atom, while sitting minding its own business in the plasma of the atmosphere, is surrounded by ions and electrons that fluctuate in number and have near pass accidents with the atom. These impulsive electric fields are too weak and too low energy to induce transitions but they do broaden the energy levels. This is a sort of environmental harassment, the more perturbed the level is (the more hits it suffers over time) the broader it will be. Hydrogen is so overwhelmingly abundant that the Balmer (and other level) series are the most visibly affected. The core of the line is formed at the lowest densities since it has the highest opacity. The wings, on the other hand, have lower opacities but are far from the line center. So when you look at the Balmer lines, for instance, they are incredibly broad in the main sequence stars (the defining characteristic), since the line is formed over a huge range of continuum optical depth (down to the photosphere) and therefore at very high pressure compared with a giant of the same ionization characteristics (hence, loosely speaking, temperature), whose lines are always much narrower. The difference, the essential feature of the MK luminosity classes, is therefore explained as a density – hence surface gravity (by hydrostatic equilibrium) – and therefore pressure effect. The more compact stars have a higher photospheric pressure and that translates into higher values throughout their atmospheres.

This also affects the abundance determination. The strength of the lines depends on their broadening. If they are broadened, they are formed over a larger pathlength through the atmosphere and therefore, can be stronger. On the other hand, depending on their ionization state, they may be restricted to certain continuum depths.

I realize this is getting a bit hairy, and I apologize if it is starting to get too heavy. Its importance for your background is that without this appreciation of how the appearance of a spectrum depends on the details of the medium in which it's formed, you might not appreciate the incredible wealth of information contained in a single profile from a static atmosphere. You've already seen how the lines formed in outflows sample the medium and give you a sort of tomographic probe of the outflow (winds) and ejecta (novae, explosions). But the same reasoning applies, with constraints, to atmospheres and once you get past this you can think about any atmosphere, whether a star or an exoplanet. You see, the spectrum seen in absorption during the transit of an exoplanet in front of its parent star is exactly the same thing. And it's the same for the Earth's atmosphere or a planet in the solar system. The key is to understand that how strong a line is depends not only on the abundance of the responsible element but also on the thermal and density structure of the atmosphere through which you're looking.

In the hope that this is more encouraging than off-putting, and with warmest wishes for the new year, I'll stop here for this installment. Your interest, questions, contributions, and enthusiasm are golden. I can't tell you all that too often! This year of our combined efforts has been the start of a new era that, with your continued force and involvement, your curiosity and excitement, will only get better.

Steve Shore
05/01/2015

your observations, taken with higher cadence than usually followed in the literature … will be key to understanding this in a broad range of systems.

Novae

Pan-chromatic observations of the remarkable nova LMC 2012
Greg J. Schwarz, Steven N. Shore, Kim L. Page, Julian P. Osborne, Andrew P. Beardmore, Frederick M. Walter, Michael F. Bode, Jeremy J. Drake, Jan-Uwe Ness, Sumner Starrfield, Daniel R. Van Rossum, Charles E. Woodward
http://arxiv.org/pdf/1412.6492.pdf

A NuSTAR observation of the fast symbiotic nova V745 Sco in outburst
Orio, M.; Rana, V.; Page, K. L.; Sokoloski, J. L.; Harrison, F.
http://arxiv.org/abs/1412.2088

Symbiotics

DT Serpentis: neither a symbiotic star nor a planetary nebula associate
Frew, David J.; Bento, Joao; Bojičić, Ivan S.; Parker, Quentin A.
Monthly Notices of the Royal Astronomical Society, Volume 445, Issue 2, p.1605-1613
http://arxiv.org/abs/1403.7847

Chemical abundance analysis of symbiotic giants - III. V694 Mon, CD-36 8436, WRAY 16-202, Hen 3-1213, V455 Sco, and Hen 2-247
Galan, Cezary; Mikolajewska, Joanna; Hinkle, Kenneth H.
http://arxiv.org/abs/1412.7596

Characterization of the Most Luminous Star in M33: A Super Symbiotic Binary
Mikolajewska, Joanna; Caldwell, Nelson; Shara, Michael M.; Ilkiewicz, Krystian
http://arxiv.org/abs/1412.6120

Supernovae

Photometric and spectroscopic observations, and abundance tomography modelling of the Type Ia supernova SN 2014J located in M82
Ashall, C.; Mazzali, P.; Bersier, D.; Hachinger, S.; Phillips, M.; Percival, S.; James, P.; Maguire, K.
Monthly Notices of the Royal Astronomical Society, Volume 445, Issue 4, p.4424-4434
http://arxiv.org/abs/1409.7066

Luminous Blue Variables and Superluminous Supernovae from Binary Mergers
Justham, Stephen; Podsiadlowski, Philipp; Vink, Jorick S.
The Astrophysical Journal, Volume 796, Issue 2, article id. 121, 24 pp. (2014)
http://arxiv.org/abs/1410.2426

With ARAS observers as authors or co-authors

Fermi establishes classical novae as a distinct class of gamma-ray sources

Ackermann, M.; Ajello, M.; Albert, A.; Baldini, L.; Ballet, J.; Barbiellini, G.; Bastieri, D.; Bellazzini, R.; Bissaldi, E.; Blandford, R. D.; Bloom, E. D.; Bottacini, E.; Brandt, T. J.; Bregeon, J.; Bruel, P.; Buehler, R.;Buson, S.; Caliandro, G. A.; Cameron, R. A.; Caragiulo, M.; Caraveo, P. A.; Cavazzuti, E.; Charles, E.; Chekhtman, A.; Cheung, C. C.; Chiang, J.; Chiaro, G.; Ciprini, S.; Claus, R.; Cohen-Tanugi, J.; Conrad, J.;Corbel, S.; D'Ammando, F.; de Angelis, A.; den Hartog, P. R.; de Palma, F.; Dermer, C. D.; Desiante, R.; Digel, S. W.; Di Venere, L.; do Couto e Silva, E.; Donato, D.; Drell, P. S.; Drlica-Wagner, A.; Favuzzi, C.;Ferrara, E. C.; Focke, W. B.; Franckowiak, A.; Fuhrmann, L.; Fukazawa, Y.; Fusco, P.; Gargano, F.; Gasparrini, D.; Germani, S.; Giglietto, N.; Giordano, F.; Giroletti, M.; Glanzman, T.; Godfrey, G.; Grenier, I. A.;Grove, J. E.; Guiriec, S.; Hadasch, D.; Harding, A. K.; Hayashida, M.; Hays, E.; Hewitt, J. W.; Hill, A. B.; Hou, X.; Jean, P.; Jogler, T.; Jóhannesson, G.; Johnson, A. S.; Johnson, W. N.; Kerr, M.; Knödlseder, J.;Kuss, M.; Larsson, S.; Latronico, L.; Lemoine,Goumard, M.; Longo, F.; Loparco, F.; Lott, B.; Lovellette, M. N.; Lubrano, P.; Manfreda, A.; Martin, P.; Massaro, F.; Mayer, M.; Mazziotta, M. N.; McEnery, J. E.;Michelson, P. F.; Mitthumsiri, W.; Mizuno, T.; Monzani, M. E.; Morselli, A.; Moskalenko, I. V.; Murgia, S.; Nemmen, R.; Nuss, E.; Ohsugi, T.; Omodei, N.; Orienti, M.; Orlando, E.; Ormes, J. F.; Paneque, D.;Panetta, J. H.; Perkins, J. S.; PesceRollins, M.; Piron, F.; Pivato, G.; Porter, T. A.; Rainò, S.; Rando, R.; Razzano, M.; Razzaque, S.; Reimer, A.; Reimer, O.; Reposeur, T.; Saz Parkinson, P. M.; Schaal, M.; Schulz, A.;Sgrò, C.; Siskind, E. J.; Spandre, G.; Spinelli, P.; Stawarz, Ł.; Suson, D. J.; Takahashi, H.; Tanaka, T.; Thayer, J. G.; Thayer, J. B.; Thompson, D. J.; Tibaldo, L.; Tinivella, M.; Torres, D. F.; Tosti, G.; Troja, E.;Uchiyama, Y.; Vianello, G.; Winer, B. L.; Wolff, M. T.; Wood, D. L.; Wood, K. S.; Wood, M.; Charbonnel, S.; Corbet, R. H. D.; De Gennaro Aquino, I.; Edlin, J. P.; Mason, E.; Schwarz, G. J.; Shore, S. N.;Starrfield, S.; Teyssier, F.; Fermi-LAT Collaboration

Science, Volume 345, Issue 6196, pp. 554-558 (2014)

http://adsabs.harvard.edu/abs/2014Sci...345..554A

Early evolution of the extraordinary Nova Del 2013 (V339 Del)

Skopal, A.; Drechsel, H.; Tarasova, T. N.; Kato, T.; Fujii, M.; Teyssier, F.; Garde, O.; Guarro, J.; Edlin, J.; Buil, C.; Antao, D.; Terry, J. N.; Lemoult, T.; Charbonnel, S.; Bohlsen, T.; Favaro, A.; Graham, K

Astronomy & Astrophysics, Volume 569, id.A112

http://adsabs.harvard.edu/abs/2014arXiv1407.8212S

Observations of rapid line variations of the H alpha line of SS 433 following a large optical flare

S. Charbonnel, O. Garde, J. Edlin

The Astronomer's Telegram, #6381

Spectroscopic classification of ASASSN-14fc as a cataclysmic variable in outburst

T. Lester (ARAS)

The Astronomer's Telegram, #6381

Spectroscopic classification of ASASSN-14cv as a cataclysmic variable in outburst

Berardi, Paolo; Lester, Tim; Teyssier, Francois

The Astronomer's Telegram, #6258

http://adsabs.harvard.edu/abs/2014ATel.6258....1B

Spectroscopic classification of ASASN-14cl as a cataclysmic variable in outburst

Teyssier, Francois

The Astronomer's Telegram, #6235

adsabs.harvard.edu/abs/2014ATel.6235....1T

The first detection of the Raman scattered O VI 1032 A line in classical novae - the case of Nova Del 2013 and Nova Cyg 2014

Skopal, A.; Wolf, M.; Slechta, M.; Teyssier, F.; Montier, J.; Lester, T.; Garde, O.; Buil, C.; Lemoult, T.; Charbonnel, S.

The Astronomer's Telegram, #6132

http://adsabs.harvard.edu/abs/2014ATel.6132....1S

Publication using spectra from ARAS Data Base

The expanding fireball of Nova Delphini 2013

G. H. Schaefer, T. ten Brummelaar, D. R. Gies, C. D. Farrington, B. Kloppenborg, O. Chesneau, J. D. Monnier, S. T. Ridgway, N. Scott, I. Tallon-Bosc, H. A. McAlister, T. Boyajian, V. Maestro, D. Mourard, A. Meilland, N. Nardetto, P. Stee, J. Sturmann, N. Vargas, F. Baron, M. Ireland, E. K. Baines, X. Che, J. Jones, N. D. Richardson, R. M. Roettenbacher, L. Sturmann, N. H. Turner, P. Tuthill, G. van Belle, K. von Braun, R. T. Zavala, D. P. K. Banerjee, N. M. Ashok, V. Joshi, J. Becker & P. S. Muirhead

Nature 515, 234–236 (13 November 2014)

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

Searching for new Be Stars

Andrew Smith and Thierry Lemoult
http://www.spectro-aras.com/forum/viewforum.php?f=32

New ARAS Page
http://www.astrosurf.com/aras/be_candidate/auto-be-candidate.html

T Tauri observations upon the request of Henz Moritz Guenther

(Harvard-Smithsonian Center for Astrophysics)

http://www.spectro-aras.com/forum/viewtopic.php?f=5&t=1033

Contribution to ARAS data base

From 01-12 to 31-12-2014

D. Boyd
J. Edlin
J. Guarro
T. Lester
J. Montier
P. Somogyi
F. Teyssier

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

Further information :
Email francoismathieu.teyssier at bbox.fr

Download previous issues :
http://www.astrosurf.com/aras/novae/InformationLetter/InformationLetter.html