

# WETAL 2013

9 Novembre 2013

**Un an d'utilisation du spectrographe Alpy 600**

**Christian Buil**

# Le spectrographe Alpy 600

## Le cahier des charges

- Instrument très compact et de très faible poids
- Faible coût
- Facilité d'utilisation (discret comme un oculaire)
- Haute qualité optique
- Flexibilité d'usage (CCD, APN, F/5, choix de fentes...)
- Compromis réso. spectrale / radiométrique ( $R = 600$ )
- Véritable spectrographe à fente longue !



**Un vrai instrument de recherche, de sensibilisation à l'observation astrophysique et pédagogique**

# Alpy 600 : un système d'observation modulaire



**Module de base**



**Jeu de fentes interchangeable**



**Fente de guidage**

## Alpy 600 : un système évolutif



Module de base (couplé à un « flip-mirror »)

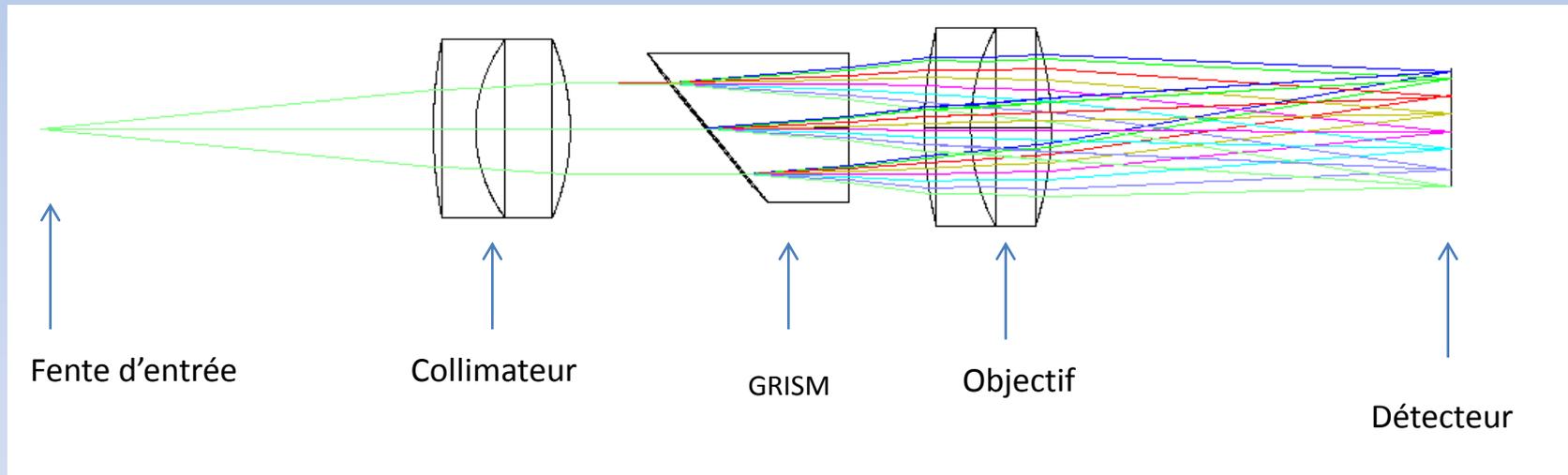


Module de pointage / guidage  
Porte oculaire guidage possible



Module d'étalonnage (lampe spectrale + lampe blanche)  
Pilotage à distance possible

# Optique du spectrographe Alpy 600



Grandissement interne = 0,98

Dispersion moyenne = 554 Å/mm

Pouvoir de résolution (R) dans le rouge avec fente 23 microns = 600

F/D accepté = 5 (4)

Couverture spectrale typique = 3750 Å – 7500 Å

# Optimisation optique

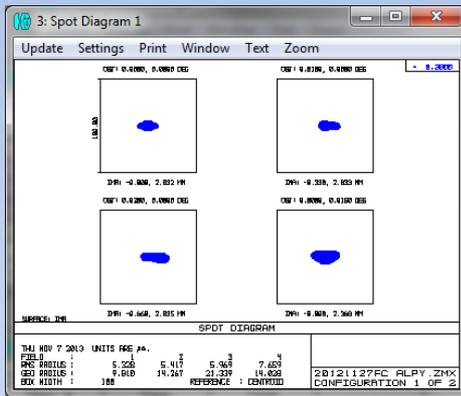
Optimisation large bande (UV-proche IR)

Éléments optiques spécialement fabriqués

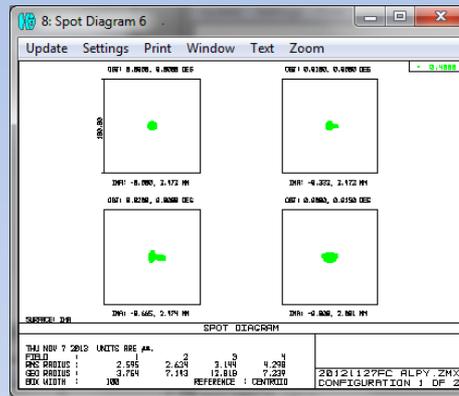
Choix d'un grandissement de 1

Profil spectral très symétrique

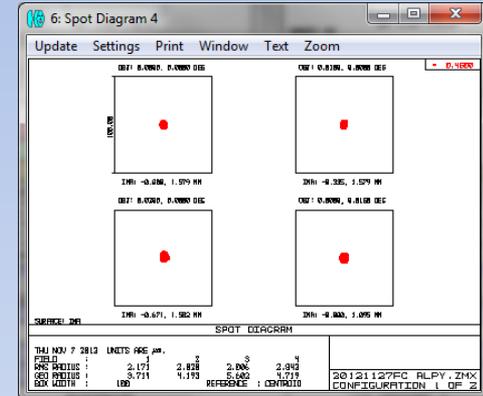
Ouverture f/4



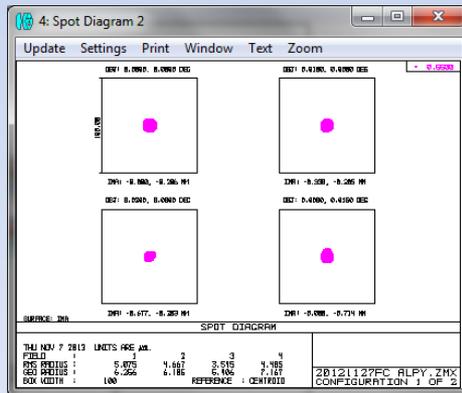
3800 A



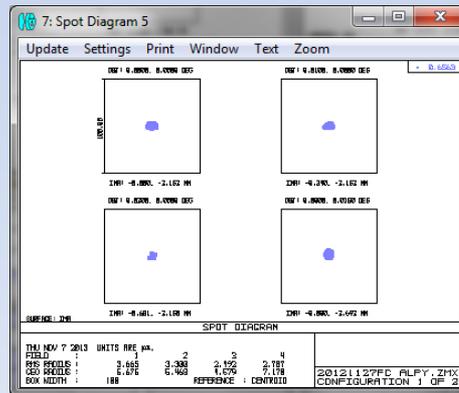
4000 A



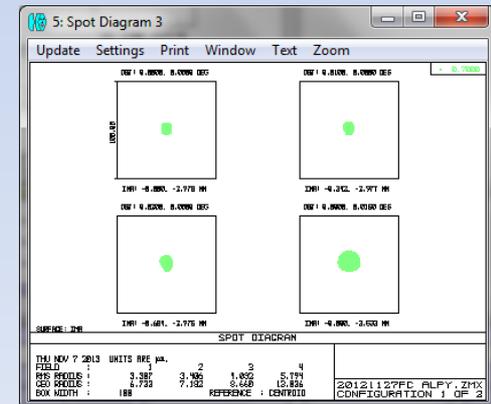
4500 A



5500 A

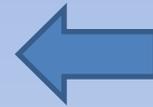


6563 A

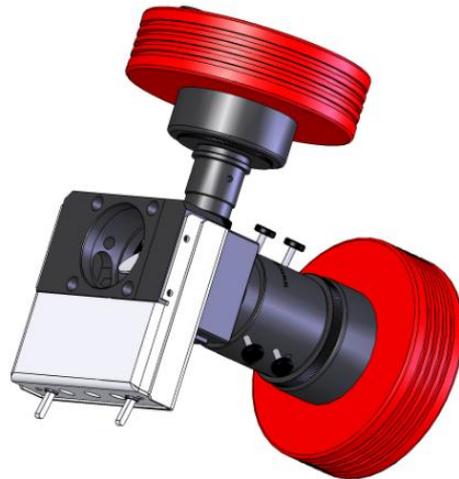
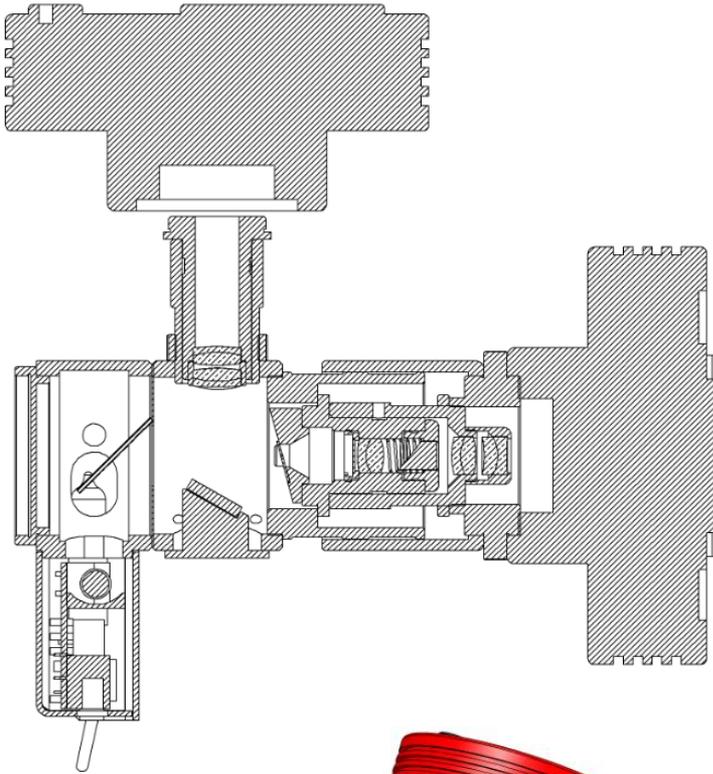


7000 A

# Intégration mécanique

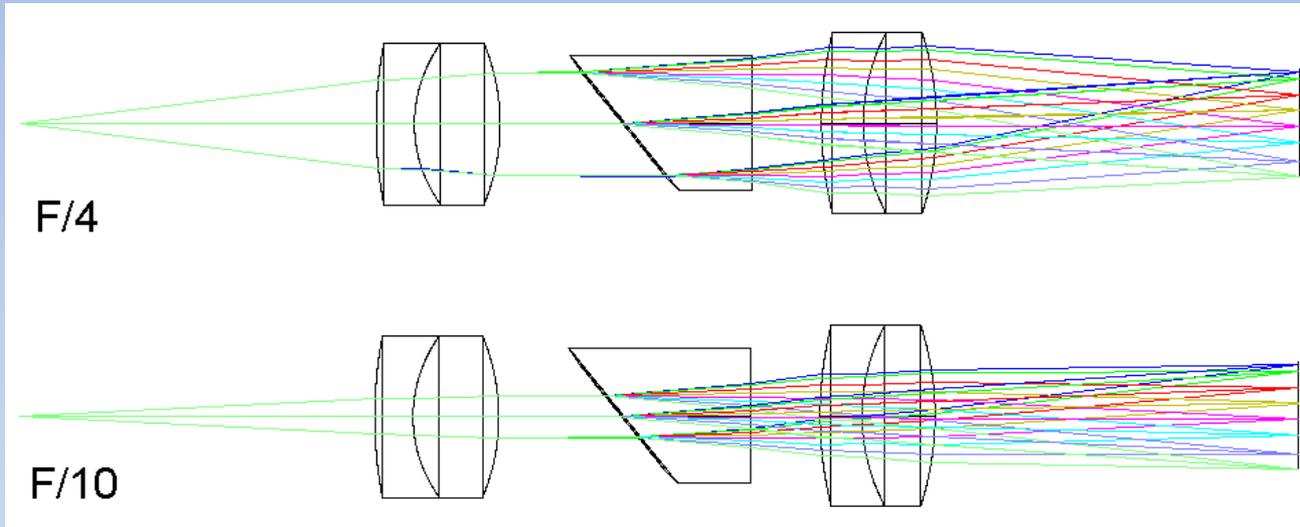


Conception mécanique compacte et rigide  
(très grande stabilité de l'étalonnage  
spectral et du focus)



# Utilisable sur des télescopes très lumineux

Ouverture numérique acceptée : jusqu'à F/4



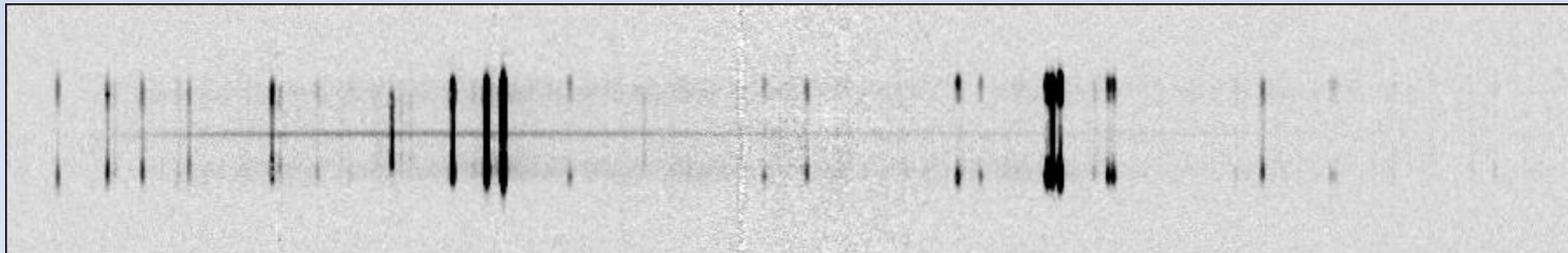
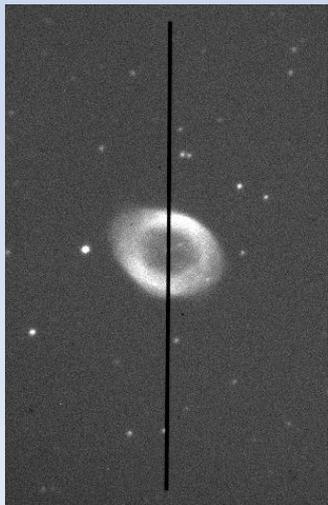
**Diamètre du télescope cible pour un  
pouvoir de résolution de  $R = 600$  :  $D = 200$  mm à 350 mm**

# Alpy 600 : magnitude limite

## Détectabilité

Pour 1 heure de pose – Etoile A0V - Seeing de 3 arcsec – Fente de 23 microns R = 600 – faisceau F/6 – Atik 460EX

Télescope	S/B de 10 @ 650 nm	S/B de 10 @ 450 nm
Réfracteur 85 mm f/5,3	12,9	14,3
Réfracteur 106 mm f/5,0	13,4	14,8
Newton CN212 (D = 212 mm f/3,9)	14,8	16,2
Schmidt-Cassegrain 8 pouces f/10	14,3	15,7
Schmidt-Cassegrain 8 pouces f/6,4	14,6	16,0
Schmidt-Cassegrain 11 pouces f/10	14,8	16,2
Schmidt-Cassegrain 11 pouces f/6,4	15,1	16,5
Schmidt-Cassegrain 14 pouces f/6,4	15,4	16,8
Newton D = 940 mm f/4	17,0	18,4



Spectre de la nébuleuse M57 – Alpy 600 sur Celestron 11 F/6.4 – Exposition : 3 x 600 secondes

# Résolution spectrale : où se situe Alpy 600

Gamme Shelyak instrument (fabriqué en France)

Pouvoir de résolution = Wavelength / Resolution -  $R = \lambda / \Delta\lambda$



*Star Analyser*  
**R~100**



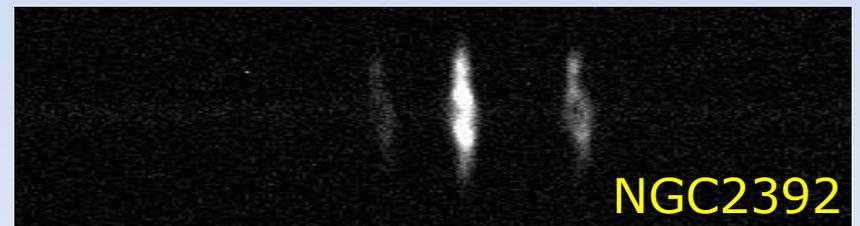
*Alpy 600*  
**R~600**



*LISA*  
**R~1000**

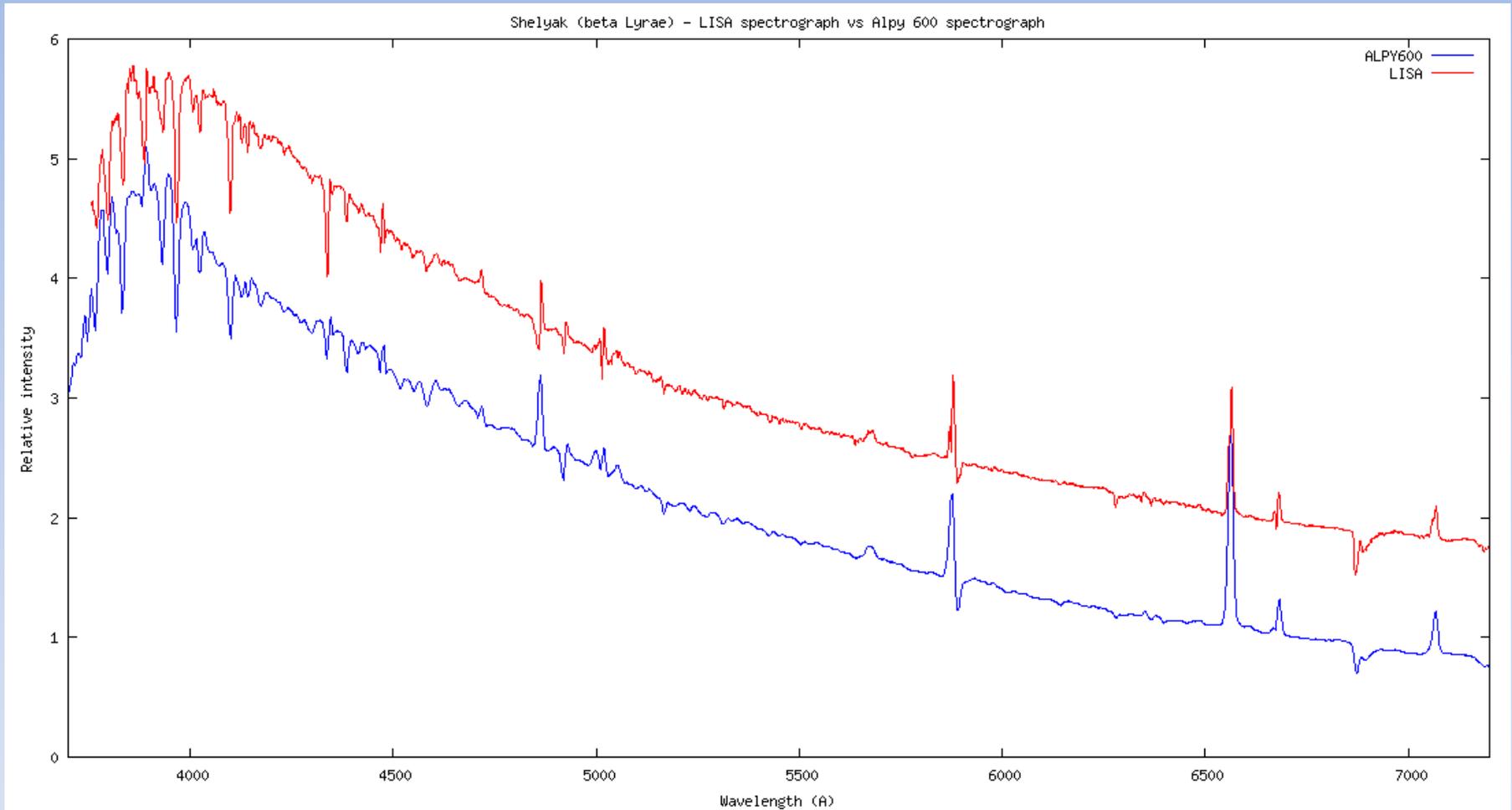


*Lhires*  
**R~17000**



# Résolution spectrale : comparaison entre Alpy 600 et LISA

Exemple sur Beta Lyre (Shelyak) – Lunette FSQ85-ED



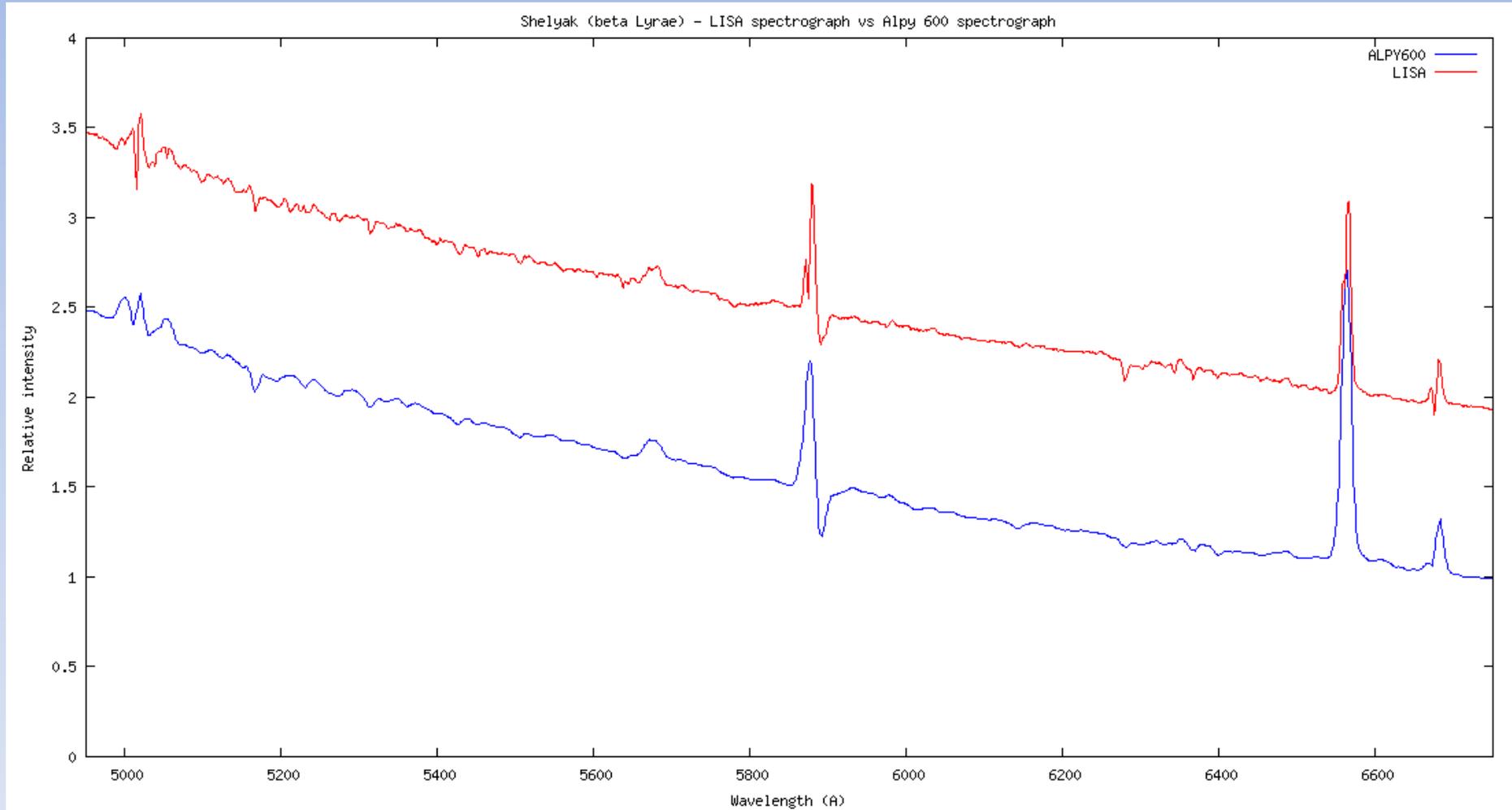
**Alpy 600 Fente 23 microns R = 600**

(R = 700 avec fente de 19 microns)

**LISA Fente 19 microns R = 1000**

# Résolution spectrale : comparaison entre Alpy 600 et LISA (détail)

Exemple sur Beta Lyre (Shelyak)



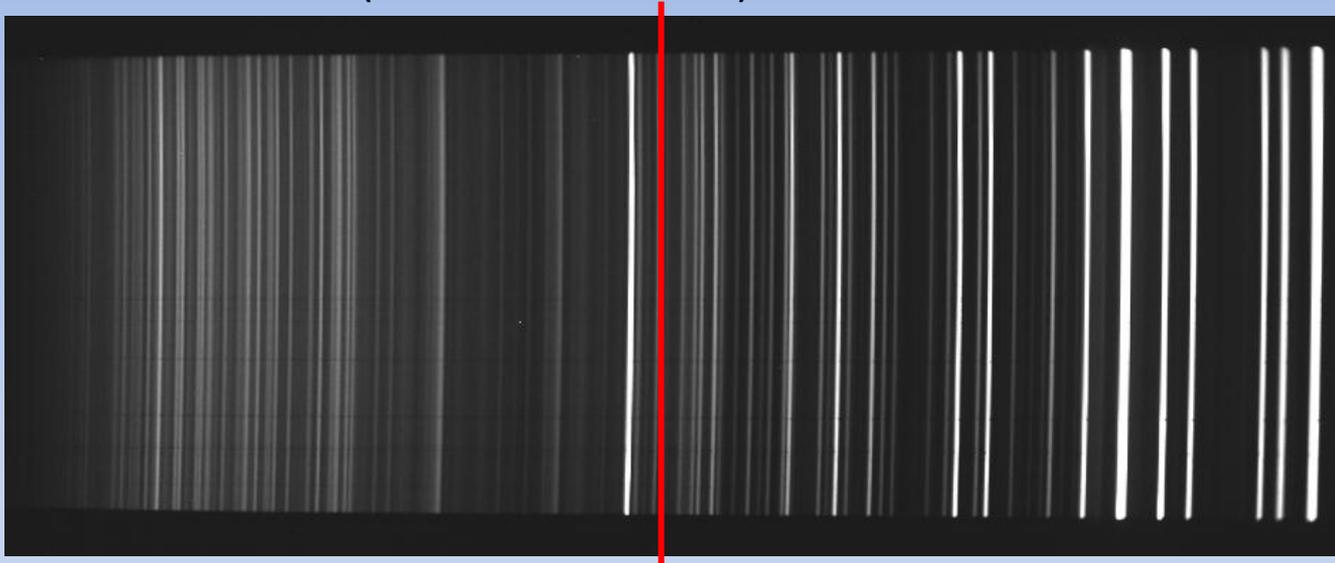
**Alpy 600 Fente 23 microns R = 600**

**LISA Fente 19 microns R = 1000**

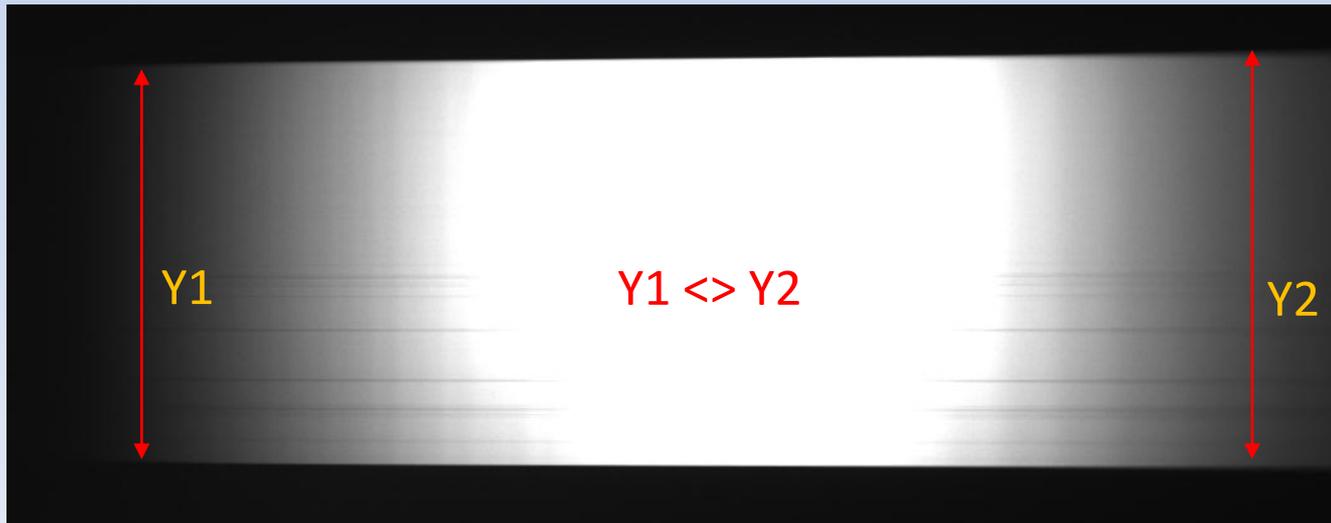
# Spécificités de l'usage d'un GRISM

Non linéarité de la dispersion : 530 Å / mm dans le rouge - 560 Å / mm dans le bleu

Effet de « Smile » (courbure des raies)

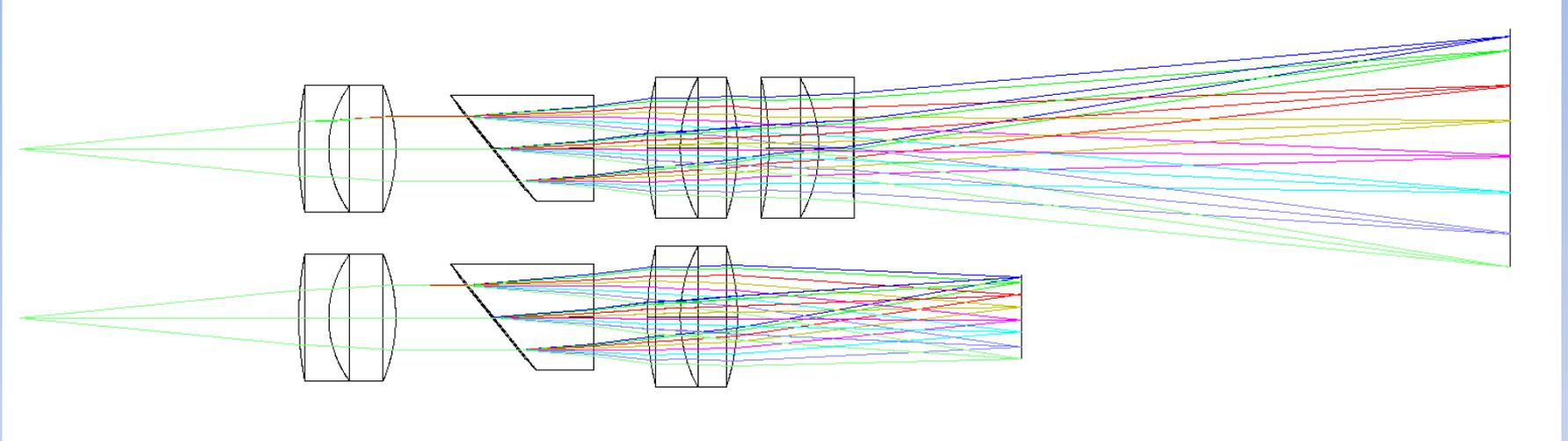


Effet de « Keystone » (variation du grandissement en fonction de lambda)



# Option APN (Appareil Photo Numérique)

## Ajout d'un complément optique en option



# Spectrographie avec appareil photo numérique (1/3)

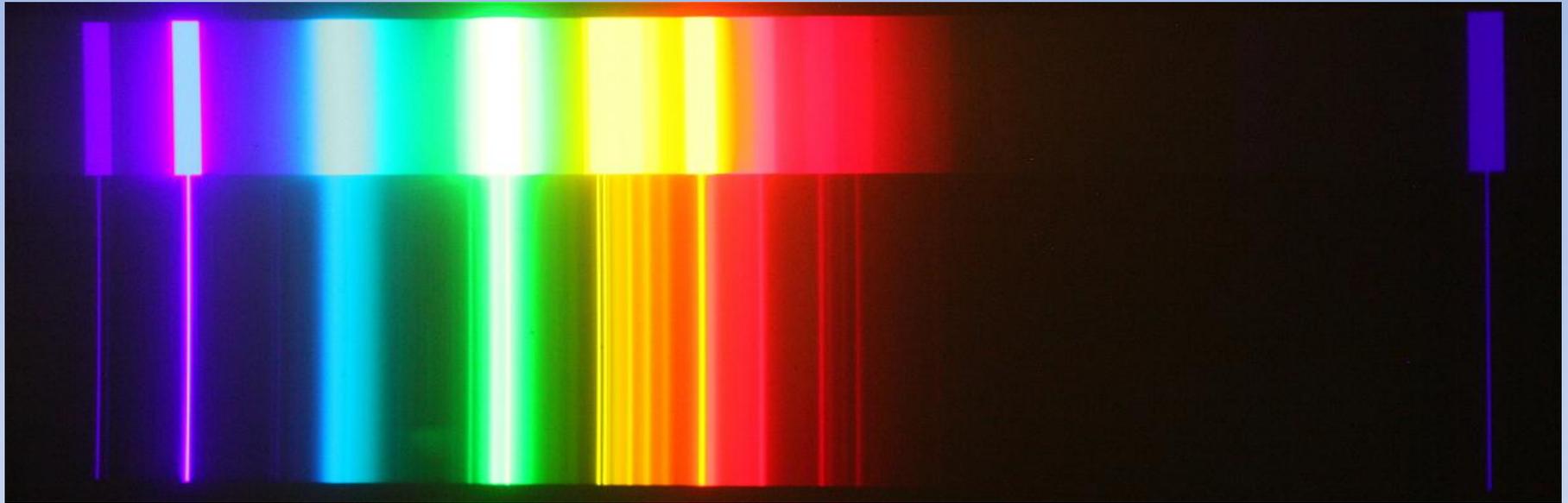


Spectre d'une lampe basse consommation domestique



# Spectrographie avec appareil photo numérique (2/3)

Lampe basse consommation



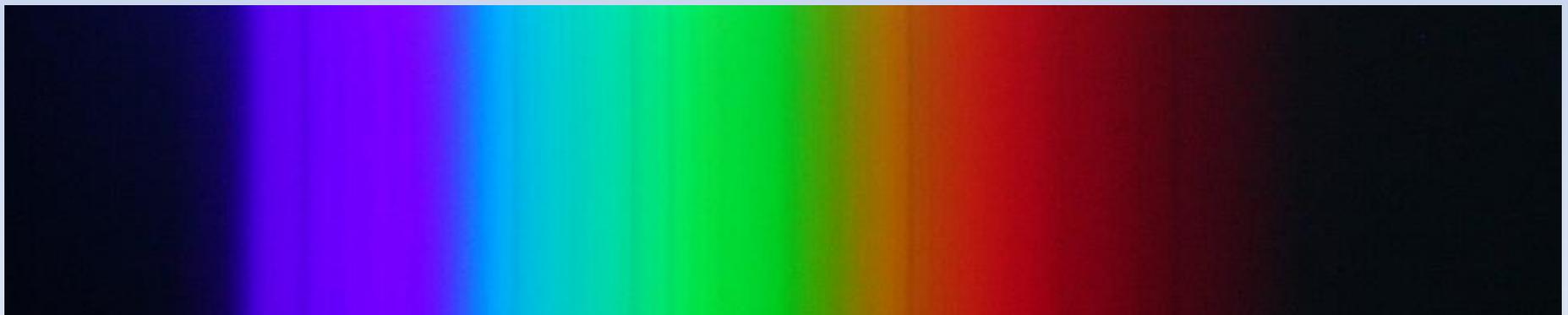
← Ordre 1 →

← Ordre 2 →

Ordre 1

Ordre 2

Lumière du jour



↑ Mg

↑ Na

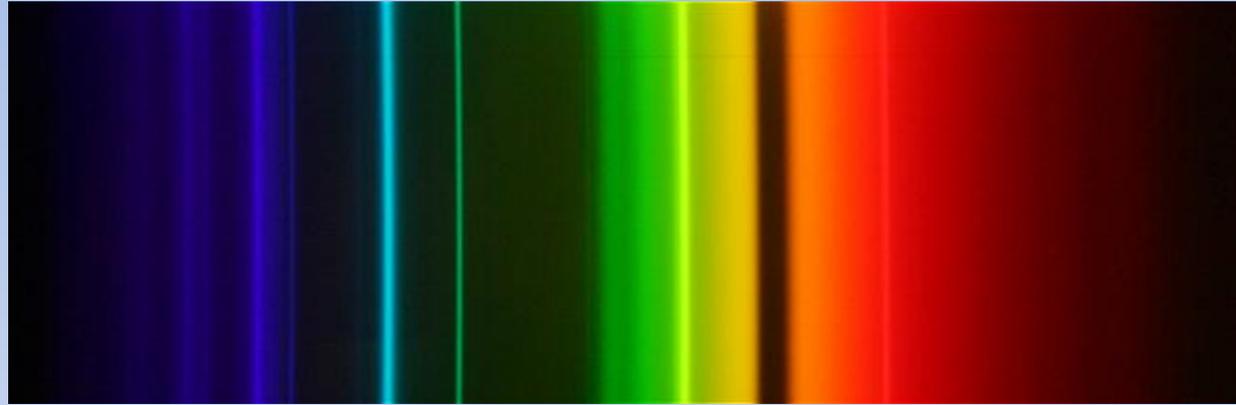
↑ H $\alpha$

# Spectrographie avec appareil photo numérique (3/3)

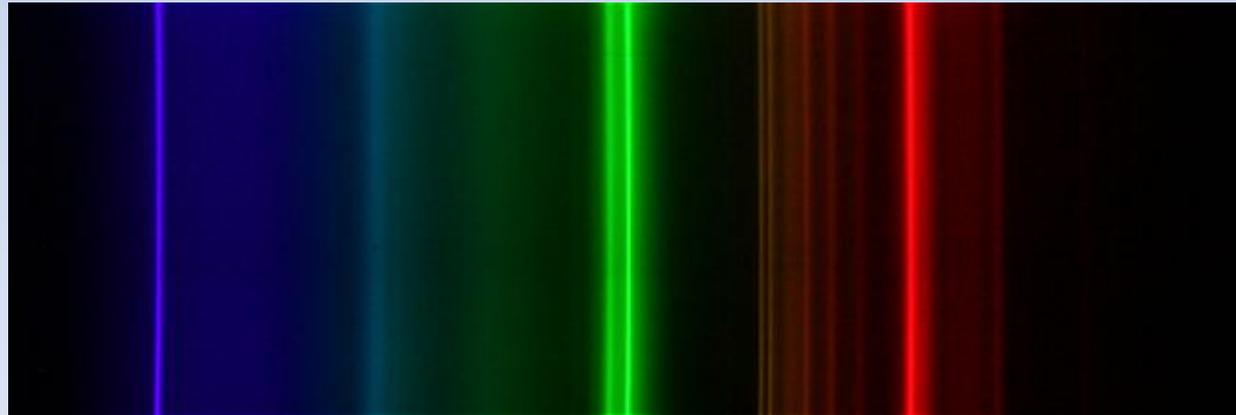
## Mesure de la pollution lumineuse (éclairage urbain)



Lampe Sodium Haute Pression



Nouvelles lampe fluo faible flux



Hapha

## Usage : du mode le plus économique...

Fente plane large, pointage par flip-mirror, pas d'étalonnage intégré



Ne veux pas dire simplicité ! Privilégier une focale courte pour simplifier les pointages, limiter ces ambitions (productivité, apprentissage), objets brillants.

## ... au mode le plus avancé

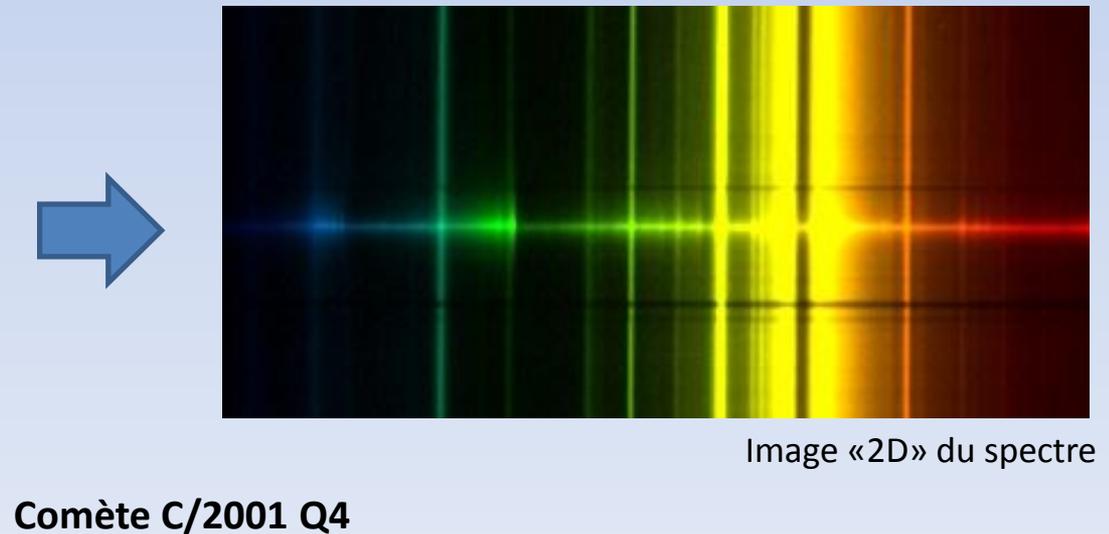
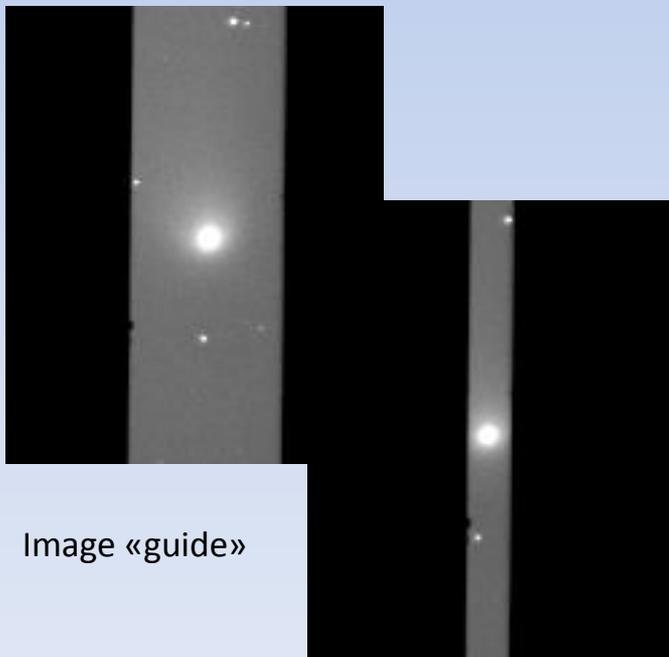
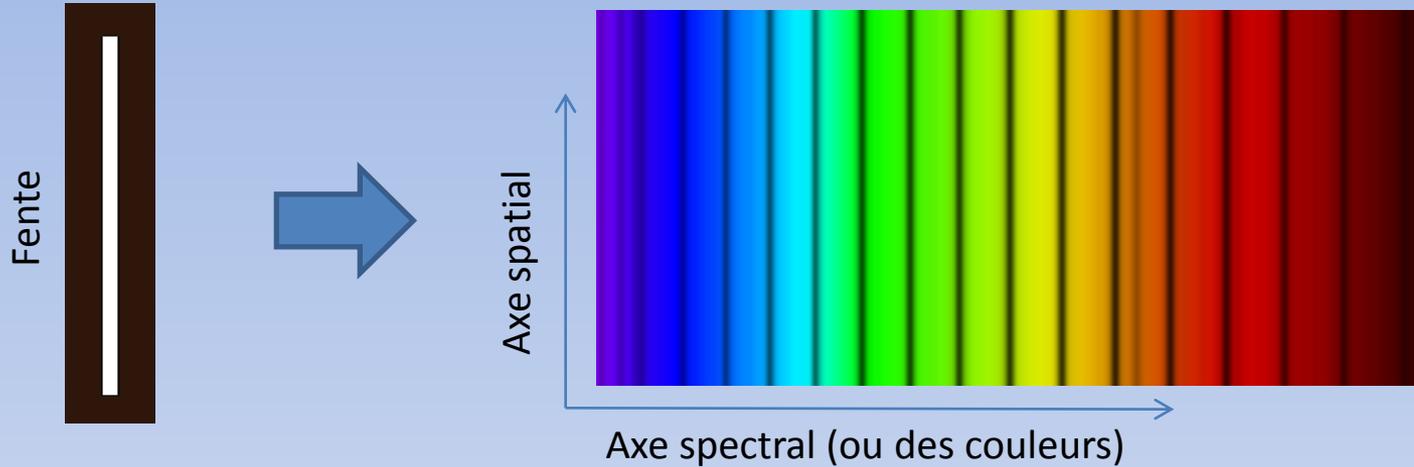
Fente réfléchissante, autoguidage intégré, caméra de pointage/guidage haut de gamme, module d'étalonnage d'étalonnage intégré



Noter l'utilisation d'un réfracteur de petit diamètre mais efficace (D = 85 mm apochromatique, f/5.3 - Takahashi FSQ80ED) – Pointage facile, haute résolution (R=800)

# Spectrographe à fente longue

*Le spectre une est succession d'images colorées de la fente*



# Pourquoi une fente d'entrée

La largeur de la fente détermine la résolution spectrale

Pouvoir de résolution  $R = \lambda / \Delta\lambda$

$\Delta\lambda$  = finesse spectrale

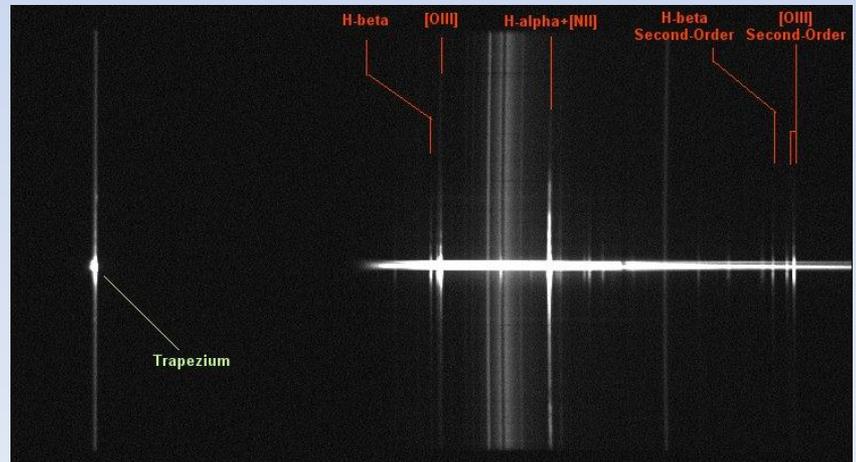
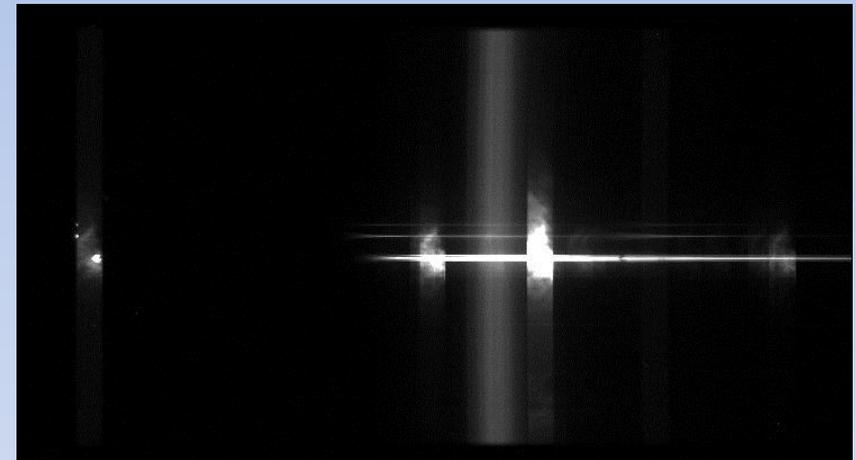
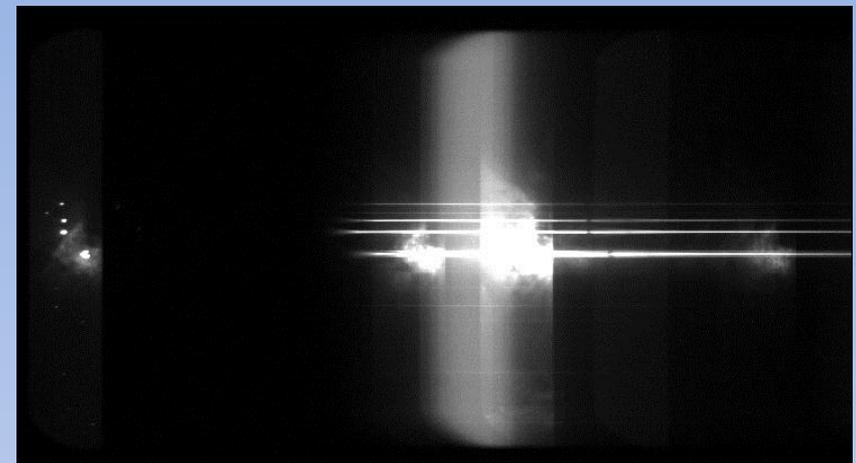
$$R = \frac{2 d_1 \tan \alpha}{\phi D}$$

Autres fonctions :

- Isoler l'objet étudié de ces voisins
- Réduire la brillance du fond de ciel

Fente de plus en plus étroite

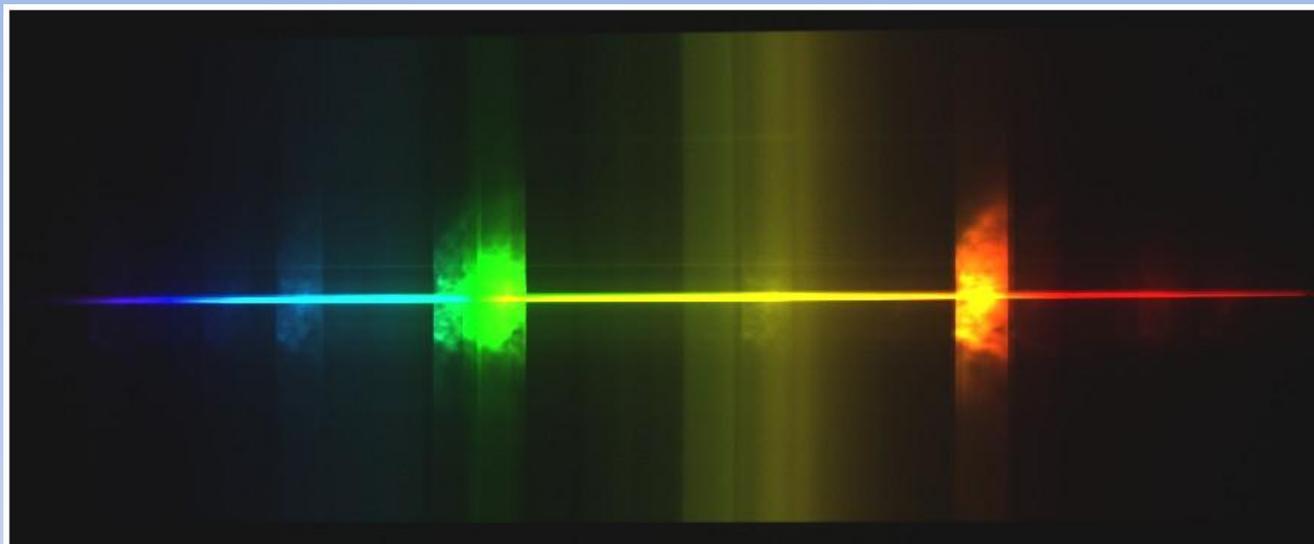
Attention au compromis résolution vs luminosité



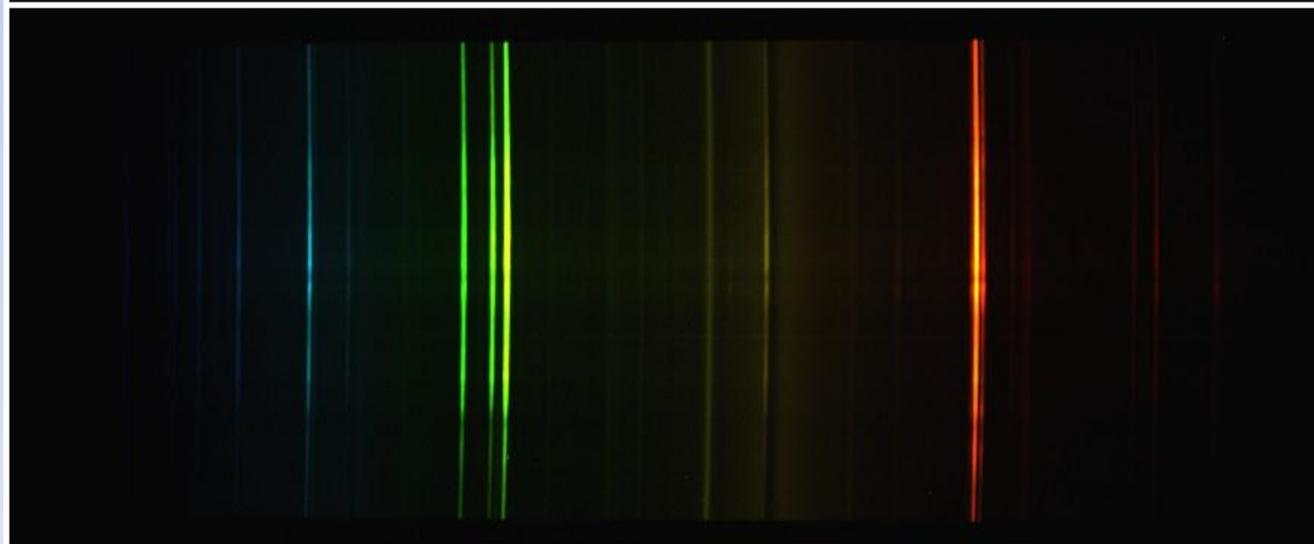
Observation de la nébuleuse M42 avec un spectrographe LORIS

# Fente large ou fente étroite : la nébuleuse Messier 42

Alpy 600 - FSQ-85ED / C11 – Caméra ATik460EX



Fente 300  $\mu\text{m}$



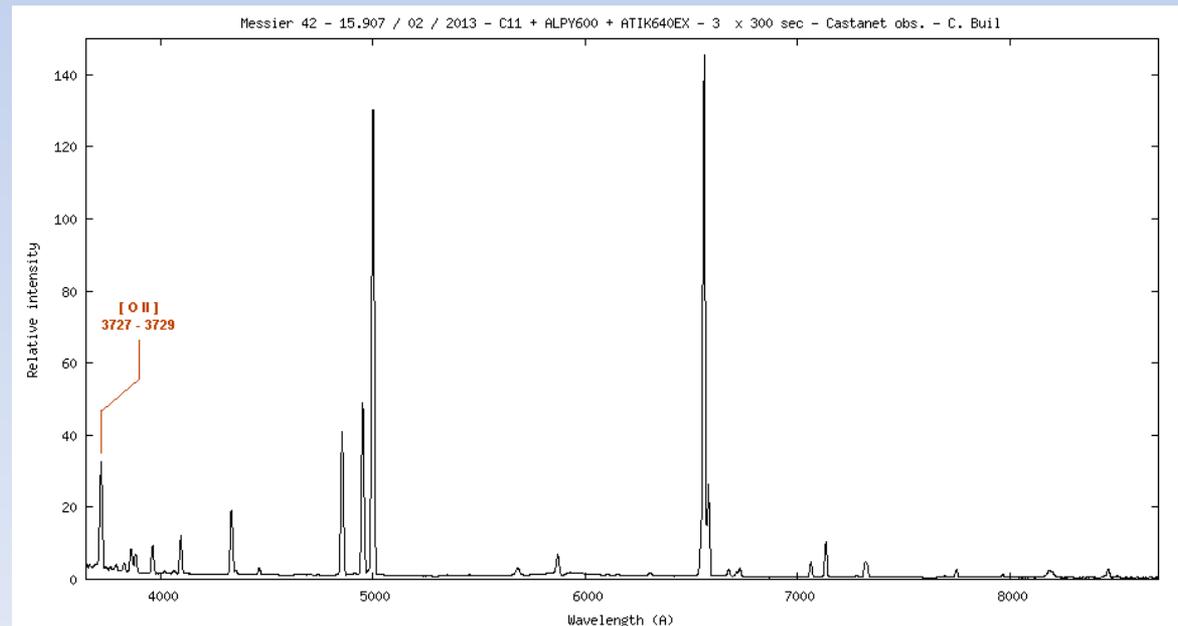
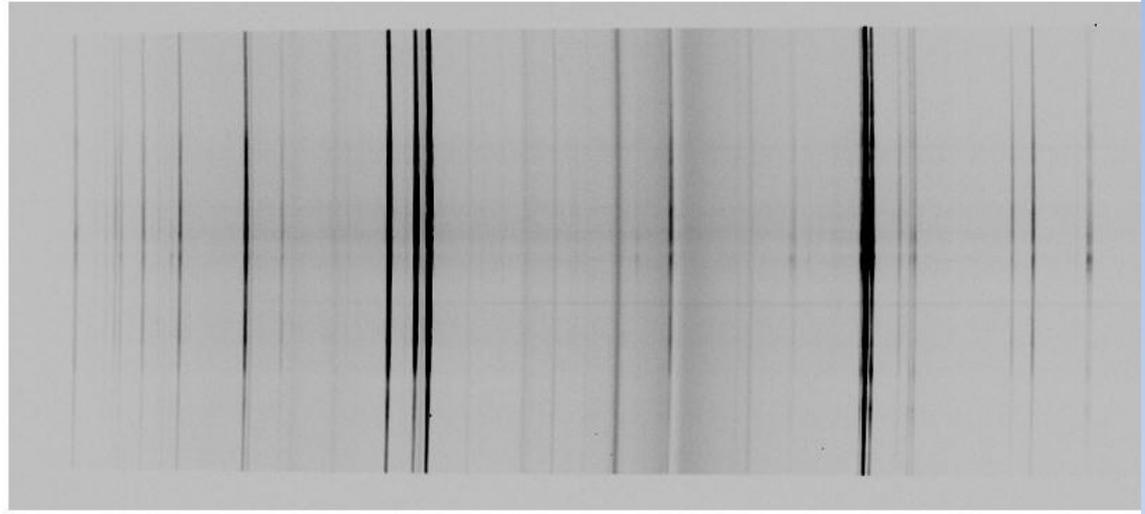
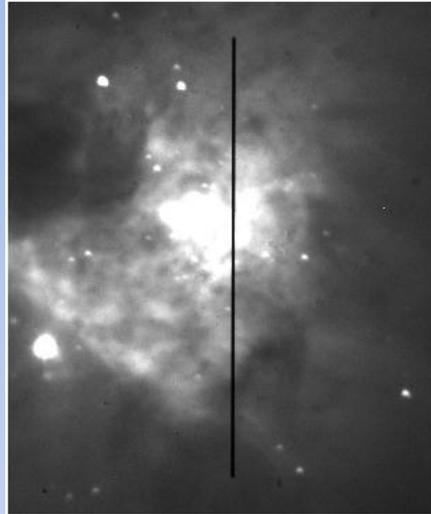
Fente de 23  $\mu\text{m}$

**Fente étroite : gain en résolution spectrale, lutte contre la pollution lumineuse**

# Résultat type sur objet à surface étendue

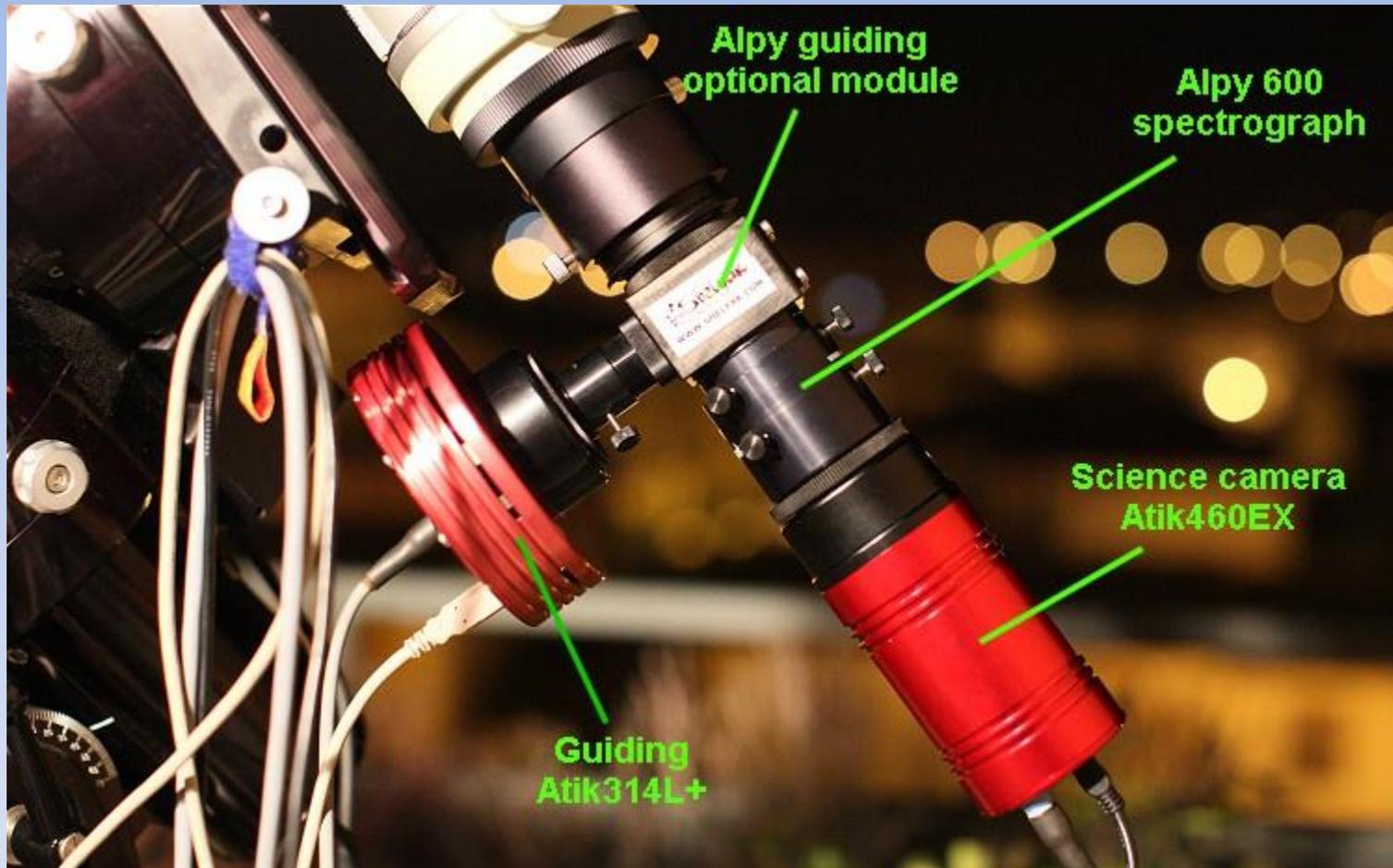
## Messier 42

Alpy 600 sur C11 – 3 x 180 sec. – Fente de 23 microns, Caméra Atik460EX



Profil spectral de Messier 42  
Observation du doublet UV [O II]  
à 3727 A – 3729 A

## Exemple de configuration



Note : en option un porte oculaire est proposé pour un guidage visuel sur le port de pointage/guidage (solution eco)

## Tout type de télescope utilisable



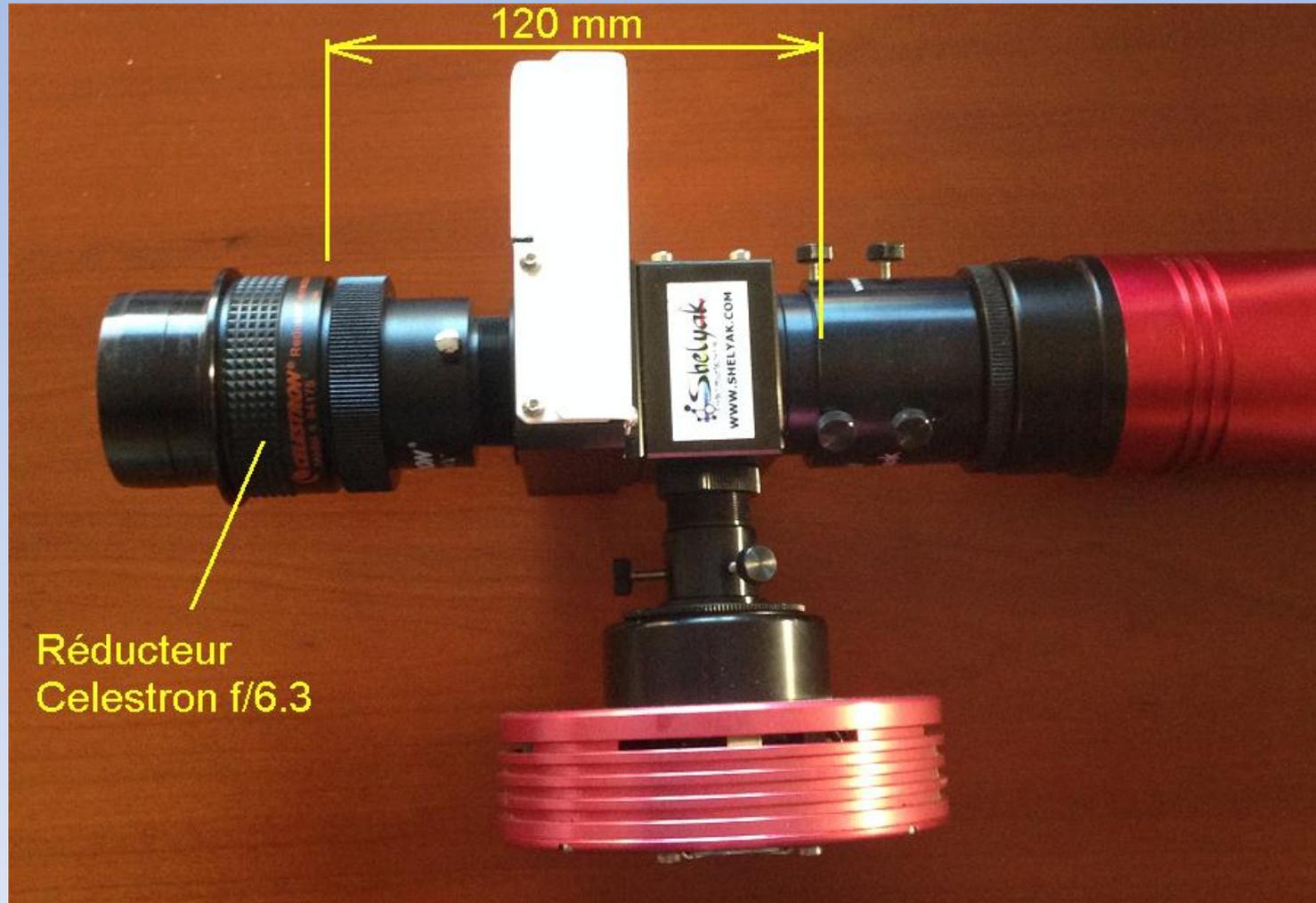
D = 200 mm F/3.9 – CN212



D = 940 mm F/ 4.45 – Saint-Caprais

# Couplage à SCT : réducteur de focale

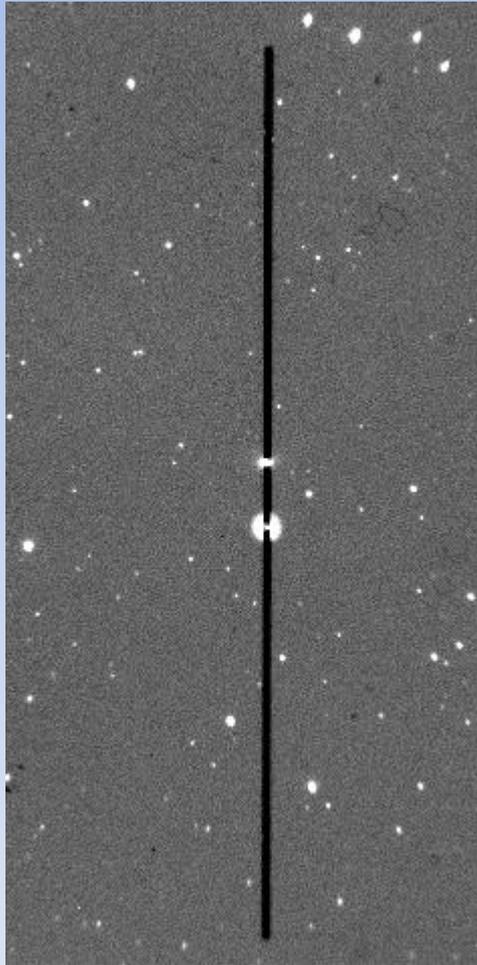
## Optimisation du tirage optique



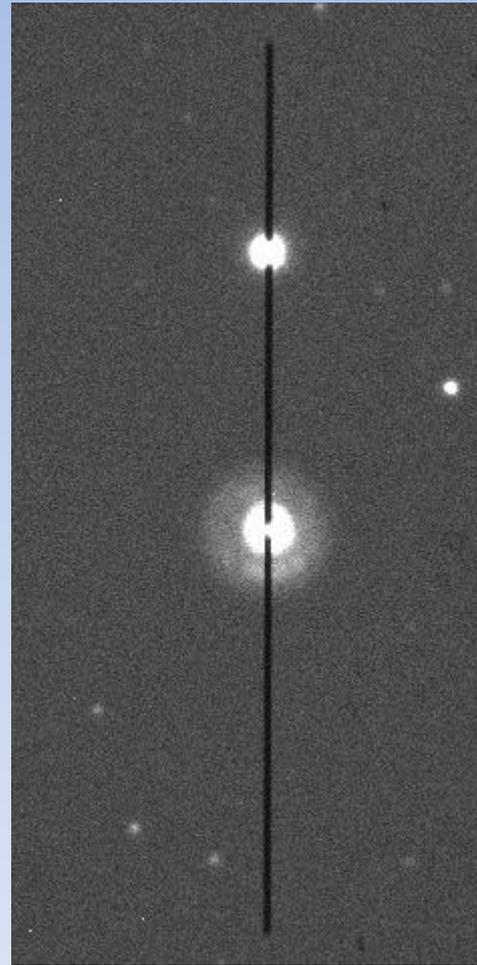
# Module de pointage / guidage

Nébuleuse planétaire NGC 2392

Plusieurs choix de largeur de fente (19  $\mu\text{m}$ , 23  $\mu\text{m}$ , 27  $\mu\text{m}$ , ...) – Ici 23 microns



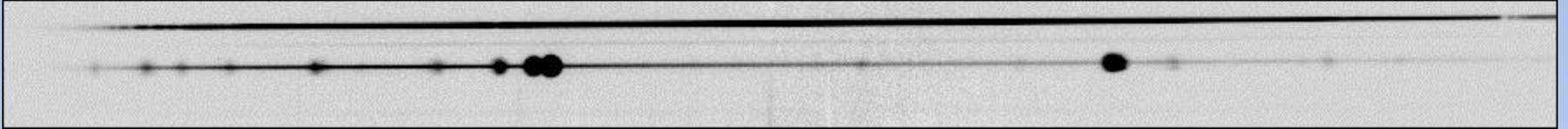
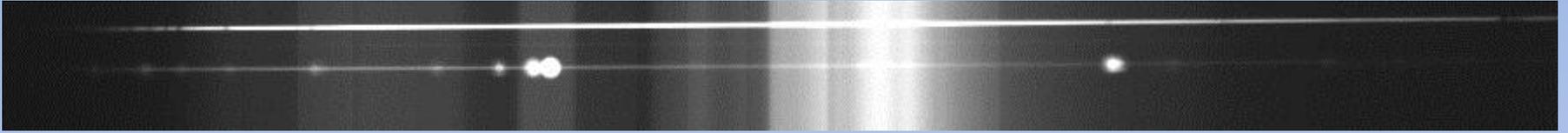
FSQ85ED  
(D = 85 mm, F = 450 mm)



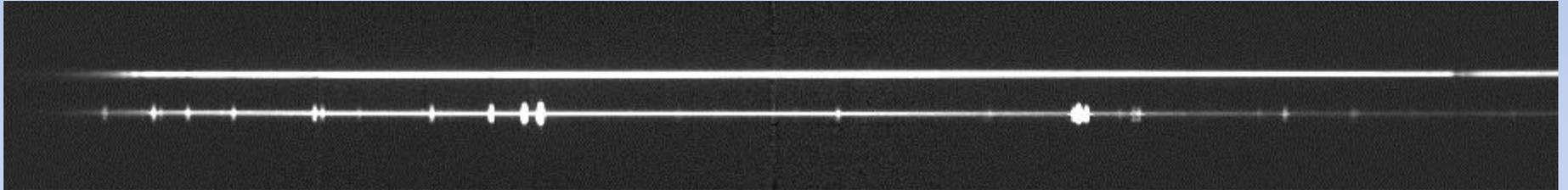
Celestron 11 + reducteur  
(D = 280 mm, F = 1800 mm)

# Choix du télescope et de la fente

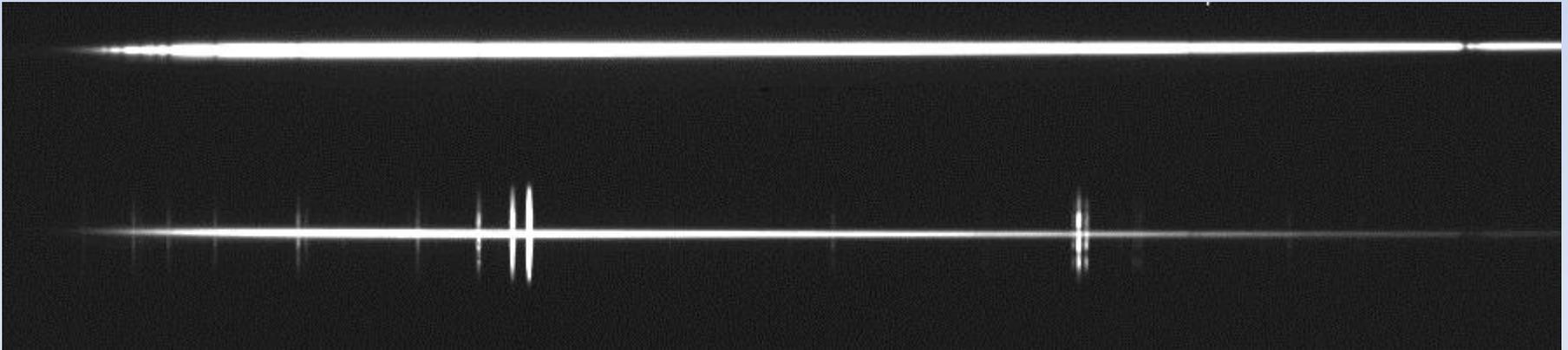
Nébuleuse planétaire NGC 2392



**FSQ85ED – Fente 300 microns – 15 x 120 secondes – pas de guidage**



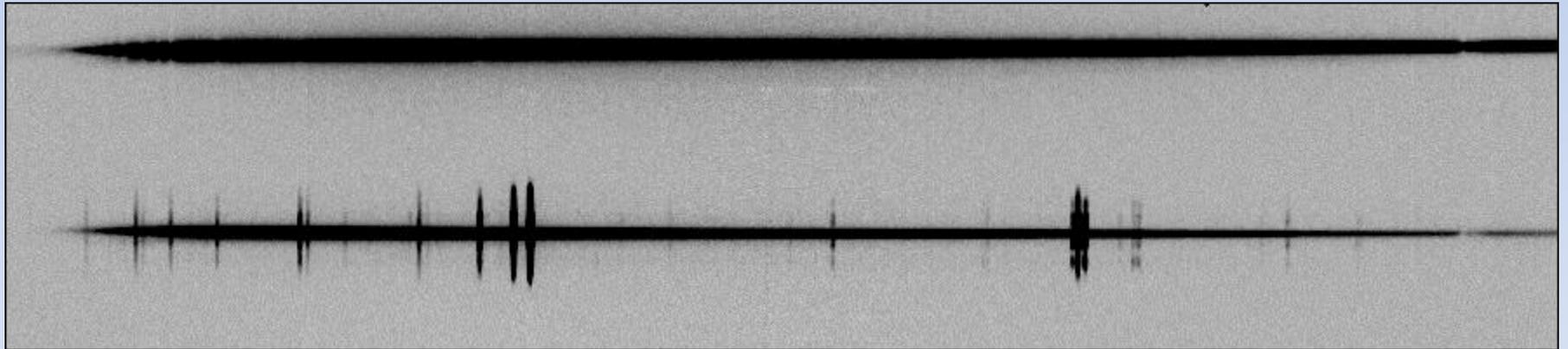
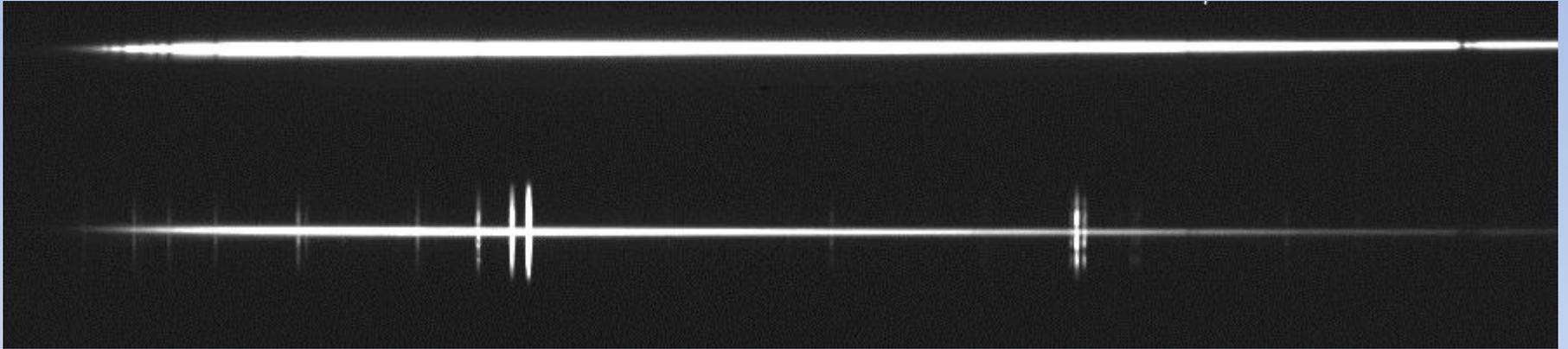
**FSQ85ED – Fente 23 microns – 4 x 300 secondes**



**Celestron 11 F/6.7 – Fente 23 microns – 6 x 180 secondes**

# Choix du télescope et de la fente

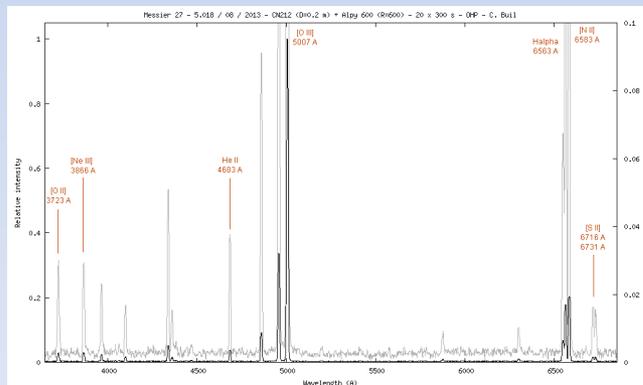
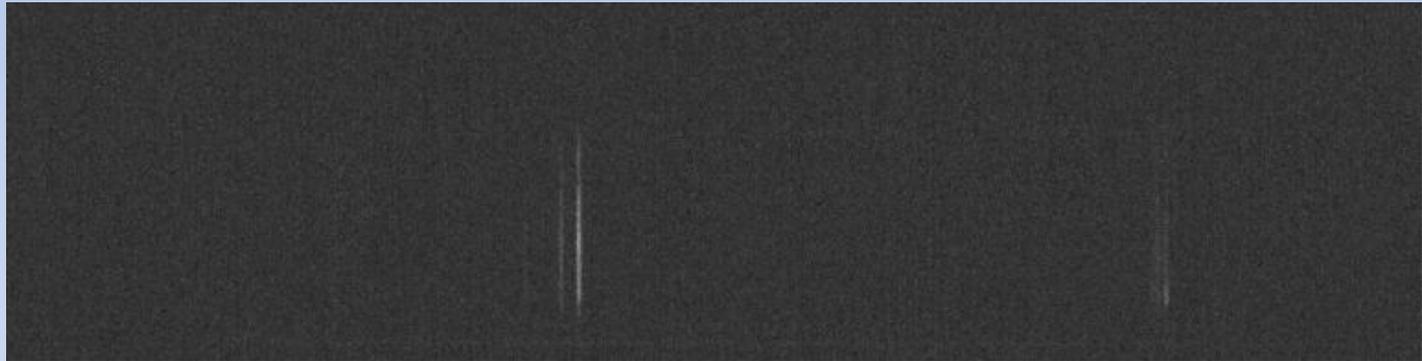
Nébuleuse planétaire NGC 2392



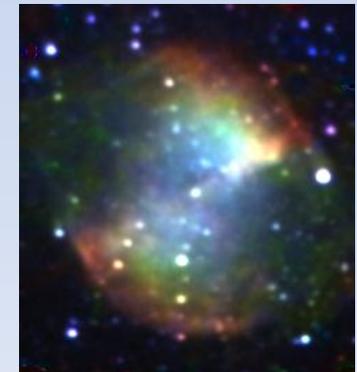
**Celestron 11 F/6.7 – Fente 23 microns – 6 x 180 secondes**

# Ou comment réaliser une image en couleur avec un spectrographe (Alpy 600 sur CN212)

L'exemple de la nébuleuse M27  
27 spectres x 5 minutes



(R) [NII] + (V) Halpha + (B) [OIII]



(R) [NII] + (V) [Halpha] + (B) HeII

# Spectrographie en ville : exemple de la comète Encke

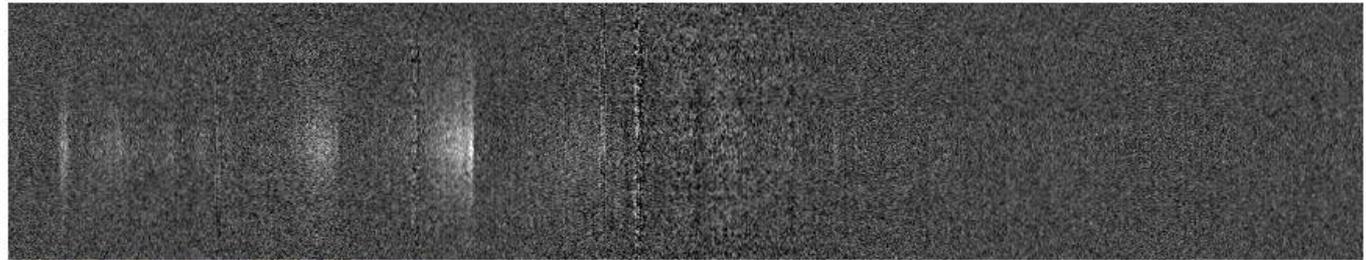
## 2P/Encke

12 October 2013

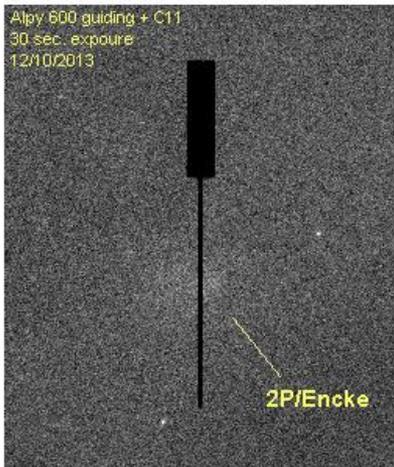
C11 telescope (D=0.28 m) +  
Alpy 600 spectrograph (R=600)  
23 microns slit  
Stack of 6 x 600 sec. exposure  
Castanet obs. (France)  
Christian Buil



2D spectrum before sky removal (note the intense sky pollution - High Pressur Sodium lamps)



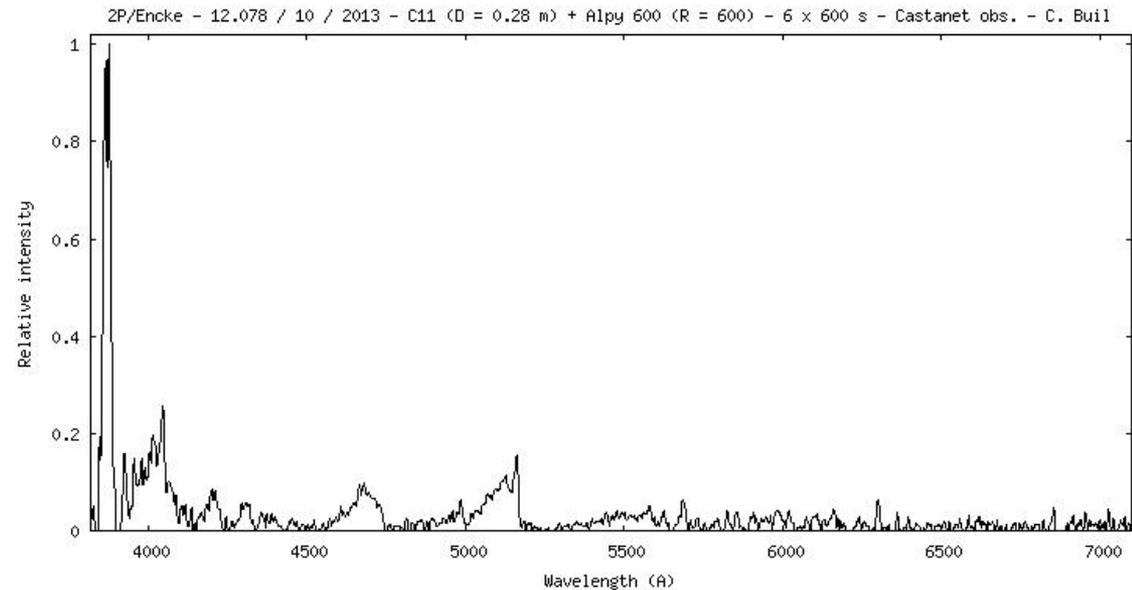
Comet spectrum after sky removal procedure



Alpy 600 guiding + C11  
30 sec. exposure  
12/10/2013

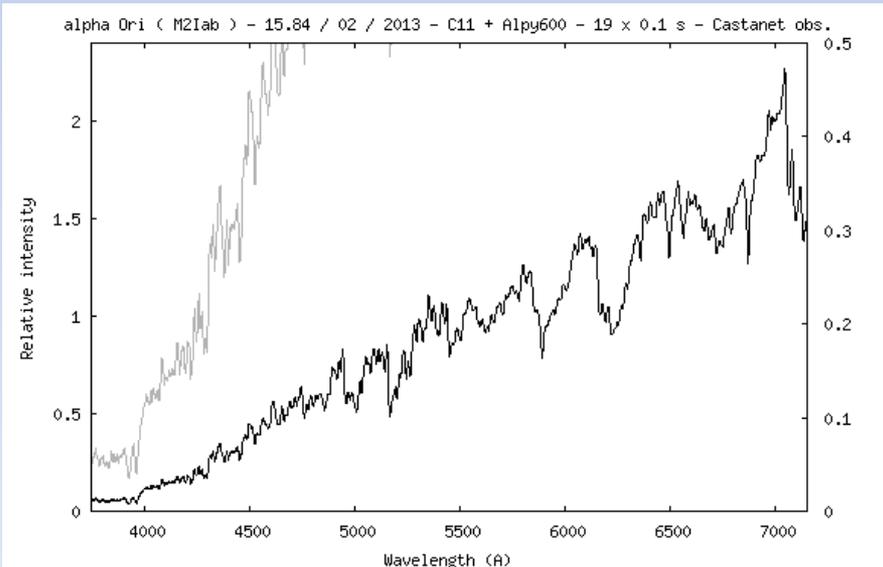
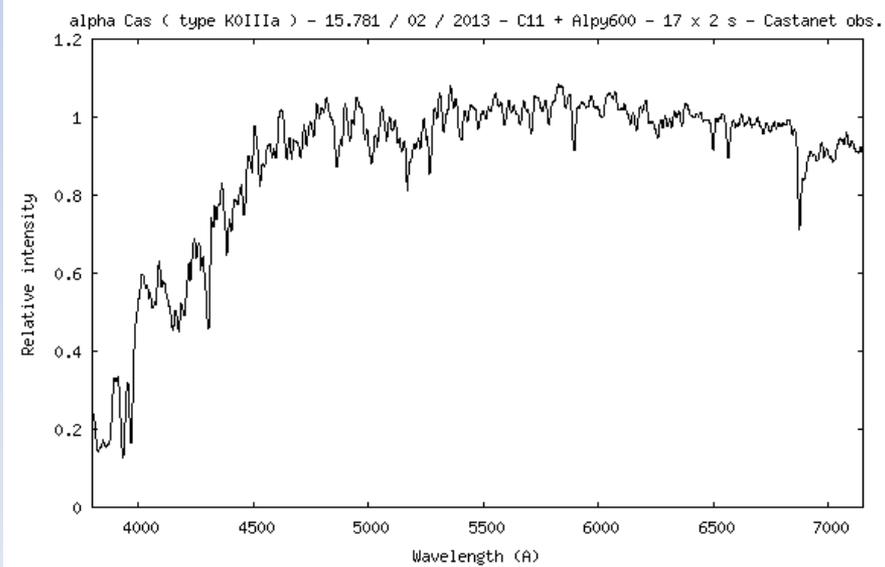
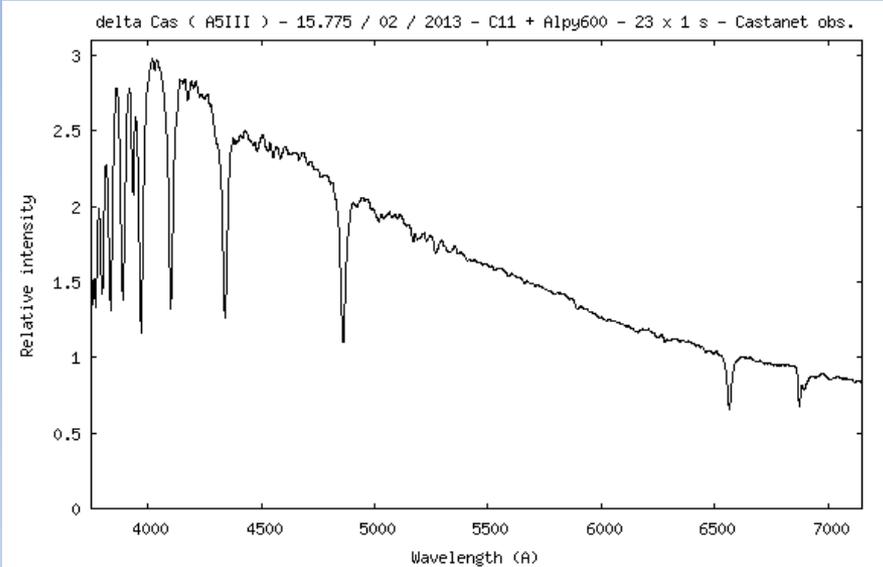
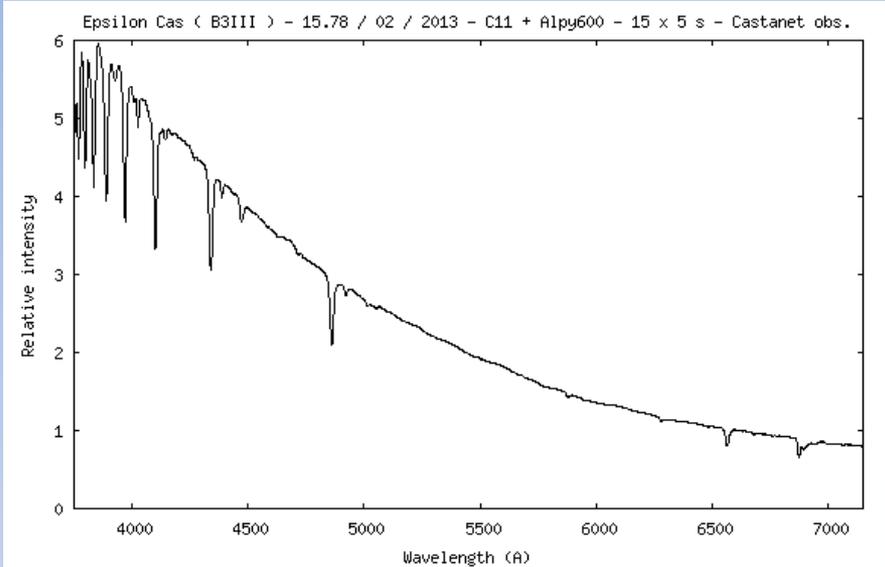
2P/Encke

Guiding image of 2P/Encke during observation  
The objet is of faint surface brightness



Calibrated spectral profile of Encke comet. The spectrum is composed of fluorescent bands for the essential)

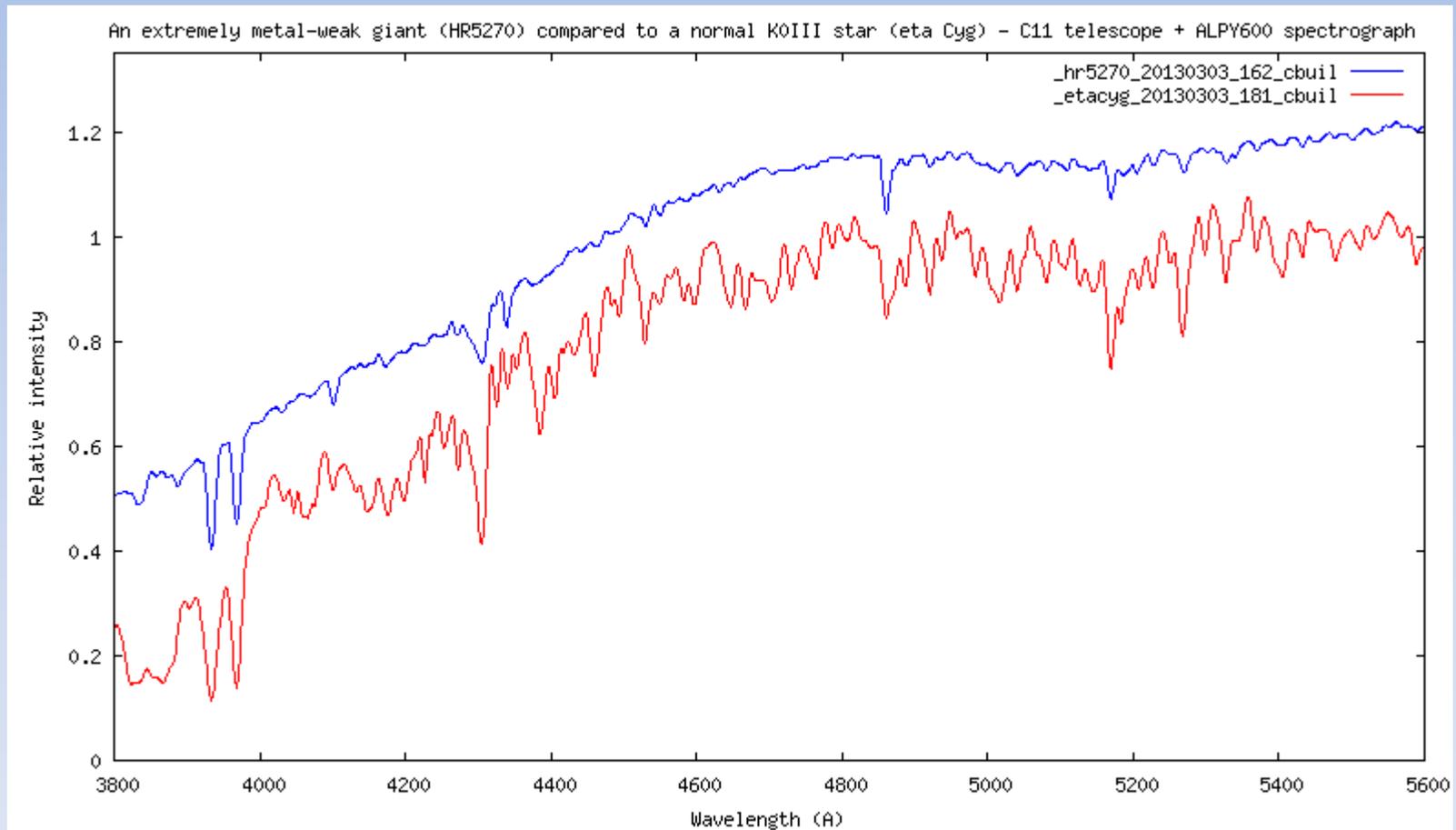
# Etoiles « normales » - Le domaine spectral de Alpy 600 couvre la partie « visible » du spectre



# Enseignement de l'astronomie

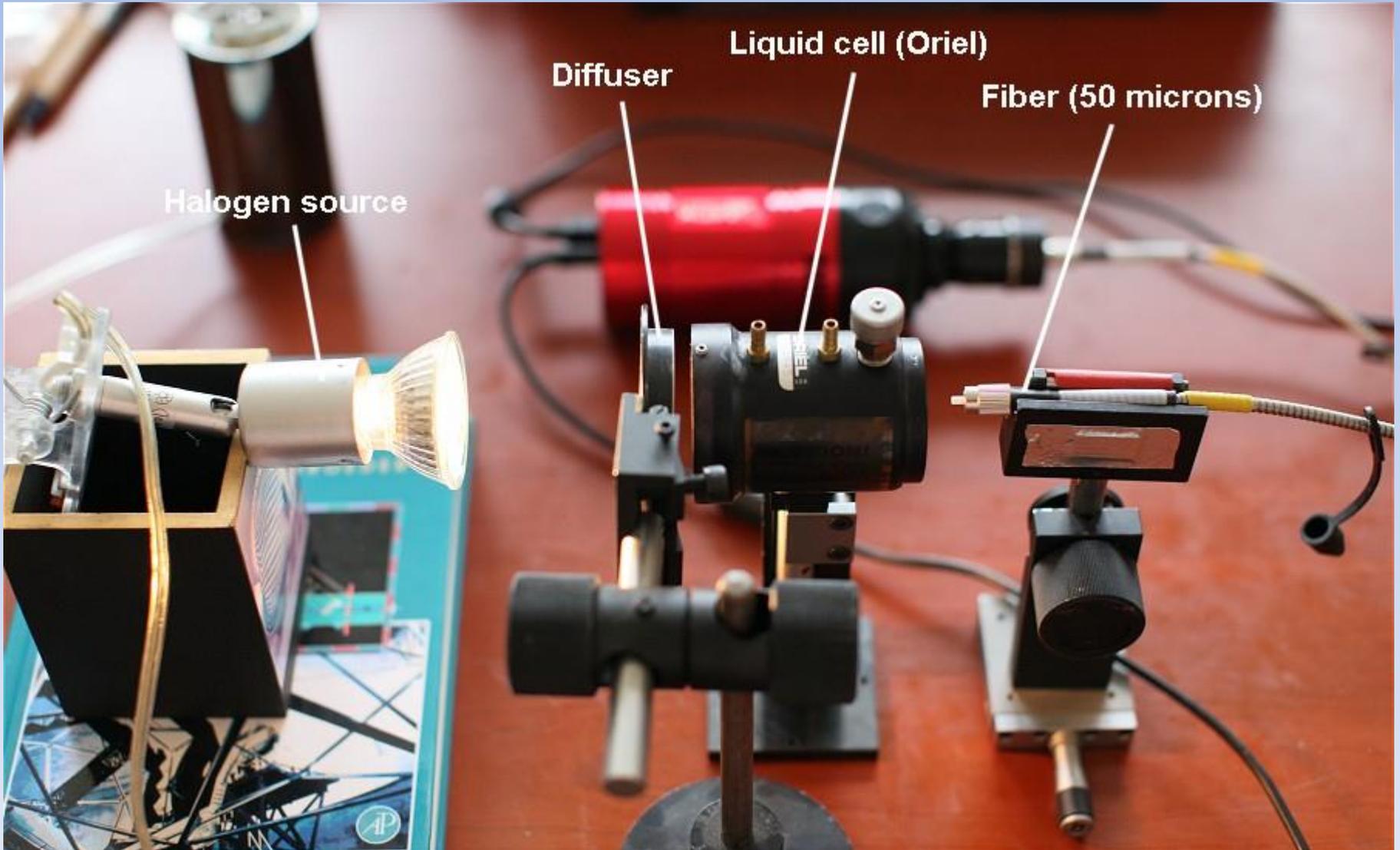
(Travaux pratiques appliqués pour clubs, écoles, universités...)

## Etoile à très faible métallicité (HD 5270)



# Enseignement sur table

(Prise en main de l'instrument, support aux cours de physique, de chimie...)



## Enseignement sur table

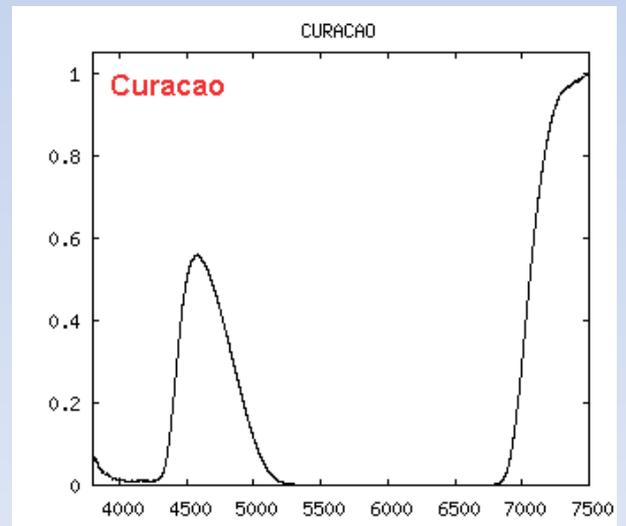
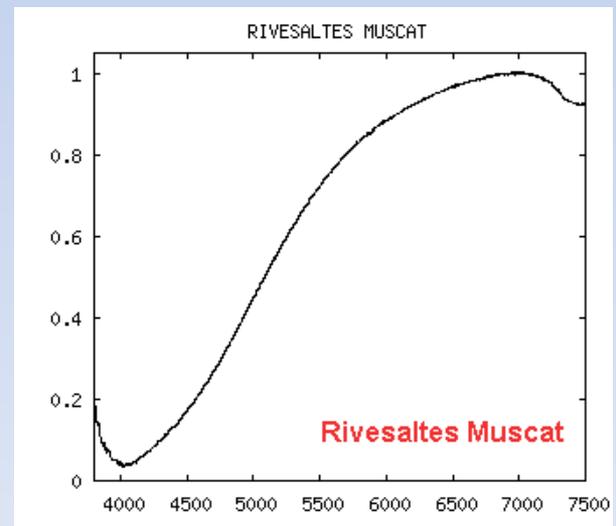
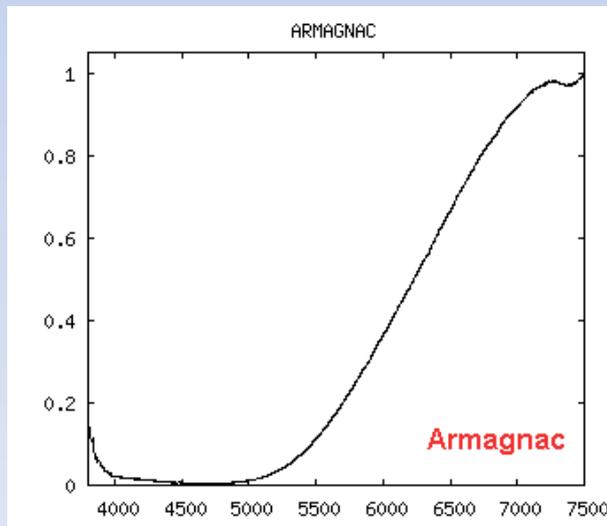
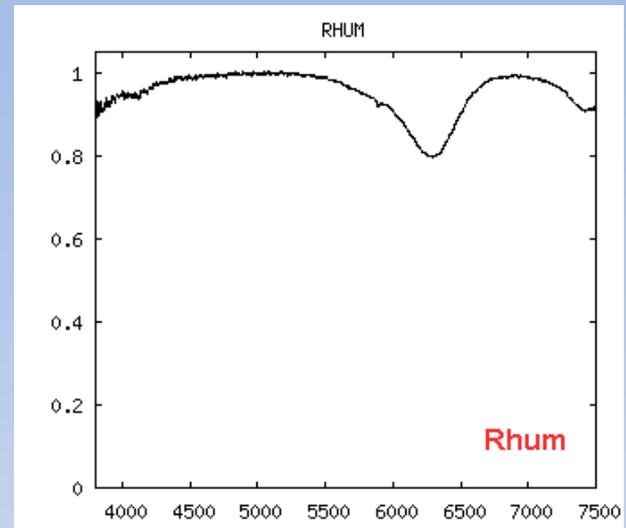
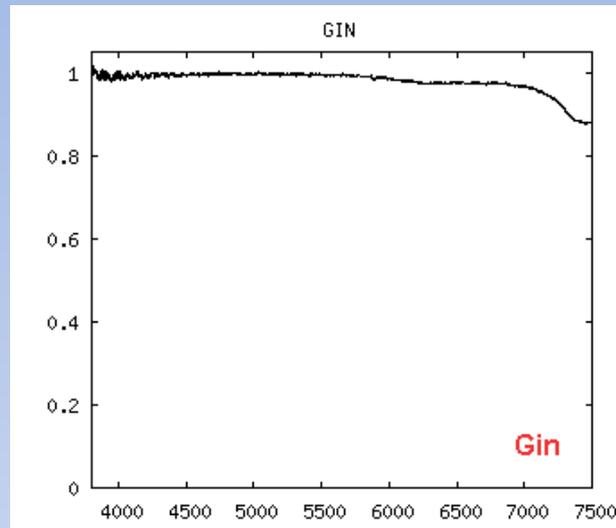
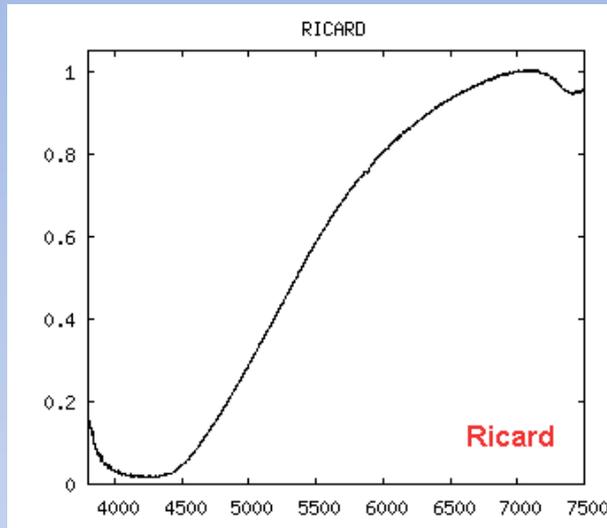
Noter la possibilité de coupler le spectrographe Alpy 600 à une fibre optique



Mesure de l'absorption spectrale (A) de liquides

$$A = \frac{\text{Spectrum taken with the substance}}{\text{Spectrum taken without the substance}}$$

# Enseignement sur table et sur le bar !



# Enseignement : introduction à la télédétection

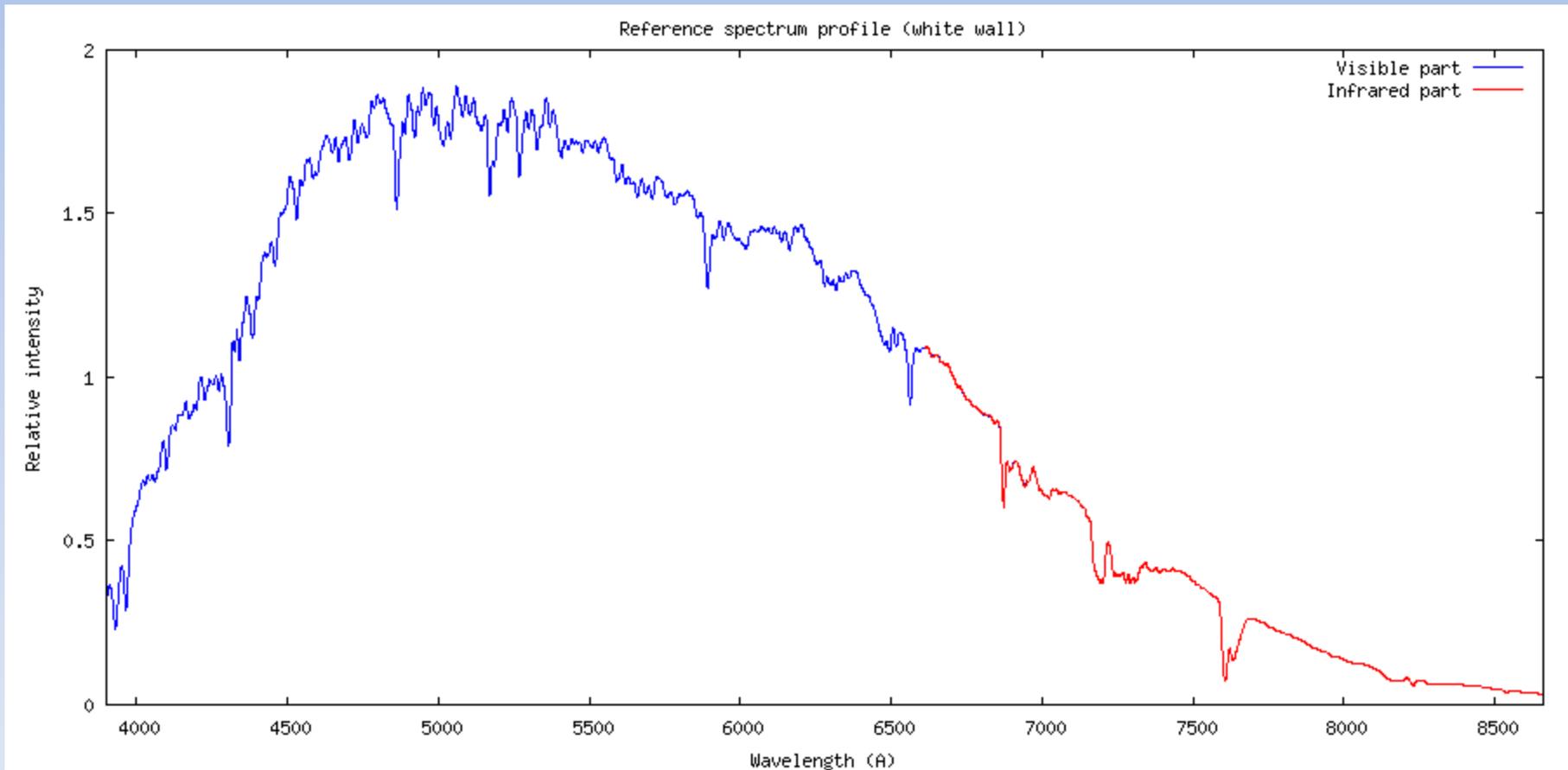
Exploitation de la capacité d'interfacer une optique photo sur Alpy 600



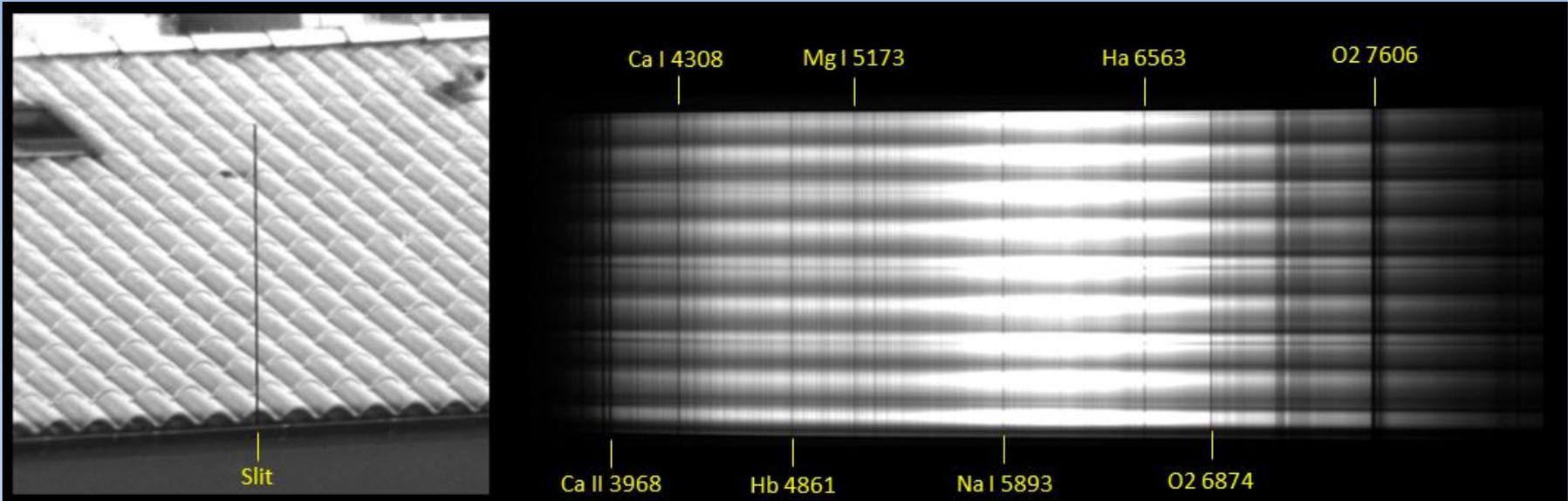
# Téledétection : spectres de réflectance

**Alpy 600 exploité dans le Visible et dans le proche infrarouge (filtre d'ordre WR25)**

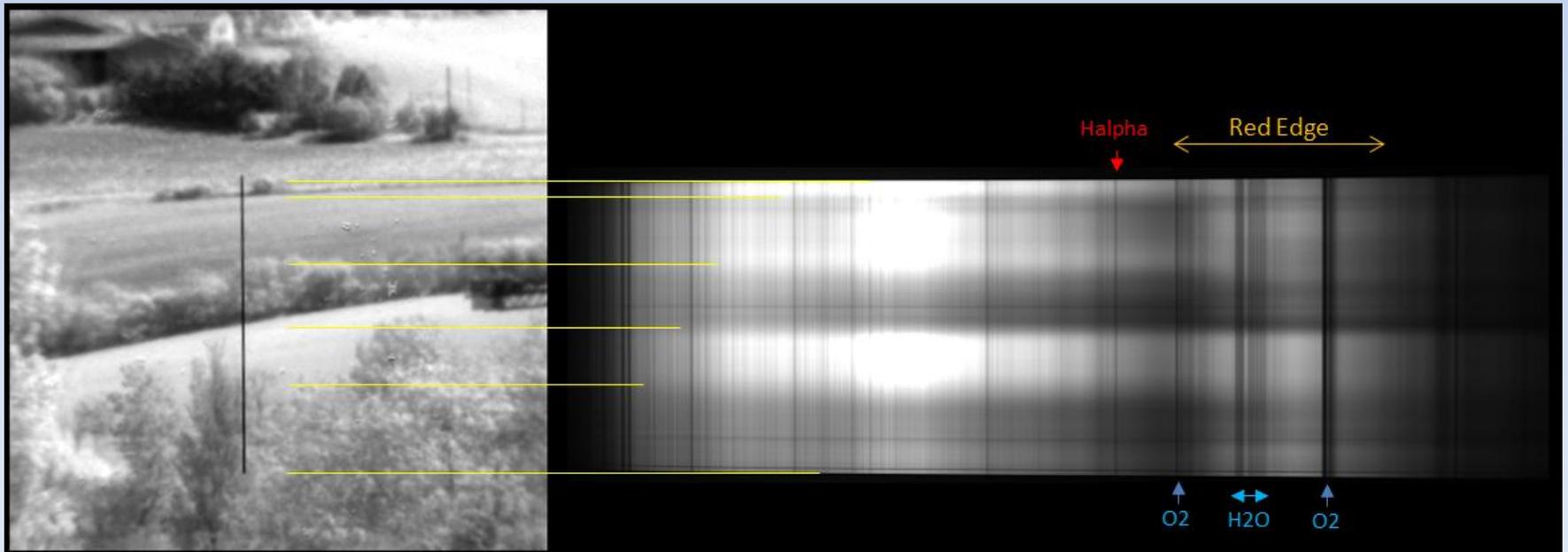
Exemple de fusion des deux portions de spectre (VIS et IR)



# Introduction à la télédétection



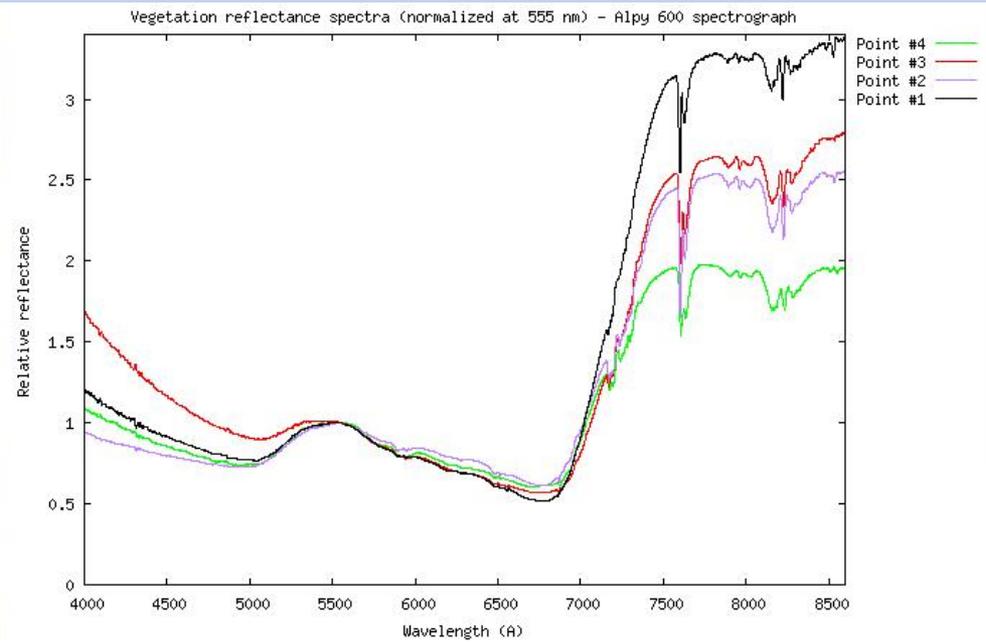
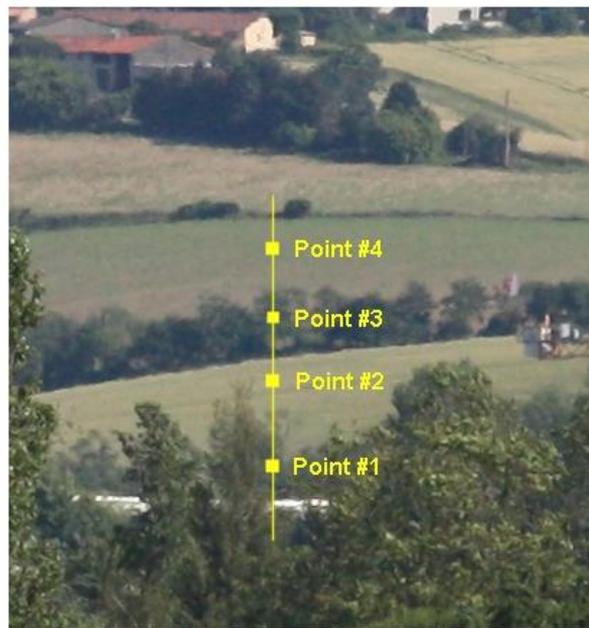
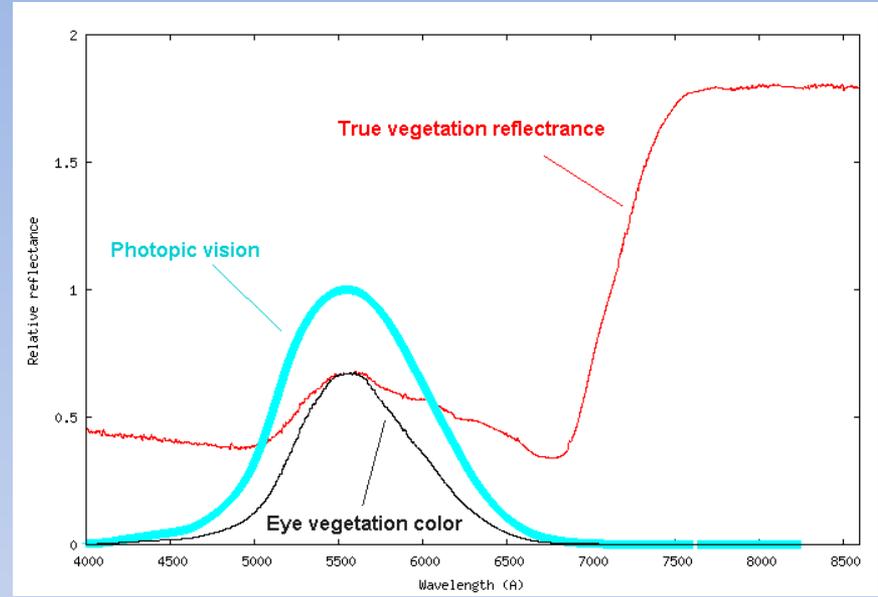
Toiture



Champs agricoles

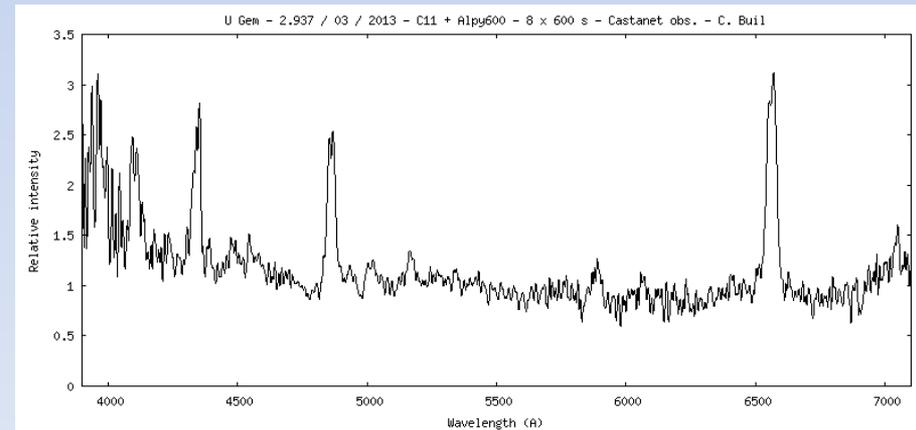
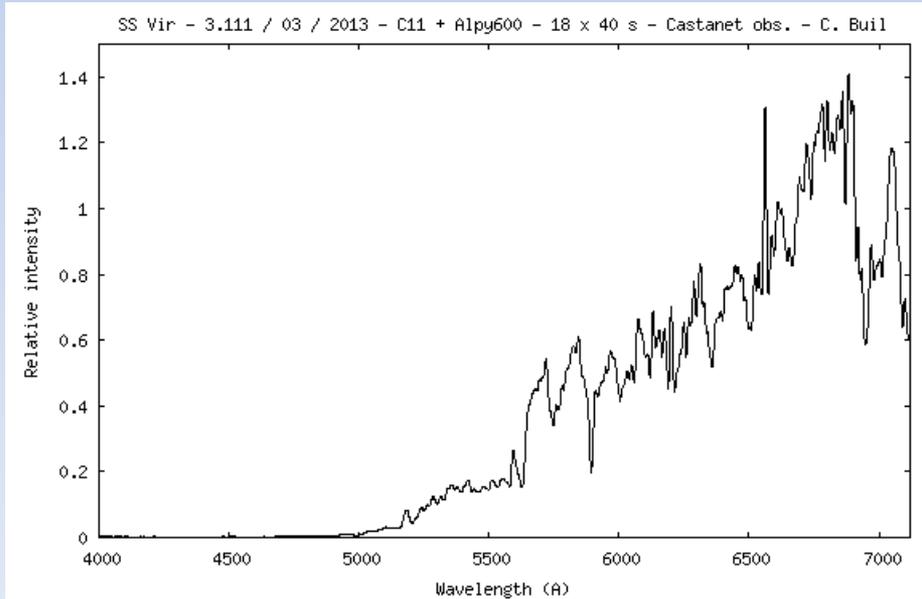
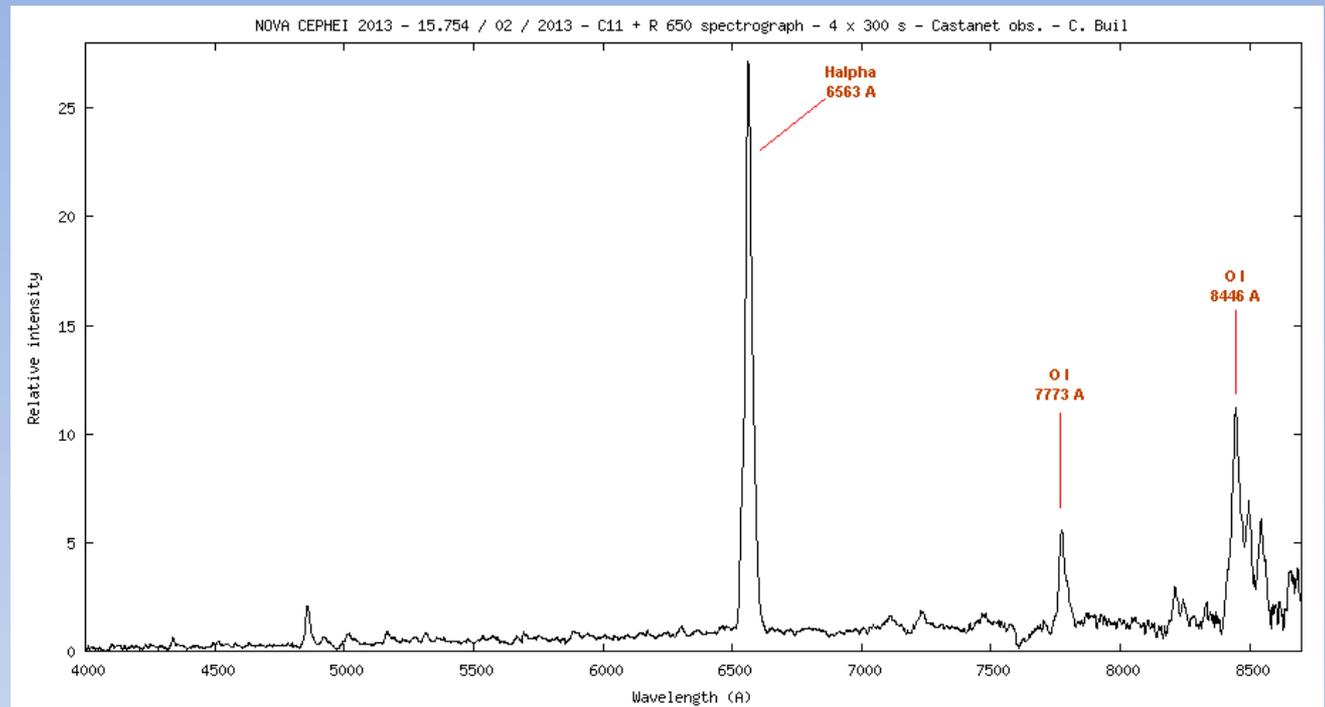
# Introduction à la télédétection

## Mesure du « red-edge » de la végétation



# Objets variables

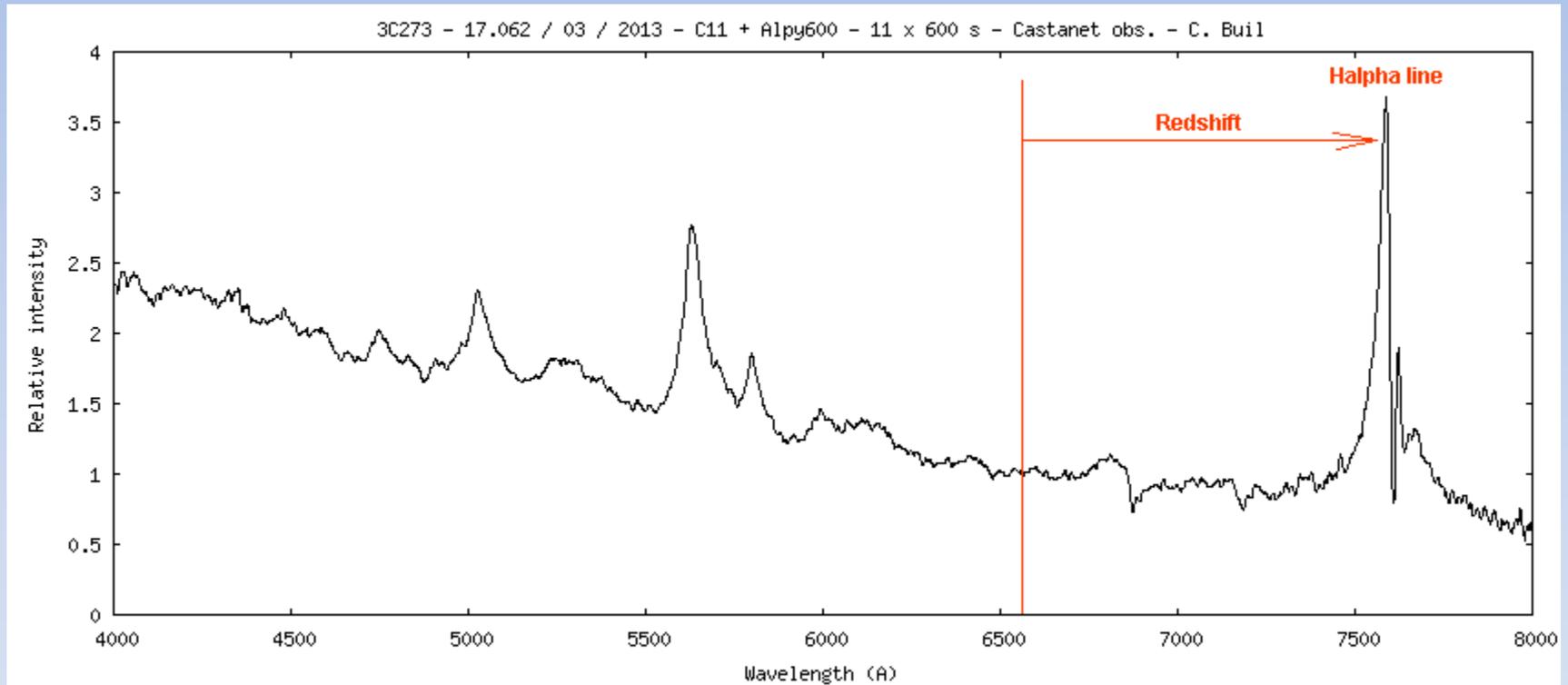
Novae, symbiotique,  
cataclysmique, ...



# Observations faible flux

**Un objet extragalactique classique et facile : le quasar 3C273 ( $V = 12,2$ )**

Alpy 600 sur C11 F/6.4 – Atik 460EX – Exposition 11 x 600 sec. – Observatoire Castanet-Tolosan

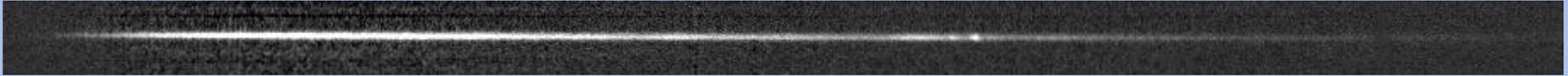


Note : observation en deux parties : VIS + IR

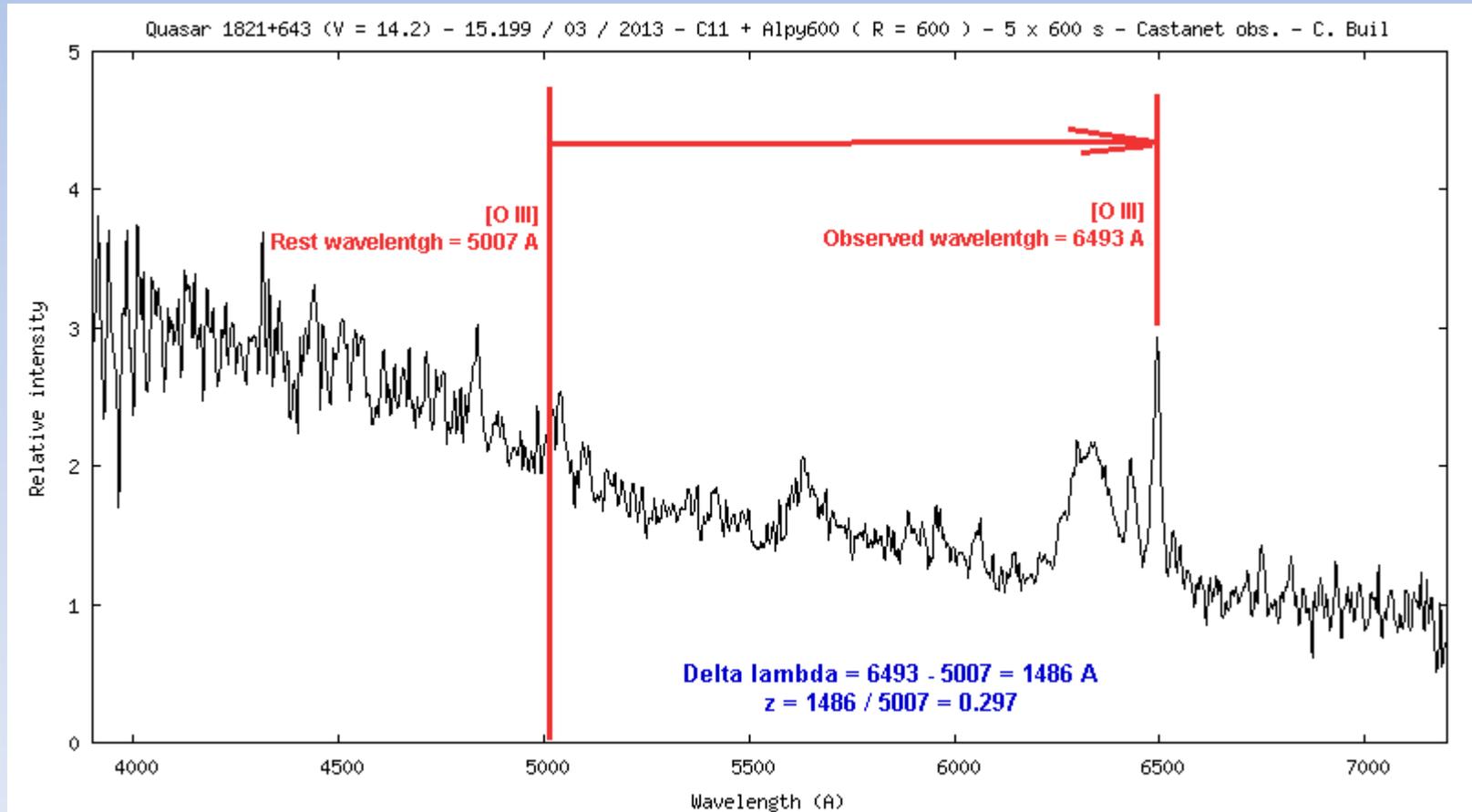
# Observations faible flux

## Quasar 1821+642 (V = 14,2)

Alpy 600 sur C11 F/6.4 – Atik 460EX – Exposition 5 x 600 sec. – Observatoire Castanet-Tolosan



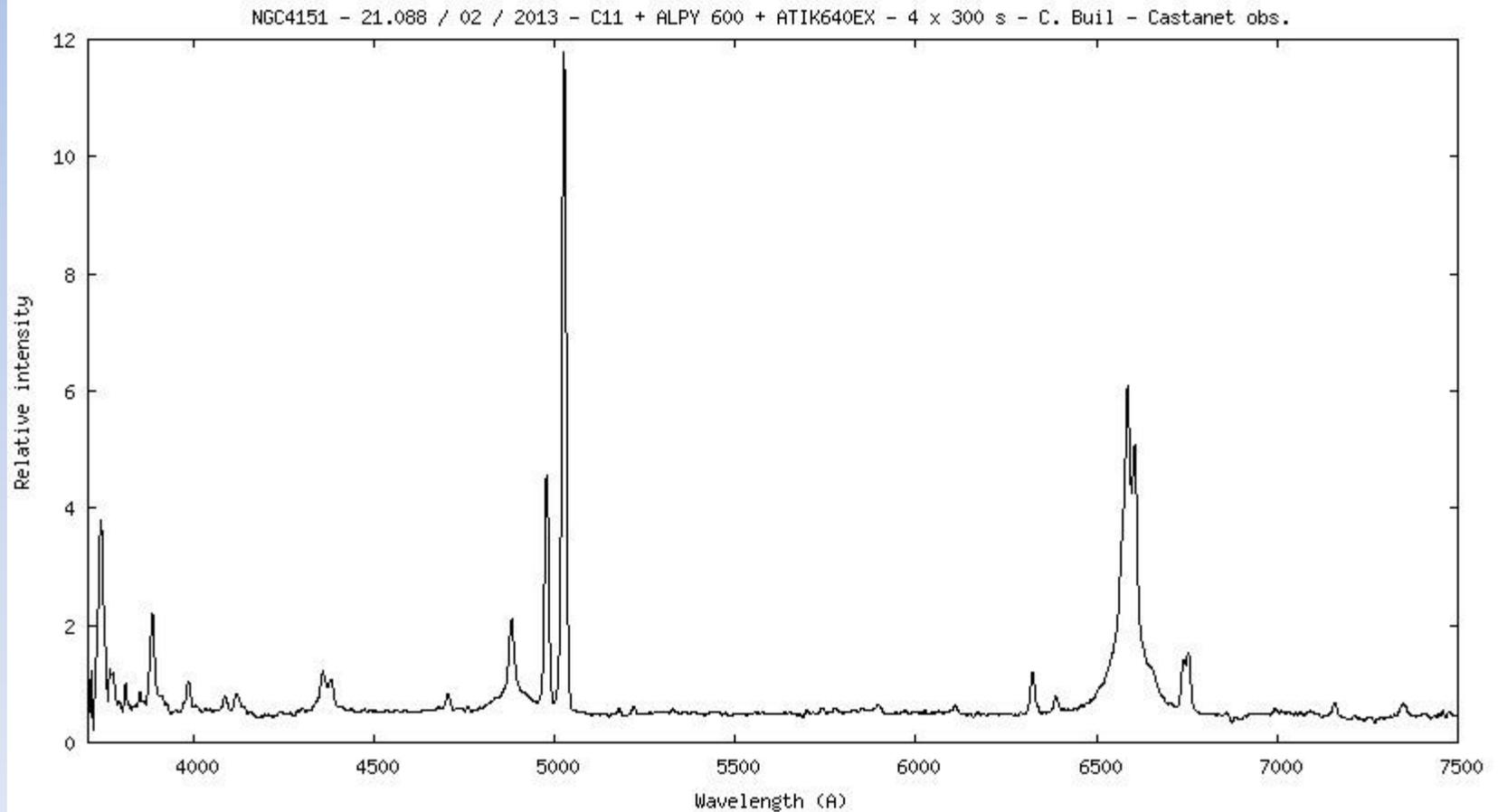
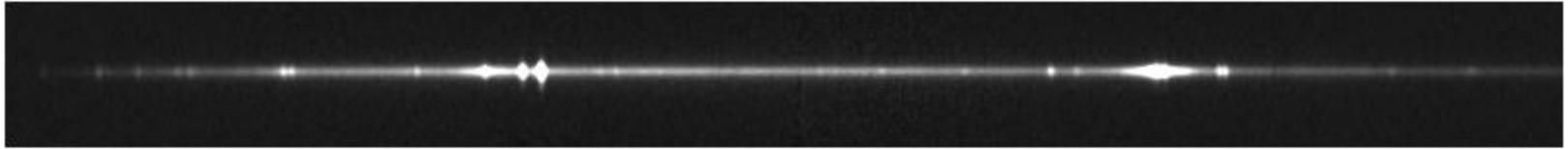
Spectre « 2D »



# Observations faible flux

## Galaxie NGC 4151

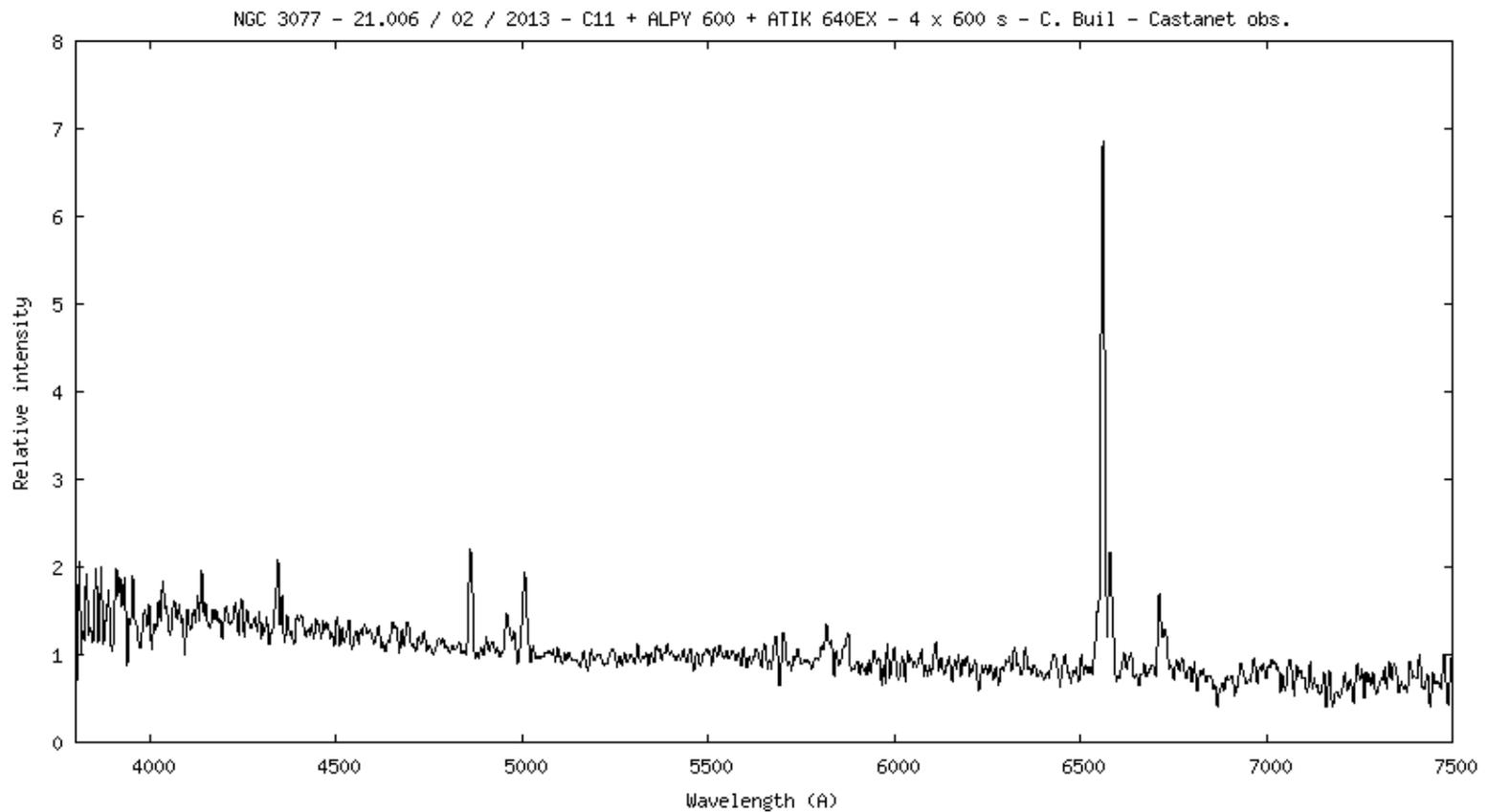
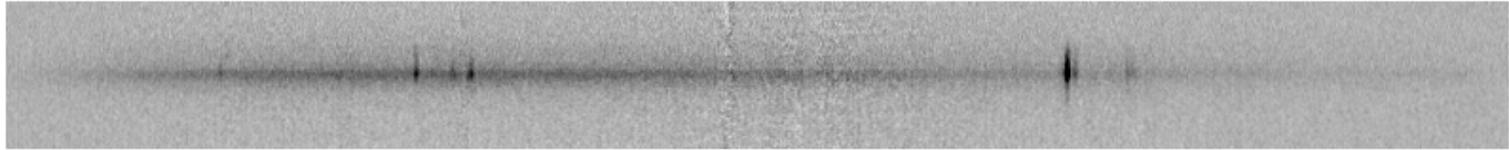
NGC 4151 (Seyfert galaxy) - Alpy 600 spectrograph + C11 telescope (4 x 300 sec. exposure)



# Observations faible flux

## Galaxie NGC 3077

NGC 3077 (Seyfert galaxy) - ALPY 600 spectrograph + C11 telescope (4 x 600 sec. exposure)

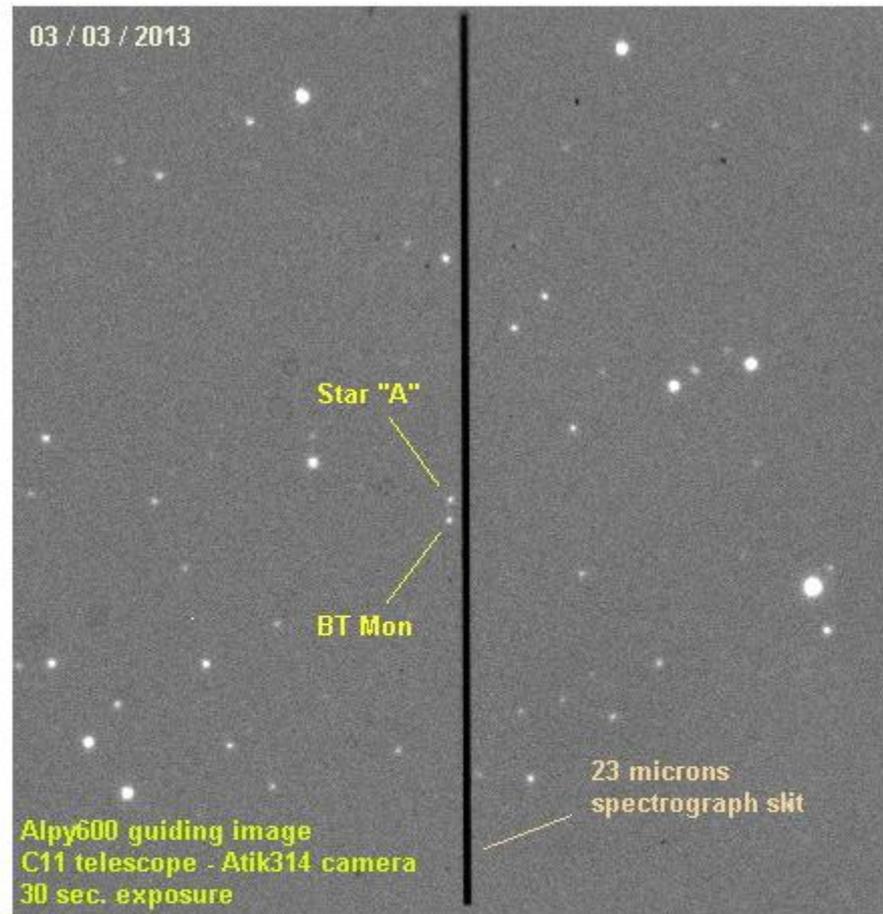


# Survey de novae anciennes : BT Mon (nova 1939) – Spectrographe Alpy 600

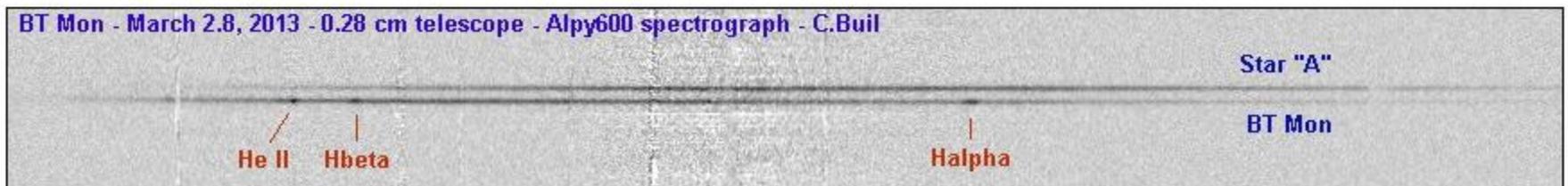
**BT Mon**  
(nova 1939)

2013 Mar 2.855  
V = 15.2 (AAVSO)

Setup:  
0.28-cm telescope  
Alpy 600 spectrograph (R = 600)  
Atik 460EX science camera  
6 x 600 sec. exposure  
Castanet obs.



BT Mon - March 2.8, 2013 - 0.28 cm telescope - Alpy600 spectrograph - C.Buil



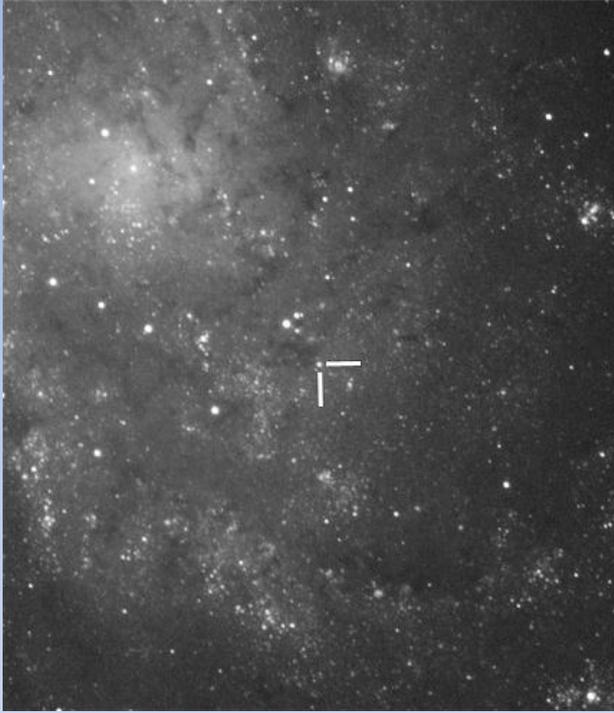
# Eruption de Variable C dans Messier 33 (étoile LBV)

(Atel #5362 – R. M. Humphreys at all)

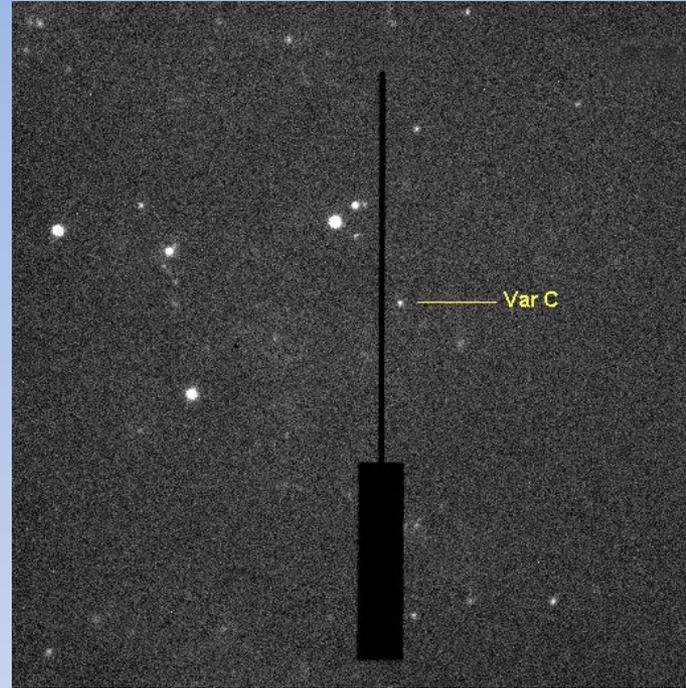


Crédit Pedro Ré  
5 octobre 2013

# Observation d'étoiles extragalactiques !

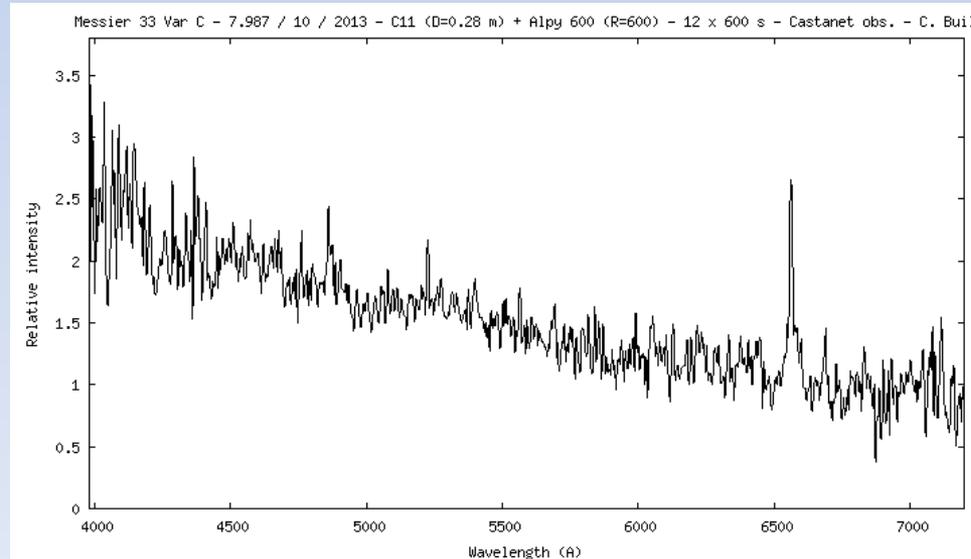


Détail de l'image Pedro Ré



Champ de guidage du spectrographe Alpy 600 (30 sec)

Spectre de Var C  
7.9 octobre 2013  
Magnitude V = 15.8



# Redshift de la galaxie Messier 31 (1/2)



Stage OHP 2013

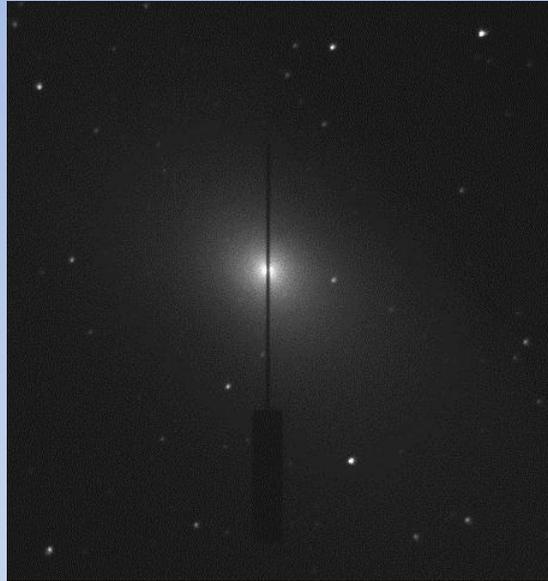
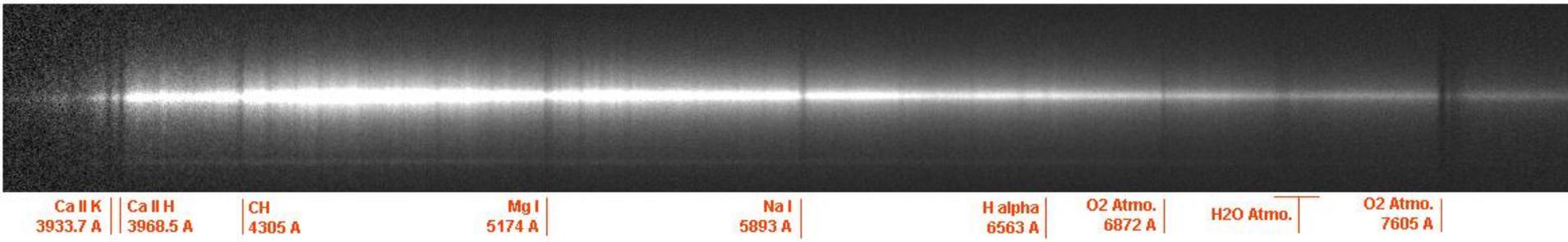
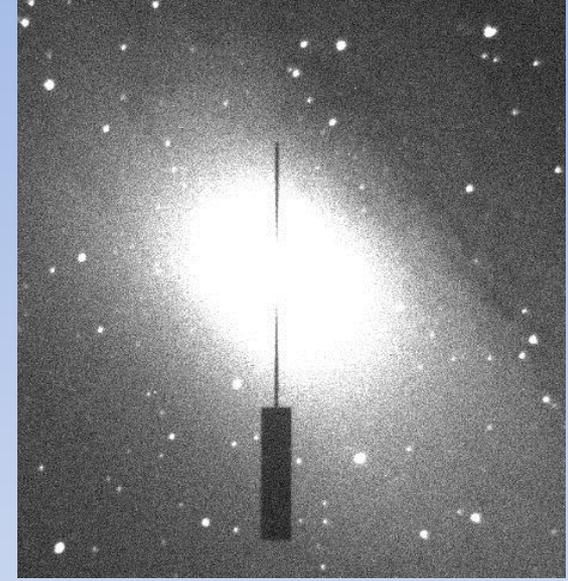


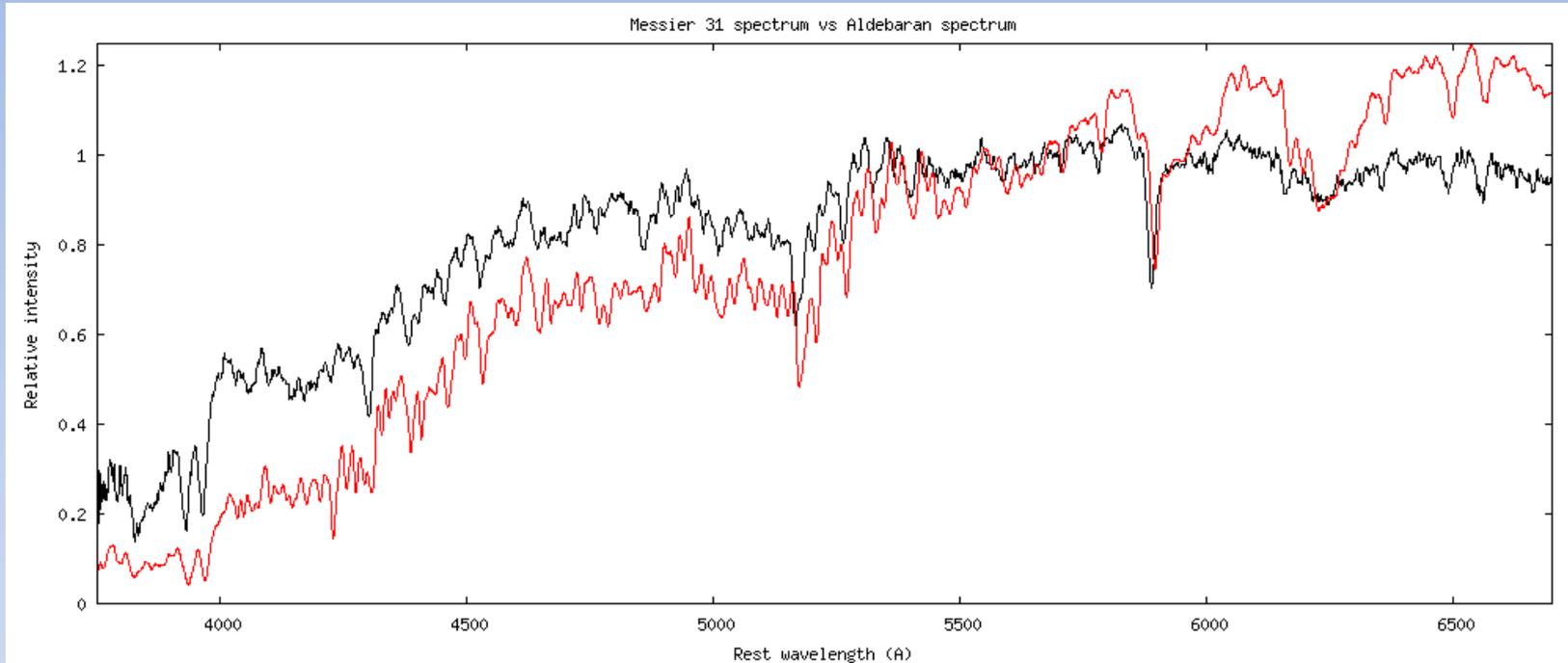
Image de guidage



Spectre 2D – Pose de 4 x 600 secondes (région centrale de M31)

# Redshift de la galaxie Messier 31 (2/2)

## Cross-correlation avec un spectre de Aldebaran



En noir M31, en rouge Aldebaran

1. Image 2. General 3. Calibration 4. Go 5. Profile 6. Grapport Masters Tools Misc Instruments Settings

Helio-centric velocity Radial velocity Atmosphere Extraction Animation DAT -> BeSS MaxDL -> ISIS Detector linearity Detector noise

Compute radial velocity difference

Object spectrum: Messier31 Vh: 0 km/s

Reference spectrum: Aldebaran Vr: -54 km/s

CF 1/2 interval: 3000 km/s Step: 2 km/s Go

Periodogram (Lomb-Scargle algorithm)

Analysed DAT file: rv

Minimal period: 2 Maximal period: 10

Computation step: 0.01 Go

Ephemeris (exoplanet)

Output file: Computation step: 0

JD start: 0 JD end: 0 JD: 0

P: 0 days K: 0 km/s RV: 0 km/s Go

Save: C:\alpyb7\@com11.dat (wavelength base)

Save: C:\alpyb7\@com2.dat (wavelength base)

Save: C:\alpyb7\@com11.dat (velocity base)

Save: C:\alpyb7\@com22.dat (velocity base)

Save CCF: C:\alpyb7\@ccf.dat

Radial velocity difference observed CCF peak = -388.000 km/s

Radial velocity difference fitted CCF peak = -305.011 km/s

(The object coming in)

Cross-correlation function

Blue shift

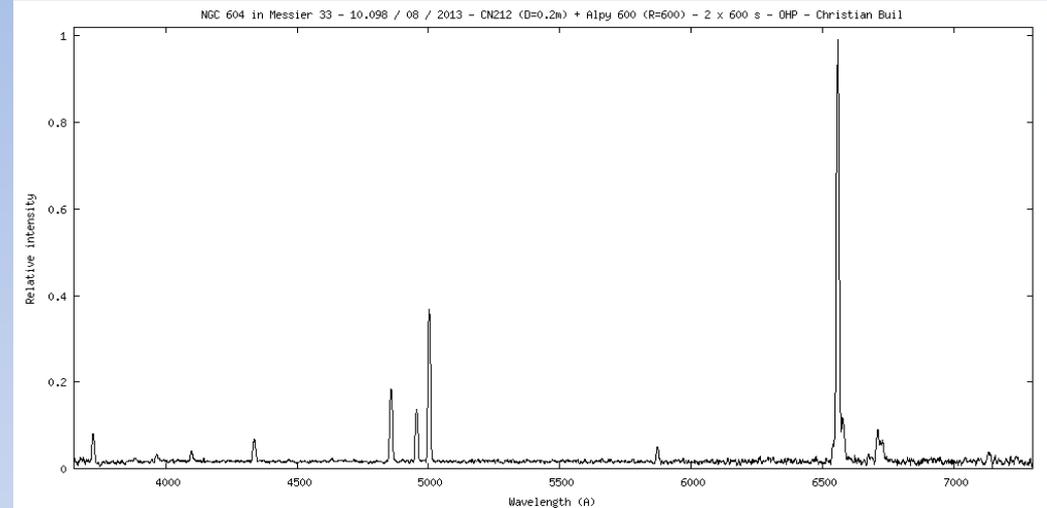
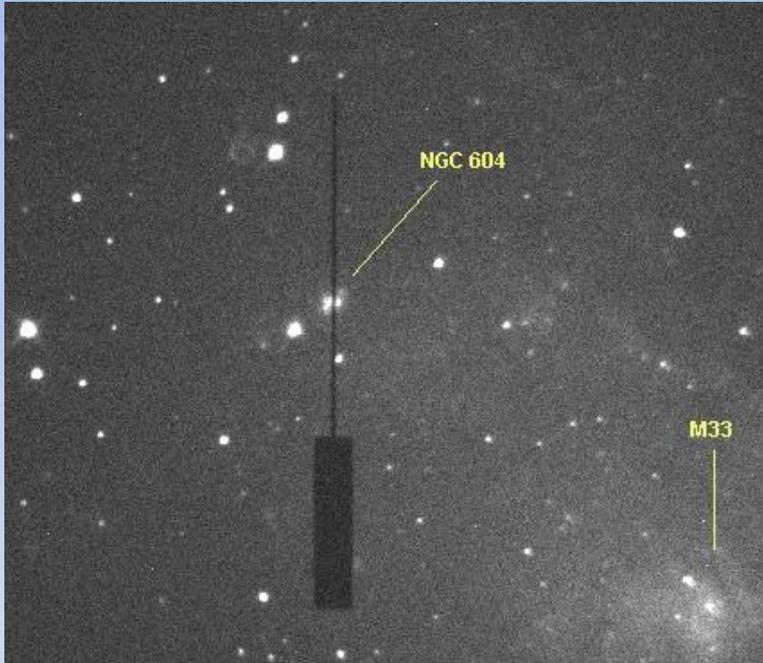
**Mesure Alpy 600 = -305 +/- 50 km/s**

(valeur Simbad = - 301 km/s)

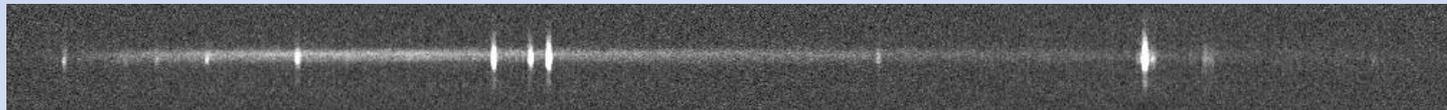
# Redshift de la galaxie Messier 33

Via la nébuleuse extragalactique NGC 604

Alpy 600 sur CN-212 (D = 20 cm)



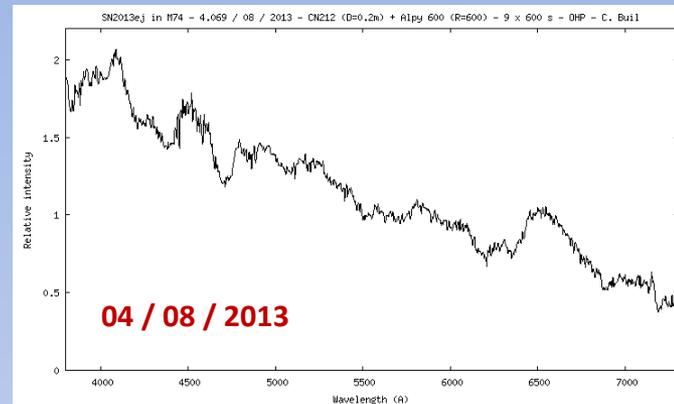
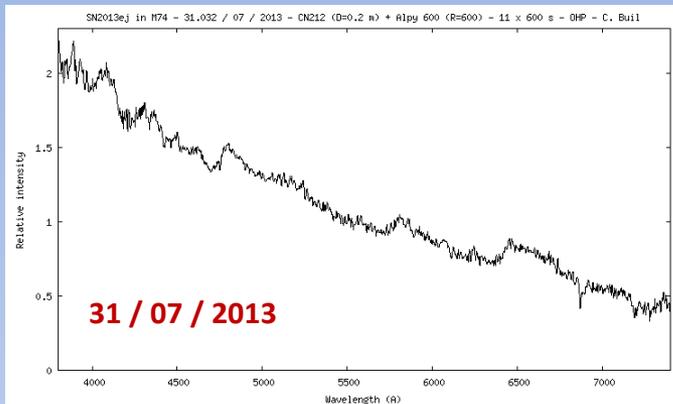
Pose de 2 x 600 secondes



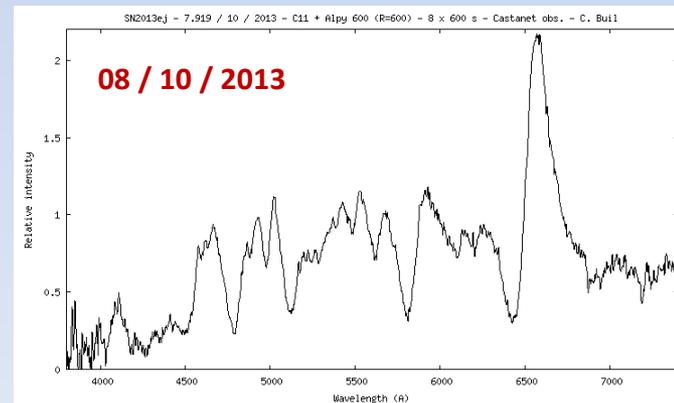
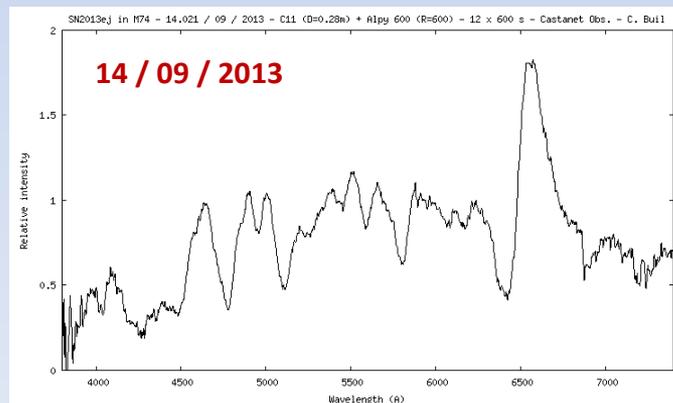
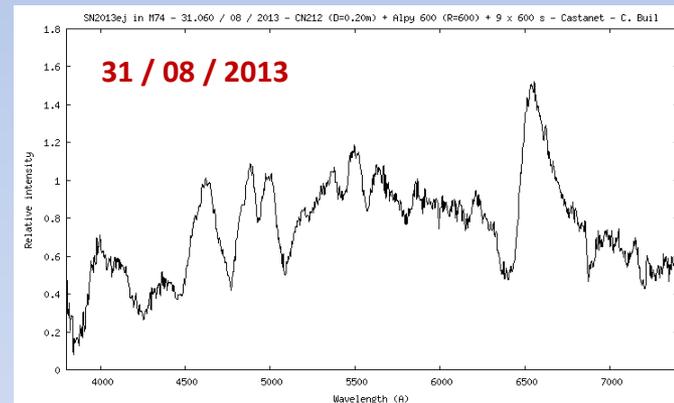
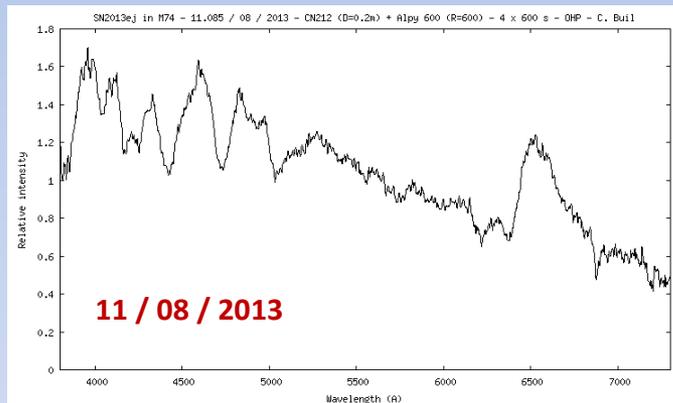
**Mesure Alpy : -214 +/- 40 km/s**

Rosa & all, A&A, 130, 29-38, 1984, indique **-240 km/s** pour NGC 604

# Supernova 2013ej dans Messier 74 – Alpy 600 sur CN212 et C11



**Type IIp**

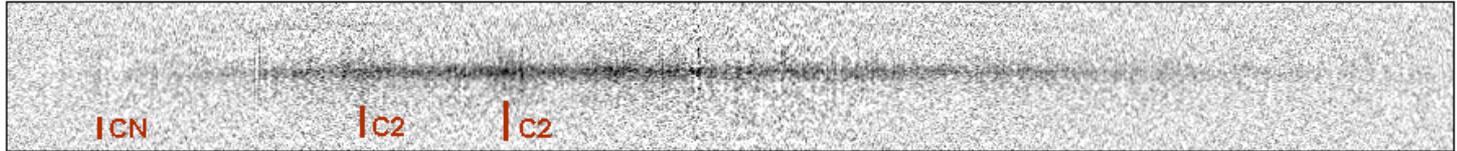


# Premier spectre amateur de la comète ISON (C/2012 S1)

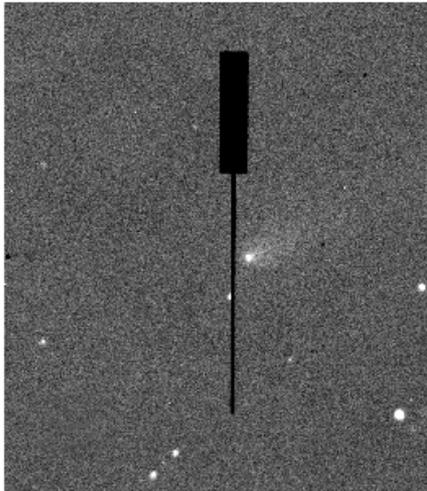
## C/2012 S1 (ISON)

Alpy 600 spectrograph (R = 600)  
on C11 telescope (D = 0.28 m)  
6 x 400 sec. exposure  
Castanet obs. - C. Buil

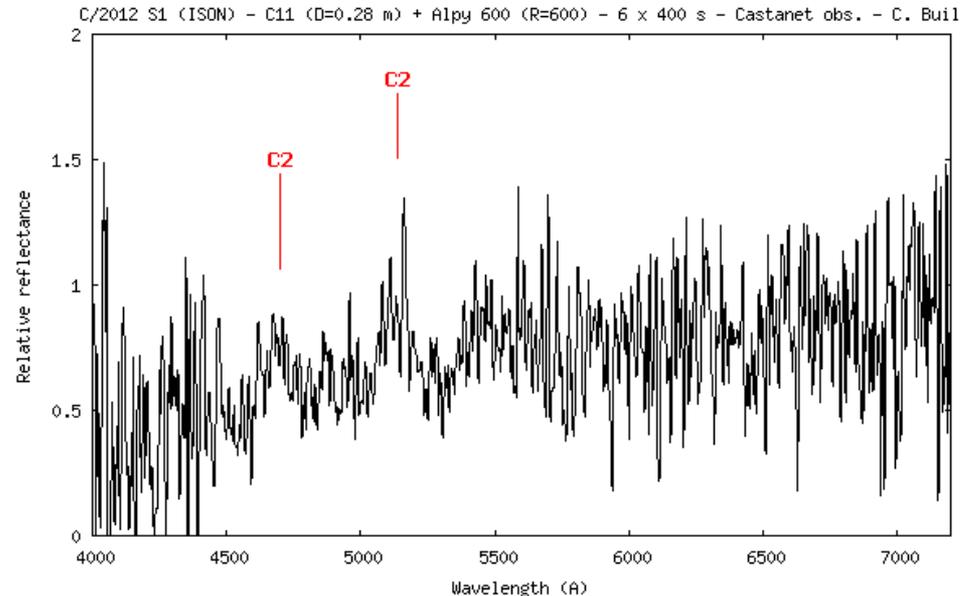
Date; 11.184 Oct. 2013



2D image spectrum after sky removal (6 x 400 sec. exposure). Note possible detection of faint 3880 Å CN line



Alpy 600 guiding image  
Atik 314 CCD camera - 30 sec. exp.  
Slit 23 microns / 230 microns



Extracted reflectance spectrum.

The ISON comet spectrum is here divided by solar type star HD86728 spectrum observed same night. Faint C2 emission is detected.



## NASA Comet ISON Observing Campaign

<a href="#">Home</a>	<a href="#">The CIOOC</a> >	<a href="#">Comet ISON</a> >	<a href="#">Workshop</a> >	<a href="#">Blog</a>	<a href="#">Resources</a>	<a href="#">FAQs</a>	<a href="#">Contact Us</a>
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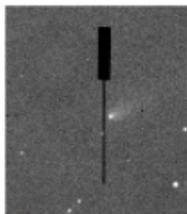
[Home](#) » [ISON Image of the Week](#)

### ISON Image of the Week

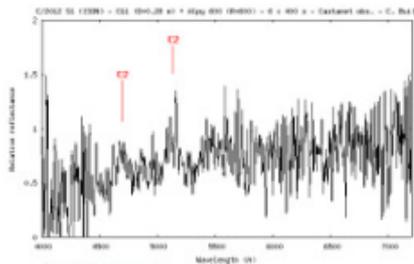
#### First Amateur Spectrum of Comet ISON (Oct 14, 2013)

##### C/2012 S1 (ISON)

Alpy 600 spectrograph (R = 500)  
on C11 telescope (D = 6.28 m)  
6 x 400 sec. exposure  
Castanet obs. - C. Buil  
Date: 11.104 Oct. 2013



Alpy 600 guiding image  
Atk 214 CCD camera - 30 sec. exp.  
580.23 microns / 7.20 microns



The first amateur spectrum of comet C/2012 S1 (ISON) in which we clearly see the C2 emission and a probable detection of CN. These are common features in comets, but this does not detract from the fantastic achievement of an amateur astronomer obtaining a spectrum of what is still a relatively small, faint and distant target!

[Image credit: [Christian Buil/Castanet-Tolosan Observatory \(France\)](#)]

facilities.

But there are exceptions to every rule, and this week we have an *exceptional* exception! Last week, amateur astronomer [Christian Buil](#) was able to obtain the first "amateur" ground based spectrum that we have seen for comet ISON using an "Alpy 600" spectrograph on a 28cm telescope at the Castanet-Tolosan Observatory, near

Scientists study comets for many reasons including how they formed, what their mass and density is, what physical and chemical processes are occurring on their surface and within their core, and even what would happen if a large one impacted our planet! That list is far from exhaustive but fundamental to all of those questions, and many others we have, is this: *what are comets made of?*

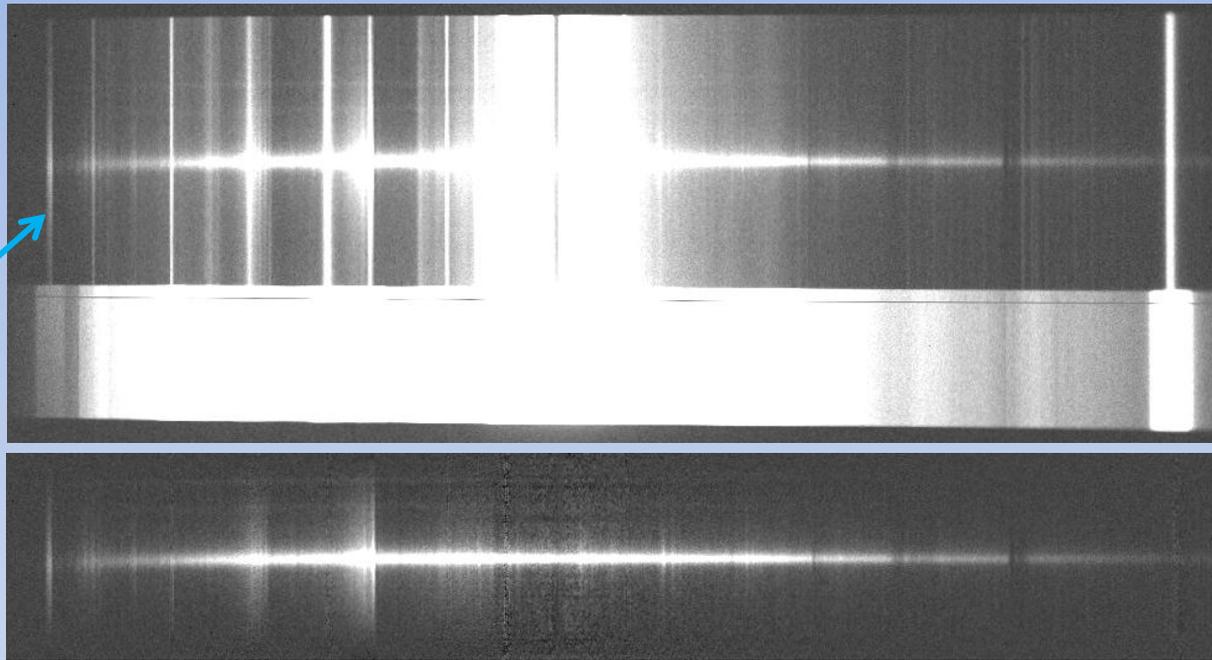
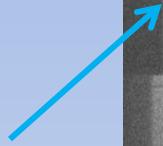
By studying their composition, we can gain tremendous insight into comets and begin to find answers to many of these questions. However, performing these studies is not simple. We can [send probes](#) to comets, but that is expensive and lengthy, and thus is something we rarely can do. In the meantime we have to find other ways to study the composition of comets, and the primary method of doing that is with the scientific technique called *spectroscopy*.

[Spectroscopy](#) is a method in which we study the properties of an object based on the light that we see coming from it (including reflected light). From Earth, spectroscopy can be tricky as our own atmosphere [blocks certain wavelengths of light](#), so most of this work is performed from space by telescopes such as [Spitzer](#) that have a clear view of the entire electromagnetic spectrum. A certain amount of spectroscopy can be done from Earth but it requires a lot of skill and specialized equipment, so remains primarily the domain of large astronomy

# Comète C/2013 R1 (LOVEJOY)

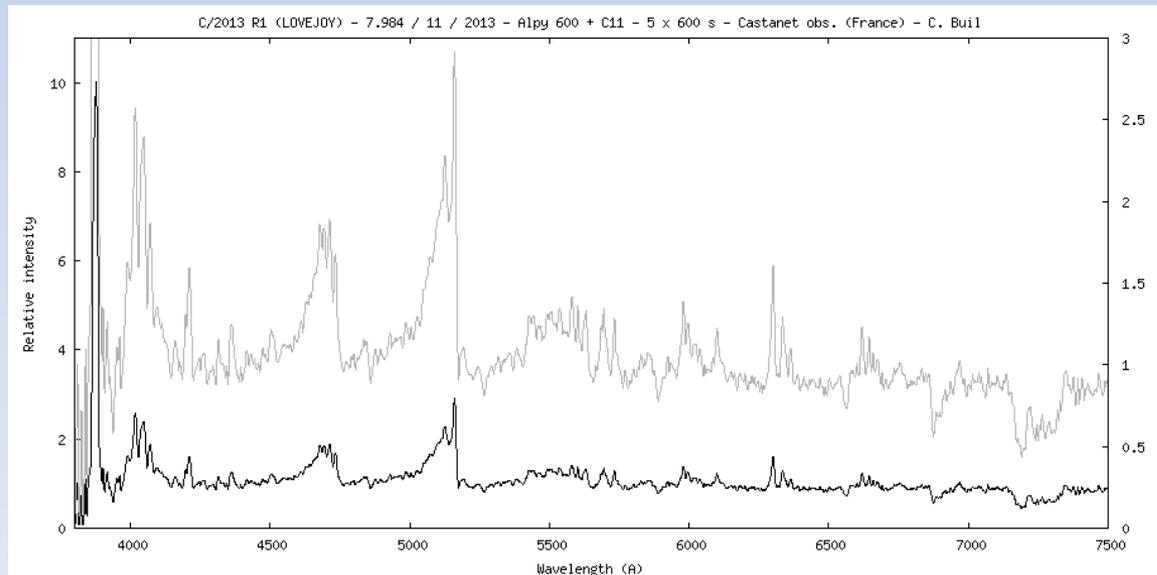
7.98 / 11 / 2013 – Alpy 600 sur Celestron 11 – 5 x 600 sec. – Castanet-Tolosan

Raie du CN  
3880 Å



Zone utile

Fente photométrique



# Nova Delphini 2013 : découverte le 14,5 août 2013 (V = 6.8)



**16 août 2013**

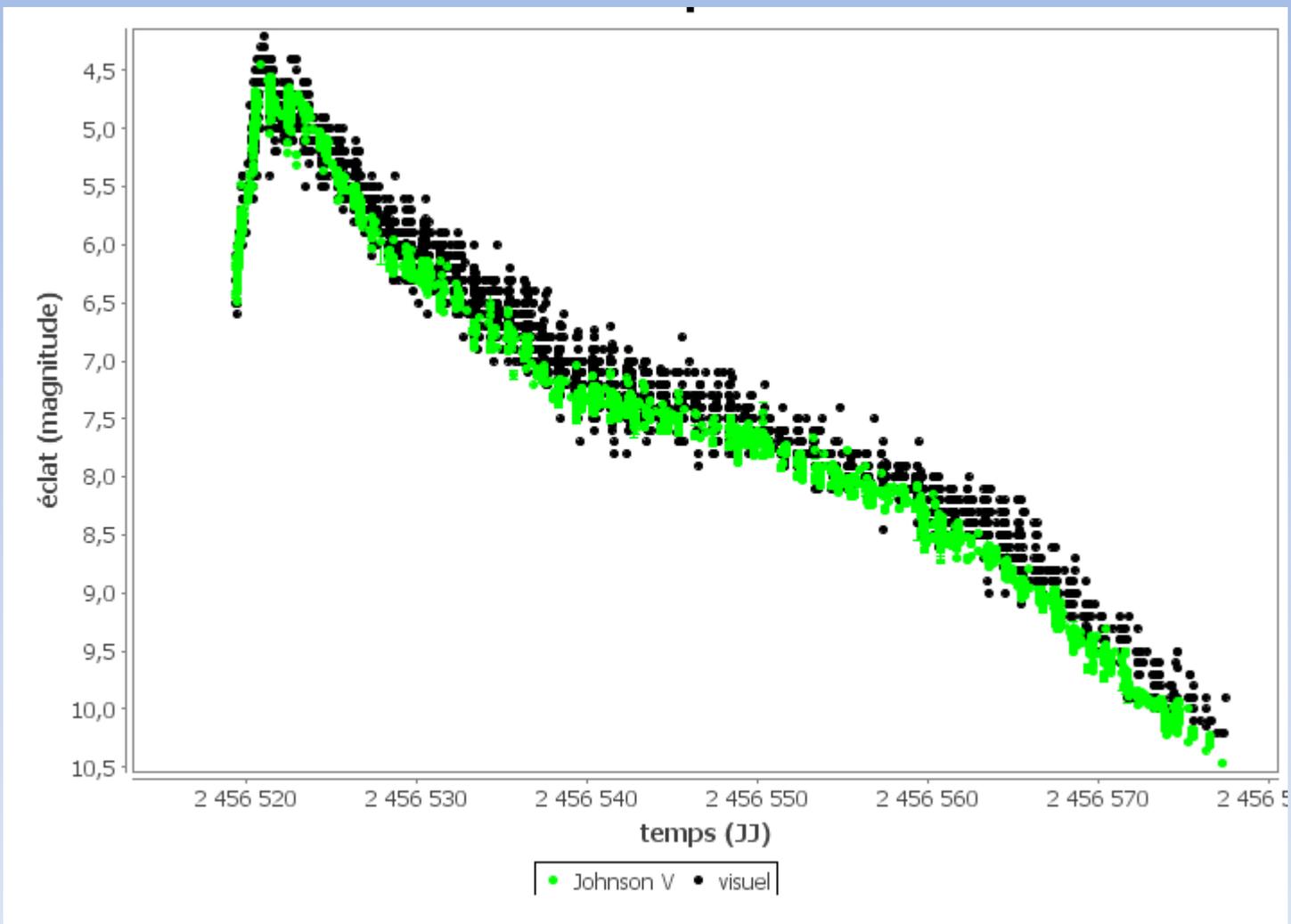
Crédit: Efrain Morales/Jaicoa Observatory.

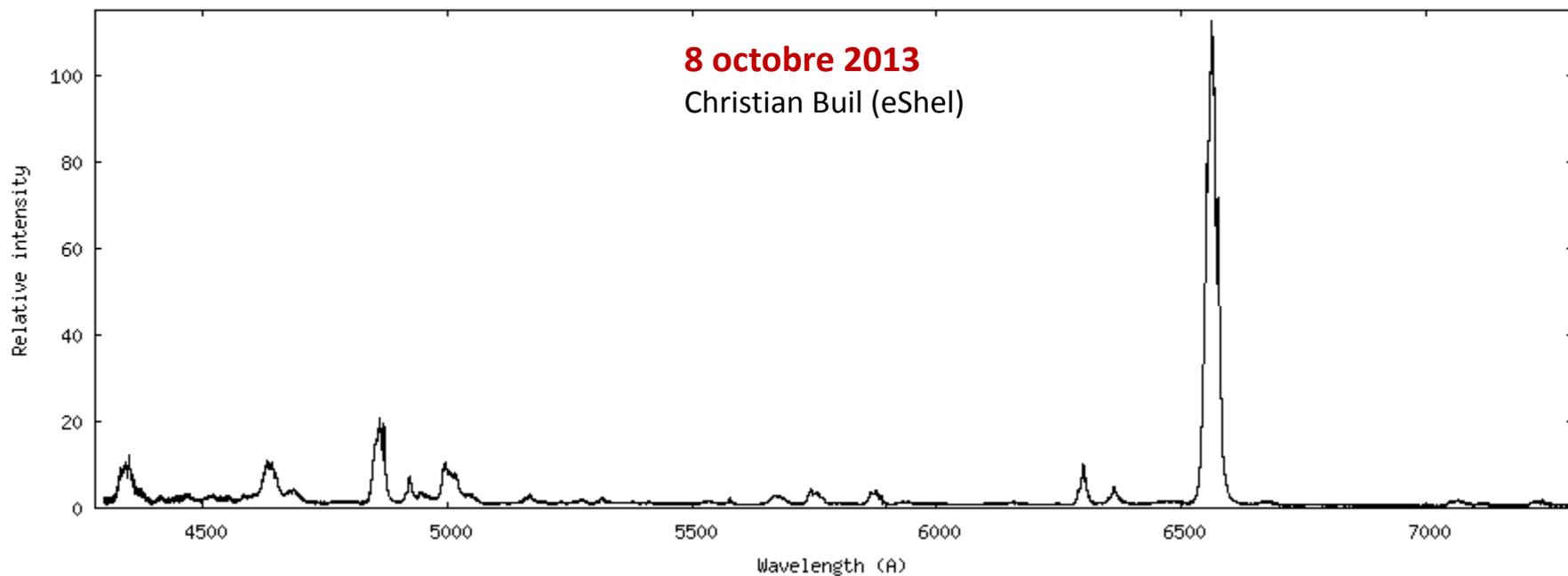
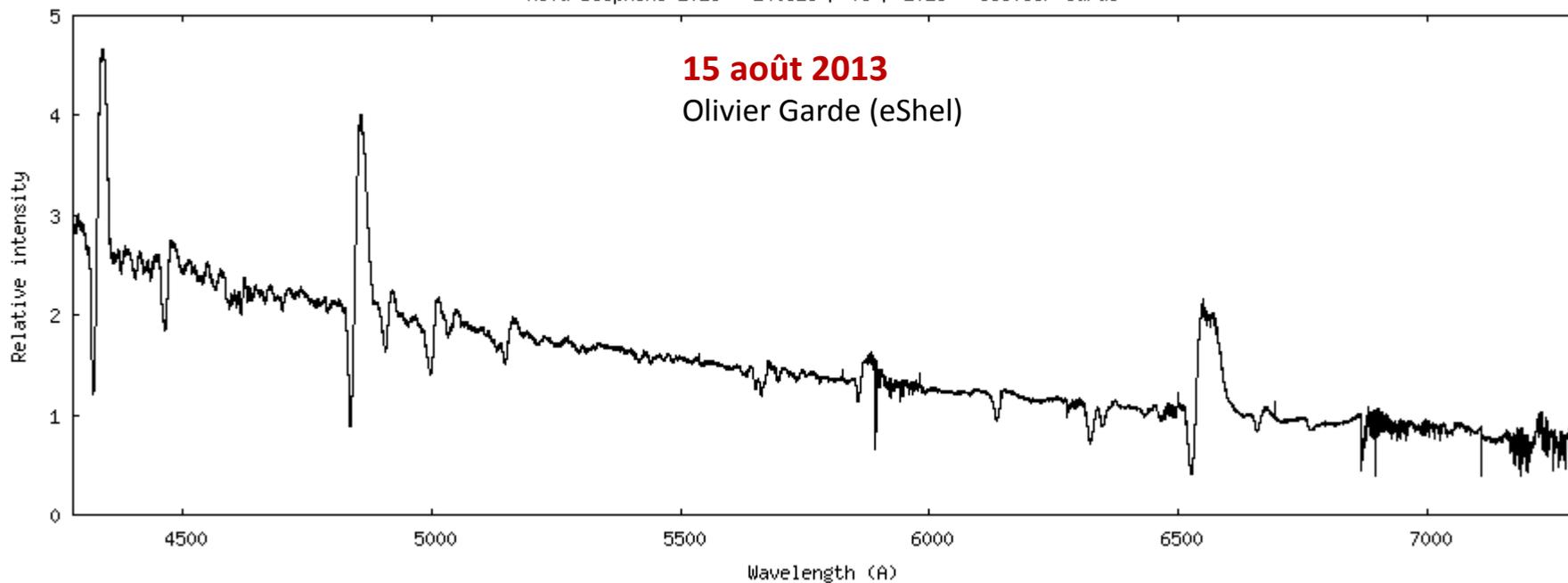


**6 octobre 2013**

Crédit : Pierre Thierry

# Nova Delphini 2013 : courbe de lumière (source AAVSO)





# Log des observation : Compilation ARAS (François Teyssier)

										Download : Right click on file and Choose "Save As"		
#	Date	Start Time (UT)	Mid J.D.	Observer	Site	Instrument	Resolution	Range	Exposure (s)	File	Zip	Validation
1	14/08/2013	19:45:16	2456519.344	OlivierGarde	Observatoirede	C14-Eshel-ATIK460EX	10000		3636	<a href="#">novadel2013_20130814_823_full.fit</a>	<a href="#">zip1</a>	v
2	14/08/2013	20:45	2456519.385	OlivierGarde	Observatoirede	C14-Eshel-ATIK460EX	10000	4185 - 7318	3349	<a href="#">novadel2013_20130814_865_full.fit</a>	<a href="#">zip2</a>	v
3	14/08/2013	21:12:32	2456519.396	ThibaultdeFrance	Meze	C9.25LISAATIKTIT		4864 - 6805	1320.022	<a href="#">novadel2013_20130814_3837_TdeFrance.fit</a>		v
4	14/08/2013	21:12:32	2456519.396	TdeFrance	MEZE	C9.25LISAATIKTITA	608	4869 - 6798	2130.002	<a href="#">novadel2013_20130814_3837_TdeFrance.fit</a>		v
5	14/08/2013	21:38:09	2456519.405	J.Guarro	STAMARIADEMONTM	16REMOTATIK460EX	754	3731 - 7427	623	<a href="#">novadel2013_20130814_901_J.Guarro.fit</a>		v
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8	14/08/2013	21:48:35	2456519.412	J.Guarro	STAMARIADEMONTM	16REMOTATIK460EX	754	3741 - 7431	621	<a href="#">novadel2013_20130815_909_J.GUARRO.fit</a>		v
9	14/08/2013	21:58:59	2456519.42	J.Guarro	STAMARIADEMONTM	16REMOTATIK460EX	754	3741 - 7431	624	<a href="#">novadel2013_20130814_916_J.Guarro.fit</a>		v
10	14/08/2013	22:07	2456519.443	OlivierGarde	Observatoirede	C14-Eshel-ATIK460EX	10000	4185 - 7318	3635	<a href="#">novadel2013_20130814_922_full.fit</a>	<a href="#">zip3</a>	v
11	14/08/2013	22:09:26	2456519.427	J.Guarro	STAMARIADEMONTM	16REMOTATIK460EX	754	3741 - 7431	621	<a href="#">novadel2013_20130814_923_J.Guarro.fit</a>		v
12	14/08/2013	22:15	2456519.449	OlivierThizy	Revel38420	TV85Alpy600Atik460E	556	3676 - 7350	3695	<a href="#">novadel2013_20130814_928.fit</a>		v
13	14/08/2013	22:19:50	2456519.434	J.Guarro	STAMARIADEMONTM	16REMOTATIK460EX	771	3741 - 7431	623	<a href="#">novadel2013_20130814_930_J.Guarro.fit</a>		v
14	14/08/2013	22:40:24		P.J.H.Gerlach	Houten,TheNetherl	GSO8RCDADOSR:600	600	3891 - 7453	600	<a href="#">novadel2013_20130814_945_Gerlach.fit</a>		v
15	14/08/2013	22:54:54	2456519.458	J.Guarro	STAMARIADEMONTM	16REMOTATIK460EX	749	3741 - 7431	626	<a href="#">novadel2013_20130814_955_J.Guarro.fit</a>		v
16	14/08/2013	22:59:49	2456519.474	TdeFrance	MEZE	C9.25LISAATIKTITA	612	4869 - 6799	2718.002	<a href="#">novadel2013_20130814_4582_TdeFrance.fit</a>		v
17	14/08/2013	23:06:27	2456519.466	J.Guarro	STAMARIADEMONTM	16REMOTATIK460EX	755	3714 - 7431	522	<a href="#">novadel2013_20130814_963_J.Guarro.fit</a>		v
18	14/08/2013	23:07	2456519.485	OlivierGarde	Observatoirede	C14-Eshel-ATIK460EX	10000	4185 - 7318	3683	<a href="#">novadel2013_20130814_964_full.fit</a>	<a href="#">zip4</a>	v
19	14/08/2013	23:15:12	2456519.472	J.Guarro	STAMARIADEMONTM	16REMOTATIK460EX	755	3715 - 7431	528	<a href="#">novadel2013_20130814_969_J.Guarro.fit</a>		v
20	14/08/2013	23:24:02	2456519.479	J.GUARRO	STAMARIADEMONTM	16REMOTATIK460EX	755	3715 - 7431	688	<a href="#">novadel2013_20130814_975_J.Guarro.fit</a>		v
21	14/08/2013	23:40:22	2456519.489	J.GUARRO	STAMARIADEMONTM	16REMOTATIK460EX	772	3715 - 7431	421	<a href="#">novadel2013_20130814_986_J.GUARRO.fit</a>		v
22	14/08/2013	23:45:07	2456519.507	TdeFrance	MEZE	C9.25LISAATIKTITA	614	4868 - 6798	2959.001	<a href="#">novadel2013_20130814_4897_TdeFrance.fit</a>		v
23	14/08/2013	23:49	2456519.514	OlivierThizy	Revel38420	TV85Alpy600Atik460E	607	3676 - 7350	3695	<a href="#">novadel2013_20130814_993.fit</a>		v
24	15/08/2013	00:02:34	2456519.504	J.GUARRO	STAMARIADEMONTM	16REMOTATIK460EX	741	3715 - 7431	423	<a href="#">novadel2013_20130815_002_J.GUARRO.fit</a>		v
25	15/08/2013	0:09	2456519.527	OlivierGarde	Observatoirede	C14-Eshel-ATIK460EX	10000	4266 - 7318	3624	<a href="#">novadel2013_20130815_006_full.fit</a>	<a href="#">zip5</a>	v
26	15/08/2013	00:09:40	2456519.509	J.GUARRO	STAMARIADEMONTM	16REMOTATIK460EX	772	3715 - 7431	422	<a href="#">novadel2013_20130815_007_J.GUARRO.fit</a>		v



910	12/10/2013	00:20:56	2456577.54	kgraham	Manhattan,IL	lx20010"AlpyAti	519	3603 - 7403	4561	<a href="#">v339del_20131012_015_kgraham.fit</a>		v
911	12/10/2013	00:23:34	2456577.55	kgraham	Manhattan,IL	lx20012"Lhires24	12856	6475 - 6646	6072	<a href="#">v339del_20131012_016_kgraham.fit</a>		v
912	12/10/2013	10:48:47	2456577.96	TBohlsen	MirranookArmidale	LISAC11Atik314L+	1506	3800 - 7300	1140	<a href="#">novadel2013_20131012_451_TBohlsen.fit</a>		v
913	12/10/2013	17:40:33	2456578.25	PBerardi	BellavistaObs.L	LHIRE3600C9SXVR	1906	4179 - 5140	2668	<a href="#">novadel_20131012_736_PBerardi.fit</a>		v
914	12/10/2013	18:36:47	2456578.29	PBerardi	BellavistaObs.L	LHIRE3600C9SXVR	2191	5116 - 6130	2601	<a href="#">novadel_20131012_776_PBerardi.fit</a>		v
915	12/10/2013	19:08:20	2456578.35	J.Guarro	Sta.MariadeMontm	16REMOTATIK460EX	1136	6637 - 10173	8425	<a href="#">novadel2013_20131012_797_J.Guarro.fit</a>		v
916	12/10/2013	19:38:30	2456578.34	PBerardi	BellavistaObs.L	LHIRE3600C9SXVR	2604	6031 - 7010	2904	<a href="#">novadel_20131012_818_PBerardi.fit</a>		v
917	12/10/2013	20:43:28	2456578.40	PBerardi	BellavistaObs.L	LHIRE3600C9SXVR	2977	6977 - 7988	6569	<a href="#">novadel_20131012_864_PBerardi.fit</a>		v
918	14/10/2013	00:20:26	2456579.54	kgraham	Manhattan,IL	lx20010"AlpyAti	523	3603 - 7404	4970	<a href="#">v339del_20131014_014_kgraham.fit</a>		v
919	14/10/2013	00:29:18	2456579.55	kgraham	Manhattan,IL	lx20012"Lhires24	11983	6475 - 6646	4857	<a href="#">v339del_20131014_020_kgraham.fit</a>		v

**1000 spectres du 14 aout 2013 au 23 octobre 2013 : jamais une nova n'a été observé aussi intensivement spectralement dans l'histoire de l'astronomie !**



# Support des professionnels : Commentaires et conseils quasi quotidien de Steve Shore !

*Ce dialogue est une des conditions pour réussir une campagne*

## Comments about line evolution and profiles by Steve Shore

The line profile is a map of the velocity with depth in the ejecta and also in 3D. A sphere at any opacity has a different profile than a bipolar ejection. A sphere, for instance, always has material moving transversely to your line of sight, a bipolar ejection doesn't.

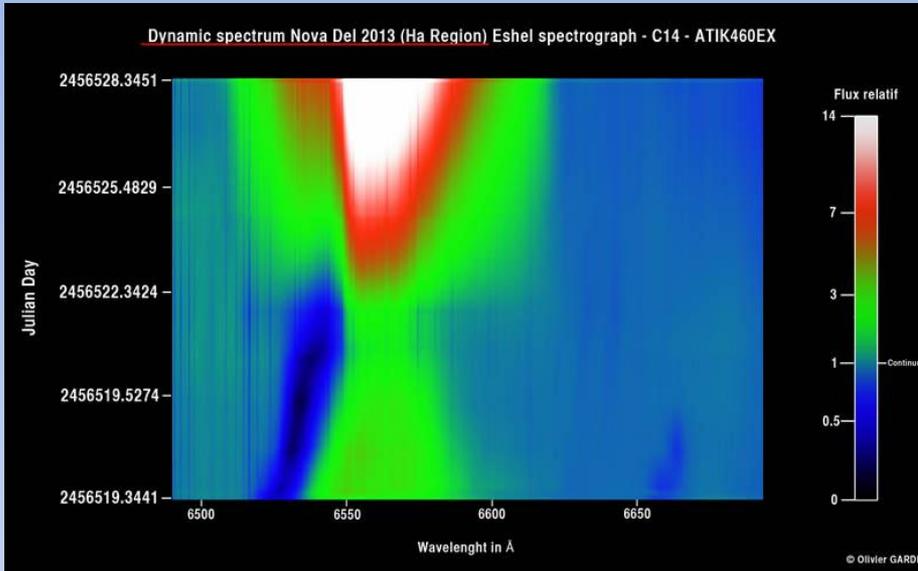
A central source illuminating a sphere has its photons always intercepted, a nonspherical ejecta doesn't, some photons can escape without any effect whether emitted centrally or within the ejecta themselves. So the intensity at any radial velocity (with respect to the observer) maps into a position in the ejecta (but differently depending on the geometry). We know this from resolved ejecta but also from, for instance, T Pyx 2011 and V959 Mon 2012. Some of this is indicated by the ratio of the emission on the profiles compared to the absorption. You can have pure emission with no absorption for bipolar ejecta oriented at large inclination relative to the observer or only displaced absorption if the opposite holds.

As the ejecta expand, the density drops throughout regardless of the geometry. The part in emission increases at first because it's less dense and less opaque. The velocity difference within the ejecta adds to this, the periphery has the highest velocity so its absorption is shifted relative to the inner part. At first, if the ejecta don't recombine, the absorption zone should move inward toward higher density and lower velocity while the emission increases. That's what we're now seeing but there is a start of the recombination indicated by the Na I D lines and the O I 8446 lines. This will stop once the ejecta start again to turn very opaque, we're still in the transition phase you see after a nuclear explosion when the fireball seems to be shrinking. But unlike the nuclear tests, this is not the static atmosphere but the debris itself that is changing. As the ejecta get more opaque there should be absorption components appearing on all of the emission lines and these should seem to move outward (toward more negative radial velocities) as the wave moved toward the outer regions. At the same time, the ionization will change and the lower metallic ions (e.g. Fe II) will get stronger. You've now seen that starting. Then what happens isn't just a temperature effect. The optical depth (the relative opacity) will continue to decline after total recombination

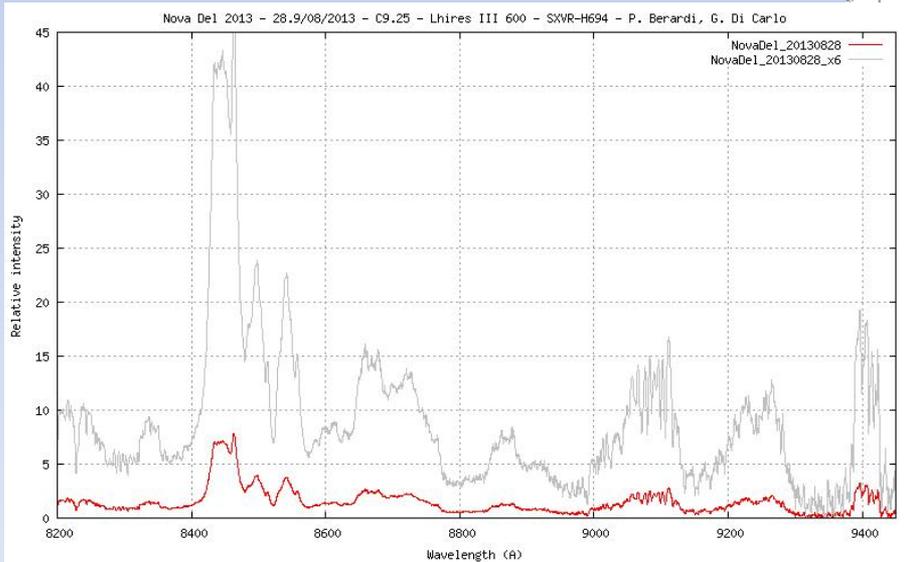
Before all that happens, there's one more -- very brief -- phenomenon of importance. If the density is high enough and the kinetic (gas) temperature low enough, meaning about 5000 K or lower -- the gas can form molecules. The most stable are simple radicals like CO, CN, and CH. In ONE nova, the dust forming DQ Her 1934, CN was observed just about now relative to the start of the outburst, it lasted for about a week starting about 6 weeks after the detection. That's where we are. I have no idea whether this will happen here, but if it does then this will form dust in about 100 days by mechanisms I'll try to explain soon (it's beyond your patience and a bit too far in the future for the moment, I hope you won't mind).

Never forget that the main difference between a nova and supernova in this regard is the survival of the WD. It is a hot, radiating source that ionizes the ejecta from the inside out (just like a planetary nebula in fast forward!) so the inner region -- the moving photosphere -- starts to get hotter and radiate more in the UV. This drives further ionization of the overlying layers and in time, the ejecta completely reionize. That's when the emission lines suddenly appear and there is no more optical absorption, the so-called nebular stage. When this happens depends on how rapidly the density drops, hence on the velocity and mass of the ejecta and the luminosity of the WD. In Del 2013, we don't know that yet. But once the ejecta are completely transparent, the line profiles give you a complete view of the structure even before the remnant becomes resolvable (if ever)

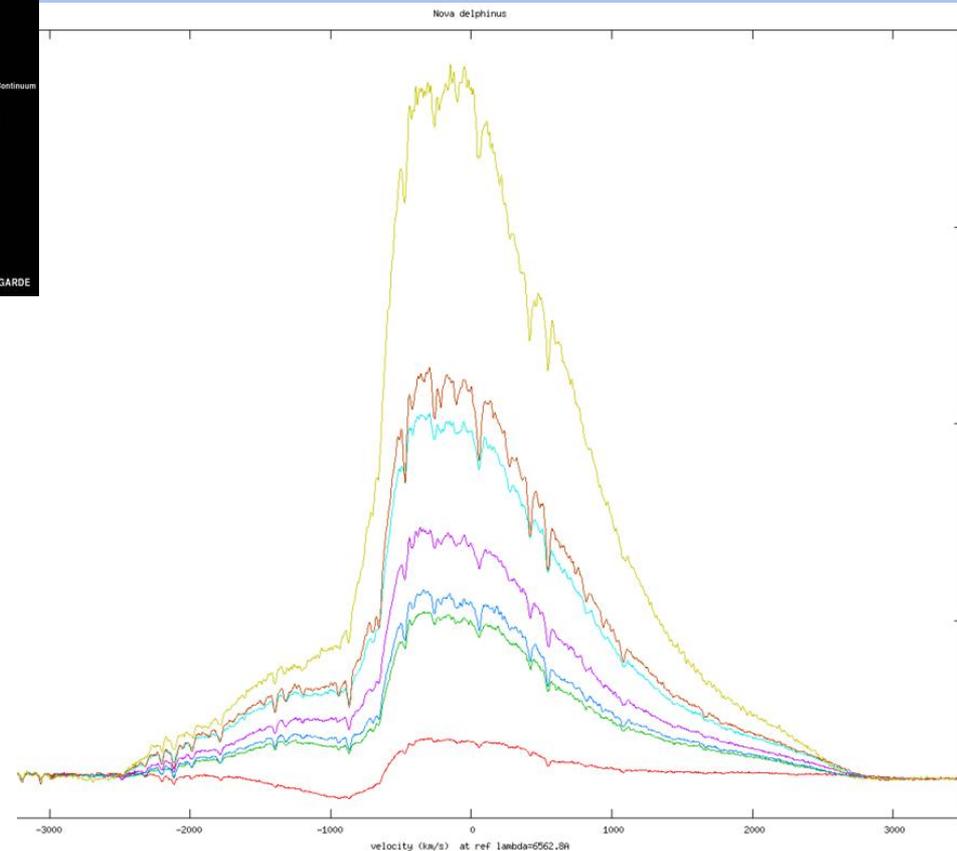
# Nova Delphini 2013 : forte mobilisation des amateurs et qualité pro !



Spectre dynamique (O. Garde)

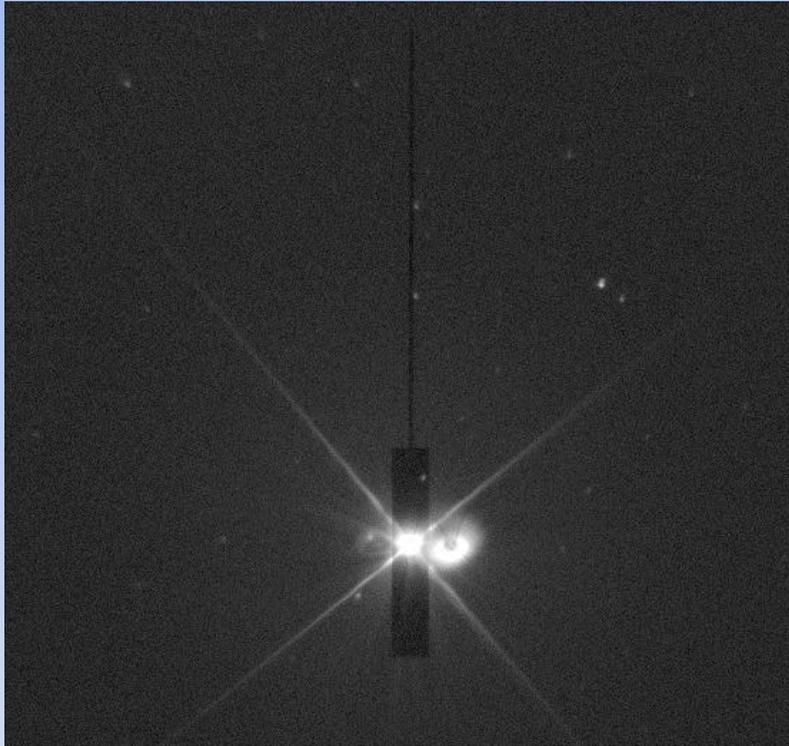


Spectre infrarouge (Paolo Berardi)



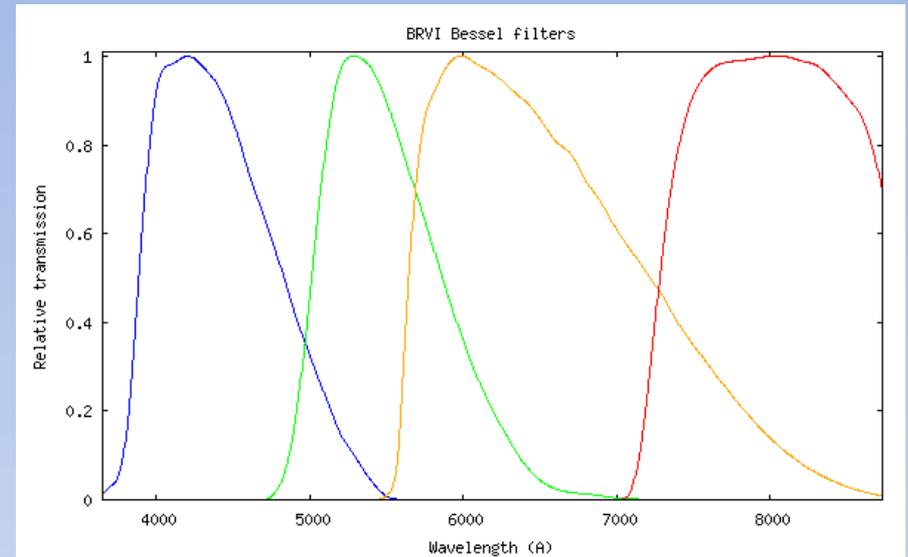
Détail de l'évolution de la raie Halpha (Thierry Lemoult)

# Nova Delphini 2013 : spectrophométrie avec Alpy 600

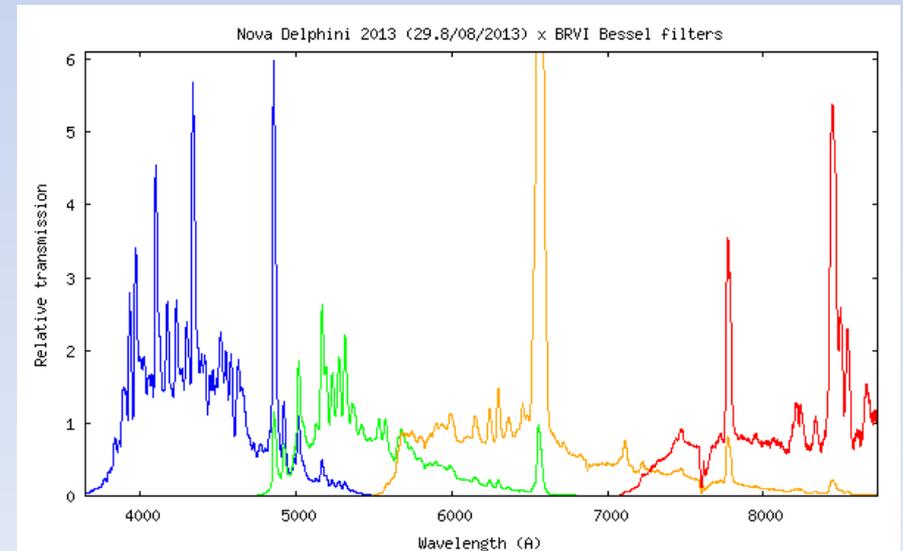


Fente photométrique Alpy 600

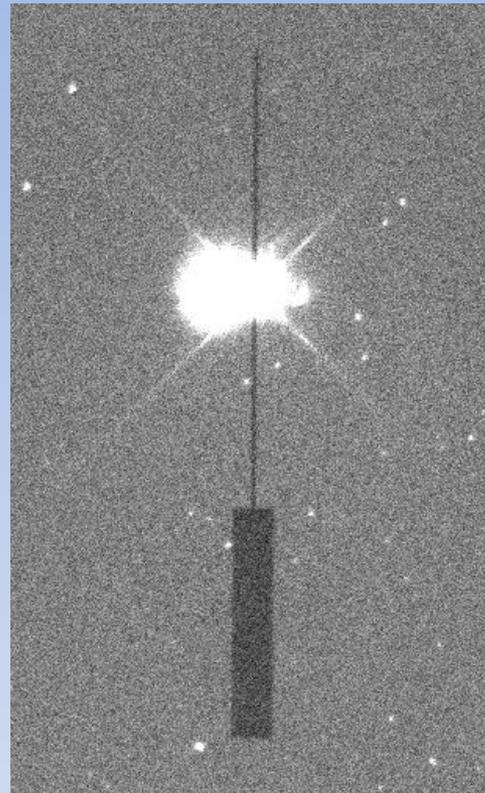
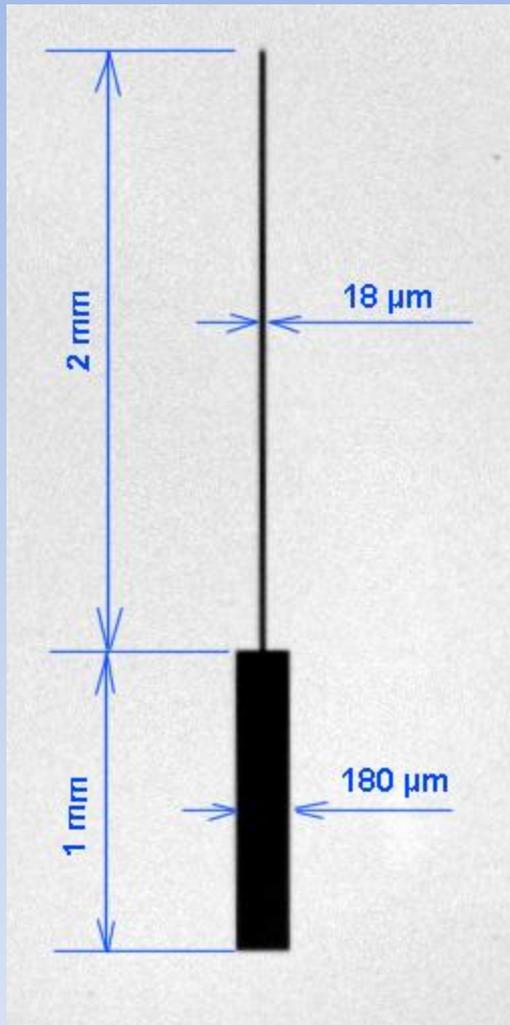
Mesure du flux  
(intégration dans les bandes)



Photométrie synthétique (bandes Bessel)



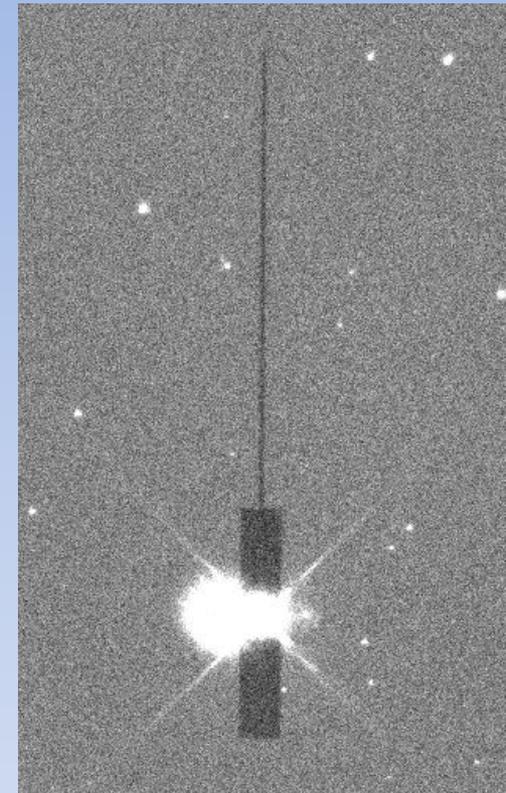
# Spectrophotométrie avec Alpy 600 (mais aussi avec LISA, Lhires III, ...)



Mode spectrographique



Spectre « haute-résolution »

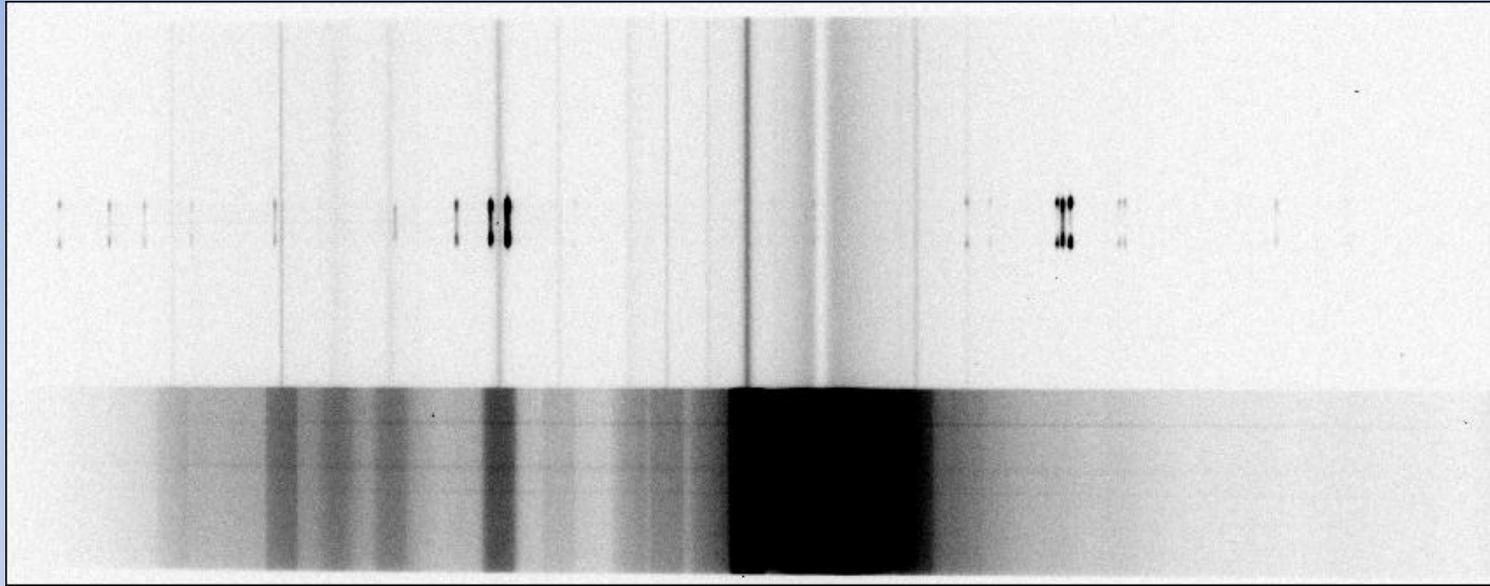


Mode spectrographique

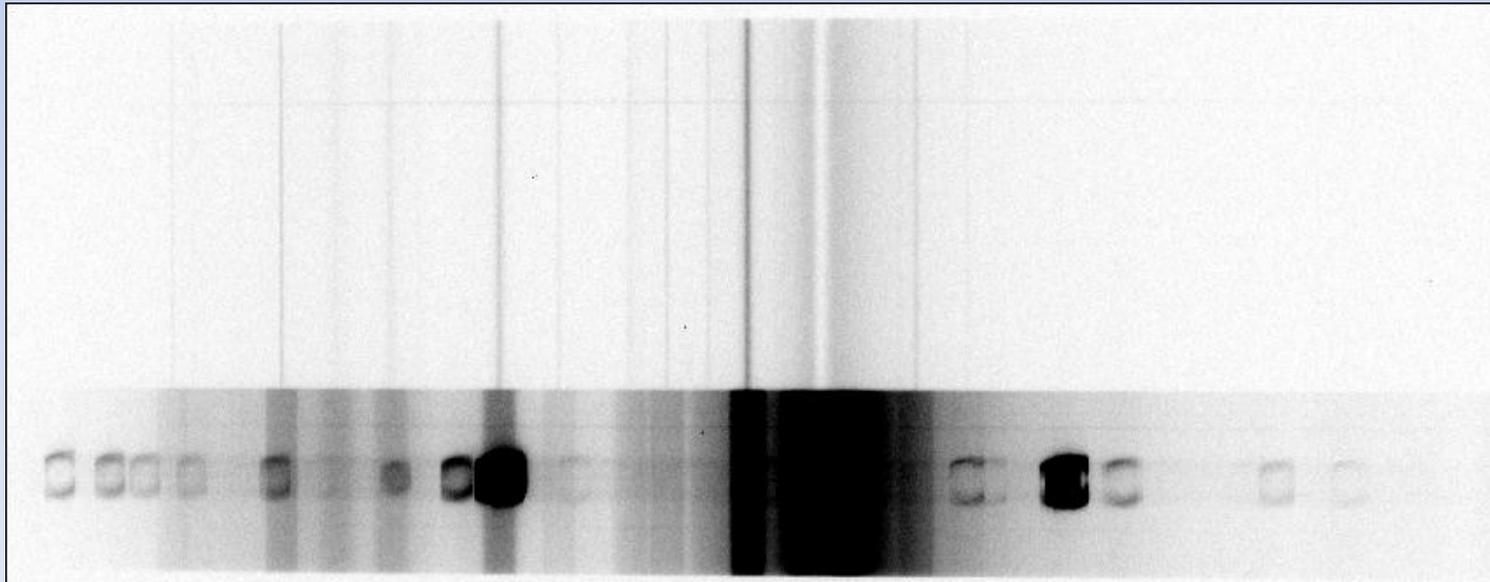


Suppression de l'effet de fente  
Photométrie indépendante du seeing et du chromatisme

# La nébuleuse Messier 57



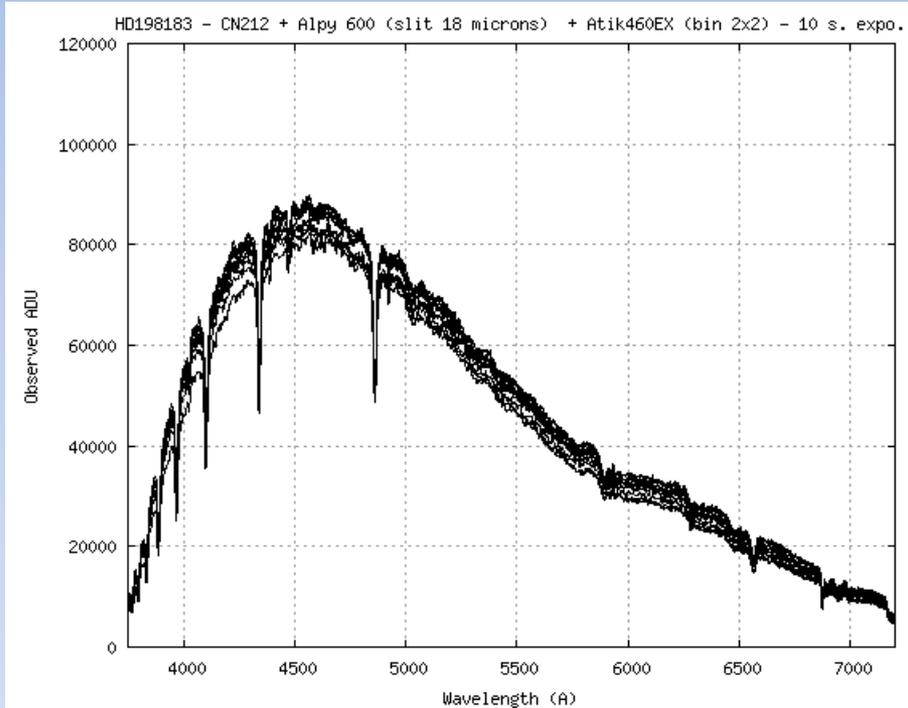
**Mode spectrographique : haute résolution et fond de ciel faible**



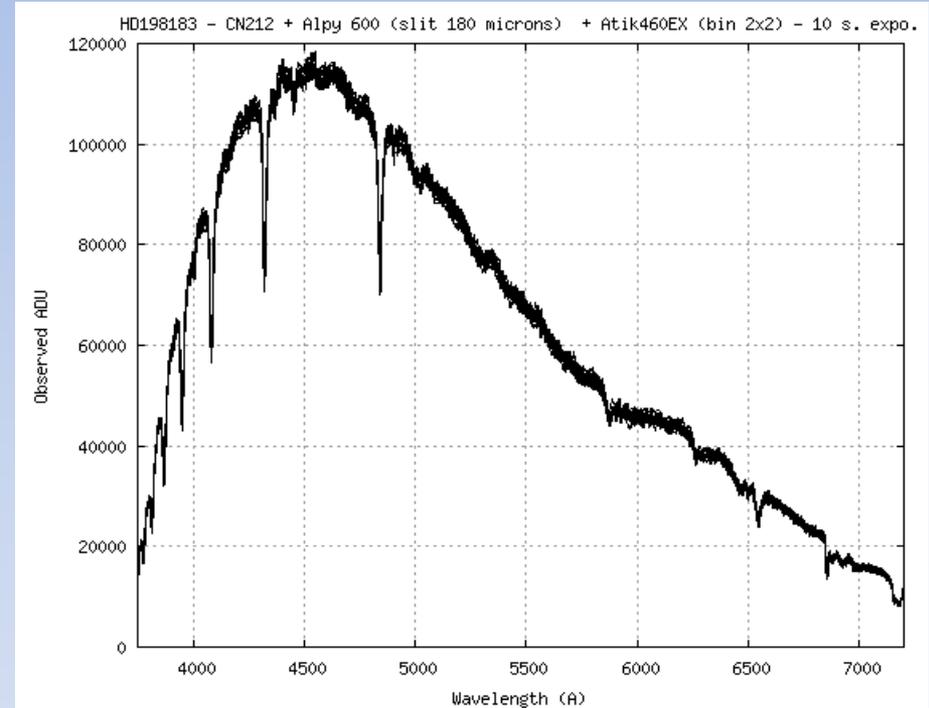
**Mode photométrique : basse résolution et fond de ciel fort**

# Gain photométrique (1/2)

Alpy 600 – Sur CN212 (télescope Newton achromatique)



Mode spectrographique

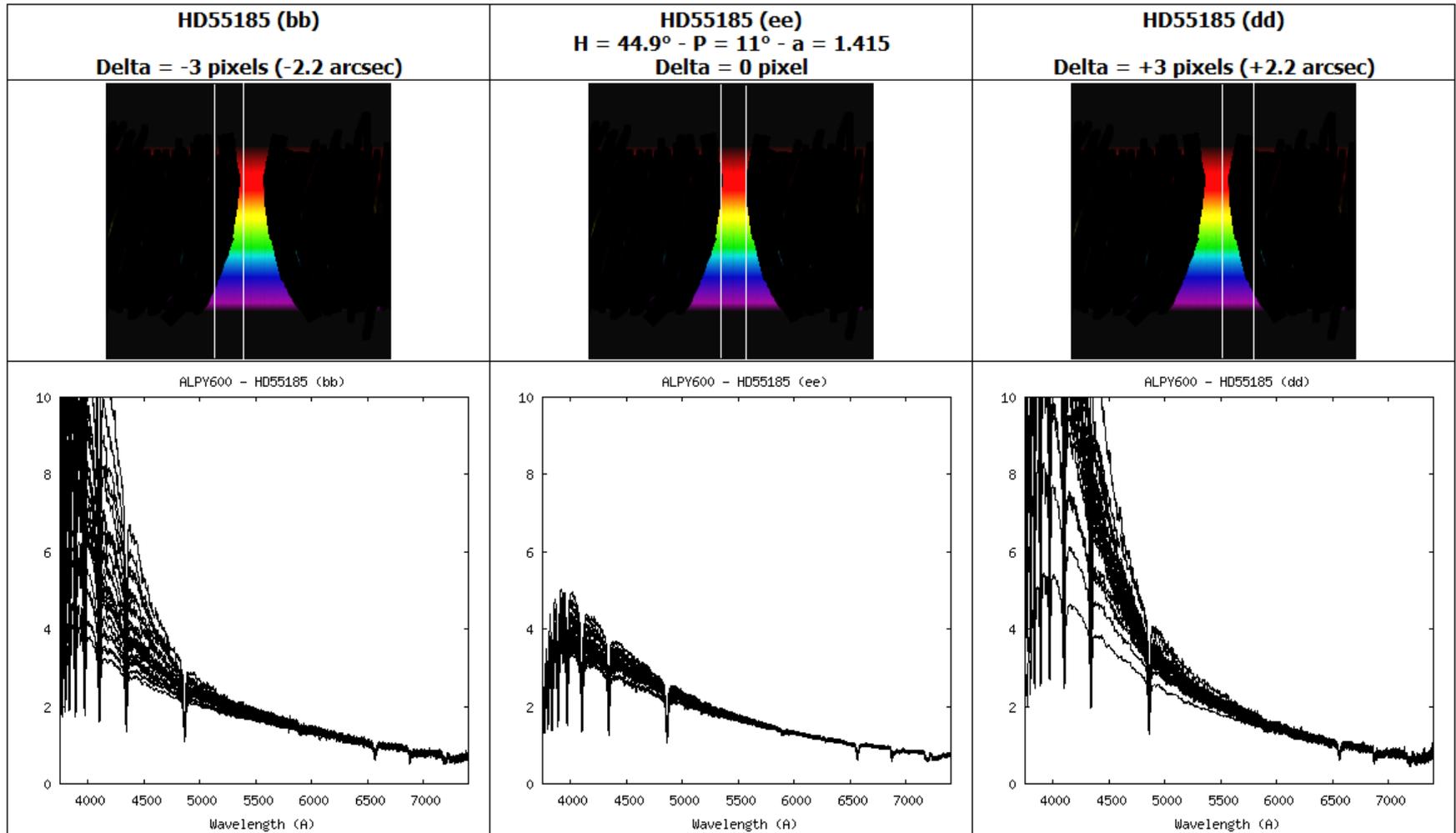


Mode photométrique

Noter la dispersion des profils individuels (poses de 10 secondes) – Effet du seeing

# Gain photométrique (2/2)

Dispersion atmosphérique + chromatisme du télescope (C11 avec réducteur)



**Très gros biais photométrique potentiel en fonction du centrage de l'étoile sur la fente**

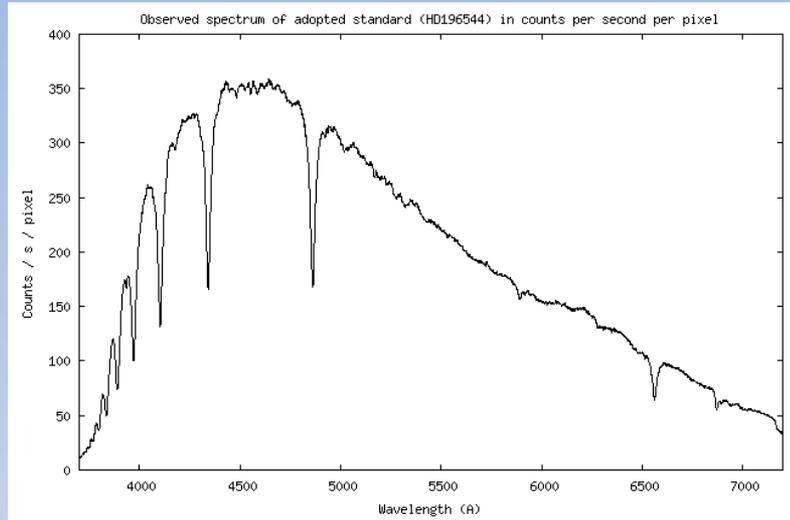
# Chromatisme atmosphérique

HD73495 – Elevation  $20^\circ$  au dessus de l'horizon

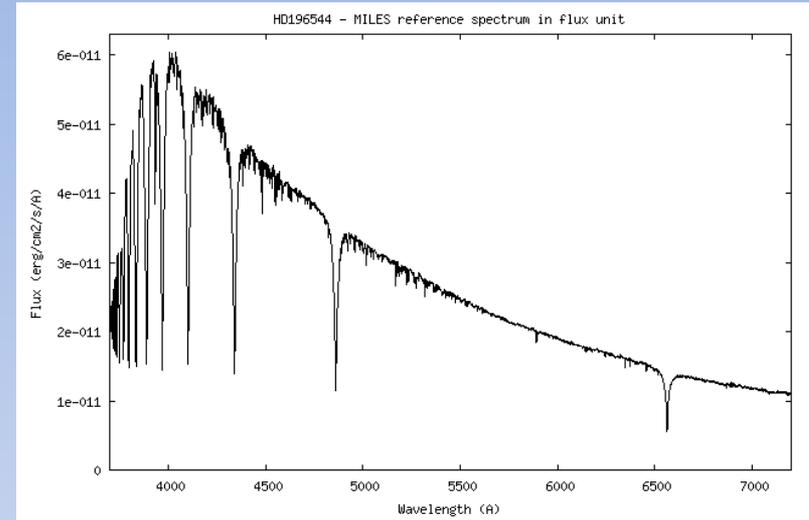


Spectre 2D (fente photométrique) – Courbure par la réfraction atmosphérique

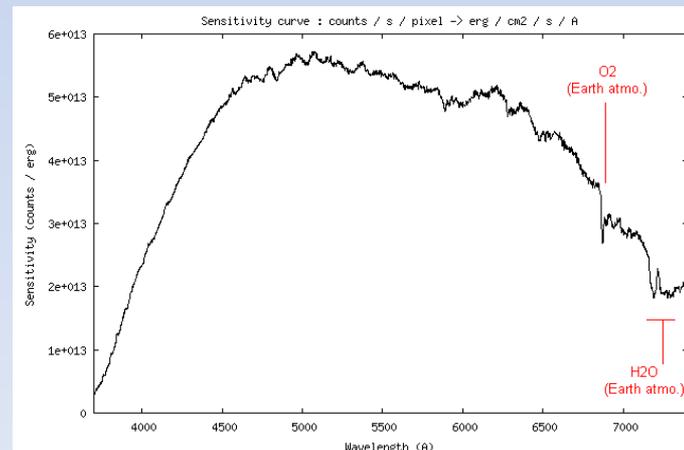
# Spectrophotométrie : étalonnage sur étoile de référence



Spectre observé en comptes numériques  
(standard spectrophotométrique)

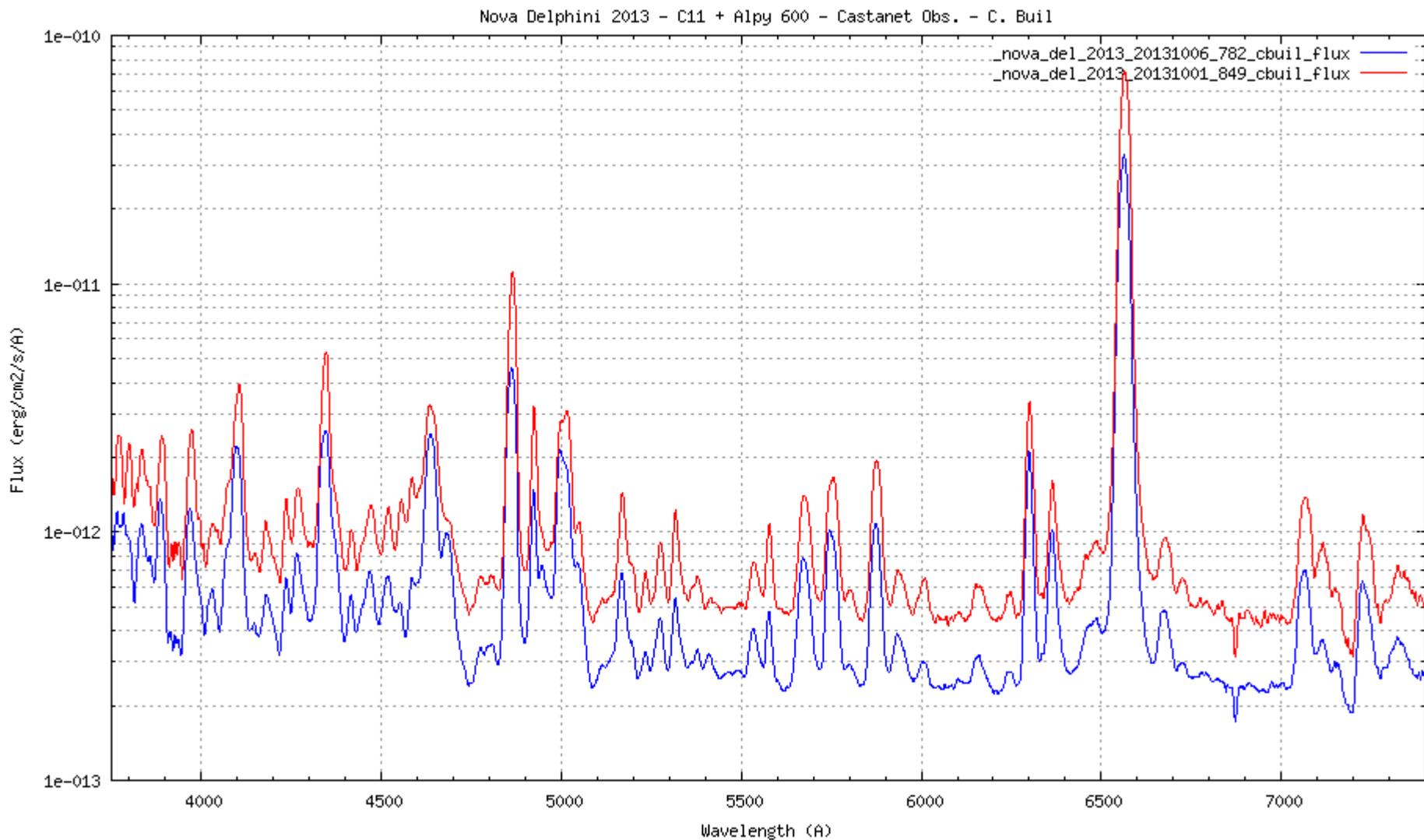


Spectre théorique en erg/cm<sup>2</sup>/s/Å



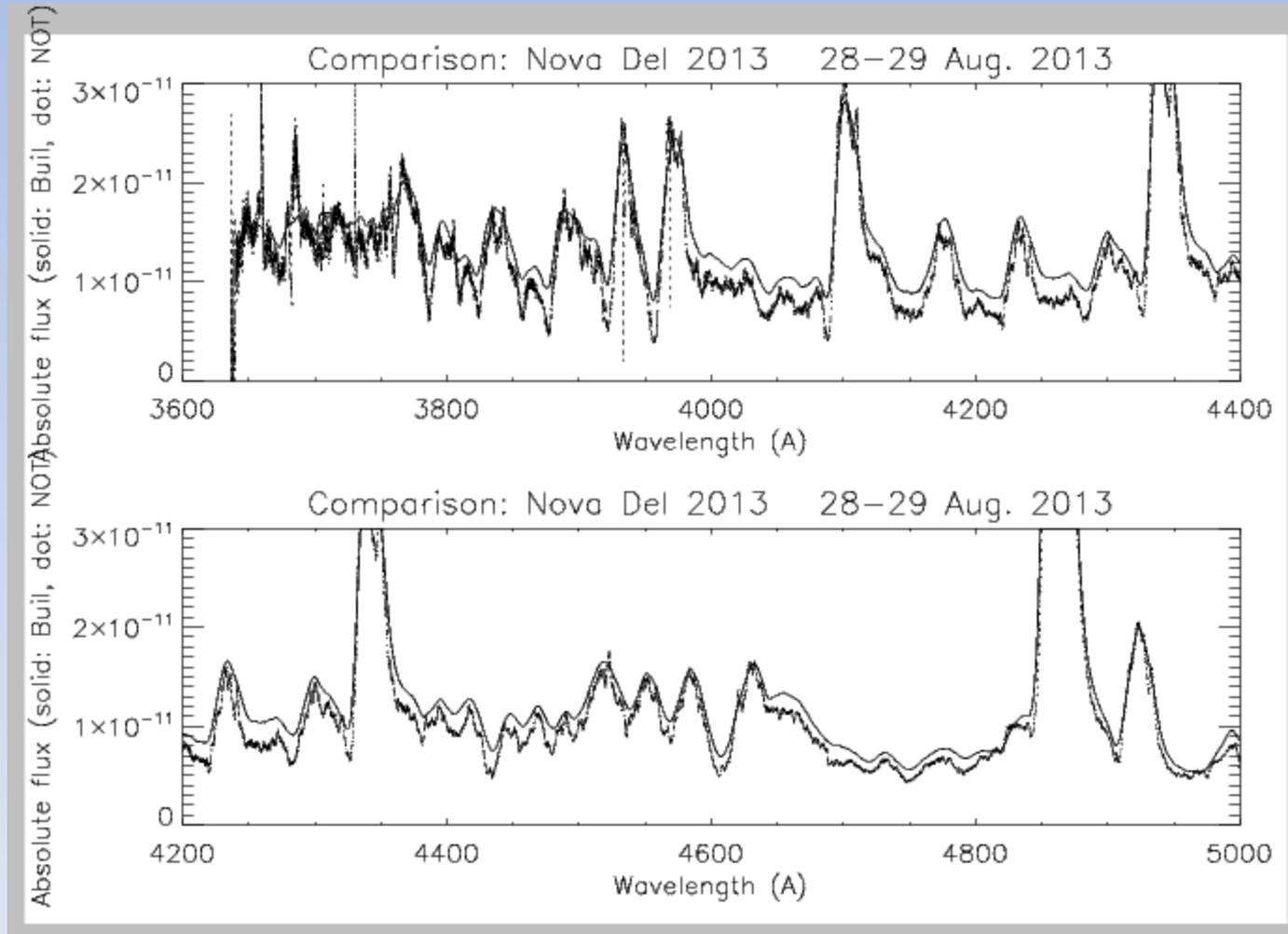
Sensibilité instrument  
Comptes / erg

# Nova Delphini 2013 : Mesure du flux absolu en unité physique (erg/cm<sup>2</sup>/s/Å)



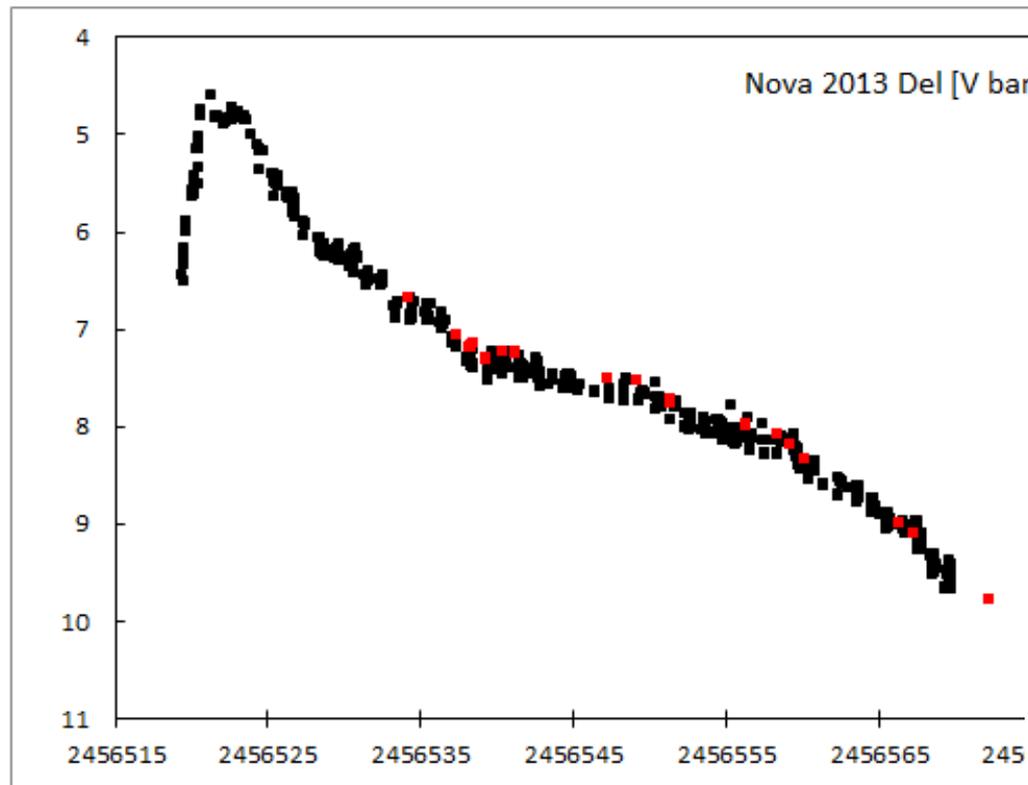
# Nova Delphini 2013 : Mesure du flux absolu en unité physique (erg/cm<sup>2</sup>/s/Å)

Comparaison en « direct » de spectres professionnels et amateurs



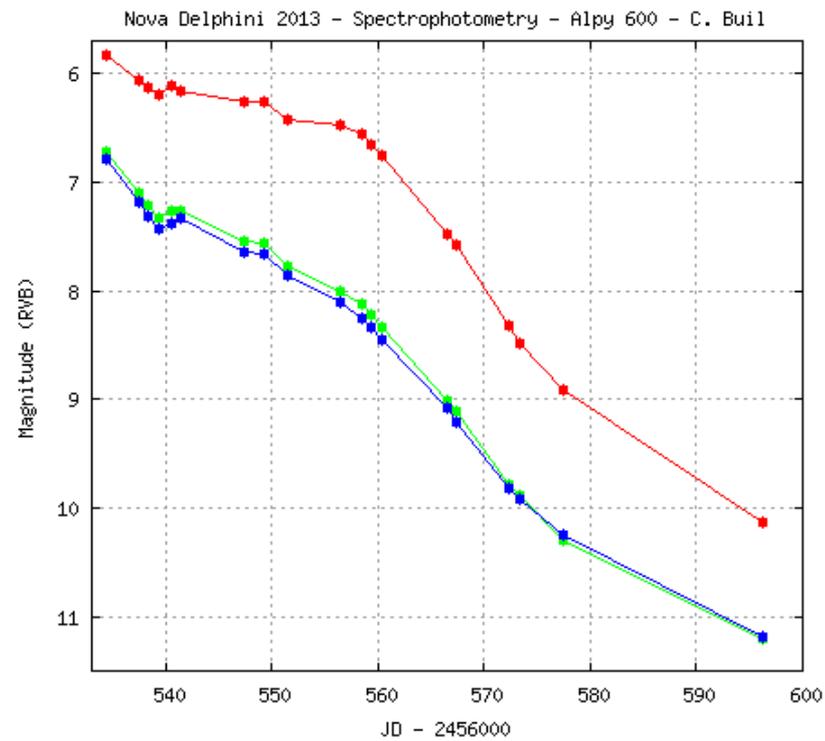
Télescope NOT / C11 + Alpy 600

# Nova Delphini 2013 : spectrophotométrie BVR avec Alpy 600



Comparaison entre AAVSO (les données les plus fiables en noir) et spectrophotométrie Alpy (en rouge)

Spectrophotométrie BVR simultanée



# Merci pour votre attention



Shelyak Instrument : <http://www.shelyak.com>  
Christian Buil : <http://www.astrosurf.com/buil>

ARAS : <http://www.astrosurf.com/aras/>