



Démarrer en spectro ? Facile !

Rencontres du Ciel et de l'Espace
Cité des Sciences de la Villette
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Au programme...



- Plusieurs astronomies
- La spectro : accéder à l'imperceptible
- Ce que l'on observe
- Principe d'un spectroscopie
- Quelques conseils
- A vous de jouer !

Plusieurs astronomies

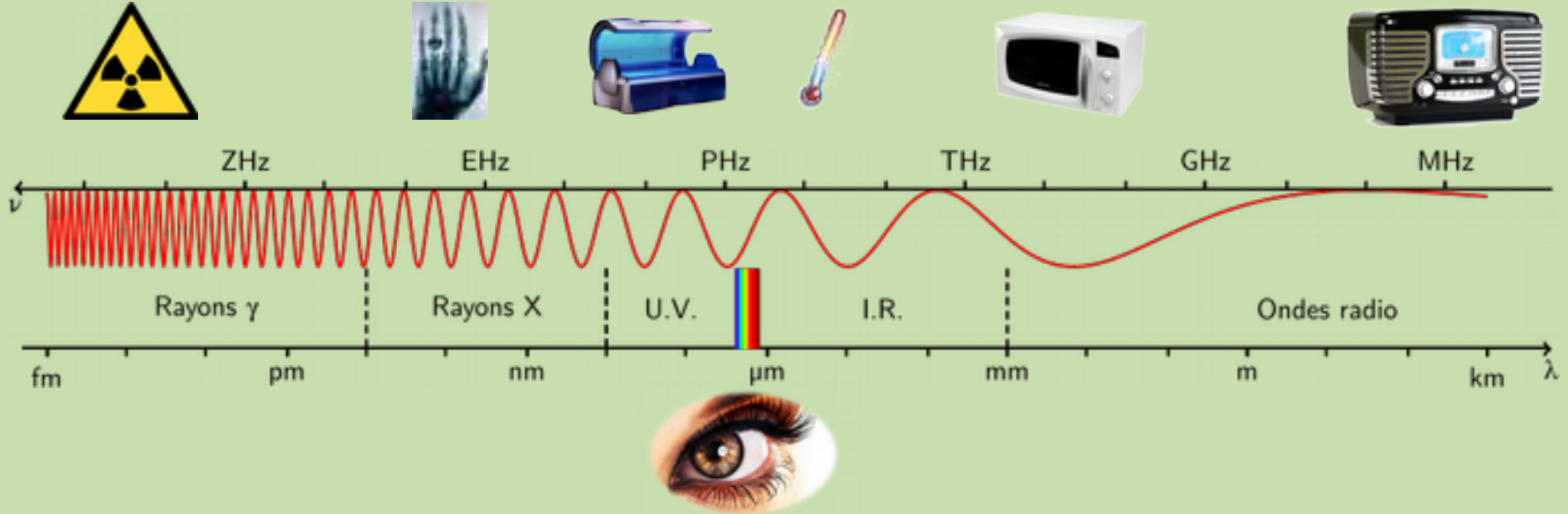
	Contempler	Mesurer
Visuel	Obs. visuelles	Etoiles variables, astrométrie
Imagerie	Belles images	Photométrie, astrométrie, imagerie planétaire
Spectroscopie	-	Paramètres physiques, Composition chimiques, Vitesses radiales
Polarimétrie	-	Polarisation (magnétisme, diffusion, réflexions)

Informations
inaccessibles
à l'œil humain

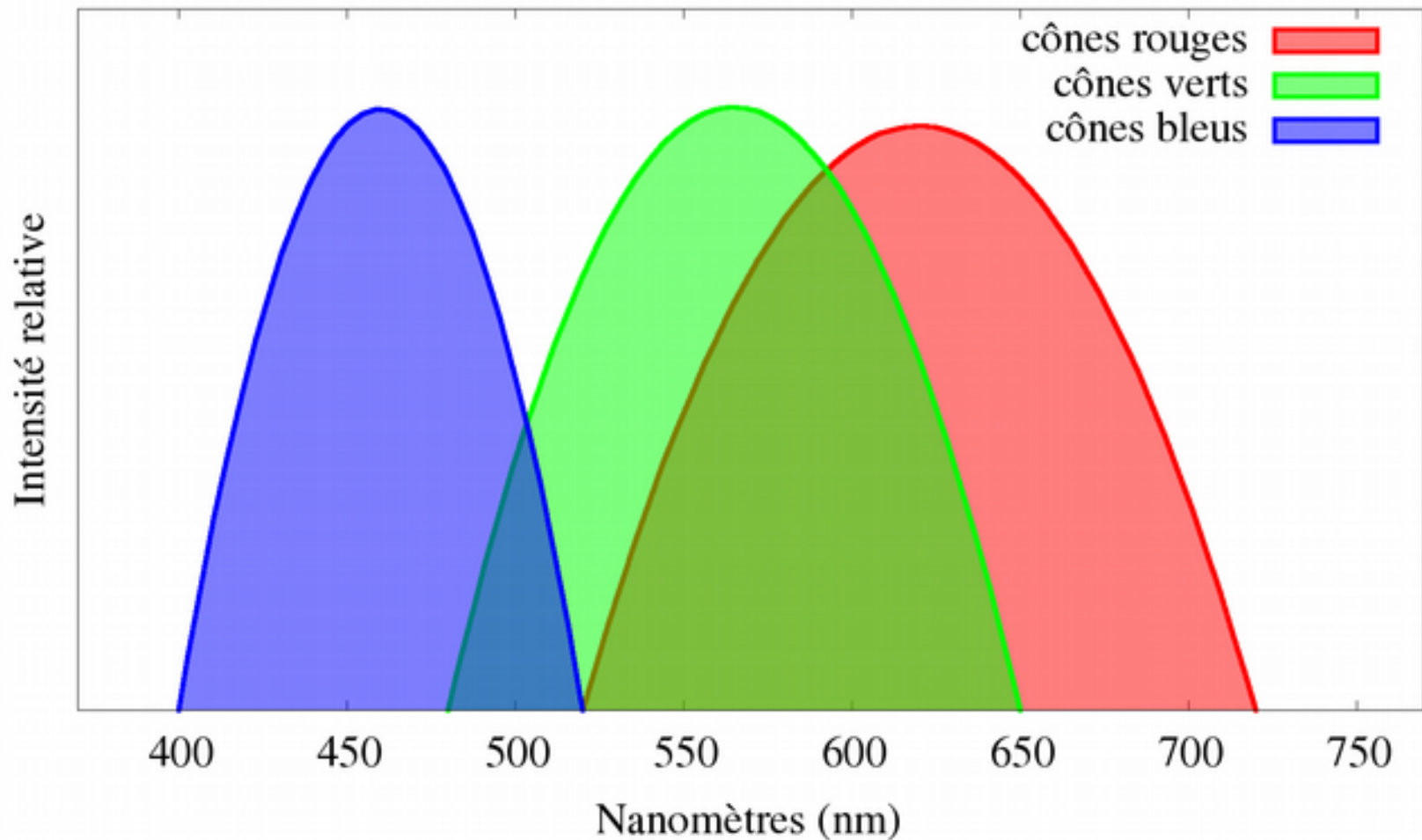
La spectroscopie

- La lumière est plus riche que ce que l'œil humain en perçoit.
- Un spectre est la décomposition fine de la lumière en fonction de la couleur / longueur d'onde.
- La fonction d'un spectroscope est de convertir une couleur / longueur d'onde en position géométrique sur un capteur.

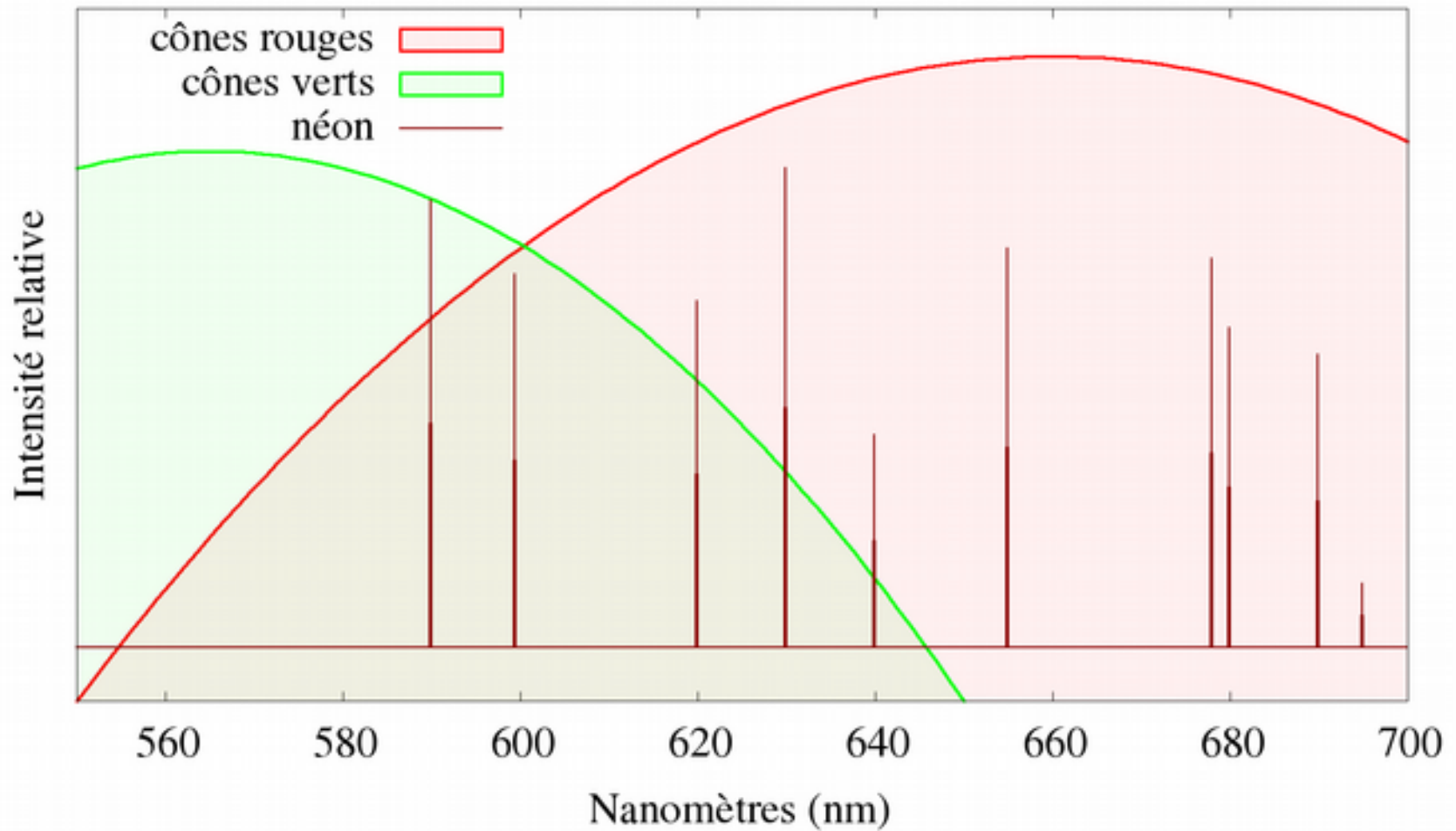
La lumière est une onde...

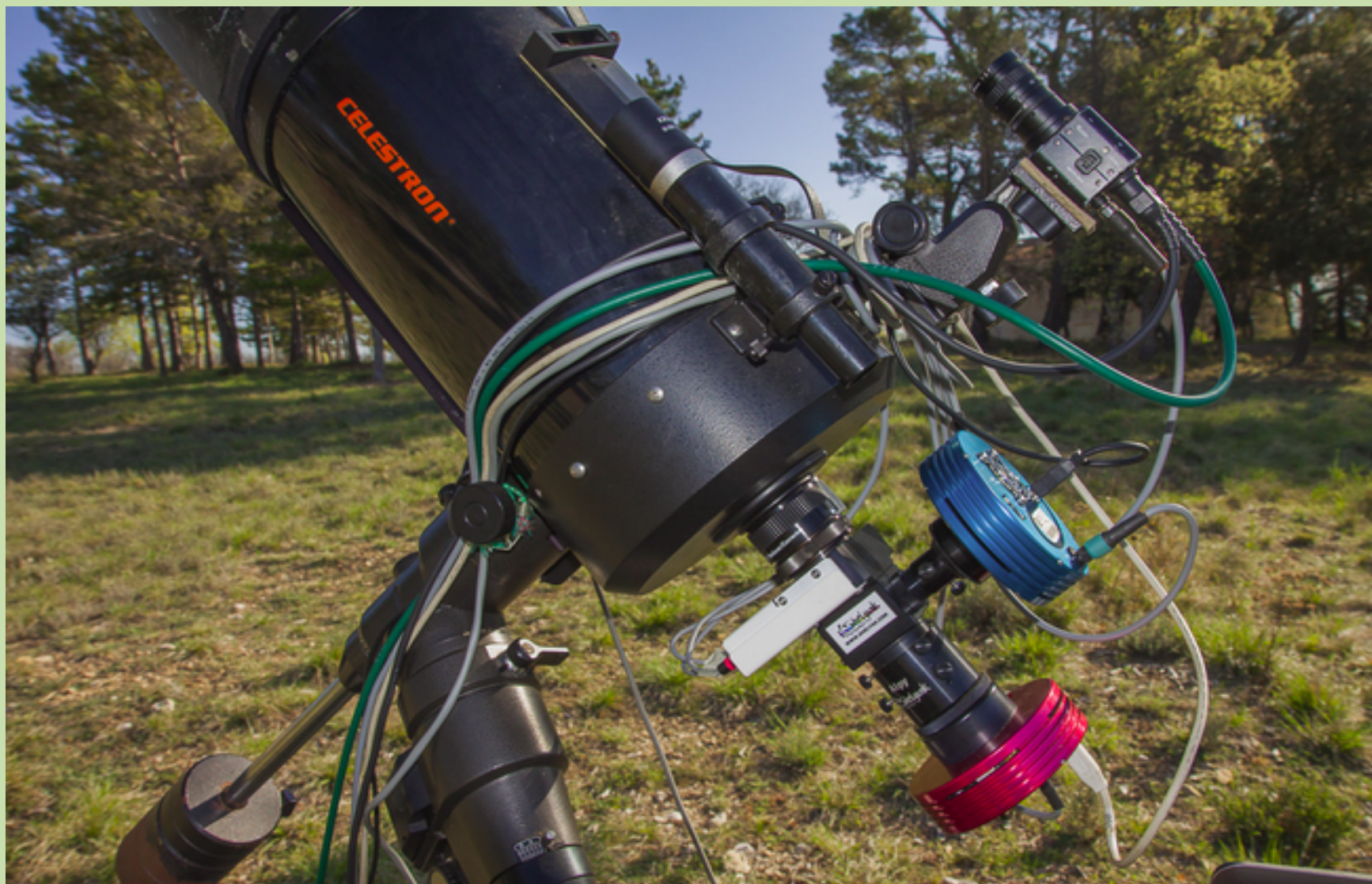


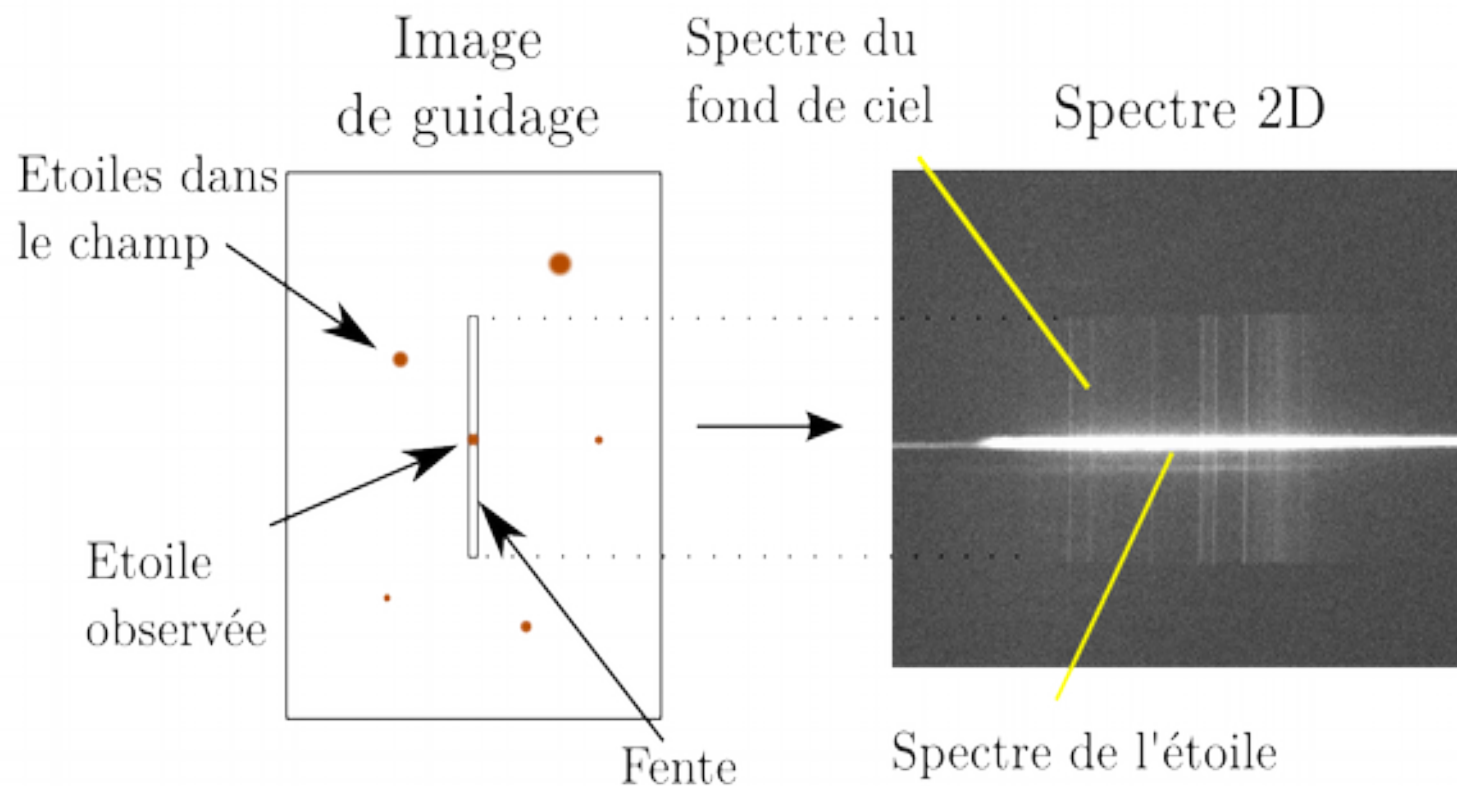
Perception de l'œil



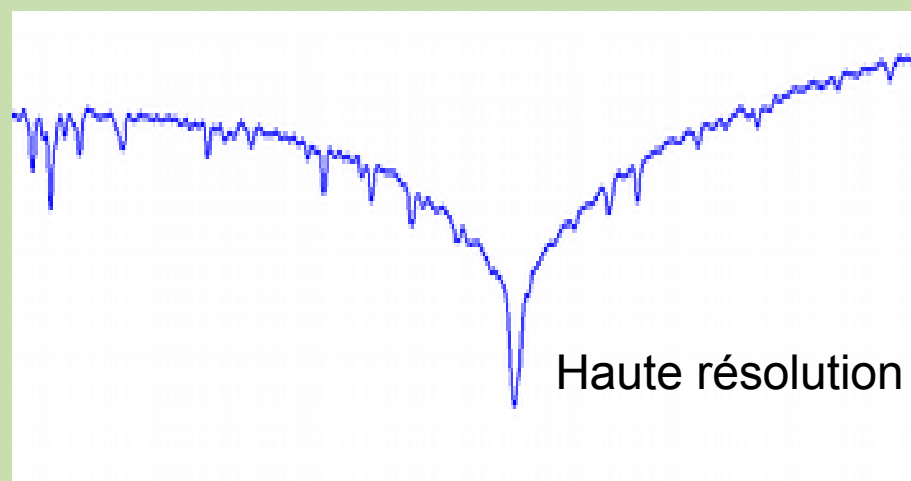
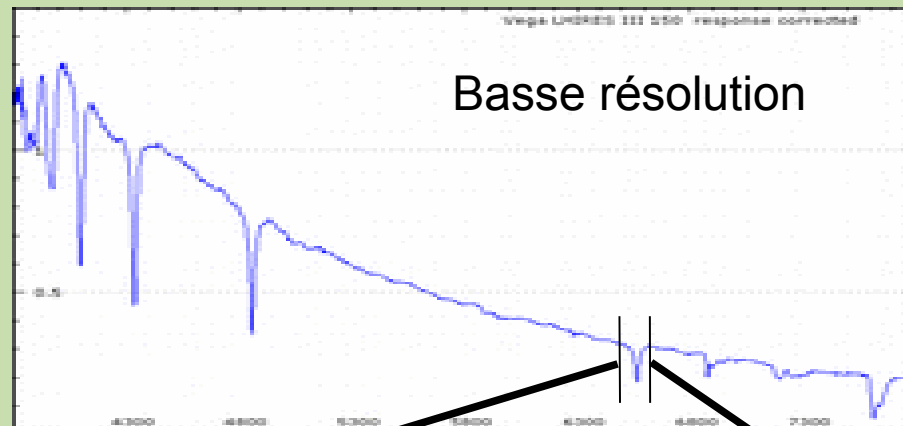
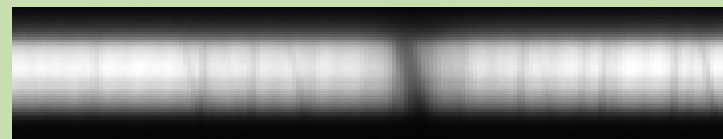
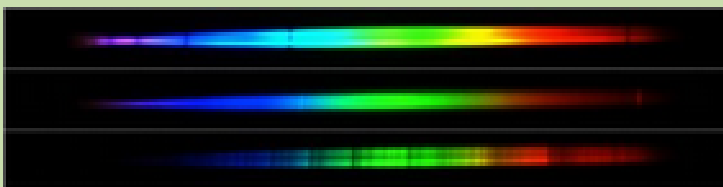
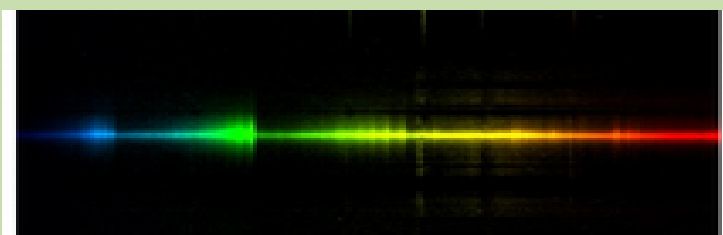
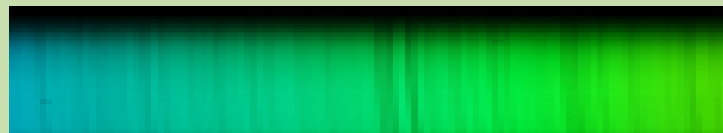
Perception de l'œil



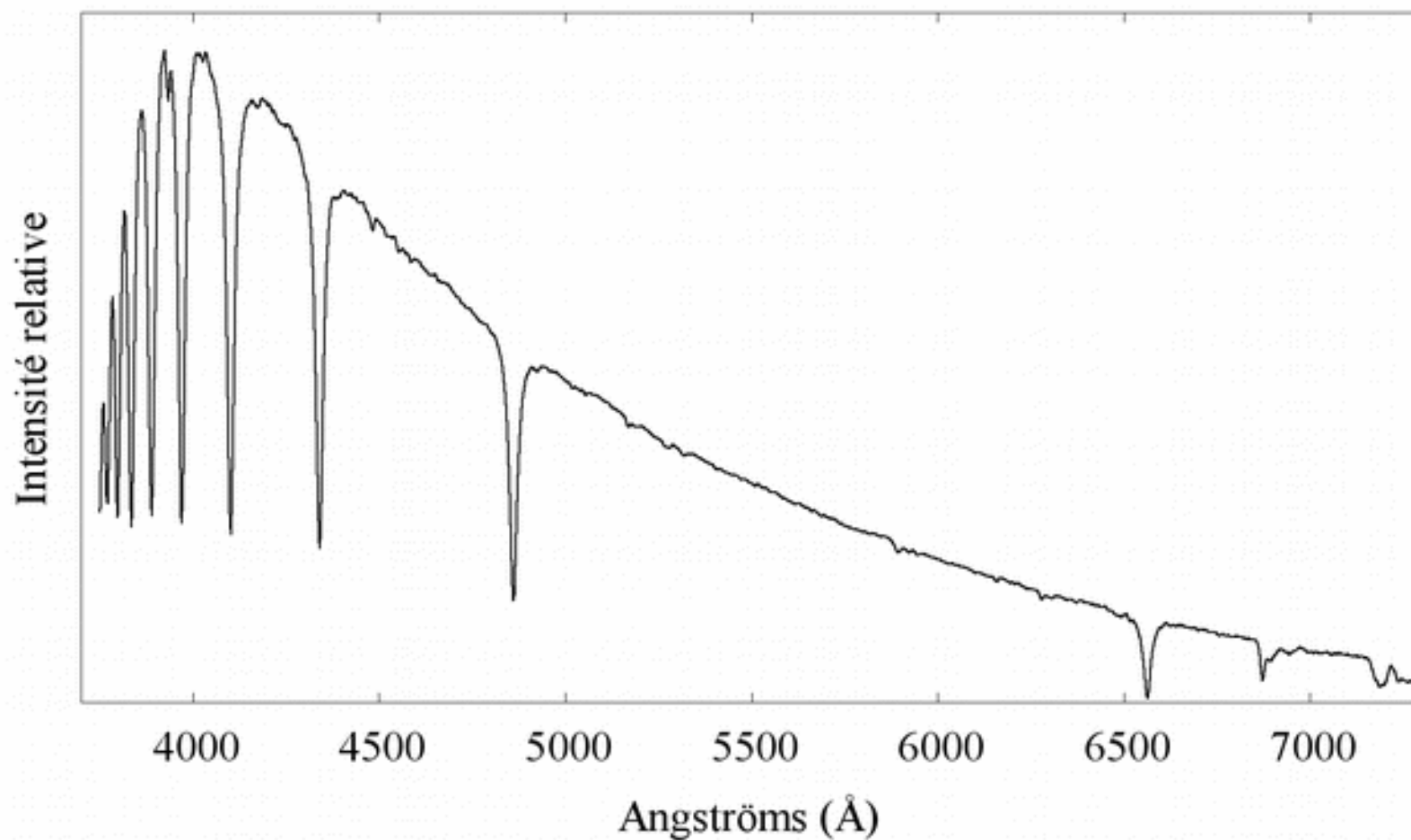




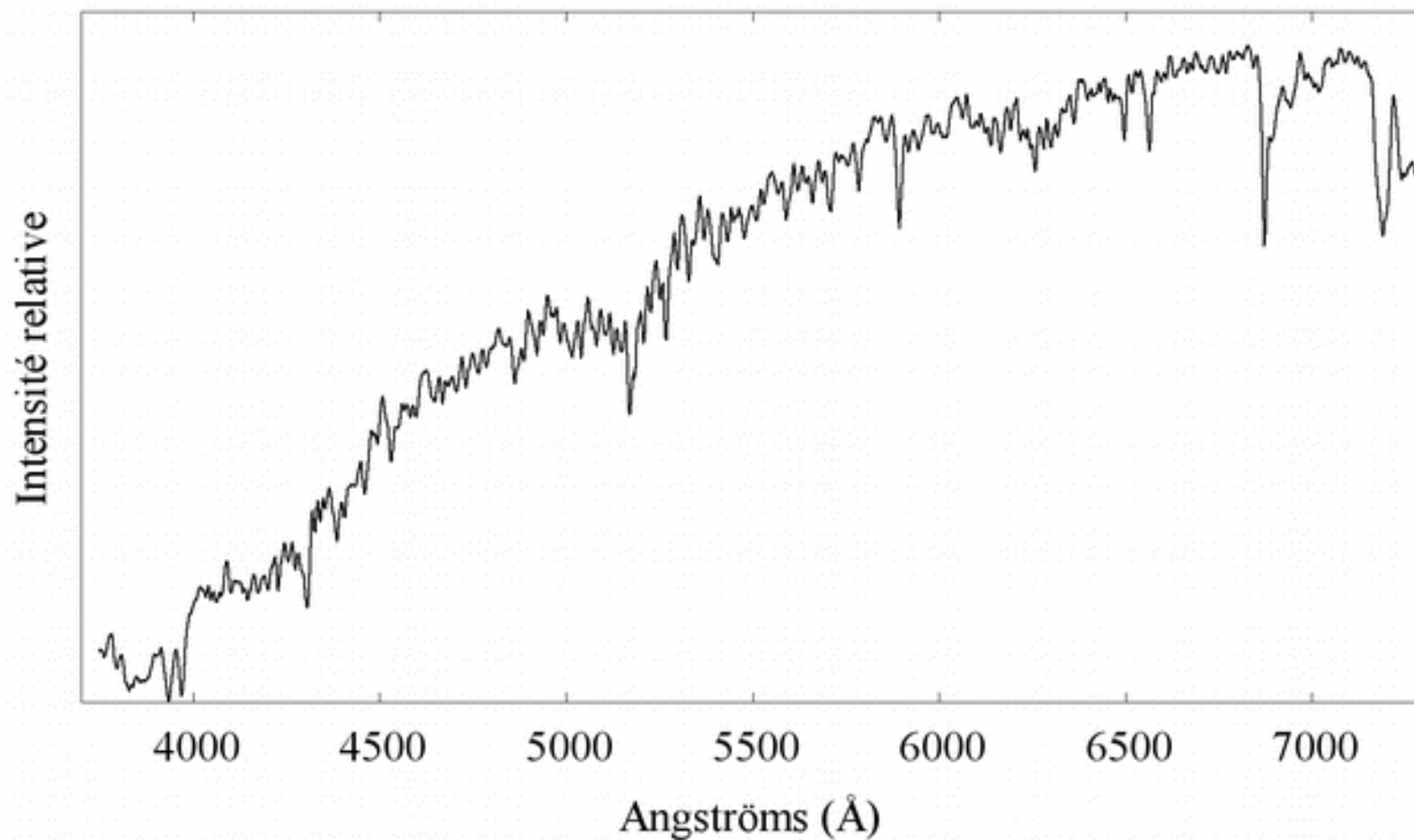
Exemples de spectres



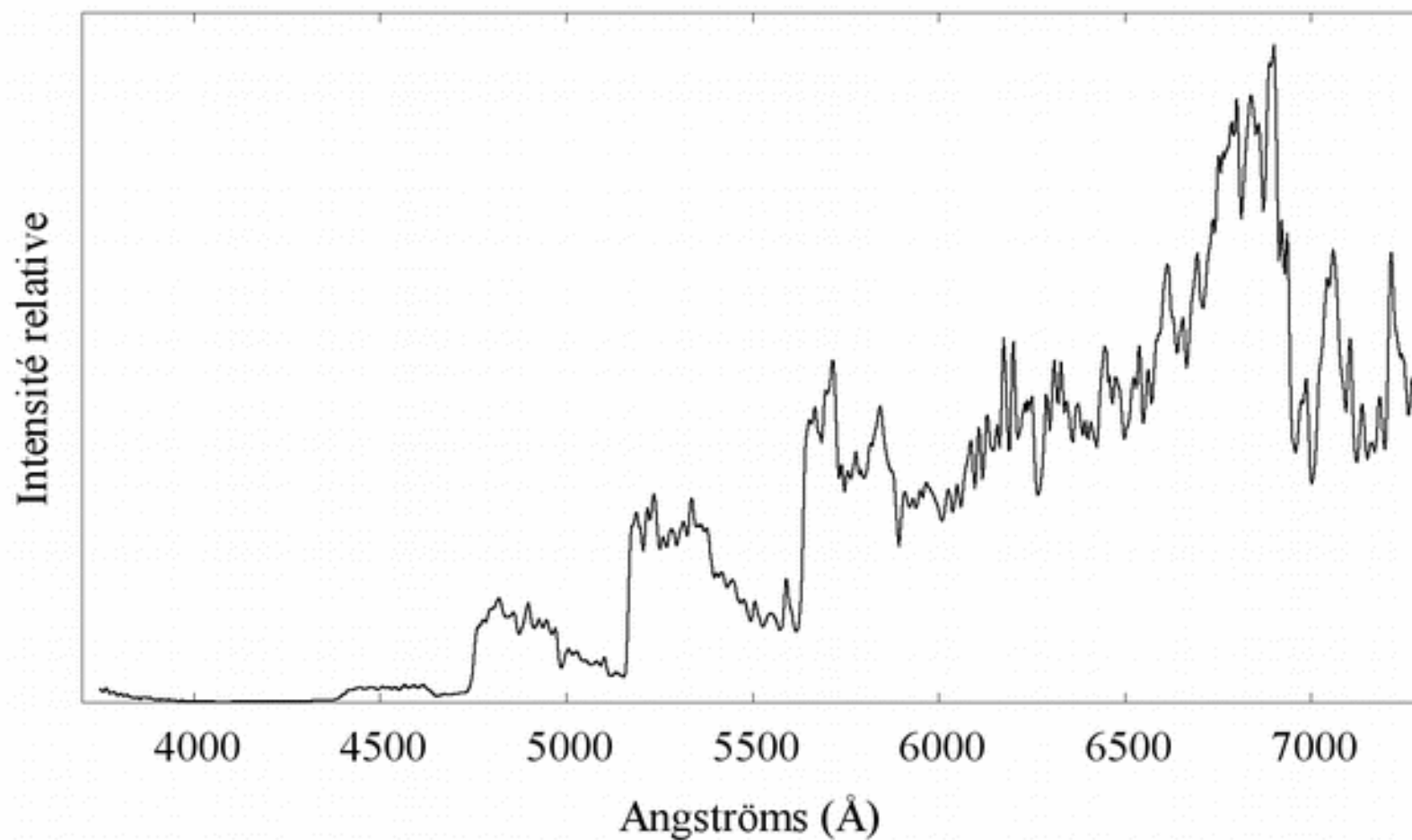
Vega - 20/08/2015 22:00 - C8-Alpy600#094-Atik314 - 7 x 1 s



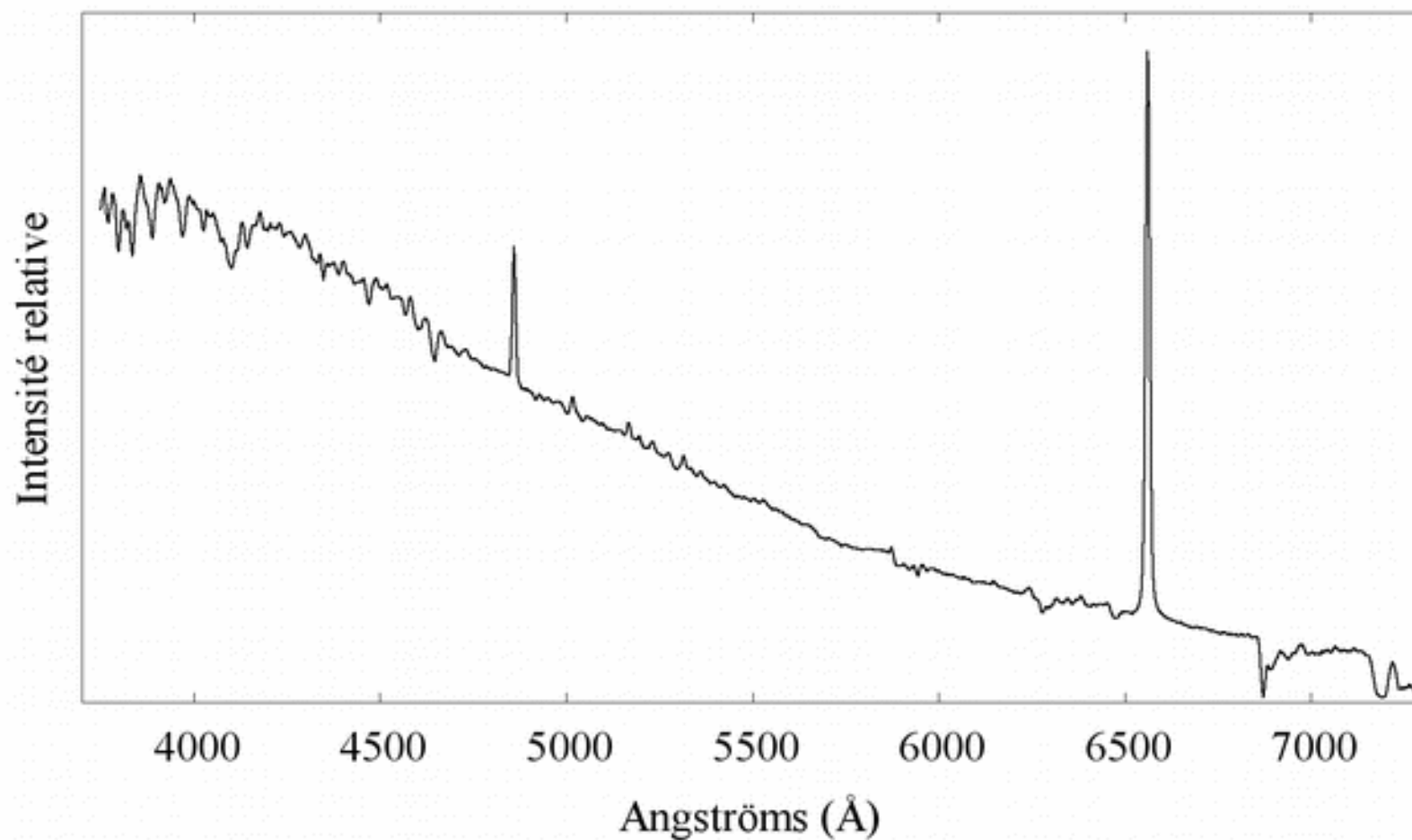
Arcturus - 20/08/2015 21:33 - C8-Alpy600#094-Atik314 - 7 x 1 s



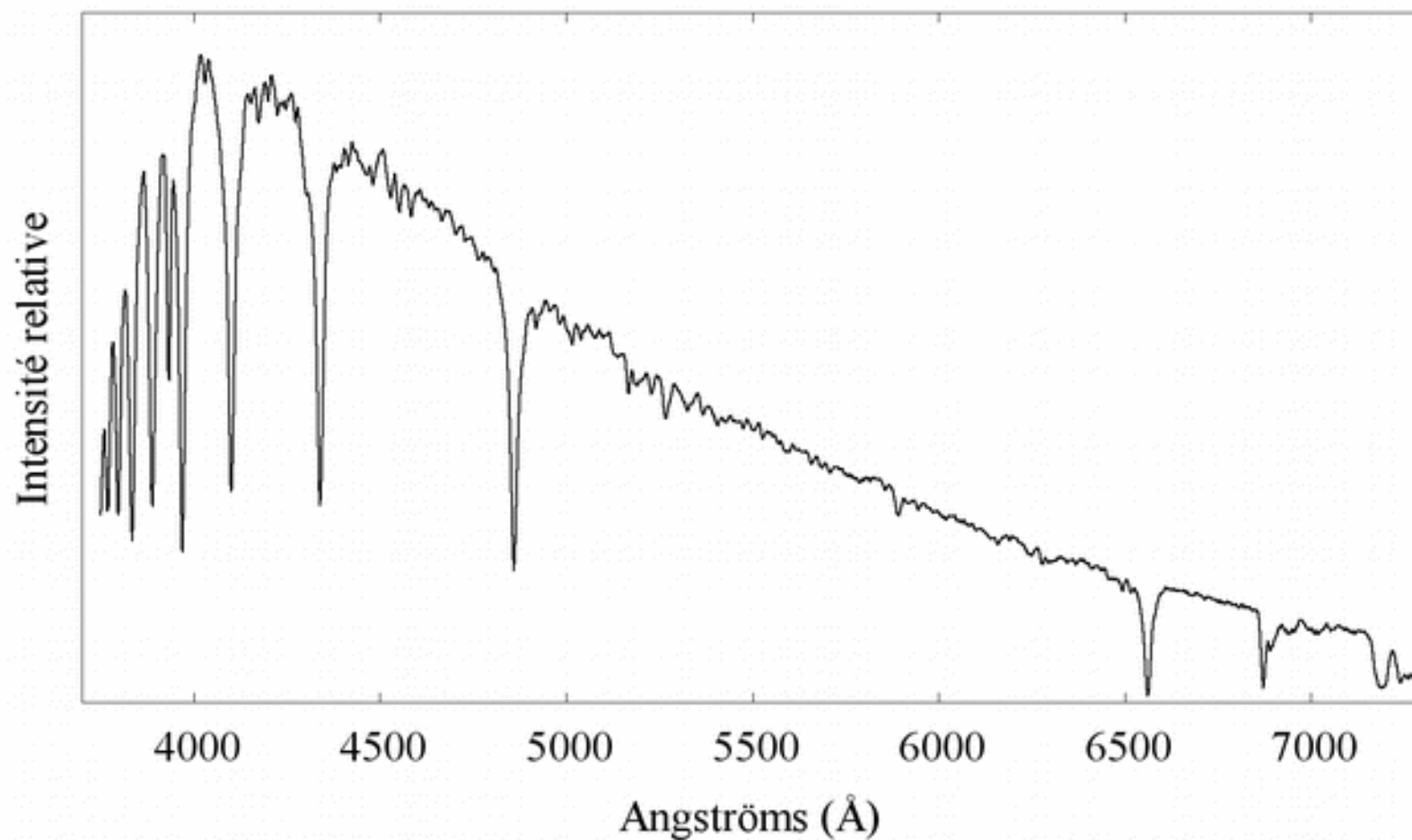
Y Cvn - 20/08/2015 21:47 - C8-Alpy600#094-Atik314 - 7 x 60 s



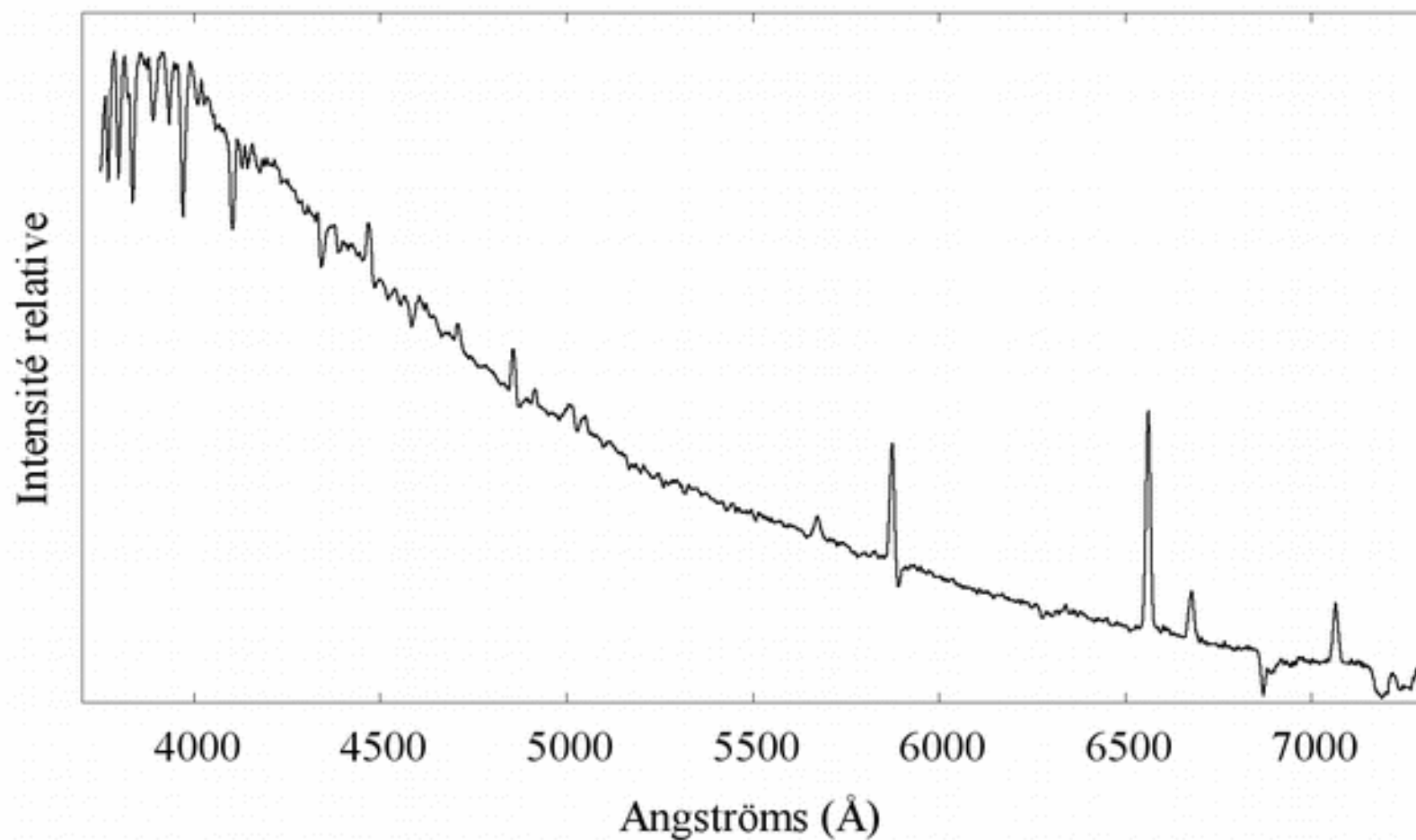
gam Cas - 20/08/2015 22:08 - C8-Alpy600#094-Atik314 - 9 x 5 s



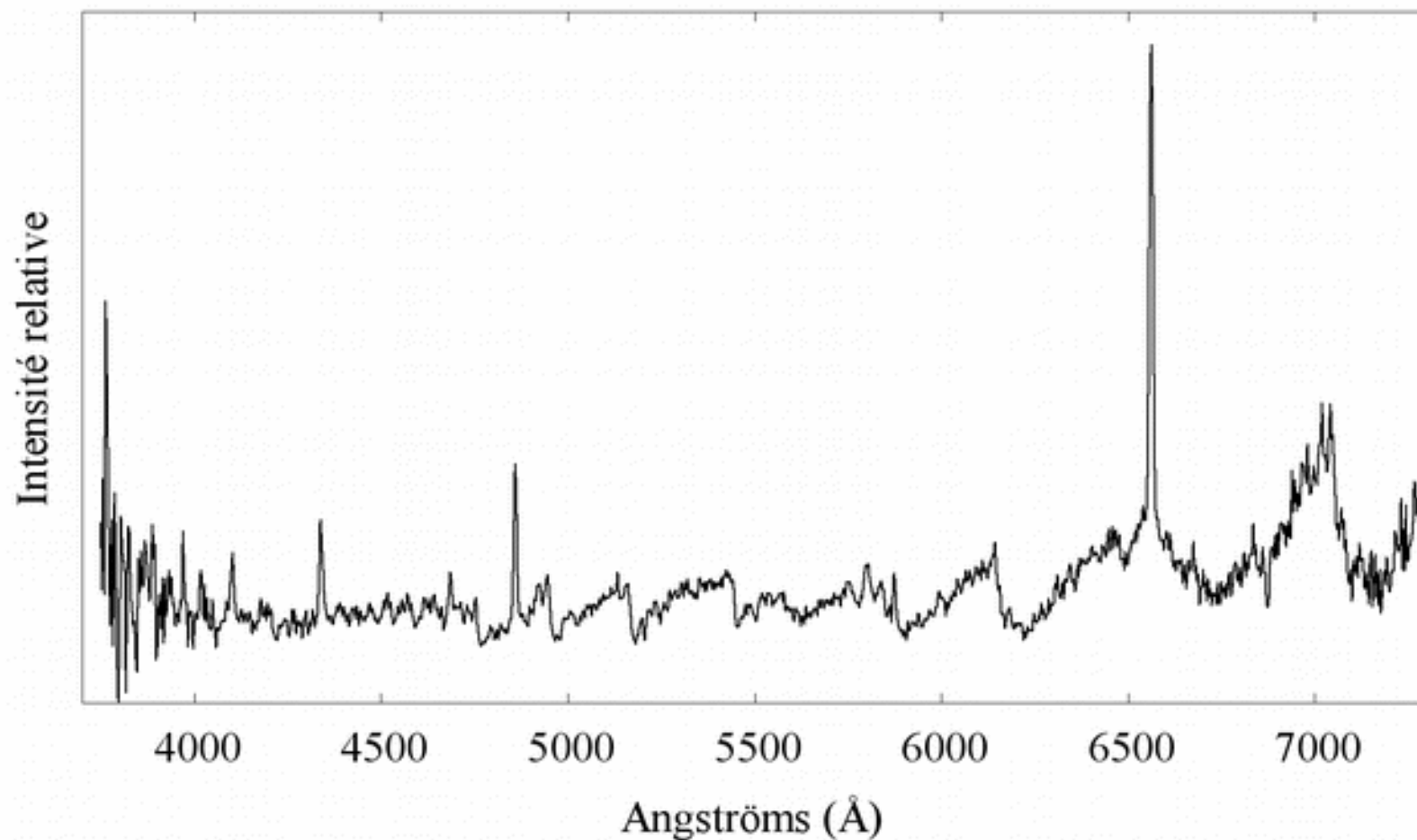
Altair - 20/08/2015 22:49 - C8-Alpy600#094-Atik314 - 2 x 3 s



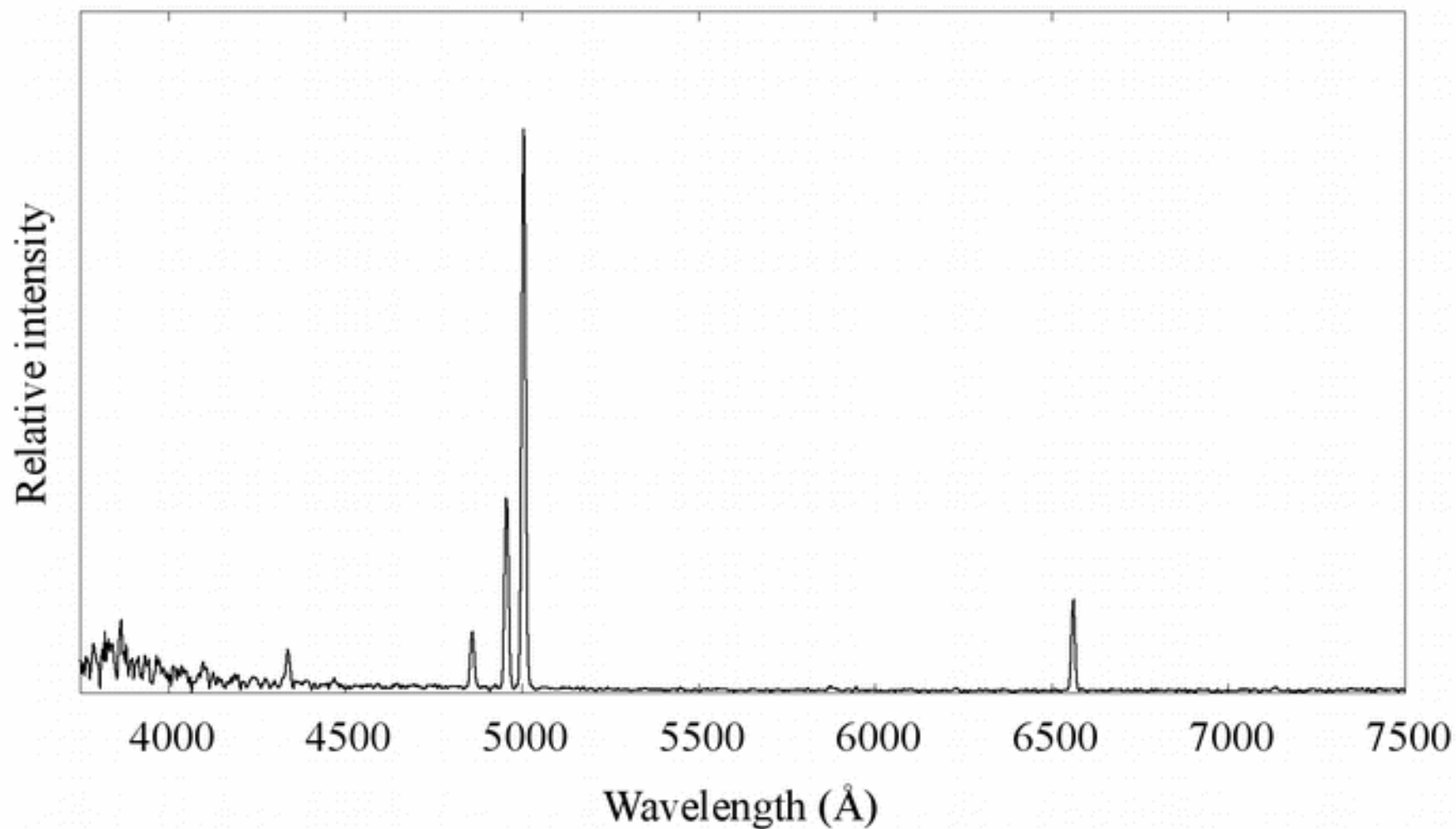
bet Lyr - 20/08/2015 22:35 - C8-Alpy600#094-Atik314 - 1 x 30 s



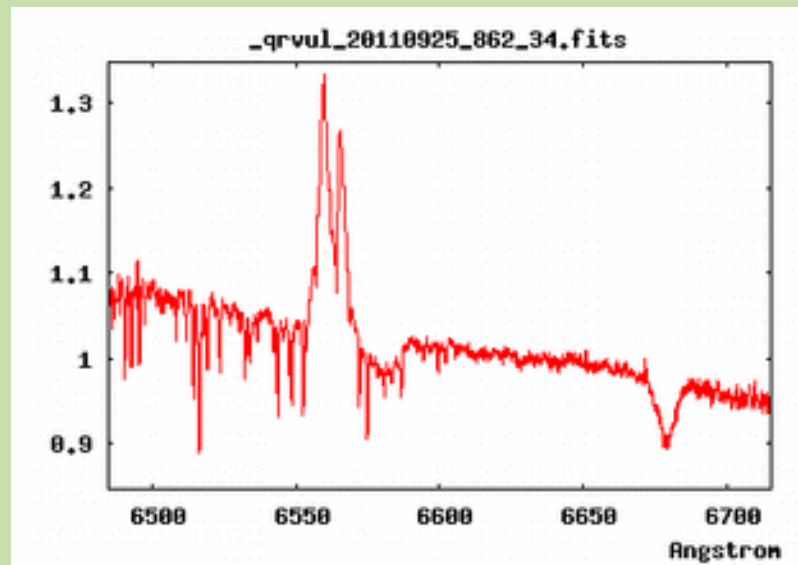
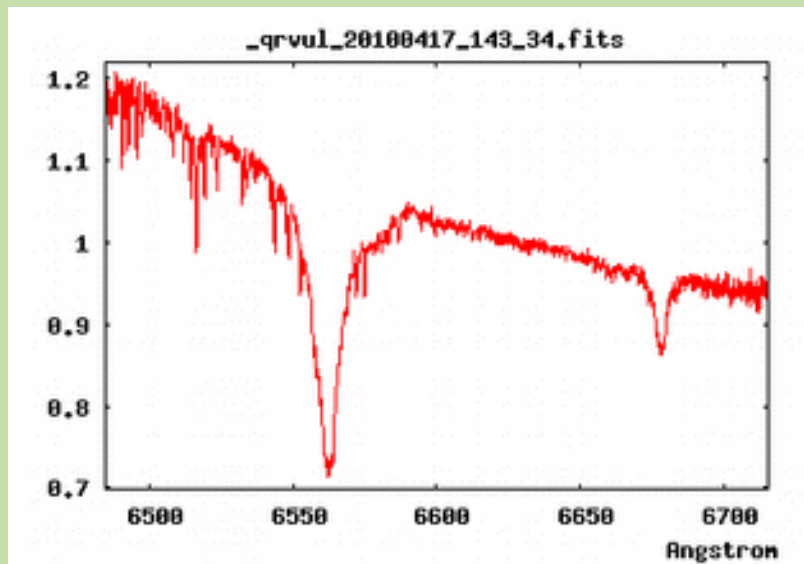
T Crb - 19/08/2015 22:41 - C8-Alpy600#094-Atik314 - 5 x 60 s



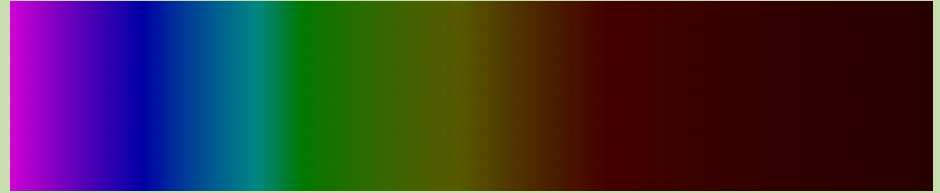
IC3568 - 2018-05-11 - 00:54:33 - Alpy600 NAT 2018



- Outburst !



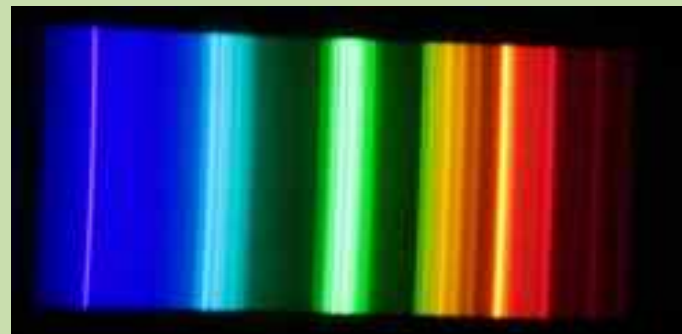
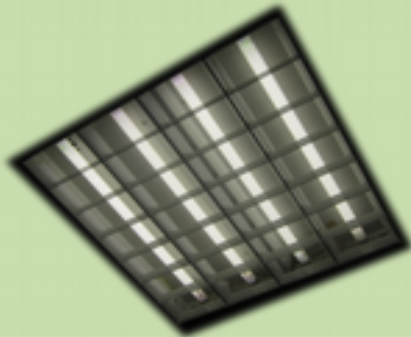
Fabriquer de la lumière

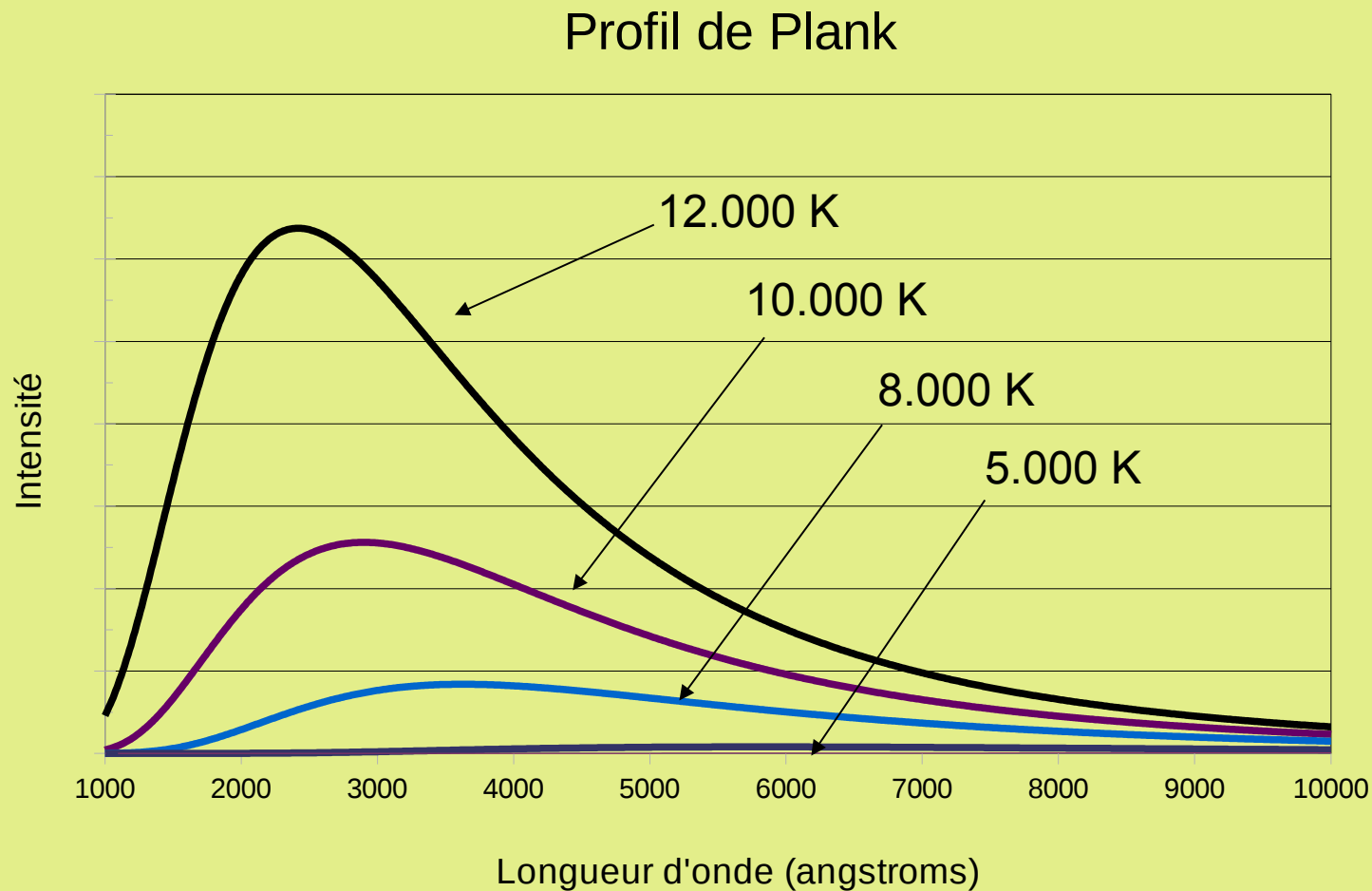


1 – en chauffant un corps

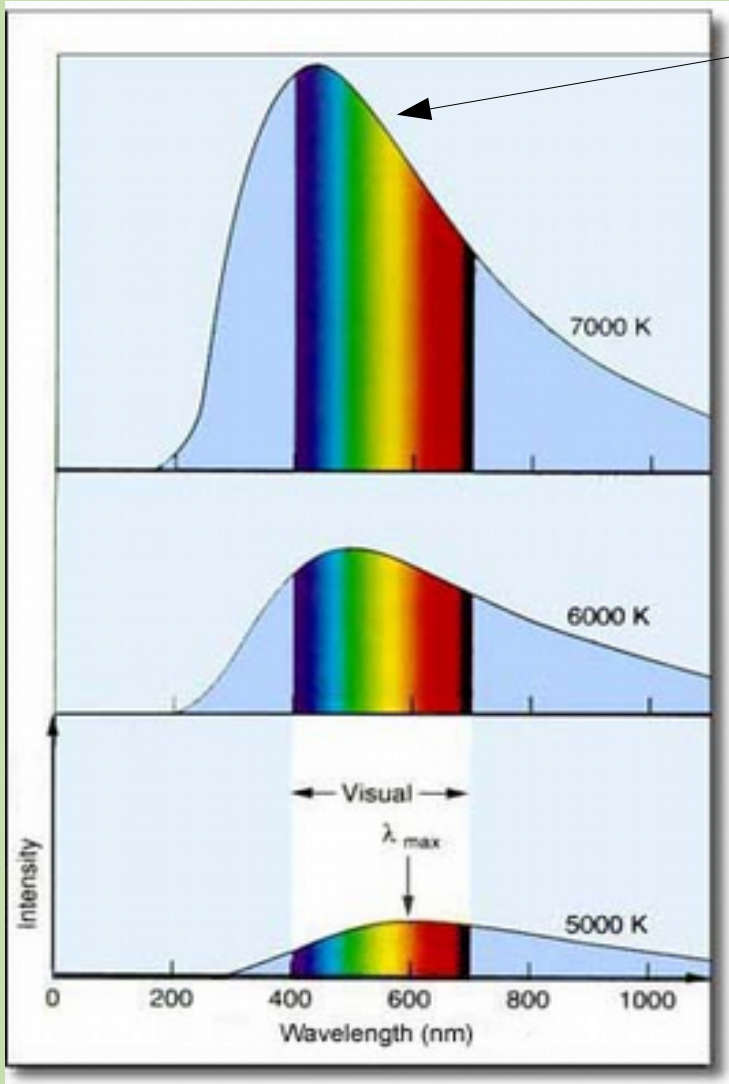
- Profil de Planck

2 – en excitant des atomes





Profil de Planck



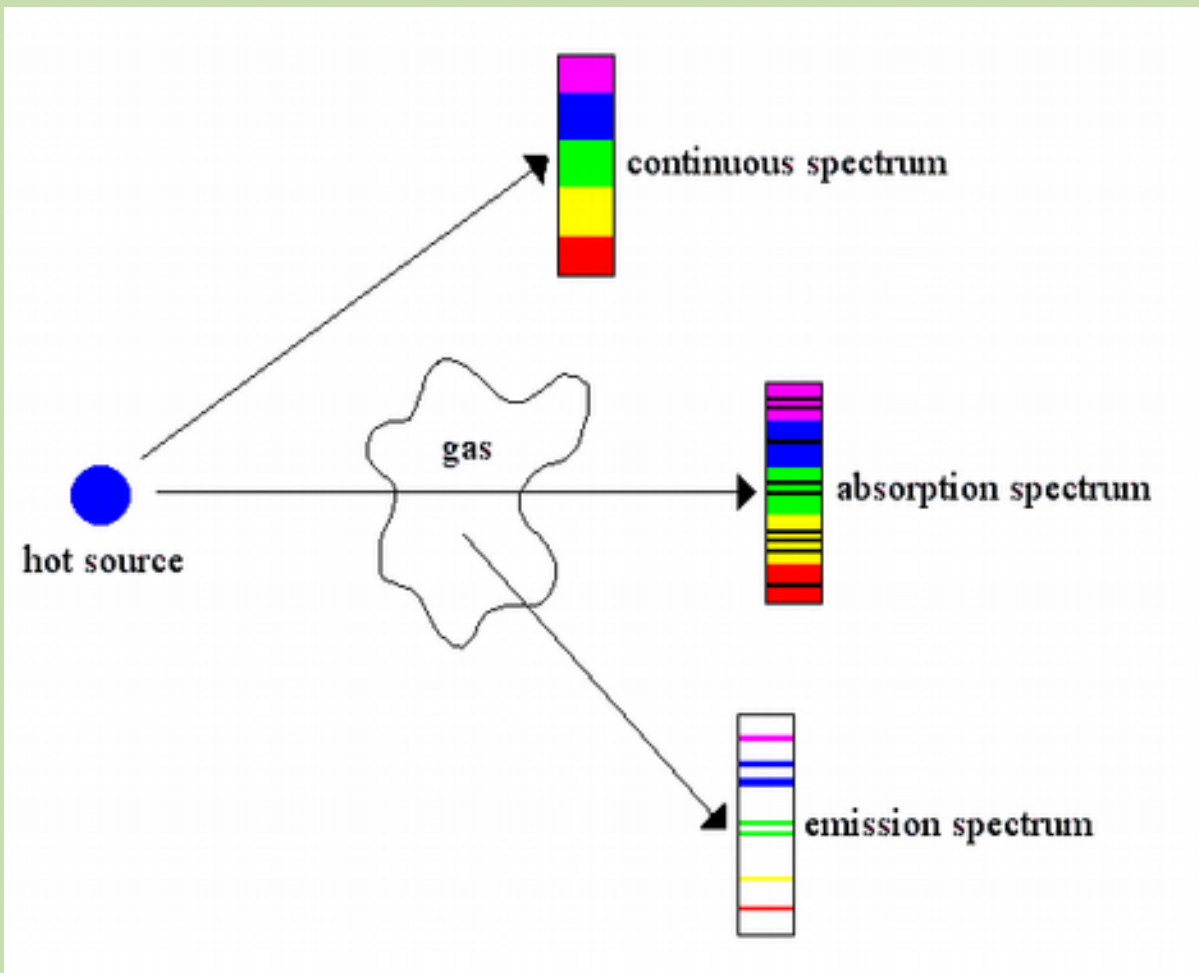
Domaine Visible
= 400-700nm (4000Å-7000Å)

- **La loi de Stefan:**
Intensité (sous la courbe)
= Constante * T^4
- **La loi de Wien:**
 λ_{max} * Température
= Constante (2900 $\mu\text{m.K}$)

==>Température = Couleur !!!

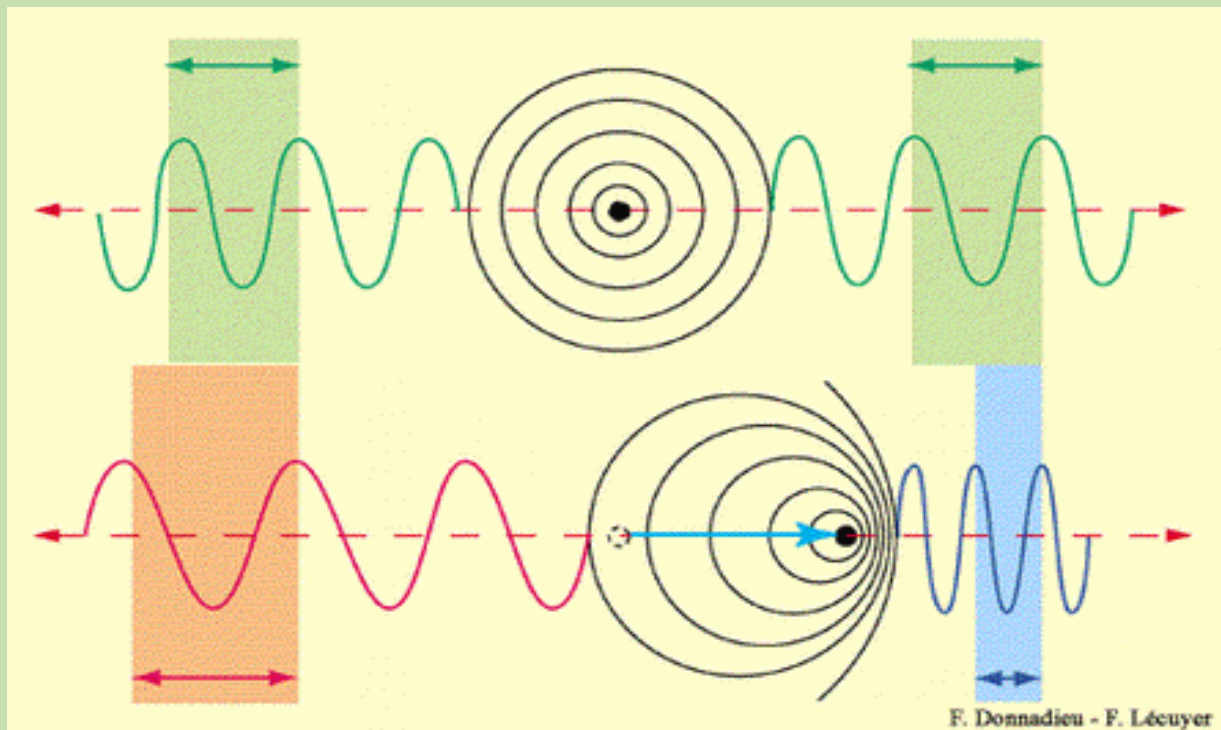
Lois de Kirchhoff

Source : <http://abyss.uoregon.edu/~js/ast122/lectures/lec05.html>



Dans les objets du ciel, on trouve tous ces phénomènes !

Effet Doppler



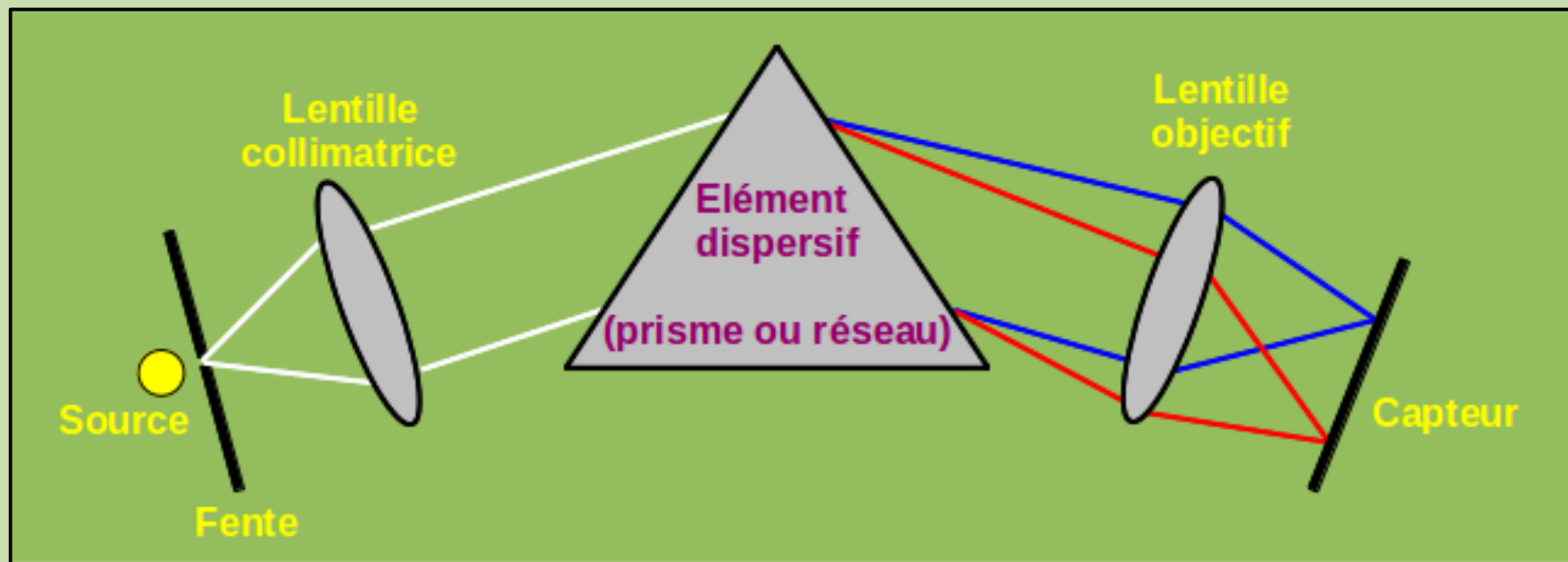
Expansion des galaxies
=
Décalage vers le rouge
(red shift)

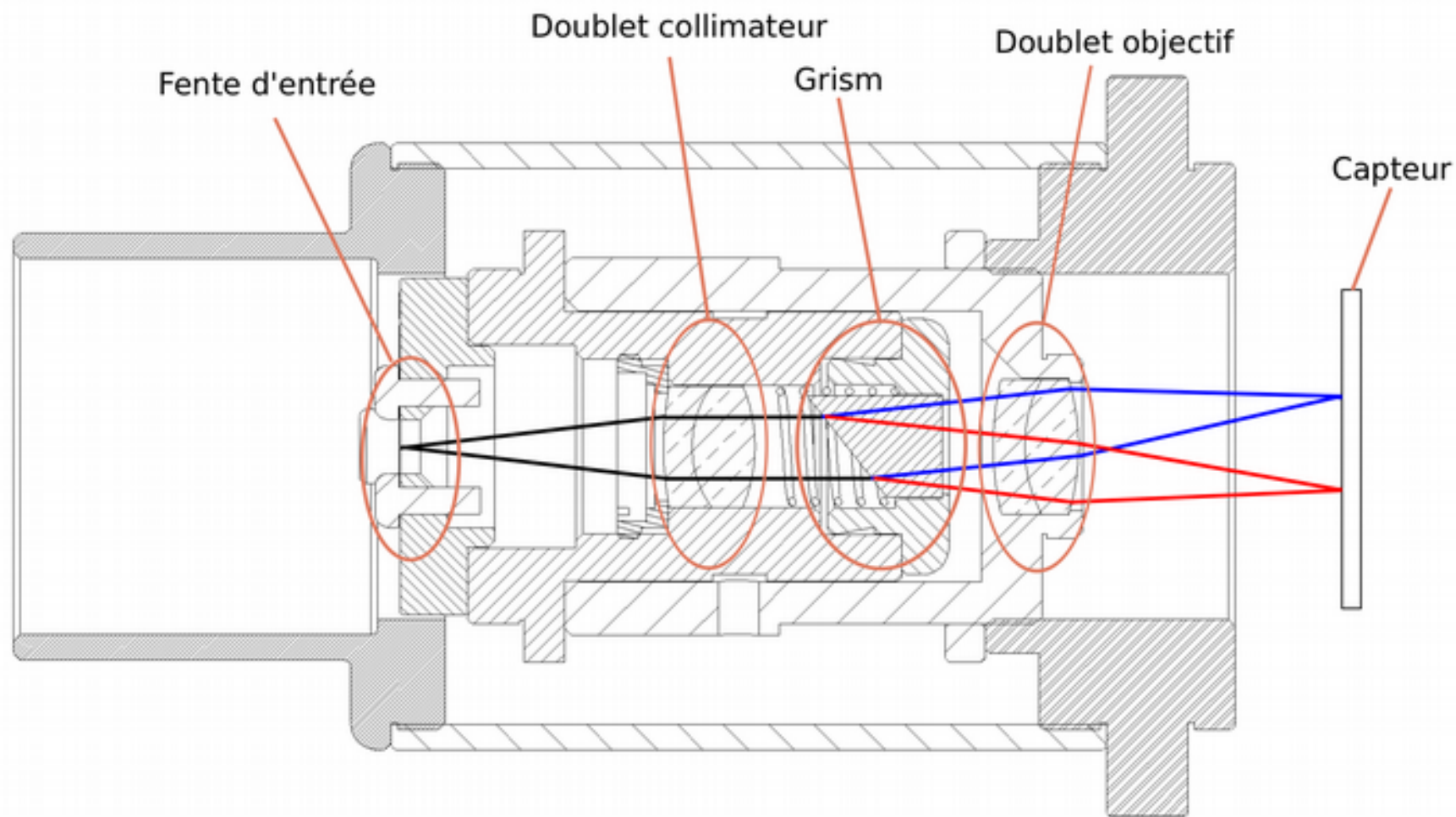
$$\frac{(\Delta \lambda)}{\lambda} = \frac{v}{c}$$

La lumière d'une étoile

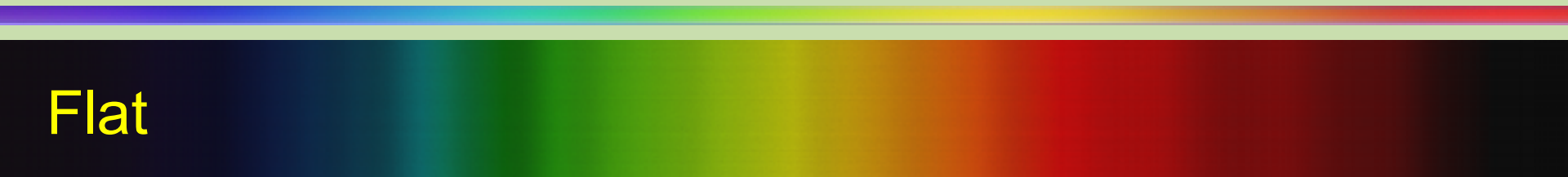
- Est fabriquée au cœur de l'étoile, par fusion nucléaire
- Traverse toutes les couches de l'étoile
- Traverse les éventuels disques, enveloppes, etc
- Traverse le milieu interstellaire
- Peut être décalée par effet Doppler
 - Agitation atomique
 - Rotation propre de l'étoile
 - Rotation de binaires
 - Mouvements propres
 - ...
- Cas particulier des nébuleuses

Principe d'un spectro

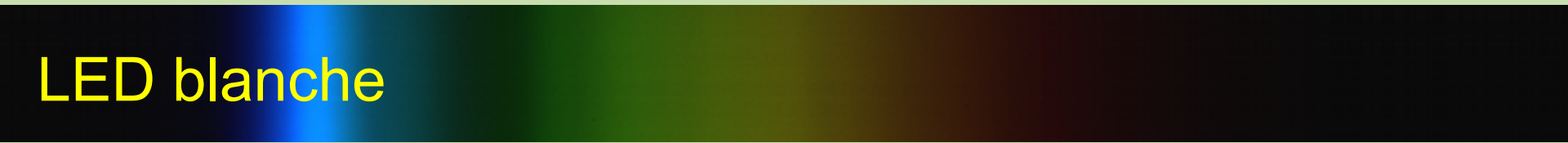




Flat

A continuous spectrum showing a smooth gradient of colors from violet on the left to red on the right, with no distinct lines.

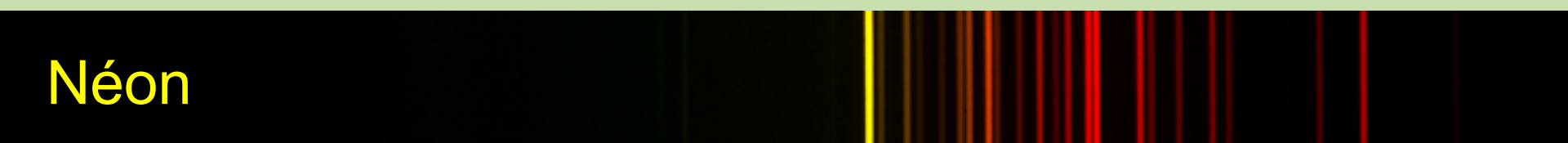
LED blanche

A spectrum showing a broad, continuous band of light with a slight peak in the blue-violet region, characteristic of white LEDs.

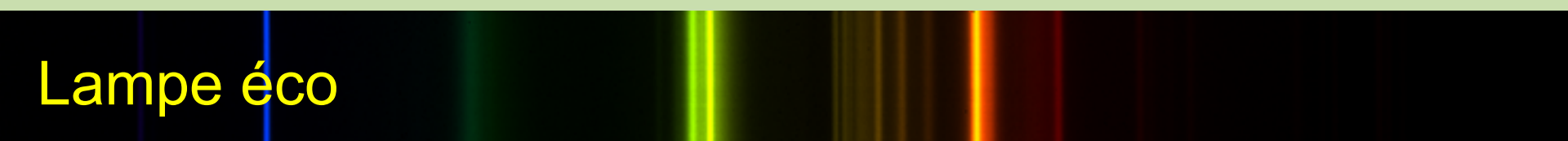
Soleil

A continuous spectrum with a smooth gradient of colors, similar to the flat spectrum but with slightly more pronounced blue and green components.

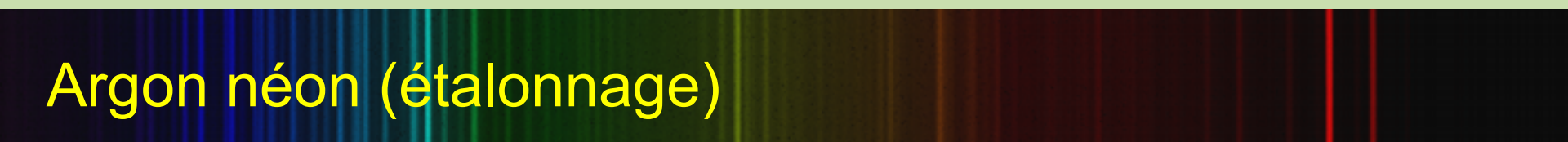
Néon

A spectrum consisting of several sharp, vertical emission lines of various colors (yellow, orange, red, green, blue) against a dark background.

Lampe éco

A spectrum showing a few sharp emission lines, primarily in the blue and green regions, with a dark background.

Argon néon (étalonnage)

A spectrum showing a series of sharp, vertical emission lines of various colors (yellow, orange, red, green, blue) against a dark background, used for calibration.

Procédez par étape

Le télescope et le spectroscopie sont deux instruments indépendants.

Maîtrisez-les indépendamment.

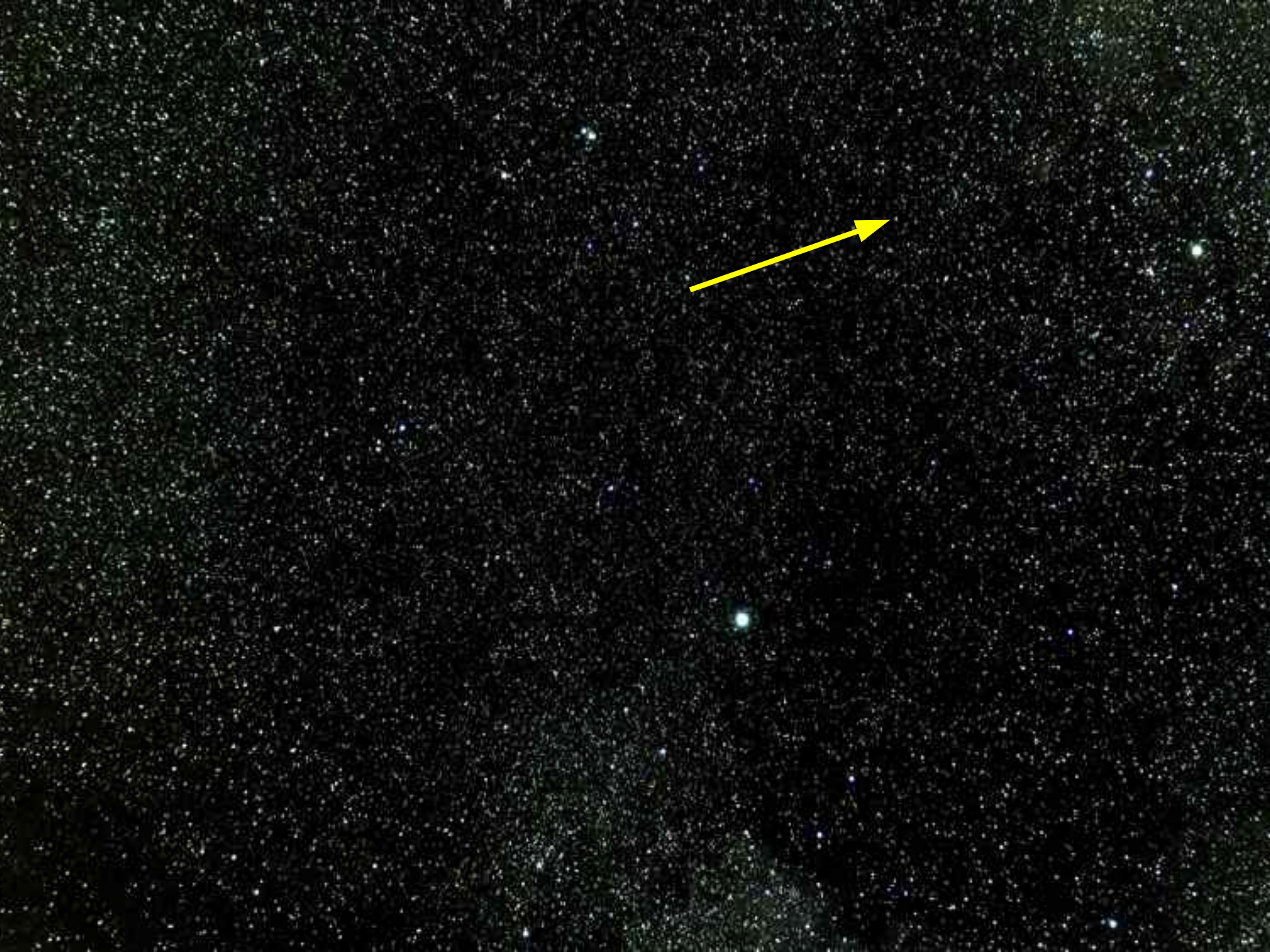
- Faites vos premiers spectres sur table
- Apprenez le maniement du télescope en imagerie
- Soignez l'assemblage

Pointer une étoile

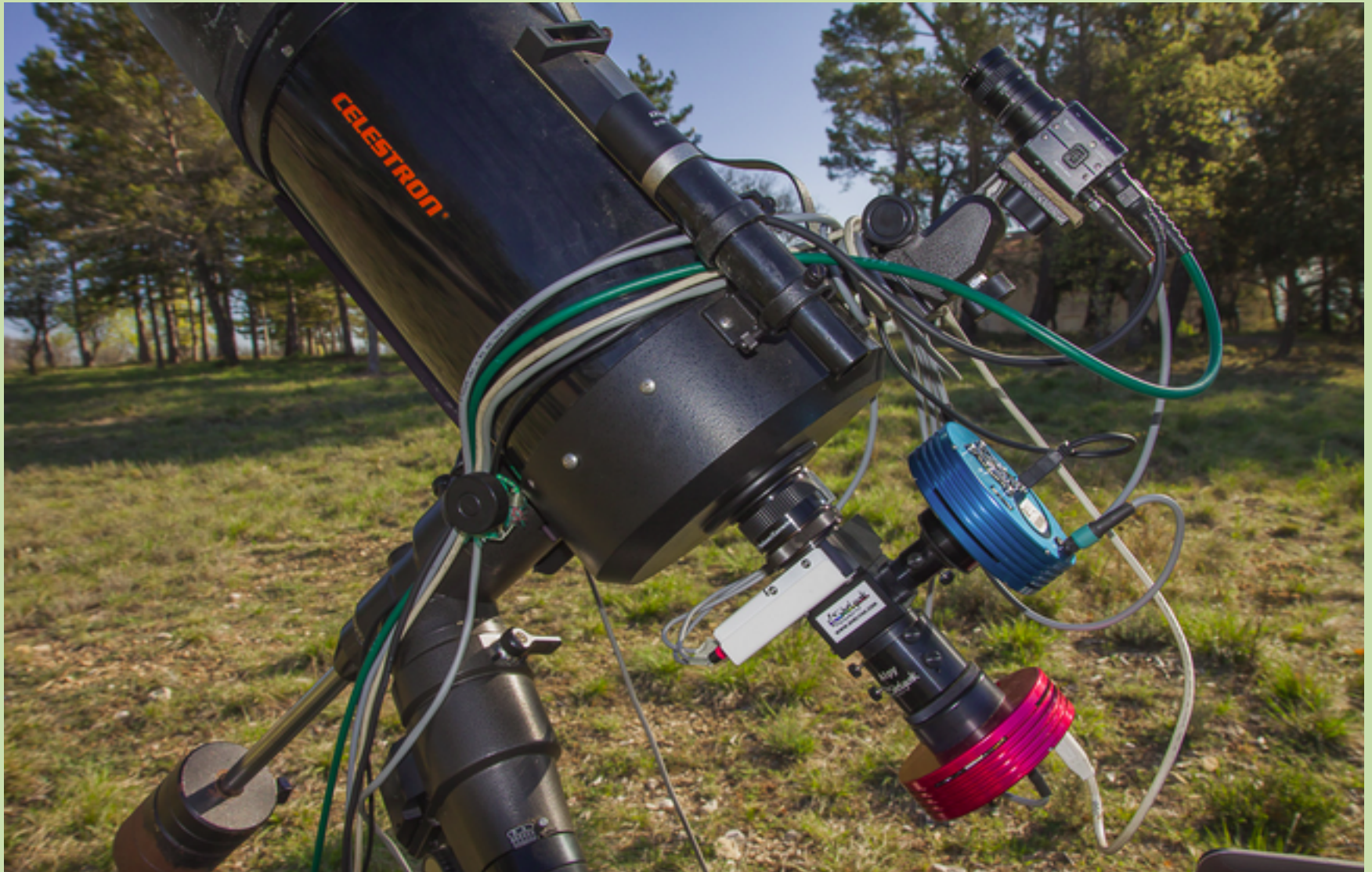
- Facile : GoTo ! (... *eh ben non...*)
 - Flexions, réfraction atm, erreurs de mise en station...
 - Champ de guidage faible
- Trouver les coordonnées de l'étoile
 - CDS, Simbad

**Saurez-vous mettre l'étoile CH Cyg
à un pixel près dans l'image ?**

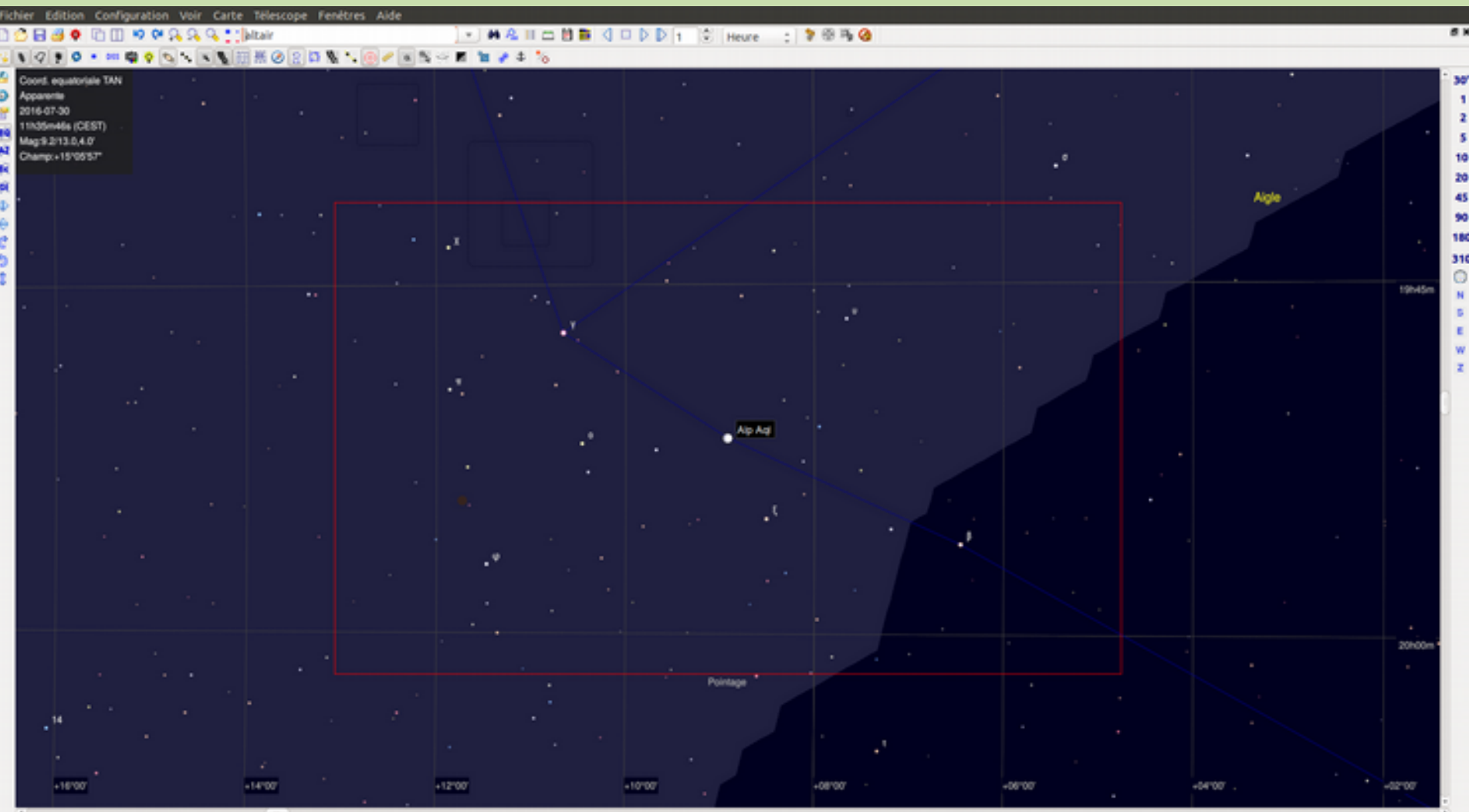




Pointer une étoile



Pointer une étoile



Un temps pour chaque chose

Un temps pour régler l'instrument,
Un temps pour observer.

- Le réglage de l'instrument se fait DE JOUR
- On ne change pas une configuration qui marche (« when it works, don't fix it »)

Tout pour la réduction (de données)

*Une observation est un ensemble d'images
au service du processus de réduction de données*

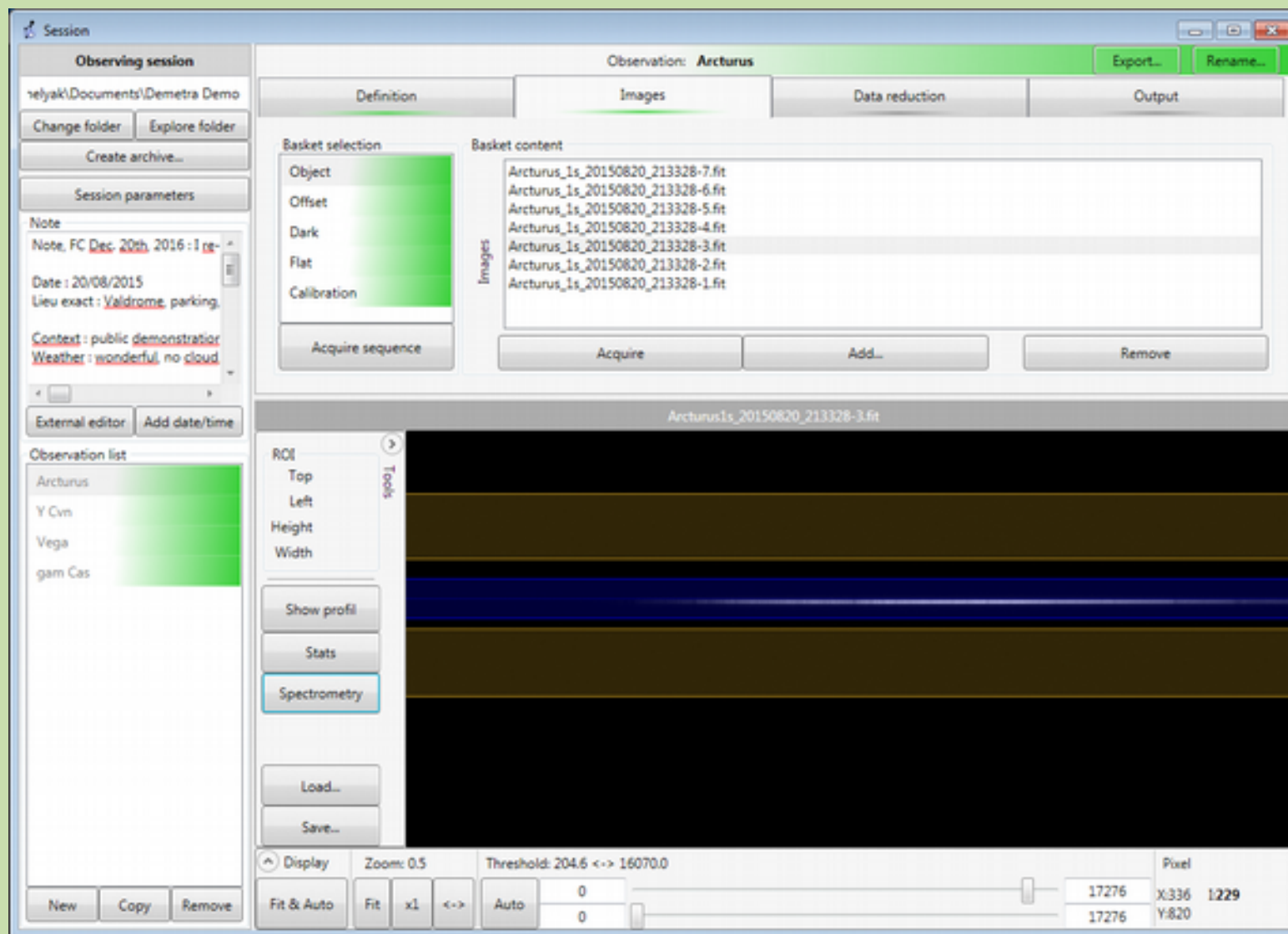
- Comprenez le processus de réduction de données
- L'étoile toujours à la même place dans la fente
- Vérifiez que le résultat est cohérent

Pratiquez régulièrement

Il est possible d'observer en ville !

- Méthode des petits pas,
- Faites une répétition générale avant une mission

Demetra - Observations



The screenshot shows the Demetra Observations software interface. The main window is titled "Session" and contains several panels and controls.

Observing session panel (left):

- Path: reljak\Documents\Demetra Demo
- Buttons: Change folder, Explore folder, Create archive...
- Session parameters: Note, Date: 20/08/2015, Lieu exact: Valdrome, parking, Context: public demonstration, Weather: wonderful, no cloud.
- Buttons: External editor, Add date/time
- Observation list: Arcturus (selected), Y Cvn, Vega, gam Cas.
- Buttons: New, Copy, Remove

Observation: Arcturus panel (top right):

- Buttons: Export..., Rename...
- Tabs: Definition, Images (selected), Data reduction, Output

Basket selection and content (middle):

- Basket selection:** Object, Offset, Dark, Flat, Calibration. Buttons: Acquire sequence.
- Basket content:** Arcturus_1s_20150820_213328-7.fit, Arcturus_1s_20150820_213328-6.fit, Arcturus_1s_20150820_213328-5.fit, Arcturus_1s_20150820_213328-4.fit, Arcturus_1s_20150820_213328-3.fit (selected), Arcturus_1s_20150820_213328-2.fit, Arcturus_1s_20150820_213328-1.fit. Buttons: Acquire, Add..., Remove.

ROI and Tools panel (bottom left):

- ROI: Top, Left, Height, Width.
- Buttons: Show profil, Stats, Spectrometry (selected), Load..., Save...

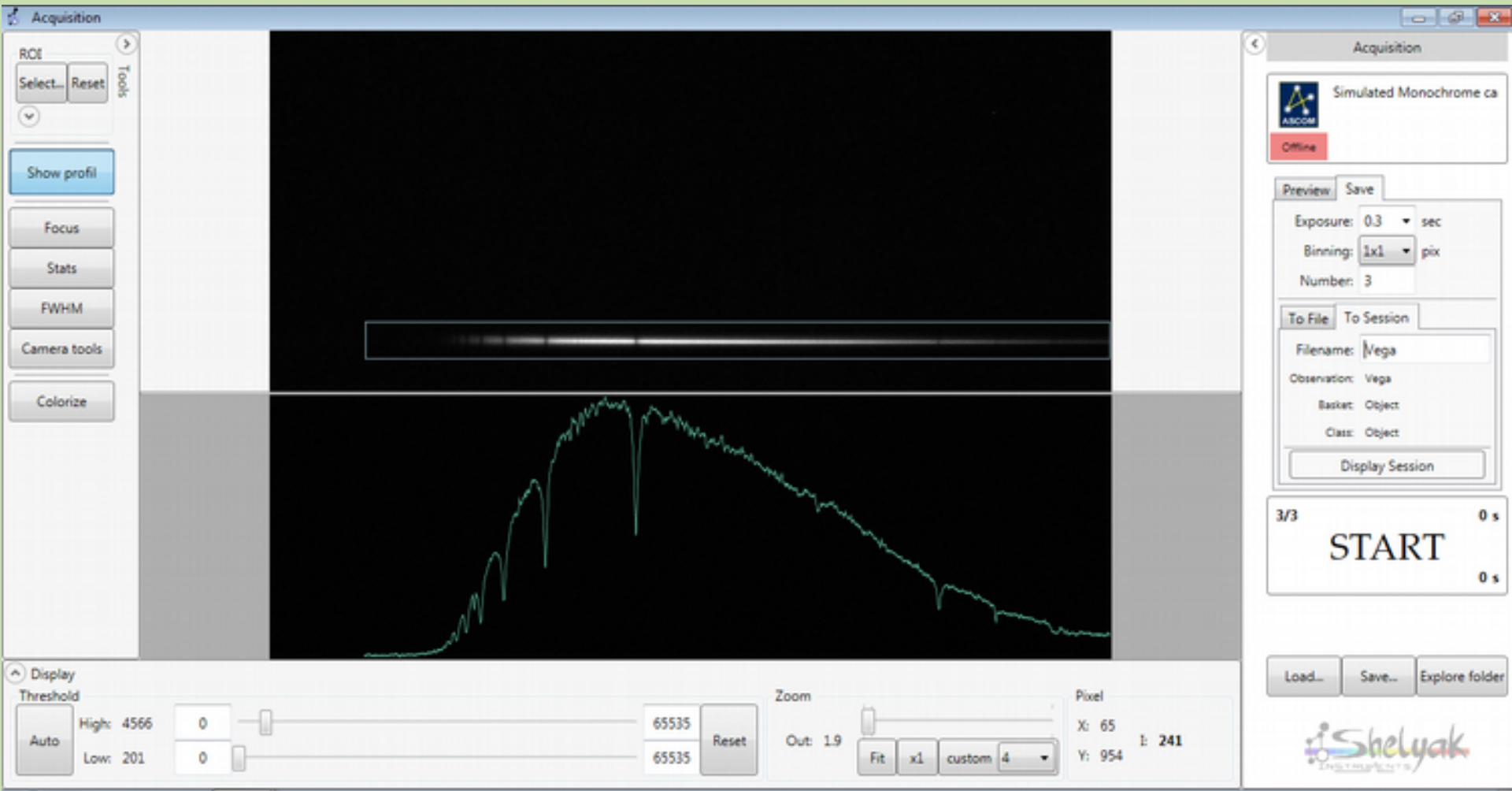
Main Image Area (bottom right):

- Image title: Arcturus1s_20150820_213328-3.fit
- Image content: A dark image with horizontal bands of light and dark regions.

Bottom Status Bar:

- Display: Zoom: 0.5, Threshold: 204.6 <-> 16070.0
- Buttons: Fit & Auto, Fit, x1, <->
- Auto: 0, 0
- Pixel: 17276 X:336 1229, 17276 Y:820

Demetra - acquisition



Demetra réduction de données

Session

Observing session

Change folder

Explore folder

Create archive...

Session parameters

Note

Note, FC Dec. 20th, 2016: I re-

Date: 20/08/2015

Lieu exact: Valdrome, parking.

Context: public demonstration

Weather: wonderful, no cloud

External editor

Add date/time

Observation list

Arcturus

Y Cvn

Vega

gam Cas

New

Copy

Remove

Observation: Arcturus

Export...

Rename...

Definition

Images

Data reduction

Output

Process

Masters

Preprocess

Geometry

Extraction

Stack

Calibration

Response

Normalization

Crop

Run

☒ Save Intern. images

Run	Offset	Offset0s_20150819_222602-5.fit	< 1 >	ArcturusOffset_M.fit
Run	Dark	Dark180s_20150819_232807-5.fit	< 1 >	ArcturusDark_M.fit
Run	Flat	Flat10s_20150820_211212-3.fit	< 1 >	ArcturusFlat_M.fit

2017/09/06 20:56:11 Information Process successfully finished
2017/09/06 20:56:11 crop Information Process step Crop succeeded
2017/09/06 20:56:11 normalization Information Process step Normalization succeeded
2017/09/06 20:56:11 calibr Information Instrumental response successfully applied.
2017/09/06 20:56:11 extraction Information Applying instrumental response...
2017/09/06 20:56:11 calibWavelength Information Image wavelength calibration succed
2017/09/06 20:56:11 calibWavelength Information Calibration coefficients: a0:2739.5168 a1:3.3464 a2:0.0003 a3:-1.6667
2017/09/06 20:56:10 calibWavelength Information automatic coefficient computation ref lines : SectionSize: 80 Backgro
2017/09/06 20:56:10 calibWavelength Information automatic coefficient computation: SectionSize: 80 Background rate:
2017/09/06 20:56:10 stacked Information Process successfully completed
2017/09/06 20:56:10 stacked Information Extracting spectrum from basket Calibration...

Open

Lock

Arcturus result

Curve selection

Arcturus result

View tools

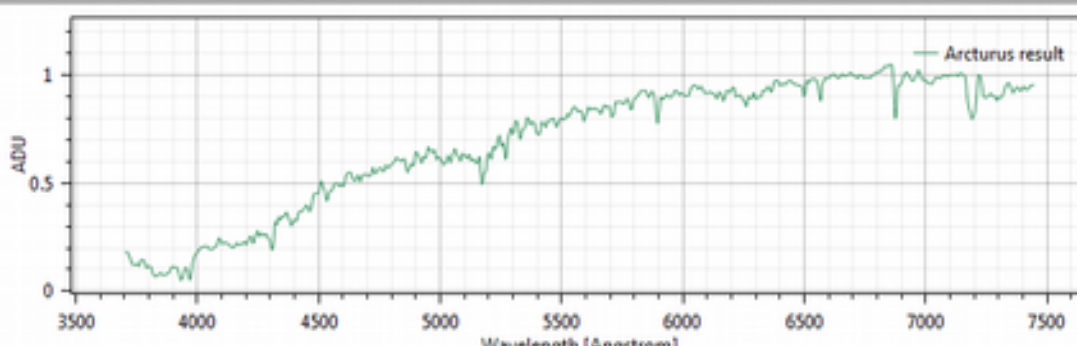
Fit

Zoom

Pixel

W: 3353.484

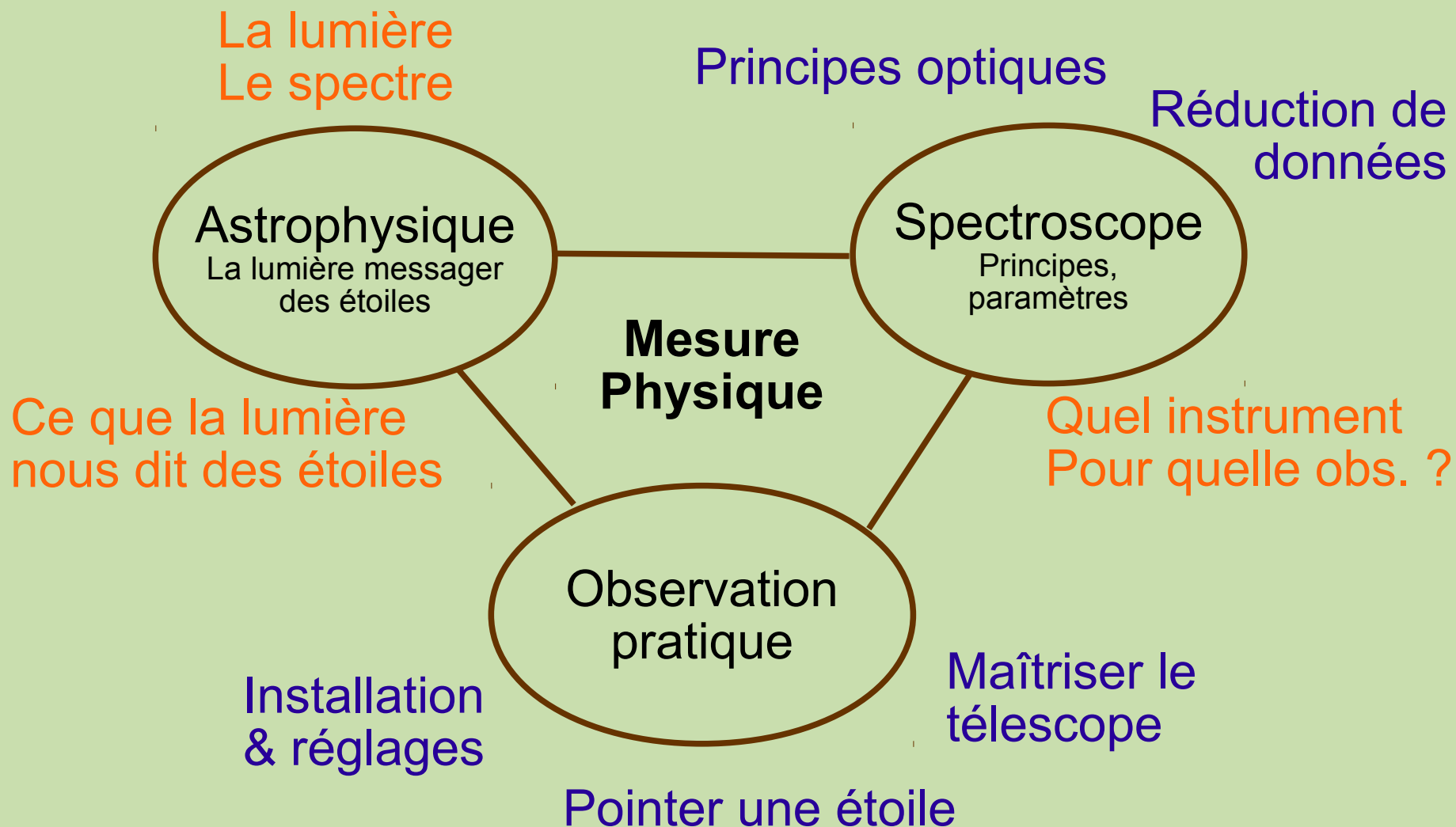
ADU: 0.939



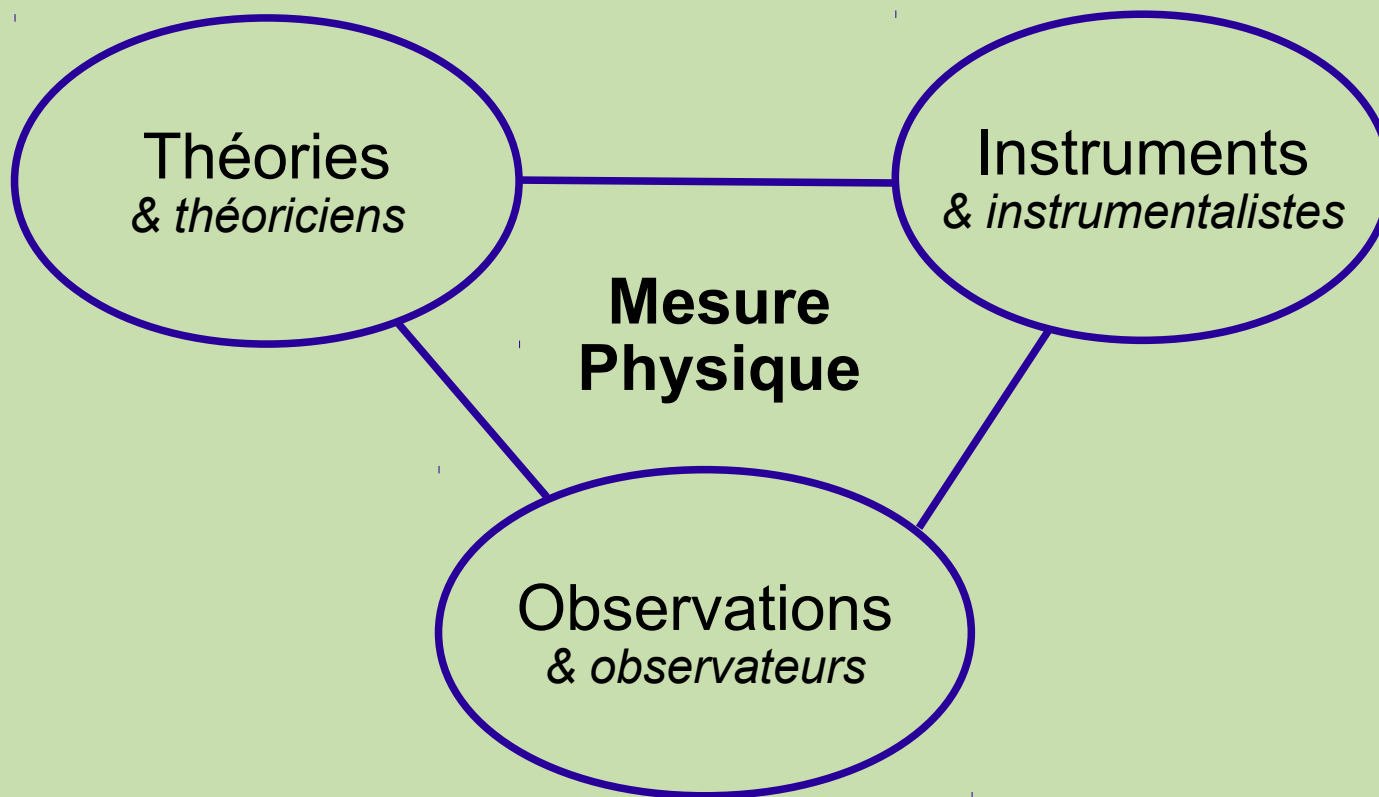
Programmes scientifiques

- **Programmes personnels**
- **Projets pédagogiques**
- **Programmes au long cours**
 - BeSS (Be)
 - Symbiotiques, cataclysmiques...
 - Nébuleuses planétaires (NP)
 - RR Lyrae
- **Campagnes**
 - Del Sco 2012, WR140, VV Cep...
- **Evénements**
 - Comète, nova, supernova
 - Nova Del 2013

Le triptyque de la spectro



Le triptyque de la recherche



Guide pratique
Disponible chez
Shelyak Instruments,
Amazon, Fnac...



Merci !

*Vous ne verrez
plus les étoiles
comme avant !*



Shelyak Instruments
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