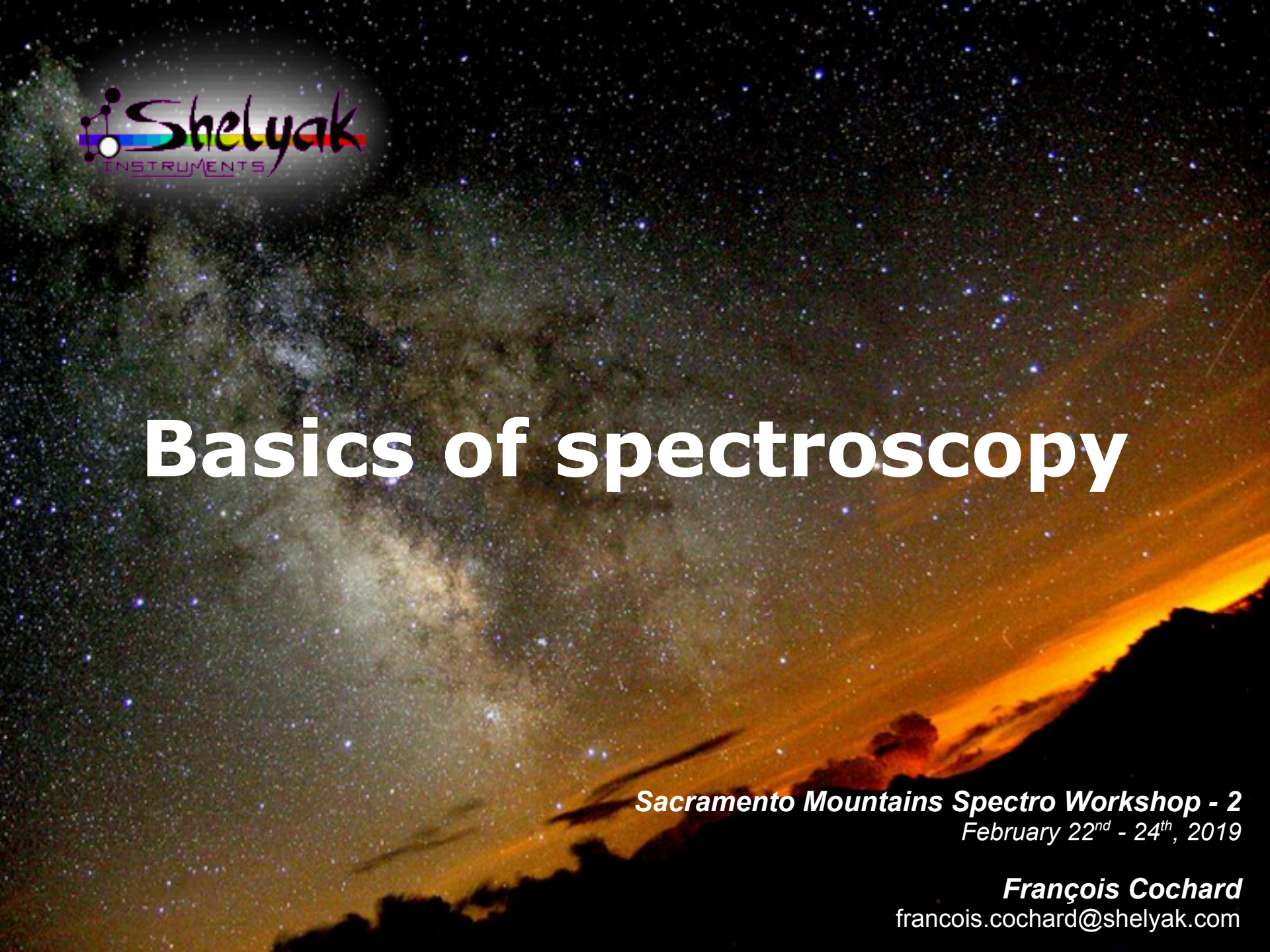


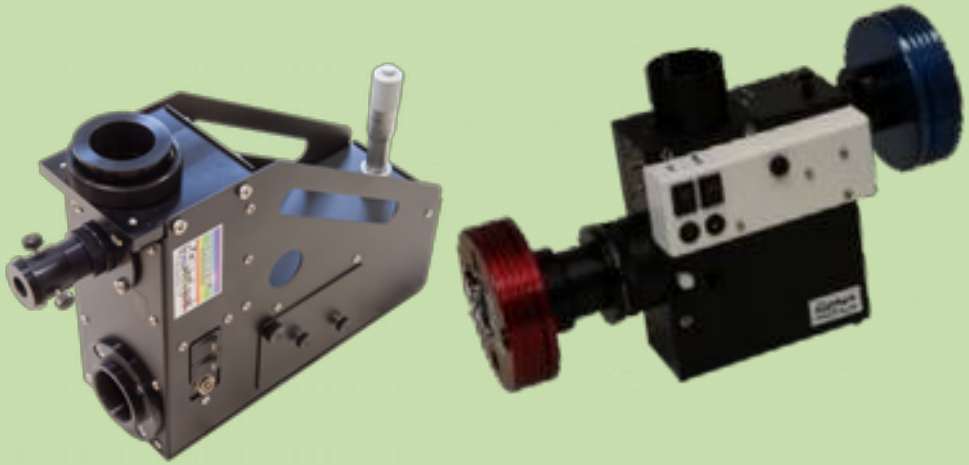
Basics of spectroscopy

Sacramento Mountains Spectro Workshop - 2
February 22nd - 24th, 2019

François Cochard
francois.cochard@shelyak.com

Product range

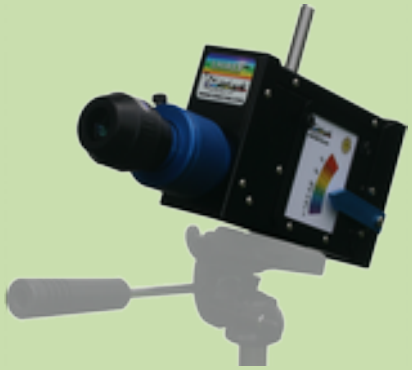
Lhires III & LISA



Eshel

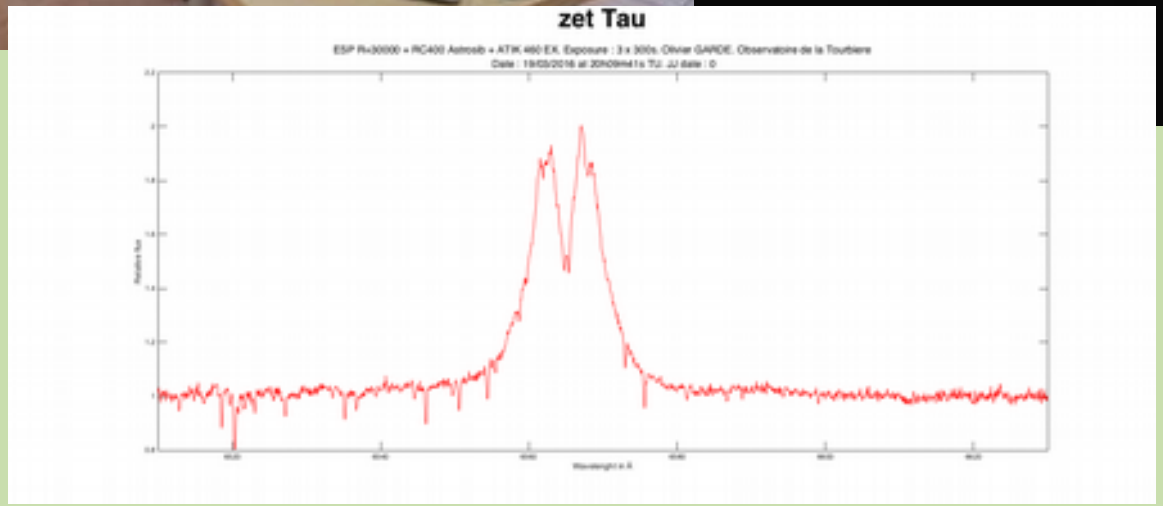
Alpy 600 & StarAnalyser

Handeled spectro & Lhires Lite

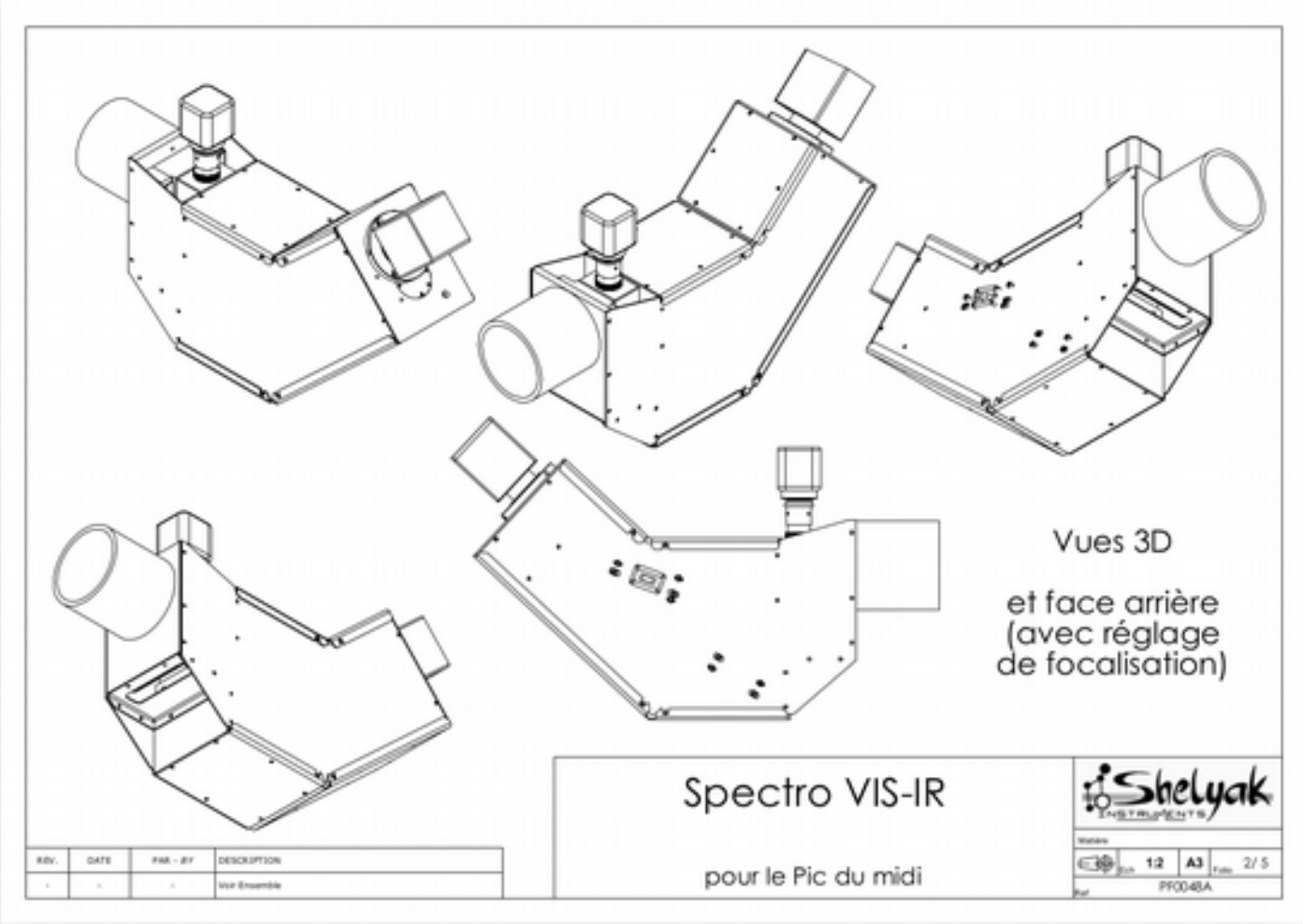


Product range

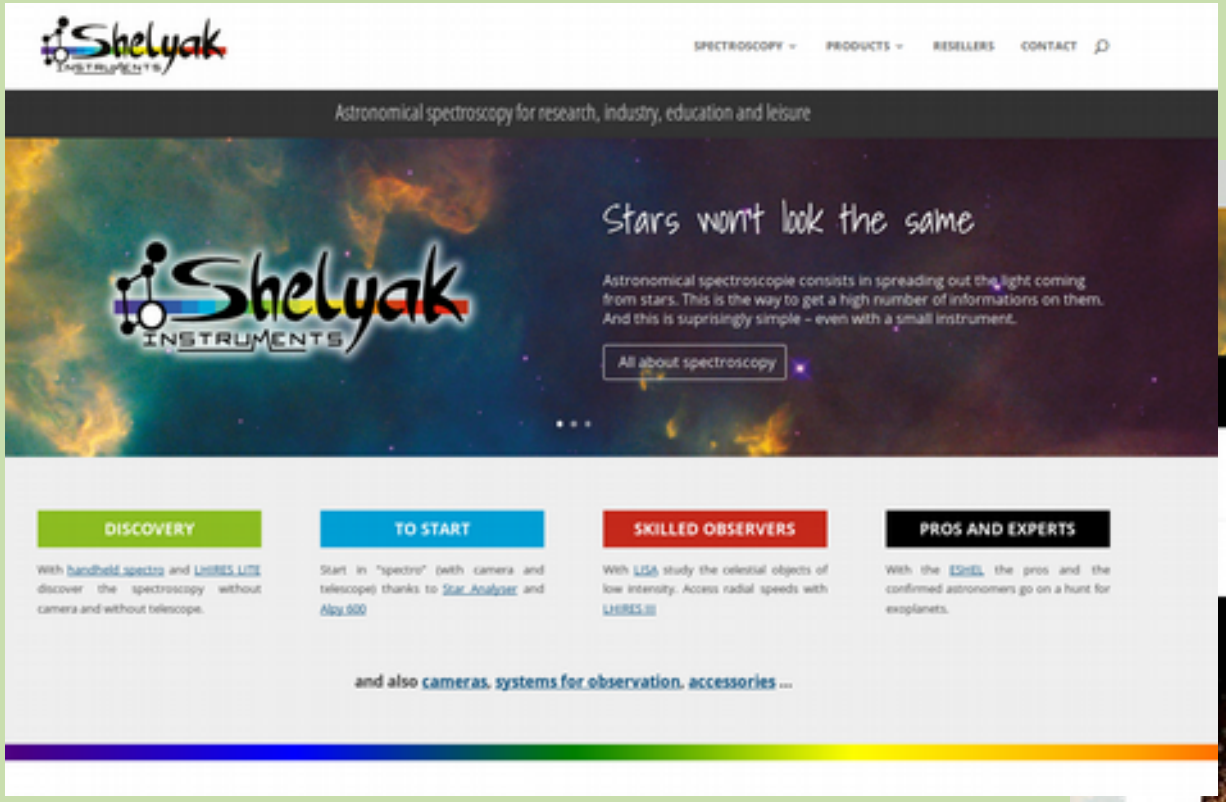
Whoppshel

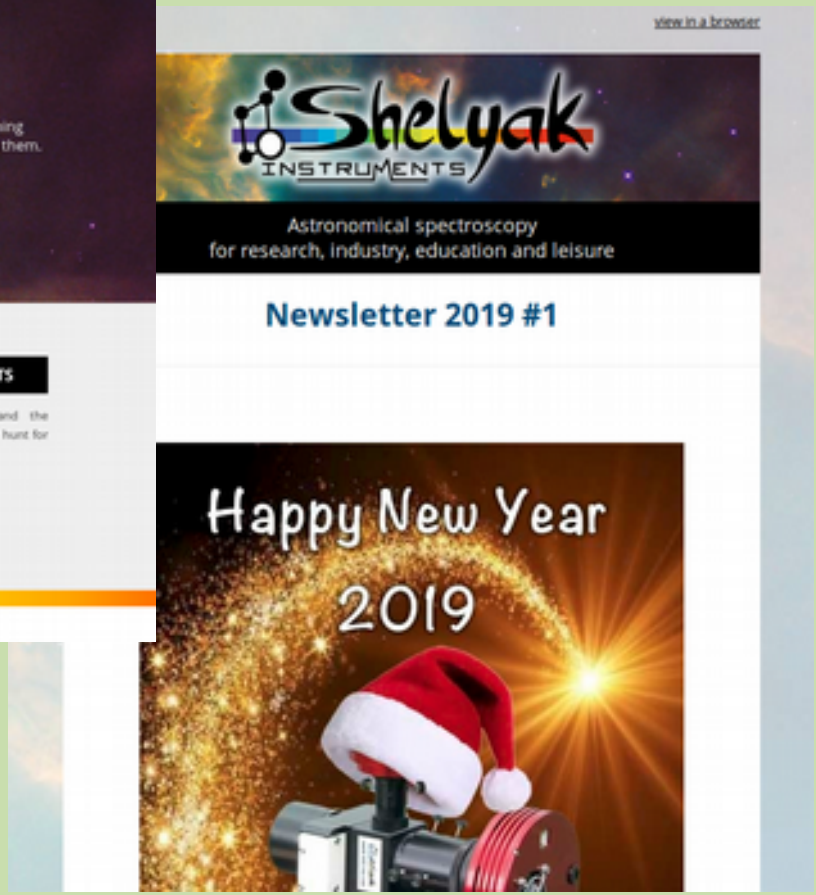


SOVAG VIS-SWIR – Pic du Midi

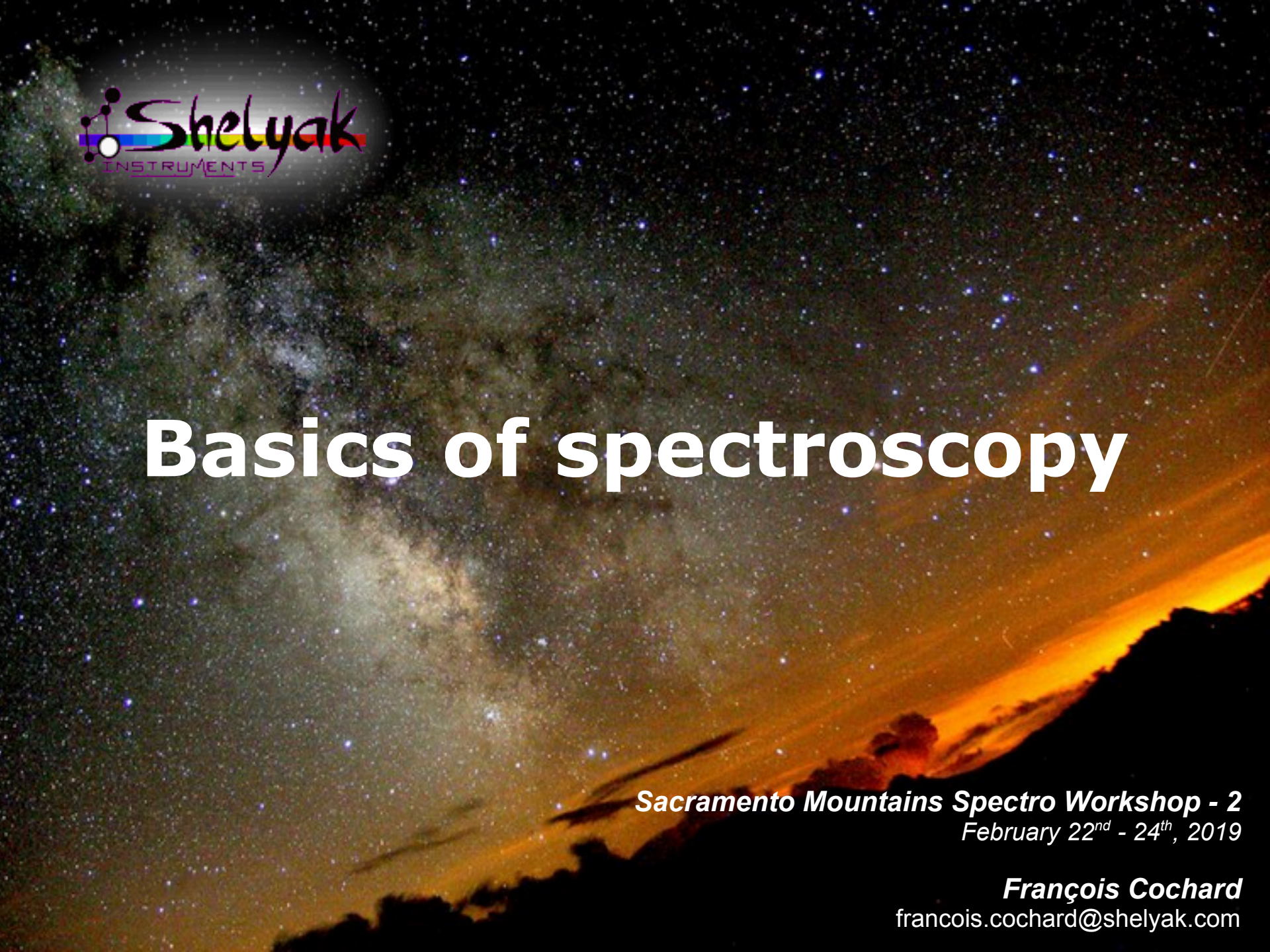


Being in contact with Shelyak





www.shelyak.com



Basics of spectroscopy

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Many ways to do Astronomy

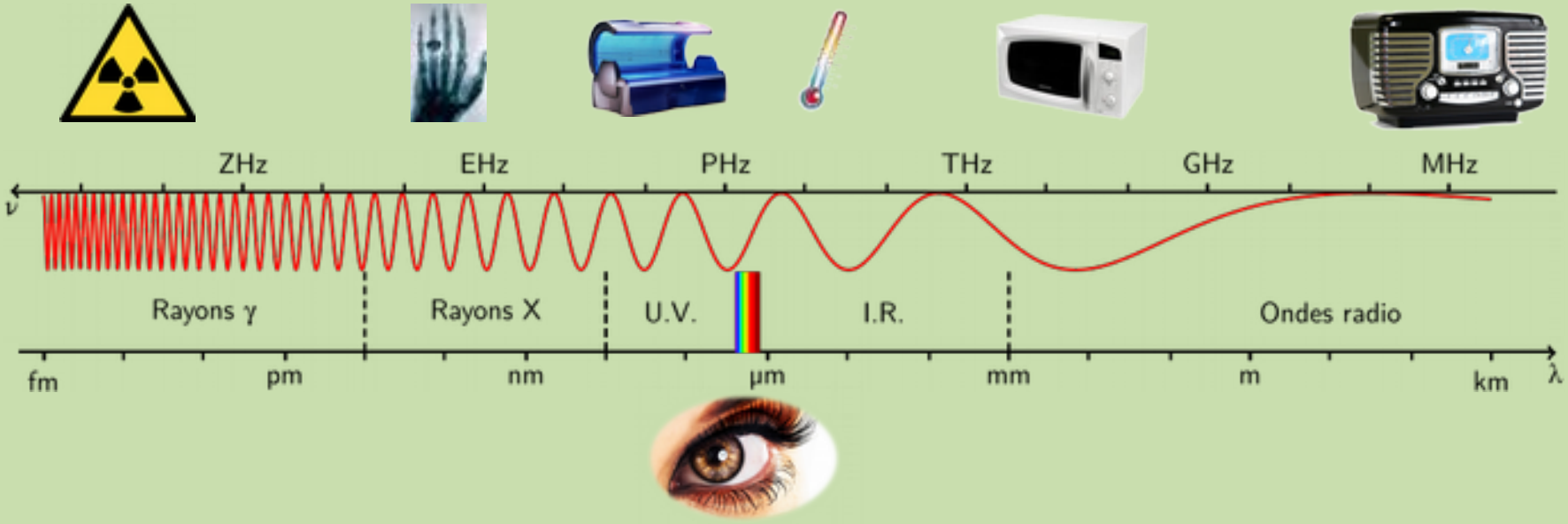
	Contemplate	Measure
Visual	Visual obs.	Variables stars, astrometry
Imaging	Nice pictures	Photometry, astrometry, planetary imaging
Spectroscopy	-	Physical parameters, Chemical composition, Radial velocites
Polarimetry	-	Polarisation (magn. field, diffusion, reflexions)

Informations not accessible to human eye

Spectroscopy

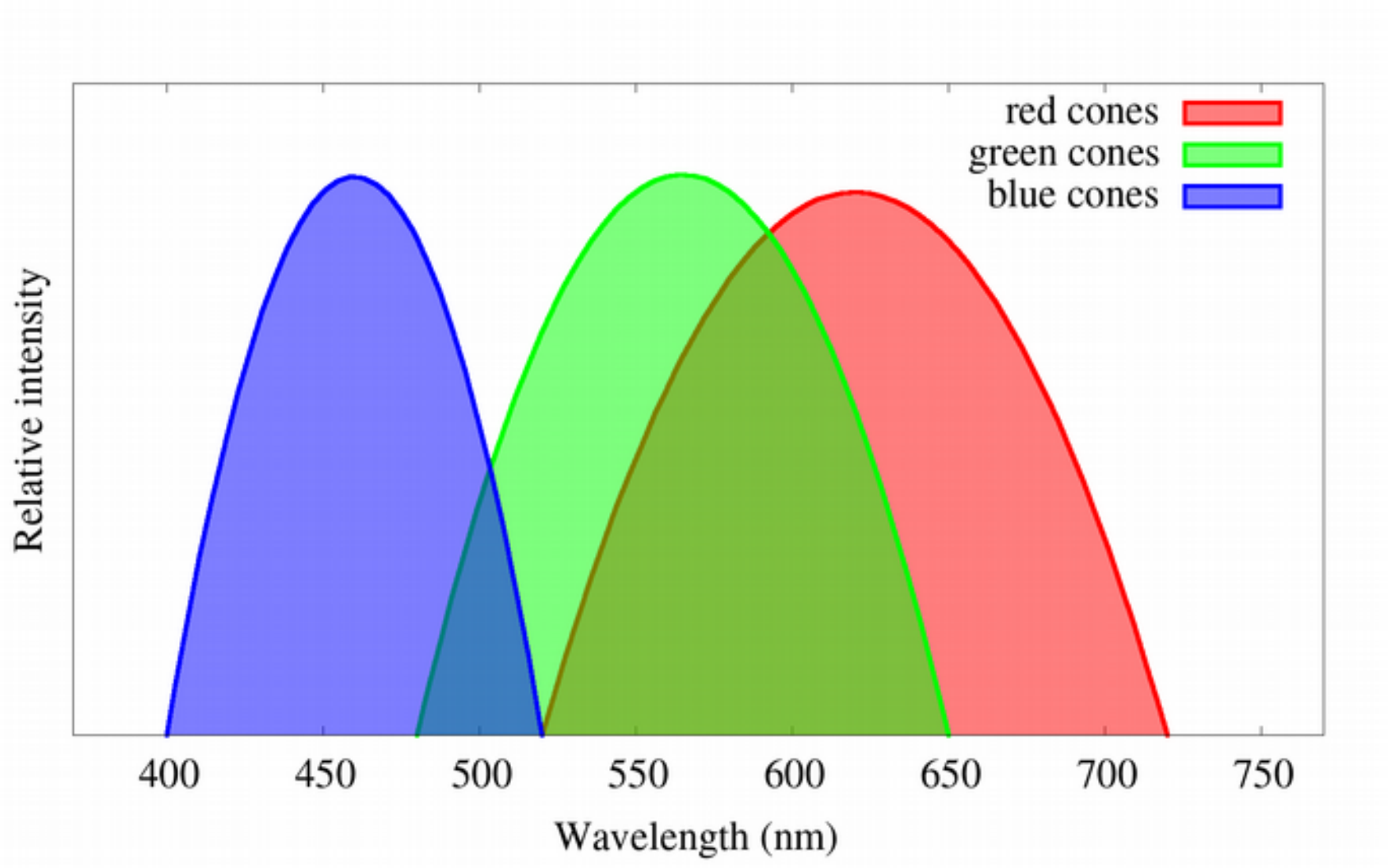
- The light contains more information than the eye (or a CCD) can perceive.
- A spectrum is a detailed decomposition of the light energy vs wavelength (or color).
- The function of a spectroscope is to convert the waelength (color) to a geometric position of an imaging sensor.

Light is a wave...

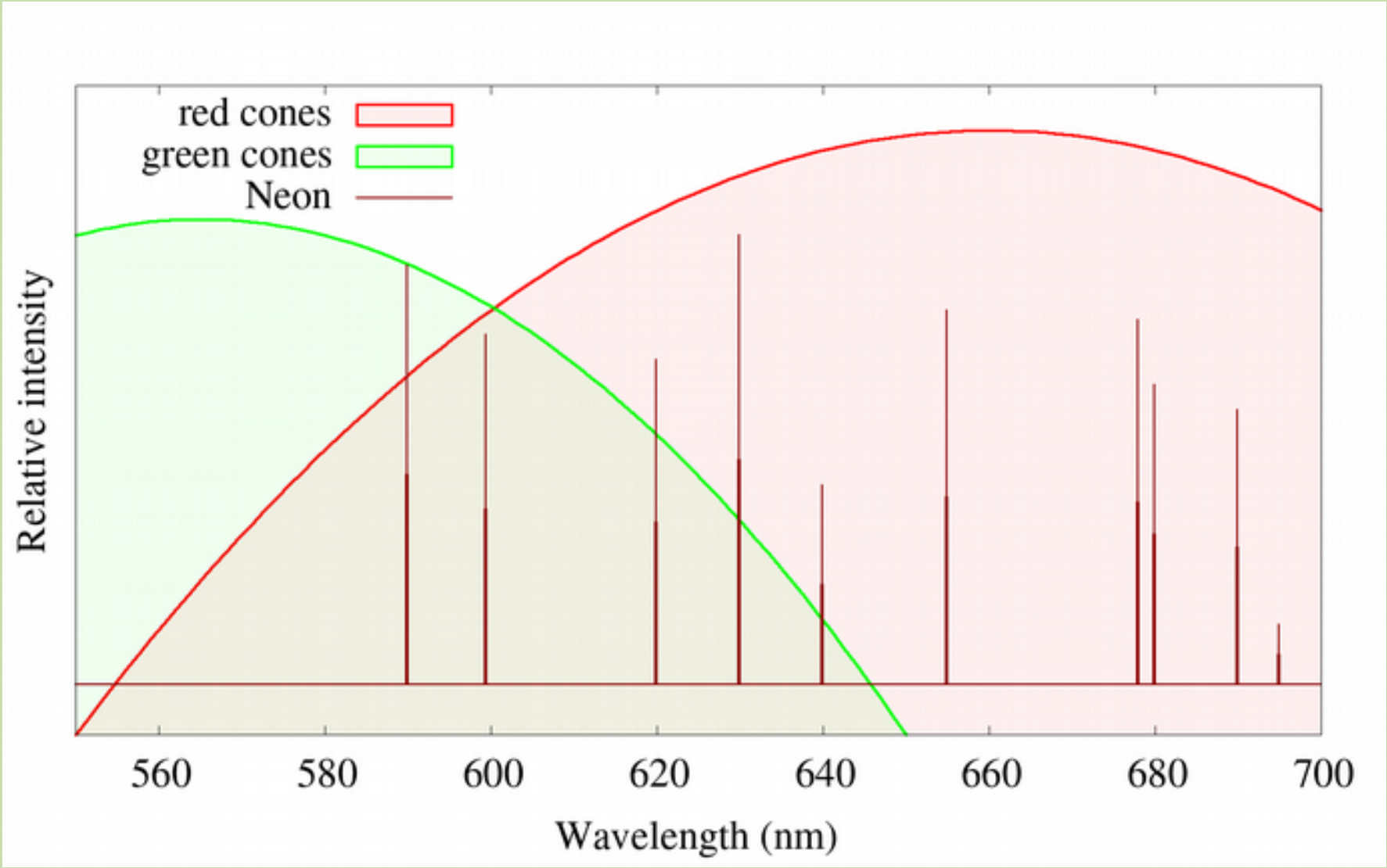


Crédit: O. Thizy

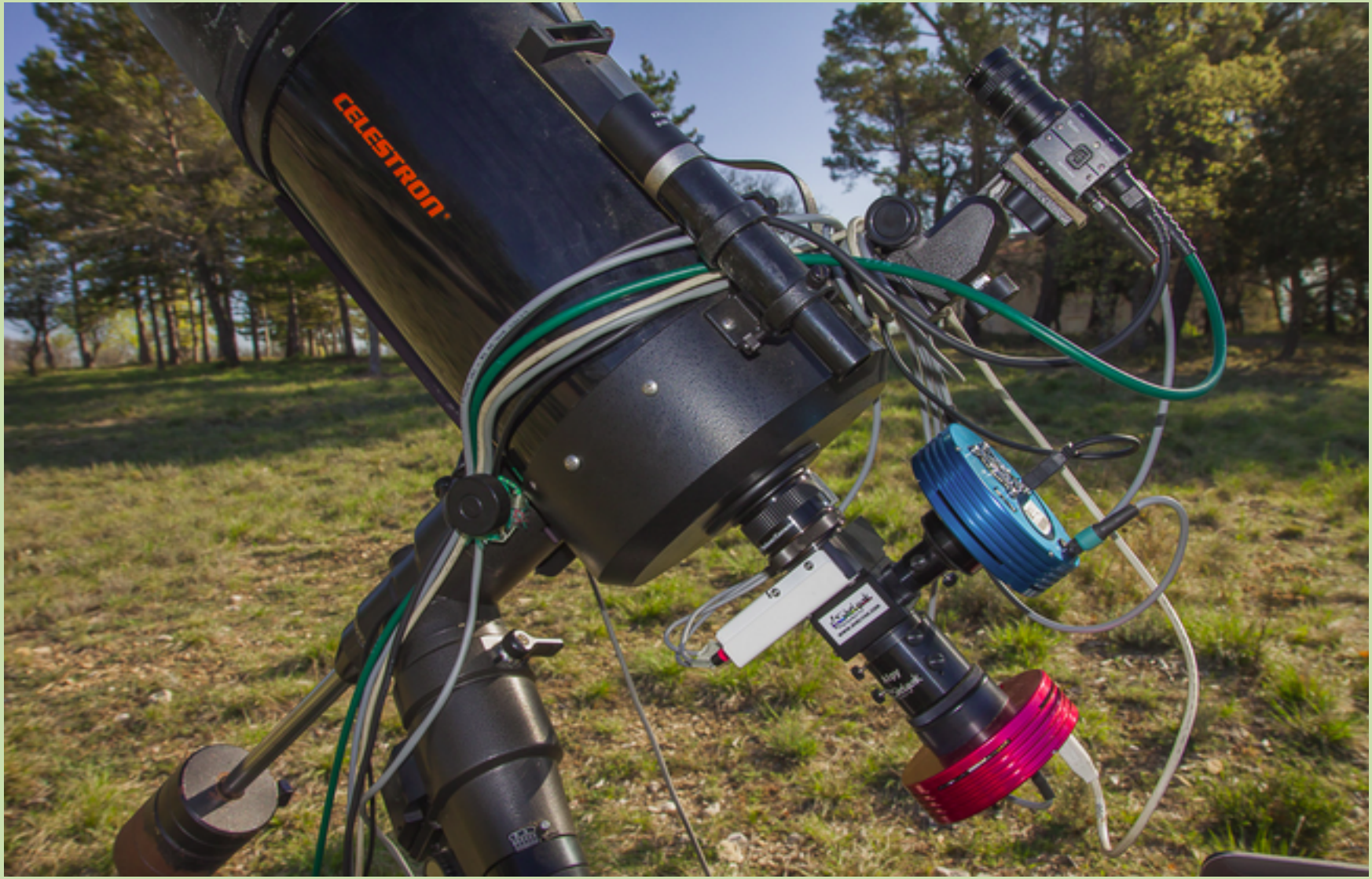
Eye perception



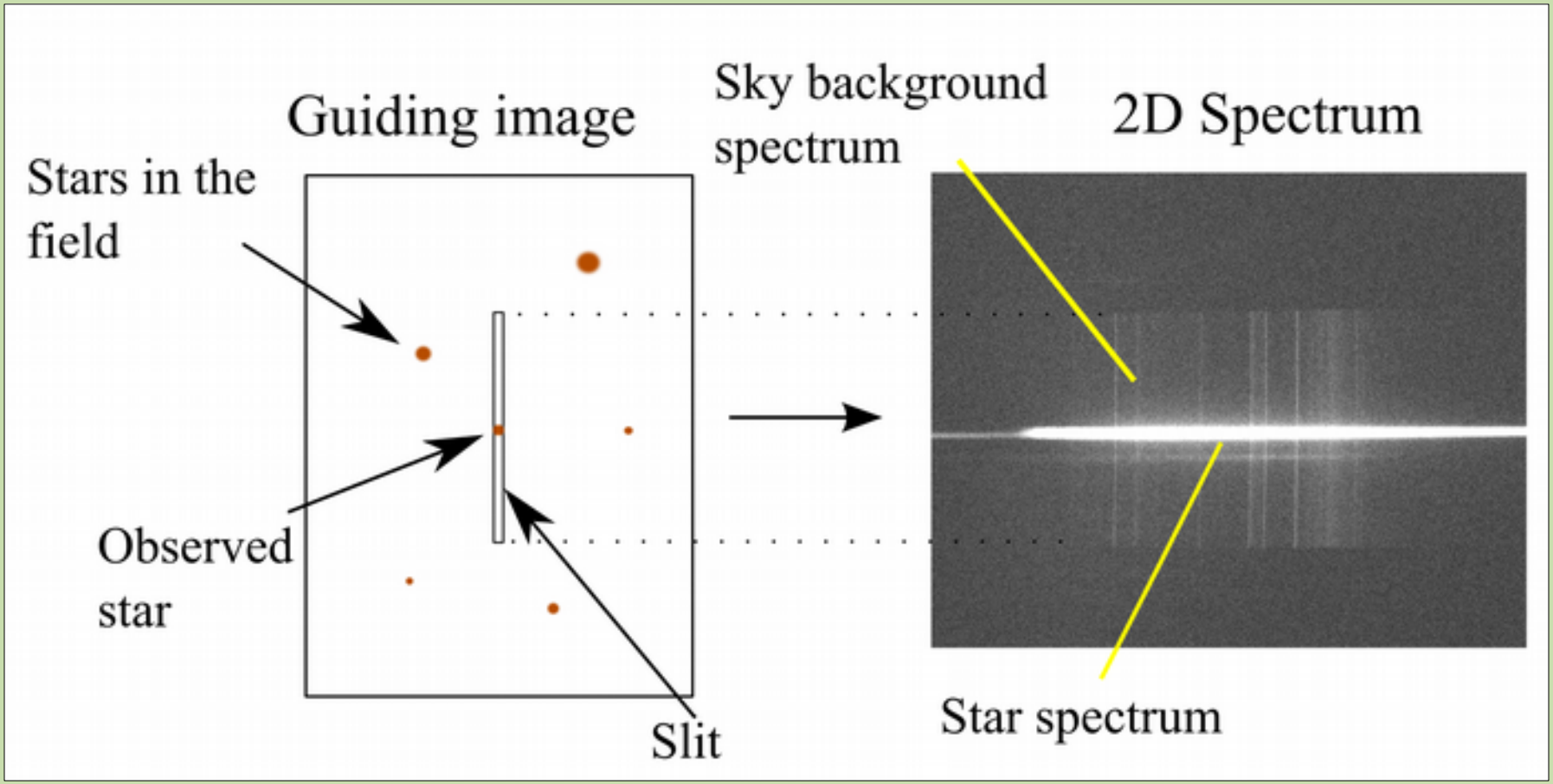
Perception de l'œil



The instrument

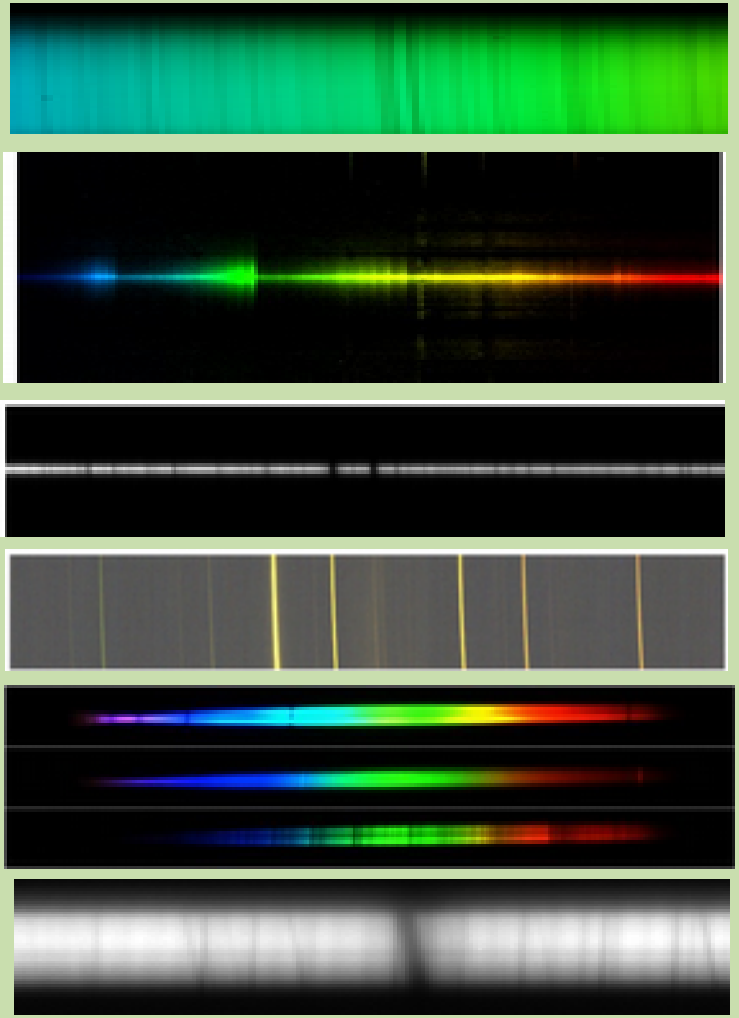


Spectroscopy

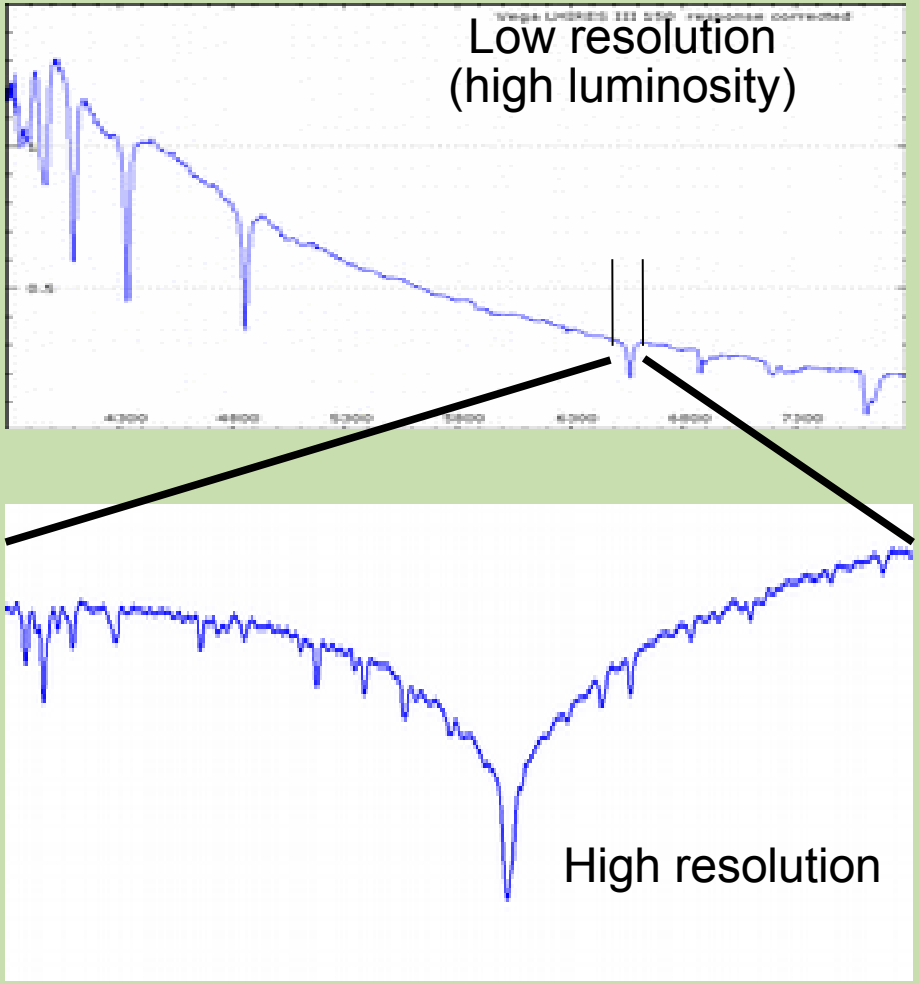


Some spectra

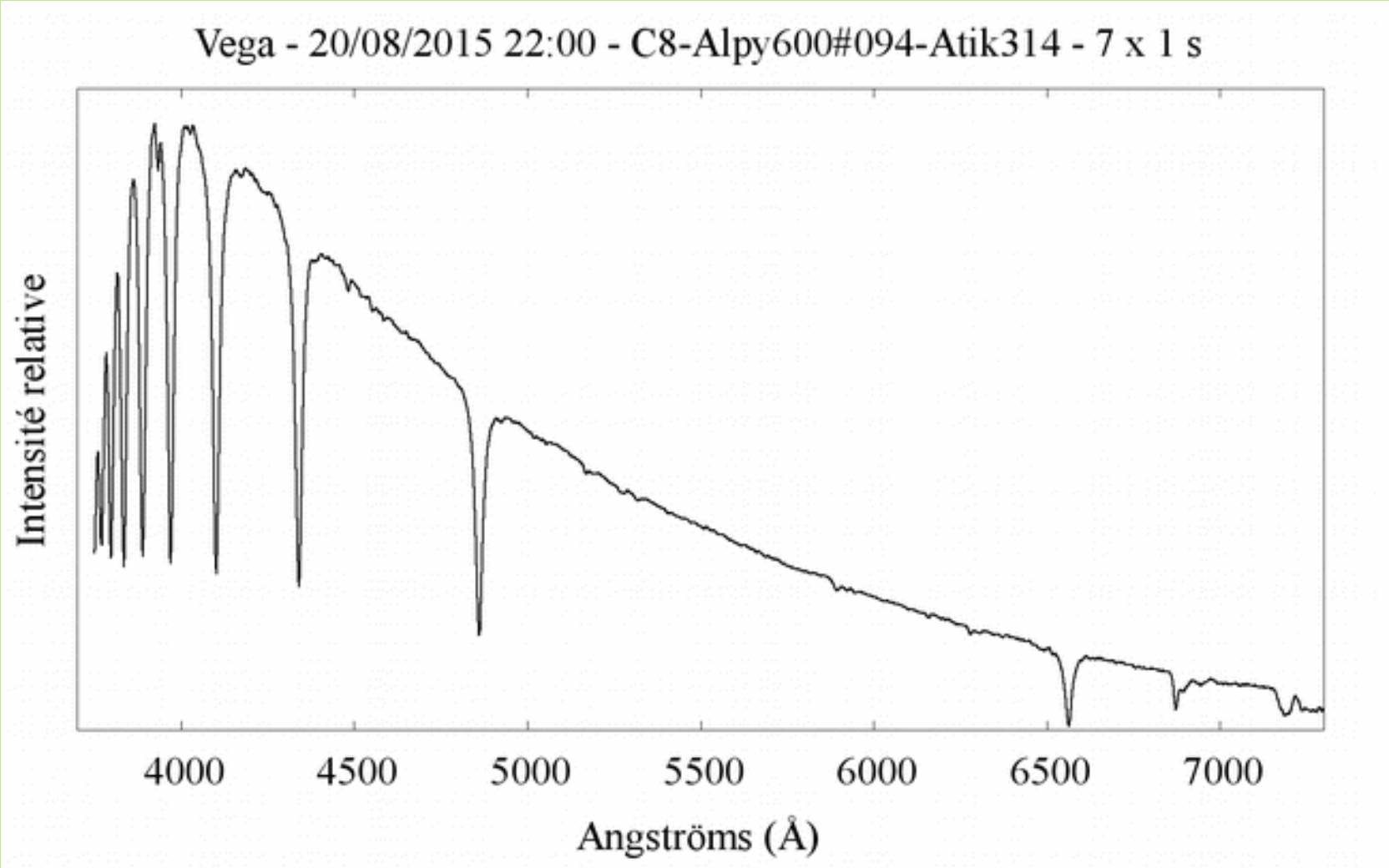
2D images



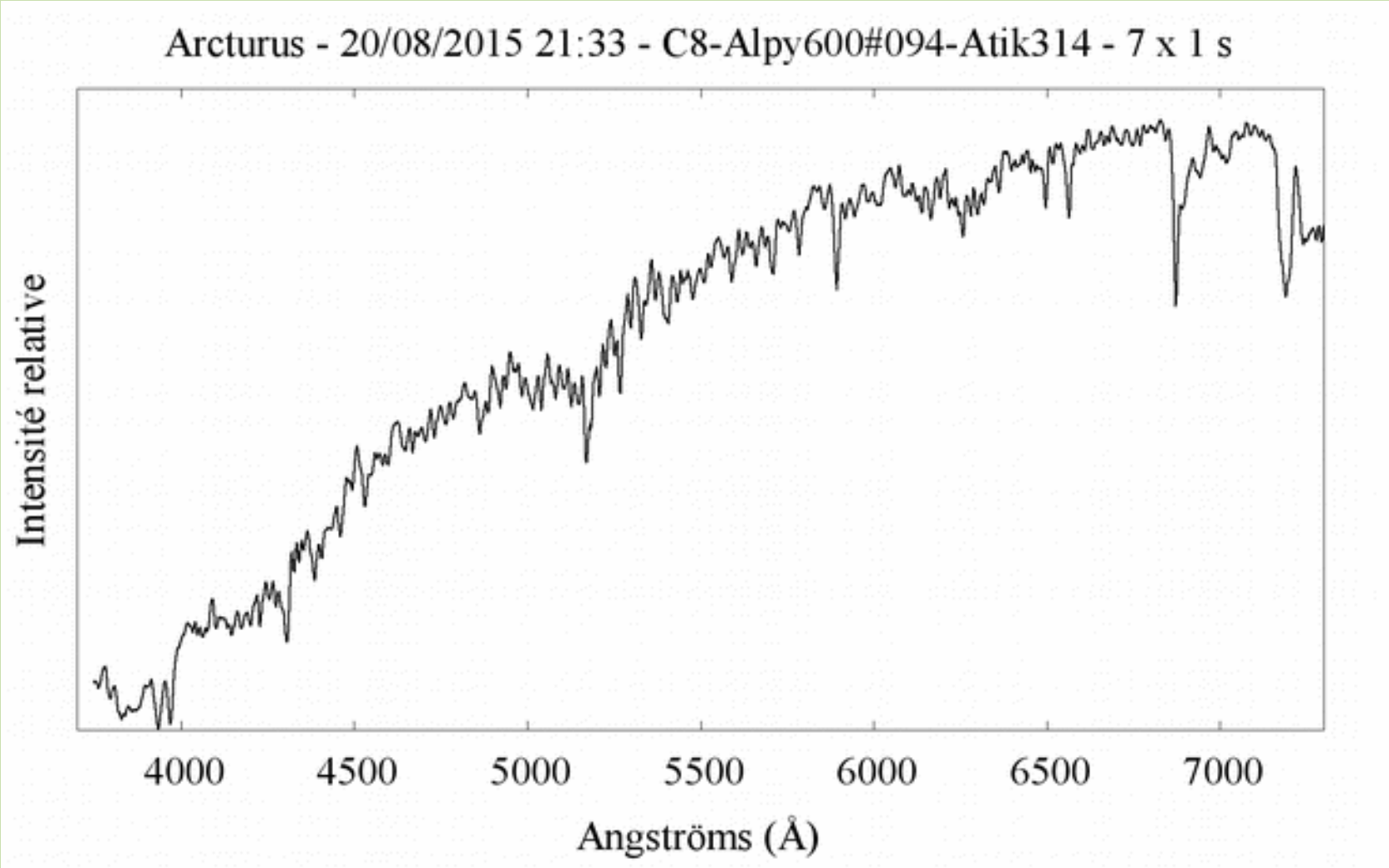
1D profile



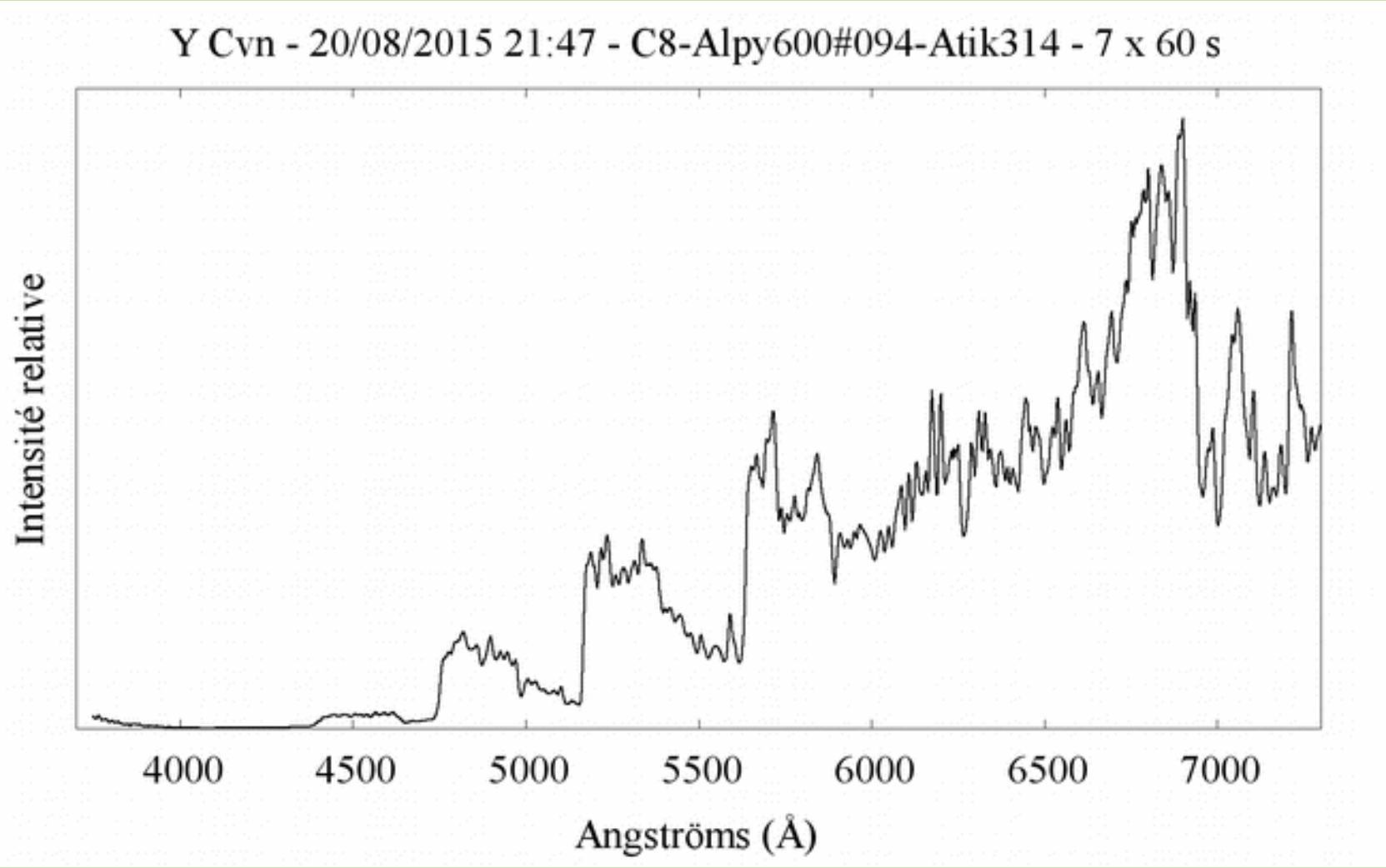
Vega


Vega - 20/08/2015 22:00 - C8-Alpy600#094-Atik314 - 7 x 1 s
Intensité relative
4000
4500
5000
5500
6000
6500
7000
Angströms (Å)

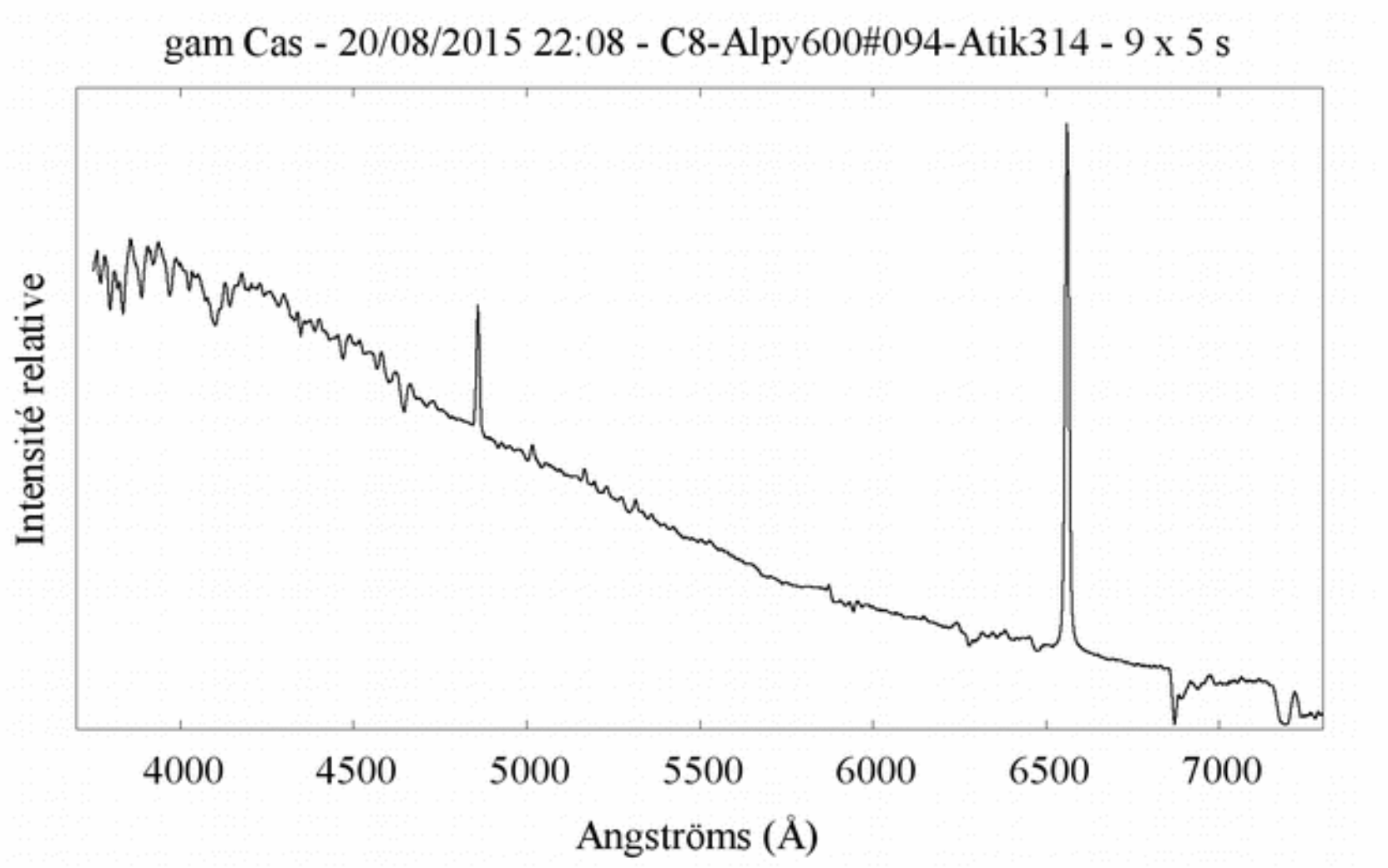
Arcturus


Arcturus - 20/08/2015 21:33 - C8-Alpy600#094-Atik314 - 7 x 1 s
Intensité relative
4000
4500
5000
5500
6000
6500
7000
Angströms (Å)

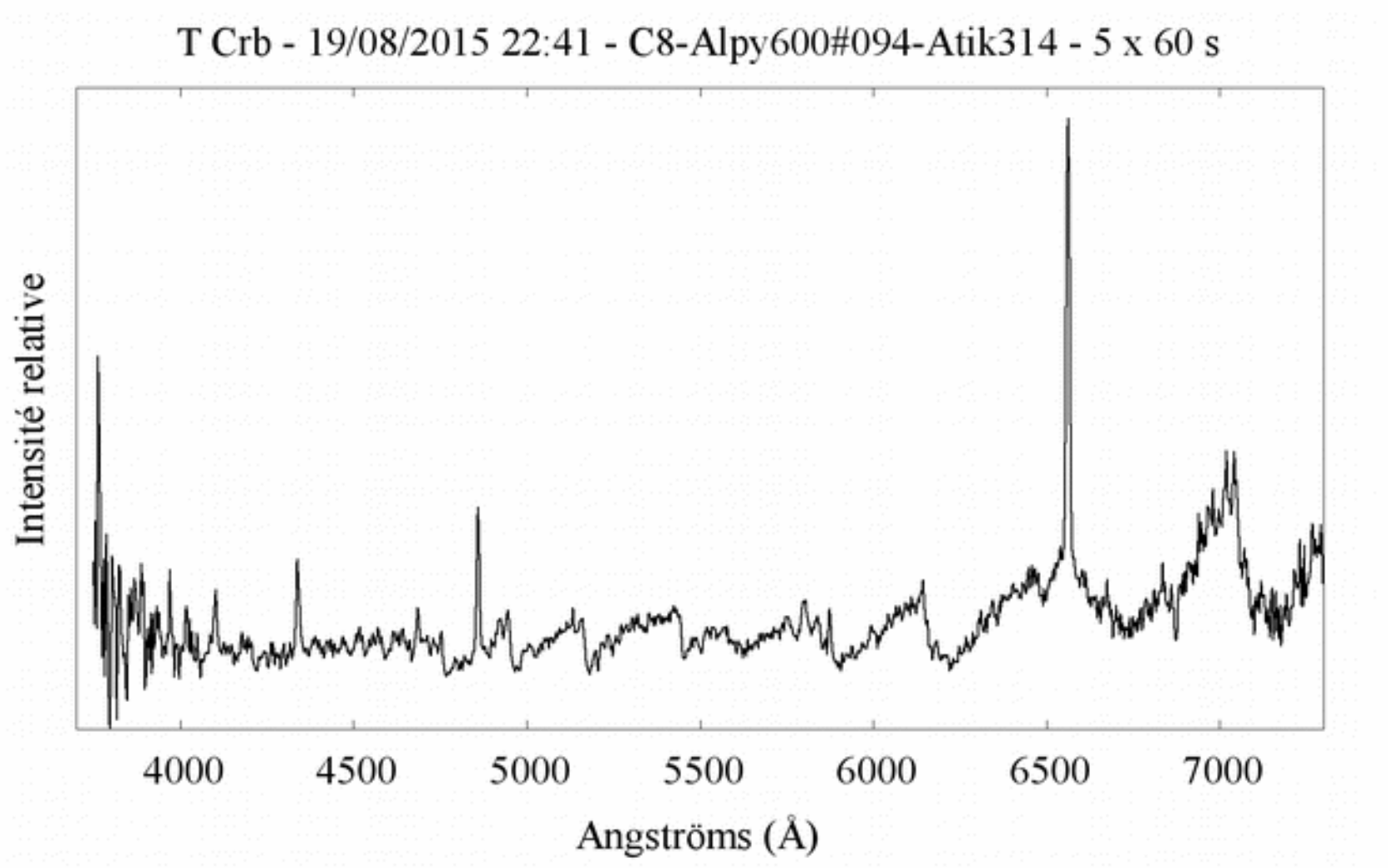
Y Cvn


Y Cvn - 20/08/2015 21:47 - C8-Alpy600#094-Atik314 - 7 x 60 s
Intensité relative
4000
4500
5000
5500
6000
6500
7000
Angströms (Å)

gam Cas


gam Cas - 20/08/2015 22:08 - C8-Alpy600#094-Atik314 - 9 x 5 s
Intensité relative
4000
4500
5000
5500
6000
6500
7000
Angströms (Å)

T Crb


T Crb - 19/08/2015 22:41 - C8-Alpy600#094-Atik314 - 5 x 60 s
Intensité relative
4000
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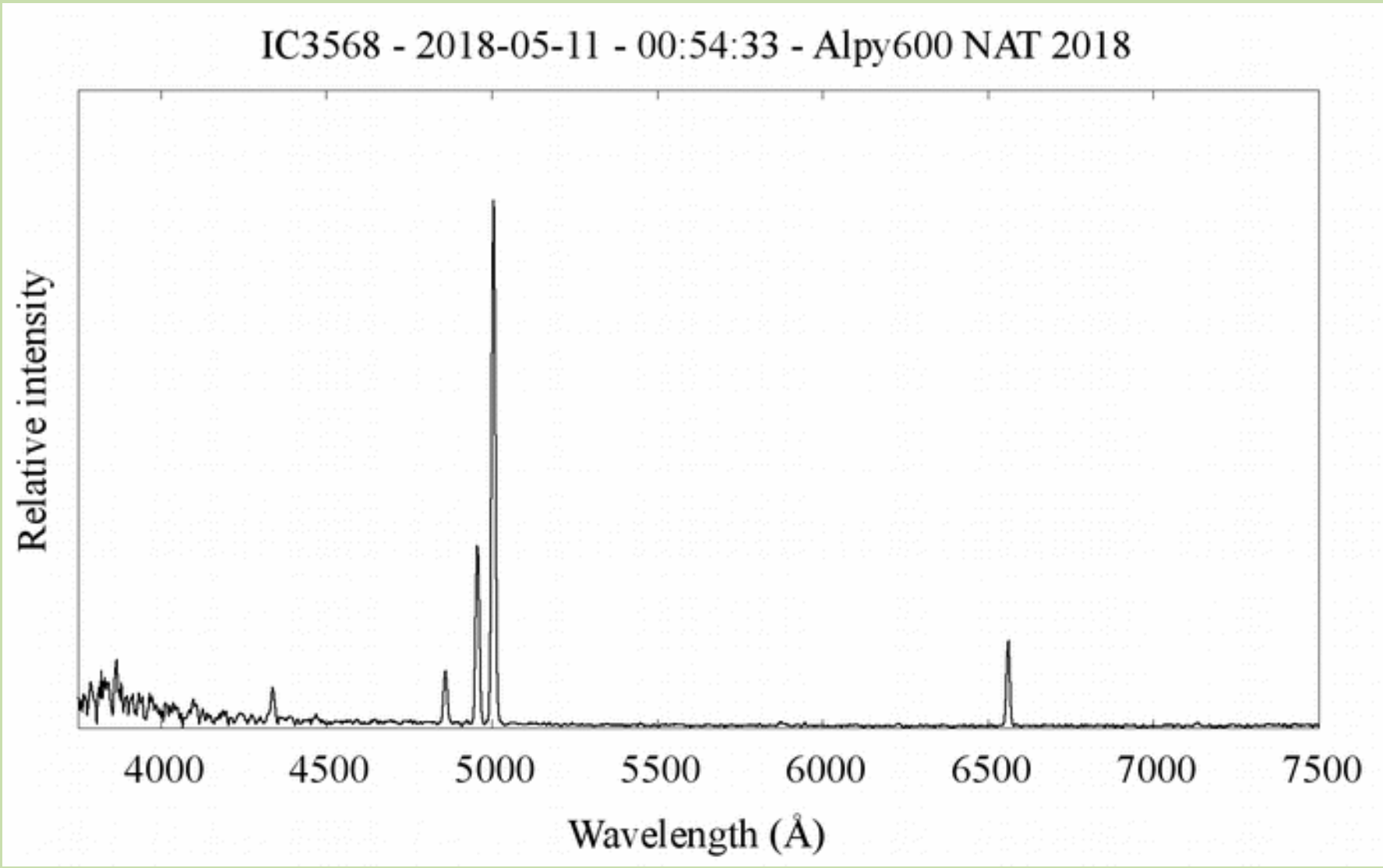
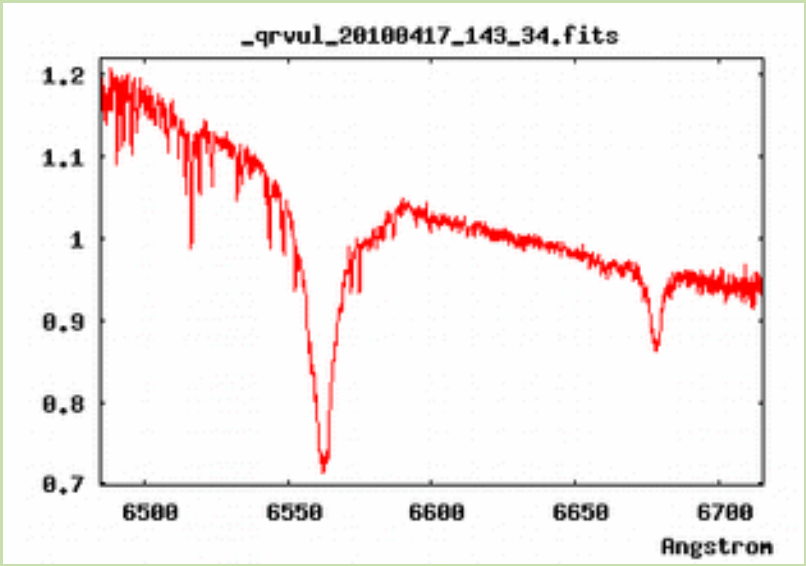
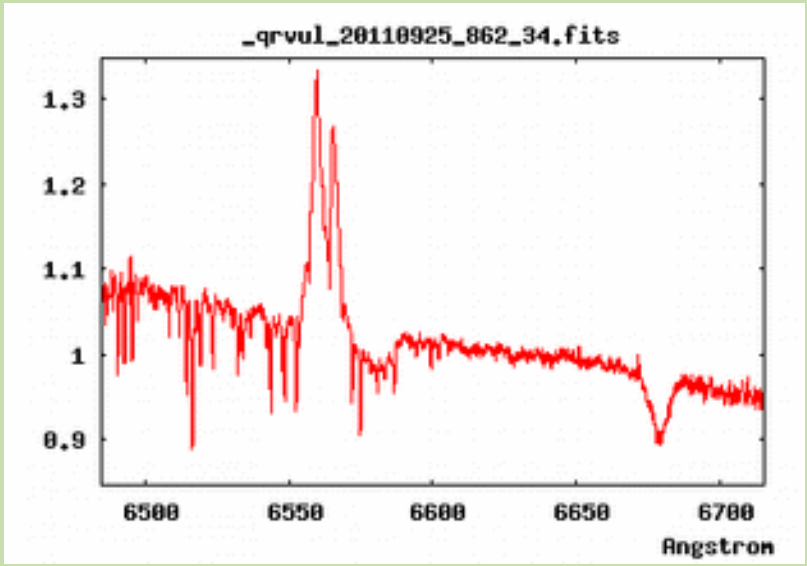
5000
5500
6000
6500
7000
Angströms (Å)


IC3568 - 2018-05-11 - 00:54:33 - Alpy600 NAT 2018
Relative intensity
4000
4500
5000
5500
6000
6500
7000
7500
Wavelength (Å)

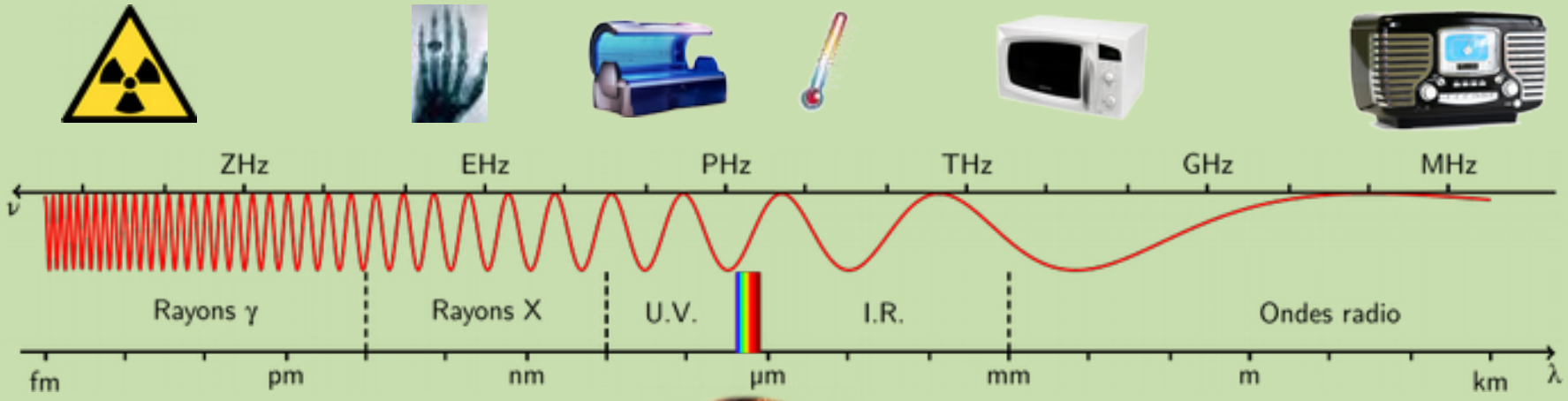
QR Vul

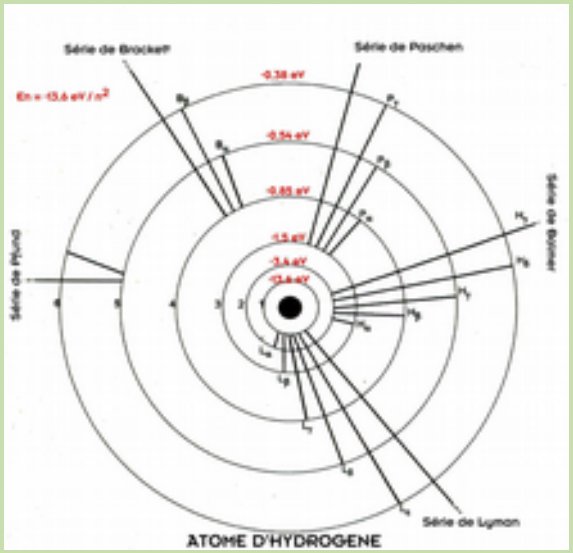
- Outburst !





Light is a wave...





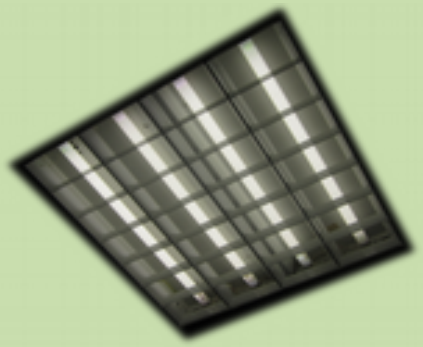
…and a particle!

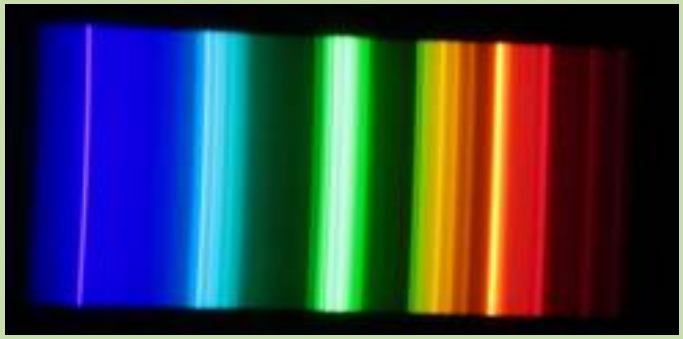
Crédit: O. Thizy

Making some light

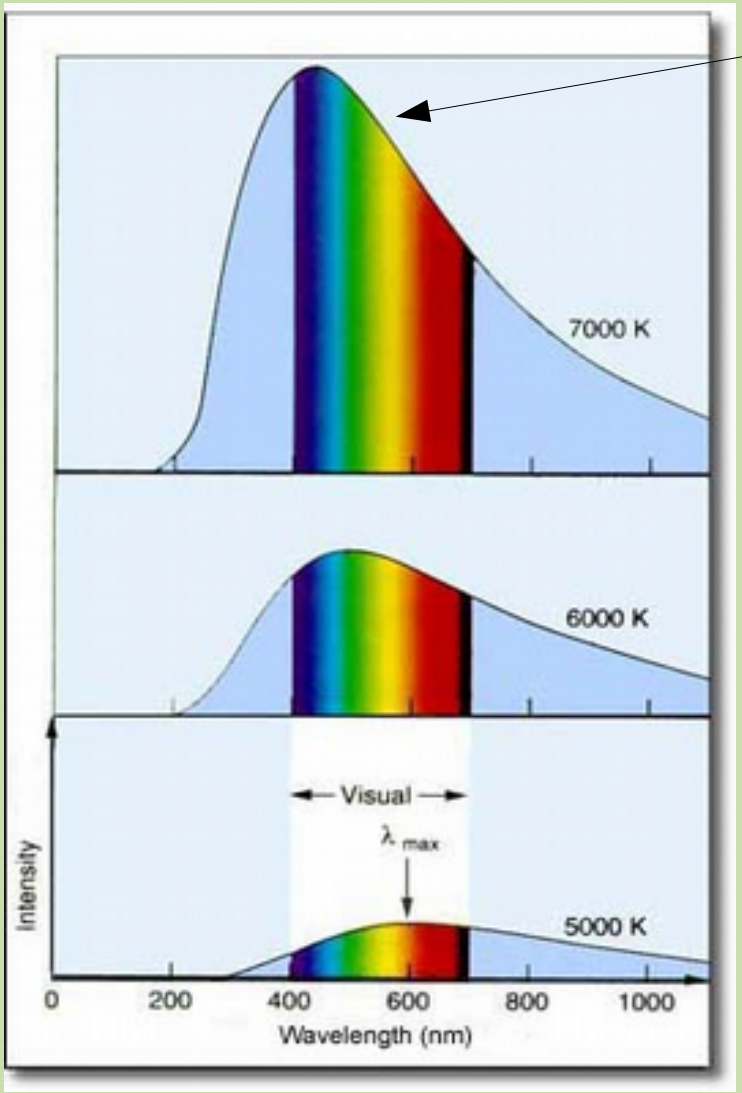
1 – By heating a material

2 – By exciting atoms





Planck profile



Visible domain
= 400-700nm (4000A-7000A)

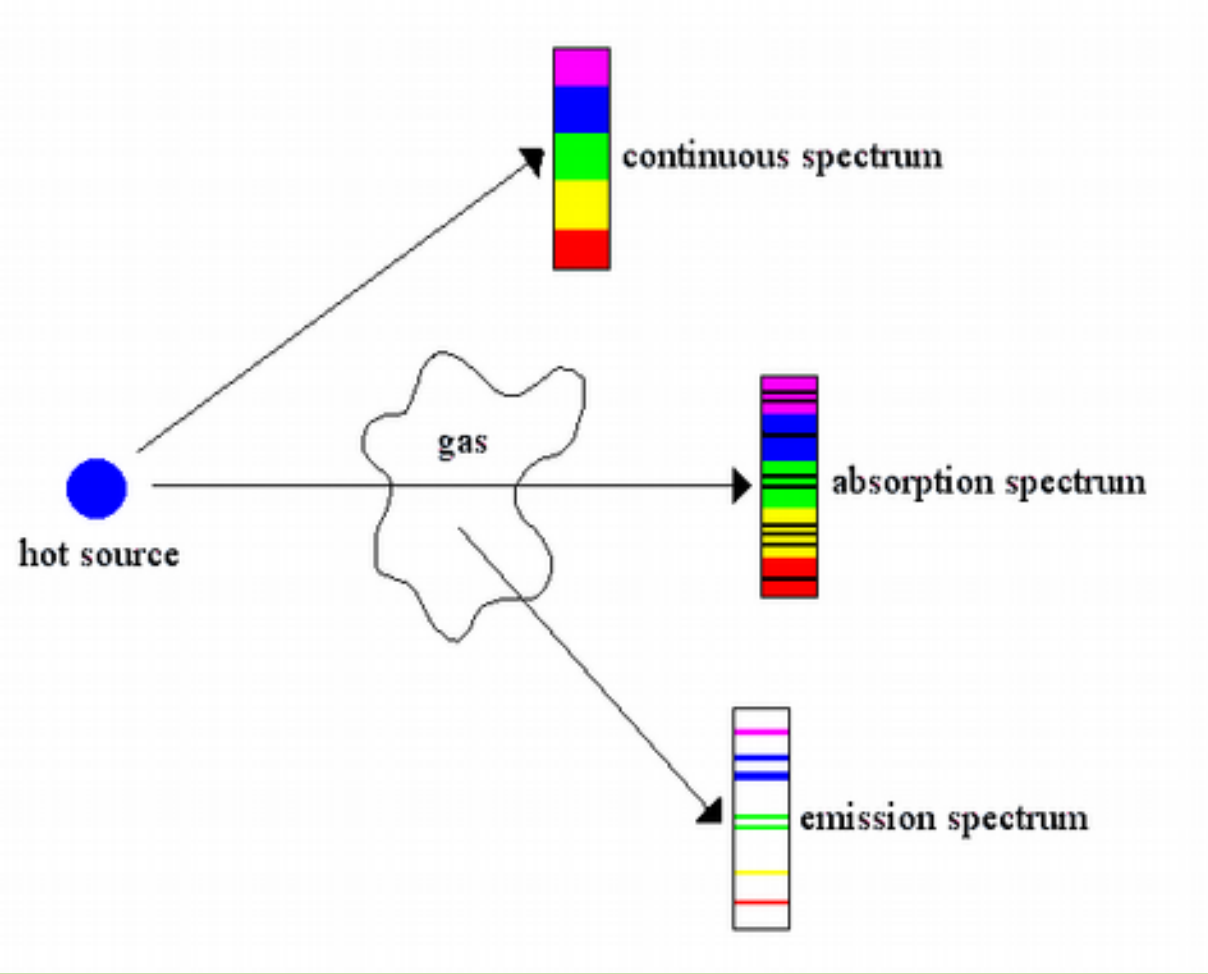
- **Stefan's law:**
  Intensity (under the curve)
  = Constant * T^4

- **Wien' s law:**
  λ max * Temperature
  = Constant (2900 µm.K)

  ==>Temperature = Color !!!

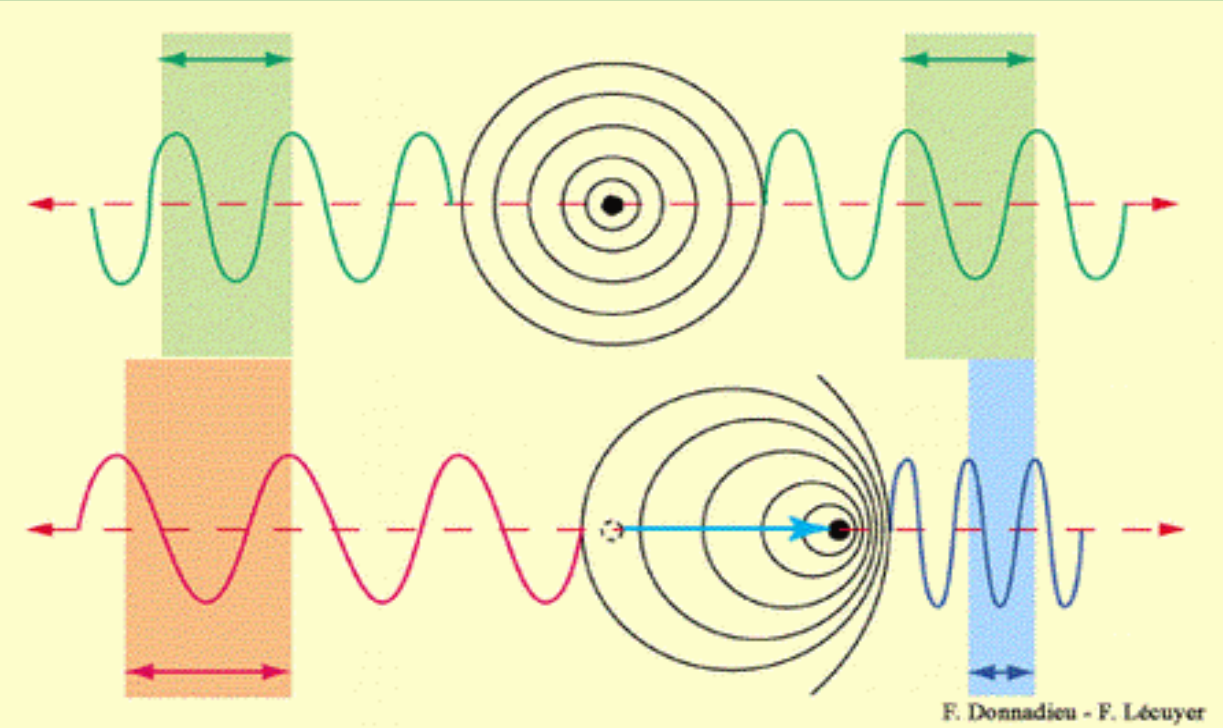
Document Wikipedia

Kirchhoff's laws



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

Doppler effect



Universe expansion
=
Red shift

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

The light coming from a star

- **Is made in its core, by nuclear fusion**
- **Crosses all layers of the star**
- **Crosses discs, envelopes, if any**
- **Crosses the interstellar medium**
- **Can be shifted by Doppler effect**
  - **Atomic movement**
  - **Star rotation**
  - **Binaries rotations**
  - **Proper movement**
  - **...**

- **Special cases : nebulae**

What is in a spectrum ?

- **The general profile**
- **Absorption lines**
- **Emission lines**
- **Line width (Vsini)**
- **Line profiles**
- **Lines shifting**
- **Evolution over the time**

Doing spectroscopy is
switching
from contemplating
to understanding the
universe

Spectroscopy is a universal tool

It can make many differents observations

Different objects

- Stars (many types)
- Nebulae
- Galaxies
- Planets & Asteroids
- Exoplanets
- Interstellar dust

Some are bright… some are not !

Different programs

- Long term (BeSS, RR lyrae...)
- Campains (del Sco, eps Aur...)
- Events (Nova Del 2013...)
- Random observations (B or Be?...)

Different goals

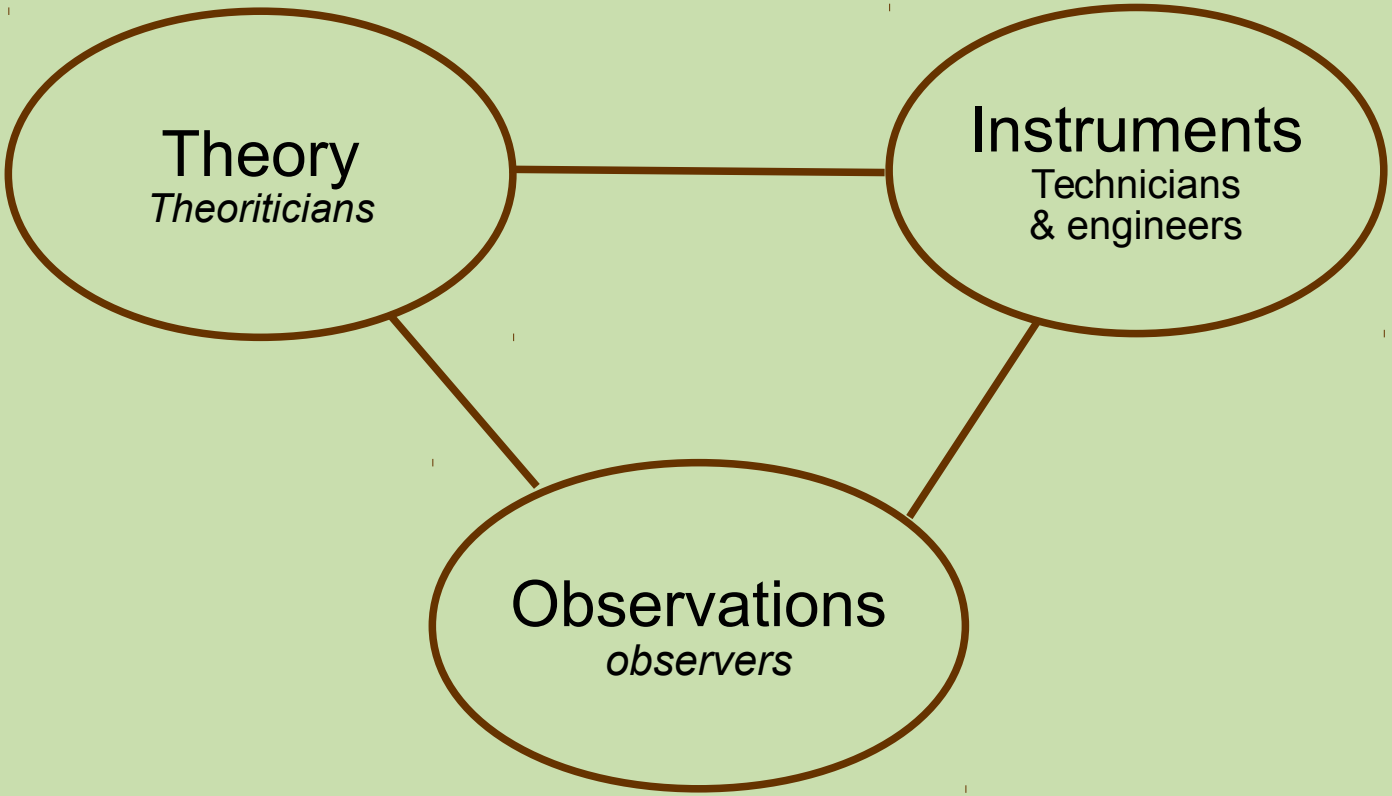
- Personnal studies (discovery)
- Education & training
- Science

When we observe all together,
we become a new kind of instrument !

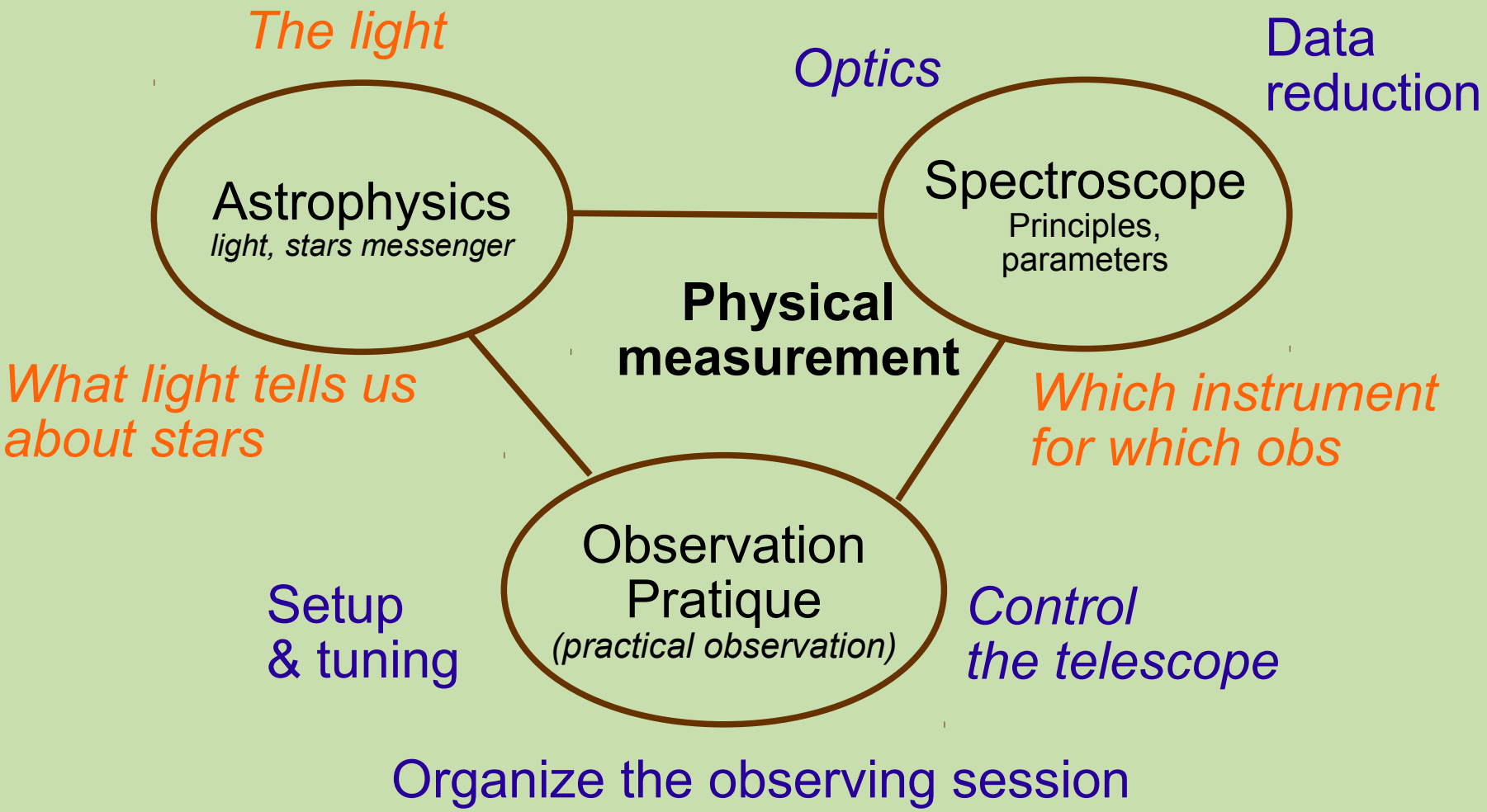
Amateurs can do observations
than pros cannot (anymore)

If you want to go fast, walk alone
But if you want to go far, walk together
Ratan Tata

Astrophysics triptich

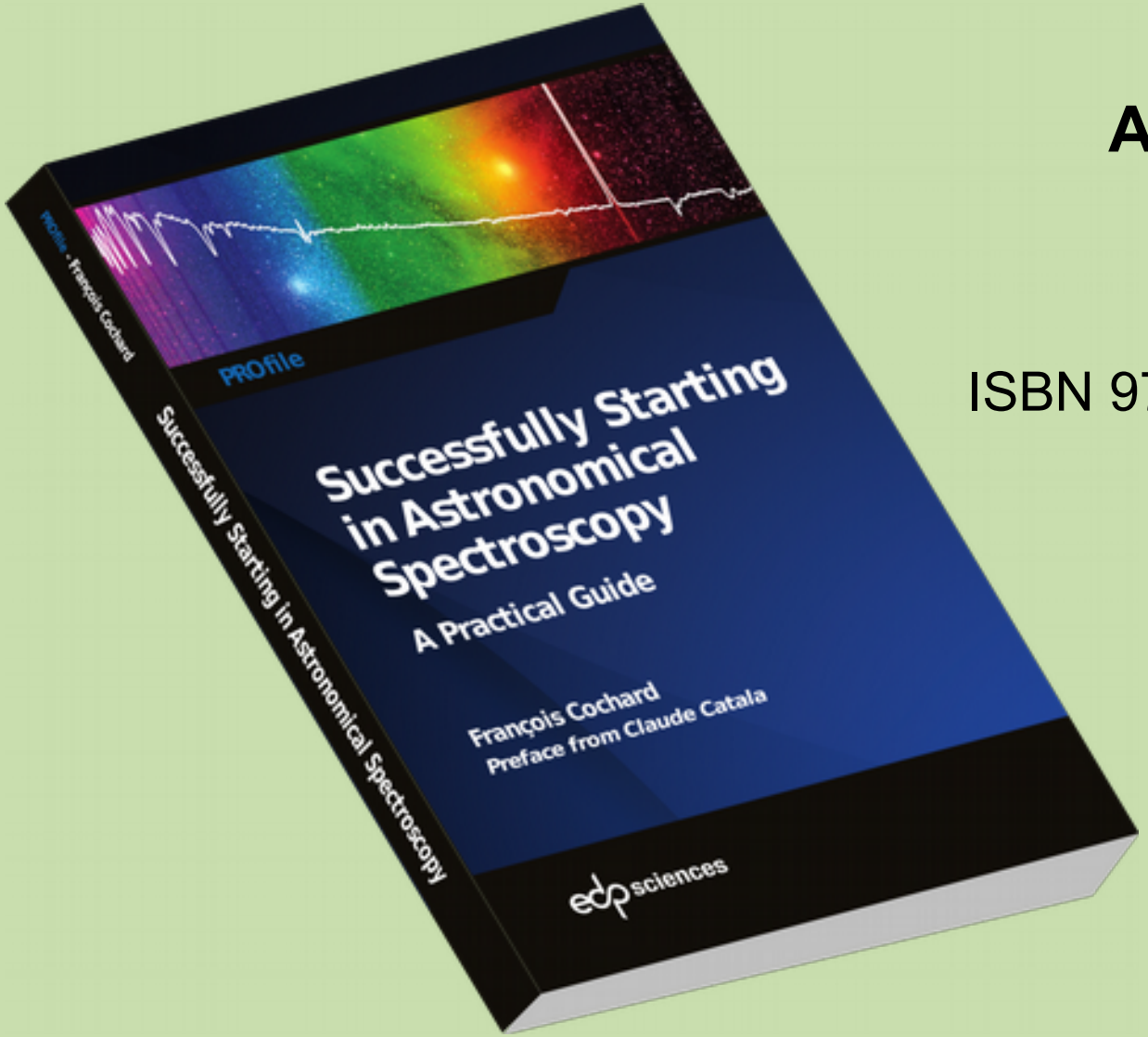


Spectro : a ***full*** astronomy



Which observer are you?

What is your project ?



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