

Atlas of emission lines from gases discharge tubes

Version 1.3
19 June 2022

Christian Buil, Antibes (France)
www.astrosurf.com/buil

Description

Atlas of emission lines from spectral tube that can be used to calibrate astronomical spectrograph (UVEX, Star'Ex, Lowspec, Alpy600, Lhires III, and more).

The light emitted by various low pressure spectral tubes (see opposite) is analyzed with a Star'Ex spectrograph used in various configurations (low resolution, medium resolution, high resolution).

Origin of spectral tubes + HT alimentation :

Sordalab : <https://www.sordalab.com>

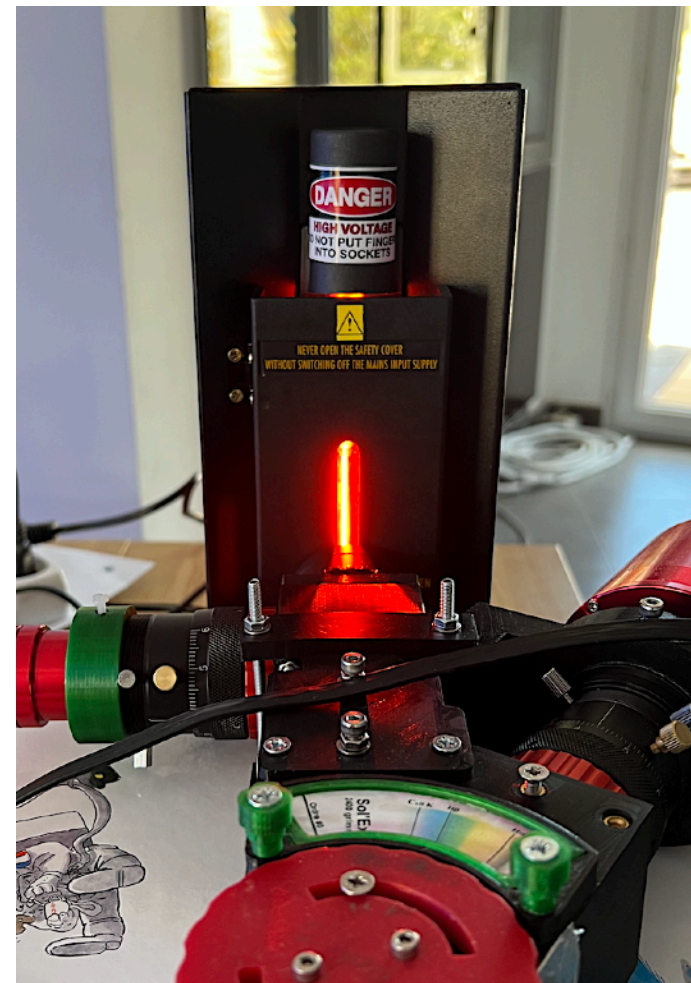
3D Scientific : <https://www.3bscientific.com>

Wavelength values for the Atlas are from the NIST database (air wavelength) : https://physics.nist.gov/PhysRefData/ASD/lines_form.html

Spectra are recorded by spectrograph Star'Ex (the « Star Explorer »). It is a 3D printing spectrograph designed for astronomical observation on small and moderate telescopes. It is a part of the Sol'Ex project (the « Sun Explorer ») : <http://www.astrosurf.com/solex/>

specINTI is used for data processing : <http://www.astrosurf.com/solex/specinti.html>

The atlas is organized according to some possible Star'Ex configurations (classical for usual spectrograph models).



Neon



Argon



Xenon



Mercury



Hydrogen



Oxygen



Nitrogen



Krypton



Helium



Configuration #1

Spectral coverage : 3850 A - 7000 A (visible range)

Star'Ex - 80 mm x 80 mm

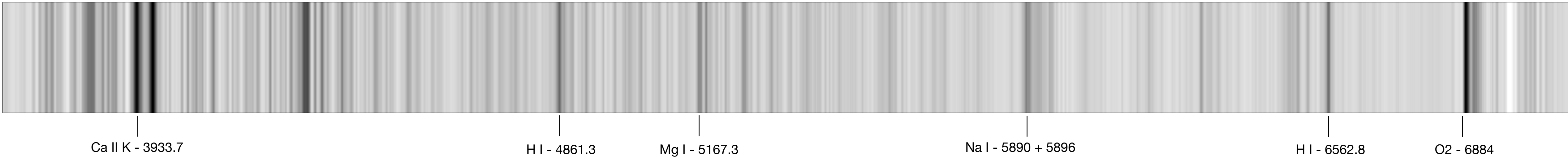
Grating : 300 lines/mm - blaze 500 nm

Slit : 19 microns

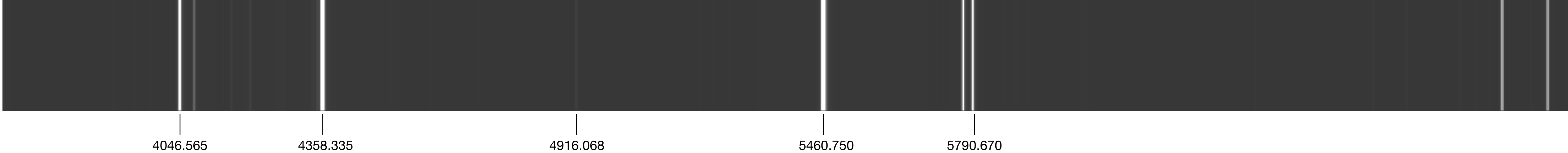
Optical beam : f/9

Camera : ASI183MM (0.973 A/pixel)

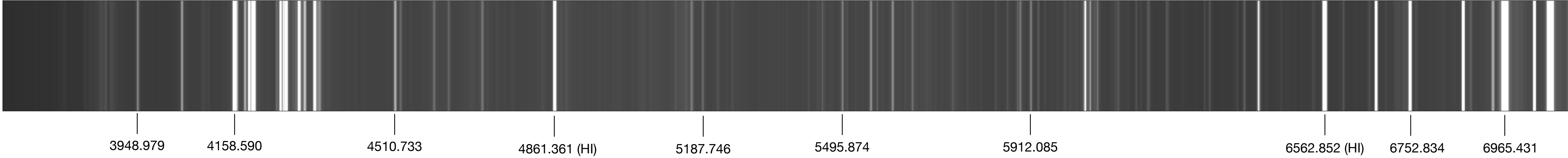
Sun (daylight)



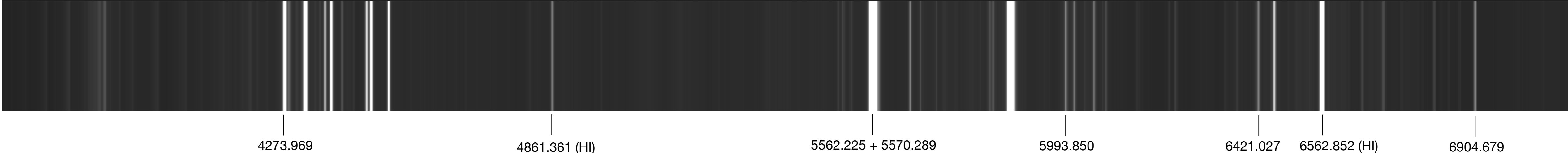
Mercury (Hg)



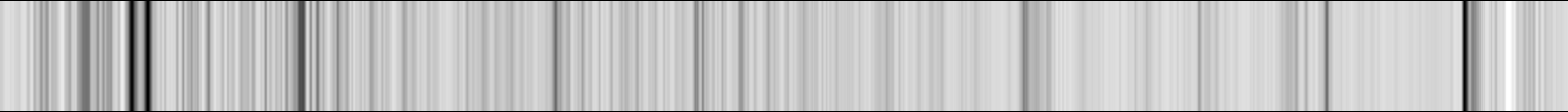
Argon (Ar)



Krypton (Kr)



Sun (daylight)



Ca II K - 3933.7

H I - 4861.3

Mg I - 5167.3

Na I - 5890 + 5896

H I - 6562.8

O2 - 6884

Neon (Ne)



5944.834

6143.063

6402.248

6598.953

6678.277

6929.467

5400.562

5852.488

5881.895

6334.428

6506.528

6532.882

6717.043

7032.413

Xenon (Xe)



3967.541

4524.680

4624.276

4829.708

5894.988

6198.260

6469.705

6827.315

3950.924

4193.528

4500.978

4671.226

4843.293

5028.279

5392.795

5823.890

6111.910

6318.062

6728.008

6976.182

Hydrogen (H)



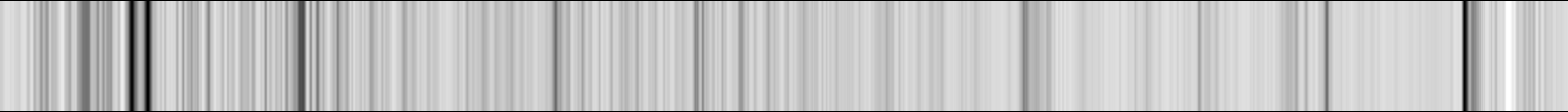
4101.710

4340.472

4861.298

6562.852

Sun (daylight)



Ca II K - 3933.7

H I - 4861.3

Mg I - 5167.3

Na I - 5890 + 5896

H I - 6562.8

O2 - 6884

Helium (He)



3888.648

4026.191

4471.480

4713.146

4921.931

5015.678

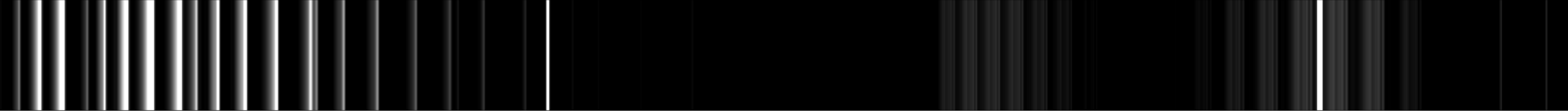
5875.621

6562.852 (HI)

6678.151

7065.190

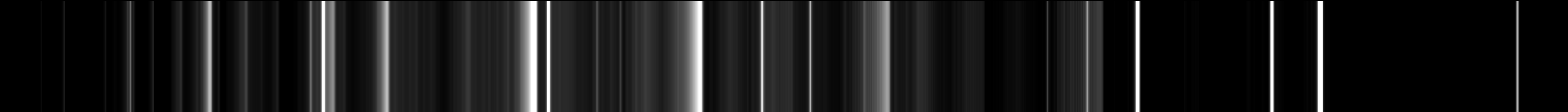
Nitrogen (N)



4861.361 (HI)

6562.852 (HI)

Oxygen (O)



3947.481

4861.361 (HI)

5329.099

5958.584

6158.187

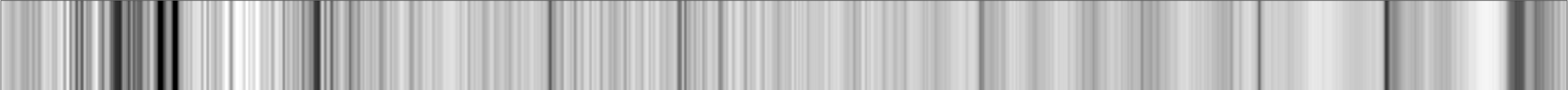
6562.852 (HI)

7002.230

Low cost composite gases discharge lamps (neon + argon)

VIS - 300 l/mm

Sun (daylight)

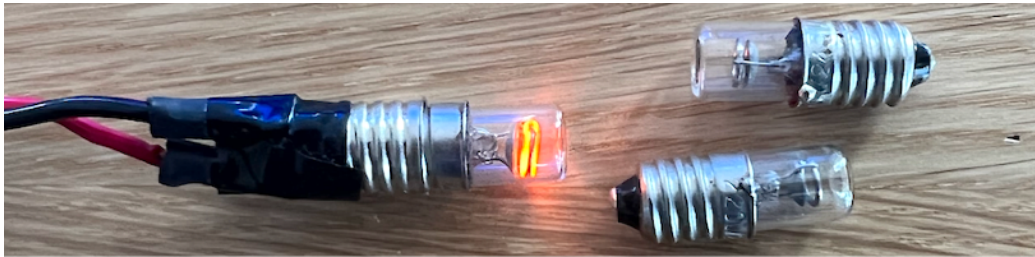


Ca II K - 3933.7

Mg I - 5167.3

H I - 6562.8

Red miniature lamp - Conrad : Barthelme 00012340 Luciole 230 V 0.30 W E10 (2.90 €)



7245.166 (Ne)



3948.979 (Ar)

4044.418 (Ar)

4333.561 (Ar)

5400.562 (Ne)

5852.488 (Ne)

5881.895 (Ne)

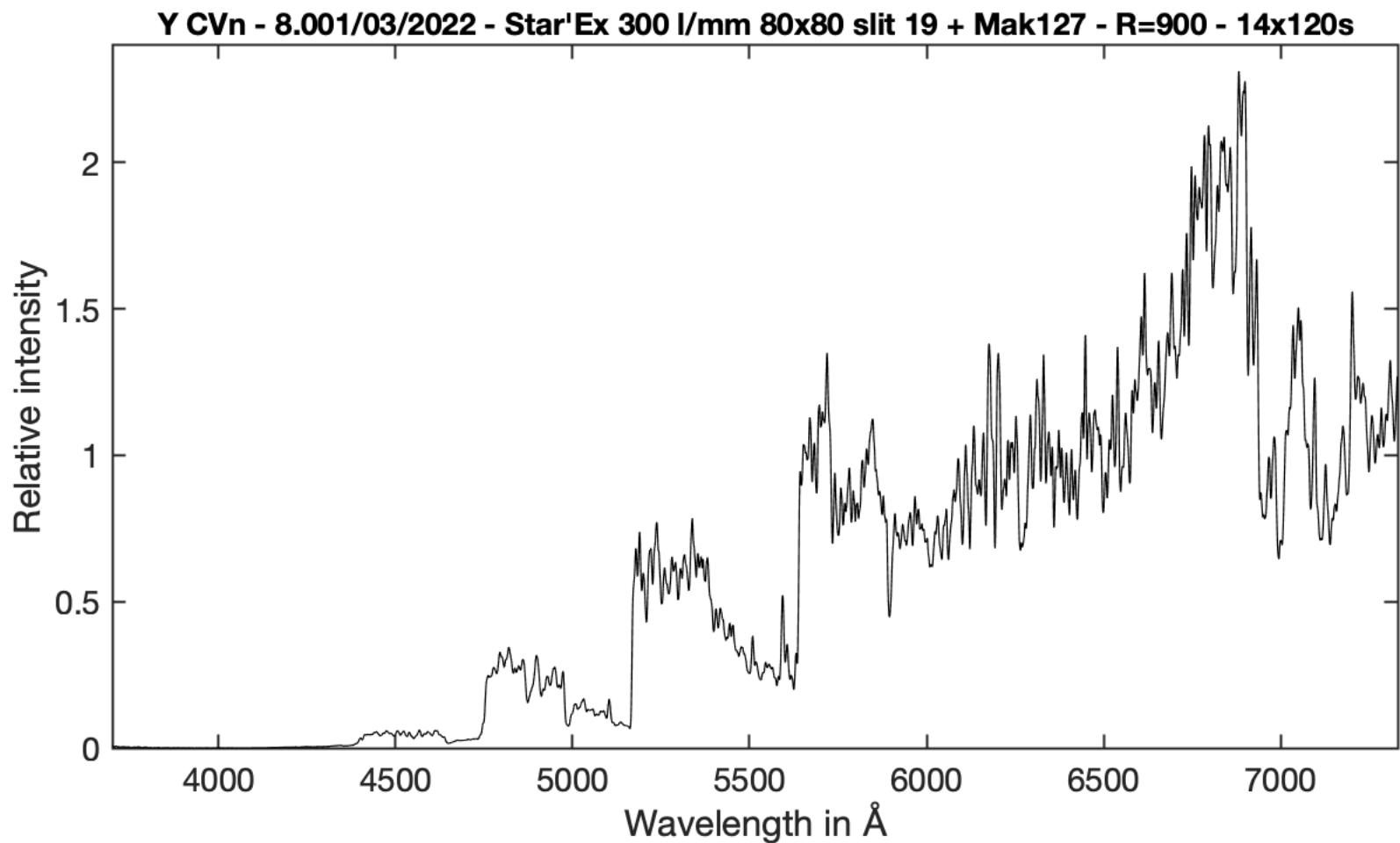
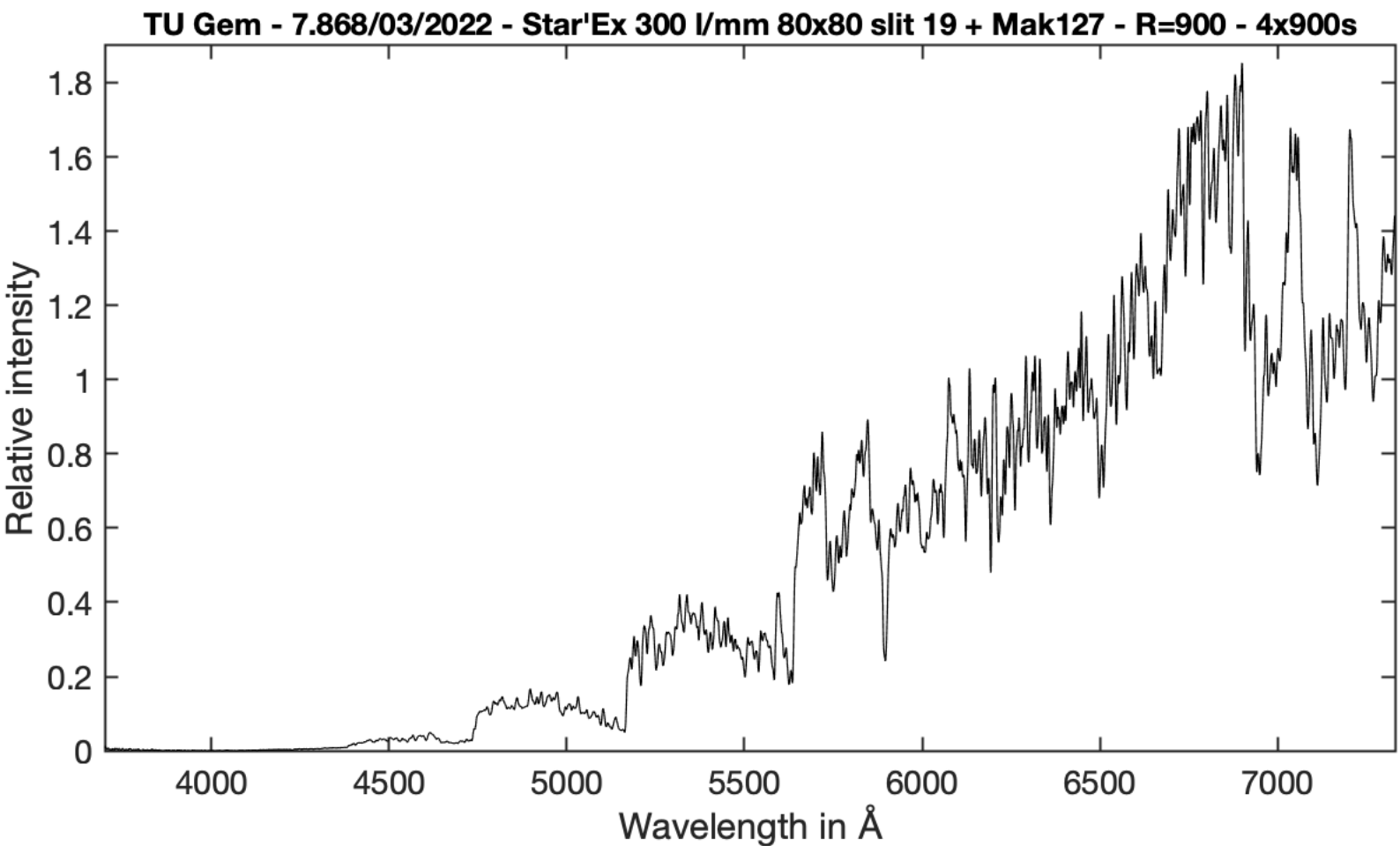
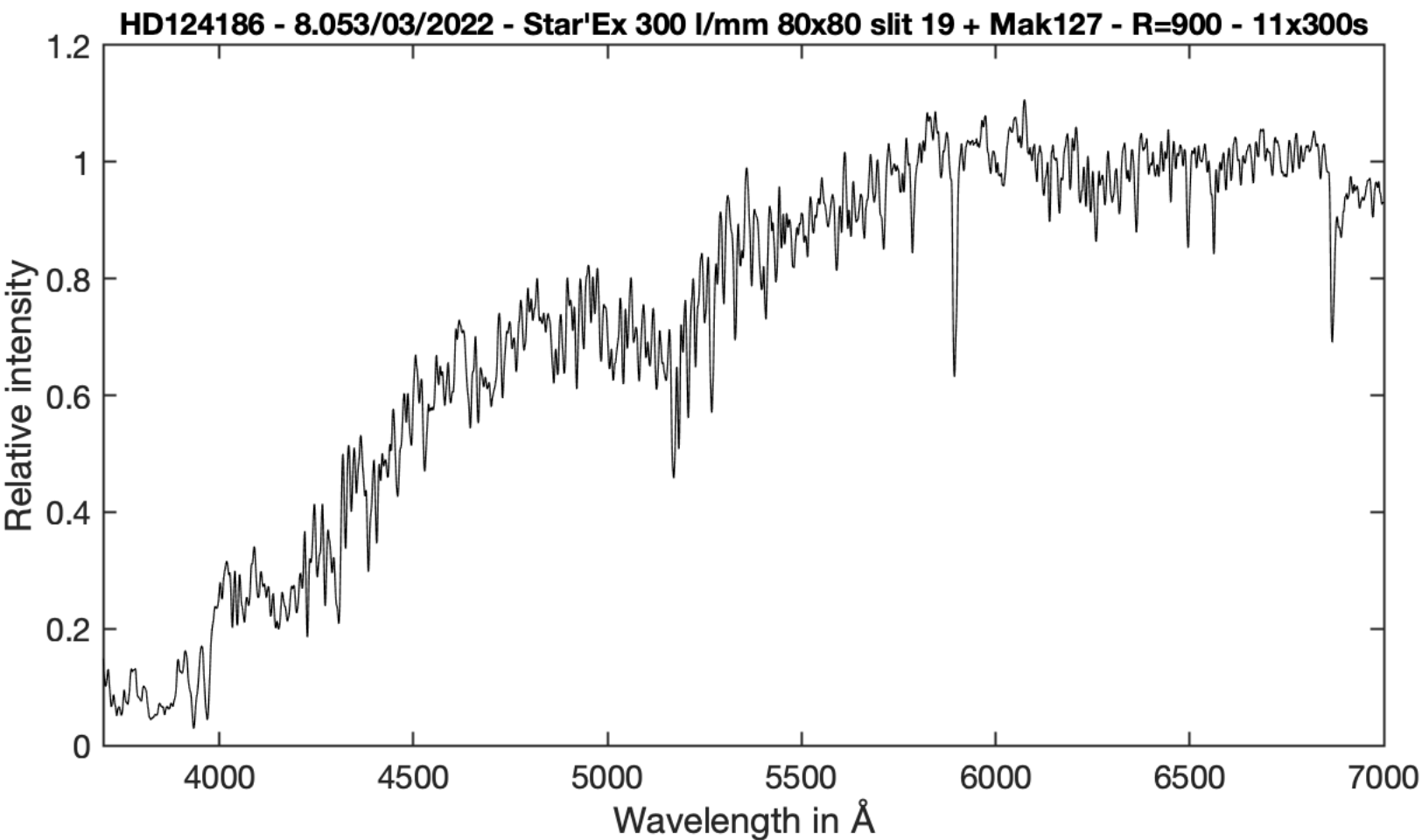
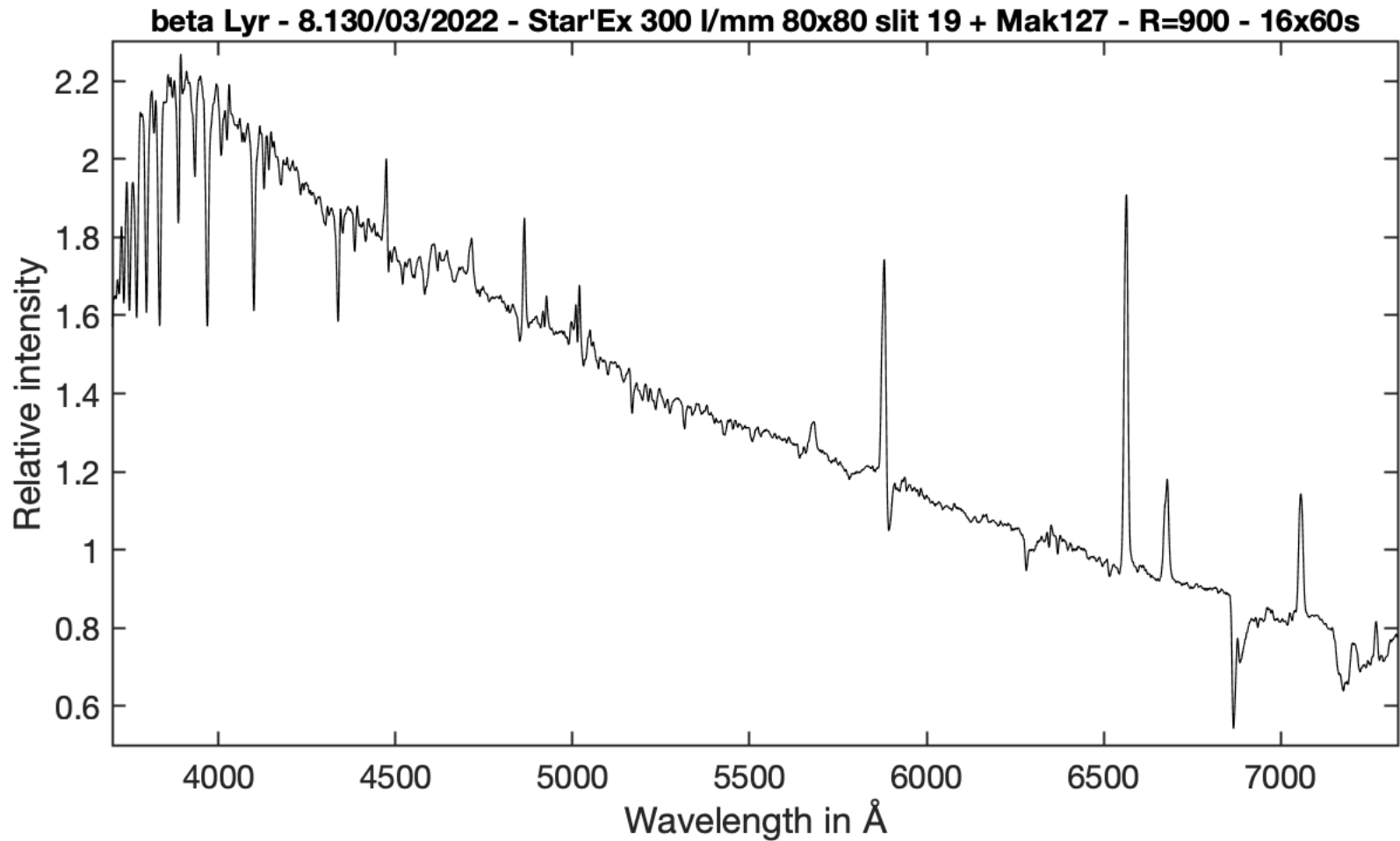
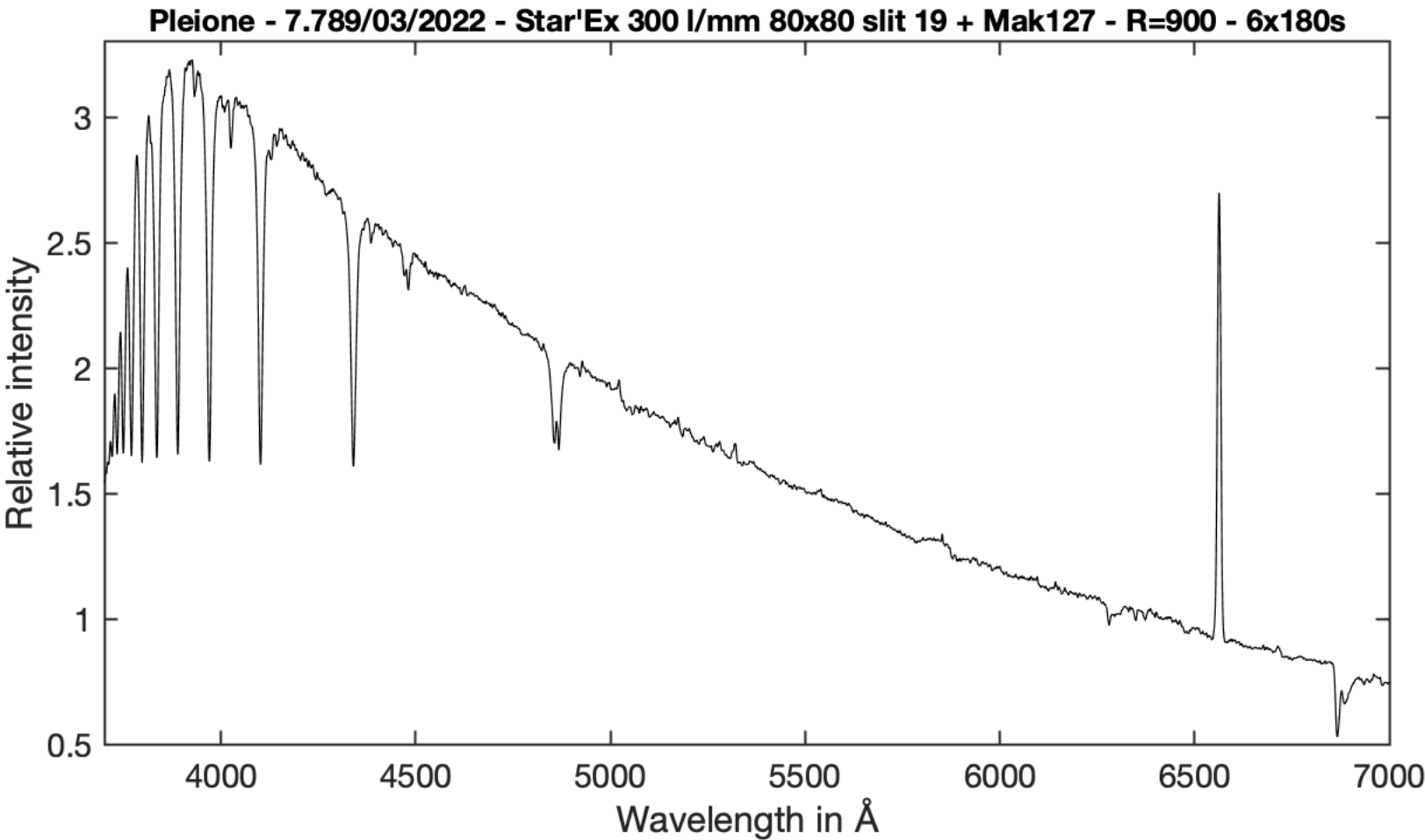
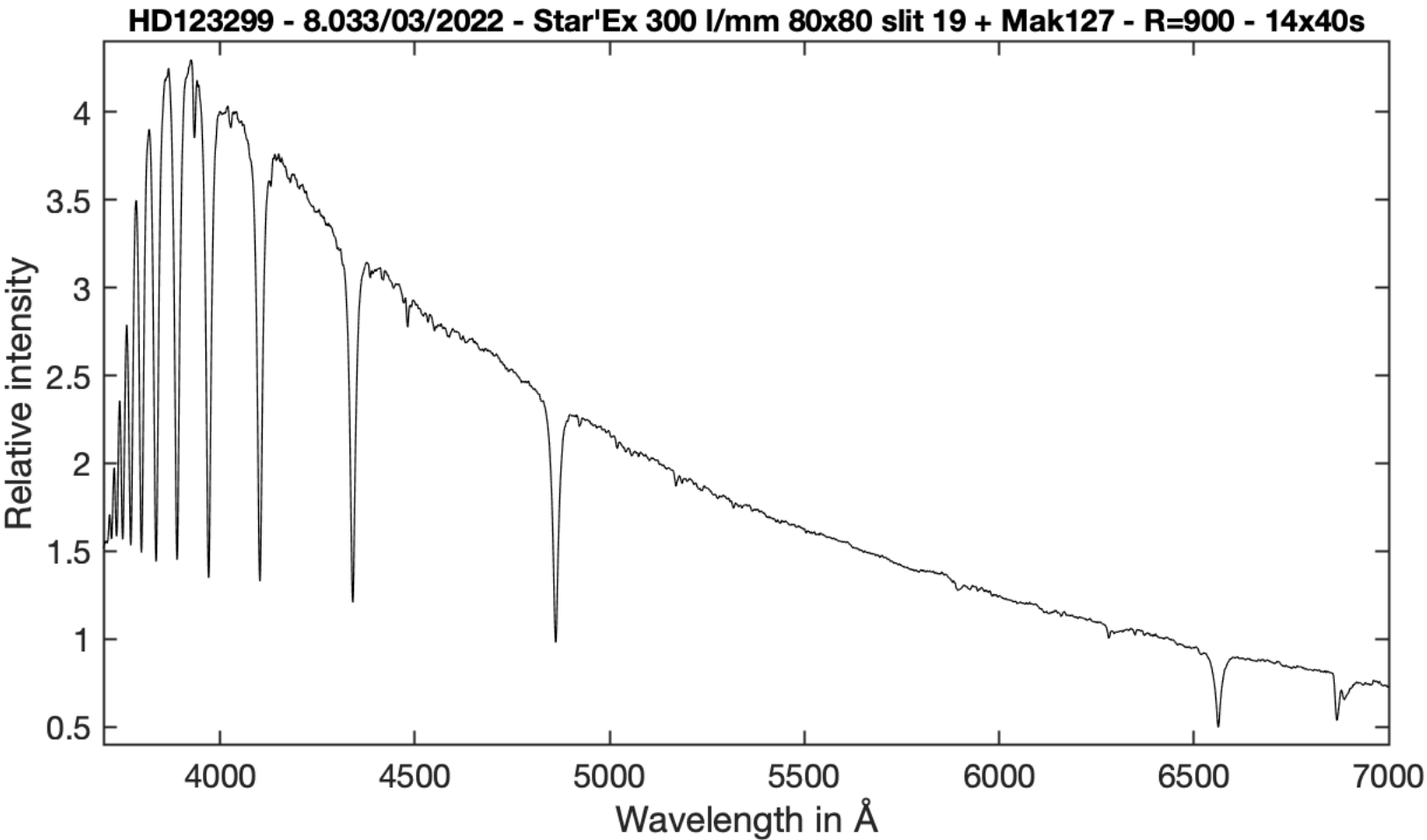
6506.528 (Ne)

6532.882 (Ne)

7032.413 (Ne)

Stellar spectra sample

Star'Ex 300 lines/mm on a Maksutov 127 mm telescope (VIS region)



Configuration #2

Spectral coverage : 3650 A - 5500 A (UV + blue range)

Star'Ex - 80 mm x 80 mm

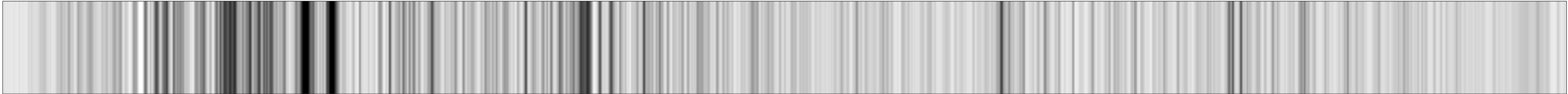
Grating : 600 lines/mm - blaze 500 nm

Slit : 19 microns

Optical beam : f/9

Camera : ASI183MM (0.495 A/pixel)

Sun (daylight)



Ca II K - 3933.68 Ca II H - 3968.49 Fe I - 4307.9 HI - 4861.34 Mg I - 5167.33

Mercury (Hg)



3654.842 4347.494 3650.158 3663.284 4046.565 4077.837 4339.223 4358.335 4916.068 5460.750

Argon (Ar)



4158.590 4200.674 4300.101 4522.323 4702.316 5558.702 3834.679 3948.979 4044.418 4190.713 4259.362 4333.561 4510.733 4596.097 4861.361 (HI) 5187.746 5495.874

Krypton (Kr)

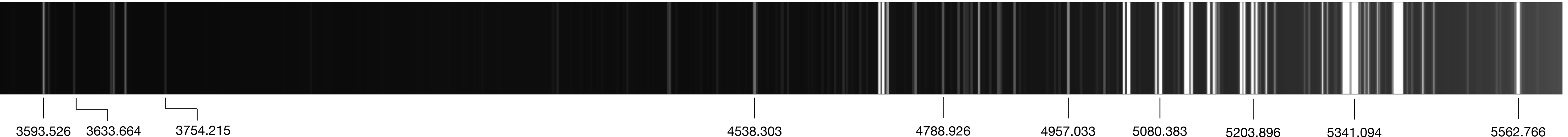


3773.424 4273.969 4319.579 4463.690 4861.361 (H1) 5490.936 5570.289 4362.642 4376.121 4502.354 4812.637 4969.075 5562.225

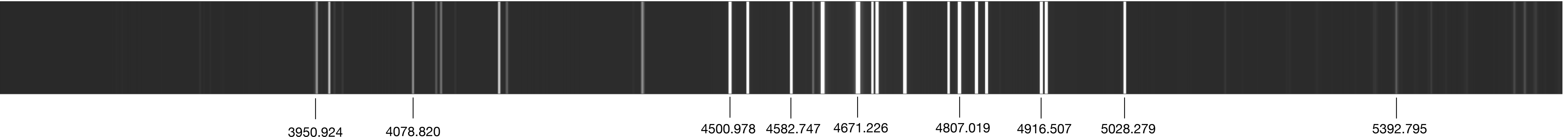
Sun (daylight)



Neon (Ne)



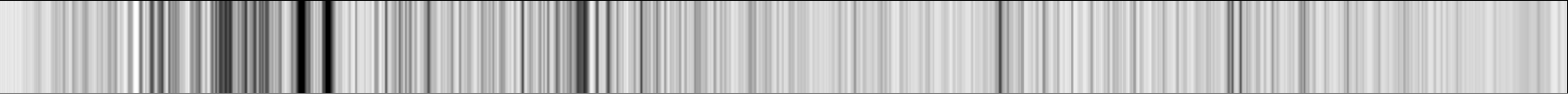
Xenon (Xe)



Hydrogen (H)



Sun (daylight)



Ca II K - 3933.68 Ca II H - 3968.49 HI - 4861.34 Mg I - 5167.33

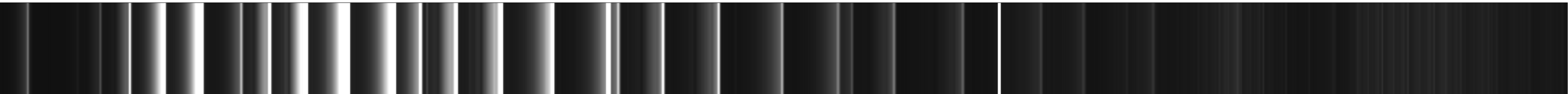
Helium (He)



3819.607 3964.729 4120.815 4387.930 4713.146 5015.678

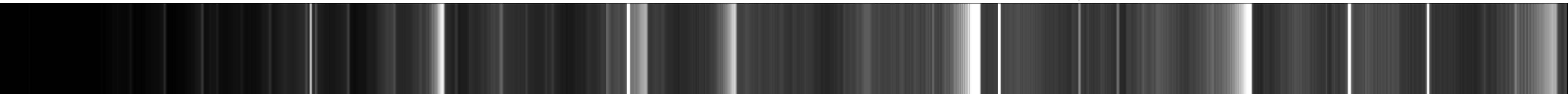
3705.005 3888.648 4026.191 4143.761 4471.480 4921.931 5047.738

Nitrogen (N)



4099.943 4861.361 (HI)

Oxygen (O)

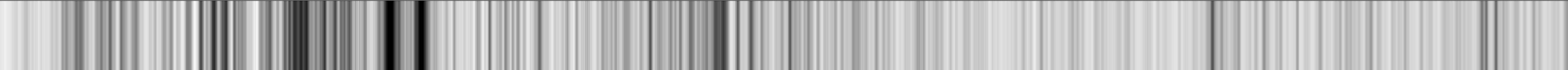


3823.414 3947.481 4368.258 4861.361 (HI) 4968.794 5019.291 5329.099 5435.775

Low cost composite gases discharge lamps (neon + argon)

UV+ blue - 600 l/mm

Sun - Daylight



Ca II K - 3933.68 Ca II H - 3968.49 HI - 4861.34 Mg I - 5167.33



Neon tube - Eisco Scientific



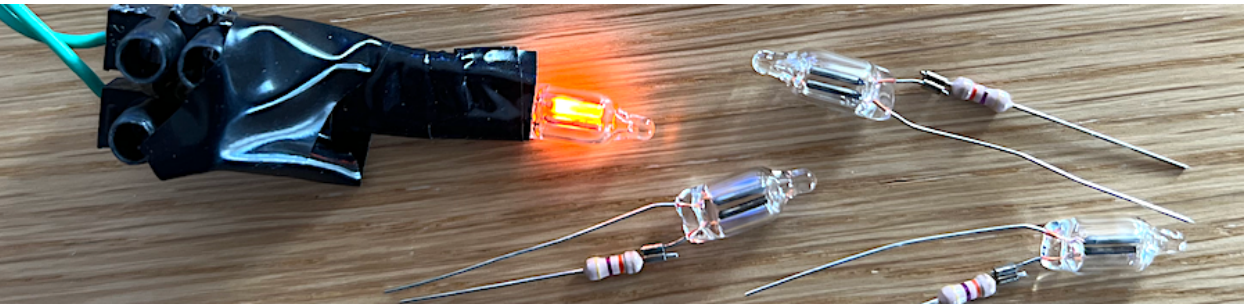
3593.526 (Ne) 3701.225 (Ne) 4538.303 (Ne) 4704.395 (Ne) 4837.314 (Ne) 4957.033 (Ne) 5203.896 (Ne)



Red miniature lamp - Conrad : Barthelme 00012340 Luciole 230 V 0.30 W E10 (2.90 €)



3593.526 (Ne) 3701.225 (Ne) 3948.979 (Ar) 4044.418 (Ar) 4200.674 (Ar) 4333.561 (Ar) 4510.733 (Ar) 4538.303 (Ne) 4704.395 (Ne) 4837.314 (Ne) 4957.033 (Ne) 5203.896 (Ne)



Red miniature lamp - Conrad : TRU COMPONENTS 1590293 Glim Lamp 230 V 0.33 W (0.60 €)



3593.526 (Ne) 3701.225 (Ne) 3948.979 (Ar) 4044.418 (Ar) 4200.674 (Ar) 4333.561 (Ar) 4510.733 (Ar) 4538.303 (Ne) 4704.395 (Ne) 4837.314 (Ne) 4957.033 (Ne) 5203.896 (Ne)

Fluo-compact lamp (mercury excition gaz)

UV+ blue - 600 l/mm

Sun (daylight)



Fluo lamp

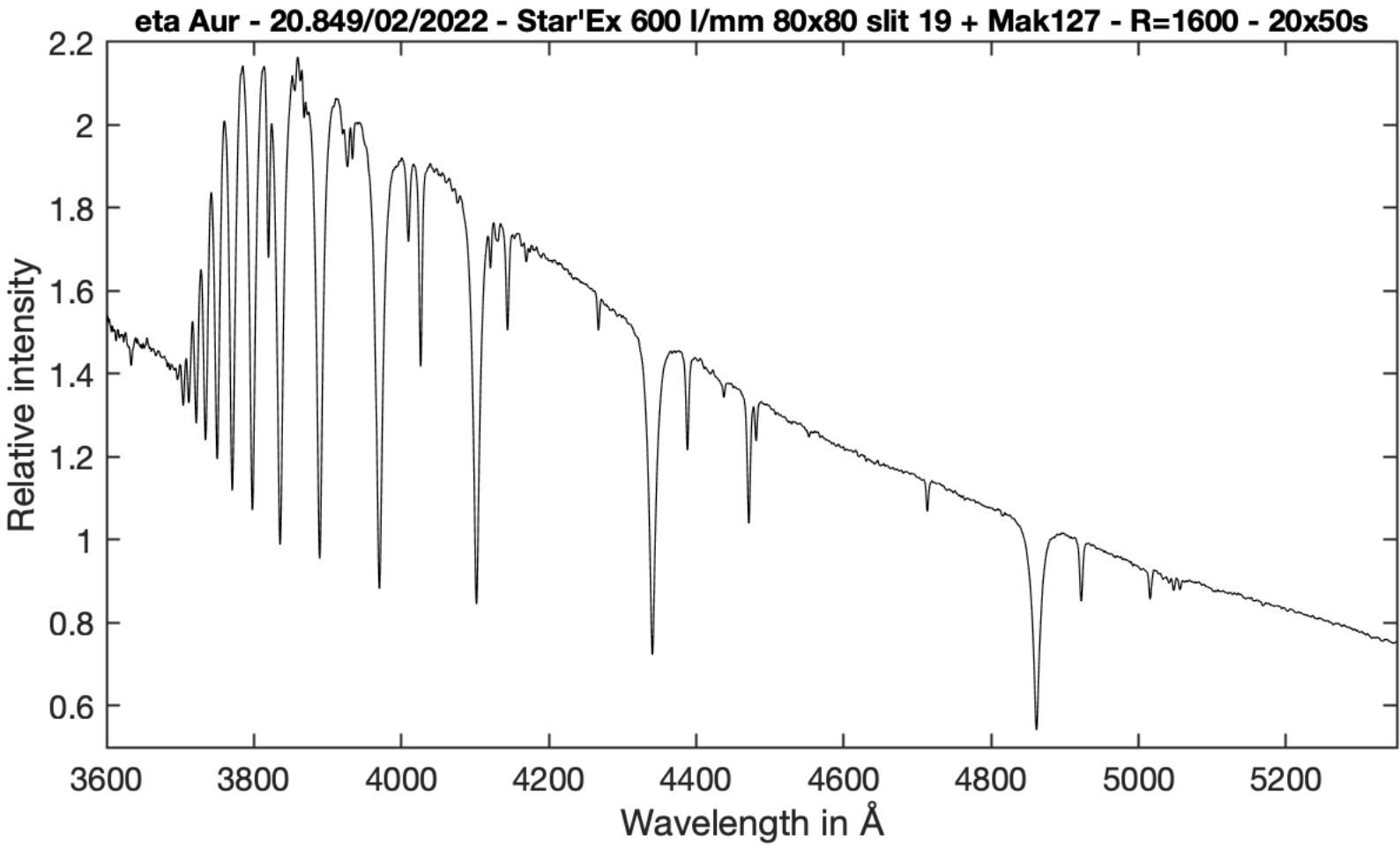
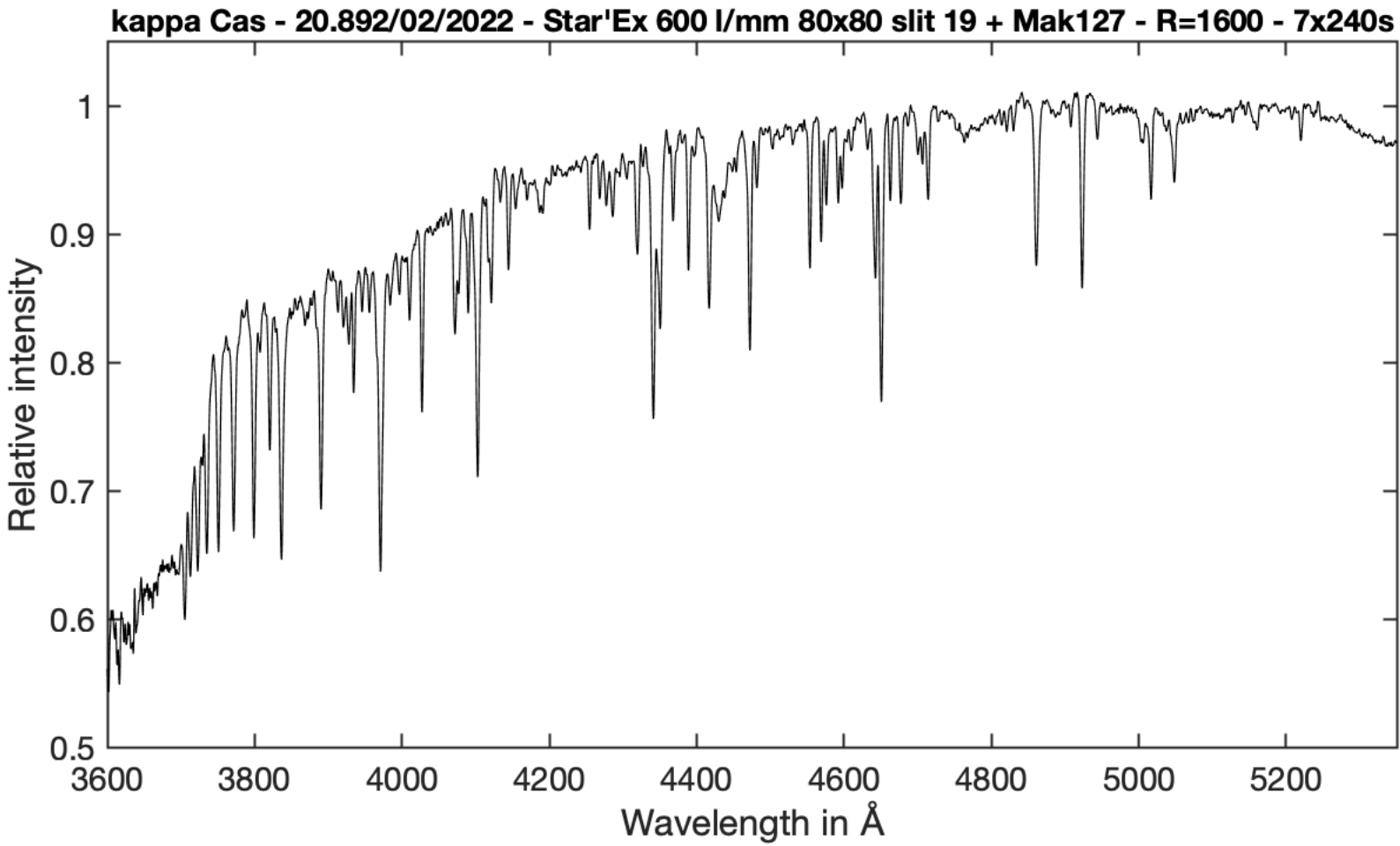
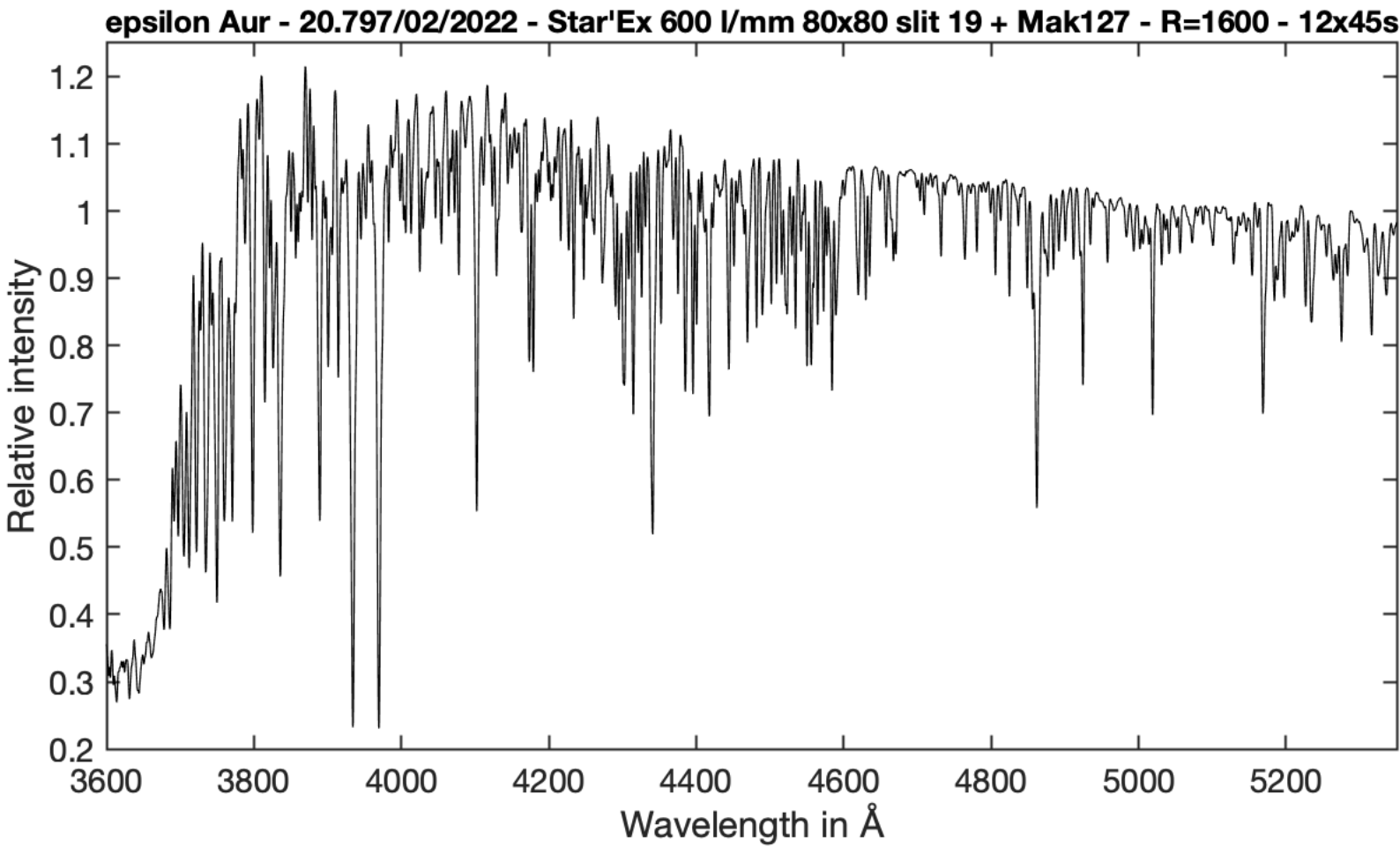
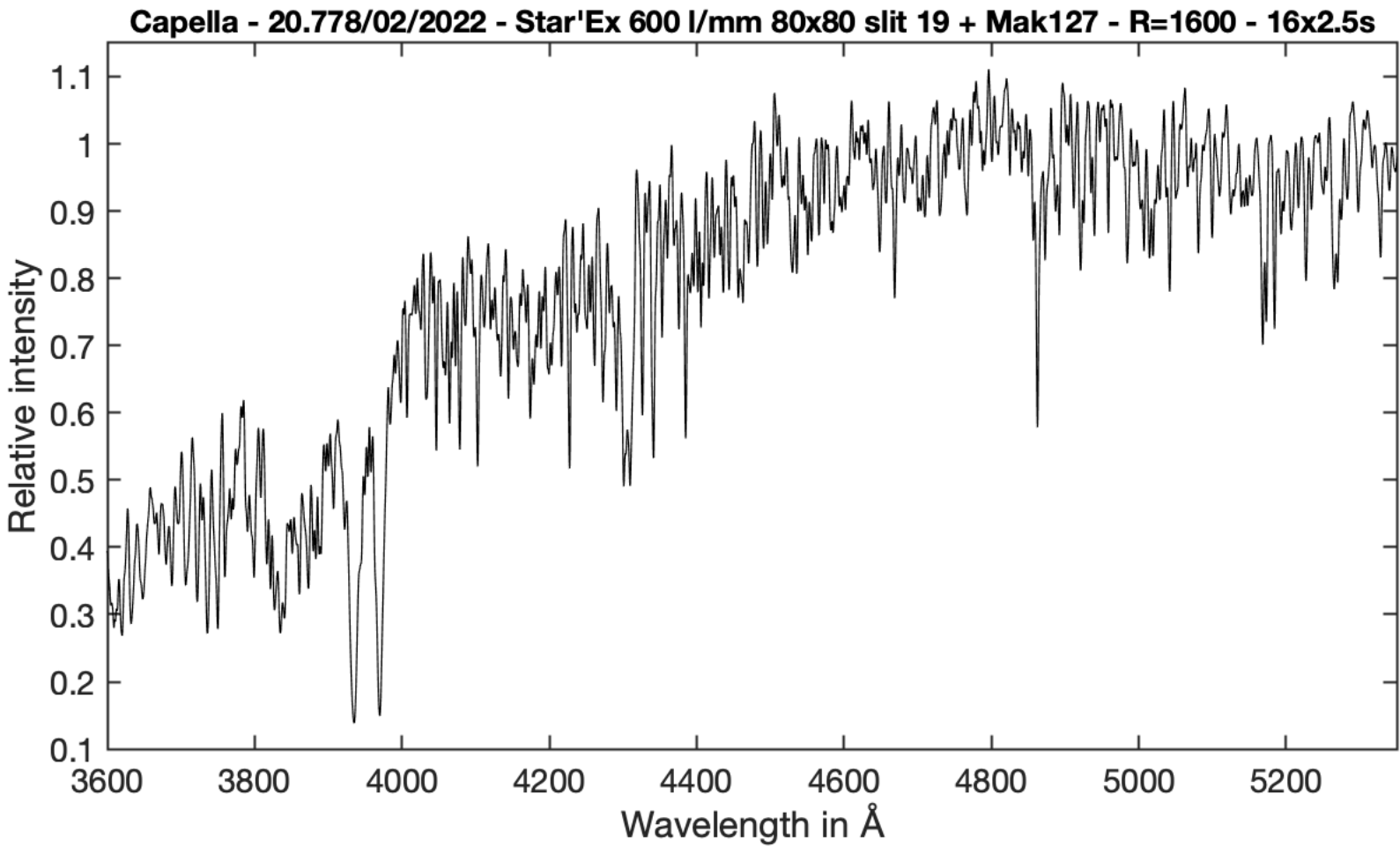


Stellar spectra sample

Star'Ex 600 lines/mm on a Maksutov 127 mm telescope (UV + blue region)



Example of spectral calibration setup on the pupil



Configuration #3

Spectral coverage : 6500 Å - 6700 Å (H-alpha line)

Configuration

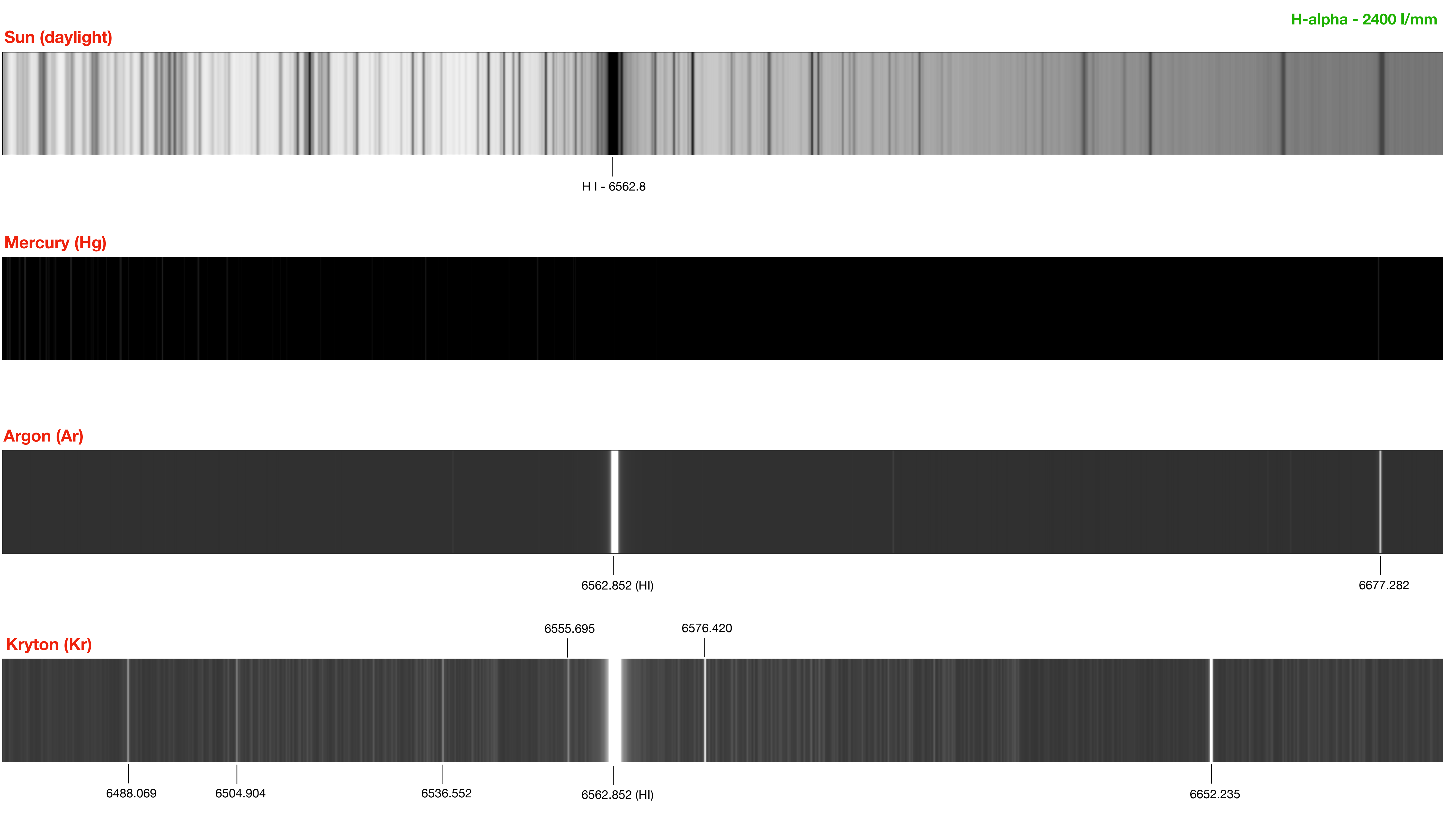
Star'Ex - 80 mm x 125 mm

Grating : 2400 lines/mm - holographic

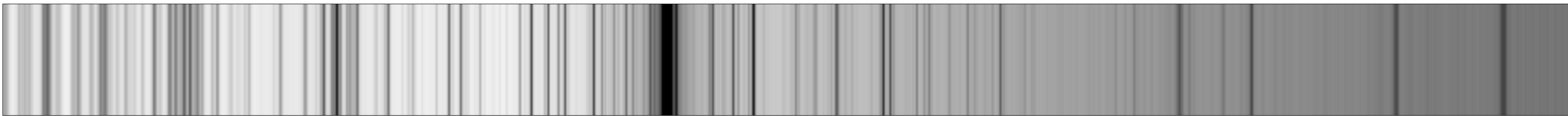
Slit : 19 microns

Optical beam : f/9

Camera : ASI183MM (0.062 Å/pixel)



Sun (daylight)



H I - 6562.8

Neon (Ne)



6506.528

6532.882

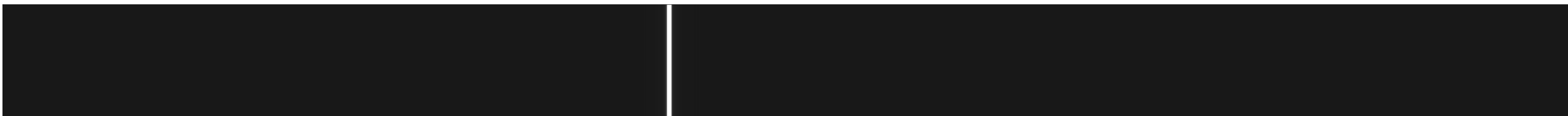
6598.953

6678.278

Xenon (Xe)



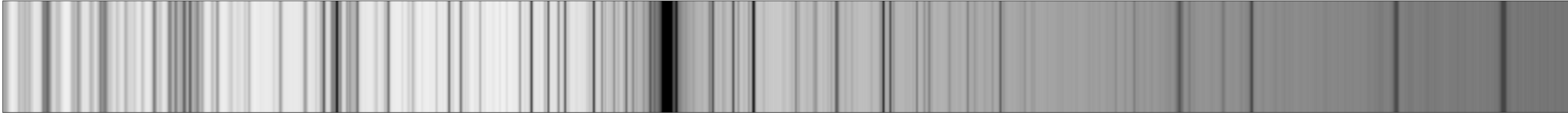
Hydrogen (H)



6562.852

Sun (daylight)

H-alpha - 2400 I/mm



H I - 6562.8

Helium (He)



6562.852 (HI)

6678.151

Nitrogen (N)



6562.852 (HI)

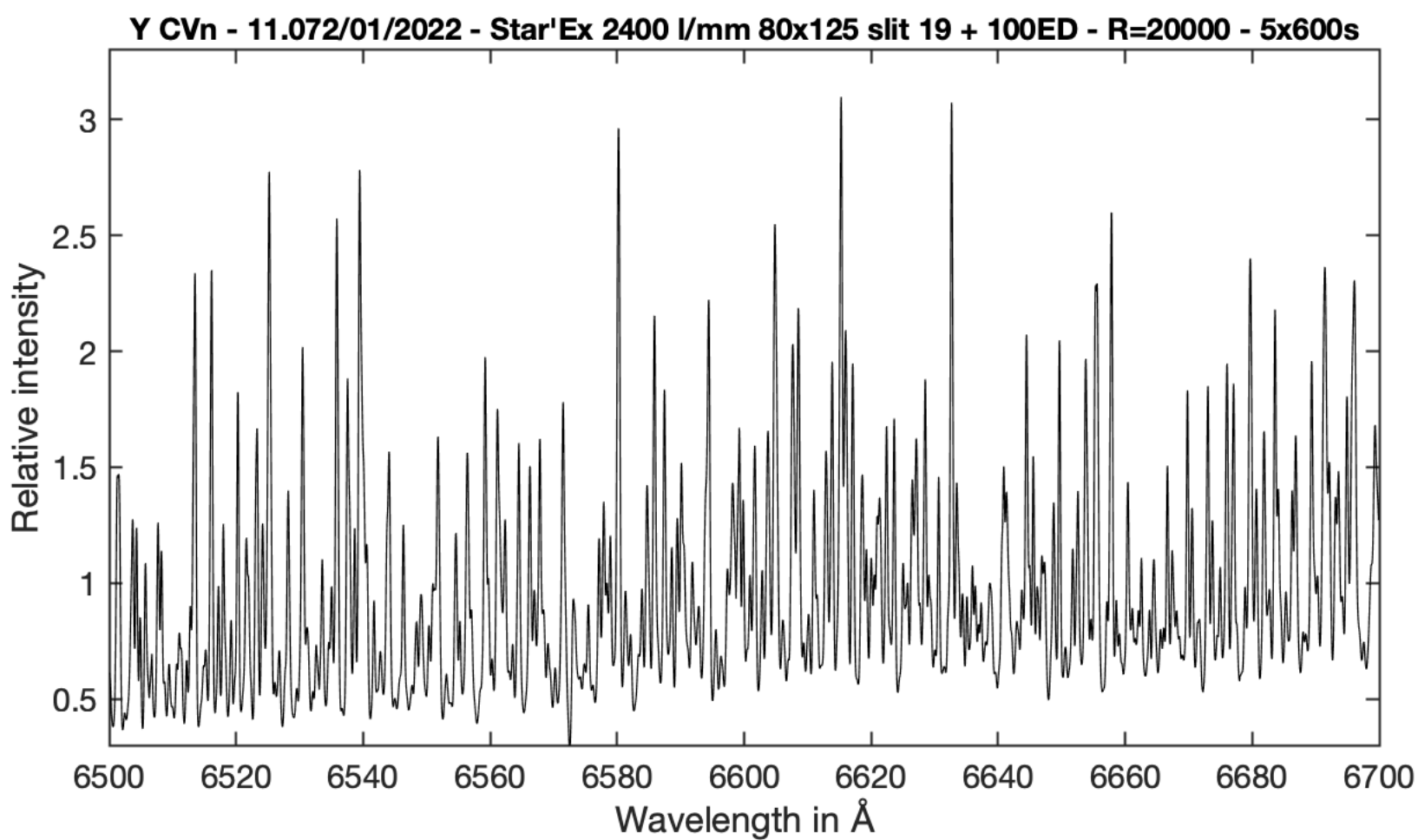
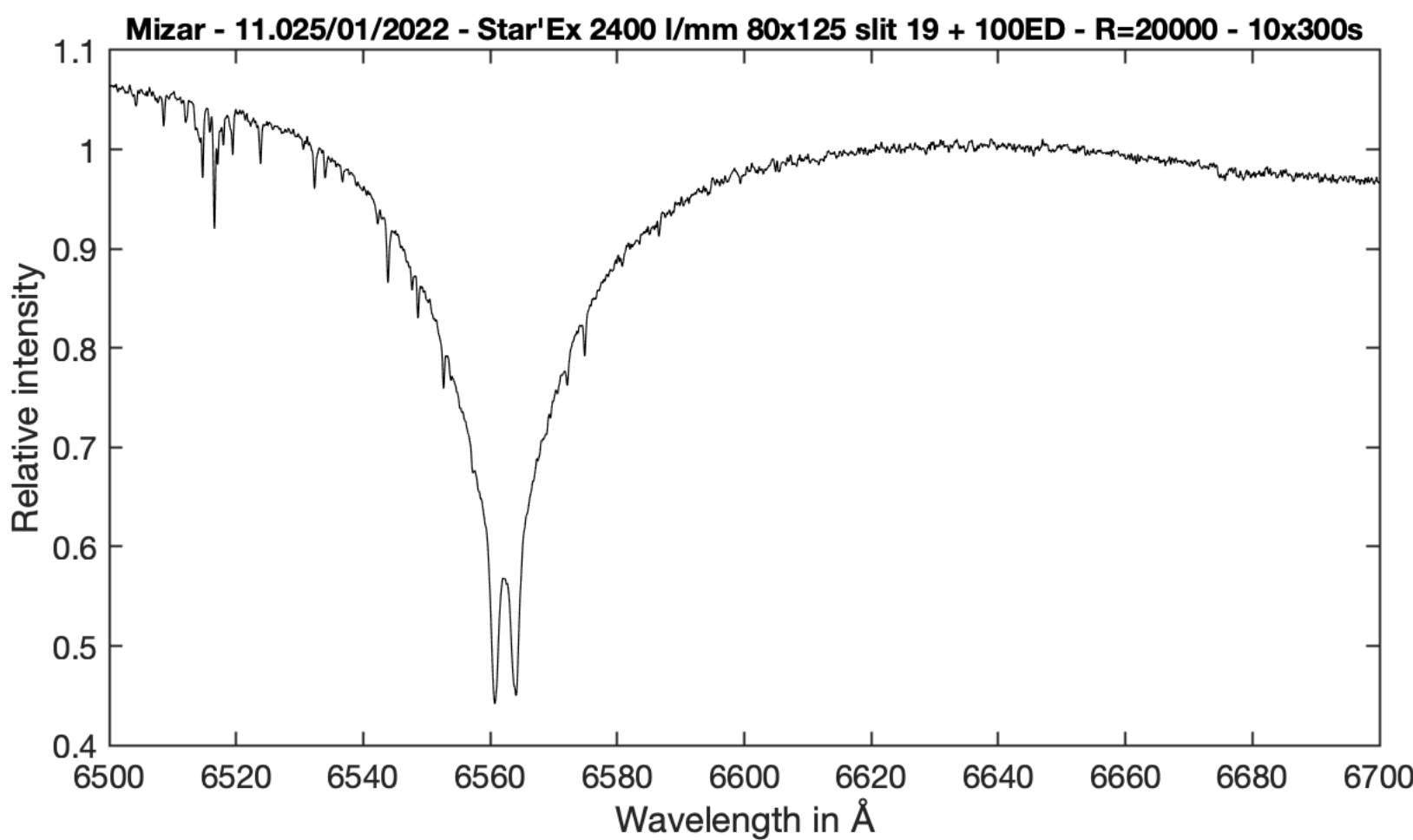
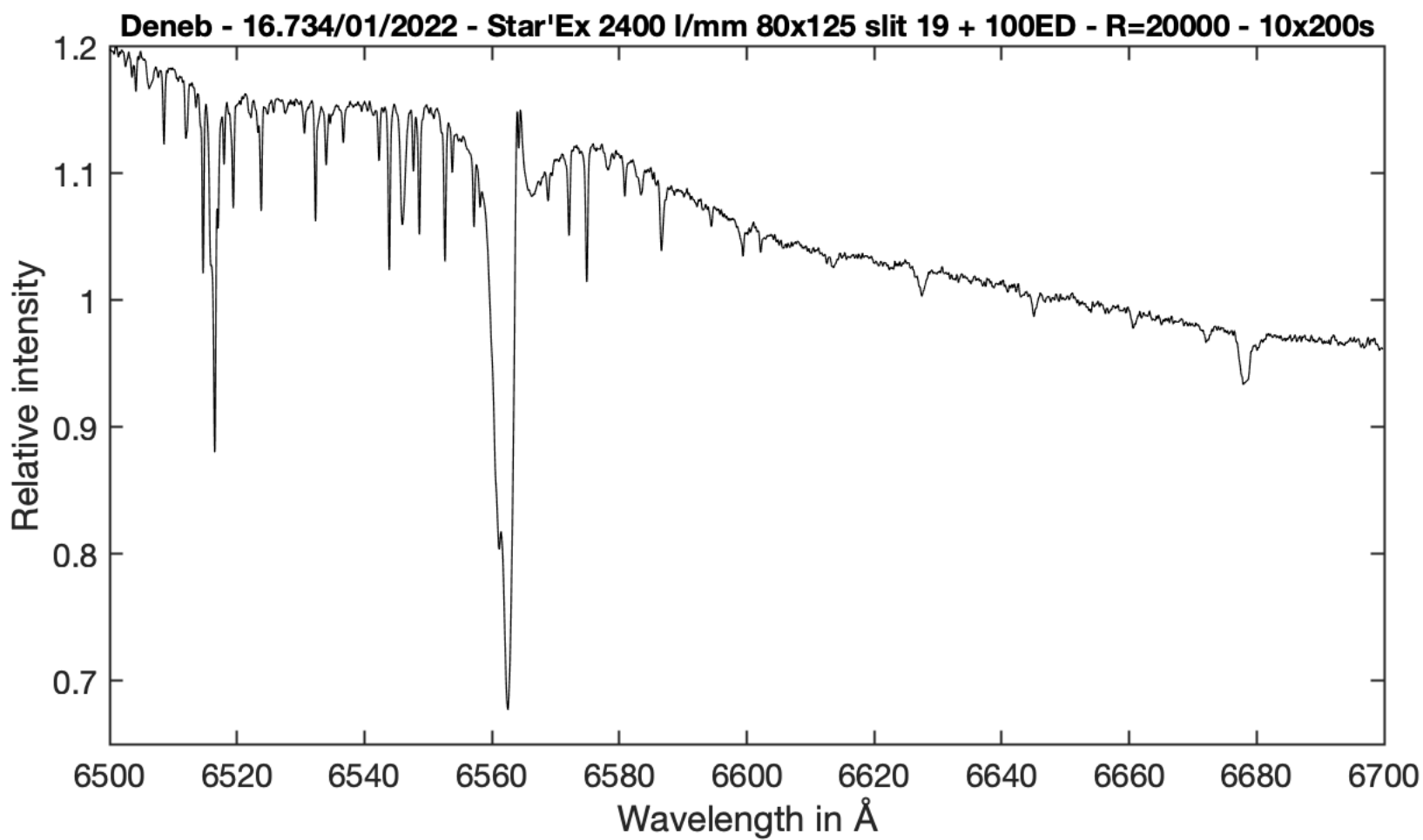
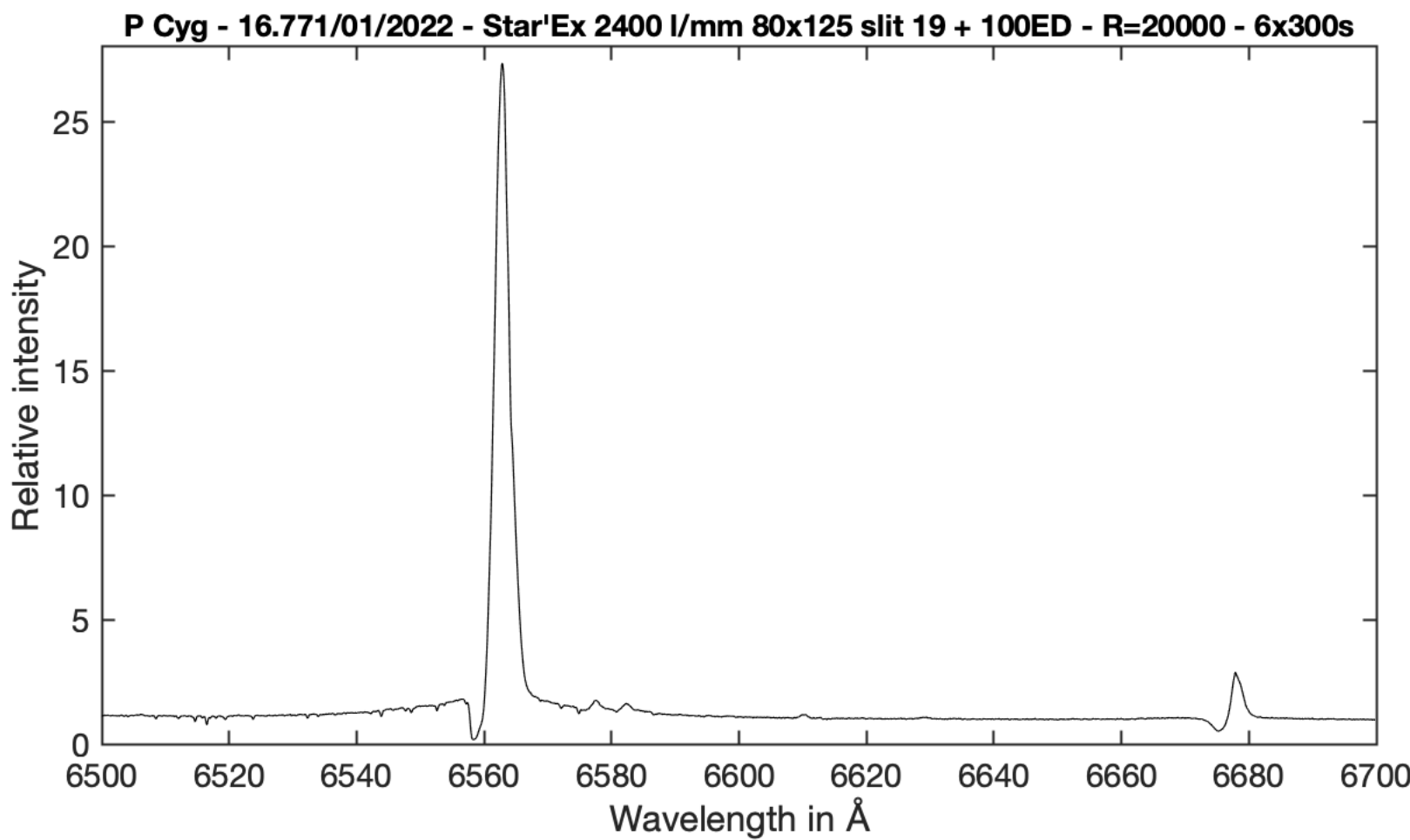
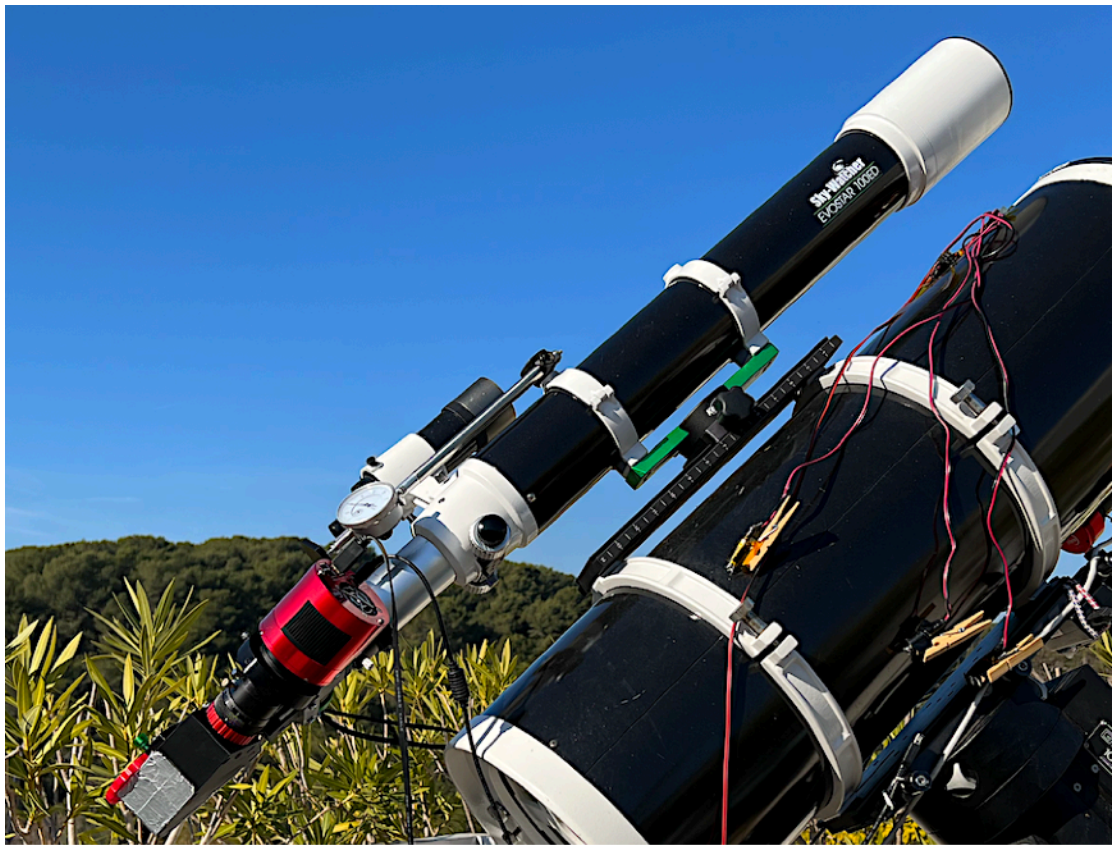
Oxygen (O)



6562.852 (HI)

Stellar spectra sample

Star'Ex 2400 lines/mm on a EVOSTAR 100ED refractor (H-alpha region)



Use of economical optical fibers (plastic) for precision spectral calibration at the entrance pupil.

Configuration #4

Spectral coverage : 4600 Å - 4950 Å (H-beta line)

Configuration

Star'Ex - 80 mm x 125 mm

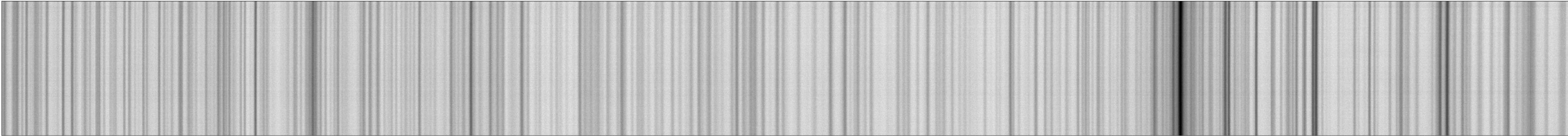
Grating : 2400 lines/mm - holographic

Slit : 19 microns

Optical beam : f/9

Camera : ASI183MM (0.075 Å/pixel)

Sun (daylight)



H I - 4861.3

4611.888

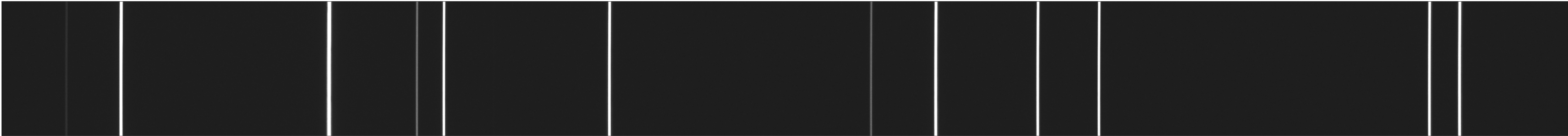
Xenon (Xe)

4697.021

4792.619

4829.708

4923.152



4624.276

4671.226

4690.970

4734.151

4807.019

4843.293

4916.507

This part of the spectrum is tested because:

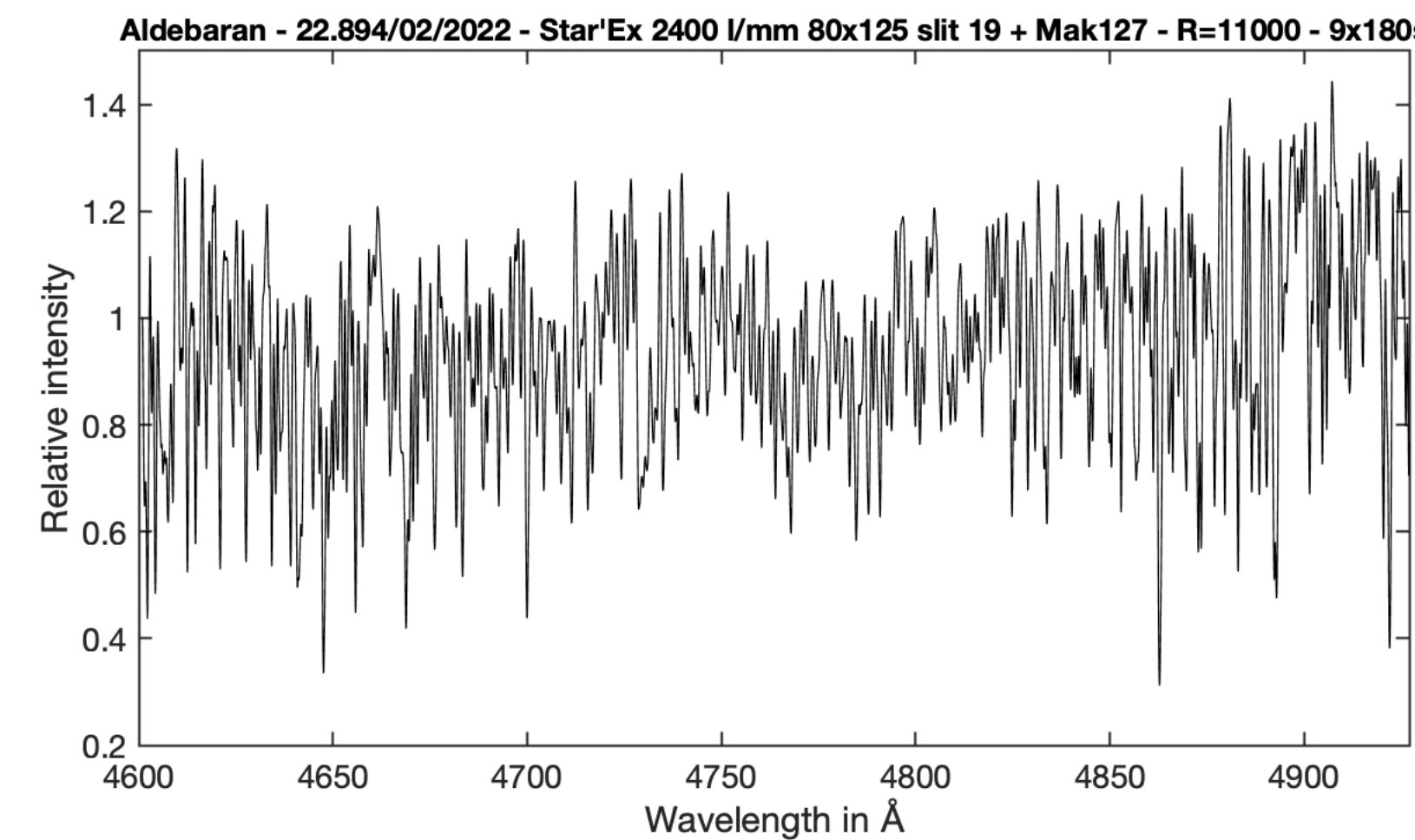
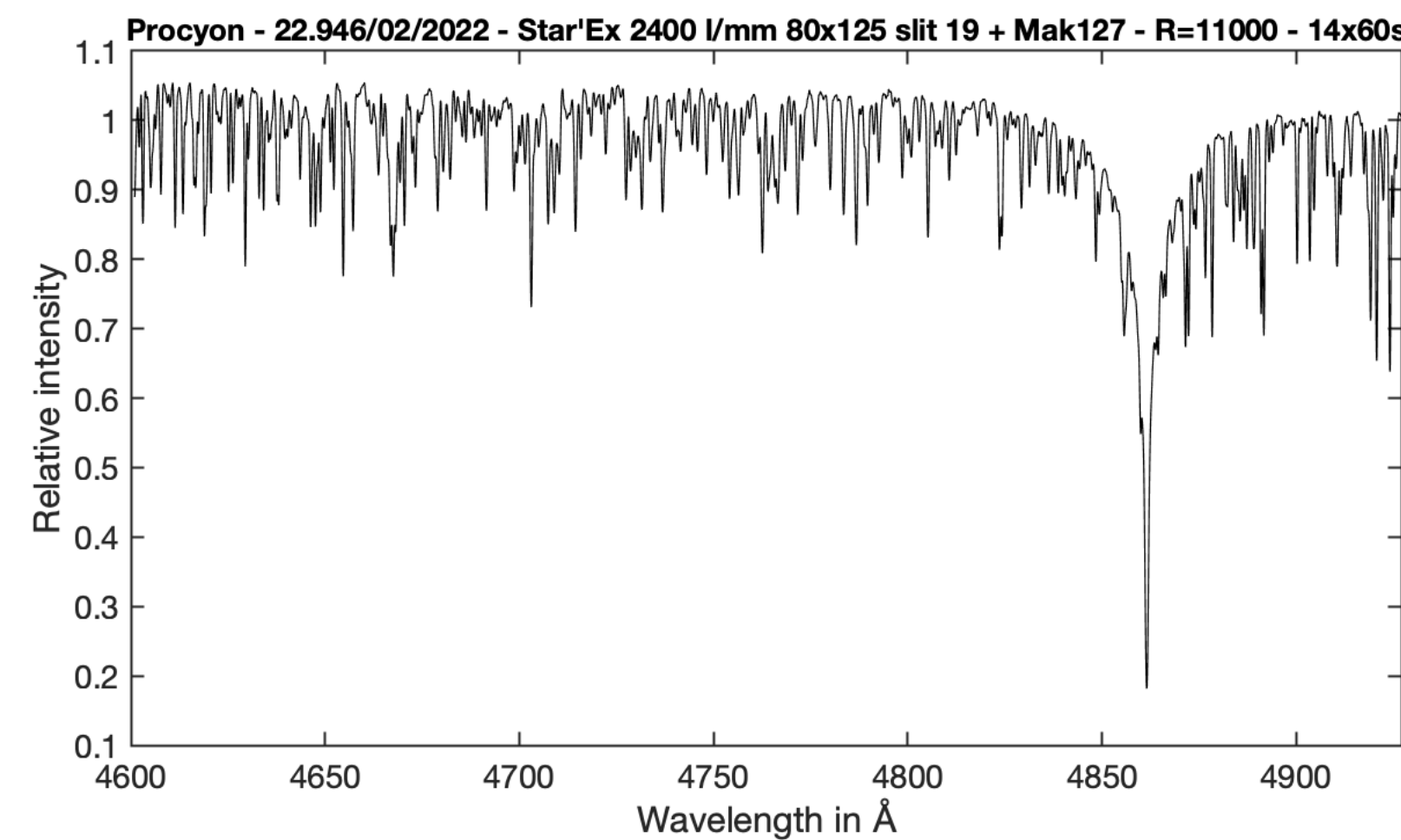
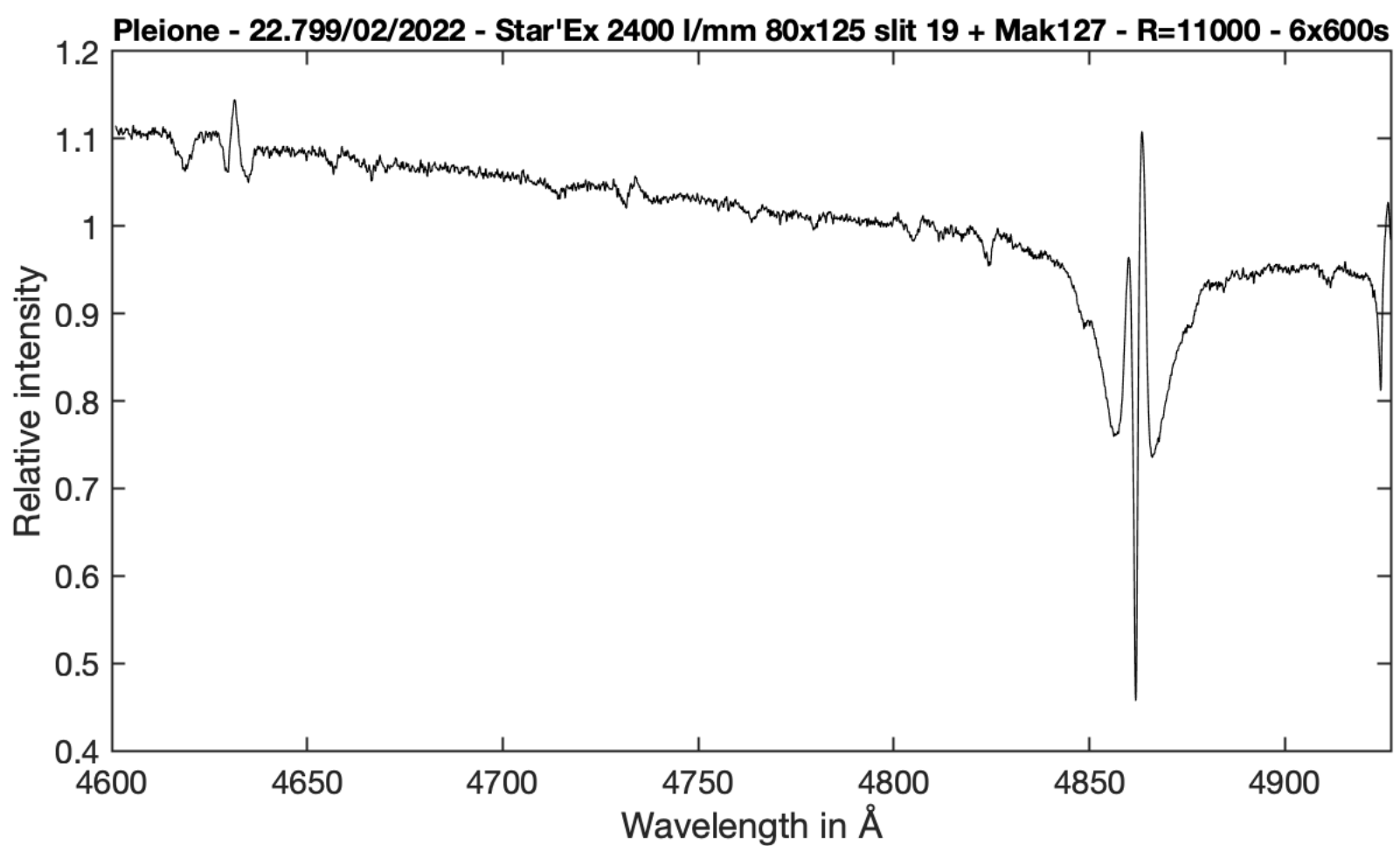
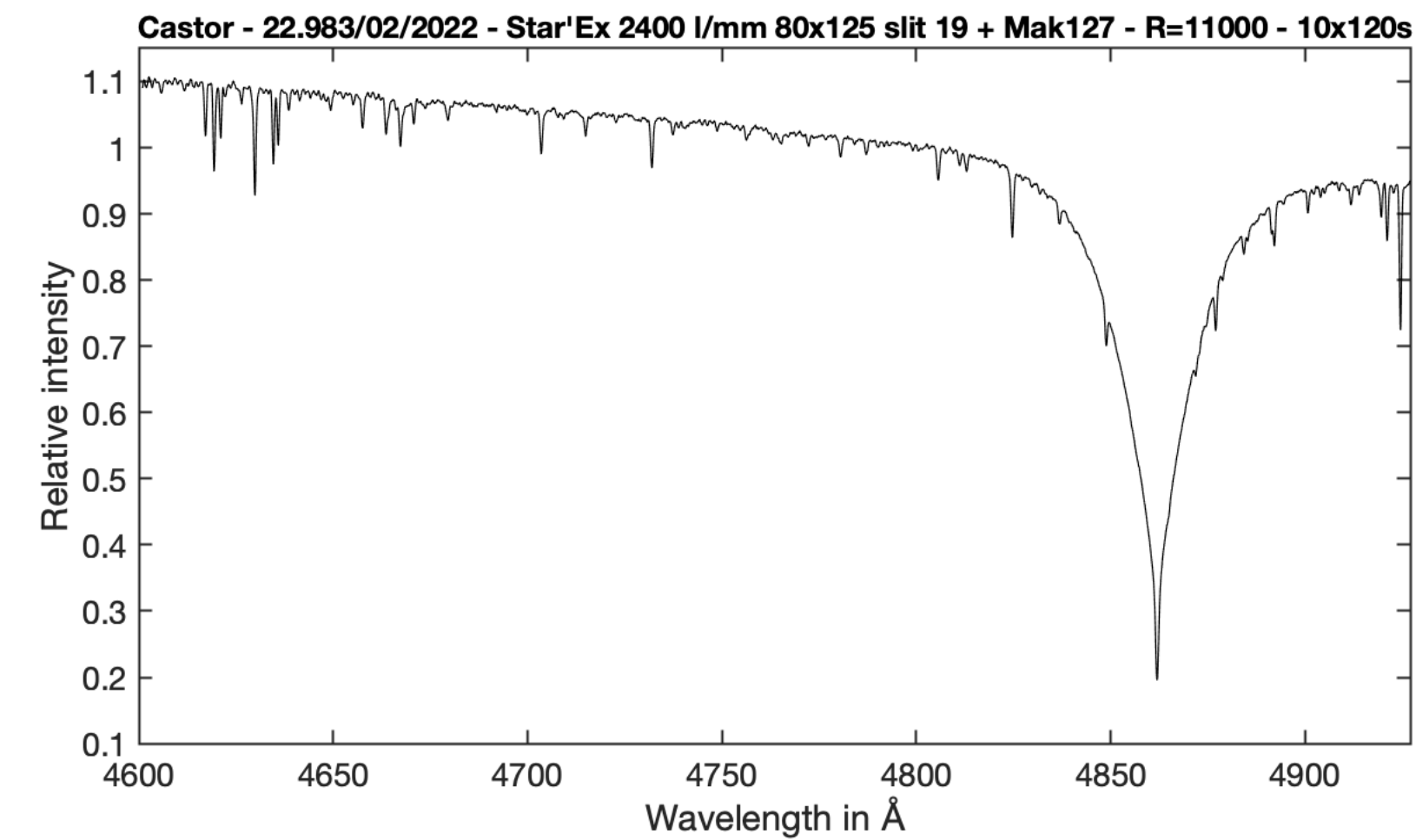
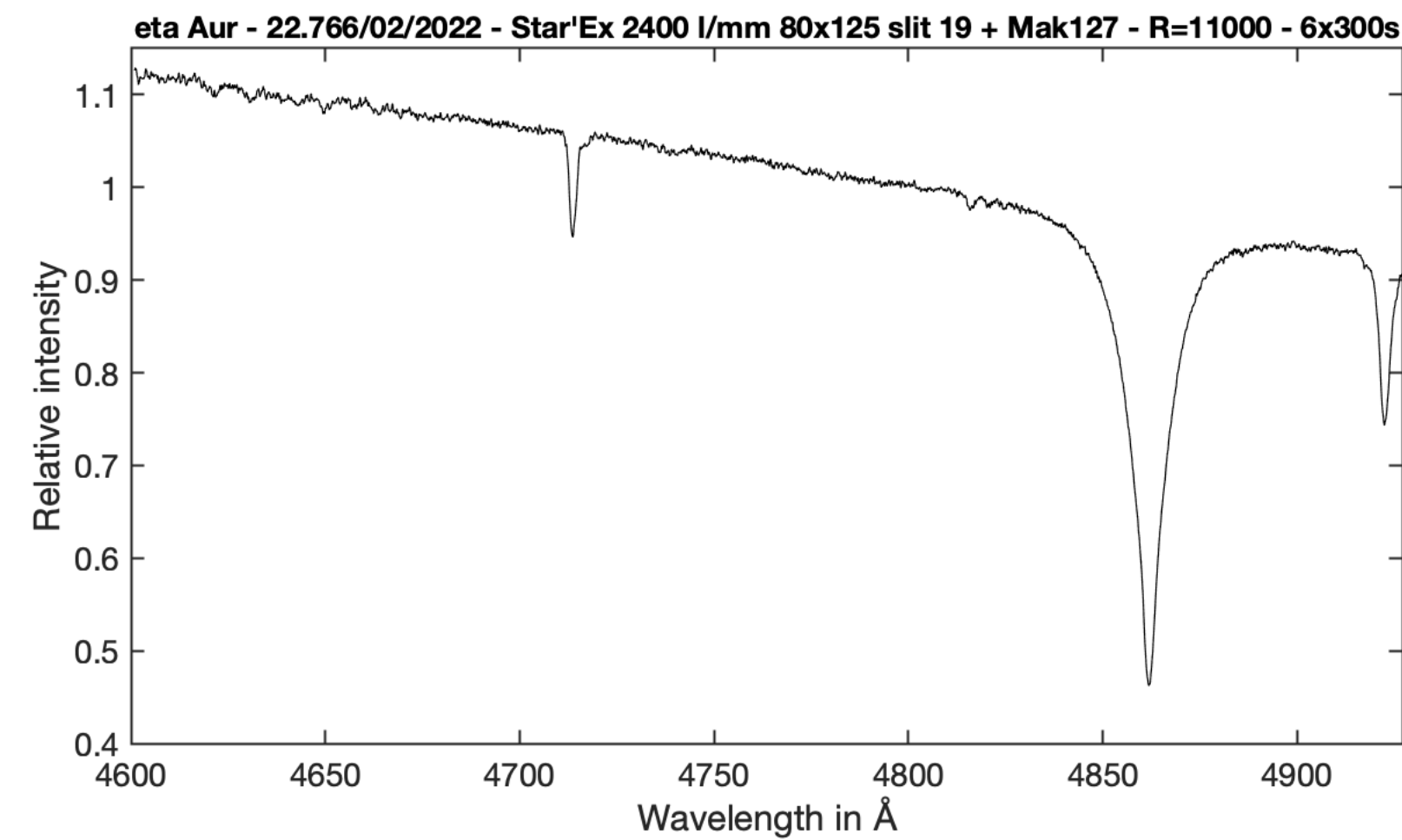
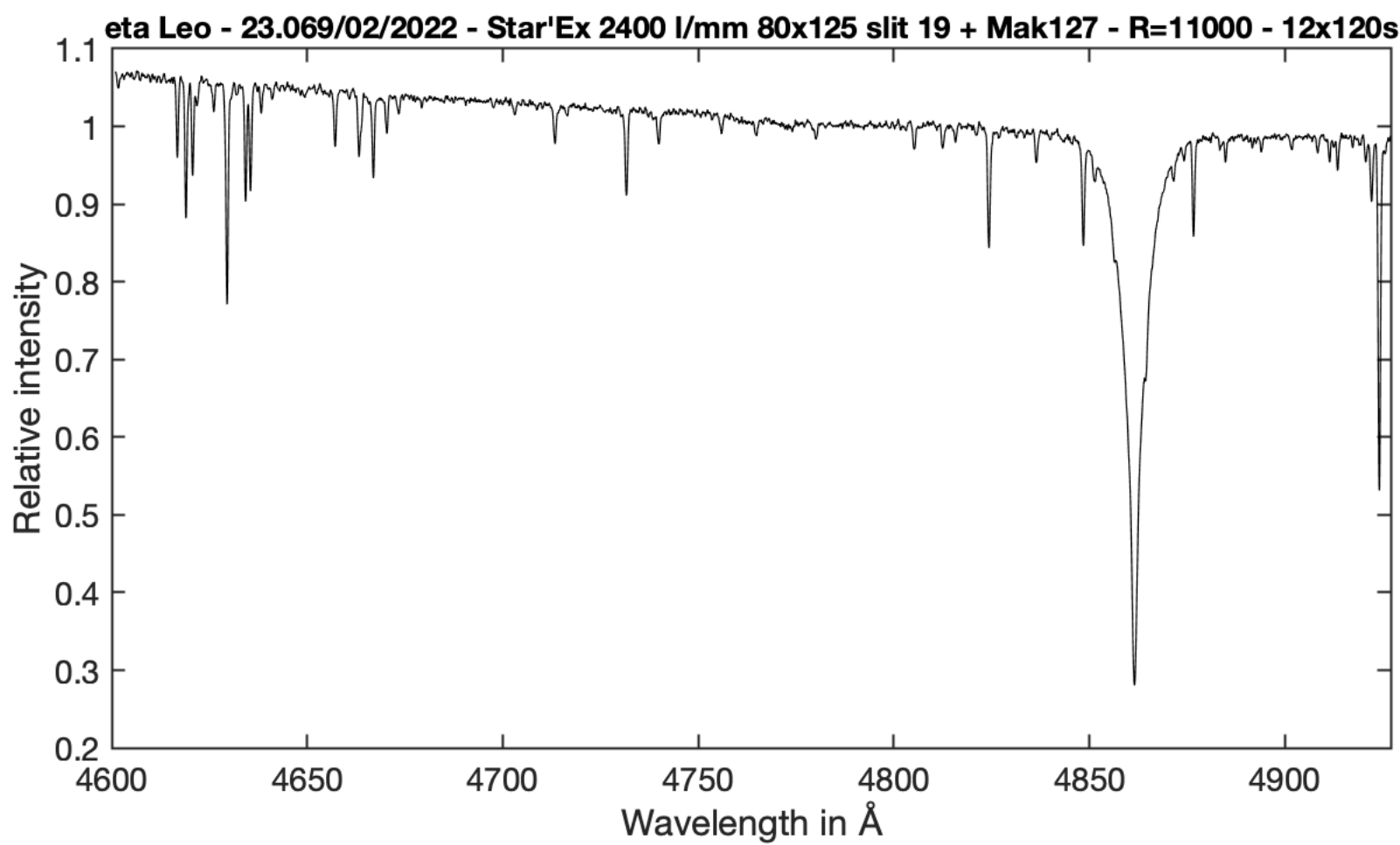
- Presence of the hydrogen H-beta line.
- Relatively high density of xenon lines (for a high spectral resolution spectrum and a non-échelle spectrograph). Spectral calibration accuracy is estimated better to +/- 2 km/s.
- High density of metallic lines for high precision radial velocity measurements (cross-corellation method). Spectral resolution power near 15000.
- Spectral domain free of atmospheric telluric lines.
- The chromatic aberration of most refractors is moderate in this spectral range.
- Good detector quantum efficiency (CMOS) and grating efficiency (holographic 2400 lines/mm).

On the left, some light sources producing xenon emission lines: miniature discharge lamp (pen-ray type), glimm glow lamp (Conrad Electronic, 720215), large discharge tube. However, the intensity of the lines is weak, it will be necessary to adapt the calibration procedure accordingly.



Stellar spectra sample

Star'Ex 2400 lines/mm on a Maksutov 127 mm telescope (H-beta region)



Configuration #5

Spectral coverage : 6800 Å - 9900 Å (infrared)

Configuration

Star'Ex - 80 mm x 80 mm

Grating : 300 lines/mm - blazed at 10000 Å

Slit : 19 microns

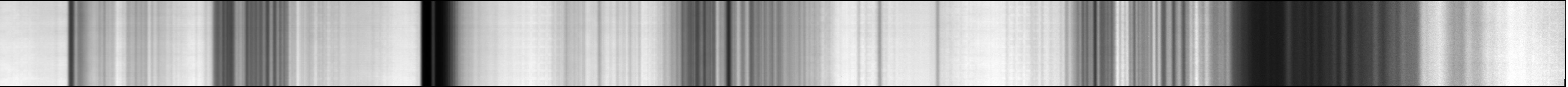
Optical beam : f/9

Camera : ASI183MM (0.986 Å/pixel)

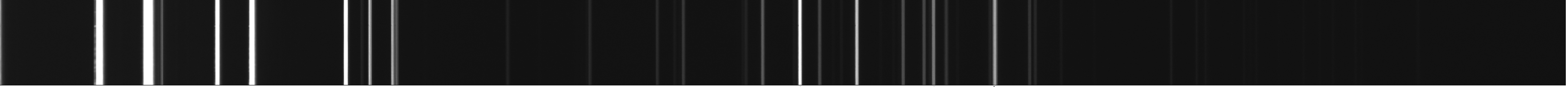


An important point: add an order filter to observe infrared (here a RG650)

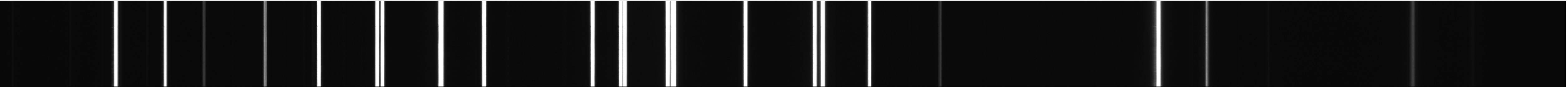
Sun (daylight)



Neon (Ne)



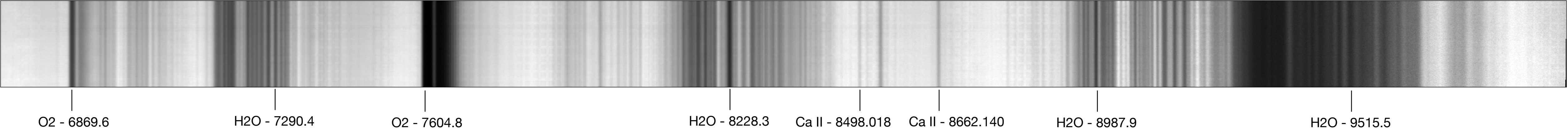
Argon (Ar)



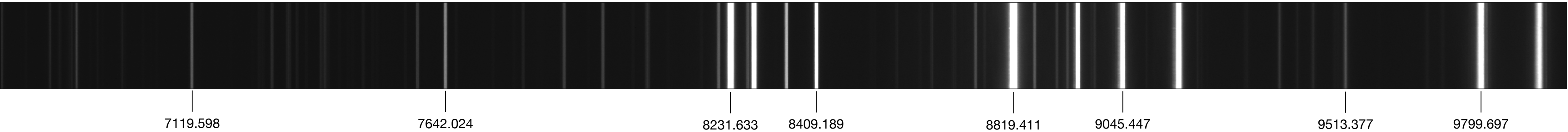
Krypton (Kr)



Sun (daylight)



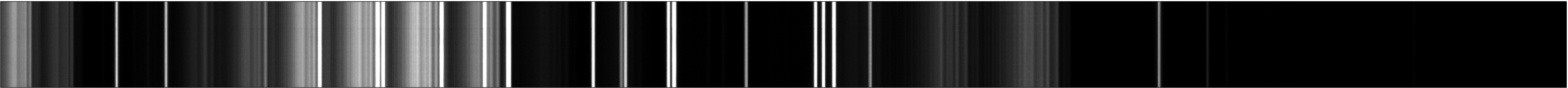
Xenon (Xe)



Helium (He)



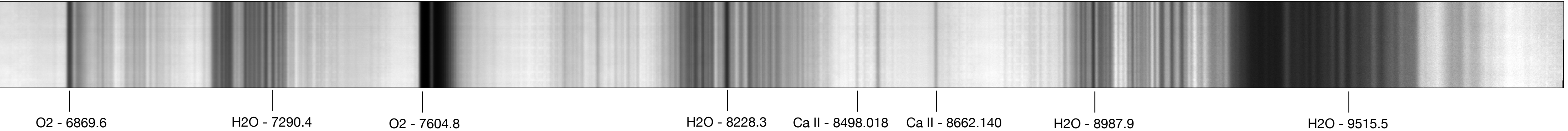
Nitrogen (N)



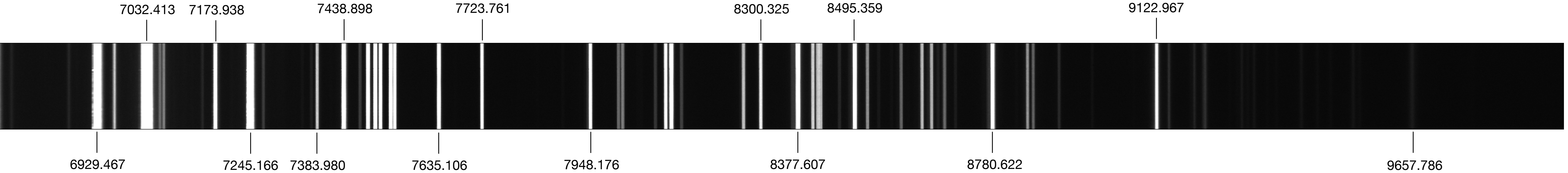
Low cost composite gases discharge lamps (neon + argon)

Infrared - 300 l/mm

Sun (daylight)

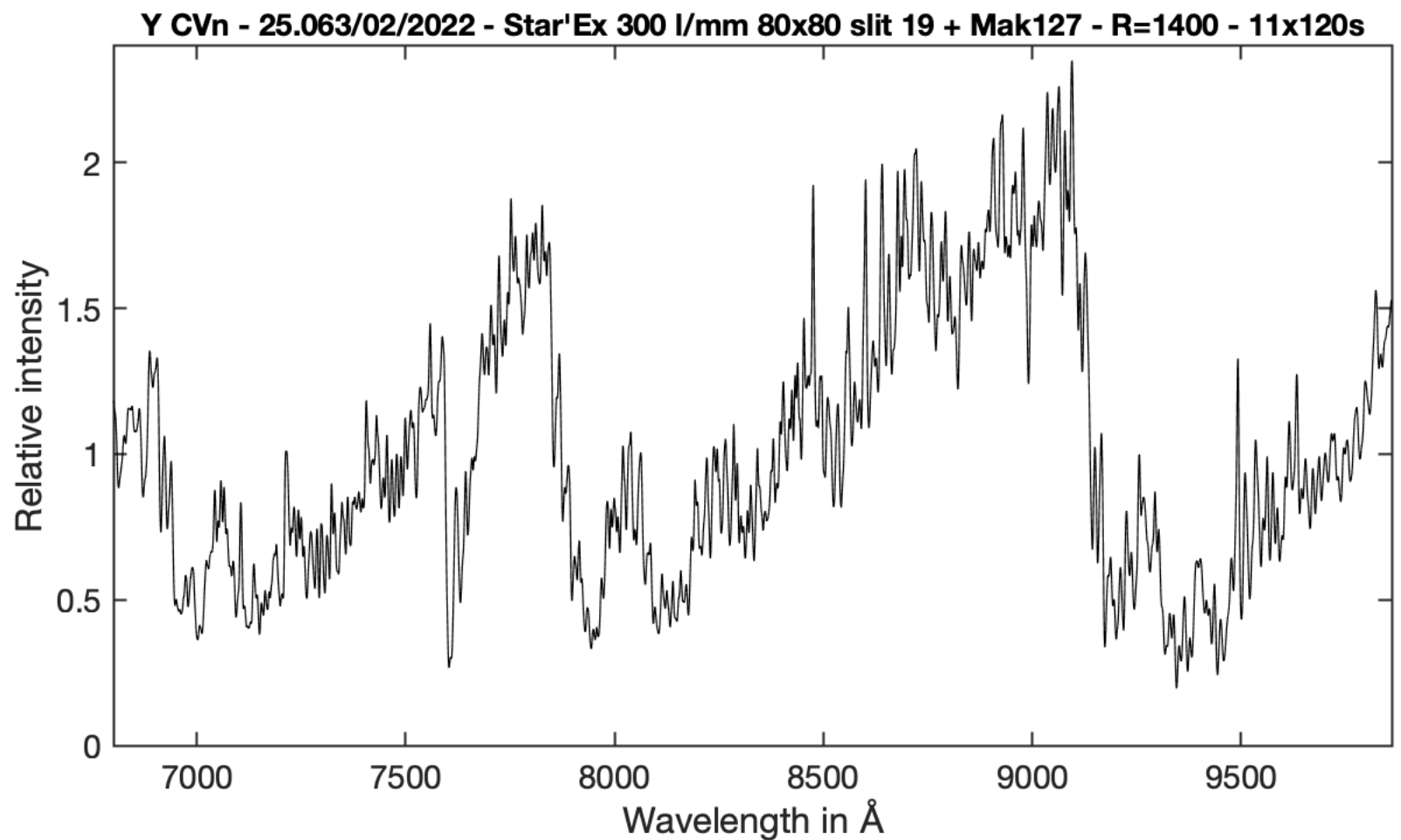
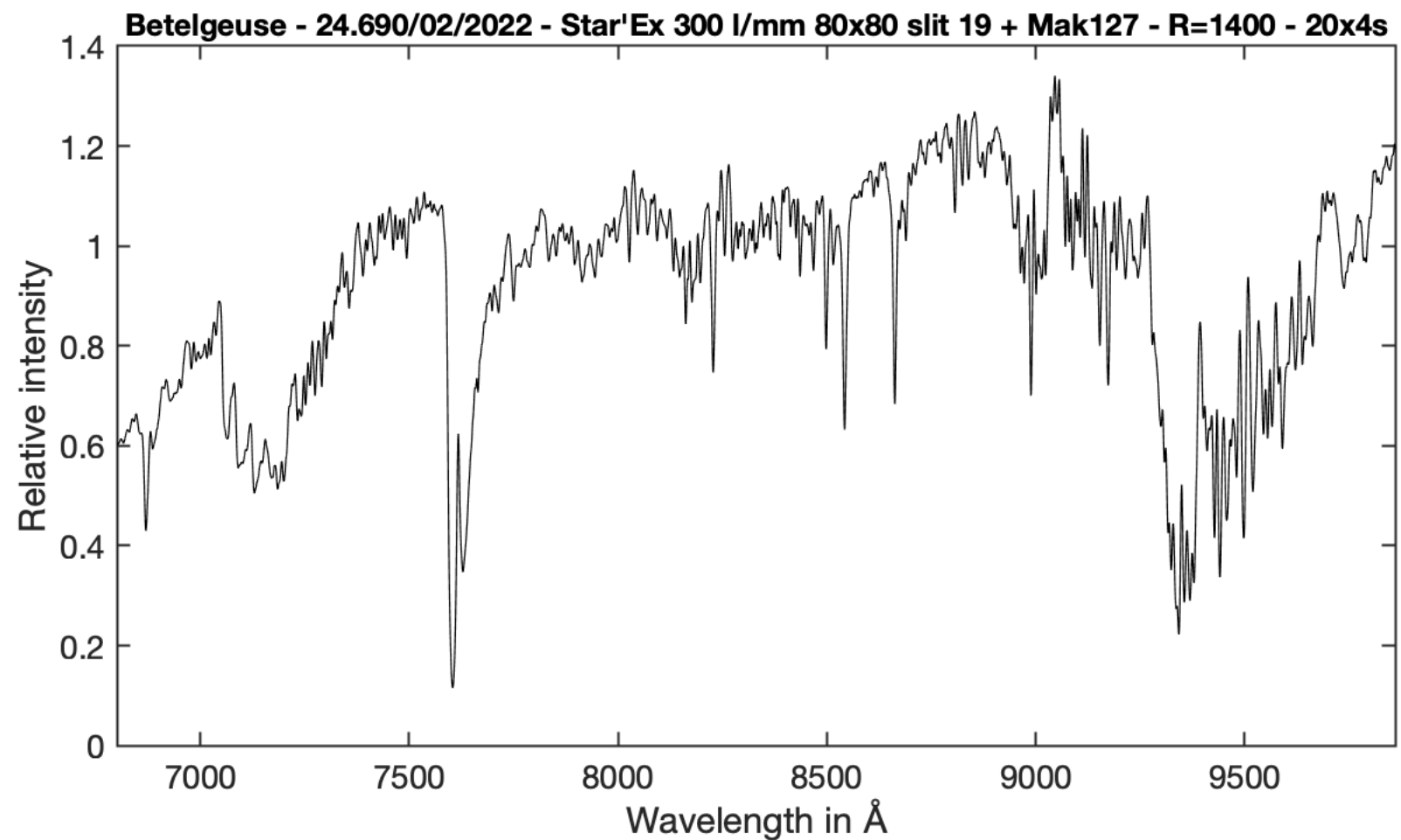
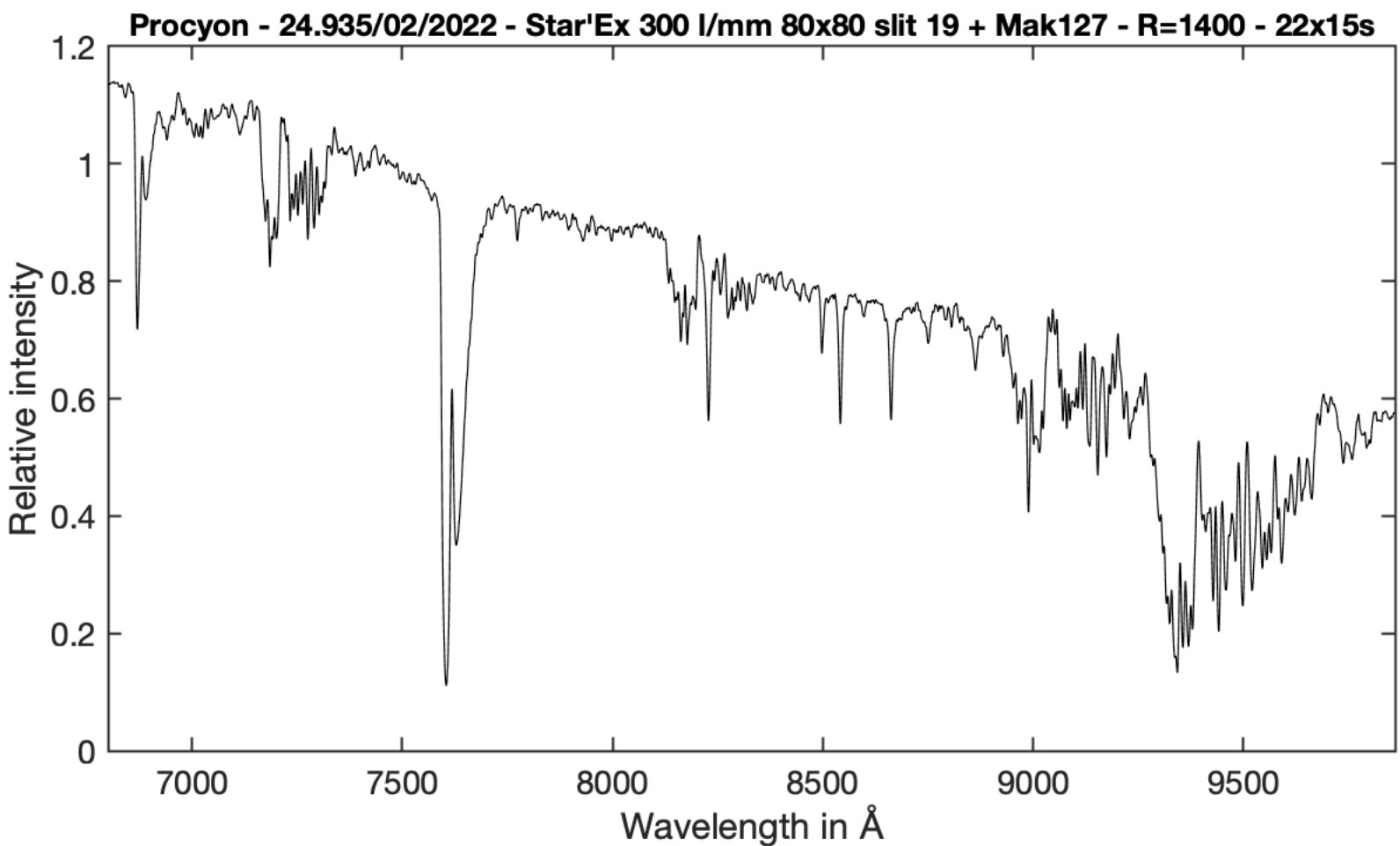
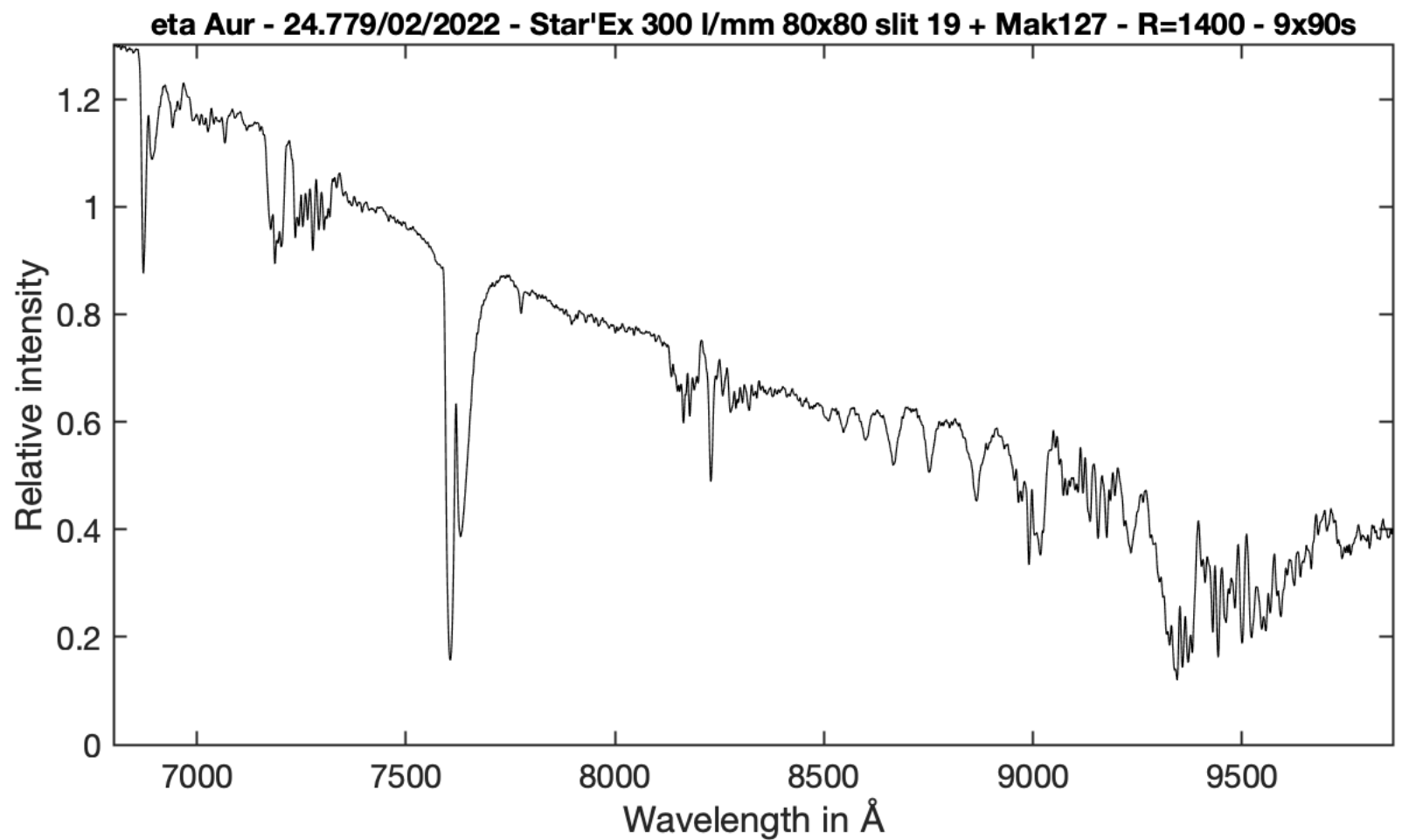
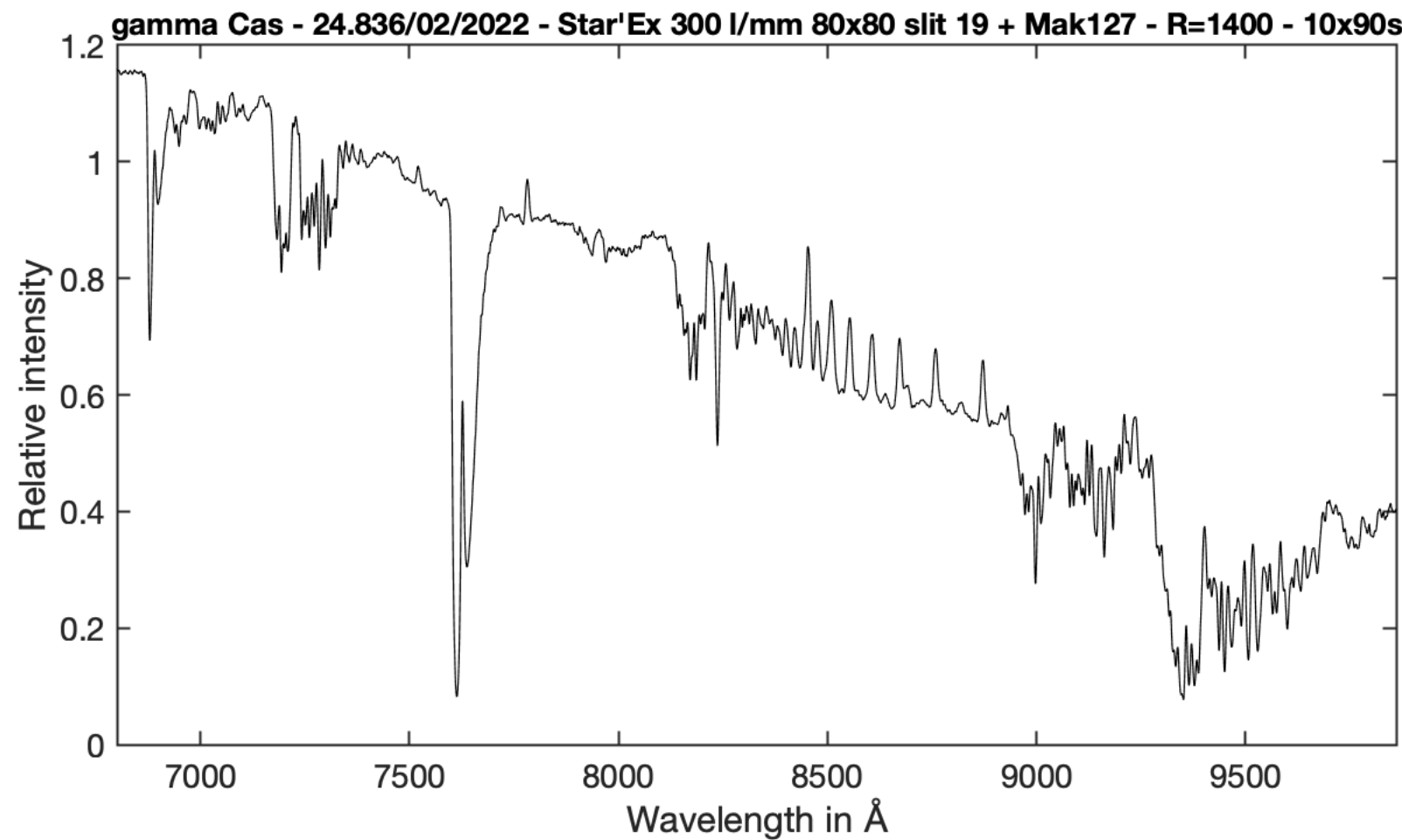
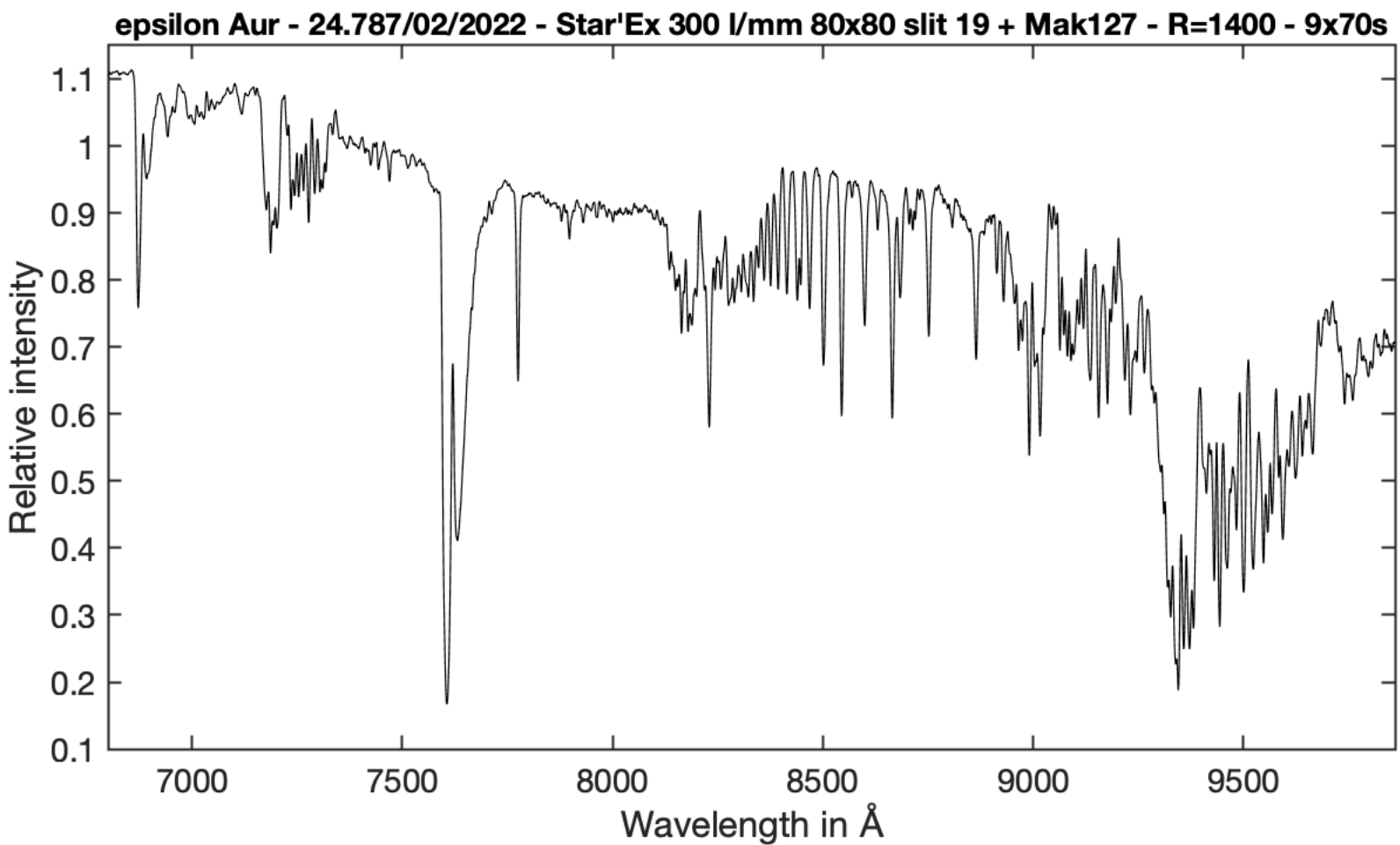


Red miniature lamp - Conrad : Barthelme 00012340 Luciole 230 V 0.30 W E10 (2.90 €)



Stellar spectra sample

Star'Ex 300 lines/mm blaze 10 000 Å on a Maksutov 127 mm telescope (infrared region)



End.