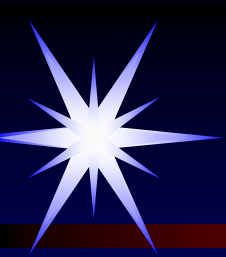




Spectra analysis Visual Spec

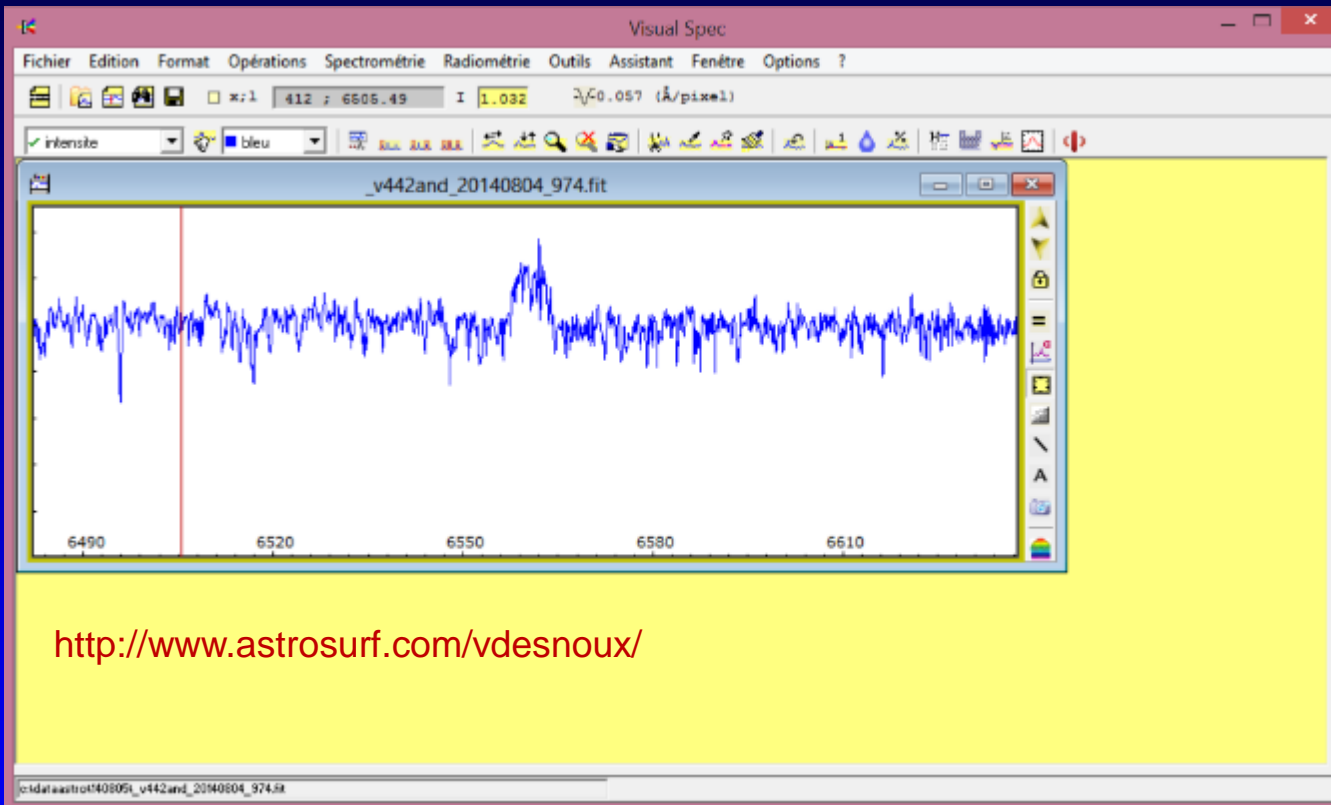
Sacramento Mountains Spectroscopy Workshop
22-24 feb 2019

Valérie Desnoux
valerie.desnoux@free.fr



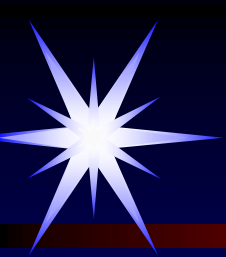
Visual Spec...

First
version in
1995



<http://www.astrosurf.com/vdesnoux/>

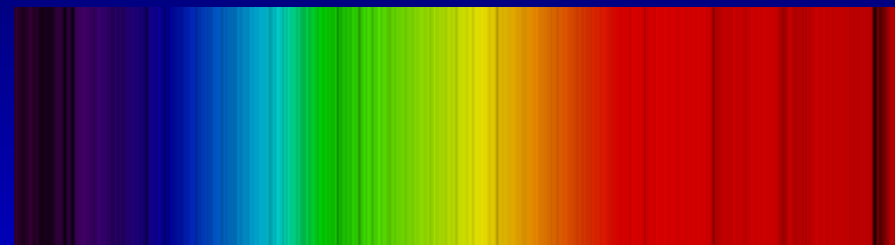
... Since version 4.4.2 installation has improved

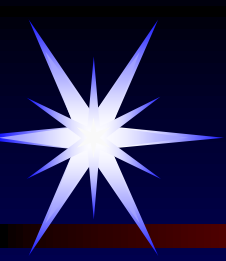


Spectral diversity



Spectral type, temperature
Line identification
Nova
Carbon star
Planetary nebulae
Supernova
Quasar
... and Be stars

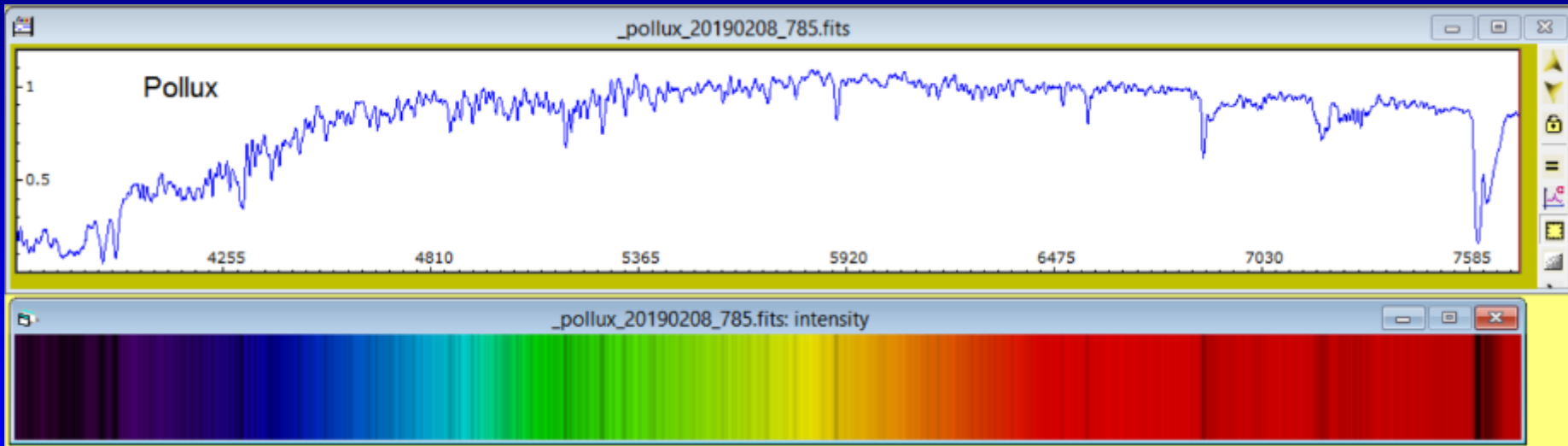




Pollux

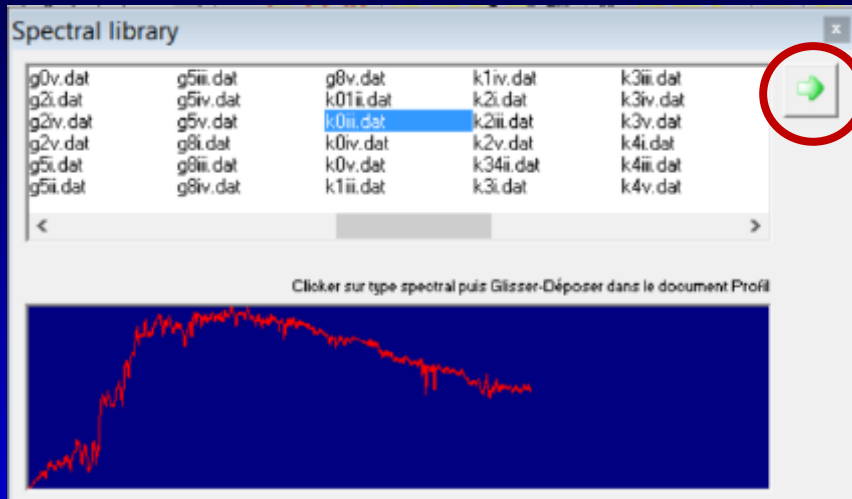


Tool > Synthesis to get a black& white synthetic image from the profile
Right click in image > color to get it in color based on wavelength

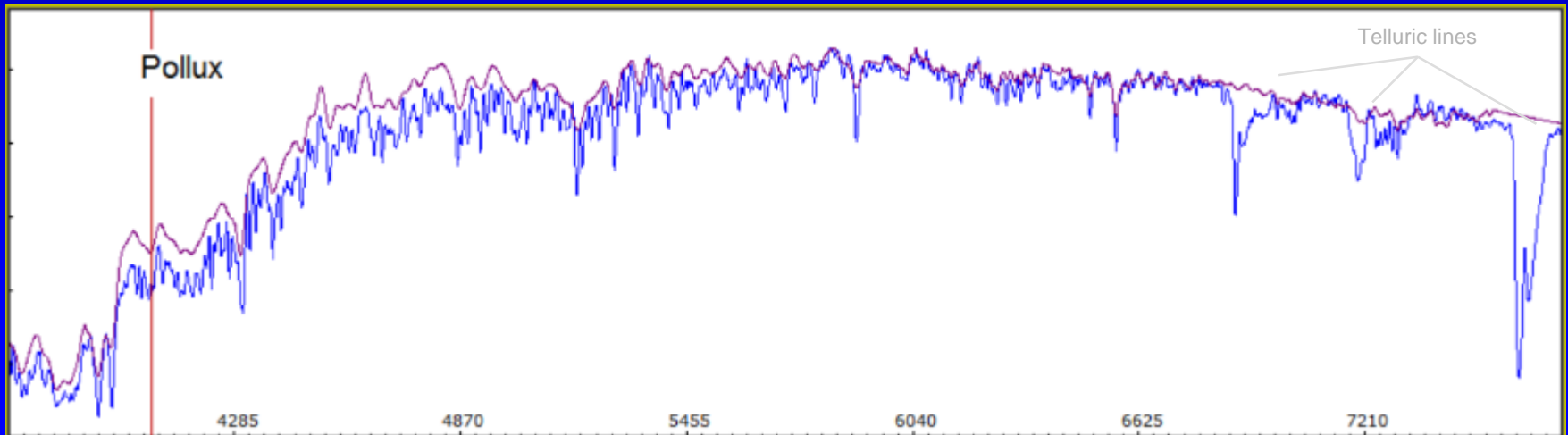


Spectral type library

| Assistant | Tools | Batch | Window |
|------------------|-------|--------|--------|
| Mendeleviev... | | | |
| Elements... | | Ctrl+E | |
| Library... | | Ctrl+L | |
| Spectral type... | | Ctrl+T | |
| Coordinates... | | | |
| Console | | Ctrl+Q | |
| Script box | | | |
| Latest script | | | |
| BeSS query... | | F2 | |
| BeSS list query | | | |
| CDS query... | | F3 | |
| Line analysis | | | |
| Run Spectrum* | | | |



Library from A.J. PICKLES
5 Angströms sampling



Element identification

- **CRC Handbook of Chemistry & Physics**

- VI/16 Line Spectra of the Elements (Reader+ 1980-1981)

Reader J. & Corliss Ch.H.

<61st ed., CRC Handbook of Chemistry & Physics (1980--81)>

- **Line catalog in stellar object**

- VI/71A Revised version of the ILLSS Catalogue (Coluzzi 1993-1999)

COLUZZI R: 1993

<Bull. Inf. CDS 43, 7>

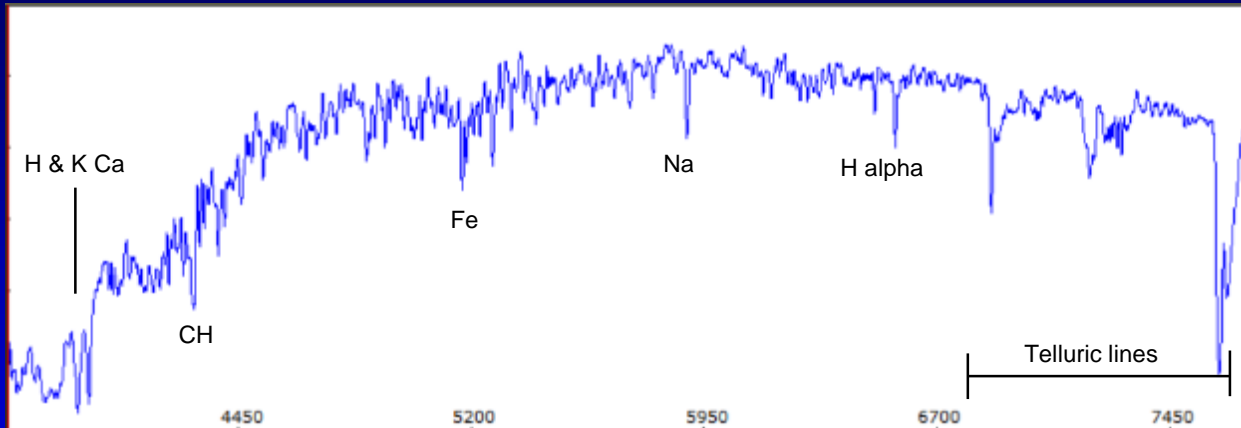
The screenshot shows a software window titled "Elements" with a table of spectral lines and several control panels on the right.

| Lambda | Ion | Intensity | Element |
|----------|-----|-----------|---------|
| 3690.28 | 1 | 1000 | V |
| 3690.34 | 1 | 5500 | PD |
| 3690.56 | 2 | 50 | YB |
| 3690.59 | 1 | 240 | MO |
| 3690.624 | 1 | 100 | TH |
| 3690.65 | 1 | 580 | HO |
| 3690.65 | 3 | 30 | KR |
| 3690.7 | 1 | 1900 | RH |
| 3691.15 | 2 | 610 | TB |
| 3691.48 | 1 | 1500 | RE |
| 3691.92 | 2 | 540 | U |
| 3691.95 | 1 | 340 | HO |
| 3692.22 | 2 | 270 | SM |
| 3692.22 | 1 | 1500 | V |
| 3692.36 | 1 | 9400 | RH |
| 3692.5 | 2 | 300 | PM |
| 3692.53 | 1 | 170 | Y |
| 3692.566 | 1 | 170 | TH |
| 3692.64 | 2 | 180 | MO |
| 3692.65 | 2 | 7900 | ER |
| 3692.73 | 1 | 10000 | BK |
| 3692.76 | 1 | 300 | TC |
| 3692.95 | 2 | 300 | TB |
| 3693.49 | 1 | 40 | XE |
| 3693.53 | 3 | 250 | BR |
| 3693.58 | 1 | 450 | TB |
| 3693.67 | 1 | 280 | MN |
| 3693.7 | 2 | 330 | U |
| 3693.91 | 2 | 180 | IN |
| 3693.93 | 2 | 1 | GA |
| 3693.93 | 1 | 90 | NI |

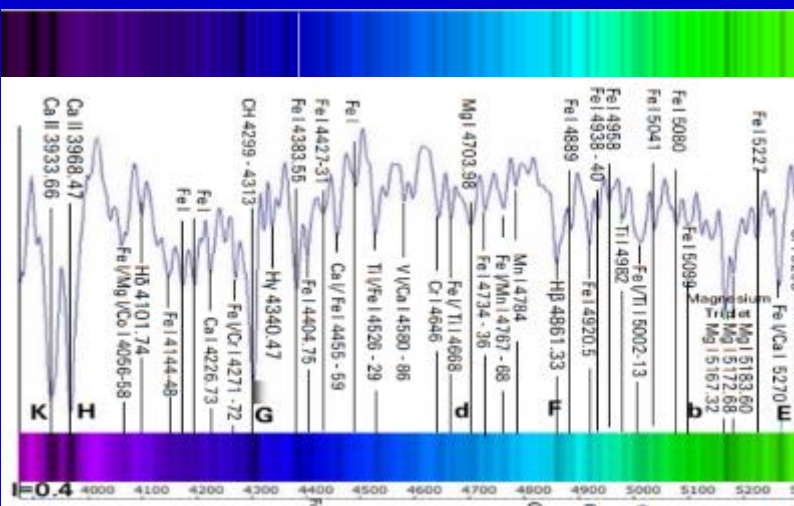
Right-side controls:

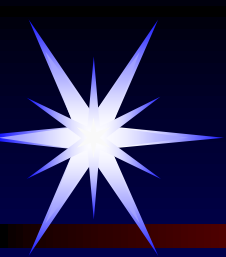
- Line:** dropdown menu with "element" selected.
- List:** "from" field (3690), "to" field (7742), and icons for search, download, and view.
- selection
- Eléments:** list of elements with checkboxes: FR, GA, GD, GE, H, HE, HF.
- Buttons: Sort, Export, Close.

Pollux spectral lines



| Lambda | Ion | Intensity | Element |
|----------|-----|-----------|---------|
| 5268.92 | 1 | 26 | CO |
| 5268.99 | 3 | 200 | CU |
| 5268.79 | 1 | 65 | GD |
| 5268.95 | 1 | 20 | MO |
| 5268.27 | 1 | 14 | RH |
| 5268.36 | 2 | 500 | I |
| 5268.48 | 2 | 120 | ND |
| 5268.537 | 1 | 1200 | FE |
| 5268.86 | 1 | 10000 | PU |
| 5268.92 | 1 | 50 | NB |
| 5268.991 | 2 | 100 | CU |
| 5270.27 | 1 | 25 | CA |
| 5270.29 | 2 | 64 | BE |
| 5270.3 | 2 | 40 | BI |
| 5270.357 | 1 | 600 | FE |
| 5270.51 | 2 | 200 | RB |
| 5270.64 | 2 | 500 | PM |
| 5270.81 | 2 | 500 | BE |
| 5270.95 | 1 | 1300 | RE |
| 5271 | 1 | 100 | LI |
| 5271.19 | 1 | 370 | LA |
| 5271.4 | 1 | 400 | SM |
| 5271.53 | 1 | 270 | NB |
| 5271.6 | 2 | 100 | CD |
| 5271.8 | 1 | 35 | MO |
| 5271.95 | 1 | 10000 | BK |
| 5271.96 | 1 | 390 | EU |
| 5271.99 | 3 | 13 | CA |
| 5272.01 | 1 | 35 | CR |
| 5272.25 | 2 | 50 | DY |
| 5272.37 | 3 | 9 | FE |
| 5272.48 | 1 | 110 | EU |
| 5272.48 | 1 | 25 | NB |
| 5272.69 | 2 | 300 | BR |
| 5272.91 | 1 | 60 | ER |
| 5272.91 | 1 | 55 | GD |
| 5272.98 | 3 | 14 | FE |
| 5273.43 | 2 | 590 | ND |
| 5273.44 | 1 | 30 | CR |
| 5274.04 | 2 | 400 | CS |
| 5274.23 | 2 | 340 | DE |



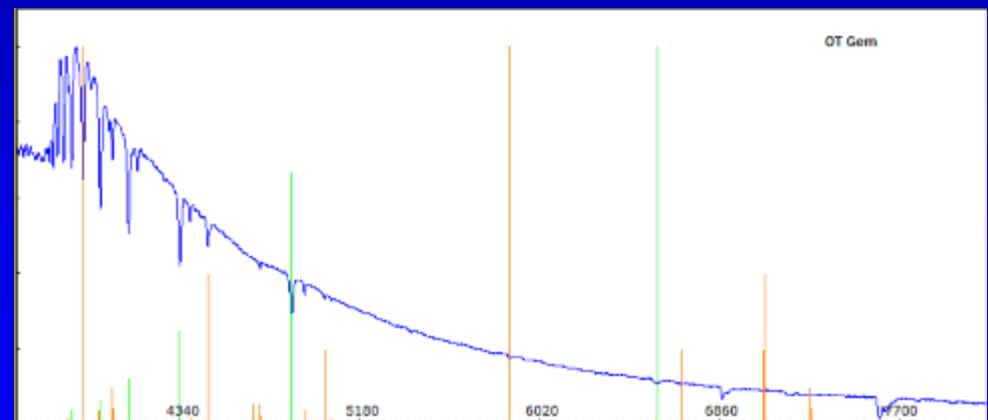
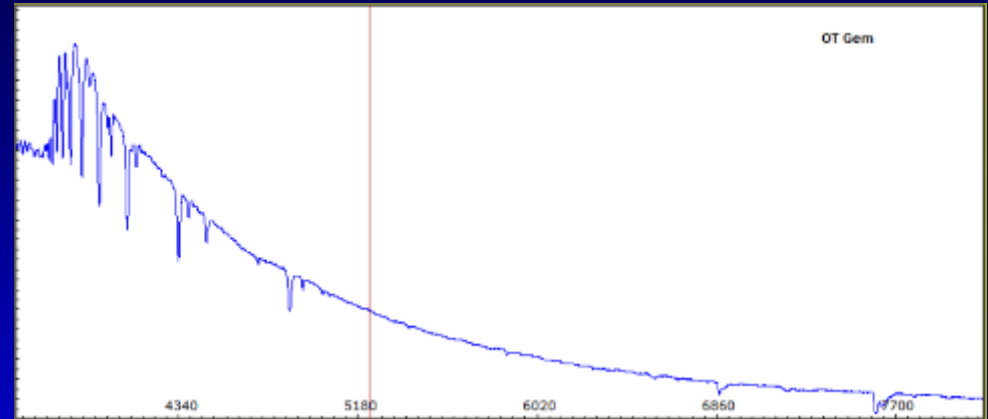


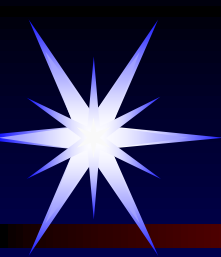
Mendeleev table

Click on the elements to overlay corresponding lines

Mendeleev table

| | | | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|
| H | | | | | | | | | | | | | | | | | He |
| Li | Be | | | | | | | | | | | B | C | N | O | F | Ne |
| Na | Mg | | | | | | | | | | | Al | Si | P | S | Cl | Ar |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe |
| Cs | Ba | ** | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn |
| Fr | Ra | ** | Rf | Db | Sg | Bh | Hs | Mt | Ds | Rg | Uub | Uut | Uuq | Uup | Uuh | Uus | Uuo |
| | | * | La | Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu |
| | | ** | Ac | Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |



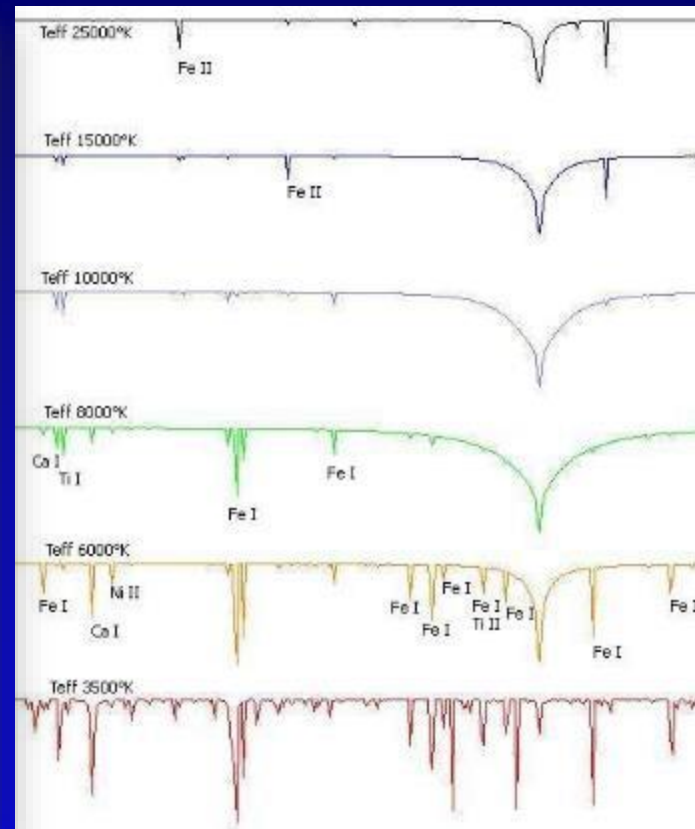
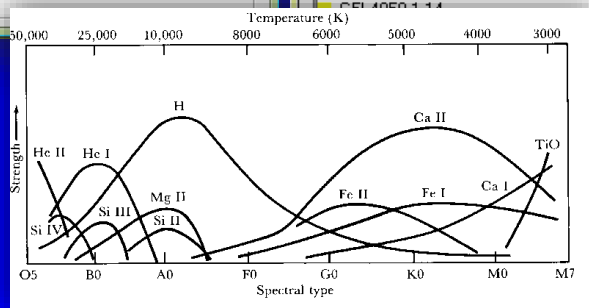
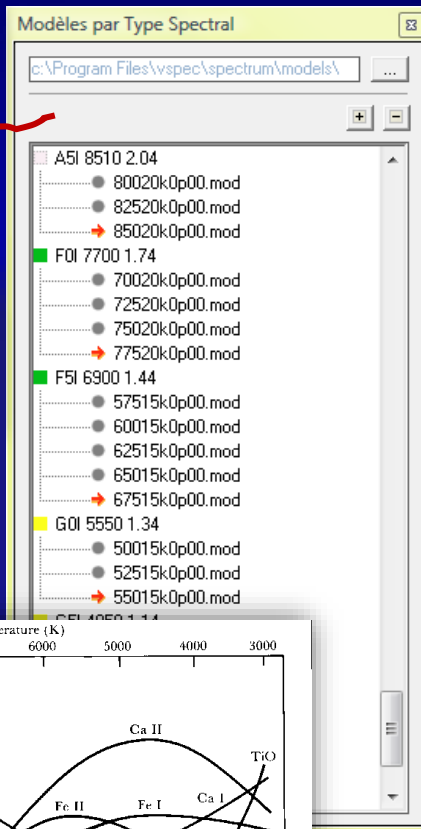
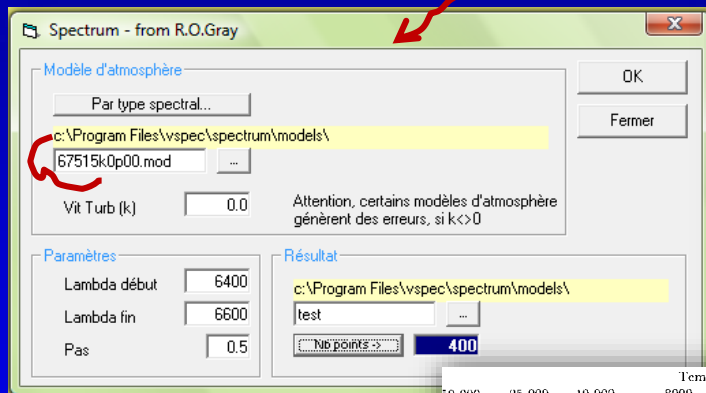


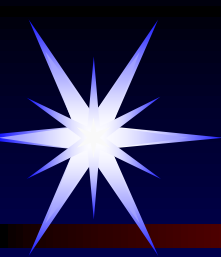
Spectrum Simulation

Star spectra simulation software from R.O.Gray

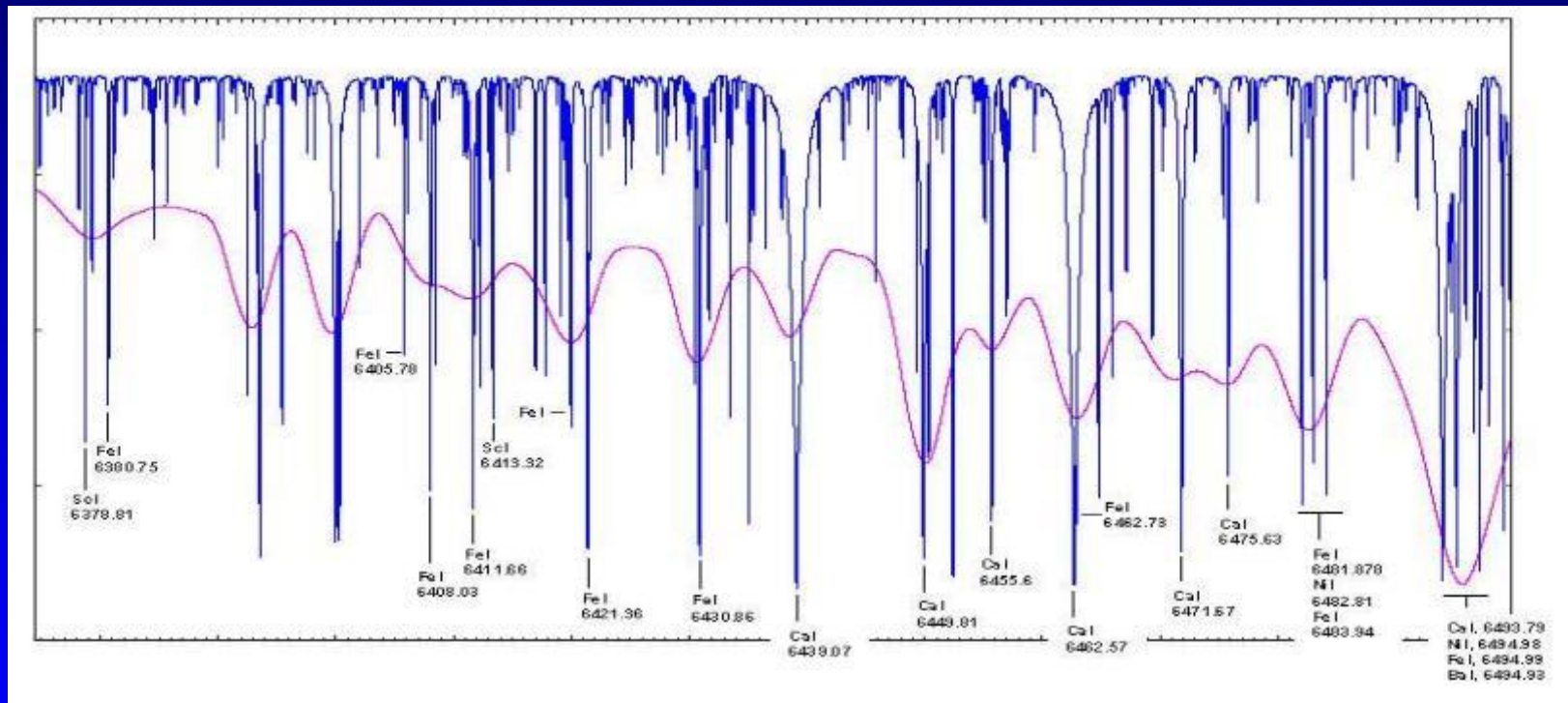
<http://www.appstate.edu/~grayro/spectrum/spectrum.html>

- Temperature
- Gravity
- Micro turbulence
- Metallicity

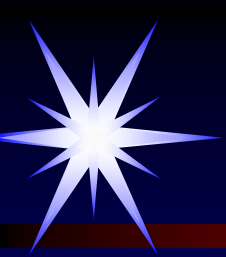




Be careful !

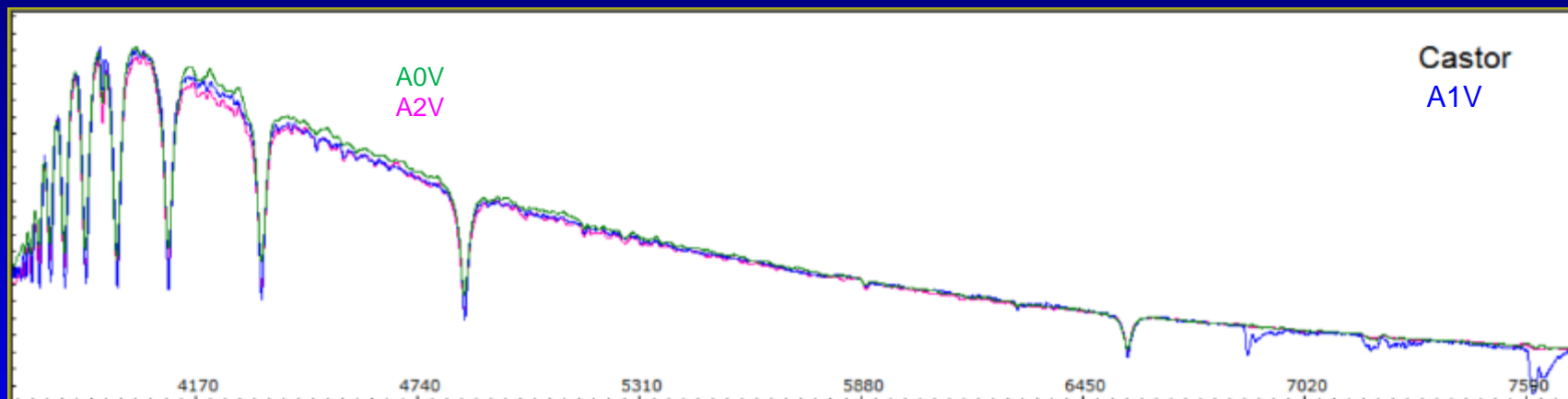


On some stars the identification can be almost impossible...

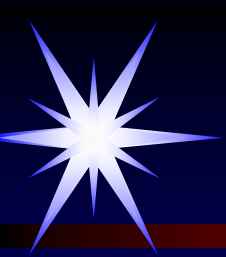


Planck temperature

Pickles Library to find the best spectral profile fit
CDS Simbad direct connection... Castor is A1V star

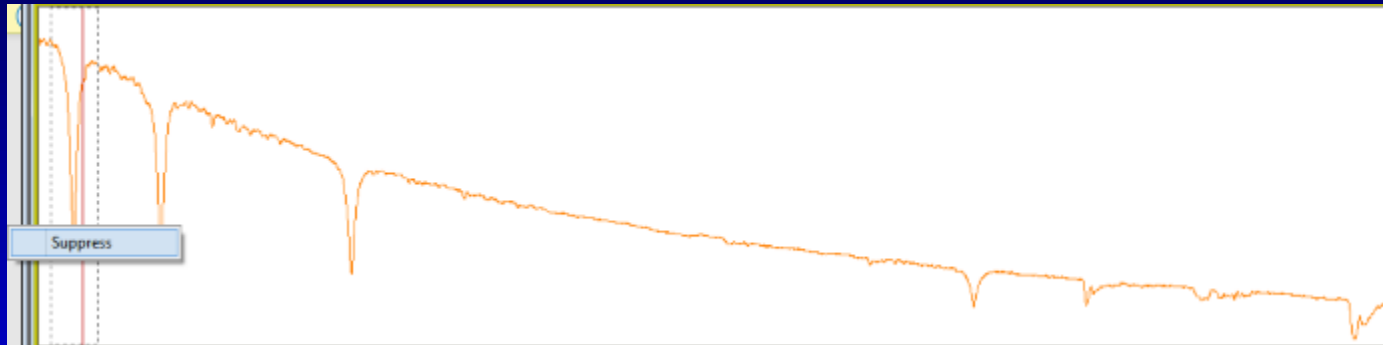


Or Extract the continuum and fit the best planck profile $f(\text{temp})$

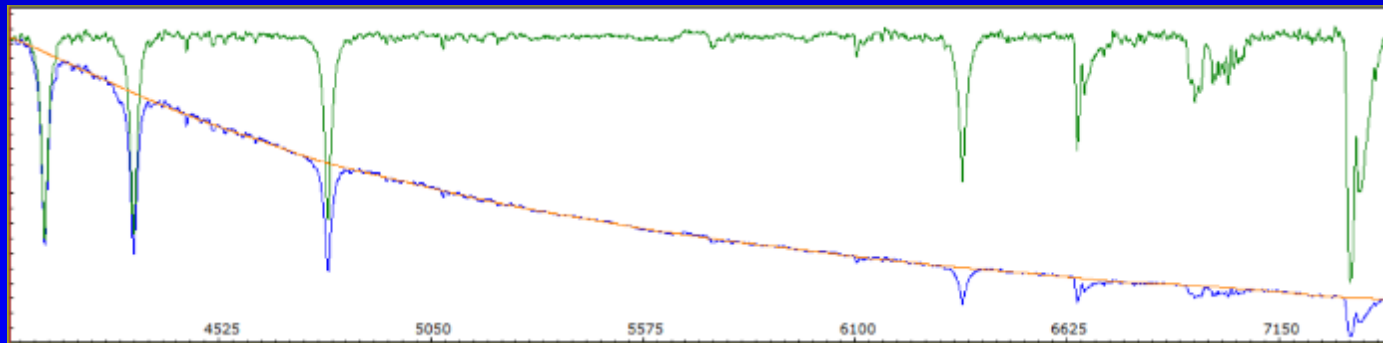


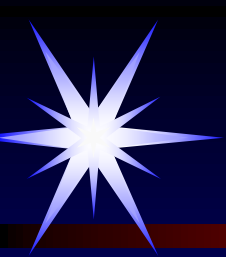
Continuum extraction

Radiometry > compute continuum



Spline filtering to fit the low frequencies

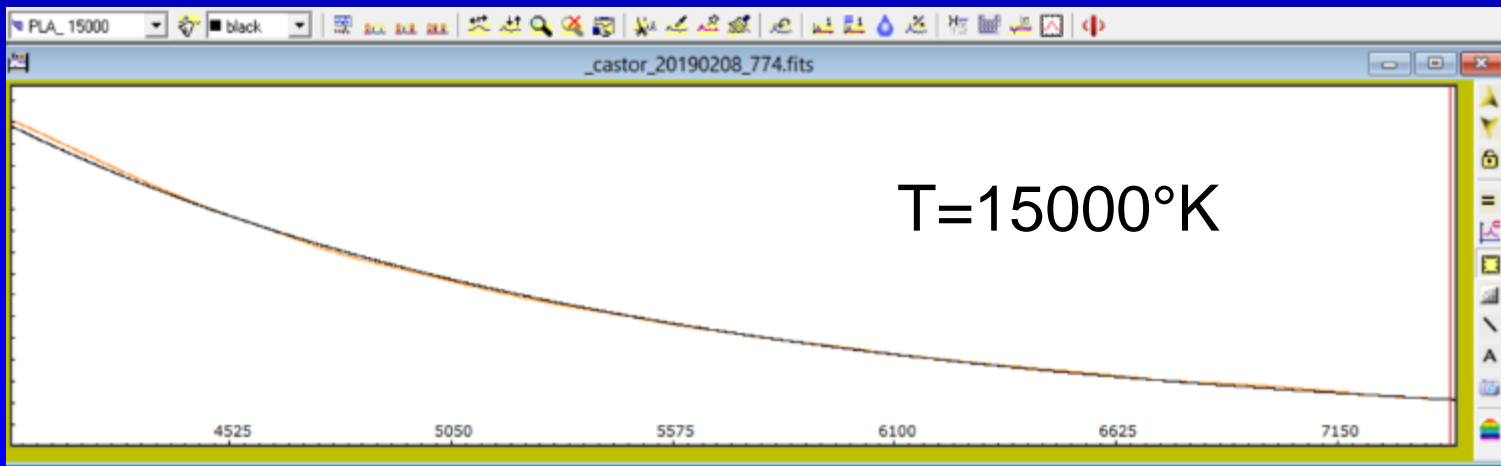
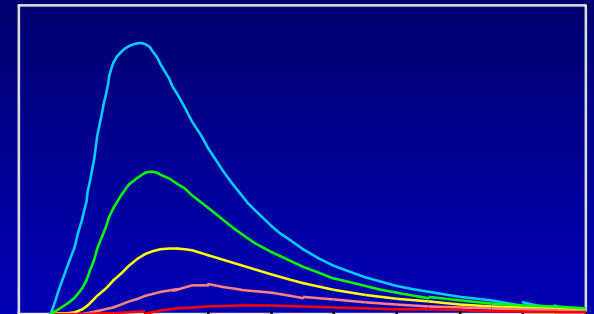
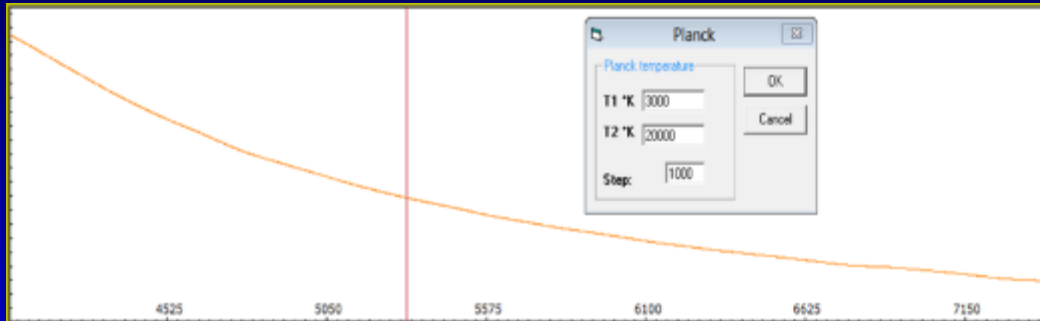


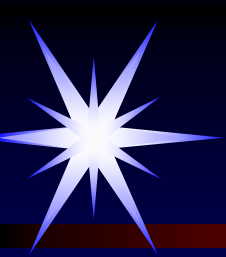


Planck profile fit

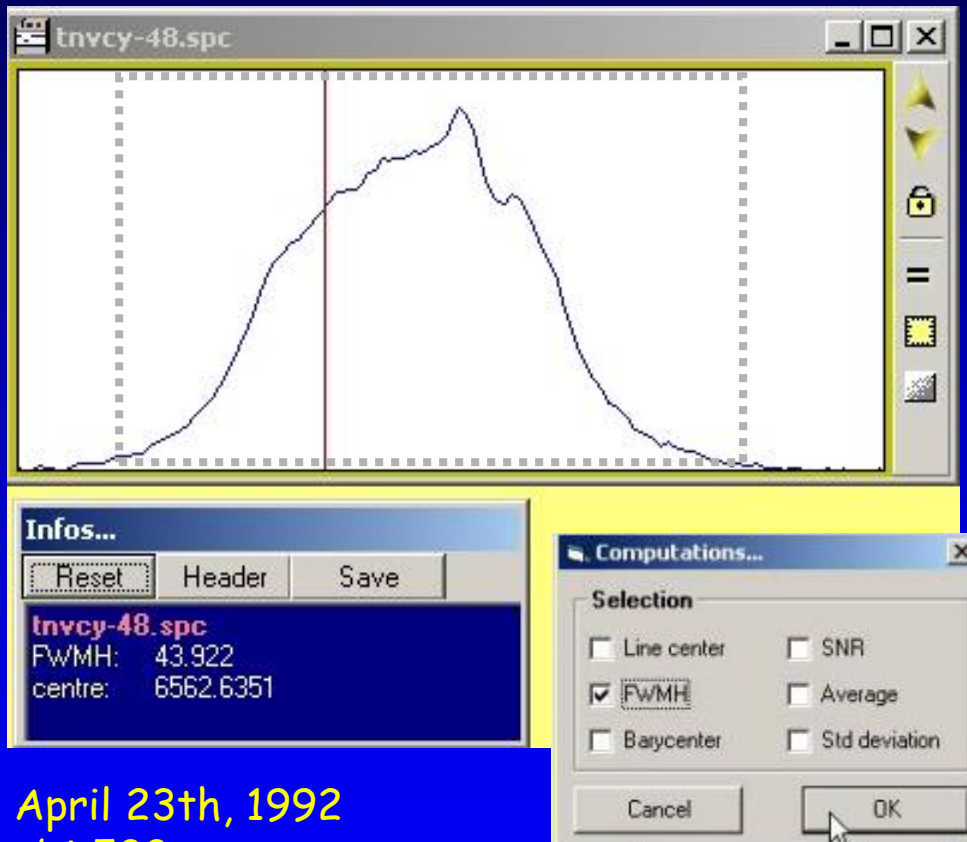


Radiometry > auto Planck





Nova Cygnii 1992



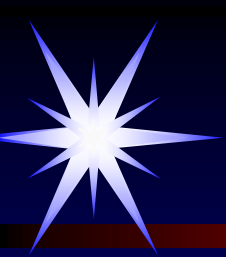
April 23th, 1992
 obj:500mm
 Réseau 600 tr/mm
 T60 pic du midi

$$\Delta V = \frac{\Delta \lambda}{\lambda} \cdot c$$

c= 300 000km/s
 lambda ref = 6562.63 angströms
 delta(lambda) = 44 angstroms

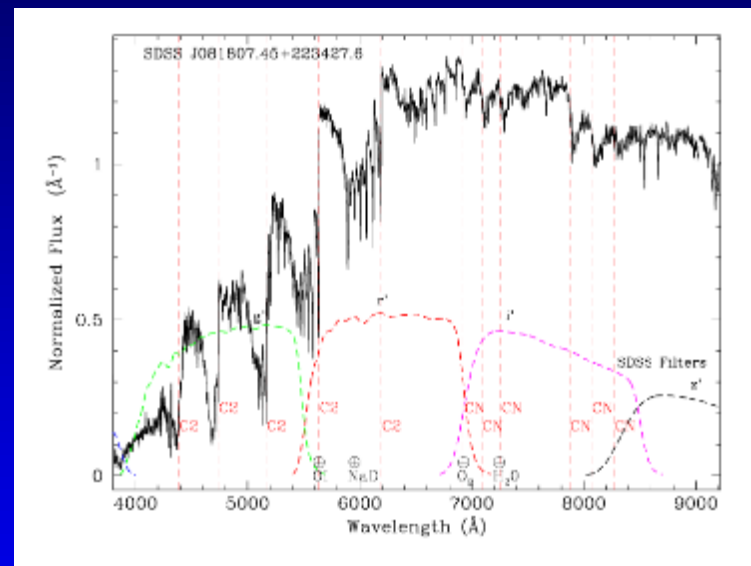
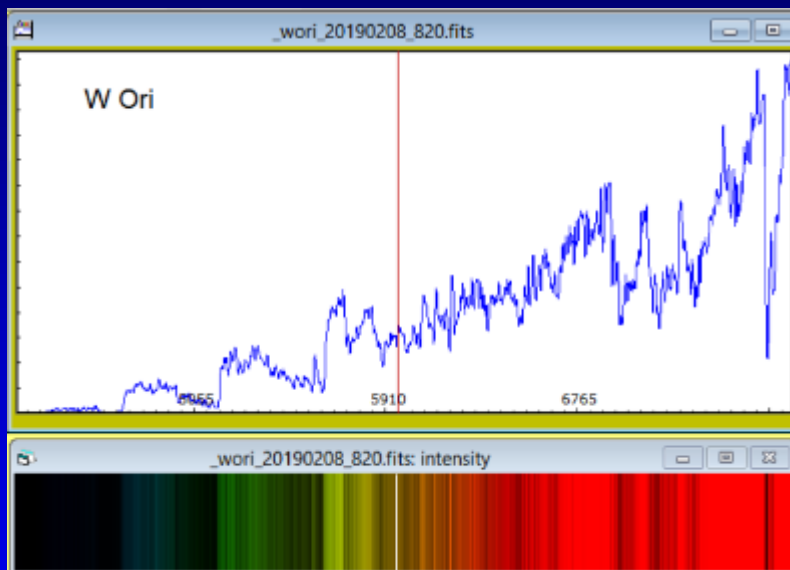
V=2008 km/s ± 100 km/s

UAI telegram
 expansion of 2050 km/s...



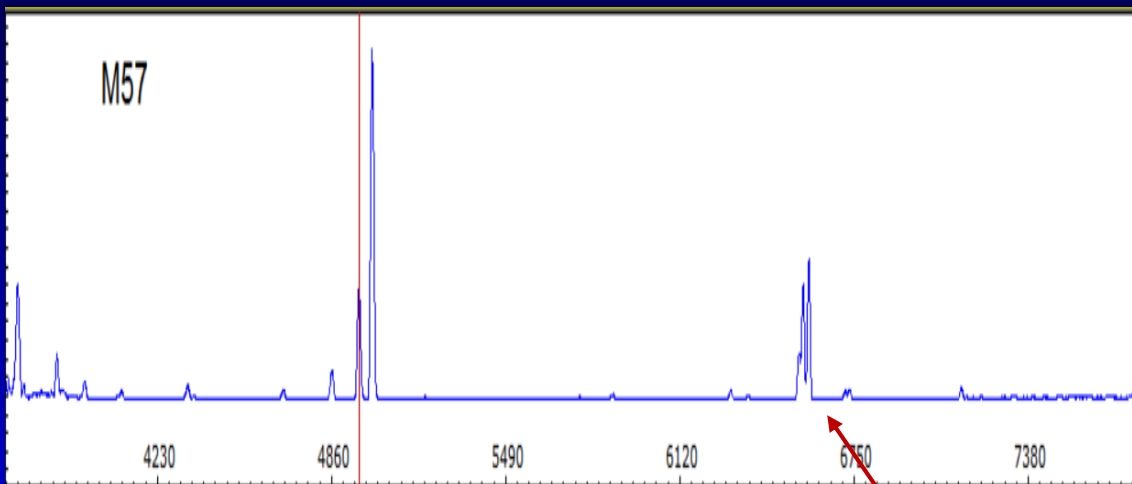
Carbon star

W Ori ... C-N5 B



These are red giants, near the end of their lives, in which there is an excess of carbon in the atmosphere.

Planetary nebulae



| Lambda | Ion | Intensity | Element |
|---------|-----|-----------|----------|
| 4541.59 | 2 | 30 | He II |
| 4640 | 3 | 120 | N III |
| 4685.68 | 2 | 30 | He II |
| 4711.34 | 4 | 50 | [Ar IV] |
| 4740.2 | 4 | 50 | [Ar IV] |
| 4861.33 | 1 | 80 | H I |
| 4958.92 | 3 | 50 | [O III] |
| 5006.85 | 3 | 50 | [O III] |
| 5199.2 | 1 | 50 | [N I] |
| 5411.52 | 2 | 5 | He II |
| 5517.7 | 3 | 50 | [Cl III] |
| 5577.4 | 1 | 50 | [O I] |
| 5754.57 | 2 | 50 | [N II] |

| Lambda | Ion | Intensity | Element |
|---------|-----|-----------|----------|
| 6300.32 | 1 | 50 | [O I] |
| 6312.1 | 3 | 50 | [S III] |
| 6363.81 | 1 | 50 | [O I] |
| 6548.06 | 2 | 50 | [N II] |
| 6562.82 | 1 | 120 | H I |
| 6583.39 | 2 | 50 | [N II] |
| 6678.15 | 1 | 100 | He I |
| 6716.5 | 2 | 50 | [S II] |
| 6730.7 | 2 | 50 | [S II] |
| 7005.7 | 5 | 50 | [Ar V] |
| 7065.3 | 1 | 30 | He I |
| 7135.8 | 3 | 50 | [Ar III] |
| 7319.92 | 2 | 50 | [O II] |

Elements

| Lambda | Ion | Intensity | Element |
|---------|-----|-----------|----------|
| 3835.39 | 1 | 5 | H I |
| 3868.76 | 3 | 50 | [Ne III] |
| 3889.05 | 1 | 6 | H I |
| 3967.47 | 3 | 50 | [Ne III] |
| 3970.07 | 1 | 8 | H I |
| 4068.6 | 2 | 50 | [S II] |
| 4101.74 | 1 | 15 | H I |
| 4340.47 | 1 | 30 | H I |
| 4363.21 | 3 | 50 | [O III] |
| 4471.48 | 1 | 25 | He I |
| 4541.59 | 2 | 30 | He II |
| 4640 | 3 | 120 | N III |
| 4685.68 | 2 | 30 | He II |
| 4711.34 | 4 | 50 | [Ar IV] |
| 4740.2 | 4 | 50 | [Ar IV] |
| 4861.33 | 1 | 80 | H I |
| 4958.92 | 3 | 50 | [O III] |
| 5006.85 | 3 | 50 | [O III] |
| 5199.2 | 1 | 50 | [N I] |
| 5411.52 | 2 | 5 | He II |
| 5517.7 | 3 | 50 | [Cl III] |
| 5577.4 | 1 | 50 | [O I] |
| 5754.57 | 2 | 50 | [N II] |
| 5875.65 | 1 | 500 | He I |
| 6300.32 | 1 | 50 | [O I] |
| 6312.1 | 3 | 50 | [S III] |
| 6363.81 | 1 | 50 | [O I] |
| 6548.06 | 2 | 50 | [N II] |
| 6562.82 | 1 | 120 | H I |
| 6583.39 | 2 | 50 | [N II] |

Line

element

element

lineident

sun

atmos

symb

nebplan

v/R

Hires3000

selection

Eléments

AC

AG

AL

AM

AR

AS

AU

Sort

Export

Close

Planetary neb assistant

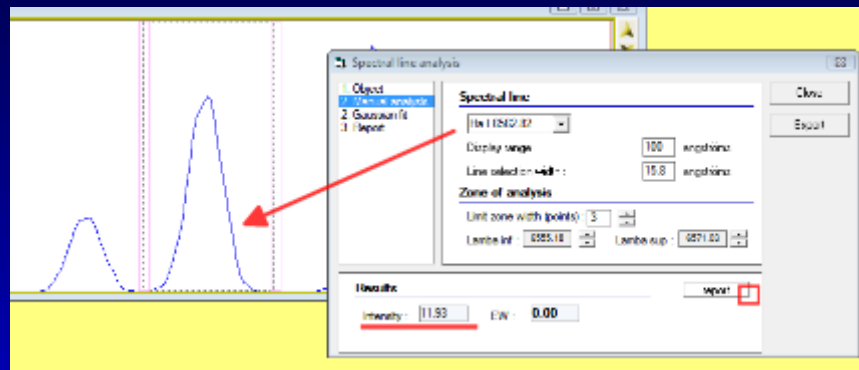
Spectral line analysis

1. Object
2. Manual analysis
2. Gaussian fit
3. Report

Object type

Plan. Nebulae
Symbiotic
Plan. Nebulae

Close
Export



Spectral line analysis

1. Object
2. Manual analysis
2. Gaussian fit
3. Report

Spectral line

Hg I 4340.47
[O III] 4363.21
He II 4685.68
Hb I 4861.33
[O III] 4958.92
[O III] 5006.85
[N II] 5754.57
He I 5875.65

100 angstroms
19.8 angstroms

Zone of analysis
Limit zone with points: 3
Lamba sup: 4373.452

Close
Export

Spectral line analysis

1. Object
2. Manual analysis
2. Gaussian fit
3. Report

Results

Intensity:

Close
Export

| Line | Im | Im (Vs Hb) | Ic |
|----------------------|-------|------------|---------|
| He II 4685.68 | | | |
| Hb I 4861.33 | 4.35 | 100. | 100.0 |
| [O III] 4958.92 | 17.4 | 400. | 400.86 |
| [O III] 5006.85 | 51.57 | 1185.52 | 1189.35 |
| [N II] 5754.57 | 0.25 | 5.75 | 5.86 |
| He I 5875.65 | | | |
| [N II] 6548.06 | 4.43 | 101.84 | 105.09 |
| H α I 6562.82 | 11.92 | 274.02 | 282.84 |
| [N II] 6583.39 | 14.66 | 337.01 | 347.96 |

Results

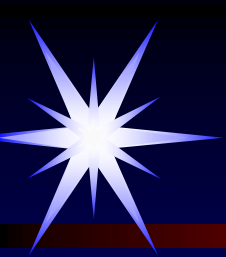
$c(Hb) = -0.042$ - $E(B-V) = -0.029$
 $T[OIII] = 11064^{\circ}K$ - $T[NII] = 11160^{\circ}K$ - $Ne (cm-3) = 358$

T* OIII
T* NII
Ne

_messier27_20120814_967.fit

Messier 27
2012-08-14T23:12:33
cbuil
OHP
FSQ85 LISA ATIK460EX

| Line | Imes | Io | Ic |
|----------------------|--------|---------|---------|
| Hg I 4340.47 | | | |
| [O III] 4363.2: | 0.39 | 9.09 | 8.97 |
| He II 4685.68 | 1.69 | 39.39 | 39.2 |
| Hb I 4861.33 | 4.29 | 100 | 99.99 |
| [O III] 4958.9: | 17.9 | 417.25 | 418.29 |
| [O III] 5006.8: | 53.49 | 1246.85 | 1251.49 |
| [N II] 5754.57 | 0.35 | 8.16 | 8.33 |
| He I 5875.65 | 0.43 | 10.02 | 10.26 |
| [N II] 6548.06 | 4.41 | 102.8 | 106.59 |
| H α I 6562.82 | 11.7 | 272.73 | 282.86 |
| [N II] 6583.39 | 14.32 | 333.8 | 346.32 |
| [S II] 6716.5 | 1.07 | 24.94 | 25.93 |
| [S II] 6730.7 | 0.89 | 20.75 | 21.58 |
| c(Hb) | -0.048 | | |
| E(B-V) | -0.033 | | |
| T[OIII]K | 10586 | | |
| T[NII] K | 13241 | | |
| Ne(cm-3) | 340 | | |

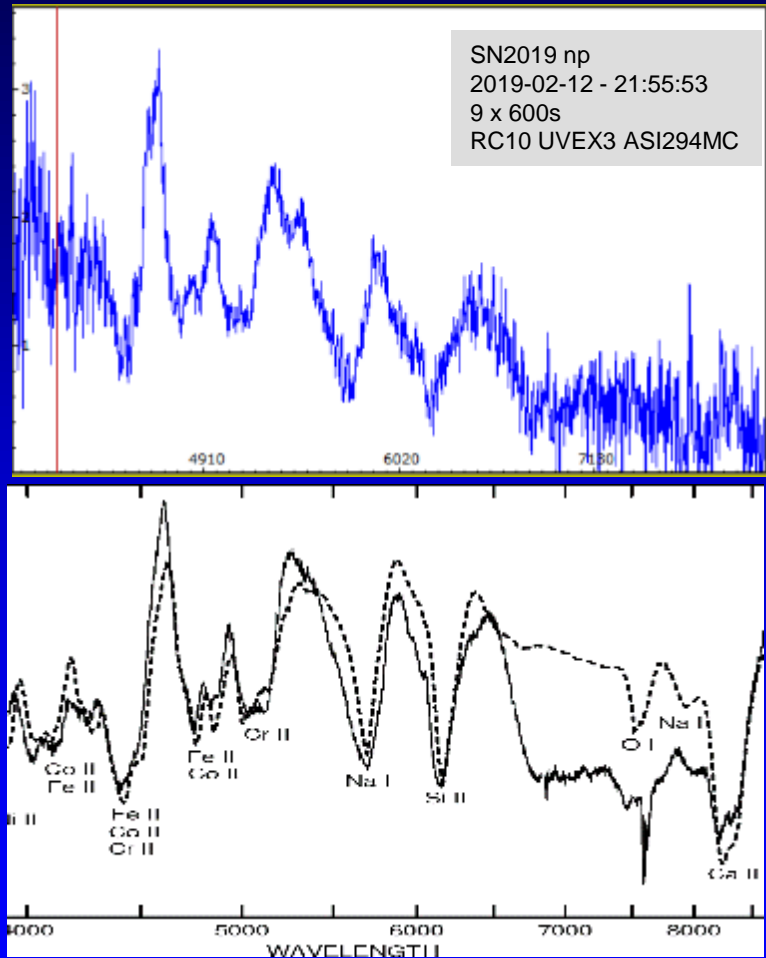


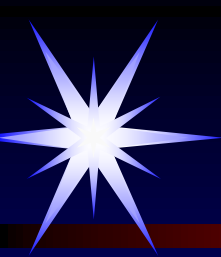
Supernova



Koichi Itagaki (Japan)
Type Ia ($z=0.00452$)
Discovered 2019/01/09.665

White dwarf which accretes enough mass to exceed the Chandrasekhar limit and collapses into a neutron star

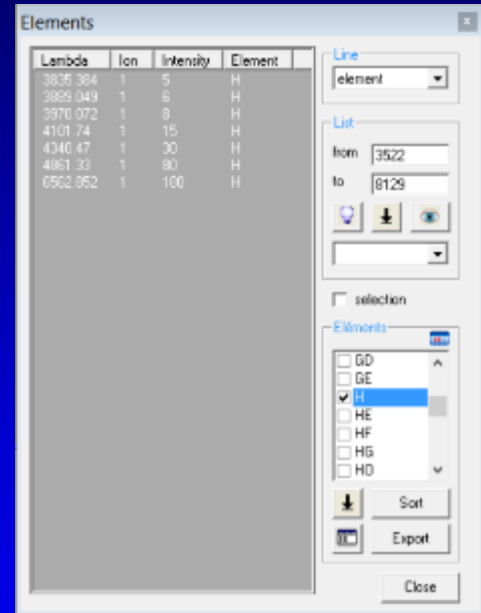
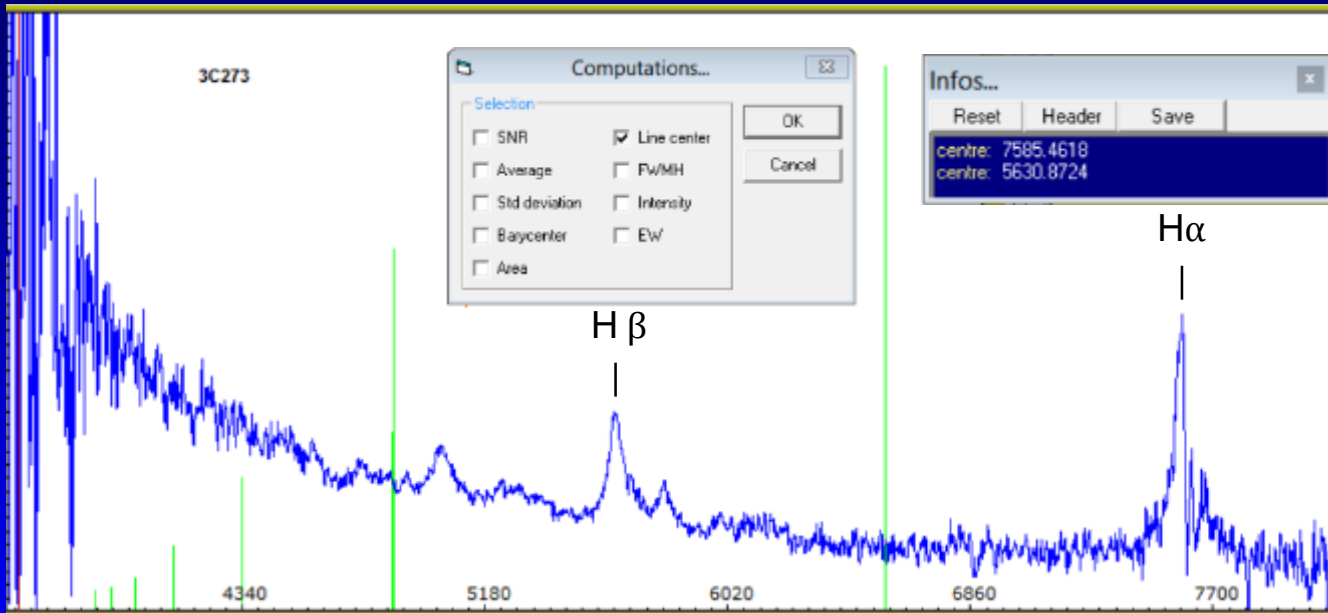




Quasar



- Z redshift : $(\lambda_1 - \lambda_0) / \lambda_0$



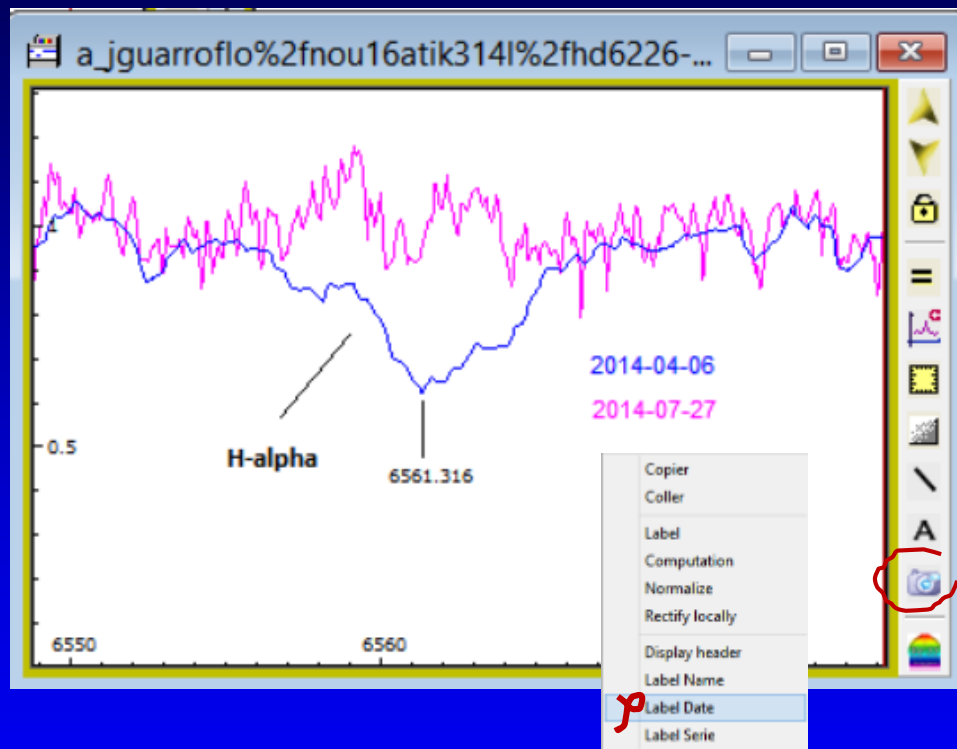
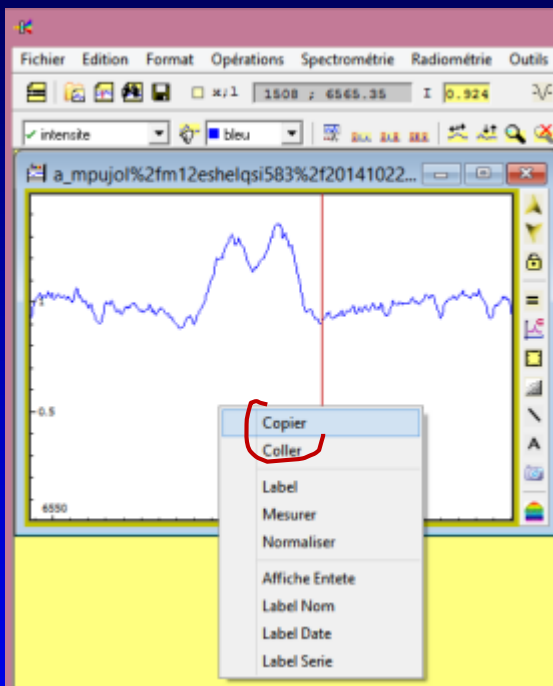
Halpha... $(7585 - 6562) / 6562 = 0.156$

Hbeta... $(5630 - 4861) / 4861 = 0.158$

Z=0.157 ± 0.01

Radial velocity / Redshift / cz : V(km/s) 43751 [20] / z(~) 0.158339 [0.000067] / cz 47468.84 [20.09]
C 1992ApJS...83...29S

Comparison

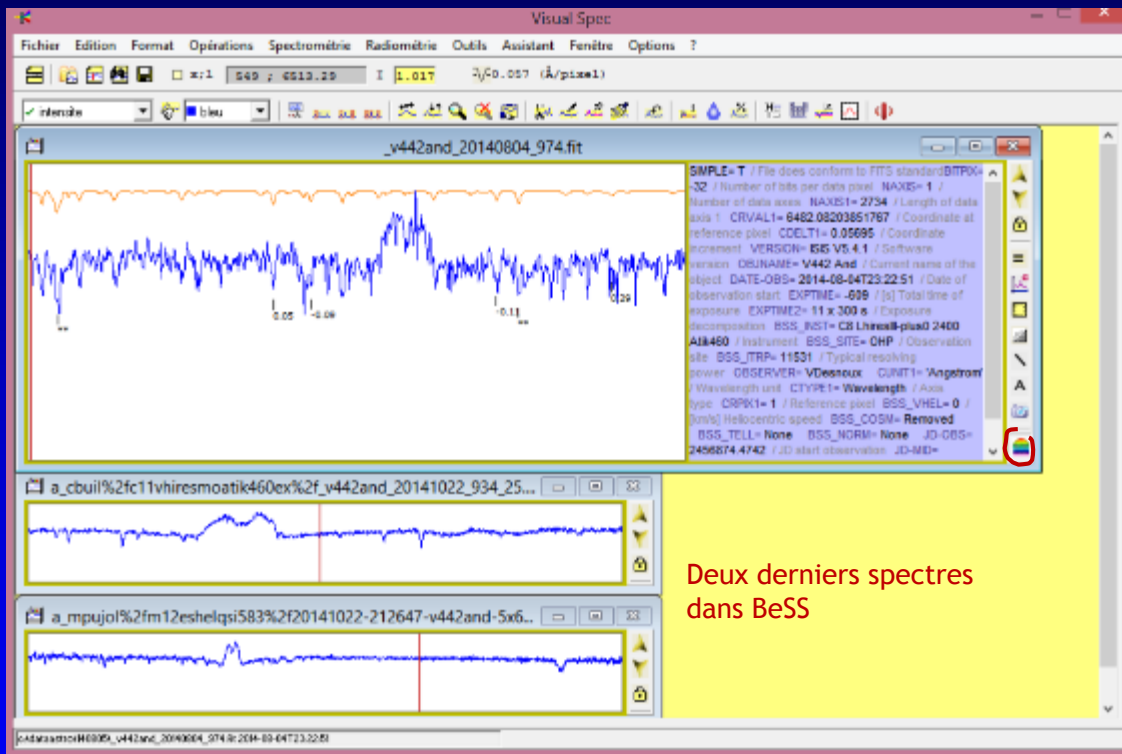


As easy as a cut & paste...

Scale the spectra on a common region of the continuum

Additional tool for date labeling and png export

Be verification

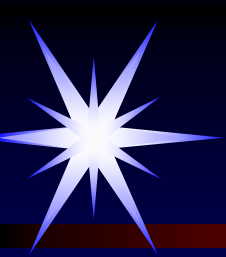


Automatic adaption to the resolution and central wavelength



Magic button

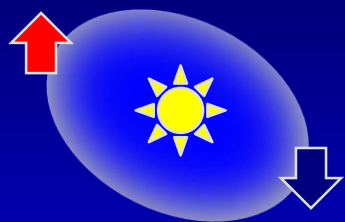
- Display the last two spectra from BeSS database
- Detect telluric lines and display shift versus theoretical position
- Display Fits header



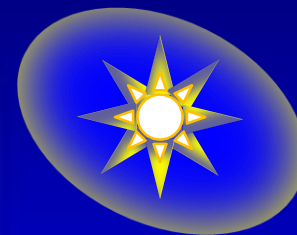
H-alpha gold mine



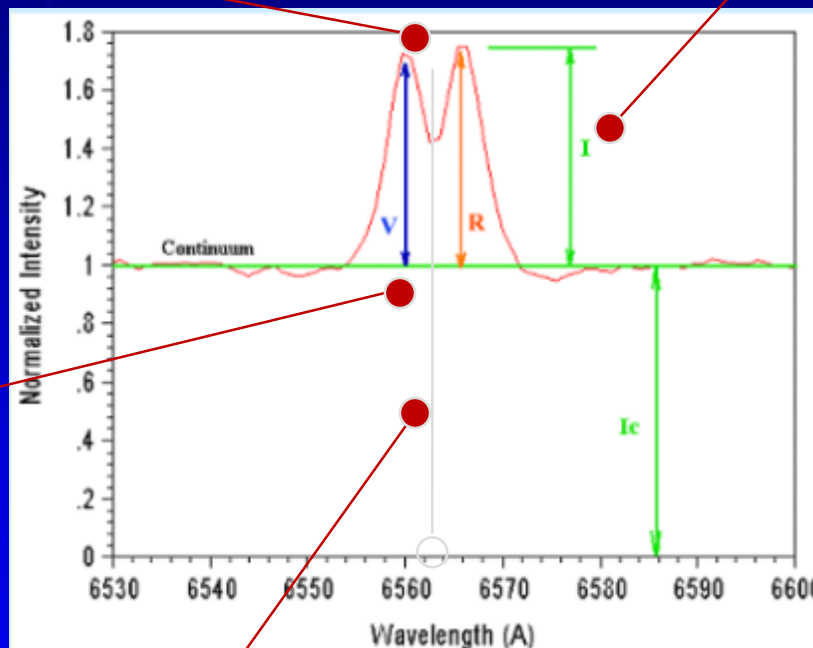
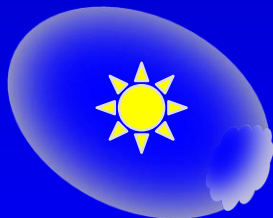
Peak separation V/R
Disk radius



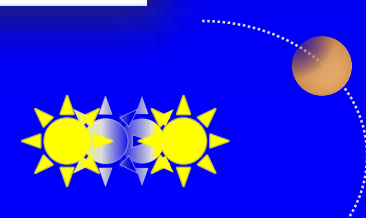
Emission, Intensity
Matter ejection

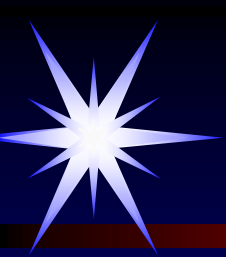


Asymmetry V/R
Disk density

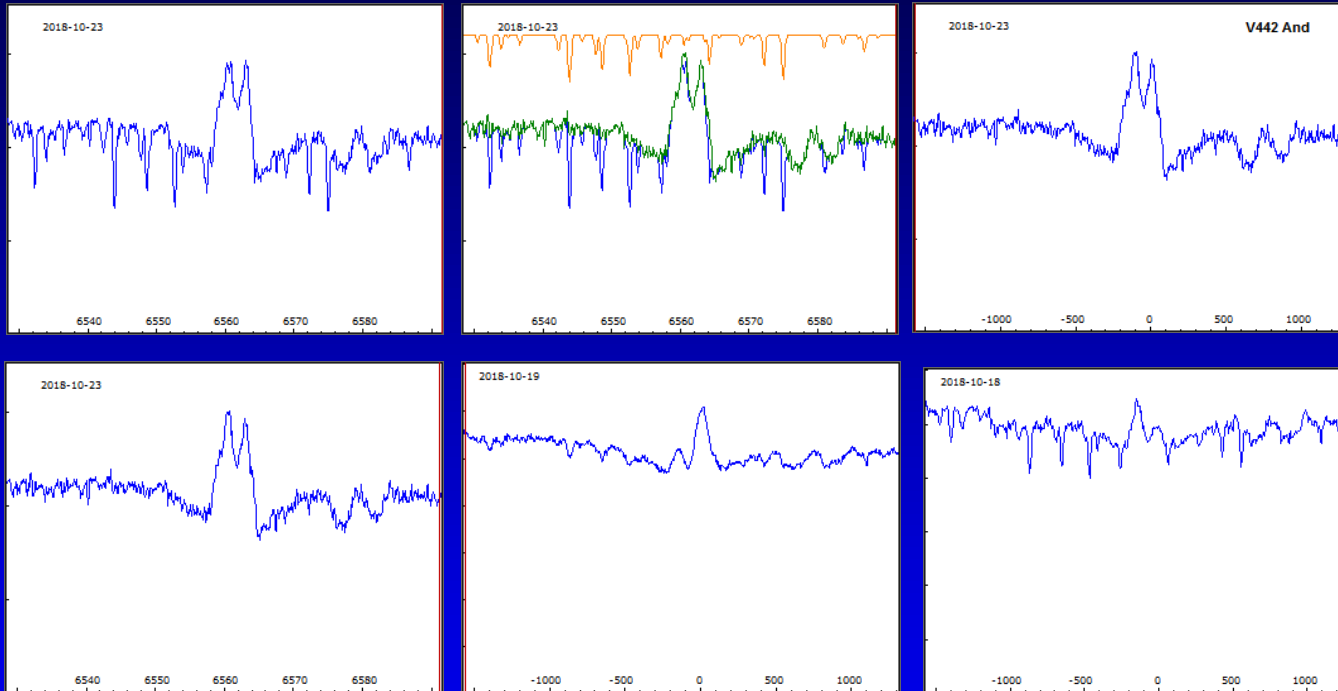


Spectral shift
Radiale velocity – « motion » of the star



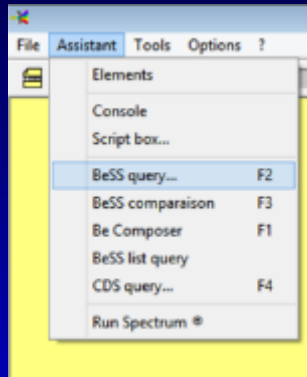


Measurement on V442 And



| | | | |
|-----------|----------------------------|----------------------------|----------------------------|
| | 2018-10-23 18:11:23.170 | 2018-10-19 19:13:25.913 | 2018-10-18 19:26:20.115 |
| Ecart V-R | 118 km s ⁻¹ | 164 kms ⁻¹ | 133 kms ⁻¹ |
| Ratio V/R | 0.83 | 0.65 | 1.1 |

Connection to BeSS



BeSS Query

Object: HD 6226 HD 6226 No check Simbad

Period: From: 2017-10-28 From 1 year To: 2018-10-28 Today (format ex: 2007-02-28)

Wavelength: Contains: 6563 H-Alpha (Angströms) Only HR

Query

All None Year Month Jour

BeSS Spectral Service at ObsPM found 217 spectra SSAP

| Fichiers | Date | Lamb |
|---|-----------------------|---------|
| <input checked="" type="checkbox"/> A_othizy%2Feshelatik460%2F_v442and_20181025_757_34.fits | 2018-10-25 20:12:08 | 6507.5 |
| <input checked="" type="checkbox"/> A_othizy%2Feshelatik460%2F_v442and_20181024_868_34.fits | 2018-10-24 22:10:3... | 6507.5 |
| <input checked="" type="checkbox"/> A_fhouper%2Fc11hiresii1942400i35qs516s%2Fbess_HD6226_2018102... | 2018-10-23 19:11:4... | 6520.5 |
| <input checked="" type="checkbox"/> A_jguarroflo%2F16remotinx460ex%2F_v442and_20181021_886_34.fits | 2018-10-21 23:11:14 | 6397.5 |
| <input checked="" type="checkbox"/> A_othizy%2Feshelatik460%2F_v442and_20181021_871_34.fits | 2018-10-21 22:36:22 | 6507.5 |
| <input checked="" type="checkbox"/> A_ckreider%2Fcdk17hires460ex%2F_v442and_20181021_754_ChK.fits | 2018-10-21 21:37:3... | 6490.5 |
| <input checked="" type="checkbox"/> A_fhouper%2Fc11hiresii1942400i35qs516s%2Fbess_HD6226_2018102... | 2018-10-20 21:28:4... | 6520.98 |
| <input checked="" type="checkbox"/> A_scharbonnel%2Ft500f5ap3600ec2eshel112atik460ex%2F_v442and_20... | 2018-10-19 23:57:31 | 6487.5 |
| <input checked="" type="checkbox"/> A_othizy%2Feshelatik460%2F_v442and_20181019_837_34.fits | 2018-10-19 22:07:0... | 6507.5 |
| <input checked="" type="checkbox"/> A_fhouper%2Fc11hiresii1942400i35qs516s%2Fbess_HD6226_2018101... | 2018-10-19 20:13:5... | 6521.78 |
| <input checked="" type="checkbox"/> A_scharbonnel%2Ft500f5ap3600ec2eshel112atik460ex%2F_v442and_20... | 2018-10-19 00:33:16 | 6487.5 |
| <input checked="" type="checkbox"/> A_fhouper%2Fc11hiresii1942400i35qs516s%2Fbess_HD6226_2018101... | 2018-10-18 20:26:4... | 6521.46 |
| <input checked="" type="checkbox"/> A_scharbonnel%2Ft500f5ap3600ec2eshel112atik460ex%2F_v442and_20... | 2018-10-18 02:33:1... | 6487.5 |
| <input checked="" type="checkbox"/> A_othizy%2Feshelatik460%2F_v442and_20181017_773_34.fits | 2018-10-17 19:54:22 | 6507.5 |
| <input checked="" type="checkbox"/> A_dil%2Fc11hires324002xbinqhying2pro%2F_hd6226_20181017_532_Do... | 2018-10-17 18:24:3... | 6501.66 |
| <input checked="" type="checkbox"/> A_fhouper%2Fc11hiresii1942400i35qs516s%2Fbess_HD6226_2018101... | 2018-10-16 22:21:5... | 6519.84 |
| <input checked="" type="checkbox"/> A_ckreider%2Fcdk17hires460ex%2F_v442and_20181016_807_ChK.fits | 2018-10-16 21:43:52 | 6492.86 |
| <input checked="" type="checkbox"/> A_ebryssinck%2Fc11hires2400triusx814%2Fbess_V442And-20181016... | 2018-10-16 19:36:4... | 6532.49 |

BeSS database
Virtual Observatory

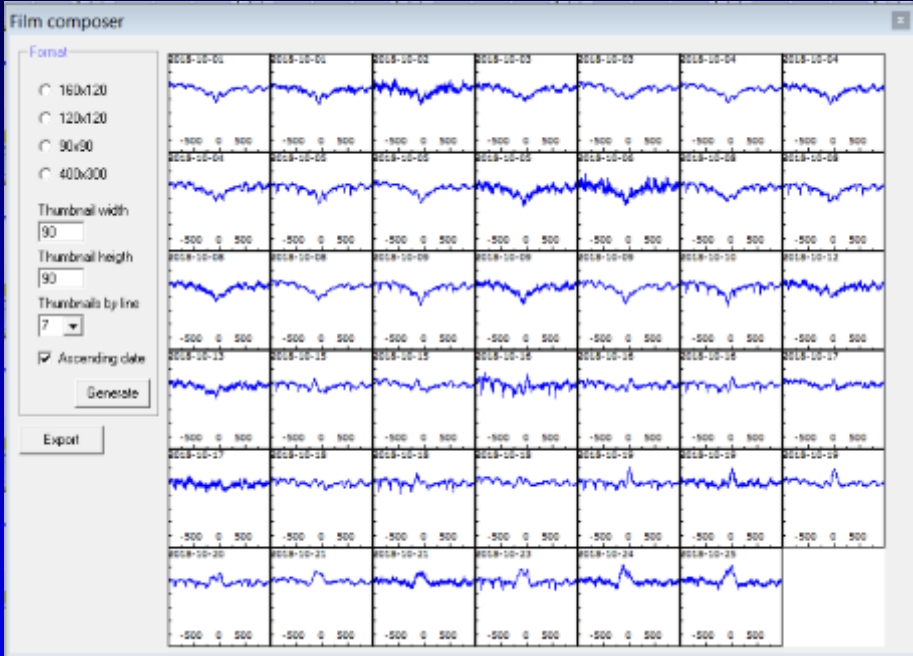
- Time period
- Central wavelength
- Resolution

Time serie

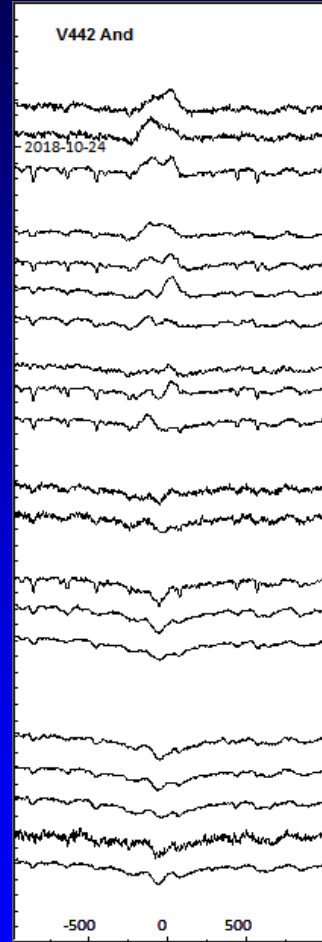


V442 And... from 1st to 26th octobre 2018

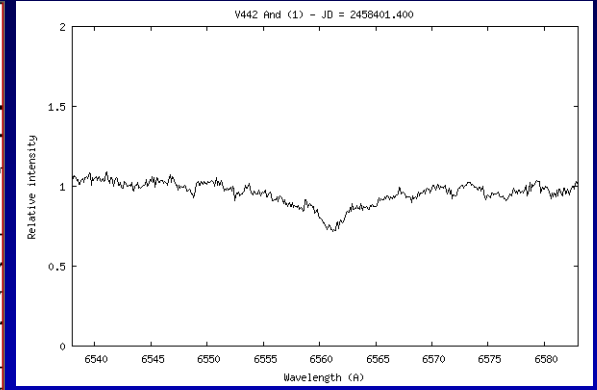
Data presentation



Vspec: Film composer

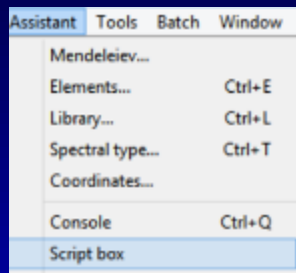


Vspec: Stack & Shift

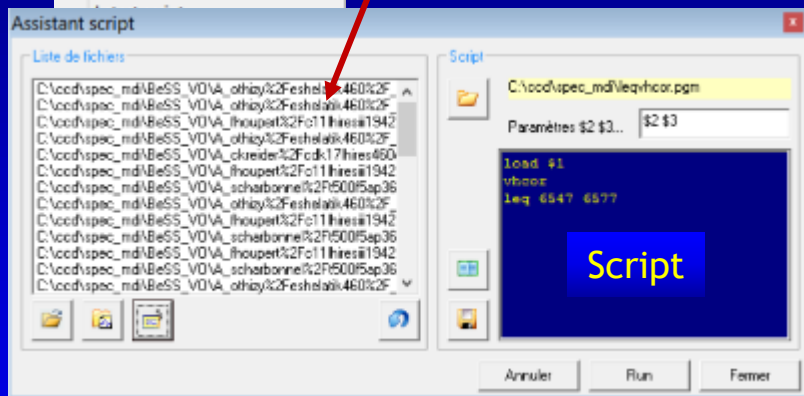


ISIS: Animation

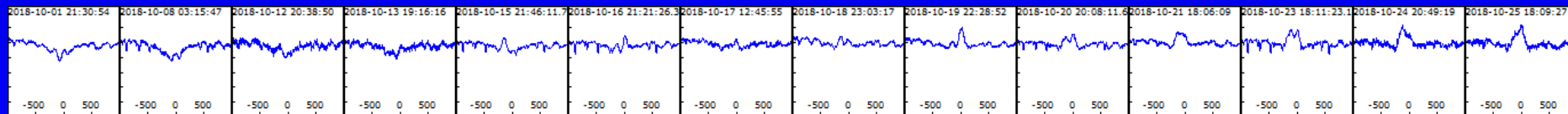
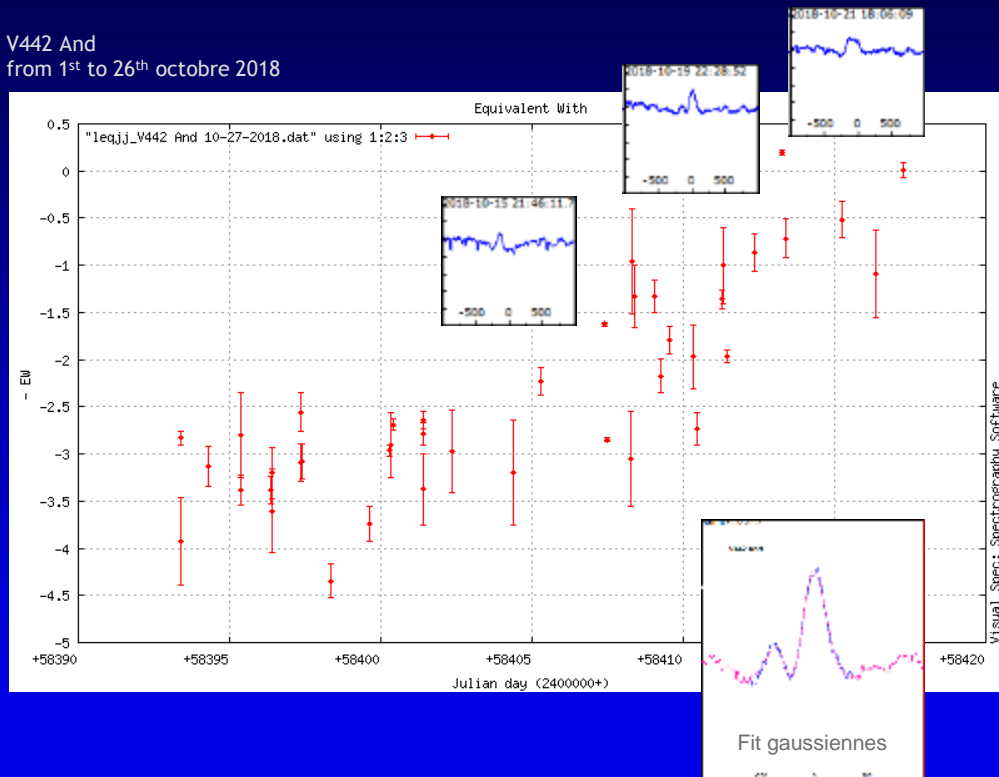
The script box

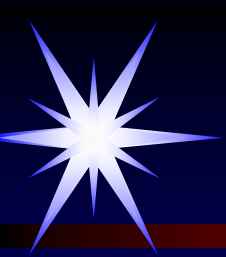


Automatic fill with the files currently opened in Vspec



V442 And from 1st to 26th octobre 2018





Measurements



| Batch | Window | Options |
|-------|--------------|---------|
| | Mean profile | |
| | EW... | |
| | Max Halpha | |

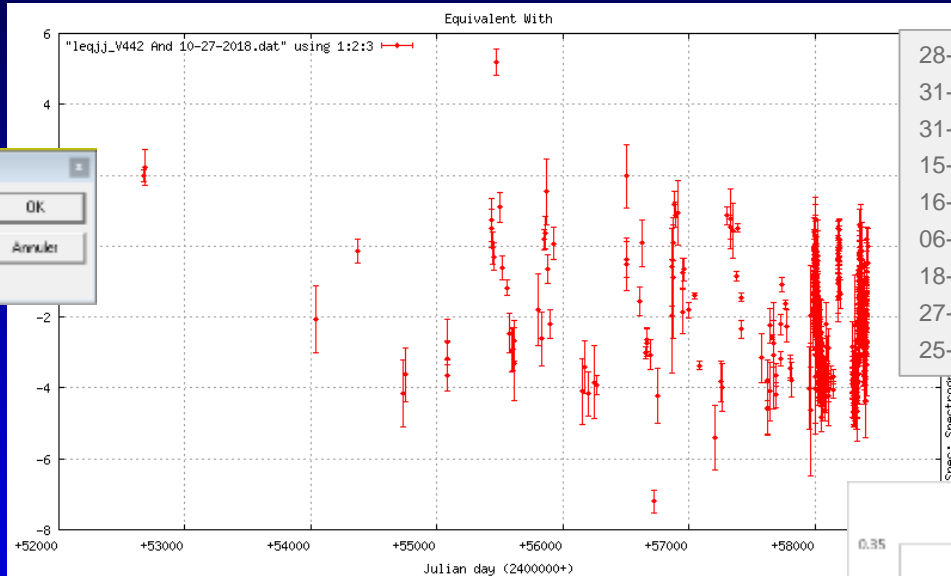
EW range

Continuum1: 6540 en angstrom

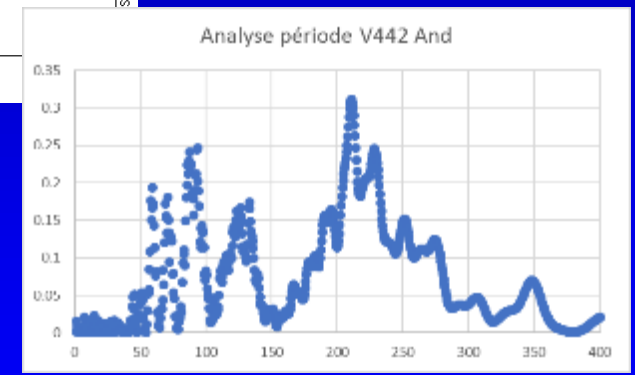
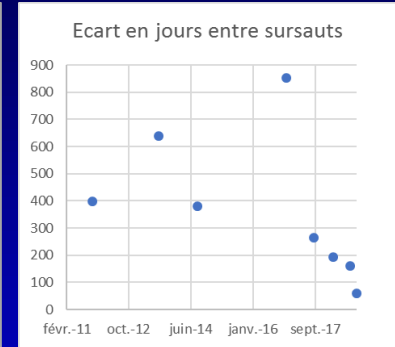
Continuum2: 6585 en angstrom

OK

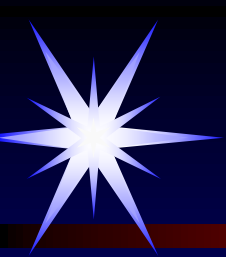
Anuler



- 28-09-2010
- 31-10-2011
- 31-07-2013
- 15-08-2014
- 16-12-2016
- 06-09-2017
- 18-03-2018
- 27-08-2018
- 25-10-2018

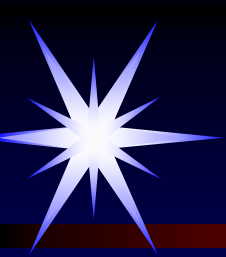


V442 And... multiple cycle of outburst...
 Equivalent Width
 Period analysis with ISIS



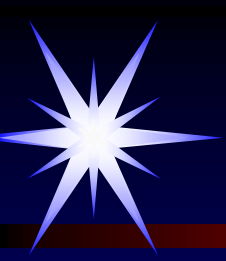
Spectro... in Provence





Spectro in Paris





Spectrographie



Imagination at Work®