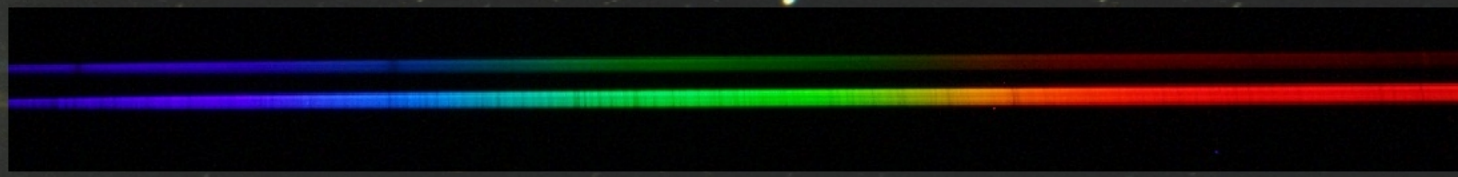
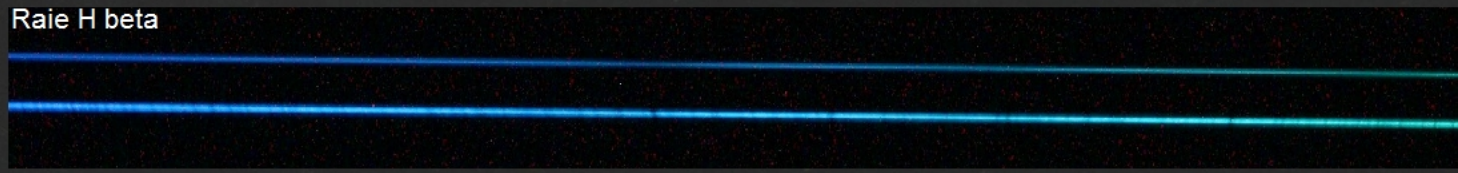
An amateur spectrometric

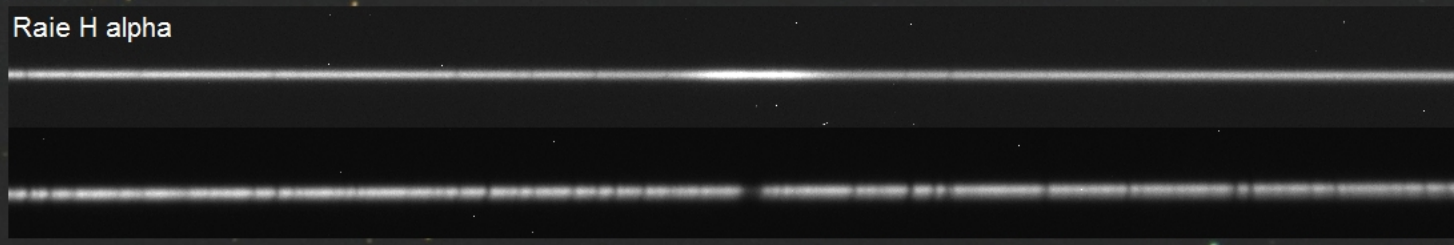
David ANTAO



RAAGSO : T250-LhiresIII 300tr/mm - Ambeyrac - 24 sept 2011



T250-LhiresIII 2400tr/mm - Fayssac - 02 oct 2011



RAAGSO : T250-LhiresIII 2400tr/mm - Ambeyrac - 15 sept 2012

Photo et spectres de David Antao

I - Why a closer look to Albireo ?

II - Raw spectrum « pics »

III - Spectrum processing

IV - Funny little mathematics !

V - Conclusion

I - Why a closer look to Albireo ?

Every amateur astronomers know that Albireo is one of the most beautiful double star in the sky. It stands in the constellation of Swan clearly visible through all the summer sky.

Both companions are very different, one is yellow while the other one is blue.

Moreover, Albireo is a true double star, physically linked.

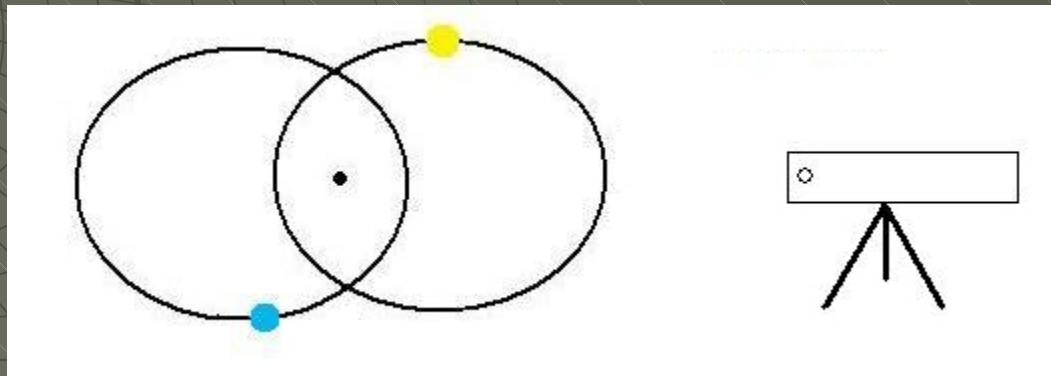
So this is also a good challenge to define which companion moves forward us and which one goes away.

It is also a good way to measure accuracy in resolution of the spectoscope Lhires III.

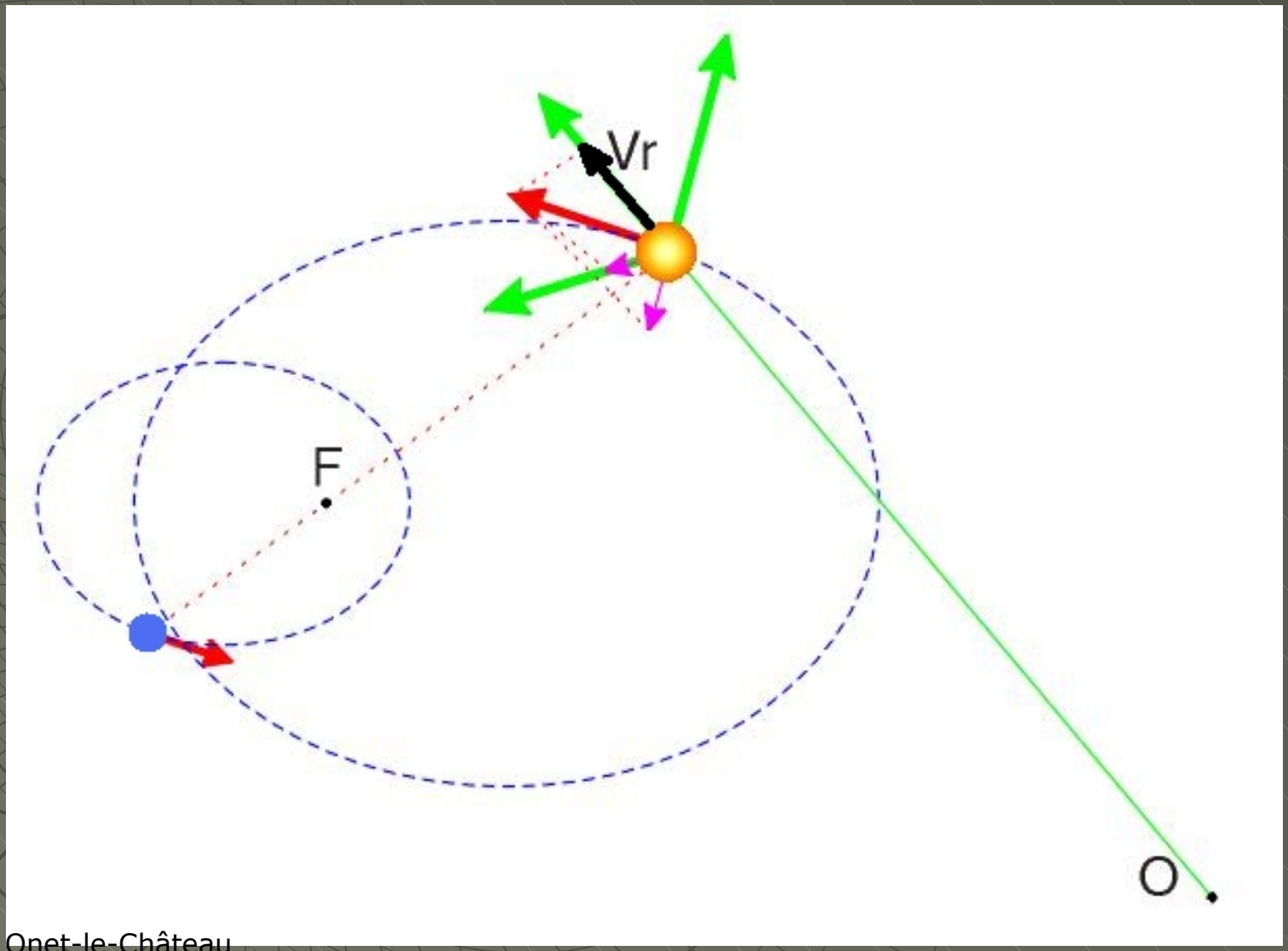
Albiréo, double star

<u>Goals :</u>

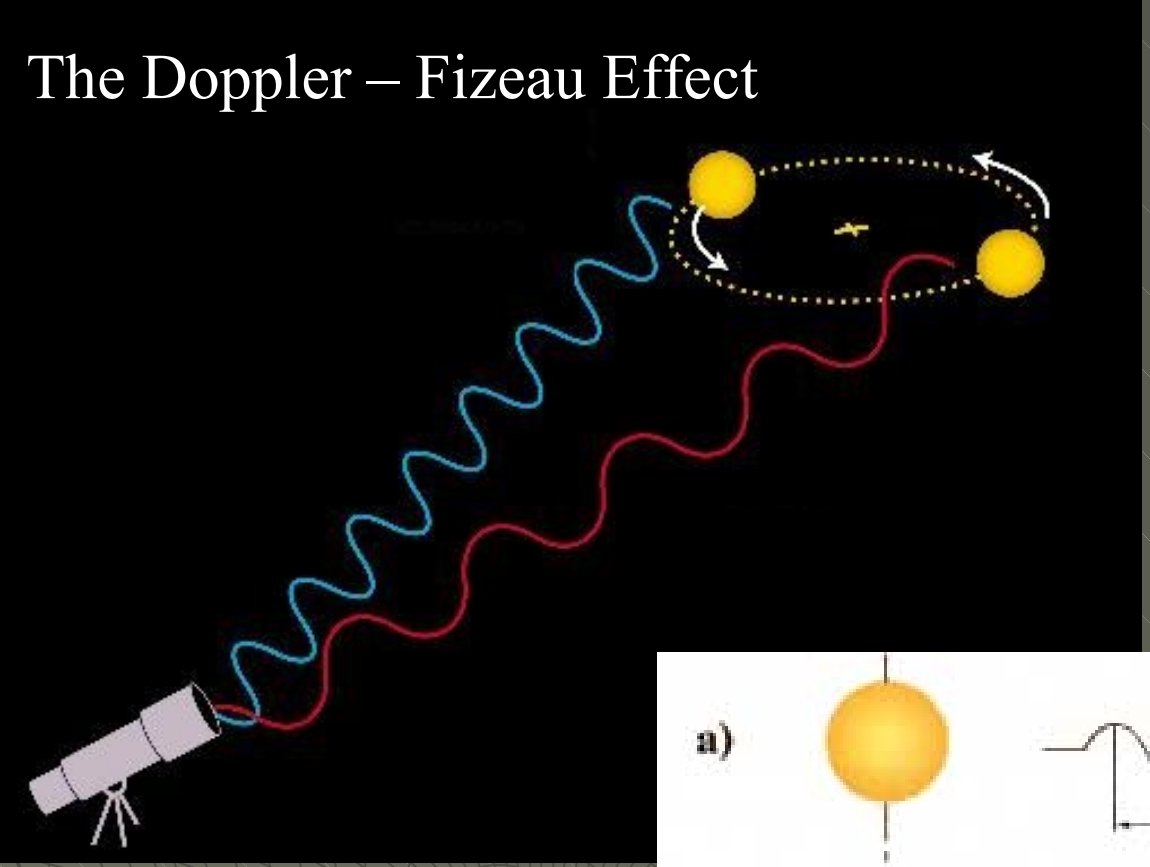
Measure the radial velocity to determine which one move forward and which backward

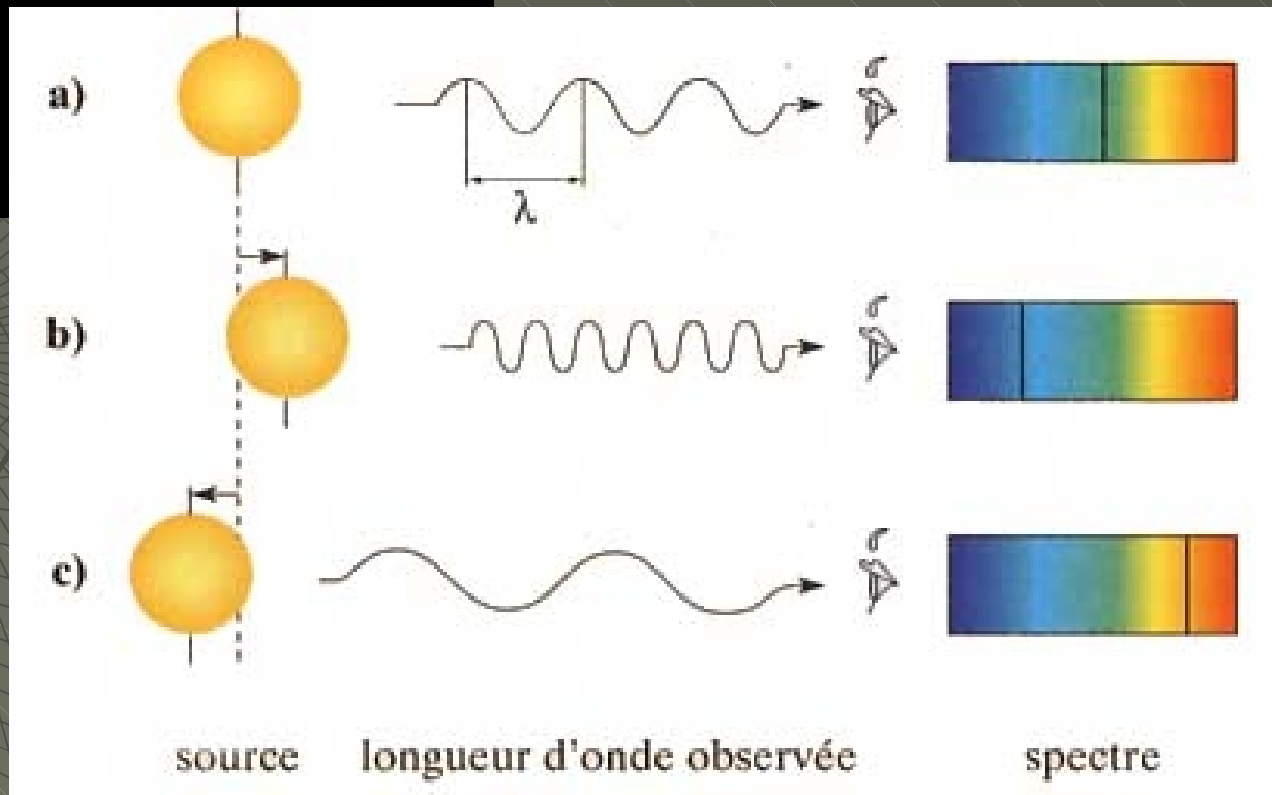


Actually, we measure the radial velocity only in the line of sight.

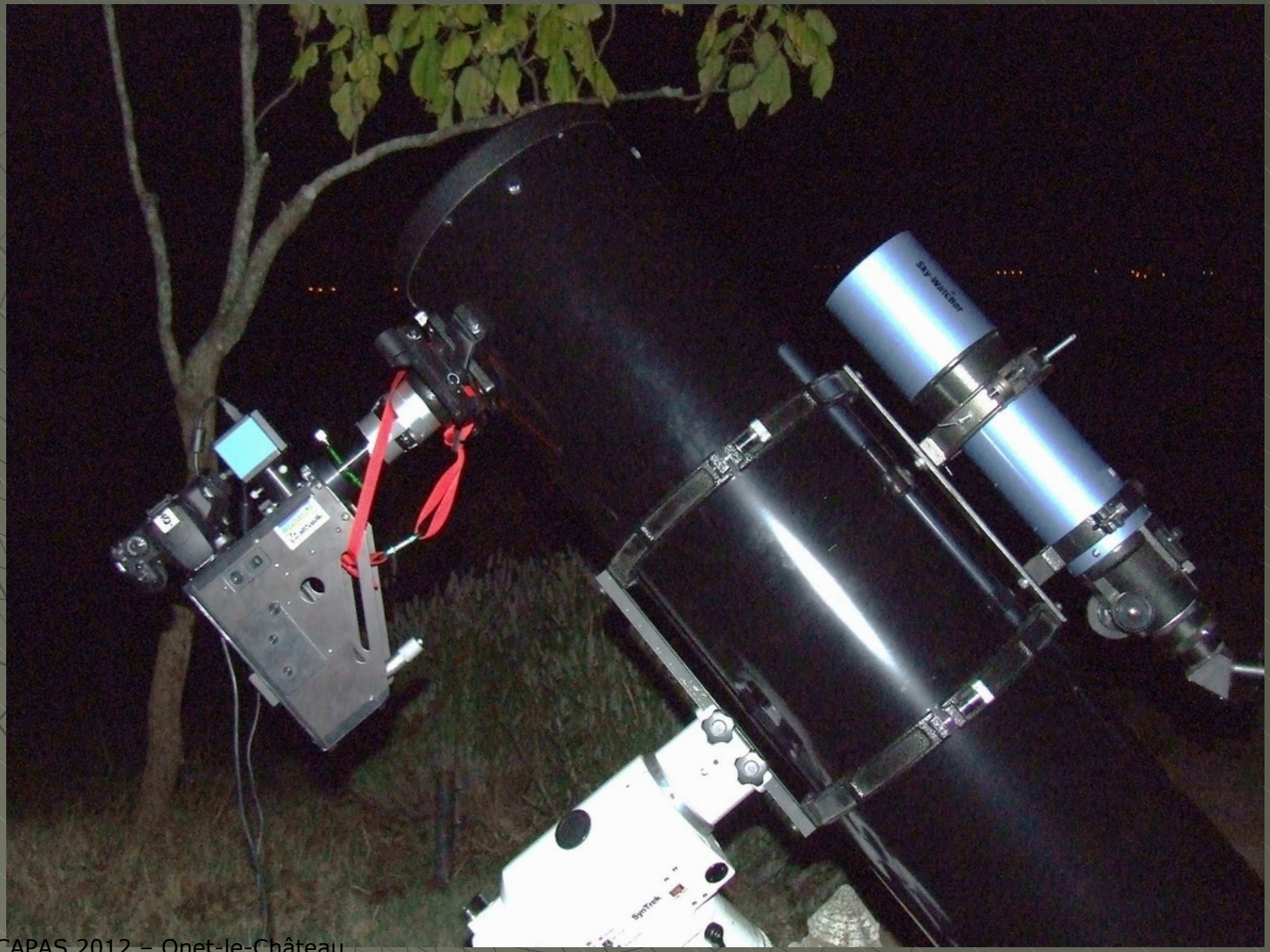


The Doppler – Fizeau Effect



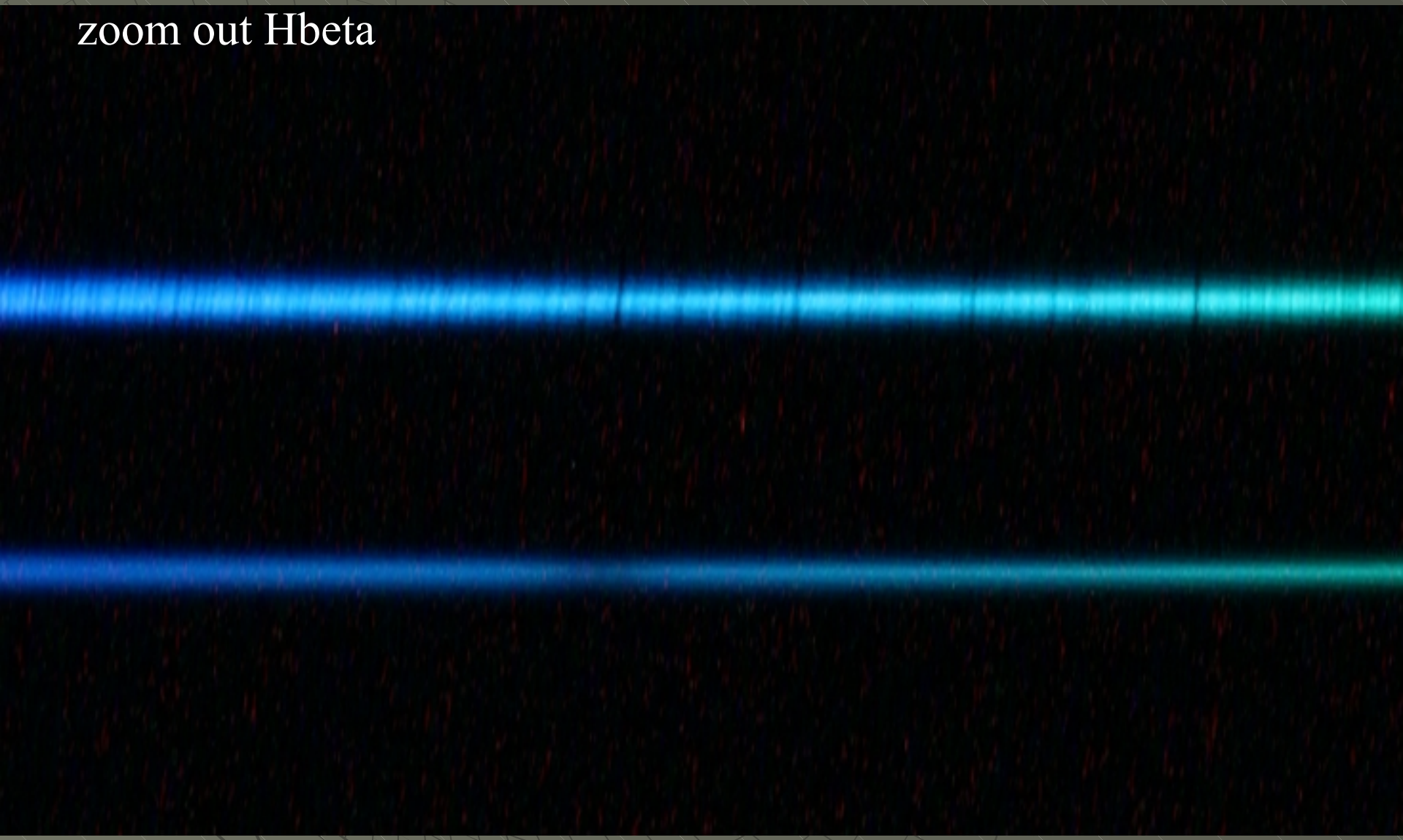


II - Raw Spectrums


Sky-Watcher
SynTrek

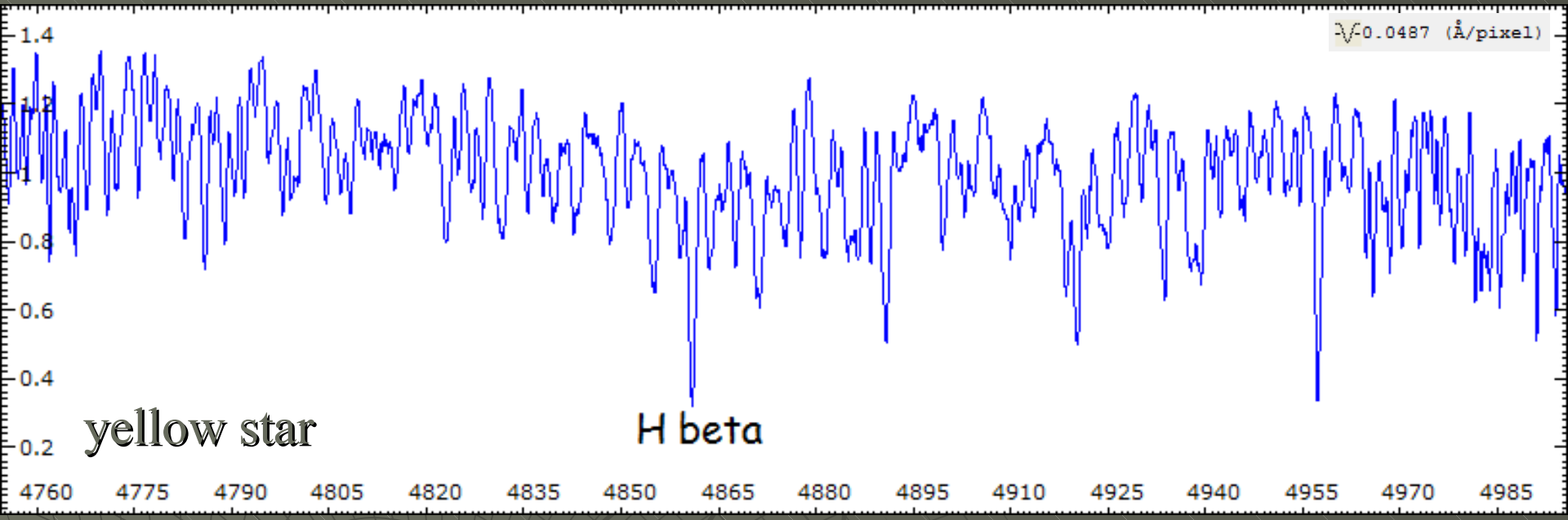
Raw spectrum: high resolution

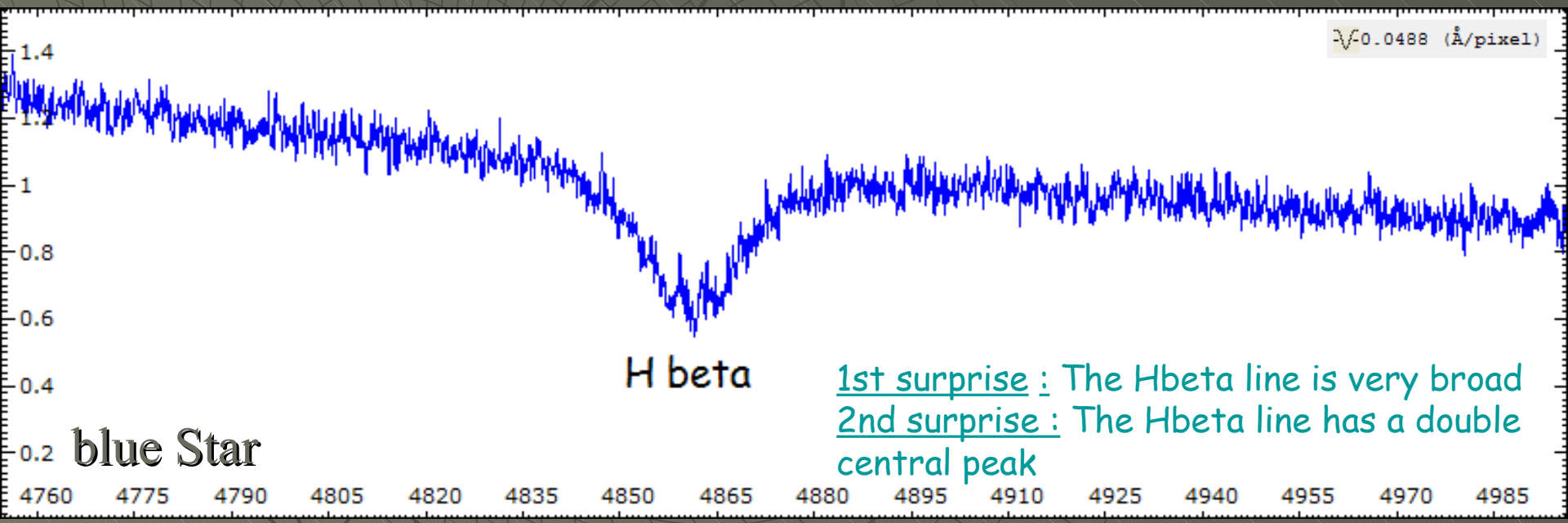
zoom out Hbeta



III
Spectrum Processing with ISIS
(freeware Christian Buil)

high resolution spectrum





1st surprise : The Hbeta line is very broad
2nd surprise : The Hbeta line has a double central peak

About the lines of the blue star :

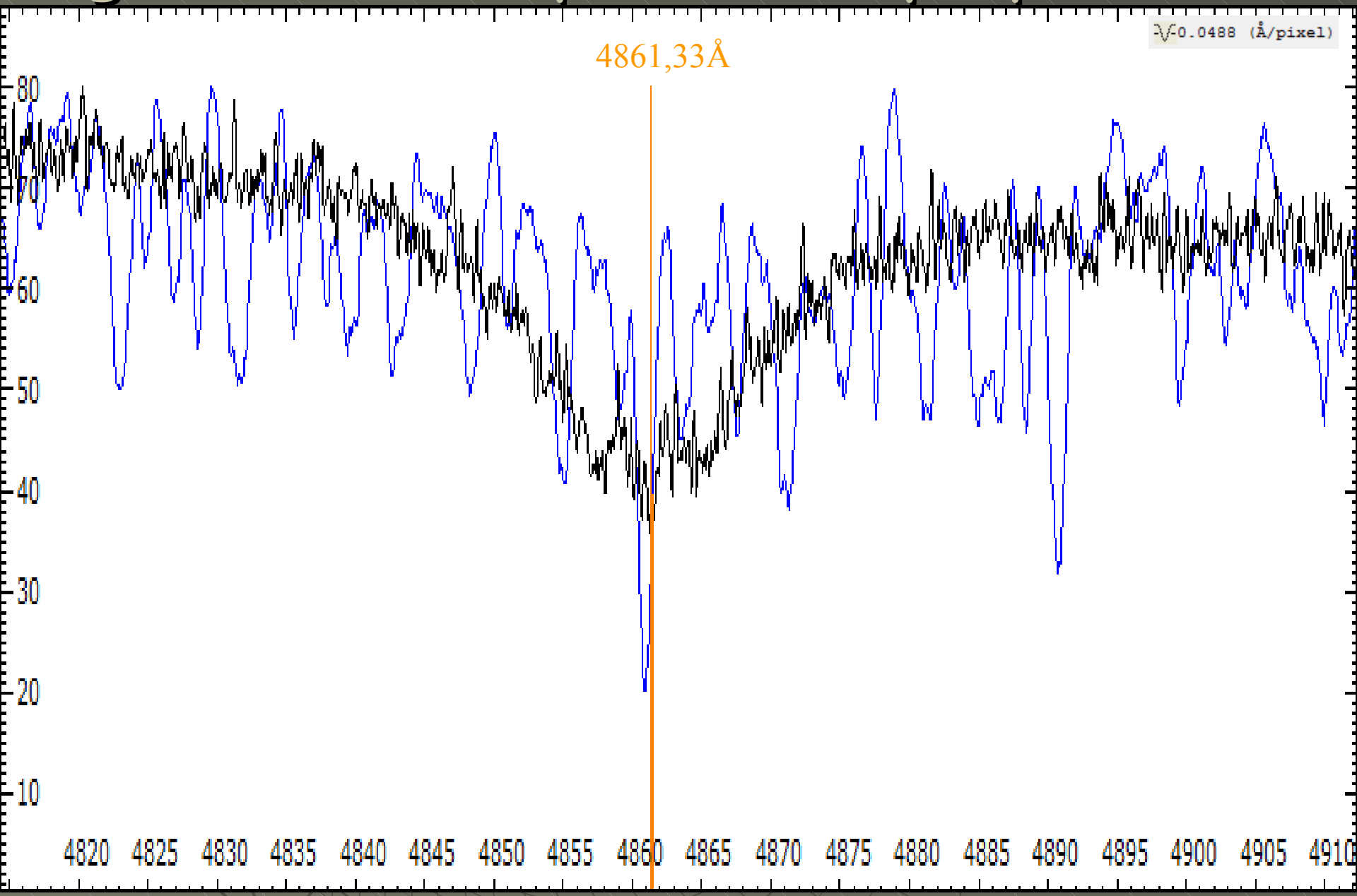
Why Hbeta line is so wide ?
This is certainly due to the rotation of the star and to its density.
The blue star rotates very fast over 0.6 days !

The Sun is only 28 days on average.

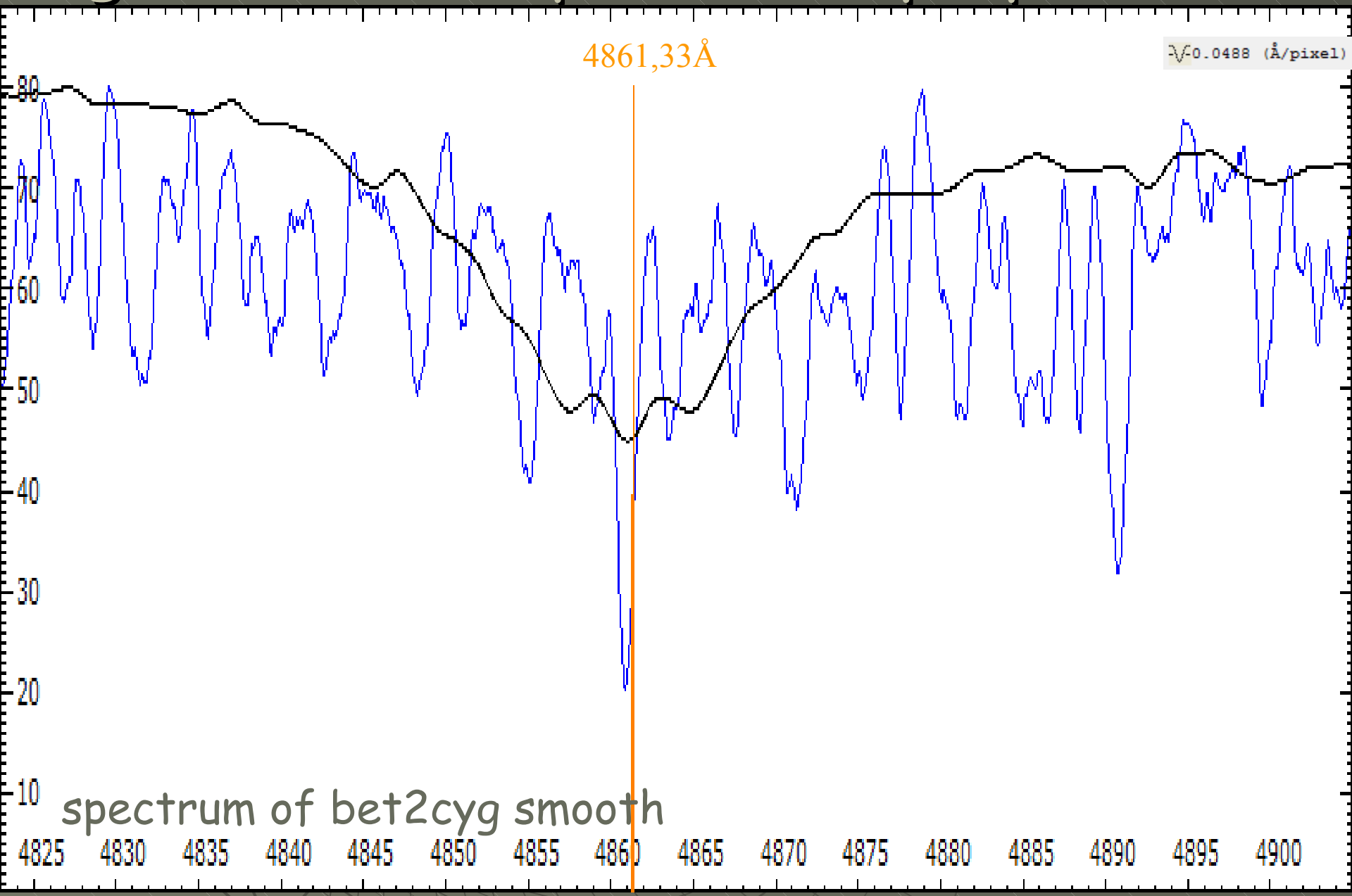
Possibility of other funny measures speed of the star, which leads to other questions ....

More studies have to be done ....

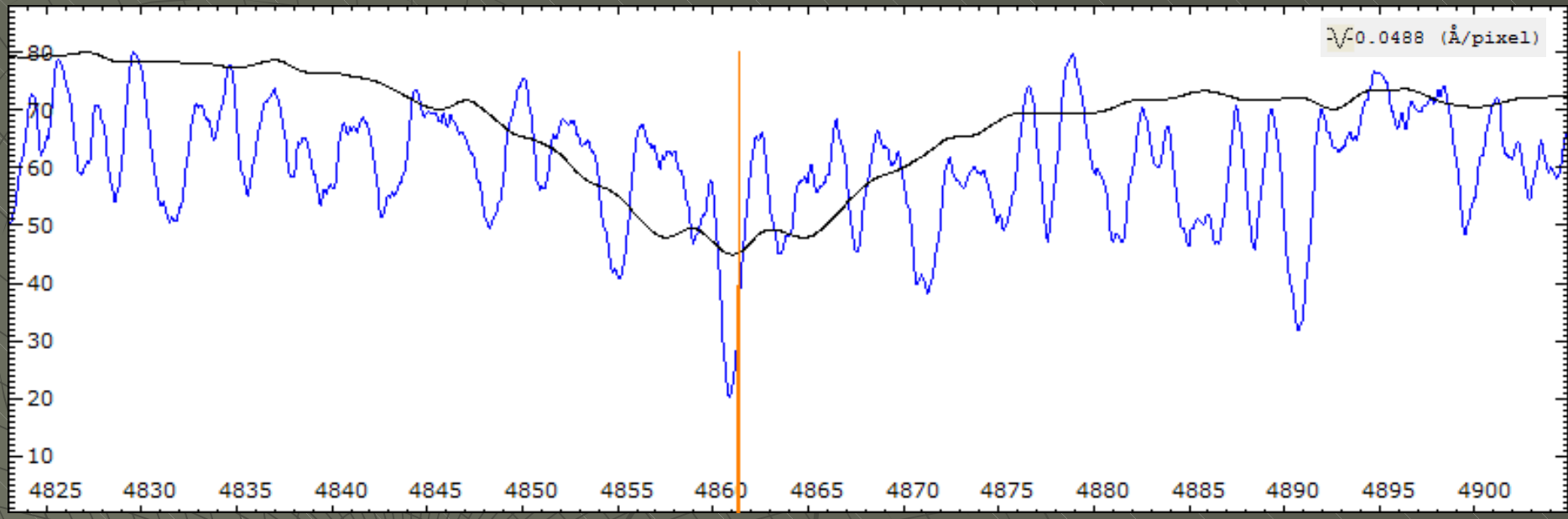
High resolution spectrum superposition



High resolution spectrum superposition



We note that the H beta line is not at 4861.33 Å (Angstrom), this means that the stars are moving relative to us. (The spectrum were corrected from the heliocentric velocity)



Measure of lines centers

Blue Star : 4861.187Å Difference with Hbeta = rIb = -0.143Å

Yellow star : 4860.889Å Difference with Hbeta = rIj = -0.441Å

There is a blue shift, so both stars moves closer to us.

The yellow star is approaching faster than the blue one

IV - Funny little mathematics !

Small simple formula for calculating radial velocity :

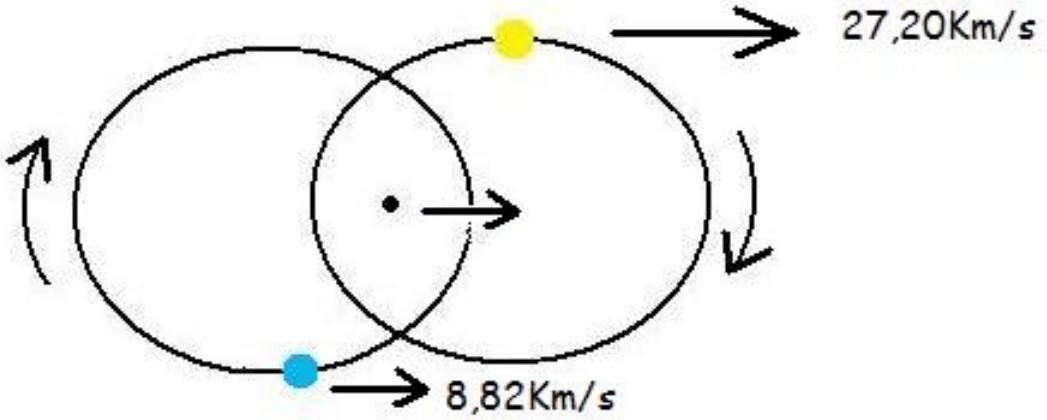
$Vr = (\triangle\lambda / \lambda) . c$

Vr blue star = (-0,143 / 4861,33) . 299792 = -8,82 Km/s

Vr yellow star = (-0,441 / 4861,33) . 299792 = -27,20 Km/s

The blue star is approaching us at 8.82 km / s and yellow 27.20 Km / s

The heliocentric velocity (speed of rotation of the Earth on its axis and around the sun) has been corrected since it is not negligible, estimated at the time of shooting at -18.39 Km/s !



Let's compare my results with data from literature to see if I am right or not!

My measurements:

Blue star :
Radial velocity : -8,82 Km/s

Yellow star :
Radial velocity : -27,20 Km/s

SIMBAD Data :

Blue star :
Radial velocity : -18,00 Km/s

Yellow star :
Radial velocity : -24,07 Km/s

Why the measures differ such a lot on the bleu star and not on the yellow ???

Where these differences can come from ?

- Is the radial velocity difference due to the inaccuracy of the measurement on the Hbeta line ?

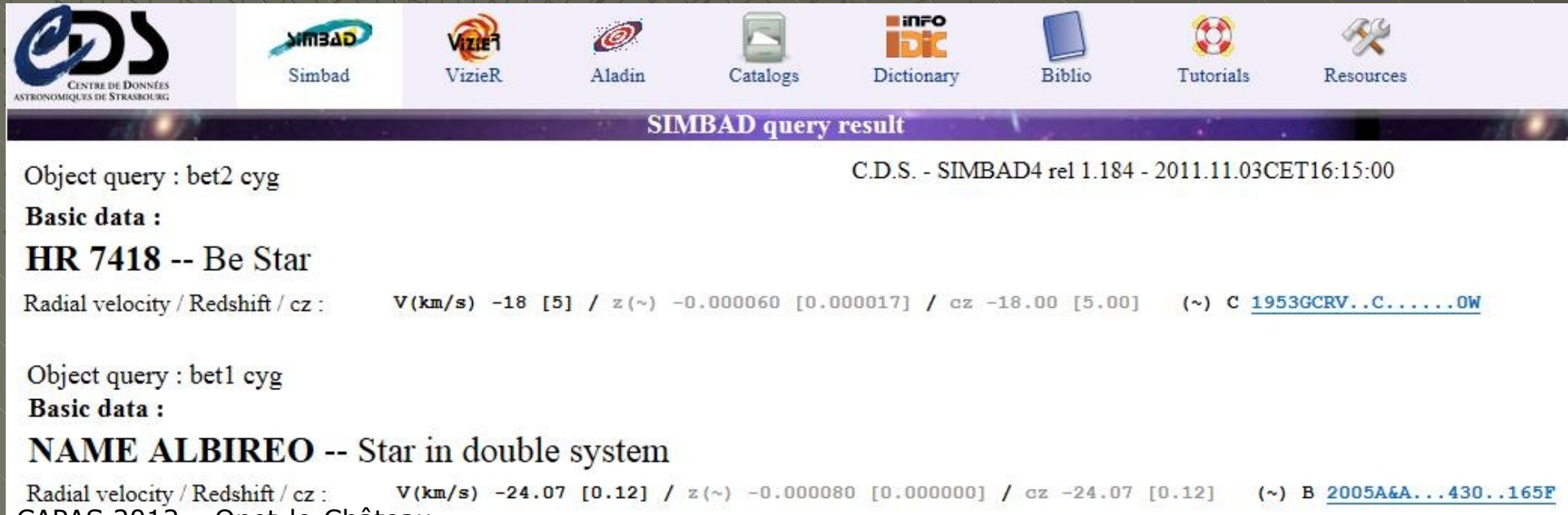
- Is that the radial velocity have change since the measures of the SIMBAD database ?

- Do I measure the radial velocity and temperatures of several stars?

Difference in radial velocity:

I noticed in the parameters of stars that the orbit period is 214 years long. Depending on the star position in its orbit there can be rapid changes in radial velocity . Then I saw on the SIMBAD database that the radial velocity of the blue star was mesured in 1953. Everything is explained ! In 58 years the star has traveled $\frac{1}{4}$ of its orbit, thus inevitably Vr have change.
For the yellow star, the given date is 2005.

But…



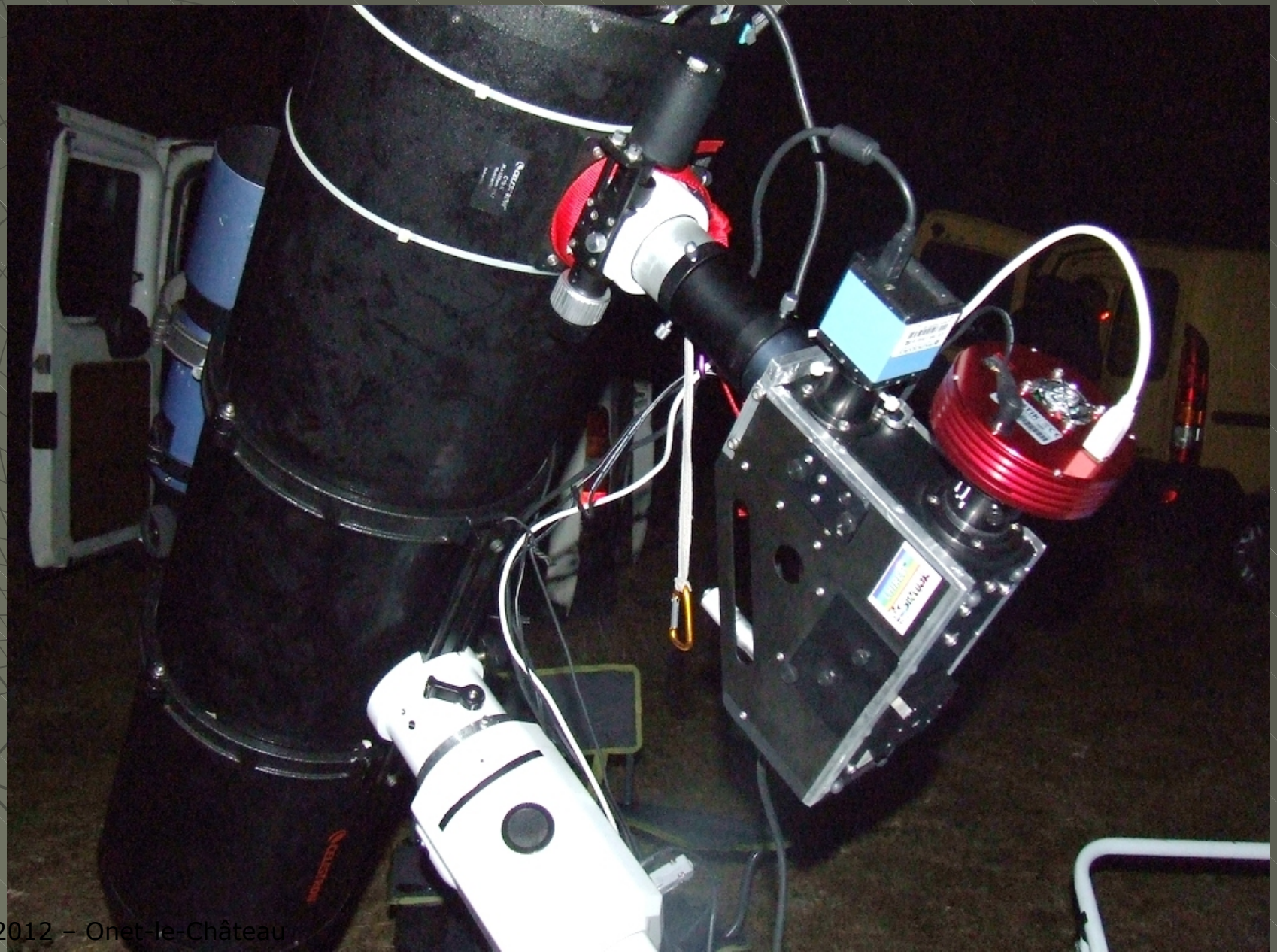
BUT ..... Rookies makes mistakes !
Small error on the heliocentric velocity : -18.453Km/s (-18.39 Kms)

+ Line centre measurement not accurate enough !

<u>After recalculation:</u>
Vr = -24.1 Bet1 Cyg Km/s (old measure -27.20 km/s)
Vr = -14.2 Bet2 Cyg Km/s (old measure -8.82 km/s)
Estimation of error of +/- 3km / s (with the camera Canon 1000D)

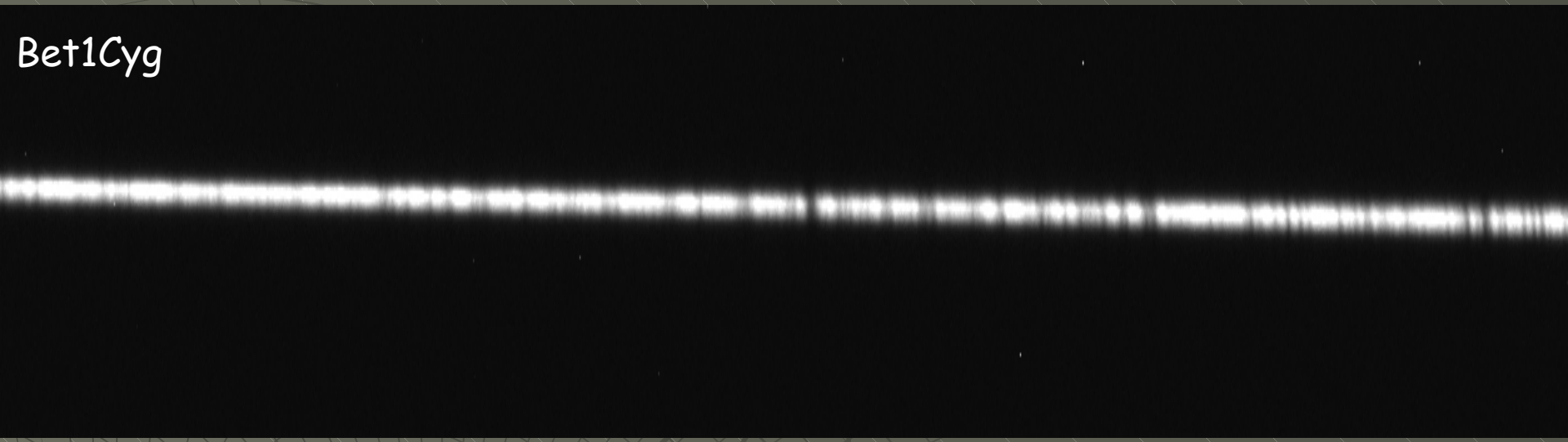
<u>Comparison with Simbad database</u>
Bet1 Cyg -24. 07 Km/s 2005 data
Bet2 Cyg -18.00 Km/s data 1953

Buying a CCD camera : Atik 314L +

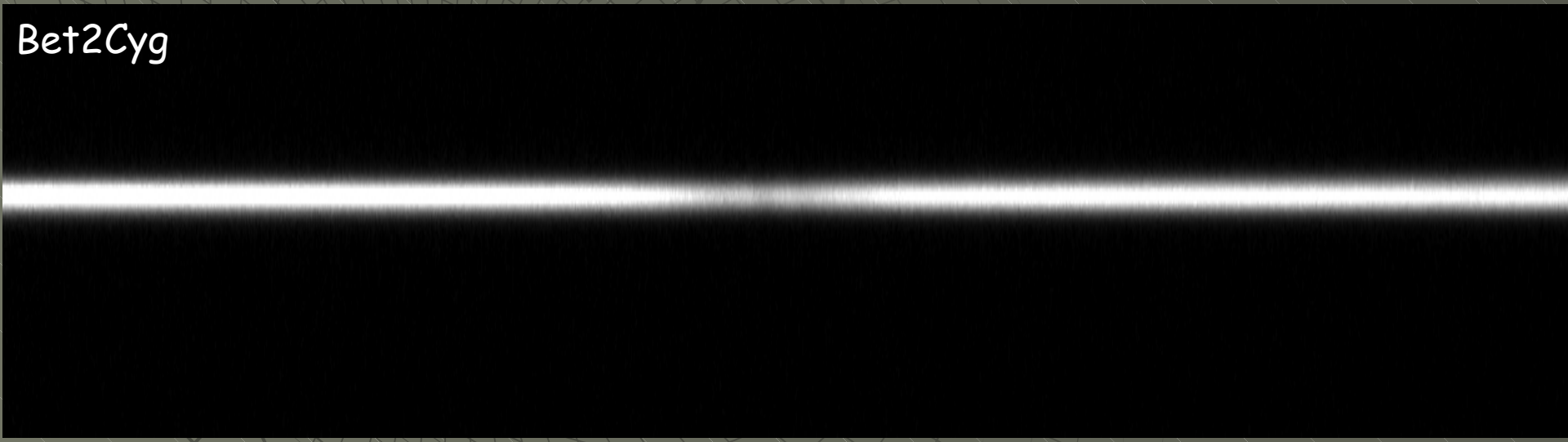


H beta line

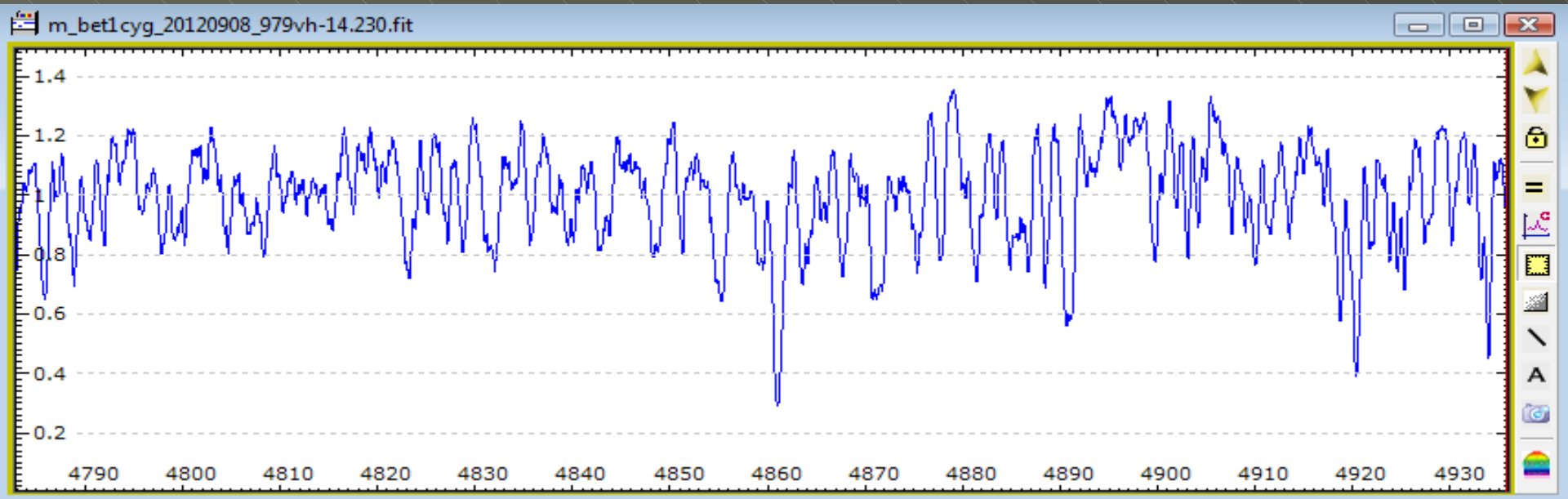
Bet1Cyg



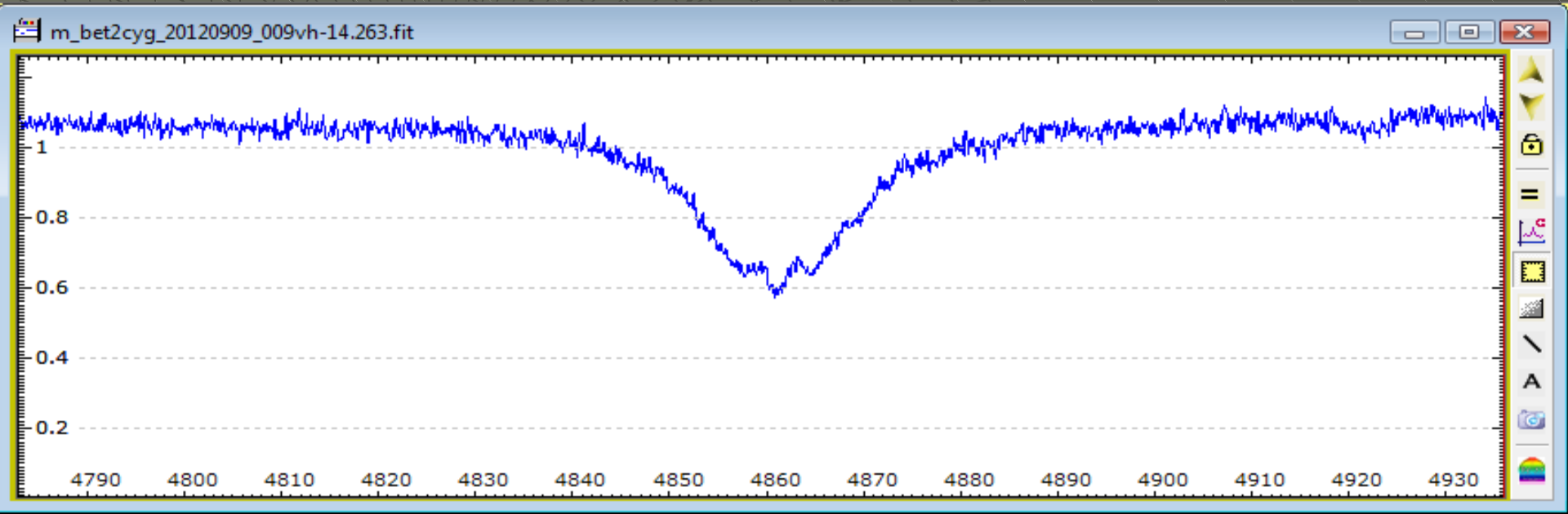
Bet2Cyg



Bet1Cyg H beta line

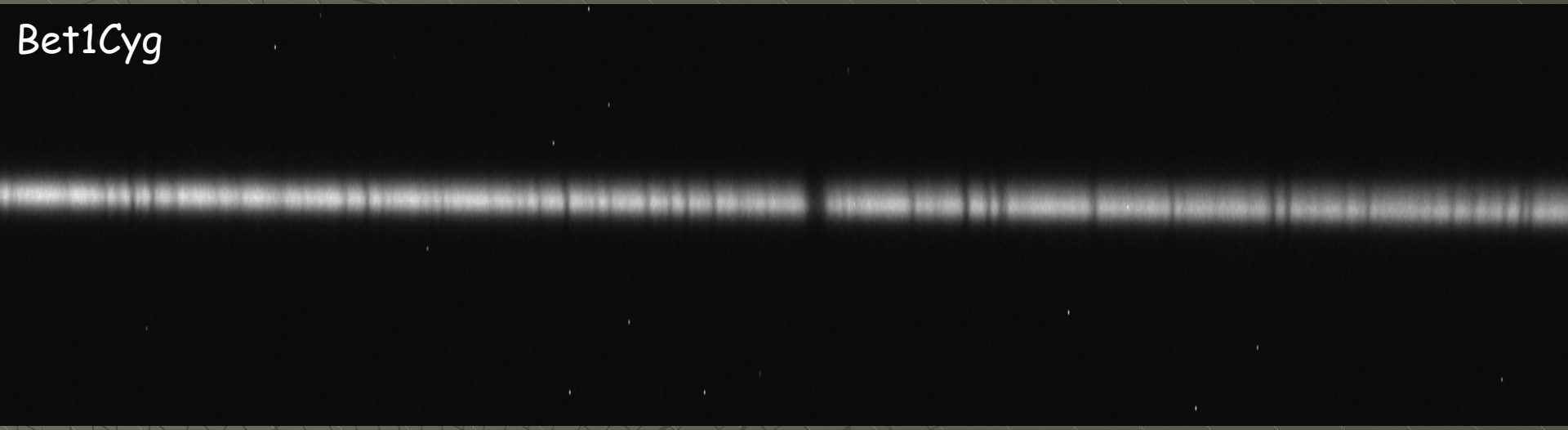


Bet2Cyg H beta line

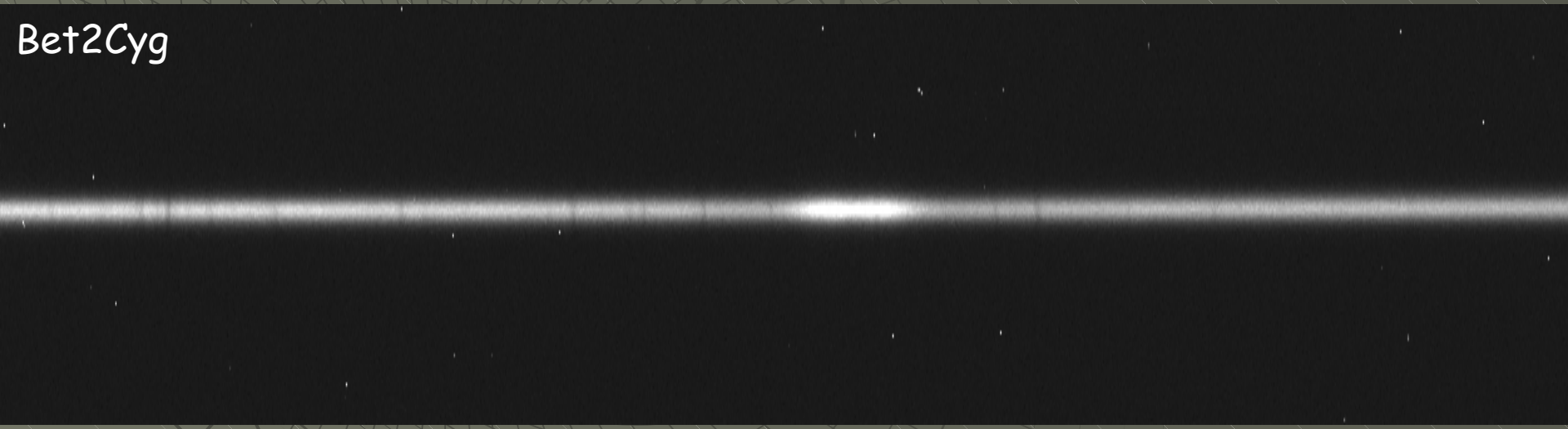


H alpha line

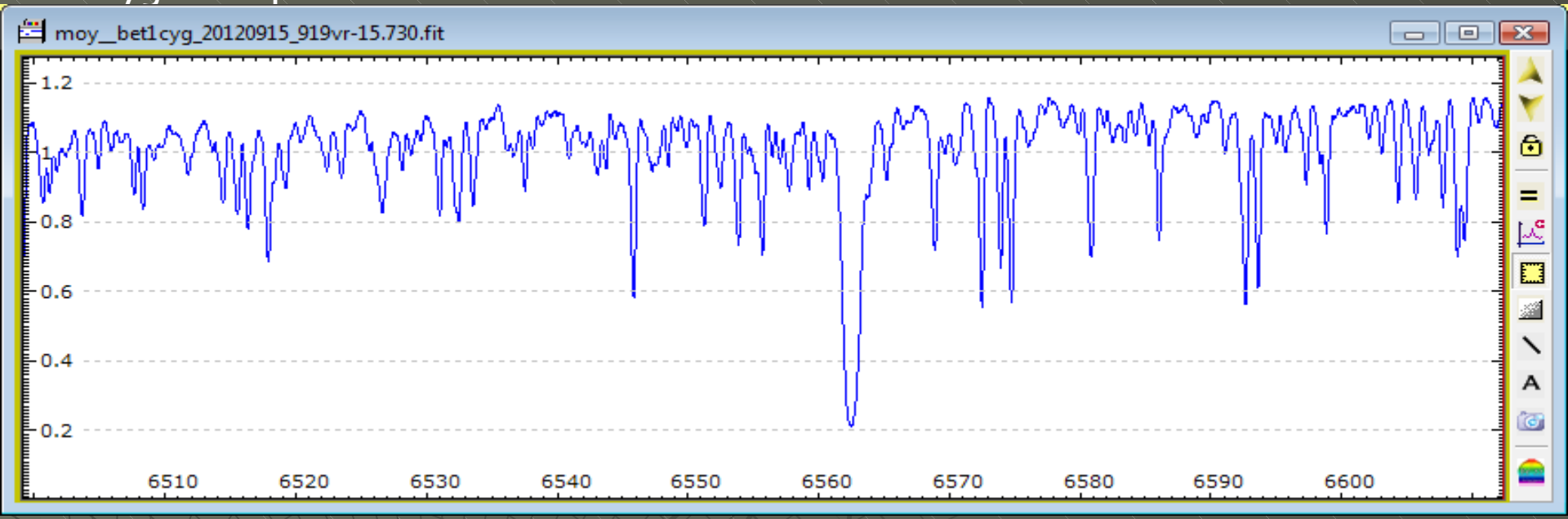
Bet1Cyg



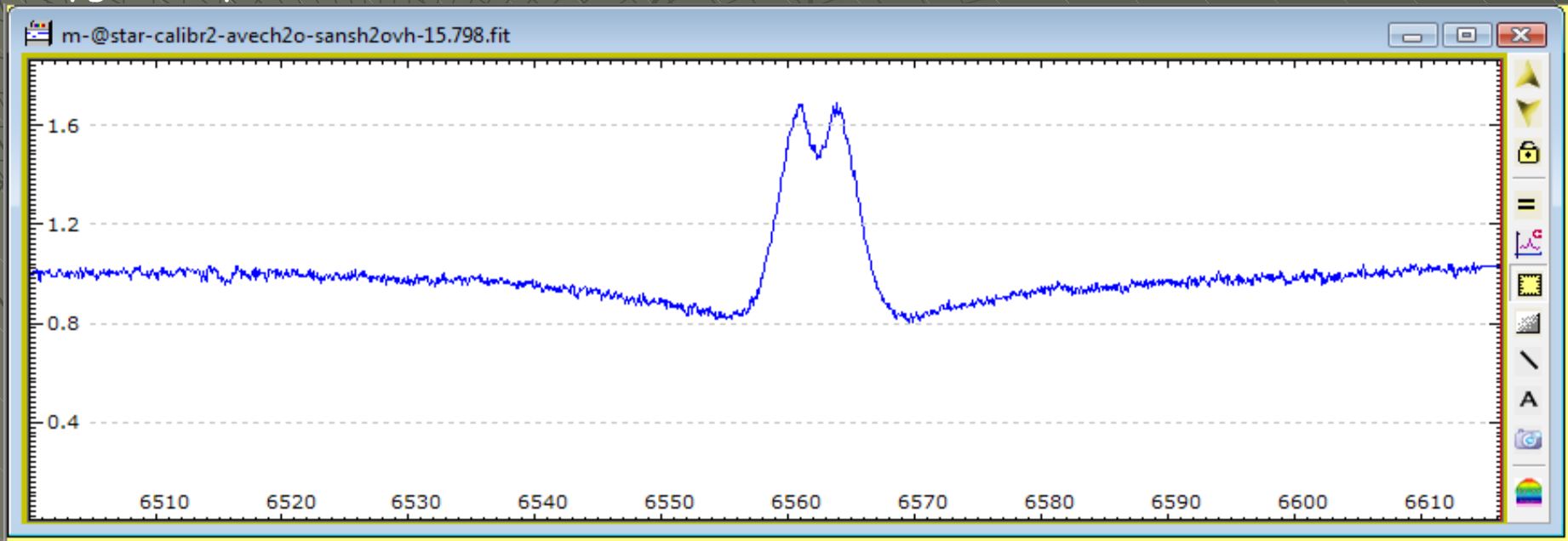
Bet2Cyg



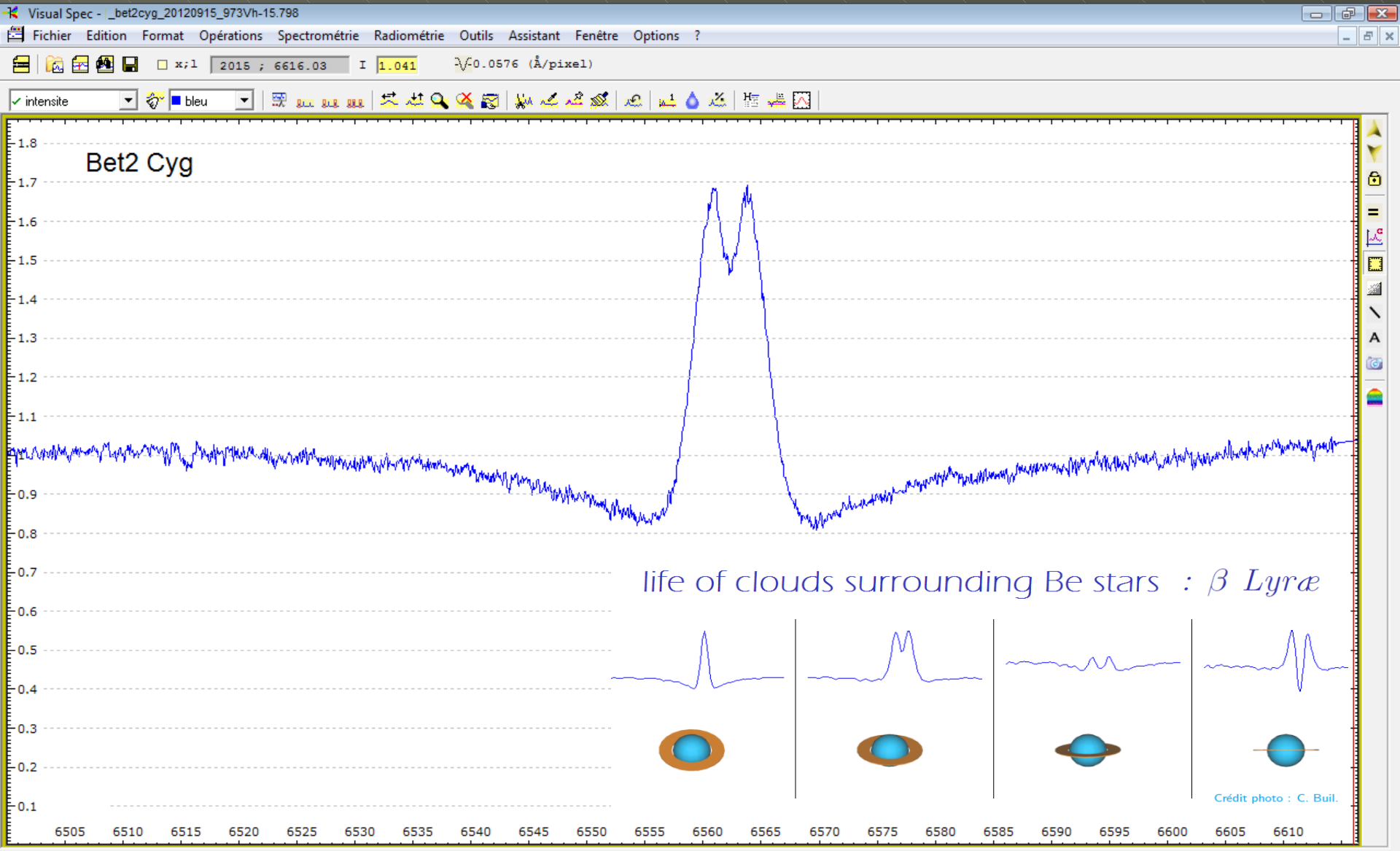
Bet1Cyg H alpha line



Bet2Cyg H alpha line

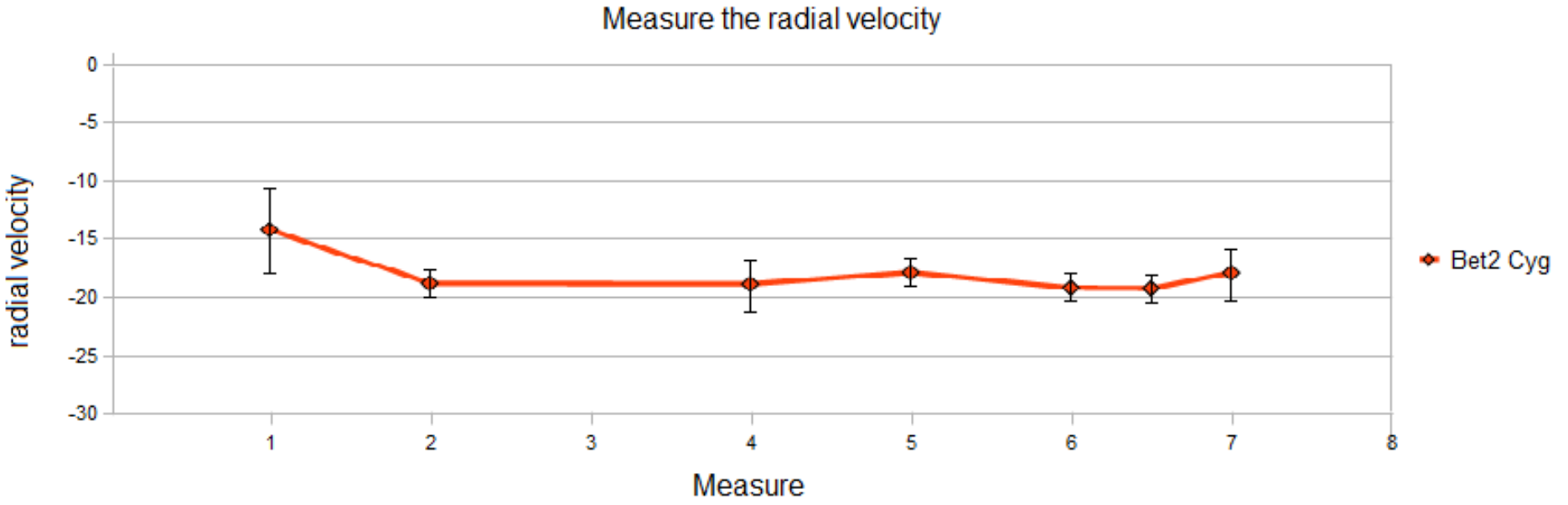


Bet2Cyg H alpha line – Be Star



New measures on Hbeta and Halpha line

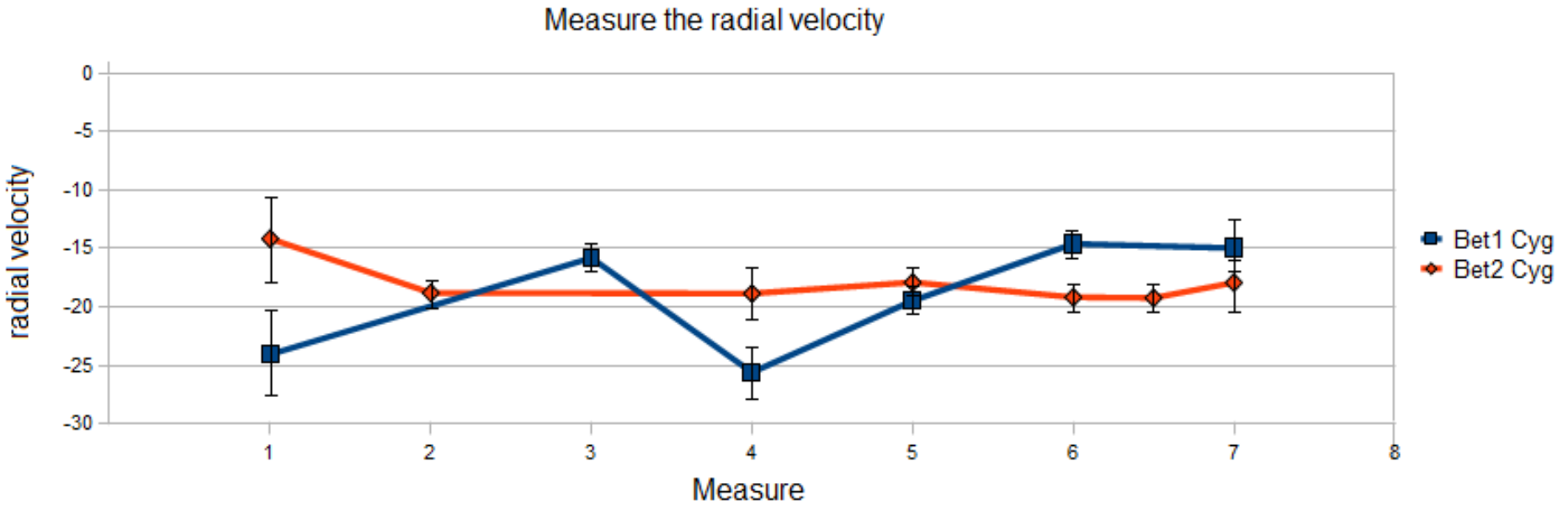
	MESURE CENTRE RAIE	MESURE Vr	ESTIMATION ERREUR
BET2 CYG		SIMBAD -18,00 Km/s	
MESURE CANON REFAITE HBETA	4861.1002	-14.17147192	+/- 3Km/s
2012_07_24 - Bet2cyg	6562.30843	-18.80118189	+/- 1Km/s
2012_09_08 -BET2CYG- HBETA	4861.02424	-18.85582792	+/- 2Km/s
2012_09_14 -BET2CYG	6562.3281	-17.90240705	+/- 1Km/s
2012_09_15 - BET2CYG 1ER HEURE	6562.30021	-19.17625601	+/- 1Km/s
2012_09_15 - BET2CYG 2IEME HEURE	6562.29908	-19.2281729	+/- 1Km/s
2012_09_22_927 - BET2CYG - Hbeta	4861.03934	-17.92463024	+/- 2Km/s
	MOY	**-18.64807933**	

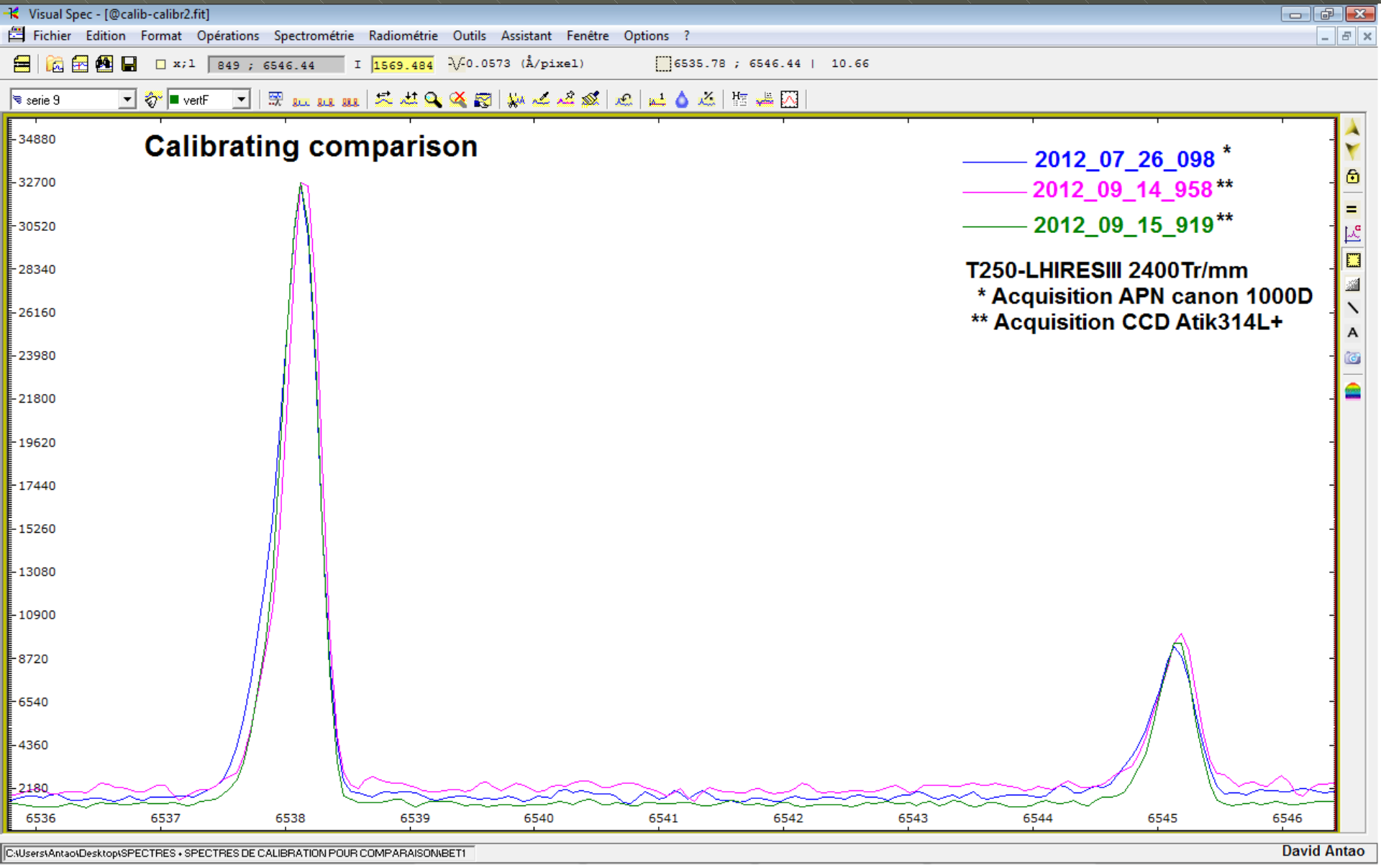

Measure the radial velocity
radial velocity
0
-5
-10
-15
-20
-25
-30
1
2
3
4
5
6
7
8
Measure
Bet2 Cyg

Why the radial velocity of Cyg Bet2 who travelled $\frac{1}{4}$ of its orbit since 1953, have not changed?

New measures on Hbeta and Halpha line

	MESURE CENTRE RAIE	MESURE Vr	ESTIMATION ERREUR
BET1 CYG		SIMBAD -24,07 Km/s	
MESURE CANON REFAITE	4860.93975	-24.06652644	+/- 3Km/s
2012_07_27 - BET1CYG	6562.37388	-15.81112817	+/- 1Km/s
2012_09_08 -BET1CYG - HBETA	4860.91503	-25.59066886	+/- 2Km/s
2012_09_14 -BET1CYG	6562.29371	-19.47337867	+/- 1Km/s
2012_09_15 - BET1CYG	6562.40029	-14.6046914	+/- 1Km/s
2012_09_22_851 -BET1CYG - Hbeta	4861.08724	-14.97069854	+/- 2Km/s


Measure the radial velocity
radial velocity
0
-5
-10
-15
-20
-25
-30
1
2
3
4
5
6
7
8
Measure
Bet1 Cyg
Bet2 Cyg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Fichier Edition Format Opérations Spectrométrie Radiométrie Outils Assistant Fenêtre Options ?
849 ; 6546.44
1569.484
0.0573 (Å/pixel)
6535.78 ; 6546.44 | 10.66
serie 9
vertF
Calibrating comparison
2012_07_26_098 *
2012_09_14_958**
2012_09_15_919**
T250-LHIRESIII 2400Tr/mm
* Acquisition APN canon 1000D
** Acquisition CCD Atik314L+
34880
32700
30520
28340
26160
23980
21800
19620
17440
15260
13080
10900
8720
6540
4360
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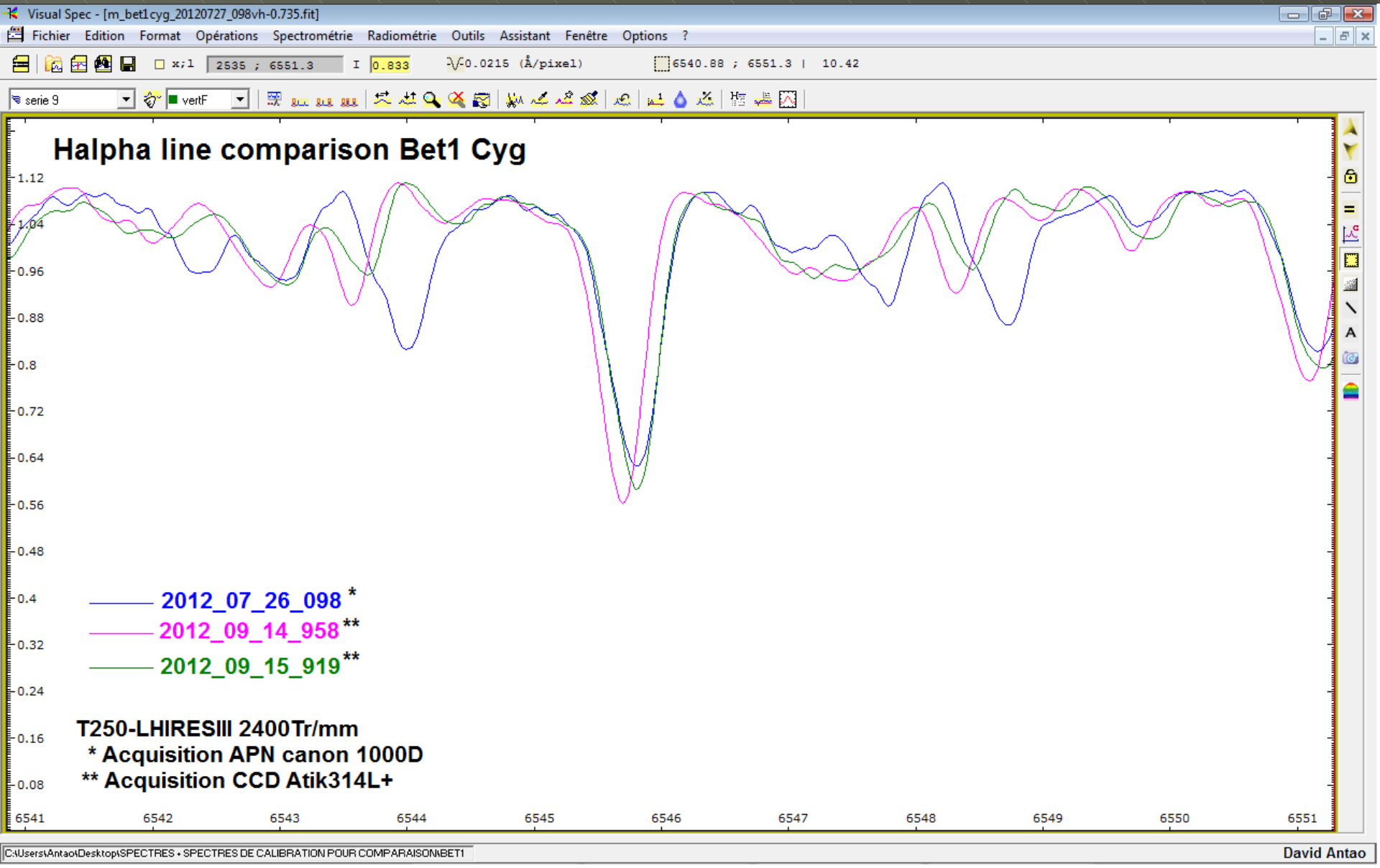
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Fichier Edition Format Opérations Spectrométrie Radiométrie Outils Assistant Fenêtre Options ?
2535 ; 6551.3
0.833
0.0215 (Å/pixel)
6540.88 ; 6551.3 | 10.42
serie 9
vertF
Halpha line comparison Bet1 Cyg
1.12
1.04
0.96
0.88
0.8
0.72
0.64
0.56
0.48
0.4
0.32
0.24
0.16
0.08
6541
6542
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6548
6549
6550
6551
2012_07_26_098 *
2012_09_14_958 **
2012_09_15_919 **
T250-LHIRESIII 2400Tr/mm
* Acquisition APN canon 1000D
** Acquisition CCD Atik314L+
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David Antao

Where does those differences comes from ?

- Measurement Error during the acquisition ?
- Real star changes ?
- Lack of accuracy ?
- ??????

V - Conclusion

Spectroscopy is an amazing domain !

At the beginning we only ask 2 questions,

V - Conclusion

Spectroscopy is an amazing domain !

At the beginning we only ask 2 questions,

We make some measures,

V - Conclusion

Spectroscopy is an amazing domain !

At the beginning we only ask 2 questions,

We make some measures,

And at the end we have more questions than at the beginning

V - Conclusion

Spectroscopy is an amazing domain !

At the beginning we only ask 2 questions,

We make some measures,

And at the end we have more questions than at the beginning

But what funny it is !!!!

Thank you to David Bregou for his help!