



Astronomical Institute
of the Czech Academy of Sciences

Time Series in Exoplanet Research



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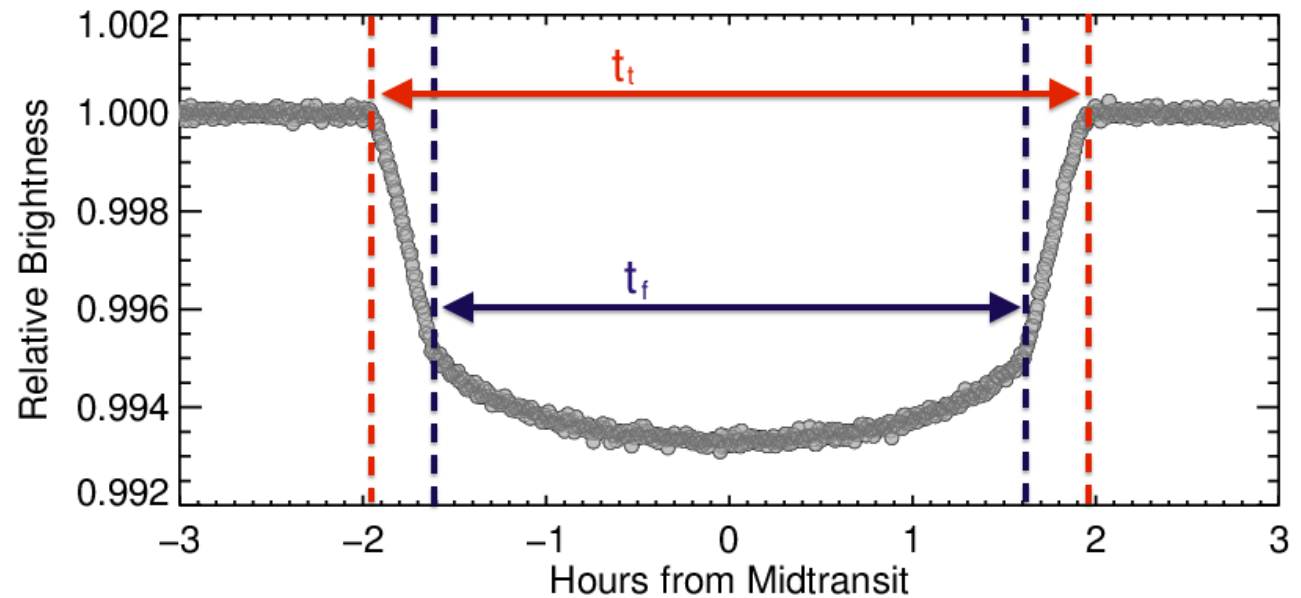
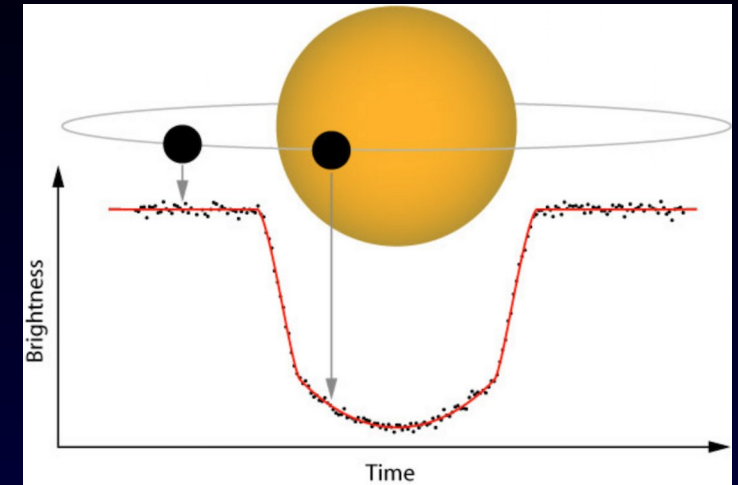
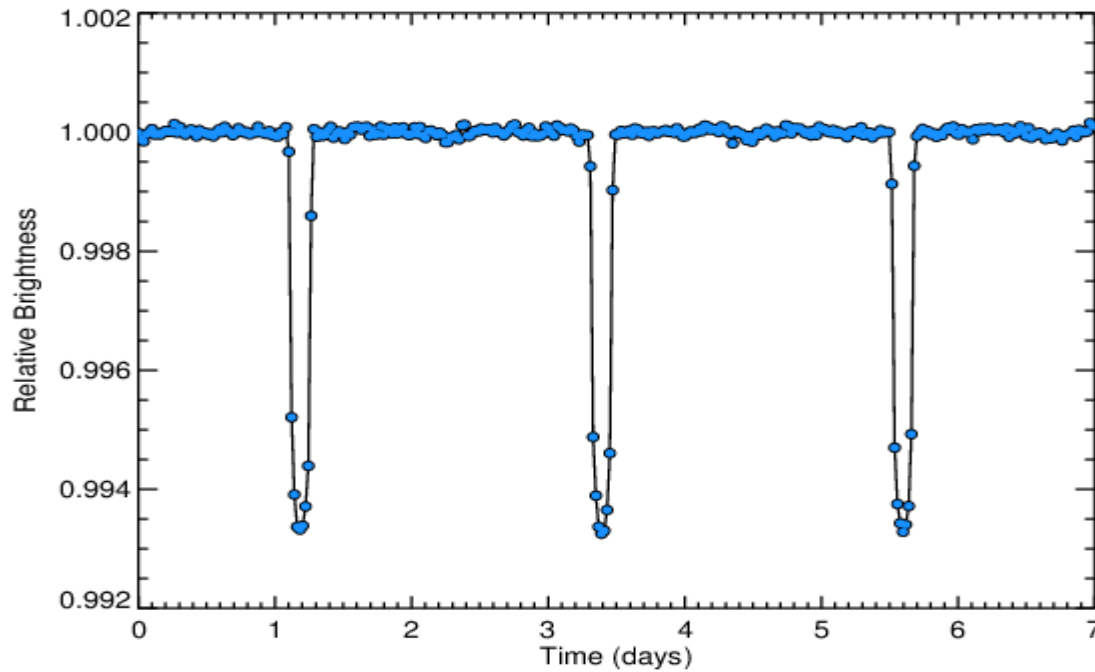
IVOA Interoperability Meeting
Time Domain Interest Group Session
Goerlitz, Germany
November 14th 2025

Credits

The presentation is based on many different sources – mainly the on-line published slides from IVOA meetings, EPRV group slides and docs, ADASS meetings, tutorials, manuals or pictures found on Internet.

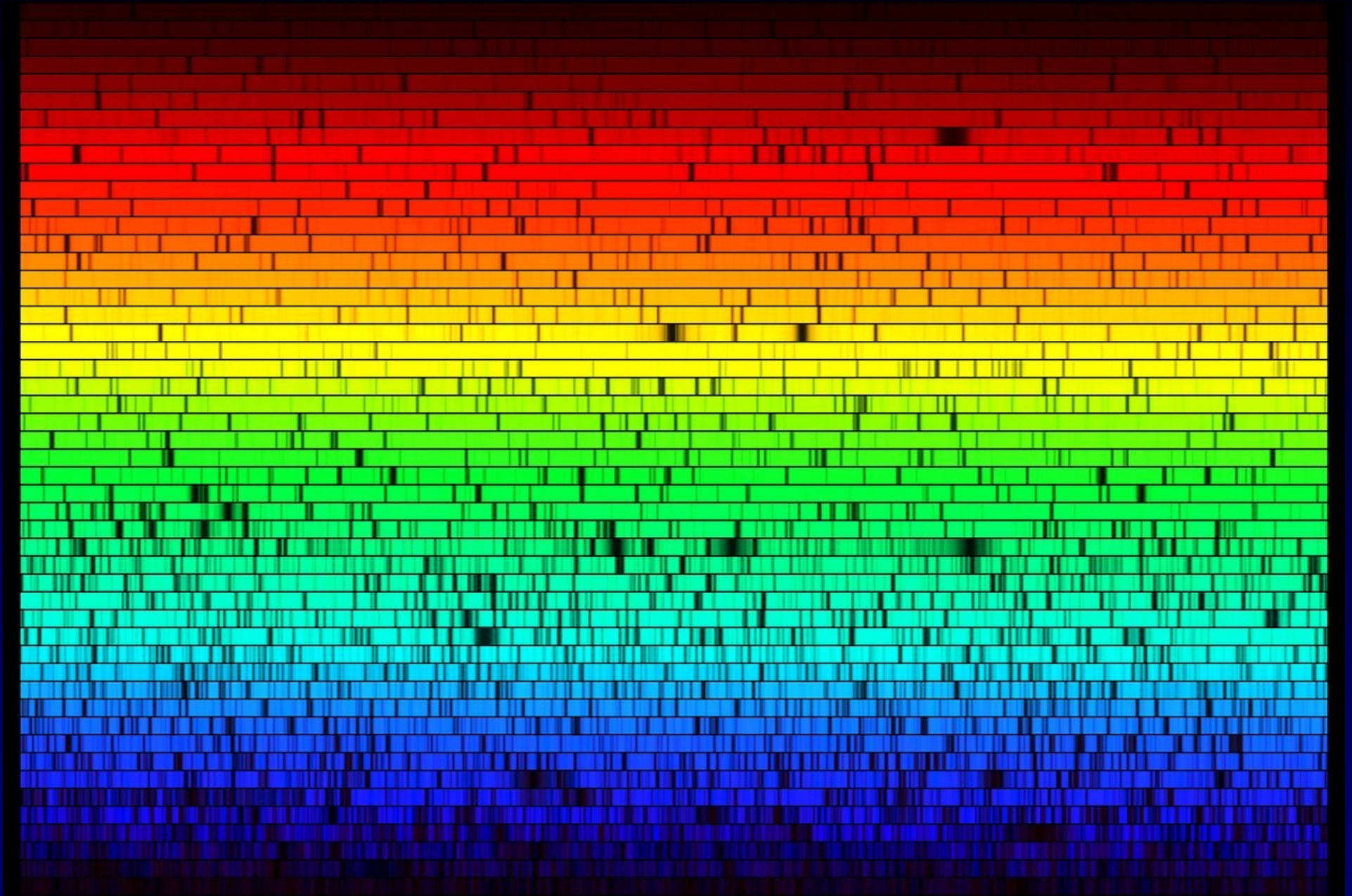
Light Curve

Light Curve HAT-P-7b



Echelle Spectra

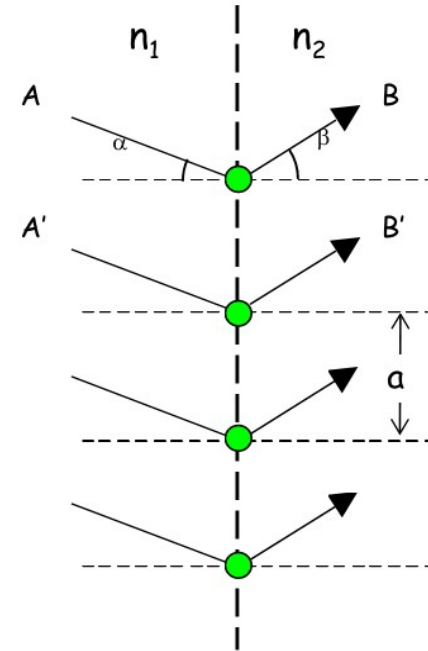
Spectrum of Arcturus (pixel-order)



Grating Equation

- Interference condition:
 $\Rightarrow$ path difference between AB and $A'B'$
- Grating equation:

$$m\rho\lambda = n_1 \sin \alpha + n_2 \sin \beta \quad \text{where} \quad \rho = \frac{1}{a}$$



Note the m is the spectrum (interference) order

High order – high dispersion $R \sim m \cdot N$ (no of lines in beam)

Échelle – stairway in French - coarse grooves (big steps)
HARPS 31.6/mm

Echelle – normal grating in 1st, 2nd order e.g. 833 /mm

Orders Define Geometry

Multiple orders

- Many orders to cover desired $\lambda\lambda$:

Free spectral range

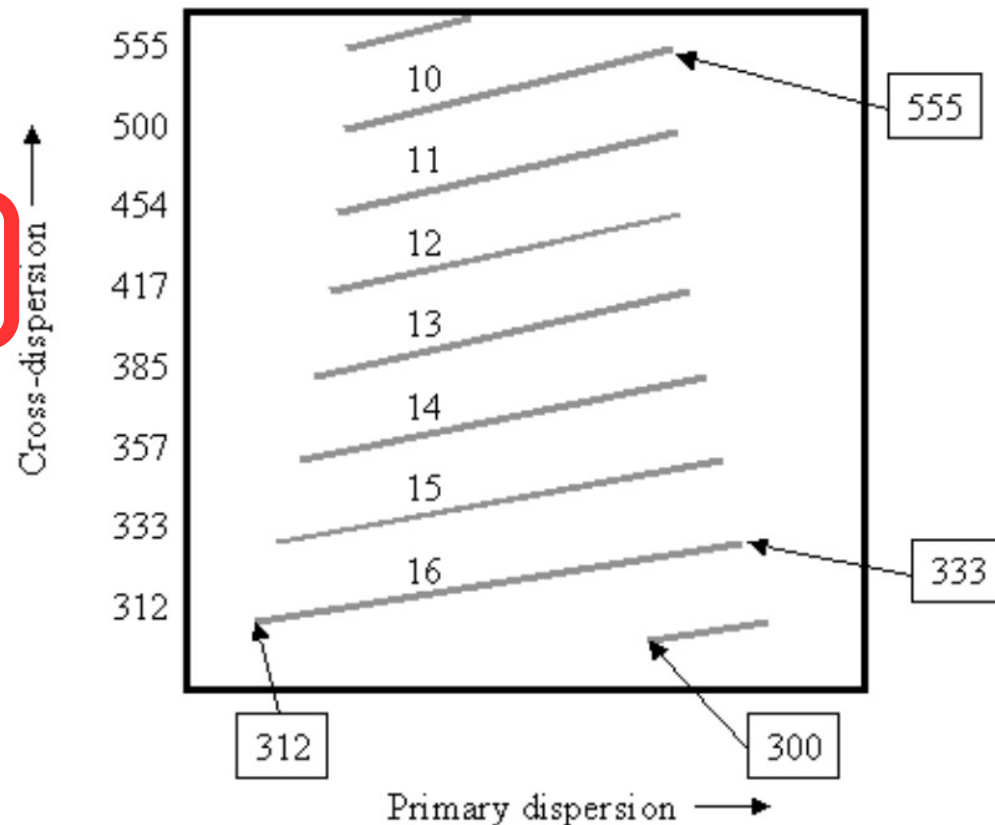
$$\Delta\lambda = \lambda/m$$

- Orders lie on top of each other:

$$\lambda(m) = \lambda(n) \times (n/m)$$

- Solution:

- use narrow passband filter to isolate one order at a time
- cross-disperse to fill detector with many orders at once



Cross dispersion may use prisms
or low dispersion grating

ESO X-Shooter

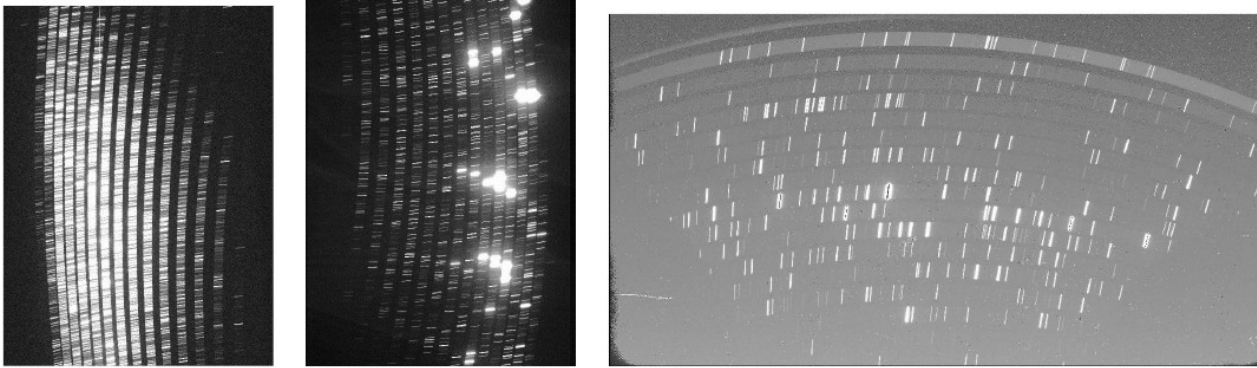
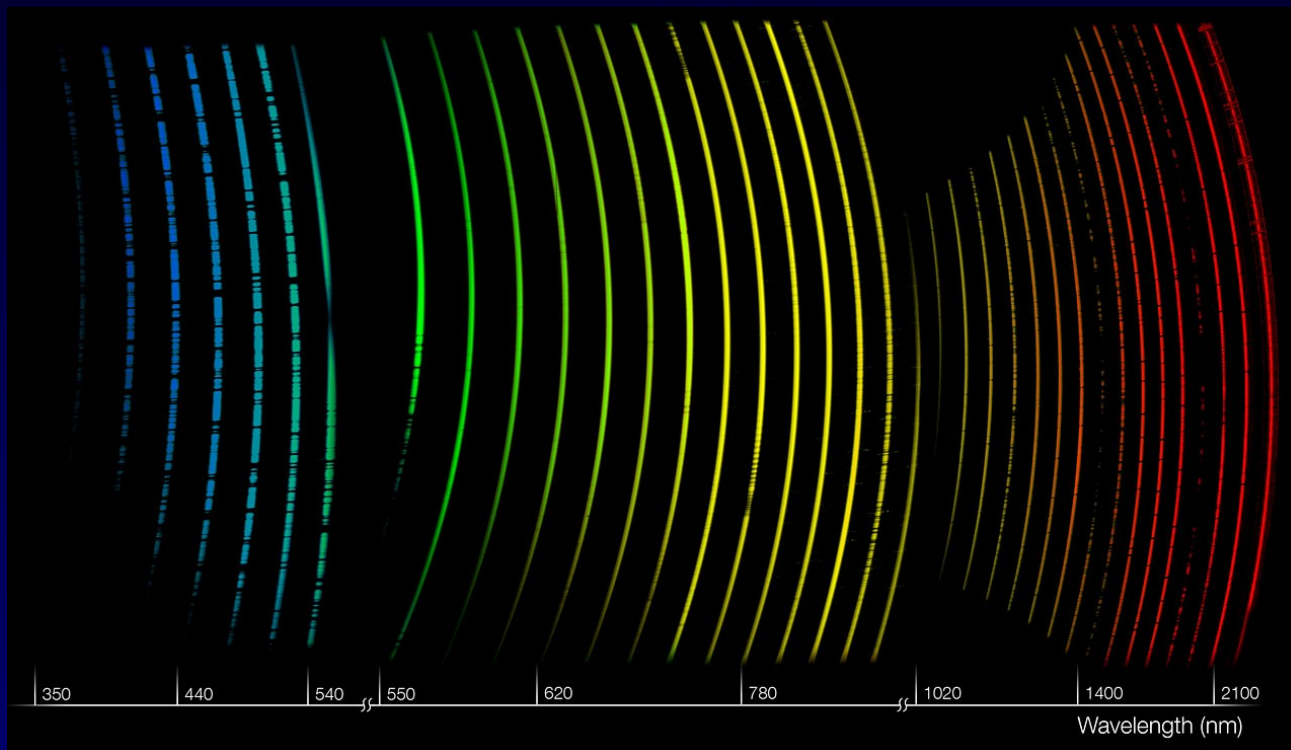
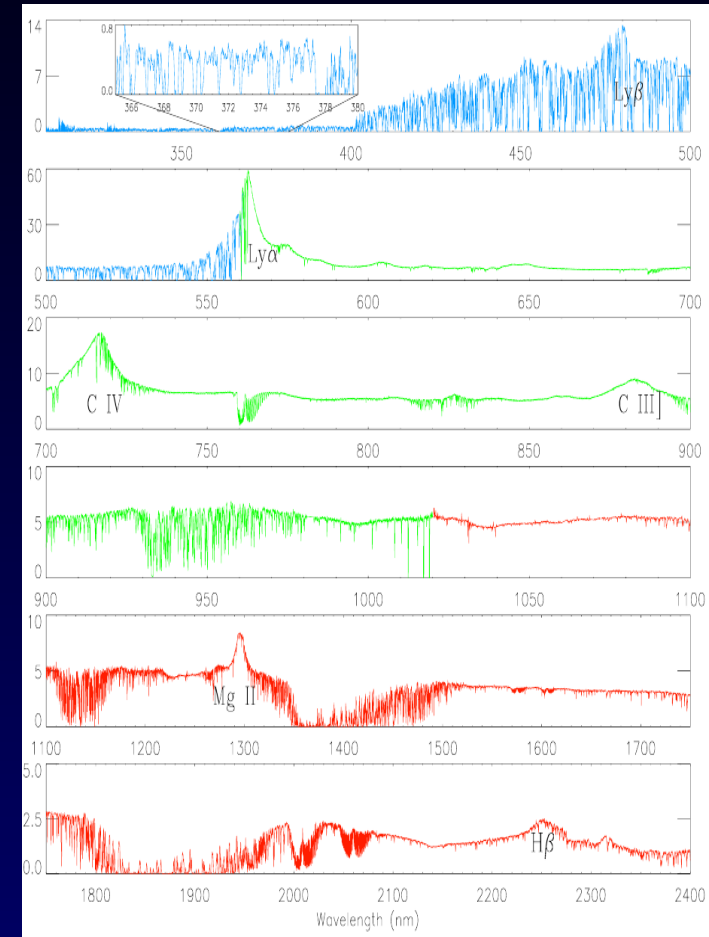


Figure 1. This image displays left to right the XSH UVB, VIS and NIR spectral formats with different image scales.



2936-24807 A,
R ~9100,17400,11300
0.5arcsec slit



High-z QSO
Vernet et al. 2011

Modigliani et al. 2010

HARPS-S



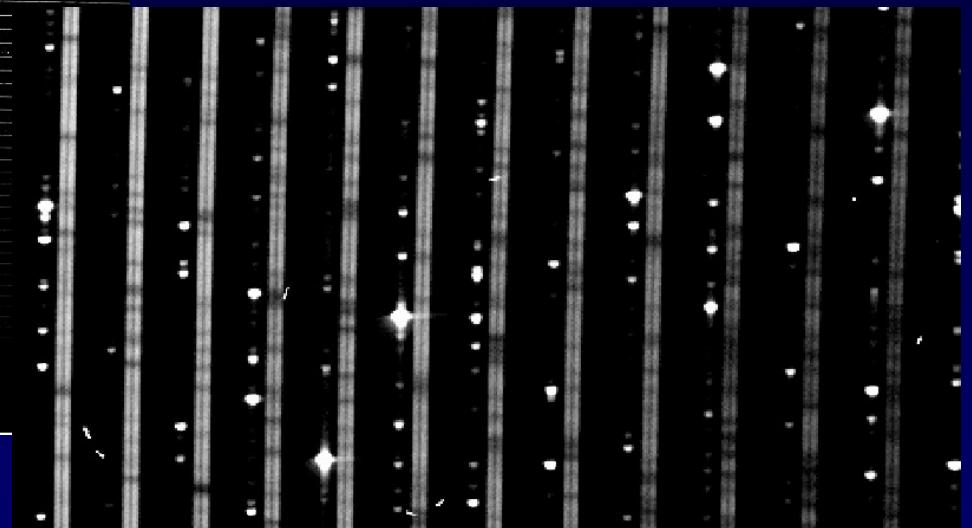
71 orders (89-161) – 115 not

3780-6910 Å

$R \sim 115000$

$dRV \sim 3 \text{ m/s}$

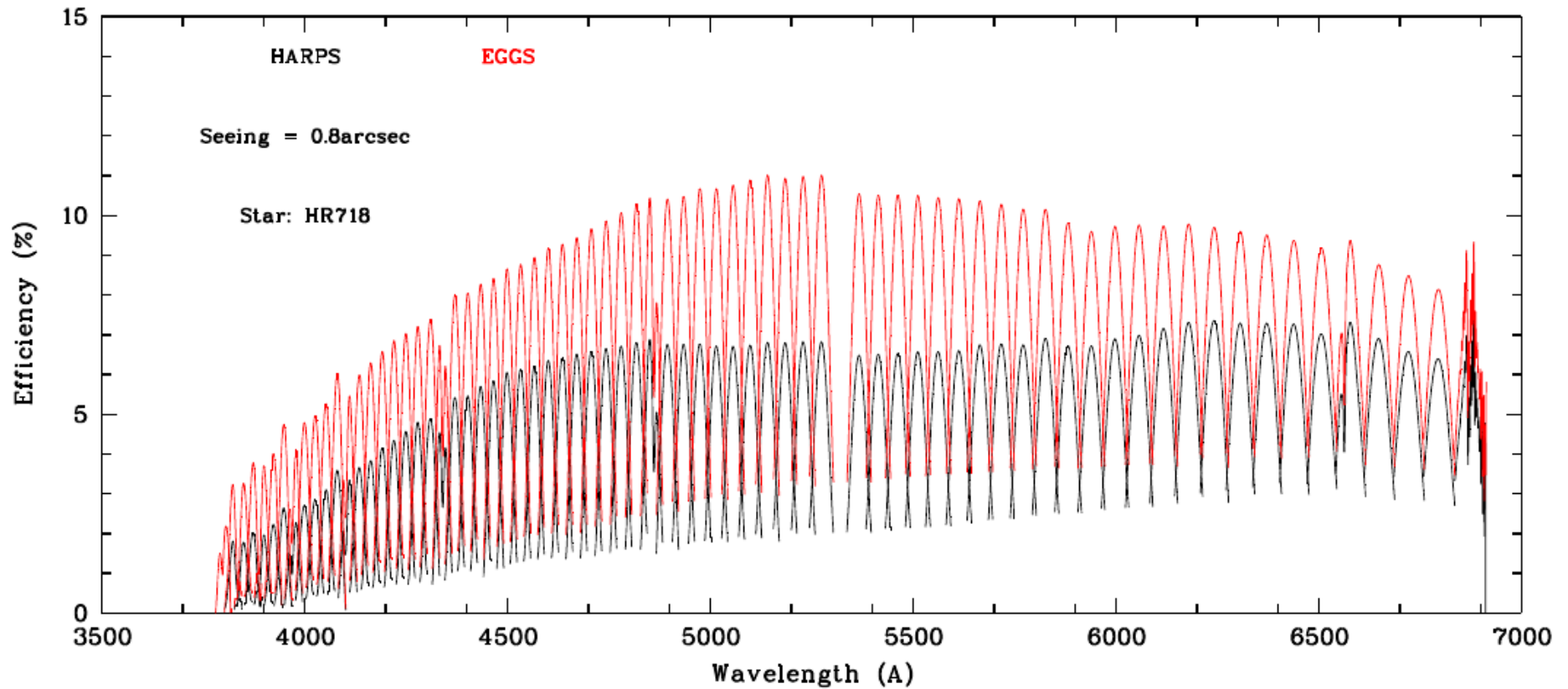
Simultaneous ThAr/Laser
comb/Fabry Perot



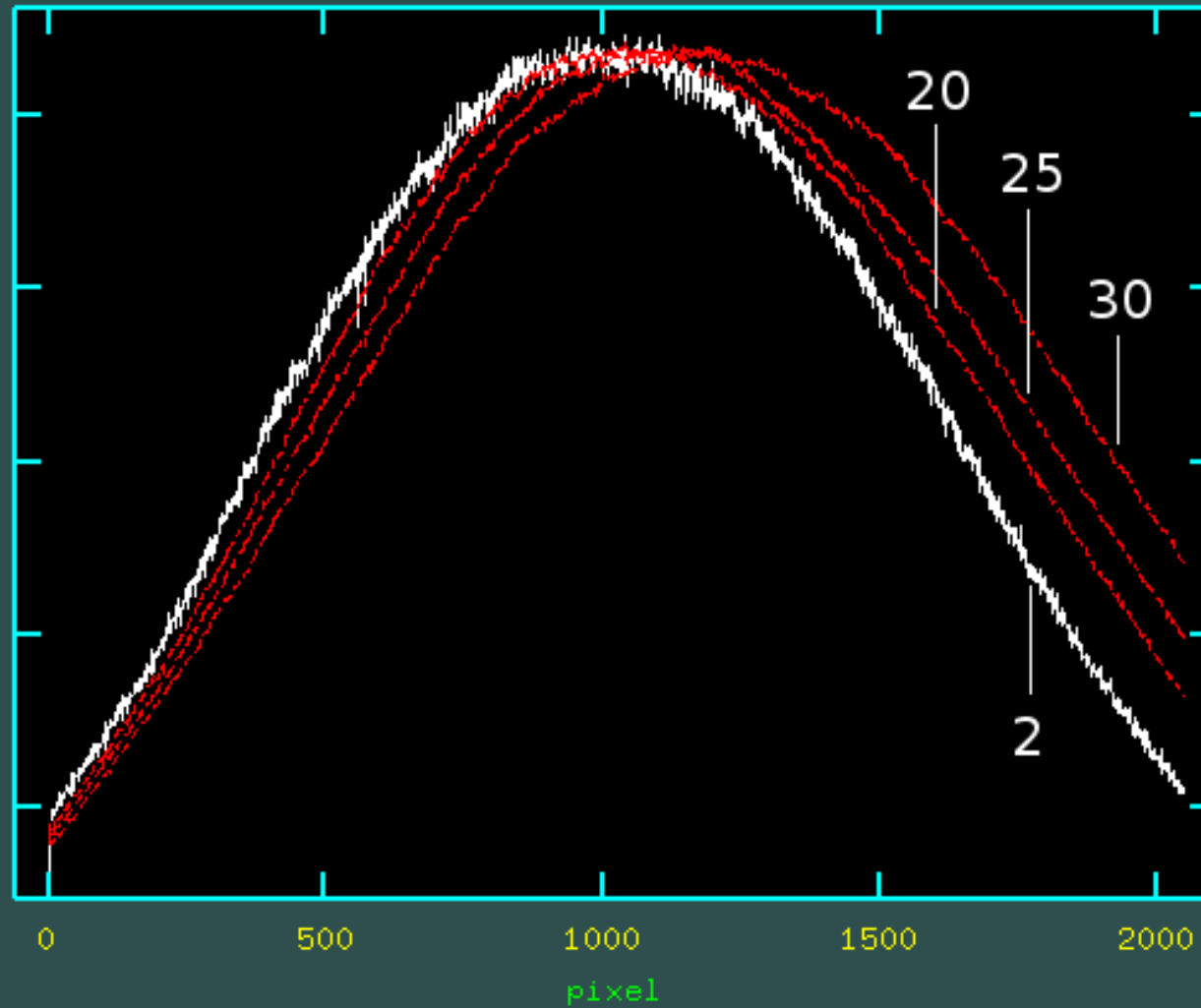
<https://cdn.eso.org/images/large/eso0308c.jpg>

PlatoSpec simcal ThAr

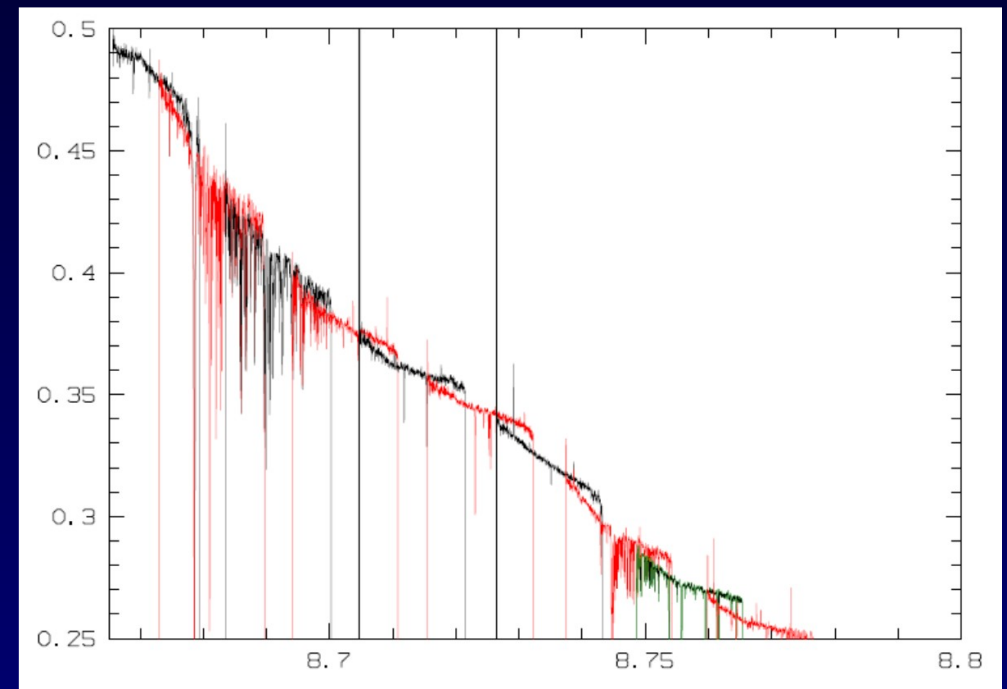
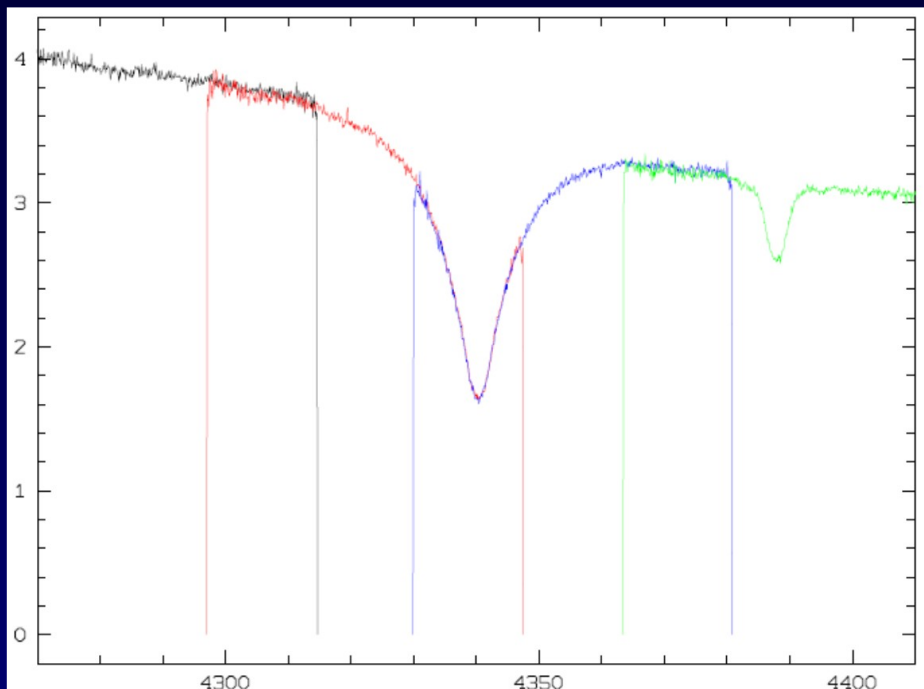
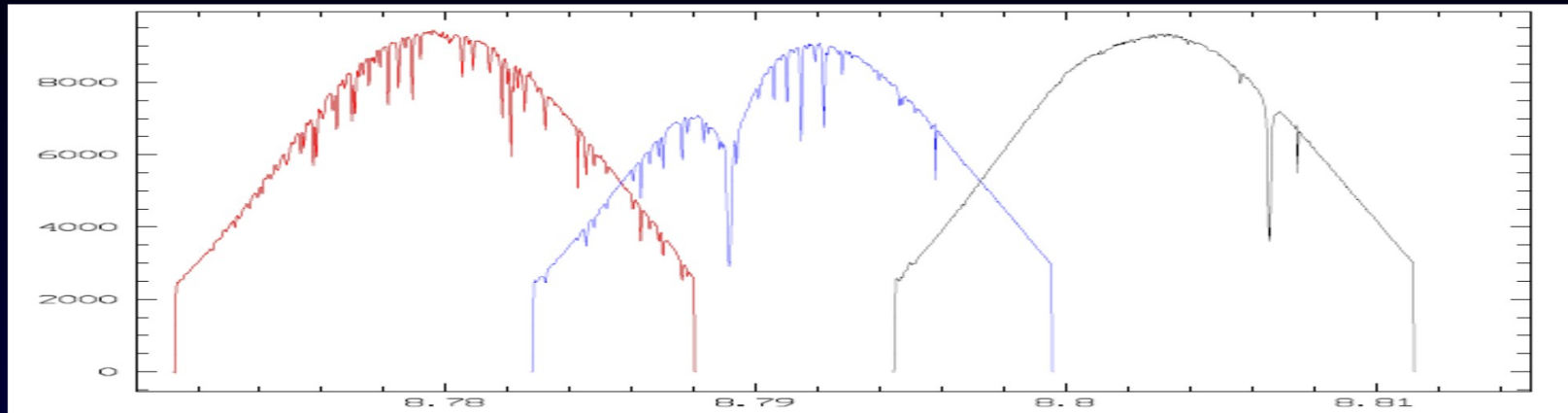
HARPS-S



OES Blaze shift



Echelle Spectra Problems in Hot Stars

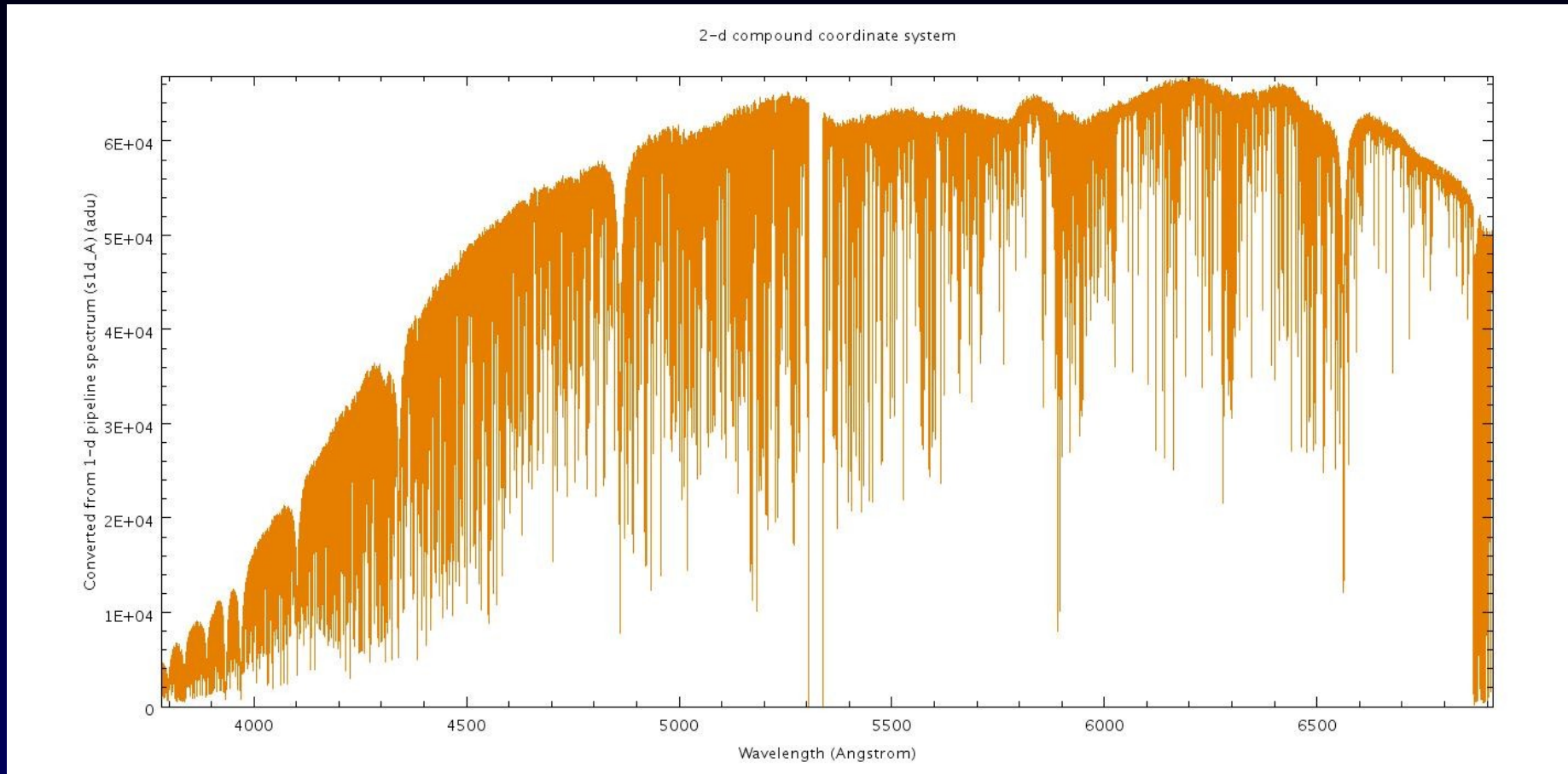


(Simple) Spectra in VO

VO Tools

- SPLAT-VO (GAVO – Ondrejov)
- CASSIS (OMP)
- IPAC Firefly (IRSAViewer)
 - All NASA data, LSST (Rubin)
 - Spectra in echelle – started
 - <https://github.com/Caltech-IPAC/firefly>
- Not Supported:
 - SpecView (HST)
 - VOSpec (ESA)

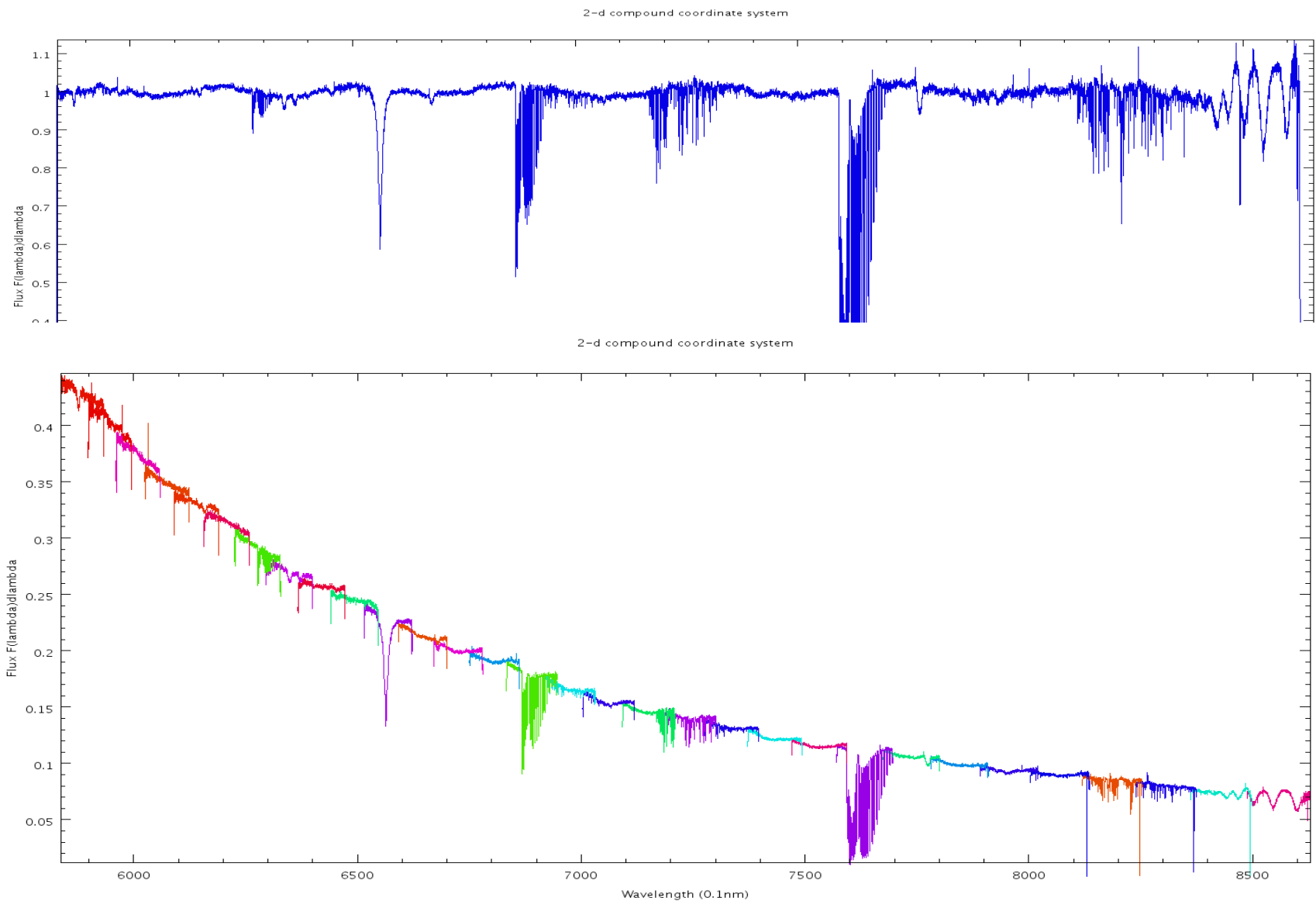
HARPS-S in SPLAT



313138 points

Procyon

DaCHS Testbed Split-Order SSAP



nu Pup HEROS red

Products derived from spectra

Time Series of Spectra

Series of Spectra – LPV

Starlink SPLAT-VO: <plot3>

File Analysis Edit Options Graphics Help



Displaying: 4 Her

Remove

Y limits (%): automatic

☐ :V-hair

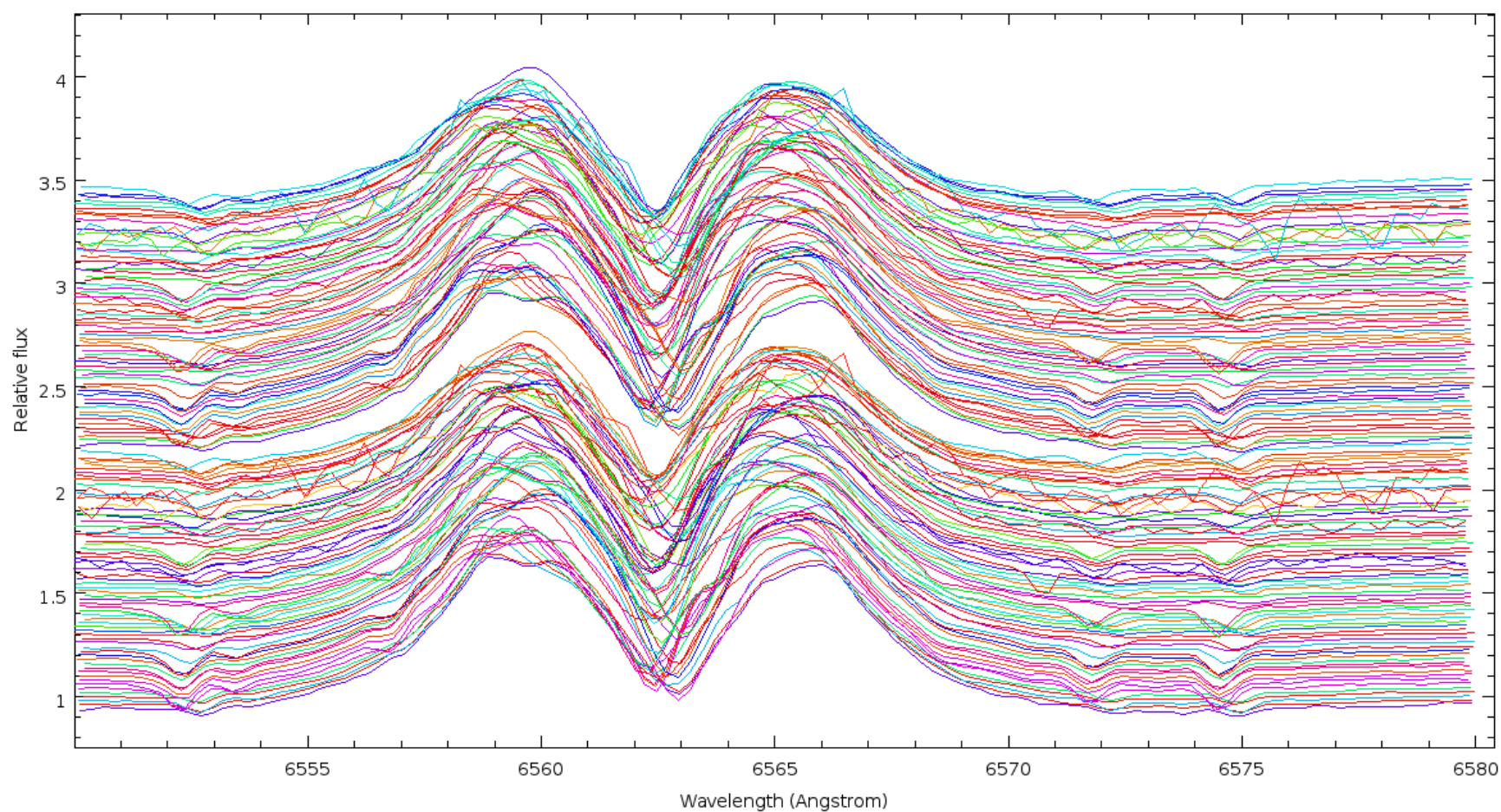
Wavelength: 6551.436 ☐ :log

Relative flux: 0.9117984 ☐ :log ☐ :Track free

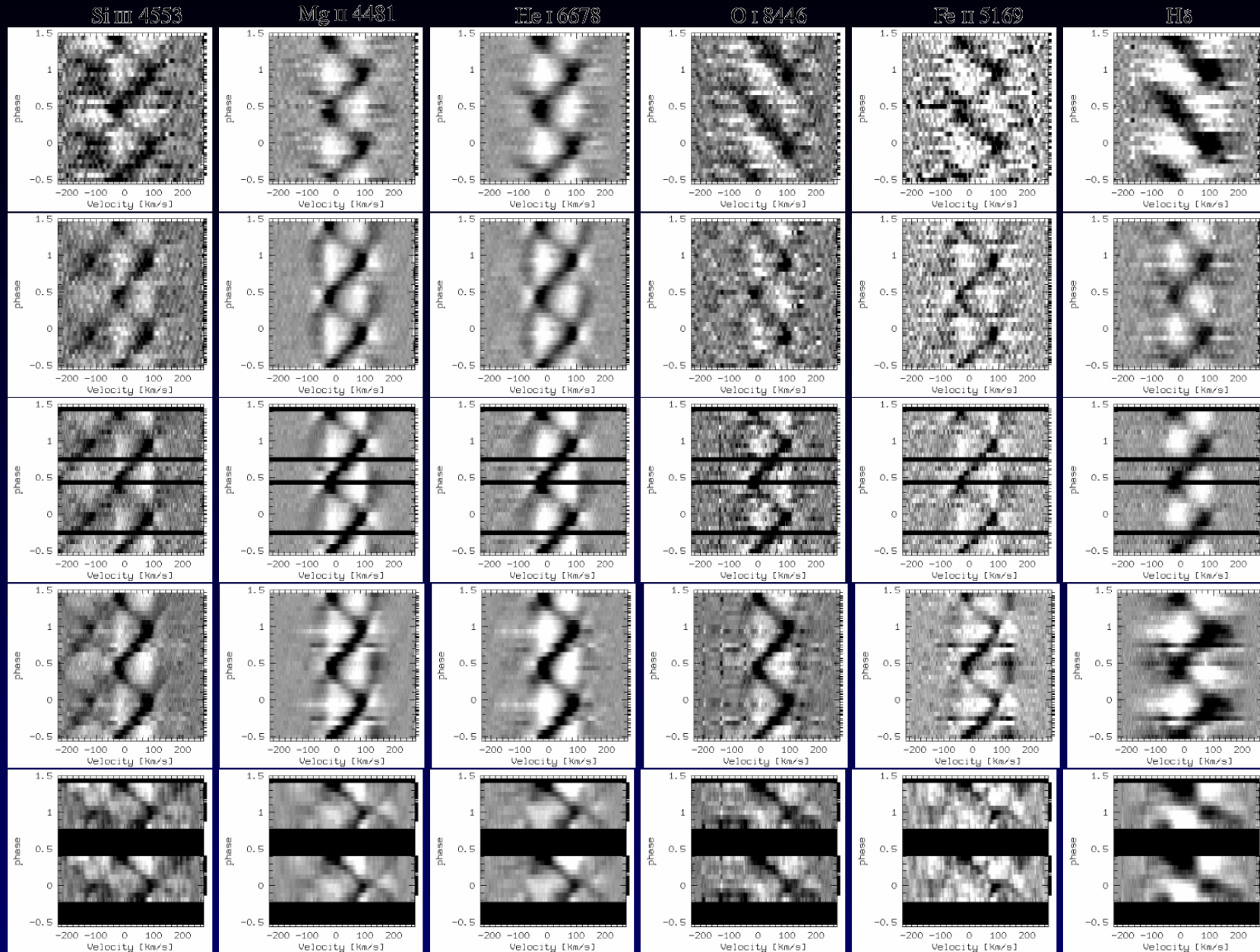
X scale: 1.0

Y scale: 1.0

2-d compound coordinate system

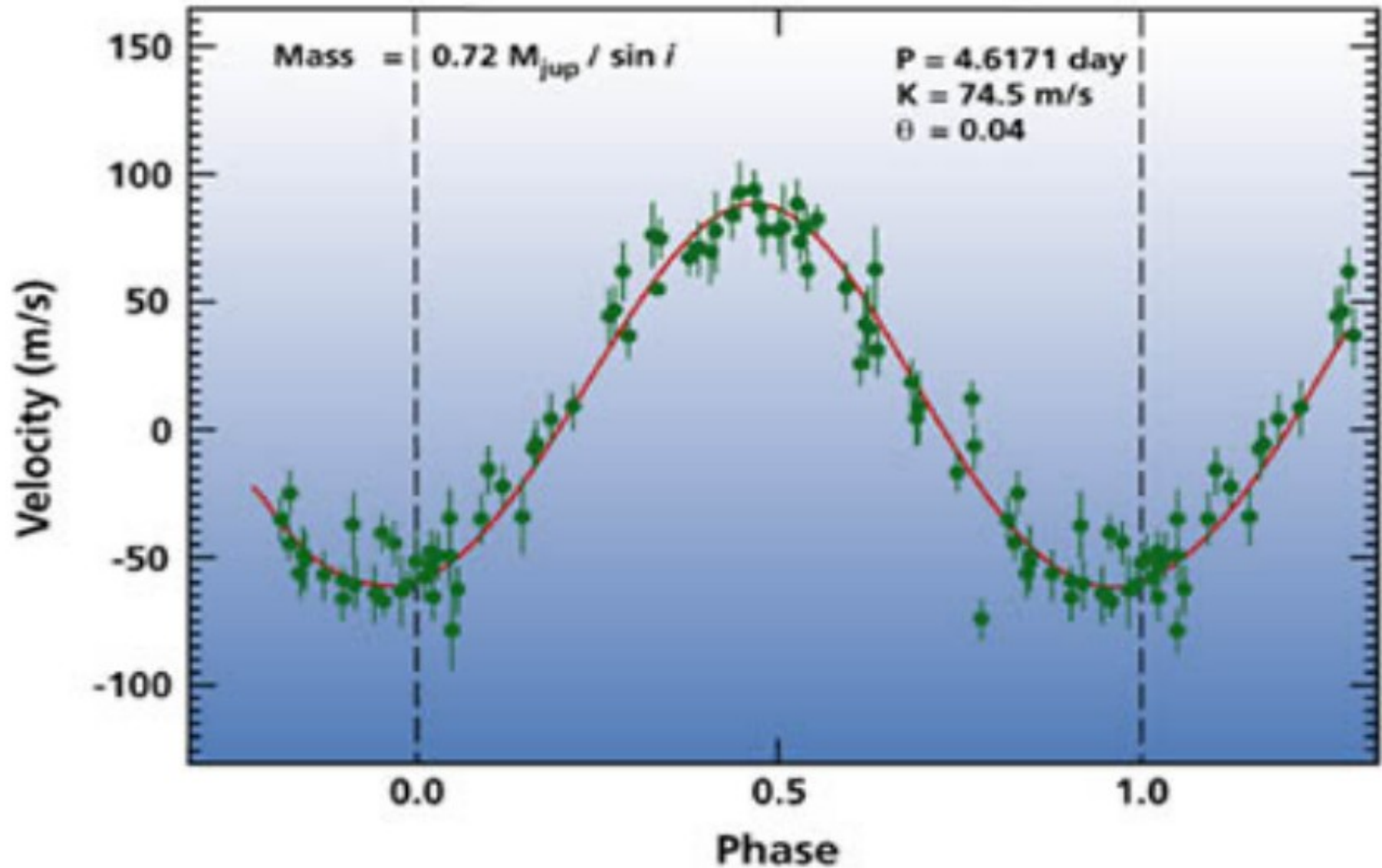


Dynamic Spectra

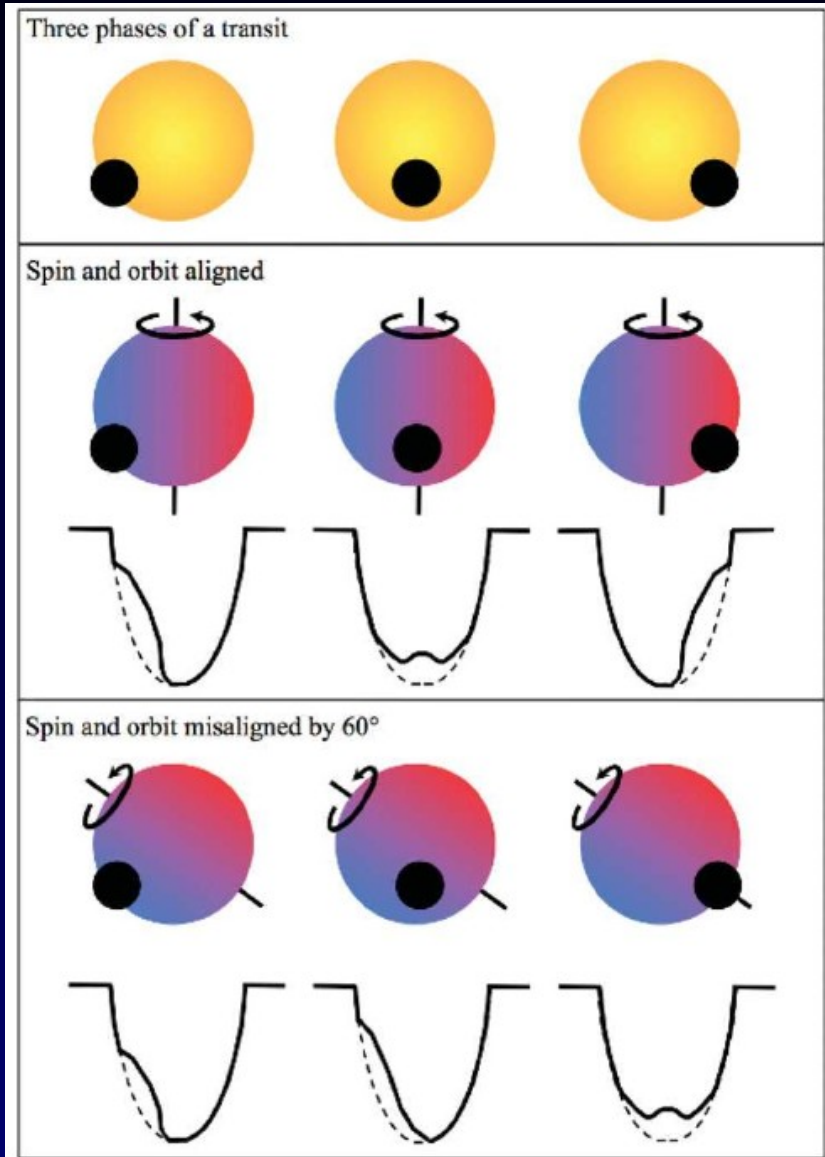


Radial Velocity Curve

Radial Velocity Curve

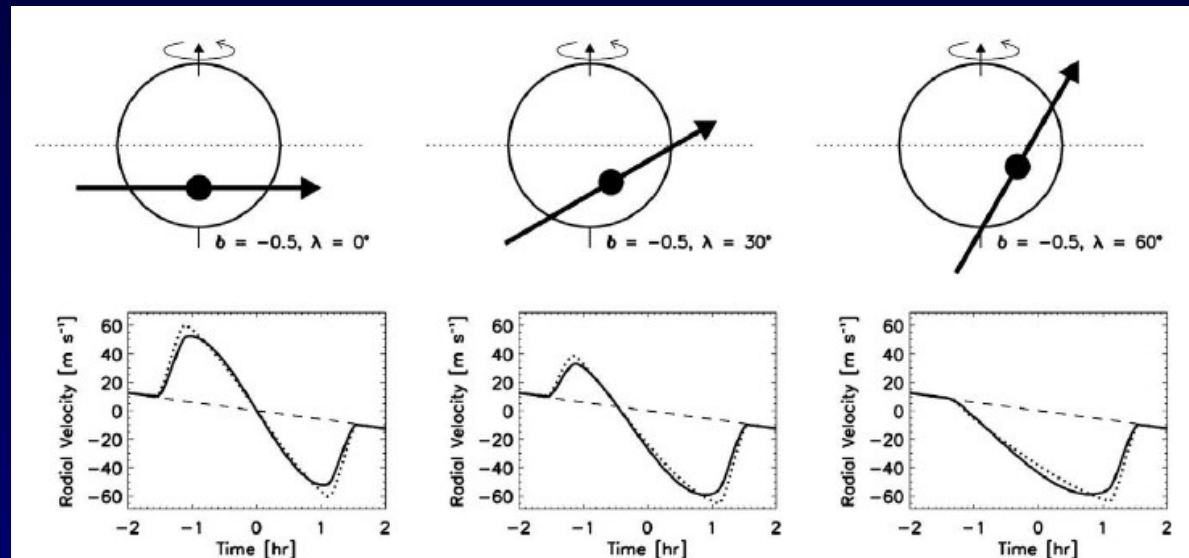


Rossiter-McLaughlin effect



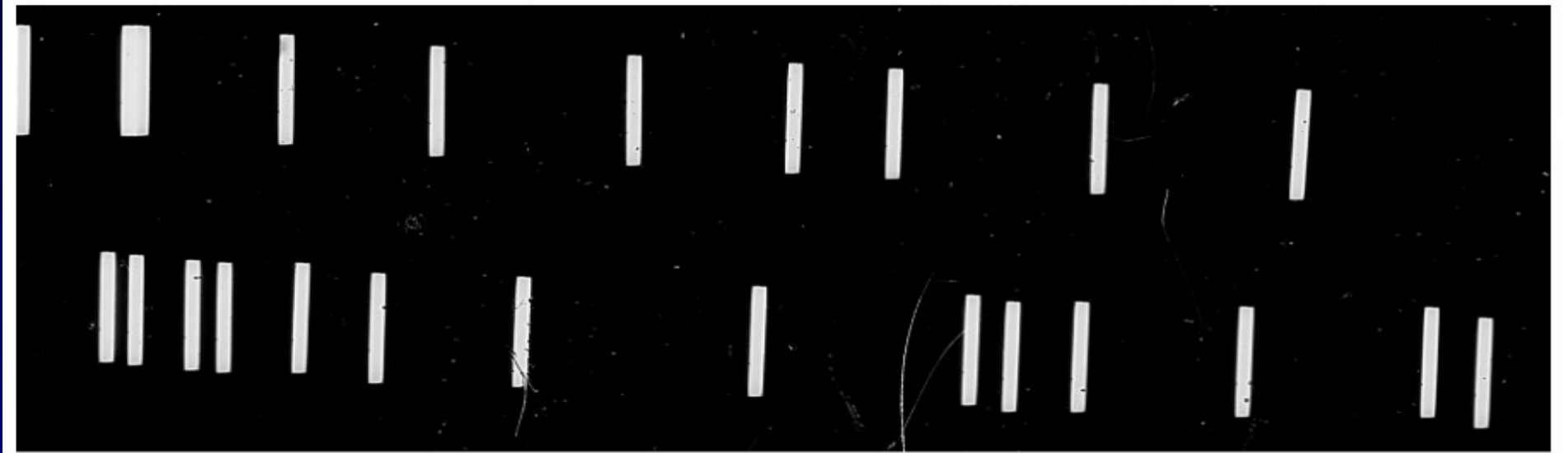
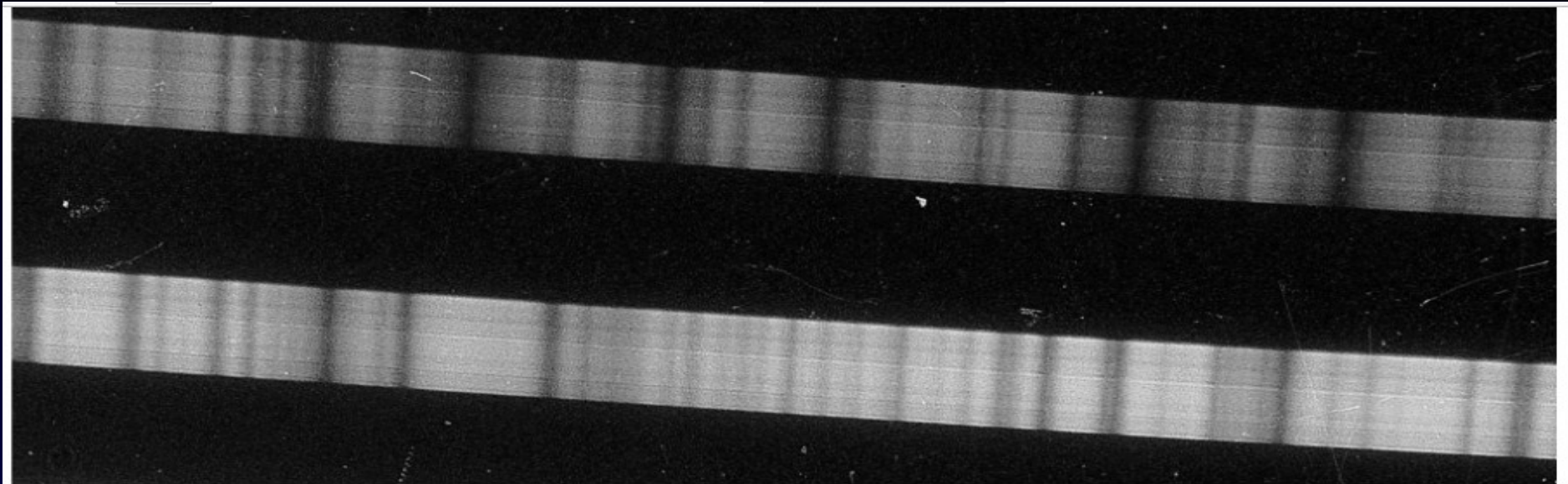
RV Curve – time series of RV

Only for direct occultation



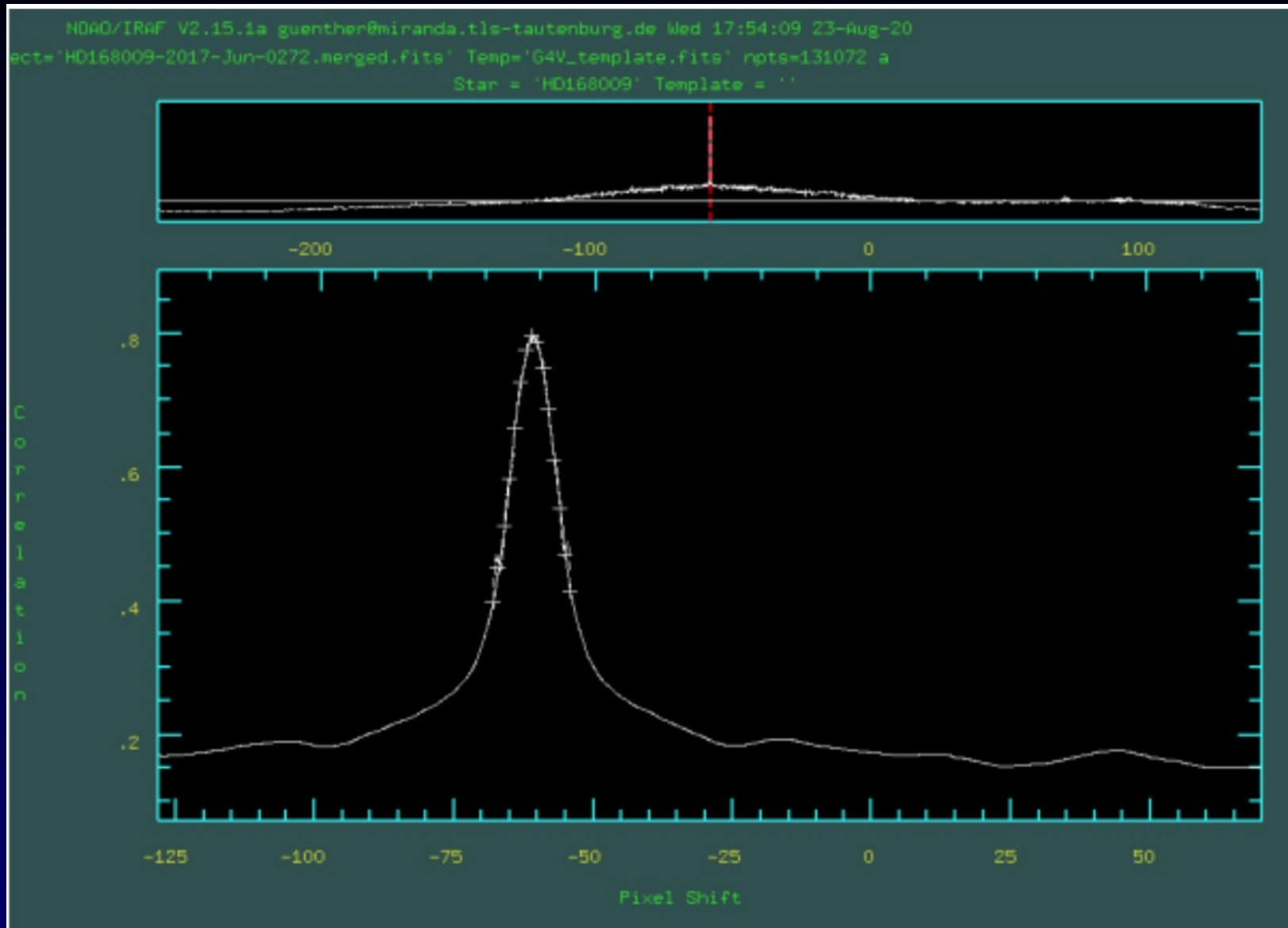
Cross Correlation Function

Analogue Technique



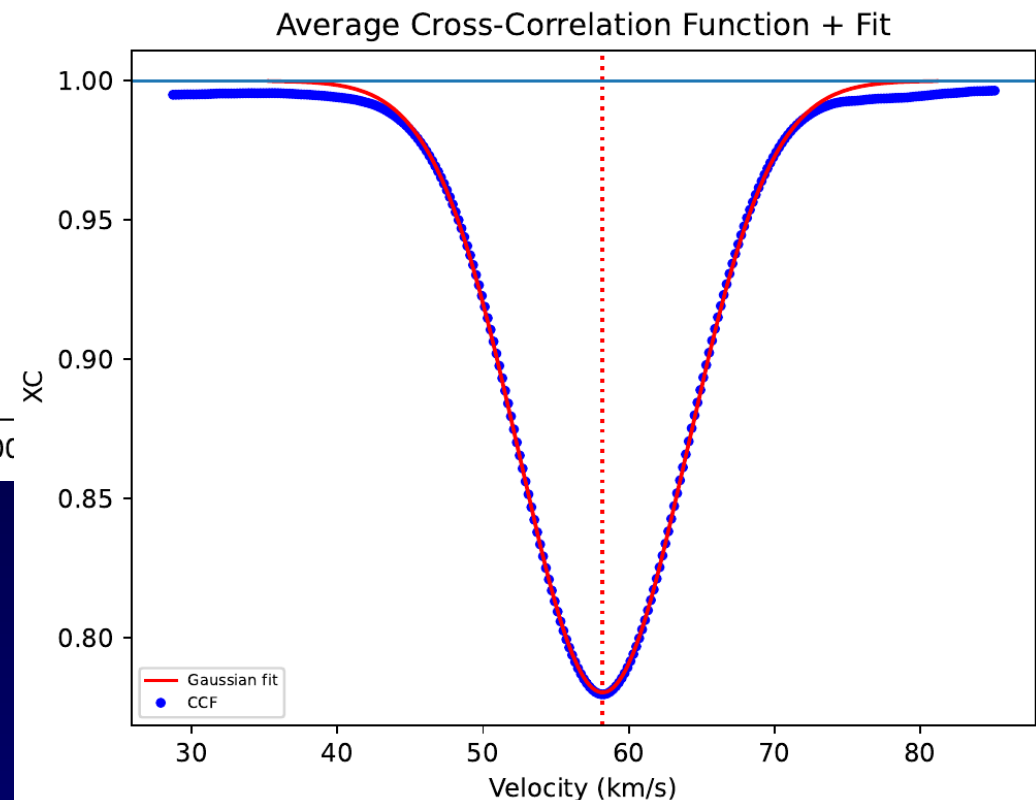
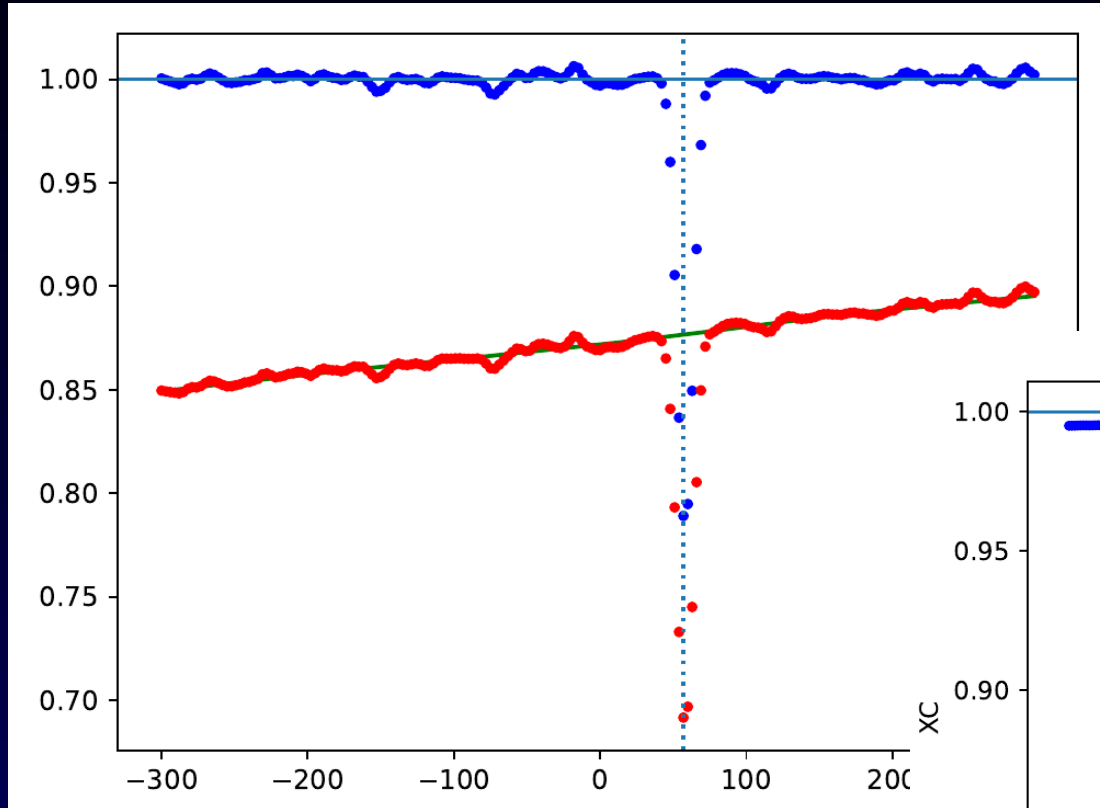
First principle Griffin 1967, DAO 122, CORAVEL ESO D154 1981

Cross Correlation Function



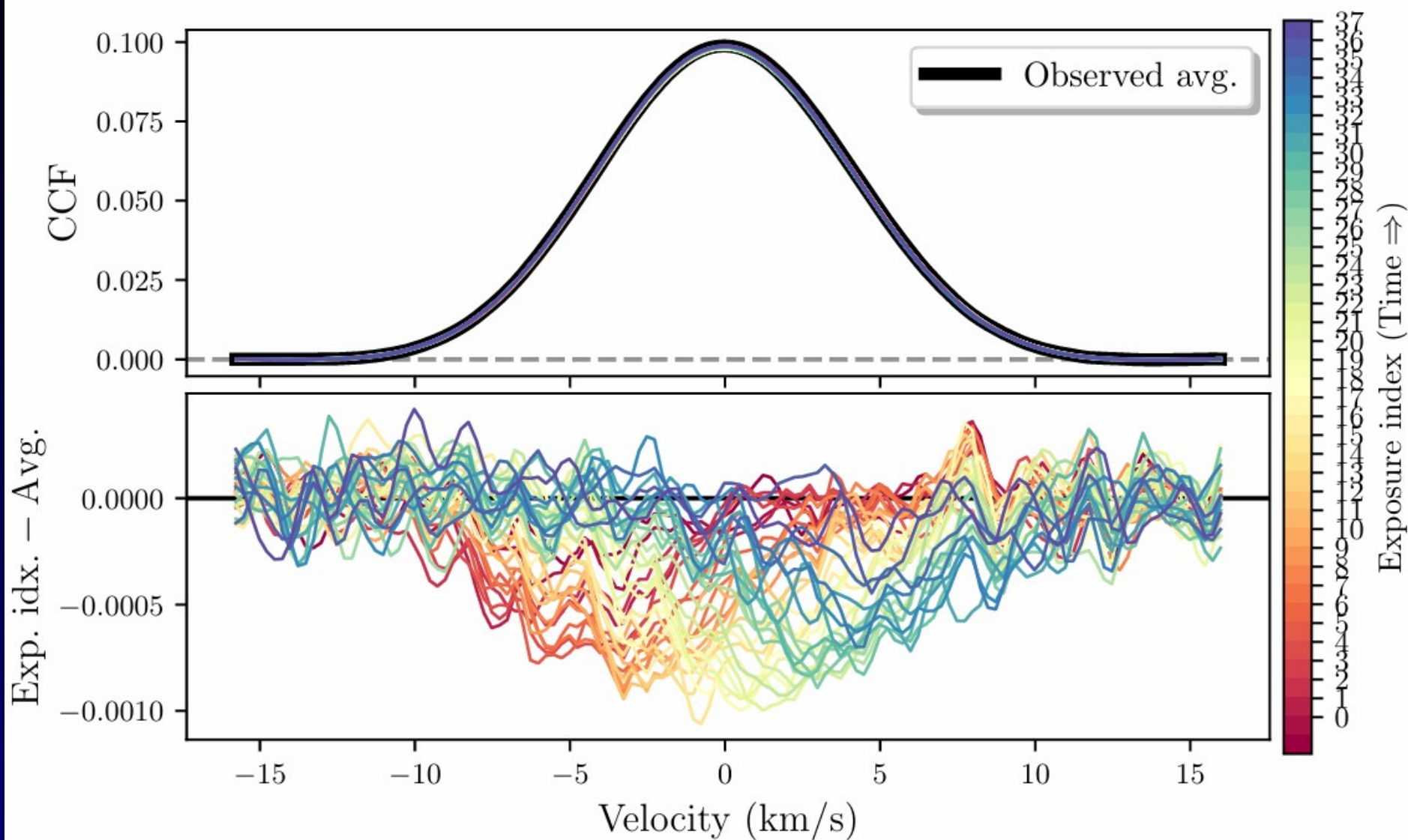
IRAF fxcor task

Cross Correlation Function - CCF

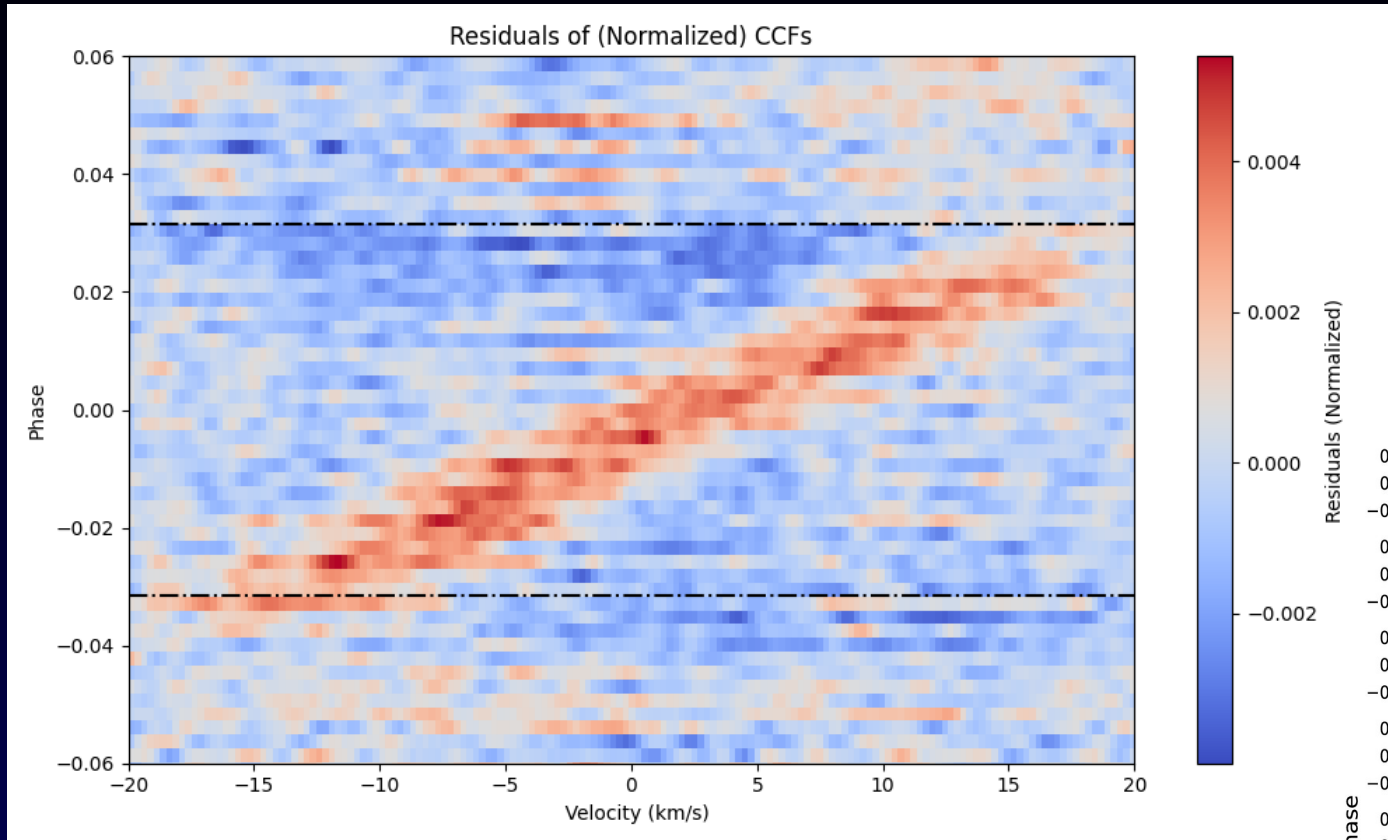


Example of PlatoSpec data reduced by CERES+

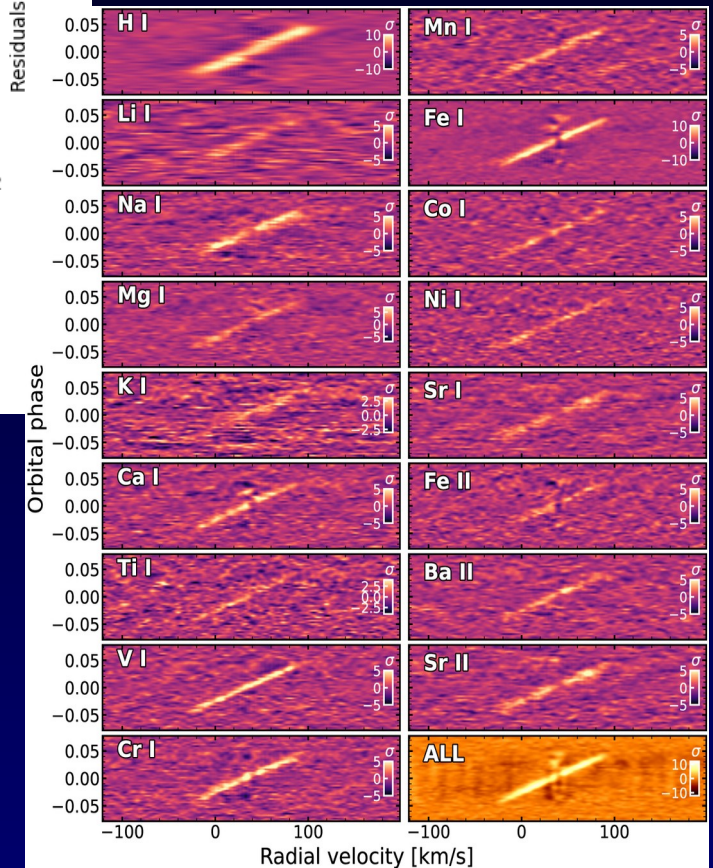
Residual CCF



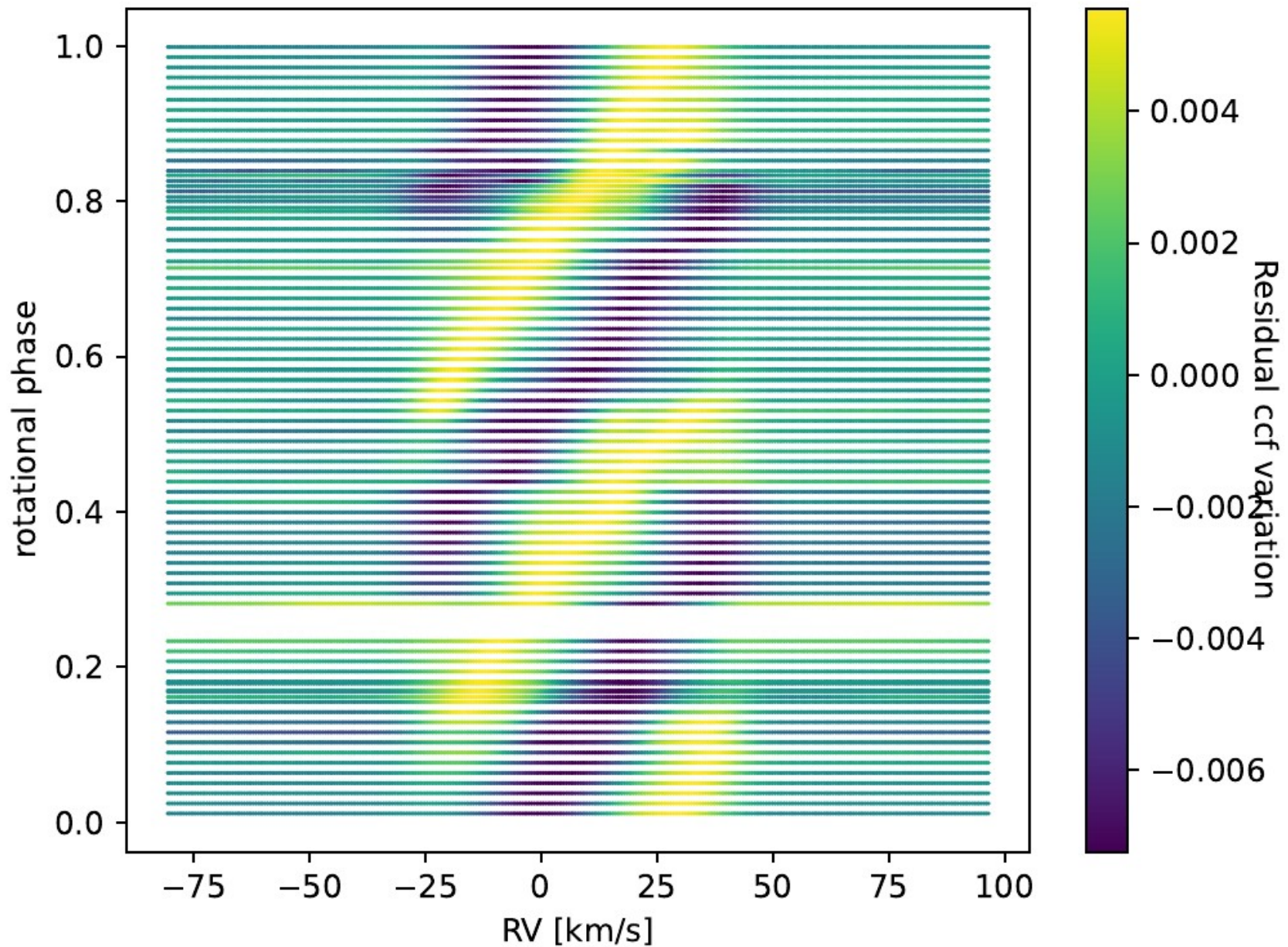
Doppler Shadow



HARPS-N archival CCF of HAT-P-41A. Balkoová 2025



Dynamic spectra – CCF



EPRV Standard

- About 15 spectrographs (~ 5 passively following)
e.g. CARMENES)
- Translators from native format
- Started 2024
- NASA JPL (EPRV project - WG)
- Bruce Berriman at IVOA 2025 June (after my advice to contact IVOA)

<https://github.com/EPRV-RCN/RVData>

<https://eprv-data-standard.readthedocs.io/en/latest>

EPRV L2 – Order by Order Unblazed

HDU	Name	DataType	MinBetDepth	Multiplicity	Required	Description
0	PRIMARY	PrimaryHDU		False	True	EPRV Standard FITS HEADER (no data)
1	INSTRUMENT_HEADER	ImageHDU		False	True	Inherited instrument header (no data)
2	RECEIPT	BinTableHDU		False	True	Table of operations that have been performed on this file
3	DRP_CONFIG	BinTableHDU		False	True	Pipeline details (settings etc) to go from native data to L2
4	EXT_DESCRIPTOR	BinTableHDU		False	True	Table describing contents of each extension
5	ORDER_TABLE	BinTableHDU		TRUE	TRUE	Table capturing the wavelength extent of each order
6	TRACE1_FLUX	ImageHDU		True	True	Flux in trace 1
7	TRACE1_WAVE	ImageHDU	64	True	True	wavelength solution for trace 1
8	TRACE1_VAR	ImageHDU		True	True	variance for trace 1
9	TRACE1_BLAZE	ImageHDU		True	True	blaze for trace 1
10	BARYCORR_KMS	ImageHDU		False	True	barycentric correction in km/s
11	BARYCORR_Z	ImageHDU		False	True	barycentric correction in redshift
12	BJD_TDB	ImageHDU	64	False	True	Photon weighted midpoint
13	DRIFT	ImageHDU		False	False	Drift measurement map in delta lambda
14	TRACE1_QUALITY	ImageHDU	UINT8	True	False	Quality of each pixel in trace 1
15	EXPMETER	BinTableHDU		False	False	Table of exposure meter counts timeseries over the exposure
16	TELEMETRY	BinTableHDU		False	False	Table of telemetry collected during the exposure
17	TRACE1_TELLURIC	ImageHDU		True	False	Telluric model for trace 1
18	TRACE1_SKYMODEL	ImageHDU		True	False	Sky model for trace 1
19	ANCILLARY_SPECTRUM	ImageHDU		True	False	Extension(s) that store ancillary spectra
20	IMAGE	ImageHDU		True	False	Extension(s) that store useful support images
21	CUSTOM1_TRACE1_FLUX	ImageHDU		True	False	Additionally corrected flux in trace 1
22	CUSTOM1_TRACE1_WAVE	ImageHDU		True	False	Additionally corrected wavelength solution for trace 1
23	CUSTOM1_TRACE1_VAR	ImageHDU		True	False	Additionally corrected variance for the flux in trace 1

EPRV L3 – Merged orders normalized

This is what we already know – SSAP, “distorted data low precision”

HDU	Name	DataType	Multiplicity	Required	Description
0	PRIMARY	PrimaryHDU	False	True	EPRV Standard FITS HEADER (no data)
1	INSTRUMENT_HEADER	ImageHDU	False	True	Inherited instrument header (no data)
2	RECEIPT	BinTableHDU	False	True	Table of operations that have been performed on this file
3	DRP_CONFIG	BinTableHDU	False	True	Pipeline details (settings etc) to go from native data to L2
4	ORDER_TABLE	BinTableHDU	TRUE	TRUE	Table capturing the wavelength extent of each order
5	STITCHED_CORR_TRACE1_FLUX	ImageHDU	True	True	Order stitched blaze-corrected flux in trace 1
6	STITCHED_CORR_TRACE1_WAVE	ImageHDU	True	True	Order stitched BC- and drift-corrected wavelength solution for trace 1
7	STITCHED_CORR_TRACE1_VAR	ImageHDU	True	True	Order stitched variance for the flux in STITCHED_CORR_TRACE1_FLUX
8	COMBINED_STITCHED_CORR_FLUX	ImageHDU	True	True	Order stitched and blaze-corrected flux co-added across all traces
9	COMBINED_STITCHED_CORR_WAVE	ImageHDU	True	True	Order stitched BC- and drift-corrected wavelength solution
10	COMBINED_STITCHED_CORR_VAR	ImageHDU	True	True	Order stitched variance for the combined flux in COMBINED_STITCHED_CORR_FLUX
11	STITCHED_CUSTOMCORR1_TRACE1_FLUX	ImageHDU	True	False	Additional corrections made to STITCHED_CORR_TRACE1_FLUX
12	STITCHED_CUSTOMCORR1_TRACE1_WAVE	ImageHDU	True	False	Wavelength solution corresponding to STITCHED_CUSTOMCORR1_TRACE1_FLUX
13	STITCHED_CUSTOMCORR1_TRACE1_VAR	ImageHDU	True	False	Variance corresponding to STITCHED_CUSTOMCORR1_TRACE1_FLUX
14	COMBINED_STITCHED_CUSTOMCORR1_FLUX	ImageHDU	True	False	Additional corrections made to COMBINED_STITCHED_CORR_FLUX
15	COMBINED_STITCHED_CUSTOMCORR1_WAVE	ImageHDU	True	False	Wavelength solution corresponding to COMBINED_STITCHED_CORR_WAVE
16	COMBINED_STITCHED_CUSTOMCORR1_VAR	ImageHDU	True	False	Variance corresponding to COMBINED_STITCHED_CORR_VAR

EPRV L4 – Derived core exo science

Radial Velocity and Cross Correlation Function (various masks)

It is the most important output of pipeline

But exoscientists need Time Series (RV curves , Doppler shadows)

VO can do it on the fly (select all observation, apply SODA extract , create time series)

HDU	Name	DataType	Multiplicity	Required	Description
0	PRIMARY	PrimaryHDU	FALSE	TRUE	EPRV Standard FITS HEADER (no data)
1	INSTRUMENT_HEADER	ImageHDU	FALSE	TRUE	Inherited instrument header (no data)
2	RECEIPT	BinTableHDU	FALSE	TRUE	Table of operations that have been performed on this file
3	DRP_CONFIG	BinTableHDU	FALSE	TRUE	Pipeline details (settings etc) to go from native data to L2
4	RV1...N	BinTableHDU	TRUE	TRUE	Derived Radial Velocity Measurement
5	CCF1...N	ImageHDU	TRUE	FALSE	Array with same dimensionality of RV1...N, that contains the CCF that produced each RV1...N
6	DIAGNOSTICS1...J	BinTableHDU	TRUE	FALSE	Activity indicators, CCF metrics, etc
7	CUSTOM_CCF1...N	ImageHDU	TRUE	FALSE	Additional CCFs from (e.g.) different masks
8	CUSTOM_RV1...N	BinTableHDU	TRUE	FALSE	Derived Radial Velocity Measurement from CUSTOM_CCF1...N

EPRV L4 – ESPRESSO Tau Cet

fv: Summary of ESPRE.2021-10-03T06:24:23.449_L4.fits in /home/skoda/EPRV/ESSPRESO/data_standard/

Index	Extension	Type	Dimension	View				
0	Primary	Image	0	Header	Image	Table		
1	INSTRUMENT_HDFR	Image	n	Header	Image	Table		
2	RECEIPT	Binary	0 cols X 0 rows	Header	Hist	Plot	All	Select
3	DRP_CONFIG	Binary	0 cols X 0 rows	Header	Hist	Plot	All	Select
4	RV1	Binary	6 cols X 1 rows	Header	Hist	Plot	All	Select
5	EXT_DESCRIPTOR	Binary	6 cols X 6 rows	Header	Hist	Plot	All	Select
6	CCF1	Image	81 X 171	Header	Image	Table		
7	DIAGNOSTICS1	Binary	4 cols X 3 rows	Header	Hist	Plot	All	Select
8	RV_TEL_CORR	Binary	6 cols X 1 rows	Header	Hist	Plot	All	Select
9	CCF_TEL_CORR	Image	81 X 171	Header	Image	Table		

fv: Image of ESPRE.2021-10-03T06:24:23.449_L4.fits[6] in /home/skoda/EPRV/ESSPRESO/data_standard/

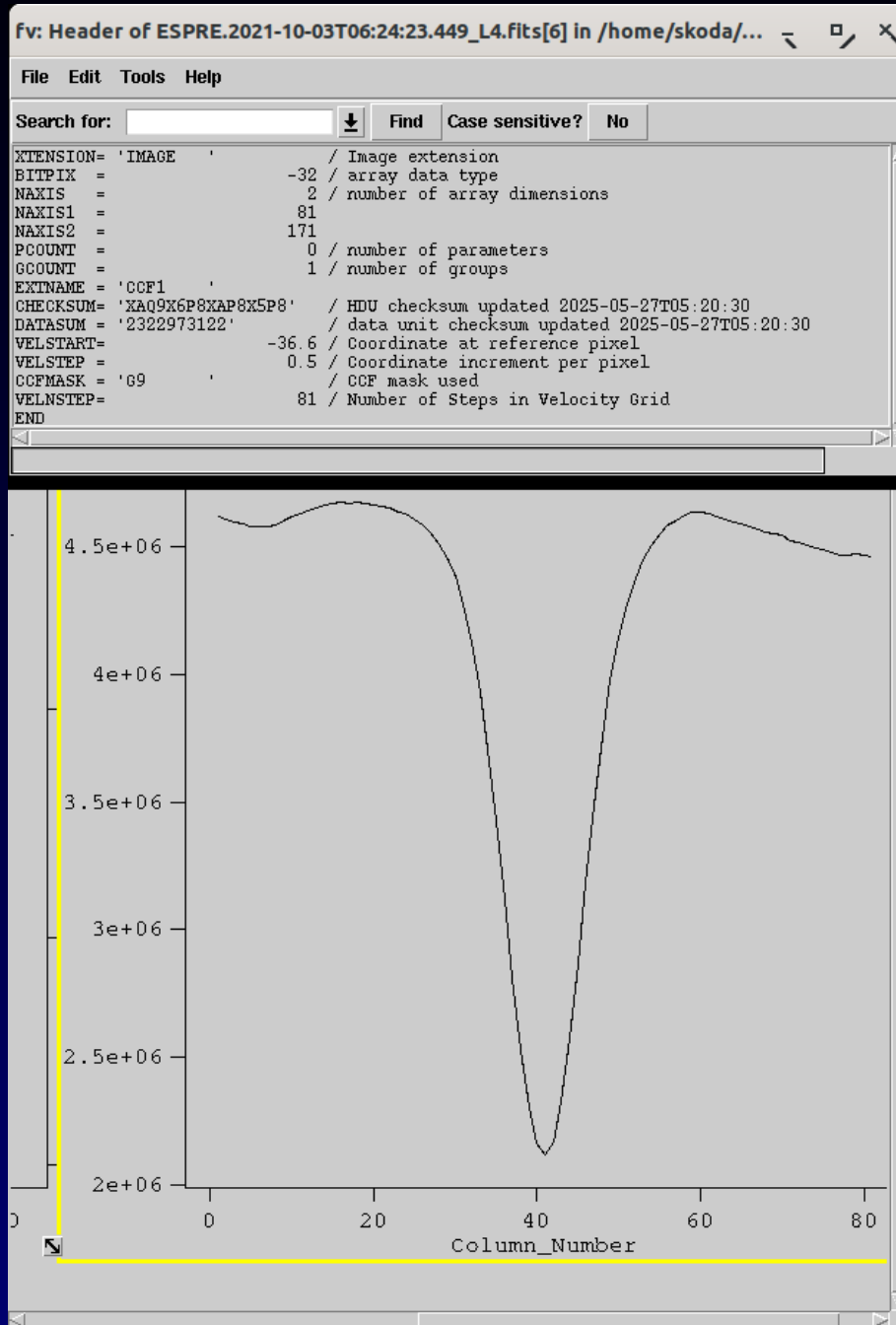
Select
☒ All
 Invert

	1	2	3	4	5	6
98	5.26381e+06	5.26814e+06	5.26253e+06	5.26152e+06	5.25577e+06	5.25909e+06
97	4.93282e+06	4.9213e+06	4.92542e+06	4.92336e+06	4.92463e+06	4.92166e+06
96	5.64695e+06	5.63776e+06	5.63015e+06	5.61536e+06	5.58759e+06	5.55647e+06
95	5.27117e+06	5.259e+06	5.24219e+06	5.2263e+06	5.2046e+06	5.1804e+06
94	5.50534e+06	5.47118e+06	5.43957e+06	5.39959e+06	5.35634e+06	5.30384e+06
93	5.02342e+06	4.99754e+06	4.9695e+06	4.93366e+06	4.89204e+06	4.84796e+06
92	2.18587e+06	2.19189e+06	2.18693e+06	2.18391e+06	2.18239e+06	2.18064e+06
91	1.86196e+06	1.86149e+06	1.8596e+06	1.85738e+06	1.85636e+06	1.85244e+06
90	4.54433e+06	4.53008e+06	4.52264e+06	4.51101e+06	4.50543e+06	4.50644e+06
89	4.61856e+06	4.61068e+06	4.59623e+06	4.58902e+06	4.58102e+06	4.57993e+06
88	5.21423e+06	5.23318e+06	5.24848e+06	5.26762e+06	5.27702e+06	5.29468e+06
87	4.90491e+06	4.91717e+06	4.93551e+06	4.95675e+06	4.97213e+06	4.98265e+06
86	6.9235e+06	6.91467e+06	6.9163e+06	6.90327e+06	6.87164e+06	6.83962e+06
85	6.53055e+06	6.53232e+06	6.52367e+06	6.50842e+06	6.48675e+06	6.45614e+06
84	3.60443e+06	3.60589e+06	3.60856e+06	3.60729e+06	3.60377e+06	3.59144e+06
83	3.36668e+06	3.3637e+06	3.36409e+06	3.36489e+06	3.36121e+06	3.35394e+06
82	125850	127562	130461	129012	129511	130110
81	119783	121979	123595	124569	124390	123490
80	4.75847e+06	4.7726e+06	4.78419e+06	4.78505e+06	4.79347e+06	4.79598e+06
79	4.52354e+06	4.53738e+06	4.54066e+06	4.54695e+06	4.55432e+06	4.56287e+06

Go to: Edit cell: ☒ Lock to Parent

Thanks:
 E.Fontanet
 2025 priv.com.

EPRV L4 CCF in fv



VLSTART=-36.6 km/s
VELSTEP=0.5 km/s

Center~41

$$-36.6 + 40 \times 0.5 = -16.6$$

Astrometry	
Radial velocity (R_v)	$-16.68 \pm 0.05^{[5]}$ km/s
Proper motion (μ)	RA: -1721.728 mas/yr ^[1]
	Dec.: $+854.963$ mas/yr ^[1]
Parallax (π)	273.8097 ± 0.1701 mas ^[1]

Thanks:
E.Fontanet
2025 priv.com.

Light Curves Gaia DR2 - Query

Starlink SPLAT-VO: Query VO for Spectra

File Options Resolver Interop Help

Service selection options

Data Source

☒ Observed data ☐ Theoretical data

Wave Band

☐ Radio ☐ Millimeter ☐ Infrared
☐ Optical ☐ UV ☐ EUV
☐ X-ray ☐ Gamma-ray ☒ ALL

Data type

☒ Spectrum ☐ Time series

Tags

SSAP Servers

short name ^	title
ELODIE	ELODIE archive
ELODIEinterp	Spectrum interpolator f...
ESO SSAP	ESO 1D reduced spectra
EUVE	Extreme Ultraviolet Exp...
F/H Orders SSAP	Flash/Heros Split-Order...
FEROS SSAP	FEROS Public Spectra
FGKM-Yee2017	Yee et al. 2017
Flash/Heros SSAP	Flash/Heros SSAP
FUSE	Far Ultraviolet Spectro...
Gaia Benchmarks	The Gaia FGK Benchma...
GAMA3 SSAP	GAMA DR3 spectra
GAUDIVO	SSAP for GAUDI
GDR2 TS SSAP	Gaia DR2 light curves S...
gdr3spec SSAP	Gaia DR3 MC sampled ...
GOT_Cplus	Galactic Observations ...
HALOMASTER	HaloSat Master Catalog
HEROS SSAP	Ondrejov H Spectra
Herschel SSAP	Herschel ESA Archive S...
HEXOS	Herschel observations ...
HFA	HyperLeda FITS Archive...
HIFISTARS	HIFISTARS
HIG	HI Extragalactic Datab...
HITOMASTER	Hitomi Master Catalog
HOP	Herschel Oxygen Project
HPOL	Wisconsin Halfwave Sp...
Hubble SSAP ESA	European HST Archive ...
HUT	Hopkins Ultraviolet Tel...
Iacob	IACOB Spectroscopic D...
INES ARCHIVE	INES: The IUE Newly Ext...
INTEGRAL/BSC	INTEGRAL Bright Sourc...
IRS_Enh	Spitzer IRS Enhanced P...
IRS_Std	Spectra of IRS Standar...
IRSA SSA	IRSA Simple Spectral A...
ISO SSAP	Infrared Space Observ...
IUE	International Ultraviole...

Search parameters:

Simple Query

Object: sz tau

RA: 04:37:14.778 Dec: +18:32:34.93

Radius: 5 MAXREC:

Band:

Time:

Query Format:

Wavelength calibration:

Flux calibration:

Optional Parameters

Use	Name	Value	UCD
☐	APERTURE		phys.angSize;instr.fov
☐	SNR		stat.snr
☐	REDSHIFT		src.redshift
☐	TARGETCLASS		src.class
☐	MTIME		
☐	SPATRES		pos.angResolution
☐	SPECPR		

Query: <SERVER>?REQUEST=queryData&POS=69.31157499999999,18.543036111111111&SIZE=0.08333333333333333

Query results:

GDR2 TS SSAP

...	ssa_specstart	ssa_specend	ssa_dstitle	ssa_targname	ssa_dateObs	ssa_timeExt
1	3.25000E-7	1.00000E-6	Gaia DR2 Gaia G lightcurve for 3409635486731094400	Gaia DR2 3409635486731094400	57179.65651	540.962
2	3.25000E-7	6.70000E-7	Gaia DR2 Gaia BP lightcurve for 3409635486731094400	Gaia DR2 3409635486731094400	57179.65683	540.962
3	6.25000E-7	1.00000E-6	Gaia DR2 Gaia RP lightcurve for 3409635486731094400	Gaia DR2 3409635486731094400	57179.65691	540.962

SSAP Service Information

short name: GDR2 TS SSAP

title: Gaia DR2 light curves SSA

description:

identifier: ivo://org.gavo.dc/gaia/q2/ssa

publisher: The GAVO DC team

contact: GAVO Data Centre Team
(gavo@ari.uni-heidelberg.de)
(gavo@ari.uni-heidelberg.de)
(gavo@ari.uni-heidelberg.de)

access URL: http://dc.g-vo.org/gaia/q2/ssa/ssap.xml?

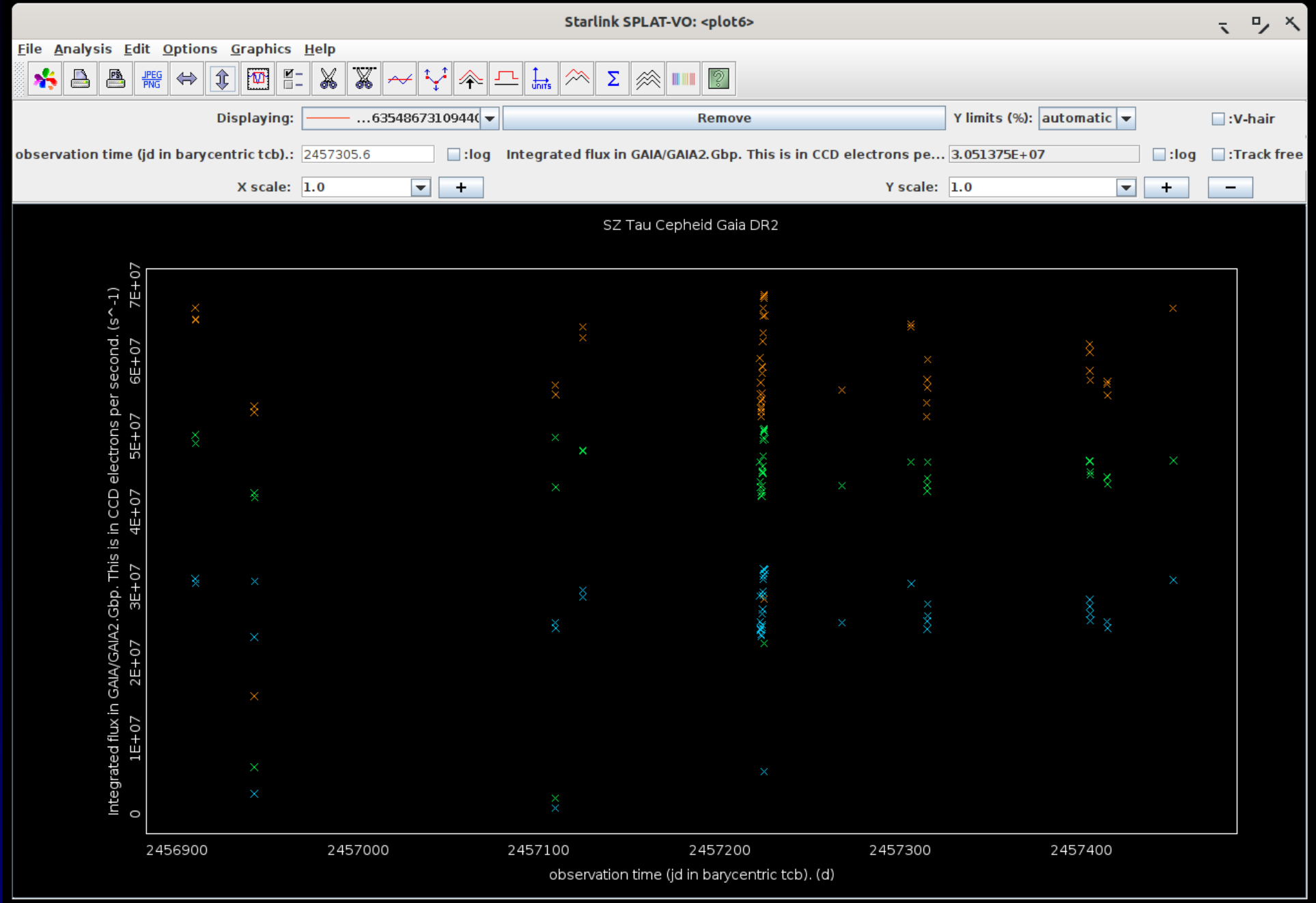
reference URL: http://dc.g-vo.org/gaia/q2/ssa/info

waveband: optical

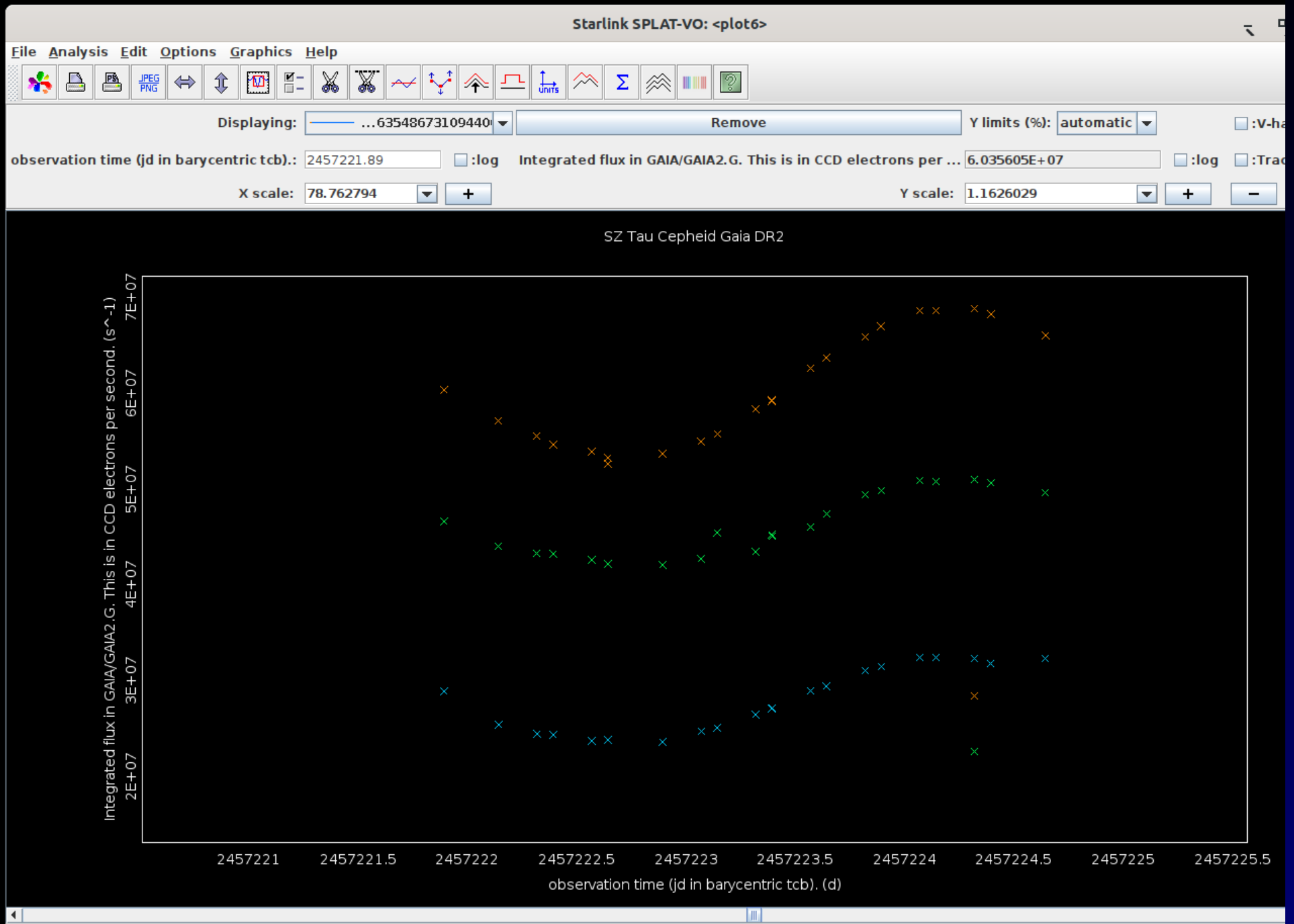
content type:

data source: survey

Gaia DR2 Light Curves



Gaia DR2 Light Curves - Zoom



Trappist-1 RV Curve – Carmenes

Starlink SPLAT-VO: Query VO for Spectra

File Options Resolver Interop Help

Service selection options

Data Source
☒ Observed data ☐ Theoretical data

Wave Band
☐ Radio ☐ Millimeter ☐ Infrared
☐ Optical ☐ UV ☐ EUV
☐ X-ray ☐ Gamma-ray ☒ ALL

Data type
☒ Spectrum ☐ Time series

Tags
[] [+] [-]

SSAP Servers

short name ^	title
SMUSES	5 mJy Unbiased Spitzer ...
6dF Spectra	6dF DR3 Simple Spectr...
AGN Arch. SSAP	Archive of AGN spectral...
AKARI_IRC_SPEC_DSP	AKARI/IRC NIR Low-resol...
AKARI_IRC_SPEC_GALPN	AKARI/IRC NIR Spectral ...
AKARI_IRC_SPEC_V1	AKARI/IRC MIR-S slit-less...
ARCHES SED	ARCHES fully calibrated...
BEFS	Berkeley Extreme and ...
BeSS	Be Stars Spectra
BGDS TS SSAP	Bochum Galactic Disk S...
califa ssa	CALIFA DR3
CARMENES_Reiners	CARMENES_Reiners2018
carmenes SSAP	CARMENES DR1: Spectra
carmenes TS SSAP	Carmenes DR1 Radial V...
CaT library	CaT library. Empirical C...
CCD700N	CCD700 ver new
CCD700 SSAP	CCD700 Ondrejov Spec...
CDFS SSAP	Optical Spectroscopy I...
CfA Hectochelle	CfA Hectochelle Spectra
CfA Hectospec	CfA Hectospec Spectra
Chandra	Chandra Observations
Chiu2006	L and T dwarf (Chiu et ...
COROT ARCHIVE	The COROT PUBLIC ARC...
CSIRO ASKAP SSA	CSIRO ASKAP Science D...
DCSSA	Data Central SSA
DFBS SSAP	Digitized First Byurakan...
DIGIT	Herschel Dust, Ice, and...
Disks_SH_Spectra	Spitzer Disks Short-Hig...
DK-154 LC	DK-154 objects
DK-154 LCs	DK-154 objects
ELODIE	ELODIE archive
ELODIEinterp	Spectrum interpolator f...
ESO SSAP	ESO 1D reduced spectra
EUVE	Extreme Ultraviolet Exp...
F/H Orders SSAP	Flash/Heros Split-Order...

Select all Deselect all
Query registry Add New Server

Search parameters:

Simple Query

Object: trappist-1 [Lookup] [Clear]

RA: 23:06:29.368 Dec: -05:02:29.04

Radius: 5 MAXREC: []

Band: [] []

Time: [] []

Query Format: [None] [v]
Wavelength calibration: [None] [v]
Flux calibration: [None] [v]

Optional Parameters

Use	Name	Value	UCD
-----	------	-------	-----

Select all Deselect all Update

Query: <SERVER>?REQUEST=queryData&POS=346.62236666666666,-5.0414&SIZE=0.083333333333333333

SEND QUERY

Query results:

carmenes TS SSAP

...	accref	ssa_dstitle	ssa_targname	ssa_dstype	ssa_timeExt	ssa_length	ssa_snr	ssa_dateObs
1	http://dc.g-vo.org/getproduct/...	CARMENES DR1 J23064-050 RVs	CARMENES J23064-050	timeseries	1.48386E7	163		

SSAP Service Information

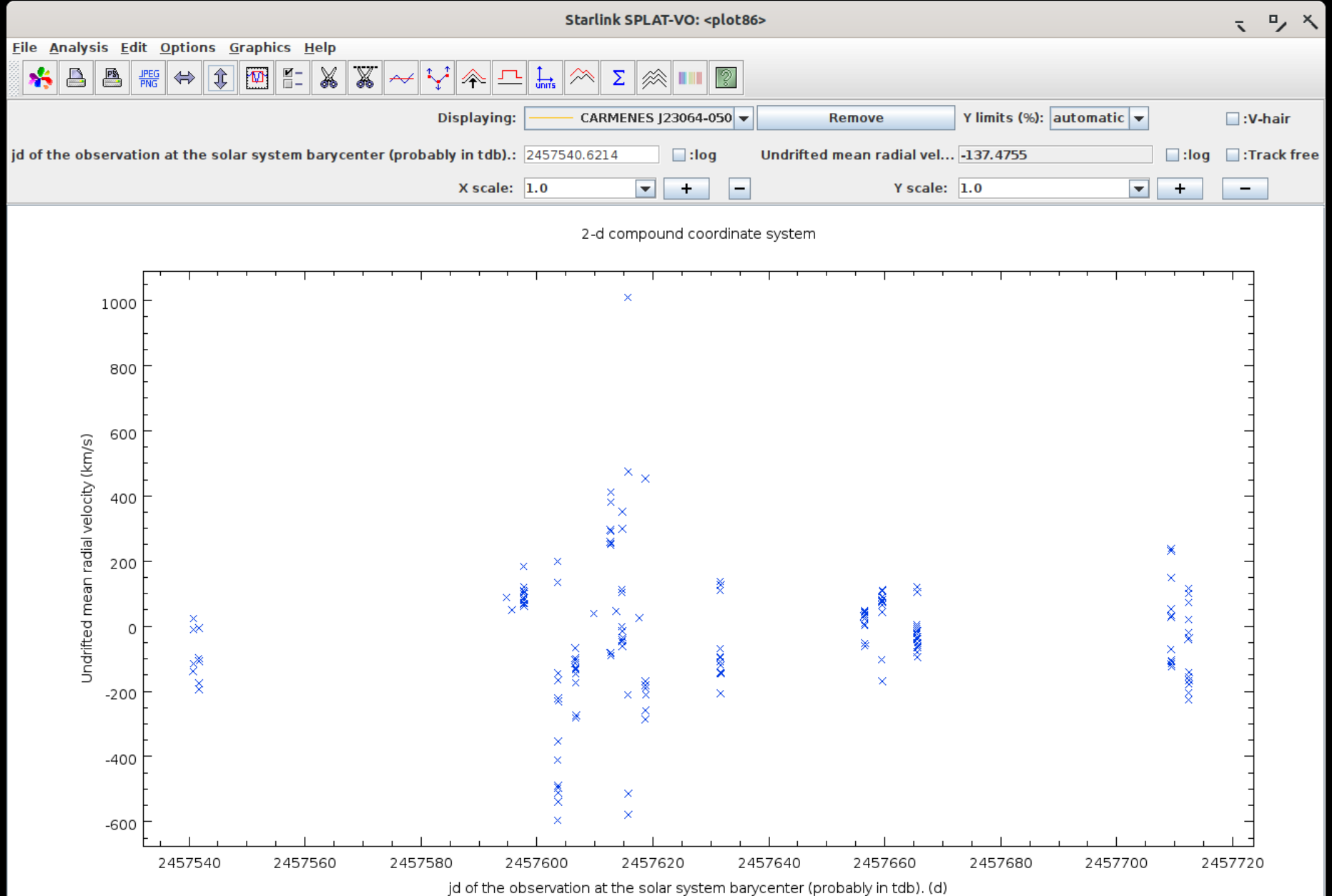
short name: carmenes TS SSAP
title: Carmenes DR1 Radial Velocity Time Series
description:
identifier: ivo://org.gavo.dc/carmenes/t/ssa
publisher: The GAVO DC team
contact: GAVO Data Centre Team
(gavo@ari.uni-heidelberg.de)
(gavo@ari.uni-heidelberg.de)
access URL: http://dc.g-vo.org/carmenes/t/ssa/ssap.xml?
reference URL: http://dc.g-vo.org/carmenes/t/ssa/info
waveband: infrared, optical
content type: archive
data source: pointed
creation type: archival

OK

Display selected Display all Download selected Download all Deselect table Deselect all DataLink Services

Save query results Restore query results Close

Trappist-1 RV Curve – Carmenes



AST Library – SSAP “flux”

```
Nov 12, 2025 9:21:20 PM uk.ac.starlink.splat.ast.ASTJ makeSpectral
INFO: Data units unknown: km/s (AST: Error at line 420 in file AstObject.c.
astGetSystem(FluxFrame): The current units (km/s) cannot be used with any of the supported flux systems.
```

```
Nov 12, 2025 9:48:08 PM uk.ac.starlink.splat.ast.ASTJ makeSpectral
INFO: Data units unknown: s^-1 (AST: Error at line 420 in file AstObject.c.
astGetSystem(FluxFrame): The current units (s^-1) cannot be used with any of the supported flux systems.
```

4.2.5.4 General Dataset Metadata

General dataset metadata describes the overall dataset.

<i>UTYPE</i>	<i>Description</i>	<i>Req</i>	<i>Default</i>
Dataset.DataModel	Datamodel name and version	MAN	Spectrum-1.0
Dataset.Type	Type of dataset	OPT	Spectrum
Dataset.Length	Number of points in spectrum	MAN	
Dataset.Deleted	Set to deletion time, if dataset is deleted	OPT	
Dataset.TimeSI	SI factor and dimensions	OPT	
Dataset.SpectralSI	SI factor and dimensions	OPT	
Dataset.FluxSI	SI factor and dimensions	OPT	
Dataset.SpectralAxis	SpectralAxis column name (native data)	OPT	
Dataset.FluxAxis	FluxAxis column name (native data)	OPT	

SSAP

4.2.5.9 Dataset Characterization Axis Metadata

The Characterization axis metadata specifies the type of physical quantity on each physical measurement axis as well as the observable.

<i>UTYPE</i>	<i>Description</i>	<i>Req</i>	<i>Default</i>
Char.FluxAxis.Ucd	ucd for flux	REC	
Char.SpectralAxis.Ucd	ucd for spectral coord	REC	

Conclusions – Are we Alone ?

To discover The Second Earth we need:

- Satellites for precise photometry
- Extremely precise spectrographs (on ELTs)
- EPRV like format as an unification standard
- VO for federation across world
- Some protocol based on SSAP approach
- Light curves (multi-color)
- RV curves (in different spectral lines, ranges)
- Graphic tool with SPLAT-VO capabilities
- Enthusiastic VO-educated experts !

Thank you