

Olga Maryeva

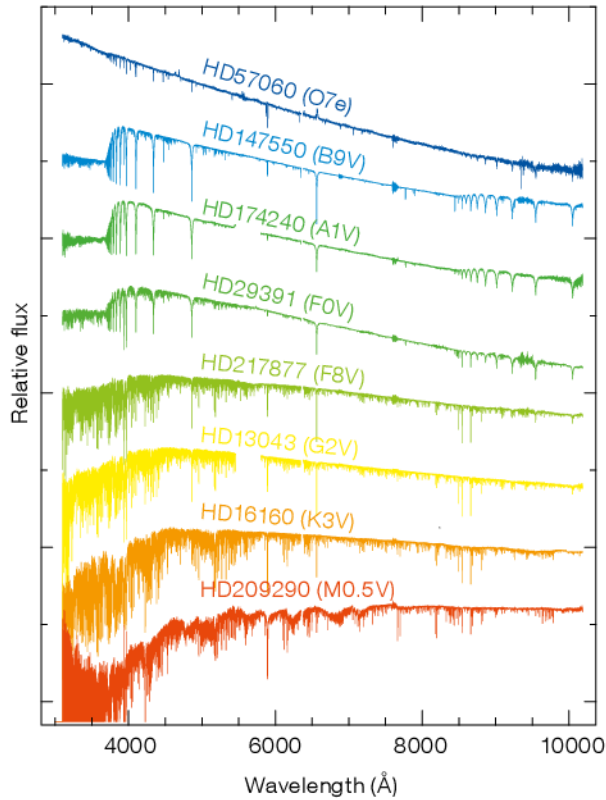
Reduction of spectral data from public archives



Spectral Data Archive

Spectral Libraries

Telescope Archives



Elodie
Sophie
LAMOST
X-Shooter
IACOB

HST
ESO
GTC
SALT
SAO
etc ...




SOPHIE / ELODIE on-line database of high-resolution stellar spectra

<http://atlas.obs-hp.fr/elodie/>

Currently **87621** (SOPHIE) + **35535** (ELODIE) spectra are fully public

ELODIE was an echelle type spectrograph installed at the Observatoire de Haute-Provence 1.93m reflector



The ELODIE archive

An on-line database of high-resolution stellar spectra

[Archive News](#) | [Publications using ELODIE Archive](#)

Enter a designation or coordinates

Examples: *HIP117998, J04 14 57 15 32 10, simbad:procyon, HD190007, HD190073, GJ%1*

a. For identifiers you can choose to query : only this object

b. For coordinate and around object queries, define a radius : [arcmin]

Query a sample of objects in a region of the sky

a. Define a region of the sky (B1950 or J2000):

Right ascension from to
 examples: *14 00 00* to *18 00 00* (B1950)
J14 00 00 to *J18 00 00* (J2000)

Declination from to
 example: *-02 00 00* to *02 00 00*

Spectra: HD188209
We found 9 records ...

objname	RA (J2000)	Dec	S	O	dataset	imanum	imatyp	exptime	sn	view_spec	view_head	get_spec	get_e2ds	cu
HD188209	J195159.0+470138		S	O	19970917	0012	OBJOd	1802.9	418	view_spec	view_head	get_spec	get_e2ds	cus
HD188209	J195159.0+470138		S	O	19970917	0016	OBJOd	900.6	197	view_spec	view_head	get_spec	get_e2ds	cus
HD188209	J195159.0+470138		S	O	19970918	0025	OBJOd	1002.1	276	view_spec	view_head	get_spec	get_e2ds	cus
HD188209	J195159.0+470138		S	O	19970919	0009	OBJOd	1200.7	348	view_spec	view_head	get_spec	get_e2ds	cus
HD188209	J195159.0+470138		S	O	19970919	0020	OBJOd	900.8	312	view_spec	view_head	get_spec	get_e2ds	cus
HD188209	J195159.0+470103		S	O	19980611	0044	OBJOd	1501.1	187	view_spec	view_head	get_spec	get_e2ds	cus
HD188209	J195159.0+470103		S	O	19980611	0045	OBJOd	1500.6	189	view_spec	view_head	get_spec	get_e2ds	cus
HD188209	J195159.0+470103		S	O	19980611	0046	OBJOd	1500.6	175	view_spec	view_head	get_spec	get_e2ds	cus
HD188209	J195159.0+470139		S	O	20010809	0026	OBJOd	900.5	175	view_spec	view_head	get_spec	get_e2ds	cus

[Display this selection as plain text](#)
[Search the CCF for the same objects](#)
[Apply the same selection to the Sophie archive](#)
[Get the wget commands to download all the selected 1D spectra](#) [Explanations](#)
[Get the wget commands to download all the selected 2D spectra](#) [Explanations](#)

Object name or list Sky search



[Introduction](#) | [Help](#)

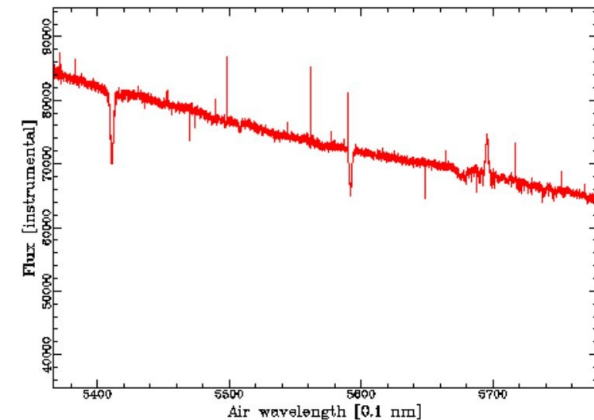
Spectra: FITS Pipeline processing

Display the spectrum

File identification and executed pipeline: `elodie:19980611/0045&z=s1d|vs`

Coord=232845.7+520850900

[Zoom out](#)



in wavelength range to

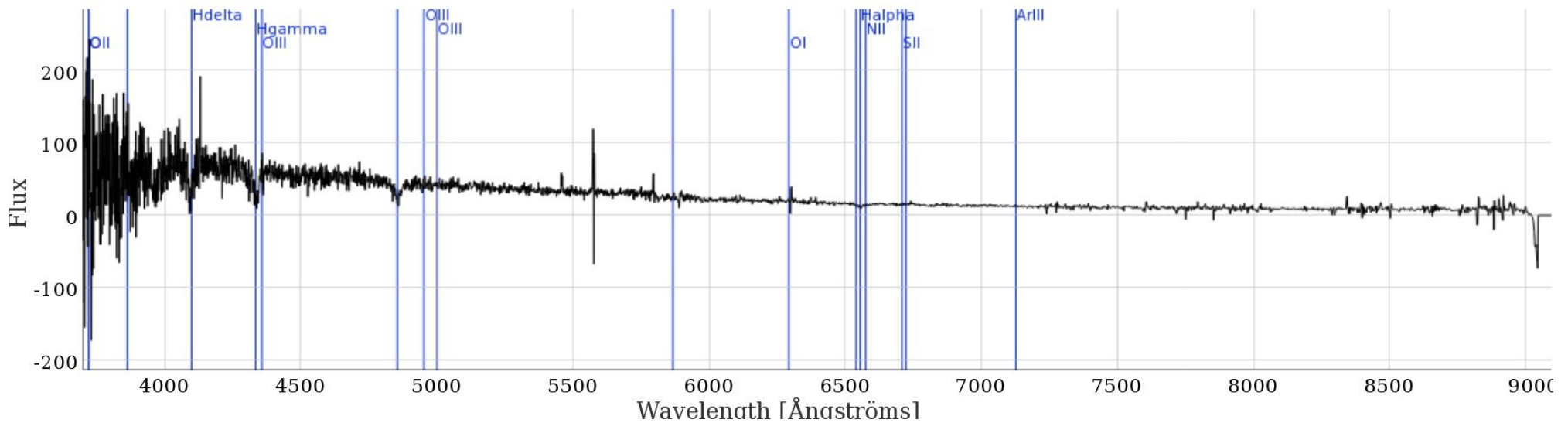
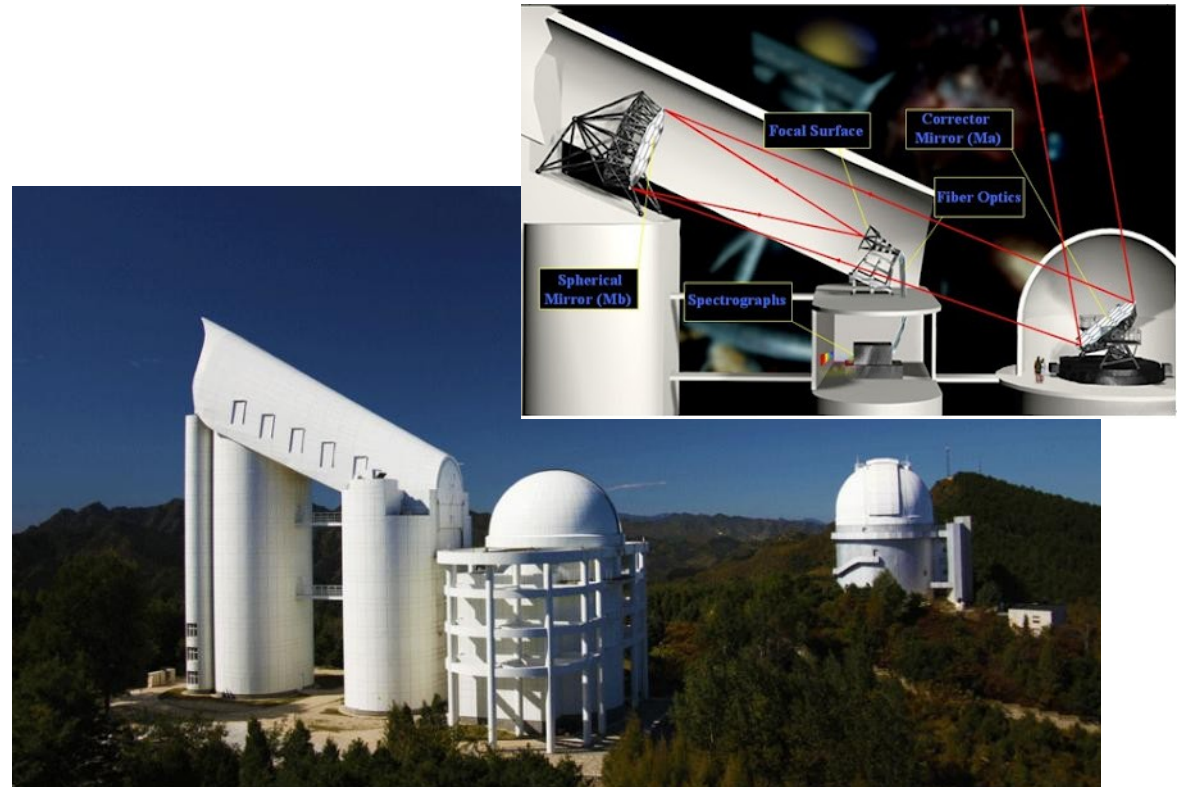
The ELODIE Archive © OHP / INSU-CNRS / OSU Pytheas
 Contact: [Database team](#)

Large Sky Area Multi-Object Fibre Spectroscopic Telescope LAMOST

DATA RELEASE DR9
2011.10.24 - 2021.06.30

Star : **10,907,516**
M Star Catalog : **832,755**
A Star Catalog: **654,940**
WD Star Catalog : **16,382**

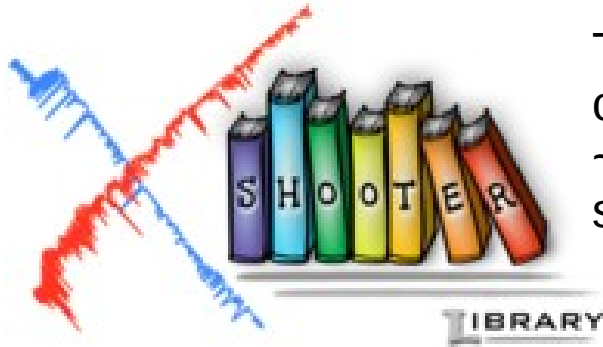
<http://www.lamost.org/dr9/>



X-Shooter Spectral Library

<http://xsl.u-strasbg.fr/index.html>

DR2=666 stars



The X-Shooter Spectral Library is a stellar spectral library covering the wavelength range 3000–25000 Å, at a resolution $R \sim 10\,000$. The library was built using the medium-resolution spectrograph X-Shooter (ESO, VLT).

ESO Library of Stellar Spectra

<http://www.eso.org/sci/facilities/paranal/decommissioned/isaac/tools/lib.html>

131 stellar spectra – all spectral types

IACOB spectroscopic database



<http://research.iac.es/proyecto/iacob/iacobcat/>



[Home](#)

[IACOB on the sky](#)

[Tecnical details](#)

[Acknowledgements](#)

[IACOB Publications](#)

[IACOB project website](#) 

Welcome to renewed interface of the IACOB spectroscopic database!

IACOB is an ambitious long-term observational project whose main scientific goal is to provide a complete and statistically significant empirical overview of the physical properties of **Galactic massive OB-type stars**. The ultimate objective of the project is that the compiled information can be used as a strong and long-lasting anchor point for our theories of stellar atmospheres, winds, interiors and evolution of massive stars.

This is the interface to have access to the spectra compiled during more than 12 years in the framework of the IACOB project: the so-called **IACOB spectroscopic database**. While not all the spectra are publicly available yet, we quote all the compiled observations for reference purposes, The different data releases (DRx) will be conveniently announced; in the meanwhile people interested in specific (samples of) spectra can contact the PI of the project by email: [ssimon \[at\] iac.es](mailto:ssimon@iac.es).

More details about the project can be found in the [project webpage](#) .

The IACOB spectroscopic database mainly comprise observations made with the FIES instrument attached to the 2.56-m [Nordic Optical Telescope](#) and the HERMES spectrograph attached to the 1.2-m [Mercator Telescope](#) . In future developments, we plan to also incorporate data of Southern Galactic OB stars as obtained with the FEROS instrument (gathered from the [ESO public archive](#)), as well as long-term medium and high cadence observations of a sample of about 40 Galactic O stars and B Supergiants, collected with the 1-m [Hertzprung-SONG](#) and the 1.2-m [STELLA](#) telescopes.

NEWS (2020/06/21): The second data release -- which includes 552 FIES and HERMES spectra for more than 240 late- and mid-B stars with luminosity classes V, IV and III -- is now available!.

Search by name

Star name (Rigel, etc.)

Spectral type

e.g.: B1* or O* or *V*

Data Release

Any

Instrument

Any

- Only spectra available to download
- Only the best spectrum per star

1035 stars 8613 spectra

Mikulski Archive for Space Telescopes – MAST

The Mikulski Archive for Space Telescopes is an astronomical data archive focused on the optical, ultraviolet, and near-infrared. MAST hosts data from over a dozen missions like Hubble, Kepler, TESS, and soon JWST.

<https://archive.stsci.edu/index.html>

The screenshot displays the MAST web interface. At the top, the search criteria are 'Schulte 7, radius: 0.20000°'. The interface shows a table of 26 rows (displaying 9) with columns for Actions, Observation Type, Mission, Provenance Name, Instrument, Project, Filters, and Wa. To the left, there are filter panels for 'Filters' and 'Product Type'. To the right, an 'AstroView' window shows a star field with a red dashed circle and RA/DEC coordinates.

Home Page MAST: Schulte 7

Displaying 26 of 1137 Total Rows

Schulte 7, radius: 0.20000°

Footprints: All

Filters

Clear Filters Edit Filters... Help...

STAR (15 of 89)
OF (14 of 39)
SUPERGIANT O (14 of 25)
MAIN SEQUENCE O (0 of 22)
ISM (11 of 11)

Show 11 More

Product Type

Name Quantity

timeseries (0 of 601)
cube (0 of 236)
image (0 of 222)
 spectrum (26 of 72)
IMAGE (0 of 6)

List View Album View

Edit Columns... Table Display: All Show Preview: Show Cutout:

	Actions	Observation Type	Mission	Provenance Name	Instrument	Project	Filters	Wa
<input type="checkbox"/>	1 [Download] [Preview] [Plot]	science	HST	CALSTIS	STIS/FUV-MAMA	HST	G140L	U
<input type="checkbox"/>	2 [Download] [Preview] [Plot]	science	HST	CALSTIS	STIS/FUV-MAMA	HST	G140L	U
<input type="checkbox"/>	3 [Download] [Preview] [Plot]	science	HST	CALSTIS	STIS/FUV-MAMA	HST	G140L	U
<input type="checkbox"/>	4 [Download] [Preview] [Plot]	science	HST	CALCOS	COS/FUV	HST	G160M	U
<input type="checkbox"/>	5 [Download] [Preview] [Plot]	science	HST	CALCOS	COS/FUV	HST	G160M	U
<input type="checkbox"/>	6 [Download] [Preview] [Plot]	science	HST	CALCOS	COS/FUV	HST	G130M	U
<input type="checkbox"/>	7 [Download] [Preview] [Plot]	science	HST	CALCOS	COS/FUV	HST	G130M	U
<input type="checkbox"/>	8 [Download] [Preview] [Plot]	science	HST	CALCOS	COS/FUV	HST	G130M	U
<input type="checkbox"/>	9 [Download] [Preview] [Plot]	science	HST	CALCOS	COS/FUV	HST	G130M	U

AstroView

20:33:14.110 +41:20:21.90
20:33:14.110 +41:20:21.90 RA DEC
hhmmss/deg

Gran Telescopio CANARIAS – GTC

<http://gtc.sdc.cab.inta-csic.es/gtc/index.jsp>

Search by Target:

Object List:

Examples (coordinates in J2000):

64.99061 52.98401
 4 19 57.75 +52 59 02.436
 4:19:57.75 +52:59:02.436
 ULAS J135058.86+081506.8

Browse...

No file selected.

Search radius:

5

arcmin

Search by Date:

Between:

16

March

2009

And:

26

August

2021

End Time	Exptime (s)	Airmass	Pub	Reduced Data						Raw Data									
				User Reduced Data ?			GTC Reduced Data ?		QLA Reduced Data ?	Raw Data			Cal. Files		Acq. Images		QC Files		
2018-09-09 02:53:36.8	600	1.02	2	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2018-09-09 02:42:56.7	900	1.03	2	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2018-09-09 02:11:17.8	600	1.07	2	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2018-09-09 02:00:37.6	900	1.09	2	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2018-09-09 01:22:34.8	600	1.17	2	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2018-09-09 01:11:53.3	900	1.21	2	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2016-08-27 02:31:12.2	600	1.11	1	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2016-08-27 02:20:31.7	900	1.14	1	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2016-08-27 02:04:58.8	1200	1.18	1	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch
2016-07-30 04:31:36.9	600	1.09	1	ADS	View	Fetch					Header	Preview	Fetch	View	Fetch	View	Fetch	View	Fetch

SALT South African Telescope

since July 10, 2020

<https://ssda.sao.ac.za/>



Target name [?]

Resolver [?]

Simbad [▼]

resolve

Right ascension [?]

Declination [?]

Search radius [?]

Radius units

Arcseconds [▼]

Target type

Galaxy ISM Solar System Body Star

Proposal code [?]

Principal investigator [?]

Proposal title [?]

Observation night [?]

Data category

Science Arcs Biases Flats Standard

Rejected observations

Include rejected observations

Archive of Russian 6-m telescope (BTA)

<https://www.sao.ru/oasis/cgi-bin/fetch?lang=en>



The General Observation Archive

Archive regulation

Acknowledgments

Current status

6m telescope

<input type="radio"/> CCD	1996-02-13 - 2000-04-30
<input type="radio"/> IFP	1997-05-14 - 2000-03-02
<input type="radio"/> LYNX	1996-02-28 - 2002-05-28
<input type="radio"/> MOFS	1997-03-07 - 2001-08-18
<input type="radio"/> MPFS	1996-08-18 - 2009-10-27
<input type="radio"/> MSS	1996-05-26 - 2017-09-11
<input type="radio"/> NES	1998-03-10 - 2019-10-19
<input type="radio"/> PFES	1996-08-06 - 2001-01-07
<input checked="" type="radio"/> SCORPIO	
<input type="radio"/> SP124	1996-02-18 - 2000-12-09
<input type="radio"/> UAGS	1994-11-08 - 2005-10-20

Small telescopes

<input type="radio"/> CEGS	1997-03-24 - 2010-10-26
<input type="radio"/> MAGIC	2020-01-25 - 2020-07-23
<input type="radio"/> MMPP	
<input type="radio"/> MNGL	2017-09-05 - 2018-12-22
<input type="radio"/> Z600	1996-01-12 - 2001-06-06
<input type="radio"/> ZMCCD	
<input type="radio"/> ZMUAGS	

Radio telescope

(request only by date)

<input type="radio"/> REF1	1982-01-12 - 2021-01-06
<input type="radio"/> REF2	2011-10-19 - 2021-05-19
<input type="radio"/> REF3	2013-02-12 - 2017-12-30
<input type="radio"/> REF4	2011-07-17 - 2017-06-21
<input type="radio"/> REF5	2008-09-04 - 2008-10-27
<input type="radio"/> REF6	1988-02-03 - 1988-04-21

First date: 1982 01 01 1982

or

select dates by [the BTA observation program key](#)

R.A.(J2000) Decl.(J2000)
(ra=hh mm ss.s; dec=[-]dd mm ss.s or in degrees)

or object name:

Radius: 5 (arcmin)

Data type: obs Observation mode: any

Filter: any

Program author:

[Info](#)

Search

Clear

SCORPIO-1 is a multi-mode focal reducer of the BTA

Zoo of Raw Data

We have a huge variety of raw data from different instruments
To properly handle them, you need to:

- Know how to work with various data formats
- Know main steps of data preparation and processing
- Know what calibration data you may need

Main steps of data processing

- Bias / dark correction
- Cosmic rays removal
- Flat-fielding

- Mask of orders (eschelle)
- Extraction of spectra
- Linearization

- Flux calibration using spectrophotometric standard stars

Calibration frames

Sometimes, calibration frames are not acquired every night, and you have to specifically look for them in data archives.

Sometimes they are part of standard observations and are distributed together with object data

FITS format

De facto standard for astronomical data exchange.

Primary elements — images or binary tables

Multi-extension FITS as a way to store heterogeneous data in a single file

- Primary header with generic information
- Set of extensions with individual headers + content (image / table)
- Every extension may have human-readable name to help identifying what's inside it

Standard tools for inspection / quick look of FITS files:

FV — supports any FITS file with any structure, shows tables / images, plots XY graphs, etc etc

SAOImage DS9 — primarily FITS image viewer, plus rudimentary image analysis

TopCat — generic tool for working with data tables in various formats, including FITS tables. Supports inspection, visualization, analysis, etc

Representation of reduced spectral data in FITS

- Binary table with separate columns for wavelength and flux
- 1d/2d image + WCS standard for wavelength data
- 2d image + IRAF multispec standard for separate wavelength info for different orders

Keywords in FITS Header (for 1D spectral data)

Representation of reduced spectral data in FITS

- Binary table with separate columns for wavelength and flux
- 1d/2d image + WCS standard for wavelength data
- 2d image + IRAF multispec standard for separate wavelength info for different orders

They all differ by FITS keywords

1d spectra in FITS images + WCS for linearization

Lambda = **CRVAL1** + **CDELTA1***(x-**CRPIX1**)

Or

Lambda = **CRVAL1** + **CD1_1***(x-**CRPIX1**)

X = 1..N (FITS standard is 1-based, not 0-based!)

FITS standard for integer data scaling

Value = **BZERO** + data***BSCALE**
e.g. 0..65535 → -32767..32767

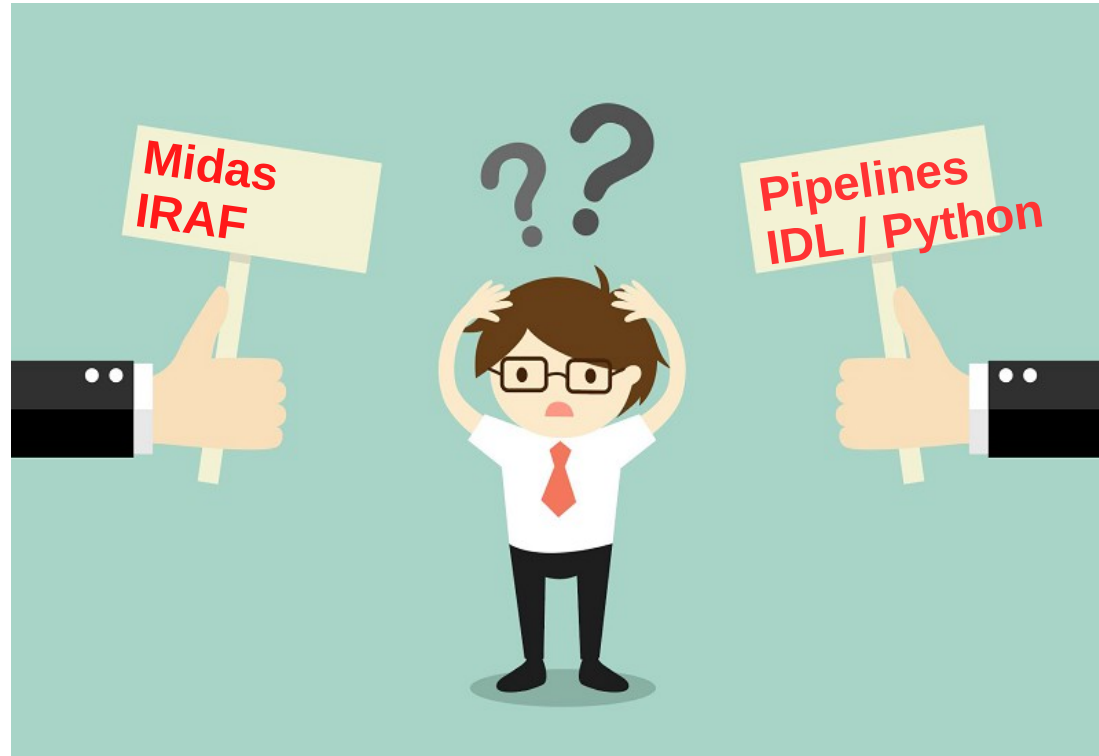
This conversion is often handled automatically by FITS reading routine, but sometimes the keywords are left in the headers — do not forget to check/remove them before saving your modified (e.g. floating-point) file!

HISTORY is for storing human-readable notes on the data provenance — e.g. history of data processing. Do not forget to use it in your scripts, it really helps to track various problems with the data later!

COMMENT is for generic comments in the header

Data Reduction

Midas, IRAF, Pipelines (for example ESO-reflex), IDL / Python



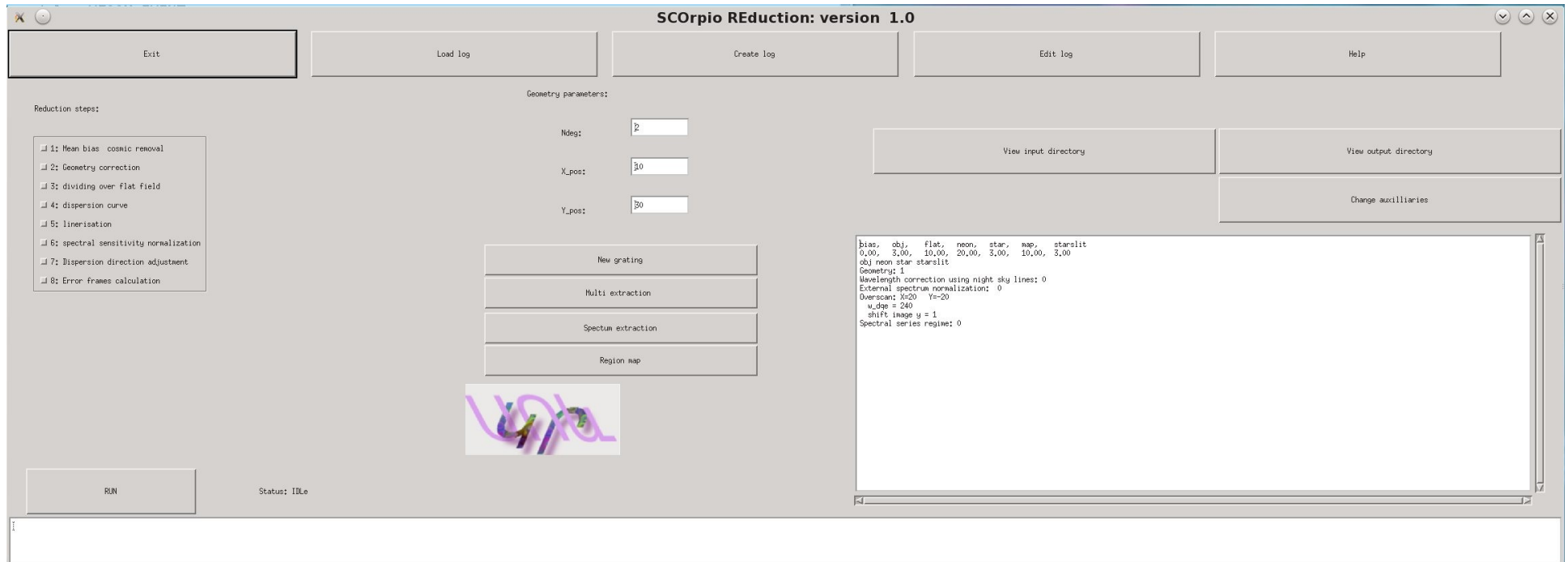
The choice is usually defined by your habits and existence of ready to use pipelines for specific data

- You may spend some time learning the pipeline someone else wrote
- Or spend some time writing your own processing scripts
- Or combine some existing tools you already know

No universal recipe exists, but think about re-usability of what you learned

My experience

Together with colleagues I wrote in IDL language a package for reduction of long-slit spectra from SCORPIO spectrograph (Russian 6-m telescope)



Later I used it to reduce the spectra from OSIRIS (GTC), FOCAS (Subaru), ISIS (WHT)

SPECTRUM REDUCTION

Load logfile

Edit logfile

Create logfile

MAIN REDUCTION STEPS:

1: Mean Bias
 2: Cosmic
 3: Flat Field
 4: Geometry Correction
 5: Create Disperse
 6: Linearization

RUN

Data Reduction Parameters:

Star standart
 ThAr for star standart

Overscan values:

X1: X2: Y1: Y2:

Cosmic:

OBJ	FLAT	THAR	STAR	THARSTAR
<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="30.00"/>	<input type="text" value="10.00"/>	<input type="text" value="30.00"/>

Grating:

Create New Grating

Add New Grating

View input directory

View output directory

View RGB

Logfile:

Description

SPECTRUM EXTRACTION:

Extraction of spectrum of object

Extraction of spectrum of star-standart

ADDITIONAL FUNCTIONS:

Normalisation

Barycent

EXIT



Takeaway message

- Do not be afraid of writing your own pipelines
sometimes it is faster and easier than learning the code made by others
(but sometimes not)
- Write for yourself, not for everyone else!
It should help you, so make it as you see it fit best
- Automate boring and repeating things
- Do not try to make too universal tools
smaller and simpler tools will be easier to adapt to some new data
- Do not be afraid to express yourself in your code!

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Thank you for your attention!

I hope it will be useful for you