

Анализ данных IRIS: особенности получения и использования

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План доклада

- Общие сведения об IRIS
- Представление и обработка данных IRIS в SSW IDL
- Примеры анализа данных IRIS

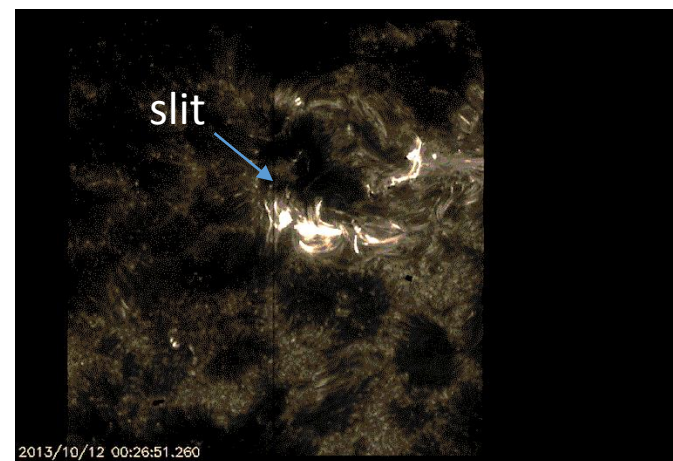
Телескоп NASA IRIS (Interface Region Imaging Spectrograph)

Запущен 27 июня 2013

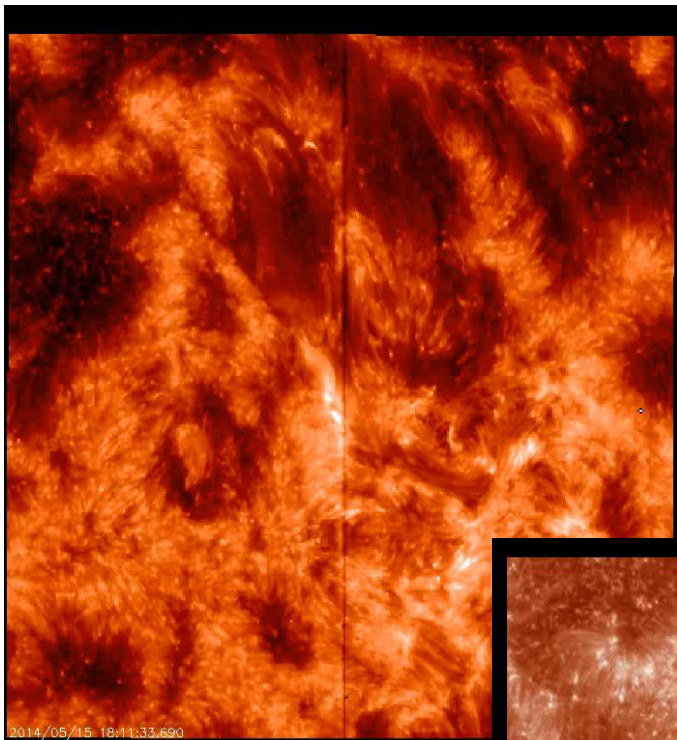
- Основная особенность – одновременное получение спектров и изображений фотосферы, хромосферы, переходной зоны и короны
- Пространственное разрешение прибора **0.33-0.4** угловые секунды, временное **~2** секунды, спектральное **26-53** мА
- Спектры в диапазонах 1332-1358А, 1389-1407А and 2783-2834А (покрывающие яркие линии Mg II h 2803А и Mg II k 2796А, C II 1334/1335А и Si IV 1394/1403А)
- Изображения в четырех фильтрах (C II 1330, Si IV 1400, Mg II k 2796, и крыло Mg II 2830А). Полосы пропускания 4А для MgII и 55А для CII и SiIV.
- Работа в режимах “dense raster mode”, “coarse raster mode” или “sit-and-stare mode”
- Данные доступны на вебсайте <http://iris.lmsal.com/>

(The Interface Region Imaging Spectrograph (IRIS), De Pontieu, B., et al, Solar Physics, Vol.289, 2014)

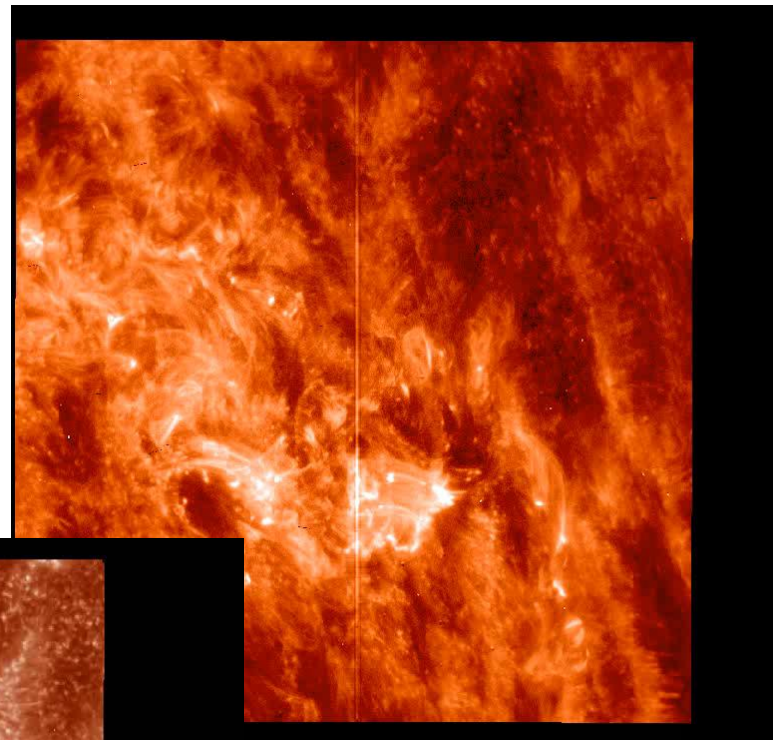
(Специальный выпуск Science “Eyeing the Sun” от 17 октября 2014)



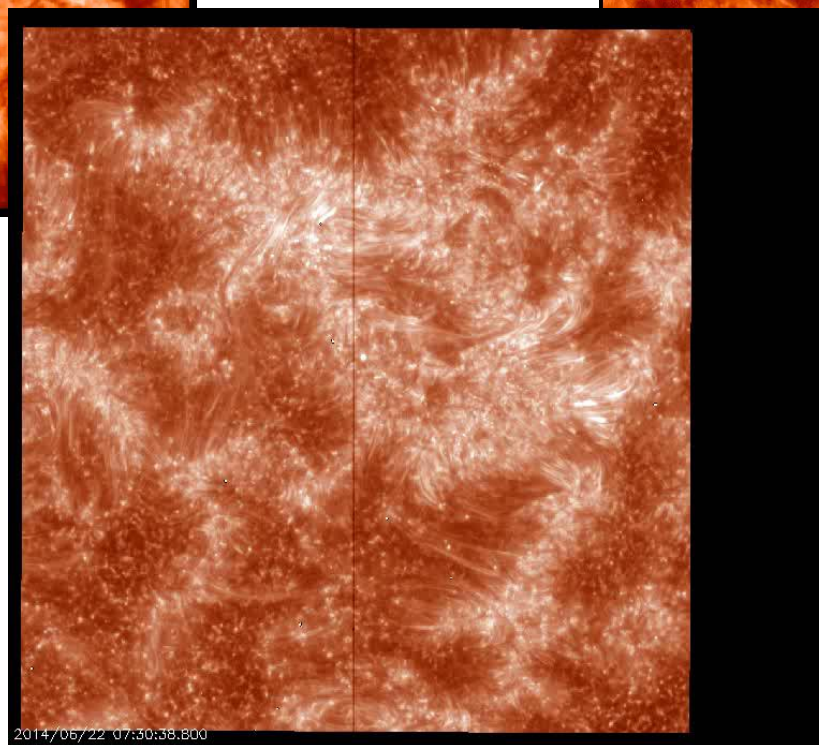
Различные режимы IRIS



“Sit-and-Stare” mode



“Coarse raster” mode



“Dense raster” mode

Поиск данных IRIS

IRIS (<http://iris.lmsal.com/>), IRIS Search (<http://iris.lmsal.com/search/>)

← → ↻ iris.lmsal.com/search/

INTERFACE REGION IMAGING SPECTROGRAPH IRIS DATA SEARCH

[Help](#)
[Export SSW](#)

<< **Start** >> << **End** >>

2014-02-15T00:00 2016-02-24T00:00

min **Raster** max min **SJI** max
FOV X FOV X
FOV Y FOV Y
Count
Cdnce

Raster Step
Count
Size
Cdnce

Cadence
1330
1400
2796
2832

Target
XCEN
YCEN
Radius
OBSID
Target

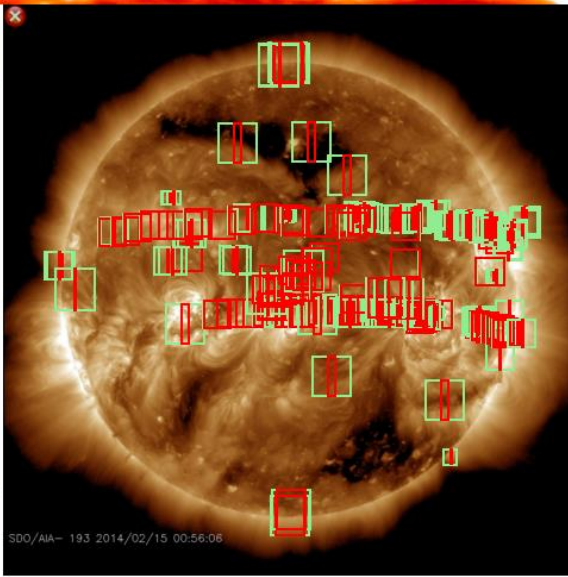
Exposure Time
Min Exp
Exp Time

Spectral Lines

Desc: Events

Count: 400 Search Reset More... 193

Only OBS with data



SDO/AIA - 193 2014/02/15 00:56:06

Time	Goal	OBS Desc.	X,Y	RX	RY	Raster Cad	Step Cad	Fast SJI	OBSID
2016-02-03 15:45-16:36	Large AR Raster	Large dense 320-step raster	876",241"	112"	119"	3057s	10s	1400: 38s	3630008076
2016-02-03 17:22-18:27	Flarewatch at E limb	Large sit-and-stare	-983",108"	0"	119"	10s	10s	1330: 10s	3660259503
2016-02-03 18:50-20:05	Flarewatch at E limb	Large sit-and-stare	-983",107"	0"	119"	10s	10s	1330: 10s	3660259503
2016-02-03 20:28-21:35	Flarewatch at E limb	Large sit-and-stare	-983",108"	0"	119"	10s	10s	1330: 10s	3660259503
2016-02-03 22:14-23:20	Orbital wobble cal roll=0	SJI MgII w, 1x1, 10s exp, 20s cadence, for wobble calibration	-45",967"	0"	180"				4202100002
2016-02-03 23:42-00:57 +1d	Orbital wobble cal roll=0	SJI MgII w, 1x1, 10s exp, 20s cadence, for wobble calibration	-45",966"	0"	180"				4202100002
2016-02-04 01:20-02:19	Orbital wobble cal roll=0	SJI MgII w, 1x1, 10s exp, 20s cadence, for wobble calibration	-45",966"	0"	180"				4202100002
2016-02-04 03:07-03:58	Large AR Raster	Large dense 320-step raster	911",218"	112"	119"	3057s	10s	1400: 38s	3630008076
2016-02-04	Large AR Raster	Large coarse 64-							

Сейчас доступны данные для 19 февраля 2016

Обработка данных IRIS

User Guide to data analysis (<http://iris.lmsal.com/analysis.html>)

iris.lmsal.com/itn26/

ITN26

Search docs

1. Introduction
2. Quickstart
3. IRIS Level 2 Data
4. IRIS Level 3 Data
5. IRIS Level 1 Data
6. Calibration of IRIS Observations
7. IRIS data notes
8. Tutorials
9. Useful codes

ITN 26 » A User's Guide to IRIS Data Retrieval, Reduction & Analysis

A User's Guide to IRIS Data Retrieval, Reduction & Analysis

Edited by Tiago M. D. Pereira, Scott W. McIntosh, Bart De Pontieu, Viggo Hansteen, Mats Carlsson, and Paul Boerner.

Last updated on September 01, 2015.

Also available in [pdf](#) and [EPUB](#).

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 - 4.1. Level 3 Data Structure

Калибровка длин волн

User Guide to data analysis (<http://iris.lmsal.com/analysis.html>)

“However, in some cases it may be necessary to apply further corrections. The O I 1355.5977 Å line is the recommended reference for the FUV, and the Ni I 2799.474 Å for the NUV”

Orbital velocity & thermal drift correction (based on fitting the Ni I 2799.474 line and anti-correlation between NUV and FUV windows):

iris_orbitvar_corr_l2.pro – input is one filename (from July 11, 2014, *_old.pro before)

iris_orbitvar_corr_l2s.pro – input is a string array

Калибровка интенсивности

Что делать, если необходимо перевести единицы интенсивности IRIS в физические единицы?

`iresp = iris_get_response(time, version='003')`; `time` – в одном из форматов `anytime`

```
IDL> help, iresp, /str
DATE_OBS      STRING  ''
LAMBDA        FLOAT  Array[3601]
AREA_SG       FLOAT  Array[3601, 2]
NAME_SG       STRING  Array[2]
DN2PHOT_SG   FLOAT  Array[2]
AREA_SJI      FLOAT  Array[3601, 4]
NAME_SJI      STRING  Array[4]
DN2PHOT_SJI   FLOAT  Array[4]
COMMENT       STRING  ''
VERSION       STRING  '003'
VERSION_DATE  STRING  '20150331'
```

where `AREA_SG` and `AREA_SJI` are the effective areas (in cm^2) as a function of wavelength (`LAMBDA`) respectively for the spectrograph and slit-jaw camera. The `DN2PHOT` tags give the conversion from DN counts to photons.

Note

With versions other than `003` the `DN2PHOT` tags are not present.

To convert the spectral units from DN to flux one must do the following:

$$\text{Flux}(\text{erg s}^{-1} \text{cm}^{-2} \text{\AA}^{-1} \text{sr}^{-1}) = \text{Flux}(\text{DN}) \frac{E_{\lambda} \cdot \text{DN2PHOT_SG}}{A_{\text{eff}} \cdot \text{Pix}_{xy} \cdot \text{Pix}_{\lambda} \cdot t_{\text{exp}} \cdot W_{\text{slit}}},$$

where $E_{\lambda} \equiv h \cdot c / \lambda$ is the photon energy (in erg), `DN2PHOT_SG` is the number of photons per DN (get from `iris_get_response`), A_{eff} is the effective area (in cm^2), Pix_{xy} is the size of the spatial pixels in radians (e.g. multiply the spatial binning factor by $\pi / (180 \cdot 3600 \cdot 6)$), Pix_{λ} is the size of the spectral pixels in \AA , t_{exp} is the exposure time in seconds and W_{slit} is the slit width in radians ($W_{\text{slit}} \equiv \pi / (180 \cdot 3600 \cdot 3)$).

A detailed discussion of the radiometric calibration steps for IRIS and how to use them on data can be found in IRIS Technical Note 24.

IRIS_Xfiles and CRISPEX

Command: iris_xfiles

Note

These two Level 3 files are arranged differently but contain the same information. The `im` fits file is arranged by (X, Y, lambda, t) while the `sp` file, that is used by CRISPEX in the next section, is ordered (lambda, t, X, Y).

The screenshot shows the 'Iris_Xfiles - QL Control Window (Not Responding)'. The window has a title bar with standard Windows controls. Below the title bar are logos for 'Hinode EIS' and 'IRIS'. The main interface includes several sections:

- Select data source:** Radio buttons for IRIS (selected), EIS/CCSDS, EIS/FITS, and EIS/HK.
- Start/Stop for file search:** Time Units: [D]-MON-[YR][R] HH:MM:SS[MS]. Start Time: 17-Jun-13 18:00:00, Stop Time: 22-Jun-16 23:59:59. Recent time-windows: 17-Jun-2013 - 22-Jun-2016. Options: Last 5 days, Up until now, ignore times (only if no tree structure).
- Set search filter:** Text input field containing 'iris_l2*'. Buttons: Edit, Start Search, Stop Search.
- Search Pattern:** dropdown menu set to 'free search'.
- Search Directory:** Text input field containing 'C:\Users\vsadykov\Desktop\IRIS data examples\example_lcr8\'.
- Table:** A table with columns: STARTOBS, OBSID, OBS_DESC, XCEN, YCEN, SAT_ROT. The first row is highlighted in blue: 2014-06-09T00:10:12.540, 3820109180, Large coarse 8-step raster, 14x120 Rs, C II, Si IV, Mg II h, 18.6, -327.2, 0.0.
- File List:** A scrollable list of file paths, all starting with 'C:\Users\vsadykov\Desktop\IRIS data examples\example_lcr8\vis_l2_20140609_001012_3820109180_'. The files are named with various parameters like 'SJI_1330_r000fits', 'SJI_1400_r000fits', 'SJI_2796_r000fits', 'raster_1000_r00000fits', etc.
- Buttons:** Confirm selection, Print filename to console, Show OBS tables.

Процедуры IDL:

```
CD, 'C:\Users\vsadykov\Desktop\IRIS data examples'
```

```
t0 = '18:50:00 10-nov-2014'
```

```
t1 = '19:00:00 10-nov-2014'
```

```
files = iris_time2files(t0, t1, level=2, drms, /urls)
```

```
sock_copy, files, dir='./'
```

```
;for dense raster mode
```

```
CD, 'C:\Users\vsadykov\Desktop\IRIS data examples\example_vldr'
```

```
;for dense raster spectra
```

```
f='iris_l2_20140214_114951_3800263296_raster_t000_r00000.fits'
```

```
d=iris_load(f)
```

```
OR d = obj_new('iris_data')
```

```
    d -> read, f
```

```
Properties and methods
```

```
header = d->gethdr(/struct)
```

```
x = d->getxpos()
```

```
y = d->getypos()
```

```
d->show_lines
```

```
data = d->getvar(6, /load)
```

```
lambda = d->getlam(6)
```

```
t = d->gettime()
```

```
help, x & help, y & help, lambda
```

```
;for dense raster SJ images
```

```
f='iris_l2_20140214_114951_3800263296_SJI_1330_t000.fits'
```

```
d=iris_load(f)
```

```
the same procedures...
```

```
;for sit-and-stare mode
```

```
;everything is the same...
```

```
CD, 'C:\Users\vsadykov\Desktop\IRIS data examples\example_iss'
```

```
f=""
```

```
;for coarse raster mode
```

```
CD, 'C:\Users\vsadykov\Desktop\IRIS data examples\example_lcr8'
```

```
f='iris_l2_20140609_001012_3820109180_raster_t000_r00000.fits'
```

```
;intensity calibration
```

```
timetest='2016-06-12T12:00:00'
```

```
iresp = iris_get_response(time, version='003')
```

```
print, iresp.name_sg
```

```
;seems that only one column of iresp.area_sg is nonzero
```

```
;iris_xfiles
```

```
;Convenient to see the vldr file
```

```
;Possible to generate level3 file from Xfiles
```

```
CD, 'C:\Users\vsadykov\Desktop\IRIS data examples\example_lcr8'
```

```
f1='iris_l3_20140609_001012_3820109180_t000_all_sp.fits'
```

```
f2='iris_l3_20140609_001012_3820109180_t000_all_im.fits'
```

```
data = readfits(f2, header) ;order x, y, lambda, t
```

```
;for crispex - make the file from dense raster
```

```
IDL> f=iris_files() ; enough if only level3 files in directory
```

```
0 iris_l2_20131007_054001_3800259115_SJI_1330_t000.fits 57 MB
```

```
1 iris_l2_20131007_054001_3800259115_SJI_1400_t000.fits 57 MB
```

```
2 iris_l2_20131007_054001_3800259115_SJI_2796_t000.fits 57 MB
```

```
3
```

```
iris_l3_20131007_054001_3800259115_t000_CII1336_SiIV1403_MgIIk2796_im.fits
```

```
1 GB
```

```
4
```

```
iris_l3_20131007_054001_3800259115_t000_CII1336_SiIV1403_MgIIk2796_sp.fits
```

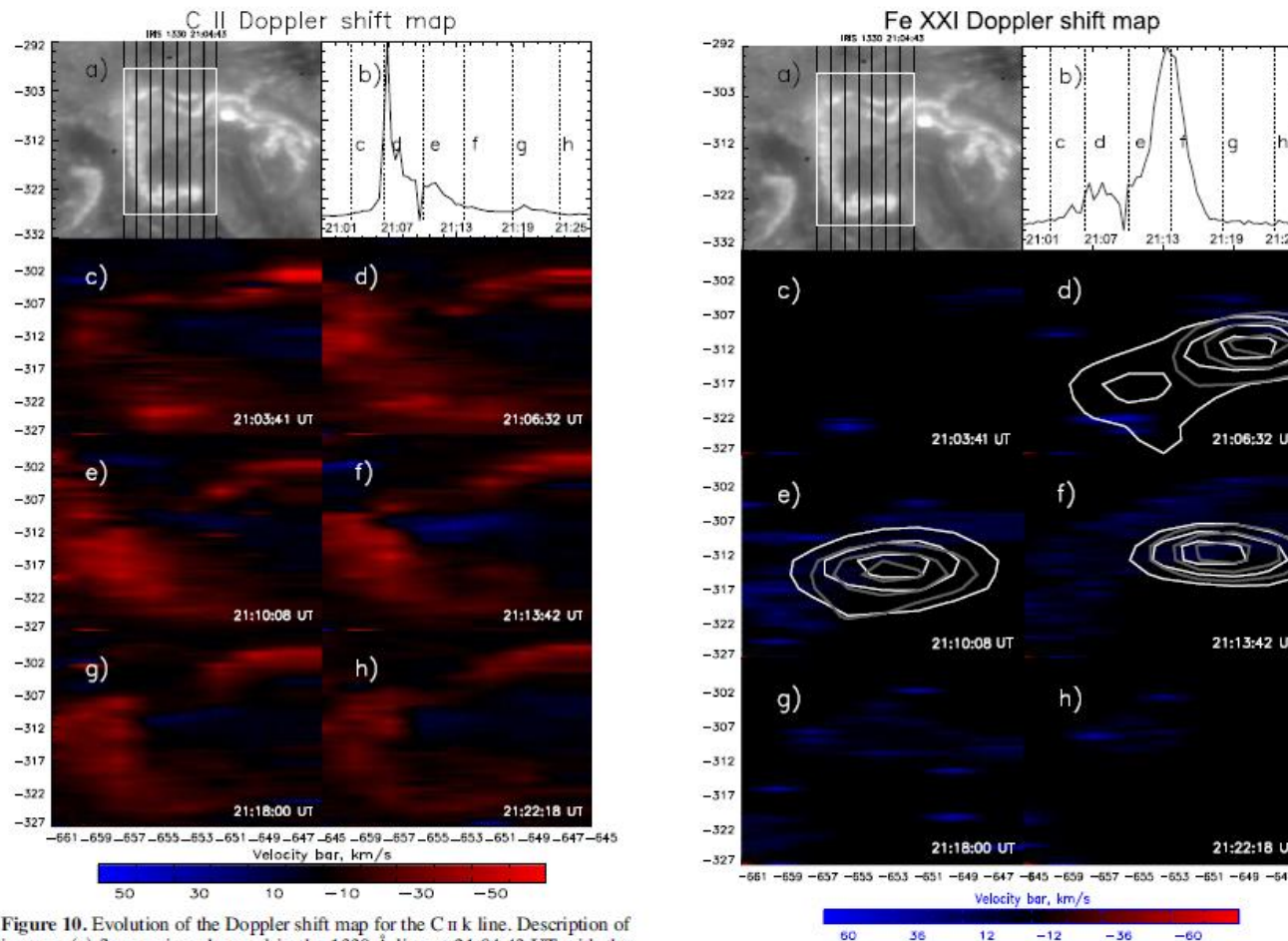
```
1 GB
```

```
;It is then possible to start crispex using the f array
```

```
IDL> crispex, f[3], f[4], sji=f[1]
```

Анализ солнечных вспышек по данным IRIS

Один из самых интересных процессов для анализа – хромосферное испарение. Благодаря одновременному наблюдению холодных линий хромосферы и переходного слоя и горячей линии железа Fe XXI 1354.1Å, возможно наблюдать движения холодной и горячей плазмы



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