

GUIDE FOR USING JS9

Part 2

The flexibility and user friendliness of JS9 allows you to easily access many astronomical databases to explore deep-sky objects. In this section of the tutorial we will show you how to use on-line data, load it into JS9, and analyze the image. We assume you have successfully navigated **Part 1** prior to using this section.

We will use for an example, an early Chandra x-ray observation of the quasar 3C273.

1) **GO TO:** <https://js9.si.edu/nso/nso.html>

Note that J9 has an extensive set of “help” pages. In particular, hints for accessing data archives can be found by navigating to: Help → General help → Accessing Data Archives. You will see something resembling Figure 1:

- [CAS-A \(Chandra\)](#)
- [Cen-X3 \(Chandra\)](#)
- [GK-Per \(Chandra\)](#)

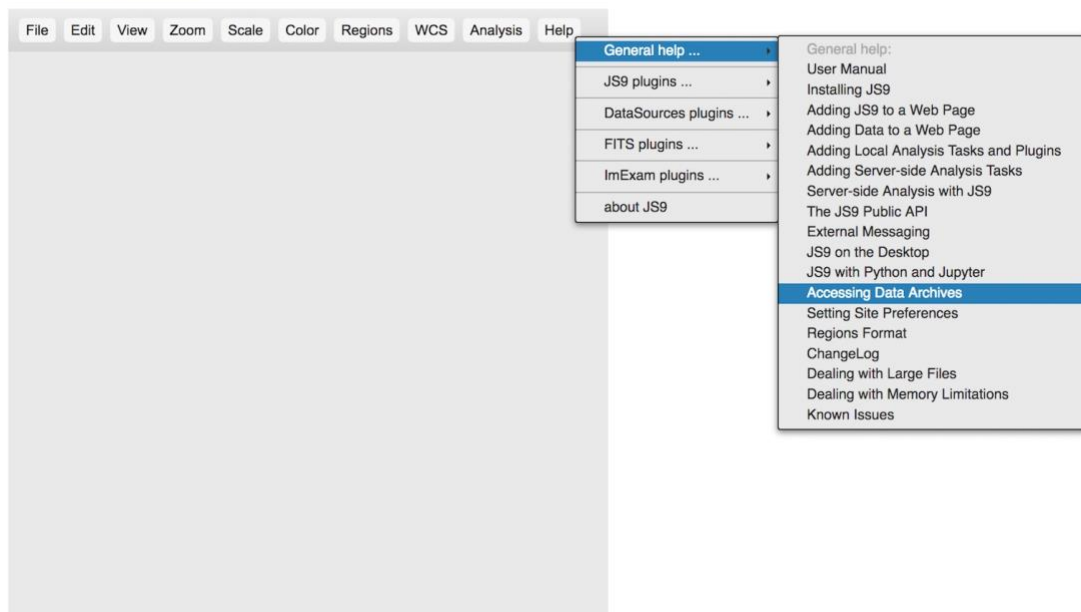


Figure 1

We will be more or less following those guidelines contained there.

2) Load the observation of 3C273:

- A) Go to: Help -->General help --> Accessing Data Archives
- B) Click on the Unofficial Chandra Archive. The following will appear:

The UnOfficial Chandra Archive Search

ObsID

Name Simbad@CfA Instrument

RA hh:mm:ss.s Grating

Dec dd:mm:ss.s Title Key

Size d:mm:ss.s Observer

The Chandra Metadata Table - 17651 records

Figure 2

This table allows you to enter the observation number directly (ObsID) if you know it, or allows you to search for all observations of a particular object by entering its Name.

- C) Type "3C273" (without the quotes) in the "Name" box and hit "Search". The following listing appears:

Name Simbad@CfA Instrument

RA hh:mm:ss.s Grating

Dec dd:mm:ss.s Title Key

Size d:mm:ss.s Observer

Search Results : Found 31 Matches

ObsID for data files from cda.harvard.edu
 RA,DEC in FK5
 Exposure is reported in kilo seconds.
 Observer for an ADS query based on the author's name
 Title for the FITS image (if available)

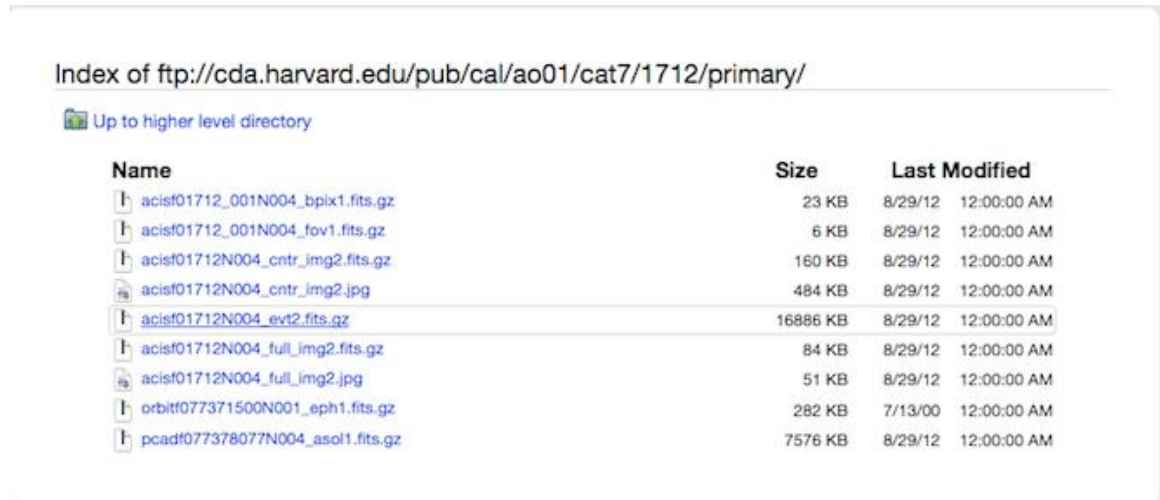
ObsID	RA	Dec	Exposure	Observer	Title
459	12:29:07.523	2:03:21.003	38.7	CXC CALIBRATION	IN FLIGHT CALIBRATION OF THE HETGS EFFECTIVE AREA AND CROSS DISPERSION PROFILE
460	12:29:07.237	2:03:25.204	39.9	CXC CALIBRATION	IN FLIGHT CALIBRATION OF THE HETGS EFFECTIVE AREA AND CROSS DISPERSION PROFILE
461	12:29:07.491	2:03:20.696	20.1	CXC CALIBRATION	IN FLIGHT CALIBRATION OF THE HETGS EFFECTIVE AREA AND CROSS DISPERSION PROFILE
1198	12:29:08.758	2:03:13.407	38.2	CXC CALIBRATION	IN FLIGHT CALIBRATION OF THE HETGS EFFECTIVE AREA AND CROSS DISPERSION PROFILE
1711	12:29:07.147	2:04:27.267	27.1	CXC CALIBRATION	IN FLIGHT CALIBRATION OF THE HETGS EFFECTIVE AREA AND CROSS DISPERSION PROFILE
1712	12:29:06.424	2:03:15.242	27.4	CXC CALIBRATION	IN FLIGHT CALIBRATION OF THE HETGS EFFECTIVE AREA AND CROSS DISPERSION PROFILE
2462	12:29:06.190	2:02:53.333	29.7	CXC CALIBRATION	A03 CALIBRATION OBSERVATIONS OF 3C273
2463	12:29:06.466	2:03:15.623	26.7	CXC CALIBRATION	A03 CALIBRATION OBSERVATIONS OF 3C273
2464	12:29:08.397	2:04:19.588	29.5	CXC CALIBRATION	A03 CALIBRATION OBSERVATIONS OF 3C273
2471	12:29:08.387	2:04:19.596	24.9	CXC CALIBRATION	A03 CALIBRATION OBSERVATIONS OF 3C273
3456	12:29:06.486	2:03:15.869	24.5	CXC CALIBRATION	MEASURING THE QE MAP FOR HETG/ACIS-S OBSERVATION AT DIFFERENT SIM_Z OFFSETS
3457	12:29:06.487	2:03:15.951	24.8	CXC CALIBRATION	MEASURING THE QE MAP FOR HETG/ACIS-S OBSERVATION AT DIFFERENT SIM_Z OFFSETS
3573	12:29:06.479	2:03:15.858	29.7	CXC CALIBRATION	A04 CALIBRATION OBSERVATIONS OF 3C273
3574	12:29:08.483	2:04:19.381	27.3	CXC CALIBRATION	A04 CALIBRATION OBSERVATIONS OF 3C273
4430	12:29:06.464	2:03:15.765	27.2	CXC CALIBRATION	A04 CALIBRATION OBSERVATIONS OF 3C273
4431	12:29:08.256	2:04:20.579	26.4	CXC CALIBRATION	A04 CALIBRATION OBSERVATIONS OF 3C273
4876	12:29:08.174	2:03:46.164	37.5	SEBASTIAN JESTER	The X-ray emission mechanism in 3C273's jet
4877	12:29:07.735	2:03:49.753	34.9	SEBASTIAN JESTER	The X-ray emission mechanism in 3C273's jet
4878	12:29:03.989	2:02:17.169	34.1	SEBASTIAN JESTER	The X-ray emission mechanism in 3C273's jet
4879	12:29:04.552	2:02:11.813	35.6	SEBASTIAN JESTER	The X-ray emission mechanism in 3C273's jet
5169	12:29:06.470	2:03:15.760	29.7	CXC CALIBRATION	A05 Calibration Observations of 3C273
5170	12:29:08.300	2:04:20.413	28.4	CXC CALIBRATION	A05 Calibration Observations of 3C273
7364	12:29:07.204	2:03:11.425	2.0	ANN WEHRLE	Coordinated Spitzer/Chandra Observations of Gamma Ray Blazars
7365	12:29:06.921	2:02:51.505	2.1	ANN WEHRLE	Coordinated Spitzer/Chandra Observations of Gamma Ray Blazars
8375	12:29:06.477	2:03:15.428	29.6	CXC CALIBRATION	A08 Calibration Observations of 3C273
9703	12:29:06.770	2:02:51.150	29.7	CXC CALIBRATION	A09 Calibration Observations of 3C273
14455	12:29:07.130	2:02:59.791	29.5	CXC CALIBRATION	Coordinated Observation of 3c 273 with NuSTAR
17393	12:29:06.864	2:02:49.187	29.5	CXC CALIBRATION	AO-16 LETG/ACIS-S Calibration Observations of PKS2155-304
18421	12:29:07.213	2:03:04.039	29.6	CXC CALIBRATION	AO-17 Cross-Calibration Observations of 3C273
19867	12:29:07.279	2:02:52.568	26.9	CXC CALIBRATION	AO-18 Cross-Calibration Observations of 3C273
20709	12:29:08.260	2:02:38.804	29.6	CXC CALIBRATION	AO-19 Cross-Calibration Observations of 3C273

Figure 3

This table displays all the Chandra observations of 3C273. We will use ObsID 1712 for this tutorial.

D) Click on the *ObsID* of the observation. This is important! Do NOT click on the Title.

E) When you do this, you will be directed to the URL where the data reside. The following listing will be displayed:



Index of ftp://cda.harvard.edu/pub/cal/ao01/cat7/1712/primary/

[Up to higher level directory](#)

Name	Size	Last Modified
acisf01712_001N004_bpix1.fits.gz	23 KB	8/29/12 12:00:00 AM
acisf01712_001N004_fov1.fits.gz	6 KB	8/29/12 12:00:00 AM
acisf01712N004_cnr_img2.fits.gz	160 KB	8/29/12 12:00:00 AM
acisf01712N004_cnr_img2.jpg	484 KB	8/29/12 12:00:00 AM
acisf01712N004_evt2.fits.gz	16886 KB	8/29/12 12:00:00 AM
acisf01712N004_full_img2.fits.gz	84 KB	8/29/12 12:00:00 AM
acisf01712N004_full_img2.jpg	51 KB	8/29/12 12:00:00 AM
orbitf077371500N001_eph1.fits.gz	282 KB	7/13/00 12:00:00 AM
pcadf077378077N004_asol1.fits.gz	7576 KB	8/29/12 12:00:00 AM

Figure 4

F) Right click to copy the *ftp link location* of the *.evt2.fits.gz file. This is the “events” file that contains the actual data. We will now paste that location into JS9, to tell it where to retrieve our observation.

G) Now, go back to File ---> open--> URL via proxy and paste the link into the box. It will look like this:

- [CAS-A \(Chandra\)](#)
- [Cen-X3 \(Chandra\)](#)
- [GK-Per \(Chandra\)](#)



Figure 5

H) Click “Load”. Be patient! After about a minute, there is our observation, ready to be analyzed. Let’s do it!

3) Analyze 3C273. First, a few comments about the image. The diagonal line extending from the upper right to lower left is an artifact of the “readout” of the data. Also, the fact that the central image looks like a solar eclipse is due to “pileup”. 3C273 is so bright that it overflows the buffers containing the data, so the central part looks dark, instead of bright. We will ignore these issues in what follows.

By the way, the “jet” that you see emanating from about 4 o’clock of the main object is emphatically NOT an artifact. It is a well-studied (and still mysterious) feature of the quasar....

A) Zoom in and change the color. Let’s make it pretty!

1) Go to: Zoom → zoom 4. This enlarges the image.

2) Go to: Color → more colormaps → inferno

The image will look like the following:

- [CAS-A \(Chandra\)](#)
- [Cen-X3 \(Chandra\)](#)
- [GK-Per \(Chandra\)](#)

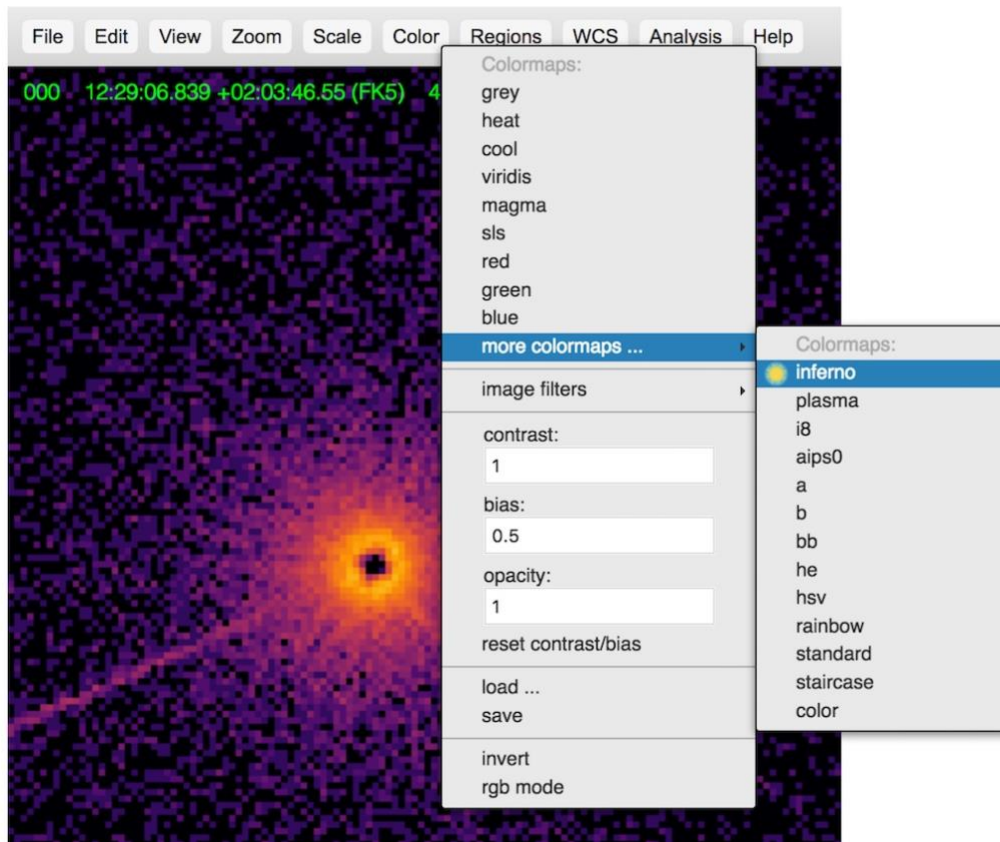


Figure 6

- B)** Get an energy spectrum of the main object
- 1) Go to: Regions → circle
 - 2) Center the circle and adjust its size so it is approximately like the circle in Figure 7.
 - 3) Go to: Analysis → Energy Spectrum
 - 4) You should see something similar to the leftmost plot in Figure 7.
- C)** Now let's do the same thing for the jet!
- 1) Go to: Regions → ellipse (delete the circular region first).
 - 2) Stretch, center and rotate the ellipse (by grabbing the top dot on the selection outline) so it extends from the center of the main object out to edge of the visible x-ray jet. See Figure 7.
 - 3) Go to: Analysis → Energy Spectrum
 - 4) You should see something similar to the rightmost plot in Figure 7.
- D)** Compare the two! In Figure 7, I have listed the regions and their sizes, as well as displayed both spectra. Note they are quite similar, but there is an important difference.

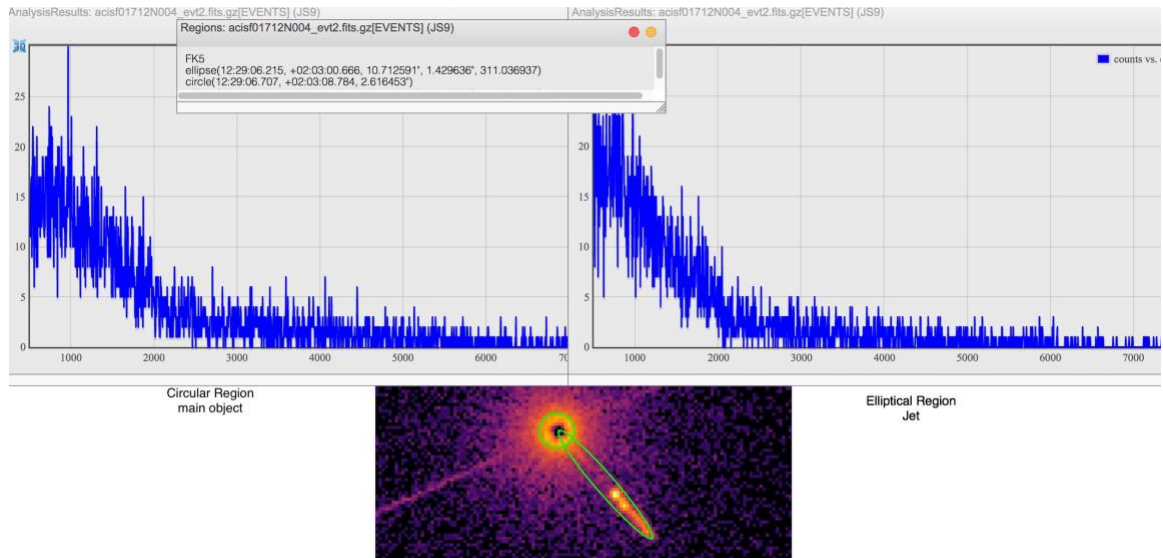


Figure 7

The main object has a “flatter” shape; it extends out to higher energies....

E) What does it mean? It means the central object is “driving” the jet. It is more energetic, and probably hotter than the jet.

F) What else can we do with this? Let's see if we can estimate the size of the jet!

- 1) Note that I have listed the elliptical region in Figure 7. (In case you've forgotten from Part 1, Go to: Regions → list). Its semi-major axis is 10."7. (Your region will probably be slightly different....)
- 2) This means that the entire length on the sky is about 21."4.
- 3) The red-shift of 3C273 is 0.158 (found by other means such as examining the visible spectrum) corresponding to a distance of about 750 Mpc. So the physical size of the jet is:

$$750 \times 21.4 / 206265 \text{ Mpc} = 78 \text{ Kpc} = 250,000 \text{ light years}$$

That's about equal to the entire diameter of the Milky Way!

In Part 3, we will explore other neat things we can do with the JS9 imaging system.