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://chandra.harvard.edu/js9/index.html

Note that this page is different from the one you used in the first part of the tutorial. It has no pre-loaded images, but instead has an extensive set of activities to the right of the JS9 window plus a link to the Chandra Archive. You will see something resembling Figure 1:

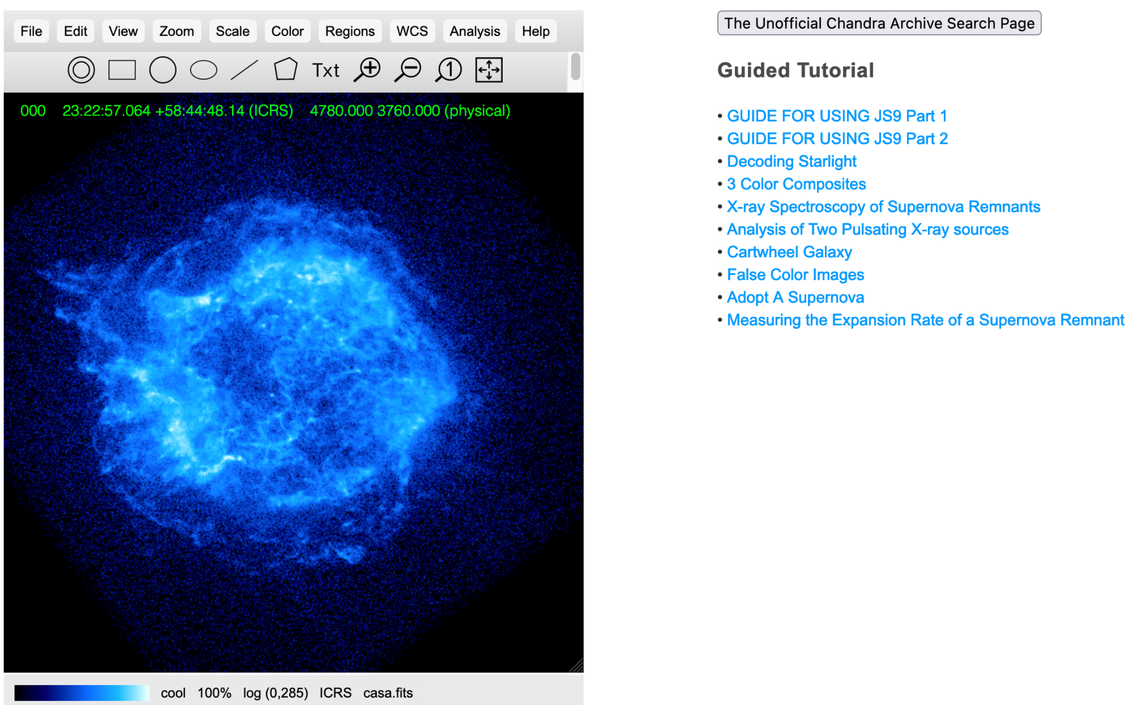


Figure 1

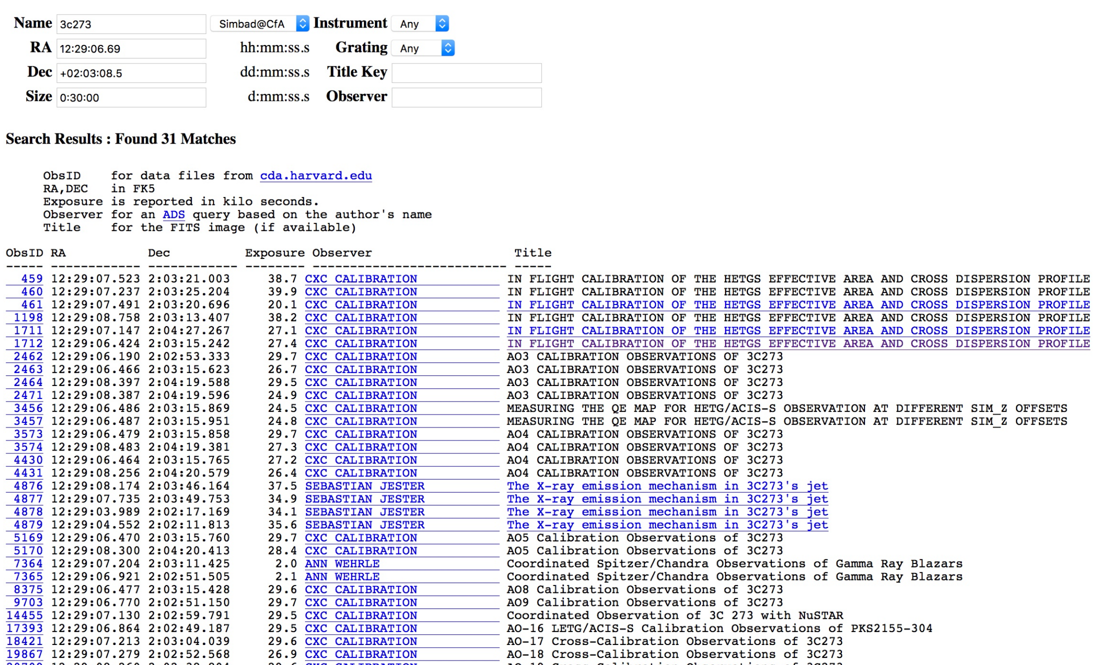
2) Load the observation of 3C273:

A) Click on "The Unofficial Chandra Archive Search Page" link. The following will appear:

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.

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



Name	3c273	Simbad@CfA	**Instrument**	Any	
RA	12:29:06.69	hh:mm:ss.s	**Grating**	Any	
Dec	+02:03:08.5	dd:mm:ss.s	**Title Key**		
Size	0:30:00	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	AO3 CALIBRATION OBSERVATIONS OF 3C273
2463	12:29:06.466	2:03:15.623	26.7	CXC CALIBRATION	AO3 CALIBRATION OBSERVATIONS OF 3C273
2464	12:29:08.397	2:04:19.588	29.5	CXC CALIBRATION	AO3 CALIBRATION OBSERVATIONS OF 3C273
2471	12:29:08.387	2:04:19.596	24.9	CXC CALIBRATION	AO3 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	AO4 CALIBRATION OBSERVATIONS OF 3C273
3574	12:29:08.483	2:04:19.381	27.3	CXC CALIBRATION	AO4 CALIBRATION OBSERVATIONS OF 3C273
4430	12:29:06.464	2:03:15.765	27.2	CXC CALIBRATION	AO4 CALIBRATION OBSERVATIONS OF 3C273
4431	12:29:08.256	2:04:20.579	26.4	CXC CALIBRATION	AO4 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	AO5 Calibration Observations of 3C273
5170	12:29:08.300	2:04:20.413	28.4	CXC CALIBRATION	AO5 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	AO8 Calibration Observations of 3C273
9703	12:29:06.770	2:02:51.150	29.7	CXC CALIBRATION	AO9 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.

C) Click, hold, and drag the *Title* column corresponding to the ObsID 1712 observation directly onto the JS9 window. Then release. This is important! Do NOT click on the ObsID itself.

D) The observation now appears in the JS9 window! It will look like this:

Figure 4

E) Our observation is 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 somewhat 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. Also, note that this is a *representation* image of the data. It looks pixillated because it is compressed. However, *all analyses use the uncompressed image and its associated "events" file.* This technique allows you to load even massive data sets and get a display quickly.

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:

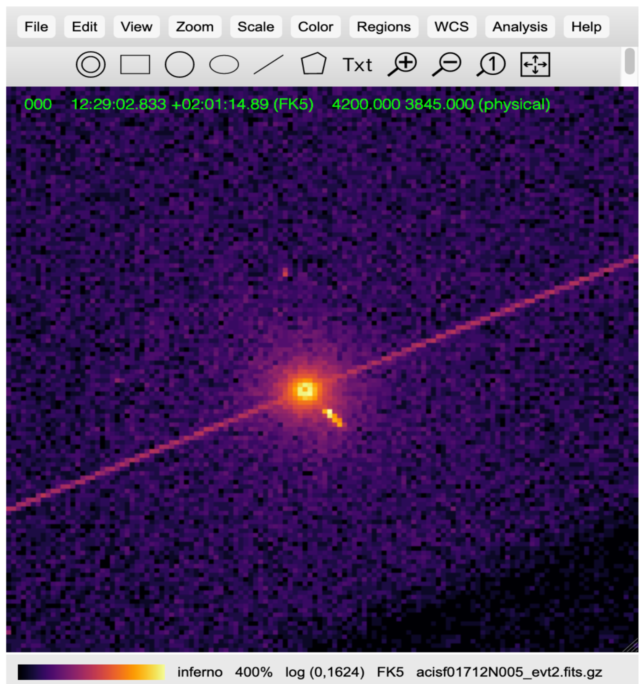


Figure 5

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 6 below.
3) Go to: Analysis → Energy Spectrum
4) You should see something similar to the leftmost plot in Figure 6.

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 6.
3) Go to: Analysis → Energy Spectrum
4) You should see something similar to the rightmost plot in Figure 6.

D) Compare the two! In Figure 6, 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.

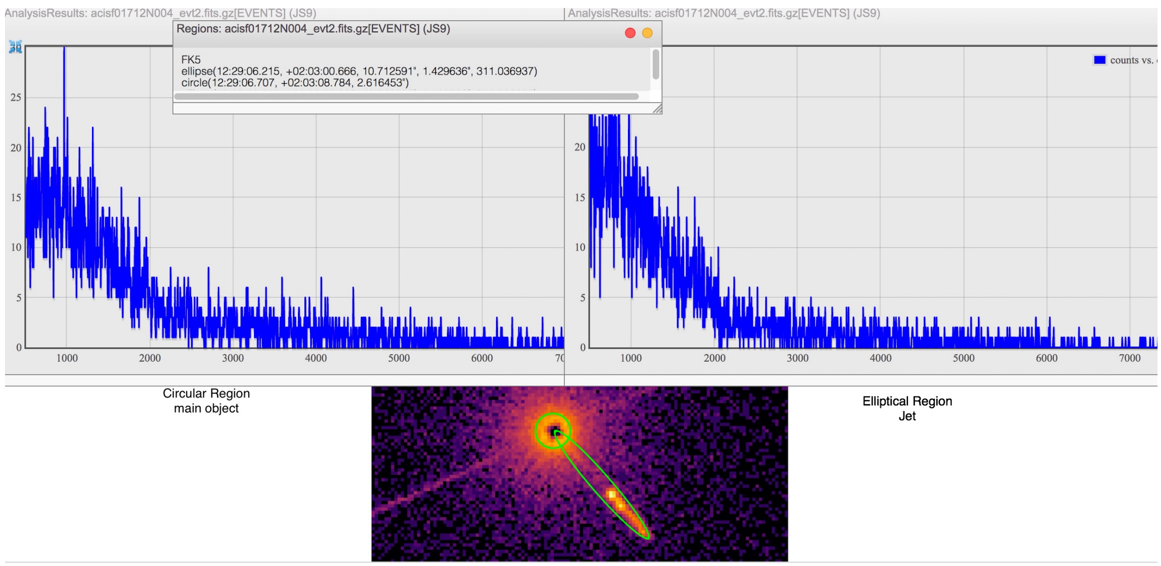


Figure 6

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 6. (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 x 21.4/206265 Mpc = 78 Kpc = 250,000 light years

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