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:
2) Load the observation of 3C273:

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

![The Unofficial Chandra Archive Search Page](image)

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:

![Search Results](image)

Figure 2

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](image)

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](image)

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 \(\rightarrow\) 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](image)

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 \(\rightarrow\) 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:

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750 \times \frac{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!