

GUIDE FOR USING JS9

Part 1

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

You will see a blank page, with several pre-loaded FITS files at the top of the JS9 imaging box.

2) LOAD AN IMAGE: Click on CAS-A (Chandra)

A) Play with color: place the cursor inside the image, and click and hold while you drag it both horizontally and vertically. (If things get messed up, go to: Color → reset contrast/bias)

Try a different color display. Go to: Color → more colormaps → inferno.

Colormaps are useful when you want to see which parts of the image are of similar (or different) intensities

B) Make an energy spectrum:

1) Go to: Regions → circle. Click. A little green circle will appear near the center of the image. Move the cursor inside the region. The arrow will change to a cross. Click and hold while you drag the circle around. (Be sure you are *inside* the region when you do this, or you will be changing the contrast/bias instead! If this happens, just reset the color via 2A above.) Center the region approximately in the image.. Now, go to the corner of the box surrounding the region. The cross will turn into an arrow. Click and hold while you drag the region size to encompass the entire remnant. Things will look similar to figure 1.

2) Go to: Analysis → Energy Spectrum. Click. Voila! Figure 2 appears.

Figure 1

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

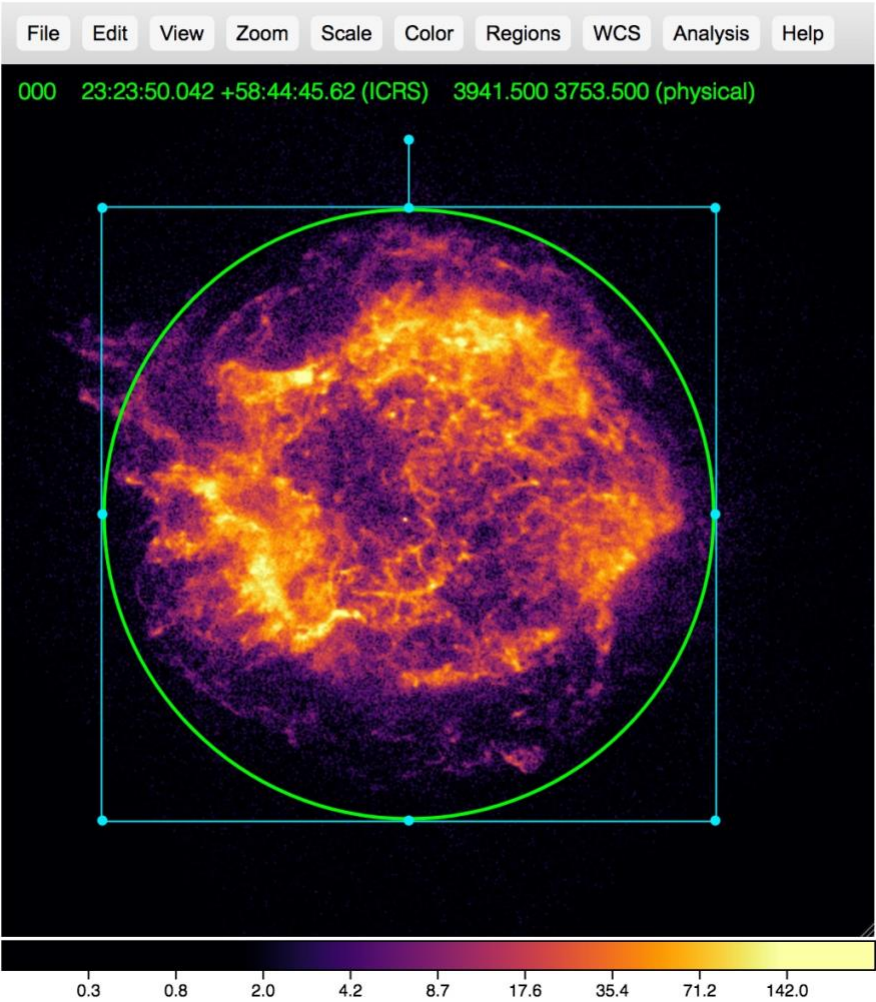
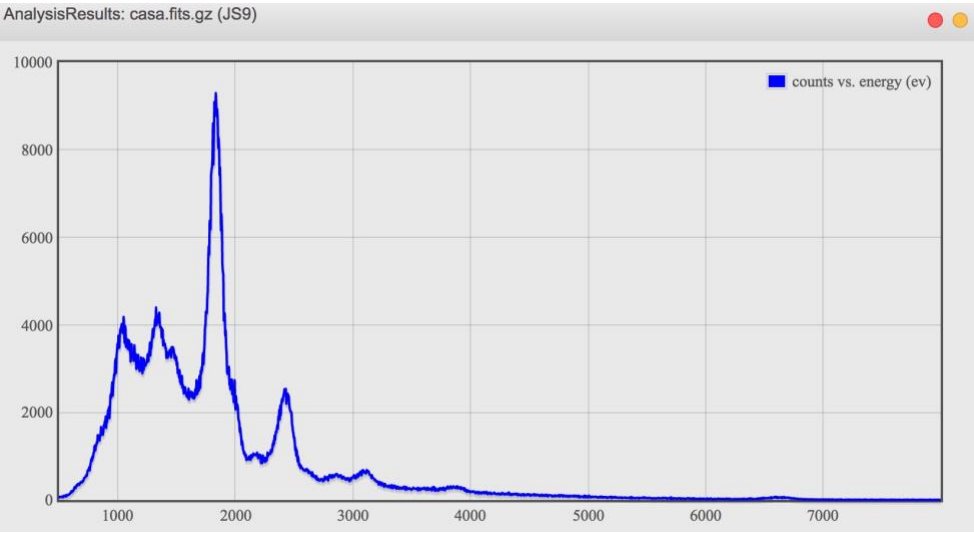


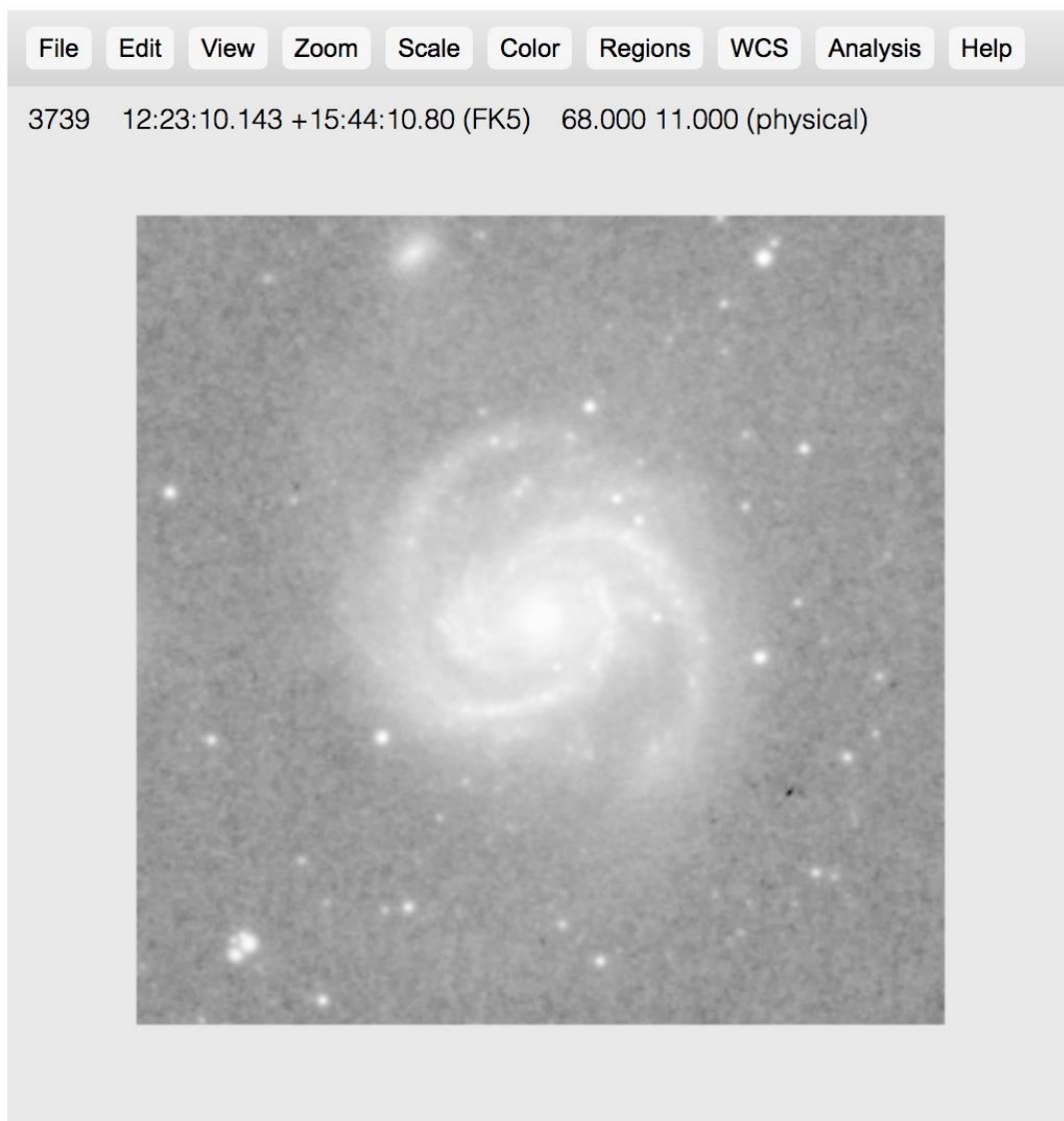
Figure 2



3) LOAD AN EXTERNAL LOCAL FILE: Use JS9 with *any* fits file. We will display the Palomar image of **M100** in JS9 and answer the 2019 NSO questions about it.

- A) Go to: <https://www.dropbox.com/s/yv6yaltse0ilcod/m100.fits?dl=0>
This is a dropbox link to the file. Click on **Open → Download**
- B) Save the **M100.fits** file somewhere convenient on your computer.
- B) Go to: File → open → local file
- C) Navigate to the **M100.fits** file and click on open. Figure 3 will appear.

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



Note the coordinates and other data at the top of the frame.

Figure 3

Now, we can play with the color and create a region to simulate Image 42 from the NSO exam.....

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

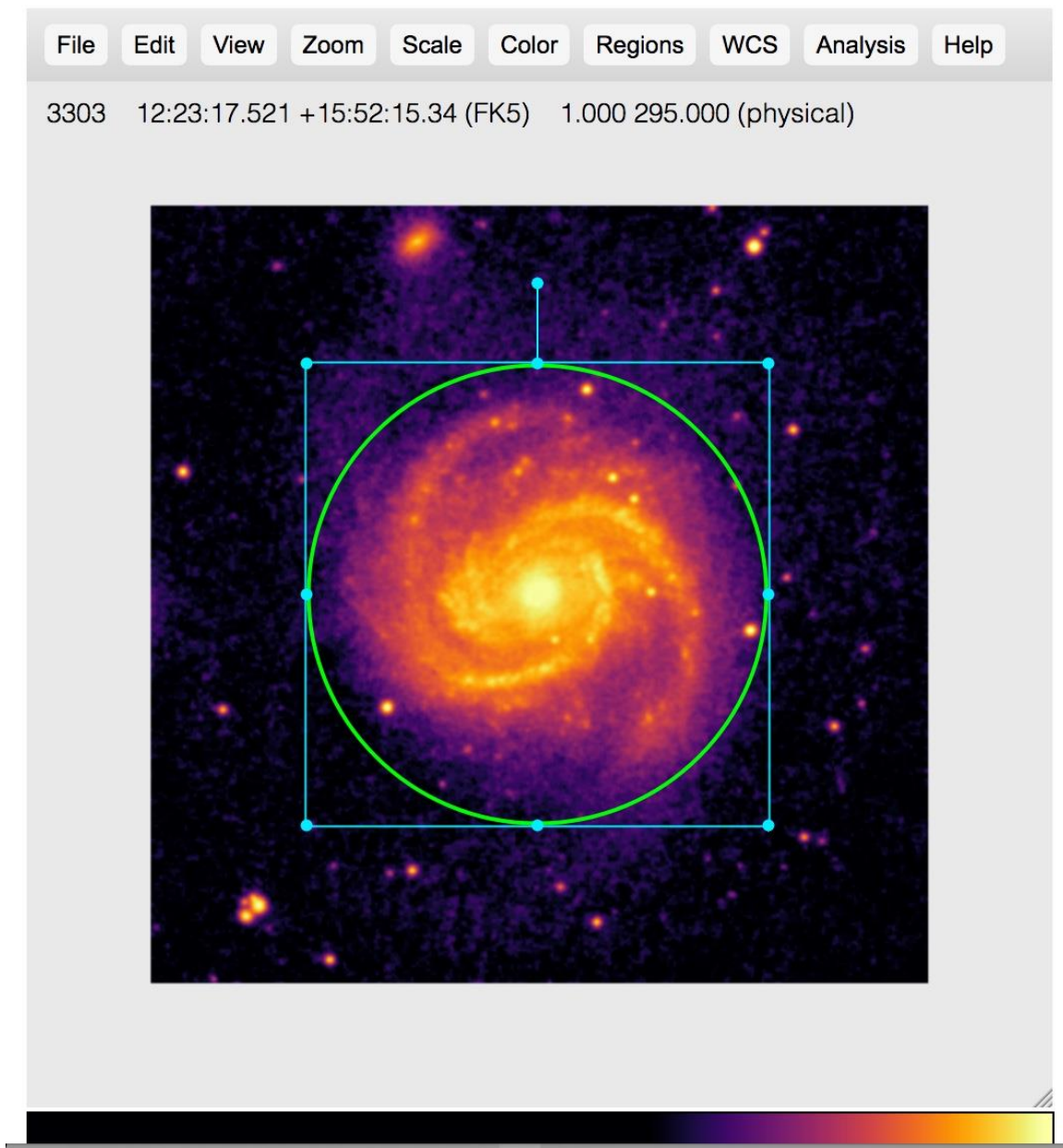


Figure 4

D) Go to: Regions → list

The coordinates of the center of the region and its radius appears. See Figure 5.

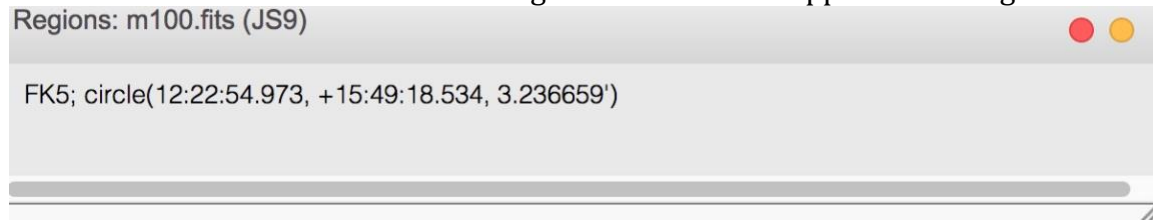


Figure 5

We see here that the radius is 3.237' of arc. (On the exam, my image region was 3.166')

Now, we can answer 23(e): $\text{Size} = \text{Distance} \times \text{subtended angle} = 16 \times 6.474/3438$
 $= 0.03013 \text{ Mpc} = 30 \text{ Kpc}$

We now proceed to question 24:

4) LOAD THE IMAGE OF GK_PER:

A) Click on **GK-Per (Chandra)** near the top of the JS9 display. The data has been pre-loaded on-line, like in the case of Cas-A. The following image appears:

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

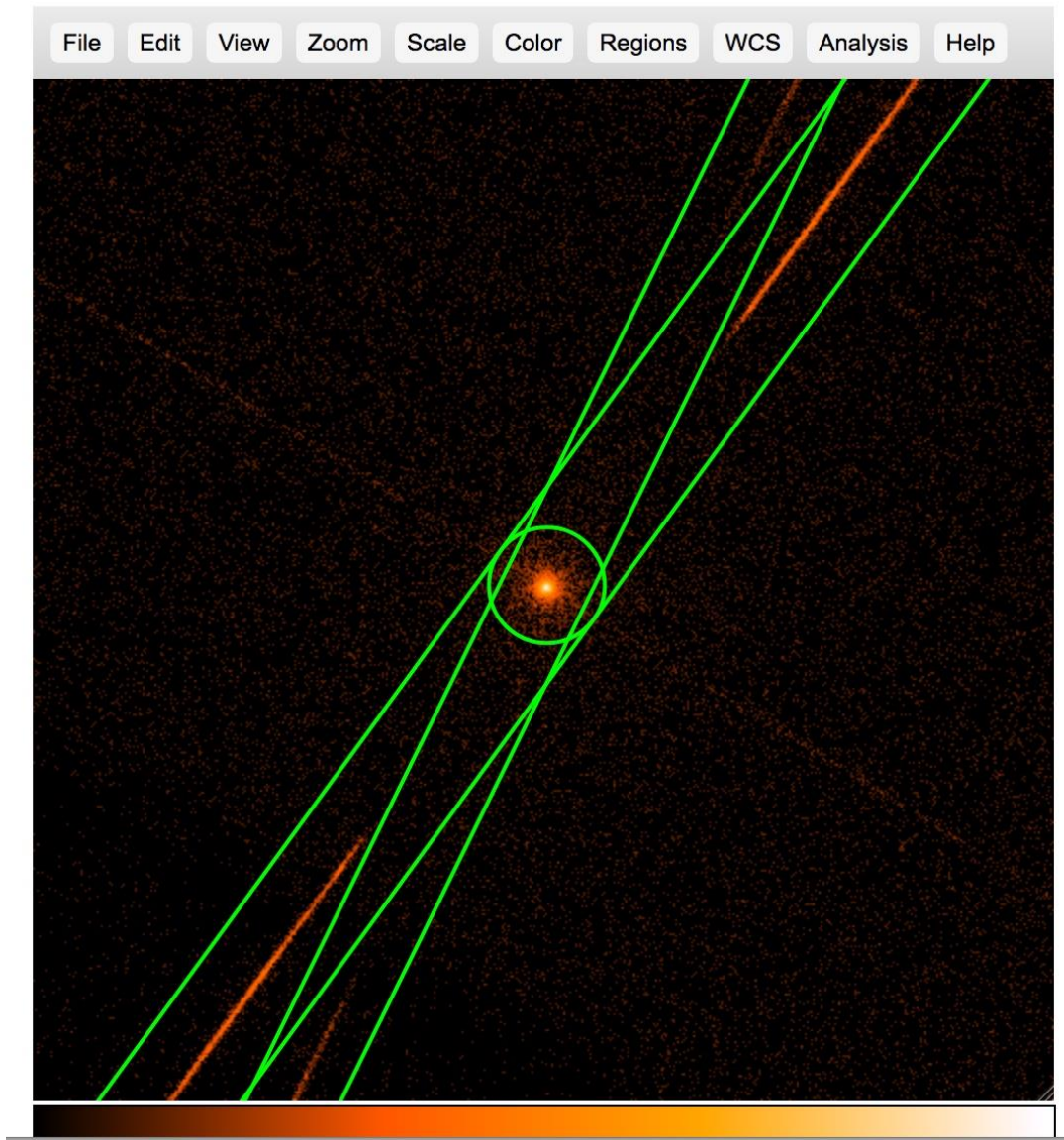


Figure 6

Note that the green regions are preloaded as well. The reason for the strange shapes that you see is that this particular observation uses Chandra's grating capabilities, so the x-ray photons are spread out into those two elongated rectangles that you see displayed at an acute angle to each other.

B) Make a light curve: Click on Analysis → Light Curve. Figure 7 appears.
(NOTE! Be sure to select the Light Curve under the NSO sub-heading!)

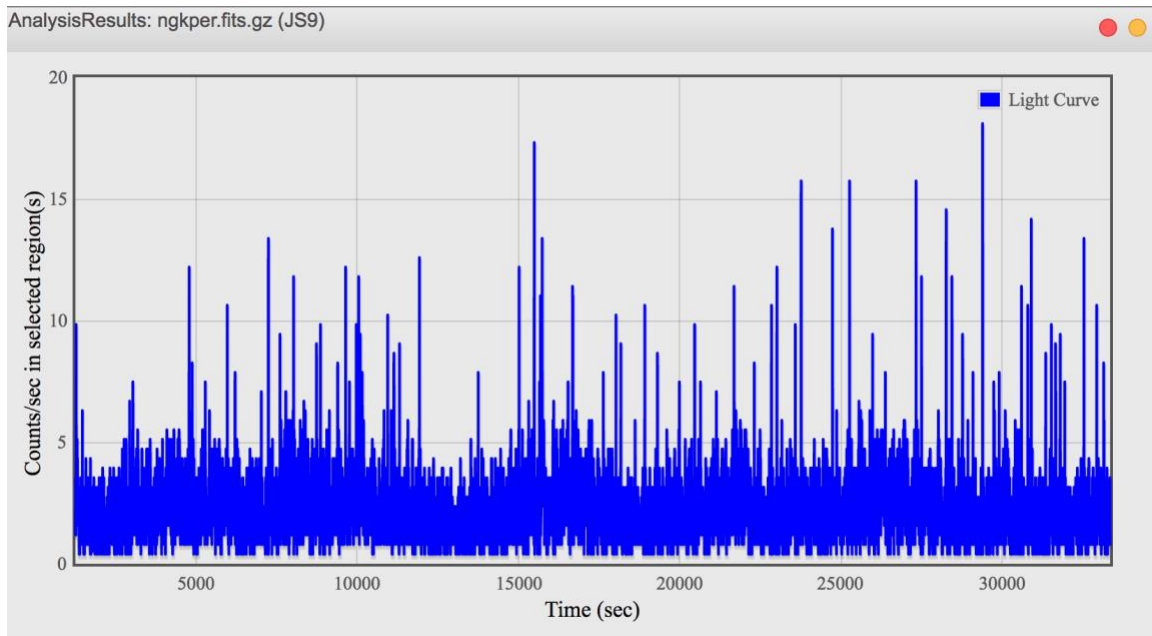


Figure 7

This is Image 43 from the NSO exam. It is certainly not obvious that anything special is going on here. But now we can ZOOM the light curve! Set the cursor near $y=0$ and $x=15,000$ (say) and hold it down while you drag it to (about) $y=20$ $x=22,000$. You should see that interval shaded as below:

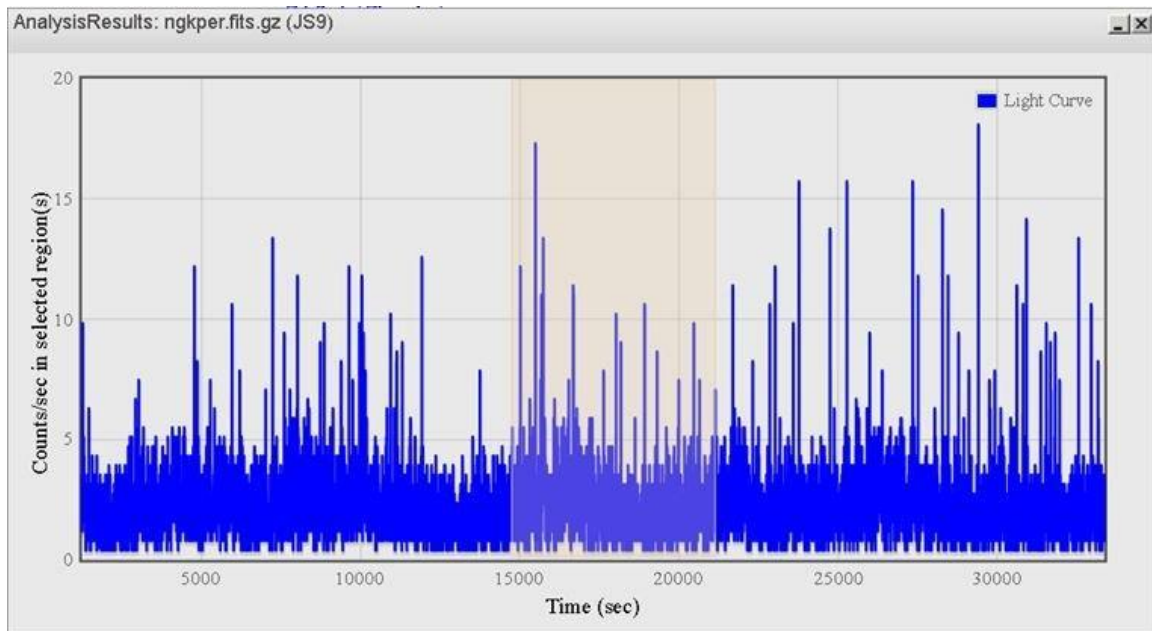


Figure 8

Now, when you release the cursor, the selected area is zoomed! See Figure 9

AnalysisResults: ngkper.fits.gz (JS9)

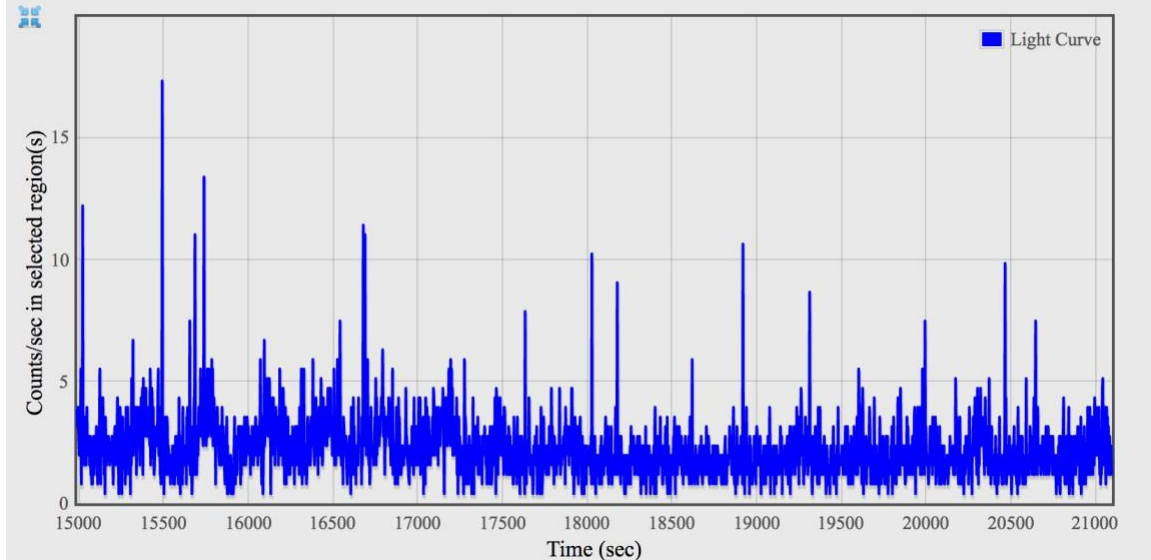


Figure 9

This is similar to Image 44 from the NSO exam. Now you can see some vague hints of regular periodicity. By the way, if you want to revert to the original curve, just click on the little collapse icon in the upper left of the graph (shown by the arrow).

But to truly exploit all the data systematically, we need to do a power spectrum. Quite similar to an FFT (Fast Fourier Transform), it gives you an exact result for how much (if any) of the power output of the source is being modulated. So let's do it!

C) Make a power spectrum: Click on Analysis → Power Spectrum
Figure 10 appears

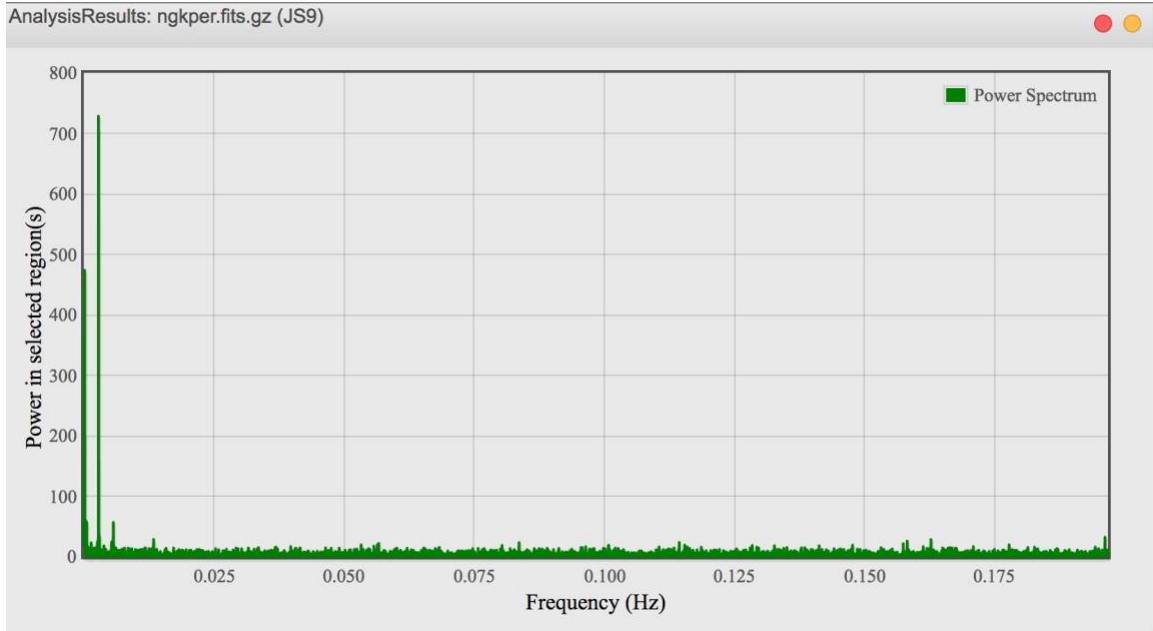


Figure 10

This is Image 45 from the NSO exam. Now we can zoom the power spectrum, just like we did the light curve. Setting the cursor on $x=0$, $y=0$, hold and drag to about $x=0.01$, $y=800$. Figure 11 appears....

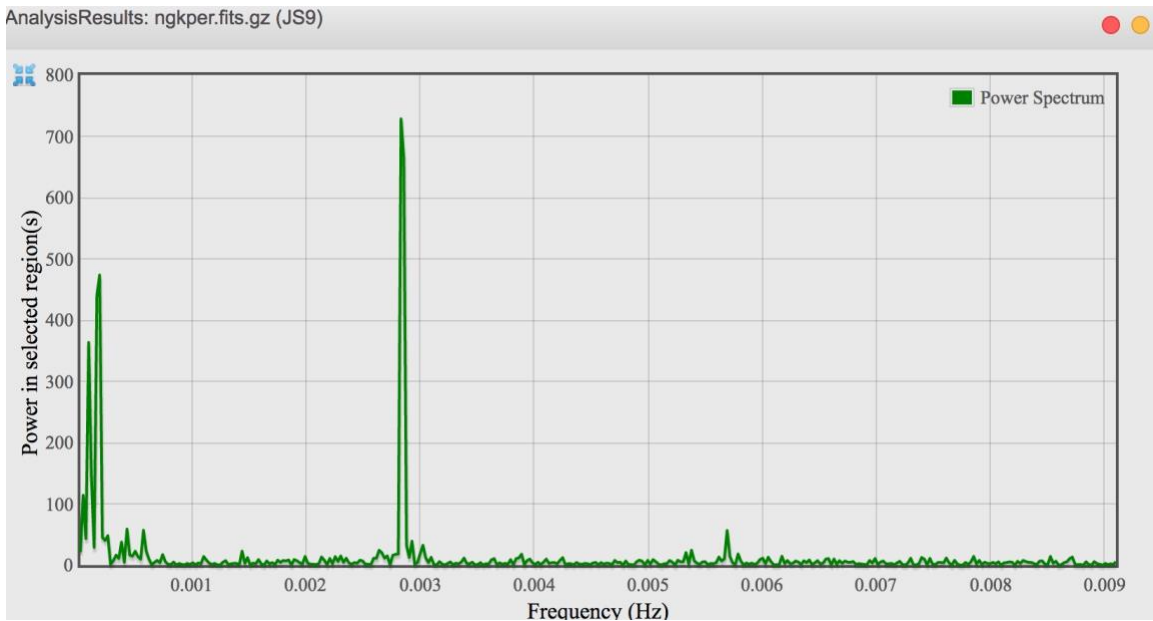


Figure 11

Now we see quite clearly what is going on! The peaks near $x=0$ represent the "steady" emission from the source, while that at $x \approx 0.0029$ represents clear

periodic emission. To get even more detail, let's zoom in again near the peak. Figure 12 appears

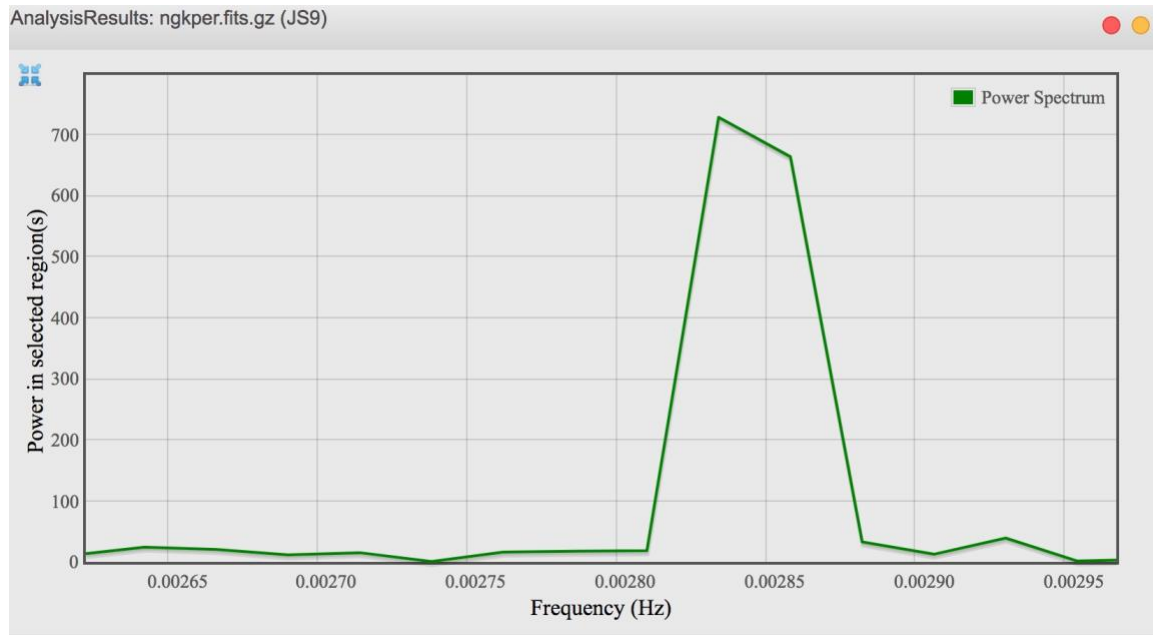


Figure 12

This is similar to Image 46 from the NSO exam. So the emission has a periodic component at $x = 0.00284$ Hz. Since that is the frequency, the period is 352 seconds. GK Per was the first white dwarf to be conclusively shown to be rotating via x-ray analysis,

Using these figures now makes Question 24 straightforward.....

In Part 2, we will explore techniques for analyzing *arbitrary* FITS data sets, using public archives. This will vastly expand the range of possibilities to examine deep sky objects.