

Lab 3

High Energy Databases and Catalogs

Log into your department Unix account and start X Windows using the “startx” command. Open a **Terminal** window. Go to your home directory and list *all* of its contents:

```
cd ~
ls -a
```

You should see the files that you created and downloaded last week, including the .cshrc file that was automatically executed when you opened the terminal window.

Take the following steps to download the Chandra X-ray FITS image of the central region of NGC 1399 – an elliptical galaxy in the nearby Fornax galaxy cluster.

- Open a browser, and go to <http://heasarc.gsfc.nasa.gov/>.
- Navigate to the **HEASARC Browse** archive interface (select the “Archive” link, followed by “Browse”).
- Do a search for **Chandra** observations of this object.
- Once the search has completed, select to view **Query Results** and sort the list of Chandra observations by time.
- Select to retrieve the **FITS and JPEG Images** for the *most recent* Chandra observation.
- Now, in the **Data Products Retrieval** tab, select to **Preview and Retrieve** these images.
- Preview the “Center Image” to be retrieved by clicking the left mouse button on that image.
- Select to retrieve only the “Center Image” (compressed) FITS data products, and then TAR selected products.
- Once the “tar file” has been created, retrieve it. Save it as a file in your home directory. This file should have a filename with extension (.tar) indicating that it is a tar file.

Check that the tar file has indeed been placed in your home directory, and then move it into the data directory that you created last week.

```
cd ~
ls *tar
mv <filename> data
```

Untar the file:

```
cd data
tar -xvf <filename>
```

By including the “v” option (for “verbose”), the names of the unpacked files will be written to the screen. You will notice that unpacking this tar file created two new levels of subdirectories. (At this point, the tar file is superfluous, and you may delete it using the Unix **rm** command.) Change directories to the subdirectory where the unpacked files reside, e.g.:

```
cd 9530
cd primary
```

or

```
cd 9530/primary
```

Note that the unpacked FITS file has a filename with extension (.gz) indicating that it is a compressed, or zipped, file. Uncompress this file using the Unix **gunzip** command that you used in last week's lab. Since you will need to use the file for this week's homework assignment, you should rename the file to something more evocative using the following Unix construction (*but always keep the .fits extension*):

```
mv <oldfilename> <newfilename>
```

Load the file into **ds9**:

```
ds9 <newfilename> &
```

Create a smoothed Chandra X-ray image with intensity contours overlaid as follows:

- Adjust the zoom factor, color table, and color scale.
- Open the **Smooth Parameters** window, located in the **Analysis** menu. Smooth the image, experimenting with various smoothing lengths ("kernel radii").
- You might want to readjust the color scale at this point.
- Open the **Contour Parameters** window, located in the **Analysis** menu. Superimpose intensity contours on the image, experimenting with different contour parameters (number of contour levels, range, linear scaling compared to log scaling, smoothness, contour color and width). Remember that contours must be generated and applied each time you wish to plot them.
- In the **File** menu of the **Contour Parameters** window, select to **Save Contours** to a file. The file should have extension (.con) indicating that it is a ds9 contour file.

Simultaneously display an optical DSS image of the same galaxy and overlay the Chandra contours, as follows:

- Select one of the DSS servers (e.g., STSCI-DSS I/II), found in **Image Servers** in the **Analysis** menu, and retrieve an optical image of the same region. This image will automatically load as a second, tiled frame.
- Keeping the two images in tiled frames, WCS-align the optical image with the *Chandra* image.
- Optimize the color scale of the optical image.
- Overlay contours on the optical image. Briefly compare these contours with those on the *Chandra* X-ray image. Do the contours associated with the extended optical emission have the same shape as the contours associated with the diffuse X-ray emission, in general?
- Clear the contours on the optical image. Display the optical image as a **Single Frame** (not tiled) in ds9.
- In the **File** menu of the **Contour Parameters** window, select to **Load Contours** choose the ds9 contour file that you previously saved with the *Chandra* X-ray contours.

Save this optical image with X-ray contours as a JPG image in your data directory. Print this image, and **turn it in at the end of lab**.

Log off the X Windows system. Then, log out of your Unix account by entering "exit" at the prompt.