New Features of SAOImage DS9

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Abstract.   SAOImage DS9 is an astronomical imaging and data visualization application. It supports FITS images and binary tables, multiple frame buffers, region manipulation, and many scale algorithms and colormaps. DS9 provides for easy communication with external analysis tasks and is highly configurable and extensible. This paper highlights new features of DS9 version 2.2.

1.   Introduction

SAOImage DS9 is an astronomical imaging and data visualization application. It supports FITS images and binary tables, multiple frame buffers, region manipulation, and many scale algorithms and colormaps. DS9 also supports advanced features such as multiple frame buffers, mosaic images, tiling, blinking, geometric region markers, colormap manipulation, scaling, arbitrary zoom, rotation, pan, and a variety of coordinate systems. It supports FTP and HTTP access, and provides for easy communication with external analysis tasks.

The latest release of DS9, version 2.2 (October 2002), contains a number of new features, including:

- support for the Virtual Observatory, which allows users to view and analyze remotely-located data from their local site.
- a built-in Help Facility, no longer requiring the use of an external web browser and network access.
- support for web-based Archive Servers, such as MAST, SkyView, NVSS, NED, SIMBAD and ADS.
- support for FITS Multiple WCS. Images may be rotated and aligned, and coordinate grids displayed using any available WCS.
- FITS Binary Table 3D binning, which allows users to create a 3D FITS Data cube and view the data as an interactive movie.
- FITS Binary Table smoothing using boxcar, tophat, and gaussian algorithms.
- new projection, panda, and compass regions. The interactive projection region displays an arbitrary cut of the image data, projected along a line.
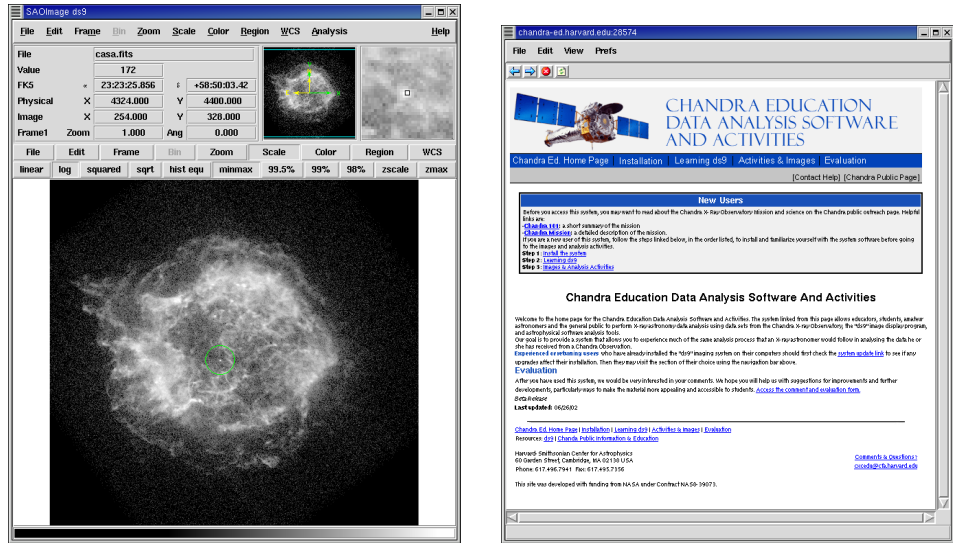
Figure 1.   Chandra Education Virtual Observatory Site

2.   Virtual Observatory

The DS9 Virtual Observatory menu option supports easy access to remotely-located data from a local site. Choosing one of the listed Virtual Observatory sites causes DS9 to register itself with the XPA name server running at that site. The DS9 web interface will then display the site's web page, which can be used to send FITS data back to DS9 for display.

For example, the Chandra Education site[1] offers Chandra-based educational activities. Once DS9 is connected to Chandra-Ed, FITS images can be sent back to DS9 for display and further analysis as part of these activities.

For speed of transfer, Chandra-Ed typically sends compressed FITS images (100Kb bytes) to DS9, rather than the original 100Mb+ Chandra event files. It also sends definitions of analysis tools that can operate on the original event data maintained at the Chandra-Ed site. These CGI-based definitions become part of the DS9 Analysis menu. Thus, after performing local DS9 analysis and/or setting up regions of interest, the user can select a remote analysis program. The associated CGI call sends parameter information back to the Chandra-Ed site, where the remote analysis program is executed on the original event data. Results are sent back to DS9 for display. All such analysis requests are processed in a secure "chroot'ed" environment.

In this way, DS9 can be used as a local frontend to remote archive/education servers that offer both data and analysis support. Moreover, this can be done without moving large data sets or complex software to the local machine.
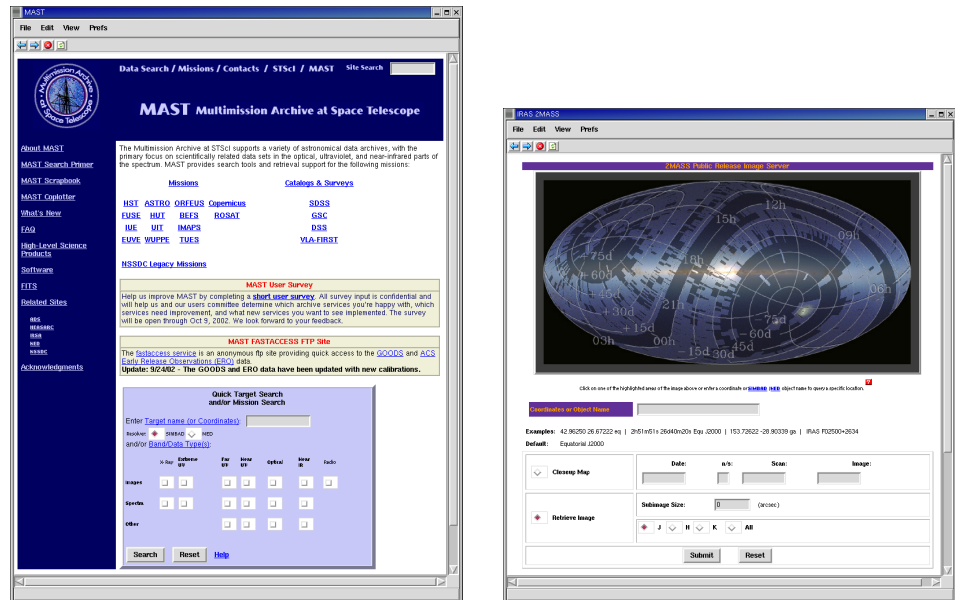
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[1]http://chandra-ed.harvard.edu

Figure 2.   Web-based Archive Servers

3.   Help Facility

DS9 2.2 supports a new built-in help facility. The reference manual, FAQ, and other documentation are available on all platforms, and no longer require an external web browser and network access. All help documentation is displayed using a built-in HTML viewer, which supports common browser functions such as hyperlinks, forward, back, and refresh.

4.   Web-based Archive Servers

DS9 2.2 provides access to web-based archive servers. Support for MAST, SkyView, 2MASS, ISSA, NVSS, First, NED, SIMBAD, SAO TDC and ADS is provided. Furthermore, DS9 allows the user to configure up to four additional sites. Retrieved FITS images are automatically displayed within DS9, while other image formats, such as GIF, TIFF, and JPEG are displayed within the web display window. When a user first invokes an archive server web page, DS9 automatically fills in certain form fields such as RA and DEC with coordinates from the current frame. This allows the user to browse and retrieve images from the archive quickly and easily.

5.   FITS Bin Table 3D Binning and Smoothing

DS9 now provides the ability to bin FITS event files into a 3D data cube. The user specifies three columns (usually X, Y, and either TIME or ENERGY) for binning. The resulting FITS 3D data cube can be viewed one slice at a time, or as an interactive movie.

Users also can smooth binned FITS event files interactively. Three smoothing algorithms are provided: boxcar, tophat, and gaussian. The resulting images can be saved as a FITS, TIFF, JPEG, or GIF image.

6.   Multiple WCS

DS9 provides support for FITS Multiple WCS. Images may be rotated and aligned, and coordinate grids displayed using any available WCS. Both equatorial and linear WCS are supported.

7.   Projection, Panda, and Compass Regions

DS9 now provides three new region types: Projection, Panda, and Compass. The projection region is characterized by two end-points and a thickness, which together define an arbitrary line. All data along the line are projected into an interactive 2D plot. If the thickness is non-zero, the data are summed or averaged as they are projected into the plot. The resulting plot may be printed or saved to a file.

The panda region is a combination of annulus regions and pie regions. The user can specify the number of radii and/or sector angles. The resulting region(s) can be used with external analysis tasks.

The compass region allows the user to place a compass onto his image for presentation purposes. The compass can be configured to reflect any coordinate system supported by the image data. The compass is anchored to the image, but remains the same size, regardless of the current magnification.

8.   Availability

DS9 is available on the web at `http://hea-www.harvard.edu/RD/ds9` or via anonymous FTP from `ftp://sao-ftp.harvard.edu/pub/rd/ds9`.