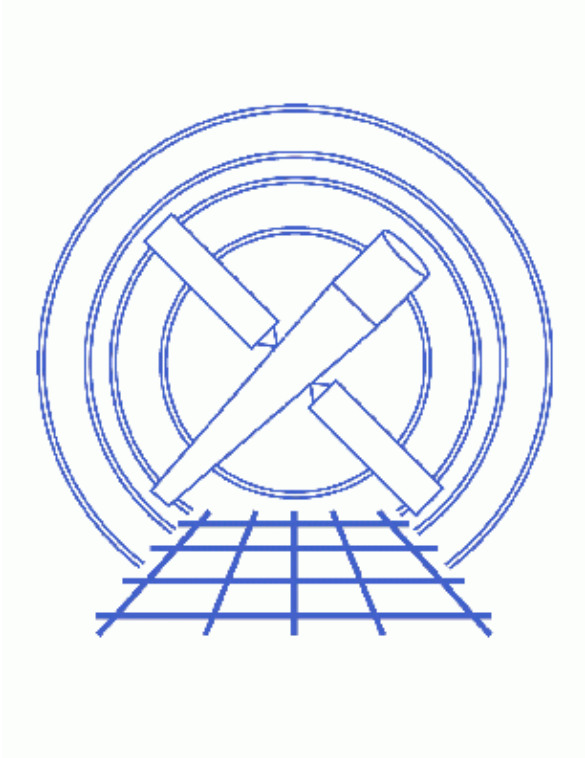
Reprojecting Coordinates of a Solar System Object



CIAO 3.4 Science Threads

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Reprojecting Coordinates of a Solar System Object

CIAO 3.4 Science Threads

Overview

Last Update: 1 Dec 2006 − reviewed for CIAO 3.4: no changes

Synopsis:

When an object is observed moving with respect to the observer, e.g. a planet or comet, the resulting event file looks "blurred" when viewed in (`x,y`) coordinates. The `sso_freeze` tool reprojects the coordinates to the frame of the object, eliminating this blurring.

Purpose:

To reproject coordinates from the frame fixed to the celestial sphere to a reference frame which is fixed to the moving solar system object (SSO).

Read this thread if:

you are working with any observation of a solar system object.

Proceed to the HTML or hardcopy (PDF: A4 | letter) version of the thread.

Choosing the Ephemeris Files

Sample ObsID used: 1463 (ACIS−S, Jupiter)

File types needed: evt2; eph1

There are two ephemeris input files needed for the tool to run. One is the spacecraft ephemeris file (`scephemfile`) and the other is the SSO ephemeris file (`ssoephemfile`).

Due to a bug in *ChaSeR*, it is necessary to obtain both of these files from the CDA FTP site.

The ephemeris files are selected based on the start time (TSTART) of the observation:

```
unix% dmkeypar acisf01463N002_evt2.fits TSTART echo+
59968797.485273
```

Now connect to `cda.harvard.edu`, using the login "anonymous" and your email address as the password:

```
unix% ftp cda.harvard.edu
Connected to cda.
220 cda FTP server (Version wu−2.6.1(1) Mon Aug 7 15:20:43 EDT 2000) ready.
```

```
Name (cda.harvard.edu:): anonymous
331 Guest login ok, send your complete e−mail address as password.
Password:
230−    Welcome to the FTP server at the CXC Science Center
230−
230−            This server is cda.harvard.edu
230−
230−If your FTP client crashes or hangs shortly after login please try
230−using a dash (−) as the first character of your password.  This will
230−turn off the informational messages that may be confusing your FTP
230−client.
230−
230−Publicly available files are in /pub
230−
230−Problems with this ftp site?  Contact cxcftp@head−cfa.harvard.edu
230−
230−    +−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−+
230−    |                                                            |
230−    | PLEASE NOTE:         (ChaSeR users only)                   |
230−    |                                                            |
230−    |    If the directory provided to you by ChaSeR appears      |
230−    |    to be empty, this is a sign that your tar file is       |
230−    |    not yet ready.  Please try again in a little while.     |
230−    |                                                            |
230−    |    If your directory seems to contain several tar          |
230−    |    files, e.g., file.tar.0, file.tar.1, ...                |
230−    |    retrieve all files, then untar as follows:              |
230−    |        cat file.tar.* | tar xvf −                          |
230−    |    We are limiting the size of individual files to         |
230−    |    less than 2 GB, but these files need to be              |
230−    |    concatenated before submitting them to tar.             |
230−    |                                                            |
230−    +−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−+
230−
230 Guest login ok, access restrictions apply.

ftp> cd /pub/arcftp/bary/ephem
250 CWD command successful.
ftp> ls
200 PORT command successful.
150 Opening ASCII mode data connection for file list.
asteroid_1998_wt24f124416300N001_eph1.fits
comet_1999_s4_linearf079920300N001_eph1.fits
comet_1999_s4_linearf081475500N001_eph1.fits
..(cut)..
jupiterf059875200N001_eph1.fits
jupiterf059875200N002_eph1.fits
jupiterf093312000N001_eph1.fits
jupiterf162475200N001_eph1.fits
marsf110592000N001_eph1.fits
moonf110563500N001_eph1.fits
moonf112492800N001_eph1.fits
moonf117504000N001_eph1.fits
moonf200016000N001_eph1.fits
moonf202550400N001_eph1.fits
moonf207316800N001_eph1.fits
orbitf050397000N001_eph1.fits
orbitf050420100N001_eph1.fits
orbitf050745900N001_eph1.fits
orbitf052088700N001_eph1.fits
orbitf053208300N001_eph1.fits
orbitf054122700N001_eph1.fits
..(cut)..
orbitf246888300N001_eph0.fits
orbitf246888300N001_eph1.fits
saturnf166665600_eph1.fits
```

```
saturnf190944000N001_eph1.fits
saturnf191505600N001_eph1.fits
titanf158112000N001_eph1.fits
uranusf145120000N001_eph1.fits
venusf095299200N001_eph1.fits
226 Transfer complete.
21088 bytes received in 1.2 seconds (17.64 Kbytes/s)
ftp>
```

The files that begin with "orbit" are spacecraft ephemeris files; the SSO ephemeris files are identified by the object name and file start time. In each case, we want to choose the file that has the highest start time *less than* the start time of the data (59968797):

```
ftp> ls orbitf059*
200 PORT command successful.
150 Opening ASCII mode data connection for file list.
orbitf059227500N001_eph1.fits
orbitf059486700N001_eph1.fits
orbitf059832300N001_eph1.fits
226 Transfer complete.
remote: orbitf059*
93 bytes received in 0.0014 seconds (66.49 Kbytes/s)

ftp> get orbitf059832300N001_eph1.fits

ftp> ls jupiter*
200 PORT command successful.
150 Opening ASCII mode data connection for file list.
jupiterf059875200N001_eph1.fits
jupiterf059875200N002_eph1.fits
jupiterf093312000N001_eph1.fits
jupiterf162475200N001_eph1.fits
226 Transfer complete.
remote: jupiter*
132 bytes received in 0.03 seconds (4.36 Kbytes/s)

ftp> get jupiterf059875200N002_eph1.fits

200 PORT command successful.
150 Opening ASCII mode data connection for jupiterf059875200N002_eph1.fits (63360 bytes).
226 Transfer complete.
local: jupiterf059875200N002_eph1.fits remote: jupiterf059875200N002_eph1.fits
63462 bytes received in 0.13 seconds (462.57 Kbytes/s)
```

If there is more than one version of a file − e.g. `N001` and `N002` − choose the newest (higher number) version available.

So the two ephemeris files for this observation are `orbitf059832300N001_eph1.fits` and `jupiterf059875200N002_eph1.fits`.

Run sso_freeze

Once you have the necessary input files, you are ready to run the tool:

```
unix% punlearn sso_freeze
unix% pset sso_freeze infile=acisf01463N002_evt2.fits
unix% pset sso_freeze scephemfile=orbitf059832300N001_eph1.fits
unix% pset sso_freeze ssoephemfile=jupiterf059875200N002_eph1.fits
unix% pset sso_freeze outfile=frozenjupiter.fits
unix% sso_freeze
Input event file or stack (acisf01463N002_evt2.fits):
```

```
Input spacecraft ephemeris file (orbitf059832300N001_eph1.fits):
Input solar system object file (jupiterf059875200N002_eph1.fits):
Output event file name (frozenjupiter.fits):
```

The contents of the parameter file may be checked using plist sso_freeze.

Display the Results

The new object−centered coordinates are stored in the `ocx` and `ocy` columns of the file. When displaying the "frozen" image, we must specify to bin on those columns (***note*** that the binning syntax for ds9 is not the same as for the DM):

```
unix% ds9 "frozenjupiter.fits[bin=ocx,ocy]" &
```

Alternatively, the image can be loaded in the usual way into ds9:

```
unix% ds9 frozenjupiter.fits &
```

Then the binning may be changed with the "Bin −> Binning Parameters..." dialog box. Choose "`ocx`" and "`ocy`" with the buttons in the "Bin Columns" section.

Figure 1 shows the original and "frozen" images side−by−side.

```
Parameters for /home/username/cxcds_param/sso_freeze.par


#-------------------------------------------------------------------------
#
#  sso_freeze.par- Parameter file for planetary transformations routine
#
#-------------------------------------------------------------------------
        infile = acisf01463N002_evt2.fits Input event file or stack
   scephemfile = orbitf059832300N001_eph1.fits Input spacecraft ephemeris file
  ssoephemfile = jupiterf059875200N002_eph1.fits Input solar system object file
       outfile = frozenjupiter.fits Output event file name
      (logfile = STDOUT)          debug log file ( STDOUT | stdout | <filename>)
        (scale = 0)               Image pixel scale (km/pixel, 0=angular coords)
    (lookuptab = ${ASCDS_CALIB}/dmmerge_header_lookup.txt -> /soft/ciao/data/dmmerge_header_lookup.txt)
      (clobber = no)              Overwrite existing output dataset with same name?
      (verbose = 0)               debug level (0-5)
         (mode = ql)
```

History

03 Jan 2005	reviewed for CIAO 3.2: no changes
16 Dec 2005	updated for CIAO 3.3: bug in *ChaSeR* means that orbit ephemeris files must be retrieved from the CDA FTP site
01 Dec 2006	reviewed for CIAO 3.4: no changes

URL: http://cxc.harvard.edu/ciao/threads/ssofreeze/ Last modified: 1 Dec 2006

Image 1: Comparison of original and "frozen" images

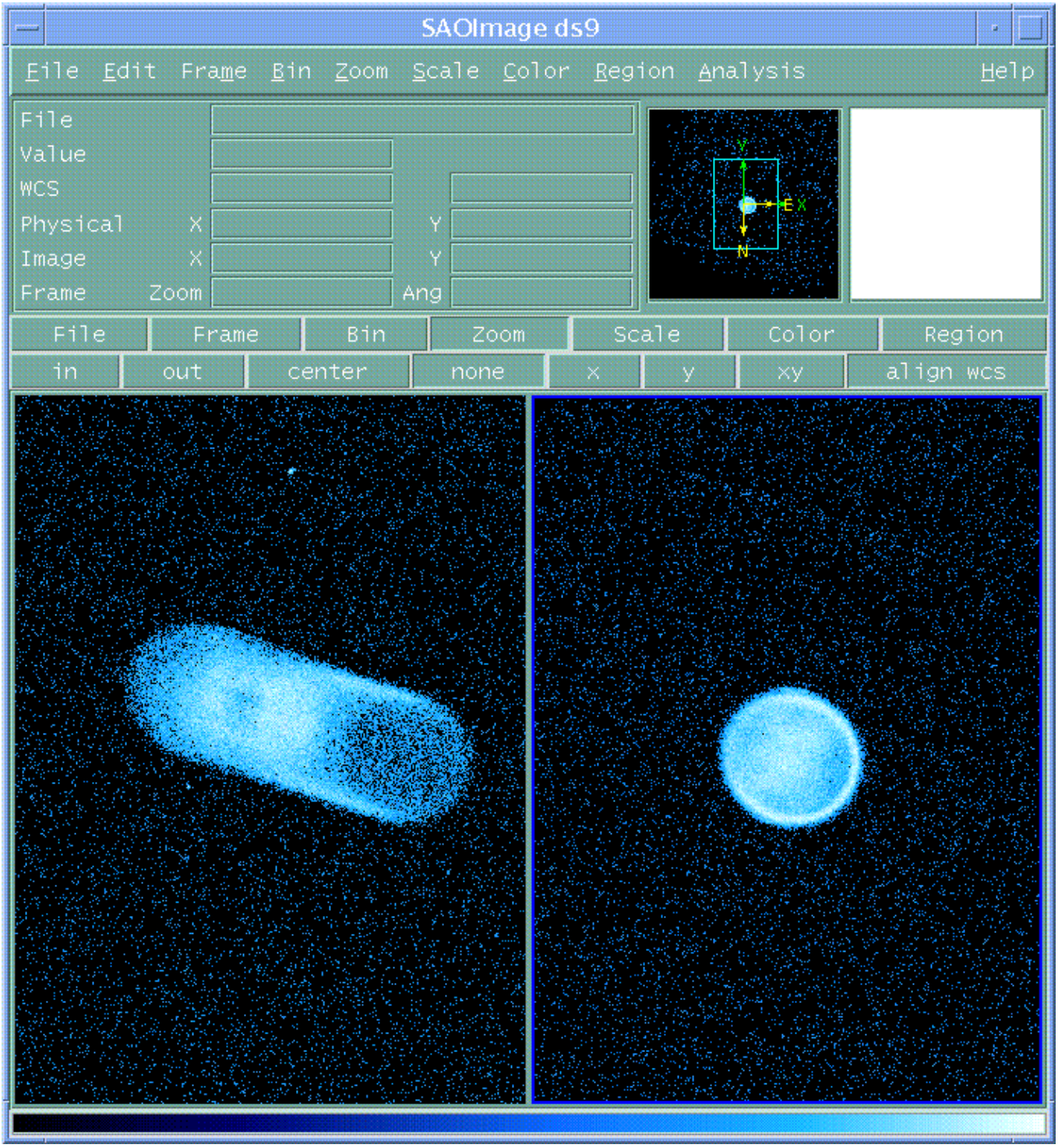

Image 1: Comparison of original and "frozen" images