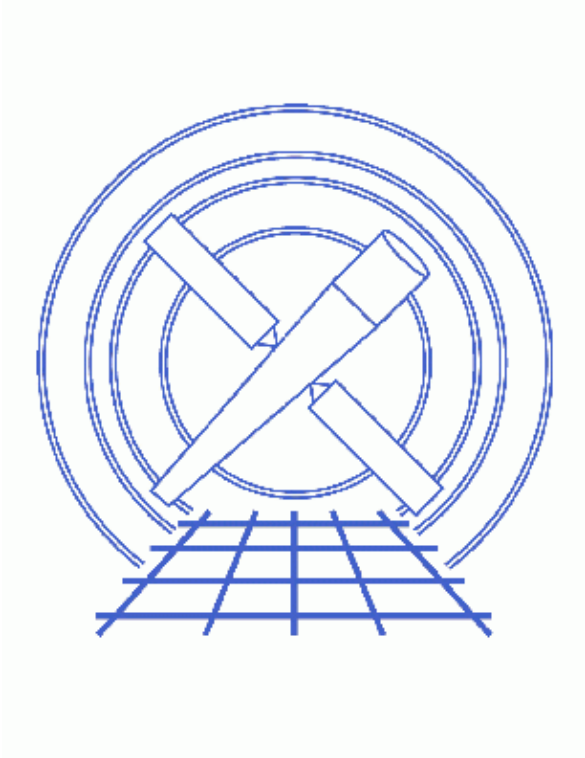
Using an Exposure Map in Fitting Image Data



Sherpa Threads (CIAO 3.4)

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Using an Exposure Map in Fitting Image Data

Sherpa Threads

Overview

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

Synopsis:

This thread shows how to use an exposure map when fitting 2−D spatial data. The exposure map file is input to *Sherpa* through the file−based exposure map model (FEXPMAP).

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

Getting Started

Please follow the "Sherpa Threads: Getting Started" thread.

Reading and Plotting 2−D FITS Data

We are using 2−D spatial data from the FITS datafile `img.fits`. This dataset is input into *Sherpa* with the DATA command:

```
sherpa> DATA img.fits
```

The dataset may be viewed as a contour plot, surface plot or an image. Here we show the surface plot method, creating a postscript file of the output as well:

```
sherpa> SPLOT DATA
sherpa> PRINT POSTFILE splot.ps
```

This creates Figure 1  .

Setting the Exposure Map

The following is similar to the process of defining responses for spectral data, where a 1−D instrument model (RSP) is defined and set as the instrument.

We define the exposure map model:

```
sherpa> FEXPMAP[emap]
emap.file parameter value ["none"] expmap.fits
```

```
emap.norm parameter value [1]
sherpa> INSTRUMENT = emap
```

To display the status of the model `emap`, use the `SHOW` command. Note that `FEXPMAP` is an alternate name for `FARF2D`; *Sherpa* identifies it by the latter:

```
sherpa> SHOW emap
farf2d[emap]
    Param   Type      Value        Min        Max                Units
    -----   ----      -----        ---        ---                -----
 1   file string: "expmap.fits"
 2   norm frozen          1          0       1000
```

The normalization (`norm`) is frozen at 1, since the exposure map is normalized to the exposure time of the image; this is how all exposure maps are generated in the CIAO exposure map threads.

Defining and Fitting the Source

One can now define a model to be used as a source model. After viewing Figure 1  , the `BETA2D` model is found to be a promising candidate for the source. Since we want to set the initial values, we leave on the parameter prompting:

```
sherpa> BETA2D[bm]
bm.r0 parameter value [80] 30
bm.xpos parameter value [36.5] 40
bm.ypos parameter value [41.5] 40
bm.ellip parameter value [0] 0.3
bm.theta parameter value [0] 5
bm.ampl parameter value [1.51294] 3.0
bm.alpha parameter value [1] 1.5

sherpa> THAW bm.ellip bm.theta
```

The `BETA2D` model is defined for the source, then the data is fit:

```
sherpa> SOURCE = bm
sherpa> FIT
 LVMQT: V2.0
 LVMQT: initial statistic value = 4.88095e+06
 LVMQT: final statistic value = 3255.75 at iteration 11
           bm.r0  12.4624
           bm.xpos  39.5139
           bm.ypos  40.8959
           bm.ellip  0.0259204
           bm.theta  4.72828
           bm.ampl  1.31312
           bm.alpha  1.66641
```

To display the fit and residuals of the plot, we again use `SPLOT`:

```
sherpa> SPLOT 2 SOURCE RESIDUALS
```

where `RESIDUALS` refers to the absolute residuals, calculated as `(data − model)`. This creates Figure 2 .

Alternately, use `DELCHI`, the sigma residuals of the fit; these are calculated as `((data − model)/error)`:

```
sherpa> SPLOT 2 SOURCE DELCHI
```

as shown in Figure 3  .

Saving a Sherpa Session

To save the *Sherpa* session:

```
sherpa> SAVE ALL expmap.shp
```

where `expmap.shp` is the output ASCII file. The information is written in the form of a *Sherpa* script. The `USE` command will restore the session when desired.

The source (unconvolved model amplitudes), model (convolved model amplitudes), and residuals may all be written out in FITS format with the `WRITE` command:

```
sherpa> WRITE SOURCE expmap_source.fits
Write X−Axes: (Bin,Bin)  Y−Axis: Amplitude (Photons/bin)

sherpa> WRITE MODEL expmap_model.fits
Write X−Axes: (Bin,Bin)  Y−Axis: Counts

sherpa> WRITE RESIDUALS expmap_residuals.fits
Write X−Axes: (Bin,Bin)  Y−Axis: Counts
```

The output may be examined as any standard FITS file, e.g. with *prism*, ds9, or `dmlist`.

Summary

This thread is complete, so we can exit the *Sherpa* session:

```
sherpa> EXIT
Goodbye.
```

History

14 Jan 2005	reviewed for CIAO 3.2: no changes
21 Dec 2005	reviewed for CIAO 3.3: no changes
01 Dec 2006	reviewed for CIAO 3.4: no changes

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Image 1: Surface plot of the data

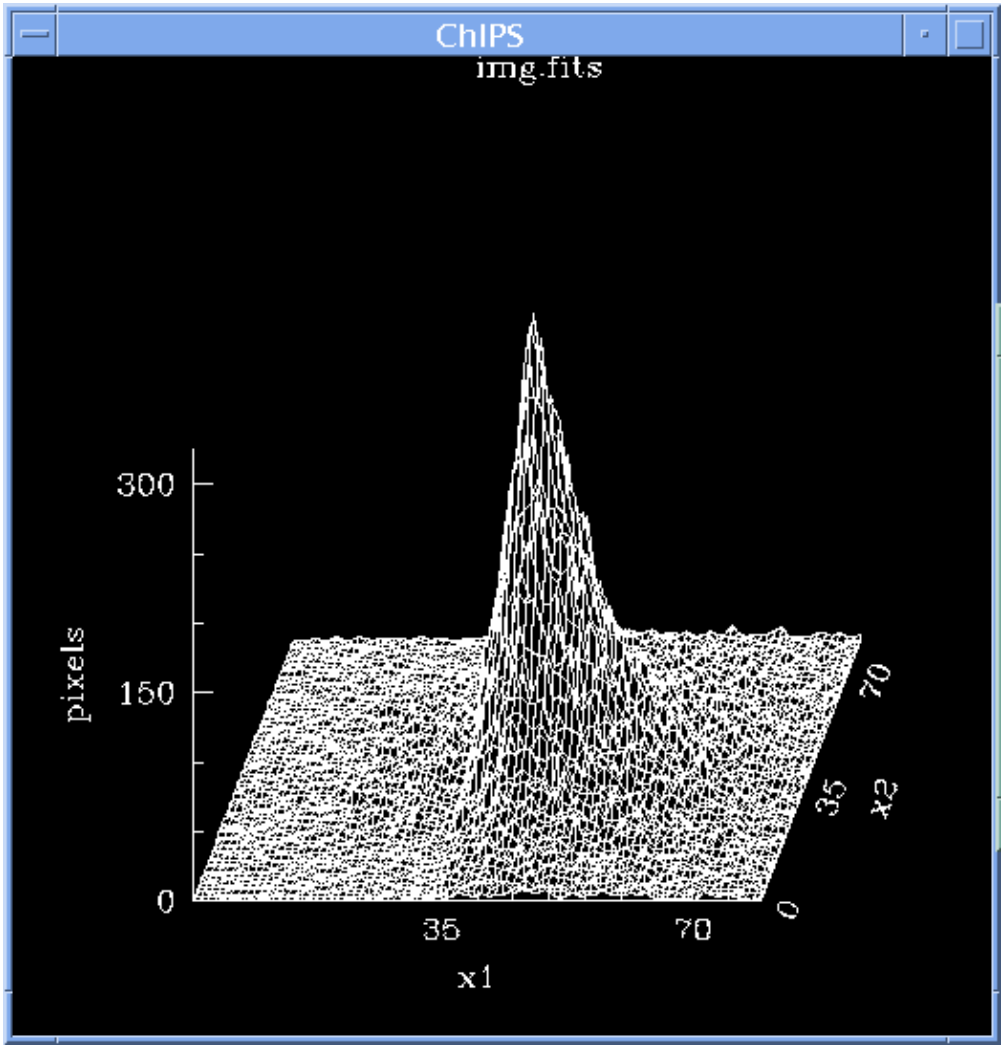

Image 2: Fit and absolute residuals

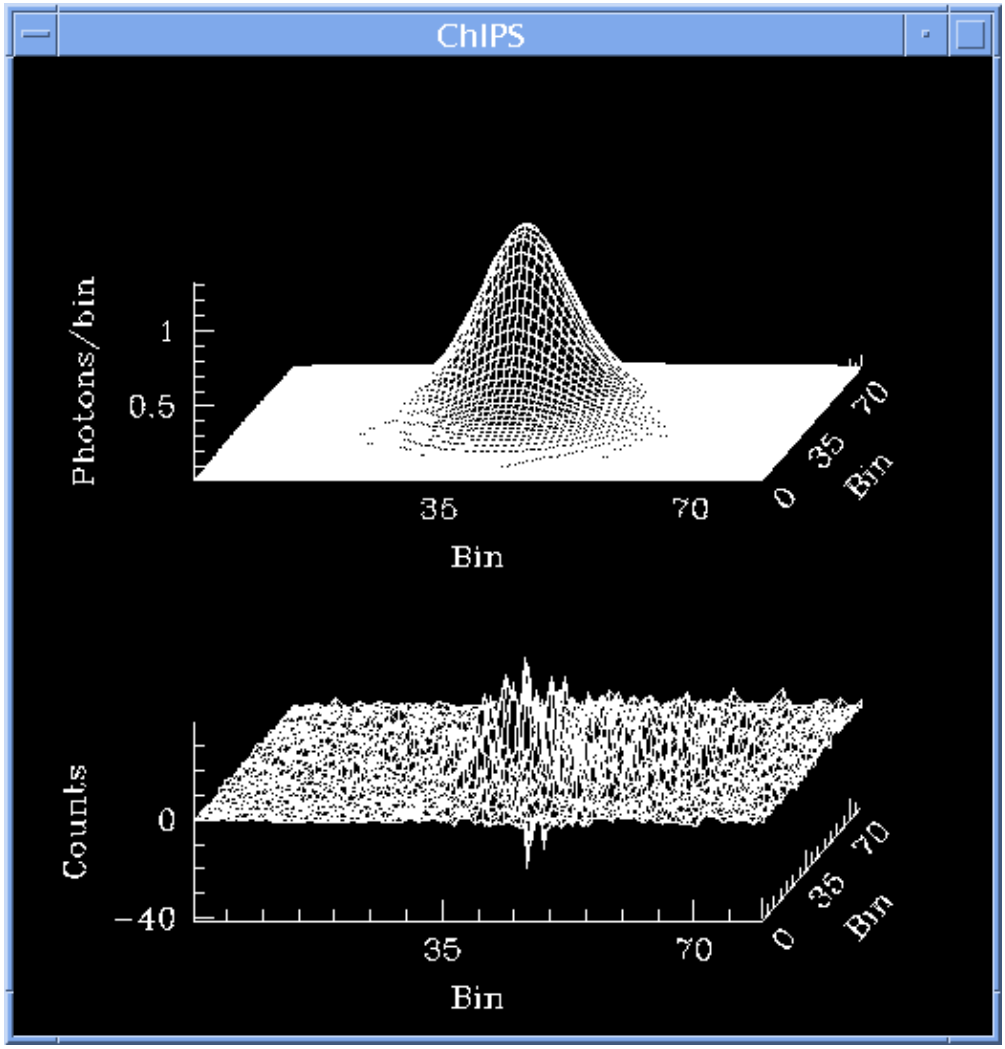

Image 3: Fit and sigma residuals