



## omsource

November 4, 2014

### Abstract

Interactive program that allows the user to either create or modify an existing source-list file by selecting sources on a displayed image. Interactive photometry can be done on the selected sources. The source-list file is compatible for use as an input file to the SAS task OMSRCLISTCOMB.

## 1 Instruments/Modes

| Instrument | Mode    |
|------------|---------|
| OM         | FAST    |
| OM         | IMAGING |

## 2 Use

|                      |     |
|----------------------|-----|
| pipeline processing  | no  |
| interactive analysis | yes |

IMAGING and FAST

## 3 Description

This program is an interactive image-analysis program which displays an OM image, using **ds9**, and allows the user to create or modify (add/delete sources) a source-list file and perform interactive photometry on any source in the list. This program creates a new source-list file with an identical structure to that produced by the SAS task **omatt**- it can therefore be used as an input file to the SAS task **omsrclistcomb**.

## 4 Usage

The following gives the various command lines for running the program.

- **omsource** In this case the program will prompt the user to select an image file, either from a list of previously assessed files or from a directory. When the main window is displayed the



user will also be able to select an existing source-list file by clicking on the **load source-list** button. She can also load another image by clicking on the **load image** button.

- **omsorce imageset=... newsrclistset=...** For creating a new source-list file (no parameter **oldsrclistset** specified). The image stored in the image file specified by the parameter **imageset** is displayed and the user can then either select sources manually, or run the **SAS task omdetect** to detect sources. The created source-list will be stored after clicking on the **exit** button.
- **omsorce imageset=... backgroundimageset=** The image stored in the image file specified by the parameter **imageset** is displayed without any source regions shown. The user can either select sources manually, or run the **SAS task omdetect** to detect sources. Again, the user can load a source-list by clicking on the **load source-list** button. When aperture photometry is performed the image specified by the parameter **backgroundimageset** will be used. This may be particularly useful for **FAST** mode photometry, in which a larger image can be used to obtain the background.
- **omsorce imageset=... newsrclistset=... wdxset=...** This is similar to the previous case, except that the **wdxset parameter** has been used. This parameter is needed when running omsorce on images reduced using SAS software versions prior to 5.4.
- **omsorce imageset=... oldsrclistset=... newsrclistset=...** The sources stored in the source-list file specified by the parameter **oldsrclistset** are loaded the image file specified by the parameter **imageset** is displayed with the source regions overlaid. Each source is numbered.
- **omsorce imageset=... oldsrclistset=... newsrclistset=... wdxset=...** Same as before, except that the **wdxset parameter** has been specified, which is needed when running omsorce on images reduced using SAS software versions prior to 5.4.
- **omsorce wdxset=...** Same as before, except that the **wdxset parameter** has been specified, which is needed when running omsorce on images reduced using SAS software versions prior to 5.4.
- **omsorce oldsrclistset=...** As before, except that the user wishes to modify an existing source-list file.
- **omsorce oldsrclistset=... wdxset=...** Same as before, except that the **wdxset parameter** has been specified, which is needed when running omsorce on images reduced using SAS software versions prior to 5.4.

When the program is running the user can load a new image/source-list file at any time. When the user exits the program and the parameter **newsrclistset** was omitted from the command-line and changes to source-list have been made, the program will display a text-input box allowing the user to type in the name of the new source-list file.

## 5 Program operation

The task starts up by displaying a small progress-dialog box whilst it is doing some initialisation work. The image file is displayed using **ds9**. When the main window is displayed the user has a choice of actions, each of which is initiated by clicking the appropriate button.

If the user did not load an existing source-list file, the user will first have to either manually select sources from the image (by clicking the **select sources** button, or run the sas task *omdetect* (by clicking the **omdetect** button, to locate sources on the image.



In the former case the *source-selection* window is displayed and the user selects sources by clicking the left-mouse button. In the latter case, the **omdetect** is shown which allows the user to run **omdetect** on the image. For both cases, when finished, the main window is shown and the user can then proceed to either examine the parameters of a particular source, by selecting it, redo its photometry, or delete it.

When sources have been selected, by either means, or by using the optional parameter **oldsrclistset**, the region for each source is displayed on the image and the top list box is loaded with some parameters of each source.

## 6 Image displayer

The image is displayed using the **ds9** ftool. Sources in the source-list are shown by ellipses with the source number also plotted. The ellipses are drawn using the shape parameters for each source (semi-major, semi-minor axes and position-angle). The colour of the ellipses is determined by the selected region colour.

## 7 The Main Window

Information about a particular button, label or table, can be obtained by positioning the cursor over that particular item, where upon a text message will appear.

### 7.1 Summary of Widgets

#### 7.1.1 table

When this button is clicked the source-list table is displayed. This table contains information about each source in the source-list. The source number corresponds to the number on the image.

#### 7.1.2 delete

When this button is clicked all the current sources are deleted. This feature is particularly useful if wishing to experiment with the **SAS task omdetect** parameters for performing automatic source detection.

#### 7.1.3 Regions colour

This spin-box determines the colour of the source regions.

#### 7.1.4 view all

When this button is clicked the whole image, with the source regions overlaid, will be displayed.



### 7.1.5 velect sources

When this button is clicked the **Source Selection Window** will be displayed, which allows user to manually select new sources from the image (section

### 7.1.6 omdetect

When this button is clicked the **Omdetect window** will be displayed which allows the **sas** task **omdetect** to be run on the image. **Please note that this button will only be “enabled” if the current source-list is empty- it can be “enabled” by clicking the delete button to the left of the table button.**

### 7.1.7 photometry

If this button is clicked the window for performing aperture photometry on the selected source is display.

### 7.1.8 delete

If this button is clicked the currently selected source is deleted.

### 7.1.9 view

If this button is clicked the **ds9** image zooms in on the currently selected source.

### 7.1.10 load image

Loads a new image file.

### 7.1.11 load source-list

If this button is clicked a new source-list file can be loaded.

### 7.1.12 information button

Displays various information about the image.

### 7.1.13 help

If this button is clicked various information about the program is displayed.



#### 7.1.14 Source no

This spin-box control allows the user to select a particular source from the list. Having selected the source, parameters for that source some information (coordinates, count-rates and instrumental magnitude) about the source is displayed, and the following actions can be performed on it:

#### 7.1.15 exit

This button should be clicked when the user wants to terminate the program and keep any changes to the source-list.

#### 7.1.16 cancel

This button should be clicked when the user wants to terminate the program and **not** keep any changes to the source-list.

#### 7.1.17 restart

This button should be clicked when the user wants to reload the source-list and start again.

## 8 Source-List Table

This table shows information about each source in the current list.

### 8.1 Summary of Widgets

#### 8.1.1 Print

Click this button to print the contents of the table.

#### 8.1.2 Delete

Click this button to delete the contents of the table (ie all of the sources).

#### 8.1.3 OK

Click this button to return to the main window.



## 9 Source Selection Window

This window allows the user to manually select new sources from the image to be added to the current list of sources. A source is selected by using the mouse to place the cursor at a particular point on the image and then clicking the left mouse-button to store it. By default, the coordinates of the source will be refined by a moments centroiding algorithm, but this can be switched off by unchecking the **centroid** button.

### 9.1 Summary of Widgets

#### 9.1.1 Newly selected sources table

The table at the top of the window stores information (x and y coordinates, aperture radius to be used for photometry and counts within the aperture).

#### 9.1.2 delete

If clicked then all the newly selected sources will be deleted.

#### 9.1.3 old regions

This spin-box control allows the user to change the way the current (before any new sources have been selected) regions are displayed on the image.

#### 9.1.4 new regions

This spin-box control allows the user to change the way the newly selected sources are displayed on the image.

#### 9.1.5 update time

This spin-box sets the time (seconds) that the image will be updated with the newly selected source regions.

#### 9.1.6 annulus

This spin-box control allows the user to change the photometry aperture that will be used to compute the photometry for the newly selected sources.



### 9.1.7 centroiding

This check-box determines if the source is to be centroided. If “checked” then the coordinates of each newly selected source will be refined by a centroiding algorithm. In some cases (eg a star near to a much brighter star) the centroiding algorithm may not work too well and it may be better to “uncheck” it.

### 9.1.8 Help

If this button is clicked then this button will provide the user with various bits of information.

### 9.1.9 okay

If this button clicked then aperture photometry will be conducted on each newly selected source, using the aperture radii stored in the table, and the window closed.

### 9.1.10 cancel

If this button is clicked then all the newly selected sources will be discarded and the window closed.

## 10 Omdetect Window

This window allows you to run the **sas** task **omdetect** on the image, which may be useful if you wish to experiment with some of the **omdetect** parameters.

### 10.1 Summary of Widgets

#### 10.1.1 nsigma

This spin-box control allows you to change the value of the **omdetect** parameter **nsigma**.

#### 10.1.2 minsignificance

This spin-box control allows you to change the value of the **omdetect** parameter **minsignificance**.

#### 10.1.3 terminate

This button is “enabled” when **omdetect is running** and if clicked it will be stopped.



#### 10.1.4 compute

If this button is clicked then **omdetect** will be set running.

#### 10.1.5 omdetect output combo box

This widget stores the output from **omdetect**.

#### 10.1.6 exit

If this button is clicked then the window will be closed (when **omdetect** is running the button is disabled).

## 11 Imaging Mode Photometry Window

### 11.1 Source type Controls

A source can be of two types, **point-like** or **extended**. The former refers to an unresolved source with a 2-dimensional pixel distribution similar to that of the point-spread function, whereas the latter refers to any source that has an extent significantly greater than that of the point-spread function.

#### 11.1.1 Point

If this check-box is enabled the photometry will be conducted in the normal way for a point source (ie aperture photometry).

#### 11.1.2 Extended

if this check-box is enabled the photometry is performed as for an extended source. The user can change the axial-ratio **by clicking on the a/b spin-box** and position-angle **by clicking on the Pos angle spin-box**) and the inner and outer background radii for the background determination (**by clicking on the Inner bck and Outer bck spin-boxes, respectively**). **Note that the background annulus will have the same ellipticity and position-angle as for the photometry aperture.**

### 11.2 Background Determination Controls

The background subtraction can be done in one of several different ways and these controls allow the user to select whatever method he/she wishes to use.

#### 11.2.1 Annulus

If this is checked then the background will be determined from an annulus region on the image.





### 11.2.2 User regions

If this is checked then the background will be determined from user-selected circular regions on the image.

### 11.2.3 Select

Clicking this button allows the user to select new circular regions from the image to determine a value of the mean background counts per pixel.

### 11.2.4 User value

If this is checked then a fixed value of the background counts per pixel will be used to subtract the background.

### 11.2.5 interpolate

This can only be checked if the **Extended** button is checked. If checked the background will be subtracted by using the pixels within the annulus regions to interpolate the background underneath the source.

## 11.3 Annuli controls

These controls determine the photometry aperture and background annulus dimensions.

### 11.3.1 Aperture

This spin-box determines the semi-major axis of the photometry aperture. For a “point” source the semi-minor and major axes are equal, but for an “extended” source the semi-minor axis is determined by the spin-box control **a/b**.

### 11.3.2 Inner bck

This spin-box determines the semi-major axis of the inner background annulus.

### 11.3.3 Outer bck

This spin-box determines the semi-major axis of the outer background annulus.

### 11.3.4 a/b

This spin-box determines the ratio of the semi-major to minor axes (only enabled if the source is “extended”). The semi-major and semi-minor axes of the inner and outer background annulus will also have this ratio.



### 11.3.5 Pos angle

If the source is “extended” then this spin-box sets the position-angle of the semi-major axis (measures anti-clockwise from the +ve x-axis).

### 11.3.6 Help

If this button is clicked various bits of information are displayed.

### 11.3.7 Compute photometry

When clicked the photometry for the selected source is computed and the computed parameters will be displayed and will replace the values for that source in the source-list. Also, an average magnitude will be computed for all the magnitude determinations made by the user, plus the original one, and displayed in the combobox near the bottom of the window. **Note that when a source is selected the contents of the table are erased.**

## 11.4 average magnitude table

This table stores the running average magnitudes computed from the table- each time the **apply** button is clicked an average magnitude is computed from all the entries in the logger table and added to the table.

### 11.4.1 Print table

When clicked the contents of the logger table are printed.

### 11.4.2 Print averages

When clicked the contents of the average-magnitude table are printed

### 11.4.3 Delete table

When clicked the contents of the average-magnitude table are deleted.

### 11.4.4 Okay

If this button is clicked the photometry parameters of the source will be replaced by the last recomputed parameters.



#### 11.4.5 Cancel

If this button is clicked photometry parameters of the source are not changed.

## 12 Fast Mode Photometry Window

Either simple aperture photometry or point-spread function fitting can be used.

### 12.1 Summary of Widgets

#### 12.1.1 Aperture

If this button is checked then the photometry method will be aperture photometry.

#### 12.1.2 PSF FIT1

If this button is checked then point-spread function fitting photometry will be undertaken. Nearby sources can also be included in the fit.

#### 12.1.3 PSF FIT2

If this button is checked then point-spread function fitting photometry will be undertaken, and the positions of the sources will be re-determined by a simplex minimization algorithm. Again, nearby sources can also be included in the fit. Please note that this method can significantly increase the CPU time.

#### 12.1.4 No to fit

This spin-box stores the total number of sources to be included in the fit.

#### 12.1.5 1/counts weights

If this button is checked then in the PSF least-squares fitting the equations will be weighted by the factor  $1/\text{pixel value}$ . Otherwise the weights will all be equal.

#### 12.1.6 Fixed background

If this button is checked then the background-subtraction will use a fixed value for the pixel counts per pixel.



### 12.1.7 Compute Background

If this button is clicked then the user will be able to select circular regions on the image will be used to determine a mean background counts per pixel value, which will be used for the background subtraction.

### 12.1.8 Input Background

If this button is clicked then the user will be able to enter a value for the background counts per pixel, to be used in the background subtraction.

## 12.2 Annuli controls

These controls determine the photometry aperture and background annulus dimensions.

### 12.2.1 Aperture

This spin-box box determines the semi-major axis of the photometry aperture. For a “point” source the semi-minor and major axes are equal, but for an “extended” source the semi-minor axis is determined by the spin-box control **a/b**.

### 12.2.2 Inner bck

This spin-box determines the semi-major axis of the inner background annulus.

### 12.2.3 Outer bck

This spin-box determines the semi-major axis of the outer background annulus.

### 12.2.4 Help

If this button is clicked various bits of information are displayed.

### 12.2.5 Compute photometry

When clicked the photometry for the selected source is computed and the computed parameters will be displayed and will replace the values for that source in the source-list. Also, an average magnitude will be computed for all the magnitude determinations made by the user, plus the original one, and displayed in the combobox near the bottom of the window. **Note that when a source is selected the contents of the table are erased.**



### 12.2.6 average magnitude table

This table stores the running average magnitudes computed from the logger table- each time the **apply** button is clicked an average magnitude is computed from all the entries in the logger table and added to the table.

### 12.2.7 Print table

When clicked the contents of the logger table are printed.

### 12.2.8 Print averages

When clicked the contents of the average-magnitude table are printed

### 12.2.9 Delete table

When clicked the contents of the average-magnitude table are deleted.

### 12.2.10 Okay

If this button is clicked the photometry parameters of the source will be replaced by the last recomputed parameters.

### 12.2.11 Cancel

If this button is clicked photometry parameters of the source are not changed.

## 13 Background Regions window

This window allows the user to select circular background regions which will be used to determine a value of the mean background-counts per pixel which may then be used in the photometry background determination.

### 13.1 Summary of Widgets

#### 13.1.1 Table

The table at the top of the window stores information (coordinates, radii and counts) of the selected background regions.



### 13.1.2 Delete

If this button is clicked then all of the background regions will be deleted.

### 13.1.3 Aperture

This spin-box sets the radius of the background regions.

### 13.1.4 Background regions

This spin-box sets the colour of the background regions.

### 13.1.5 update time

This spin-box sets the time (seconds) that the image will be updated with the new background regions.

### 13.1.6 OK

If this is clicked the window is closed.

## 14 Photometry Methods

### 14.1 Point-Source Photometry

Aperture photometry is conducted in a similar fashion to that undertaken by **omdetect**.

The counts for a source are extracted within the aperture radius and the background subtracted. If necessary, the background-subtracted counts are extrapolated to the coincidence-loss area corresponding to a circle of 12 unbinned pixels, using the point-spread function (this correction is tabulated as **psf1 corr**). A correction is then made for coincidence-losses (this correction is tabulated as **coinc corr**). For UV data, a further correction is made to extrapolate the counts to a radius of 35 pixels using the point-spread function (this correction is tabulated as **psf2 corr**). The count-rate is then corrected for the CCD dead-fraction and an instrumental magnitude derived from it. The user can change the aperture radius to exceed the coincidence-loss radius, in which case the photometry will be computed as for an extended source.

The aperture radius can be changed between  $6/\text{bin}$  and  $12/\text{bin}$  pixels, where bin is the binning factor (1 for unbinned data, 2 otherwise). The upper limit corresponds to the cal calibration radius. Using a smaller radius than the upper limit will result in the source counts being scaled to the calibration radius using the point-spread function (this correction is the tabulated psf1 corr value).



## 14.2 Extended-Source Photometry

Extended-source photometry cannot be done in the same way as is done by **omdetect**, because information about the sources that **omdetect** used is not available to **omsource**. Basically, **omdetect** uses the pixels assigned to a source to compute source counts from the source, and the value obtained obviously depends on the “thresh-hold level” (please see the **omdetect** documentation for more information).

Omsource uses each pixel within the aperture to obtain the source counts. For each pixel within the aperture a coincidence-loss correction factor is computed by assuming this pixel is centred on a point-source and then computing the correction-factor as for a point-source. The pixel value is then corrected using the correction value. The background is computed from the pixels within the background annulus, which can be elliptical. The apertures can be elliptical, and the user can fix the ellipse parameters (the semi-minor axis, ellipticity and position-angle of the major-axis). **Please note that the accuracy of this method has not yet been evaluated.**

The background can be determined by one of three ways-

1. By using the background annulus to determine a value for the mean background counts per pixel.
2. By using a fixed value for the background counts per pixel.
3. By using the pixels within the background annulus to interpolate the background to within the source annulus.

The source photometry parameter values are displayed at the top of the window. In the middle of the window spin-boxes allow the user to change the photometry aperture radius and the inner and outer background annuli. The user can also select the background-determination method

## 14.3 Aperture Photometry on FAST mode data

Aperture photometry is conducted in a similar fashion to that for the **Imaging mode**. Because of the very small window, an **IMAGING** mode window containing the source can be used, through the parameter **backgroundimageset**, to obtain the background. In this case the source counts will be extracted using the image, whilst the background will be obtained using an annulus centred on the source in the background image.

The aperture radius can be changed between 6 and 12 pixels. The upper limit corresponds to the cal calibration radius. Using a smaller radius than the upper limit will result in the source counts being scaled to the calibration radius using the point-spread function (this correction is the tabulated psf1 corr value).

## 14.4 Point-spread Fitting on FAST mode data

The procedure involves fitting the **point-spread function** to one or more sources by a least-squares fit. The background can either be determined in the fit, or a fixed background value. Additionally, the x and y coordinates can be determined using a simplex minimization routine- the user should be warned that this method increases the CPU time significantly. For more details of the **PSF** fitting method please refer to the documentation on the **SAS** task **omphotom**.

The weighting scheme used in the fitting can be either 1/pixel variance or 1 (equal weights).



For information about how the latter is done, please refer to the documentation for the **SAS** task **omphotom**.

## 15 Parameters

This section documents the parameters recognized by this task (if any).

| Parameter | Mand | Type | Default | Constraints |
|-----------|------|------|---------|-------------|
|-----------|------|------|---------|-------------|

|                 |     |        |      |  |
|-----------------|-----|--------|------|--|
| <b>imageset</b> | yes | string | none |  |
|-----------------|-----|--------|------|--|

name of OM OSW FITS image file

|                           |    |        |      |  |
|---------------------------|----|--------|------|--|
| <b>backgroundimageset</b> | no | string | none |  |
|---------------------------|----|--------|------|--|

name of OM OSW FITS image file to be used for background

|                      |     |        |      |  |
|----------------------|-----|--------|------|--|
| <b>newsrclistset</b> | yes | string | none |  |
|----------------------|-----|--------|------|--|

name of new output OM OSW source list file

|                      |    |        |      |  |
|----------------------|----|--------|------|--|
| <b>oldsrclistset</b> | no | string | none |  |
|----------------------|----|--------|------|--|

name of input OM OSW source list file

|               |    |        |      |  |
|---------------|----|--------|------|--|
| <b>wdxset</b> | no | string | none |  |
|---------------|----|--------|------|--|

name of input wdx file- Needed when using images reduced prior to SAS 5.4.

## 16 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

**Any memory allocation errors** (*fatal*)





## 17 Input Files

- **Image file** file Modulo-8 corrected OSW FITS image product file (output from ommodmap (\*OM\*IMAGE\_\*FIT eg- P0123920101OMS006IMAGE\_1000.FIT for exposure 006).
- **Background image file** file Modulo-8 corrected OSW FITS image product file (output from ommodmap (\*OM\*IMAGE\_\*FIT eg- P0123920101OMS006IMAGE\_1000.FIT for exposure 006), or an background image file created by **omdetect**.
- **Source list file** Intermediate source list file created by **omdetect** (**pipeline product \*I0\*OMS\*SWSRLI\*** eg **I0123920101OMS006SWSRLI10001.FIT** for exposure 006) or a source-list file created by **omdetect**, and subsequently modified by OM-MAG AND OMATT) (**pipeline product \*P0\*OM\*SWS\*SWSRLI\*** eg **P0123920101OMS006SWSRLI10001.FIT** for exposure 006).
- **wdx - window-data file** FOR DATA REDUCED PRIOR TO **SAS 5.4** THIS FILE IS NEEDED BY OMSOURCE TO OBTAIN SOME CCD PARAMETERS. THIS FILE WILL BE FOUND IN THE ODF- (**\*OM\*WDX\*FIT** eg **0081.0123920101\_OMS00800WDX.FIT**) - THERE IS ONE SUCH FILE FOR EACH EXPOSURE- THE EXAMPLE IS THE NAME OF THE WINDOW FILE FOR EXPOSURE 008 IN THE ODF.

## 18 Output Files

1. new OM OSW source list file that contains all the information needed by OMSRCLISTCOMB

## 19 Algorithm

subroutine omsource

- 1) Read in image
- 2) If present, read in the old source-list file
- 3) Display the image
- 4) Display the main window allowing the user to:
  - a) Select a particular source to either redo the photometry or delete it.
  - b) Select additional sources from the image to add to the source-list.The position, shape, photometric and astrometric properties are calculated for each source in a similar fashion to what the sas tasks **omdetect**, **ommag** and **omatt** do.
- c) Print the source list.
- d) Display the main image (using ds9).
- e) Run **omdetect**

When the user quits the program the new source-list file is constructed from the current stored source-list. This source-list file can then be used as an input source-list file to either **omsource** or **omsrclistcomb**.

end subroutine omsource



## 20 Future developments

The program will be modified to do photometry on extended and overlapping sources.

## References