Appendix A UIMAGE MENU TREE AND HELP FILES

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```
UIMAGE   [MAIN MENU]

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Report Problems or Comments

HELP
Exit UIMAGE
```

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X1 / X2

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(X1*wt1-X2*wt2)/(wt1+wt2)

SQRT(X)
LOG10(X)
ABS(X)
1./X

C0 + C1*X1 + C2*X2 +...+ Cn*Xn
Average (X1, X2, X3,...,Xn)
Weighted Avg((X1*wt1,..., Xn*Wtn)/Sum(wt1-n))

HELP
Return to Main Menu
```

```
UIMAGE   [MAIN MENU]

Data I/O and Management...

Display Manipulations...
Image Enhancement...
Algebraic Operations...
Spectrum Operations...
Line Plots and Statistics...
Modeling and Fitting...

Journal Enable/Disable    ON
Report Problems or Comments

HELP
Exit UIMAGE
```

```
Modeling and Fitting

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HELP
Return to MAIN MENU
```

MAIN MENU

UIMAGE is an image-based analysis program that works with data from each of the three COBE instruments (FIRAS, DIRBE, and DMR). Additionally, it works with other astronomical data that is also in the quadrilateralized spherical cube projection and in a supported resolution.

UIMAGE is menu-based. Options available from the main menu are:

Data I/O and Management... displays a submenu through which you will be able to import and export data sets, create PostScript files for printing, and report on or remove data objects from your analysis session. (**NOTE**: a data object can consist of either a graph, an image, or a 3-D array).

Display Manipulation... displays a submenu through which users can modify the visual representations of their various data objects. You can use this submenu to change the color table, to stretch the contrast of images (rescaling), to replot graphs with specified axis labels and ranges, add labels, *etc*.

Image Enhancement... displays a submenu containing operations which generate new images from existing ones. These operations include zooming, smoothing, edge enhancement, array up- or down-sizing, histogram equalization, and reprojection into other coordinate systems and projections (Aitoff, Mollweide, *etc*.)

Algebraic Operations... displays a submenu through which you can add, subtract, multiply, or divide two images or graphs; find weighted sums or averages of multiple images or graphs; or take the square root, reciprocal, absolute value, or logarithm of an image or graph.

Spectrum Operations... displays a submenu through which you can operate on spectral data cubes (*i.e.*, 3-D arrays) by extracting a spectrum for a single pixel or an average spectrum for a user-defined area; by taking frequency/wavelength slices; and/or by integrating over frequency/wavelength.

Line Plots and Statistics... displays a submenu for operations which involve plot generation or which print out scalar quantities derived from images. You can make histograms, scatter plots, or geometric cross-sectional plots. You can also extract statistical information (average, min, max, etc.) about areas of pixels or print out values for individual pixels.

Modeling and Fitting... displays a submenu of fitting and modeling utilities. Currently six operations are available. One which calculates and subtracts a dipole from a selected skymap, one which fits spectra with a 3 blackbody model, one which fits spectra with a Bose-Einstein plus blackbody model, one which models the background of a 2-D map, a quadrupole subtraction routine, a polynomial fitting routine for graphs and a Gaussian fitting routine.

Journal Enable/Disable toggles creation of an ASCII history file that tracks many of your UIMAGE operations. When enabling journaling, you will be prompted for a name of a file that will be written into your default (or otherwise specified) directory.

Report Comments or Problems invokes your default editor where you can record any problems or comments you may have. Type a `^Z`, followed by EXIT, when you are finished. Your message will be sent to the Guest Investigator support group where it will be addressed.

HELP invokes this information.

Exit UIMAGE brings you back to the environment that you were in prior to entering UIMAGE.

DATA I/O AND MANAGEMENT

Read a data set... invokes a submenu describing the kind of data sets available. These are: the COBE initial product sky maps, their corresponding FITS files, and IDL save sets. For each case you will be presented with a menu of available data sets for each instrument, and the available fields (signal, signal error, coordinates, *etc.*) for each data set. You may also choose **`User-defined`** instead of an instrument if you know the file name, directory, and field name(s) of interest for any arbitrary dataset anywhere in the COBEtrieve archives.

Write a data file... enables you to write out either a FITS file or an IDL save set. In the either case, the ancillary information about the data (instrument, signal units, projection, cube orientation, bad pixel value) are also automatically stored in the save set. You will be prompted for a file name and the data set will be written into your default (or otherwise specified) directory.

Create a PostScript file lets you generate a PostScript file for any selected image or graph. You can print that file out after you exit UIMAGE. Both black & white and color PostScript is supported. X Window users have the ability to create a PostScript file which contains both image data and overlaid graphics (such as labels and coordinate grids) together.

Associate weights with an object will tell the chosen data object to use the chosen weight object in any operations involving weights. This option can be chosen multiple times to overwrite previous choices.

Extract Face from skymap will extract a face from a full skycube or 3-D skycube. If there are weights associated with the data then the appropriate face of the weight object is also extracted.

Combine 2D objects into 3D object will create a new 3D object out of the selected 2D objects. If there are weights associated with the data then a set of 3D weights will be created.

Report object attributes will display ancillary information about any of your objects. The reported information may include things such as the object title, instrument, projection, coordinate system, data min and max, bad pixel value, *etc.*, depending on whether the object is a map, a zoomed section, or a graph.

Remove an object lets you remove a selected data object from memory. All information associated with that data object is lost, unless it has been stored in a file. For X Window users, the visual representation of the object is removed from the screen.

Some other data objects may be necessarily linked to the object which you have selected for deletion. If this is the case, then you will be presented with a list of the linked objects and informed that the deletion of the selected object will be accompanied by the deletion of the linked objects. You will be given the ability to abort the deletion at that point if you want to.

Removing objects for which you no longer have any use is good practice, as it frees up machine memory.

Display/hide an object can be used to select whether a chosen UIMAGE object is displayed or not. When an object is not displayed it still exists and can be chosen as an operand in any of the functions.

Remove ALL objects lets you remove all data objects from memory. All information associated with that data objects is lost, unless it has been stored in a file. For X Window users, the visual representation of the object is removed from the screen.

HELP invokes this information.

Return to MAIN MENU returns you to the UIMAGE Main Menu.

DISPLAY MANIPULATION

All of the operations on this menu change the display conditions of one or more objects but do not generate any new objects. Some of the operations are accessible only by users of X Window terminals.

Refresh an image (X Windows only) will restore an object to its original display conditions, *e.g.* with no superimposed contours. (However, it does not restore the original contrast stretch).

Resize/redraw all windows (X Windows only) lets you adjust the magnification factor that applies to all windows. Normally, this factor depends on the size of the largest resident image. If, for example, a 1024 × 768 map is one of the objects, then the factor is set to 1 so that that map will fit on the screen. If, on the other hand, only 128 × 96 DMR or FIRAS maps are present, the factor is set to 2 by default so that images will appear increased by a factor of 2.

Change color table (X Windows only) lets you modify the color table by selecting one of IDL's standard color tables, or else by using **`XPALETTE`** so as to make changes to the current color table. Additionally, **`XLOADCT`** and **`ADJCT`** can be used to load or adjust color tables.

Stretch contrast (X Windows only) lets you control the scaling factors that are used to set the grey scale/color range. (The default is the minimum and maximum of the good data.) You will be prompted for an alternative display scaling range.

Change a window title lets you change the title of a selected data object.

Resize a graph (X Windows only) lets you change the display window size of a graph. You will be offered a menu of *X* and *Y* dimensions for the new window; the units are 58 screen pixels in the *X* direction and 47 pixels in the *Y* direction. The size of the graph's window will be modified and the graph will be replotted.

Change X and Y axis ranges lets you redefine the range of the *X* and/or *Y* axis for a selected graph.

Change graph axis labels lets you change the *X* and/or *Y* axis labels for a selected graph.

Change a graph's color (X Windows only) lets you change the color in which a selected graph is plotted.

Overlay graphs lets you overplot multiple curves together on a single graph.

Change Log Scaling of Graph lets you choose between the various combinations of linear and log scaling for axes on graphs.

Change Plot Symbol of Graph lets you choose the plotting symbol used for the selected graph. The valid choices are the standard IDL symbols.

Put Label in Window lets you place a label anywhere in the selected window.

Add Colorbar to Window adds a color bar plus an optional label to the selected window.

Mark positions on a map marks specified positions on a map with a defined label.

HELP invokes this information.

Return to MAIN MENU returns you to the UIMAGE Main Menu.

IMAGE ENHANCEMENT

Most of the operations from this menu generate new objects from existing ones.

Smooth an image convolves a 2-D image with a kernel that can be entered from the keyboard or retrieved from a file. If you enter the kernel from the keyboard, you will be prompted for its size (square, either 3, 5, or 7 map pixels on a side) and elements.
The kernel is assumed to be symmetric, so you are prompted only for the nonredundant values. If the data object has weights associated with it, then they will be used in the smoothing.

An arbitrary, asymmetric rectangular kernel may also be used by creating beforehand an IDL save set containing a variable called `KERNEL`, which need only be a 2-D array with odd dimensions. At the prompt, choose to enter a file name and supply the name of the save set.

Note that the smoothing algorithm is smart enough to avoid bad pixels by giving them zero weight. It also normalizes the kernel to unit area to conserve map flux.

Change array resolution interpolates a skycube map either up or down in resolution. (Going down in resolution is equivalent to smoothing and resampling.) Each step in resolution halves or doubles the pixel size in both *X* and *Y*, so be careful when stepping up: moving from resolution 6 to 9, for example (*i.e.* FIRAS to DIRBE) creates a 1024×768 map from a 128×96 one. Too many of these will fill memory quickly and degrade performance noticeably!

Histogram equalization creates a new map whose data values are scaled from 0 - 255 such that each value occurs with equal frequency. This procedure is good for enhancing structure in maps that are dominated by a few bright features, but flux is not conserved and all brightness units information is lost.

Edge enhancement creates a new image from a selected image by applying a high pass filter (either a Roberts or a Sobel filter can be used - see the IDL manual for details). It can give strange results on arrays whose resolution has been increased, since the interpolated areas have small or zero derivatives.

Zoom an image (X Windows only) lets you zoom in on a section of a selected image. Use the mouse to center the zoom window, and the left button to create the new image. The middle button gives a menu to select the zoom factor and *X* and *Y* sizes of the new window. (*X* and *Y* dimensions are in units of 58 × 47 screen pixels.) The right button terminates the operation but leaves the zoomed image intact as a new object.

3-D surface plot (X Windows only) lets you change the visual representation of a selected image by displaying it as a 3-D surface plot, with contours "floating" above it in the *Z*-direction. THIS DOES NOT CREATE A NEW OBJECT. The original appearance of the image can be restored by invoking the **`Refresh an image`** operation.

Reprojection lets you create a reprojected map from a selected skycube or face. You will be presented with menus so you can select the desired projection type (Aitoff, Mollweide, or Global Sinusoidal) and the desired coordinate system (Galactic, ecliptic, or equatorial).

The reprojection is a new object whose existence depends upon the original skycube object; if you remove the latter from memory (via the **`Remove an object`** operation), the reprojected image will also disappear. The rasterized reprojection can be passed out to a UIDL variable by going to the UIDL command line and invoking **`UGETDATA`**.

Plot coordinate grid lets you overlay a coordinate grid onto a selected image. After being prompted for the image to draw the grid on, you will be asked for the coordinate system to use (Galactic, ecliptic, equatorial) and for the values of the parallels and meridians you want to display. These values can either be entered specifically or as an absolute increment.

HELP invokes this information.

Return to MAIN MENU returns you to the UIMAGE Main Menu.

ALGEBRAIC IMAGE OPERATIONS

This menu lets you apply algebraic operations which produce new objects from one or more existing objects. Either images or graphs can be used as operands.

With regards to image data, these operations are such that if any pixel is designated as bad in any of the input images (or, for some operations, in the sole input image), then the output image will also have that same pixel designated as bad. All the input images must be of the same size for those operations which work with multiple images.

With regards to graphs, the operations which work on more than one input graph produce a resulting graph whose abscissa values are only those where all the input graphs overlapped precisely.

X1 + X2
X1 - X2
X1 * X2
X1 / X2
(X1*WT1 + X2*WT2)/(WT1 + WT2)
(X1*WT1 - X2*WT2)/(WT1 + WT2)

These binary operations require that the user select two operands. Note that in the case of division, the contrast stretch for the display of the result is over the range of the average value plus or minus 2 sigma, rather than the whole good data range. This is to prevent near-zero divides from dominating the display. You can readjust it if desired using the **`Stretch contrast`** option on the **`DISPLAY MANIPULATION`** menu. All operations will propagate weights if they exists.

SQRT(X)
LOG10(X)
ABS(X)
1./X

The unary operations require a single operand. Data points which had a negative value in the input object get flagged as bad in the result after applying the LOG10 or SQRT operators.

C0 + C1*X1 + C2*X2 +...+ Cn*Xn
Average(X1, X2, X3, ..., Xn)
Weighted Avg((X1*wt1,..., Xn*Wtn)/Sum(wt1-n))

These N-ary operations first ask for the number of objects to include in the operation, then repeatedly prompt you with a menu of objects until the specified number have been selected. When doing a weighted average, the selection of each object will be followed by a prompt for a weight coefficient (C1...Cn). Weighted averaging propagates the weights.

HELP invokes this information.

Return to MAIN MENU returns you to the UIMAGE Main Menu.

SPECTRUM OPERATIONS

All of the operations accessible from this menu work on spectral data cubes (3-D objects) only. For each operation, if there is more than one 3-D object in memory, then you will be presented with a data menu so you can identify the object to use as the operand. If, however, there is only one 3-D object in memory, then that one will automatically be chosen as the operand.

Extract spectrum from pixel lets you generate a graph of the spectrum at a specified location from a selected 3-D object.

If you are using a non-X Window terminal, you will then be asked for the coordinate system that you would like to use when entering the location. After that you will be prompted for the longitude and latitude. A graph of the spectrum is then produced.

If you are using an X Window terminal, you will be asked to choose either keyboard or mouse input. For the latter you are presented with a menu of images derived from the 3-D object. (If you get a message that says that there are no such images available, then you can create such an image via the **`Extract a frequency slice`** or **`Integrate over frequency`** operations). Pick whichever image you would like to use as a fiduciary for marking points. Then you can use the mouse to mark a point on the selected image, after which the graph of the spectrum will be produced. Lastly, you will be asked if you wish the spectrum dumped to an ASCII file for later use.

Average spectra in an area generates a spatially-averaged spectrum for a user-defined area within a selected 3-D object. If there are weights associated with the selected object then they will be used in the area averaging.

What happens after selecting this operation is almost identical to what happens as described above for **`Extract spectrum from a pixel`**, only here you need to identify vertices for the desired area. X Window terminal users will need to mark off multiple points using the mouse (hit the leftmost mouse button to mark off all points except for the last one, hit the rightmost button to mark off the last point). Non-X Window terminal users will have to enter in at least 3 coordinate pairs, one at a time, and then hit an empty carriage return when done. A graph of the spectrum will then be displayed. The number of pixels used in the spatial average is displayed in the DECterm window. Lastly, you will be asked if you wish the spectrum dumped to an ASCII file for later use.

Extract a frequency/wavelength slice creates a 2-D slice through a spectral data cube. You will be prompted for an index number in the frequency (or wavelength) direction and the name of the object through which to take the slice. The **`Display a frequency table`** operation (described below) will be helpful to use if you don't know what frequency is associated with each index. If there is a 3-D weight array associated with the object then a 2-D weight slice will also be created.

Integrate over frequency/wavelength creates a 2-D slice by summing over the frequency (or wavelength) index in all pixels of a spectral cube. You will be shown a menu of available 3-D objects, then prompted for a range of index numbers over which to sum.

Display a frequency/wavelength table displays a table of frequencies or wavelengths associated with a selected 3-D object.

HELP invokes this information.

Return to MAIN MENU returns you to the UIMAGE Main Menu.

LINE PLOTS AND STATISTICS

Tek or VT200 grey scale plot lets you create a crude grey scale display of a selected image on any terminal that accepts Regis or Tektronix 4010-series terminal graphics commands.

Cross sections, slices lets you create a graph of data values along a specified great circle arc drawn on a selected image. Users of non-X Window terminals can enter two pairs of longitude and latitude values, which denote the endpoints of a great circle arc. Prior to entering those values, you will be asked to identify the coordinate system of the points.

Users of X Window terminals have the option of either defining the endpoints of the arc in the manner described above, or else by marking the endpoints on the selected image via clicks of the leftmost mouse button.

You may take slices through reprojected images such as Aitoff displays, but be aware that for purposes of accuracy, the program is invisibly going back and taking the slice through the corresponding pixels of the skycube from which the reprojection was made.

If you are using an X Window terminal then you will encounter a submenu within this operation that lets you change the mode of designating endpoints of arcs (*i.e.*, from mouse to keyboard or vice versa) or to make a graph of the data values along the complementary direction of the previously defined slice, i.e., the "long way around" on the great circle.

Scatter plot (2 maps) lets you plot the data values of one image versus the data values of another image of the same size. You will be given a menu of available images and asked to select two. Any pixel that has a bad value in one or both of the maps will not appear on the plot. **RESTRICTION:** The two maps must have the same quadcube resolution. If they are single-face (as opposed to full-sky) images, they must be the same face.

Contour plots lets you generate contours from a selected image. After identifying the desired image from which contours should be made, you will be prompted for any changes to the default contour levels and number of contours. X Window terminal users are given the opportunity to have multi-colored contours, and to overlay the contours on another image if desired. After the contours are drawn, you are given an option to have a PostScript file produced. Be aware that this plot file is of the contours alone and does not include the underlying image. X Window users can use the **`Create a PostScript File`** operation to create a PostScript plot of the complete image with contours.

Single pixel information There are two pathways for this procedure. Keyboard Input: returns the data value, pixel number and coordinates for a keyboard selected pixel in a 2-D map. Mouse Input (X Windows only): returns the data value and coordinates for mouse-selected pixels in a 2-D map. Use the left mouse button to pick out pixels repeatedly. The right button terminates the operation.

Pixel information for graphs (X Windows only) returns the data value, coordinates, and the index of the array element for mouse-selected pixels in a 1-D graph. Use the left mouse button to pick out pixels repeatedly. The right button terminates the operation.

Statistics & Histogram lets you calculate statistics (min, max, mean, median, standard deviation, and number of pixels) for all or part of a selected image. If you want to work with just a part of the selected image, then you will need to define the vertices of a polygon which encloses the desired area. X Window terminal users can do this by marking off an arbitrary number of points on the selected image with the leftmost mouse button, and then clicking the rightmost button to designate the final point. Non-X Window users can identify the vertices by typing in the coordinates of each point, after having identified the coordinate system which will be used.

To plot a histogram, you will be prompted for the number of bins to use as well as the min and max *x*-axis range for the plot. Finally, you must choose whether the histogram should be displayed as a linear or semi-log plot.

HELP invokes this information.

Return to MAIN MENU returns you to the UIMAGE Main Menu.

MODELING AND FITTING

This menu lets you access fitting and/or modeling utilities.

Subtract a Dipole creates a new skymap from a selected 2-D map by fitting and subtracting a dipole. After selecting the input skymap, you will be asked to type in a galactic exclusion angle in degrees. Acceptable values range from 0 to 90 degrees, and 20 degrees is the default value. If the object has a weight array it will be applied for the calculation. The parameters which describe the dipole are calculated from the selected skymap and are displayed on the screen (the mean CMBR intensity, the dipole amplitude, and the galactic longitude and latitude of the dipole pole). A new skymap is then created which is equal to the original skymap minus the calculated dipole.

Fit Spectra with a 3 B-Body Model fits spectra with a three blackbody model. One blackbody typically corresponds to the cosmic background while the other two can be used to fit the residual dust. Choices for inputs are a single spectrum (graph) or a 3-D data cube. After selecting the input spectrum(a) if there are no weights you will be prompted for a sigma which is used in the output sigma calculations (*e.g.* for FIRAS use 2.5e-7).

You will then see a menu of possible input parameters to define. If the input was a 3-D object then the first seven choices correspond to any previously determined value arrays (stored as UIMAGE objects). These are used only for multiple spectra fitting where each spectrum can have a different fixed input parameter. If the input was a 1-D graph then these choices are not shown. The next 4 choices on the menu are more global and should be chosen only if the user does not want to use the default values.

Next, you will be prompted for a series of singular values for the initial values. These are global values for all spectra. You will also be asked if you want to vary these or have them fixed.

Lastly, a series of questions will prompt you for the various output choices. If the input was a single spectrum any new spectra created will be displayed. If the input was a 3-D object, due to UIMAGE constraints only some of the outputs are valid. The valid choices are to create a 3-D object of the residuals or to obtain the parameter sigmas. Whenever a 3-D object is chosen for an input, a series of 2-D maps corresponding to the parameters which were varied are created.

Fit Spectra with a Bose-Ein. plus BB Model fits spectra with a Bose-Einstein plus a residual blackbody spectrum. Choices for inputs are a single spectrum (graph) or a 3-D data cube. After selecting the input spectrum(a) if there are no weights you will be prompted for a sigma which is used in the output sigma calculations (*e.g.* for FIRAS use 2.5e-7).

You will then see a menu of possible input parameters to define. If the input was a 3-D object then the first five choices correspond to any previously determined value arrays (stored as UIMAGE objects). These are used only for multiple spectra fitting where each spectrum can have a different fixed input parameter. If the input was a 1-D graph then these choices are not shown. The next 4 choices on the menu are more global and should be chosen only if the user does not want to use the default values.

Next, you will be prompted for a series of singular values for the initial values. These are global values for all spectra. You will also be asked if you want to vary these or have them fixed.

Lastly, a series of questions will prompt you for the various output choices. If the input was a single spectrum any new spectra created will be displayed. If the input was a 3-D object, due to UIMAGE constraints only some of the outputs are valid. The valid choices are to create a 3-D object of the residuals or to obtain the parameter sigmas. Whenever a 3-D object is chosen for an input, a series of 2-D maps corresponding to the parameters which were varied are created.

2-D Background Modeling Tool is a general background modeling tool. The type of background model returned is determined by the combination of input keyword parameters. The default fit (using no keywords) is a quintic interpolation to pixels specified interactively using the mouse. A single menu is used to define the various input/output parameters. If a menu choice is not selected then either the default (as listed) is used OR if no default is listed, this type of fit is not performed. If after viewing the specialized fit menu the user wants to use the default fit then simply choosing done without any other choices is sufficient. Note, if a final source subtracted map is desired then the number of standard deviations used to ID a source MUST be selected.

The default output is the background model. This is initially not an UIMAGE object but is duplicated as a hidden UIMAGE object for future use. If a final source subtracted map or background subtracted map is requested these are also displayed.

1-D Polynomial Fitting is a general polynomial fitting tool. This routine fits polynomials to any UIMAGE graph using the IDL USERLIB routine **SVDFIT**. A single menu is used to define the various input/output parameters. The first item, the degree of polynomial, is mandatory while the other choices are optional.

Subtract a Dipole + Quadrupole creates a new skymap from a selected 2-D map by fitting and subtracting a dipole plus a quadrupole. After selecting the input skymap, you will be asked to type in a Galactic exclusion angle in degrees. Acceptable values range from 0 to 90 degrees, and 20 degrees is the default value. If the object has a weight array it will be applied for the calculation. The parameters which describe the dipole and quadrupole are calculated from the selected skymap and are displayed on the screen (the mean CMBR intensity, the dipole amplitude, the Galactic longitude and latitude of the dipole pole, the quadrupole intensity and the five quadrupole terms). A new skymap is then created which is equal to the original skymap minus the calculated dipole plus quadrupole. The pure quadrupole model is an optional output.

1-D Gaussian Fitting is a general Gaussian fitting tool. This routine fits Gaussians to any UIMAGE graph using the IDL routine **CURVEFIT**. A single menu is used to define the various input/output parameters. An optional baseline can be included in the fit. The baseline can either be linear or quadratic.

HELP invokes this information.

Return to MAIN MENU returns you to the UIMAGE Main Menu.