microObservatory Image

version 2.1

Index of Command Functions

Command description [keyboard shortcut]:description including special instructions.
Keyboard short for a Windows PC: the Control key AND the shortcut key.
For a MacIntosh: the Meta or Command (Apple symbol) key AND a shortcut key.
*Note: lower case characters only!*

Under the **MicroObservatoryImage** menu (Mac OSX version only):

1. **About MicroObservatoryImage**: Program information, including program release version, contact information and Internet address for the software program and instructions. A toggle button allows the user to check for the most current version of the MicroObservatoryImage program.
2. **Services**: Not applicable.
3. **Hide MicroObservatoryImage** [**Meta h**]: Minimize the program.
4. **Hide Others** [**Option Meta h**]: Minimize all other programs.
5. **Quit** [Meta q] : Quit the program and closes all images. Note: The program will prompt you to save all open, unsaved images *BEFORE* quitting the program.

Under the **File** menu:
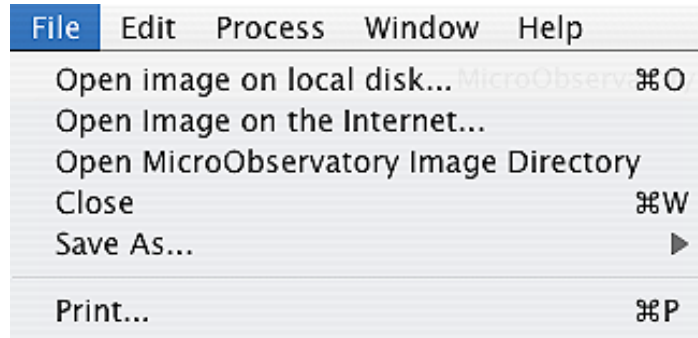
1. **Open an image on local disk…** [Meta o] : Open an image file from your local computer. The program only opens FITS and GIF formatted image files. The 'Drag and Drop' feature allows you to drag an image, a file, or a URL address onto MicroObservatoryImage icon (Mac OSX version only) or into the application window (all versions) to open each.

2. **Open an image on the Internet…** [n/a] : Open an image file directly from the Internet. Type or copy an URL address [copy to clipboard (Mac) or shortcut (PC) and then paste with Meta v or click on the Paste button] and click the OK button. The 'Drag and Drop' feature allows you to drag an image, a file, or a URL address onto MicroObservatory Image icon (Mac OSX version only) or into the application window (all versions) to open each.

3. **Open MicroObservatory Image Directory** [n/a] : The Image Directory on the MicroObservatory web page is opened via your default internet web browser. Follow directions above to open an image file in the program.

4. **Close** [Meta w] : Close current image.

5. **Save As / GIF…** : Save an image file in GIF format (graphics interchange format, a 256-brightness levels or 8-bit format). This data format may be gray scale or composite color image. Remember to type the .GIF postfix to the end of each file name created.
    Save As / FITS… : Save an image file in FITS format (flexible image transport system, the standard data format used in astronomy, which has basically an unlimited data size, but this program can manipulate signed 32-bit images or over 4 billion color/gray shades). Note: The original FITS header information is saved with the image, even if you have changed the image in anyway. Remember to type the .FITS postfix to the end of each file name.
    Note: MicroObservatory images originally come from a 12-bit digital imaging device but they are stored using the 16-bit FITS data format standard. 12-bit means there are 4096 brightness levels or shades of gray between black and white. Black has a value of 0 and white equals 4095.
    Save As / Animated GIF… : Save an image file in GIF format, similar to above but this contains several images in sequence which display as an animation. Note: only a Stacked image can be saved as an animated GIF, which is created from Process / Stack / Convert Images to Stack command. Remember to type the .GIF postfix to each file name.

6. **Print** [Meta p] : Print the current image.

Under the **Edit** menu:

(Note: all these commands are for text functions, NOT for image processing steps, except the Undo function.)

1. **Undo** [Meta z] : Undo last command performed. Works on Adjust Image, Color Table, Sharpen, Reduce Noise functions.
2. **Cut** [Meta x] : Highlight text with mouse then cuts or remove text. Cut text is saved in memory.
3. **Copy** [Meta c] : Highlight text with mouse then makes a copy without removing text. Copied text is saved in memory.
4. **Paste** [Meta v] : Text saved in memory from Cut or Copy command is pasted where the mouse cursor is located.
5. **Select All** [Meta a] : All text in current window is highlighted.

Under the **Process** menu:

1. **Adjust Image** [n/a] : Rescales or remaps the brightness values of each picture element (pixel) of the displayed image to a different range of brightness values. A new window pops up with the title 'Adjust Image'. You may choose either **Linear** (the default) or **Log to** scale the image values by clicking on the appropriate button. The maximum and minimum values of the image are initially displayed (as the default values) showing the full range of values. You may want to adjust the displayed range of brightness values to see detail not seen. You may adjust the maximum and minimum values either by clicking, holding and sliding the arrows to the right of the scale or by typing an integer value into the respective boxes on top and bottom. The Auto button automatically rescales the image with

the optimized linear or logarithmic scaling method, depending on which button is chosen.

Auto-Linear scaling sets the minimum and maximum values at two standard deviations from the mean pixel brightness value, then scaling 4095 brightness values between these established min-max values. Auto-Log scaling sets the minimum at the mode value and the maximum at five standard deviations then stretches the contrast scale logarithmically between these values to emphasize small changes in brightness near the mode (the most common pixel brightness value) while deemphasizing the brightest pixel values image components.

The **Reset** button returns the image to the default full-scale linear minimum and maximum display values.
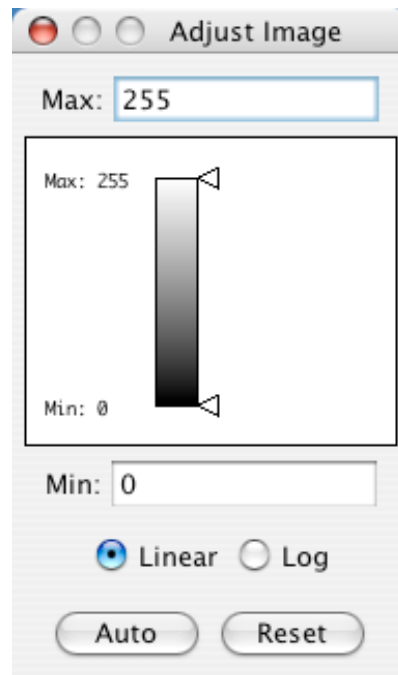
Linear rescaling is best for displaying bright objects like the Moon and planets. Logarithmic rescaling optimizes faint detailed features in nebulae and galaxies while still seeing the brighter details in the image.

2. **Color Tables / various color options** [n/a] : The image can be 'colorized', meaning that for each individual brightness level a specific color can be assigned to that value. The default 'color table' is a gray scale where the smallest or faintest value is black and the highest or brightest value is white, with intermediate values being lighter shades of gray as pixel values increase. Matched the color table for filtered image is useful in creating RGB color imagery. See **Stack** command.

> **Color Tables / Gray Scale**: Different shades of gray represent pixel brightness values, black being faintest and white being the brightest.
> **Color Tables / Red**: Light red colors are bright high values, and darker red to black are low dimmer values. Use for red filtered images to create full color images.

Color Tables / Green: Light green colors are bright high values, and darker green to black low dimmer values. Use for green filtered images to create full color images.

Color Tables / Blue: Light blue colors are bright high values, and darker blue to black low dimmer values. Use for blue filtered images to create full color images.

Color Tables / Spectrum: A multicolor (rainbow) table, where violet and blue are brighter pixel values and yellow to red are dimmer values. This table helps viewing low contrast images.

Color Tables / Fire: A different multicolor table. Brighter pixel values are yellow to red and fainter values are violet to blue.

Color Tables / Ice: Another multicolor table, the reverse of Fire. Brighter pixel values are red to pink and fainter values are blue to green.

Note: the brightness values for pixel in the image DO NOT change, only how they are represented or viewed on the display.

3. **Invert Color** [n/a] : Invert the brightness values of the images, converting the brightest high value to the lowest and the faintest value to the highest, and doing the same to all the intermediate values, to create a negative image of the original.

4. **Sharpen** [n/a] : Sharpen is a processing function that increases the brightness difference for a pixel as compared the all the surrounding pixels. This function increases the contrast, detail and noise of an image.
Warning: The actual image data is changed with this function, unlike other functions in which the data is just displayed differently.

5. **Reduce Noise** [n/a] : Reduce noise is a function that averages a pixel's value with the surrounding pixels. This function reduces the noise viewed in an image but also reduces the detail or blurs the image, which can also reduce the contrast. This function is also called smoothing. Note: This function does not remove cosmic ray events but rather hides them in the background.
Warning: The actual image data is changed with this function, unlike other functions in which the data is just displayed differently.

6. **Crop** [n/a] : Takes a portion of the image as highlighted by the box tool and creates a new image file. To use, open an image, select the box tool (located in the upper left corner of the image window), click and drag the mouse to create a box of the appropriate size and unclick. The box can be moved about the image by clicking and holding the mouse cursor inside the shape and repositioning the shape, unclicking the mouse to fix its position on the original image. Then choose crop and a new image of the highlighted region is created in a different window.

7. **Measure** [Meta m] : Measures the pixel statistics for all the pixels highlighted by the box or circle tools. Select the area of the image to be measured by choosing the box or circle tool (located in the upper left corner of the image), click and drag the mouse to create a box or circle of the appropriate size and unclick. The box or circle can be moved about the image by clicking and holding the mouse cursor inside the shape and repositioning the shape, unclicking the mouse to fix its position. The shape can also be positioned with precision by pressing the 'i', 'j', 'k', and 'l' keyboard keys, which moves the box or circle pixel by pixel.
Then choose Measure. A new window displaying a table of statistical values of the highlighted area is created. The first column of the table is the name of the highlighted area, which you can rename by clicking within that cell and typing a

new name. The next columns display the area enclosed by the shape tool, mean value of all the pixels, total value of all the pixels, the minimum and maximum value found in all the pixels, as highlighted in the area. The contents of the table can be copied, either each row (click on the row) or all and successive rows (click AND also hold the Shift key, drag the cursor across the rows) or separate rows (click AND hold the Control key, then individually select each row of interest). Once selected, go to the **Edit** submenu and choose **Copy**. You can then paste the statistical values into any other text editing or spreadsheet program.

8. **Image Calculator…** [n/a] : Performs arithmetic functions between two images. Select this command and a new window labeled Image Calculator is displayed. The most current image viewed is showed in both image registers. Only images currently open are listed in pull-down image registers. Select which image as Image 1, then either the add, subtract, multiply, divide function, and finally which image as Image 2. By default, a new image window is created by the operation. You must have more than one image frame open! Both images must have the same dimensions (width, height and bit depth).

> **Add**: Image1 is added to Image2 (Image1 + Image2).
> **Subtract**: Image2 is subtracted from Image 1 (Image1 – Image2).
> **Multiply**: Image1 is multiplied by Image2 (Image1 x Image2).
> **Divide**: Image1 is divided by Image2 (Image1 / Image2).

Useful for subtracting 'dark' image frames from your image data. Experiment with the calculator. You might be surprised at the results from a simple calculation. The calculator performs only integer arithmetic and rounds values up or down to the nearest integer. The resultant values must remain within the range of values, 0 to 255 for 8-bit images and 0 to 4095 for 12-bit images. Overflowing or underflowing this range may produce severe rounding of pixel values and some very troublesome results. For example: Subtracting a high pixel value from a low pixel value will result in a zero value, not a negative value. Multiplying one image by another image can overflow the pixel value range, producing strange results.

Caution: You cannot divide by zero! If you wish to divide one image by another image that has a zero pixel value, add 1 to the image with the zero pixel value by using the **Math** command.

9. **Math** [n/a] : Performs image arithmetic functions with integers to a single image. Similar to the Image Calculator in function but instead of an image operating on another image, an image is operated on by a constant value. The current image highlighted will be operated upon. Select command and a new window labeled as the arithmetic function (Add, Subtract, Multiply, Divide) is displayed. Type in an integer value and click OK. By default, a new image window is created by the operation.

    Math / Add: An integer is added to the image.
    Math / Subtract: An integer is subtracted from the image.
   **Math / Multiple**: The image is multiplied by an integer.
    Math / Divide: The image is divided by an integer.

    Experiment with the arithmetic functions. Simple calculations are not always simple. The calculator performs only integer arithmetic and rounds values up or down to the nearest integer. The resultant values must remain within the range of values, 0 to 255 for 8-bit images and 0 to 4095 for 12-bit images, etc. Overflowing or underflowing this range may produce severe rounding of pixel values. For example: Subtracting a high pixel value from a low pixel value will result in a zero value, not a negative value. Multiplying an image by a high value can produce an overflowed high value.
   *Caution:* You cannot divide by zero!

10. **Shift…** [n/a] : Aligns one image with another. Select this command and a new window opens, displaying a background and foreground pulldown image register, magnification pulldown selection menu and a display window with two views, an unmagnified and the magnified view of the images selected. Choose one image as the background (preferably the image with brighter objects, such as the red filtered image) and another image as the foreground. Only those images currently opened in the program are listed in the pulldown image registers. You need at least two images open to use this function. In the Shift display window, the unmagnified image is seen on the left and the magnified view is seen on the right. Magnification range is between 1 to 8 times the unmagnified view and is showed in the small window in the upper right corner. The magnified view is a portion of the unmagnified left image centered on the cursor position, as indicated by a crosshair cursor. You can use both the mouse for large position shifts (click and hold then release) and arrow keys on the keyboard for precise pixel by pixel movements (Meta up, Meta down, Meta left and Meta right arrows) to move the foreground image over the background image.

    Useful for creating RGB full color images from individual filtered images, or making an animated GIF movie, or adding several images together to create a longer exposed image. Refer to the **Stack** command.
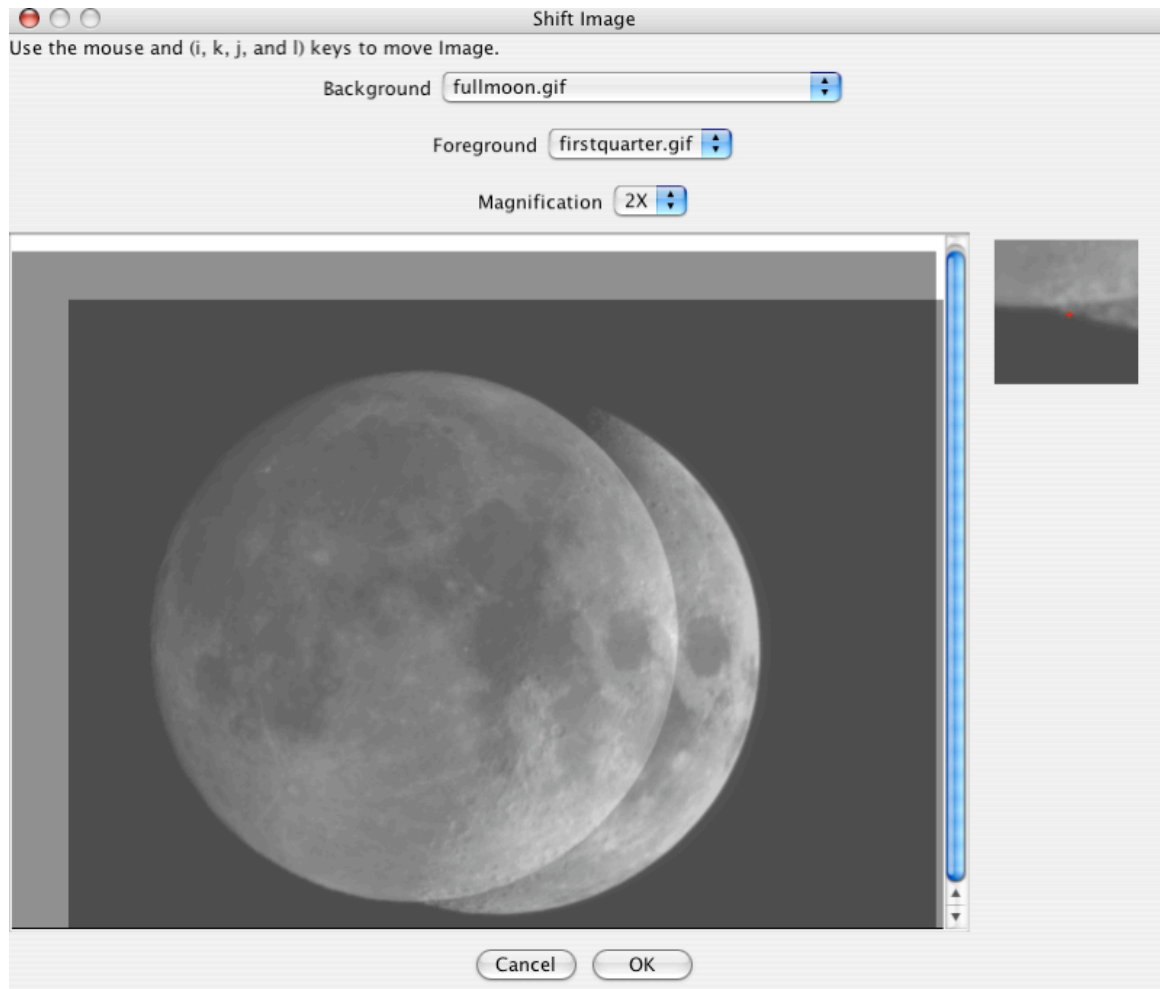
Use the unmagnified view and mouse to approximately fit the two images together, then use the magnified view and arrow keys for fine alignment. You may want to initially begin with a lower magnification and then select progressively higher magnified views for more precise alignment. Once alignment is accomplished, click OK. The foreground image is repositioned using the background image coordinates. This command may be used with both GIF and FITS images, including aligning a GIF with a FITS image. Note: Any pixels from the foreground image that are not within the background image boundary are *permanently lost*. Conversely, due to the shifting operation, new area is created on the foreground image that was not there previously. This new area assumes a similar background pixel value (the mode) from the original foreground image but note that fake stars are not created! Experiment, because the process takes some practice. Note as to what part of the shifted foreground image is real and what is fake. *Caution:* Always save the new shifted image with a different file name than the origin. Best to use a copy of the origin data in any procedure that alters the data!

11. **Stack** [n/a] : Compiles of several images into one image to either create color RGB imagery or animations or a 'longer exposure'. All the images to be stacked must be the same format, either all GIF or all FITS and have the same width, height and bit depth. Click on the image frame of interest; next choose **Add Slice**

to begin creating a stack. The image display changes, with a new window title labeled Stack, with a numerical counter at the bottom with forward and reverse directional arrows for sorting the slices. This numerical counter shows how many slices are in the stack. Continue adding slices until all the requested images are included. To remove an image, click the forward or reverse arrows at the bottom of the frame until the unwanted image is displayed, then select **Delete Slice**.
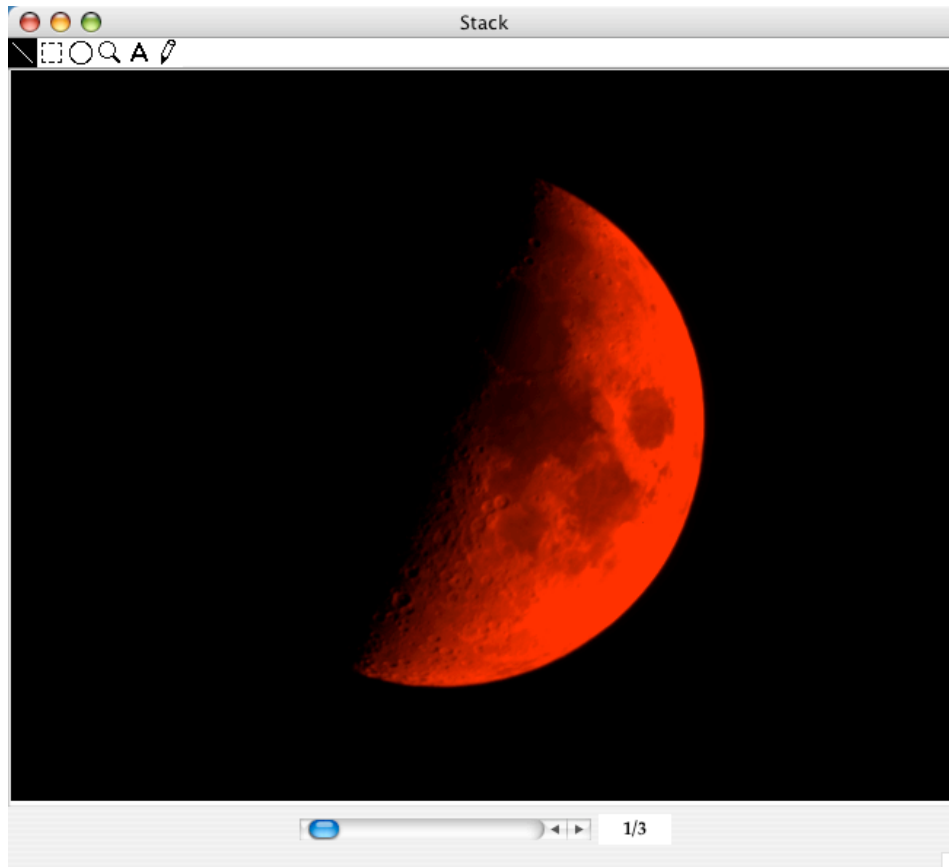
Program functions can still operate on each individual slice within the Stack, such as **Shift**, **Color**, **Crop**, etc. even all the **Tool Bar** utilities, with the exception of the **Process/Image Calculator** and the **Window/FITS Header** functions.

Stack / Add Slice: Add current active image frame to Stack.
Stack / Delete Slice: Delete the displayed, specific image slice from Stack.
Stack / Convert Images to Stack: Automatically add all open images within the program onto a Stack. Each image is added to the stack by order of most recent frame viewed to last frame viewed. Every image must have the same dimensions and bit depth.
Stack / Convert Stack to Images: Automatically remove every slice from the Stack, creating a new image for each slice within the Stack. Data format is preserved from the original image when 'unstacked'.
Stack / Convert Stack to RGB: Convert three separate, colored images into a composite RGB color image. Begin procedure by adding only three images to

a stack. Select red, green or blue (by the **Color Tables** command) for each slice in stack (choose image frame by arrows at frame bottom). Each image may be colorized before adding the images to the stack also. Either method works. There must be only one red colored slice, one green slice and one blue slice in the stack or an error is displayed. Finally, choose the Convert Stack to RGB command. Note: This command converts all image formats to a 8-bit depth format, which can not be reversed. Higher bit depth image information will be lost permanently.

Stack / Convert RGB to Stack: Converts a single RGB color image into three separate image slices within a Stack, one slice each of a red, green, blue color. If you unstuck the slices, each resulting image would be an 8-bit GIF formatted image.

Stack / Start Animation: Begin animation sequence of stacked images. Review sequence prior to saving the image stack.

Stack / Stop Animation: End animation sequence of stacked images.

Stack / Animations Options…: Set rate each frame in stack is displayed during animation sequence. Command shows a window entitled Stack Animation Settings and box where the frame rate, in frames per second (fps) can be adjusted. The slowest rate may be set to 1 fps and the fastest at 24 fps.

Remember to save the converted RGB stack to GIF image as a GIF image by the command **File / Save As / Gif…** . Use the command **File / Save As / Animated GIF…** to save the stack as an animation file. Note, once a stack is saved as an animated GIF formatted file, the frame rate cannot be altered.

Under the **Window** menu:

1. **Image Info** [Meta I] : Displays basic information on the FITS or GIF image and provides a zoomed (magnified) view of the current cursor location, indicated by a red crosshair. When the user starts the program, the Image Info window is opened in the top right of the program by default. Instructions stating "*Place Cursor Over Image, Use Up and Down Arrows to Zoom in and out of Image*" are shown to explain how image information can be viewed and is only displayed when the cursor is not positioned over an image. The image information shown:

   **Data**: 8 or 16-bit grayscale or color data image format standard.
   Image window name is displayed, if a Stack.
   Size: 'XX' x 'YY' (horizontal by vertical) numerical dimensions in pixels of the image. The origin (at the 0,0 position) is located in the upper left corner of the image.
   Window Mag: Magnification factor of the active image window. There are 1 to 16 levels of magnification centered on the present cursor position. Level 1 has no magnification and 16 the highest zoom factor. Refer to the **Magnification Tool** description in the **Tool Bar** section for more information about this feature.
   Image Info Mag: Magnification factor of smaller zoomed portion of active window shown in Image Info display window. There are 1 to 7 levels of zoom (magnification) available, centered on the cursor position. Level 1 is the lowest zoom factor and 7 the highest.

Level 1 = 100 x100 square array (no magnification)
Level 2 = 50x50 square array
Level 3 = 32x32 square array
Level 4 = 24x24 square array
Level 5 = 20x20 square array
Level 6 = 16x16 square array
Level 7 = 14x14 square array
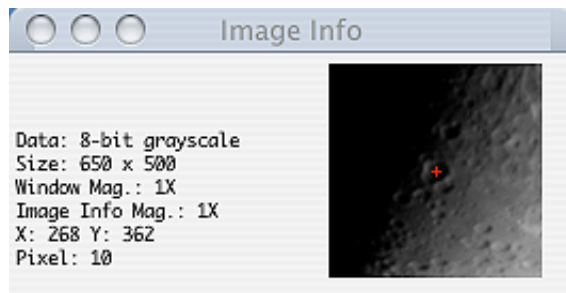
Cursor position and pixel value: X, Y, brightness value. The X value is the column or left to right position on the image. The Y value is the row or top to bottom position on the image. The pixel brightness value is measured brightness for the specific individual pixel the cursor is currently pointing to.

To recall the Image Info window if closed, click on the command under the Windows menu. If the window cannot be seen amongst numerous open windows, click on the Image Info command, which will place the window in the uppermost right of the application window.

2. **FITS Header** [Meta f] : Displays information from a FITS (flexible image transport system) data file, called the FITS Header. Note: **Edit** menu functions

Select All and **Copy** can be used in this file window, to paste this data into another application.

3. **Intensity Histogram** [n/a] : Graph of pixel brightness values for the image data. The graph displays brightness level of pixels versus the number of pixels with that particular brightness value. The graph automatically sets the faintest brightness value on the left of the X-axis to the minimum pixel value found in the array and the brightest value to the maximum pixel value. A grey-scale bar is displayed below the X-axis to indicate darker to brighter scale of the represented values. The Y-axis values are automatically set to zero (no pixel with this brightness value) to the most frequent occurrence of a pixel brightness value in the image. Below the graph is displayed statistics for the image, including the image data file the histogram is calculated from, the minimum pixel brightness value, the maximum brightness value, the mode (most frequent value occurring within the image), the mean (average brightness value), the variance (the dispersion of brightness values from the mean value), the standard deviation (the square root of the variance) and the bin width (range of values). The variance can be used to characterize the noise and other factors of the digital detector. The standard deviation is another measure of noise characteristics. The bin width represents the frequency of pixel brightness values within a range of brightness values for the image data. This graph represents how many pixels within the image have those values.
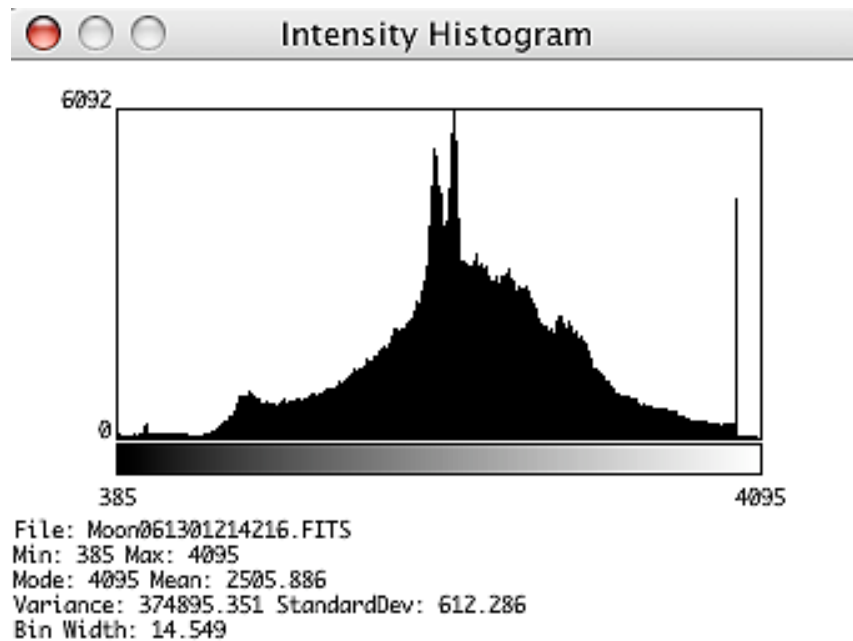
A histogram can be calculated for each image opened within the application, so you can compare different image histograms.

4. **Windows Open Utility** [n/a]: All the open images and histograms within the application are listed at the bottom of the Windows pull down menu. The active, topmost window is listed first and each successive image/histogram there after. Selecting any window from the list makes it the active, topmost window.

Under the **Help** menu:
1. **About MicroObservatory Image…** [n/a] : Program information, including program release version, programmer contact and Internet address for the program and instructions. A toggle button allows the user to check for the most current version of the MicroObservatoryImage program.

Note: Memory recommended to run this program is 256MB.

The Tool Bar (in the upper left corner of every image window, below the file name):

1. **Diagonal Line** [n/a] : Measures separation between two points on the image. Select the diagonal line icon at the top left of the image window. Click and hold the mouse then drag and release at end point. To the right of the Tool Bar is displayed the starting point in X,Y (horizontal, vertical) image pixel coordinates and the length in pixels of the line. Remember the origin (or 0,0) position is the upper left corner of the image. Note: Use the **Image Info**/Zoom Window or the **Magnification** tool when selecting the beginning and ending point for more precise linear measures.

2. **Box** [n/a] : Measures the area enclosed by the scalable and moveable box. Select the square box icon at the top left of the image window. Click and hold the mouse then drag and release to define the box shape and size. Click and hold the mouse button within the box, then drag and release at the preferred location moves the box to a new location. Alternatively, for precise repositioning of the box, press the 'i', 'j', 'k', or 'l' keys on the keyboard to move the shape a pixel at a time. To the right of the Tool Bar is shown the upper rightmost corner of the box in X,Y (horizontal, vertical) pixel coordinates and the width and height of the box, also in pixels. Remember the origin (or 0,0) position is the upper left corner of the image. This tool is used to define the area of the image to crop or measure pixel values, found under the **Process** menu. Note: Use of the **Image Info**/Zoom Window or the **Magnification** tool when making more precise area measures.

3. **Circle** [n/a] : Measures the area define within the circumference of a scalable and moveable circle. Select the circle icon at the top left of the image window. Click and hold the mouse then drag and release to set the radius. Click and hold the mouse button within the circle shape, then drag and release at the preferred location to reposition the circle. Alternatively, for precise repositioning of the circle, press the 'i', 'j', 'k', or 'l' keys on the keyboard to move the shape a pixel at a time. To the right of the Tool Bar is shown the center of the circle in X,Y (horizontal, vertical) pixel coordinates and the radius of the circle in pixels. Remember the origin (or 0,0) position is the upper left corner of the image. Note: Use of the **Image Info**/Zoom Window or the **Magnification** tool when making precise area measures.

4. **Magnification** [n/a] : Full screen magnification utility. Select the magnifying glass icon at the top left of the image window. Position the mouse button within the image window and click to magnify the image window centered on this location. Each successive mouse button click doubles the magnification for this portion of the image, again, centered on where the mouse is clicked on the displayed image. Maximum zoom level is 16 times magnification (level 16). Click on the magnification icon in the Tool Bar to zoom in one magnification level or double click to return to an unmagnified image (level 1).

5. **The Letter A** [n/a] : A text writing tool for GIF images only. The GIF image must not be magnified. Select the letter 'A' icon in the Tool Bar at the top left of

the image window. Click and hold the mouse button then drag and release to define the text box. Click and hold the mouse button within the defined text box, then drag and release at the preferred location to reposition. Double clicking on the letter A in the Tool Bar allows you to adjust the font, size, style and color of the text. A sample text "Type Text Here" is shown. This text is deleted once one starts typing in the text box. Only one font, size, style, etc. is permitted in the text box. One space character is displayed between words, as multiple spaces do not add additional spacing. A space character can start a new line. The carriage return key is not available. The delete/back space key erases all mistakes. Long words are automatically repositioned on a new line and will overfill the boundaries of the defined text box if permitted. The text box can be resized but is of limited functional use. Double click outside of the text box to set the location of the text box on the image. Use the **Edit** menu command **Undo** to start over, if desired. Note: Experiment with this tool before altering a final processed image.
Caution: Adding text will permanently alter the image, so save a copy of the origin GIF image file.

6. **The Pencil** [n/a] : This tool allows free-hand drawing of a single line on the image. Select the pencil icon at the top left of the image window. Click and hold the mouse to draw a line. To the right of the Tool Bar is the current location of the mouse cursor. Double clicking on the **Pencil** in the **Tool Bar** allows you to adjust the thickness and color of the line. The **Edit** command **Undo** will erase the last completed line only. Experiment with this tool before altering the image.
Caution: Drawing lines on the image will permanently alter the image, so save a copy of the origin GIF image file.

MicroObservatoryImage, version 2.1 can be selected as the default application to open FITS and/or GIF image files in Mac OSX. Choose the image file (FITS or GIF format) and select **Get Info** [Meta i]. A new window displaying the file information appears. Select the MicroObservatoryImage application from the **Open with:** pull down selection menu within the Get Info window.

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