

A Quick Start Guide of Makali`i

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Among several image processing software, Makali`i is tuned for astronomical images in FITS format. FITS is a worldwide format of images to make astronomical researches. A FITS image is uncompressed and keeps exact information of all pixels such as position and intensity, although some image formats used as an output of popular digital cameras like jpeg do not keep them. Almost all data released for scientific research from National Astronomical Observatory of Japan and other institutions are recorded in FITS format. Other observatories for public education will release images in FITS format in near future.

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■ Installation

Just execution of “MklSetup.exe” downloaded from the official site (<http://makalii.mtk.nao.ac.jp/index.html.en>) makes installation automatically.

Click an icon appeared after the setup, the software start up.

You can get an official installation manual (PDF; in Japanese) from the following web site.

An official installation manual of Makali`i

http://paofits.nao.ac.jp/Makalii/manual/Mkl_inst.pdf



Icon of the installer



Icon of the Makali`i

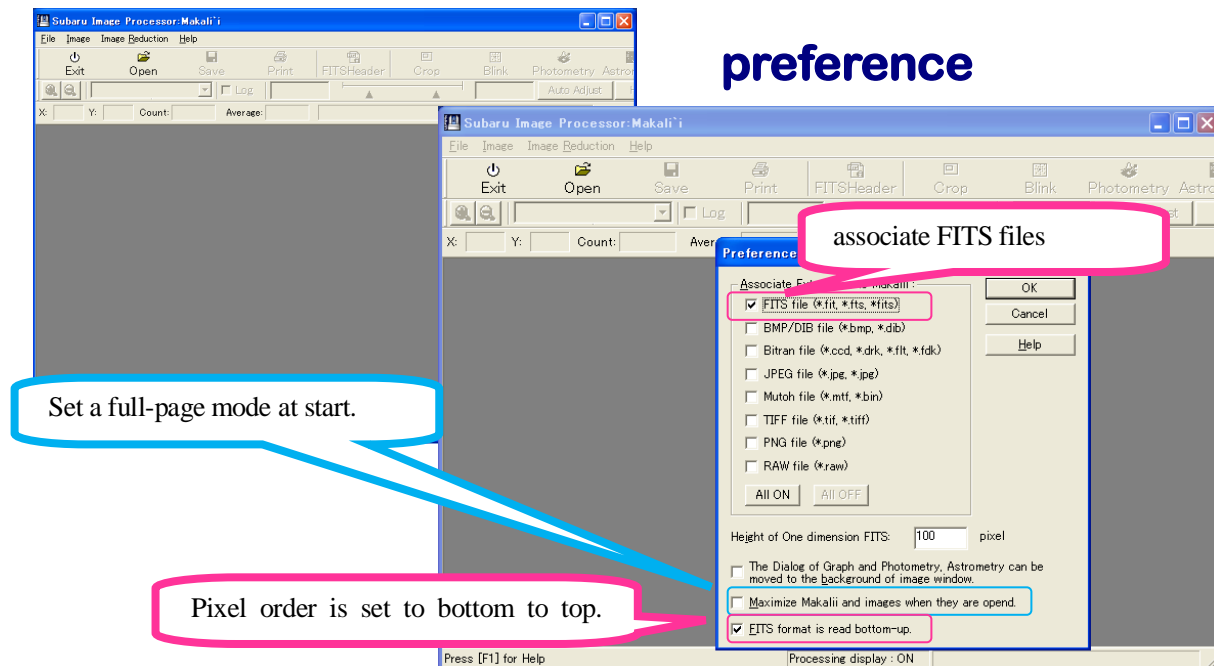
■ Start up & set up the environment

Click [File] in the menu bar and choose [preference...] from the pull-down menu and check the “FITS file”. With this setup and after restart the Makali`i the files with extension “fits”, “fit” or “fts” are associated to the software. Although this setup is not required to use Makali`i, you can start the software only make a double click on a FITS file. If you want to use automatic start with a double click on an image file, you can choose other types of image formats from this panel. Option “Maximize Makalii and images when they are opened.” is another convenient option.

Another option “FITS format is read bottom-up” is also important. It is checked as a default. With this choice, the origin of the image is set to the bottom-left corner, which is the official definition of FITS format, although some images violate this definition).

startup

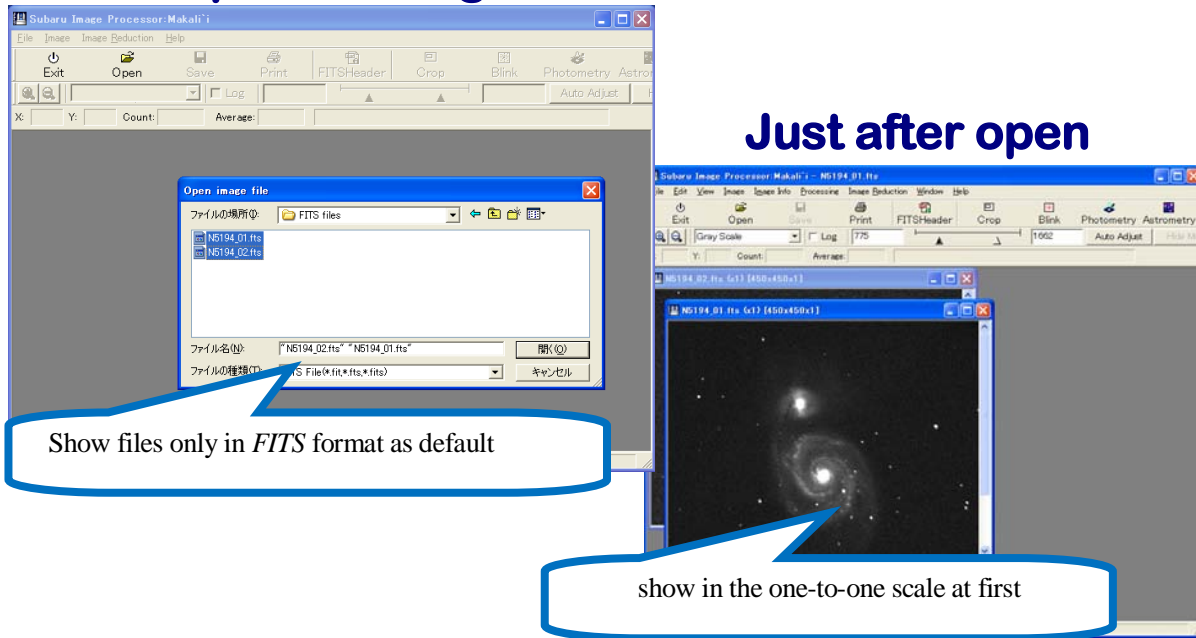
preference



■ **Open an image**

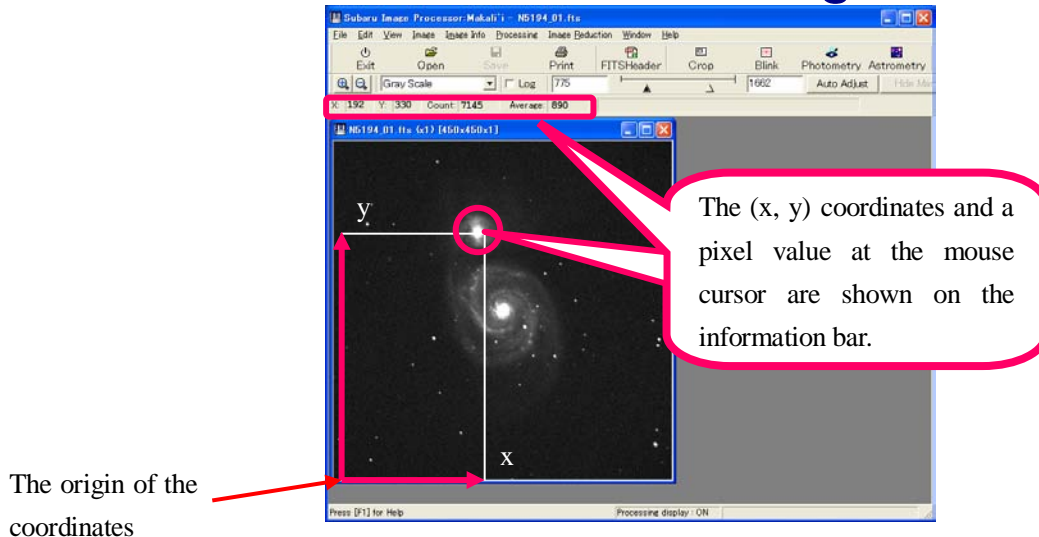
Click [**F**ile] in the menu bar and choose [**O**pen...] or click an icon of [**O**pen]. You can find a folder which contains your FITS images in a dialog of [**O**pen image file]. Point the files you want to read and click the button [**O**pen]. Usually only files in *FITS* format are shown in the dialog. If you want to read files in another format, click [**f**ile **T**ype] tab and change the file type to show. It is convenient that all images you want to process are opened at once. Just after reading, only a part of the image is shown on the screen.

Open an image



When you move the mouse on an active window, which is known by color change of the window bar, the (x, y) coordinates are shown in the information bar. When you check the option “FITS format is read bottom-up” in the pull-down menu of [**p**reference...] in the menu bar [**F**ile] (default setup), the origin of the coordinates (x, y) is the left bottom corner of the image.

Information of the image



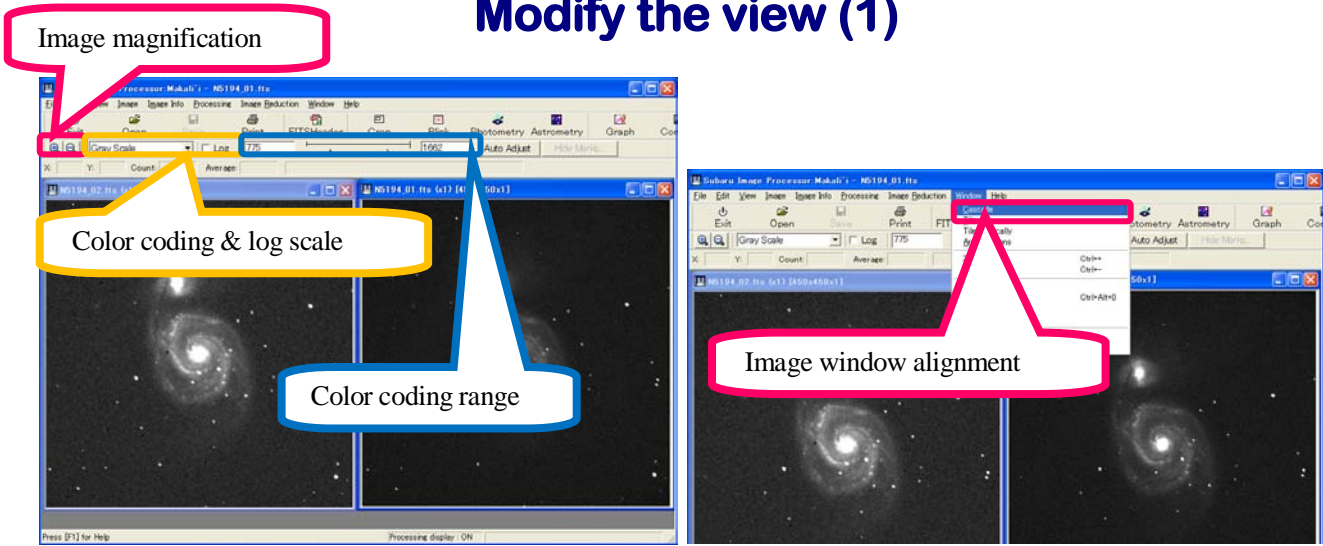
■ **Modify the view (1)**

When the default image size is too small or large to display in the Makali`i window, you can scale up or down the image using the “loupe” icon.

If you want to change the alignment of images, click the [Window] in the menu bar, you can choose one from three automatic alignment styles: [Cascade], [Tile], [Tile V]ertically].

You can arrange the display color of the image. When you check the box for “log”, an image with wide range in brightness can be shown properly. The white and black triangles on the slide-bar show the maximum and minimum brightness of the image to show. You can change the range with dragging these triangles. By this tuning you can see the detail structure of the image. You can input the numbers from keyboard in the boxes in both sides of the slide-bar.

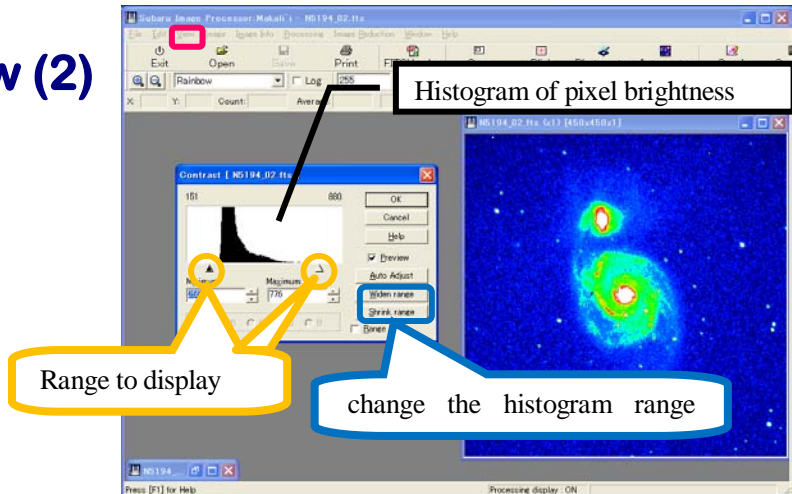
Modify the view (1)



■ **Modify the view (2)**

You can modify the view of the image also using [Contrast...] on the pull-down menu under [View] in the menu bar. A histogram of the image brightness is shown in a new window and you can change the coded range using a black and a white triangle. You can drag them or input by number. The histogram can be scaled up and down. This function helps you to modify the view.

Modify the view (2)



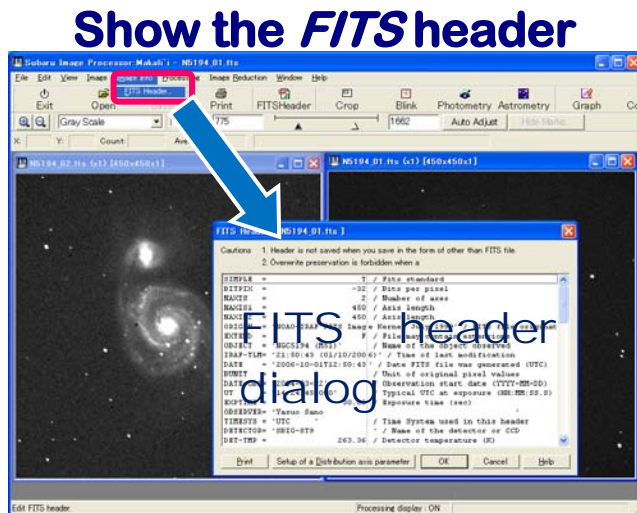
When you change the view, the pixel values of the *FITS* data are not affected. The software only affects the view with these operations. You try to change the view without any worry about giving the damage to the image data.

■ **Show the *FITS* header**

A *FITS* data file is composed of two parts: one part is called as “header” which has additional information about the image. The other part is the pixel values itself. Software which can read a *FITS* file uses the header to display the image.

The additional information contains such as observation date, the coordinates of the image, telescope name, a color filter to observe the image, history of image processing, etc. The format and entries of the header are defined by the International Astronomical Union.

You can read the *FITS* header with choosing [FITS Header...] on the pull-down menu under [Image Info...] menu, or with clicking icon “FITS header”.



An example of information stored in the *FITS* header

BITPIX	=	-32	<i>A pixel value is stored as a 32 bit floating value (16 means 16 bit integer)</i>
NAXIS	=	2	<i>The number of axes. “2” is for 2 dimensional data or a usual image on a plane.</i>
NAXIS1	=	450	<i>The number of pixels along the first axis, which is usually the horizontal size of the image.</i>
NAXIS2	=	450	<i>The number of pixels along the second axis, which is usually the vertical size of the image.</i>

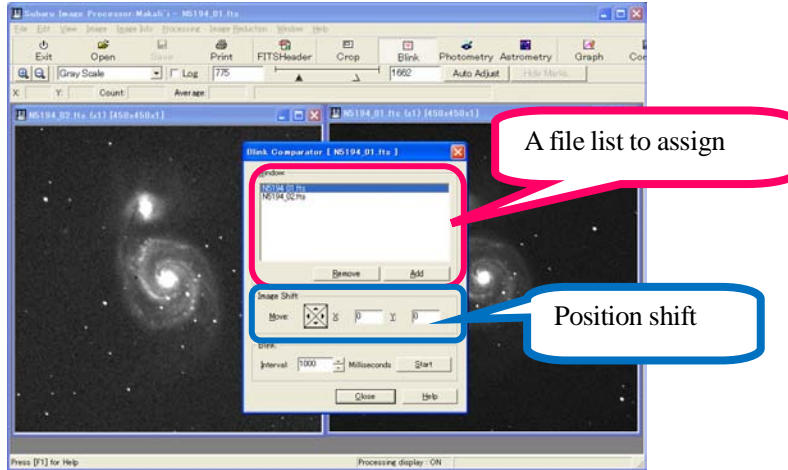
■ **Use a blink function**

The function “blink” switches some images quickly.

If you want to find an asteroid or a variable star including a supernova, you must compare the several images taken at the different epoch. In such cases the “blink” is very helpful.

Choose [Blink...] under [Processing] on the menu bar or click the [Blink] icon activates the blink function. Assign the images from the file list, click the start button. You can shift the relative position of each image in real time with blinking using the “Image shift: move” cursor buttons. This function helps to estimate the relative shift between two images: using the estimated value with this function and apply it with [Move...] under [Image] on the menu bar.

Blink

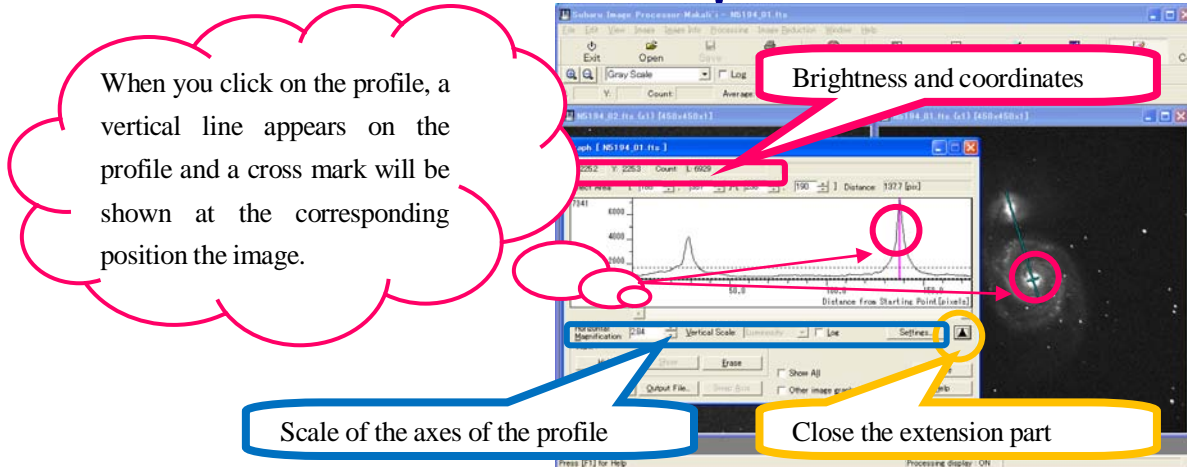


■ Draw a profile

One of outstanding functions of Makali`i is the [Graph] function. To use this function, choose [Graph] under [Processing] on the menu bar or click the [Graph] icon.

To draw a graph of brightness, which is called a “profile”, point the start position on the image and drag the mouse to the end position. During the dragging a line can be modified its length and direction before release the mouse button. After releasing the button, “a graph of brightness along the line” or “a profile” is shown on the [graph] dialog window. When you click on the profile, the vertical line is shown on the profile and its brightness and coordinates are shown at the left top part of the dialog. When you drag the vertical line, a mark at the corresponding position is shown on the image. It is helpful to know the relative position on the profile and the image. Although the horizontal and

Draw a profile



vertical axes are scaled automatically, you can fix it using [Horizontal Magnification] and [Vertical Scale] functions.

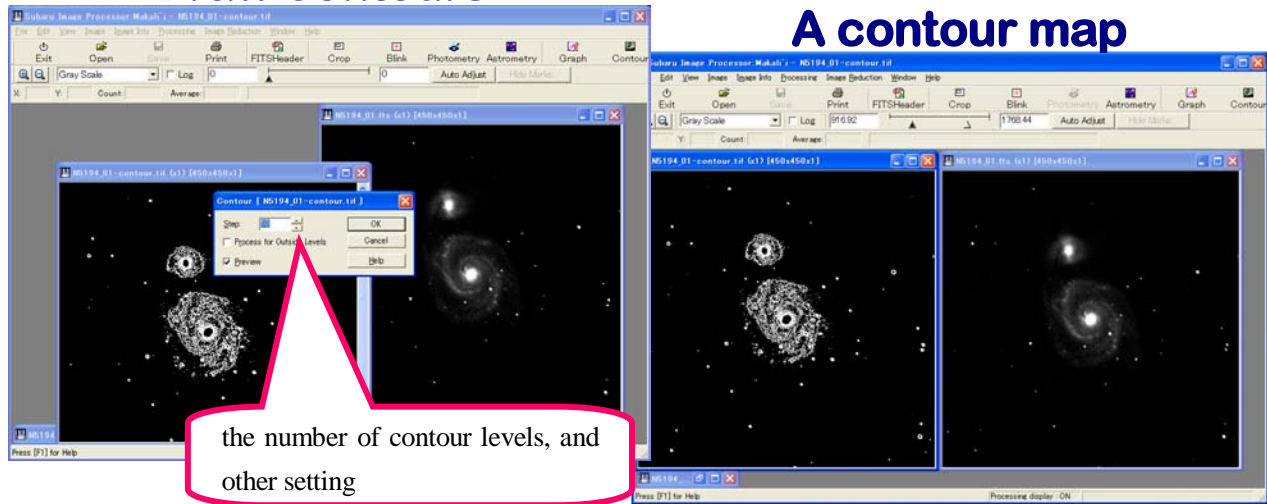
The data of the resultant profile can be written in the CSV or plain text format. Most of spread sheet software, such as Excel, can read it.

■ Draw a contour map

A contour is a line connecting pixels with the same value. A topographical map and weather chart are usually drawn as a contour map. To draw a contour map of the image, choose [Contour...] under [Processing] on the menu bar or click the [Contour] icon.

The number of contour levels are initially set to 10. Each contour level is set to be the same interval step between max and min assigned by setting of the color coding range (see a black and white triangles in “Modify the view (1)”). You can change the number of contour levels. Using these functions you can set any contour levels as you like.

Draw contours



A contour map

■ Image calculation

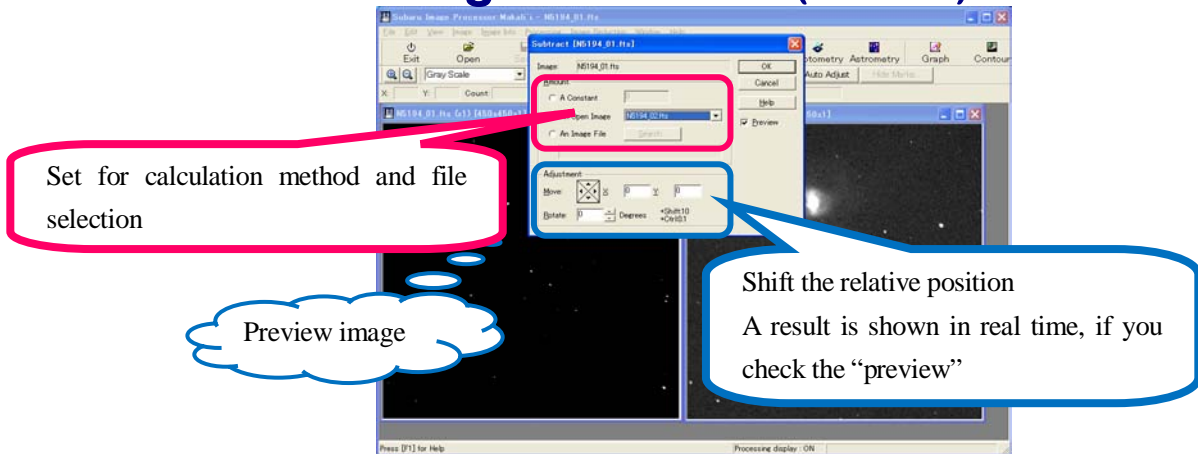
You can add, subtract, multiply, or divide one or two images and get a resultant image using [Image] in the menu bar. These calculations are done for each pixel in the image.

Choose one in the pull-down menu, a dialog window appears. When you choose [Subtract...] in the pull-down menu, a subtraction dialog appears. You can select the subtraction image from three options; [a constant], [an open image], or [an image file]. If you check the [Preview], a result is shown in real time. You can also shift the image before subtraction. In many cases a resultant image is uniformly white or black. This is due to improper setting of the view and an actual image may not be uniform.

When you click the [OK] button, the original image on the computer memory is overwritten by the resultant image. So, the original image file is replaced by the resultant image, if you “save” the image after this process. In many cases, you should use [Save As...] in the pull-down menu under [File] in the menu bar instead of using “Save” icon.

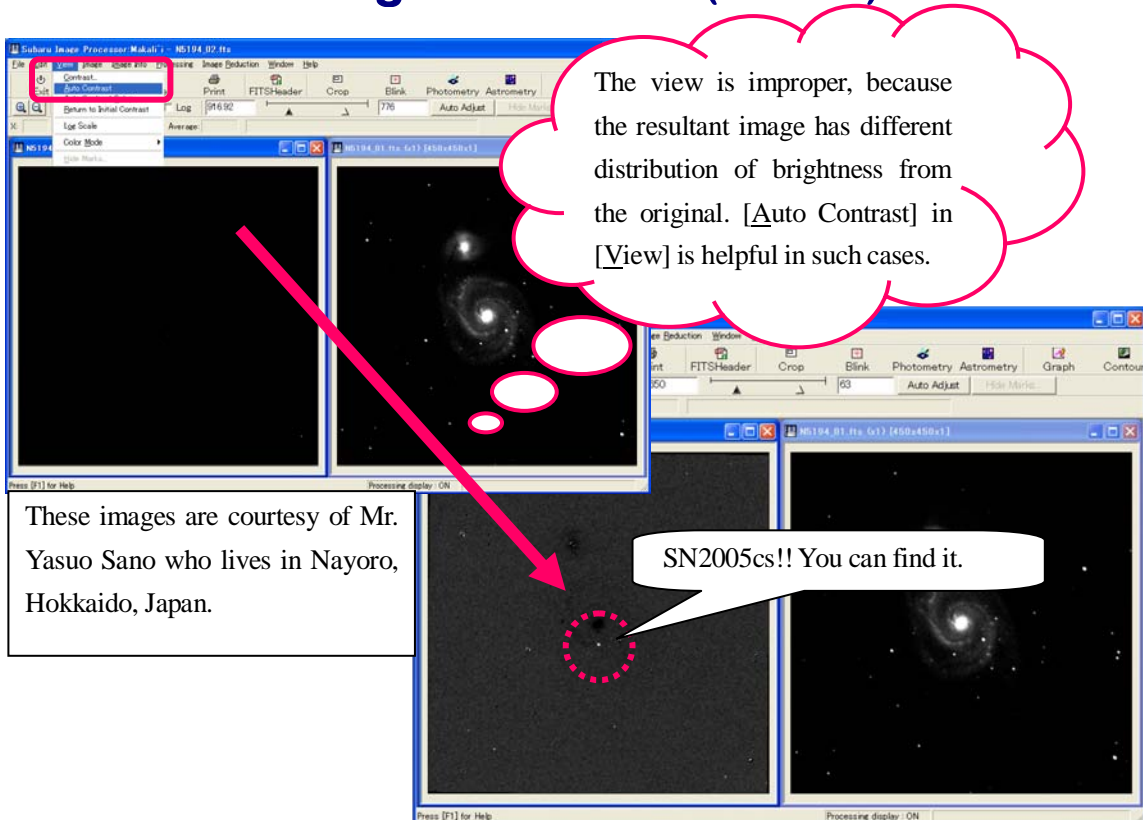
The following is an example of two images of the same galaxy before and after appearing a supernova. The author got it according to the following procedure.

Image calculation (subtract)



- Download the following two FITS files from web page of PAOFITS WG (<http://paofits.nao.ac.jp/>) or sample files in this sample set.
 - N5194_01.fitsAn image of M51 taken at 22 March 2004
 - N5194_02.fitsAn image with SN2005cs taken at 30 June 2005
- Open the both files. After opening, align two images using [Tile Vertically] under [W]indow in the menu bar.
- Focus the window of "N5194_02.fits" and click [Subtract...] under [Image] in the menu bar. Check the [an open image], and choose [N5194_01.fits] from the pull-down menu. It gives subtraction the image without SN2005cs

Image calculation (subtract)



from the image with SN2005cs.

- With checking [Preview], N5194_02.fits is replaced by the resultant image.
- Adjust the relative position of the second image. The author found the best parameters are $X=-0.6$, $Y=-0.2$, $Rotate=0.6$ degrees.
- After setting the parameters, click [OK] button to execute the calculation.
- The resultant image should be uniformly black because of improper setting for the view. Click [Auto Contrast] under [View] in the menu bar, or modify the view manually.

■ Save the results & quit Makali`i

After processing the image, you should save it as the different name from the original. Click [Save As...] under [File] in the menu bar, and give a new name as you like.

During the data save procedure, the system asks you the data format and bit width; real or integer, from 8 to 64 bits. In most cases, 32 bit real is good.

To quit Makali`i, click [Exit] under [File] in the menu bar, which is the same as other Windows application softwares, or click [Exit] icon.

■ Other functions

- ◆ Print... Printout the image
- ◆ Image
 - Flip Vertically Flip the image upside down
 - Flip Horizontally Flip the image left to right
 - Rotate... Rotate the image with any angle
 - Image Size... Resize the image with least
 - Batch - Composite... Automatic composition of many images
- ◆ Processing
 - Trim Trim a part of the image by a rectangular window
 - Photometry... Measure the intensity of a star or a point like source. Subtract the background sky level using an apparture.
 - Astrometry... Measure the position of a star or a point like source only with mouse clicking.
- ◆ Image Reduction
 - Bias Frame/Dark Frame/Flat field...
The first stage reduction for digital images taken with a digital camera

File formats which Makali`i can open.

Makali`i can open a file in *FITS*, BMP, GIF, JPEG, TIFF, RAW and other formats as an output from major CCD

cameras. But it has some restriction to read and write. For example, Makali`i can read a file in JPEG format but cannot write it in *FITS* format. This is because the JPEG format is a deformed image and improper to export as *FITS* to avoid misunderstanding at the scientific measurements.

■ References

- * Makali`i official web site
<http://makalii.mtk.nao.ac.jp/>
Distribute, registration, user support, etc.
- * PAOFITS WG
<http://paofits.nao.ac.jp/>
Some *FITS* data files, Official installation manual (in Japanese), some textbooks which use *FITS* files
- * Japanese FITS committee
<http://www.fukuoka-edu.ac.jp/~kanamitu/fits/>
The latest definition of *FITS* format and other information on FITS itself, some softwares to access the *FITS* files
- * Japan Association for Hands-On Universe (JAHOU)
<http://www.jahou.org/>