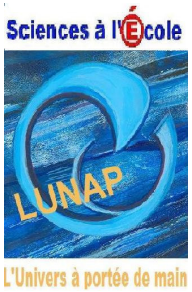
SalsaJ, a software for data analysis at school



Socrates

Notice:

SalsaJ is operational
but it is still a development version

http://www.euhou.net/

Feed back from TRA, pilot-school teachers and their pupils is expected

Feed back from other interested users is most welcome

salsaj@euhou.net

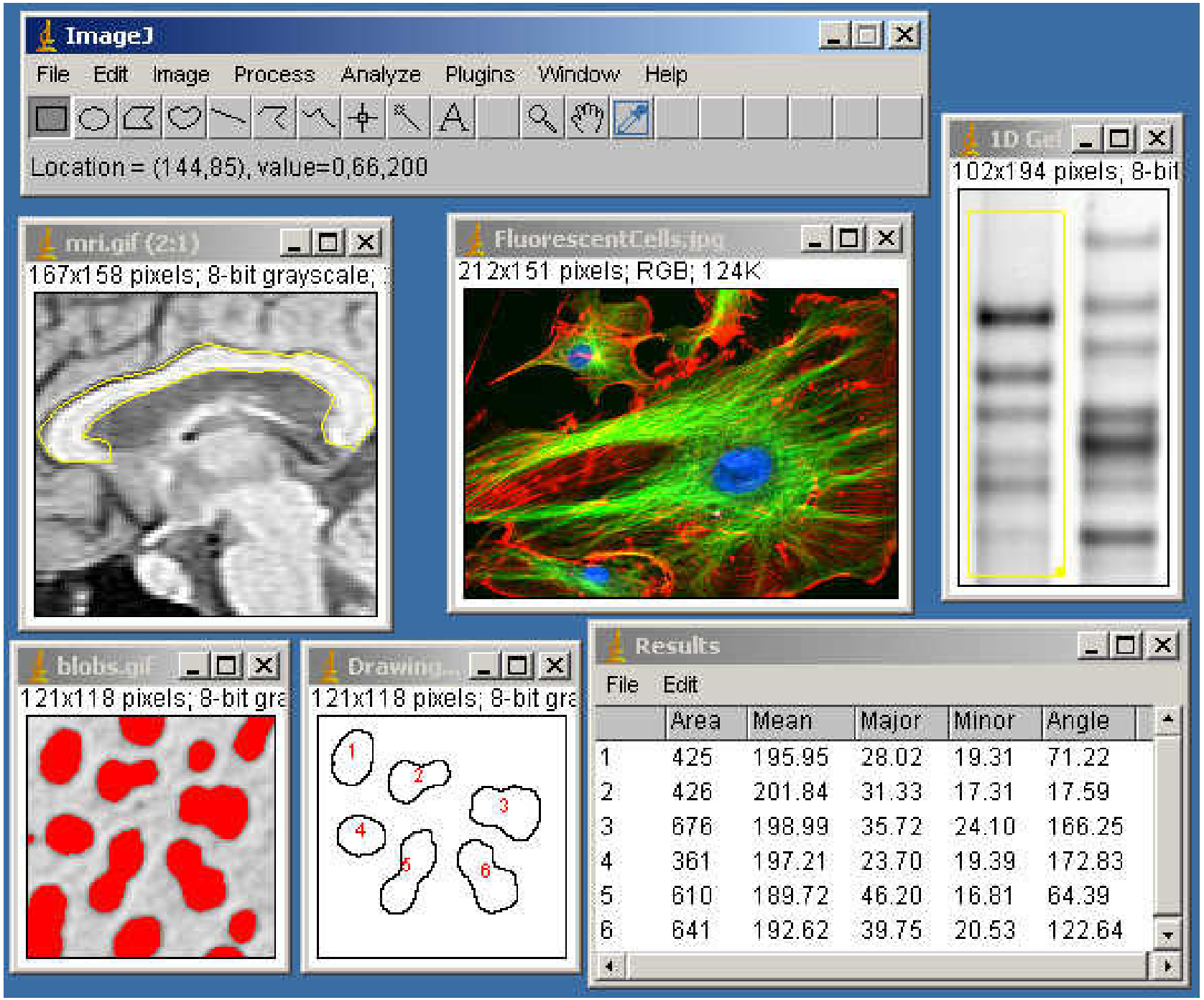
SalsaJ: Introduction to data analysis

➔ Educational tool derived from ImageJ (NIH/USA)

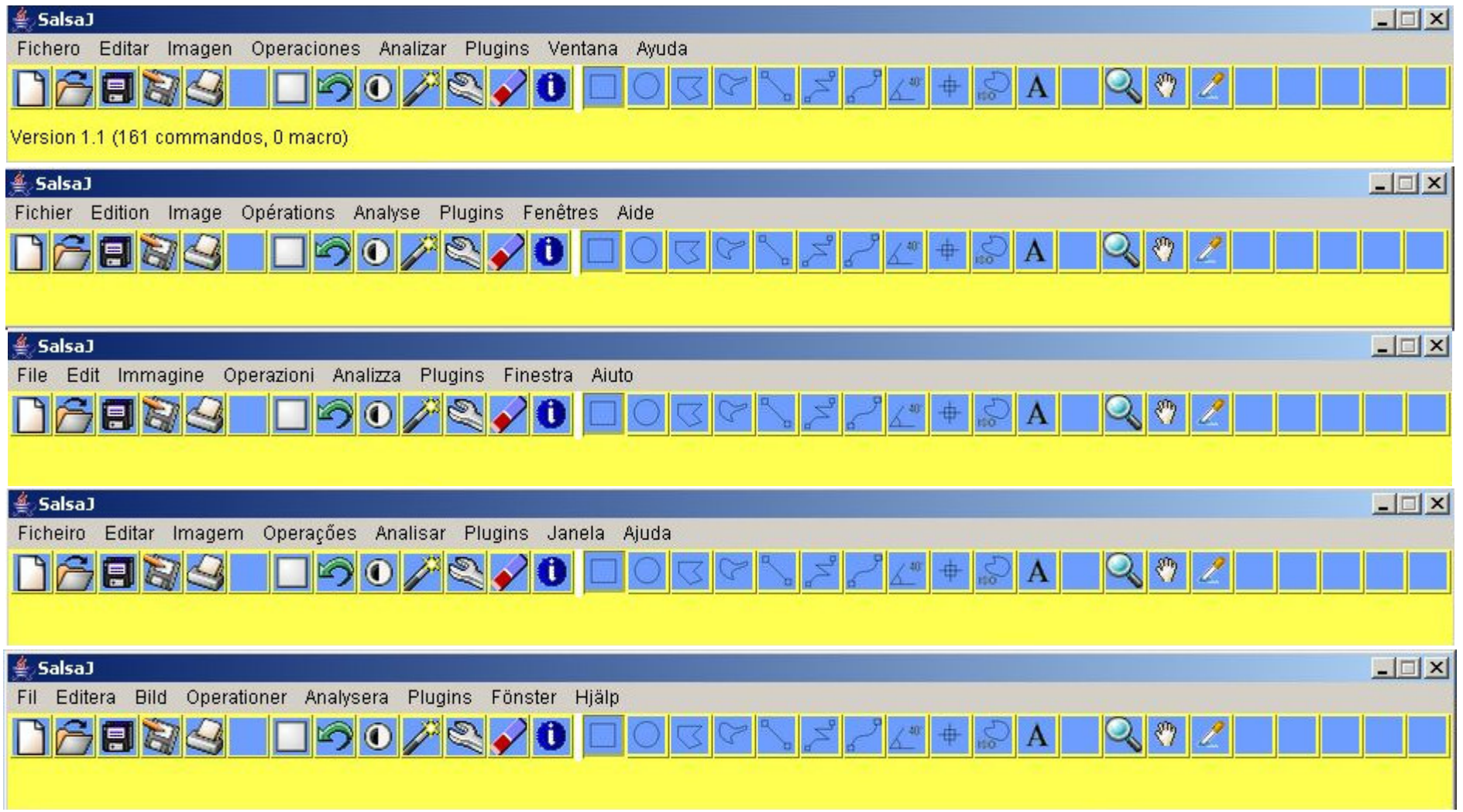
➔ Multilanguage interface
(8 languages of the project/regional setting of the system)

➔ Modification of menus and some tools (didactic motivations)

➔ Introduction of astronomical functionalities (format, photometry)


ImageJ
File Edit Image Process Analyze Plugins Window Help
Location = (144,85), value=0,66,200
mri.gif (2:1)
167x158 pixels; 8-bit grayscale;
FluorescentCells.jpg
212x151 pixels; RGB; 124K
1D Ge
102x194 pixels; 8-bit
blobs.gif
121x118 pixels; 8-bit gra
Drawing...
121x118 pixels; 8-bit gra
1
2
3
4
5
6
Results
File Edit
Area Mean Major Minor Angle
1 425 195.95 28.02 19.31 71.22
2 426 201.84 31.33 17.31 17.59
3 676 198.99 35.72 24.10 166.25
4 361 197.21 23.70 19.39 172.83
5 610 189.72 46.20 16.81 64.39
6 641 192.62 39.75 20.53 122.64

SalsaJ: a multilingual interface



What is an image?

« Single-frame» images

➔ Acquired in one given filter by CCD

➔ Pixel intensity coded with false colours (or B&W)

➔ Use of LUT

➔ Direct manipulation of data

Format: FITS

RGB images= « real » colour images (= 3 images)

➔ Obtained with webcam, camera, web, etc.

➔ « True » colour

In astronomy:

➔ nice looking images

➔ relatively difficult to produce in astronomy:

- 3 images of same area
- Registration, calibration
- Combination

Example of an RGB image:

470 x 441 pixels

(X,Y) coordinates

(row, column)

+ 3 intensity (RGB) values for each pixel

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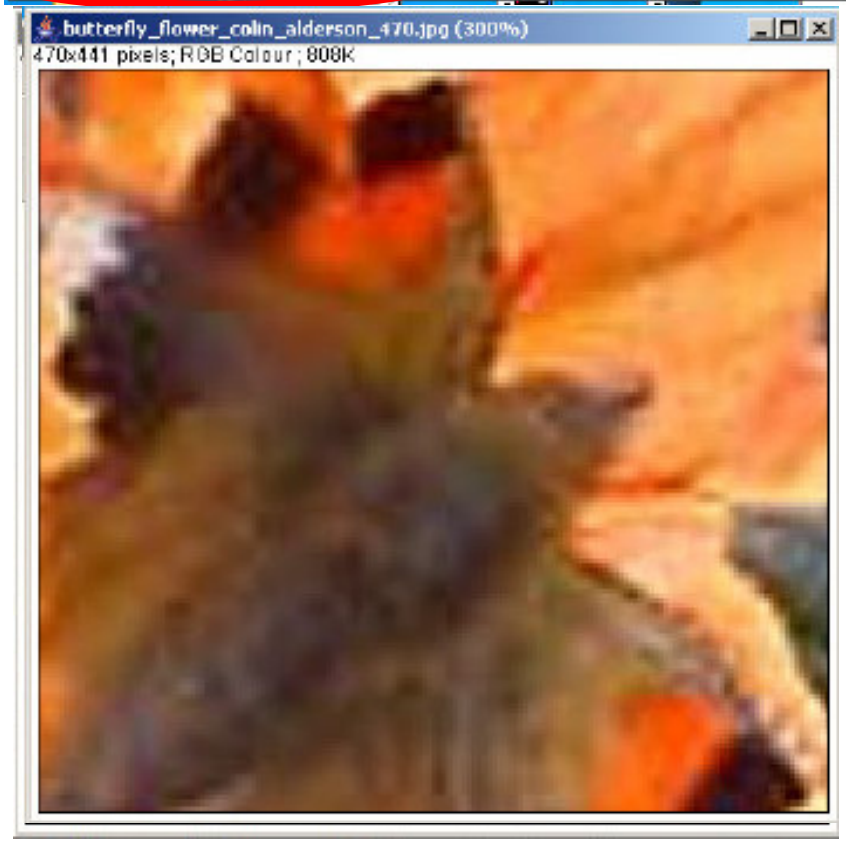


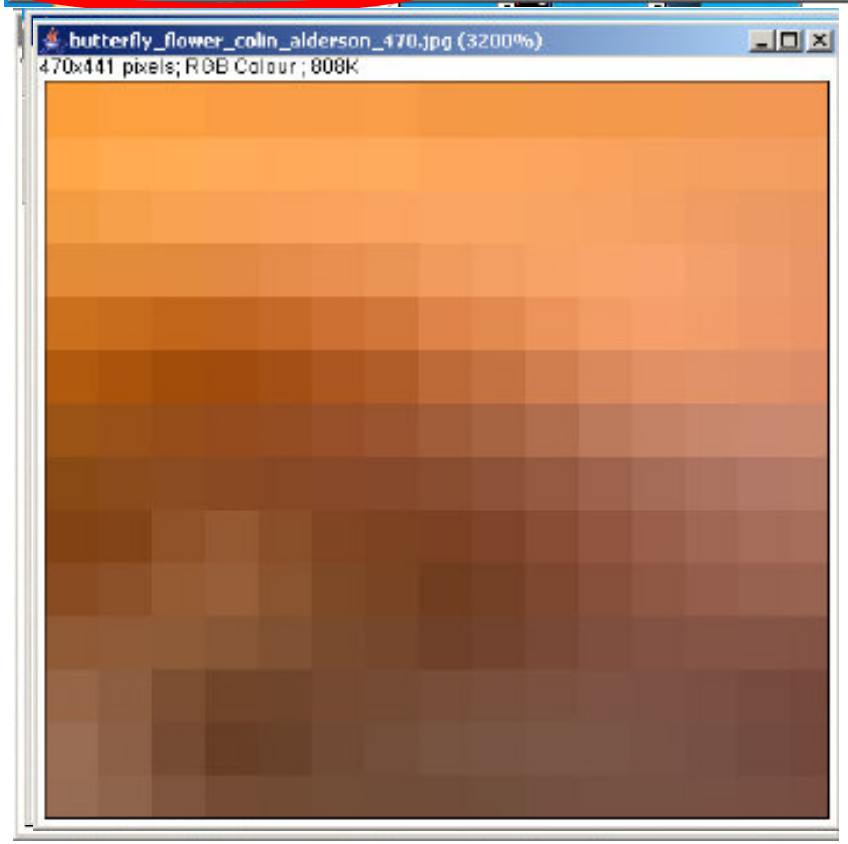
Example of an RGB image:

470 x 441 pixels

(X,Y) coordinates

(row, column)

+ 3 intensity (RGB) values for each pixel



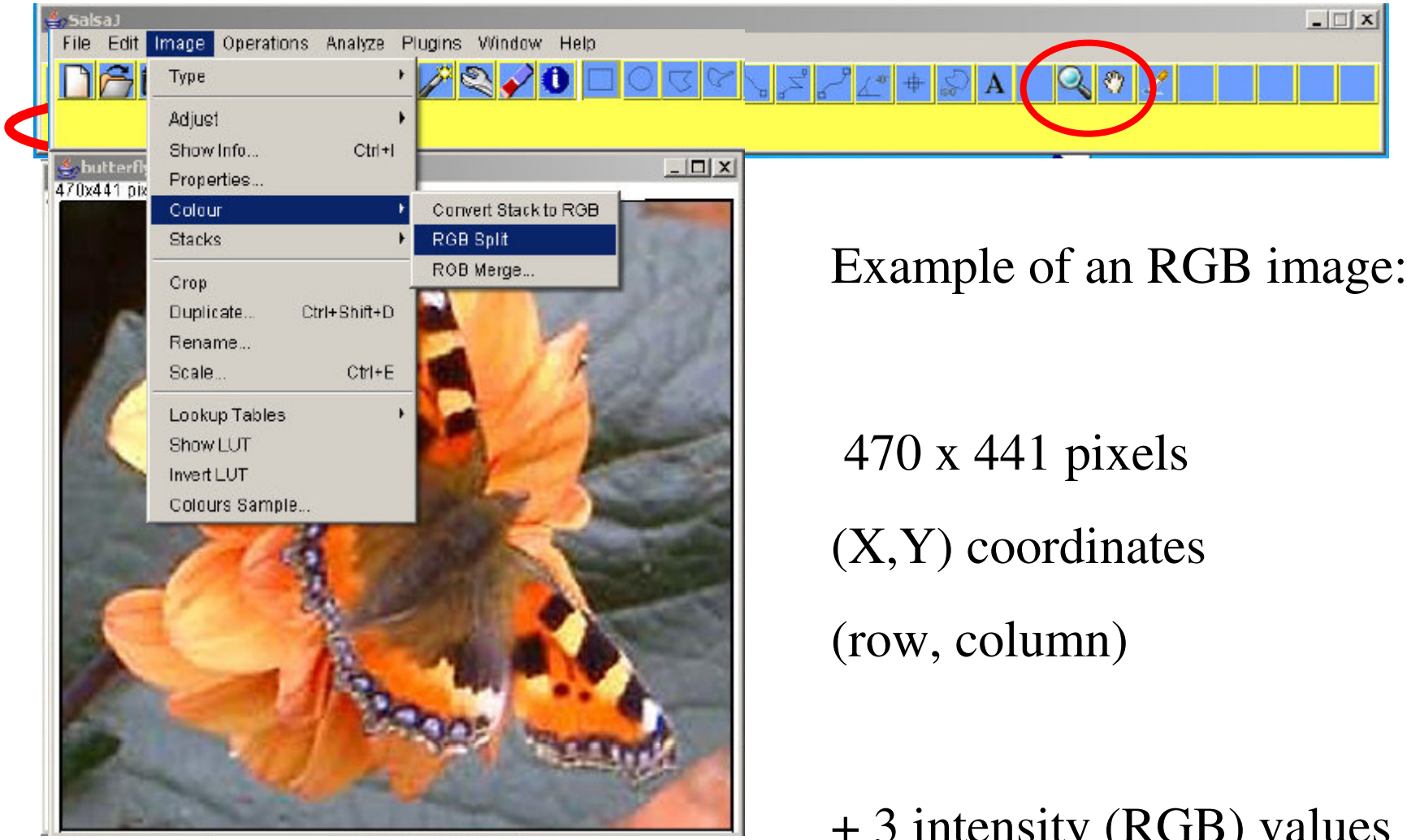
Example of an RGB image:

470 x 441 pixels

(X,Y) coordinates

(row, column)

+ 3 intensity (RGB) values for each pixel



Example of an RGB image:

470 x 441 pixels

(X,Y) coordinates

(row, column)

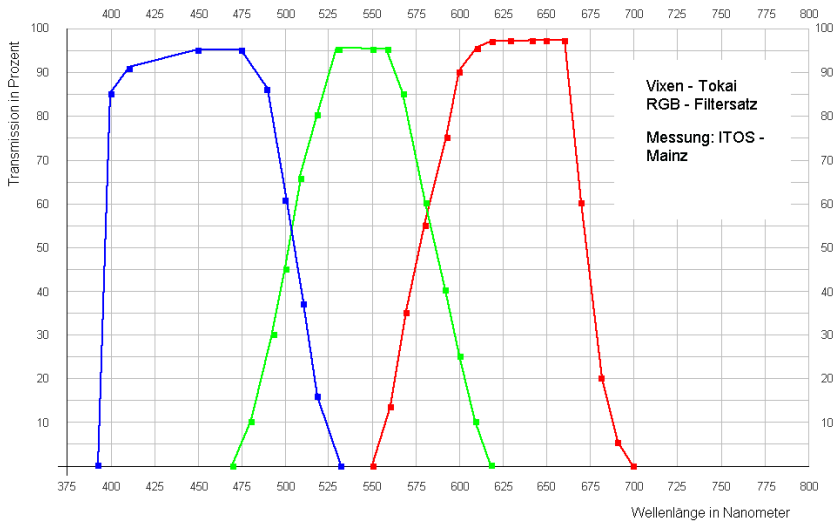
+ 3 intensity (RGB) values for each pixel


ImageJ
File Edit Image Operations Analyze Plugins Window Help

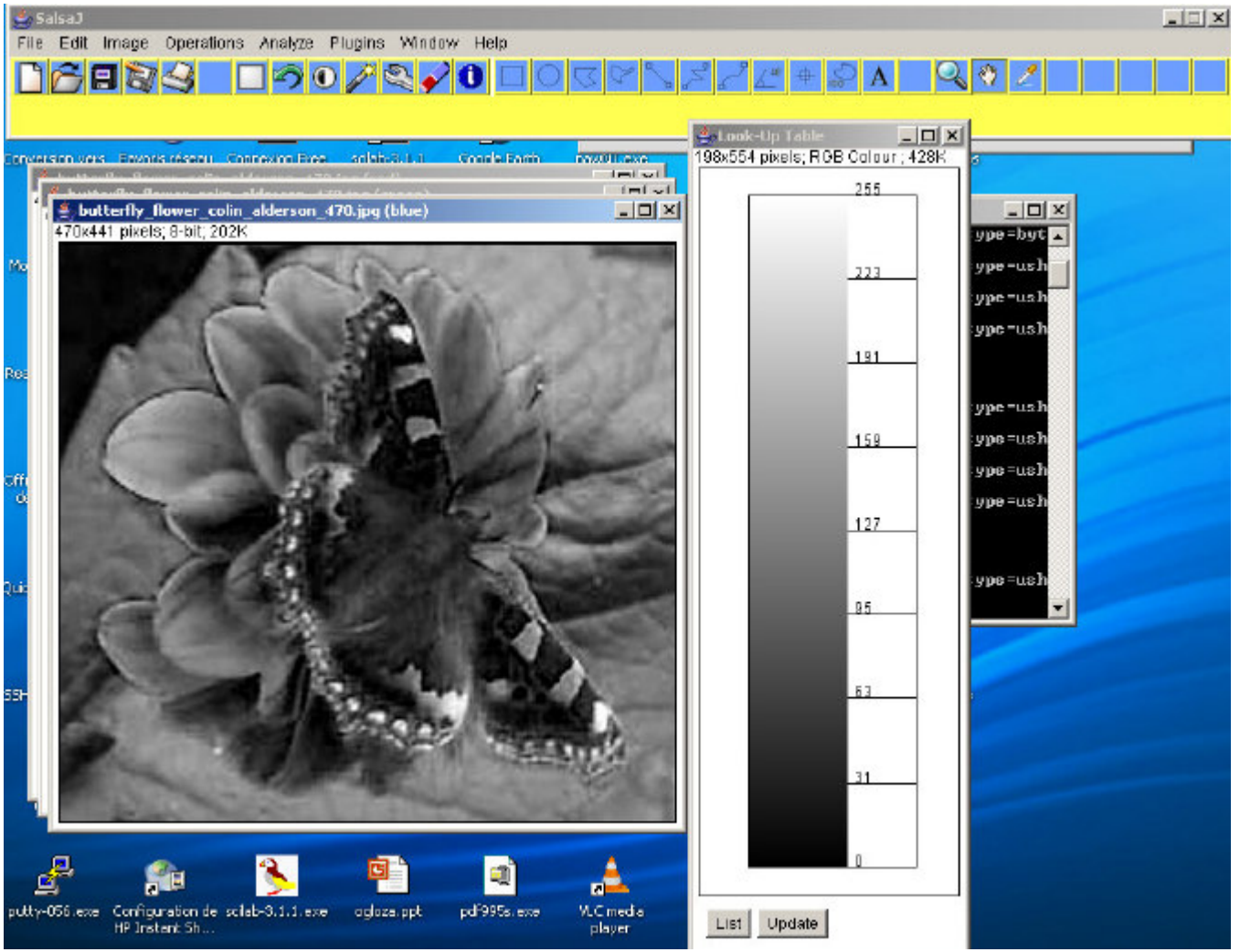

butterfly_flower_colin_alderson_470.jpg (red)
470x441 pixels; 8-bit; 202K
Red


butterfly_flower_colin_alderson_470.jpg (green)
470x441 pixels; 8-bit; 202K
Green

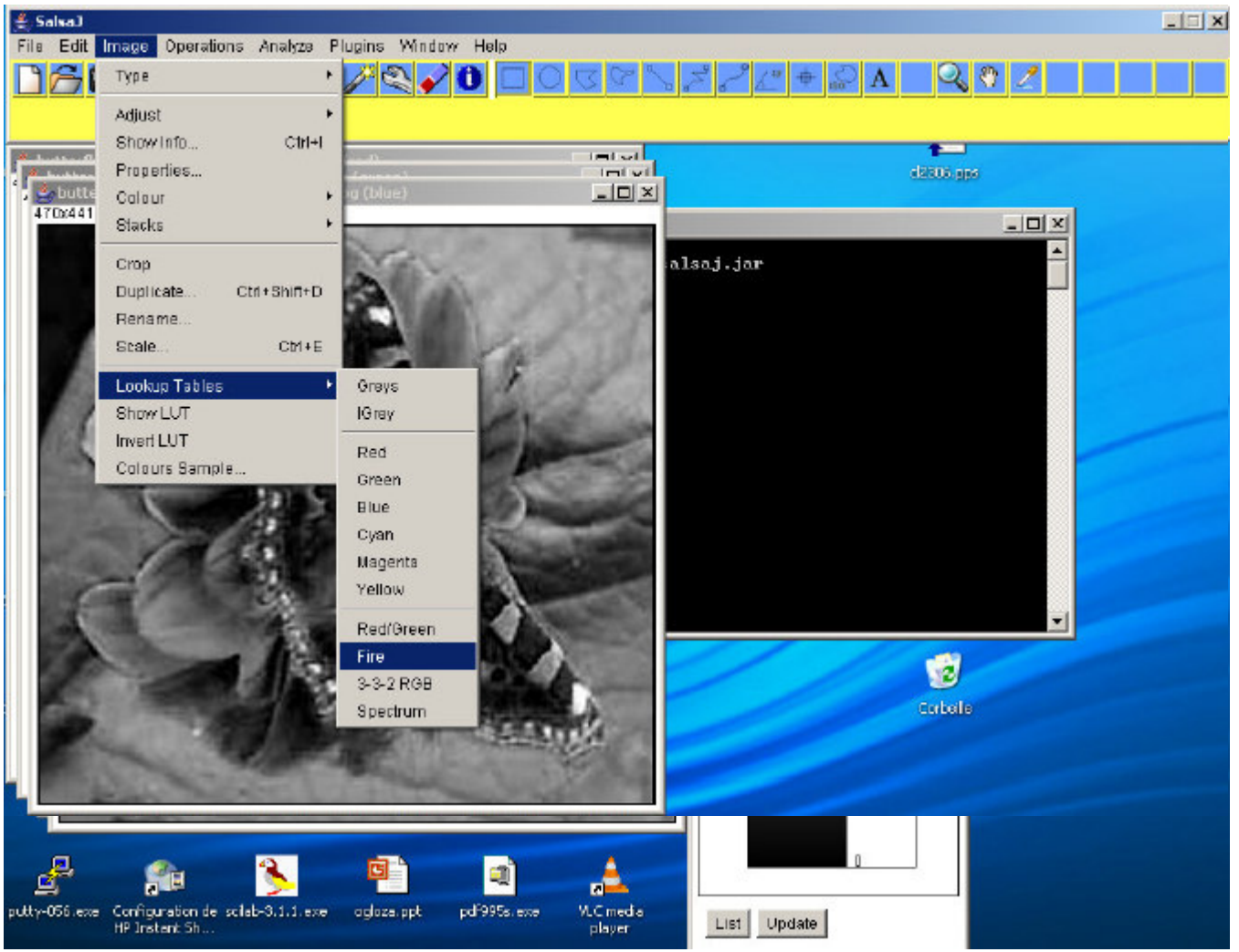

butterfly_flower_colin_alderson_470.jpg (blue)
470x441 pixels; 8-bit; 202K
Blue


Transmission in Prozent
Wellenlänge in Nanometer
Vixen - Tokai
RGB - Filtersatz
Messung: ITOS - Mainz

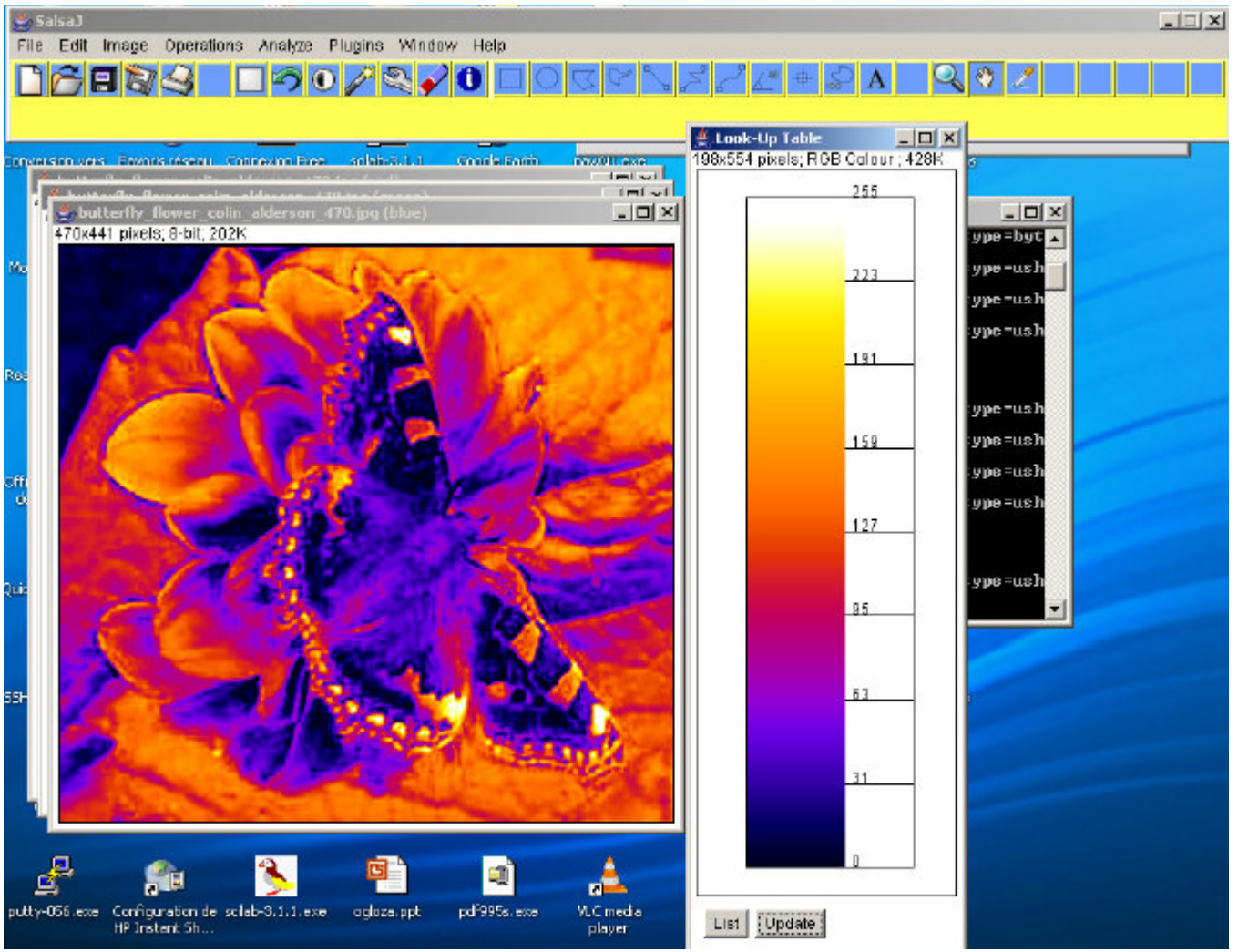
Look-Up Table (LUT) & False colours



Look-Up Table (LUT) & False colours



Look-Up Table (LUT) & False colours



Back to astronomy…

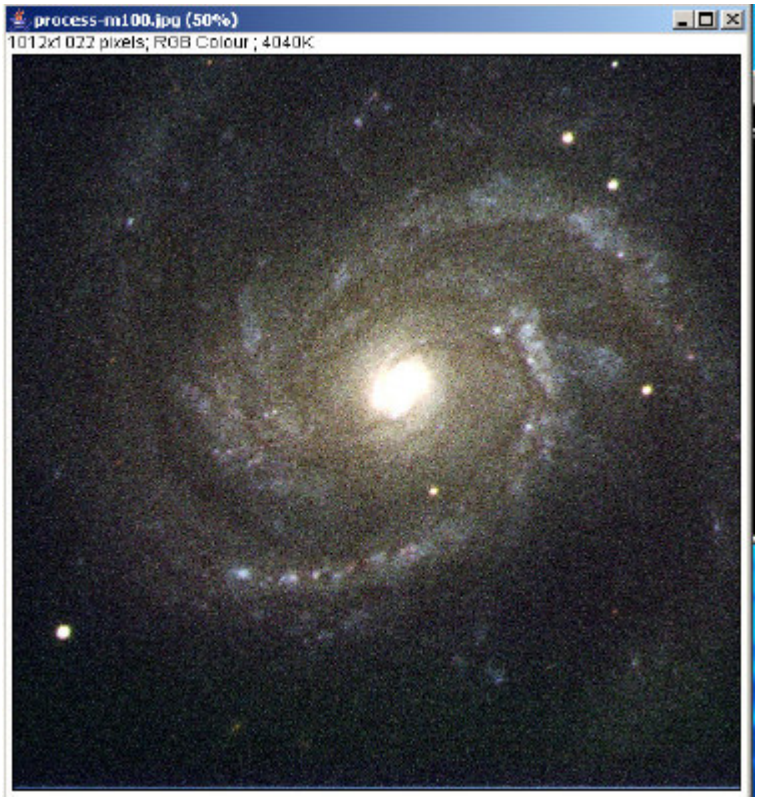


Image of the galaxy M100 obtained with the Faulkes Telescope Project

Back to astronomy…

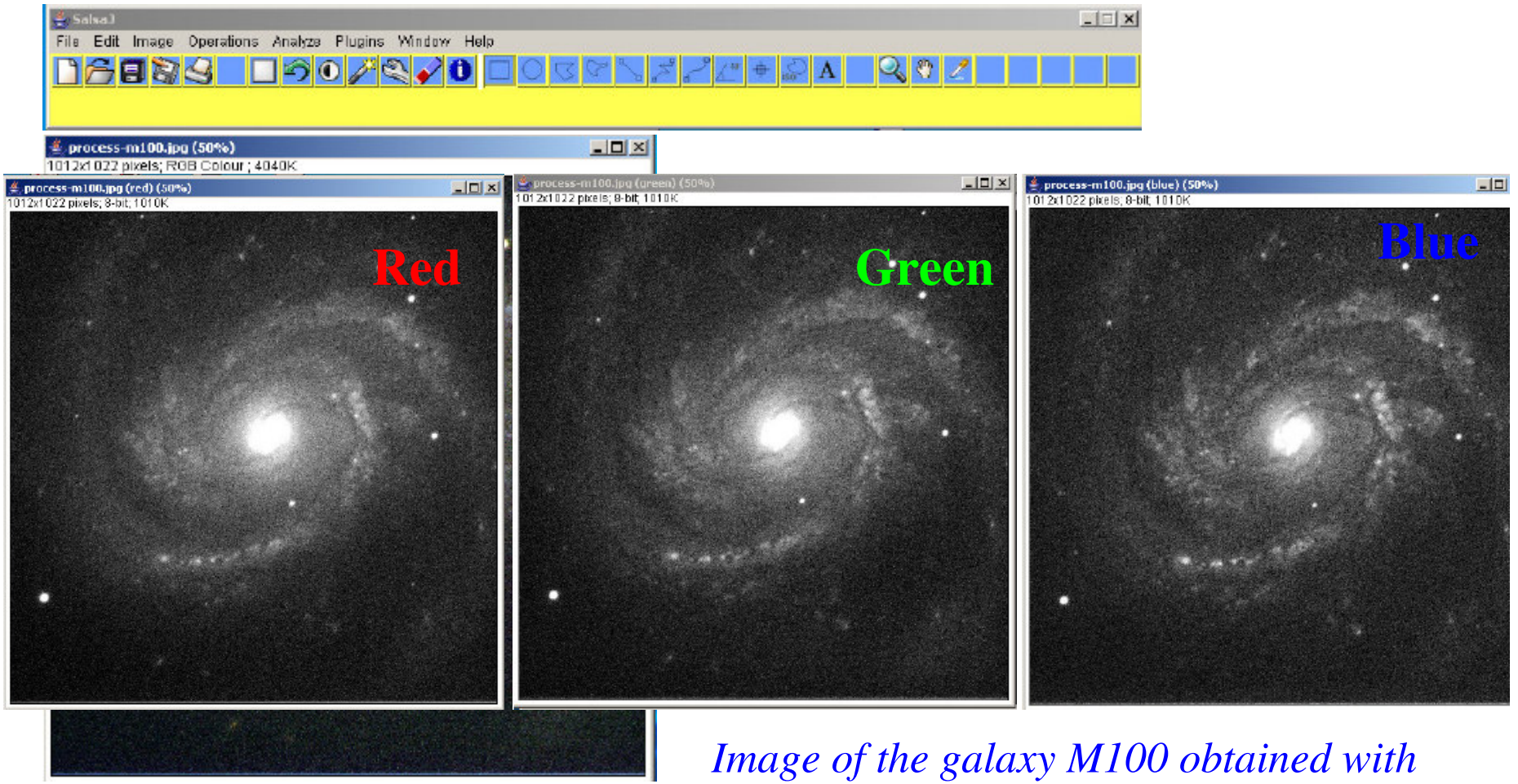
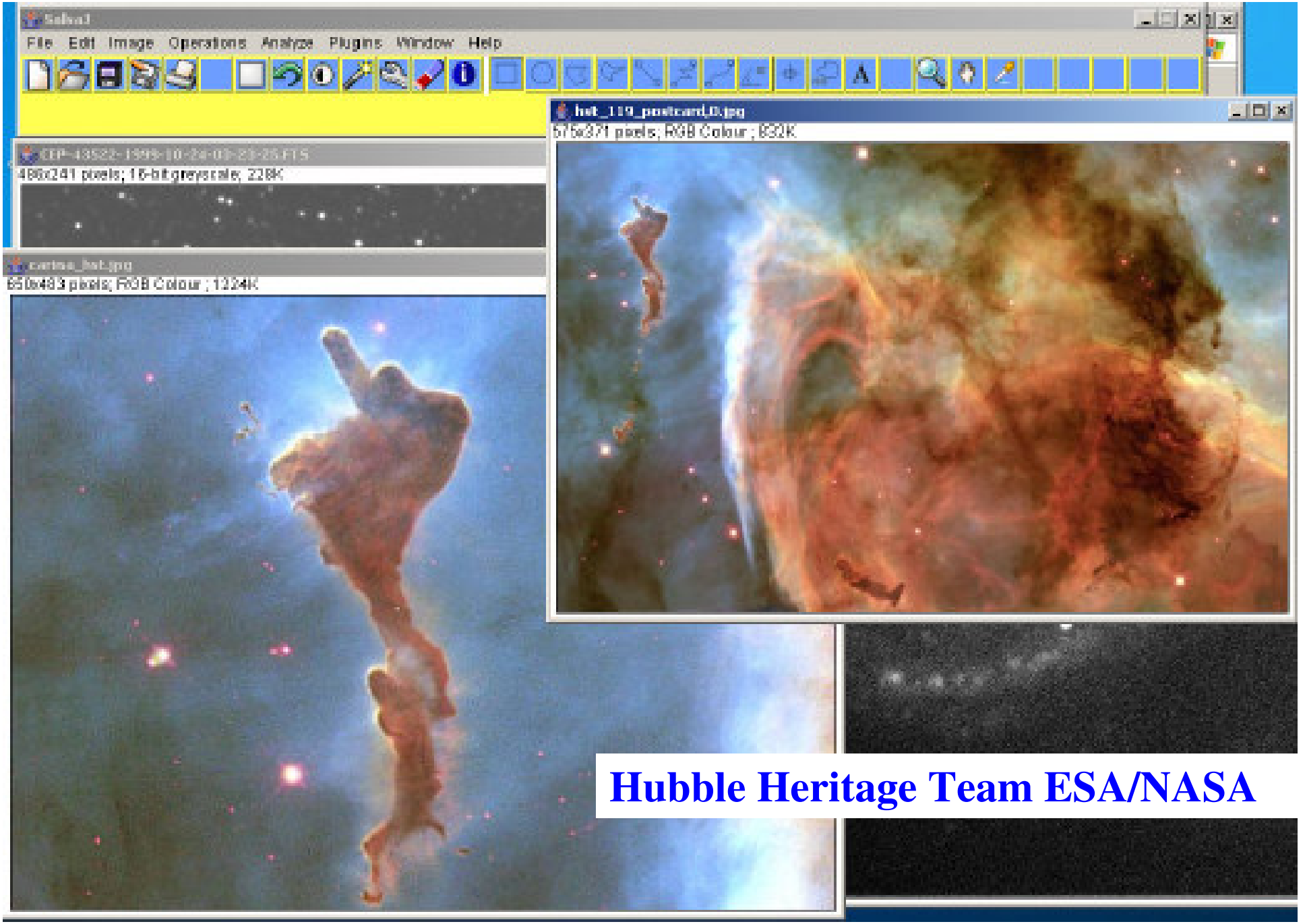
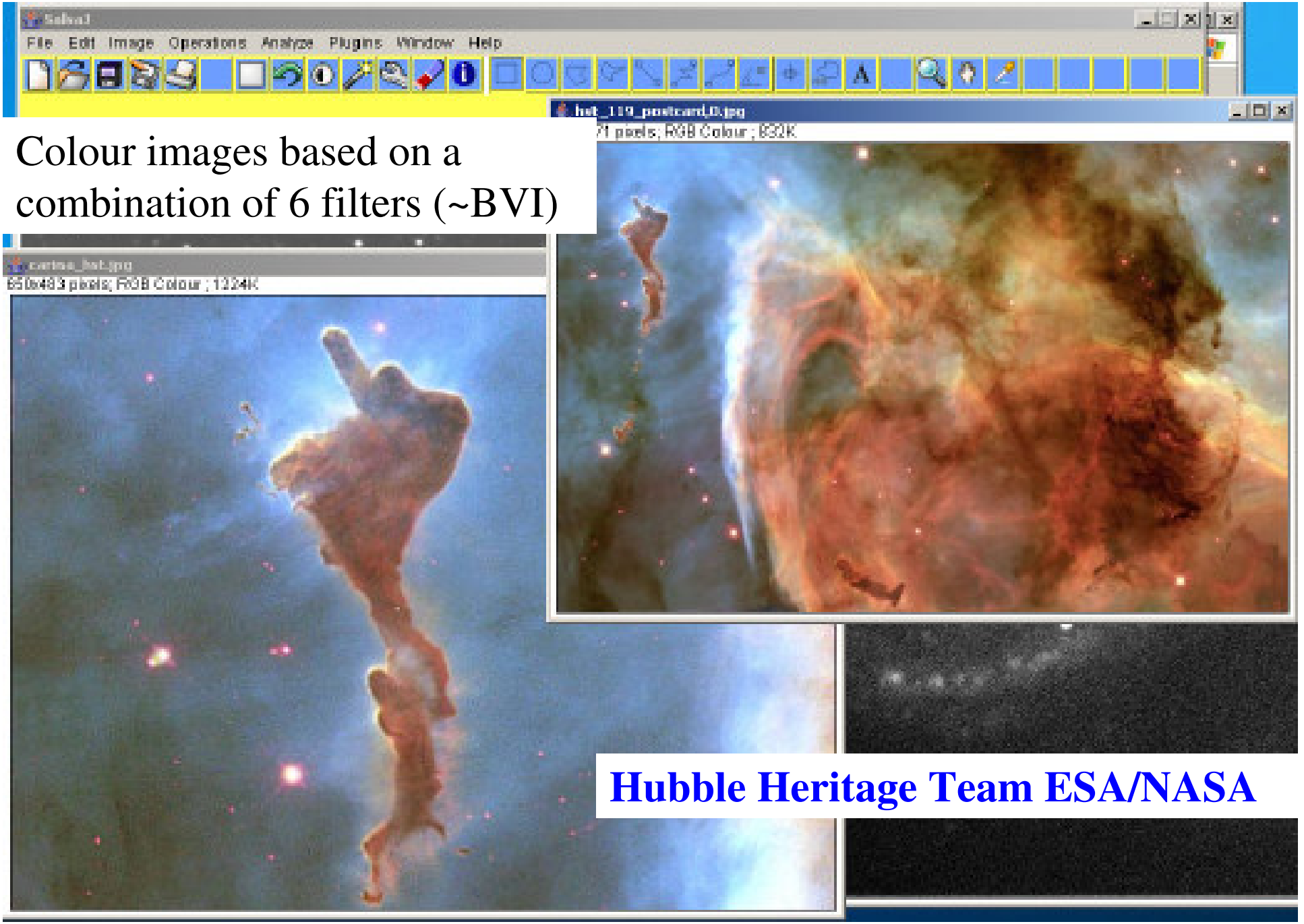


Image of the galaxy M100 obtained with the Faulkes Telescope Project


ImageJ
File Edit Image Operations Analyze Plugins Window Help
hst_119_postcard_D.jpg
675x371 pixels; RGB Colour ; 832K
486x241 pixels; 16-bit greyscale; 228K
carina_hst.jpg
650x483 pixels; RGB Colour ; 1224K
Hubble Heritage Team ESA/NASA


File Edit Image Operations Analyze Plugins Window Help
Colour images based on a combination of 6 filters (~BVI)
Hubble Heritage Team ESA/NASA

Understanding an image

Content:

Dynamic of the data/histogram

Classical image /astronomical image

Cuts: min/max; brightness and contrast tuning

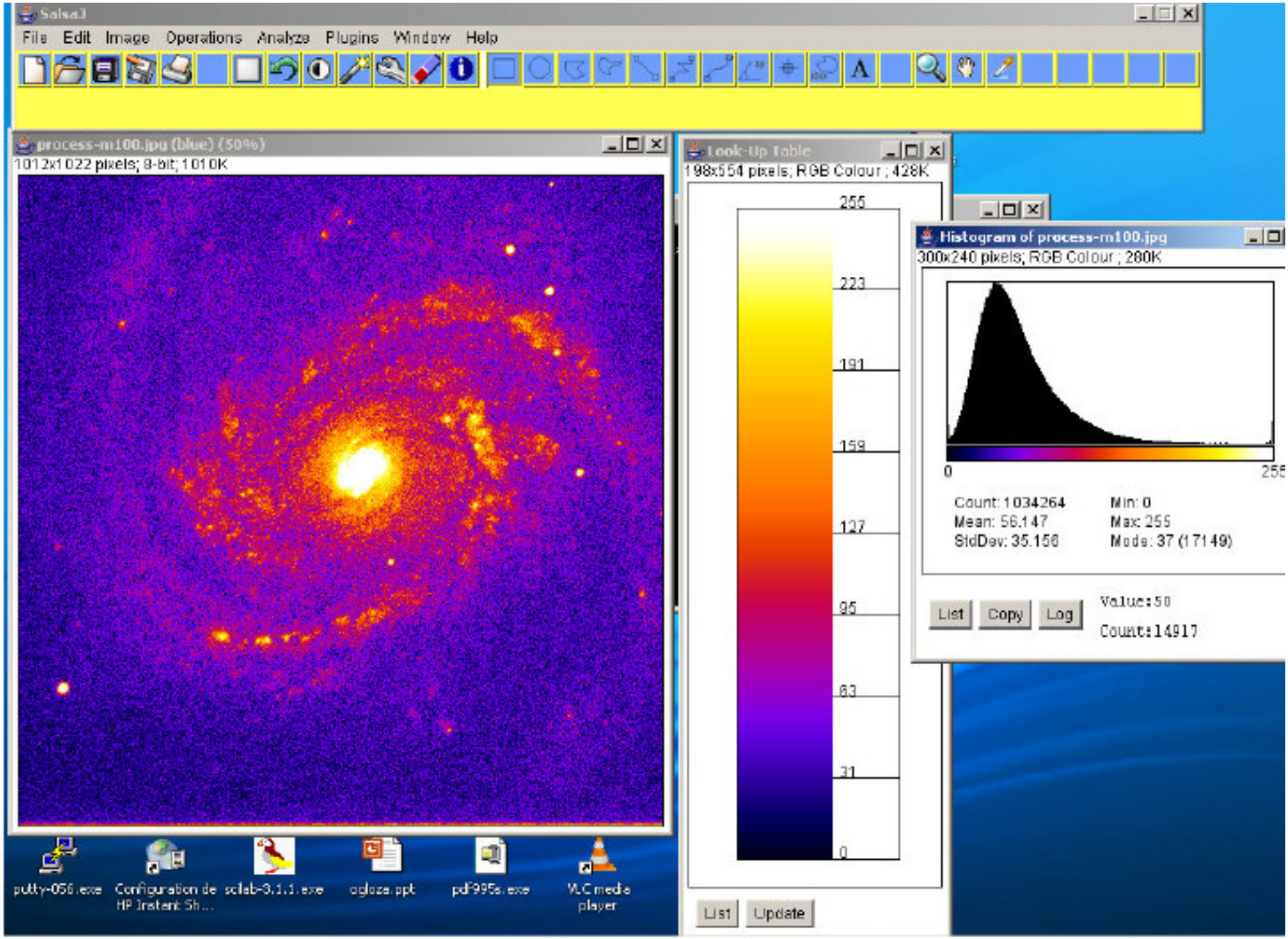
Look-Up Table (LUT)

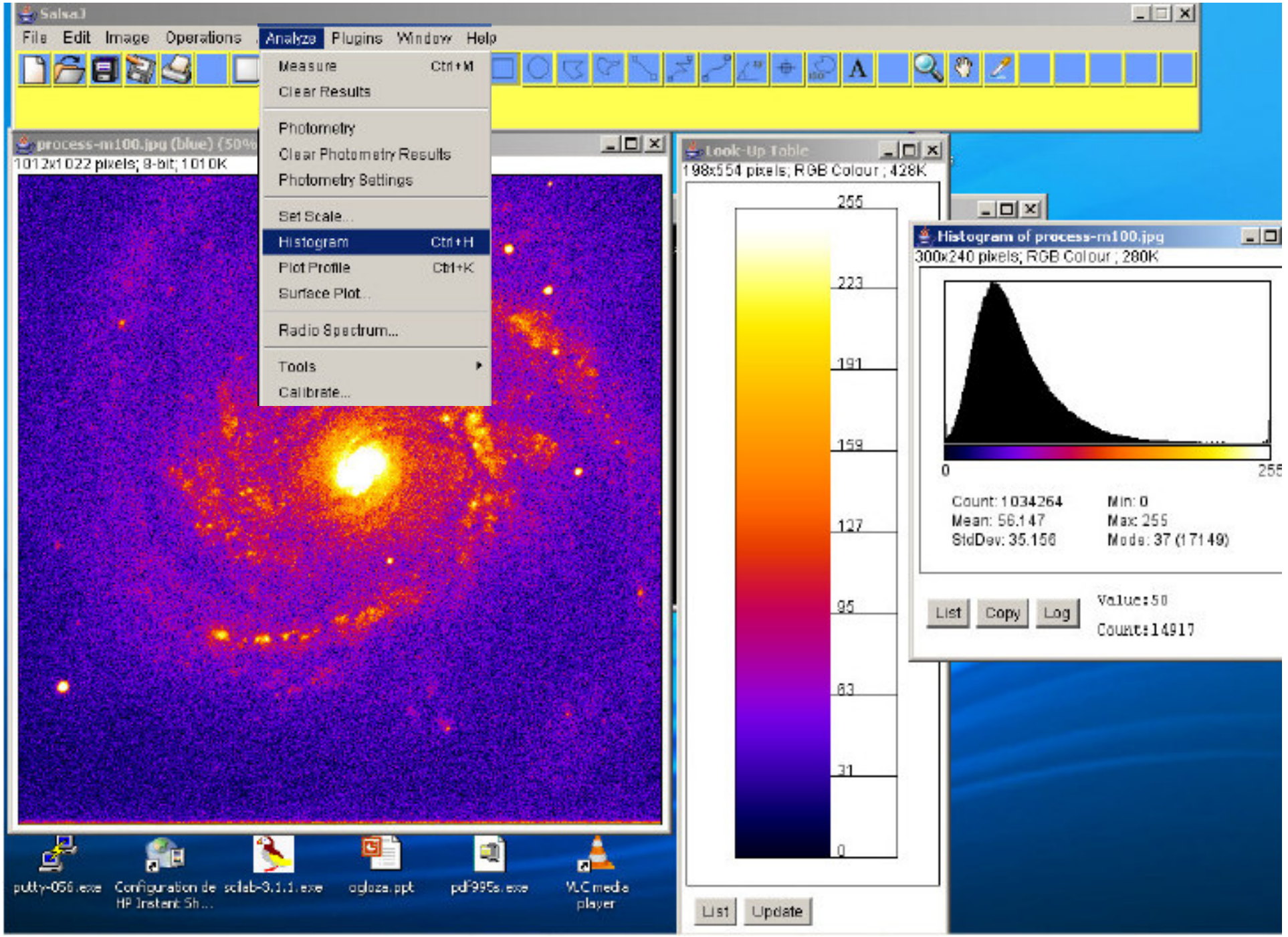
Astronomical context:

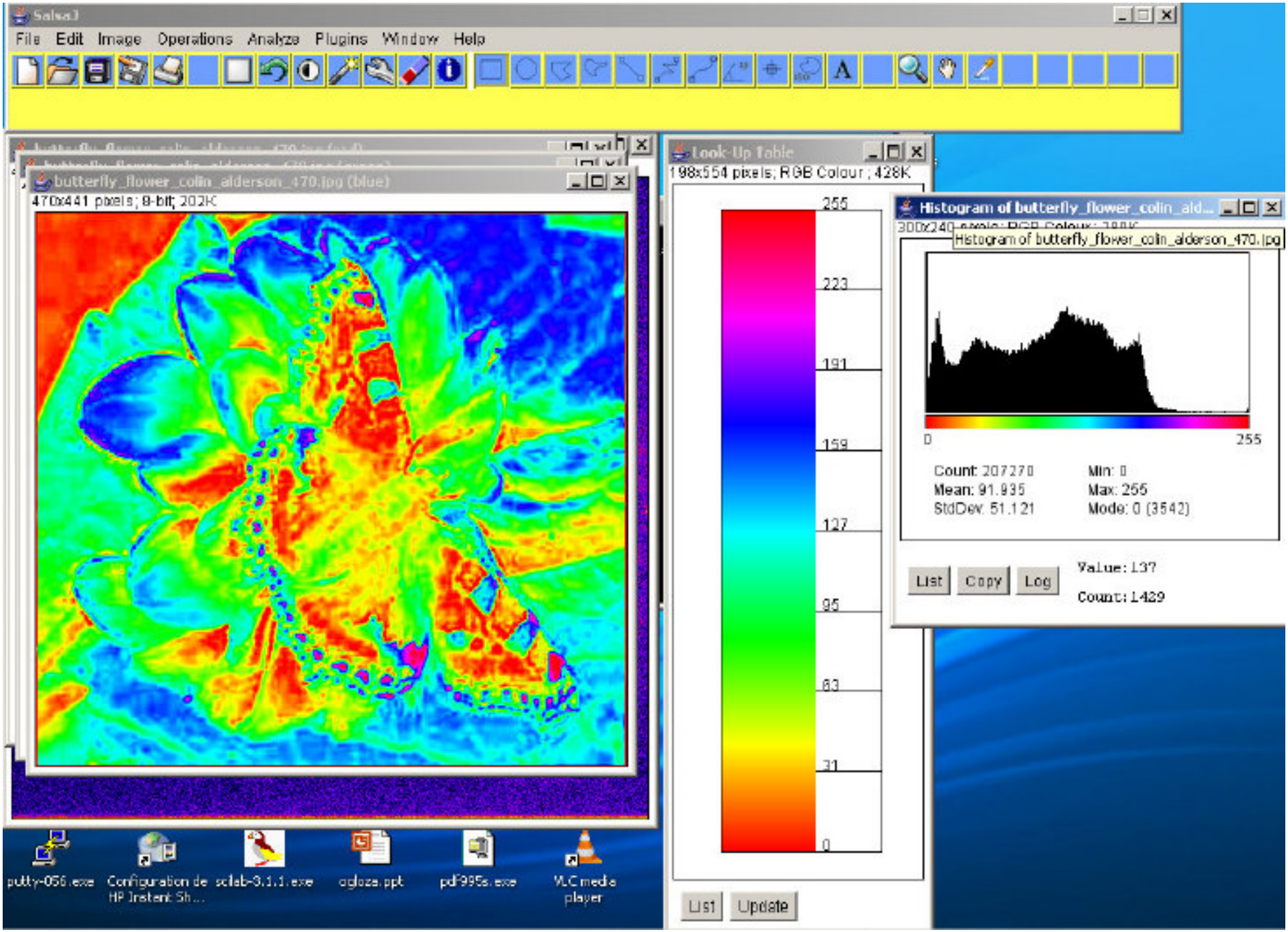
Sky background & photon noise

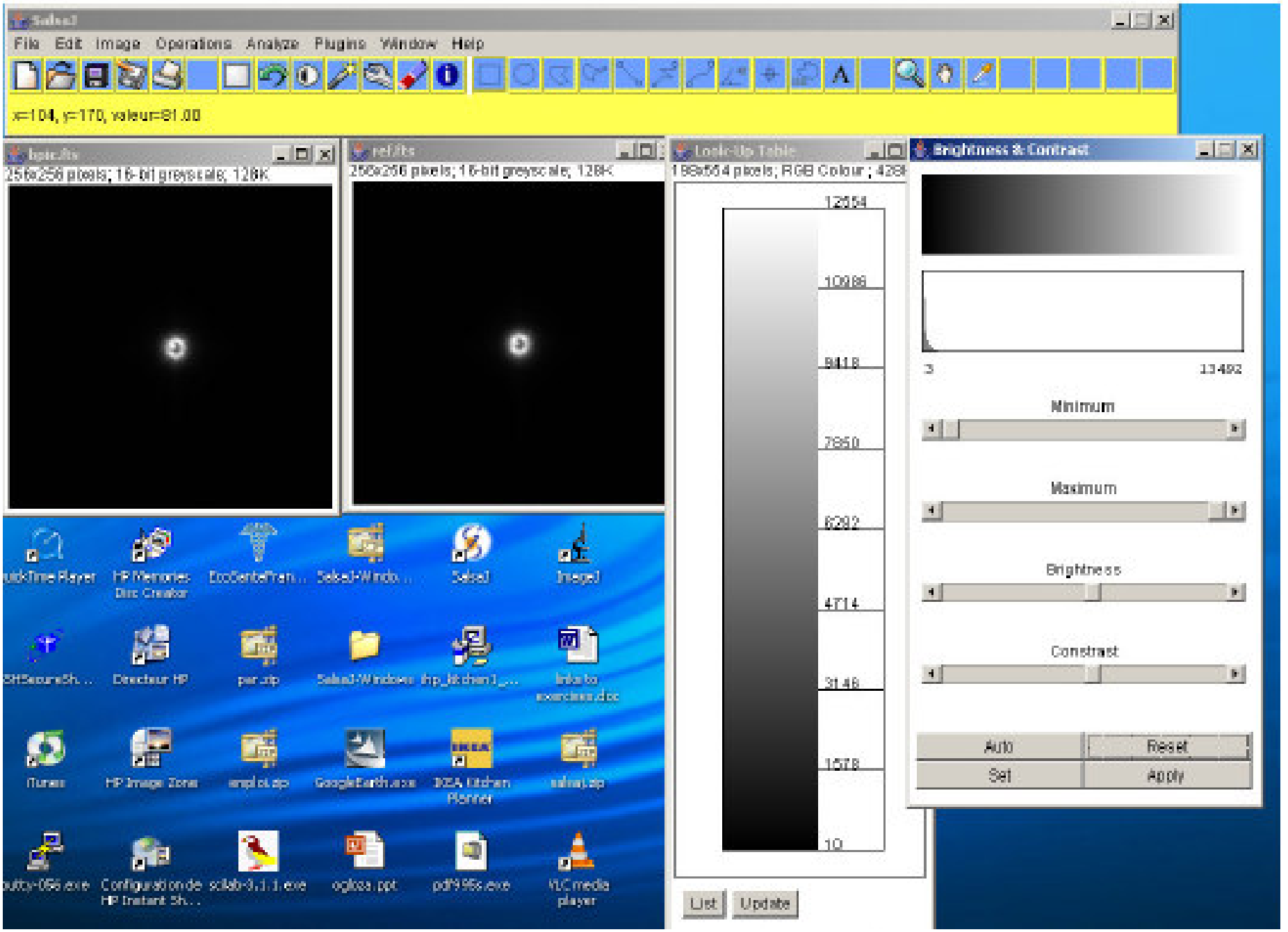
Variation of the observing conditions

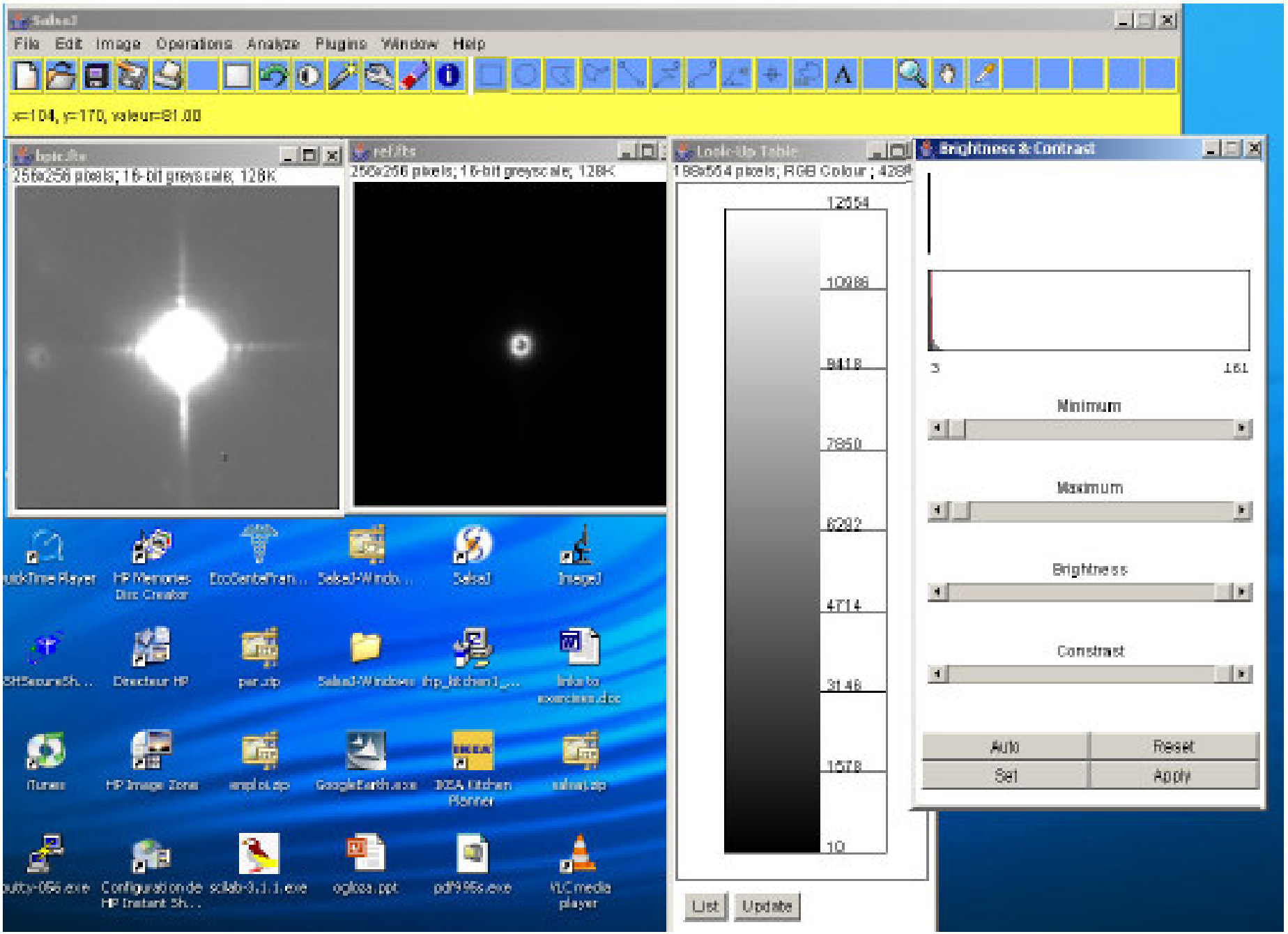
Stellar objects


ImageJ
File Edit Image Operations Analyze Plugins Window Help
process-m100.jpg (blue) (50%)
1012x1022 pixels; 8-bit; 1010K
Look-Up Table
198x554 pixels; RGB Colour; 428K
255
223
191
159
127
95
63
31
0
List
Update
Histogram of process-m100.jpg
300x240 pixels; RGB Colour; 280K
0
255
Count: 1034264
Mean: 56.147
StdDev: 35.156
Min: 0
Max: 255
Mode: 37 (17149)
List
Copy
Log
Value:50
Count:14917
putty-056.exe
Configuration de HP Instant Sh...
scilab-3.1.1.exe
ogloza.ppt
pdf995s.exe
VLC media player


ImageJ
File Edit Image Operations Analyze Plugins Window Help
Measure Ctrl+M
Clear Results
Photometry
Clear Photometry Results
Photometry Settings
Set Scale...
Histogram Ctrl+H
Plot Profile Ctrl+K
Surface Plot...
Radio Spectrum...
Tools
Calibrate...
process-m100.jpg (blue) (50%)
1012x1022 pixels; 8-bit; 1010K
Look-Up Table
198x554 pixels; RGB Colour; 428K
255
223
191
159
127
95
63
31
0
List
Update
Histogram of process-m100.jpg
300x240 pixels; RGB Colour; 280K
0
255
Count: 1034264
Mean: 56.147
StdDev: 35.156
Min: 0
Max: 255
Mode: 37 (17149)
List
Copy
Log
Value:50
Count:14917
putty-056.exe
Configuration de HP Instant Sh...
scilab-3.1.1.exe
ogloza.ppt
pdf995s.exe
VLC media player


ImageJ
File Edit Image Operations Analyze Plugins Window Help
butterfly_flower_colin_alderson_470.jpg (blue)
470x441 pixels; 8-bit; 202K
Look-Up Table
198x554 pixels; RGB Colour; 428K
255
223
191
159
127
95
63
31
0
List
Update
Histogram of butterfly_flower_colin_ald...
Histogram of butterfly_flower_colin_alderson_470.jpg
0
255
Count: 207270
Mean: 91.935
StdDev: 51.121
Min: 0
Max: 255
Mode: 0 (3542)
List
Copy
Log
Value: 137
Count: 1429
putty-056.exe
Configuration de HP Instant Sh...
scilab-3.1.1.exe
ogloza.ppt
pdf995s.exe
VLC media player


File Edit Image Operations Analyze Plugins Window Help
x=104, y=170, valeur=81.00
256x256 pixels; 16-bit greyscale; 128K
256x256 pixels; 16-bit greyscale; 128K
Look-Up Table
188x554 pixels; RGB Colour ; 428
12554
10988
9418
7850
6282
4714
3146
1578
10
List
Update
Brightness & Contrast
3
13492
Minimum
Maximum
Brightness
Constrast
Auto
Reset
Set
Apply
QuickTime Player
HP Memories Disc Creator
Sekad-Windo...
Sekad
ImageJ
Directeur HP
per.zip
Sekad-Windows
ihp_jtchen1_...
links to exercises.doc
iTunes
HP Image Zone
GoogleEarth.exe
IKEA Kitchen Planner
Configuration de HP Instant Sh...
scilab-3.1.1.exe
ogloss.ppt
pdf995s.exe
VLC media player


File Edit Image Operations Analyze Plugins Window Help
x=104, y=170, valeur=81.00
256x256 pixels; 16-bit greyscale; 128K
256x256 pixels; 16-bit greyscale; 128K
Look-Up Table
188x554 pixels; RGB Colour ; 428K
12554
10988
9418
7850
6282
4714
3146
1578
10
List
Update
Brightness & Contrast
3
161
Minimum
Maximum
Brightness
Constrast
Auto
Reset
Set
Apply
QuickTime Player
HP Memories Disc Creator
Scilab2-Windo...
Scilab
ImageJ
Directeur HP
Scilab2-Windows
iTunes
HP Image Zone
GoogleEarth.exe
IKEA Kitchen Planner
scilab-3.1.1.exe
ogloos.ppt
pdf995s.exe
VLC media player

Understanding an image

Content:

Dynamic of the data/histogram

Classical image /astronomical image

Cuts: min/max; brightness and contrast tuning

Look-Up Table (LUT)

Astronomical context:

Sky background & photon noise

Variation of the observing conditions

Stellar objects

Variation of observing conditions:

2 exposures of the same field at 2 different epoch

+ shift (rotation) (pointing uncertainty)

+ transparency of atmosphere

+ sky background (Moon)

➔ **Relative variation** (flux ratio) between 2 stars on one frame

➔ **Corrections**

Registration of frame

Calibration ($\Phi_1 = a\Phi_2 + b$)

Correction of variations of observing conditions:

Variable objects: supernovae, cepheids…

Moving objects: asteroids.

➔ Blink

➔ Subtraction of frames

Scales, size & cross-products

« Pixel size »:

➔Physical size of pixel (e.g.15µm)

➔ angular size in sky (e.g. 0.3 arcsec)

[depends on optical path followed by photons

provided with image]

```
CCDXPIXE =     0.0000135 / [m] Size of pixels, in X:13.5um
CCDYPIXE =     0.0000135 / [m] Size of pixels, in Y:13.5um
CCDSCALE=      0.2783700 / [arcsec/pixel] Scale of CCD pixel on sky
SEEING  =      5.252304E+00 / [pixels] frame seeing in pixels
```

Example for Faulkes Telescopes Project

Dimensions & size of craters

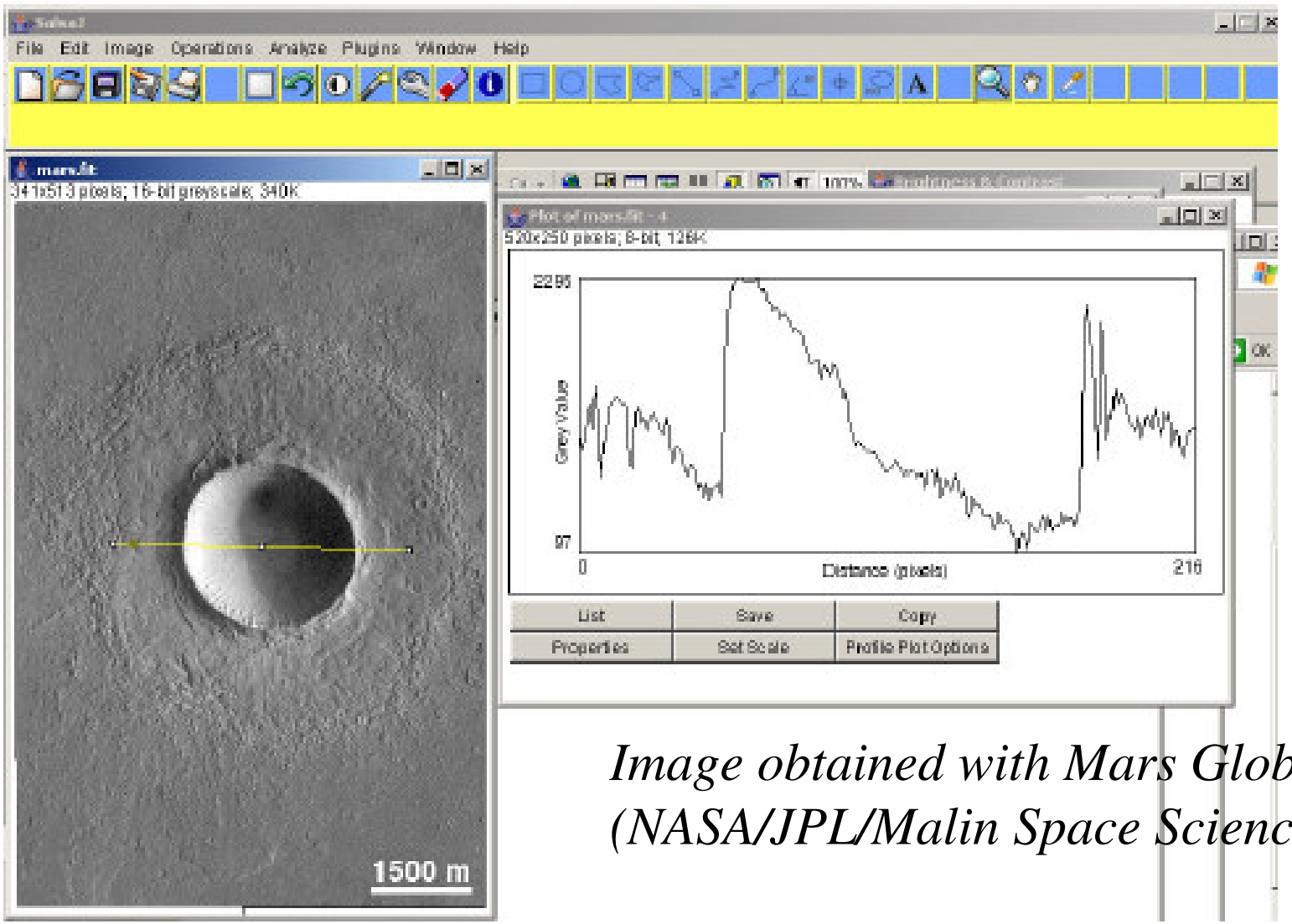
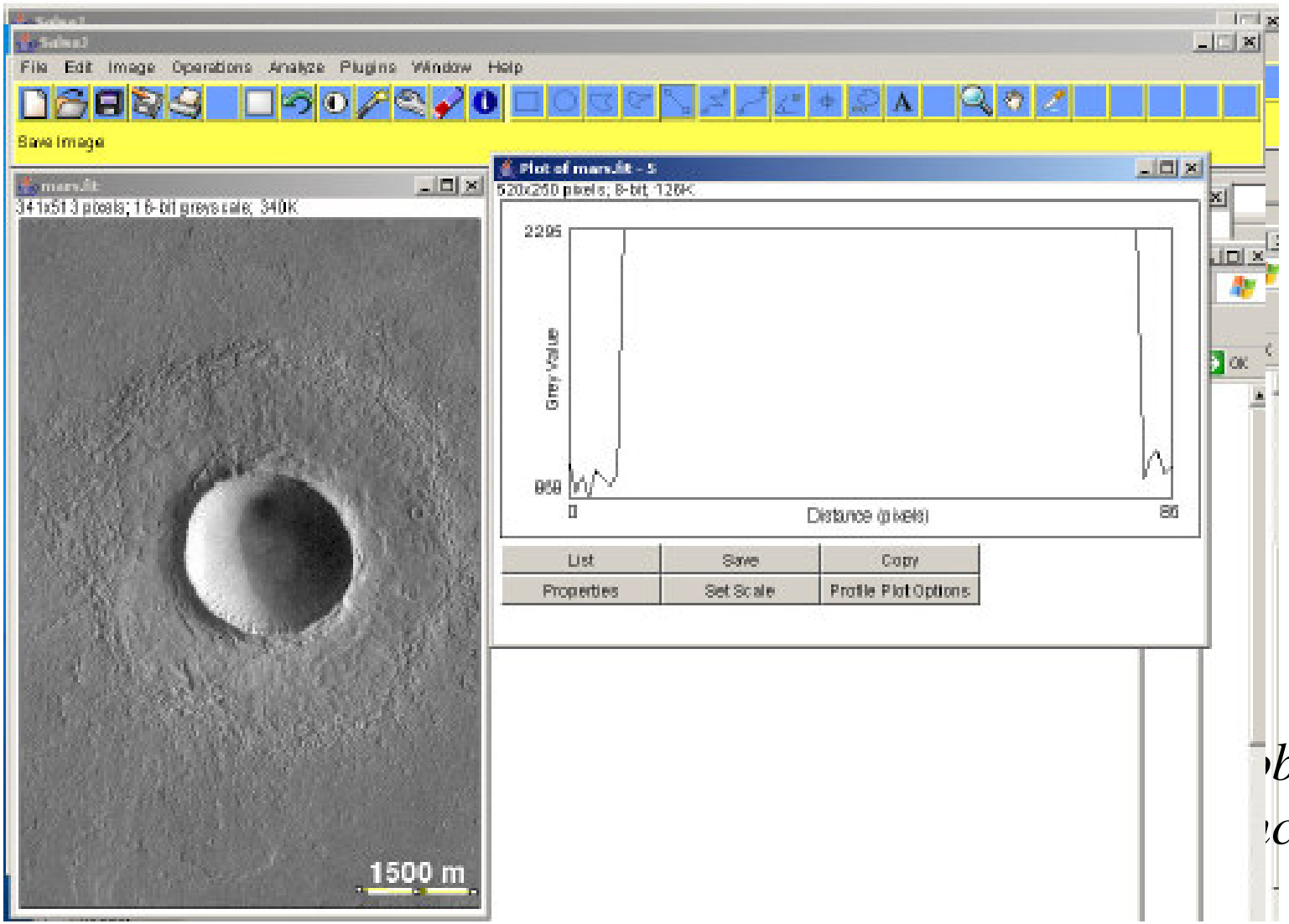


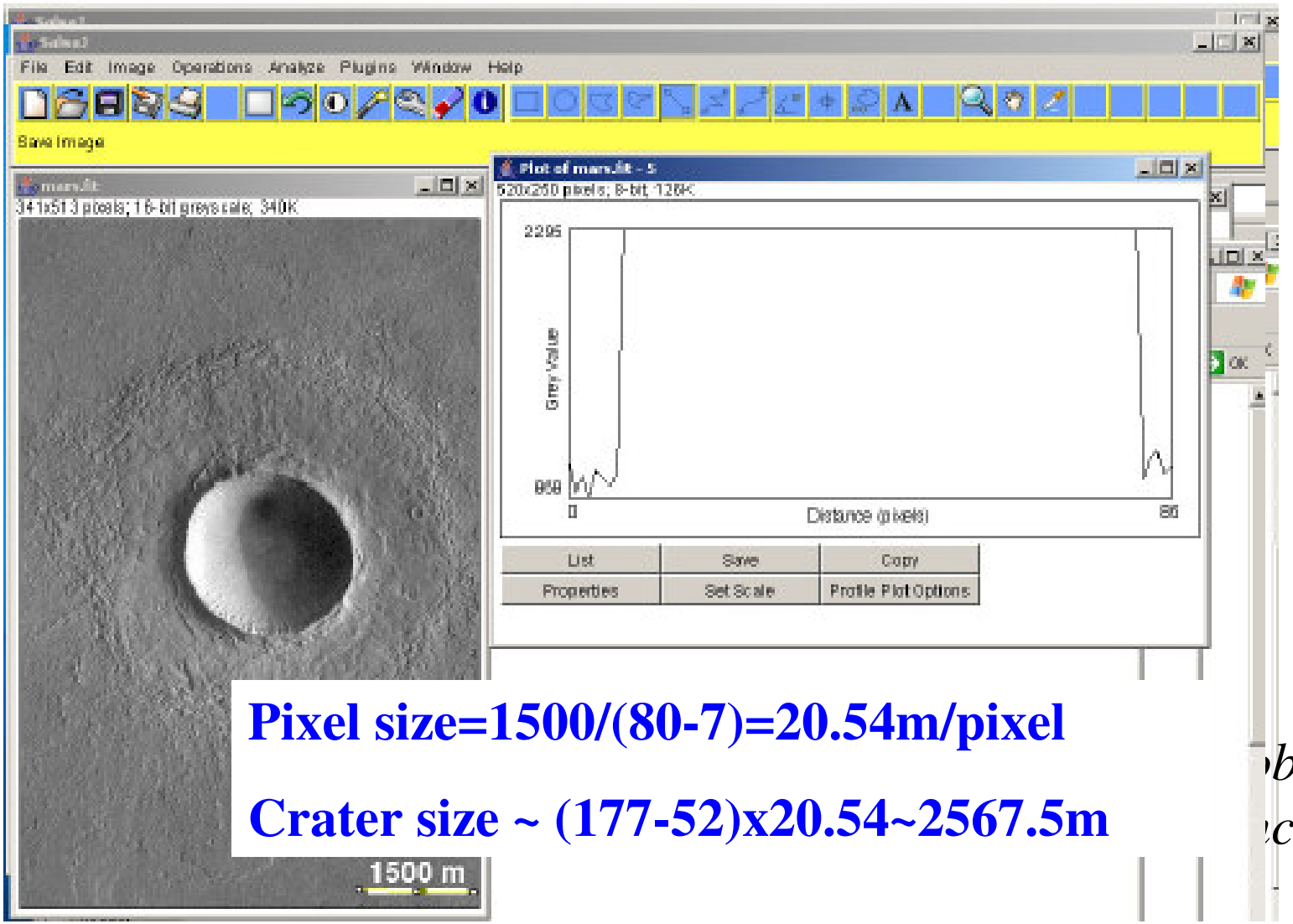
Image obtained with Mars Global Surveyor (NASA/JPL/Malin Space Sciences Systems)

Dimensions & size of craters



bal Surveyor
ces Systems)

Dimensions & size of craters



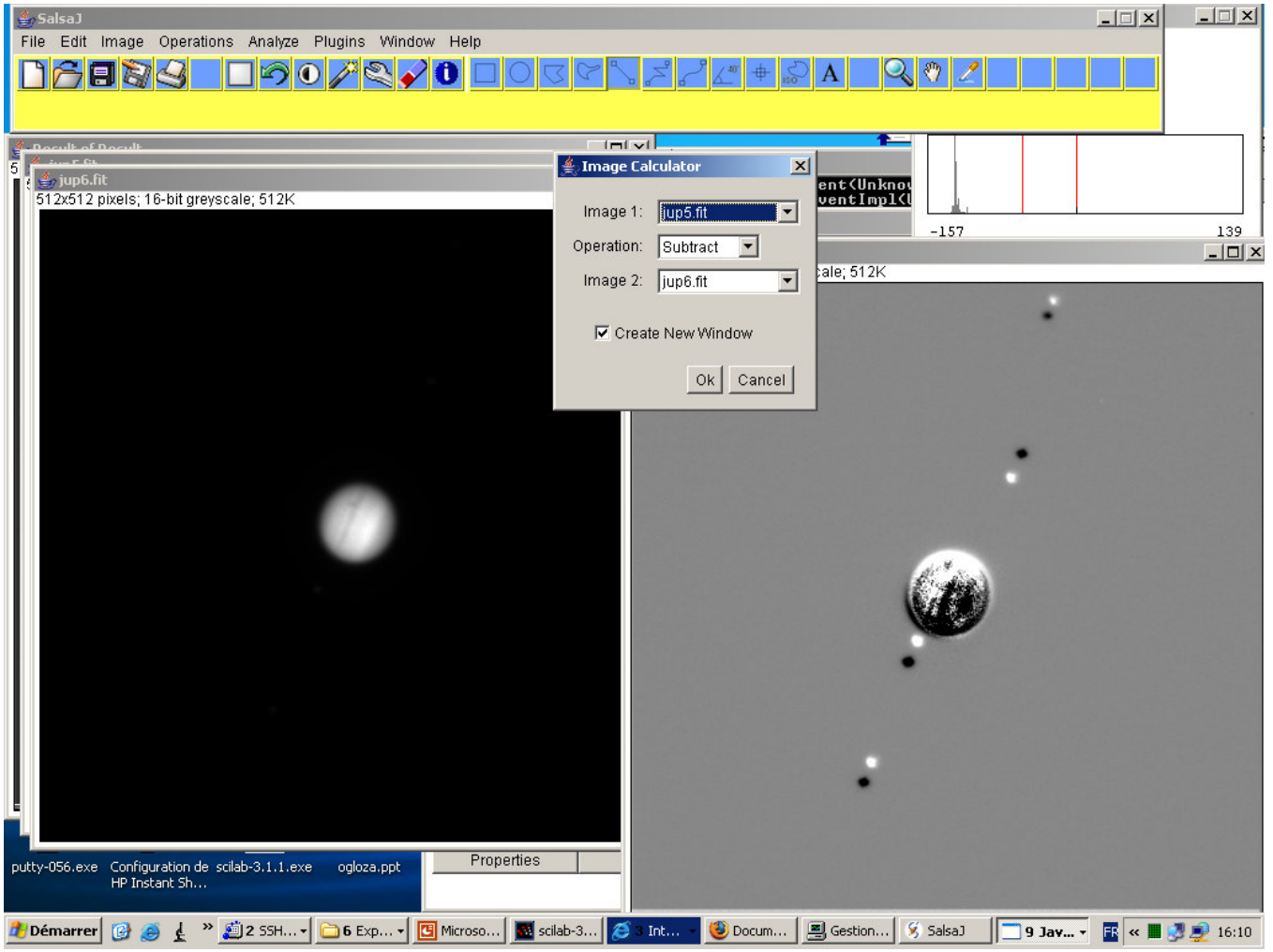
Pixel size=1500/(80-7)=20.54m/pixel

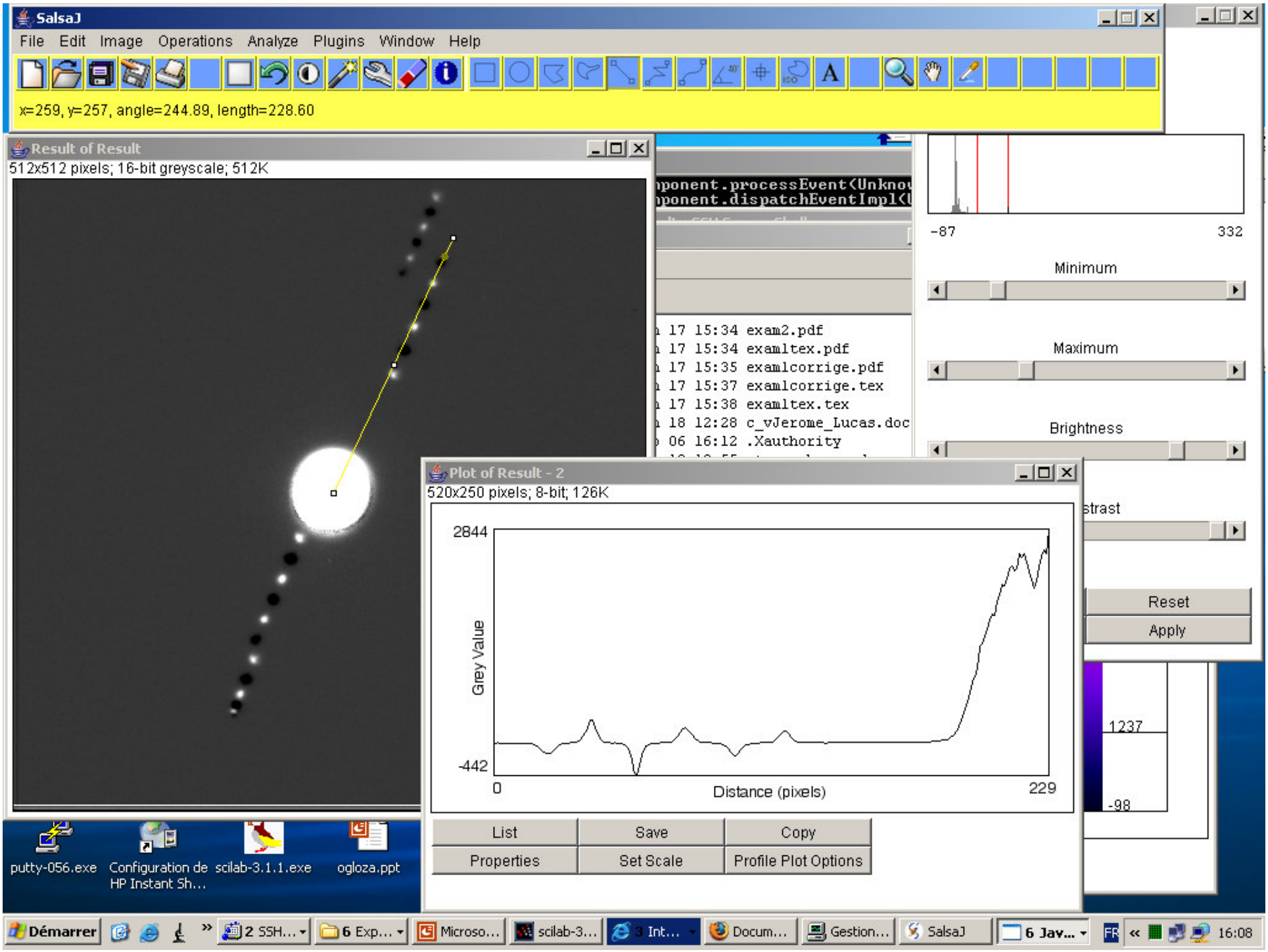
Crater size ~ (177-52)x20.54~2567.5m

bal Surveyor

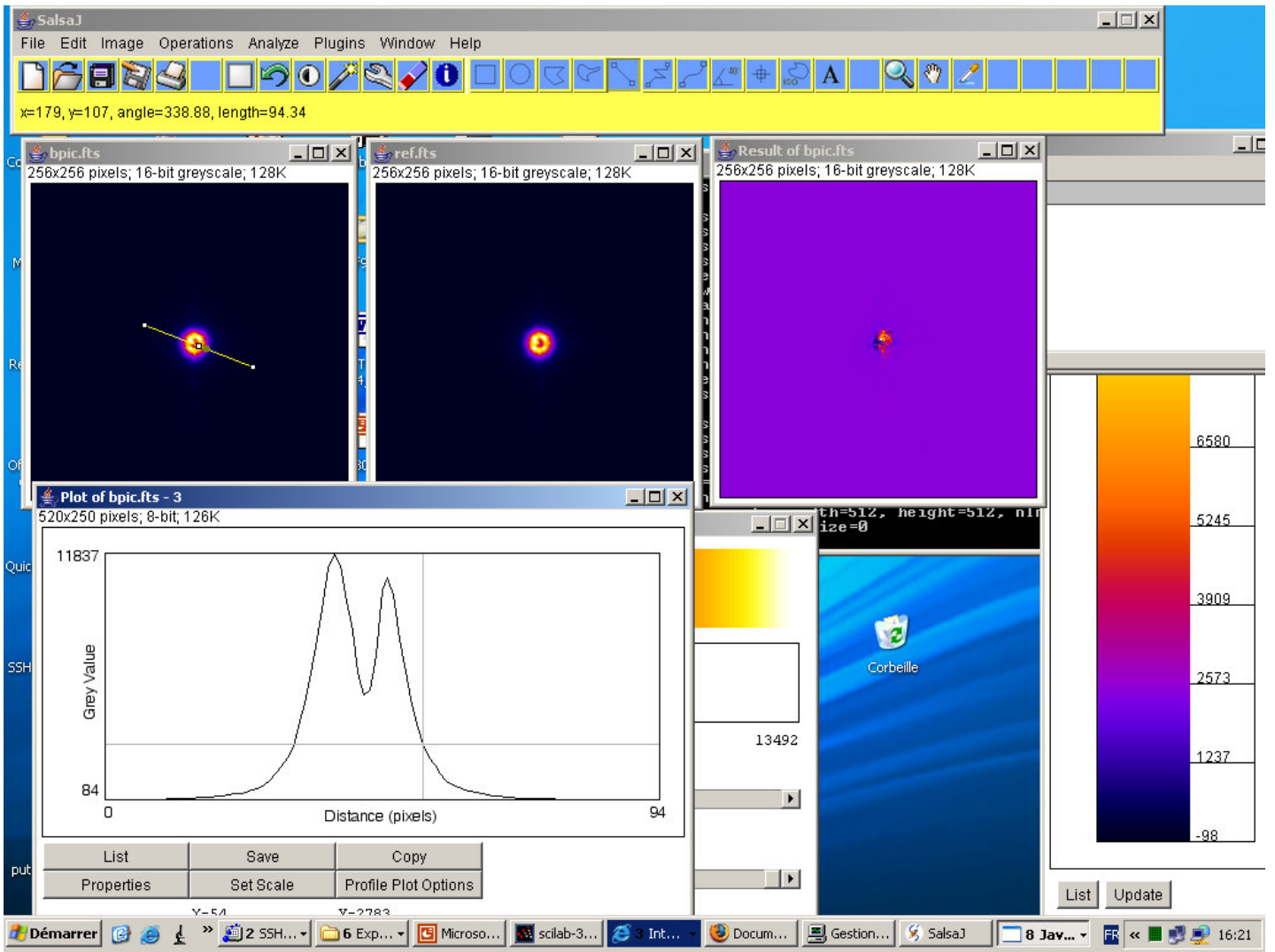
ces Systems)

Subtraction of frames and Galilean satellites



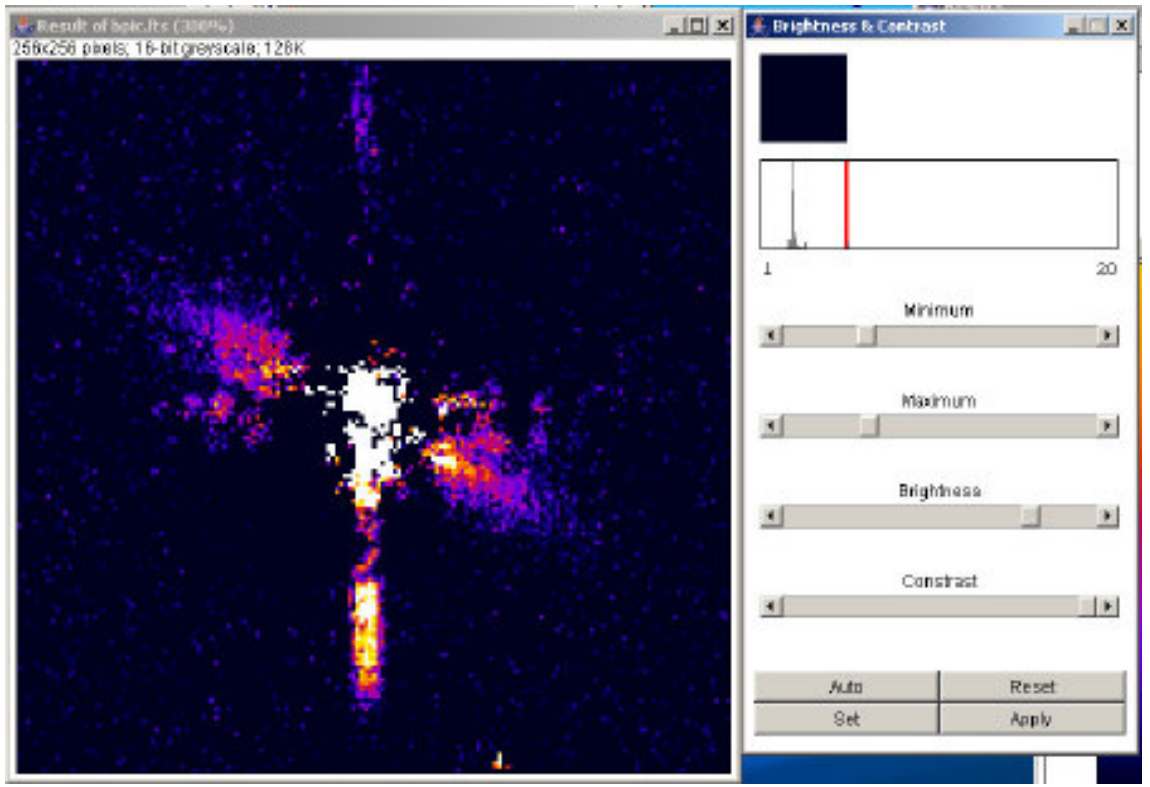

SalsaJ
File Edit Image Operations Analyze Plugins Window Help
x=259, y=257, angle=244.89, length=228.60
Result of Result
512x512 pixels; 16-bit greyscale; 512K
-87
332
Minimum
Maximum
Brightness
Reset
Apply
Plot of Result - 2
520x250 pixels; 8-bit; 126K
2844
-442
Grey Value
0
229
Distance (pixels)
List
Save
Copy
Properties
Set Scale
Profile Plot Options
1237
-98
putty-056.exe
Configuration de HP Instant Sh...
scilab-3.1.1.exe
ogloza.ppt
Démarrer
16:08

Subtraction of frames & proto-planetary circumstellar discs

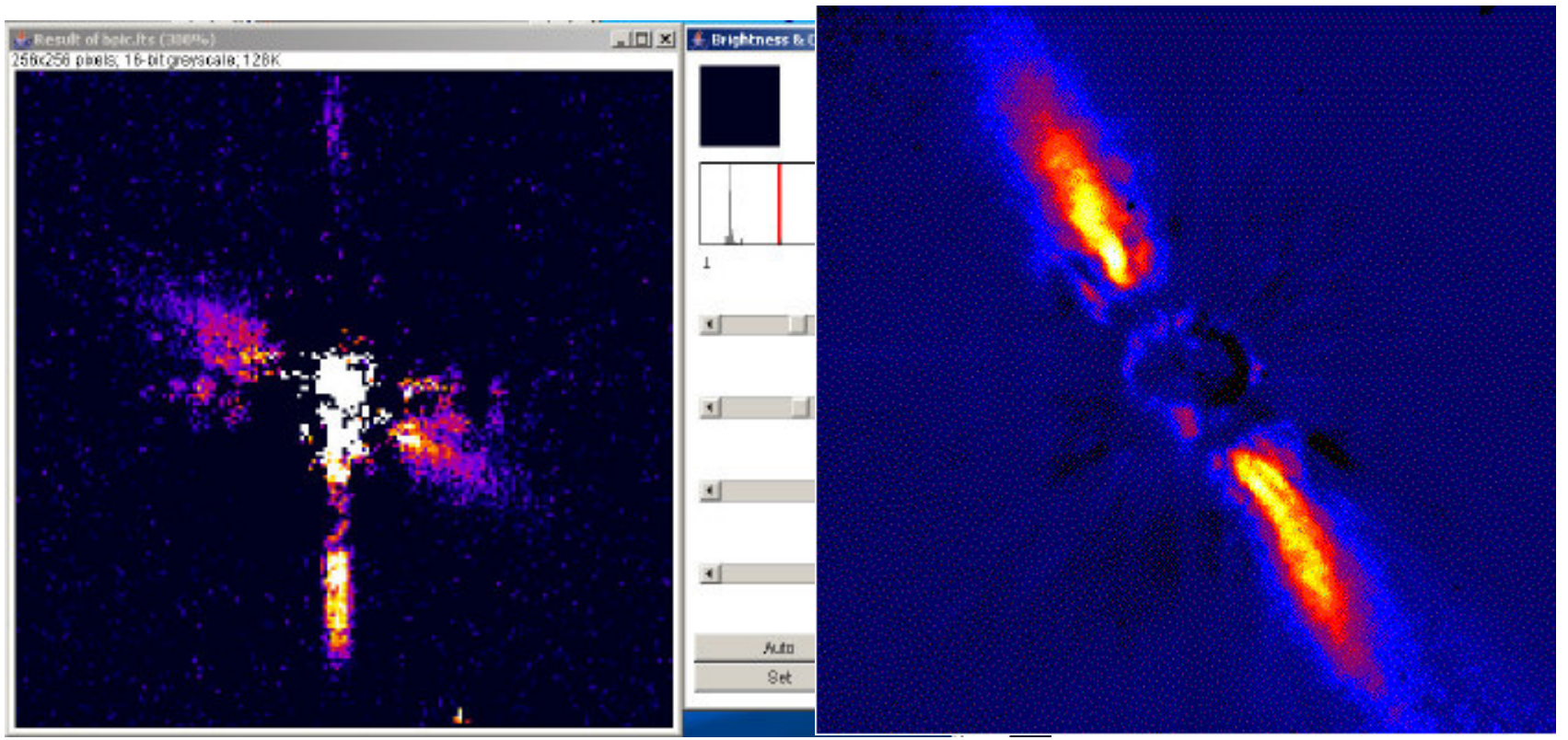


ESO images prepared by D. Mouillet (Grenoble)

Subtraction of frames & proto-planetary circumstellar discs



Subtraction of frames & proto-planetary circumstellar discs



Mouillet et al. 1997 A&A 324, 1083

Registration of frames and detection of supernovae

« Standard » procedure:

Shift, rotation (dilation – negligeable)

Subtraction

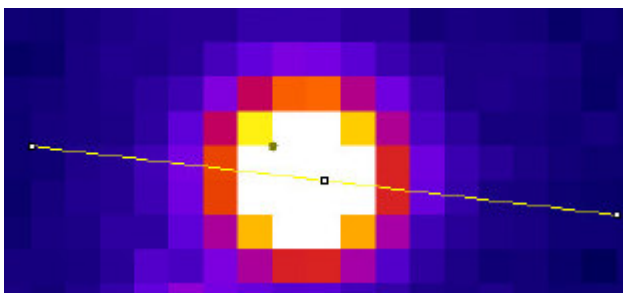
Blink or subtract

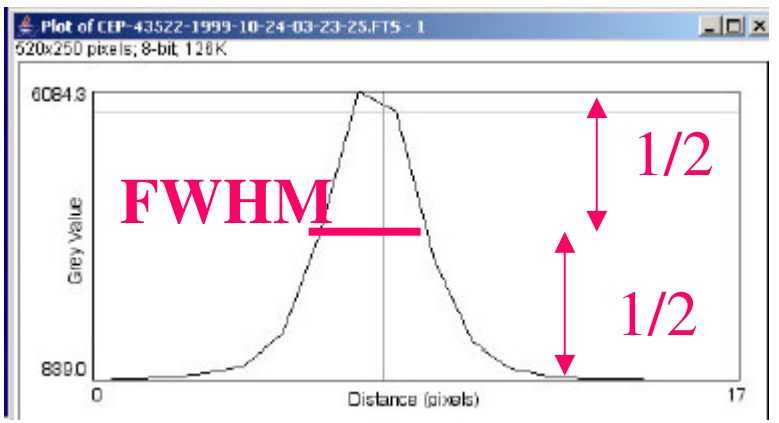
Qualitative alternative: plot profile

Photometry & stellar objects

Stellar objects = point sources

Convolved by the Point Spread Function (PSF) of the « instrument » (atmosphere + optics)





PSF ~ bell-like shape function ~ Gaussian + tails

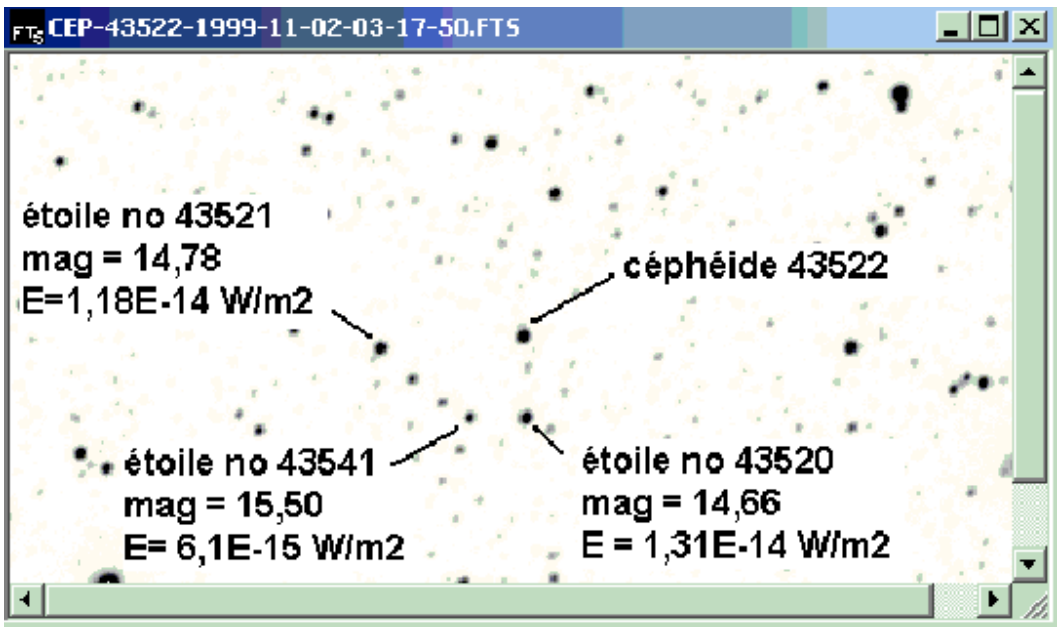
Characterised by its Full Width Half Maximum (FWHM) in arcsec (cf pixel size)

Good sampling: FWHM ~2-3 pixel size

Photometry & distance measurements in the Universe with cepheids

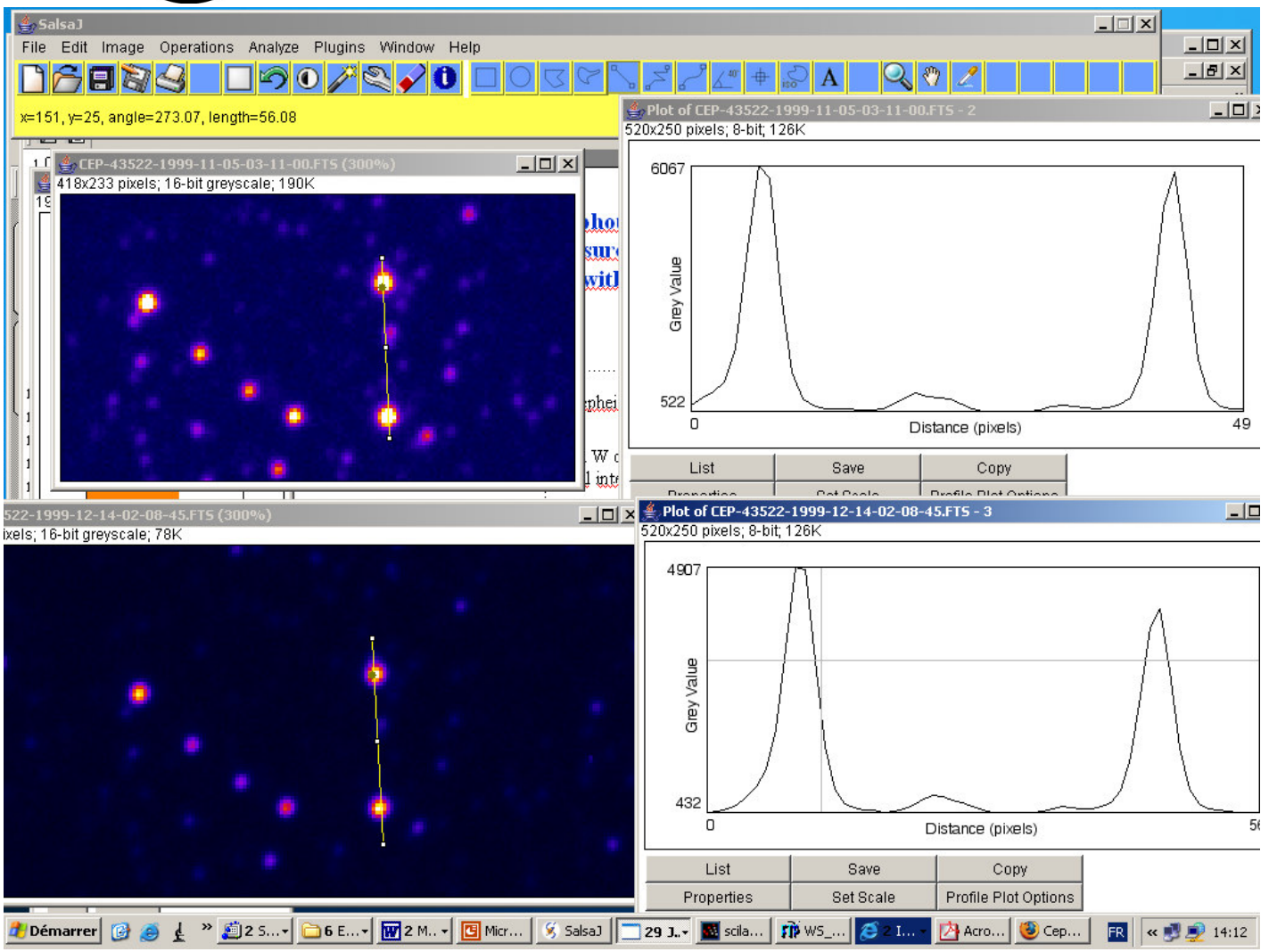
Example of a cepheid star in the Small Magellanic Cloud:

measurement of the relative variation of stellar flux.



Data from OGLE collaboration

Quick look: with plot profile



Photometry & distance measurements in the Universe with cepheids

- Measurement of relative variation of cepheid as a function of time

[Absolute calibration of each frame (real luminosity in W or real flux in Wm^{-2}) difficult to obtain and of limited educational interest.]

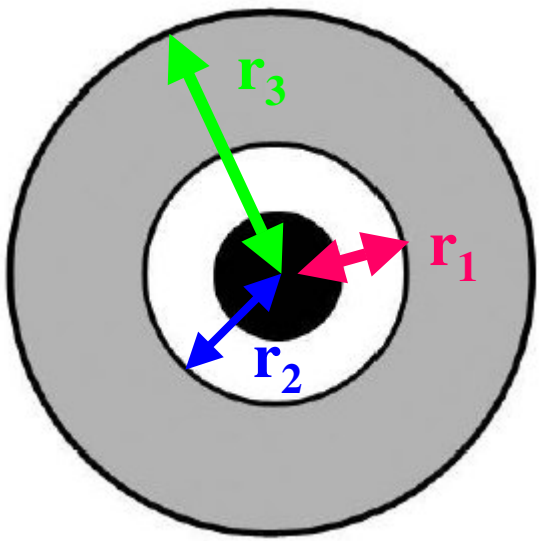
Aperture photometry

F_{star}= Sum of intensity (pixels with r<r_1) –**Sky***N_1

N_1 = Number of pixels in the radius r_1

Sky = Sum of intensity (pixels with r_2<r <$\mathbf{r_3}$) / N_{23}

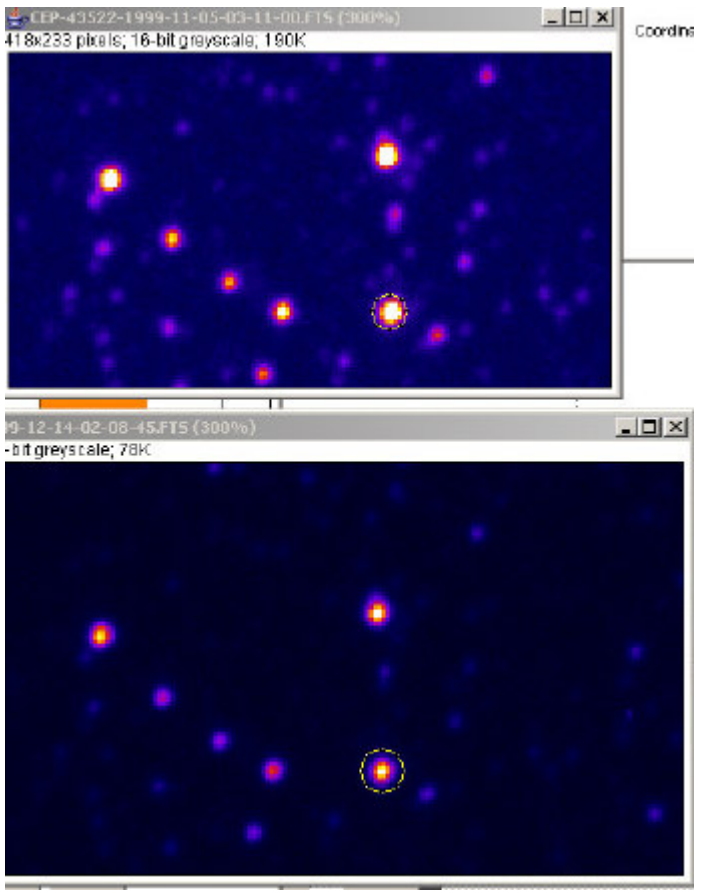
N_{23} = Number of pixels in the corona $r_2 < r < r_3$

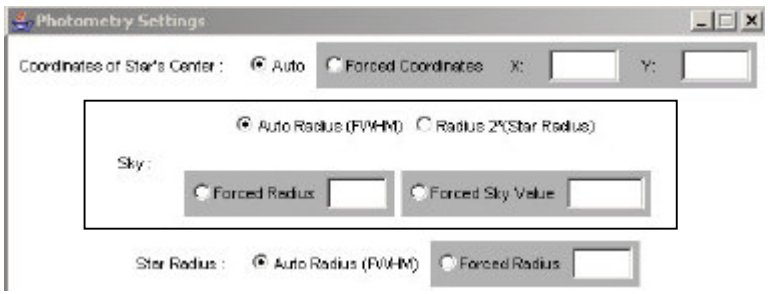


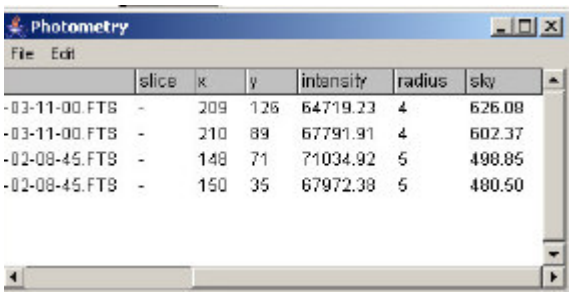
Use:

Instrumental value proportional to the stellar object flux (luminosity)

Aperture photometry & distance measurements in the Universe with cepheids







Working with stacks and movies

Interval movie by Kinga Janusz (Zespol Szkol Speckalnych No 3, Cracow, Poland)

Working with stacks and movies

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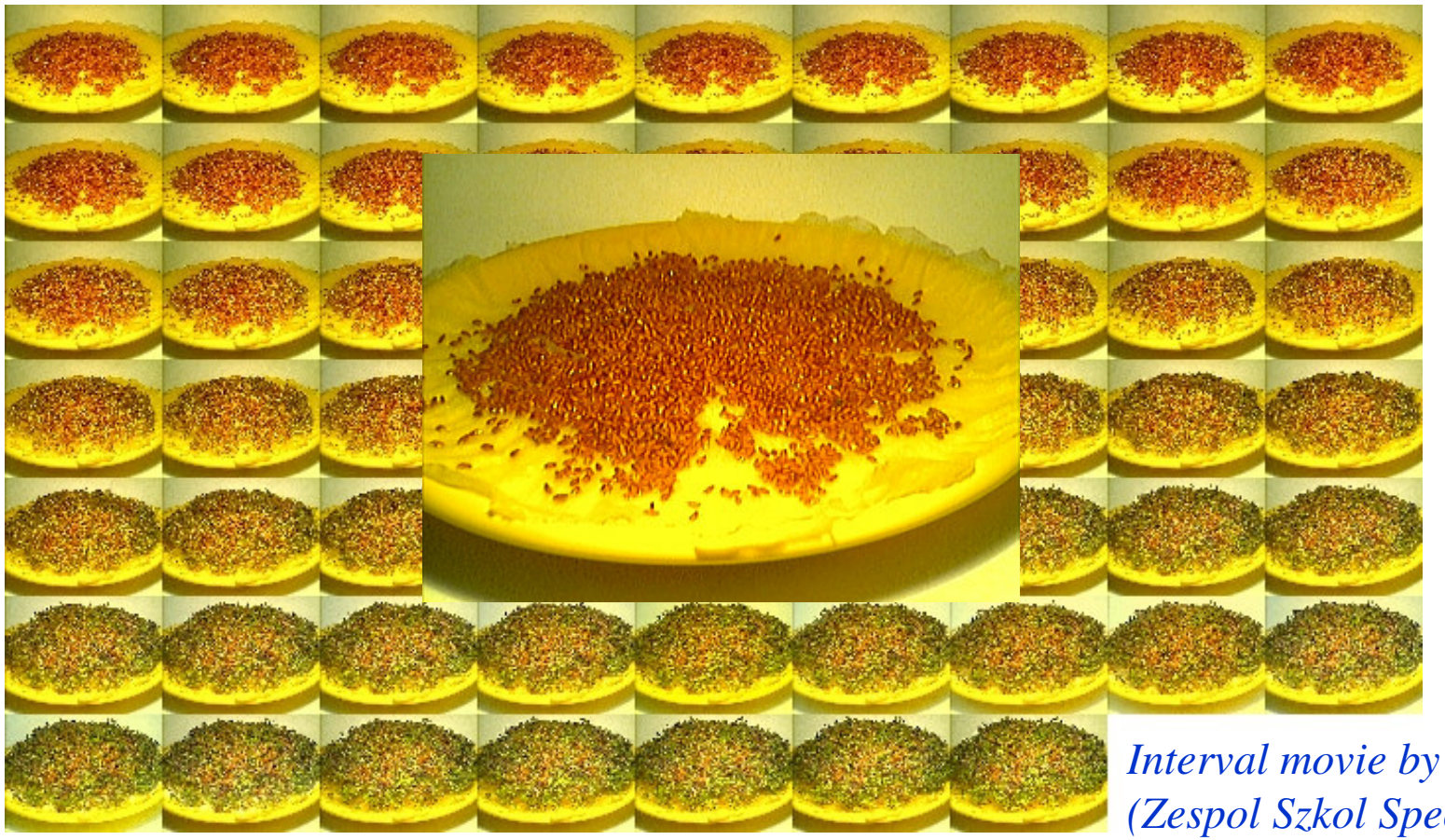
Interval movie by Kinga Janusz (Zespol Szkol Speckalnych No 3, Cracow, Poland)

Working with stacks and movies



Interval movie by Kinga Janusz (Zespol Szkol Speckalnych No 3, Cracow, Poland)

Working with stacks and movies

Application for the detection of planets by radial velocity method: detection of a Doppler effect

Courtesy of M. Mayor et al.

Exercise on Extra-solar planet, R. Ferlet

Perspectives:

- Addition of other astronomical functionalities (astrometry, PSF photometry, etc.)

- Optimisation of the tool with intensive testing in schools

- Extension to biological imaging and developments of more synergy with ImageJ (sustainability of the software).

- Translation in other languages

Sustainability

-Thomas Bouvier (UPMC) – technical and scientific referent for future developments (link with ImageJ)

- Prospect to get additional staff support from UPMC