L.E. ©

Torino, 22 October, 2014

Sunspot’s temperature

IN A WORD

Brief description

Measure of the sunspot temperature from a picture of the sun using the free software Iris and Stefan-Boltzmann law.

Why this activity?

1. Introduce the magnetic activity of the sun (very important because it could affect Earth’s climate) - See Maunder Minimum.
2. Show how it’s possible to know the temperature of an object even if it’s 150 10^6 Km far from us.
3. Let student apply, in a real situation, the Stefan Boltzmann Law.
4. A good way to introduce random errors
5. A good way to introduce digital images

Links

- http://www.helioviewer.org/
- http://sohowww.nascom.nasa.gov/home.html
- http://en.wikipedia.org/wiki/Maunder_Minimum

Proposal

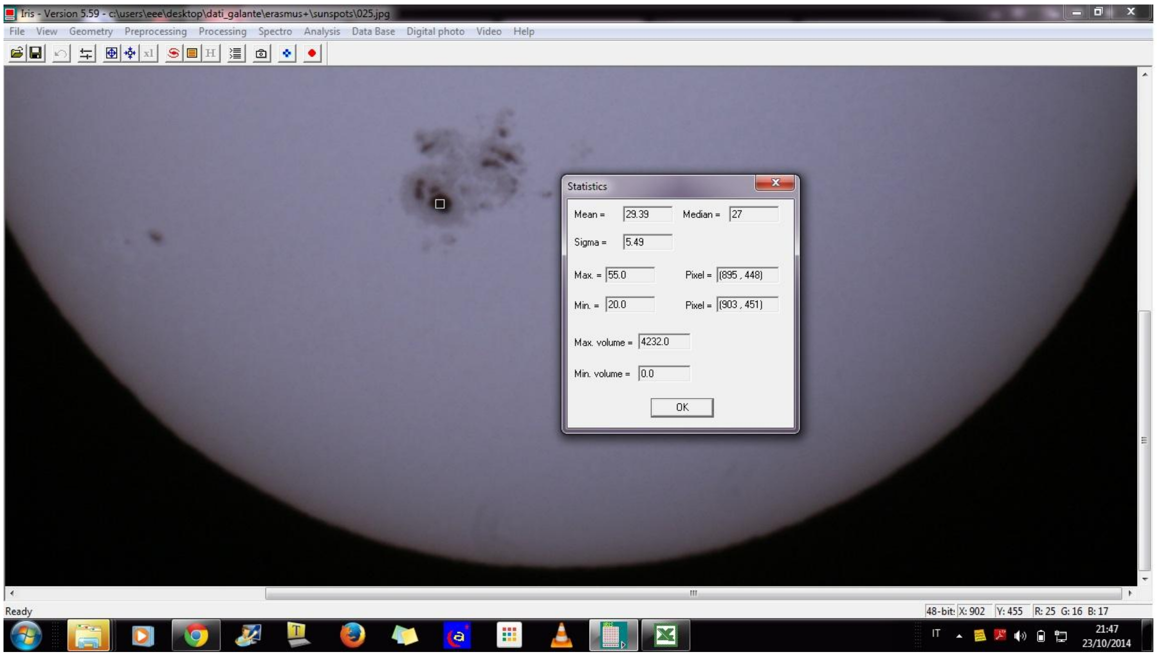
Today (22 October 2014) we have observed the sun photosphere. At the end of the observing session we took this picture with a digital camera. From this picture we can start our analysis and work out the temperature of the sunspots. It would be nice to go on working together, let me know If somebody wants to work on this with us! Best regards

How to work out the spot's temperature.

1. Send me an email so I'll give you the image of the sun we took yesterday.
2. With the free software IRIS (that you can download here:http://www.astrosurf.com/buil/us/iris/iris.htm) open the Sun image and highlight with the mouse a rectangular box inside the biggest black spot.(see attached image)
3. Right click and choose 'statistics'
4. From the 'statistics' window take note of the mean value of the pixels in the highlighted box (we will call this value Is i.e Intensity of the spot)
5. Do the same with a similar box in the photosphere not too close to the Sun edge (we will call this value Ip, i.e. Intensity of the photosphere)
6. From the black body law - Stefan-Boltzmann Law - you can find that

$Ts = 5497 * (Is/Ip)^{(1/4)}$,

where Ts is the temperature in Celsius Degrees of the spot and 5497 is the temperature of the photosphere in Celsius.



How Introduce random errors and Gauss distribution with the sunspot activity.

1. cut a small part of the photosphere from the sun picture

2. paste it and create a new small image, only with that region of the sun (see image2)

3. Open with Iris the small image, you've just created

4. highlight almost all the pixel of the image with the mouse

5. right click and select statistics

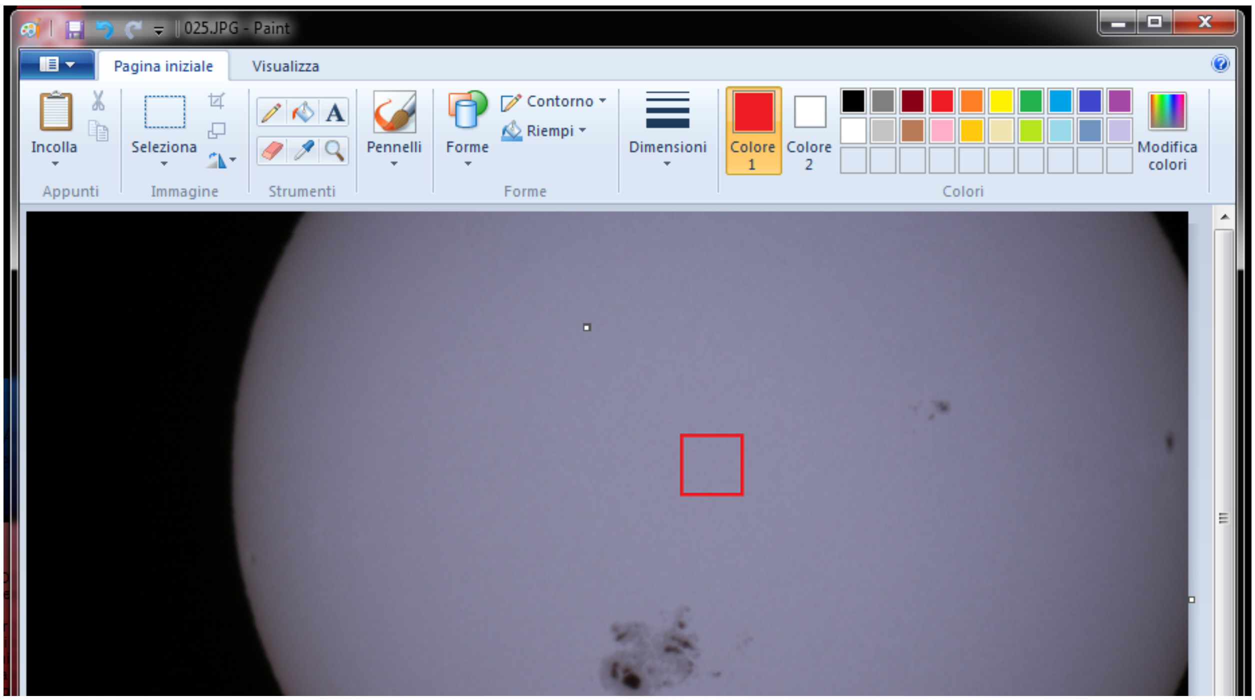
6. in the toolbar select View and then Histogram; in options adjust the x-axis scale (from 125 to 150, ticks 5) and you'll have in front of you a more or less random distribution of the pixel values of the highlighted region!

(see image 3)

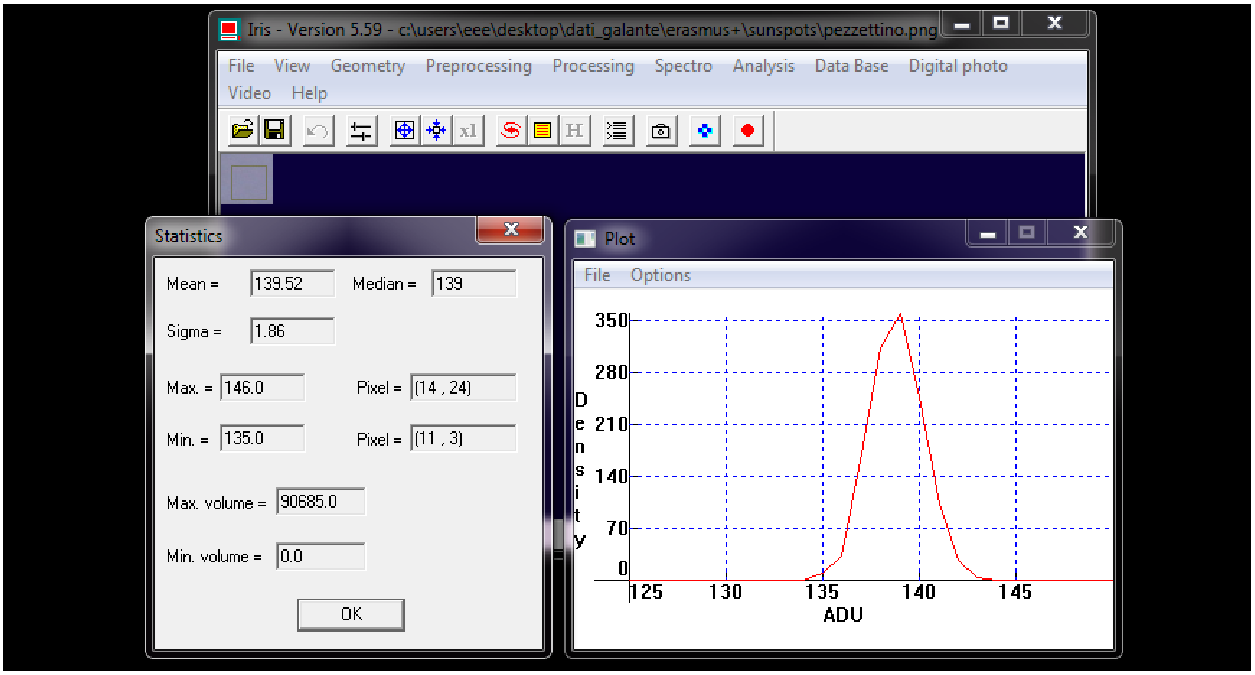
L.E. ©

7. compare the mean value of the statistics window with the center of the distribution, compare the standard deviation sigma with the thickness of the gaussian function.

This idea came out this morning from a discussion with a physics teacher of Liceo G Bruno - Torino. We will test it with students from 13 to 14.



img. 2

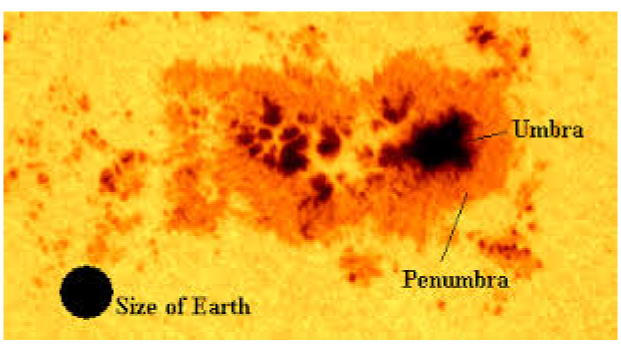


img. 3

The computation.

(from a box completely inside the spot)

(from a box more or less of the same dimensions of the previous, in a photopshere region near the spot. **NOT** in the <u>penumbra</u> of the spot)



in good agreement with the predictions: “Although they are at temperatures of roughly 3,000–4,500 K (2,700–4,200 °C), the contrast with the surrounding material at about 5,780 K (5,500 °C) leaves them clearly visible as dark spots, as the luminous intensity of a heated black body (closely approximated by the photosphere) is proportional to the fourth power of its temperature” (from Wikipedia).

The Equipment

The picture was taken from Torino, on the 22nd of October 2014 (14:00 pm LT) with the equipment shown in the image below.

Telescope MEADE LX 90 - 8”
canon 350 D
suitable filter on the top of the optics.