UNIT 4:

GAS GIANTS

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ACTIVITY 1

MEASUREMENT OF JUPITER'S FLATTENING AND DETECTION OF ITS RED SPOT

OBJECTIVES

The objective of this activity is for students to apply and develop the skills acquired in the analysis of astronomical images with basic software tools. The aim is to study the morphology of the planet Jupiter by observing its bands and zones, looking for remarkable features in its atmosphere, such as the Great Red Spot, and measuring the flattening of the planet due to its rapid rotation. For this, we will make use of astronomical images obtained with the Liverpool Telescope.

INSTRUMENTATION AND EQUIPMENT

For the realization of this practice we will use a selection of images of Jupiter obtained on different dates with the Liverpool Telescope of the Roque de los Muchachos Observatory, which are stored in the *JUPITER* folder of our web page **www.iac.es/peter**. For their processing we will use the *PeterSoft* program, which we can also download from the web site above and install on our computer. The tool we will use the most is the distance measurement tool.

METHODOLOGY

Each astronomical image will be examined and measurements will be made of the size of the planet, both in the equatorial and polar directions, to determine its flattening degree. We will measure and calculate the size of different details that can be observed in its atmosphere, such as the bands and the Great Red Spot.

PROCEDURE

1. **Open the image of Jupiter**

The first step is to download and unzip in the hard disk the file *U4_imagenes_Jupiter.zip* where we can find all the images to be analyzed in this activity. Then we will run the image analysis program *PeterSoft* and open the file 547g000.hfit, which is the image of Jupiter obtained on the date of its opposition. As we are going to measure the flattening of the planet, we will use an image that does not present phase, that is to say, that corresponds to the moment when the planet was just in the opposite direction to the Sun (at opposition). By doing so, we eliminate the uncertainty that would imply measuring the diameter of the planet when it is in shadow.

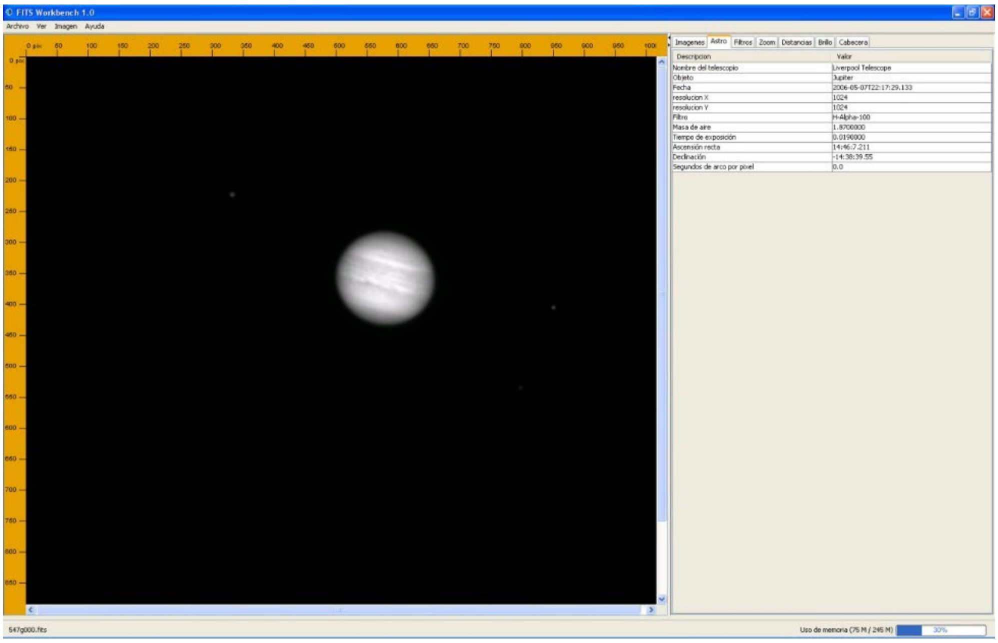
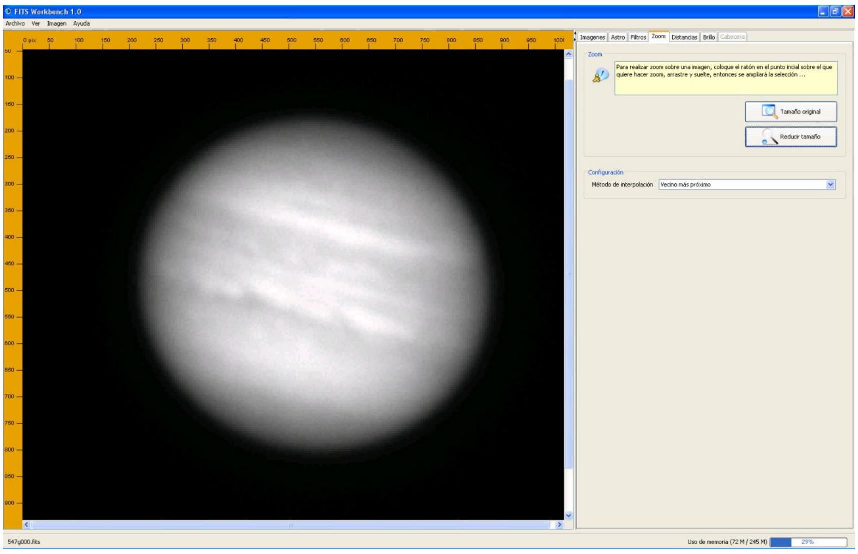


Image information contained in the ASTRO tab

Once we open the image in the program, we can get information about it in the *ASTRO* tab: date and time when the image was taken, filter used, exposure time in seconds, the scale used in arcseconds per pixel, etc. This information is very important, since we will extract the necessary from it and from our measurements.

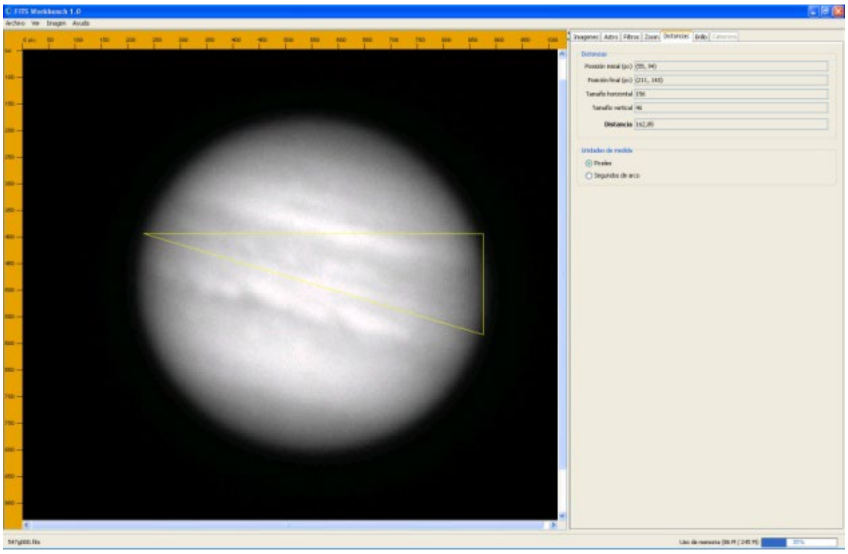
To zoom in on the area we want to study, click on the *ZOOM* tab and draw a box around the planet by holding down the left mouse button.

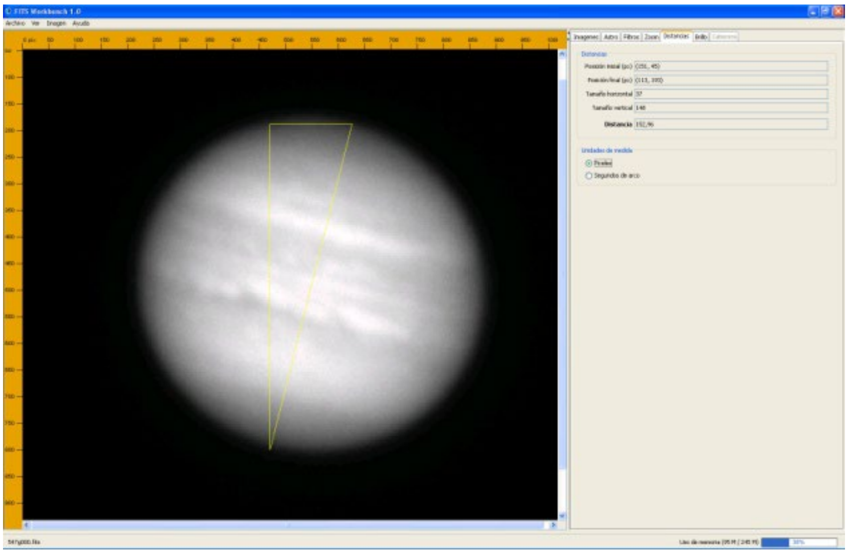


2. Measuring the diameter of the planet

We use the measurement tool, located in the DISTANCIAS tab, to measure the apparent diameter of the planet from one edge to the other. The result can be obtained in two units: pixels (size in digital photography) or arcseconds (size spanned in the sky as seen from the Earth). It doesn't really matter, because we can easily convert one unit into the other using the image scale for this telescope that we find in the ASTRO tab: 0.27837 arcseconds per pixel. **In this practice we are going to use pixels.**

As we want to obtain the flattening of the planet, we will make two measurements: one is the distance from one end of the planet to the other at the equator; the other is similar, but in the polar direction, that is, from one pole to the other. Remember: the bands and zones of Jupiter are parallel to the equator and, therefore, perpendicular to the poles.





3. Calculate the flattening

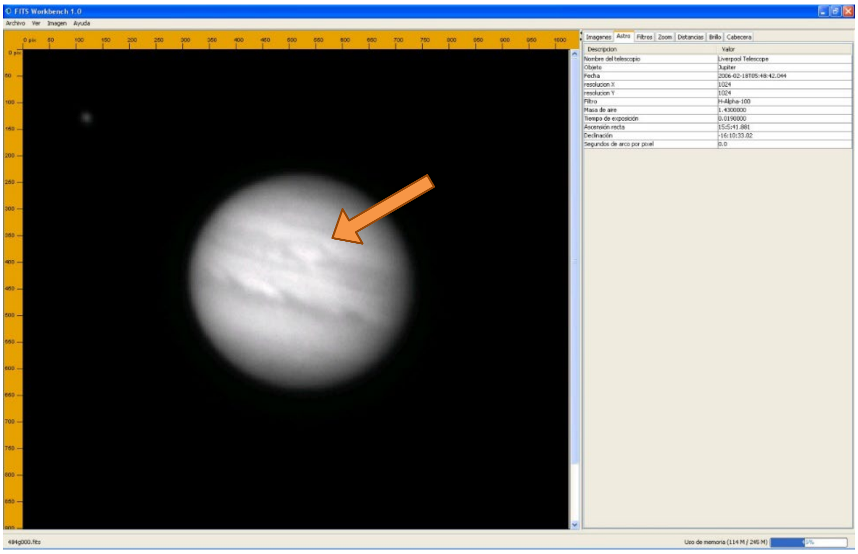
As you may have noticed, the planet is larger in the equatorial than in the polar direction. This is what we call flattening. We quantify it as a percentage, so 0% is for a perfectly spherical planet and 100% would be for a perfectly flat planet. We use this formula

$$\left(1 - \frac{Diameter\ polar}{Diameter\ ecuatorial}\right) * \ 100 = \_\_\_\_ \ \%$$

Draw a picture of the planet showing the dark bands and light areas seen in the image. How many do you get to see?

4. Calculate the size of the Great Red Spot

Next, we will locate and measure Jupiter's Great Red Spot (GRS) by opening the file 484g000.hfit and, as in the previous case, zoom in to make it visible.



Remember you can use the different filters and tools in the *IMAGEN* tab, which will help you to better detect the details in the planet's atmosphere

We use the distance tool again to calculate the size of the structure. We will measure the spot from one end to the other and get our measurement in pixels. Knowing that each pixel represents 1,040 *km* at the distance the planet was on the day it was photographed, can you calculate how many kilometers long the GRS is with the measurement you have obtained?

For further information, visit our website: **www.iac.es/peter**

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