UNIT 1:

INNER PLANETS – OUTER PLANETS

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ACTIVITY 2

APPROACHING AND RECEDING FROM THE PLANET MARS. OPPOSITION.

OBJECTIVES

In the previous activity, we established an initial contact with the measurement tools of the image analysis software. In this practice we're going to reinforce the skills we acquired, by measuring the apparent size of an outer planet when approaching or moving away from it, trying to calculate the closest approaching date to Earth.

INSTRUMENTS AND MATERIAL

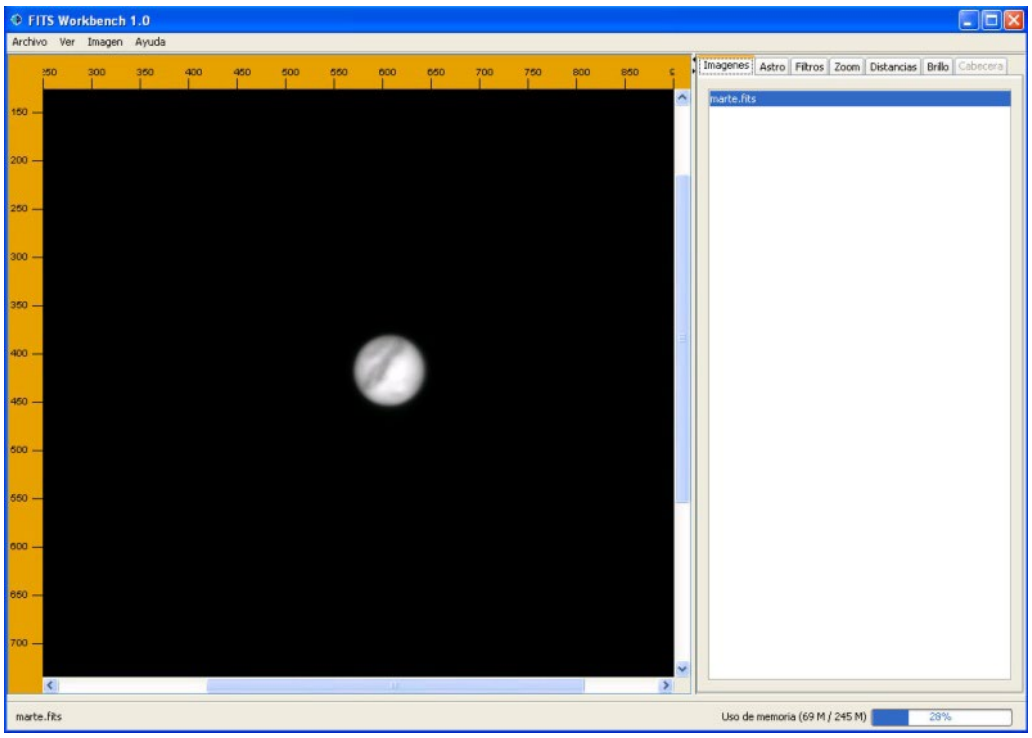
To complete this exercise, we will use a selection of images of Mars taken over several months with the Liverpool Telescope at the Roque de los Muchachos Observatory on the Canary Island of La Palma. The images are contained in the MARS folder on our website **www.iac.es/peter**. We will use the *PeterSoft* program to process them. The tool of this program that we will use most is the distance measurement tool.

METHODOLOGY

We will examine each astronomical image and measure the apparent size of the planet. We will obtain a table of data, which we will plot on a graph to deduce the variation in the apparent size of the planet over several months, and we will try to calculate the date of closest approach.

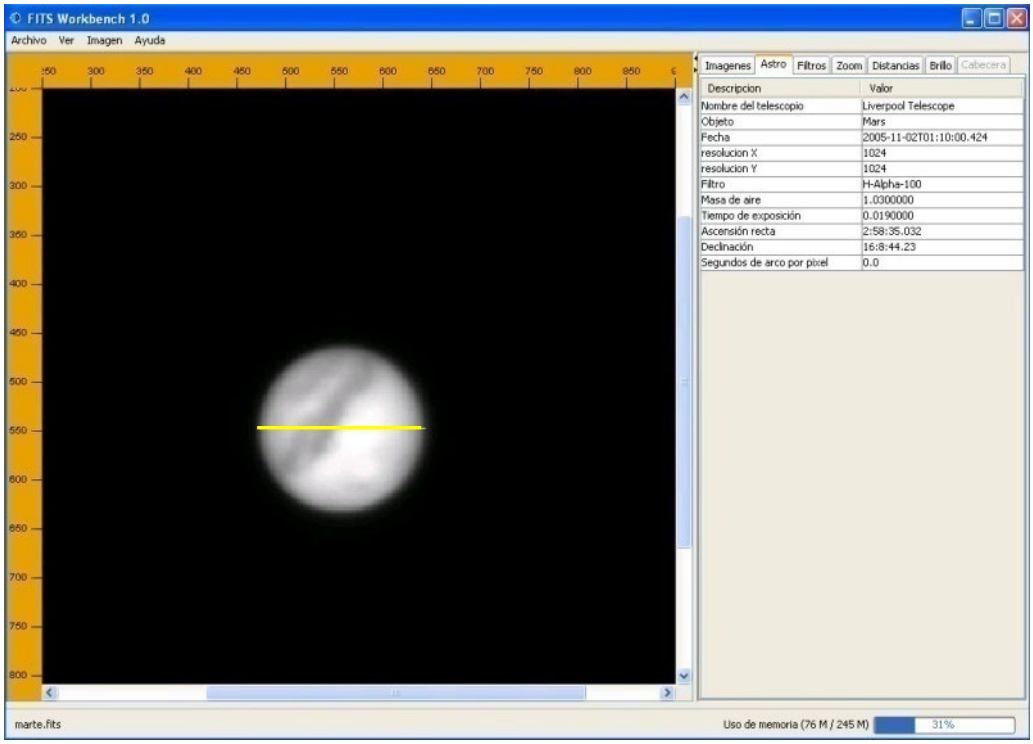
PROCEDURE

The first step is to download and unzip the file *U1_imagenes_Marte.zip* onto your computer, which contains all the images we are going to study. Next, open the *PeterSoft* image analysis program and open the image files.



Once the images have been loaded into the program, we can obtain information (in the *Astro* tab) about each one: date and time it was taken, filter used, exposure time in seconds, etc. This information is very important, as it together with our measurements will provide us with the data necessary for the purpose of this activity.

As we did in the previous activity, we will use the zoom to increase the size of the planet. Now it will be essential to enlarge the image because, as you will see, in some of the images the planet appears very small due to its distance.



As we did with Venus, we will use the *DISTANCES* tab tool and measure the diameter of the planet from end to end. We have to take this measurement from one pole to the other, as Mars also has phases. The phases of Mars are not as pronounced as those of Venus, nor does it go through all of them. At opposition, Mars shows us its entire surface fully illuminated, while a few months before and after opposition we see the planet slightly sideways (given its proximity) and therefore show us part of the surface that is not illuminated by the Sun. On those days, Mars shows a small phase like the one we see on the Moon about 3 days before or after the full moon.

What we want to do is check how the apparent size of the planet changes in relation to its distance from Earth and determine when it was closest to Earth. Therefore, we are going to obtain a table of data with the date each image was taken and the apparent size of the planet we have obtained with our measurements in arcseconds.

Image	Date	Size (pixels)	Size (arcsecs)
370j000			
383a000			
407g000			
430e000			
438c000			
445e000			
455i000			
470f000			
506g000			

In these images the *Astro* tab doesn't have the scale of arcsecs per pixel, which is needed for estimating the apparent angular size of Mars. The scale is the same as in the previous activity: 0.27837 arcsecs per pixel.

Finally, we will plot the data on a graph, so that we can check how the planet apparent size increases and decreases when approaching and moving away from us, respectively.

If you look at the images you will see that the planet surface is not always the same, as it is the Moon case. Since Mars has a rotational period higher than ours, over the days we can observe surface portions that cannot be seen on other images. Would you like to learn more things about Mars? We could also find out which Martian surface parts are observed in the images. To do this, you need to use a map of the planet's surface and we recommend using the images in which Mars looks bigger (it was closer), because you could better distinguish the details of its surface.

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

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