

Reach the Sky

Reach the Sky



Erasmus+

2015 - 2017





Astrocurriculum description

The purpose of this curriculum is to enable students to develop and apply knowledge of the universe and compare the conditions, properties, and motions of bodies in space. Emphasis shall be placed on concepts of the solar system, historical astronomy, the earth as a system in space, the earth/moon system, the sun as a star, and stars.

Teachers are encouraged to adjust their's curriculum to best work within their unique educational program.

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Do you know how to count stars in the night sky?

Authors: Polish Team



Here's a simple astronomical observation

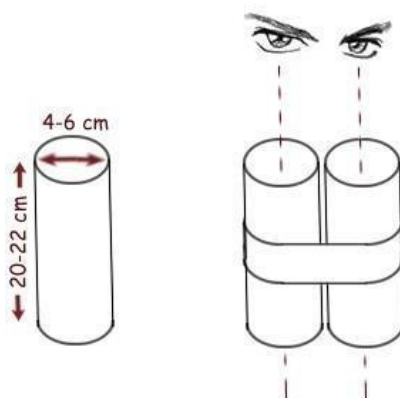
I'm sure everyone of us, looking at the night sky, has wondered how many stars they can see. It sometimes seems that there are so many of them that it's impossible to count them. However, stars are easy to count and when we do that, we can learn a lot of interesting things about the Earth and the universe.



Count how many stars you can see

Get ready – make a paper tube

You can use a tube from paper kitchen towels or make one yourself, using cardboard or a transparent plastic tube. It should be 20-22 cm in length and 4-6 cm in diameter. If counting is difficult because you can see too many stars, make the tube a little longer or narrower. Measure the length and diameter of your tube and write it down in the observation report below. If you prefer to make observations with both of your eyes, make two tubes (they need to be exactly the same) and put them firmly together. Be careful, your eyes should see the same fragment of the sky.





Write down the date and the place of your observation in the report.

You can give Earth coordinates and height above the sea level or the exact name of the place where you carry out the observation.



Wait until the night falls

You can start counting stars no sooner than two hours after sunset and no later than two hours before sunrise. Also, **don't carry out observations if there's Moon in the sky.**



(4) Estimate the sky cloudiness

When it gets dark, take the report with you , go out and estimate, more or less, how much sky is covered with clouds: 0%, 25%, 50%, 75% or 100%. Write down the result in the report. **If there's over 50% of the sky covered with clouds, you should wait for another with less cloudiness.**



Find a place for observations

The place should be **far away from light**, like for example street lights. Before you start counting, let your eyes get used to the dark. You need about 10-15 minutes.



Count the stars

When your eyes get used to the dark, you can start counting. Put the tube (or tubes) to your eye (eyes) and look at the sky. Count how many stars you can see and write down your result in the report as 'area 1'. Then choose another area in the sky, count the stars again and write down the result as 'area 2'. Do the same until you count stars in 10-20 different areas. The more areas you have, the more accurate final result you'll get. Choose areas at different height above the horizon and in different directions, even if you can't see very many star there. You might see only one or no stars in one area. Don't worry, it's not a mistake, write down what you can see in the report.

Estimate how many stars you can see.

$$\begin{bmatrix} 3 & 2 \\ 5 & 2 \\ 3 & 4 \end{bmatrix} + \begin{bmatrix} 2 & 2 \\ 3 & 4 \\ 3 & 3 \end{bmatrix} = \begin{bmatrix} 5 & 4 \\ 1 & 6 \\ 6 & 0 \end{bmatrix}$$

Go back home and use all the results you've written down to estimate the number of stars. First, count all the stars in all the areas you've got in your report. Divide the number you get by the number of areas and in this way, you'll know how many stars on average you could see through your tube (tubes). Put this number, together with the length and diameter of your tube into the formula in the report. After you complete calculations, you'll get the number of stars which you can see in the sky in the place where you carried out your observations. Double check for mistakes.

What do your results mean?

Does everyone see the same number of stars?

Ask other people to carry out this observation in the same place as you did. Compare your results. They can be different. What does it mean? People's eyesight differs. Those with good eyesight can see weaker stars, so they can see more of them. With very good eyesight, you can see over 2000 stars. And what if we 'improve' our eyesight using binoculars or a telescope? You'll see even more stars. With the biggest telescopes, you can see millions of stars. If so, how many stars are there in the universe? Astronomers estimated that there are about 10^{22} (ten thousand billion billion stars). It's hardly imaginable and can be compared to the number of grains of sand on all the beaches all around the world.



Can you see the same number of stars everywhere in the world?

Try doing the same task in different places: in the city, in the country, in the mountains and even on the sea. Every time, you'll get a different number of stars. Why? Because of light pollution. In large cities, the night sky is as bright as if there was full moon. While in the country, far away from cities, you can see over 2000 stars, in centres of very big cities you can see under 300.

We count stars – observation report

Date(day – month –year;time) _____

Place _____

Cloudiness _____

Tube: length (L) _____ cm; diameter (D)

_____ cm; type (underline):

single double

(attention: if you wear glasses, add 1.5 cm to the length) Counting stars:

The number of stars you can see through your tube in different places in the sky:

(attention: choose minimum 10 areas)

area no1: _____ area no11: _____

area no 2: _____ area no 12: _____

area no 3: _____ area no 13: _____

area no 4: _____ area no 14: _____

area no 5: _____ area no 15: _____

area no 6: _____ area no 16: _____

area no 7: _____ area no 17: _____

area no 8: _____ area no 18: _____

area no 9: _____ area no 19: _____



area no 10: _____ area no 20: _____

Total number of counted stars (**T**): _____

Average number of stars you could see through your tube (**A**): _____ (**T divided by the number of areas**)

Total number of stars visible in the sky (**N**):

Formula:
$$N = \frac{8L^2}{D^2} \times A = \frac{8 \times L \times L}{D \times D} \times A$$

Put your
$$N = \frac{8 \times \underline{\quad} \times \underline{\quad}}{\underline{\quad} \times \underline{\quad}} \times \underline{\quad}$$

data:
$$N = \underline{\hspace{2cm}}$$

Give your result:



Astronomical observations 21st June 2016 'Reach the Sky' Erasmus + Project

Authors: Polish Team



Task 1

Determining the local meridian by observing the shadow cast by a gnomon (the "hand" of sundial)

- we set or dig in the gnomon (a wooden stick or metal rod) on the playground and we draw circles around the gnomon;
- we observe the shadow which changes its location and we mark the points in which the shadow intersects with the circles;
- we join the two points on the same circle with a line and we determine the centre of the segment;
- we draw a line from the point where the gnomon is set to the centre of the segment- this is the local meridian;
- we mark the north and the south.

Task 2

Determining the East and the West on the plane of the horizon.

We have determined the North and the South in Task 1- we mark them on the ground and we mark the remaining East and West as well as NE, NW, SE, SW.

Task 3

Measuring the height of the Sun over the horizon at solar midday and calculating the latitude of the position of our observation.

- we measure the height of the gnomon;
- we observe the changing length of the shadow and we mark its shortest segment- we measure the length of the shadow;
- Method 1- we draw a right- angled triangle and we mark the angle between one cathetus (the length of the shadow) and hypotenuse (the direction of the incidence of sunrays). It is the angle of the height of the Sun over the horizon and at the same time the angle in which the sunrays fall on the Earth. We take a protractor and we read the angle;
- Method 2- using trigonometric functions we calculate the tangent of the angle



between the direction of the sunrays' incidence and the shadow cast by the gnomon. From mathematical formula tables we read the measure of the angle (the height of the Sun over the horizon).

Task 4

Showing the difference in solar time between partner schools

We must determine at what hour of the official time the shadow is the shortest (that is when the true solar midday is at the observation point in each partner country). The official time is the time you can see on your watch and it's based on time zones. It's the hour for the middle meridian in each time zone. For Poland in June it's 30 ° E; for Romania, it's 45E; for Turkey, it's 45 E; for the Canaries, it's 15 E. to sum up, we want to write down at which hour official time the shadow is the shortest (the true solar midday is).

Task 5

Calculating the Wolf number

The **Wolf number** is a quantity that measures the number of [sunspots](#) and groups of sunspots present on the surface of the sun. It determines how active our star is. Solar activity changes every 11 years and it can influence us in a number of ways, for example it has influence on how quickly satellites on the low orbit around the Earth gets lower.

How to calculate the Wolf number R?

$$R = k \cdot (10g + p) \quad (a)$$

g - numer of groups of sunspots

p – total numer of sunspots

k – fixed ratio, for amateur observations $k = 1$

1. Set the telescope to see the whole face of the Sun clearly and sharply.
2. Count how many groups of sunspots you can see.
3. Count the total numer of sunspots you can see.
4. Use the formula (a) to calculate the Wolf number.
5. Fill in the table with your results.



WOLF NUMBER FOR A GIVEN DAY

I/p	NUMBER OF GROUPS OF SUNSPOTS g	NUMBER OF SUNSPOTS p	FIXED RATIO k	WOLF NUMBER R	LEVEL OF ACTIVITY
1					

LEVELS OF ACTIVITY:

0 – 11 (1) – no activity

12 – 30 (2) – low activity

31 – 60 (3) – low activity

61 – 100 (4) – average activity

101 – 150 (5) – average – high activity

151 – 200 (6) – high activity

>200 (7) – very high activity



Lunar Eclipse – Stellarium workshop

Authors: Polish Team

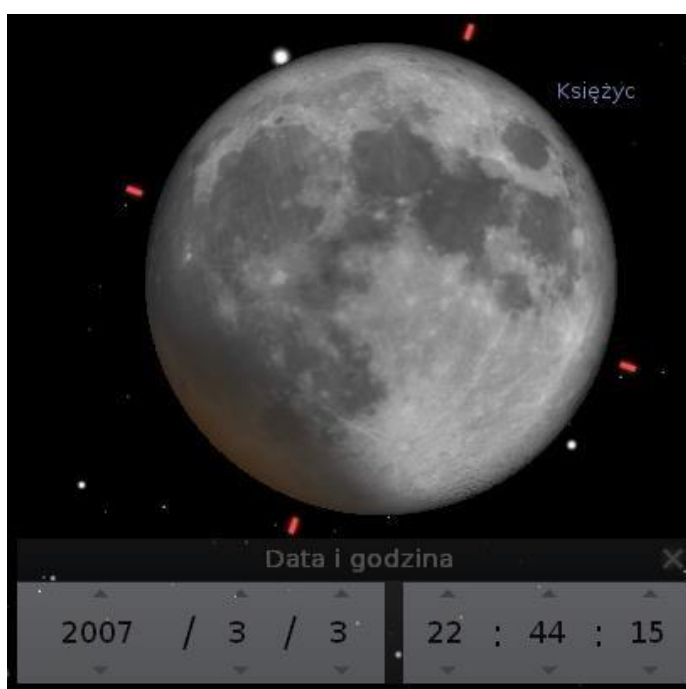


Objectives:

In this task, we'll learn why we can observe the eclipse of the Moon only during some full moons. We'll learn about three different types of eclipses as well as how ancient scientists predicted eclipses.

How to carry out the task:

Let's go back to 3rd March 2007 when, at 10.30 pm, partial eclipse began.



Using the time control menu, let's write down the times of the following phenomena:

- the beginning of partial eclipse:
- the beginning of total eclipse:
- the end of total eclipse:
- the end of partial eclipse:



Before partial eclipse begins and after it ends, there's so-called penumbral eclipse. It's connected with a very subtle, almost invisible change in the Moon's light. Thanks to Stellarium and the location menu, we can 'travel' to The Moon and observe the Sun from its surface.

Underline the correct answer:

During penumbral eclipse, an observer on the Moon can see:

total eclipse, b) partial eclipse, c) annular eclipse, d) can't see any eclipse



Phases of the Moon

Authors: Polish Team



Objectives

We'll learn about periodical changes in the Moon's face. We'll check the connection of a given phase of the Moon with the time when it can be observed.






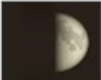


How to carry out the task

Task 1

Using Stellarium and the sky it shows, check if there's any connection between the face of the Moon and the time when you can see it in the sky.

- Check the Internet or the calendar for the next full moon and the date of the new moon before it.
- Put the date into Stellarium and check what the Moon looks like on this day at midnight.
- Changing the time in the time menu, check what time the Moon is visible,; put "x" in the table below. Change the date in the program to get the face of the Moon like in the illustrations and complete the table.

Table – faces of the Moon

wygląd tarczy Księżycy*	Data / liczba dni po nowiu	O północy	Przed świtem	O wschodzie	Przedpołudniem	W południe	Po południu	O zachodzie	wieczorem
 pełnia									
									
 ostatnia kwadra									
 now									
									
 pierwsza kwadra									
									
 pełnia									

Task 2

Using the results from task 1, underline the correct answer.

In full moon, the Moon rises:

a) at the sunrise, b) at midday, c) at the sunset, d) at midnight.

In full moon, the Moon sets:

a) at the sunrise, b) at midday, c) at the sunset, d) at midnight.

In the first quarter, the Moon rises:

a) at the sunrise, b) at midday, c) at the sunset, d) at midnight.

In the last quarter, the Moon sets:

a) at the sunrise, b) at midday, c) at the sunset, d) at midnight.

The Earth seen from the Moon:

a) is in the same phase, b) is in the opposite phase, c) is always in full earth, d) is always in new earth.



INNER PLANETS – OUTER PLANETS

Author: Oswaldo González

Revision: Nayra Rodríguez

Scientific Advisor: Alfred Rosenberg

Illustrations: Inés Bonet



The Planets

Planets are celestial bodies orbiting the sun in elliptical orbits. Unlike the stars, the planets do not have their own light but reflect the sunlight. The brightest, like Venus or Jupiter, can be seen perfectly in the sky at first sight as very bright stars (more than any night star). However, we need optical instruments to find other planets, such as Uranus and Neptune. Our solar system consists of eight planets (after relegating Pluto to dwarf planet status in 2006), six of which, including The Earth, are visible to the naked eye.

Are there planets around other stars? The answer to this question is yes. The process of star formation is similar to what originated the Sun. So many of them have had to form **proto-planetary disks**. These discs are stellar remnants forming planets. The great distances from us and proximity to the stars around which they orbit make impossible, for the moment, any direct vision. Through various methods of research and the study of light coming from the stars, they have been found hundreds of planets around other stars.

The Inner Planets.

The inner planets are those whose **orbits**, that is to say, paths travelling around the sun, are closer to the star than the one around our planet, the Earth. That means that only Mercury and Venus are inner planets and their circles around the sun are completed in less than a year, around 88 and 225 days, respectively.



One consequence of being inner planets is that we will always see them in the sky near the sun but not at midnight. For this reason the observation of Mercury is complicated by its proximity to the Sun. Mercury can be observed for only a brief period during either morning or evening twilight.

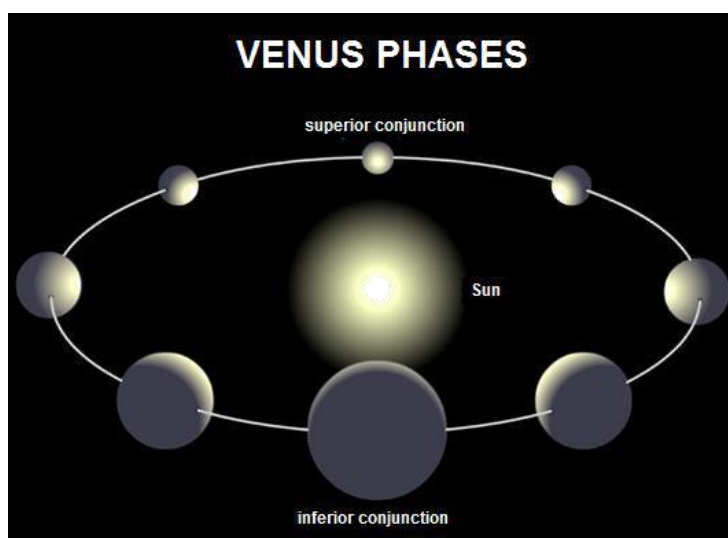
On the contrary, Venus is best observed than Mercury due to its larger orbit and it can be observed from Earth with a largest sun separation. Venus can be easily be seen even 3 hours will may see up to 3 hours after sunset or 3 hours before sunrise.

At first glance Venus appears as the brightest object in the sky after the Sun and the Moon. It appears as a very bright and yellow light point. When its brightness is higher, it is even visible in sunlight, provided we know where to look.

Seeing Mercury with a telescope is quite difficult. For example, at twilight when we point with a telescope to that planet, we must do it closer to the horizon, so the atmospheric turbulence prevents us from seeing clearly its surface morphology. However, this is not the case of Venus, which appears higher in the sky once the sun is below the horizon. Nevertheless, this planet has an atmosphere 90 times denser than the Earth, which prevents from seeing any surface characteristics. At best, some structure in its surface may be observed, but only with the appropriate filters.

Through a small telescope Venus can be easily seen to have phases, which change appearance every week. These phases are similar to the Moon, when illuminated by the sunlight as it rotates around our planet.

The Moon is not always equally illuminated. Depending on its position relative to the Sun, the illuminated portion seen from our planet will be larger or smaller. This phenomenon is known as the **phases** of the Moon. With Venus it happens something similar, but it's not only the phase that changes but also the distance that separates us from the planet. This way, in Venus a phase change is accompanied by a change in the apparent size of the planet.





The orbit of Venus is slightly inclined to the one of the Earth. This causes that in **inferior conjunctions**, which means that the planet is between the Sun and the Earth, it goes above or below the solar disc. But sometimes, when Venus crosses the **ecliptic** (orbital plane of the Earth around the Sun), the planet passes in front of the solar disc, and it must be observed by using suitable solar filters. This is a rare phenomenon; the next one will take place on 5 June 2012 and it can be observed from the Pacific.



Venus transit in front of the Sun. Author: O. González

The name of Venus comes from the Roman goddess of beauty and love. It is the planet most similar to Earth on certain aspects: both have almost the same size, mass, gravity and density. But there are also significant differences. Venus has an extremely high atmospheric pressure, 92 times higher than the Earth. This high density and elevated concentrations of carbon dioxide in atmosphere causes what is called greenhouse effect, resulting in a bigger increase of temperature in its surface, almost 480°C. Its density is so high that solar radiation doesn't reach the surface of the planet, being reflected into space or absorbed by the atmosphere. As we couldn't see the surface of the planet it was impossible to calculate its rotation period. Nowadays and with the help to the radar, it is known that the planet rotation on its axis is carried out in 243 days, and surprisingly retrograde, that is to say, it turns in the opposite direction to the rest of planets in the Solar System.

Sky distances. Angles.

Angles are used in astronomy to express the sky distances. When we say the Moon is 40 degrees from a given star, what we are really describing is the angle between our arms when we point one to the moon and other to the star. This way you can describe any celestial object extent and location.

Angles are measured in degrees, minutes and arcseconds. A circle has a 360° and a right angle 90°. Each grade is divided into 60 arcminutes (60'). For example, 1 Euro coin seen



from side to side of a basketball court, has an angular diameter of about 1 arcmin. Every arcminute is divided into 60 arcseconds (60"). A car seen 100 km away would have an angular diameter of 8 arcsec (8").

Some celestial objects can provide angles references that will help us. For example, both the Sun and the Moon have 0.5 diameter degrees (30 arcminutes); a large crater on the Moon can reach of 1' (1 arcmin) size and a very distant planet as Uranus presents about 3" (3 arcsec) size. To see such a small angle is needed increase greatly the image and that is why we use telescopes.

ACTIVITY 1:

SIZE ESTIMATION OF VENUS AND PHASES CALCULATION

OBJECTIVES

This activity is for the students to familiarise with astronomical images, using basic tools of the image analysis software, obtaining an estimated result of the planet physical size, using astronomical images obtained with Liverpool Telescope. It will also be observed the planet change face, both on the size and the phase over the months.

INSTRUMENTS AND MATERIAL

For this practice we are going to use selected images from Venus obtained in different dates with the Liverpool Telescope Roque de los Muchachos Observatory, which are contained in the folder */Venus/* in our website www.iac.es/peter. For processing them we will use the "peter_soft" program, which can be downloaded on the same website and installed in our computer. The tool we will use the most is the one for measuring distances.

METHODOLOGY

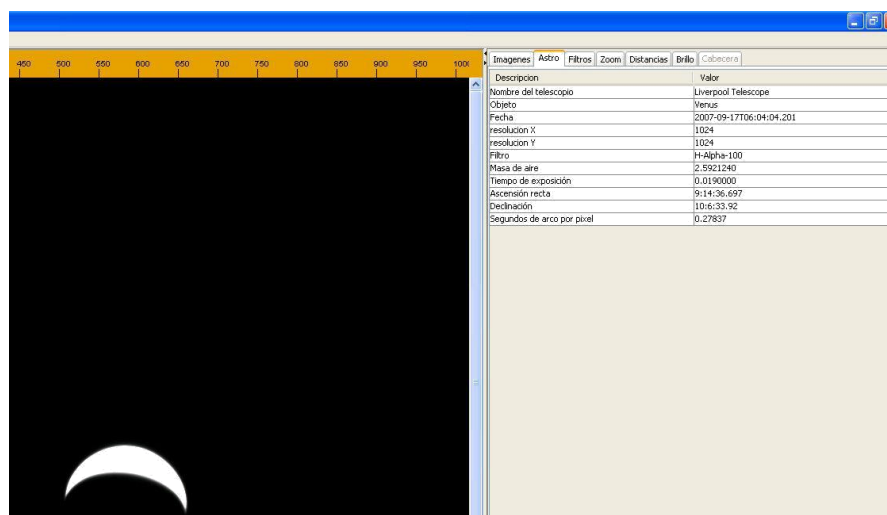
Each astronomical image will be examined. Then we will measure the planet size, as well as the part of the illuminated planet in order to calculate its phases. We will obtain a data table that will be represented on graph so it can be deduced the size variation of the planet depending on its distance, as well as the phase variation as it moves away from us.

PROCEDURE

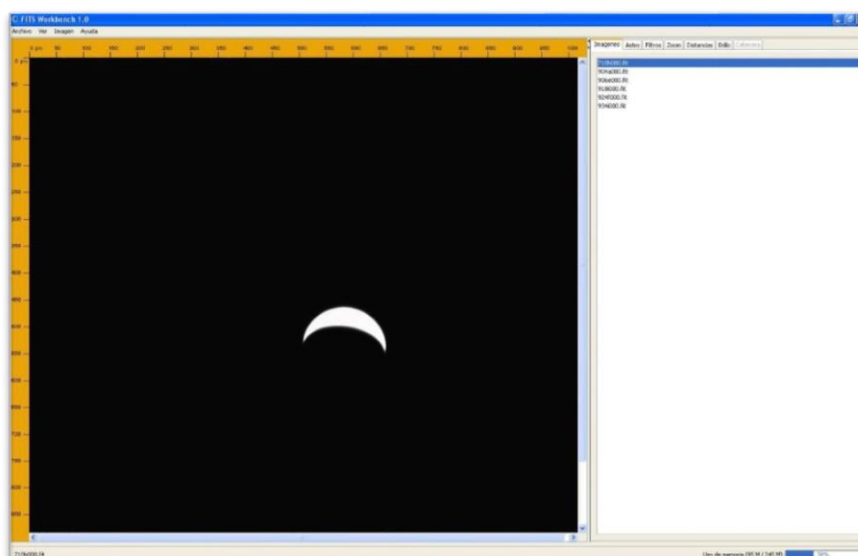
1st part. Diameter of Earth

The first thing to do is to download and unzip in our computer the file *U1_imagenes_Venus.zip*, where are contained all this activity images. Then we will run the "peter_soft" image analysis program and we will open the folders containing the images. To do this, we must click on the "File" tab and then "open file". The maximum number of images we can open at the same time is around 15.

Once we have loaded all the images in the program, we can obtain information of each of them by clicking the ASTRO tab: date and hour the image was taken, as well as the used filter, exposure time in seconds, the arcsec/pixel scale, etc. This information together with the previously obtained measurements is very important as this will help us to get the necessary data for the purpose of this practice.



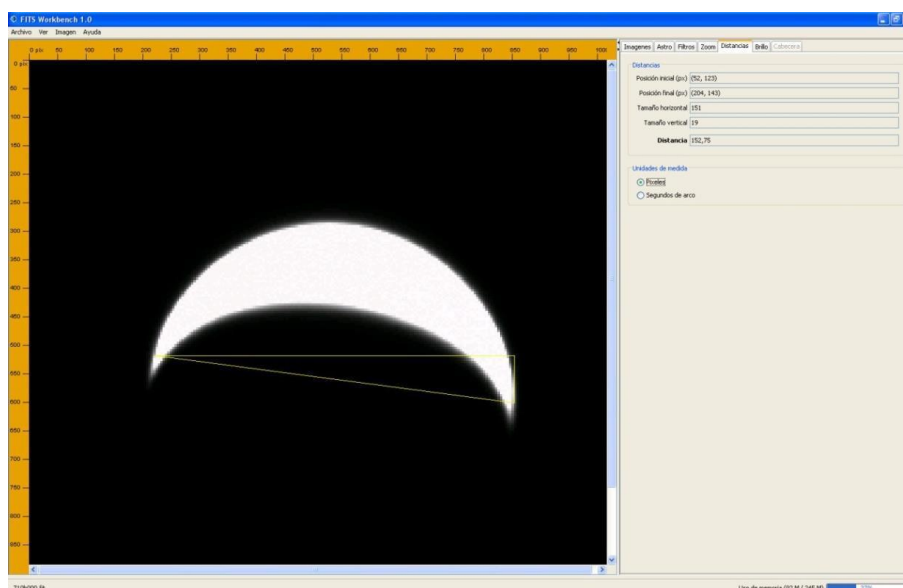
Please be aware that the object we want to study, Venus in this case, may not be in the centre of the image. You can increase the viewing window or reduce the image size (ZOOM tab) to see it in full.



To increase the area we want to study (in our case, the planet), we must click on the ZOOM tab and, with the left-hand mouse button pressed, we make a square around the planet in order to increase the specific area for our measurements.

By using the measurement tool, located in *DISTANCES* tab, we measure the diameter of the planet from one end to the other. We have to measure the larger distance between the planet limbs. The result can be obtained in two units: pixels and arcsecs. It really doesn't matter, because as we have seen in the image information, the image scale obtained with this telescope is 0,278 arcsecs per pixel (see *ASTRO* tab). The software enables to convert to arcsecs, but we will use pixels in this practice.

NOTE: One **pixel** is each light-sensitive cell composing the chip (CCD) of the astronomical camera, similar to the digital cameras that we normally use to take pictures. For example: a 7 megapixel camera has a chip containing 7 millions of very small photosensitive cells with the size of few microns. The difference between our digital cameras and the astronomical cameras lies in the bigger sensitivity of these last ones. Moreover, astronomical cameras are in black and white and refrigerated with liquid nitrogen to avoid the electronic noise in the image.



This measurement is going to be taken with each image, obtaining a table with the planet diameter in pixels for all of them. Given that we are able to know the each image date and scale in km/pixel using the *ASTRO* tab, we can calculate the planet diameter, in kilometres, for any given date. We just have to multiply the measurement obtained by the scale and the result will be given in kilometres.

Image	Date	Measurement (pixel)	Scale (km/pix)	Diameter (km)
902a000				



906e000				
918i000				
924f000				
934i000				

You will probably see that the result obtained is not the same on each image. That doesn't mean that the planet is growing or retreating like a balloon, but we haven't taken into account the error made when measuring.

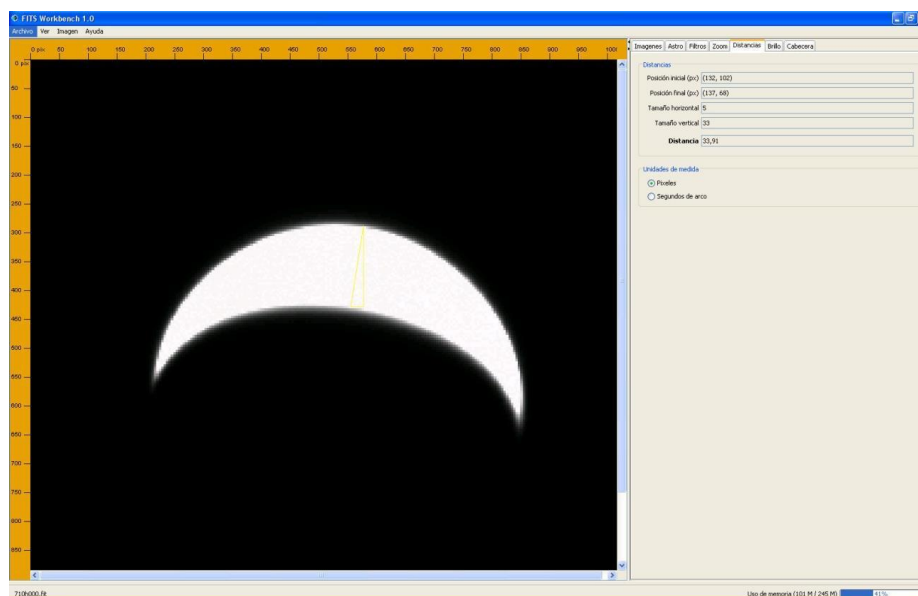
In sciences, when a measure of a given quantity, either a distance, time, temperature, etc., is obtained you must specify the mistake made carrying out that measure, such as accuracy, quality of instrumentation, etc. In this unit we are not taking into account the mistake, since the purpose is to have an initial contact with basic tools used by an astronomer.

As it's possible to obtain five different measures for the diameter of Venus, what we need to do is to obtain a **mean value**, that is to say, we add up the five values and we divide it by 5. This will be our value for the planet diameter. In a book or in the internet, look up the real value (understood as the most accurate measure so far), in order to know how close you are to that value. Think that you have only calculated pixels in one photograph of a planet and knowing the scale and the distance we can know its size, even if it is millions of kilometres far from us.

2nd part. Phases of Venus.

We had already discussed that as well as the Moon, Venus and Mercury present phases because of the different sunlight received. When we see the planet surface fully illuminated, we say that its phase is 100% (concerning the Moon we call it "Full Moon"). When half of the Moon is illuminated, its phase is 50% (first quarter or last quarter). And finally if the side that we observe is not illuminated by the Sun, its phase is 0%. In this last case, it could only be observed when moving in front of the Sun. This phenomenon is called **transit** in the case of planets and **solar eclipse** in the case of the Moon (the Moon would be between the Sun and us. This may only happens on a New Moon).

Well, we are going to calculate the phase presented by Venus on each one of the five images. To do this, we shall only make an additional measure for each image. This measure is to count the pixels illuminated in a straight line going from the centre of the planet to the limb, as it's indicated in the image below. .



In other words, we have to measure the illuminated wedge width. What we really want to determine is the illuminated planet portion, so we must divide this zone width by the planet size diameter, and the result will be represented as percentage.

$$\text{PHASE} = A / D \times 100$$

where:

A = Illuminated zone width measure

D = Planet diameter measure (obtained in the previous section)

Image	A (pixel)	D (pixel)	A / D x 100 (%)
902a000			
906e000			



918i000			
924f000			
934i000			

Once results are obtained, you will notice how the phase changes as the planet moves away from us.

Outer planets.

Outer planets are those whose orbits, that is to say, paths travelling around the sun, are further to the star than the one around our planet, the Earth. So, Mars, Jupiter, Saturn, Uranus and Neptune are outer planets. The farther they are from the Sun, it takes longer to turn around the Sun, so we can therefore find **translational** periods up to 2 years, as it's the Mars case, and 164 years for Neptune.

Unlike inner planets, we can observe outer planets at midnight, at any height over the horizon and not necessarily near the Sun. Mars, Jupiter and Saturn are bright and easy to see; on the contrary, Uranus and Neptune are much further away and shine less, so we will need binoculars to observe them.

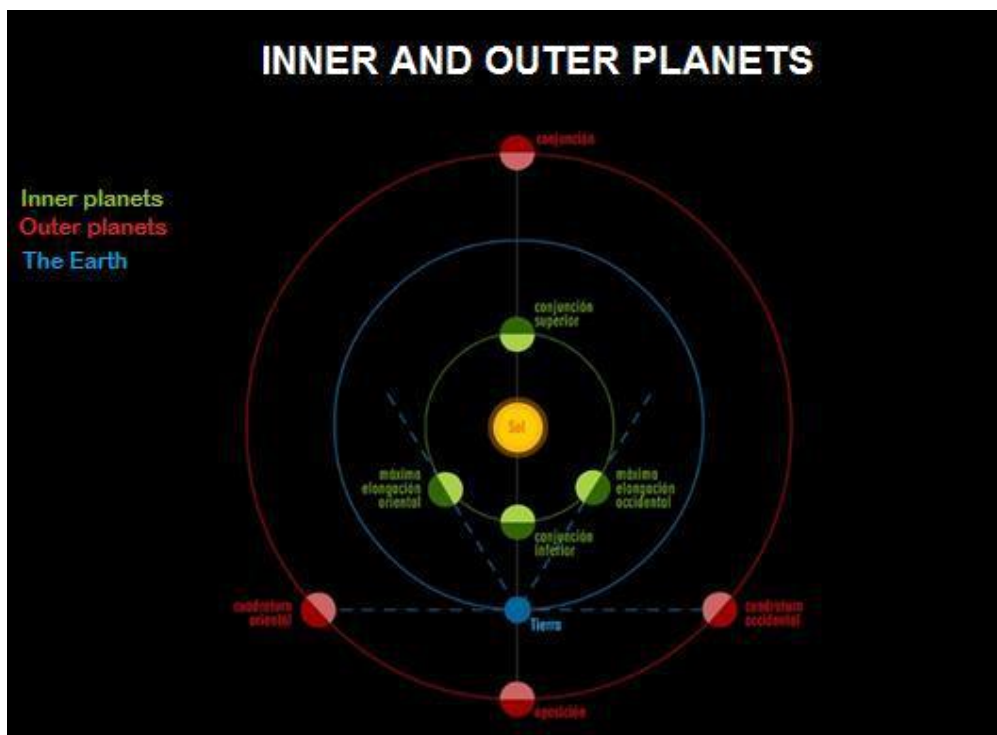
Seen from the Earth, planets can have different positions relative to the Sun, depending on whether they are inner or outer planets.

As inner planets, outer planets are not visible during the **conjunction**, when they are moving behind the Sun. This planet disappearing lasts for couple weeks. Outer planets don't present inferior conjunction as inner planets, because they don't go between the Sun and us (that's why only Mercury and Venus produce solar transits).

Having a larger orbit than the Earth one, when a planet is in the opposite direction of the Sun, that's to say, when the planet is on the eastern horizon, once the Sun has set on the western horizon, it's said to be in **opposition** – in the opposite direction to the Sun -, and it coincides roughly on the date it's closer to us (it can vary from a few days because orbits aren't circular but elliptical).

In outer planets there is a great difference between the distance of the planet with respect to Earth when it's in conjunction – behind the Sun – or in opposition – in the

opposite direction to the Sun -. This big difference between distances makes the planet to be seen through the telescope with apparent sizes very unequal, mostly Mars, the closest to them.



Mars (considered by the Romans as war god) is the fourth planet from the Sun and also known as the “red planet” because of its reddish colour. Mars is about half the size of Earth and it rotates on its axis in 24 h and 37 min. Its rotation axis is 25.2° tipped which produces a seasonal cycle, similar to the Earth.

Mars mass is 11 times less than Earth. Since Mars has less mass than Earth, the surface gravity on Mars is less than the surface gravity on Earth. The surface gravity on Mars is only about 38% of the surface gravity on Earth. In other words, an individual with a weight up to 75 kilograms on Earth, on Mars would weigh around 28 kilograms. Martian atmosphere is very thin, mainly consisting of carbon dioxide. With a very low density, the planet surface pressure is less than one-hundredth of ours. It has two small satellites, Phobos and Deimos with a diameter of about 23 and 11.6 kilometres respectively. Interestingly, all outer planets, together with Earth, have satellites, but inner planets don't.



ACTIVITY 2

APPROACHING AND RECEDING TO THE PLANET MARS. OPPOSITION.

OBJECTIVES

In the previous activity, students established an initial contact with image analysis software measurement tools. In this practice we're going to reinforce the skills they 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

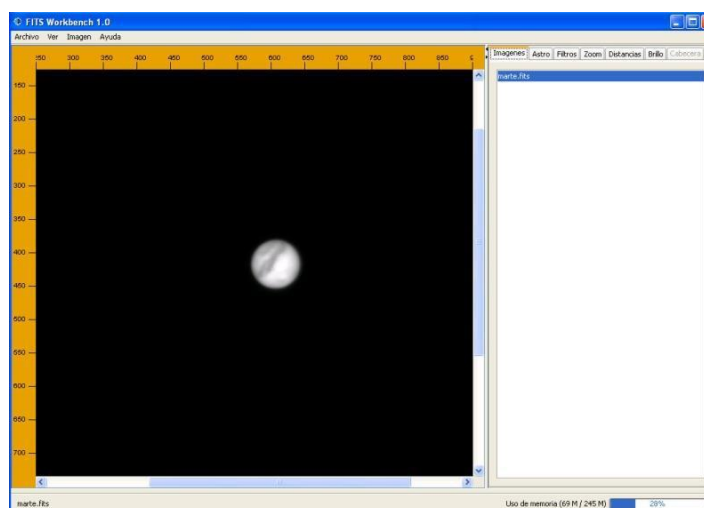
For this practice we are going to use a selection of images of Mars which have been taken over several months with the Liverpool Telescope Roque de los Muchachos Observatory. These images are contained in the folder */Mars/* in our website www.iac.es/peter. For the images processing we will use the “peter_soft” program, which can be downloaded and installed in our computer on the same website. The tool we will use the most is the one for measuring distances.

METHODOLOGY

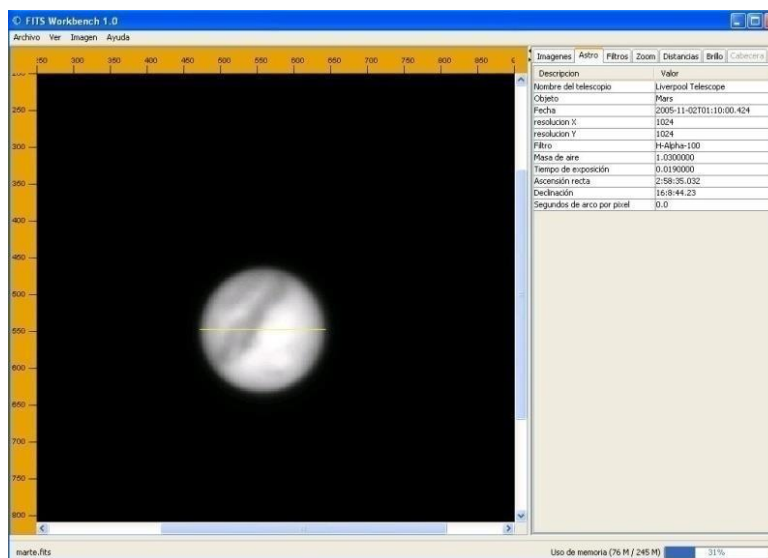
Each astronomical image will be examined. Then we will measure the apparent size of the planet. We will obtain a data table that will be represented on graph in order to deduce the size variation during the months and we'll try to calculate the date of closest approaching.

PROCEDURE

The first thing to do is to download and unzip in our computer the file *U1_imagenes_Marte.zip*, where are contained all the images we're going to study. Then we will open the “peter_soft” program and the image files.



Once we have loaded all the images in the program, you can obtain information of each of them by clicking the ASTRO tab: image date and hour was taken, exposure time in seconds, etc. This information is very important as this will help us to get the necessary data for the purpose of this practice.



As we have done in the previous activity, we're going to use the zoom to increase the planet size. The zoom is very important in this step because, as you will see, the planet appears small, due to its remoteness.

We will also use the *DISTANCES* tab tool and we will measure the planet diameter from one end to the other. This measurement must be done from one pole to the other. The phases of Mars are not like in Venus. Some months before and after the opposition (when Mars shows all its surface fully illuminated) we can see a small portion of one side of the planet (given its proximity) and, therefore, we can see a part of the area not illuminated by the Sun, offering us a small phase similar to the Moon 3 days before and after Full Moon.

We want to see how the apparent size of the planet changes its distance from the Earth and to determine the closest approaching moment. So, we are going to obtain a data table with the date on which the image was taken, as well as the planet apparent size in arcsecs.



Image	Date	Size	Size
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 will be the same as the activity 1:0.27837 arcsecs per pixel.



We will finally represent the data on a graph, so that we can check how the planet apparent size increases and decreases when approaching or moving away from us.

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. We could also find out which martian surface parts can be observed in the images (particularly those where Mars shows a larger size), by using a surface map.

TEACHER'S GUIDE

This unit is designed for student with no previous knowledge of trigonometry. They just have to know measurement length units. For graphical representation it would be useful an Excel worksheet (or any other similar program).

It's not expected that the student will get an equal result to the real one (understood as the most accurate magnitude value), just an acceptable approximation. It is also intended to teach them to use different computing tools for studying astronomical images.

Now we are going to show the results of each activity, as well as the graphs. It should be noted that results do not have to be the same obtained by the teacher or student, they are just a reference.

In some tables a column with real value of magnitude for measuring is added.

ACTIVITY 1. (1st PART) VENUS SIZE

Image	Date	Measure	Scale(km/pix)	Diameter (km)
902a000	19/09/2007	152,3	82,5	12565
906e000	28/09/2007	129,6	94,5	12247
918i000	27/10/2007	91,6	137,6	12604



924f000	01/11/2007	85,9	145,3	12481
934i000	16/11/2007	74,9	167,9	12576

The mean diameter obtained for Venus is: 12.495 km. A very close value to the real one which is 12.103 km.

- Data obtained from the information provided by the image.
- Data obtained from the measure made by the student.
- Data obtained from the relevant calculations.

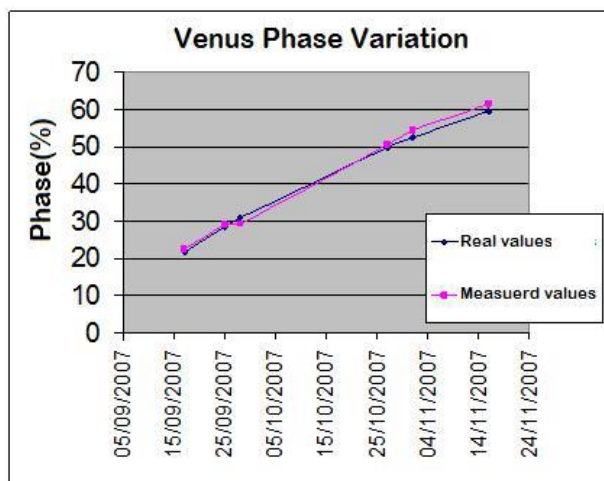
ACTIVITY 2. (2nd PART) VENUS PHASES

Image	A (pixel)	D (pixel)	A / D x 100 (%)	REAL VALUE
902a000	38,5	152,3	25,3%	23,3%
906e000	37,9	129,6	29,3%	30,8%
918i000	46,6	91,6	50,7%	49,7%
924f000	46,9	85,9	54,5%	52,4%
934i000	46,1	74,9	61,5%	59,6%

The “real” Venus phase values for each day (and for the La Palma location, where images were taken) have been obtained by using the astronomical ephemerides application form of the National Astronomical Observatory (<http://www.oan.es/servidorEfem/formulario.html>).



If we represent all the data obtained and Venus phase real values, we can see how this increases as the planet moves away from us, going from 23% to 60% of the illuminated disc.



ACTIVITY 2

APPROACHING AND RESENDING TO THE PLANET MARS. OPPOSITION.

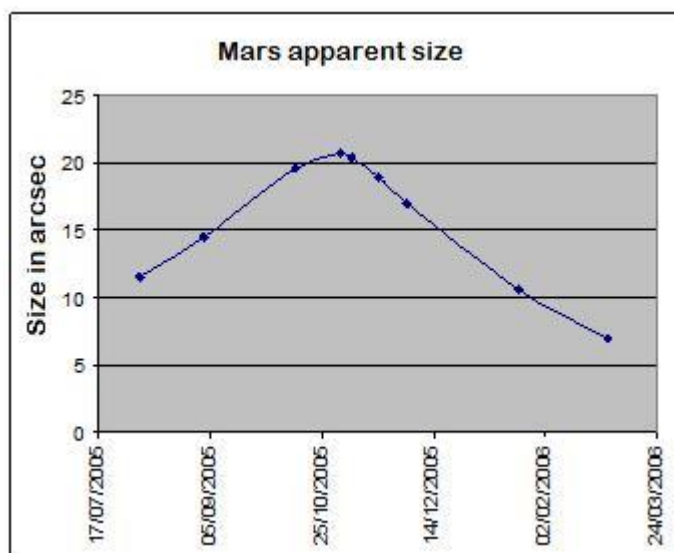
Image	date	Size in arcsec
370j000	04/08/2005	11,5
383a000	02/09/2005	14,5
407g000	13/10/2005	19,6
430e000	02/11/2005	20,7
438c000	07/11/2005	20,4



445e000	19/11/2005	19,0
455i000	02/12/2005	17,0
470f000	21/01/2006	10,6
506g000	02/03/2006	7,0

The opposition of Mars happened on November 7th 2005, when the Sun, Earth and Mars were aligned. The closest approaching of Mars to us took place 9 days before, on October 29th 2005, when Mars and our planet met at a distance of 69,422,386 km. Let us remember that Mars has an elliptical orbit that causes an approaching of our planet to the red planet few days before or after the opposition.

On the graph we can clearly check that the biggest planet apparent size took place some days before November 2nd, date where the fourth image was taken.



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



DISTANCES (1st part). GALAXIES

Author: Oswaldo González

Review: Nayra Rodríguez

Scientific Advisor: Alfred Rosenberg

Illustrations: Inés Bonet



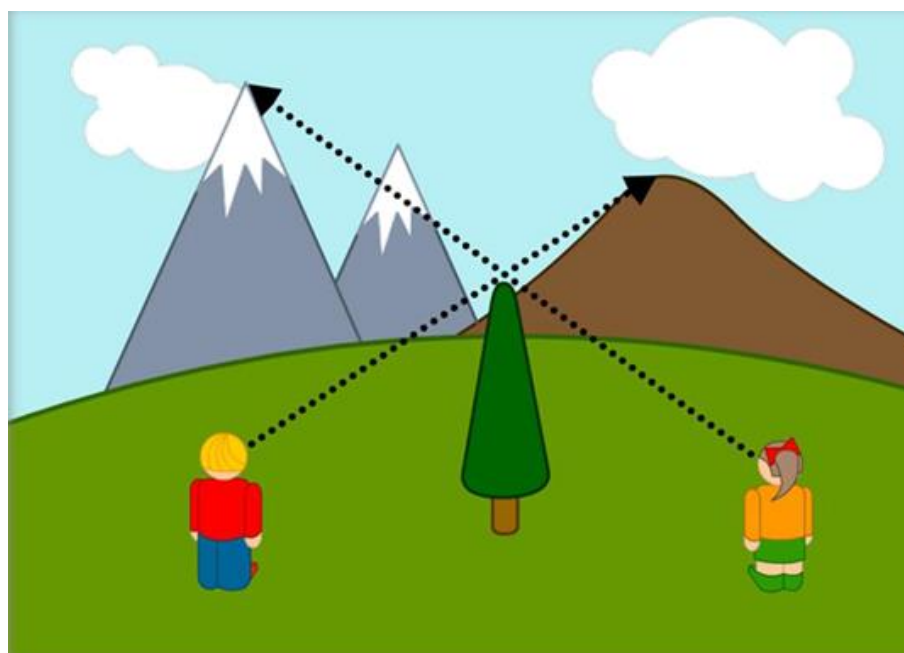
Measuring the distance to the stars

It's complicated to determine the distance to a star because we can not travel to it. These distances have to be measured indirectly, in the same way we measure the distance to objects that are on the other side of a gorge without having to go through it. This method is called parallax, and thanks to it we can estimate the distance in which close objects can be found. How does this method works? It's very easy, reach out your arm and lift the thumb, now close one eye and see which objects are behind the finger, try again but now with the other eye closed and you will see that now behind the finger there are other objects. The method's basis is in the distance between the eyes, that is, the distance or **baseline** between the two points from which we observe the finger and what there is behind it.

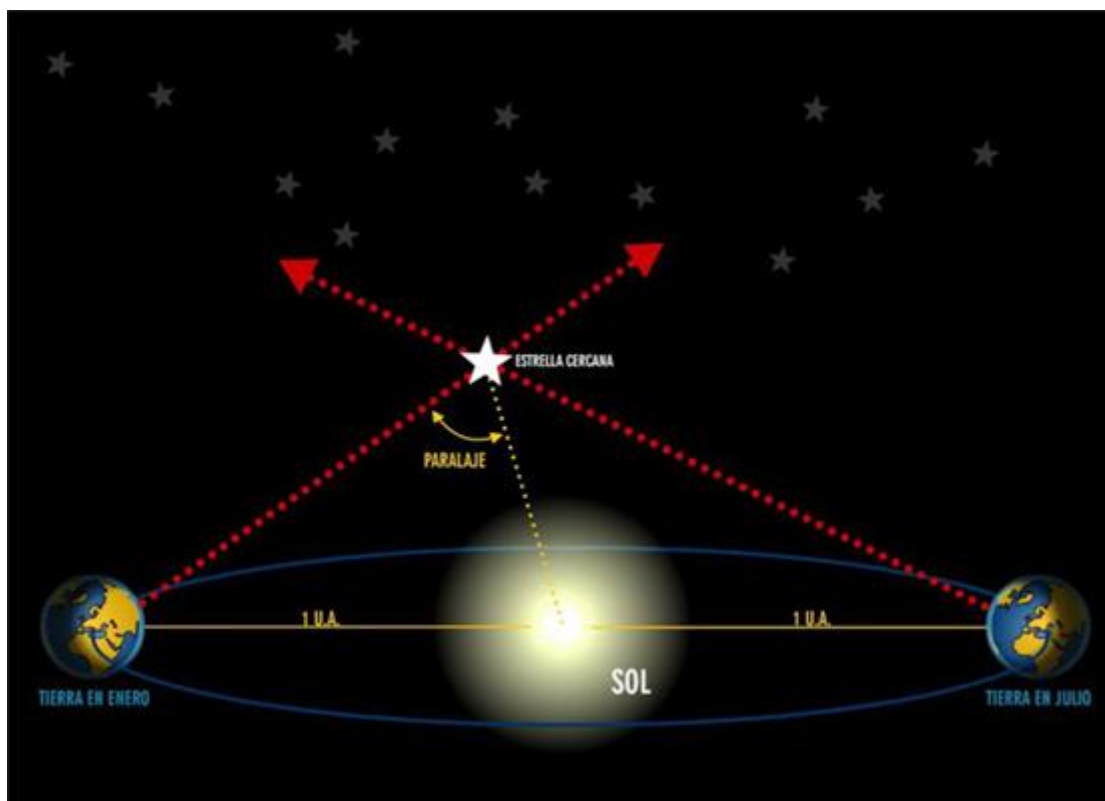
Thanks to years of experience, we have memorized that the greater or lesser angle at which we observe objects close to us, using the stereoscopic vision that having two eyes gives us, is inversely proportional to the distance that separates us from these objects. For example, if we bend our arm and look at the thumb alternately with each eye, we realize that the vision angle increases, however, it decreases as we move the finger away when we stretch the arm. In order to estimate the distance to a tree on the other side of a gorge, what we need to do is to observe it from two different positions, moving several meters. If we measure the angle that the tree forms from the two positions and we know the distance between such positions (baseline), we will obtain a triangle through which we can, by basic trigonometry, know the distance that separates us from the tree. To find out the distance to a star, we have to use a



very long baseline, for example, the Earth's orbit diameter. If we take a nearby star photograph and we wait 6 months to take another picture of the same star, the Earth will have moved half of its orbit, therefore, the distance between the two points where the photographs were taken is two Astronomical Units. An **Astronomical Unit** (AU) is the average distance between the Sun and Earth, ie, if the Earth's orbit radius were circular, it would be nearly 150 million km. Through this way, we are observing the star position from two places that are about 300 million km far from each other. In the photos, we will detect, that the stars are not exactly in the same position relative to the farthest stars, generally weaker. This apparent shift in the star position is called **parallax**. Parallax (α) is the object's apparent change in position due to the change of the observer placement.



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Measuring the very tiny α angle is very difficult. A nearby star has less than 1 arcsecond parallax and the most distant stars have increasingly smaller parallax.

The stars distances are so huge that is not convenient to measure it in astronomical units. When we measure the parallax distances is convenient to use the distance unit called **parsec**, that is equivalent to 206,265 AU (On the next page you will find more information of this number). In other words, one parsec is the distance from which we would see the Earth's orbit radius with an apparent size of 1". Due to the limited telescopes accuracy, this system is only useful to calculate stars distances over 30 parsecs far from us.

Another often used distance unit is the **light-year**, which is the distance that light travels in one year, a very large unit, especially when we think that light moves in the vacuum space at a speed of almost 300,000 km per second. A light-year is equivalent to 63,240 AU and one parsec is 3.26 light-years.

Our Galaxy "The Milky Way"

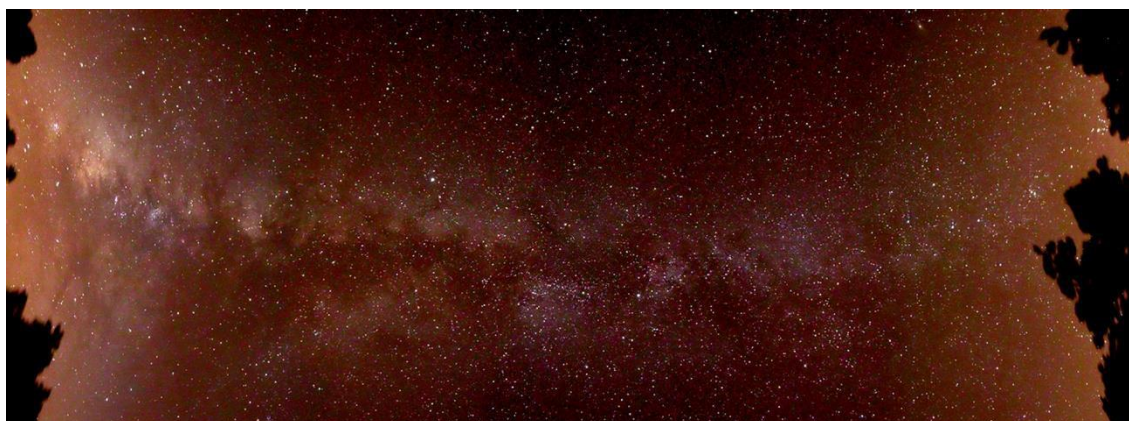
On a dark night, a light band across the sky can be seen with the naked eye. It's our own galaxy, the Milky Way, which means road made of milk. Nowadays we call Milky Way to a two hundred billion stars group, including our Sun, which rotate together in a giant



whirlpool with gas and dust. There are billions of systems like the Milky Way spreaded through the universe. We call them **galaxies**.

Actually, all celestial objects that we see with our naked eyes are our galaxy members, although there are three exceptions: two small irregular galaxies that we can observe from the southern hemisphere, called Magellanic Clouds; and Andromeda galaxy, that is seen with naked eye as a faint light patch, very similar to our galaxy, in the Andromeda constellation.

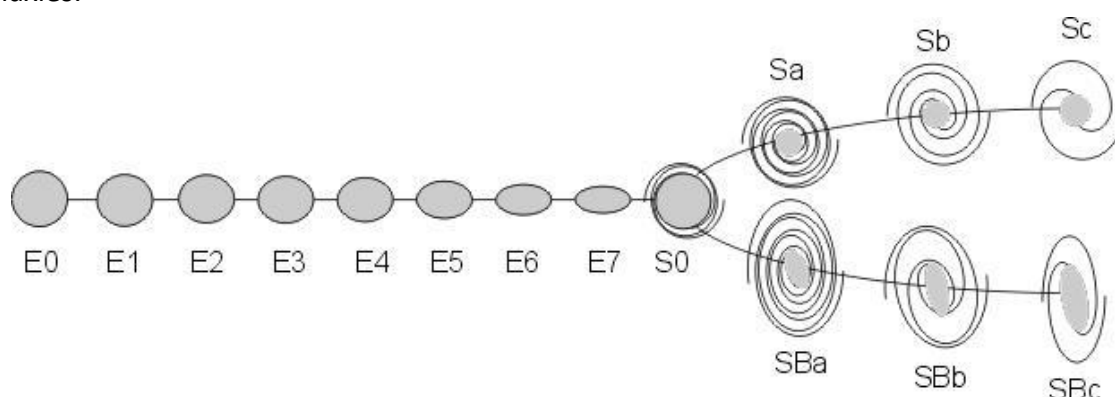
Being immersed within our galaxy, we can't see it as a whole as we see other galaxies, or observe much of it due to dust and gas clouds that hides the light. We can only take photos just over 10% of our galaxy, but it is enough to know the size and shape it has. The Milky Way is disc-shaped and the Sun (and therefore also the Earth) is located approximately midway between the center and the disc end, inside one of the spiral arms it forms.



Our Galaxy, the Milky Way. Author: O. González

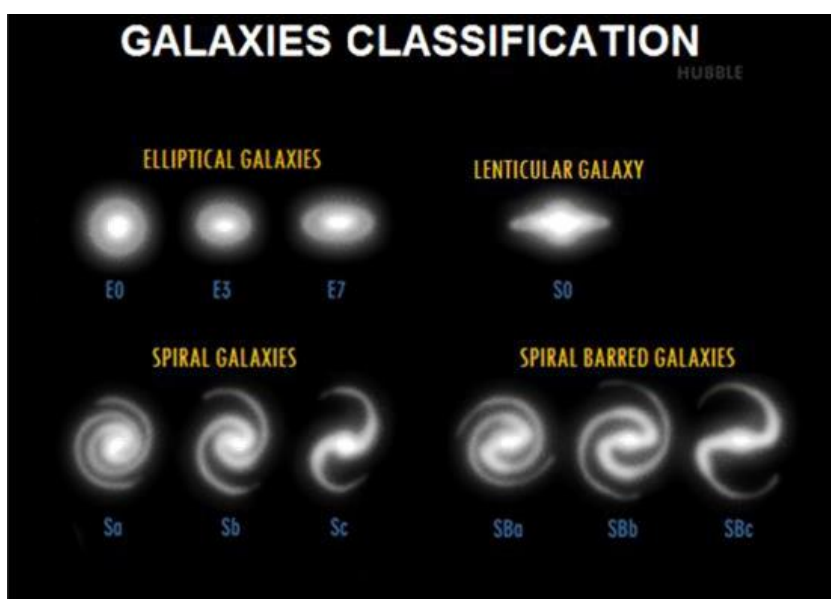
Galaxy Classification

In 1936 the astronomer Edwin Hubble devised a fairly simple system to classify the countless galaxies he observed with professional telescopes. Hubble ordered galaxies in a diagram (called Hubble sequence or Hubble tuning fork) according to their shape, ie, according to their visual morphology. The galaxies can be divided into ellipticals, spirals, lenticulars and irregular galaxies.





Approximately 70% of all galaxies in our nearby universe are **elliptical**. Its appearance is circular or elliptical and no trace of gas, dust, or hot bright stars can be seen. It does not have a spiral structure neither. Elliptical galaxies in the Hubble classification are denoted by the letter E followed by a number from 0 to 7, indicating the apparent aspect of the galaxy. Circular appearance galaxies are classified as E0. The more elliptical galaxy is like, greater number will have.



Although they only represent 30% of all nearby galaxies, the **spirals** galaxies, are the most striking ones. They are easily distinguished by the presence of a **disc**-shaped component containing gas, dust and stars (many of them hot and bright). In addition, they have another component in its center, very bright and composed by stars, known as **bulge**. Spiral galaxies are called this way because they have spirals structures extending from the central bulge, where gas, dust and young stars are concentrated forming what we call **spiral arms**. It is easy to identify a spiral galaxy when we look at it in sideways, when we can see its spiral arms. Nevertheless, the dust is more visible on the galaxies which can be observed by its sideways, because we will notice dark bands throughout the disc that correspond to the zones where the dust is. Spiral galaxies are so bright that they are easily seen from very long distances.

Among spiral galaxies, which are identified with the letter S in the Hubble classification, we mainly distinguish three types:

Lenticular galaxies: those without spiral arms. They are represented as S0.



Regular spirals galaxies: They have spiral arms that come from the galaxy's center where new stars are made. They are represented as $Sa-c$, where the lowercases show the opening level arm. Sa are galaxies that show more closed arms, almost completely closed; Sb , represent the more opened ones like our galaxy or Andromeda; Sc are the ones with completely open arms.



Regular spiral galaxy example

Barred spiral galaxies: They have a bar-like star central group, which comes from the bugle. They are represented by the letters $SBa-c$, and like the previous types, the lowercases show how open the spiral arms are. In this case the spiral arms come from the bars ends not from the galaxy bugle like in the previous case.



Barred spiral galaxy example

Finally, the irregular galaxies are those that don't fit in other Hubble classifications. Their appearance is chaotic and lot of gas and dust is mixed with young and old stars.



Apparently they don't have bugle, arms or spirals. Some of those irregular galaxies are small spiral galaxies that have been distorted by another neighbor galaxy crash or closeness. Magellanic Clouds, easily visible from the south hemisphere are a good example.



Magellanic Clouds taken from Australia. Credits: Chris Schur. NASA Images

ACTIVITY

GALAXIES CLASSIFICATION

OBJECTIVES

The following activity's objective is for students to be familiar with astronomical images, getting to know the handling tools given by the image analysis software, recognizing and identifying the different galaxies shapes and classify them according to its morphology. To do all this, the students will use an images selection obtained by the Liverpool Telescope. They should also calculate, approximately, the galaxy size and be familiar with the different distance units.

INSTRUMENTS AND MATERIALS

To carry out this activity we are going to use a galaxies images selection obtained at different dates by the Liverpool Telescope Roque de Los Muchachos Observatory, which are contained in the folder /Galaxies/ in our web site www.iac.es/peter. To



process the pictures we will use the software “peter_soft” that can be downloaded and installed. The software tools that we are going to use the most, will be the ones that measure distances and different types of filters to improve the visualization of the different parts of the galaxies.

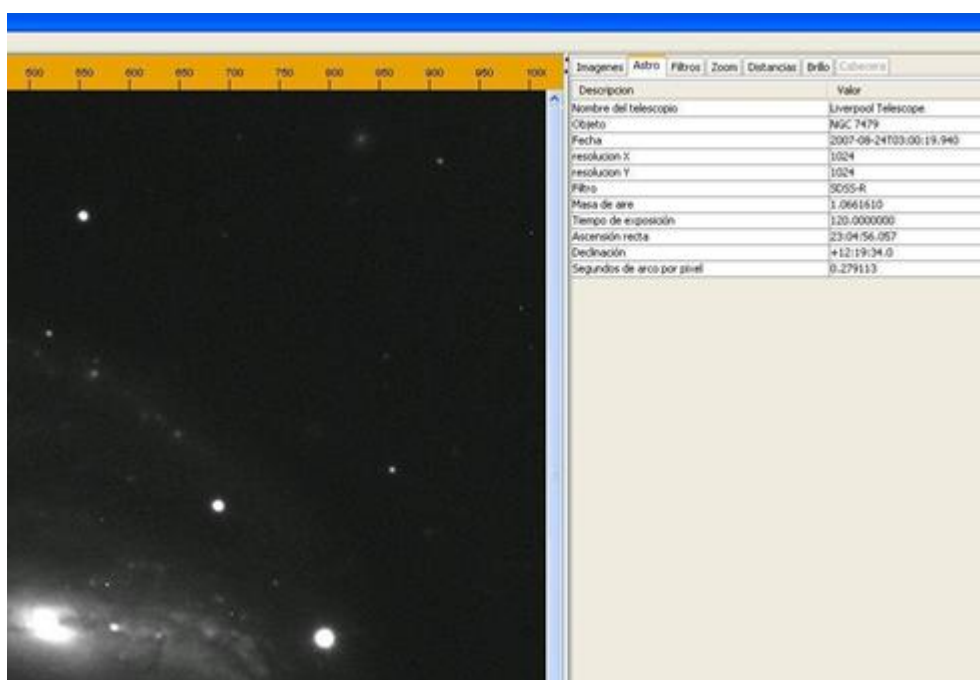
METHODOLOGY

We will proceed to download the group of images and analyze them one by one, identifying the galaxies different parts, classifying them by its morphology and measuring its approximate diameter. We will make a table where we will catalog the galaxies by its appearance.

PROCEDURE

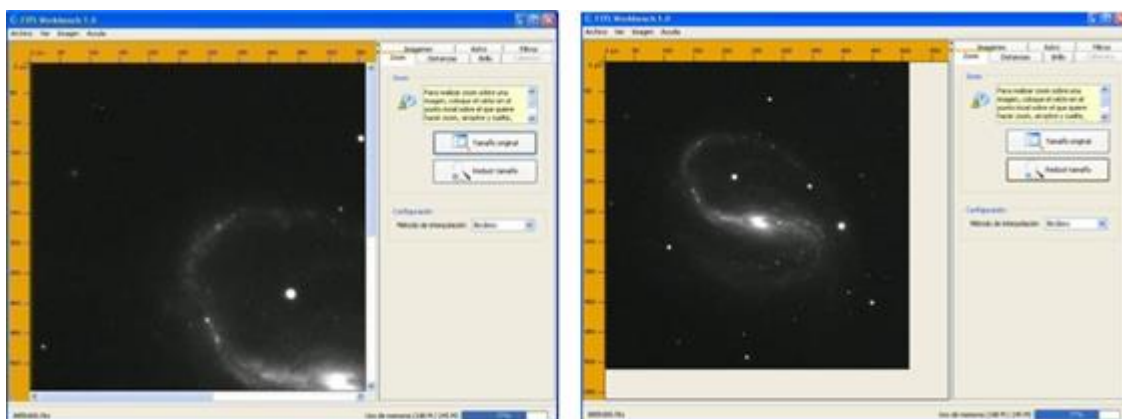
First, download and unzip the file “U2_imagenes_galaxias.zip” in the hard drive, where all the galaxies images that we will classify are. Then run the image analysis program “peter_soft” and open up the images to analyze.

Once the images in the program are loaded, you can obtain their information 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 because the measurements and the necessary data for the activity objective depends on it.

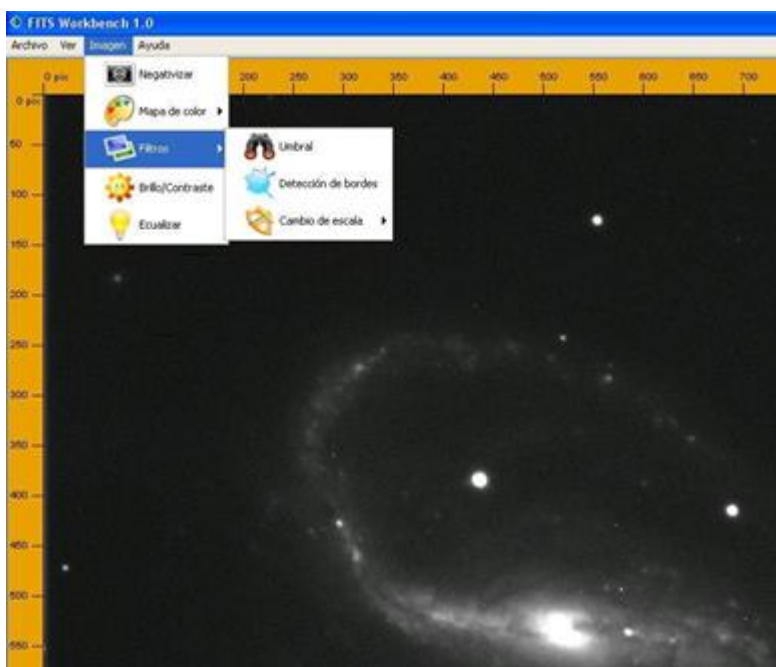




If in any case you need to increase or decrease the images size for a more comfortable viewing, press the Zoom tab. You can use that tool to reduce their size and observe the entire galaxy because, in most cases, galaxies occupy almost the entire image.



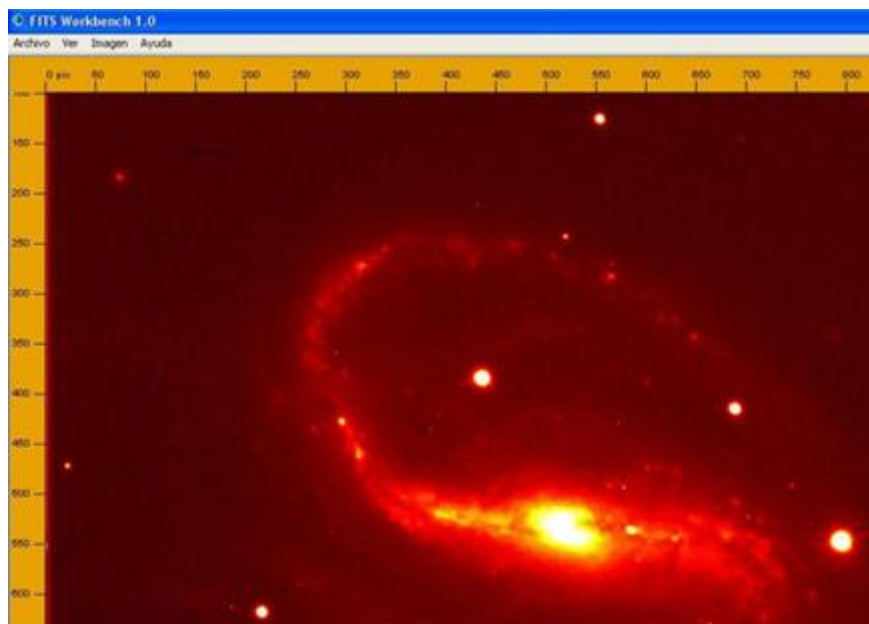
Astronomers use different filters that allows them to properly visualize the bulge, the spiral arms or gas areas of some galaxies parts. To do this, you have to use the different filters available in the "Image" tab in the program top toolbar



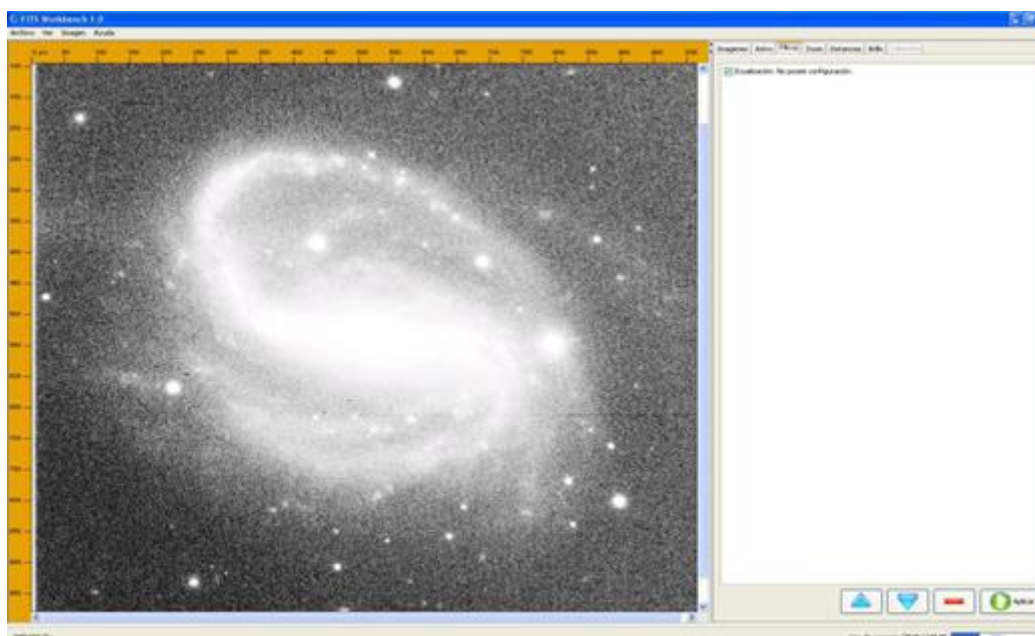
These filters modify the image by changing its brightness, contrast, detecting edges or changing colors. This way, their use can display different image aspects that otherwise could not be observed at first sight. An example can be found in the filter "Thermal



image". When it's applied to an image, the option "color map" in the "Image" tab shows the different parts with colors scale in yellows and reds for easy viewing. The brightest areas are shown in white or yellow and, in dark red tones the weakest.



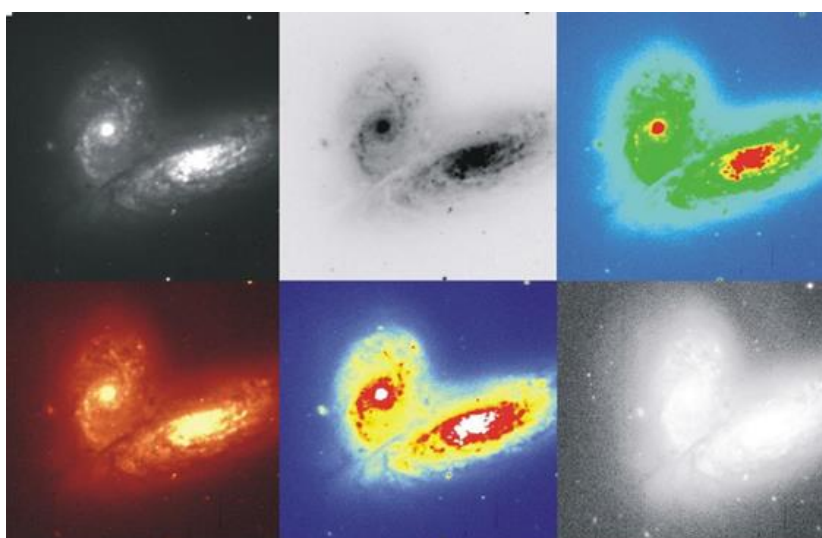
We can also intensify the image equalizing it, ie adjusting the histogram that makes us see the galaxy's weakest parts. To do this, we will use the "Equalize" tool. This process is done at the expense of saturating the brighter parts of it, such as the bugler.



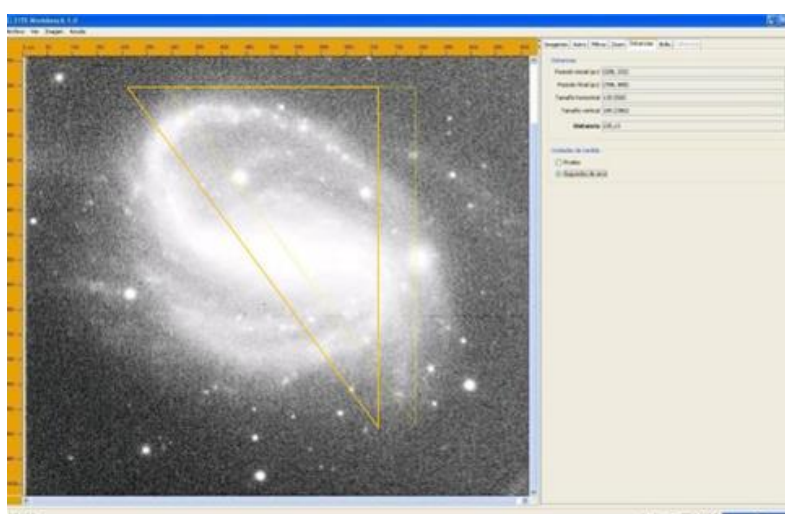


As we use a filter after another, the image changes its appearance for better or worse. In the last case, we can go back cancelling the filter that its not helpful. For that, we need to get into the Filters tab in the toolbar (on the image right side), where we can see the image filters applied to each image, selecting those that you want to apply and cancelling the ones you do not. We will do this by checking the filter boxes of the ones we want to apply (by default all the boxes are checked) and unchecking those boxes we do not want to apply. After all this we need to click on the “Apply” button on the screen right bottom.

An image can look very different depending on the filter we use.



To measure the galaxies sizes use DISTANCES tool (like in previous units) and calculate in pixels the galaxy diameter that you are analyzing, using the appropriate filter that allows you to see how far the galaxy extends to.





In the ASTRO tab you'll find the the galaxy name (Object); the image scale in arcsec per pixel, which is always $0.27837''/\text{pixel}$ for a Liverpool Telescope images; and also the pixel scale to the object, which indicates us the corresponding light-years to a pixel in that particular galaxy image. To calculate this data we have used Equation (1) on page 4 and the distance to the galaxy that we know by other methods beforehand.



Solar System Unit

Authors: Turkish Team



Aims, Goals, or Objectives: Students will be able to experience the meaning of our solar system through multiple modes of expression and through deep immersion in sensory activities.

Grade Level: 4th

Standards:

EARTH SYSTEMS SCIENCE

1. Earth is part of the solar system, which includes the Sun and Moon and other bodies that orbit the Sun in predictable patterns that lead to observable paths of objects in the sky as seen from Earth.

DRAMA AND THEATER ARTS

1. Create characters from scripts or improvisation using voice, gestures and facial expressions.
2. Participate collaboratively with partners and groups.
3. Demonstrate safe use of voice and body to communicate characters.

READING AND WRITING

1. Correct sentence formation, grammar, punctuation, capitalization and spelling are applied to make the meaning clear to the reader.

Introduction: Students will be introduced to the concept of our solar system through several different, immersive experiences. The unit begins by reading a poem about the sun to students with the lights off and a solar system video projection on. After the poetry reading - setting the stage -- the students are introduced to the lesson components. Students will choose their own planet to research using the Internet and books to learn about their individual planet properties. Their research, for the most part, will be self-guided inquiry. Students will create a solar system dance rotating around the Sun in which each student “becomes” and dances as the planet they researched. Students will do the solar system dance again, but the teacher will “freeze” movement and call on students/“planets” to recite their poems.



Gravity and Weight on Other Planets

Authors: Turkish Team



Students learn about gravity, mass, and weight by calculating their weights on various planets.

Grades 3 | 4 | 5 | 6

Subjects: Science

Objectives

Students will practice multiplication skills.

Students will learn about mass, weight, and gravity.

Materials

Scale (one per class is plenty)

Calculator (optional)

Weight Chart (see lesson)

Procedure

Start with a mini lesson about mass, weight, and gravity. Here is some background information:

Weight is a measurement of the force on an object caused by gravity trying to pull the object down. Mars has less gravity than Earth. Therefore if you were on Mars you'd weigh less because the force of gravity wouldn't be as strong as it is here on Earth.



Does this mean you would suddenly be thinner on Mars? No. You would have the same amount of mass as you do on Earth. (Mass is the amount of stuff inside an object.)

So, on Mars, your mass would be the same as it is here on Earth. But you'd weigh less because Mars has less gravity than Earth.

Gravity is an attractive force. This doesn't mean it's pretty. What "attractive" means is that an object's gravity pulls other objects toward it. Look at the chart (see below). The Earth's gravity naturally pulls us, and everything else, toward the center of the planet, which keeps us from drifting off into space.

The Earth isn't the only thing that has gravity. In fact, every single object in the universe has gravity. The tables you're sitting at have gravity. They are pulling you towards them. You have gravity, and you are pulling the tables towards you. We can't see or feel these things happening because people and tables have such a small mass that the effects of gravity cannot be seen.

Mass is the amount of stuff contained inside an object. It takes a lot of mass to make a lot of gravity. The Earth has a lot of mass, so it has a lot of gravity. The moon's gravity is about 1/6 the amount of the Earth's because the moon has less mass than the Earth.

So what does all this have to do with weight? Well, weight is the force on a object caused by gravity trying to pull the object down. A scale measures how much gravity your mass has. A person with more mass has more gravity, and therefore weighs more.

You've probably seen video footage of astronauts walking on the moon. They seem to float between each step. Remember that the moon has about 1/6 the amount of gravity that the Earth has? Well, if you went to the moon, you'd weigh less than you do here on Earth. Does this mean you would suddenly be thinner on the moon? Absolutely not. Your mass would be the same -- there is no less of you on the moon. But your weight is different because the moon's gravity is different.

Instructions for the Project:

Look at the Weight Chart.

Weigh yourself, or guess what you weigh.

Record your mass in the chart below. Your mass is your weight on Earth.

Multiply your mass times the gravity in each row to figure out your weight at each location.

Where do you weigh the most? Where do you weigh the least?



Weight Chart

Location	Mass	Gravity	Weight
Earth		1	
Outer space		0	
Earth's moon		0.17	
Venus		0.90	
Mars		0.38	
Mercury		0.38	
Jupiter		2.36	
Saturn		0.92	
Uranus		0.89	
Neptune		1.13	
Pluto*		.07	

To calculate your weight: mass x gravity = weight



Why teach Astronomy?

Authors: Turkish Team



Astronomy can be one of the most exciting units you teach. Few subjects offer you so much versatility covering many areas such as History, Physics, Geology, Geography, Art, and much more. Most importantly the children enjoy learning about Astronomy. It is fun for children, because it stretches their imaginations forcing them to contemplate the stars, nebula and planets.

- For young children, role-play is a good way to learn science concepts. You can teach them the concepts of rotation and revolution by holding a large ball to represent the sun and having them hold smaller balls for planets, turning around slowly to represent rotation and walking around you to represent revolution
- In addition to sharing factual information about stars and constellations, you can also share the stories various cultures have developed around the constellations This can interest your child not just in astronomy, but mythology and folklore as well.

HOW TO TEACH YOUR STUDENTS ASTRONOMY

Preschool

Children who can walk will have an interest in the sky. Start with preschoolers by pointing out the Moon and the Sun. Talk about how they are always in different places. Their first lesson about the mechanics of the solar system can be the simple observation that the Sun seems to rise in the morning and fall in the evening.

Preschool is an ideal time to talk about what the stars are and what the Moon is. You don't need any equipment. Just informally engage with children about what they see. Show them lots of pictures of the Earth from space and of our solar system. Let their questions guide your focus.

Kindergarten Through Second Grade

Children learn best by doing. As children get older the more doing of astronomy they will be able to participate in. But young children can still do a lot of science. Have the children keep



a Moon Log. In a small notebook have them observe the Moon every day, or several times a week for a month. Every night they need to look for the Moon and draw a picture of what they see. Children with adequate language skills can write a brief description as well. For bonus points have the children record the time they made their observation in the log as well. Over the course of a month they will see all the phases of the Moon. They may also notice the Moon appearing in different places in the sky. After the Moon log is complete discuss with the children what they learned. Let them present their findings. A Moon Log can also be the basis for making a report on poster board.

During these years children start to learn about their place in the world and universe. You can teach them that they belong to a family, that lives in a city, that is in a state, that is part of a country, that is on a continent, that is part of the Earth, that is a planet in the Solar System, that is part of the Milky Way Galaxy, that is part of the Universe. Astronomy helps children learn about their relationship to what they see and to understand they are a part of something small and something huge.

Third Grade Through Fifth Grade

Now is the time to get a telescope. You don't have to get anything super expensive. A basic one can be bought for under \$100 and will be adequate for most uses. This age can learn in more detail about the Moon and its relationship to Earth. With the use of a telescope and the Internet, children at this stage can be experts in lunar geography. They can learn the names of the craters and Lunar Seas.

Children at this stage are also ready to move beyond the Moon. Several planets can be seen with the naked eye or a simple telescope. Show the children Mars and Venus, or even Jupiter. They should know the planets and organization of the solar system.

Middle School

The Middle School years are a great time to learn about the sky and the contents of our galaxy in more detail. The concept of the light-year should be introduced. Middle school students can combine astronomy with math by calculating how long it takes light to reach Earth from a star given its distance in light years. Telescopes can be used to observe Venus and Mars, as well as a few bright stars.

Middle School is also a great time to introduce some of the weird and strange phenomena in our universe. Everything from black holes and quasars to nebula and red dwarfs are usually of interest. Learning about the local moons of other planets in our own solar system is also a possibility.



Projects for this age group may include planning a long-term interplanetary trip. The student can design the ship and explain how to overcome the enormous distances that currently preclude human space exploration much beyond our Moon. Students could explain where they hoped to go and hypothesize on what they may find.

High School

Students at this age are ready to not only understand how a telescope works, but to build their own telescope. There are many excellent online tutorials. The materials are relatively cheap. Understanding how the optics of a telescope work has a wide variety of useful applications.

Students at this age are often far more interested in happenings beyond the Moon and are usually mature enough to pick their own focus. Some possibilities are more advanced study of black holes and the theory of relativity.

In addition to spending time practicing spotting landmarks in the night sky, students can learn to navigate using the stars as ancient mariners did. Another great activity for high school students is to have them mentor younger students on how to use a telescope or how to find different objects of interest in the night sky.

No matter which level one is supposed to teach, it should be remembered that teaching Astronomy might be a bit challenging since your students might have difficulties in understanding certain phenomenons. Therefore, it might be a good idea to include some role-playing activities, funny cartoons etc. to our curriculum to keep them focused and visit observatories to motivate them to learn more about Astronomy which is of vital importance since it will give our children the opportunity of pursuing careers in science and technology by engaging in astronomy related educational activities.



Sally Ride EarthKAM or Modern teaching Process through the use of Space Technology in teaching Natural Science lessons

Authors: Slovenian Team



Introduction

The implementation of E-learning has become an everyday practice in the modern teaching process, because it allows quick access to information, enabling the implementation of learning interaction and global communication. Internet also allows teachers to develop students skills of independent learning in the field of ICT.

Sally Ride EarthKAM is a NASA educational program that allows students around the world to take photos of Earth from a digital camera aboard the International Space Station. The founder of the program is Sally Ride, the first American woman in space, who wanted to share with others her experience of seeing planet Earth from space. The program began in 1996 under the name of KidSat, a year after the death of an astronaut in 2012, the program was renamed to Sally Ride EarthKAM. So far hundreds of schools from around the World have participated in Sally Ride EarthKAM missions and their students have recorded more than 70,000 photos of the Earth's surface [1]. So far Sally Ride EarthKAM is the only one public available program on any orbital device [2]. Photographing the Earth's surface takes place four times a year. 854 schools from all over the world were involved in November mission, 2014, including the first one from Slovenia, Franjo Malgaj Primary school from Šentjur.



Communication Between Participations and International Space Station

The main communication between participants and International space station is carried out on a web portal <http://www.earthkam.ucsd.edu> is administrated by coordinators from the California University in San Diego. All students must first register for the Sally Ride EarthKAM program and sign up to participate in any of the missions.

Once the students are logged in they can start the procedure to the Mission Operations Center page which is an entry point for submitting requests for images to the Sally Ride EarthKAM camera. Before carrying out the mission they received a list of entry codes for individual requests.

After students identified targets for photographing, making the image requests is easy. Once all the requests are selected, they are sent through Johnson`s Space Center in Houston to the International Space Station.

After the images are taken from aboard the International Space Station, the files are transmitted back to Sally Ride EarthKAM, where students receive their images.



Fig. 1. Diagram of the procedure (Source: Sally Ride EarthKAM)

Registration and signing on a mission

The teacher whose school wishes to participate on a mission must fill the registration procedure and log in to the web portal of the Sally Ride EarthKAM Mission Operation centre. From here on the work of the teacher is only to take control of the students work because the web portal is designed to allow students to be fully autonomous in further work (Fig. 2).



Fig. 2. Student's Autonomy by submitting Request (Source: Jure Radisek)

Identifying Targets

In this stage, students having determined the areas of the Earth, they want to take photos, taking into account all the technical requirements of photography. This provides some additional geographic background knowledge, especially knowledge of determining the geographical location and analysing weather forecasts.

Students must be careful not to choose an area outside the International Space Station orbits and they can only choose orbits from the day period of the selected area. During the camera is taking photos also the weather should be clear, otherwise the surface in the photos is not clearly visible (Fig. 3).

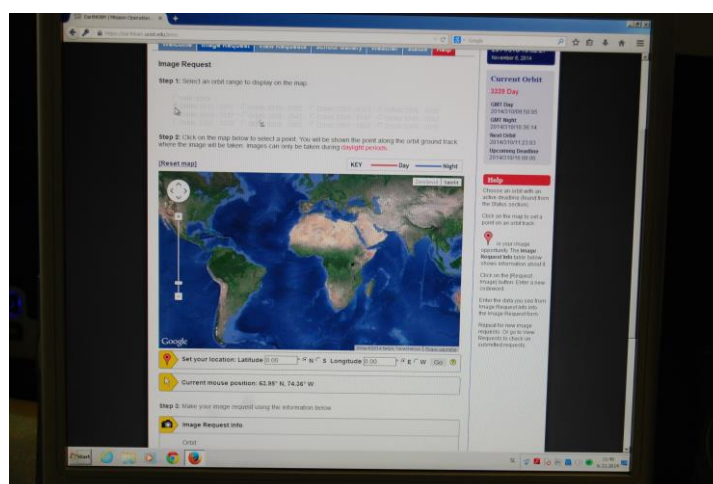


Fig. 3. Determining the ISS orbit (Source: Jure Radisek)



Submission of Requests and Taking Surface Photos

When students successfully identify the wishing area the requests are gathered at UCSD and forwarded to the Johnson's Space Center and further to the International Space Center (Fig. 4).

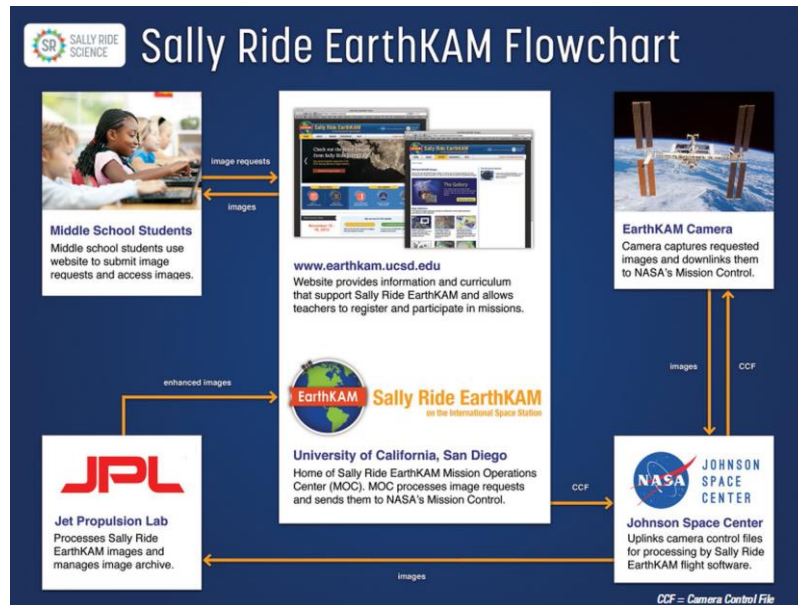


Fig. 4. Chart of Procedure (Source: Sally Ride EarthKAM)

If students have carefully followed to all the necessary technical requirements, they should receive their own Earth's surface photos (Fig. 5).

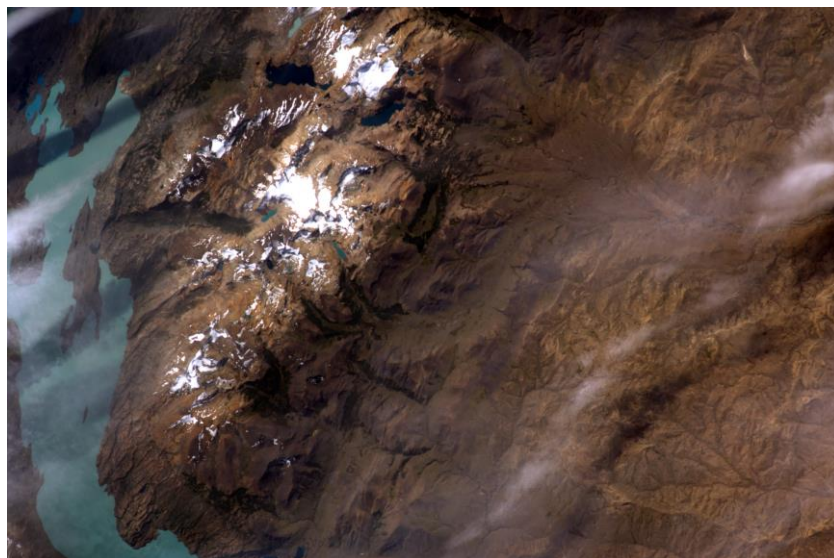


Fig. 5. Photo of Selected Area (Source: ISS_IMAGE_81182)

Analysing Photos

Successfully captured images are available in the School Gallery [3]. When Students find their photos, they can be downloaded in a JPG or TIFF format together with a KML file. The KML file allows you to observe the photographed area in Google Earth where photos can be compared with their actual location in three-dimensional model of the Earth, and thus identify the processes and phenomena visible on the taken photos of the surface (Fig. 6Fig. 6).

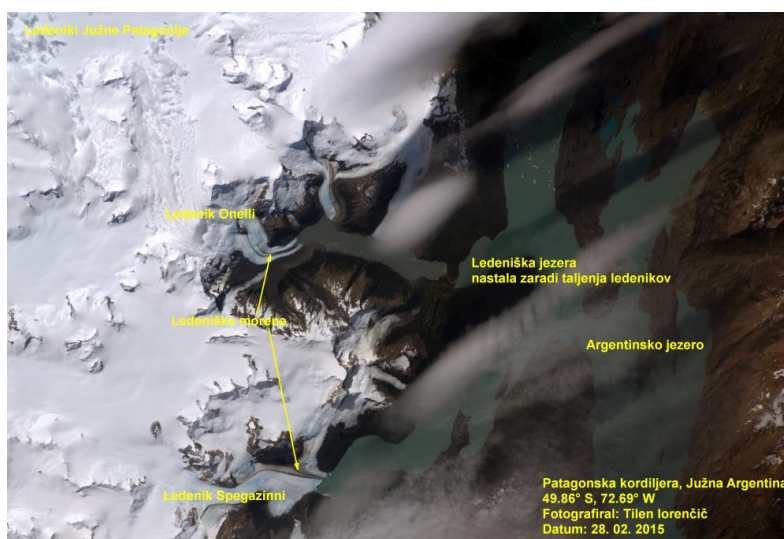


Fig. 6. Example of the Analysis of photographed Area (Source: ISS_IMAGE_81181)

Conclusions

The program allows students a unique perspective view of the Earth's surface from aboard the International Space Station. Therefore, all gained photos have an educational and personal note. In Geography lessons we use photos in learning about the relief features, water bodies, glacial and wind erosion and identification of human impacts on the surface.

Students have showed a lot of interest and motivation, especially in the identification of the individual natural and social characteristics that were visible on the surface. The main objective of using the internet to support the process of teaching has been successfully achieved. At the same time students have improved their motivation in Geography lessons, practiced their communication skills and improved teamwork skills. Students were impressed by the fact that they can remotely manage the camera on the International Space Center and determine the objectives on the surface of the Earth to be taken by the camera. These facts give the program actually another dimension and confirm the usefulness of the Internet in the process of teaching.



1 Attachments

Name: _____

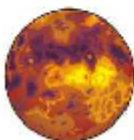
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Calculate Your Weight on Other Worlds



Mercury is the smallest planet, and the planet closest to the sun.
The gravity of Mercury is 38% of Earth's gravity.
To calculate your weight on Mercury, multiply your weight by 0.38.

$$\frac{\text{(Your Weight on Earth)}}{\text{(units - lbs or kg)}} \times \frac{\text{(Multiply by)}}{\text{(Multiply by)}} = \frac{\text{(Your weight on Mercury)}}{\text{(units - lbs or kg)}}$$



Venus is known as the "Cloudy Planet" because it is covered with thick, yellow clouds.
The gravity of Venus is 90% of Earth's gravity.
To calculate your weight on Venus, multiply your weight by 0.9.

$$\frac{\text{(Your Weight on Earth)}}{\text{(units - lbs or kg)}} \times \frac{\text{(Multiply by)}}{\text{(Multiply by)}} = \frac{\text{(Your weight on Venus)}}{\text{(units - lbs or kg)}}$$



The Earth's moon is the only heavenly body that people have walked on.
The gravity of the moon is 17% of Earth's gravity.
To calculate your weight on the Moon, multiply your weight by 0.17.

$$\frac{\text{(Your Weight on Earth)}}{\text{(units - lbs or kg)}} \times \frac{\text{(Multiply by)}}{\text{(Multiply by)}} = \frac{\text{(Your weight on the Moon)}}{\text{(units - lbs or kg)}}$$



Mars is known as the "Red Planet" because the soil is filled with orange-red particles.
The gravity of Mars is 38% of Earth's gravity.
To calculate your weight on Mars, multiply your weight by 0.38.

$$\frac{\text{(Your Weight on Earth)}}{\text{(units - lbs or kg)}} \times \frac{\text{(Multiply by)}}{\text{(Multiply by)}} = \frac{\text{(Your weight on Mars)}}{\text{(units - lbs or kg)}}$$



Jupiter has more moons than any other planet. So far, scientists have discovered 63!
The gravity of Jupiter is 234% of Earth's gravity.
To calculate your weight on Jupiter, multiply your weight by 2.34.

$$\frac{\text{(Your Weight on Earth)}}{\text{(units - lbs or kg)}} \times \frac{\text{(Multiply by)}}{\text{(Multiply by)}} = \frac{\text{(Your weight on Jupiter)}}{\text{(units - lbs or kg)}}$$



