



HOW TO GIVE COLOUR TO THE UNIVERSE

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In this scenario we will try to teach the students how to use a robotic telescope. They will have the opportunity to take their own photo of an object of the universe and we will give them instructions how to analyze the picture and give colour to it.

EDUCATIONAL CONTEX

AGE: 12-15

DURATION: 3 hours

PREREQUISITES

The students have to know how a filter works and what is the electromagnetic spectrum.

EDUCATIONAL OBJECTIVES

The students have to learn:

- which are the main parts of a telescope
- How to use a robotic telescope
- How to process a picture taken from the telescope with tools such as salsaj, gimp, astroimagej, etc

AFFECTIVE OBJECTIVES

Students will learn how we can process an image taken by a telescope and how we can improve it.

PSYCHOMOTOR OBJECTIVES

Students will feel how an astronomer works and how important is to understand how the universe works.

CONNECTION TO THE CURRICULA

Greek students at junior high school (12-15 years old) learning about phenomena with light such as refraction, diffusion etc. With this scenario we



will show them the importance to analyze the light from an object of the deep space with different filters.

EDUCATIONAL APPROACH

How does a telescope work?

The students will learn about the basic parts of a telescope and how it collects the light from objects that they are too far from us.

A **telescope** is a tool that astronomers use to see faraway objects. Most telescopes, and all large telescopes, work by using curved **mirrors** to gather and focus light from the night sky.

The first telescopes focused light by using pieces of curved, clear glass, called lenses. So why do we use mirrors today? Because mirrors are lighter, and they are easier than lenses to make perfectly smooth.

The mirrors or lenses in a telescope are called the “optics.” Really powerful telescopes can see very dim things and things that are really far away. To do that, the optics—be they mirrors or lenses—have to be really big.

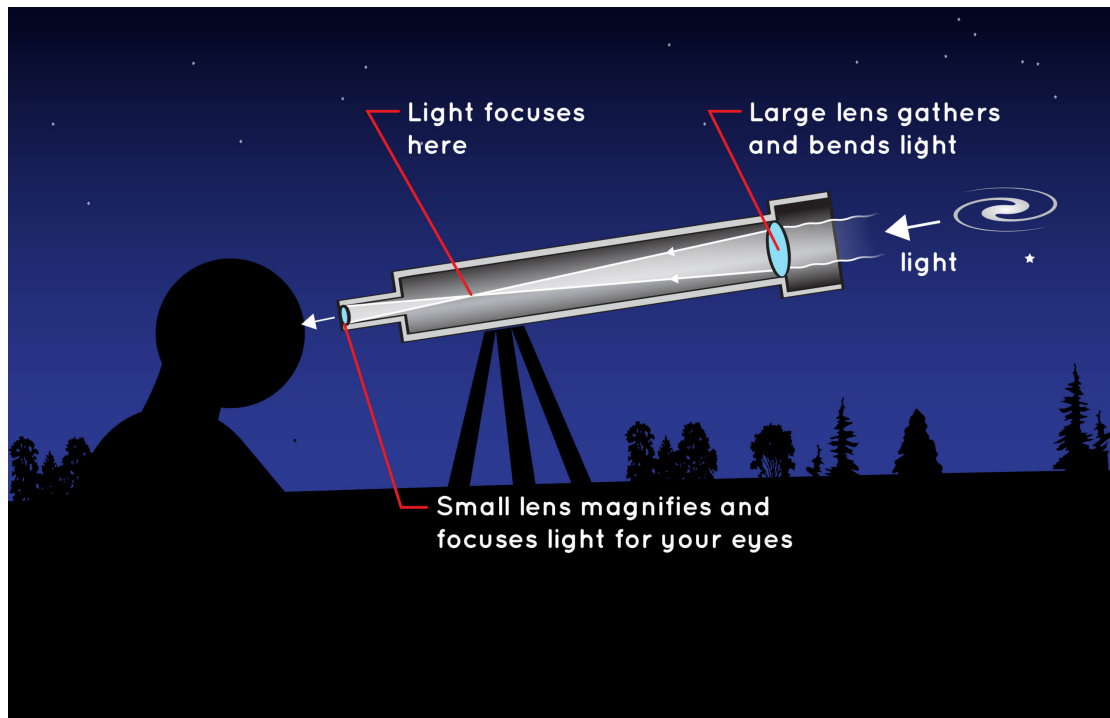
The bigger the mirrors or lenses, the more light the telescope can gather. Light is then concentrated by the shape of the optics. That light is what we see when we look into the telescope.

The optics of a telescope must be almost perfect. That means the mirrors and lenses have to be just the right shape to concentrate the light. They can't have any spots, scratches or other flaws. If they do have such problems, the image gets warped or blurry and is difficult to see. It's hard to make a perfect mirror, but it's even harder to make a perfect lens.

Lenses

A telescope made with lenses is called a **refracting telescope**.

A lens, just like in eyeglasses, bends light passing through it. In eyeglasses, this makes things less blurry. In a telescope, it makes faraway things seem closer.



A simple refracting telescope uses lenses to make images bigger and more visible. Credit: NASA/JPL-Caltech

People with especially poor eyesight need thick lenses in their glasses. Big, thick lenses are more powerful. The same is true for telescopes. If you want to see far away, you need a big powerful lens. Unfortunately, a big lens is very heavy.

Heavy lenses are hard to make and difficult to hold in the right place. Also, as they get thicker the glass stops more of the light passing through them.

Because the light is passing through the lens, the surface of the lens has to be extremely smooth. Any flaws in the lens will change the image. It would be like looking through a dirty window.

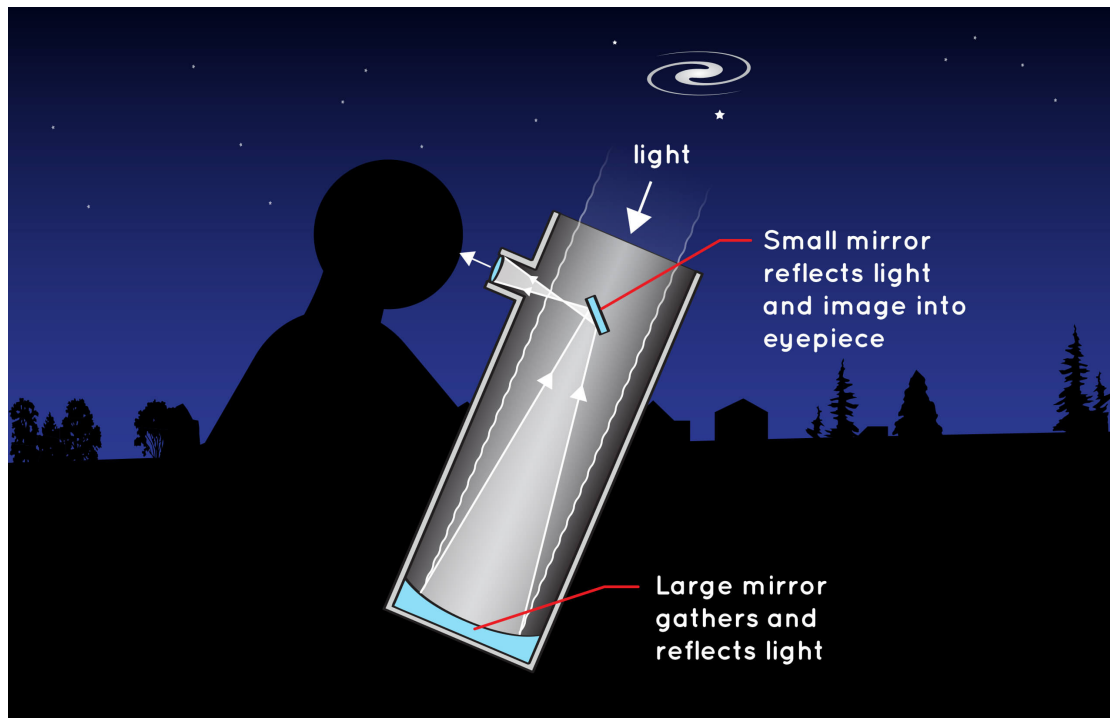
Why Mirrors Work Better

A telescope that uses mirrors is called a **reflecting telescope**.

Unlike a lens, a mirror can be very thin. A bigger mirror does not also have to be thicker. Light is concentrated by bouncing off of the mirror. So the mirror just has to have the right curved shape.

It is much easier to make a large, near-perfect mirror than to make a large, near-perfect lens. Also, since mirrors are one-sided, they are easier than lenses to clean and polish.

But mirrors have their own problems. Have you ever looked into a spoon and noticed your reflection is upside down? The curved mirror in a telescope is like a spoon: It flips the image. Luckily, the solution is simple. We just use other mirrors to flip it back.



*A simple reflecting telescope uses mirrors to help us see faraway objects.
Credit: NASA/JPL-Caltech*

The number-one benefit of using mirrors is that they're not heavy. Since they are much lighter than lenses, mirrors are a lot easier to launch into space. Space telescopes such as the **Hubble Space Telescope** and the **Spitzer Space Telescope** have allowed us to capture views of galaxies and nebulas far away from our own solar system. Set to launch in December 2021, the [James Webb Space Telescope](#) is the largest, most powerful space telescope ever built. It will allow scientists to look at what our universe was like about 200 million years after the Big Bang.



This image of the Crab Nebula was created with information from the Hubble Space Telescope, the Spitzer Space Telescope, the Chandra X-ray Observatory, European Space Agency's XMM-Newton and the Very Large Array. Credit: NASA, ESA, NRAO/AUI/NSF and G. Dubner (University of Buenos Aires)

Info: <https://spaceplace.nasa.gov/telescopes/en/>

Connection with the LCO telescopes!

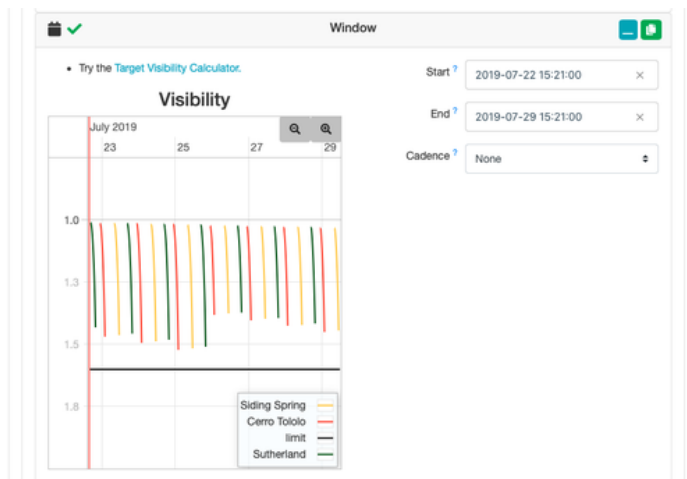
The screenshot shows the LCO Observation Portal interface. The main content area is titled 'Duration of Observation Request?' and displays '0 min 0 sec'. Below this, there are sections for 'Request' and 'Configuration'. The 'Request' section includes a 'Name' field with a red border and a 'Proposal' dropdown menu, both with red error messages: 'Please provide a name.' and 'Please provide a proposal.' respectively. The 'Configuration' section includes an 'Instrument' dropdown menu set to '0.4 meter SBIG'. On the right side, there is a sidebar with buttons for 'Clear Form', 'Save Draft', 'Submit Request', and 'Toggle Navigation', along with a list of error messages: 'General Information' and 'Request #1'. The top navigation bar includes 'Home', 'Submit Observation', 'Manage Proposals', 'Planning Tools', and 'Help'. The bottom of the browser window shows the Windows taskbar with various application icons and system tray information.

The students have to take a picture of an object at the sky using different telescopes with different exposure time and they have to recognize the differences among their images. The steps that a student should follow to take an image from a telescope are shown below

Step 1: Define your Observation Window – Select the time period within which you'd like your observations taken. We recommend a minimum length of one week.

Step 2: Select a visible object. For example M42

(LCO Visibility Plot: When scheduling your observations on the LCO queue, after you have defined your time window, a plot will appear showing the visibility of your target object at each observatory location during this period. Each site is coded with a different colour and visibility is shown as the change in airmass (essentially, the amount of atmosphere through which light from the object must travel) of the object over time.)



Step 3: Select a suitable exposure time - The exposure time is how long the telescope shutters stay open to collect light from your object. A suitable exposure time must be selected: if the exposure time is not long enough, the object will appear too faint, while over-exposure leads to saturation and loss of detail.

Step 4: Select suitable filters – Each telescope class has different filter sets available – these are detailed in the table below. If you are just interested in making a colour image then we recommend you take an image with the red, green and blue filters (N.B. the MuSCAT3 camera on FTN has fixed filters and takes an image using all filters at the same time, so on this telescope you cannot choose a filter).

Step 5: Schedule your observations – once you know what telescope size, object, exposure time and filter you plan to use, you are ready to go onto the [LCO observing portal](#) and schedule your observations – good luck and happy observing!

Info: Sarah Roberts : LCO Robotic Telescope Observation Planning Steps

Which are the main causes that the images of the same object are different ?

The students have to wonder reasons that affect the image of an object.

The main causes are:

The diameter of the telescope.

The exposure time.

The filters we use.

The weather conditions.

The visibility of the object during a period.

Why do we use filters while taking an image?

Like a photographic filter, telescope filters enhance details and improve contrast. They do this by cutting out unwanted colors, or wavelengths of light.

How can we process an image?

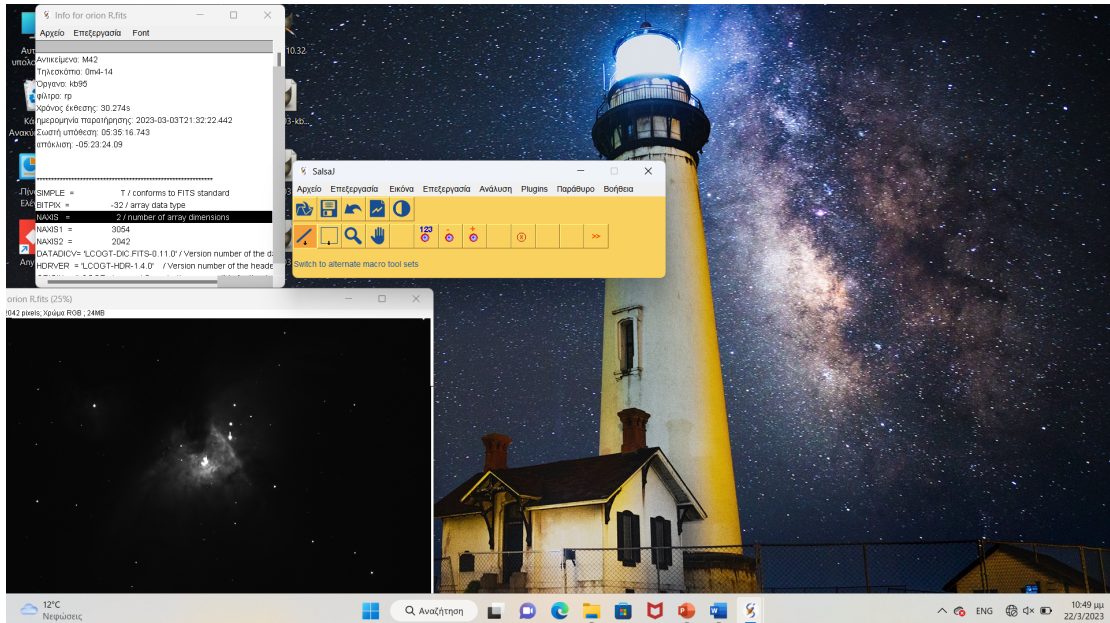
Students will have the opportunity to process the image of a nebula using the Salsa J and give colour to it. In the next page there is an image of the nebula M42 taken by a 0.4m telescope.



Colour images with salsa J

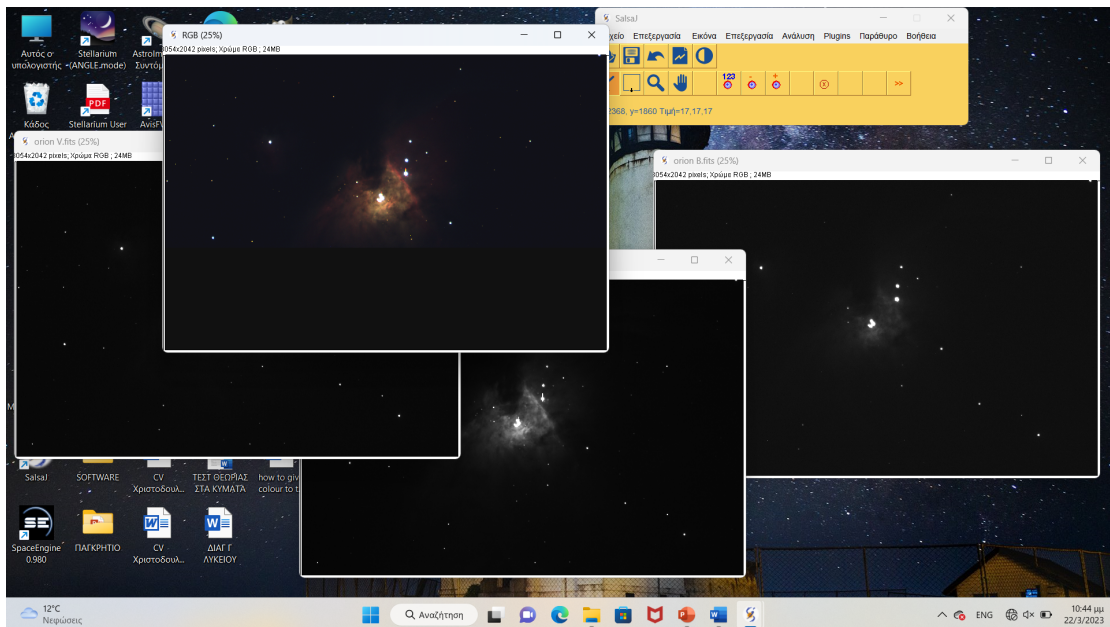
You can download salsa j from the link below:
<http://www.euhou.net/index.php/salsaj-software-mainmenu-9>

Open M42 blue, green and red images.



Usually the filter is not part of the name of the image. To find this you have to check the image info.

Build a color image using 'RGB Merge' of 'color' in "Image" menu



Your image is ready!

Conclusion

With this scenario students will learn how important is to process an image taken by a telescope and analyze it. They will realize the magic of the universe and the secret colours which are hidden!

After this activity students will take an image of an object using Ico telescopes and they will have to process it.

