



Young Astronomers

Colour the universe

Classroom activity – After visiting the Observatory

Overview

Age Range: 7-10 years

Lesson Time: 1h 45 min - 2h

Cost per activity: Low

Includes the use of: computer, SAO Image DS9 program (free to download) and/or SkyView virtual telescope (online)

Outline

Why is the Sun green in a photo taken with a UV camera? We can't actually see UV light, so the colour of the photo was just chosen to be green!

In this assignment, you can choose any colour scale for an image of space taken to capture a specific wavelength of light.

This activity is about making space images more interesting to look at! Which colours make the image look the most interesting?

Pupils will learn:

- There are different types of light in addition to visible light, including X-rays, ultraviolet light, infrared (or heat) radiation and radio waves, which can all be used to take images of space. However, our eyes can only see visible light.
- We can colour pictures from space however we want. The colours rarely show what the object would actually look like if you could see them with your eyes. Instead, the colours may simply indicate which parts of the image are brighter (i.e., radiate more intensely) and which are dimmer.



Lesson Plan:

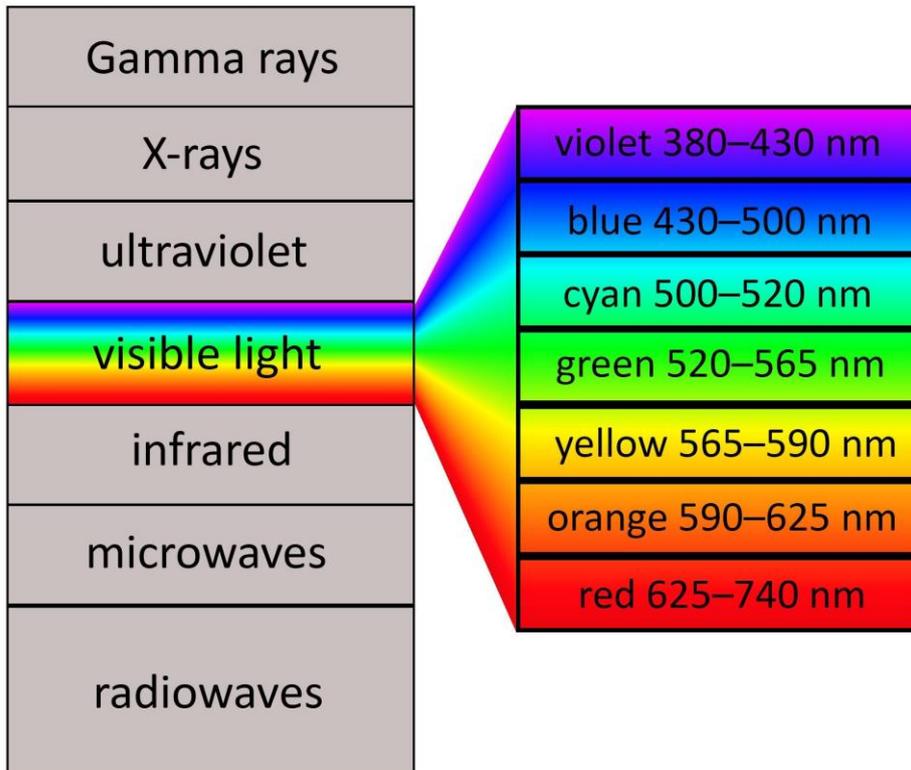
Description	Time	Notes
Introduction to the subject	15 min	You can show space photos from NASA/Hubble/ESA/ESO: https://www.jpl.nasa.gov/spaceimages/ https://www.spacetelescope.org/images/archiv e/top100/ https://www.esa.int/ESA_Multimedia/Images https://www.eso.org/public/finland/images/arc hive/top100/
Activity 1	about 30 min	Try changing the colours in an image using SkyView virtual telescope: https://skyview.gsfc.nasa.gov/current/cgi/titlepage.pl Time required depends on how many pictures you choose.
AND/OR Activity 2	30-45 min	You can choose between Activity 1 and 2, or do both. You can also try changing the colours in an image by downloading SAO Image DS9 (free): http://ds9.si.edu/site/Download.html Time required depends on how many pictures you choose to work on.
Assessment	15 min	
Further activity	about 15 min	Learn more about multiwavelength images – the following pages help explain how images can be made using light from different parts of the spectrum: https://public.nrao.edu/color/ http://support.faulkes-telescope.com/multimedia/colour_img_2/ https://chandra.harvard.edu/photo/multi.html

The online observatory collaboration consists of the following partners:

Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory



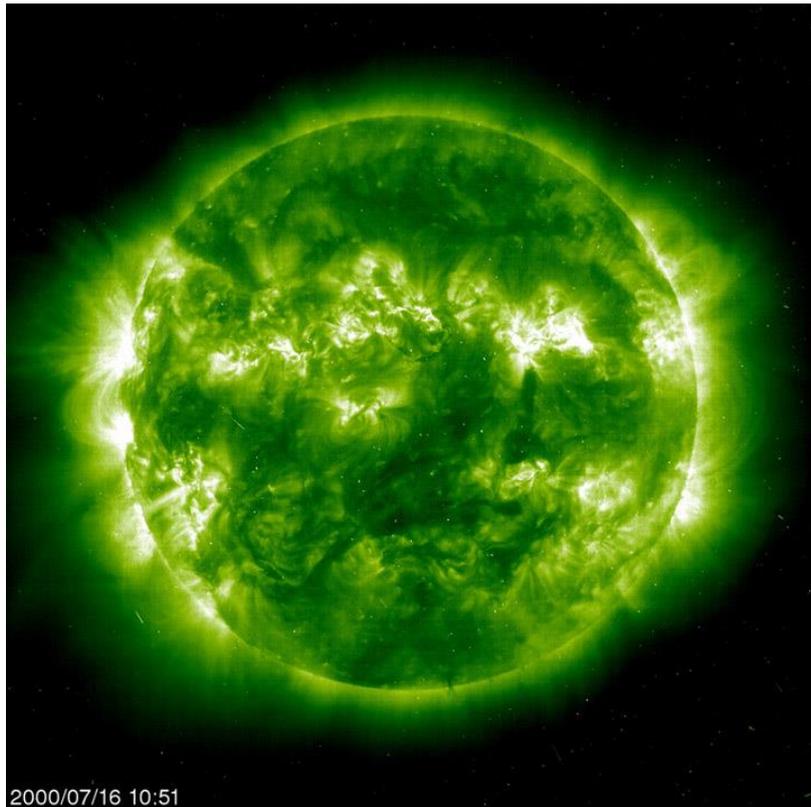
Introduction to the subject:



Different wavelengths of light. The visible light can be divided into different colours, each of which has a specific wavelength (describing how wide the light wave is). Credit: HUM.

Have you seen colourful pictures from space and wondered if they would look the same if you could see them with your own eyes? Actually the colours in space pictures are often “false” – meaning that they rarely show what the object would look like if you could go look at it yourself. For example, a picture of the Sun taken with a UV or ultraviolet camera could be coloured green, because we can't see UV light with our eyes, and so it doesn't really have a colour.

You will soon learn that the colour scale can be anything, and that different scales make it easier to highlight different things in the image. Often the colour just shows which parts of the image are brighter (i.e., radiate more intensely), and which are dimmer. Try it yourself!



The Sun in UV light from the SOHO satellite. Credit: SOHO (ESA & NASA).

You may have seen images taken with an infrared (IR) camera. Often the images from an infrared camera show warm parts as red (or white for “very hot”) and cooler parts as blue. But in reality, the thing that is being imaged is probably not red or blue at all! These “false colours” are just showing us the distribution of temperature of the object.



An IR image showing hot faces (white), warm bodies (red), colder hair (yellow) and walls (blue). Credit: HUM.

The online observatory collaboration consists of the following partners:

Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory



Activity 1:

Now you can try out different colour scales (often called palettes) and change colours in a space image!

1. Open the SkyView Virtual Telescope website (you do not have to download anything to your computer): <https://skyview.gsfc.nasa.gov/current/cgi/titlepage.pl>
2. Press "Query Form" to choose an object and an instrument that you want to use for observations. Let's first obtain a black-and-white image of the object. Choose one of the following targets and options:
 - **Horsehead nebula**
"Coordinates or Source": Barnard33, SkyView Surveys: from Optical DSS choose DSS1 or DSS2 Red, image size (pixels): 1000
 - **Crab nebula**
"Coordinates or Source": M1, SkyView Surveys: from Optical DSS:n choose DSS2 Red, image size (pixels): 400
 - **Eagle nebula**
"Coordinates or Source": M16, SkyView Surveys: from Optical DSS:n choose DSS2 IR, image size (pixels): 600
 - **Andromeda galaxy**
"Coordinates or Source": M31, SkyView Surveys: from Optical DSS:n choose DSS1 Blue, image size (pixels): 2000
 - **Whirlpool galaxy**
"Coordinates or Source": M51, SkyView Surveys: from Optical DSS:n choose DSS1 Blue, image size (pixels): 600

After selecting the values press "Submit Request".

3. Now return back to the "Query Form" window to try out different colour palettes! Choose a colour palette of your liking from "Other options" at the bottom of the page. Then press "Submit Request" again.
4. Explore different ways to colourize the image! Did you notice that, depending on which palette you choose, the light and dark areas are given different colours?

Activity 2:

Pre-activity steps:

- Download the SAO Image DS9 program (free):
<http://ds9.si.edu/site/Download.html>

During the lesson:

1. Download a space image that you want to use. DS9 program can open images in FITS format. You can obtain FITS images e.g. from the Faulkes telescope webpage (section 2, FITS Data):

The online observatory collaboration consists of the following partners:

Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory



<http://resources.faulkes-telescope.com/course/view.php?id=48>

Alternatively, you can find FITS images from the NASA website (you can choose from images taken with different filters, or in other words, different wavelengths):

https://www.spacetelescope.org/projects/fits_liberator/datasets_archives/, where you can choose e.g. Andromeda galaxy:

https://www.spacetelescope.org/projects/fits_liberator/m31data/

Unzip the images to your computer.

Remember also that you can make FITS images in the SkyView Virtual Telescope website by following the steps 1 and 2 in the Activity 1. Having produced a black-and-white image, there is a download link below the image.

One more option is to use “import” command in DS9 to open any space image in a jpg format! On the SOHO solar observatory webpage (<https://soho.nascom.nasa.gov/home.html>), for example, you can find photos of the Sun taken in one wavelength: click “The Sun now”, and then “More 512x512” below the image of your choice. A page with several images of the Sun will open. Choose one of the images, click it and save it to your computer in a jpg format.

2. Open your image in the SAO Image DS9. If you intend to use an image in a jpg format, use “import” command.
3. Ensure that the image fits properly on the screen: press first “zoom” and then “zoom fit”.
4. If the image looks very dark, you can press “scale” to try out different brightness scales. Use the one that looks best for your image. A tip: “log” is quite often a good choice!
5. Now you can change the colour palette by clicking “color”. Try out different options. Did you notice that, for example, the Sun can be green or red, depending on which palette you choose? Remember that you are just “playing” with colour scales or palettes, you are not actually changing the data – just how it appears on your screen.

Assessment:

- Discuss what kind of a colour scale you think would work best for the images you chose. Which colour palette works best to show the bright and dark areas? Do you all agree that this is the “best” colour scale? Some people will have different opinions!
- How can a photo be misleading?
[A photo can be misleading if the viewer thinks that the object is being shown as it would look like to the naked eye. Think of some examples!]



Further Activities:

You've now tried out different colour scales on a photo using a single wavelength of light, known as a greyscale image. In astronomy, observations are often made from such greyscale images. However, most of the impressive space photos are made by combining information from several different greyscale images into one. This means that a single image could actually be a combination of images, taken by different cameras seeing different types of light.

Here is a quick example of how a telescope combines greyscale images:

http://support.faulkes-telescope.com/multimedia/colour_img_2/ (needs Flash) and <https://public.nrao.edu/color/>

The Multiwavelength (i.e. many different wavelengths) photo gallery of the Chandra telescope allows you to combine space images of different wavelengths in one click:

<https://chandra.harvard.edu/photo/multi.html>

Background Material/Knowledge:

The scientists obtain many different colourful images from space. For example, the Sun can be coloured green or orange in these pictures!



Different images of the Sun in the Helsinki Observatory's exhibition. Credit: Sakari Kiuru.

The online observatory collaboration consists of the following partners:

Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory