The Universe in my pocket

The color of the sky

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THE UNIVERSE IN MY POCKET

Julieta Fierro

Institute of Astronomy,

UNAM, Mexico

Sunlight can be decomposed into different colors on the surface of liquid detergent.

The color of objects depends on the light they absorb or reflect.

Strawberry flowers look white because they reflect all the sunlight, leaves and fruits look green or red because they absorb all colors except the ones we see.

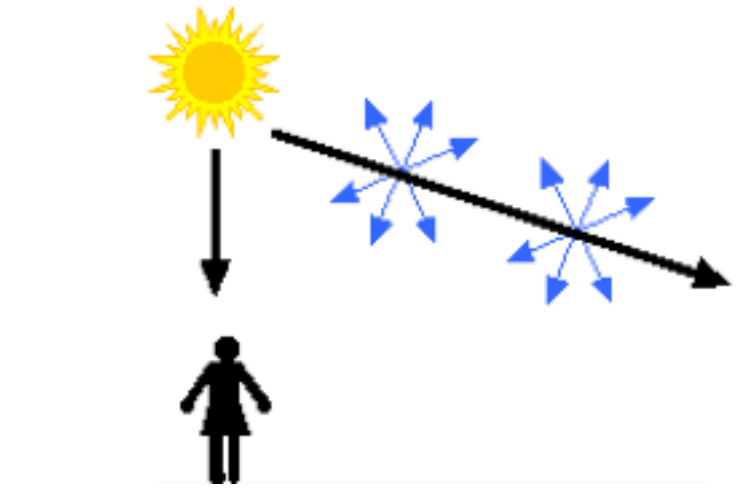
The color of the sky

Have you ever wondered why sometimes the sky looks blue, or gray, or even orange during sunsets? Are you curious to know what the color of the sky would be if you were a cosmonaut exploring the Moon or Mars? In this booklet you will find the answers to these questions.

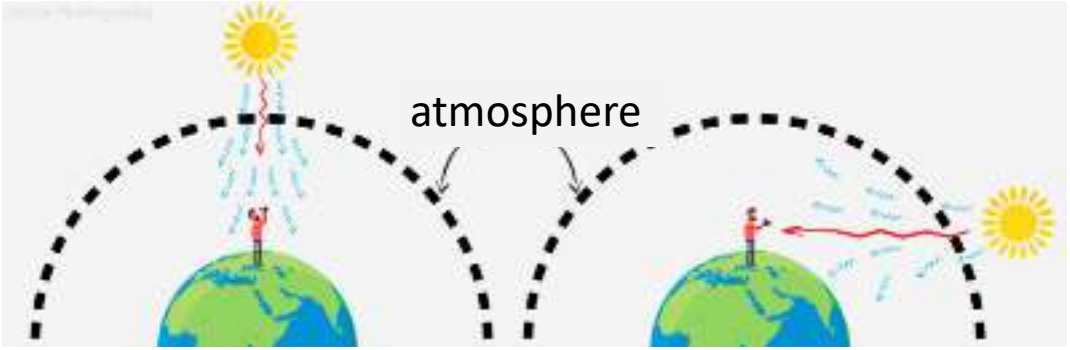
Sunlight is a mixture of all colors. You can see this when you see a rainbow, as the water droplets allow you to observe its range of colors.

Objects absorb part of the light, which determines their color. Black absorbs all colors; a mirror reflects all colors.

Clouds look white when they are light and reflect all the mixed colors of sunlight. On the other hand, clouds look gray when it is going to rain, because they are thicker and prevent all the light they receive from the sun from passing through them.



The sky is blue in the daytime because oxygen and nitrogen molecules scatter the blue light from the Sun most strongly. So we get blue light from everywhere in the sky.



At sunset the sunlight has to pass through a thicker layer of atmosphere and its oxygen and nitrogen molecules scatter all the blue and green light out of the line of sight, letting only the orange and red pass through in that direction.

Sky blue and sunset red

When light from the Sun reaches the Earth, it passes through the atmosphere. The oxygen and nitrogen molecules in the atmosphere scatter the light in all directions, but they don't scatter all colors equally. They scatter blue most strongly. This means that the blue light from the Sun, instead of going straight through like yellow or red light, bounces all over the place before it reaches our eyes, and that is why the whole sky looks blue.

Sunsets turn red and orange because the sunlight travels a longer path through the atmosphere. Along this long path, the blue and green light gets scattered out, leaving only the orange and red. That is why the sky looks so colored. When the Sun rises or sets its light must pass through a greater thickness of the atmosphere than when it is at the zenith. That is why the rising or setting sun is orange or red, but it appears yellow when high overhead.

The Sun is evaporating and produces the solar wind. This wind is very diffuse, so it can only be detected with particle detectors in space.

The image above is an artist's impression of the solar wind as it travels from the Sun and encounters the Earth's magnetic field, the magnetosphere.(This image is not to scale).

Auroras form when the Sun's wind collides with the Earth's magneto-sphere, which channels these particles into the atmosphere near the poles.

There are also auroras on Jupiter and Saturn.

Saturn's auroras change their appearance from day to day.

The auroras

The Sun is evaporating, it produces a 'solar wind' that fills the entire solar system. The Earth is like a huge magnet. Its magnetic field channels the solar wind particles from the Sun to the Earth's poles. When they hit the Earth's atmosphere they make it glow, producing the auroras.

The colors of the auroras depend upon the energy of the solar wind particles, their speed, and the region of the atmosphere where they collide. If the wind particles are energetic and collide with oxygen atoms, the auroras are green and sometimes yellow; if they are lower energy and collide with nitrogen ions higher in the atmosphere, they are red, and sometimes violet or blue.

Other planets such as Jupiter and Saturn produce auroras, both have extended atmospheres and intense magnetic fields.

When humidity is low in the environment and you brush your hair or rub it with a balloon it can become electrically charged and lift in interesting ways.

Thunderstorm.

Lightning strikes at high, sharp points. Lightning rods conduct the electricity from the lightning strikes to the earth where it does not cause damage.

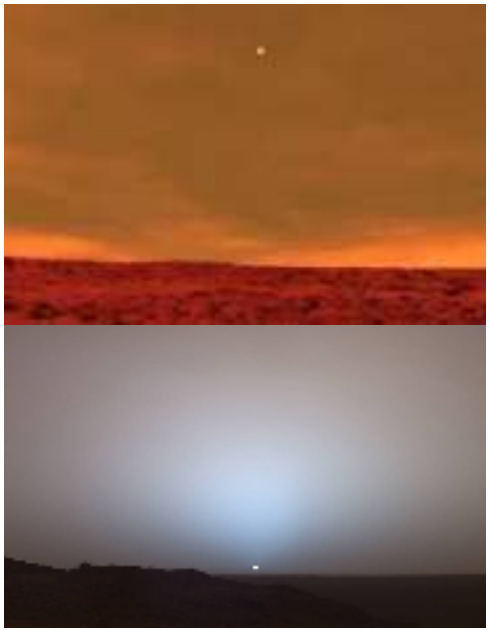
The sky during a storm

In general, storms are accompanied by thunder and lightning that illuminate the sky in a spectacular way.

To understand what lightning is, you may have seen sparks on your blankets or your shirt when you take it off in the dark. Lightning is a very intense spark. The sparks are produced when the fabric rubs against your body producing an electrical charge and it changes places. When an electric charge moves, it is called an electric current; if it passes through the air, it heats it and makes it glow. That is also why lightning is so spectacular. If a large volume of air is suddenly heated it produces a burst because it suddenly swells, causing thunder. Huge clouds laden with raindrops move and become charged with electricity, which can travel between the clouds or to the Earth's surface. When the discharge is strong, we see lightning.

On Earth the daytime sky darkens at high altitudes due to the lower density there. There are too few particles to scatter enough light to give the sky a strong color.

The sky on the Moon is black because there is no atmosphere. Without atoms to scatter the light, the sky cannot have color.
The colors of the sky on Mars are the reverse of what they look like on Earth.



When the Sun is high, the sky on Mars is orange, due to the dust suspended in its atmosphere. The bright spot is the Earth as seen from Mars.

A sunset on Mars produces a faint blue light.

More about the color of the sky

At the highest mountain peaks on the Earth, the sky that climbers see is dark blue because the density is lower.

The sky is black at night because the atmosphere is not illuminated and there is no sunlight to scatter. On Mercury and the Moon, there is no atmosphere, so there is no scattered light, and the sky is always black, even during the day.

When there are sandstorms in the Earth's desert areas, the sky can appear orange because the sand scatters the red and yellow light from the Sun. The same thing happens on Mars, since there are also sand and dust storms there.

On the other hand, there is also a very fine dust in the atmosphere of Mars that is just the right size for the blue light from the Sun to penetrate the atmosphere efficiently. That is why during its sunset on Mars the Sun looks blue.

There are no images of the sky from deep in Jupiter's atmosphere, but it is thought to be blue. This is a artistic representation of how it might appear.

On planets and satellites circling stars other than the Sun, the color of the sky could have fabulous hues yet to be discovered. This is an imaginary view of what the sky would look like from one of the planets in the TRAPPIST-1 system.

The color of the sky in other worlds

The sky has not been observed from many planets. However, scientists think that planets like Jupiter and Saturn, which are almost entirely gaseous worlds, must have atmospheres with a wide variety of hues.

If on Earth the sky acquires so many shades, imagine the diversity of colors that the sky may have in the huge number of extrasolar planets that are being discovered. On these worlds with atmospheres different from ours, or that move around stars of other colors, the sky must be amazing.

An experiment you can do in your home to discover the colors of sunlight

Instructions on the reverse side

How to do the experiment

Get a compact disc. Hold it up to the window where the light is coming in. You will notice that a range of colors is produced.
Now bring the disk close to several lighted lamps, notice what colors form on the surface.

You will notice that the lamps try to reproduce as much as possible the colors of sunlight.

Look out the window. What color is the sky? Why?

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This booklet was written in 2022 by Julieta Fierro of the Instituto de Astronomía, UNAM, Mexico and revised by Grażyna Stasińska of Paris Observatory and Michael Richer of the Instituto de Astronomía, UNAM, Ensenada.

Cover image: The color of the sky on Earth can change throughout the day; it depends on where we are, or the seasons of the year. Stefan Corfidi.

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Translation: Michael Richer