Sky Colors

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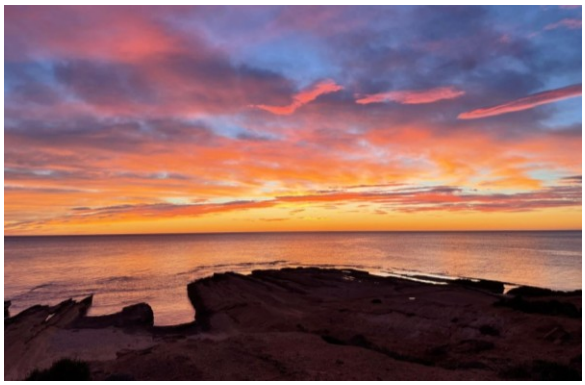

Credits: Miguel Ángel de Andrés and Rosa M. Ros

The proposal from NASE for the celebration of the International Day of Light (IDL) in 2025 is to observe the colors of the sky on any day between March 20 and September 22, 2025, conduct related experiments, and photograph various observations. This project is listed on the UNESCO IDL website among the proposed events worldwide.

The report with data and 2 or 3 photos of the students performing the observations and activities, will be saved in PDF format and named with the first three letters of the country, the month, the day, and any three numbers from 000 to 999. E.g., SPA0515123.pdf. The report must be uploaded to the form https://forms.gle/NgsHkWfjdSWMgq7U6. (Only if the form is inaccessible, it can be exceptionally sent by email to newsletter.nase@gmail.com). **The participation period is from March 20 to September 22, 2025**.

The blue of the sky

On the Moon, the sky always appears black, even during the day. On Earth, it is different because of the atmosphere. As sunlight passes through these gases, primarily nitrogen and oxygen, the molecules can scatter the trajectory of photons in what is called Rayleigh scattering. This scattering depends heavily on the wavelength.

The light that reaches us from the Sun contains photons of all the colors of the rainbow (Fig. 1): reds, oranges, yellows, greens, and blues, which together appear as white light.

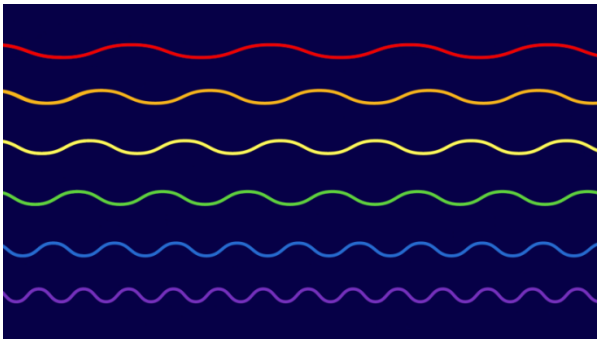

Fig. 1. Red light photons have a longer wavelength than blue photons.

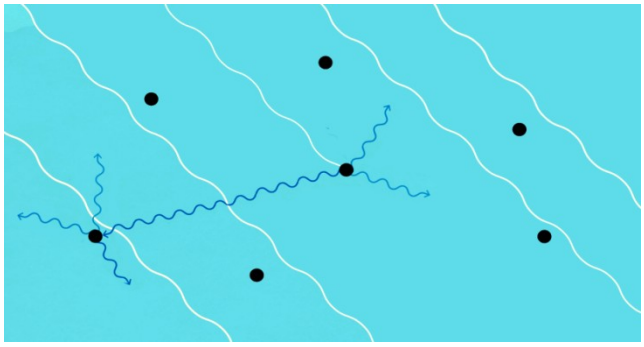

Fig. 2. Blue photons scatter when they collide with air molecules and change their direction.

When they reach Earth's atmosphere, photons can scatter as they collide with air molecules and particles. Blue light scatters more easily than other colors because its wavelength is shorter (Fig. 2). These blue photons interact repeatedly until they reach our eyes, and it seems as though they are coming from all directions. That is why we see the sky as blue during the day, in all directions we look [1].

Colors at sunset and sunrise.

As the Sun moves lower in the sky, its light passes through more layers of the atmosphere. Almost all the blue photons scatter, and the light that reaches us contains only photons of red, yellow, orange, and green light (Fig. 3). As can be observed in Activity 3, when green light is mixed with red light, we see it as yellow. This is why at sunset and sunrise, the Sun appears yellow (Fig. 4) [2].

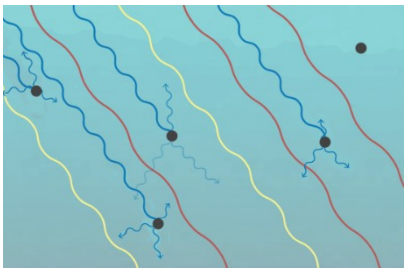

Fig. 3 At sunset and sunrise, all the blue photons scatter, leaving the others, which give a yellowish color.

Fig. 4. The yellowish color of the sky at sunsets and sunrises is caused by the scattering of blue photons.

Fig. 5. Very reddish sunset, due to the aerosols present in the atmosphere.

Sometimes sunsets appear very red (Fig. 5). This happens when there are aerosols in the atmosphere (dust, ash, pollution, etc.), which also scatter the green and even the orange photons, leaving only the red ones.

Venus Belt

On the horizon opposite the area where the Sun has set, peculiar colors can be observed in the sky. This phenomenon is called the Venus belt or anti-twilight arc: the dark lower part is the Earth's shadow, which only appears after the Sun has set and gradually grows, and a pinkish zone above it, produced by the scattering of the Sun's blue photons as they pass through the atmosphere [1].

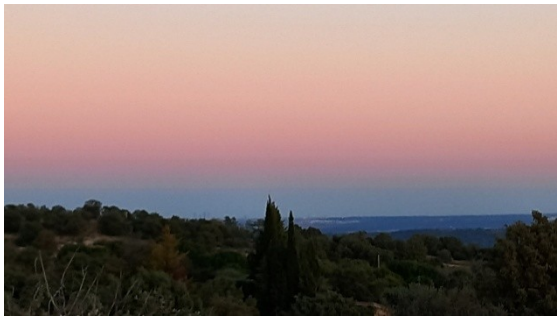

Fig. 6. On the horizon opposite the sunset, a dark area (Earth's shadow) appears, and above it, a pinkish zone (Venus belt or anti-twilight arc).

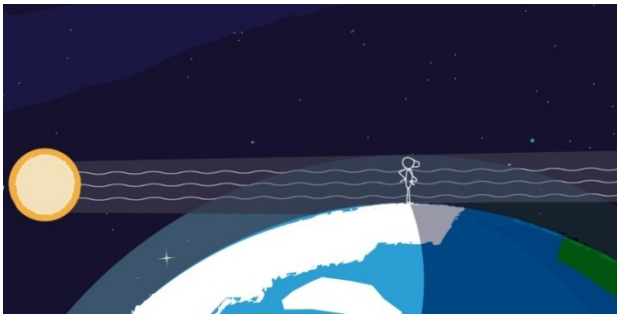

Fig. 7.If we look at the area opposite the sunset, we see a dark zone on the horizon (Earth's shadow) and another with hardly any blue photons, which appears pink (Venus belt).

Golden hour

Photographers call the time before sunset the "golden hour," when the light is yellowish.

Fig. 8. Just before sunset (photo on the right), the light is more yellowish. Photographers call it "the golden hour."

Some film directors, like Terrence Malick (The Thin Red Line, The Tree of Life), shoot their films only during those hours to take advantage of that light [3].

The colors of the sky in culture

- The sky blue of the flag of Kazakhstan (Fig. 9) symbolizes the clear sky seen in the country, associated with the freedom of its people.

Fig. 9. Flag of Kazakhstan. The sky blue symbolizes the country's sky and the freedom of its people.

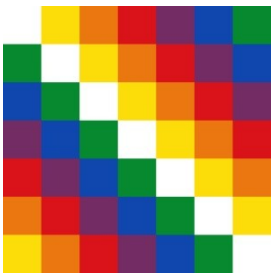

Fig. 10. Wiphala flag, used by various indigenous peoples in South America.

- The wiphala (Fig. 10) is a square flag of seven colors, initially used by the Andean peoples and later adopted by other indigenous peoples. Its presence extends across Bolivia, Peru, Colombia, Argentina, Chile, Ecuador, and Paraguay. A chronicle from 1612 associates it with the crossing of two rainbows. The color blue represents space, cosmic energy, infinity, and the spirit that animates everything.

- There are popular proverbs and sayings that reference the colors of the sky. In general, they associate red sunsets with good weather, and red sunrises with bad weather. For example,
  - "Red sky at night, delight; red sky in the morning, take warning";
  - "Sol poniente el cielo grana, buen tiempo para mañana"; "Cielo rojo al amanecer, es que ha de llover";
  - "朝霞不出门，晚霞行千里".
  - "Rouge couchant, demain beau temps". “Temps rouge au matin, met la pluie en chemin”
  - “Sol vermelho no poente, esta noite boa e a manhã excelente”. “Manhã ruiva, ou vento ou chuva”.
  - "At sunset, you say it will be good weather because the sky is red, and in the morning, that there will be a storm because the sky is reddish and gloomy" (Mt, 26, 2-3).
- The Egyptians saw baboons positioning themselves in front of the rising sun to warm up in the morning and interpreted their behavior as a greeting to the sun. The cries and howls of the baboons were seen as a religious sign, a greeting to the god Ra (Fig. 11 and 12) [4]. The pinkish color of the baboons' face, buttocks, and hands also corresponded with the colors of the rising sun (Fig. 13 and 14). To obtain the baboons, the Egyptians had to travel over a thousand kilometers, reaching what is now Ethiopia and Somalia.

Fig. 11 The baboons greeted the morning sun by barking. In reliefs from ancient Egypt, they are depicted raising their hands towards the Sun.

Fig. 12: Other reliefs from ancient Egypt depict baboons raising their hands towards the sun in a sign of worship.

Fig. 13: The walls of Tutankhamun's tomb are decorated with twelve baboons.

Fig. 14: The hamadryas baboon had a pinkish face, like the rising Sun.

INTERNATIONAL DAY OF LIGHT 2025: NASE'S PROPOSAL

Participation in the project involves completing at least two of the activities proposed in this text [2], and submitting 2 or 3 photos, some of which should include the participants. Additionally, other activities can be added, and popular sayings related to the colors of the sky can be included.

Activity 1: Dispersion in the water

We need the flashlight of a mobile phone, which gives a white light similar to that of the Sun, a tall transparent glass, water, and a little milk. We add a few drops of milk to the glass filled with water (about 1 drop of milk for every 50 ml of water) [6].

Place the glass over the flashlight. When looking through the sides of the glass, a bluish-white light is visible (Fig. 15). When looking from above, the light appears yellowish (Fig. 16). If the glass is gradually emptied, the color of the light will change. Can you explain why?

Fig. 15The light from the flashlight that comes out from the side of the glass appears bluish.

Fig. 16. The light from the flashlight that passes through the glass appears yellowish.

Activity 2: Dispersion in silicon

We need the mobile phone flashlight and a silicone stick from a "hot glue gun," which is used as adhesive in DIY projects. The sticks should be almost transparent and about 10 cm in length (Fig. 17). Place the stick over the mobile flashlight, and you will immediately see how the blue photons scatter, leaving the light yellow, and eventually only red (Fig. 18) [4][6].

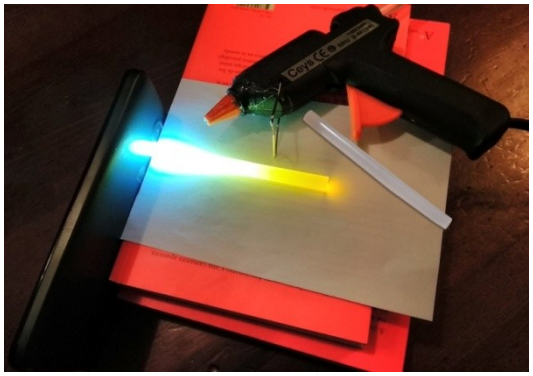

Fig. 17. We need a silicone glue stick for a hot glue gun..

Fig. 18. The white light from the flashlight scatters as it passes through the stick, just like sunlight in the atmosphere.

Activity 3: Addition of colors

We make three tubes out of black cardboard, about 3 cm in diameter and 5 cm long. We place a piece of red transparent paper at the end of one tube, green transparent paper in another, and blue transparent paper in the third (Fig. 19). Through these, we pass the white light from three mobile phone flashlights and project the three colors onto a white wall (or the ceiling of the room) (Fig. 20) [5] [6].

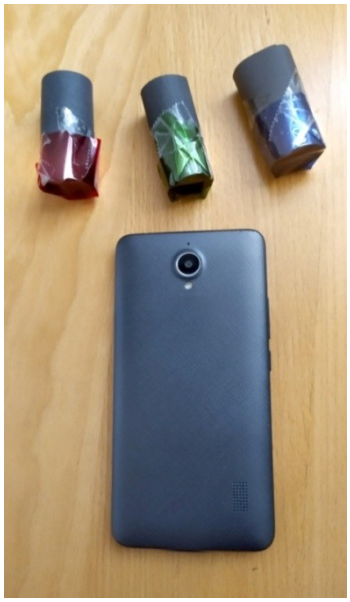

Fig. 19. We need three tubes with red, green, and blue cellophane paper, and the flashlight from three mobile phones.

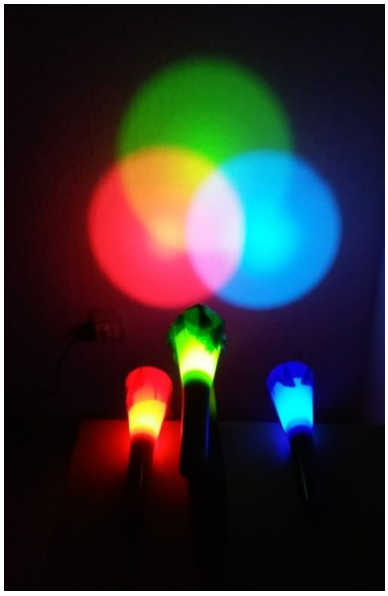

Fig. 20. When the three colors are combined, they produce white light. If only red and green remain, the light appears yellow.

If we combine the three colors, we see white light, like the Sun (Fig. 20). If we remove the blue light, the mixture of green and red light appears yellow, which is what happens at sunsets. If the green light decreases (due to the presence of aerosols in the atmosphere), it appears orange or even red.

One could make a fourth tube with yellow cellophane, but it would just give more yellow light, so it's not necessary.

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