# Travel with light

Have you ever wondered, maybe, how the rainbow is formed?

The magic of this pleasant phenomenon is in the concepts of physics, more precisely optics. It is an area of physics that deals with the properties and propagation of light. It is impossible to study everything around us without light - imagine a world without it where you cannot see anything.

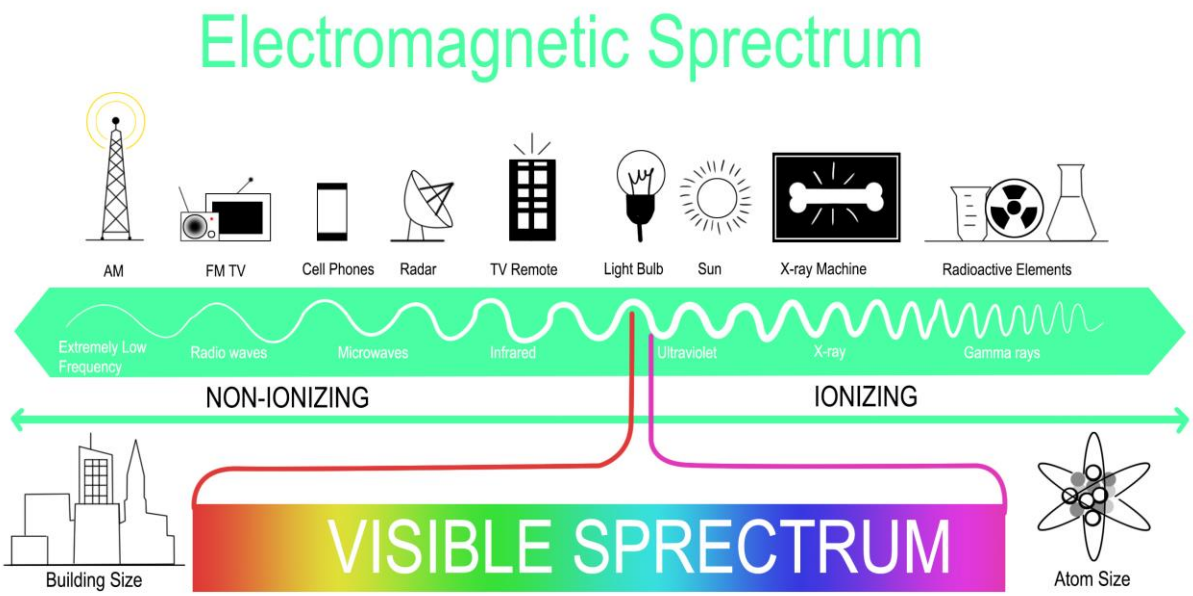
Then we would have only 4 senses and would be able to recognize objects through touch, scent and sound emanating from objects and their taste. Our 5 senses have receptors, whose work obeys the laws of physics and chemistry. For example, the sense of hearing has mechanical receptors (physics), the sense of taste and smell have chemical receptors (chemistry), and the sense of sight has photoreceptors (physics).

The path from stimulation to perception of a stimulus is the following: the brain receives information about prepared coffee with the help of light through a visual pathway, while the smell of coffee is recorded through the particles of coffee released into the air.

The receptors in the eye respond to the light stimulus, while the receptors in the nose respond to the stimulation of the coffee particles (smell). A doctor takes the patient's medical history and talks to him during an examination. At the same time, he hears as the sound waves emitted by the speech apparatus reach him, and he sees the patient thanks to the fact that the light waves that reflected off the patient fell on his eyes. Sound is a mechanical wave, while light is an electromagnetic wave. During the examination, if the doctor concludes that some of the symptoms need to be checked further, he or she may refer the patient for a diagnostic examination. Such examinations are performed with the help of sound and light that are on other wavelengths and we cannot register them with our senses of hearing and sight.

With evolution, our senses are limited to hearing sound with a frequency of 16 to 20,000 hertz and light with a wavelength of approximately 380 to 760 nanometers. In medicine, diagnostics are usually performed using ultrasound and X-rays, which have high frequencies that cannot be recorded with our senses.

In fact, the spectrum of electromagnetic radiation is divided into intervals, which differ in their wavelengths.




EM waves whose wavelengths belong to one of these intervals are called: radio waves, microwaves, infrared, ultraviolet, X-rays, and gamma waves. Radio waves are generated in electrical oscillatory circuits (antennas) and are not harmful to living organisms, while gamma rays are emitted by atomic nuclei and cause damage.

Let's go back to the term light - depending on the way of interpretation - it includes the infrared part of the spectrum, the visible light (the one that can be registered with our eyes), and the ultraviolet part of the spectrum. Our subject of interest is the visible light. It is known that it has a dual nature, ie sometimes the particle and sometimes its wavy nature is shown. When light is mentioned, the first thing that comes to mind is our largest natural light source, the Sun.

Sun-symbol of victory, power, inexhaustible enthusiasm, hope, above all a source of life on Earth. Earth is the only planet in the solar system that has life. It is well known that if we observe

the sky during the day, it is blue, except for sunrise and sunset when the Sun is above the horizon and has an orange or red color. But in fact, the reason for the "light" in the sky during the day is due to the scattering of sunlight from the Earth's atmosphere. On the Moon and the planets that do not have an atmosphere, such a phenomenon of scattering does not occur - that is why both the bright stars and the fiery solar disk are observed on a black background.
When the Sun rises, not only the light emitted from it but also the scattered light comes to us. Even before the Sun rises, light comes to us from that part of the sky that is closest to the solar disk, and after the Sun rises, in addition to direct light, light comes from all over the sky. The scattering of light is actually the phenomenon in which the light beam in a given environment deviates in all possible directions. And how the scattering of light helps us interpret why, for example, the sky is blue or why at sunrise and sunset the sky turns orange or red, why the clouds are sometimes white and sometimes gray, etc.
We know that the air itself is transparent and isn't blue. But there is a large number of particles and molecules of various gases in the atmosphere. When light from the Sun reaches the atmosphere, it diffuses. The largest diffusion occurs in short-wavelength light, that is, the purple and blue components of white light. That's why the sky turns blue.

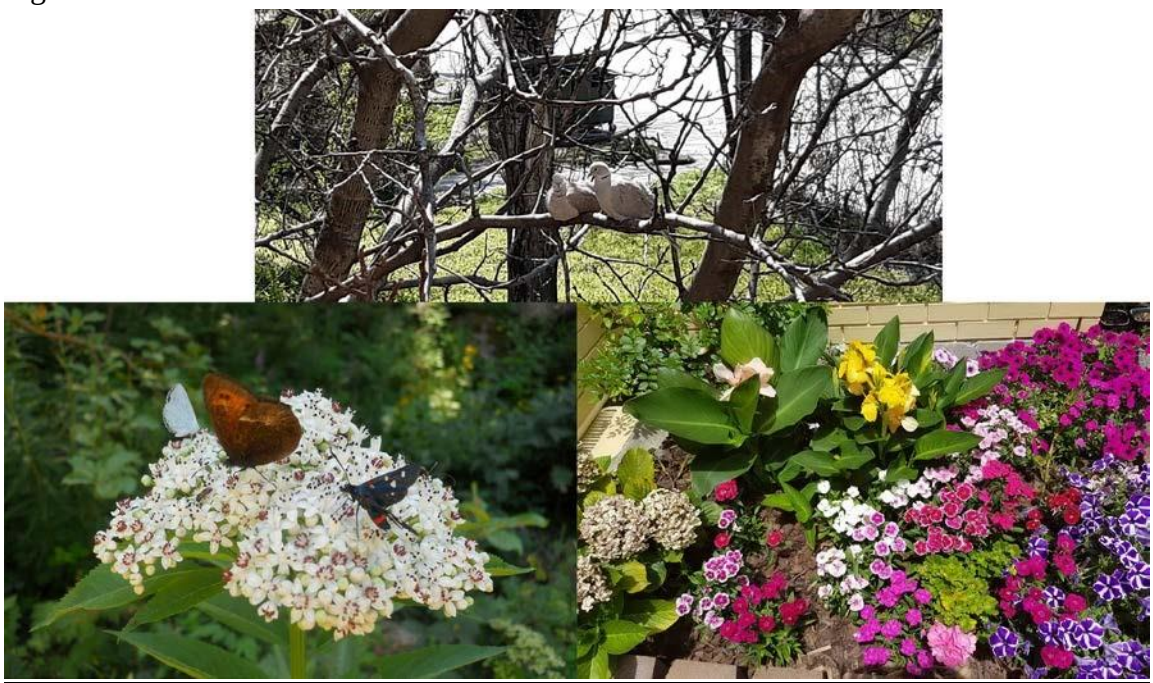
But the particles in the atmosphere are larger than the air molecules, so all the rays are reflected equally and the sky turns whitish. So the sky is whiter when the pollution is higher. Evening redness in the sky occurs when the Sun is close to the horizon and it is caused by the absorption of short-wavelength light rays by air molecules. Because light has the longest path when the Sun is close to the horizon, there's an almost complete loss of light with short wavelengths. Thus, the sky and clouds turn orange or red.

But why are clouds white? As sunlight passes through a cloud, it interacts with the water droplets, which are much bigger than the atmospheric particles that exist in the sky. In a cloud, sunlight is scattered by much larger water droplets. They scatter in all colours almost equally meaning that the sunlight remains white and thus making the clouds appear white against the blue sky. And why are clouds sometimes grey?

Clouds bases are often grey as a result of the same scattering that makes them white. When light is scattered in a cloud it is usually sent back upwards or out, so the sides of the cloud appear whiter than the base which receives less light. This is more prominent in the rain clouds because the cloud droplets are bigger thus scattering more light. This means that even less light from

the Sun reaches the base of the cloud, giving rain clouds their intimidating appearances. Because the tops of the clouds have a constant source of white light, they are always white, if we are ever on a plane and if we look out the window when we are above the clouds we will see that the tops of all the clouds are brilliant white.

However, we humans are constantly trying to respond cleverly to the riddles set by nature. I look out the window and immediately my eyes delight in the colorful flowers, birds that bounce happily on the branches of the blooming trees - I enjoy the beautiful view that spring has brought.



But then again, here's something to think about - where do the different colours come from when they are all illuminated by the same source - the Sun? We can observe objects in reflected light or transit light. If white light strikes an object, and the object reflects all the invading light, then that object is white. The object is red if it reflects just the red light, and absorb the other components of white light. So, the color of opaque objects mostly depends on the surface of the object. However, many people cannot enjoy the colourful world around us. Mark Zuckerberg (the founder of Facebook) recognizes the blue colour, but not others. He sees the other colors as shades of gray.

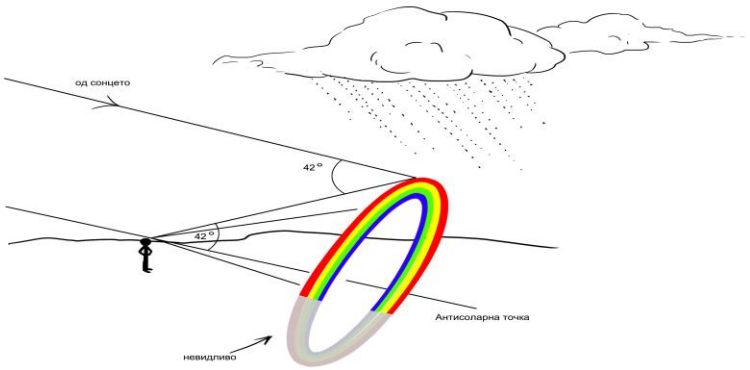
About 8% of men and 0.5% of women have this disorder of the photoreceptors and do not recognize any of the colors or confuse one color with another. Some people are completely blind to colors - they see objects in different shades of gray. This eye defect was discovered by John Dalton, an English physicist and chemist, it's named after him - Daltonism.

But how do other living things on Earth see? Insects see the object pixelized, while dogs probably see the objects blurred in shades of gray. The dogs' world is a world of scents, not a world of colours. But let's assume - if there were living things on the other planets, then they would have been able to see in the infrared part of the electromagnetic spectrum. Every living thing radiates, so it could be seen in that area, too.


Or maybe these living things could develop the ability to emit X-rays and thus notice the obstacles they encounter. Such creatures could see through objects. But, could these assumptions be ever proved, only time will tell.

Now let's go back to reality, to Earth, of course. In the beginning, I mentioned the phenomenon called rainbow, whether it was primary or secondary, I started this travel with light with a rainbow and I will end it with a rainbow. Why?

Besides looking beautiful - its appearance is reminiscent of certain laws related to geometrical optics, such as the refraction of white light through raindrops, which means the dispersion of spectral colors, as well as the total reflection of light that occurs inside of the drop. Also to explain something intriguing as to why does it appear as an arc?




When we see rainbows we see them as arcs when in truth they are formed as circles. The rainbow is formed around a point called antisolar point. We don't see the full circle of the rainbow because the horizon gets in the way. As the Sun goes down we can see more of the rainbow and the higher the Sun is on the sky the smaller the arc seems. Sometimes people at high elevation, like in planes, see the rainbow as a full circle because they don't have the horizon to block their view. However, I take my hat off to the power of nature, its perfection, symmetry, timeless colorful beauty, to everything it gives us. And humans should only interpret and scientifically explain nature's messages, not to change it.

Користена литература :

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