LAWS OF REFLECTION AND REFRACTION OF LIGHT

Turapova Xurshida Abdumajidovna
School specializing in foreign languages, teacher of physics
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Annotation: This article provides definitions and information on the laws of reflection and refraction of light.

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Optics is the science of light, which is a very short, weak field of electromagnetic waves. The source of natural light is the Sun. The science of light is as old as the Sun (optics). The first theory of optics, i.e., light, was created as a result of attempts to answer the question of why people see things around them. The first ideas about the nature of light appeared in ancient times.

By the 17th century, phenomena of light interference and diffraction were observed. To explain this phenomenon, Huygens and Fresnel put forward the wave theory of light. According to this theory, light consists of waves, and interference and diffraction phenomena occur as a result of their propagation in the medium.

By the 18th century, the phenomenon of birefringence of light was observed. Based on this phenomenon, Maxwell created the electromagnetic theory of light. According to this theory, it is explained that light is not a simple wave, but arises as a result of the propagation of vibrations of vector forces in mutually perpendicular planes in the medium. By the 19th century, phenomena such as the photoeffect, light pressure, and the Compton effect were observed. To explain these phenomena, M. Planck gave the quantum theory of light. According to this theory, light consists of elementary particles - quanta (photons), and each quantum has energy, momentum and mass. Thus, the theory of particle and wave dualism of light is born.

It is known that if an opaque object is placed between the eye and a smaller source of light, the source of light becomes invisible. This is because light travels in a straight line in a homogeneous medium. The propagation of light along a straight line is a fact that was established by experiment in very ancient times. For example, the law of propagation of light along a straight line was described in the work of Euclid, who lived 300 years before the new era, but this law was probably known even before that. The well-known shadow formation phenomenon is caused by light spreading along a straight line in a homogeneous medium.

Optics is the science of light and the laws of phenomena related to it. In ancient times, some laws of light phenomena were determined experimentally.

1. The law of propagation of light along a straight line. In a homogeneous medium, light spreads along a straight line. This law is found in a work on optics believed to be written by Euclid (300 years before our era), but this law was probably known and used much earlier than him. Observations on sharp shadows created by point light sources or images obtained using small apertures are experimental confirmation of this law.

2. The law of independence of light propagation. The light stream can be divided into some light bundles using diaphragms. Since the effect of these separate light bundles is independent, the image formed by one bundle does not depend on the simultaneous effect of another bundle. For example, if light is falling on the camera lens from a wide landscape, then if we block part of the light beam, the image of the other beam will not change.

3. The law of return of light. The incident ray, the normal to the reflecting surface and the reflected ray lie in the same plane, in which the angle between the ray and the normal is equal to each other.

Experiments show that n is greater than one for any substances, so it can be concluded that the rate of diffusion of fuel in substances is greater than the rate of diffusion in a vacuum. Huygens (1736) relies on the wave theory to explain light phenomena. Light is described as waves propagating in the hypothetical medium "universal ether" that fills all existence (from outer space to even the composition of matter).

The return of light is the partial or complete return of light falling on the boundary surface of two media with different refractive coefficients to the medium from which it came. Depending on the properties of the boundaries of the two environments, the nature of the return of Light can also be different. If the size of boundary irregularities is smaller than the wavelength of light, such a surface is called a specular surface. Rays of light falling on such a surface in the form of a bundle of thin parallel rays remain in the form of a bundle of parallel rays even after returning from the surface. Such reflection of light is called flat reflection, and a surface that reflects light flat is called a mirror. If light rays scatter in different directions after returning, such a return is called diffuse return.

The spatial distribution of light is determined by Lambert's law. We see objects that do not emit light themselves only because of the same scattered return of light from them. Even from a very smooth surface, light is scattered very little. Otherwise, we would not be able to see the surface of such bodies. Some natural phenomena, such as the mirage in the desert, are based on the phenomenon of the return of Light.The law of refraction of light. When a light beam falls on a smooth surface of a transparent medium, the reflected light itself is not formed. Another ray emerges from the incident point, called the refracted ray, and propagates in a second transparent medium. The direction of the refracted ray, generally speaking, is not the same as the direction of the incident ray, but there is a certain connection between them, and this connection can be determined experimentally.

Based on experiments, the following laws of refraction of light were found:

The incident ray and the perpendicular transferred from the point of incidence of this ray to the boundary of two mediums lie in any plane, the refracted ray also lies in this plane. Even if the angle of incidence changes with the angle of refraction, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is an invariant quantity for these two media. This quantity is called the refractive index of the second medium compared to the first medium.

The mathematical expression of this law can be written in the form of the following formula:

$$\frac{\sin\alpha}{\sin\beta} = \frac{n_2}{n_1} = n_{2,1} = n. \qquad (1)$$

n - the relative refractive index of the second medium compared to the first medium is called, α - angle of incidence, β - angle of refraction.

By 1620, the Dutch physicist Snellius quantitatively established the law of refraction of light at the boundary between two media. The laws of reflection and refraction are explained based on the wave properties of light. Refraction of light is the result of the speed of light changing when it passes from one medium to another.

In practice, the refractive index is usually determined relative to air rather than vacuum. To find the refractive index of a substance in vacuum, multiply the refractive index of that substance in air by the absolute refractive index of air, which is equal to 1.0003. The refractive index of a substance depends on the color of light. Which of the two substances compared to each other has a higher refractive index, that substance is called a substance with a higher optical density.

The refractive index of a substance obtained in relation to vacuum is called the absolute refractive index of this substance. The concept of refractive index has a deep physical meaning. The absolute refractive index n shows how many times the speed of light in a vacuum s is greater than the speed of light v in a substance, i.e.:

$n = \frac{c}{\vartheta}$ (2)

The quantity that characterizes the reduction of the speed of light passing through the medium compared to its speed in space is called the optical density of this medium. The smaller the speed of light in the medium compared to its speed in space, the greater the optical density of the medium is than the vacuum density. Optical density should not be confused with the density of matter. Even if the density of substances is different, their optical density can be the same. For example, water methyl alcohol, quartz and table salt have the same optical density, but different densities.

The optical density of vacuum is assumed to be equal to one. The optical density of air is also considered practically equal to the optical density of a vacuum, since the speed of light in air is approximately 0.9997 times its speed in a vacuum. It should be noted that the vibration frequency of electromagnetic waves does not depend on the optical density of the medium, that is, when light passes from one medium to another, its vibration frequency does not change. The wavelength changes in direct proportion to the speed of light propagation. Therefore, electromagnetic waves can be characterized by their wavelengths only for one specific medium.

Full return is used in various optical devices, for example, military binoculars, periscopes, light conductors. A number of phenomena, such as the glistening of a dew drop in the sunlight, sparkling fountains, the sparkling appearance of gems, and the formation of mirages, are caused by the return of light. The field of phenomena studied by physical optics is very wide. Optical phenomena are closely related to phenomena studied in other fields of physics, and optical research methods are one of the most sensitive and precise methods.

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