AMERICAN JOURNALS
Open Access, Peer Reviewed Journals

American Journal of Pedagogical and Educational Research
ISSN (E): 2832-9791| Volume 42, |November - 2025

CORPUS-CULAR-WAVE DUALISM OF LIGHT

Khushvaktov Bekmurod Normurodovich
Doctor of Philosophy (PhD) in Pedagogical
Sciences, Associate Professor Navoi State University

M. Z.Nasriddinova,
M. B. Nematova,
N. M. Kholmuminova
Masters of NavSU
E-mail: bekmurodxushvaqtov84@gmail.com

A B S T R A C T

This article highlights the importance of using innovative and interactive pedagogical technologies in teaching physics, particularly the optics section. The organization of physics education based on modern approaches allows developing students' logical and creative thinking, connecting theoretical knowledge with practice, and effectively organizing the educational process. The article also analyzes the effectiveness of the interactive method "Dividing Processes into Families" in teaching the topic "Corpuscular-Wave Dualism of Light" in the optics section.

K E Y W O R D S

Physics education, optics, innovative technologies, interactive methods, the method of "division of processes into families," wave-particle duality of light, scientific thinking, visual learning

INTRODUCTION

Physics is an experimental science that studies the laws of nature through experiment, observation, and theoretical analysis. The peculiarity of this subject is that theoretical knowledge is always tested through experience, as a result of which students develop scientific thinking, logical thinking, and problem-solving skills. However, in the learning process, many students and pupils face certain difficulties in understanding physical phenomena or their practical representation. This situation sometimes creates negative psychological states in them, such as insecurity in their knowledge, a decrease in interest in lessons.

Taking this into account, one of the urgent tasks facing a physics teacher today is the design of modern educational technologies, their integration into the educational process, and orientation towards effectiveness. For example, such tools as computer modeling, virtual laboratories, digital laboratory equipment, animated visualizations allow students to visualize complex processes in a clear and understandable form.

In the modern educational process, interactive methods (problem-based learning, cluster, "brainstorming," project method, laboratory experiments) stimulate the study of physics, involving students in the process as active subjects. As a result, students not only acquire ready-made knowledge, but also acquire the ability to apply it to real-life problems.

When using interactive methods in physics education, the teacher chooses the appropriate technology, taking into account the purpose of the lesson, the level of knowledge of the students, the psychological characteristics of the group, and the existing learning conditions. In this case, the effectiveness of each method is manifested when the student actively participates and strives to express their opinion on a scientific basis.

The use of innovative technologies in teaching the optics section of the physics course in general education schools, professional educational institutions, and the higher education system brings a new approach to the pedagogical process and the activities of teachers and students, a spirit of creativity and cooperation. Thanks to the introduction of innovative technologies, the learning process will become more active, understandable, and interesting.

For example, when explaining the topic "Corpuscular-Wave Dualism of Light" in the optics section, an interactive method called "Familiarization of Processes" can be effectively used. In this method, students are given a list of various light phenomena (for example, interference, diffraction, photoelectric effect, Compton effect, etc.). They will have to analyze these phenomena and divide each into a "family" of wave or corpuscular nature. This process forms independent thinking, logical analysis, and a deep understanding of the essence of physical phenomena in students. As a result, students will be able to experimentally and theoretically analyze the existence of two natures of light - that is, it has both wave and particle (photon) properties at the same time. This creates a solid foundation for understanding the quantum foundations of optics, helping students to visually understand the topic (Fig. 1).

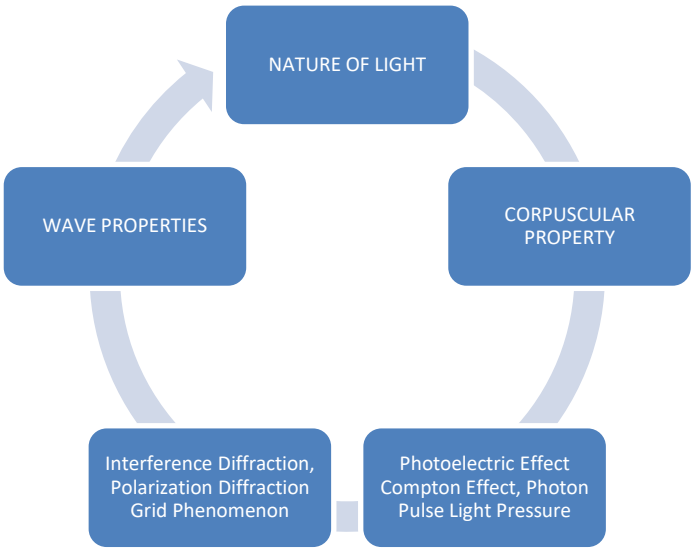

Figure 1. Corpuscular-wave dualism of light

In the image above, it is advisable to use various methods such as color separation, using connecting lines-arrows, or writing separately in rows. Similarly, by dividing the phenomena of geometric and wave optics into families, it is possible to consolidate the concepts about them.

The corpuscular and wave theories of light lead to the existence of various types of relationships between the refractive index of a substance and the speed of light propagation in a substance. According to Newton's theory, it is assumed that the refraction of light at the boundary of two media changes the normal component of the velocity of the corpuscles by the force acting at this boundary (Fig. 2).

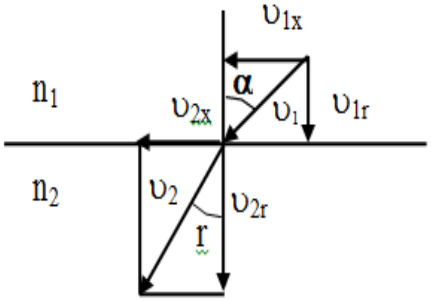

Figure 2 Corpuscular properties

$$sin\alpha = \frac{\vartheta_{1x}}{\vartheta_1} \quad (1)$$

$$sinr = \frac{\vartheta_{2x}}{\vartheta_2} \quad (2)$$

According to the condition, the tangential component of the velocity does not change. ($\frac{\vartheta_{1x}}{\vartheta_{2x}}$). Therefore, from (1) and (2) it is possible to obtain such an expression.

$$\frac{sin\,\alpha}{sin\,r} = \frac{\upsilon_{1x'} / \upsilon_1}{\upsilon_{2x'} / \upsilon_2} = \frac{\upsilon_{1x'} \cdot \upsilon_2}{\upsilon_{2x'} \cdot \upsilon_1} = \frac{\upsilon_2}{\upsilon_1} \quad (3)$$

Considering (3) according to the law of refraction,

$$\frac{sin\alpha}{sinr} = \frac{n_2}{n_1} \qquad \frac{n_2}{n_1} = \frac{\vartheta_2}{\vartheta_1} \quad (4)$$

If light refracts at the boundary of the medium adjacent to the cavity (vacuum), then $n_1 = 1; \vartheta_1 = c$ (c is the speed of light in vacuum), if we take $\vartheta_2 = \vartheta$ and take n_2 as n, the following expression is obtained.

if we set $\frac{n_2}{n_1} = n$, then $n = \frac{\vartheta}{c}$ (5)

The wave theory of light leads to a conclusion opposite to this expression.

It is known that, according to Huygens' principle, every point reached by the wavefront can be a source of a new secondary wave. Let a plane wave front AB propagate in a cavity with a velocity c, falling at an angle to the medium adjacent to the cavity, and let the speed of light in the medium be. After a certain time intervalΔt, the wave propagating from point B travels the distance BK = cΔt and reaches the boundary of the medium. At the same time, the wave propagating from point A travels a distance AD = υ Δt (Fig. 3).

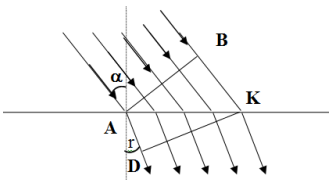

Figure 3 wave property

As can be seen from the figure, side AK is the hypotenuse for two right triangles ABK and ADK, and its value is equal to

$$AK = \frac{c\Delta t}{sin\alpha} = \vartheta\Delta t\frac{\vartheta\Delta t}{sinr} \quad (6)$$

$$\frac{c}{sin\alpha} = \frac{\vartheta}{sinr} \quad (7)$$

or $$\frac{sin\alpha}{sinr} = \frac{c}{\vartheta} \quad (8)$$

It is known that for n media, n is always greater than one (n>1). Therefore, according to the corpuscular theory, $\vartheta > c$, and according to the wave theory, $c > \vartheta$.

In 1851, Foucault measured the speed of light in water and confirmed the validity of expression (8). Thus, it was established that light possesses both wave and particle properties.

In some phenomena, such as interference, diffraction, and polarization, light exhibits its wave properties, while in others, such as the photoelectric effect, it exhibits its particle properties. Depending on the wavelength of light, its corpuscular (particle) and wave properties also change. If it is difficult to notice the corpuscular properties of light rays with a large wavelength, then it is difficult to determine the wave properties of light rays with a small wavelength. Consequently, a theory that gives a complete understanding of light must take into account its wave and quantum properties together. That is, light is the unity of discreteness and continuity.

In conclusion, the use of innovative and interactive technologies in the optics section serves not only for students to deeply master the topic, but also for the development of their independent thinking, analytical approach, and scientific thinking skills. The method of "division of processes into families" allows for a systematic analysis of light phenomena and ensures visual, logical, and interactive assimilation of the topic.

REFERENCES:

1. B.N. Xushvaqtov Integrative model of improving the content of classes in optics European journal of research and reflection in educational sciences vol 7 (12)
2. B.N.Khushvaktov Using fresnel bipprisms to explain the theme of light interference science and innovation 2023 46-48b
3. B.N.Khushvaqtov Didactic factors affecting improvement academicia: an international multidisciplinary research journal 2021y 1823-1826b
4. B.N.Khushvaktov Teaching physics on the basis of pedagogical technologies uzbek scholar journal volume- 24, january, 2024 www.uzbekscholar.com
5. B.N.Xushvaqtov Sferik ko‘zgu va unda tasvir yasash mavzusini o’qitishning ilmiy-nazariy asoslari uzbek scholar journal volume- 25, february, 2024 ww.uzbekscholar.com 115-119b
6. B.N.Xushvaqtov Optika darslarida interfaol metodlardan foydalanish imkoniyatlari uzbek scholar journal volume - 25, february, 2024 www.uzbekscholar.com 201-205b
7. B.N Xushvaqtov Innovative fundamentals of non-traditional teaching (on the example of the optics department) journal of ethics and diversity in international communication”. e-issn