

## ADVANTAGES OF TEACHING THE STRUCTURE OF AN ATOMIC USING INTERDISCIPLINARY INFORMATION TECHNOLOGIES

**Saytdjanov Shovkat Nigmatjanovich**

*Associate professor, PhD*

**Khursanjonov Javokhir Jamol ogli**

*Assistant saytdjanov123@mail.ru Tashket State Transport University*

**Annotation:** *The article discusses the advantages of teaching the structure of the atom based on interdisciplinary information technologies, taking into account didactic requirements, criteria and principles.*

**Key words:** *particle, wave, microparticle, microworld, diffraction, microobject, classical physics, quantum physics, photon, energy, phenomenon, process, synthesis, thermonuclear.*

The reforms taking place in the innovative education system in our country serve to increase the quality and efficiency of education in linking the "Atomic Structure" with chemistry. The Concept for the Development of the Public Education System of the Republic of Uzbekistan until 2030 sets out the following tasks: "qualitatively renewing the content of the continuous education system, improving teaching methods, increasing attention to the study of physics in conjunction with chemistry, and developing criteria for evaluating pedagogical activity based on the competencies provided for in the State Educational Standards." This justifies the need to study the various physical and chemical properties of substances in their gas, liquid, solid, and plasma states, based on their atomic structure.

Based on the above ideas in the process of teaching physics, we will dwell on the methods and techniques for studying the structure of the atom based on the connection between natural sciences:

### 1. Particle-wave dualism

It is known that in physics textbooks of secondary schools, the idea of Louis de Broglie and the conclusions arising from its proof are logically considered, and it is stated that the laws of classical mechanics cannot be applied to the study of quantum objects, and that there are special laws operating in the micro world. However, the importance of particle-wave dualism in studying the nature of the micro world and the conclusions arising from it are not sufficiently explained. Only when the essence of particle-wave duality is sufficiently revealed will students be able to better understand the laws of quantum physics without replacing the concept of a micro-object with a particle or a wave. Indeed, the main formulas that summarize the wave ( $\lambda\nu$ ) and particle ( $E, p$ ) nature of light are:

$$E = h\nu \quad \text{and} \quad P = \frac{h}{\lambda} \quad (1)$$

(1) Louis de Broglie continued that it is possible to determine the energy and momentum of a photon using formula (2),

$$\lambda = \frac{h}{mv} \quad (2)$$

and suggested that these relations have a universal nature and are also valid for massive particles moving at all speeds, and that their wavelengths should be determined using formula (2). In an experiment, the observation of the diffraction of electrons, protons, and atoms, the observation of the diffraction phenomenon by a sequential flow of individual electrons, showed that an individual electron has its own de Broglie wave.

These confirmed Louis de Broglie's idea, but also raised the question of whether electrons, protons, or neutrons are "waves" or "particles". In the process of explaining this question to students, by calculating  $\lambda$  for particles of different masses and speeds using formula (2), it should be achieved that as the mass of the observed object increases, its de Broglie wavelength approaches zero. It can be studied using the laws of classical mechanics, considering it as a massive particle.

On the contrary, as the object becomes smaller and becomes a micro object, the length of the de Broglie wave increases, and its wave properties begin to manifest themselves more. In this case, the micro object cannot be studied using the laws of classical mechanics, and they are considered a quantum objects. Because in Newtonian mechanics, the object is studied without taking into account the wave properties of the object. In fact, although there is no clear boundary indicating when a micro object becomes a quantum object, it is worth saying that if it is impossible to study a micro object without taking into account its wave properties, they are considered a quantum objects.

The thing is that if we want to learn about an object, for example, if we want to study ordinary chalk, we first of all study it based on its properties (whiteness, brittleness, etc.). If we study chalk without taking into account any of its properties, the information about chalk will be incomplete. When the mass of such an object decreases and becomes equal to the mass of an atom, its wave properties appear, and it is impossible to obtain complete information about it without taking this property into account. Therefore, the motion of micro objects is studied using laws that act in the micro world and take into account the wave properties, without being expressed in the laws of classical physics.

We see that the objects studied, taking into account the de Broglie wave, electrons, protons, neutrons, etc., which are included in quantum objects, have both particle and wave properties. To the question "Are they particles?", "Are they waves?" it should be said that although such a question is correct, it is logically incorrect. Because, for example, asking whether an electron is a particle or a wave is like asking "Is it white? Is it brittle?" in the above example. Because the particle and wave nature is a duality characteristic of the electron. As another example, the dual nature of a

micro object can be compared to a centaur with a horse in the lower part and a human head, or a mermaid with a half-fish, half-girl appearance. In this case, the centaur or mermaid is not called a human, but is called by another name, which emphasizes the presence of both properties. When talking about such micro objects, it is not called a particle or a wave, but rather a quantum object, which emphasizes the presence of both properties.

Usually, when we think of an electron or a proton, it is natural that we think of a particle like a ball, because in many experiments they behave like a ball. For this reason, it has become customary to call them micro particles. In fact, they are quantum objects, and their particle properties are more pronounced. It should be noted that it is necessary to be careful with the expressions used in some applications, such as “Particle and wave properties of a micro particle”. In our opinion, the expressions used as “micro particle wave” are far from the true essence of the words used as “micro particle wave” or “white fragility”, as in the above example. Therefore, instead of expressions like “micro particle wave”, it is better to call quantum objects - electrons, protons, atoms, etc., or, as Louis de Broglie himself used it, matter waves, which brings us closer to the essence. To strengthen our opinion above, it is useful to solve problems such as the following.

What is the de Broglie wave for an electron, a hydrogen atom, and a ball with a mass of 0.1 g? If their kinetic energies are.

A) 100 eV;

B) 1.5 MeV,

For each case, check how the de Broglie wave changes depending on the mass.

2. Studying the motion of micro particles using the uncertainty relation.

In physics textbooks written on the basis of the current improved program, special attention is paid to the content of topics related to quantum physics, in which, along with studying the Bohr atom model, it is noted that it is not without its shortcomings and that in order to eliminate these shortcomings, it is necessary to consider the electron state in the atom based on the duality of the micro object, that is, the particle-wave property. However, it is not emphasized that due to the very duality of the micro object, the Heisenberg uncertainty relation arises, and the concept of an electron cloud, which follows from the probabilistic laws, should be used instead of the concept of a trajectory.

In the process of studying these laws, in addition to showing that the values of the coordinate and momentum of a micro particle should be estimated using the uncertainty relation, it becomes possible to theoretically substantiate the electron cloud atom model proposed in chemistry textbooks and to strengthen the results achieved in this regard. For this, in the course of explaining the idea of Louis de Broglie, it is shown that if a particle of mass  $m$  moves at a  $v$ -velocity, its de Broglie wave can be found by formula (2) and its universal characteristics are found, and this expression has been proven to be excellent in experiment, and as a conclusion, it is

worth noting that it is impossible to know the coordinate and momentum of a particle simultaneously. Because the requirement to determine the values of the x-coordinate and the mv-momentum simultaneously (at a point) is as illogical as asking what the  $\lambda$ -value is in the x-coordinate, according to formula (2).

If it is necessary to know the values of these two quantities simultaneously, it is necessary to show that their accuracy is limited  $h = \frac{h}{2\pi}$  by the Planck constant and the Heisenberg uncertainty relation

$$\Delta x \Delta p_x \geq h \quad (3)$$

Using this relation, it is possible to study the motion of electrons in spheres of different sizes and show that the states of electrons in an atom cannot be determined by an exact orbital trajectory. For this, it is appropriate to examine conditions similar to the following examples.

Case I. Let the electron move with a velocity  $v = 2 \cdot 10^8$  m/s in a sphere much larger than the dimensions of the atom, for example, in a betatron with a radius  $r = 3$  m. If its trajectory radius is calculated with an uncertainty of 0.002 mm, then using formula (3), it is possible to calculate the uncertainty of the velocity  $\Delta v$  to do this, having found the uncertainty in determining the radius  $\Delta r = r \cdot 0,002 = 0,06$  (mm), taking into account the relativistic change in the electron mass at high velocities

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} = 7m_0 \quad (4)$$

We find the uncertainty in the velocity as follows

$$\Delta v = \frac{h}{m\Delta r} = 0,28 \text{ m/s} \quad (5)$$

We see that the uncertainty in the radius  $r = 3$  m is  $\Delta r = 0.06$  mm and the uncertainty in the velocity  $v = 2 \cdot 10^8$  m/s is  $\Delta v = 0,28$  m/s, which is so small that they can be ignored. Since the coordinate  $r$  and the velocity  $v$  have an exact value at the same time, in such cases, the trajectory of the electron can be easily represented. We observe such cases in cathode ray tubes.

Case II. Let the electron move with a speed of  $v = 10^6$  m/s in a sphere corresponding to the dimensions of the atom, for example, in an atomic orbit with a radius of  $r = 0,5 \cdot 10^{-10}$  m. Let us assume that the uncertainty in the orbit radius is one percent of the radius, then the uncertainty will be  $\Delta r = 0,01 r = 5 \cdot 10^{-13}$  m. Using this, the uncertainty in the velocity can be determined as before  $\Delta v = \frac{h}{m\Delta r} = 2 \cdot 10^8$  m/s

We see that the uncertainty in the velocity is 200 times greater than the value of the velocity. From this, it follows that if the electron coordinate in the atom is accurate, the velocity is inaccurate, and it is impossible to show the trajectory of the electron motion.

In general, as the studied area of the micro-object becomes smaller and approaches the atomic size, the importance of the uncertainty relation increases, if the

coordinate is accurate, the uncertainty of the speed increases, and on the contrary, if the speed is accurate, the uncertainty of the coordinate increases, and it becomes impossible to know these two quantities accurately at the same time. As a result, the ability to clearly show the trajectory is lost, and the concept of trajectory for micro-objects cannot be used. Their motion is determined by probabilistic laws using the de Broglie wave. If the state of electronic movement in an atom is studied with the help of such laws, it is determined that it will be in the form of a cloud of a certain shape, consisting of points indicating the probability of finding an electron.

#### REFERENCES:

1. Шпольский Э.В. Атом физикаси. 2-жилд. Т.1-2. –Т.: Ўқитувчи, 1970.
2. Saytdjanov Sh.N., Mirsalikhov B.A. The significance of studying the subject “Atomic structure chemical bonding in physics and chemistry in higher education institutions (in the areas of railway transport and materials science and new materials technology). //Science and innovation International scientific journal., Volume 2, Issue 2, February. 2023. -P. 10-17.
3. Сайтджанов Ш.Н., Махмудов Ю.Ф. Межпредметных задач по физике “Атома и атомного ядра”. //Фан ва таълим-тарбиянинг долзарб масалалари мавзусидаги Республика илмий-назарий ва амалий анжуман. 3-бўлим. – Нукус, 2018. - Б.341-343.
4. Сайтджанов Ш.Н., Махмудов Ю.Ф., Мирсалихов Б.А. Ядро реакциялари кинематикаси. //Таълим-тарбия узлуксизлиги ва узвийлигида интегратив ёндашувлар вариативлиги. Илмий-услубий мақолалар тўплами. –Тошкент, 2019. -Б 299-300.
5. Сайтджанов Ш.Н., Махмудов Ю.Ф. Атом ядроларининг бўлиниши //Таълим-тарбия контекстида фанлараро синхрон ва асинхрон боғланишлар. Илмий-услубий мақолалар тўплами. –Тошкент, 2019. –Б.36-42.