Proceedings of the 2nd International Conference on Computing Innovation and Applied Physics (CONF-CIAP 2023)
DOI: 10.54254/2753-8818/5/20230272

A review on the hypotheses leading to the creation of quantum mechanics

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Abstract. On April 27, 1900, the famous British physicist William Thomson (Baron Kelvin) delivered a speech entitled "The Dark Clouds of the Nineteenth Century on the Theory of Heat and Photodynamics" at the Royal Society. In his speech, he pointed out that, in the "edifice of physics" based on force and heat, there were two hypotheses that could not be solved at that time. One was the ether medium and the other was the black body radiation. Later, the flaws of physics were proved and the quantum mechanics and relativity were thus created. This paper introduces the origin of the concept of aether and the inference of its reality through subsequent scientific experiments. It also illustrates the emergence of a series of hypotheses such as blackbody radiation, which laid the foundation for the beginning of quantum physics.

Keywords: Aether, Michelson experiment, Aether wind, Newton's laws, classical mechanics, quantum mechanics.

1. Introduction

Overturning the basic physical theory that "dynamic theory affirms that heat and light are two modes of motion", the first dark cloud refers to the state in which light propagates in the universe, and what medium does gravity propagate through. This leads to the "ether wind". The ether concept - abandoned for a long time but reinstated by Dirac in1951-1953 - has in recent years emerged into a fashionable subject in theoretical physics [1]. The second dark cloud that Kelvin mentioned mainly refers to the law of equal distribution of energy in thermology. The theoretical interpretation of gas specific heat and thermal radiation energy spectrum has obtained results that are different from experiments, and the most prominent one is the "ultraviolet catastrophe" that appeared in the black body radiation theory. This paper fully explains the origin and development of quantum based on the aether hypothesis and Michelson experiment, illustrating the journey of development for ancient quantum physics.

2. The origin and principle of Aether

People’s lives are inseparable from the movement of objects, and this process may be a single particle that can be micronized, or a medium through which the movement of energy can propagate to form waves. Ancient Greek Aristotle once put forward the hypothesis of ether to explain the reason why light can travel between the universe. Before that, people believed that the world is composed of four elements: fire, water, earth, and air. They are also important media for energy transmission.

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This hypothesis was well put forward for various phenomena that could not be explained at the time, such as where gravity come from and why light could continue to travel in the universe. Newton believed that gravity and light were the same. They all needed this small elasticity and thin mediums were used to explain the problems of the time. In the 19th century, Maxwell's electromagnetic theory also described that electromagnetic waves and light both have wave-particle duality, that is to say, they have a common hypothetical medium "ether", Since then, the concept of ether coincides with Newton's conjecture.

The creation of new things must be accompanied by problems. If one assumes that ether is a medium for waves, then the problem of "ether wind" will arise. The earth has been revolving around the sun at a speed of nearly 30 kilometers per second. If the previous hypothesis is true, then it means that the ether is existing all over the universe, and the earth is also receiving the impact of the ether wind in the opposite direction every second. Propagation must also be accompanied by a lot of changes. The problem of this ether wind has led to more and more people entering the study of ether wind later.

3. The Michelson-Morley experiment

In the year of 1887, Michelson and Morley conducted a test that was enough to destroy all theories about the ether hypothesis. The Michelson-Morley experiment revealed the interference of photons [2]. The test passed the hypothesis that there is indeed ether being as a medium for light. If light receives different refractions at the same time and distance, then the spectral effect will be definitely different in the end.

First is to prepare a laser and a mirror that can refract and transmit at the same time. Then, a reflector is placed at the final refraction and transmission position to ensure that the two beams of light can be reflected on the mirror that transmits and refracts for the first time. (Note: the plane angle of refracted light and transmitted light needs to be 90 degrees.)

The laser is allowed to work, but the experiment is to prove that the light beams from the same source have different spectral effects after changing part of the transmission and part of the refraction, because they have changed in the medium of ether.

In order to ensure the same optical path, the experiment needs to add an additional condition to add another beam splitter after a beam splitter, which ensures that the two beams of light go through the same path and finally reach the screen.

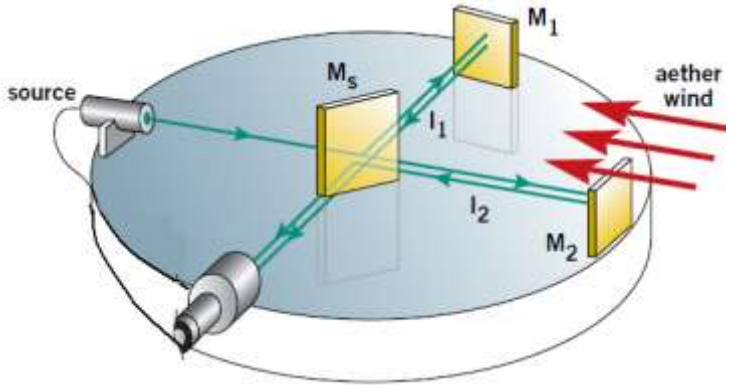

Figure 1. Step diagram of the experiment (source from HSC Physics).

According to the final comparison of the spectra, the interference fringes of the two beams of light on the final screen are exactly the same, which means that either the speed of the ether as the reference frame of the light is always zero or there is no so-called ether at all. Additionally, a new analysis of the Michelson Morley experiment shows that light propagates anisotropically relative to a moving system, and is dependent on the velocity and the angle between the velocity and the direction of motion. The two-way (back and forth) velocity is isotropic [3]. The experimental verification is that in 1893 (this model is gauge invariant, unlike massive-photon theories based on the Proca equation, and it predicts

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anisotropy of both the speed of light and the electric field of a point charge5) [4], the famous London physicist Lodge found that when the official could rotate two huge dry disks rapidly, the observed speed did not change, which proved for the second time that the influence on the external medium did not change. It will not have any effect on the speed of light or the spectrum presented. In subsequent experiments, scientists are trying to use various means to prove the existence of aether, but the result is that whether it is from the speed of light or the final light, according to the spectrum presented, the aether has been proved time and time again that it does not exist.

In 1905, A. Einstein, from the experiments of Michelson and Morley in 1887, enunciated the light speed constancy principle in the inertial frames of reference [5]. According to Lorentz, the transformation of Lorentz is to propose the idea that the speed of light is constant without giving up the concept of ether, since so many observational experiments have proved that if ether is used as the reference frame, its velocity is zero. That is to say, no matter from which speed state the observer observes the light, the speed is always the same. In the end, Einstein simply and directly stated that the ether is not necessary to exist. Instead of proving the existence of ether all the time, it is better to directly abandon the reference frame it represents, after all, it has no meaning (if a reference frame is zero, then any follow-up mathematical calculation can directly discard it), thus proposing the famous principle of the invariance of light speed. In the following scientific journey, Einstein proposed the principle of special relativity and completely denied the ether. The demise of the ether also laid the foundation for the birth of the special theory of relativity.

4. The origin of quantum mechanics

4.1. The concept of radiation

As the largest radiation source of the solar system, the sun, the most important heat energy source of the earth, can release about 3.8 x 10^26 joules of energy per second, and the main form of transmission of these energy is thermal radiation. If the temperature of an object is above absolute zero, then whether the object is gas or liquid, it will radiate outward, and no matter which of the two objects has a higher or lower temperature, both objects will radiate toward the other, so whether there is an ideal substance that can absorb all the radiation it receives is something that scientists have wondered in the past. That is to say, no matter at any temperature and any wavelength of electromagnetic wave, the ratio of its absorption and exposure to radiation is always 1. However, because the metal element has too many free electrons, the conductivity contained in it will increase its reflection and absorption. The efficiency of releasing radiation is why the mobile phone often fails to receive the signal when people are taking the elevator. In subsequent studies, scientists began to conduct experiments on ideal black bodies based on this phenomenon.

4.2. The black body radiation experiments

The results of the experiment have tentatively proved the original conjecture, but some obstacles that have always existed in this process cannot be easily explained by the knowledge of classical physics at that time. Many people have tried to use mathematical formulas to represent the relational quantities of black body radiation in experiments, but the formulas created at the beginning are often only able to satisfy very few cases.

$$E_{b\lambda}(T) = C_1\lambda^{-5}e^{-\frac{C_2}{\lambda T}} \quad (1)$$

It was German physicist Wien (who was awarded the Nobel Prize in Physics for discovering the law of thermal radiation) who first proposed the mathematical relationship of the black body hypothesis, but unfortunately this formula is only applicable to relatively short wavelengths and cold temperatures. When environment is relatively cold, it is the same as the result collected by the actual experiment, but people at that time still choose this algorithm. Although there are some small errors, it can greatly help in the countless relational expressions at that time.

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$$E_{b\lambda}(T) = C_3\lambda^{-4}T \quad (2)$$

British physicists Rayleigh and Kings took the opposite direction and tried to prove the equation of the experimental variable. They first assumed that energy is a kind of constant change, and then they created the formula for the temperature and the longer wavelength, but until now scientists have not found a formula that can be applied to all situations. All the formulas known now are based on the fact that experiments can only be performed in a specific environment with the same experimental results, and the Rayleigh formula points out that as long as the wavelength can continue to be shortened, the radiation can be infinite. This problem became an unsolved mystery at the time. It was not until the emergence of Planck's correction that this "disaster" for the entire physics community completely came to an end.

$$E_{b\lambda} = \frac{c_1\lambda^{-5}}{e^{c_2/(\lambda T)}-1} \quad (3)$$

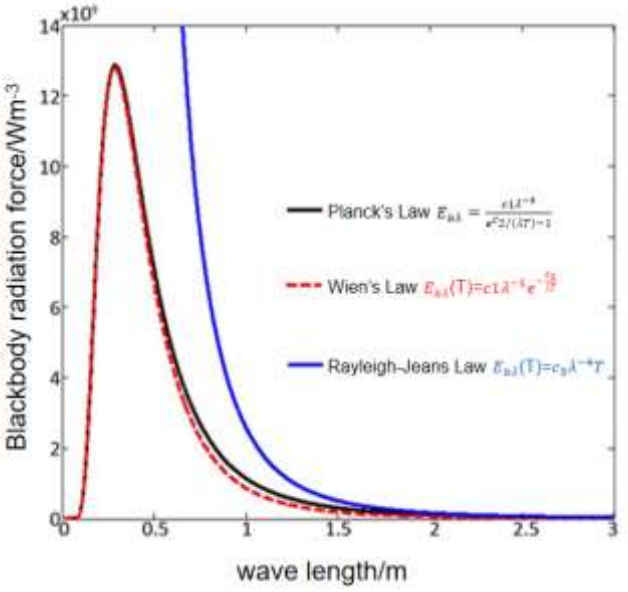

Figure 2. Matlab code and the relationship between the three laws [6].

4.3. The emergence of planck's correction

Planck first adopted the same prominent quantization assumption as Einstein at that time. In layman's terms, he believed that the propagation of energy was not continuous. This assumption was unprecedented in history. The black-body radiation is reinterpreted in terms of the photon's many-body wave functions in analogy with the condensed matter physics. This interpretation has implications on the wave-particle duality, and on the difference between the photon and the matter wave [7]. It directly updated the concept of energy at that time. However, this idea is indeed Einstein's idea. Planck created Planck's constant through this hypothesis. Later, Einstein combined the follow-up experiment and confirmed the photoelectric effect. It's the frequency of some kind of electromagnetic wave, but it is the particle at the same time. And in subsequent experiments, if a photon collides with an electron, the photon will completely follow Newton's law. Newton's "superb theorem" for the gravitational inverse-square-law force states that a spherically symmetric mass distribution attracts a body outside as if the entire mass were concentrated at the center [8]. At this time, classical mechanics finally found the connection point with quantum mechanics.

Finally, after Planck completed the theory of energy discontinuity, the foundation of quantum mechanics was finally consolidated, but its journey was definitely more than that. It was just the beginning and cause of quantum mechanics. however the emergence of quantum mechanics awakened

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people, there are still many unknown things. At that time, the theoretical basis can be said that any exploration of the unknown is accompanied by problems that may trouble people for a lifetime. If there is no continuous exploration of experiments conducted by these people, then the descendants such as Heisenberg, Schrodinger, etc. would need more time to thoroughly consolidate this discipline. It can be said that the emergence of quantum mechanics is definitely the most breakthrough exploration in modern times, and it is applicable to various fields, medicine, and environmental protection. Classical physics fails where quantum physics prevails. This common understanding applies to quantum phenomena that are acknowledged to be beyond the reach of classical physics [9]. But today there are still many things that cannot be completely explained by science, but in any case, people must believe that the occurrence and combination of things must be orderly and followable. Advances in quantum technologies are giving rise to a revolution in the way fundamental physics questions are explored at the empirical level. At the same time, they are the seeds for future disruptive technological applications of quantum physics [10].

5. Conclusion

Based on ether hypothesis and Michelson experiment, this paper explains the origin and development of the quantum mechanics, including the concept of radiation, the black body radiation experiments, and the emergence of Planck's correction. For those unknown theories, people tend to depend on previous knowledge, and only after one hundred years of scientific development in the past era of hot and force, some theories start to remain absolutely correct. Later generations begin on the basis of the complement.

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