

CLASSIC IDEAS ABOUT PHOTO EFFECT AND COMPTON EFFECT

There are two theories to explain the photoelectric effect: P. Lenard's first theory (resonance theory) sees the cause of the effect in the mechanism of the atom, Einstein's second theory sees the reason in the special properties of light. According to the first theory, light, as O.D. Khvolson put it, plays the role of a release mechanism: each electron oscillates with its characteristic period, thanks to its inherent intra-atomic energy; when there is a resonance between its oscillation and the oscillation of light, the electron is ejected. Since, with such a point of view, it would be necessary to assume that in an atom there is a set of electrons with an infinite variety of velocities corresponding to an infinite variety of periods of incident light, this theory is changed in the sense that light is considered as a cause causing an electron to oscillate, the period of which is close to period of oscillation of light. At a certain limiting speed of the electron, which depends on the speed of the incident light, the electron leaves the plate. Full resonance for a given electron can occur only at a certain period of the incident light and the effect in this case should be greatest (selective effect).

As for the second theory, it rests on the hypotheses of Planck and Einstein. Planck suggests that the emission of light by a molecule occurs always in amounts that are multiples of $h\nu$, g de ν is the number of oscillations of the molecule and h - universal constant equal to 6.55×10^{-27} erg sec. Einstein, on the other hand, believes that light is not only emitted in certain portions, but also continues to exist in nature in the form of such portions so that the light falls on the object, so to speak, in the form of pellets atoms of light (quantum). Without touching on the question of how the incident light causes the photoelectric effect, many aspects of this phenomenon can be explained if we assume that 1) the energy of photoelectrons is obtained due to the energy of the absorbed light and 2) the light is absorbed in portions that are multiples of $h\nu$, where ν is the number of oscillations molecules. Under the influence of the received portions of energy and with its sufficient accumulation, the electron flies out and carries the accumulated energy with it.

from I. Haber's article "Photoelectric effect" // ["Bulletin of Experimental Physics and Elementary Mathematics"](#), No. 637, 1915, p. 11

- If the surface of a metal placed in a vacuum is illuminated with ultraviolet rays, a certain amount of electrons will fly out of this surface. Since their speed does not depend on the state in which the metal is, in particular on its temperature, it is natural to conclude that the source of energy of the emitted electrons is not in the metal, but in the rays of light that fall on it. Further, moving the light source away from the metal, it is easy to establish that the speed of the electrons does not depend on the intensity of the light. It depends only on the wavelength: the shorter the wave, the greater the speed. Explaining this fact presents an insurmountable difficulty for our theory. It is not clear where the electrons get their energy from,

- The only possible explanation for this fact, apparently, lies in the fact that light energy does not spread quite uniformly - it remains concentrated in some clumps that fly in all directions at the speed of light. Each such bunch, falling on the surface of the metal, can transfer its energy to the electron, and this energy, of course, remains the same, no matter how great the distance from the light source ...

- As we can see, the old corpuscular theory of light is resurrected here again, albeit in a completely changed form. However, the same phenomenon, which at one time stood in the way of light corpuscles, now presents enormous difficulties for clots of light. I mean interference. It is difficult for us today to explain how two light bunches, meeting each other, can neutralize each other without violating the law of conservation of energy ...

- In such a situation, it is natural to assume that the source of energy of electrons detached from the metal is still not in the rays, but in the metal itself. As for the rays, they only release it, serve as a kind of fuse - after all, one spark is enough to blow up a keg of gunpowder ...

*fragment of M. Planck's 1919 report from the book:
[Moroz O. "The Light of Illumination", M.: Knowledge, 1980, p. 143](#)*

The phenomenon of a change in wavelength during light scattering could be explained from the wave point of view using the Doppler phenomenon: electrons scattering X-rays, under their influence, are ejected from atoms in different directions at different speeds. Thus, the scattered radiation should have a changed wavelength depending on the speed and direction of the scattering electrons. By calculating how the scattering electrons should move, it is not difficult to obtain the classical picture of the Compton phenomenon.

The movement of electrons, which have received noticeable speeds as a result of X-ray scattering, can be observed directly experimentally. For this purpose, studies were carried out using a *Wilson camera*, which allows one to judge both the direction of the scattered rays and the direction of motion of the electrons knocked out during the scattering of X-rays ("recoil" electrons). Both the path of the electrons and the path of the scattered X-ray light appear as ions, on which water vapor condenses, making these paths visible.

As already indicated, it is possible to calculate the mutual directions of electrons and scattered rays, which are necessary for the classical explanation of the Compton phenomenon using the Doppler effect. On the other hand, this distribution of the directions of electrons and photons can be calculated using the theory of elastic collisions. These two points of view lead to different results. The mentioned experiments testify in favor of the quantum theory of the phenomenon, so that its explanation using the Doppler effect should be considered unsatisfactory. Thus, the Compton phenomenon, like the basic laws of the photoelectric effect, speaks in favor of the concept of photons.

from the book: [Landsberg G.S. "Optics", Moscow: Nauka, 1976, p. 656](#)

The Compton collision of photons and electrons is just another form of the Doppler effect. The existing experimental confirmation of the Compton effect for bound electrons is not final, as well as the qualitative experimental confirmation of the inverse Compton recoil of photons from high-energy electrons.

from W. Kantor's article "Equivalence of the Compton Effect and the Doppler Effect" // [Spectroscopy Letters, 4, 1971](#)

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