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Why Can We Only See Visible Light?

Gong BingXin
bingxin_gong@hotmail.com

Visible light is the most familiar form of electromagnetic radiation and makes up that portion of the spectrum to which the eye is sensitive. This span is very narrow.

This paper outlines two reasons why we can only see visible light. The photoconductive effect and electric conductivity decrease with ω and are determining causes. Because the author does not have detailed data about the eye, this paper is a semi-quantitative analysis, but it may be generally applicable to the relevant phenomenon.

Limitations of the Orthodox Theory of Vision

Orthodox vision theory says that the failure of short wavelengths to stimulate vision is due to absorption by the ocular media[1] This is not in accord with the obvious fact that X rays and Gamma rays can easily penetrate ocular media, yet we cannot see them.

Another orthodox theory says that the failure of long wavelengths to stimulate vision is due to absorption by the ocular media[2], but this is also not in accord with the obvious fact that RF radiation can penetrate deep into the body. Radiation of 2450MHz will penetrate to a muscle depth of 1.70cm, 40.68MHz to a depth of 11.2cm, 27.12MHz to a depth of 14.3cm, 13.56MHz to a depth of 25.0cm, but we cannot see RF radiation.

Two Reasons Why We Can Only See Visible Light

According to the orthodox vision theory, the eye's rods behave as transducers in that they convert light into electrical energy. The optic nerve transmits the electrical energy to the brain.

The author thinks that to be received by the brain, a minimal threshold electrical energy is required. There are two steps to achieve this process.

Ejecting electrons from rod cells by light is the first step (as we know in the photoconductive effect,). To increase the concentration of the current carrier in a semiconductor requires a minimal threshold frequency of ω. The author thinks that to

[1] Please see the entry colour vision(from eye, human), Britannica Encyclopedia
[2] Please see the entry vision, modern medicine, Chinese Encyclopedia; I am sorry that I cannot find relevant content in English.

eject the electrons from rod cells also requires a corresponding minimal threshold frequency of ω. This minimal threshold frequency is that of red light. Below it, no electrons can be ejected from rod cells, and no minimal threshold electrical energy will be transmitted to the brain by the optic nerve. Thus, we cannot see light that has a frequency below that of red light. If the infrared radiation is strong enough, wavelengths as long as 10,000–10,500 angstroms evoke a sensation of light. An explanation can be found in my paper, “The Photoelectric Effect And Multi-Photoelectric Emission”.

When the light force ejects the electrons from the rod cells, they will be transmitted to the brain by the optic nerve. The damping force will affect the electrons. There is a direct ratio between the damping force F and the velocity $\frac{dr}{dt}$,

$$F \propto -md\frac{dr}{dt} \tag{1}$$

where m is the mass of the electron, d is the coefficient of damping.

The equation of motion of the electron can be expressed by the following equation

$$m\frac{d^2r}{dt^2} + md\frac{dr}{dt} = eE \tag{2}$$

For the sine field,

$$E = \mathrm{Re}(E_0 e^{j\omega t}) \tag{3}$$

Suppose

$$r = \mathrm{Re}(r_0 e^{j\omega t}) \tag{4}$$

We can obtain

$$r = \frac{-je}{m\omega}\frac{E}{d + j\omega} \tag{5}$$

$$\frac{dr}{dt} = j\omega r = \frac{e}{m}\frac{E}{d + j\omega} \tag{6}$$

Suppose the number of the free electrons in unit volume is n. The electric current density J can be expressed as follows:

$$J = ne\frac{dr}{dt} = \frac{ne^2}{m}\frac{E}{d + j\omega} \tag{7}$$

The electric conductivity σ_0 is

$$\sigma_0 = \frac{J}{E} = \frac{ne^2}{m(d + j\omega)} \tag{8}$$

$$\sigma = \mathrm{Re}\,\sigma_0 = \frac{ne^2 d}{m(d^2 + \omega^2)} \tag{9}$$

We can see that the electric conductivity σ decreases with the frequency ω.This means that if the frequency ω is over a certain limit, such as the frequency of ultraviolet radiation, we will not see these waves. n increases with the intensity of the incidence light. From the equation (9), we can also understand why our eyes are more sensitive to low frequency electromagnetic wave.

Conclusion

From the above analysis it may be stated that the reason why plants only absorb visible light for photosynthesis, is applicable to all relevant phenomenon, such as photosynthesis generally. The author believes that above a certain frequency, the electric conductivity σ of any photoconductive material like semiconductors and dielectrics, will decrease or will become zero.