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PHYSICAL MEANING OF PLANCK'S CONSTANT

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Abstract. The photon energy with its corresponding frequency, wavelength and distance can be determined by the main physical parameters (mass, distance, time) of the particles (electrons, nucleons, molecules) as a result of their excitation, transition, vibration and rotation. All calculations for mass, distance and time for all particles give the same value which corresponds and equals to Planck's constant in all electromagnetic bands, so the physical meaning of Planck's constant is interpreted which represents these three main physical parameters as a result of the physical mechanisms responsible for excited states of nuclei, atoms and molecules. As a result of the equality between Planck's constant and the mentioned three physical parameters a new equation of calculating exact distance of all emitted photons from nuclei, atoms and molecules from radio waves to gamma rays is deduced.

***Keywords**:* photon, frequency, wavelength, mass, energy, distance, time.

1. INTRODUCTION

In 1901 Max Planck published a proposal to describe the spectral distribution of the electromagnetic energy radiated by hot bodies and proposed a concept of quantum of energy [1], which in turn allowed Einstein in 1905 to introduce the concept of photon [2]. Both concepts are an important part of the theoretical foundations of quantum mechanics and its empirical mathematical expression

$$E = h\nu$$

which is called Planck-Einstein relation. The proportionality constant h is known as Planck's constant and is equal to 6.626×10^{-34} J.Hz^{-1}.

The photoemission spectroscopy technique has experienced a great advancement in the last few decades [3–6]. In modern photoemission spectroscopy, the energy of the photoelectrons can be precisely measured, and the emission angle of photoelectrons can also be measured that provides information of electron momentum in the measured material.

Atoms and nuclei have discrete energy levels and their locations and properties are governed by the rules of quantum mechanics. In molecules, both vibration and rotation are also quantized.

2. PHYSICAL FOUNDATIONS

The Physical relations and laws can be expressed in terms of the main physical parameters responsible for their origin.

In the case of all electromagnetic radiation, the excitation, transition, vibration or rotation of particles (nuclei, atoms and molecules) are the main causes of all photons. Therefore, the main physical parameters (mass, distance, time) should be included in the main Planck's equation relating photon energy and its frequency.

3. MATHEMATICAL FOUNDATIONS

The Planck's equation is

$$E = h\nu \tag{1}$$

All calculations for all emitted photons either from nuclei, atoms and molecules either for excited electrons, excited nucleons and rotated or vibrated molecules (their masses, their distances, their elapsed time between excited and ground state) give the same value which corresponds and equals to Planck's constant in all electromagnetic bands. Then Planck's constant represents three main physical parameters (mass, distance, time), so Planck's equation takes the following form

$$E = \frac{m \times d^2}{t} \times \nu \tag{2}$$

Since $\nu = \frac{1}{t}$, then Planck's equation has the following form in unit of Joule

$$E = \frac{m \times d^2}{t^2} \tag{3}$$

Since $\nu = \frac{c}{\lambda}$, then the equation of calculating the wavelength of photon in unit of meter is

$$\lambda = \frac{m \times d^2 \times c}{E \times t} \tag{4}$$

and the equation of calculating the frequency of photon in unit of Hertz is

$$\nu = \frac{E \times t}{m \times d^2} \tag{5}$$

where: E is the energy of photon in J; λ is the wavelength of photon in m; ν is the frequency of photon in Hz; m is the mass of electron, nucleon or molecule in kg; d is the atomic, nuclear or molecular distance in m; t is the reciprocal of frequency of certain photon, $t \times \nu = 1$.

4. CALCULATING EXACT DISTANCE OF ALL EMITTED PHOTONS

By knowing that and taking the hydrogen molecule:

– electron mass = 9.1×10^{-31} kg,

– nucleon mass = 1.7×10^{-27} kg,

– mass of hydrogen molecule = 3.4×10^{-27} kg

and comparing equation (1) and (2) then Planck's constant is

$$h = \frac{m \times d^2}{t} \tag{6}$$

$$d = \sqrt{\frac{h \times t}{m}} \tag{7}$$

From equation (7) we can determine the exact distance for certain excitation, transition, vibration or rotation for certain particle (electron, nucleon, molecule) where h (Planck's constant), t (reciprocal of frequency), m (mass of particles) are known parameters.

It is noticed that each excitation, transition, vibration and rotation have unique distance.

Then by using equations (3, 4, 5, 7) we can calculate the photon energy, photon frequency, photon wavelength and exact distance of each photon from gamma rays to radio waves and all calculated values are identical with the calculated values from the main Planck's equation as indicated in the appendix.

Important note. The larger the energy or frequency of the emitted photon the smaller the distance inside nuclei, atoms and molecules.

5. CONCLUSIONS

The energy of photons, frequencies, wavelengths and distances can be determined from the main physical parameters (mass, distance, time) as a result of excitation, transition, vibration or rotation of the particles responsible for their origin. The calculated values from modified equation for photon energies, wavelengths and frequencies are identical with calculated values from Planck's equation.

APPENDIX

Table 1

Physical parameters for Gamma (γ) rays

Mass	Distance	Time	Frequency	Energy	Wavelength
1.7×10^{-27} kg	6.243×10^{-16} m	10^{-24} s	10^{24} Hz	6.62×10^{-10} J	3×10^{-16} m
1.7×10^{-27} kg	1.974×10^{-15} m	10^{-23} s	10^{23} Hz	6.62×10^{-11} J	3×10^{-15} m
1.7×10^{-27} kg	6.243×10^{-15} m	10^{-22} s	10^{22} Hz	6.62×10^{-12} J	3×10^{-14} m
1.7×10^{-27} kg	1.974×10^{-14} m	10^{-21} s	10^{21} Hz	6.62×10^{-13} J	3×10^{-13} m
1.7×10^{-27} kg	6.243×10^{-14} m	10^{-20} s	10^{20} Hz	6.62×10^{-14} J	3×10^{-12} m

Table 2

Physical parameters for X- rays

Mass	Distance	Time	Frequency	Energy	Wavelength
9.1×10^{-31} kg	2.698×10^{-12} m	10^{-20} s	10^{20} Hz	6.62×10^{-14} J	3×10^{-12} m
9.1×10^{-31} kg	8.533×10^{-12} m	10^{-19} s	10^{19} Hz	6.62×10^{-15} J	3×10^{-11} m
9.1×10^{-31} kg	2.698×10^{-11} m	10^{-18} s	10^{18} Hz	6.62×10^{-16} J	3×10^{-10} m
9.1×10^{-31} kg	8.533×10^{-11} m	10^{-17} s	10^{17} Hz	6.62×10^{-17} J	3×10^{-9} m

Table 3

Physical parameters for ultraviolet radiation

Mass	Distance	Time	Frequency	Energy	Wavelength
9.1×10^{-31} kg	8.533×10^{-11} m	10^{-17} s	10^{17} Hz	6.62×10^{-17} J	3×10^{-9} m
9.1×10^{-31} kg	2.698×10^{-10} m	10^{-16} s	10^{16} Hz	6.62×10^{-18} J	3×10^{-8} m
9.1×10^{-31} kg	8.533×10^{-10} m	10^{-15} s	10^{15} Hz	6.62×10^{-19} J	3×10^{-7} m

Table 4

Physical parameters for visible radiation

Mass	Distance	Time	Frequency	Energy	Wavelength
9.1×10^{-31} kg	1.019×10^{-9} m	2.5×10^{-15} s	7×10^{14} Hz	4.63×10^{-19} J	4.3×10^{-7} m
9.1×10^{-31} kg	1.101×10^{-9} m	2×10^{-15} s	6×10^{14} Hz	3.97×10^{-19} J	5×10^{-7} m
9.1×10^{-31} kg	1.206×10^{-9} m	1.66×10^{-15} s	5×10^{14} Hz	3.31×10^{-19} J	6×10^{-7} m
9.1×10^{-31} kg	1.349×10^{-9} m	1.42×10^{-15} s	4×10^{14} Hz	2.65×10^{-19} J	7.5×10^{-7} m

Table 5

Physical parameters for infrared radiation

Mass	Distance	Time	Frequency	Energy	Wavelength
3.4×10^{-27} kg	4.414×10^{-11} m	10^{-14} s	10^{14} Hz	6.62×10^{-20} J	3×10^{-6} m
3.4×10^{-27} kg	1.349×10^{-10} m	10^{-13} s	10^{13} Hz	6.62×10^{-21} J	3×10^{-5} m

Table 6

Physical parameters for microwave radiation

Mass	Distance	Time	Frequency	Energy	Wavelength
3.4×10^{-27} kg	4.414×10^{-10} m	10^{-12} s	10^{12} Hz	6.62×10^{-22} J	3×10^{-4} m

Table 7

Physical parameters for radio waves

Mass	Distance	Time	Frequency	Energy	Wavelength
3.4×10^{-27} kg	1.396×10^{-9} m	10^{-11} s	10^{11} Hz	6.62×10^{-23} J	0.003 m
3.4×10^{-27} kg	4.414×10^{-9} m	10^{-10} s	10^{10} Hz	6.62×10^{-24} J	0.03 m
3.4×10^{-27} kg	1.396×10^{-8} m	10^{-9} s	10^{9} Hz	6.62×10^{-25} J	0.3 m
3.4×10^{-27} kg	4.414×10^{-8} m	10^{-8} s	10^{8} Hz	6.62×10^{-26} J	3 m

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