Karbala University-College of Veterinary Medicine
Medical Physics-Lecture (1)

Interactions of Electromagnetic Radiation with Matter

There are two types of physics, a classical physics (Newtonian physics) which is the physical quantities (energy, mass, size) the amounts of continuous and quantum physics, which is the physical amounts gagged a small physical systems like (electron, photon, etc ...) and that have not They may classic laws explain the behavior of these Small systems to the need for the emergence of other hypotheses have emerged It is a set of principles and laws that were not previously known to explain the behavior of large systems with a few speed compared to the speed of light, but failed to explain the small particle movement, such as the electron and the components of the nucleus of Speed high and approaching the speed of light .

The success of classical physics in the interpretation of various natural phenomena led to scientists Integration components belief, but in the beginning of the twentieth century as a result of the great development witnessed Devices measurement range of experimental views that are incompatible with the classical laws recognized her health appeared, prompting scientists to develop new hypotheses not based on any classic foundations, and the first hypotheses that have been developed to resolve this contradiction is the quantum hypothesis of Planck in 1901 so I suppose that the energy emitted from the radiant body issued in the form of payments (punched quanta) of energy, amounting to one-quantum energy (hf). The idea of using the quantum could be the answer to many of these contradictions .

One of the phenomena that failed to classical physics for interpretation while the idea of quantum interpreted in a resounding success is succeeded radiation with the material that will be discussed in the following paragraphs interaction:

Photoelectric Effect

Is the photon collision process plopped in the amount of energy hf with orbital electrons to one of the physical medium in which the photon is going through atoms and after the collision energy absorption all fallen by the electron energy in two parts this happens:

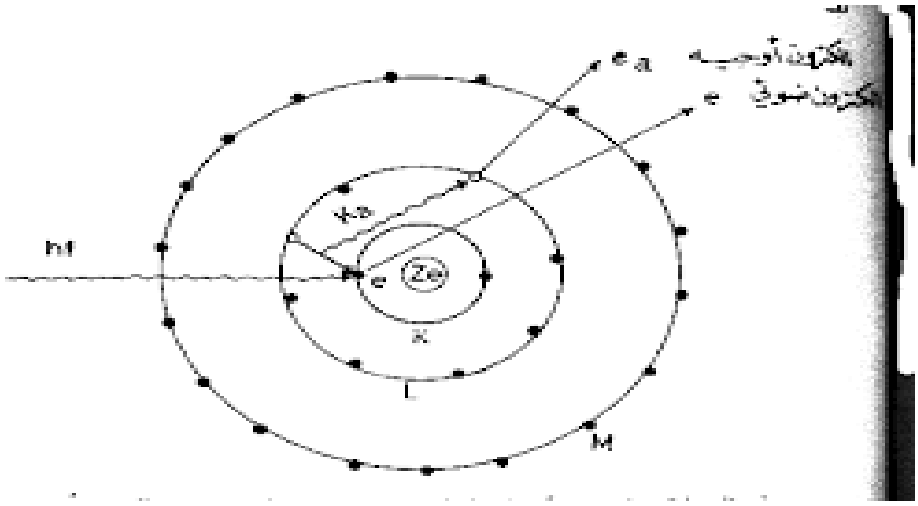
(A) to decode the correlation of atoms.

(B) as energy and the application of his kinetic energy conservation law we get.

$$hf=B.E+T \_\_\_\_\_ (1)$$

Where B.E is the linkage atom energy And T is the kinetic energy of the electron

The photon falling in this process tends to clash with the internal electrons of atoms (near atoms), where up the possibility of a collision with the crust K to 80% of the other, or other crust that are LMN ... interaction., To the necessity of a nucleus near the event site for the purpose of keeping law Momentum, energy and after the liberation of the electron from the atom leaves a vacuum or the gap fill up by an orbital electron of a higher level and is accompanied by this transition photon emission x-ray in equal to the difference between the primary level and the final energy and there is a possibility the interaction of photon X-rays with orbital electrons another in atoms and electron n liberal in this The situation called (Electron Oger).



Experimentally observed the emission of electrons from the metal surfaces at the fall of the light by this process is known as the photoelectric phenomenon. The figure shows (1) the device used to study this phenomenon as it consists of a tube deflated containing two electrodes online Department of Foreign Affairs. Electrons emitted from the metal after the fall of light caused by the current can be measured by the ammeter.

The greater the effort obstructionist fewer electrons reach the cathode, and thus the value of the photoelectric current will be reduced at a certain value to the effort where it becomes mainstream photoelectric zero and called this value is hard suspension V◦ (stopping potential) and when this effort, the potential energy balance of the electron with kinetic energy, the e V◦ = 1 / 2 $m_e V^2$.

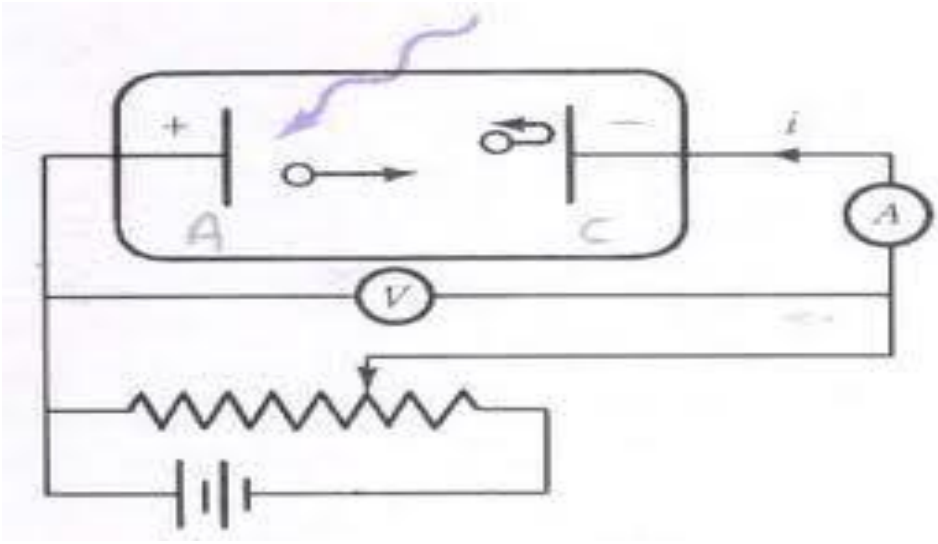


Figure 1 device used to examine the phenomenon

Photoelectric properties

1- photoelectric effect achieved if greater frequency waves fallen from a particular frequency is called frequency threshold or the critical frequency

The threshold frequency/ is less frequency of the incident light enough to emission of electrons from the surface of the metal without teaching them the movement of energy and depends on the type of material that covers the surface of the cathode.

2- the photoelectric emission occurs as soon as the fall of electromagnetic waves with a frequency appropriate to the surface of the cathode, whatever the intensity of these waves is weak in the sense that check the phenomenon does not need to store energy .

3- the number of electrons emitted from the surface of the cathode depends on the severity of the incident light in the sense that it increases the intensity of the current in a photovoltaic cell circuit to increase the intensity of incident light.

4- increase the maximum value of the energy of electrons emitted from the surface of the metal movement to increase frequency of the incident light.

Compton Effect

In this phenomenon, a collision between a photon falling in energy amounting happen (hf) and the electron in the outer orbitals of atoms, the electron and the resulting collision partial absorption of the photon energy incident where Scattering photon card amount hf 'which is less than the energy fall and the remainder of the photon energy incident have on the kinetic energy form the electron and the liberal application of the law of conservation of energy we get:

$$Hf= hf' +T \_\_\_\_\_ (2)$$

In the application of the law of keeping the momentum to get the law to calculate the photon energy scattered as :

$$hf'=hf/(1+hf(1-cos\theta)/m_0c^2 \_\_\_\_\_ (3)$$

أي إن:

$$hf - hf' = T \quad \ldots\ldots\ldots(3)$$

$$E=\sqrt{m^2c^4 + (pc)^2} \ , m=0 \implies E= pc$$

$$p = \frac{E}{c} = \frac{hf}{c} \quad \ldots\ldots\ldots(4)$$

من قانون حفظ الزخم conservation of momentum

$$\frac{hf}{c} + 0 = \frac{hf'}{c}cos\theta + pcos\emptyset \quad \ldots\ldots\ldots(5)$$

$$\frac{hf'}{c}sin\theta = psin\emptyset \quad \ldots\ldots\ldots(6)$$

$$\lambda' - \lambda = \frac{h}{m_ec}(1-cos\theta) \quad \ldots\ldots\ldots(7)$$

المعادلة (10)تعطينا التغير في الطول الموجي لفوتون مشتت بواسطة الكترون كدالة لزاوية التشتت

θوان هذا التغيرات يعتمد على طول موجة الفوتون الساقط . الكمية$\frac{h}{m_e c}$تدعى بطول موجة كومبتن للجسيم المشتت

وتبلغ $0.024A^{\circ}$ للإلكترون .

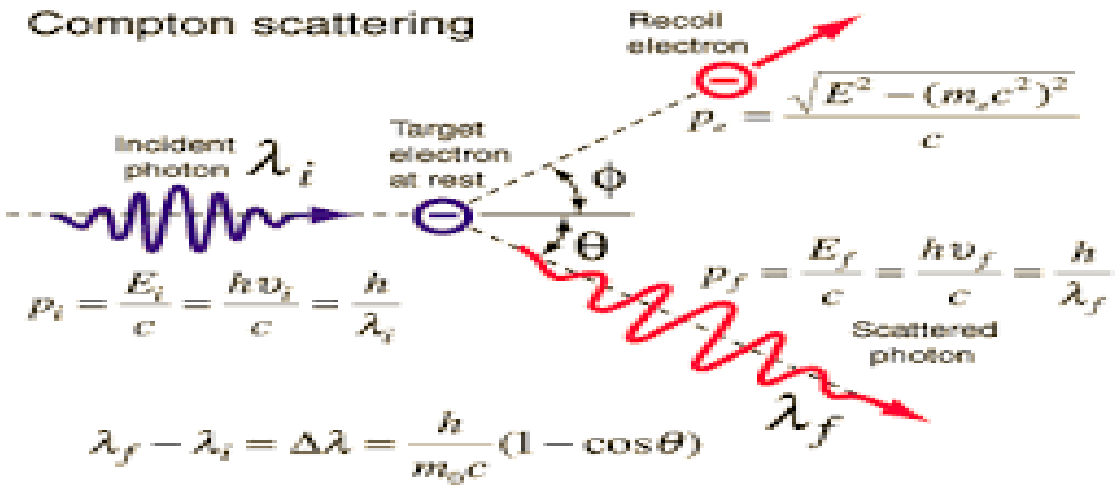


Figure 2 shows the collision between the photon and electron orbital

Pair Production

Intended in the production of the pair is the generation of electron pair Boztron after yard photon beam Kama spoke of this phenomenon in two conditions:

A -This phenomenon is occurring near the nuclear field.

B - must photon energy gamma rays are falling is greater than 1.022 million electron volt.

$hf \geq 1.02MeV$

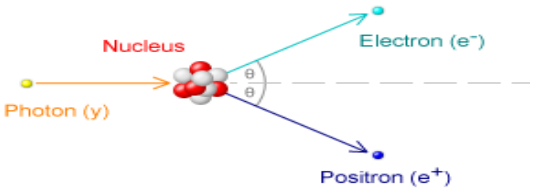
نحتاج الى طاقة مقدارها $2m_e c^2$لتكوين جسيم الكترون بوزترون

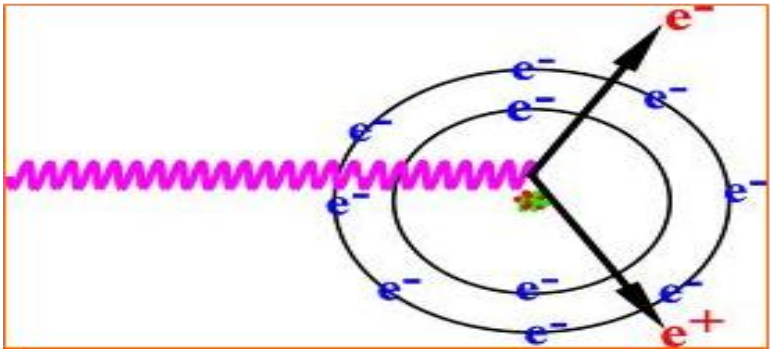
If the incident photon energy is higher than the remaining amount of this energy in the form of kinetic energy of the electron pair Boztron equally as in the following relationship.

$$hf = 2m_e c^2 + T_{e^+} + T_{e^-} \quad \ldots\ldots\ldots\ldots\ldots(11)$$

As we have noted that the photon can give all or part of its energy hf to the electron, in addition to that of the photon it can be turned into material on Electron -boztron form (e + -e-). In this process electromagnetic energy into a static energy.

. This process occurs near the nucleus of the atom and the photon energy must possess equal to the threshold of the static energy of the electron ($2m_e c^2$) any 1.022MeV.
In this process are: the total shipment reserved, as the total charge of the electron and positron is equal to zero and is equal to the photon shipment. As well as check the law of conservation of energy as:





طاقة الفوتون الساقط = الطاقة المستخدمة في توليد الزوج + $T_{e^+} + T_{e^-}$

$$hf = 2m_e c^2 + T_{e^+} + T_{e^-} \quad \ldots\ldots\ldots(10)$$

وكذلك تحقق قانون حفظ الزخم ، إذ تتم العملية قرب النواة وتمتص النواة جزءً من زخم الفوتون فلا يمكن أن تحث في الفراغ .