**DOES ENERGY AND IMPULSE ARE INTER CONVERTABLE**

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Abstract：

Keywords:

Introduction

Consider a photon of relativistic mass **‘m’** moving with speed **‘c’** is associated with the wavelength **‘λ’** is given by the relation ***λ=h/mc, Where h=planck’s constant (6.625\*10^-34 JS).***

According to **wave theory,** speed of the photon wave is given by **c = λ /T**, where **T**= time period.

By substitution of value of **‘c’** in the equation **λ = h/mc,** we get the expression **m λ^2 = hT.**

According to **wave theory,** as frequency of photon wave is given by **f=1/T.**

Then the equation **m λ^ 2 = hT** becomes **f=h/mλ^2**

De Broglie wavelength associated with the photon is given by **λ= h/p,**

thus the equation **f=h/mλ^2** becomes **f=p/mλ.**

Angular frequency associated with the photon is given by **ω= 2 πf.**

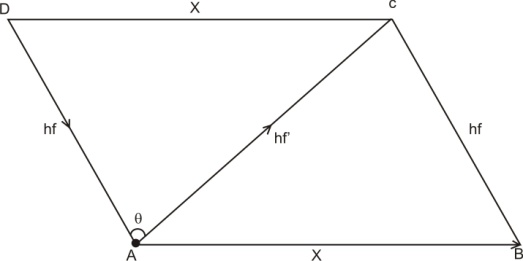
By putting the value of **f=p/mλ.** in theabove equation we get **ω= 2 πp/mλ.**

The above equation **ω= 2 πp/mλ.** can be applied to both photons and material particles like electron inmotion.Debroglie wavelength associated with the electron is given by **λ=h/mv**

Where v=velocity of electron in motion

Then the equation **ω= 2 πp/mλ** becomes **ω= 2 πpmv/mh** i.e **ω= 2 πpv/h.**

**Part : 2** Consider a electron of mass **“me”** at rest, total energy associated with the electron is given by **“me c^2”.** Suppose radiation of energy **hf** is incident on this electron at rest. Part of energy **hf”** is absorbed by electron and part of energy **hf’** is scattered by electron . Absorbed energy **hf”** is converted to motion of electron, hence electron travels a distance **‘x’** in time **‘t’.** let **θ** is the scattering angle.



**Figure :1** –schematic diagram of scattering of energy of photon by electron

x= Linear displacement of electron

hf = Energy of incident radiation

hf’ = Energy of scattered radiation

θ = scattering angle

Consider a parallelogram ABCD constructed as shown in the figure 1.

Let AB=CD=x, AD=BC=hf, AC=hf’(opposite sides in parallelogram are equal)

Law of cosine is given by **a^2=b^2+c^2-2bc cos θ.** Let a = x, b=hf, c=hf’, cos A = cosθ.

By applying the law of cosine to the triangle ADC, we get

**X^2=(hf)^2+(hf’)2-2(hf)(hf’) cos θ = 1**

By law of conservation of momentum of photon.

We get where  be the momentum of incident, absorbed and scattered photon respectively.

Let us assume absorbed momentum of photon = momentem of electron

i.e. 

Thus  where  = momentum of electron

 Squaring on the both sides we get

P^2= ^2, as (a-b)^2=a^2+b^2-2ab Thus the above equation becomes **p ^2=py ^2+py’ ^2-2** |y . y’|

According to dot product rule **| |= |a||b|cosθ**

Then we get **p^2= py ^2+ py’ ^ 2-2| py | | py’ | cos θ**

Let us multiply the above equation by **c ^ 2**we get

Where **c** = speed of light in vaccum **(3\* 10 ^ 8 m/s)**

**P ^2 c ^2 = py ^ 2c ^2 +py’ c^2-2| py | | py’ |c^2 cos θ**

As we know frequency of photon is directly proportional to it’s momentum

i.e **hf** **= pc** thus the below equation is obtained

**p ^2 c ^ 2= =(hf)^2+(hf’)2-2(hf)(hf’)cos θ = 2**

By comparison of 1 and 2 we get **x ^ 2 = p ^2 c^ 2**

i.e **x = pc** (position of electron is defined as the function of it’s momentum)

As told earlier position of electron is defined as a function of it’s momentum i.e **x = pc**

Small change in momentum of electron causes small change in it’s position **i.e. dx = dpc** hence,

**dp = dx/c**

**Newton second law of motion** is mathematically represented by equation **F=dp/dt**

Where **F =** force exerted by photon

**dp =** Small change in momentum of electron with respect to time

**As dp = dx/c** then the above equation becomes **F= dx/dtc.**

as velocity of electron is defined as **v = dx/dt.**

Then **F =v/c** is obtained

Force exerted by photon is defined as function of velocity of electron

As impulse exerted by photon is mathematically given by **I = F dt.**

then the equation **F= dx/dtc** becomes **Fdt = dx/c**

**i.e I =dx/c**

Impulse exerted by photon is defined as function of change in position of electron At point A and B mass of electron is mei.e total energy assosiated with electron is mec^2. (as electron is at rest at point Aand B) But in between point A and B mass of electron is mc^2 (since electron is in motion in between point A and B ) Hence total energy of electron in motion is mathematically given by **E= mec^2+hf**’ (As absorbed energy adds up to rest mass energy ) where E= total energy of electron in motion hf’=absorbed energy of photon mec^2=rest mass energy of electron As absorbed momentum of photon equals the momentum of electron i.e **py’’= p** As **x=pc** (position of electron is defined as the function of it’s momentum) then x= py’c **py’c=hf’**then **x=hf’** then the equation **E= mec^2+hf’** becomes equation **E= mec^2+x=3** According to Einstein equation **E= mec^2+Ek=4** By camparison of 3and 4 we get **Ek = x** i.e kinetic energy of electron = position of electron Small change in kinetic energy of electron causes small change in it’s position i.e **d Ek = dx** i.e **I =dx/c** i.e **I= d Ek/c** i.e **d Ek=Ic** According to **workenergy theorm** Work done on particle equals change in kinetic energyof particle **i.e W= d Ek** i.e **W= Ic** Work done on particle involves storage of energy in particle i.e **W=Ea** where Ea= Energystored in particle. **Ea =Ic ,**energy stored in particle is defined as a function of impulse applied Thus **Ea *a***I (as c is constant ) i.e impulse and energy are interconvertable.

**2) Proof for Einstein predicted formula E=tc** As **x = pc** (position of electron is defined as the function of it’s momentum)

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As momentum of electron can be given by **p=mv** then the equation **x = pc** becomes **x=mvc i.e x/v=mc** According to newton **v=x/t i**.e equation **x/v=mc** becomes  **t=mc** According to Einstein **E=mc^2** hence **E=mcc** becomes **E=tc**

Discussion

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References