The Photon Impact

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Abstract

The impact of a photon hitting a surface is determined. Newton law of dynamics is demonstrated from thermodynamics considerations in which Planck oscillator is considered as a 4-space dimensions oscillator. Wave-corpuscle duality is remodeled. Vacuum is a sea of positive charges and negative charges.

Key words: Photon impact, fundamental law of dynamics, Planck oscillator, absolute time, 5-dimensions Universe, wave-corpuscle duality.

1-Introduction :

The “radiancy” of a black body is given by Cardoso & de Castro law as a generalized Stefan-Boltzmann law in $D - Dimensional$ Universe [1]:

$E_T = R_T = \sigma_D T^{D+1}$ (1)

With $\sigma_D = \left(\frac{2}{c}\right)^{D-1} (\sqrt{\pi})^{D-2} \frac{k^{D+1}}{h^D} D(D-1)\Gamma(\frac{D}{2})\zeta(D+1)$: generalized Stefan-Boltzmann constant .

$D > 1$: spatial dimension of the Universe.

$k = 1.38\ 10^{-23}\ Joule.K^{-1}$: Boltzmann constant ;

$h = 6.626\ 10^{-34}\ Joule\ .s$: Planck constant ;

$c = 3\ 10^8\ m.s^{-1}$; speed of light in vacuum.

T: Temperature of equilibrium of the black body;

$\Gamma(z) = \int_0^\infty y^{z-1}e^{-y}dy$: Gamma function;

$\zeta(z) = \frac{1}{\Gamma(z)}\int_0^\infty \frac{y^{z-1}}{e^y-1}dy$: Zeta function

-For $D = 3$ we have $\sigma_3 = \sigma = \frac{2\pi^5 k^4}{15c^2h^3}$: Stefan-Boltzmann constant given in thermo dynamical analysis and proved by experience.

-For $D = 4$

$$E = \frac{4\pi k^5}{c^3 h^4} T^5 \zeta(5)\Gamma(5) \approx \frac{120 k^5}{c^3 h^4} T^5 \qquad (2)$$

We can obtain (2) as:

$$E = \int_0^\infty \frac{4\pi \nu^2}{c^3} \frac{h\nu^2}{\exp\left(\frac{h\nu}{kT}\right) - 1} d\nu \qquad (3)$$

Or as:

$$E = \int_0^\infty \frac{8\pi \nu^2}{c^3} \frac{\frac{1}{2} h\nu^2}{\exp\left(\frac{h\nu}{kT}\right) - 1} d\nu \qquad (4)$$

But

$\frac{8\pi\nu^2}{c^3} . \frac{1}{\exp\left(\frac{h\nu}{kT}\right)-1} d\nu$ is the number of oscillators per unit volume in the frequency intervalν & $\nu + d\nu$ in the three dimensional space.

Equation (2) is the density of power of the black body in $[Watt. m^{-3}]$.

What does it mean?:

Equation (3) mean that the mean power of an oscillator is:

$$W = \frac{h\nu^2}{\exp\left(\frac{h\nu}{kT}\right) - 1} \qquad (5)$$

And so in a black body oven that at any time only 50% of Planck resonators radiate energy, the others (also 50%) are absorbing energy. It is logic in an equilibrium state.

Equation (4) mean that all oscillators radiate energy & the mean power of an oscillator is $\frac{\frac{1}{2}h\nu^2}{\exp\left(\frac{h\nu}{kT}\right)-1}$. We reject this description because the black body will explode by this manner and there is no equilibrium.

If we take in consideration Planck assumption that only $\eta = 1 - \exp\left(-\frac{h\nu}{kT}\right)$ oscillators radiate energy in the frequency interval ν & $\nu + d\nu$ so we should have that[2]:

$$E = \int_0^\infty \frac{8\pi\nu^2}{c^3} \frac{h\nu^2}{\exp\left(\frac{h\nu}{kT}\right) - 1} \left(1 - \exp\left(-\frac{h\nu}{kT}\right)\right) d\nu = \frac{4\pi k^5}{c^3 h^4} T^5 \zeta(5)\Gamma(5)$$

And this leads us after replacing $\frac{h\nu}{kT}$ $by\ x$ to:

$\int_0^\infty \frac{x^4 . e^{-x}}{e^x - 1} dx = 12\zeta(5)$which is a wrong result.

If now we consider Planck theory of heat radiation we have for the mean energy of the oscillator [3]:

$$\frac{dU}{dt} = Constant$$

But we have also that $U = \frac{h\nu}{\exp\left(\frac{h\nu}{kT}\right)-1}$ than we get:

$$\frac{dU}{dt} = \frac{d(h\nu)}{dt} . \frac{1}{\exp\left(\frac{h\nu}{kT}\right) - 1} + h\nu . \frac{-\frac{\frac{d(h\nu)}{dt}}{kT} . e^{\frac{h\nu}{kT}}}{[\exp\left(\frac{h\nu}{kT}\right) - 1]^2}$$

And to be conform with Planck approximation ($h\nu \ll kT$) we get:

$$\frac{dU}{dt} \approx \frac{d(h\nu)}{dt} . \frac{kT}{h\nu} + h\nu . \left(\frac{kT}{h\nu}\right)^2 . \left(-\frac{\frac{d(h\nu)}{dt}}{kT}\right) . \left(1 + \frac{h\nu}{kT}\right) = -\frac{d(h\nu)}{dt} = -\alpha_0 \quad (6)$$

α_0 : is declared a new universal constant (but Planck don't do this declaration).

2-The fundamental law of dynamics:

Planck oscillators are classic oscillators. We can conclude from equation (5) that the power radiated by a single oscillator is:

$$\delta = h.\nu^2 \qquad (7)$$

The energy absorbed by an oscillator is as a multiple integer of the quantity:

$$\varepsilon = h.\nu \qquad (8)$$

This energy is as:

$$\varepsilon = \int \delta . dt \qquad (9)$$

So:

$$d\varepsilon = \delta . dt$$

Than:

$$dt = \frac{d\nu}{\nu^2} \qquad (10)$$

By definition the power is the force scalar the speed of the corpuscle (we suppose that motion is in a straight line):

$$W = f.v = h\nu^2$$

So the force acting on the corpuscle is:

$$f = \frac{1}{v}.h\nu^2$$

Duality of wave-corpuscle implies that:

$$\frac{1}{v} = \frac{d\tilde{k}}{d\omega}$$

with $v = v_g$: the group speed of the packet of waves assimilated as a corpuscle;

$\tilde{k}$: wave-vector of the packet of waves

$\omega = 2\pi\nu$: the frequency of the packet of waves.

So:

$$f = h\nu^2.\frac{d\tilde{k}}{d\omega} = h\nu^2.\frac{d\tilde{k}}{2\pi d\nu} = \hbar\nu^2.\frac{d\tilde{k}}{d\nu} = \frac{d(\hbar\tilde{k})}{dt}$$

With : $\hbar = \frac{h}{2\pi}$: reduced Planck constant.

$\hbar k$: have the dimension of a moment. So:

$f = \frac{dp}{dt}$ with $= mv$: is the moment of the corpuscle.

This relation is generalized as:

$\boldsymbol{f} = m\boldsymbol{\gamma}$ (11)

With: $\boldsymbol{\gamma} = \frac{dv}{dt}$the acceleration of the corpuscle

m : the mass of the corpuscle.

Equation (11) is the fundamental law of dynamics or the Newton first law.

3.The photon impact:

For a packet of waves the force is :

$$f = h\nu^2.\frac{d\tilde{k}}{d\omega} = \frac{\hbar\omega^2}{4\pi^2}.\frac{d\tilde{k}}{d\nu} = \frac{\hbar\omega^2}{2\pi^2}.\frac{d\tilde{k}}{d\omega}$$

For a photon considered as a packet of waves we have:

$\frac{1}{c} = \frac{d\tilde{k}}{d\omega}$ because $\tilde{k} = \frac{\omega}{c}$

So the impact of a photon which hit a surface is:

$f = \frac{\hbar\omega^2}{2\pi^2 c}$ (12)

4.Universal time:

From equation (6) we can deduce that for an oscillator:

$h\nu = \alpha_0 \tau$ (13)

with: τ: a characteristic time of the oscillator &$d\tau = d\tilde{\zeta}$when the energy of the oscillator is varying;

$\tilde{\zeta}$: Universal time (the time τ is the "position" of the oscillator in the axle of the absolute time). It is like a fifth dimension of the oscillator.

Since the radiancy (2) of the black body have the dimension of $Watt.m^{-3}$ than the Universe in which the black body exist have five dimensions (Do the analogy with Kurlbaum measurements: since the radiancy have the dimension of $Watt.m^{-2}$ than the Universe in which the black body exist have three dimension).

The time t is relative .

Since we declare that the speed of light c is an universal constant than Lorentz transformations of space & time are applicable.

The Planck formulae $\varepsilon = h\nu$ holds for classic dynamics and for relativist dynamics. In relativist dynamics the relation $\hbar\tilde{\boldsymbol{k}} = \boldsymbol{p}$holds also with $\boldsymbol{p} = \frac{m.\boldsymbol{v}}{\sqrt{1-\frac{v^2}{c^2}}}$ but the relation of dynamics (11) doesn't hold because it is not invariant by Lorentz transformations. Which is invariant in relativist dynamics is the transformations of energy & moment. Energy of a corpuscle in relativist mechanics is $\varepsilon = \frac{m.c^2}{\sqrt{1-\frac{v^2}{c^2}}}$.

5.Wave-corpuscle duality:

Planck oscillator should have enough time to absorb energy from radiation . The Planck condition for this is that the frequency of the oscillator times time should be a great integer or in other manner:

$\nu.t \gg 1$ (14)

A corpuscle should be considered as a pulse and not as a packet of waves because in the model of the last one waves are reinforced an destroy each other in many regions of space-time . The model of the pulse is limited in space-time and so the pulse should not spread so much in time. This condition implies that:

$\nu.t < 1$ (15)

The condition satisfying the two models is :

$$\nu . t \approx 1 \qquad (16)$$

Which means that:

$$dt = -\frac{d\nu}{\nu^2} \qquad (17)$$

We take always dt positive and so we can omit the sign minus in (17).

6-Generalasation of the notion of density of power:

The number of modes with frequencies between ν & $\nu + d\nu$ in a $D - volume\ V$ is :

$$N(\nu) = (D-1)V.\frac{2}{\Gamma(\frac{D}{2})}\left(\frac{\sqrt{\pi}}{c}\right)^D \nu^D d\nu \qquad (18)$$

The density of "energy" of a black body in $D - 1\ space\ dimensional$ Universe is :

$$\rho_T = \int_0^\infty \rho_T(\nu)d\nu \text{ with } \rho_T(\nu)d\nu = \frac{N(\nu)}{V}.\frac{h\nu}{\exp\left(\frac{h\nu}{kT}\right)-1}d\nu = (D-2).\frac{2}{\Gamma(\frac{D-1}{2})}.\left(\frac{\sqrt{\pi}}{c}\right)^{D-1}\frac{h\nu^D}{\exp\left(\frac{h\nu}{kT}\right)-1}d\nu \qquad (19)$$

The "radiancy" of a black body in $D - dimensional$ Universe is :

$$R_T = \frac{\Gamma(\frac{D}{2})}{\Gamma(\frac{D+1}{2})}.\frac{c}{2\sqrt{\pi}}.\rho_T = \frac{\Gamma(\frac{D}{2})}{\Gamma(\frac{D+1}{2})}.\frac{c}{2\sqrt{\pi}}.\int_0^\infty 2\left(\frac{\sqrt{\pi}}{c}\right)^D.\frac{D-1}{\Gamma(\frac{D}{2})}.\frac{h\nu^D}{\exp\left(\frac{h\nu}{kT}\right)-1}d\nu = \frac{1}{\Gamma(\frac{D+1}{2})}.\int_0^\infty 2\left(\frac{\sqrt{\pi}}{c}\right)^{D-1}.\frac{D-1}{\Gamma(\frac{D}{2})}.\frac{\nu^{D-2}h\nu^2}{\exp\left(\frac{h\nu}{kT}\right)-1}d\nu \qquad (20)$$

This means the density of power per unit $D - 1$ volume.

The mean power of an oscillator is $\frac{h\nu^2}{\exp\left(\frac{h\nu}{kT}\right)-1}$.

The percentage of power radiant oscillators is:

$$\eta_{D-1} = \frac{\frac{1}{\Gamma\left(\frac{D+1}{2}\right)}.(D-1)}{(D-2)\frac{2}{\Gamma(\frac{D-1}{2})}}$$

Using the identities $\Gamma(z+1) = z\Gamma(z)$ and $\Gamma(2z) = \frac{2^{2z-\frac{1}{2}}}{\sqrt{2\pi}}\Gamma(2z)\Gamma(z+\frac{1}{2})$ than we get:

$$\eta_{D-1} = \frac{1}{D-2} \qquad (21)$$

7-Vacuum energy:

7-1-The mean energy of an oscillator:

Plank oscillator is a classic oscillator. The curve of the oscillator in the phase space position-moment is elliptic. The phase space of Planck oscillator in a black body is divided in regions $C_0, C_1, \dots C_n, \dots . etc$. where the mean energy of the oscillator in the n^{th} region is :

$E_n = nh\nu N_n$ (22)

With $N_n = N.w_n$

w_n : probability of the oscillator to have the energy E_n

N : total number of oscillators

Of course we should have:

$1 = w_0 + w_1 + \cdots + w_n + \cdots$ (23)

$N = \sum_{n=0}^{n=\infty} N_n$ (24)

The region N_0 correspond to the region when all the oscillators are in their fundamental states.

The mean energy of the an oscillator is :

$E = h\nu \sum_{n=0}^{n=\infty} nN_n$

So:

$\frac{E}{h\nu} - N = \sum_{n=0}^{n=\infty} nN_n - N = \sum_{n=0}^{n=\infty}(n-1)N_n = -N_0 + P$

With $P = 0N_1 + 1N_2 + \cdots$ a great integer.

To get the same formulae as Planck did in his theory of black body in 1900 we should have $N_0 = N$ i.e at $T = 0K$ all Planck oscillators lies in the region C_0-

The mean energy of Planck oscillator is :

$U = \frac{h\nu}{\exp\left(\frac{h\nu}{kT}\right)-1}$ (25)

At $T = 0K$ all Planck oscillators lies in the region C_0 and they are all in their fundamental states.

Planck oscillators are classic oscillators.

According to quantum mechanics an oscillator in its fundamental state have the energy:

$E = \frac{1}{2}h\nu$ (26)

Equation (26) is a full equation as Planck formulae for an oscillator at any temperature different from zero $(E = h\nu)$.

We can take the same Planck model for a cavity at a temperature different to zero and equal to zero with a little difference in definitions.

The mean energy of quantum oscillator at a temperature equal to zero is:

$$U = \frac{\frac{1}{2}h\nu}{\exp\left(\frac{\nu}{\nu_0}\right)-1} \quad (27)$$

With :ν_0 is that when $\nu \ll \nu_0$ the mean energy of the oscillator is $U \approx \frac{1}{2}h\nu_0$. This frequency is declared as an universal constant.

7-2 -Vacuum energy from cosmology:

The energy density of vacuum as given by General Relativity is as follows[4] :

$$U_0 = \frac{\Lambda.c^4}{8\pi G} \approx 10^{-9}\,Joule.m^{-3} \quad (28)$$

With :

$\Lambda = 1{,}088\ 10^{-52}m^{-2}$: cosmological constant ;

$c = 3\ \ 10^8 m.s^{-1}$: light celerity in vacuum ;

$G = 6{,}67\ \ 10^{-11}\ SI\ units$: gravitationnel constant ;

The total energy density of the vacuum is then according to the black body theory at $T = 0K$:

$$U_0 = \int_0^\infty \frac{8\pi\nu^2}{c^3}.U d\nu = \int_0^\infty \frac{4\pi h}{c^3}.\frac{\nu^3}{\exp\left(\frac{\nu}{\nu_0}\right)-1}d\nu = \frac{4\pi^5 h}{15.c^3}.\nu_0^4 \quad (29)$$

Equating (28) & (29) we get:

$$\nu_0 = \left[\frac{15\ \Lambda.c^7}{32.\pi^6.G.h}\right]^{\frac{1}{4}} \approx 0{,}7\ 10^{12}\ Hz \quad (30)$$

7-3-Vacuum energy from atoms:

According to Bohr model of the atom, the electron in an hydrogen atom is moving in planetary motion (circular) as the speed of the electron is equal to αc where $\alpha = \frac{1}{137}$ the fine structure constant. The vacuum in atoms is the same vacuum in the cosmos. Vacuum which is fill with energy has a certain mechanical impedance & with negative pressure there is no friction in the motion of any corpuscle is it is given by General Relativity. However we can get the value of the constant ν_0 when we suppose that the hydrogen atom is in a medium which its temperature is near zero.

The energy exchanged with vacuum for the electron is:

$$\varepsilon = \int_0^{\alpha c} a\boldsymbol{v}.\boldsymbol{v}dt = \int_0^{\alpha c} a.v^2.dt \qquad (31)$$

With : $a = \frac{h\nu^2}{c^2}$ the mechanical impedance of vacuum.

ν : is the frequency of the fundamental state of the electromagnetic field filling the space. It is also the frequency of the oscillator "electron" as a packet of waves.

Planck oscillator is a classic oscillator and the speed of the electron can be considered as non relativist. From equations (13) &(17) injected in (31) one can deduce that:

$$\varepsilon = \int_0^{\alpha c} \frac{h\nu^2}{c^2}.v^2.\frac{dv}{\nu^2} = \int_0^{\alpha c} \frac{h}{c^2}.v^2.d\left(\frac{1}{2}m\frac{v^2}{h}\right) = \left[\frac{1}{4}m.\frac{v^4}{c^2}\right]_0^{\alpha c} = \frac{1}{4}\alpha^4 mc^2 \qquad (32)$$

With: $m = 9{,}1\ 10^{-31} Kg$ the mass of the electron.

Electromagnetic field is two dimensions oscillator. Its energy at low frequency & low temperature (zero Kelvin) is equal to $\frac{1}{2}h\nu_0$. For a quantum of energy we should multiply this by two.

To get the density of power in black body we had considered as the black body have four space dimensions i.e. Planck oscillator have four space dimensions. It means that a corpuscle assimilated to a point have zero dimension is without any sense . To associate four space dimensions to Planck oscillator we should that the real electron is having the three ordinary space dimensions and another compactified dimension. Planck oscillator is two space dimensions. The energy (32) is calculated only for one space dimension. To get a full quantum of energy $h\nu_0$ we should multiply (32) by 8 and so:

$$\nu_0 = 2\frac{\alpha^4 mc^2}{h} \approx 0.7\ 10^{12}\ Hz \qquad (33)$$

It is the same value given by cosmology.

$\alpha_0 = h\nu_0^2$ is the quantum of power of Planck oscillator at very low temperature.

The expression of fine structure constant in the cgs system is $\alpha = \frac{e^2}{\hbar c}$

Where: $e = 4.8\ 10^{-10}\ ues\ cgs$ the electric charge

$\hbar = \frac{h}{2\pi} = 1.034\ 10^{-28}\ erg.s$: Reduced Planck constant

Equation (33) means that the electric charge is a characteristic of vacuum.

Vacuum can be considered as a sea of positive charges $+e$ and negative charges $-e$ having a moment of inertia as: $J_0 = \frac{h}{4\pi^2\nu_0}$ which is an universal constant.

The energy of the fundamental state of electromagnetic field at zero Kelvin is:

$$E_0 = \frac{1}{2}J_0\omega_0^2 = \frac{1}{2}.\frac{h}{4\pi^2\nu_0}.(2\pi\nu_0)^2 = \frac{1}{2}h\nu_0$$

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