The Weird Mistake in Planck's Law

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Abstract

By examining Planck's equation $\boldsymbol{E=h\nu}$, one finds an analogy with accounting billing for electricity. Frequency and power have a physical dimension T^{-1}, so one obtains an energy value accounted for over a time interval by multiplying them by this time interval. By investigating this analogy, one finds a surprising mistake in Planck's law for the frequency of black body radiation: confusion between two contexts, one for radiation power and one for a timeless energy density. One goes from one to the other by an accounting-type transformation: a multiplication by 4π/c or c/4π. Correcting this mistake makes a Planck constant $\boldsymbol{h}$ timeless, invalidating the photon definition and de Broglie's wave-particle duality. Despite this mistake, one obtains the same value for the black body radiation; it goes unnoticed.
Consequently, the Planck relation becomes $\boldsymbol{P=h\nu}$, with the energy of a cycle equal to $\boldsymbol{h}$, whatever the frequency. One can consider this cycle as a new photon, which behaves like a particle by its radiation pressure. Its energy-mass equivalence $\boldsymbol{h=m_{\gamma}c^2}$ gives a mass of $\mathbf{4.134883524 \cdot 10^{-15}}$ eV, in the range referenced by the Particle Data Group. This correction of Planck's relation calls quantum physics into question.

1. Introduction

In 1900, Max Planck found the black body Law formula, confirmed by experimentation up to date. He explained it in his 1901 article: "*Ueber das Gesetz der Energieverteilung im Normalspectrum* [1,2]," where one finds the paradoxical equation $\boldsymbol{\varepsilon=h\nu}$. Analyzing it, one sees a weird mistake in the law.
The black body story started in 1860 when Gustav Kirchhoff introduced a perfect physical body, absorbing all the radiation that reaches it. In his law, one has equal emissive and absorption power at thermal equilibrium, following a universal function of the radiation wavelength and temperature. In 1884, Ludwig Boltzmann finalized the Stephan-Boltzmann law, stating that the radiation power is proportional to the fourth power of the temperature. In 1893, Wilhelm Wien found the displacement law, where radiation power peaks at different wavelengths [3], inversely proportional to the temperature. In 1896, he introduced a black body law that used Maxwell-Boltzmann statistics, replacing radiation power with energy density. However, in 1898, Lummer and Kurlbaum designed the cavity for the black body experiment that is still used today and showed that this law is false for long wavelengths. In 1900, Max Planck finally corrected Wien's law to give the right one. Today, one continues the story and corrects Planck's law, removing a mistake induced by an inappropriate transition from radiation power to energy density.

This article is organized with Chapter 2, describing the evidence that indicates a potential mistake in Planck's law for the frequency of black body radiation. Then, in Chapter 3, reworking his 1901 article and with energy density or radiation power, one shows that Max Planck made a mistake, as one obtains the result anticipated in Chapter 2. In Chapter 4, as part of a discussion, one shows that this calls quantum physics into question and indicates new hypotheses deduced from this correction. Finally, in Chapter 5, one provides a conclusion and an outlook.

2. The Paradoxes

2.1. The Planck Relation Paradox

The Planck's relation ***E=hν*** (*ε=**hν***) presents a paradox. The energy ***E*** in joules does not vary over time at temperature equilibrium. In contrast, the frequency ***ν*** of blackbody radiation is in Hertz, as the number of cycles per second. This number varies over time; over two seconds, the number of cycles doubles; over three seconds, and so on. Then, assigning the units "*joule·second*" to Planck's constant ***h*** is similar to the energy accounted for in an electricity bill, with the equation ***E=P*Δt** in Kw-h. Radiations do not evolve in an accounting world, and one should have radiation power and ***h*** only in joule, with a relation ***P=hν***, or *ε*/**Δt=*hν*** for **Δt**=1s.

2.2. The Planck's Law Paradox by Dimensional Analysis

A dimensional analysis shows the paradox of Planck's law for frequency. One recalls the following definitions:

- Power is energy elements per unit of time
- Frequency is the number of cycles per unit of time
- Wavelength is the length of a cycle or a wave

To show a simplification one will do, one begins with the formula $\lambda = \frac{c}{\nu}$:
$dim\ c = LT^{-1}, dim\ \nu = T^{-1}, dim\ \lambda = dim\ c \cdot\ (dim\ \nu)^{-1} = LT^{-1}T$, where one obtains $dim\ \lambda = L$; and with SI units:

$$c = m \cdot s^{-1}, \nu = Hz = s^{-1}, \lambda = \frac{c}{\nu} = m \cdot s^{-1} \cdot Hz^{-1} = m \cdot s^{-1} \cdot s = m$$

One notices that s^{-1} of ***c*** and Hz^{-1} of ***ν*** cancels each other out.

Then, with the law for frequency $B_\nu(\nu, T) = \frac{2h\nu^3}{c^2} \frac{1}{exp(\frac{h\nu}{kT}) - 1}$:

$dim\ h = ML^2T^{-1}, dim\ \nu = T^{-1}, dim\ c = LT^{-1}$, where one obtains $dim\ B_\nu(\nu, T) = ML^2T^{-1}T^{-3}L^{-2}T^2 = ML^2T^{-2}L^{-2}$; and with SI units, simplifying as for wavelength: $B_\nu(\nu, T) = W \cdot sr^{-1} \cdot m^{-2} \cdot Hz^{-1} = J \cdot s^{-1} \cdot sr^{-1} \cdot m^{-2} \cdot Hz^{-1} = J \cdot sr^{-1} \cdot m^{-2}$. Therefore, the law gives energy when the measurement indicates power; one corrects it by changing ***h*** in joule. That gives $dim\ h = ML^2T^{-2}$ and results in

$$dim\ B_\nu(\nu, T) = ML^2T^{-3}L^{-2}$$

In SI units, it is equivalent to

$W \cdot sr^{-1} \cdot m^{-2}$.

The cycle, absent from the SI, replaces the frequency. It indicates power relative to a frequency and sharing the same unit of time.

On the other hand, this paradox is absent from Planck's law of wavelength.

3. The Planck's law correction

3.1. The Basics

Imagine a torus containing a mole of perfect gas moving in one direction with an ad hoc attractive center. Its circumference permits all molecules at the same speed passing through a section to go around in one second. These molecules act as a flywheel with their kinetic energy. It is equivalent to the thermal energy with a chaotic motion of the molecules. In a torus section, one measures the power per area with a value equal to the energy in its volume. Then, at a constant speed, to increase power, one must increase the number of molecules and reverse it for a decrease. It is similar to light, replacing the number of molecules with the number of cycles in a frequency. To correspond to the black body model, one can add an airlock on a torus section, absorber resonators at the input, and emitter resonators at the output.

In the black-body experiments, one measures radiation power: the rate at which resonators transfer thermal energy into radiation energy. However, Max Planck explains his law of converting this radiation power into energy density. In his mind, one needs this conversion to provide an environment close to Maxwell-Boltzmann statistics: one multiplies by 4π/c, which implies a multiplication by the unit of time. It is a similar operation to account for energy in electricity, where multiplying electrical power by a time interval gives energy. Therefore, with a time interval of one second, a resonator's energy equals its power value. However, this implies two contexts:

1. The radiation power
2. The radiation energy density

Moreover, there are four dimensions in the energy density context: one for energy and three for space. Therefore, time is absent, with an energy snapshot in one-second unit of time; speed becomes length, and frequency becomes the number of cycles, like waves on the sand. For example, into the radiation energy density, as there is no time dimension, imagines it as a beach with static waves on the sand. To obtain the wavelength ***λ*** with the formula ***λ=c'/ν'***, one counts several cycles ***ν'*** and measures the length c' between the first and the last. Then, one sets the constant SI time units **Δt=1**s, and it follows a conversion table:

Table 1.

Radiation power context	Radiation energy density context	Relation
c as the speed of light in ms^{-1}	***c'*** as the length in m (over one second)	***c=c'*/Δt**
ν as the frequency of light in Hz (cycle s^{-1})	***ν'*** as the number of cycles (over one second)	***ν=ν'*/Δt**
P as power in watts (joule s^{-1}) sr^{-1} m^{-2}	***E*** as energy in joule m^{-3}	$P = \frac{Ec\prime}{4\pi\Delta t}$ $E = \frac{P4\pi}{c}$
***U*/Δt** as resonator's power	***U*** as resonator's energy over (one second)	
***ε*/Δt** as the resonator's power element	***ε*** as the resonator's energy element (over one second)	
$B_\nu(\nu,T)$ as radiation power or spectral radiance per frequency	***u*** as energy density for cycles (over one second)	$B_\nu(\nu,T) = \frac{uc}{4\pi}$

Max Planck's work fits into the second context based on these definitions. However, he defined his resonators as mathematical objects placed in walls that absorb thermal energy and oscillate to emit radiation. That describes converting one form of energy into another, therefore, power. Then, the correction can be done equally well in these two contexts with these definitions.

3.2. Correction in Radiation Energy Density Context

Planck's law for frequency contains a mistake that has gone unnoticed because it gives good values. However, these values are in watts for the measurements and joules for the law. So, to correct it, one must return to Max Planck's 1901 article [1,2], chapter II, and paragraph § 7 (the translated text is in italics, the equations reference numbers are underlined, and comments are in square brackets) in replacing ***ν*** by ***ν'*** and ***c*** by ***c'*** in the energy density context, where there is:

*Therefore, denote the spatial density of the energy of the radiation belonging to the spectral region **ν'** to **ν' + dν'** by **udν'**; this is how to write **udν'** instead of **Edλ**, **c'/ν'** instead of **λ** and **c'dν'/ν'²** instead of **dλ**. This results in*

$$u = \vartheta^5 \cdot \frac{c'}{\nu'^2} \cdot \psi(\frac{c'\vartheta}{\nu'})$$

[Radiation power context] *According to Kirchhoff-Clausius law, the energy of a temperature **ϑ** and the number of vibrations **ν**, when emitted by a black surface per unit of time into a diathermic medium, is inversely proportional to the square c^2 of the propagation speed.*

[Radiation energy density context] *So the spatial energy density **u** is inversely proportional to c'^3, and one gets:*

$$u = \frac{\vartheta^5}{\nu'^2 c'^3} f(\frac{\vartheta}{\nu'}),$$

*where the constants of the function **f** are independent of **c'**.*

Instead, one can write if f denotes a new single-argument function each time, including in the following:

$$u = \frac{\nu'^3}{c'^3} f(\frac{\vartheta}{\nu'}) \qquad (\underline{7})$$

Moreover, the radiation energy $u\lambda^3$, in the cube of one wavelength of a specific temperature and number of vibrations, is the same for all diathermic media.

*§ 8. Next, for a stationary resonator located in the radiation field with the same number of vibrations **ν**, to move from the spatial radiation density **u** to the energy **U**, one uses the relationship expressed in equation (34) of my treatise on irreversible radiation processes [6]:*

$$K = \frac{\nu'^2}{c'^2} U$$

*(**K** is the intensity of a monochromatic, rectilinearly polarized beam), which, together with the well-known equation:*

$$u = \frac{8\,\pi\,K}{c'}$$

The relationship provides:

$$u = \frac{8\,\pi\,\nu'^2}{c'^3} U \qquad (\underline{8})$$

From this and from (7) it follows:

$$U = v' f(\frac{\vartheta}{v'})$$

Where c no longer occurs at all. Instead, one can also write:

$$\vartheta = v' f(\frac{U}{v'})$$

*§ 9. Finally, one also introduces the entropy **S** of the resonator by setting:*

$$\frac{1}{\vartheta} = \frac{dS}{dU} \qquad (9)$$

Then it happens:

$$\frac{DS}{DU} = \frac{1}{v\prime} f(\frac{U}{v\prime})$$

And integrated:

$$S = f(\frac{U}{v\prime}) \qquad (10)$$

*i.e., the entropy of the resonators vibrating in any diathermic medium depends on the single variable **U/v'** and contains only universal constants. That is the simplest known version of Wien's displacement law.*

*§ 10. If applying Wien's displacement law in the last version to the expression (6) of the entropy **S**, one sees that the energy element **ε** must be proportional to the number of vibrations **v'**, so:*

$$\varepsilon = hv'$$

[Note, with ***ε*** and ***v'*** timeless**,** that Planck's relation gives a constant ***h*** only in joules.]

Thus:

$$S = k \left\{ \left(1 + \frac{U}{hv\prime}\right) log \left(1 + \frac{U}{hv\prime}\right) - \frac{U}{hv\prime} log \frac{U}{hv\prime} \right\}$$

Here, h and k are universal constants.
Substitution in (9) gives:

$$\frac{1}{\vartheta} = \frac{k}{hv'} log\,(1 + \frac{hv'}{U})$$

$$U = \frac{hv\prime}{e^{\frac{hv\prime}{k\vartheta}} - 1} \qquad (11)$$

Then, from (8), the sought energy distribution law is as follows:

$$u = \frac{8\pi hv\prime^3}{c\prime^3} \cdot \frac{1}{e^{\frac{hv\prime}{k\vartheta}} - 1} \qquad (12)$$

[Also note, with ***v'*** and ***c'*** timeless**,** Planck's law only gives a constant ***h*** in joule.]

[Radiation power context]
[Next, according to (12), the spectral radiance law for frequency is as follows:

$$B_v(v, T) = \frac{c}{4\pi} \cdot \frac{8\pi hv'^3}{c'^3} \cdot \frac{1}{e^{\frac{hv\prime}{k\vartheta}} - 1}$$

That gives

$$B_v(v,T) = c \cdot \frac{2h(\frac{v\prime}{\Delta t})^3}{(\frac{c\prime}{\Delta t})^3} \cdot \frac{1}{e^{\frac{hv\prime}{k\vartheta}} - 1}$$

And results in

$$B_v(v,T) = \frac{2hv^3}{c^2} \cdot \frac{1}{e^{\frac{hv\Delta t}{k\vartheta}} - 1}$$

]

[Radiation energy density context] *Or if one reintroduces the wavelength **λ** instead of the number of vibrations **v'** with the substitutions given in § 7:*

$$E = \frac{8\pi c\prime h}{\lambda^5} \cdot \frac{1}{e^{\frac{c\prime h}{k\lambda\vartheta}} - 1} \qquad (13)$$

[Radiation power context]:

[Next, according to (13), the spectral radiance law for wavelength is as follows:

$$B_\lambda(\lambda,T) = \frac{c}{4\pi} \cdot \frac{8\pi c' h}{\lambda^5} \cdot \frac{1}{e^{\frac{c\prime h}{k\lambda\vartheta}} - 1}$$

That results in

$$B_\lambda(\lambda,T) = \frac{2hc^2\Delta t}{\lambda^5} \cdot \frac{1}{e^{\frac{ch\Delta t}{k\lambda\vartheta}} - 1}$$

]

The expressions for the intensity and entropy of the radiation propagating in the diathermic medium and the law for increasing the total entropy in non-stationary radiation processes can be derived elsewhere.

III. Numerical values.

§ 11. The values of the two natural constants, h and k, can be calculated precisely using the available measurements. F. Kurlbaum found that if one denotes by S_t, the total energy radiated into the air in 1 second by 1 square cm of a black body at t° C:

$$S_{100} - S_0 = 0.0731\ \frac{Watt}{cm^2} = 7.31 \cdot 10^5 \frac{erg}{cm^2\ sec}$$

This results in the spatial density of the total radiation energy in the air at absolute temperature **1***:*

$$\frac{4\ .7{,}31 \cdot 10^5}{3 \cdot 10^{10} \cdot (373^4\ -\ 273^4)} = 7{,}061 \cdot 10^{-15} \frac{erg}{cm^3\ degree^4}$$

On the other hand, from (12), the spatial density of the total radiation energy for $\vartheta = 1$ *is:*

$$u = \int_0^\infty u dv'$$

That gives $u = \frac{8\pi h}{c\prime^3} \int_0^\infty \frac{v\prime^3\ dv\prime}{e^{\frac{hv\prime}{k}} - 1}$

And then $u=\frac{8\pi h}{c'^3}\int_0^\infty \nu'^3(e^{-\frac{h\nu'}{k}}+e^{-\frac{2h\nu'}{k}}+e^{-\frac{3h\nu'}{k}}+\ldots)\,d\nu'$

Moreover, integrating term by term:

$$u=\frac{8\pi h}{c'^3}\cdot 6\,(\frac{k}{h})^4\,(1+\frac{1}{2^4}+\frac{1}{3^4}+\frac{1}{4^4}+\ldots)$$

And results in:

$u=\frac{48\pi k^4}{c'^3 h^3}\cdot 1{,}0823\,\frac{erg}{cm^3\,degree^4}$ [Planck: $\frac{second^3\,erg}{cm^3\,degree^4}$]

If one set this:

u= $7{,}061\cdot 10^{-15}\,\frac{erg}{cm^3\,degree^4}$

*Since **c'**=3x10[10] cm, it results*

$\frac{k^4}{h^3}=1{,}1682\cdot 10^{15}\,\frac{erg}{degree^4}$ [Planck: $\frac{second^3\,erg}{degree^4}$] *(14)*

*§ 12. 0. Lummer and E. Pringsheim determined that the product **$\lambda_m\vartheta$**, where **λ_m** is the wavelength of the maximum of **E** in the air at temperature **ϑ**, was **2940** μ degrees. So, in absolute terms:*

$$\lambda_m\vartheta=0.294cm\cdot degree$$

*On the other hand, it follows from (13) if one sets the differential quotient from **E** to **λ** equal to zero, whereby **$\lambda=\lambda_m$***

$$(1-\frac{c'h}{5k\lambda_m\vartheta})\cdot e^{\frac{c'h}{k\lambda_m\vartheta}}=1$$

And from this equation

$$\lambda_m\vartheta=\frac{c'h}{4{,}9651\cdot k}$$

Consequently

$$\frac{h}{k}=\frac{4{,}9651\ \cdot\ 0{,}294}{3\cdot 10^{10}}$$

This results in

$\frac{h}{k}=4{,}866\ \cdot\ 10^{-11} degree$ [Planck: $\frac{degree}{second}$]

From this and from (14), the values of the natural constants:

$h=6{,}55\ \cdot 10^{-27} erg$ *(15)*

$k=1{,}346\ \cdot 10^{-16}\,\frac{erg}{degree}$ *(16)*

These are the same numbers indicated in a previous communication.

[The end]

According to this demonstration, the numerical value of Planck's constant is only in the energy dimension. Moreover, in Planck's law of spectral radiance for frequency, the physical dimension is Power, not Energy.

Planck's relation results in

$P=h\nu$ (1)

or

$$\frac{\varepsilon}{\Delta t} = h\nu \qquad (2)$$

3.3. Correction in Radiation Power Context

Another way to explain Planck's law is by using the context of power. That is how Kirchhoff, Stephan-Boltzmann, and Wien displacement laws are defined. As the resonators convert thermal energy in the walls to radiation energy, that is, power, using it with Boltzmann statistics for entropy, adapted by Max Planck, follows the same demonstration. The relationship between the power of the resonator and the energy is only a constant of proportionality: **Δt**. As they are on the walls, their numbers are the same. So, one can rework the 1901 Max Planck article and keep all his demonstrations in radiation power by replacing energy with power up to a constant. Hence, the energy ***U*** of a resonator with its radiation power ***U*/Δt**, ***ε*** with ***ε*/Δt** as the power element, and ***u*** with ***uc*/4*π*** as the spectral radiance changes nothing in the result to its combinatorial demonstration for the entropy ***S***. Then in (6) one has

$$S = k\{(1 + \frac{\frac{U}{\Delta t}}{\frac{\varepsilon}{\Delta t}}) log(1 + \frac{\frac{U}{\Delta t}}{\frac{\varepsilon}{\Delta t}}) - \frac{\frac{U}{\Delta t}}{\frac{\varepsilon}{\Delta t}} log \frac{\frac{U}{\Delta t}}{\frac{\varepsilon}{\Delta t}}\}$$

Hence, in Chapter II, one gets the relationship: $\frac{\varepsilon}{\Delta t} = h\nu$. Moreover, naming ***P*** the power element a resonator emits gives $P = \frac{\varepsilon}{\Delta t}$.

This results in

$$P = h\nu$$

Then, one has the following equation:

$$S = k\{(1 + \frac{\frac{U}{\Delta t}}{h\nu}) log(1 + \frac{\frac{U}{\Delta t}}{h\nu}) - \frac{\frac{U}{\Delta t}}{h\nu} log \frac{\frac{U}{\Delta t}}{h\nu}\}$$

As in the energy density context

$$\frac{1}{\vartheta} = \frac{dS}{dU}$$

In the radiation power context

$$\frac{\frac{1}{\vartheta}}{\Delta t} = \frac{\frac{dS}{dU}}{\Delta t} \qquad (9)$$

Then, with substitution in (9)

$$\frac{\Delta t}{\vartheta} = \frac{k}{h\nu} log(1 + \frac{h\nu}{\frac{U}{\Delta t}})$$

$$\frac{U}{\Delta t} = \frac{h\nu}{e^{\frac{h\nu\Delta t}{k\vartheta}} - 1}$$

As in (8) of the 1901 Planck article, after adaptation to power

$$\frac{uc}{4\pi} = \frac{2\nu^2}{c^2} \cdot \frac{U}{\Delta t}$$

Then, the law

$$B_\nu(\nu, T) = \frac{2h\nu^3}{c^2} \cdot \frac{1}{e^{\frac{h\nu \Delta t}{k\vartheta}} - 1}$$

Planck's constant ***h*** only in joules gives Planck's frequency law in watts.

4. Results and Discussion

4.1. The New Photon

The correction of Planck's law has no impact on the values of measurements. However, the change in the physical dimension of Planck's constant, especially the corrected Planck's relation, is of capital importance. For example, the de Broglie wavelength ***λ = h/p = h/mv*** with its new physical dimension ML^2T^{-2} M^{-1} $L^{-1}T = LT^{-1}$ can no longer be a wavelength, and one must express different wave-particle duality. Moreover, the photon also becomes an invalid real-time object because its energy quantum ***E=hν*** vanishes. On the other hand, with the new Planck's relation ***P=hν***, one obtains that the energy of a cycle is always equal to h, whatever the frequency. One can then consider this cycle and its Maxwell radiation pressure as a virtual particle, a new photon. This new photon, at the microscopic level, fits perfectly into Maxwell's continuous electromagnetism at the macroscopic level since it represents a cycle of an electromagnetic wave, remaining fully compatible with the theory of general relativity for the redshift. Moreover, one can calculate the mass of the new photons by its energy-mass equivalence. Then, one gets:

$$h = m_\gamma c^2$$
$$m_\gamma = \frac{h}{c^2}$$
$$m_\gamma = 0.7372497324 \cdot 10^{-50} kg$$
$$m_\gamma = 4.134883524 \cdot 10^{-15} eV$$

It is a value that falls within the range of the measurements carried out [4] and makes them consistent with an energy-mass equivalence independent of frequency.

4.2. Light-matter and Heat

The photon is a light particle defined to explain light-matter interaction phenomena. It can be absorbed and emitted at different energy levels, that is, frequencies; above a specific one, it can eject electrons or more. However, light beams with a flux of new photons can now give energy during a time interval with finer granularity. Then, it is possible to explain the simultaneous expulsion of several electrons from an atom by a high-energy X-ray laser pulse [5]. Moreover, one can consider that an electron has a time interval on its atom orbital to absorb the energy flow of new photons. Below a threshold frequency, an electron will only cause its atom to recoil with it. Then, outside this interval, it returns to its fundamental level, emitting radiation power with a new recoil in the opposite direction. One can thus put forward a new hypothesis: thermal energy is a flux of thermal radiation absorbed and emitted chaotically inside and outside matter.

4.3. The Electron-Resonator

In a black body wall, electrons and their atoms move around chaotically, with something like synchrotron radiation emitted in all directions. One can then consider them as electron

resonators. On the other hand, in the two capacitor plates, the electrons go simultaneously in the same direction, like an electric current. Then, these electron resonators emit polarized radiation in the same direction. In the plate of a capacitor where electrons arrive, an emitting group of electron resonators faces an absorbing one in the other plate, converting electric energy into radiation and vice versa: a Maxwell displacement current hypothesis.
A dipole antenna converts electric energy into radio waves with the same principle of electron resonators. In a theoretically perfect dipole antenna, the electric power equals the radiation power. Where one has:

$$P = \frac{1}{2} R_{ray} {I_{max}}^2$$

(with $\boldsymbol{P}$= power, $\boldsymbol{R}_{\mathbf{ray}}$ = radiant resistance, $\boldsymbol{I}_{\mathbf{max}}$ = peak current), whatever the frequency of the electric current oscillation. So, one cannot use the same reasoning as for the thermal radiation of the black body, where constant temperature corresponds to a chaotic motion at the atomic level. In an antenna, the electrons all move simultaneously in the same direction and are alternately accelerated and then decelerated with each cycle of a traveling wave. So these electron resonators emit radiation in the same direction, orthogonal to the antenna, therefore polarized and modulated in intensity, following the phase of the electric current. Considering the electrical power modulated like a progressive wave, electron resonators emit synchronized new photons varying in intensity, therefore in power, in the form of a progressive wave. The electron resonators of a receiving antenna will absorb a small part, where this energy flow will create an electric wave in phase opposition to that of the transmitting electric current. That can be the link between Planck's law and radio waves.

5. Conclusion and Outlook

This article corrects a mistake made by Max Planck to justify his law for black body radiation. A mistake that does not change the value of the result and has gone unnoticed for 123 years. This only concerns the law for frequencies, which gives energy when one measures power. However, the primary correction is to the Planck constant in joule only, providing a new Planck relation:

$$P = h\nu$$

(with $\boldsymbol{P}$ as power in watts). That challenges quantum physics; the elementary quantum of energy is now the radiation cycle with constant energy $\boldsymbol{h}$, regardless of frequency. An energy cycle that gives the radiation pressure replaces the photon at the elementary level and expresses the wave-particle duality. This electromagnetic cycle, acting like a particle, is the new photon. Its constant energy, $\boldsymbol{h}$, gives its mass with the mass-energy equivalence. It is also fully compatible with continuous Maxwell electromagnetism at the macroscopic level. Consequently, one must review everything based on Planck's relation and constant.

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Conflict of Interest

The author declares no conflict of interest.

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