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The new solution of Ultraviolet Catastrophe of Rayleigh-Jeans and the new *form of energy*

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Abstract

It is possible to individualize in an accurate way, the error inborn in the model adopted by Lord Rayleigh and Sir James Jeans (R&J) [8] which solution leads to the famous ultraviolet catastrophe. The individuation of the right model to adopt leads to a new formula that is in accord to experimental results of Black body and that, differently from that one proposed by Planck [9], foresees the existence of a new form of energy that also explains natural radioactivity phenomenas. It also allows to determinate the temperature over that the material is in plasma status (IV status of material) and permits to establish energetic distribution in this status.

It is possible to understand Plank's hypothesis, by that the energy is quantized, It cannot foresee the new form of energy, because, even if it is essentially correct, is likewise strongly limited. Infact it is possible to show both in an experimental and theoretical way [1] that Planck hypothesis by that $E = h\nu n$, fundamental platform of the actual Quantum Mechanics, is rigorously amenable to the **classic theory of resonances** [1], phenomenon that only verifies for alloyed dipoles. So it can't describe even ionization to those is attributed this new form of energy.

Introduction

In accord with Larmor relation [2] the power emitted by an oscillating dipole is given by the famous relation

$$W = \frac{2q^2a^2}{3C^3} \tag{1.1}$$

where q is the oscillating charge, a is its medium acceleration and C is light's velocity.

Rayleigh and Jeans (R.&J.) consider an *harmonic* oscillator for that is verified the know relation

$$m\,a = -\bar{k}\,x\,. \tag{1.2}$$

From that relation we have that

$$a^2 = \left(\frac{\bar{k}x}{m}\right)^2 = \frac{\bar{k}}{m}2\left(\frac{1}{2}mv^2\right) = \frac{1}{m}mv^2\left(2\pi\nu\right)^2. \tag{1.3}$$

Now the power that a radiation field by its spectral distribution $E(\nu,T)$ give the oscillator is [2]

$$W' = \frac{\pi q^2}{3m}E(\nu,T). \tag{1.4}$$

In stationary conditions must be $W = W'$ and so we have

$$E(\nu,T) = \frac{8\pi\nu^2}{C^3}mv^2. \tag{1.5}$$

Because from Classic Mechanics we have that

$$m\,v^2 = k\,T\ ,$$

we obtain

$$E(\nu,T) = \frac{8\pi\,k\,T}{C^3}\nu^2. \tag{1.6}$$

This relation, written in function of the wave length and by indicating by P_{Vol} the power per volume unit becomes

$$P_{Vol} = C\frac{k\,T}{\lambda^4}\ , \tag{1.7}$$

that conduces to the ultraviolet catastrophe.

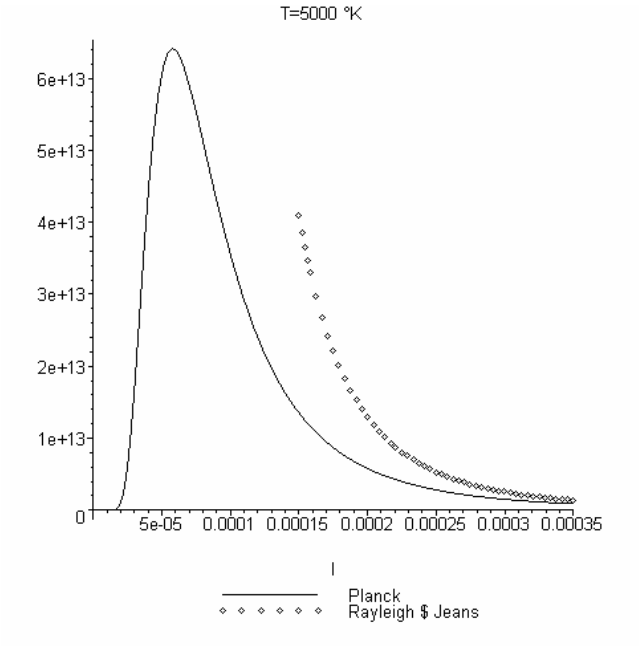

fig. 1

As we can see from fig. 1, even if the formula of R.&J. conduces to the ultraviolet catastrophe, it always, by growing values of λ it tends to the exact solution. Even T. Kuhn observes that [3], but there's nothing common between (1.7) and Planck's formula

$$P = \frac{hC^2}{\lambda^5} \frac{1}{\exp\left(\frac{hC}{kT\lambda}\right) - 1} \tag{1.8}$$

at least to have it we could substitute in one or the other of the two solutions the following relation

$$\frac{hC}{\lambda} = kT \,, \tag{1.9}$$

in that case both of them could not be able to faithfully reproduce experimental results.

This could appear as a marginal question, taking count of the confirms *to posteriors* obtained by Q. M., as we'll better see, it otherwise is of extreme importance.

We immediately observe that the model adopted by R.&J. is constituted by the harmonic oscillator. It is notoriously the projection on masses x-coordinates that moves above a circumference so the situation is analogue to that one of a modern astronomer that would write the efemeridies of a planet ignoring that, generally, obits described in a central field by an inverse-proportional law to the square of distance are conic sections. The suspect that the model adopted by R.&J. would be perfectible is reinforced by the fact that R.&J. solution, for big wave length, tends to the experimental results.

Keplerian Oscillator

If we consider a charge that in a central Columbian field describes a generic conic given by the known relation

$$r = \frac{p}{1+\varepsilon\cos\varphi} \tag{1.10}$$

end we propose to study the move of the said mass on the x-coordinates we have that on this axis it is subjected to the force

$$F_x = \frac{e^2}{r^3}x \tag{1.11}$$

where e is the electron charge.

By posing

$$\cos(\varphi) = \frac{x}{r} \tag{1.12}$$

and

$$\omega^2 = \frac{e^2}{mp^3} \tag{1.13}$$

we have that acceleration is given by the relation

$$a = \frac{d^2x}{dt^2} = -\frac{\omega^2 x}{\left(1-\varepsilon\frac{x}{p}\right)^3} \tag{1.14}$$

that reduces to the model adopted by R.&J. only when $\varepsilon = 0$.
The following figure n. 2 represents (1.10) for various values of ε that can belong to the interval

$$\varepsilon \in [0,\infty]. \tag{1.15}$$

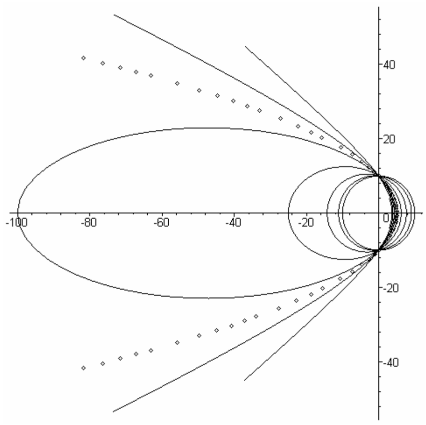

fig. 2

It underlines the extreme poorness of R.&J model and in a big part of Theoretical Physics.

Because we are interested in the medium acceleration that endures the mass and this medially take the position [4]

$$\langle x \rangle = -\frac{3}{2}\frac{p\,\varepsilon}{\left(1-\varepsilon^2\right)} \tag{1.16}$$

we'll have that medium acceleration of the Keplerian dipole is given by the relation

$$\langle a \rangle = \left\langle \frac{d^2x}{dt^2} \right\rangle = \frac{3}{2}\,p\,\omega^2\,\frac{\left(1-\varepsilon^2\right)^2\varepsilon}{\left(1+\frac{1}{2}\varepsilon^2\right)^3}. \tag{1.17}$$

In the fig. 3 is represented the square of (1.17) in function of ε , in the interval

$$\varepsilon \in [0,1] \tag{1.18}$$

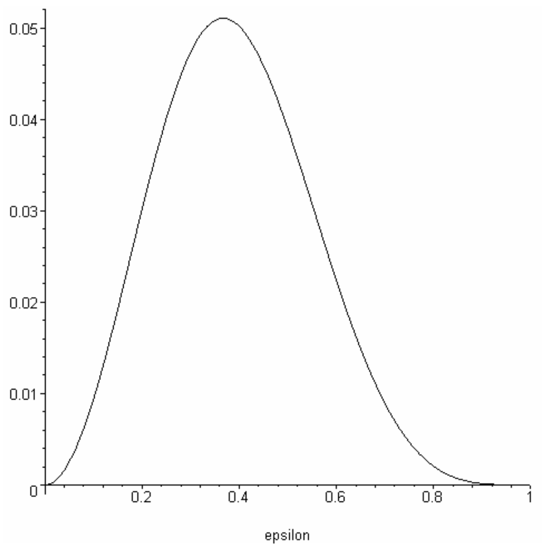

fig. 3

so it only represents alloyed dipoles.

Fig. (4) instead represents both alloyed dipoles for those $\varepsilon \in [0,1]$, and ionized ones corresponding to the interval $\varepsilon \in [1,\infty]$.

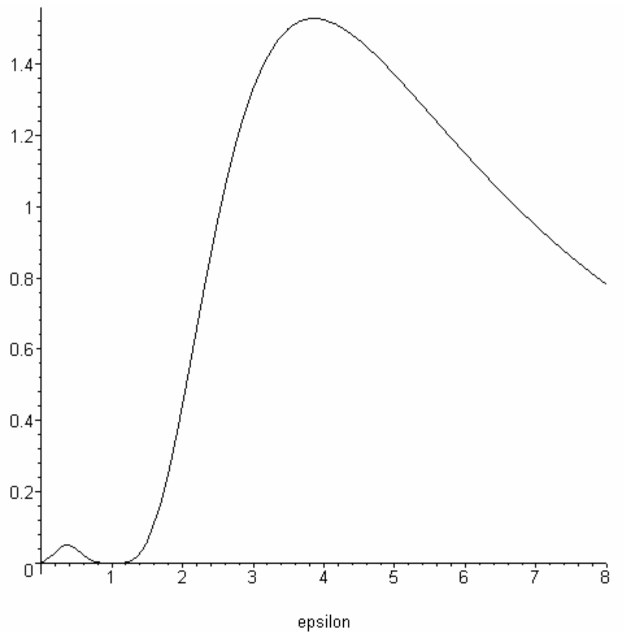

fig. 4

Before passing to the solution of the Black Body Problem it's important the integration of (1.14). For it we have

$$E_{tot} = \frac{1}{2} m v^2 + \frac{1}{2} m \frac{\omega^2 x^2}{\left(1 - \varepsilon \frac{x}{p}\right)^2} = m \overline{v}^2 + m \frac{\overline{\omega}^2 \overline{x}^2}{\left(1 - \varepsilon \frac{\overline{x}}{p}\right)^2} \qquad (1.19)$$

so total energy equally puts between kinetic and potential one, the last one is given by the equation

$$E_{tot} = m \frac{\omega^2 \, \overline{x}^2}{\left(1 - \varepsilon \frac{\overline{x}}{p}\right)^2} \qquad (1.20)$$

.

This equation, at the variation ε, is reported in fig. 5.

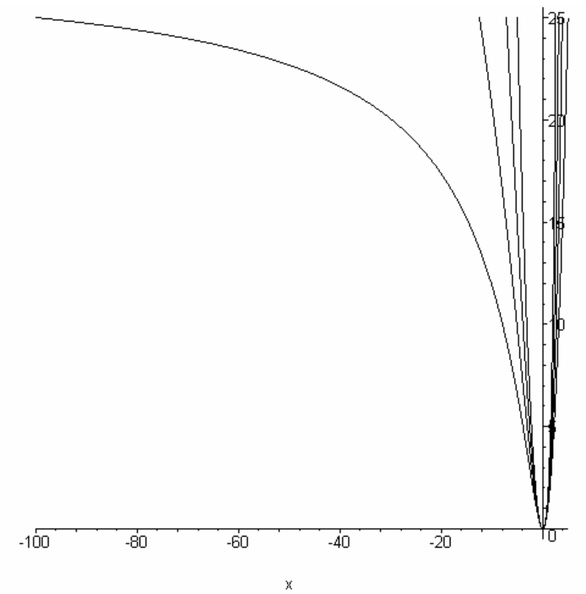

fig. 5

If we rotate the graphic of fig. 5 we obtain the graph reported in fig. 6

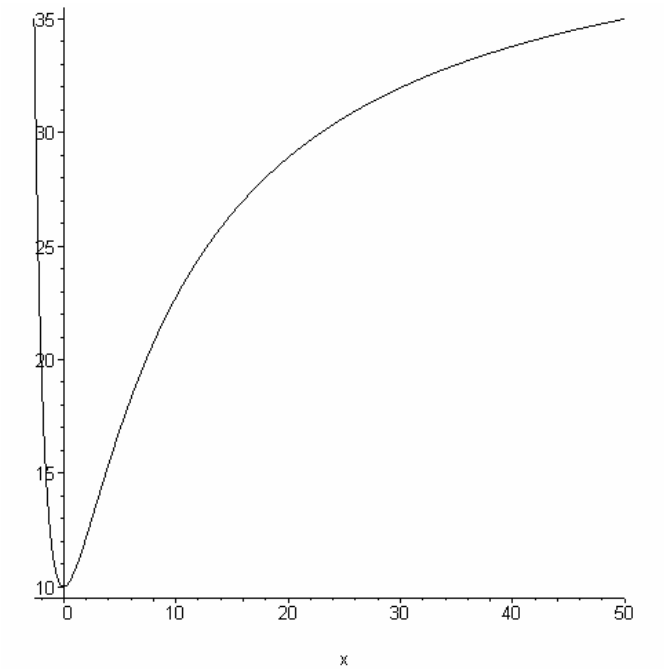

fig. 6

very simile to experimental equations of Morse and Rydberg related to diatomic molecules [5] and obtained by the hypothesis of attractive and repulsive forces of the nucleus above the external charge.

Ultraviolet Catastrophe Solution

If we make again R.&J. reasoning, we substitute to the medium acceleration of the harmonic oscillator that one give by the keplerian oscillator. In that case, in accord to (1.17), we'll have that

$$E_{(\nu,T)} = \frac{2m\langle a\rangle^2}{\pi C^3} = \frac{2m}{\pi C^3}\left[\frac{3}{2}p\omega^2\frac{\left(1-\varepsilon^2\right)^2\varepsilon}{\left(1+\frac{1}{2}\varepsilon^2\right)^3}\right]^2 . \qquad (1.21)$$

Attended:

- that eccentricity is defined by the relation between two lengths, we'll pose

$$\varepsilon = \frac{\lambda_o}{\lambda}; \qquad (1.22)$$

- that acceleration given by (1.17) is related to a unique reference system with its origin in the focus of all the conics represented in fig. 2, otherwise the wave lengths posed on x-coordinates and related to black body curve are related to an reference system external to the various conic focuses, more exactly we'll write

$$\varepsilon = \frac{\lambda_o}{\lambda_s + \lambda} \qquad (1.23)$$

- that the grandness λ_o and λ_s can be defined by the relations

$$\lambda_o = \alpha\frac{hC}{kT} \qquad (1.24)$$

$$\lambda_o = \beta\frac{hC}{kT}, \qquad (1.25)$$

where α and β are constants to be determinable for (1.21) to represent experimental results, by saying this we have

$$E_{(\nu,T)} = \frac{2m\langle a\rangle^2}{\pi C^3} = \frac{9}{2}\frac{m}{\pi C^3}p^2\varpi^4\frac{\left(1-\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^4\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2}{\left(1+\frac{1}{2}\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^6}d\nu \qquad (1.26)$$

or that

$$E_{(\nu,T)}=\frac{2m\langle a\rangle^2}{\pi C^3}=\frac{9}{2}\frac{kT}{\pi C^3}\left(2\pi C\frac{\lambda_o}{\bar{\lambda}}\right)^2\frac{C}{(\lambda_s+\lambda)^4}\frac{\left(1-\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^4}{\left(1+\frac{1}{2}\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^6}d\lambda \qquad (1.27)$$

so volumic power becomes

$$P_{Vol}=C\frac{kT}{(\lambda_s+\lambda)^4}\frac{\left(1-\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^4}{\left(1+\frac{1}{2}\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^6}d\lambda. \qquad (1.28)$$

Remark

Positions (24) and (25) could appear as right. Instead it's important to observe [6] that the energy of any electric dipole (not polarized) can be written

$$E=\frac{e^2}{\psi}=\frac{2\pi 137\, e^2}{2\pi 137\,\psi}$$

and remembering that

$$2\pi 137 e^2=hC$$

if we pose [1,6]

$$\lambda=2\pi 137\psi$$

we obtain

$$E=\frac{hC}{\lambda}.$$

For a particular oscillator of the black body (for example that one for volumic power P_{Vol} assumes maximum value) it can be written

$$E=\frac{hC}{\lambda_{\max}}=\alpha kT\ ,$$

from what we have

$$\lambda_{\max}=\frac{1}{\alpha}\frac{hC}{kT}$$

This is also obviously valid for $\bar{\lambda}$ that appears in (1.28) so we can say that

$$\bar{\lambda} = \gamma \frac{hC}{kT}$$

so the relation $\lambda_o / \bar{\lambda}$ is an absolute constant that does not depend on the absolute value of temperature.

To let (1.28) represent experimental values (Planck's law) we must pose

$$\lambda_o = 0.1465 \frac{hC}{kT} \quad e \quad \lambda_s = 0.0929 \frac{hC}{kT}\,. \tag{1.29}$$

This values can anyway be determined more precisely. Fig. n. 7

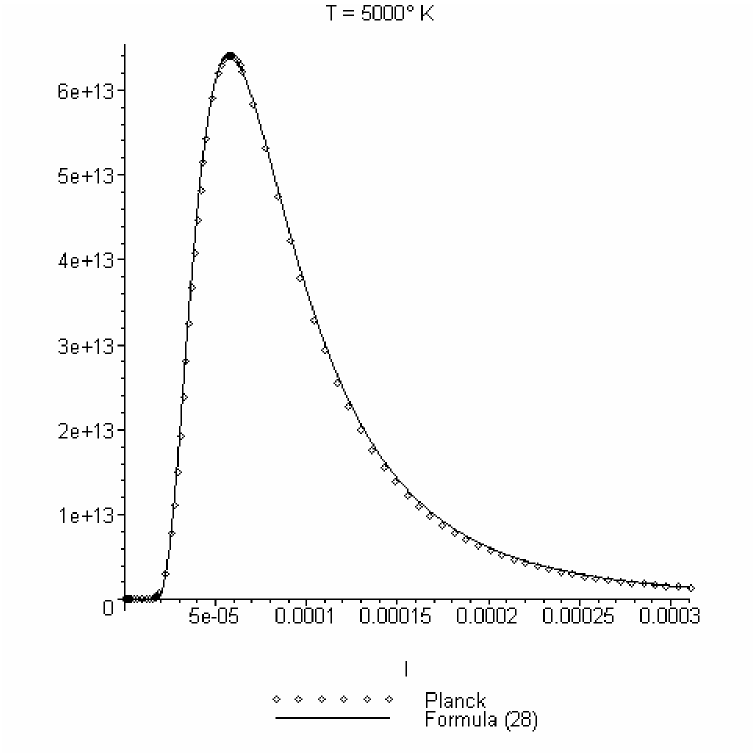

fig. 7

permits the confront between Planck's equation and (28) for a temperature of 5000° K. Fig. n. 8, reports the confront for a temperature of 2000°K. We can note that the graphs are the same except that for a scale difference.

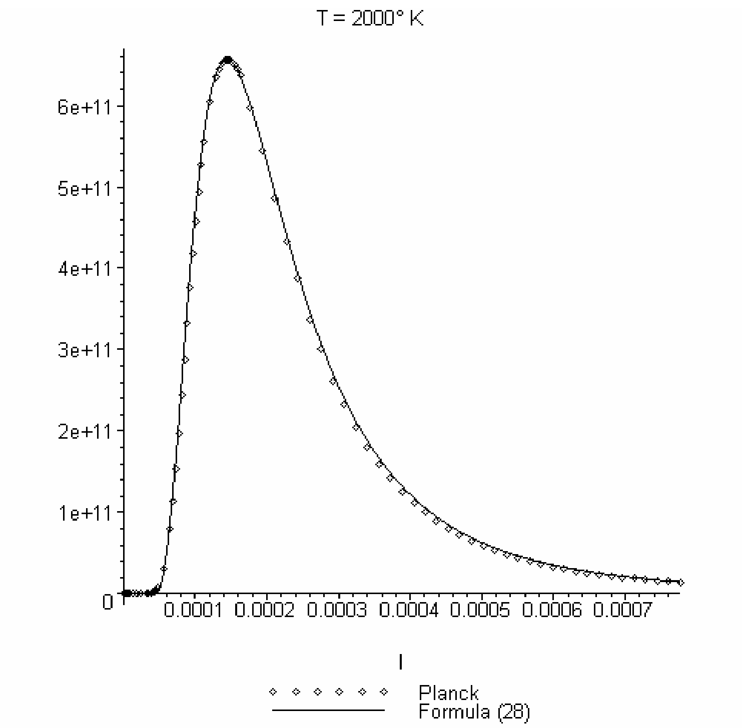

fig. 8

About precision on previsions we have to say that a formula that better represents experimental results is the one of Pringsheim & Lummer [7], even it of experimental origin

$$P = \frac{hC^2}{\lambda^5} \frac{1}{\exp\left(\frac{hC}{kT\lambda}\right) + \exp\left(-\frac{kT\lambda}{hC}\right) - 1}.$$

Fig. 9 allows the confront between Planck's formula and that one suggested afterward by Pringsheim & Lummer (P. & L.) [7]. From it we can still observe there are some differences from the two ones.
About this it's necessary to observe that (1.28), with a more opportune choice of the parameters α, β and of the relation $\lambda_o / \bar{\lambda}$ [10], it can approximate the experimental relation of (P. & L.) better than Planck's formula.

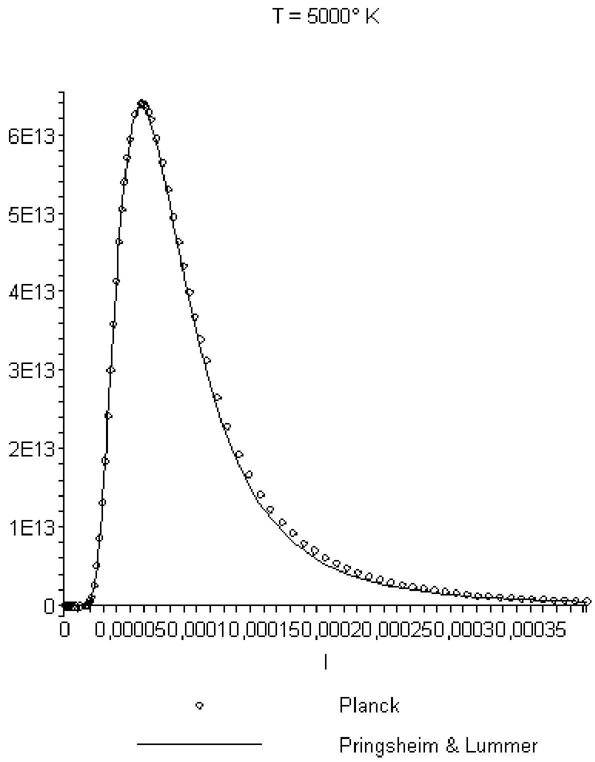

fig. 9

Before to talk about substantial differences between Planck's solution (1.8) and that one given by (1.28) it's important to express the last one in function of the frequency. It results to be given by the equation

$$E(\nu,T)=\frac{8\pi}{C^3}kT\,\nu^2\left[\left(\frac{\nu_s}{\nu_s+\nu}\right)^4\frac{\left(1-\frac{\nu_s^2\nu^2}{\left(\nu_s+\nu\right)^2}\left(\frac{\nu}{\nu_o}\right)^2\right)^4}{\left(1+\frac{1}{2}\frac{\nu_s^2\nu^2}{\left(\nu_s+\nu\right)^2}\left(\frac{\nu}{\nu_o}\right)^2\right)^6}\right]d\nu \qquad (1.30)$$

with the corresponding positions

$$\nu_o=\frac{1}{0.1465}\frac{kT}{h} \quad e \quad \nu_s=\frac{1}{0.0929}\frac{kT}{h}\,. \qquad (1.31)$$

The (1.30) has two maximums given by

$$\nu_{\max_1}=2.78\frac{kT}{h} \quad e \quad \nu_{\max_2}=71.53\frac{kT}{h} \qquad (1.32)$$

and three minimums

$$\nu_{\min_1}=0 \quad , \quad \nu_{\min_2}=18.66\frac{kT}{h} \quad , \quad \nu_{\min_3}=\infty \qquad (1.33)$$

If we represents (1.28) in the whole interval $\lambda \in [0, \infty]$ its gear is detectable by fig. 10

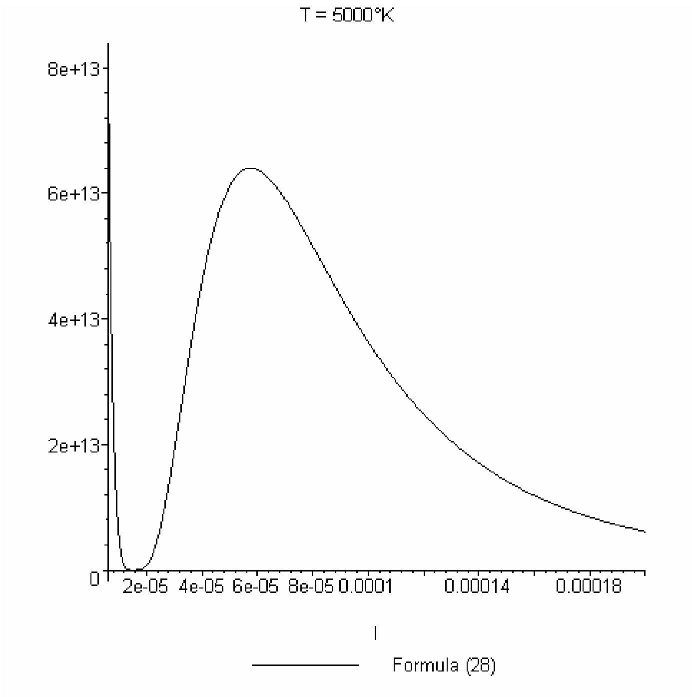

fig. 10

Fig. 11 represents the same formula in function of frequency, that is (1.30), confronted with the one of Plank, for a temperature of 5000° K

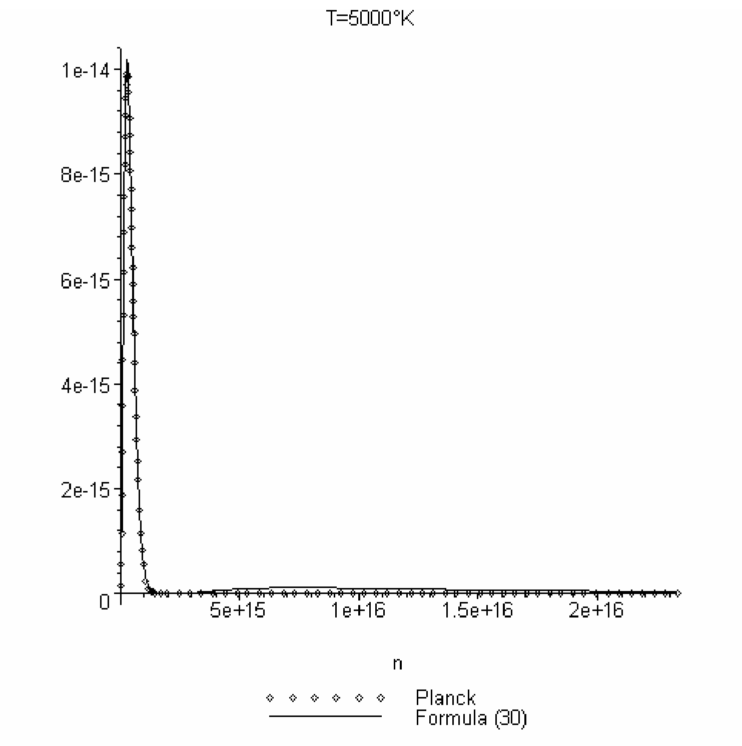

fig. 11

As we can see better with this figure and the one that follows, otherwise Plank's formula, after it has arrived to the maximum, arrives to the null point for a frequency equal about to $\nu_{\min} \simeq 2.5\times10^{15}$, (1.30) has another maximum that we can barely see in fig. 12

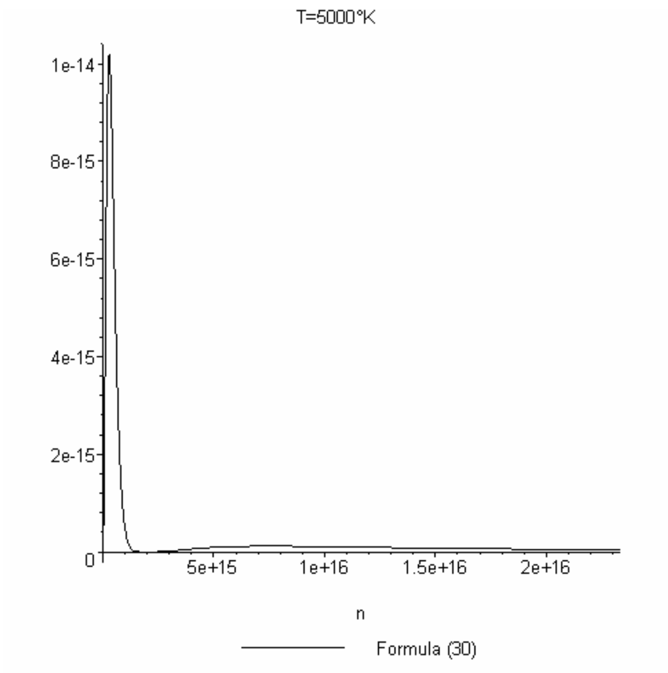

fig. 12

and that is more appreciable in fig. 13.

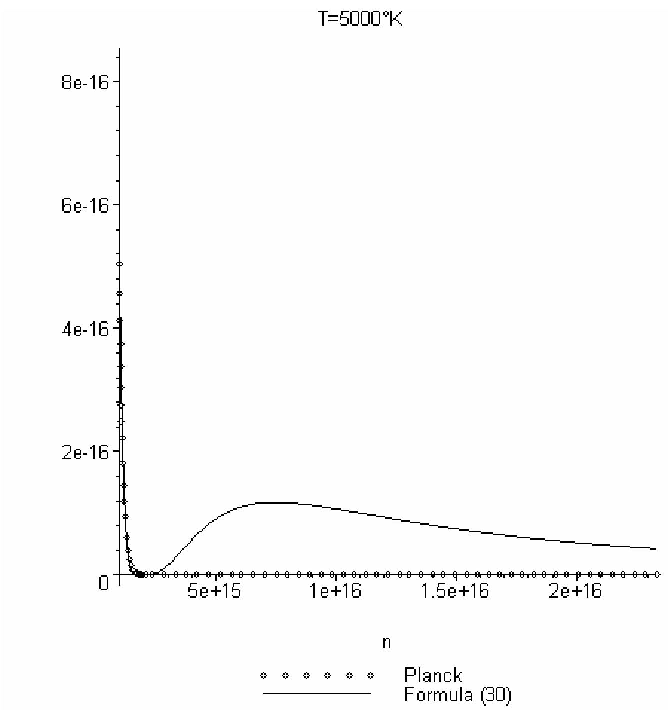

fig. 13

New maximum, that for T=5000° K , is obtainable for a frequency equal about to $\nu_{\max 2} \simeq 7.5\times10^{15}$.

It's immediate to relieve that this new form of energy, not foreseeable by Planck's theory because of the reasons we're going to see, is given to the fact that the model constituted by keplerian oscillator also foresees ionized dipoles. Infact fig. 2 represents all the possible conic sections, both alloyed (circumferences and ellipses) and loosed ones (parabolas and hyperboles), those last curves on which the particle is anyway subjected to accelerations so it is still fully applicable (Larmor) relation. Even fig. 4 anticipates this result.

Contrarily, as we will see better [1], Plack's enigmatic equation talking about the fact that energy would be quantized in basis to the empiric equation

$$E = h\nu\, n = \hbar\Omega\, n \tag{1.34}$$

It's nothing else that a more general resonance equation of a common harmonic oscillator so it only and exclusively affects the alloyed dipoles [1]. From that its impossibility to foresee this new form of energy.

On the other hand Planck was induced to write (1.34) to be able to justify *to the posteriors* a formula already *experimentally* obtained and that better described the delicate results found by the various researchers [7]. But, as we said, (1.34) can be reread as a more ample resonance condition of any resonancer [1], always with the strong limitation it only treats, very superficially, alloyed dipoles. Resonance Phenomenon that instead constitutes the most powerful and unique physic phenomenon through any form of energy (even visible light), can be absorbed, emitted, diffracted, refracted o reflected from material in which interacts.

Integral power of (1.30), contained in the interval $\nu \in \left[0, \nu_{\min_2}\right]$ and that

$$E_{d.l.} = \int_{\nu=0}^{\nu=\nu_{\min_2}} E_{(\nu,T)}\, d\nu \cong 6.6\, \frac{k^4 T^4}{h^3 C^2} \tag{1.35}$$

competes to alloyed dipoles. It is practically coinciding with the one given by Planck.
Instead integral power of (1.30), contained in the interval $\nu \in \left[\nu_{\min_2}, \infty\right]$ and that

$$E_{d.s.} = \int_{\nu=\nu_{\min_2}}^{\nu=\infty} E_{(\nu,T)}\, d\nu \cong 3.98\, \frac{k^4 T^4}{h^3 C^2} \tag{1.36}$$

refers to ionized dipoles.

The global integral power contained in the interval $\nu \in \left[0, \infty\right]$ is equal to

$$E_{d.l.} + E_{d.s.} = \int_{\nu=0}^{\nu=\infty} E_{(\nu,T)}\, d\nu \cong 10.58\, \frac{k^4 T^4}{h^3 C^2} \tag{1.37}$$

.

The multiform aspect of Coulomb's law.

As we'll better see [1,6], between the ampleness ψ of the charge oscillation and the electromagnetic wave length that it produces, subsists the new relation[1]

$$\lambda = 2\pi 137\psi . \tag{1.38}$$

From (1.38) we elicit that black body's energy is given by the relation

$$E = kT\frac{\left(1-\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^4}{\left(1+\frac{1}{2}\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^6} \tag{1.39}$$

that, taking count of (1.38), can be rewritten in the following way

$$E = kT\frac{\left(1-\left(\frac{\psi_o}{\psi_s+\psi}\right)^2\right)^4}{\left(1+\frac{1}{2}\left(\frac{\psi_o}{\psi_s+\psi}\right)^2\right)^6} = m\overline{C}^2\frac{\left(1-\left(\frac{\psi_o}{\psi_s+\psi}\right)^2\right)^4}{\left(1+\frac{1}{2}\left(\frac{\psi_o}{\psi_s+\psi}\right)^2\right)^6}. \tag{1.40}$$

It is evident that the (medium) power acting on the charge is given

$$F = -\frac{dE}{d\psi} \tag{1.41}$$

We'll obtain the power by (1.39) and so

$$F = -\frac{dE}{d\lambda}, \tag{1.42}$$

taking count than of (1.38). It is

$$F = -\frac{8kT\left(1-\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^3\lambda_o^2}{(\lambda_s+\lambda)^3\left(1+\frac{1}{2}\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^6} - \frac{6kT\left(1-\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^4\lambda_o^2}{(\lambda_s+\lambda)^3\left(1+\frac{1}{2}\left(\frac{\lambda_o}{\lambda_s+\lambda}\right)^2\right)^7} \tag{1.43}$$

---

[1] We observe that $\lambda_{\max} = \frac{1}{5}\frac{hC}{kT} = \frac{1}{5}\frac{2\pi 137 e^2}{m\overline{C}^2} = \frac{1}{5}2\pi 137\psi .$

The fig. 14 represents it for a temperature of 5000° K.

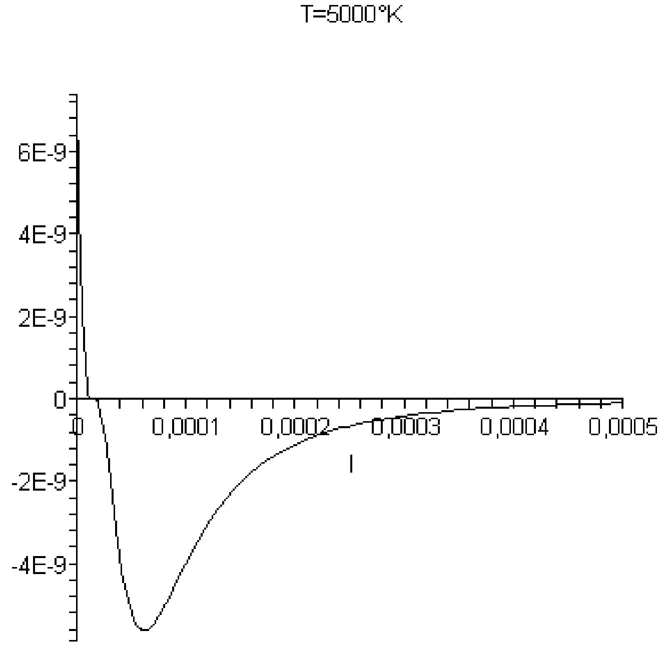

fig. 14

This power law would be incomprehensible and comparable for nothing to Coulomb's law if we would not take count of the important role of eccentricity, always completely neglected (v. fig. 2 e fig. 4).
Founder fathers of the actual Q. M. have always and only took count of the harmonic oscillator. The unique exception is for Sommerfeld that, thought to find a bigger theory than that one of Bohr, remained strongly deluded. The fig. 14 synthesizes the only model exclusively utilized in theoretic physics.

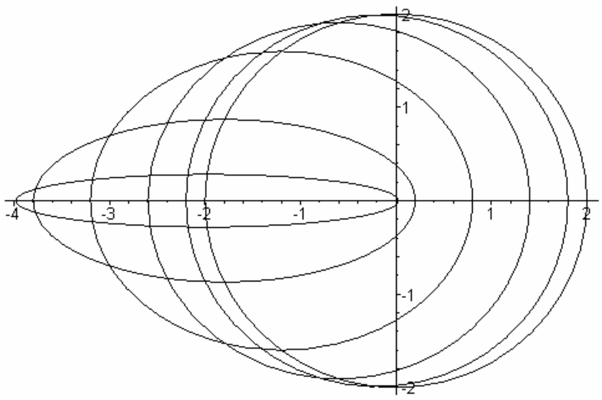

fig. 14
In that case, even if we consider keplerian orbit eccentricity, we consider the only case in that conic diameters would be all equal among them.

II plasma, IV Status of material

Classic ray of the electron is given by

$$R_e = \frac{e^2}{mC^2} .$$

By taking count that

$$2\pi 137 e^2 = hC$$

we have

$$2\pi 137 R_e = \frac{2\pi 137 e^2}{mC^2} = \frac{hC}{mC^2} = \frac{h}{mC} = \lambda_{Comp}.$$

If we impose that $\lambda_{\min}$ of (1.28) (or $\nu_{\min_2}$ of (1.30)) would coincide with Compton wave length (cutt-off) we'll have

$$\lambda_{\min} = 2\pi 137 \frac{e^2}{mC^2} = \frac{2\pi 137 e^2}{mC^2} = \frac{hC}{mC^2} = \frac{h}{mC} \cong \left(0.1465 - 0.0929\right)\frac{hC}{kT} = \frac{1}{18.66}\frac{hC}{kT} \qquad (1.44)$$

from what

$$\lambda_{Comp} = \frac{h}{mC} = \frac{1}{18.66}\frac{hC}{kT}$$

so

$$T_{plasma} = \frac{mC^2}{18.66k} \simeq 317\ 624\ 450°K . \qquad (1.45)$$

once this temperature is exceeded alloyed dipoles become more and more rare so energy distribution of the black body is given by the equation (1.30) that is represented in fig. (15) for a temperature of $500\,000\,000° K$, relatively to the existence interval of ionized dipoles.

$$\nu \in \left[\nu_{\min_2}, \infty\right].$$

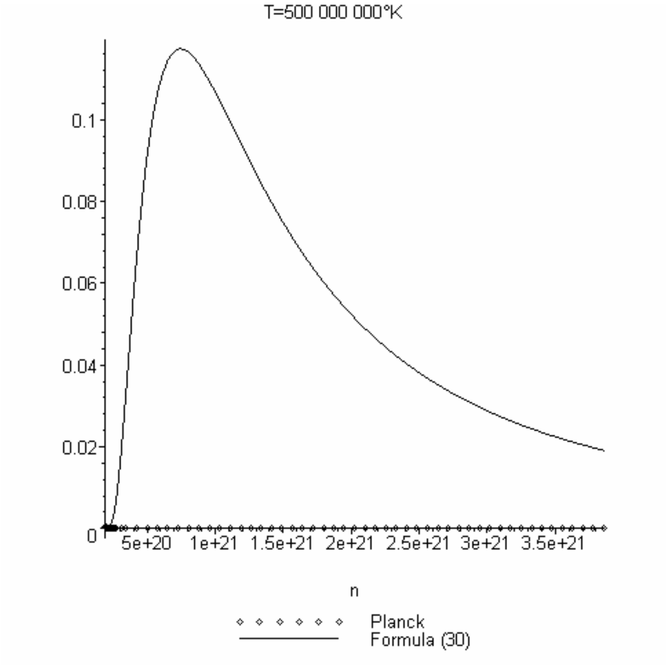

fig. 15

More evolvements will be the body of a next note.

References

[1] C. Santagata, ***Resonance Frequencies and Plank's Formula***
[2] W. Heitler, ***The Quantum Theory of Radiation***, Oxford (1960)
[3] T. Kuhn, ***Black-body theory and quantum discontinuity***, New York, Oxford University Press, (1978)
[4] Tisserand, ***Traité de Mecanique Celeste***, Tome I, Paris (1889)
[5] P. Fleury & J.P. Mathieu, ***Atomi, Molecole, Nuclei***, Vol 8, par. 4-11, Zanichelli Bologna (1965)
[6] C. Santagata, ***New quantum relations***
[7] H. Kangro, ***Early History of Planck's Radiation law***, Taylor & Francis L.t.d.,London (1976)
[8] W. Strutt &, Lord Rayleigh, ***Remark upon the law of complete radiation,*** Philosophical Magazine, 1990, XLIX, pp. 593-540
[9] M. Planck, ***Uber irreversible Strahlungsvorgage,*** Sitzungsberichte der Koniglich-Preubischen Akademie der Wissenschaften Berlin, 1897 (I), pp. 57-68, ibid., (II), pp. 715-717; pp. 1122-1145; ibid., 1898 (II), pp. 449-476; ibid., 1899 (I), pp. 440-480.
ID., ***Zur Theorie des Gesetzes der Energieverteilung im Normalspectrum***, in Verhandlungen der Deutschen Physikalischen Gesellschaft, 1900, II, pp. 237-245.
ID., ***Ueber irreversible Strahlungsvorgange***, in Annales der Physik, 1900, 306, pp. 69-122.
ID., ***Ueber das Gesetz der Energieverteilung im Normalspectrum***, in Annales der Physik, 1901, 309, pp. 553-563.
[10] C. Santagata, ***Classical foundations of quantum postulates***, in Journal of Information & Optimization Sciences, Vol. 17 (1996), N° 1, pp. 97-126