# The Thermally Conditioned Electromagnetic Field

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Abstract

As consequence of thermic motion the thermally conditioned electromagnetic field (TEMF) is defined which should produce the temperature-radiation by means of dipole formation. Since 1960 we think that elementary particles have a structure. In terms of historic development of temperature-radiation and diffraction of light is shown that it is overdue to consider by way of trial the structure of the photon as medium or basis of quantization of radiation. A photon with the frequency f is only stable in structure and emitable if the Einstein-equation E = h f is fulfilled.

## I. Introduction

Heat is today considered incontestably caused by the inner motion of matter what is acknowledged as kinetic theory of heat. In form of temperature-radiation heat energy is transformed into electromagnetic-radiation. The question is therefore:

„Why do hot bodies glow?"

Planck's law of radiation gives the mathematical relation. Otherwise there is not given a concrete physical concept of this transformation.

There is known Hertz's dipole-radiation where electrical energy is transformed in radiation at which could radiate many quanta pro period.

The spontaneous-emission is characterized that light is not emitted directly after excitation (impact or interaction) but during or after an average life-time or residence-time and then only one quantum pro process.

The stimulated-emission presumed stimulated states so that one photon is able to release second photons.

All three kinds of origins are not fit without further ceremony for origin of temperature-radiation.

The possibility of origin of temperature-radiation by dipole-formation of matter is often demanded for example already by Einstein [1], but at that time no structure of elementary-particle was known, so could be stated no particulars.

## II. Planck's interpretation of quanta

Planck [2] united in his radiation-formula all hitherto statements. Planck considered radiation present. He demanded only equilibrium with coal-motes, resonators or in later time oscillators. The quantization ensued in every case by swinging of (linear or harmonic) oscillators. These should emit energy of oscillation only as manifolds of a energy-amount of $\varepsilon$ in the beginning and later of hf/kT.

Bohr [3] characterized (translated): "Now, the theory of radiation in the original form given by Planck misses inner consistency, as it is generally confessed. ..." By other authors in statistics is introduced quantization through phase-cells and their occupations as possibility as result of distinction of particles. The quantization also results formally or it was established with the hollow-space or of its walls. For example Kuhn [4] reported about this in historical sight.

## III. Quantization by Bohr

Bohr started from line-spectra and their laws (series-formulas) for penetration into the construction of atoms. He expected a connection of electronic-orbits with the emitted spectral-lines. At the beginning a length of a manifold of wave-length should be as condition for stable or stationary orbits. Later the impulse-moment of rotation or the angular-moment had to be n h. There is not the single value which determines frequency of emitted photons but the difference of energy of two such orbits. If for the orbit with higher energy the conditions are occupied or filled for emission and the orbit with lower energy is free, so emission can ensue by sentence of statistics. For transition from one to a lower orbit he put in the quantum-jump for establishing quantization. Difficulty yielded out of this model by the necessary of running delivery of energy from moved electrons, which should result in a collapse of the atom.

Later Bohr gave up descriptive interpretation like the planetary system and concluded an indescriptness for quantum-process; only formal quantum-numbers are to fulfil. The dualism of wave and particle as complementary and the exclusive probability-statements at quantum-processes as indeterminism were the basis of Heisenberg-Bohr's quantum-theory as Copenhagen-interpretation.

IV. Quantization by Einstein

Einstein [5] proceeded from light-electrical effect which demanded cogently for photon a quantum-nature. But by this also he could not explain diffraction and interference, which one believed to explain since Fresnel with and only with waves. Einstein [6] demanded instead of dualism a fusion of wave and particle and appeared against indeterminism and indescriptness in quantum-processes.

The photon self as basis of quantization was at that time not thinkable for it was valid as mass-point. Since 1960 a structure of elementary-particles is discussed, but the photon and its structure to consider as cause or medium for quantization that is not attempted hitherto. That has its foundation for photons and electrons were pretended a formal structure by dualism of wave and particle; and this prevented from progress in this direction. On the other side this attempt is long (since 1960) overdue. By Kuhn [7] this is a change of paradigm with all there described consequences.

Nieke [8] offered as solution of this problem the process of collecting-emission. Here the life-time is considered as time for photons in 'status nascendi'. During the life-time the mechanical oscillation-energy of excitation is transformed in energy of rotation of electromagnetic field, at which the emission with the frequency f ensued first if the energy is collected according the Einstein-equation $E = h f$.

By Nieke [9] the photon has the structure of an electromagnetic vortex-pair, so the photon can be building up during the life-time of a state by steps. Therefore electromagnetic impulses coming from the here interested heat-motion can be stored and if the energy $h f$ is collected, then the photon will be emitted. How electromagnetic impulses by heat-motion can originate and contribute to radiation, this shall be examined here.

V. Definition of thermally conditioned electromagnetic field (TEMF)

The origin of temperature-radiation as an electromagnetic radiation is according our knowledges only thinkable if the thermic-motion originates or agitates di- or multi-poles. The through heat-motion originated electromagnetic field has not a name and that shows that this field is insufficiently treated, well, already special cases have own names.

As thermic electromagnetic field (TEMF) shall be designated field-quantities or energy of that electromagnetic field which is caused through heat-motion (translations, rotations and potentials) of parts of matter or their interaction inclusive the thermic-radiation of the own system.

With it are contained also the so called virtual photons in the TEMF which Nieke [8] discussed as photons in 'status nascendi'. The TEMF succeeded in the rhythm of heat-motion. Local and temporal averaged the non emitted field is compensated in great distance. The energy as part of thermal energy does not be compensated of course.

VI. General statements for TEMF

Already the definition admits statements upon the TEMF. According energy-conservation law local and thermal averaged the energy of TEMF $W_{TEMF}$ can not be greater than thermal-energy $W_T$ which is named in thermo-dynamics as inner energy, therefore

$$W_{TEMF} < W_T. \qquad (1)$$

At high temperatures in thermal equilibrium is

$$W_T = m N k T \qquad (2)$$

with m as number of degree of freedom and N as number of atoms. Else are instead of (2) to put in the corresponding law of thermo-dynamics.

For the field quantities of TEMF is valid in sufficient small volume v

$$W_{TEMF} = 1/2 \left( \int (H B)\, dv + \int (E D)\, dv \right). \qquad (3)$$

For that the TEMF can be composed of dipoles, whilst besides of manifest di- and multi-poles, according the next laying opposite charges are collected to dipoles.

VII. Quasi-molecule formation at collision- and scatter-processes

Born and Huang [10] calculated the at collision-processes originated dipole-moments for the cases of adiabatic and harmonic approach. Smith [11] reported about two models of colliding atoms. At overlapping model the outer atomic electron shells are over- or across-lapped and at the distortion model they are deformed as a tennis-ball from the racket. Bobashev [12] showed that after a collision a quasi-molecule excitation can be existing still further.

First Born and Franck [13] considered the formation of quasi-molecules during a collision- or scatter-process. Because the short duration of collision they expected no strict quantization but a continuous spectrum. Landau [14] demanded this as quasi-classical part. By Finkelnburg and Peters [15] the spectrum of quasi-molecule should be primary continuous by free start- and end-states, if the change of energy from collision-processes can be considered as free states corresponding of velocities-distribution and collision-parameter. All collision-processes demand corrections of the calculation of dipole-moments through regrouping of electrons, as already Fock [16] directed. That demands atoms as deformable media. Summary it is to establish that quasi-molecule formation contributes to TEMF.

VIII. Thermal energy in solids

If atoms in crystal-lattice are considered as coupled pendula, so every swinging continued from one and to the other. The crystal lattice should have an infinite heat-conductivity, for every energy of swinging runs through the whole crystal. Experiments do not confirm this if it is disregarded from extreme low temperatures. For the lattice-heat conduction was measured a 1/T-dependence, the higher the temperature so lower is the heat-conduction.

Peierls [17] introduced for explanation the umklapp (flap-over)-process where after a way length the progressive swinging is interrupt. If the energy is transported as with coupled pendula so is that the normal-process. At the U-process energy of swinging is not transported in the same direction but it comes back if the following atom prevents through its momentary position the energy transport in the hitherto rhythm. The energy of swinging is locally stored short- time and is soon returned. At this position there are peculiar occasions for origin of TEMF what is different of the normal-process, for here is to expect an additional dipole formation. With rising temperature the number of U-processes rise and with it the TEMF.

Merten [18], Claus [19] or Merten, Claus and Brandmüller [20] referred this as phonon-polaritons. Maradudin [21] discussed this with enharmonic forces, Schober [22] as scattering of phonons.

Long since are distinguished acoustic and optical oscillations. The optical lattice oscillations cause dipole-momentums which are periodical disposable, and they are considered always. At acoustic lattice oscillations is to aspect no or only a small dipole-momentum. On the other hand at excited oscillations the process analogous the quasi-molecule formation by change of direction in normal- or U-process can be taken into consideration. Atom-nuclei and electron-shells swing then in unequal amplitude or phase shifted in rhythm of oscillations of centre of gravitation of nucleus and shell. In every case a (small) dipole-momentum arises. On this effect the absorption of light of the frequency of lattice oscillations for example in germanium could originate, for in pure homeopolar crystals else no absorption by lattice oscillations is to expect.

By Renk [23] lattice defects could so lattice-oscillations make infrared active. Schuller [24] observed particular the surface influences on dispersion of crystals what he discussed by phonon-polaritons with quenching.

General thermic emission implies cooling. Aimed this is used for cooling of atoms as laser-cooling which reported Cohen-Tannoudji [25]. With the method 'velocity selective coherent population trapping' is attempt with a fitted repulsion in opposite direction of thermal velocity of atom to bring the velocity to nought. By the other methods is attempted with a stimulated Raman-emission to withdraw energy of the atom.

Formal or real here are described processes which can contribute to TEMF. Lattice-oscillations lose increasingly at high temperatures on importance in form of collective-swingings, the particles of lattice are swinging increasingly independent from others, at which the radiation of them approach to that of black-body radiation.

IX. Continuous radiation through the TEMF

If with thermal excitations spectral-lines are emitted so is this surely a consequence of TEMF too, where only one sort of dipoles cause emission. The spectrum of temperature-radiation is even continuos.

A black-body can be realized approximately with a hollow-space in thermic equilibrium with a little hole. It was shown experimentally that the quality or nature of the walls - black or reflecting - had only a subordinate importance. The point is to hold a hollow-space in thermal equilibrium and the little hole prevents from noticeable impair of thermal equilibrium. Therefore black-body-radiation is also named hollow-space radiation but this is no hint for its formation.

Cum and Roy [26] reported about sonoluminescence. No direct stimulation by ultrasonics in liquids is supposed but bubbles of gas can emit luminescence light by collapsing. There originates a light-flash less than 50 ps with frequencies in visible spectrum without special sonoluminescence-frequency.

At the stimulated emission a photon hits a photon which is in the state of collection so will the first photon deliver synchronously a second photon. This would also carry over similarly on the effect of black radiation as stimulated continuous-emission, but more rarely than in laser. Hits this radiation a wall of hollow-space so this energy there can be used either to complete or supply loss which originated by thermic collision or to deliver a nearly ready photon by stimulated emission. In agreement with this model Hanbury-Brown and Twiss [27] showed also at radiation of thermal sources that the photons arrive partially not statistical single but in troops or lumps.

X. Trial on partition of not-black radiation in shares

Planck [2] considered radiation as given and evasived so the TEMF. Non-black (also as grey named) radiation originated by Planck if the dipole-length is not small against the wave-length, the dipoles are not in thermic equilibrium or a coupling of dipoles is existing. For examination of non-black radiation the emissivity will be disintegrated in shares corresponding the introduction of TEMF.

The thermic energy for generation the TEMF can be smaller or have an other distribution than presupposed at Planck's law of radiation. So the factor $\varepsilon_1$ yields to

$$\varepsilon_1 = W_T / W_{Planck} < 1. \qquad (4)$$

The distribution of energy in the matter correspond to Boltzmann or Fermi-Dirac statistics and this is different from Bose-Einstein statistics for photons. In $W_T$ are to set the for concerning case valid thermo-dynamics. By Zukale [28] this approximately can be respected through a m-factor in the denominator of the exponent of the e-function ($\Delta E$ = energy gap):

$$\exp (\Delta E / m\ k\ T). \qquad (5)$$

To this also give specific heat and similar sizes the basis of calculations.

The effective thermic energy $W_T$ can effect in its movements different electro-magnetic dipole-moments, therefore a different $W_{TEMF}$.

It is in mechanics a known appearance that swingings only are to stimulate or to swing up if these are stimulated with the eigen-frequency or in its proximity. First the eigen-frequency permits to transmit a suitable amount of energy in the necessary time. So results

$$\varepsilon_2 = W_{TEMF} / W_T < 1. \qquad (6)$$

$\varepsilon_2$ can be smaller than 1 if frequency of stimulation does not agree with frequency of dipole, oscillations or impacts are not full connected with a dipole-moment or a compensation of field through movable charges takes place by Fock [16]. Causes for example the kinetic energy no TEMF and is the potential full connected with a dipole-moment, so shall be by harmonic forces $\varepsilon_2 = 1/2$ . Prevails the time of kinetic energy (neutral gases at low pressure) so becomes $\varepsilon_2$ still lower. For optical lattice-oscillations are to expect $\varepsilon_2$ near 1, whereas for acoustic lattice-oscillations $\varepsilon_2$ is small but unequal nought as corresponding at quasi-molecule a dipole formation is not excluded.

Further the energy $W_{TEMF}$ must not be radiated with the maximal possible energy $W_{rad}$ results, the third factor:

$$\varepsilon_3 = W_{rad} / W_{TEMF} \leq 1. \qquad (7)$$

About transitions without radiation being necessary for this process exist no clearness. Often the Auger-process is made responsible for that. For solids this problem referred Haug [29]. By Nieke [8] a transition is always radiatless if not two opposite part-vortices can come together with the energy h f as photon. Special for $\varepsilon_3$ that is the case, if during the time of collecting-emission the excitation can

be reduced through thermic collisions. In hallow-space this is compensated in equilibrium. The factor $\varepsilon_3$ would correspond by Planck [2] a coupling of dipoles.

According all measurements of emissivity, the surface of sample has a great influence. So polished surfaces of metals have a small emissivity which are essential greater at rough or oxidized surfaces. Every surface signifies an extreme strong disturbance of structure of every solid, for the binding-structure of interior are changed in every case. The influence of surface perhaps can described with the factor $\varepsilon_3$, but it can be suitable to mark the influence of surface with a separate factor. Only in a hollow-space this influence for loss of energy is compensated.

If the here accepted causal-chain is valid so the radiation of non-black body is smaller than the factor $\varepsilon$ as corresponded to Planck's law of radiation.

$$\varepsilon = \varepsilon_1 \ \varepsilon_2 \ \varepsilon_3 = W_{rad} \ / W_{Planck} \qquad (8)$$

XI. Results

At the beginning was asked the question: Why do hot bodies glow? According this paper the question has to be answered: At thermic motion also dipoles are formed. These dipoles generate the TEMF. Is collected with the frequency f local the energy h f, so will be emitted a photon with structure. For this structure of photons yield also with their periodicity the so called wave-nature of light, so is omit in the duality of wave and particle the wave and therefore the dualism is untenable. It remains the photon with structure and field as fusion as demanded by Einstein [6].

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