Solitary-Waves Effects on Ions Emissions in the Living Matter

G. DUBOST, A. BELLOSSI and J. BARE

***Abstract*—We present a quantic theory to explain the "spontaneous" and the "induced" emissions of the ions whose photon energies are following a radioactive decreasing law in the ultraviolet, visible and infrared spectrum. These emissions are due to solitary-waves or solitons issued from an external confined plasma device.**

The spectral energy density inside the living matter depends on the plasma characteristics, the modulation frequency of the carrier wave, and the distance from the device. As we know the dipolar transition electric moment we determine both the probability of the "spontaneous" emission and with the spectral energy density the probability of "induced" emission. We can deduce the fundamental lifetime of the photons. Furthermore the number of the photons by unit of area is calculated. It depends on the modulation frequency, the spectral energy density, and its wavelength. In UV spectrum, for an efficient "induced" emission the modulation frequency has to be high. In that case, with our device the photon lifetime and the used irradiation exposure are of the same order.

Our results are in good agreement with two recent published experiments. In one of them, some authors have shown specific effects, in a near environment, of alternating electric fields applied with two insulated electrodes. For some days of application the proliferation of malignant cells in culture, and tumors growing in mice, were inhibited.

In the order, the biophoton density measured in the optical spectrum and spontaneously emitted by all living systems are in good agreement with our generated photon density evaluation. We can say the "induced" Ultraviolet emission by the ions in the living matter due to our external plasma device can interfere with the biophotons emitted by the DNA

***Index Terms*— ions, living matter, radioactive emission, solitons.**

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I. SYMBOLS

A_t spontaneous emission probability of the dipolar transition (s^{-1})

B_t probability coefficient of induced emission or absorption of the dipolar transition

B_i probability coefficient of induced emission or absorption of the ion

$B_i\, u_{fr}$ induced emission probability of the ion per unit of time

c speed of the electromagnetic waves in the vacuum medium

d thread of the dipole spatial array

e elementary load $\left(1.6.10^{-19}\mathrm{C}\right)$

f_r modulation frequency

h Planck's constant $\left(h = 6.63.10^{-34}\,\mathrm{J.s}\right)$

I_{fr} current of ionic discharge

k Boltzmann's constant $\left(k = 1.38.10^{-23}\,\mathrm{J/deg\,ree}\right)$

L length of the ionic discharge

N mean density of the photons included in the range $\left(\lambda_1, \lambda_2\right)$ (per unit of time and surface)

N_1 density of the ions at the fundamental state (per unit of volume)

N_2 density of excited ions (per unit of volume)

$n_2\left(\lambda_o\right)$ photon spectral density (per unit of time and surface)

n_i ion density of plasma medium (per unit of volume)

P mean density of the photons radiated in the λ_1, λ_2 spectrum (w/m^2)

P_d mean density of radiated power by the whole solitons (w/m^2)

P_m mean radiated power (W)

P_t electric moment of the dipolar transition

r radial distance in the meridian plane of the plasma column

R_r radiation resistance of the ionic discharge in the confined plasma

t time (s)
T thermodynamic temperature (Kelvin degrees)
u mean density of energy (J/m^3)
u_ν spectral density of thermic radiation $J.s/m^3$
u_{fr} spectral density of the solitons $\left(J.s/m^3\right)$ equal to du/df_r
V_p Δn_i volume of the confined plasma
W energy of the quantic oscillator $(W = h\nu)$
Z ion atomic number
Δn_i fluctuation of the ion density following the long time scale in the plasma
ε_o permittivity of the vacuum $\left(1/\varepsilon_o = 36\pi.10^9\right)$
λ_o variable wavelength in the free space
λ_1 lowest wavelength in UV range
λ_2 highest wavelength in IR range
μ_o permeability of the vacuum $\left(\mu_o = 4\pi.10^{-7} : wb/A.m\right)$
τ_A spontaneous emission lifetime of the dipolar transition(s): $\tau_A = 1/A_t$ (s)
τ_B induced emission lifetime of the ion (s) : $\tau_B = 1/B_i u_{fr}$
ν frequency of the range UV - visible – IR : $\nu = c/\lambda_o$

II. INTRODUCTION

WE have shown that it was possible to develop a radiation inside the living matter in the range UV-visible-IR by means of an outside confined plasma device [1] and [2]. A special transmitter [10] coupled to a variable frequency square-wave generator, a linear amplifier and a plasma tube antenna has produced harmonic generation quite prodigious. The ions in the living matter are solicited by the solitary-waves issued from the ionic plasma discharge. The evaluation of the solitons appeals to the non-linear effects inside the plasma discharge according to the hydrodynamic theory. The theoretical results were in good agreement with the experimental ones. We present now a quantic theory to explain the spontaneous and induced emissions of the ions in the living-matter. Firstly we define the spectral energy density of solitons in III. Secondly the exchange of energies between the solitary-waves and the ions gives rise to their induced and spontaneous emissions in the form of photons whose energies are following the radioactive decreasing law in IV. Then the photon spectral distribution in the living matter that occurred in the ultraviolet, visible and infrared spectrum is given in V. Numerical applications of the theory applied in the interstitial medium are shown in VI. At last it appears in VII that recent published experiments are in good agreement with our theory proving, in particular, that the induced emission by the ions in the living matter due to our external plasma device [2], can interfere with the biophotons emitted in UV by the ADN.

III. SOLITON SPECTRAL ENERGY DENSITY

The spectral energy density is expressed in energy-time unit per volume unit as for a black body radiation by the Planck formula :

$$u_\nu = 8\pi h \cdot \left(\frac{\nu}{c}\right)^3 \cdot \frac{1}{\exp\left(h\nu/kT\right)-1} \quad (1)$$

Let be the polarized radiation of the confined plasma. The mean power of the whole solitons which is radiated is given by (2) :

$$P_m = (1/2).R_r.\left|I_{fr}\right|^2 \quad (2)$$

where $\left|I_{fr}\right|$ is the ionic discharge (3) and R_r the radiation resistance (4) :

$$\left|I_{fr}\right| = 2\pi\ f_r.e.(\ \Delta n_i\ ).\ V_p \quad (3)$$

$$R_r = \left(\frac{2\pi}{3}\right)\mu_0.L^2 f_r^2/c \quad (4)$$

Δn_i is the fluctuation of the ion density following the long time scale in the confined plasma [1] and [2].

The maximum size of one soliton is equal to :

$$\Delta n_i/n_i = \left[\left(r_o/d_e\right)\exp\left(-d_e/\lambda_{De}\right)\right]^3 \quad (5)$$

with r_o the Landau length, d_e the mean distance between two ions : $d_e = \left(n_i\right)^{-1/3}$ and λ_{De} the Debye wavelength.

The mean power density in view of the whole solitons radiation is equal to (6) when using (2), (3), (4) :

$$P_d = \frac{P_m}{4\pi r^2} \cdot = \frac{1}{12} \cdot \frac{f_r^4}{c^2} \cdot \sqrt{\frac{\mu_o}{\varepsilon_o}}\left[2\pi e\left(\Delta n_i\right)V_p \cdot \frac{L}{r}\right]^2 \quad (6)$$

The mean energy density per unit volume is given :

$$u = P_d / c = P_d \sqrt{\mu_o \varepsilon_o} \quad (7)$$

At last, the spectral energy density of the solitons are given by (8) :

$$u_{fr} = \frac{du}{df_r} = \frac{1}{3}\left(\frac{f_r}{c}\right)^3 \sqrt{\frac{\mu_o}{\varepsilon_o}} \left[2\pi e \cdot (\Delta n_i) \cdot V_p \cdot \frac{L}{r}\right]^2 \quad (8)$$

IV. EXCHANGE OF ENERGIES BETWEEN SOLITARY-WAVES AND IONS. INDUCED AND SPONTANEOUS EMISSIONS

Considering an ion or atom with only two different energy levels. Let N_1 be the ion density at the fundamental state and N_2 the density of excited ones. The emitted photons are following the radioactive decreasing law during a dipolar transition :

$$N_2 = N_2(o).\exp(-t/\tau_A) = N_2(o)\exp(-A_t t) \quad (9)$$

A_t is the spontaneous emission probability of the dipolar transition and τ_A its lifetime.

The probability coefficient of induced emission or absorption of the dipolar transition is such that :

$$B_t = A_t \lambda_o^3 / 8\pi h \text{ with } \lambda_o = c/\nu \quad (10)$$

For a balanced thermic (10) can be written with (1) :

$$\frac{B_t u_\nu}{A_t} = \frac{1}{\exp(h\nu/kT) - 1} \quad (11)$$

The energy of the quantic oscillator $W = h\nu$ is used to write :

$$A_t = \frac{1}{W} \cdot \frac{d\overline{W}}{dt} \quad \text{with} \quad dW = \frac{4\pi^3}{3} \sqrt{\frac{\mu_o}{\varepsilon_o}} \frac{\nu^4}{c^2} P_t^2 dt \quad (12)$$

P_t is the electric moment of the dipolar transition equal to the product of the charge of electron by the atomic radius.

A_t, inverse of a time, is expressed with (12) as :

$$A_t = \frac{4\pi^3}{3h}\left(\frac{\nu}{c}\right)^3 \cdot \frac{P_t^2}{\varepsilon_o} \quad (13)$$

Then with (10) and (13) we deduce for the dipolar transition:

$$B_t = \frac{\pi^2}{6h^2} \cdot \frac{P_t^2}{\varepsilon_o} \quad (14)$$

In one ion of atomic number Z we suppose Z/2 dipolar transitions. Then the equivalent electric moment of the ion is : $\frac{Z}{2} P_t$, and its probability coefficient B_i is then equal to :

$$B_i = \frac{\pi^2}{24h^2} \cdot Z^2 \cdot \frac{P_t^2}{\varepsilon_o} \quad (15)$$

For each ion solicited by the solitons the quantic energy follows the radioactive law as :

$$W = W_o \exp(-B_i . u_{fr} . t) = W_o \exp(-t/\tau_B) \quad (16)$$

$B_i\, u_{fr}$ is the induced emission probability per unit of time. The induced emission lifetime is equal to :

$$\tau_B = 1/B_i\, u_{fr} \quad (17)$$

This relation is valid provided that he mean distance d between two ions has to the higher than the free wavelength λ_o, in other words when their interaction is weak [see Table II].

The ratio of the induced emission probability of the ion to the spontaneous emission probability of the dipolar transition is equal to :

$$\frac{B_i u_{fr}}{A_t} = \frac{\pi}{24} \cdot \left(\frac{f_r}{\nu}\right)^3 \cdot \frac{e^2}{h} \cdot Z^2 \left[(\Delta n_i) \cdot V_p \frac{L}{r}\right]^2 \sqrt{\frac{\mu_o}{\varepsilon_o}} \quad (18)$$

The radio of N_2 / N_1 is expressed in (19) :

$$\frac{N_2}{N_1} = \frac{B_i u_{fr}}{A_t + B_i u_{fr}} = \frac{n}{1} \quad (19)$$

When there is n photons in the phase space and if the induced emission is proportional to n, the spontaneous emission is proportional to 1.

V. PHOTON SPECTRAL DISTRIBUTION IN THE LIVING MATTER

Supposing an uniform gathering for the emitted ions in the interstitial medium. They set up a spatial array of dipoles of constant thread d equal to :

$$d = (N_2)^{-1/3} \quad (20)$$

Let $n_2(\lambda_o)$ be the photon spectral density induced by the ionized ions. With (6) and (8) we obtain :

$$n_2(\lambda_o) = \frac{P_d}{h\nu} = \frac{f_r u_{fr}.\lambda_o}{4h} = \frac{fr}{\nu}\cdot\frac{cu_{fr}}{4h} \quad (21)$$

It is expressed per unit of time and per unit of surface then per s and m^2 in SI units.

The mean density of the photons included in the range (λ_1, λ_2) is equal to :

$$N = \frac{1}{\lambda_2 - \lambda_1}\int_{\lambda_1}^{\lambda_2} n_2(\lambda_o)\, d\lambda_o = \frac{1}{8}\cdot\frac{f_r u_{fr}}{h}\cdot(\lambda_1 + \lambda_2) \quad (22)$$

It is expressed per square meter and per second.

According to the properties of the radiating arrays, when $d/\lambda_o < 1/\pi$, two adjacent dipoles area are encroached up, and their mutual coupling is such that the radiation is suppressed. In that case the interaction between them is strong. Then the highest wavelength λ_2 must be limited to : $\lambda_2 = \pi d$ (23) . Consequently we can write with (21) and (22) :

$$n_2(\lambda_o) = 2N\frac{\lambda_o}{\lambda_1 + \lambda_2} \quad (24)$$

VI. APPLICATION TO THE INTERSTITIAL MEDIUM

We only use the international unit system.

The attenuation of the interstitial medium is roughly comprised between 1 and 0.1 dB/µm in UV, visible and near I.R. The medium has been defined in [3] and [4]. Its ionic concentration according to Roch and Fulton leads to : $N_1 = 1.85\, 10^{26}/m^3$. For the ion calcium the atomic number Z is equal to 20 (15). The spectral density of the solitary wave energy given by (8) is calculated with the following parameters of our device [2], that is :

$$\Delta n_i = 5.6 10^{11}/m^3,\ V_p = 2.3 10^{-4},\ L = 0.6m,\ r = 0.35m$$

We find :

$$u_{fr} = 2.3\ 10^{-43}\cdot f_r^3 \quad (25)$$

expressed in $J.s/m^3$. Then with $P_t = e.\ddot{1} = 1.6\,10^{-29}$ the coefficient of absorption or emission probability of the ion (15) is equal to : $B_i = 1.083\,10^{22}\,m^3/J.s^2$. The probability of the induced emission is then :

$$B_i\ u_{fr} = 2.5\,10^{-21} f_r^3 \qquad \tau_B = 4.10^{20} f_r^{-3} \quad (26)$$

The table I shows the lifetime of the calcium ions in terms of the modulation frequency f_r.

TABLE I

f_r	10^3	10^4	10^5	3.10^5	10^6
$\tau_B(s)$ (26)	4.10^{11}	4.10^8	4.10^5	$1.5\ 10^4$	4.10^2

With $A_t = 1.8\,10^{-12}/\lambda_o^3$ (13) we deduced with $A_t >> B_i\ u_{fr}$ (19) :

$$\frac{B_i u_{fr}}{A_t} = 3.7\,10^{16}\left(\frac{f_r}{\nu}\right)^3 = n = \frac{N_2}{N_1} \quad (27)$$

The distance d between two adjacent dipoles of the spatial array is given with (20) and (27) by :

$$d(\mu m) = 0.53(\nu/f_r).10^{-8} \quad (28)$$

The ratio d/λ_o is equal to :

$$d/\lambda_o = 1.6\,10^{-6}/\lambda_o^2 f_r \quad (29)$$

From (23) and (30) we deduce the highest wavelength λ_2 :

$$\lambda_2(\mu m) = 2.24\,10^3/\sqrt{f_r} \quad (30)$$

The Table II gives for $f_r = 300$ KHz with $\lambda_2 = 4.09$ µm (30), λ_1 =0.2 µm and N = 151 per cm^2 and per second (22) : the photon spectral density $n_2(\lambda_o)$ (21), the ratio N_2/N_1 (27), d(µm) (28), d/λ_o (29) and the photon energy W(eV).

TABLE II

valid for $f_r = 3.10^5\,\mathrm{Hz}$, and $\tau_B = 1.5\,10^4\,\mathrm{s}$

$\lambda_o\,(\mu m)$	0.2	0.6	1	2	3	4
$\nu\,(\mathrm{Hz})$	$1.5\,10^{15}$	5.10^{14}	3.10^{14}	$1.5\,10^{14}$	10^{14}	$7.5\,10^{13}$
N_2/N_1 (27)	3.10^{-13}	8.10^{-12}	$3.7\,10^{-11}$	3.10^{-10}	10^{-9}	$2.4\,10^{-9}$
$n_2(\lambda_o)$ (21) per cm^2, s	14	42	70	140	211	281
d(μm) (28)	26.5	8.8	5.3	2.65	1.77	1.325
d/λ_o (29)	133	14	5.33	1.33	0.59	0.33
W(eV)	5.2	1.7	1	0.5	0.35	0.26

Remark : The mean power density P_d radiated by the whole solitons is given by (6). In the spectrum (λ_1, λ_2) the mean power density P radiated by the photons is equal to :

$$P = \left(f_r.uf_r.c/4\right)\int_{\lambda_1}^{\lambda_2} d\lambda_o = \frac{f_r.uf_r.c}{4}\left(\lambda_2 - \lambda_1\right) \quad (31)$$

With the previous values we find :

$$P_d = 1.4\,10^{-13}\left(W/m^2\right),$$
$$\text{and} \quad P = 5.4.10^{-19}\left(w/m^2\right)$$

As $N_2 << N_1$ (see Table II) and whatever the lifetime τ_2, we have : $P << P_d$.

Beyond λ_2, the main part of the energy which is unradiated is dissipated in the infrared spectrum (white noise ?).

VII. DISCUSSION

Now we show that the theoretical results deduced from the radiation of our confined plasma device [2] are in good agreement with experiments recently published .

In one of them [7] we read in the abstract :

"low intensity, intermediate frequency (100 – 300 KHz), alternating electric fields, delivered by means of insulated electrodes, were found to have a profound inhibitory effect on the growth rate of a variety of human and rodent tumor cell lines and malignant tumors in animals. This effect, shown to be nonthermal, selectively affects dividing cells while quiescent cells are left intact. These fields act in two modes : arrest of cell proliferation and destruction of cells while undergoing division. Both effects are demonstrated when such fields are applied for 24h to cells undergoing mitosis that is oriented roughly along the field direction …".

We have to note the limited volume between the two electrodes. The frequency and the exposure time chosen in Table II are in some idea of the experimental ones. Moreover the array resonance for $\lambda_o = 2.3\,\mu m$ which, with $N_2 = 8.3.10^{16}/m^3$, implies d = λ_o can explain a spatial directivity and then a relative strong electric field radiated by the ion induced emissions.

We have yet shown in [5] and [6] that it was possible to develop, inside the human body, an UV radiation by means of low frequency ionic currents along nervous fiber excited by solitons, a low frequency and high amplitude electric field diffracted by the nervous fibers and finally excitation of ions and induced emission of photons following the present radioactive theory.

The amount of energy absorbed by a single cell required for triggering its division turned around 5eV, thus corresponding to λ_o = 250 nm in UV [8]. That perfectly coïncides the wavelength of A.G. Gurwitch mitogenic radiation.

Biophoton are photons emitted spontaneouly by all living systems, in particular in the range from visible wavelenghts to UV. Actually the intensity of "biophotons" can be registered from a few photons per second and square centimeter on up to some hundred photons from every living system under investigation [9]. It appears that evidence of the coherence of biophotons can be drawn from the experimental results and implies the information transfer within and between cells. The crucial question of intra and extracellular biocommunications seems now to be proved. The photon spectral density $n_2(\lambda_o)$ in Table II also expressed per square centimeter and per second, is well correlated with the measured intensity of "biophotons" [9].

In conclusion we can say that the radioactive "induced" UV emission in the form of photons under the influence of our external plasma device may interfere with the biophotons emitted by the DNA.

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REFERENCES

[1] G. Dubost, A. Bellossi : « Rayonnement et propagation d'ondes solitaires générées par un plasma confiné ». RSTD *(Revue Scientifique et Technique de la Défense)* 57, sept. 2002, p. 115 à 126.

[2] G. Dubost, A. Bellossi, J. Bare : « Efficiency of solitary-waves radiated by the discharge in a confined plasma column ».. B.E. of EMFS, 3rd Intern Workshop KOS (Greece), October 2004, pp. 473 to 481.

[3] G. Dubost, A. Bellossi : “Rerayonnement in situ d’une fibre nerveuse irradiée par un champ électromagnétique externe de très basse fréquence”. RSTD61, Octobre 2003, p. 127 à 140.

[4] G. Dubost, A. Bellossi : « Electromagnetic field diffracted by a nervous fiber excited by an external electric field ». B.E. of EMFS, 3rd Intern. Workshop KOS (Greece), Octobre 2004, pp. 482 to 491.

[5] G. Dubost, A. Bellossi : “Modèle physique de la membrane cellulaire dans les spectres infrarouge, visible et ultraviolet”. RSTD 64, Juin 2004, p. 113 à 127.

[6] G. Dubost, A. Bellossi : « Cell membrane physical model in near infrared, visible, and near ultraviolet spectra ». B.E. of EMFS, 3rd Intern. Workshop KOS (Greece), Octobre 2004, pp. 492 to 500.

[7] Eilon D. Kirson, Zoya Gurvich et all : “Disruption of cancer cell replication by alternating electric fields”. Haïfa Israel Cancer Research 64, 3288-3295 May 1, 2004

[8] A.A. Koslov : “A penetrating radiation for the external radioactive sources as a trigger for cell divisions”. Intern. Institute of Biophysics, 1999.

[9] F.A. Popp : “About the coherence of biophotons”. Intern. Institute of Biophysics 2001, Raketenstation 41472 Neuss, Germany.

[10] J.E Bare Conference Record of the Twenty- Fifth International Power Modulator Symposium and 2002 High-Voltage Workshop .June 30-July 3 2002, IEEE,Catalog Number, 1076-8467, Pages 513-516, Article # 0-7803-7540- 8/02.