

# 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 ( $1.6.10^{-19} C$ )
- $f_r$  modulation frequency
- $h$  Planck’s constant ( $h = 6.63.10^{-34} J.s$ )
- $I_{fr}$  current of ionic discharge
- $k$  Boltzmann’s constant ( $k = 1.38.10^{-23} J/deg\ ree$ )
- $L$  length of the ionic discharge
- $N$  mean density of the photons included in the range  $(\lambda_1, \lambda_2)$  (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)
- $n_2(\lambda_o)$  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  $\lambda_1, \lambda_2$  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 ( $J/m^3$ )  
 $u_v$  spectral density of thermic radiation  $J.s/m^3$   
 $u_{fr}$  spectral density of the solitons ( $J.s/m^3$ ) equal to  $du/df_r$   
 $V_p$   $\Delta n_i$  volume of the confined plasma  
W energy of the quantic oscillator ( $W = h\nu$ )  
Z ion atomic number  
 $\Delta n_i$  fluctuation of the ion density following the long time scale in the plasma  
 $\epsilon_o$  permittivity of the vacuum ( $1/\epsilon_o = 36\pi \cdot 10^9$ )  
 $\lambda_o$  variable wavelength in the free space  
 $\lambda_1$  lowest wavelength in UV range  
 $\lambda_2$  highest wavelength in IR range  
 $\mu_o$  permeability of the vacuum ( $\mu_o = 4\pi \cdot 10^{-7} : wb/A.m$ )  
 $\tau_A$  spontaneous emission lifetime of the dipolar transition(s):  
 $\tau_A = 1/A_t$  (s)  
 $\tau_B$  induced emission lifetime of the ion (s) :  $\tau_B = 1/B_i u_{fr}$   
v frequency of the range UV - visible - IR :  $v = c/\lambda_o$

## 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 :

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

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

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

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

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

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

$\Delta n_i$  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 :

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

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

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

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

The mean energy density per unit volume is given :

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

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

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

#### 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 :

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

$A_t$  is the spontaneous emission probability of the dipolar transition and  $\tau_A$  its lifetime.

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

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

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

$$\frac{B_t u_v}{A_t} = \frac{1}{\exp(hv/kT) - 1} \quad (11)$$

The energy of the quantic oscillator  $W = hv$  is used to write :

$$A_t = \frac{1}{W} \cdot \frac{d\bar{W}}{dt} \quad \text{with} \quad (12)$$

$$dW = \frac{4\pi^3}{3} \sqrt{\frac{\mu_o}{\epsilon_o}} \frac{v^4}{c^2} P_t^2 dt$$

$P_t$  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 :

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

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

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

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 :

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

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

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

$B_i u_{fr}$  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 the mean distance  $d$  between two ions has to be higher than the free wavelength  $\lambda_o$ , 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 :

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

The ratio 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.

$$\Delta n_i = 5.610^{11}/m^3, V_p = 2.310^{-4}, L = 0.6m, r = 0.35m$$

## 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 :

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

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  $(\lambda_1, \lambda_2)$  is equal to :

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

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  $\lambda_2$  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/ $\mu m$  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 :  $N_1 = 1.85 \cdot 10^{26}/m^3$ . 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 :

We find :

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

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

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

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)	$4.10^{11}$	$4.10^8$	$4.10^5$	$1.5 \cdot 10^4$	$4.10^2$

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

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

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

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

The ratio  $d/\lambda_o$  is equal to :

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

From (23) and (30) we deduce the highest wavelength  $\lambda_2$  :

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

The Table II gives for  $f_r = 300$  KHz with  $\lambda_2 = 4.09 \mu m$  (30),  $\lambda_1 = 0.2 \mu m$  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),  $d(\mu m)$  (28),  $d/\lambda_o$  (29) and the photon energy  $W(eV)$ .

TABLE II

valid for  $f_r = 3.10^5$  Hz, and  $\tau_B = 1.510^4$  s

$\lambda_o$ ( $\mu\text{m}$ )	0.2	0.6	1	2	3	4
$v$ (Hz)	$\frac{1.5}{10^{15}}$	$5.10^{14}$	$3.10^{14}$	$\frac{1.5}{10^{14}}$	$10^{14}$	$7.510^{13}$
$N_2/N_1$ (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 $\text{cm}^2, \text{s}$	14	42	70	140	211	281
$d(\mu\text{m})$ (28)	26.5	8.8	5.3	2.65	1.77	1.325
$d/\lambda_o$ (29)	133	14	5.33	1.33	0.59	0.33
$W(\text{eV})$	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  $(\lambda_1, \lambda_2)$  the mean power density  $P$  radiated by the photons is equal to :

$$P = (f_r \cdot u f_r \cdot c / 4) \int_{\lambda_1}^{\lambda_2} d\lambda_o = \frac{f_r \cdot u f_r \cdot c}{4} (\lambda_2 - \lambda_1) \quad (31)$$

With the previous values we find :

$$P_d = 1.4 \cdot 10^{-13} \left( \text{W} / \text{m}^2 \right),$$

$$\text{and } P = 5.4 \cdot 10^{-19} \left( \text{w} / \text{m}^2 \right)$$

As  $N_2 \ll N_1$  (see Table II) and whatever the lifetime  $\tau_2$ , we have :  $P \ll P_d$ .

Beyond  $\lambda_2$ , 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  $\lambda_o = 2.3 \mu\text{m}$  which, with  $N_2 = 8.3 \cdot 10^{16} / \text{m}^3$ , implies  $d = \lambda_o$  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  $\lambda_o = 250$  nm in UV [8]. That perfectly coincides the wavelength of A.G. Gurwitsch mitogenic radiation.

Biophoton are photons emitted spontaneously by all living systems, in particular in the range from visible wavelengths 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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