A System to Generate Intense Fluxes of Extremely-Low Frequency Radiation

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A system for generating intense fluxes (>>1μ W.m^{-2}) of extremely-low frequency (ELF) radiation, in the range of about 1Hz, is described in this work. It is based on the generation process of cyclotron radiation, and can be used in the research of biological effects of the ELF radiation and also in the therapies that use ELF radiation.

Key words: Extremely-Low Frequency Radiation, ELF Transmitter, Cyclotron Radiation.

1. Introduction

Extremely low frequency (ELF) radiation is the designation for radiation of the lower extreme of the electromagnetic spectrum $\left(f << 10kHz\right)$. ELF radiation has not enough energy to remove charged particles such as electrons. Thus, it is called of *non-ionizing radiation*. Some sources of ELF radiation include power lines, household wiring, etc. This means that people are frequently exposed to ELF radiation. But the ELF radiation emitted from these sources has very-low intensity.

The building of ELF transmitters is very difficult because the length of the antenna is enormous. In the case of 1Hz the antenna length must be of the order of 100.000km. However, by using the process of gravitational *redshift* at laboratory scale, shown in a previous paper [1] it is possible for example, to reduce frequencies $f \cong 1GHz$ down to ~1Hz. In order to produce a power density $D \cong 10^{-6} W/m^2$ at ~1Hz, by the mentioned redshift process, it is necessary an initial flux with $D \cong 10^3 W/m^2$ at ~1GHz, what corresponds to the minimum frequency band of masers. Unfortunately, this process wastes a lot of energy.

Here is described a more efficient system for generating intense fluxes* (>>1μ W.m^{-2}) of ELF radiation, in the range of about 1Hz. It is based on the generation process of cyclotron radiation, and can be used in the research of biological effects of the ELF radiation and also in the therapies that use ELF radiation.

2. The System

The frequency f and the intensity I of the electromagnetic radiation emitted from a particle with inertial mass m and electrical charge q that describes a *circle* with velocity v, $(v << c)$†, inside a constant, uniform magnetic field, B, are given, respectively, by [2]

$$f = \frac{qB}{2\pi m} \tag{1}$$

$$I = \frac{2\pi\mu_r\mu_0 q^2 v^2 f^2}{3c} \tag{2}$$

This radiation, as we known, is called *Cyclotron Radiation*.

Now consider the system shown in Fig 1. Basically, it is a parallel plate capacitor, placed inside a coil, which produces the magnetic field B. The area of the plates of the capacitor is A, and the distance between them is d; the dielectric is *Barium Titanate*, which has a relative permittivity $\varepsilon_r = 1250$‡ at 20°C.

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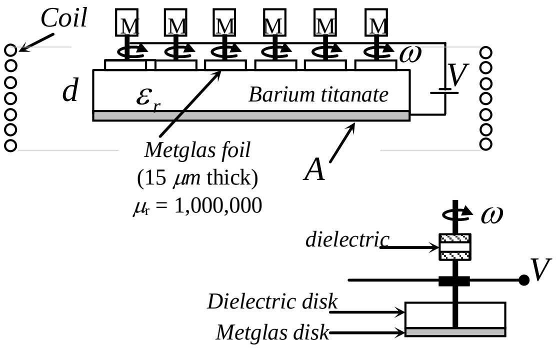
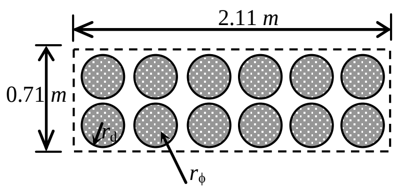
* Since we can write that $D_{ELF} = \left(f_{ELF}/f_{light}\right)D_{light}$, then, considering $f_{ELF} = 1Hz$ and $f_{light} \approx 10^{14}Hz$, we get $D_{ELF} \approx 10^{-14} D_{light}$. An intense flux of light usually has $D_{light} > 10^8\, watts/m^2$. Thus, a flux with 1Hz and $D_{ELF} > 10^{-6}\, watts/m^2$ can be considered intense.

† c is the *speed of light*.

‡ Recently, materials with giant dielectric constant of about ~10^4-10^6 have been discovered; CaCu3Ti4O12 (CCTO) has a giant dielectric constant of up to 10^5 at room temperature [3, 4]. There have been numerous reports on discovery of giant dielectric permittivity materials called internal barrier layer capacitor in the recent years. One of such materials is BaTiO3 with SiO2 coating [5]. See also [6, 7, 8].



(a)



(b)

Fig.1 - A system for generating intense fluxes (>>1μ W.m^{-2}) of extremely-low frequency (ELF) radiation, in the range of about 1Hz.

As shown in Fig.1, there are several disks with radius r_d above the dielectric (barium titanate). Each disk is made of dielectric material with its bottom covered with a *Metglas* foil $(\mu_r = 1{,}000{,}000; \rho = 7{,}590\, kg.m^{-3})$, which spins with an angular velocity ω. Thus, we can say that the charge q^-, given by

$$q^- = q^+ = \varepsilon_r \varepsilon_0 CV = \varepsilon_r \varepsilon_0 (AV/d) \qquad (3)$$

is spinning with an angular velocity ω; $\varepsilon_0 = 8.854 \times 10^{-12}\, F.m^{-1}$ is the permittivity of the free space; V is the voltage between the capacitor plate and the *Metglas* disks ; d is the distance between the plate and the disks (See Fig.1).

Note that, in the *Metglas* disks there are several holes with radius r_ϕ in order to reduce the mass of the *Metglas* disks. Therefore, the total mass m of the n spinning *Metglas* disks is $m = n\left(\pi r_d^2 - n_\phi \pi r_\phi^2\right)\Delta x \rho$, where Δx is the thickness of the disks and ρ the density of them. If we make $n_\phi \pi r_\phi^2 = 0.9\pi r_d^2$, and if $n\pi r_d^2 \cong A$, then we get

$$m = 0.1\left(n\pi r_d^2\right)\Delta x \rho \cong 0.1 A \Delta x \rho \qquad (4)$$

Substitution of $q = q^-$ and m, given respectively by Eqs. (3) and (4), into Eqs. (1) and (2) yields

$$f = \frac{qB}{2\pi m} = \frac{10\varepsilon_r \varepsilon_0 VB}{2\pi \Delta x \rho d} = 2.32 \times 10^{-12} \frac{VB}{\Delta x d} \qquad (5)$$

$$I = \frac{2\pi \mu_r \mu_0 q^2 v^2 f^2}{3c} = \frac{2\pi \mu_r \mu_0}{3c}\left(\frac{\varepsilon_r \varepsilon_0 AV v f}{d}\right)^2 =$$

$$= 1.07 \times 10^{-24}\left(\frac{AV\omega\, r_d\, f}{d}\right)^2 \qquad (6)$$

For $V = 5kV$ (dielectric strength of Barium titanate is $6kV/mm$), $d = 1mm$, $\Delta x = 15\,\mu m = 1.5 \times 10^{-5}\, m$, $B = 1.29T$, $A = 1.5m^2$, $\omega = 2.1 \times 10^4\, rad/s \ (200{,}000 rpm)$ and $r_d = 0.17m$ the Eqs. (5) and (6) give

$$f \cong 1Hz \qquad (7)$$

and

$$I \cong 7.67 \times 10^{-4}\ W \qquad (8)$$

Then, we get

$$D = \frac{I}{A} \cong 5 \times 10^{-4}\ W.m^{-2} \qquad (9)$$

Thus, the system described in this work can be used in the therapies using ELF radiation in the range of about 1Hz and power density >>1μ W.m^{-2} [9]. Also, it can be used in the research of biological effects of the ELF radiation.

References

[1] De Aquino, F. (2012) *Gravitational Blueshift and Redshift generated at Laboratory Scale*, http://vixra.org/abs/1208.0239

[2] Landau, L. and Lifchitz, E. (1969) *Theorie du Champ*, Ed.MIR, Moscow, Portuguese version (1974) Ed. Hemus, S.Paulo, p.260.

[3] Subramanian, M. A. et al., (2000) *J. Solid State Chem. 151*, 323–325.

[4] Homes, C. C. et al., (2001) *Science*, *293*, 673–676.

[5] Tatsuya I., et al., (2013). *The possibility of giant dielectric materials for multilayer ceramic capacitors*, App. Phys. Lett., 102, 062901.

[6] Wu J, et al., (2002) *Giant Dielectric Permittivity Observed in Li and Ti Doped NiO*. Phys Rev Lett. 89: 217601.

[7] Thongbai P, et al., (2008) *The sintering temperature effects on the electrical and dielectric properties of Li0.05Ti0.02Ni0.93O ceramics prepared by a direct thermal decomposition method.* J Appl Phys. 2008**;** 104: 074109.

[8] Sarkar. S., et al., (2006) *Copper (II) oxide as a giant dielectric material.* Appl Phys Lett. 89: 212905.

[9] De Aquino, F. (2012) *Quantum Reversal of Soul Energy* https://hal.archives-ouvertes.fr/hal-01129313