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Discharge Generation Quantum Effect on Storm Cloud Near Field Electrodynamic Model

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Abstract

In the following work, a theoretical proposal is presented on the mechanism of electric discharge generation in a storm cloud under anisotropic medium (gas) conditions using the quantum model of near field electrodynamics through paths integrals. The aim is calculate the quantum factor of possible trajectories fluctuation in a beam of charge carriers that follow in the cloud.

Keywords: Discharge, charge trajectory, charge carrier, storm

THEORETICAL MODEL

Taking into account the near field electrodynamic model [1, 2, 3, 4], the possible trajectories that a certain particle can choses (in this case a charge carrier), depends on the conditions imposed by the environment, it is isotropic or not, and how much electromagnetic permissive it is. Just in the moment when the discharge begin on the storm cloud [5, 6, 7, 8], the propagation medium of charge carriers beam becomes very electromagnetic unstable and locally conductive.

In this theoretical development, the fluctuation factor is calculated taking into account the possible flux charge carrier's trajectories, which at the same time are the atmospheric discharge generators. We propose; using the near field perturbations model [8, 9, 10, 11], demonstrate how the first discharge is generated, in the very first moment of time and an elemental volume with N particles.

Using the theoretical model proposed by Feynman [12, 13], the quantum behavior of possible trajectories that could chose a certain charge carrier between a point Xb and Xb in a electromagnetic field configuration, is expressed as:

$$\langle x_b; t_b | x_a; t_a \rangle = \langle x_b | \widehat{H(t)} | x_a \rangle =$$
$$\int dx_1 \dots\dots \int dx_j \left\langle x_b \middle| e^{-i\frac{H}{\hbar}t} \middle| x_{j+1} \right\rangle \langle x_{j+1} | x_j \rangle \langle x_j | x_a \rangle \qquad (1)$$

Where the electromagnetic interaction Hamiltonian operator is:

$$\widehat{H} = \left[\frac{1}{2m} \left(\hat{p} - \frac{e}{c} \hat{A} \right)^2 - \frac{k_e}{r^3} \hat{p}_o{}^2 + eV(r) - \mu B \right] \qquad (2)$$

being: $\hat{p}$ – momentum operator; $\hat{A}$ – magnetic potential; $\hat{p}_0$ – dipole moment; $\mu -$ magnetic moment; $B -$ magnetic field; $V(r) -$ electric potential; k_{e-} dielectric constant; and $m -$ electron mass.

The matrix electron that distinguishes the moment operator action over the propagation beam function is defined as [14, 15, 16]:

$$\langle x_{j+1} | p_j A_j | x_j \rangle = e^{-\frac{i}{\hbar}\tau U^*} \frac{A_j}{h} \int p_j dp_j e^{-\frac{i}{\hbar} p_j^2 \frac{\tau}{2m} + \frac{i}{\hbar} \frac{e}{mc} p_j A_j \tau} \qquad (3)$$

And the energy system (gas - charge carrier) could be expressed as:

$$U^* = \frac{1}{2m} \left(\frac{e}{c} A_j \right)^2 + eEx_j - \mu B \qquad (4)$$

Then, the trajectory integral for the carrier is:

$$\langle x_b; t_b | x_a; t_a \rangle = \langle x_b | \widehat{H(t)} | x_a \rangle$$
$$= \int dx_1 \dots\dots \int dx_j \langle x_{j+1} | p_j A_j | x_j \rangle \langle x_{j+1} | x_j \rangle \langle x_j | x_a \rangle =$$
$$\int dx_1 \dots\dots \int dx_j e^{-\frac{i}{\hbar}\tau U^*} \frac{A_j}{h} \int p_j dp_j e^{-\frac{i}{\hbar} p_j^2 \frac{\tau}{2m} + \frac{i}{\hbar} \frac{e}{mc} p_j A_j \tau} \langle x_{j+1} | x_j \rangle \langle x_j | x_a \rangle \qquad (5)$$

And using the results of position integrals, the equation (5) lets calculate the fluctuation quantum factor of the possible beam trajectories or generated discharge on a storm cloud as:

$$\langle x_b; t_b | x_a; t_a \rangle = \sqrt{\frac{2\pi m}{i\tau\hbar}} \exp\left(\frac{i}{\hbar} U(x_j) \tau \right) \left(\frac{e}{2c} B_j \right) \sqrt{\frac{\pi}{a}} \left(\frac{b}{2a} \right) \exp\left(\frac{b^2}{4a} \right) \qquad (6)$$

Where is obtained the fluctuation quantum factor to the trajectories for a charge carrier beam, given the expression:

$$F_j = \sqrt{\frac{2\pi m}{i\tau\hbar}} \left(\frac{e}{2c} B_j \right) \sqrt{\frac{\pi}{a}} \left(\frac{b}{2a} \right) \exp\left(\frac{b^2}{4a} \right) \qquad (7)$$

Taking into account that the coefficients for equation (7) are:

$$U_0 = \frac{i}{\hbar} eV\tau = i1{,}518E15V\tau; \; a = -\frac{i}{\hbar} \frac{1}{m} \left(\frac{e}{c} B_j \right)^2 \tau;$$
$$b = -\frac{i}{\hbar} eE_j \tau; \; d = \frac{i}{\hbar} U(x_j) \tau = \frac{i}{\hbar} eV\tau; \qquad (8)$$

SIMULATED MODEL

The first steps in the presented work were found and simulate one of the possible trajectories of a charge carrier on the cloud and later find the behavior of the fluctuation quantum factor of a group of trajectories. The figure 1, shows the possible trajectory simulation for a charge carrier on a storm cloud in anisotropy space conditions.

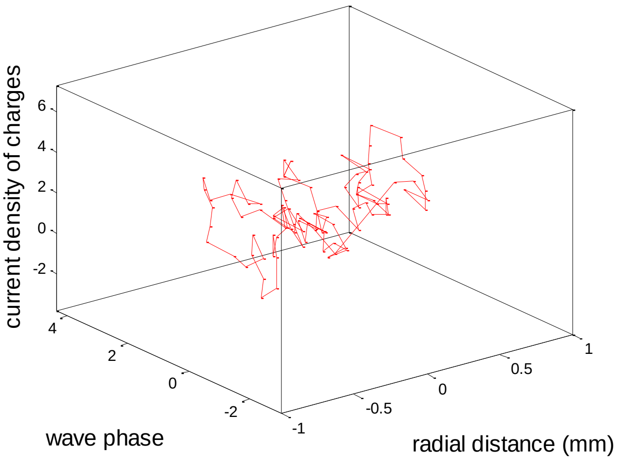

Figure 1. Simulated model of a possible trajectory for a charge carrier on a storm cloud in an anisotropy space

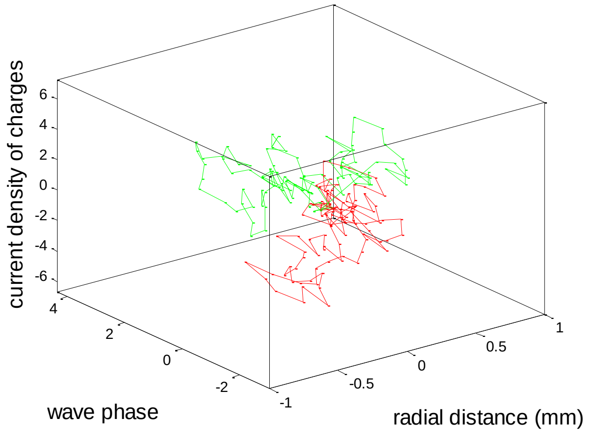

Figure 2. shows the simulated model using equation (7), which represents the normalized fluctuation factor for trajectory series of the charge carriers flux in unstable space conditions that means in the model of energy perturbations.

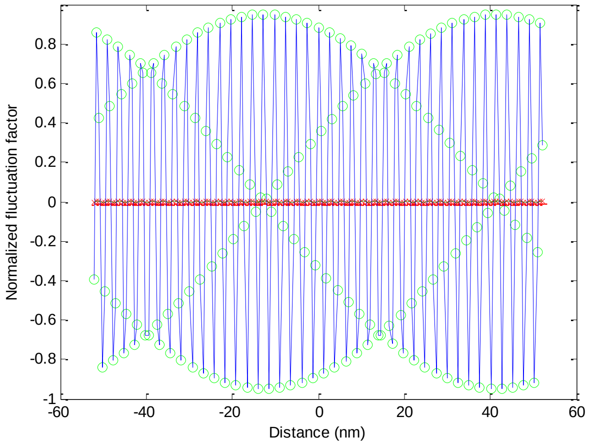

Figure 3. Simulated model that represents the normalized fluctuation factor for trajectory series of the charge carriers flux in unstable space conditions

DISCUSSION AND CONCLUSIONS

- The showed theoretical proposal will give an experimental model that validate the results and have a mechanism that specify the behavior of the discharged cloud phenomena in order to understand completely the atmosphere beam behavior.
- Although each possible trajectory described by the load flow in the storm cloud, in the perturbation model proposed in the present work, is homotopically equivalent, the discharge conditions mean that at each point of the same the trajectory due to the number of vacancies and become multiply connected, which makes their paths diverse after a time t. The previous statement can be seen in Figure 3, in which two possible trajectories were compared in the discharge, finding similarity conditions and in turn their high divergence at the time of generating their final trajectories.

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