

Two explanatory hypotheses for the generation of lightning and ball-lightning phenomena

Abstract

In the paper is presented a possible explanation of the initiation of the lightning phenomenon, by the conclusion that the gamma-ray glows which precede and cause the lightning strikes, having low energy, are generated by collisions of accelerated electrons at non-relativistic speeds ($v \ll c$) and on short distances with air molecules, by the converting of infrared and visible radiation photons into ionizing (X, γ) quanta inside the vibrated/excited electrons considered in a vortical model, these ionizing quanta generating more free electrons and ionized discharge channels with lower electric resistance, by the repetition of the phenomenon, which explains the discharge streamers specific to weak initiatory flashes with durations of $0.5 \div 2 \mu\text{s}$ and peak VHF powers of $0.09 \text{ W} \div 0.64 \text{ W}$. Regarding the ball lightning phenomenon, the fibrillary black ball-lightning is explained by the hypothesis that the annular B-field generated by the normal lightning generates positively ionized ozone molecules and quasi-annular chains of N-O^+ linked by neutral atoms of oxygen, which attracts thereafter neutral molecules of O_2, N_2 and H_2O forming atomic fibrils with the central chain in the form: $\text{O-O}^+-\text{O}=\text{O}-\text{O}^+-\text{O}$ or/and $-\text{N}-\text{ONO}=\text{ONO}^+\text{O}-$ which explain the lifetime of the BL by the additional known conclusion that the plasmatic sphere forming the BL is enveloped by a layer of neutral molecules generating a superficial tension σ .

Keywords: lightning generation, electron's emission, gamma ray glows, bremsstrahlung photons, ball lightning

Volume 4 Issue 4 - 2020

Marius Arghirescu

State Office for Inventions and Trademarks, Patents Department, Romania

Correspondence: Marius Arghirescu, State Office for Inventions and Trademarks, Patents Department, Romania, Tel 0040745795507, Email marisa@yahoo.com

Received: July 11, 2020 | **Published:** July 24, 2020

Abbreviations: LMA, lightning mapping array; NBE, narrow bipolar event; FPB, fast positive breakdown; IC, intracloud; CG, cloud-to-ground; IEC, initial electric-field change; UPFs, unusual plasma formations; RREA, relativistic runaway electron avalanches

Introduction

It is known that the electrons in air have a mean free path of $\sim 1 \text{ cm}$, compared to the fast, relativistic electrons ($v \rightarrow c$) which have a mean free path up to 100 times longer. The most popular theory of lightning initiation, based to this fact, is those named "the runaway breakdown", proposed by Alex Gurevich in 1992,¹ which considers that an electric field which can accelerate electrons to a relativistic speed and high energies, which release more relativistic electrons when they strike air molecules, creating an avalanche multiplication of "runaway" electrons. But the theory imply also the existence of a source of high-energy electrons from a cosmic ray, for the starting of the "runaway" process. It is know that the lightning develops in a bidirectional manner, with leaders carrying negative and positive charge propagating in opposite directions away from the flash initiation point.² While negative leaders propagate intermittently and produce intense VHF radiation, the positive leaders propagate more continuously and generally produce much weaker VHF radiation, (associated source powers of $\approx -20 \text{ dBW}$ in the 60–66 MHz band of the Lightning Mapping Array (LMA). It is known also that- despite great efforts by the scientific community, there is still no generally accepted, qualitatively consistent mechanism of lightning initiation from the initiating event through the subsequent development to the beginning of a stepped leader.^{1,2}

It was concluded by more researchers³ that the initiating event of all lightning flashes is a narrow bipolar event (NBE) caused by "fast positive breakdown" (FPB), which- compared to normal positive breakdown which is VHF dim and propagates at $1-10 \times 10^4 \text{ m} \cdot \text{s}^{-1}$,

is VHF bright and propagates at apparent speeds of $4-10 \times 10^7 \text{ m/s}$. Typical NBEs also have large power in the HF/VHF frequency band of 3-300 MHz.⁴ Generally, for the positive NBEs initiating intracloud (IC) flashes, the peak powers in the VHF band (30-300 MHz) are ranging from 1–274,000 W, while for negative NBEs initiating cloud-to-ground (CG) flashes it was found NBE peak powers ranging from 1–600 W with apparent propagation speeds of $4 \times 10^7 \text{ m/s}$.⁵ But recent findings suggest that most lightning flashes are not initiated by NBEs; rather, most flashes are initiated by much shorter and much weaker events, (Marshall et al.,⁶) by VHF events with durations of $0.5 \div 2 \mu\text{s}$ and peak VHF powers of $0.09 \text{ W} \div 0.64 \text{ W}$, which suggests charges moved a distance of order 5 m.

Some researchers⁷ identified the next key-points in the lightning's generating:

- I. Relativistic runaway electrons from extensive air showers start electron avalanches in many small volumes with electric field $> 3 \text{ MV}/(\text{m} \cdot \text{atm})$;
- II. Lightning initiation occurs when many ordinary positive streamers, with speeds of $0.1-1 \times 10^6 \text{ m/s}$, develop from these electron avalanches;
- III. Mechanism accounts for variety in observed characteristics of initiating event, initial electric field change, and initial breakdown pulses.

According to another proposed mechanism,⁷ the lightning initiation occurs in a region of $\sim 1 \text{ km}^3$ with average electric field $E > 0.3 \text{ MV}/(\text{m} \cdot \text{atm})$, which contains, because of turbulence, numerous small E_s -volumes of $\sim 10^{-4}-10^{-3} \text{ m}^3$ with $E \geq 3 \text{ MV}/(\text{m} \cdot \text{atm})$, by one of two observed types of events: either by a high power of VHF (very high frequency) event such as a Narrow Bipolar Event (NBE³), or by a weak VHF event, (weak NBEs also having smaller VHF powers of 3–300 W), both types of initiating events being caused by a group

of relativistic runaway electron avalanche particles (where the initial electrons are secondary particles of an extensive air shower) passing through many E_s -volumes, thereby causing the nearly simultaneous launching of many positive streamer flashes. Due to ionization-heating instability, unusual plasma formations (UPFs) appear along the streamers' trajectories of the streamers. These UPFs combine into three-dimensional (3D) networks of hot plasma channels during the *initial electric-field change* (IEC), resulting in its observed weak current flow. The subsequent development and combination of two (or more) of these 3D networks of hot plasma channels then causes the first *initial breakdown pulse*, (IBP- a bipolar electrical pulse occurring in the first few ms of a flash³). Each subsequent IBP is caused when another 3D network of hot plasma channels combines with the chain of networks caused by earlier IBPs.

Also, by satellites were observed not only X-rays but also terrestrial gamma-ray flashes (TGFs) associated with the lightning activity. Comparison between calculations based on the model of relativistic runaway electron avalanches (RREA) in large-scale weak electric field in thunderstorms, the satellite measurements usually shows that the photons spectrum is consistent with source altitudes around 15 km and intra-cloud lightning (IC) discharges responsible for TGFs at altitudes of ~10km). It is considered that the TGF sources are based on the mechanism of direct acceleration of electrons in the lightning leader field and is determined from the geometry of the electric field lines produced by the lightning leader.⁸

The production mechanisms of TGFs are still uncertain. TGFs are associated with thunderstorm activity and originate from bremsstrahlung emission by energetic electrons, (million—electron volts.⁹ It is presumed that TGF photons are emitted by electrons traveling at speeds very close to the light speed, that collide with atomic nuclei of the air and release their energy in the form of gamma rays, in electric discharges, between two electrodes or between cloud and ground or within clouds, the electrons producing bremsstrahlung photons while scattering off air molecules. This “deceleration radiation”, is electromagnetic radiation produced by the deceleration of a charged particle when deflected by another charged particle, typically an electron by an atomic nucleus. A few cases of TGFs have shown unusual patterns that can be explained by such electron/positron beams, but such events are very unusual. Calculations have shown that TGFs can liberate not only electrons, positrons, but also neutrons and protons.¹⁰

But it was observed that there are two known kinds of gamma-ray phenomena associated with thunderclouds: the short-lived terrestrial gamma-ray flashes (TGFs), which occur as lightning strikes and gamma-ray glows- weak emissions which last about a minute and are much less intense than TGFs. Both occur in regions of thunderclouds sandwiched between layers of varying charge, the charged regions generating relativist electrons which generates bremsstrahlung radiation. A recent research of a Japanese team¹¹ suggests that in certain conditions, weak gamma-ray glows from thunderclouds may precede lightning bolts and their accompanying gamma-ray flashes. More precisely, the research team saw a gamma-ray glow in the same area at almost the same time, in the sense that the gamma-ray glow abruptly disappeared when the lightning struck, resulting that the events are intimately connected and suggesting that the gamma-ray glows precede lightning strikes because in fact they cause them, even the radiation levels of the gamma-ray flashes are quite low, (approximately a tenth the level one may receive from a typical medical X-ray,¹¹).It is raised naturally also the question: ‘Which is

the nature of the gamma-ray glows, how they are generated?’ In this sense, it exists an explanatory theory which postulates that the showers of relativistic electrons are created by cosmic rays, being thereafter accelerated to higher velocities via the process called “runaway breakdown”¹, generating gamma rays, but this theory cannot explain the cause of the gamma-ray glows which precede the lightning strikes. The main aim of the paper is to give a possible plausible answer to the previous question.

Theoretical explanatory premises

In a Cold Genesis Theory of Matter and Fields of the author, (CGT),^{12,13} based on the Galilean relativity the discovered elementary particles are explained by a vortex model, of composite fermion type, as Bose –Einstein Condensate of N^p gammons considered as thermalized pairs: $\gamma^*=(e^-e^+)$ of axially coupled electrons with opposed charges which became degenerate electrons inside the neutral N^p cluster, i.e- quasi-electrons with diminished mass, charge and magnetic moment, i.e.:

$$m_e^* \approx 0.81 m_e; e^* \approx \left(\frac{2}{3}\right)e; \mu_e^* \approx m_e(2.79 m_e / m_p) \approx \mu_p = \frac{1}{2}(e \cdot c \cdot r_\mu)$$

$m_e^* \approx$ and with attached positron in the case of proton, (similar to the classic Anderson's model) and with rotated negatron in the surface of the protonic quantum volume, in the case of the neutron, (similar to the “dynamide” Lenard-Radulescu' model), but with degenerate magnetic moment of the incorporated electrons.^{12,13}

The particle's magnetic moment μ_c^* results in CGT as etherono-quantonic vortex : $\Gamma_\mu^*(r) = \Gamma_A + \Gamma_{B^*}$, of heavy („sinergonic”) etherons ($m_s \approx 10^{-60}$ kg)- generating the magnetic potential A and of quantons ($m_q = \hbar \cdot 1/c^2 = 7.37 \times 10^{-51}$ kg) - generating vortex-tubes ξ_b that materializes the B-field lines of the magnetic induction, the vortexed quantons having the light' speed c until the limit of the magnetic moment's radius (the reduced Compton radius, $r_\mu = \hbar/m_c c$), which is decreased when the electronic super-dense kernel is included into a denser quantum volume, (CGT).^{12,13}

It is known also the possibility of using microwaves for generating dynamic force and a kinetobaric effect,¹⁴ consisting in a dynamic effect over a balance with a body with water and a microwaves antenna, obtained by the absorbed microwave energy of 900-1600 MHz, transmitted in pulses of high frequency but at lower power, the dynamic effect being higher than the consumed power. The effect, obtained by the electrogravitics experiments of Zinsser^{15,16} involve a dielectric medium, like water, for greater charge density and efficiency, being obtained in this way forces of ~100 dynes acting over a mass of 200÷500g. Because the kinetobaric effect cannot be obtained in vacuum of 10^{-5} torr, this effect was explained by the author in the frame of CGT^{12,13} by the hypothesis of scalar radiation quanta emission,¹⁷ realized according to the energy conservation law applied to the conversion of quasi-simultaneously captured photons of IR or visible spectra radiation, by vibrated charges, into an ionizing scalar quantum formed as doublet of two photons with bigger mass coupled in antiphase, at a critical value E_v^0 of charge's vibration energy $\Delta \varepsilon_v$ per emitted scalar quantum, (vibration “in shocks”, with high amplitude) according to the equation:

$$n \cdot \varepsilon_i + m_p c^2 \rightarrow (by \Delta \varepsilon_v) \rightarrow m_p^* c^2 + \varepsilon_w; n \Delta \varepsilon_i \approx \varepsilon_w; \Delta \varepsilon_v > E_v^0 = \varepsilon_w / K_v; \quad (1)$$

where: ε_i ; ε_w -are the energy of the captured photons and respectively, of the emitted scalar quantum generated with a vibration energy $\Delta \varepsilon_v$ /

per emitted scalar quantum and K_v is a constant which can be of over-unity value- according to some experiments such as the Hutchison effect¹⁸ and the kinetobaric effect,¹⁴⁻¹⁶ without contradiction with the energy conservation law. The eq. (1) results as possible in CGT by the fact that- according to the vortexial model of electron and to the multi-vortexial model of nucleon,^{12,13} at the vibration “in shocks” of the atomic particles, their surface become more penetrable by photons with lower energy, like the IR radiation photons. In this case, the eqn. (1) may explain the kinetobaric effect as a consequence of the ionizing effect of the ϵ_w -scalar quanta,^{12,13} in concordance with the effect of γ -rays production into a plasma of ionized gold atoms by laser pulses of $\sim 10^{15}$ W,¹⁹ explained by eqn. (1) as effect of photons absorption by the vibrated atomic charges.²⁰

In the presence of a gas, the ionizing effect of scalar quanta generates charge separation which- in the presence of a high electrostatic potential, may produce a displacing force of air pressure difference acting over a body. The emitted bosonic double pairs with a null spin: $\epsilon_w = 2(m_w - m_w)c^2$, corresponds to the characteristics of the scalar radiation photons which- as in the theory of Gupta and Bleuler,²¹ do not contribute to the electromagnetic radiation energy- phenomenon explained with the soliton model of photon²² by the fact that these bosons represents a pair of two $h\nu$ - photons of electromagnetic radiation coupled in antiphase, as in the Tesla’s theory of scalar waves, with inertial mass but with null magnetic moment along $x/m_w c$. These scalar radiation quanta corresponds also with the experimental results of TG Hieronymus²³ concerning the emission of scalar radiation obtained by electromagnetic vibration of atomic nuclei, with the energy of scalar quanta in the violet and ultraviolet spectra: $\epsilon_w \cong 2 \cdot h\nu_w$ - proportional with the mass of the vibrated nucleus, according to the equation of harmonic oscillator frequency: $\nu \sim \sqrt{k/M}$; ($M = m_n \cdot A$; k -the quasielastic constant).

It is plausible also the conclusion that the reaction (1) may be extended for the explaining of some observed nuclear transmutations into short-life isotopes of Cs137 and Sr90 nucley, induced by X-rays,²⁴ (explained by conversion of some X-ray quanta into a γ -quantum conform to eq. (1), according to the quantum-vortexial model of particle specific to CGT). According to the theory and by eq. (1), the nuclei which presents nuclear self-resonance and giant-resonance, are emitters also of scalar radiation quanta.

Explanatory model

The initiation of the lightning phenomenon, generated between two clouds or between a cloud and the earth even if the dielectric properties of the atmosphere not explain the electric charge conduction, may be better explained- in our opinion, by the conclusion that the gamma-ray glows which precede and cause the lightning strikes¹¹ are generated according to eqn. (1), by collisions of accelerated electrons at non-relativistic speeds ($v \ll c$) and on short distances with air molecules, specific to weak initiatory flashes with durations of $0.5 \div 2 \mu s$ and peak VHF powers of $0.09 W \div 0.64 W$, which suggests charges moved at a distance of ~ 5 m, produced according to the observations of Marshall et al.,⁶ even if the specific VHF power is relative low. The possibility to explain the kinetobaric effect¹⁴ by eqn. (1) sustains the possibility to explain in this way the generating of gamma-ray glows (flashes) which precede the lightning and which have low energy, (approximately a tenth the level received from a typical medical X-ray,¹¹) by the conversion. The producing of gamma-ray glows according to the previous considered scenario may initiate the lightning between two clouds or between intra-cloud parts with opposed charges, in a relative wet air, the collided atomic charges

converting infrared and visible radiation photons into ionizing (X, γ) quanta, according to eq. (1), which will generate more free electrons and ionized discharge channels with lower electric resistance, by the repetition of the phenomenon, which will generate discharge streamers specific to narrow bipolar event (NBE), i.e. to normal breakdown and to “fast positive breakdown” (FPB), which precedes the lightning³ in the sense of the generated electric field. By the same mechanism may be converted into gamma-quanta also X-radiation photons, generated by electrically excited atoms of the discharge streamers.

Arguments

Some lightning flashes are made up of as many as 25 or more lightning bolts (strokes), (Figure 2). An argument for the proposed mechanism is a similitude with the aura generated by the Kirlian effect to living structures such as a leaf (Figure 3)²⁵ consisting in bright streaks of electric discharges between a negative plate with the living structure and a positive plate, forming an electric capacitor, at high potential difference and high frequency, (e.g. 10 KV and 1024 Hz), the emission of ionizing quanta according to eqn. (1) resulting by the electrons’ vibrations at the action of the high frequency electric discharges. Also, this proposed explanatory mechanism is in concordance with the fact that the gamma-ray glows have low energy, approximately a tenth the level received from a typical medical X-ray.¹¹ Another argument for the considered phenomenon’s existence may be also the results of the photons-electron interaction experiment,²⁶ of γ -rays emission by high energy electrons interaction with green laser pulse, this observed phenomenon being explained- according to the model, by eq. (1) in which the converted photons into scalar quanta, identified as gamma-rays quanta, are luxons.

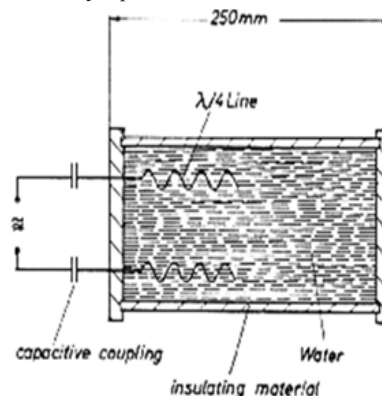


Figure 1 Sample capacitor probe used by Zinsser.



Figure 2 Bolts of lightning (NASA).



Figure 3 Kirlian effect to a violet leaf.

Regarding to the observed terrestrial gamma-ray flashes (TGFs) associated with the lightning activity, of higher energy, even if this phenomenon seems to be well explained by the bremsstrahlung emission produced by relativist electrons, it is possible also another explanatory mechanism, of K-electron capture by atomic nuclei induced by the relativist electrons of the lightning, which may induce by their energy transmitted to atomic electrons, also stimulated transition of K-electrons ($n=1$) to a sub-fundamental level $n=1/2$,^{12,13} from which it may be captured by the atomic nucleus, transforming a nuclear proton into neutron by forming a (semi)hard gamma quantum emitted as relativist pair $\gamma^*(e^+e^-)$ by coupling with a positronic proton-considered in a classic Anderson's model, but with degenerate magnetic moment, according to CGT.^{12,13} Particularly, a γ^+ -quantum can be 'splitted' into a (e^+e^-) -pair in the field of a nucleus.

An argument for this possibility is the fact that the calculations have shown that TGFs can liberate not only electrons, but also positrons, neutrons and protons,¹⁰ so- they can generate also nuclear transmutations. An argument for the considered quasi-classic „dynamide” model of neutron used in CGT and for the previous hypothesis is the possibility to explain naturally not only the the beta--decay (by the conclusion that the electron liberated from the protonic quantum volume re-obtain its normal value of the magnetic moment by the energy of etherono-quantonic winds of the quantum vacuum), but also the nuclear phenomenon called „ giant dipole resonance (GDR) produced in photonuclear reactions with gamma rays at energies from 7 to 40 MeV,²⁷ which cause or increase the dipole moment of the nucleus by adding energy that separates charges in the nucleus. According to the well-known Goldhaber and Teller model of GDR, the protons and the neutrons are simply assumed to oscillate with opposite phases around the common centre of mass, by the changing of protons' and of neutrons' mass/density distributions.

But we observe that if the possible inferior value of the excitation energy (7MeV) is distributed to all nucleons, the excitation energy per nucleon is much lower than the mean value of the binding energy per nucleon, (~ 8 MeV), and is difficult to explain the GDR as nucleons' oscillations around the common centre of mass. According to the “dynamide” neutron model, if the nucleus' excitation is realised with electromagnetic gamma rays, even if the electric E-field of the gamma-wave cannot generate the collective oscillation of protons around the mass' centre, it can generate the collective oscillation of the neutronic negatrons around the mass' centre, phenomenon which can explain the observed GDR effect as apparent collective movement (oscillation) of neutrons and of protons. The “dynamide” model of neutron could be verified – in consequence, by inducing of GDR and

of beta⁺-emission by $p^+ \rightarrow n^0$ transforming and nuclear transmutation with intense electromagnetic gamma-rays or with petawatts laser pulses, according to CGT.

The ball lightning's explaining

The vortexial nature of ξ_b -field lines may explain also the fibrillar structure of some photographed black ball-lightning (Figure 4). According to the resulted explanatory model,^{12,13} because the ball lightning is produced by an electrical discharge lightning of a thunderstorm, we may suppose that the genestic lightning ($I=3 \div 5 \times 10^4$ A), induces a strong circular magnetic field $B=\mu_0 I/2\pi r$, in the form of vortexial rings-according to CGT, which aligns locally attractively the atomic magnetic moments of N and O of the air, forming in this way positively ionized ozone molecules, i.e. $O-O^+-O$ and nitrogen monoxide molecules: NO^+ , and quasi-annular chains of $N-O^+$ linked by neutral atoms of oxygen, which attracts thereafter neutral molecules of O_2 , N_2 and H_2O -particularly, forming in this way fibers, as bunches of atomic fibrils (Figure 5) with the central chain in the form:

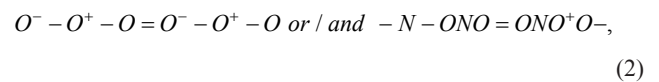


Figure 4 Black ball-lightning.³⁰

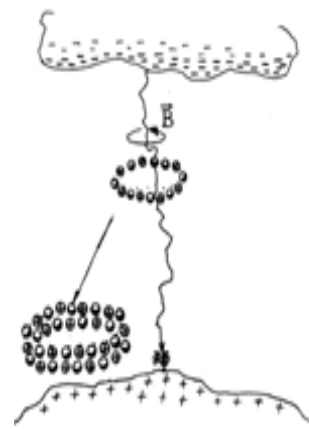


Figure 5 The ball-lightning's genesis, (th. model,¹²).

so-with covalent and ionic links, which are resistant to usual temperatures until at least 100°C, explaining the lifetime of ball lightning.

This theoretical conclusion is based on the fact that the ozone and the nitric oxide are produced naturally during the electrical discharges of lightning in thunderstorms and is also in accordance with the used speculation that the nitrogen dioxide ($NO_2=NO+O$) is

formed as occurring via the ONOONO intermediate.^{28,29} The positive charge considered for the central chain of ball lightning fibrils is explained by the charge separation made after the lightning by the thunderstorm negative charge and may explain the destructive effect of the BL which can disintegrate biologic structures and other non-metallic structures, by the effect of electrons adsorption and the BL auto-destroying by explosion, in some cases. Also, the vibration of BL fibers may explain-according to the model, the sound emission (whistlins) of some BL cases, Habarovsk³⁰ and the vibration of some ions and neutral atoms between BL fibrils may explain the microwaves emission and the infrared or visible light emission of BL.

It is plausible also the conclusion that the plasmatic sphere forming the BL is enveloped by a layer of neutral molecules generating a superficial tension σ , as in the Stahanov's model of BL, (plasma sphere with layer of water molecules,³⁰ the stability equation of BL being:

$$\begin{aligned} p_i^e &\approx \frac{2 \cdot \sigma_e}{R_e}; & P_i \cdot xV_e &= \frac{M}{m_o} \cdot R \cdot T_e; & \sigma_e &= \frac{u}{2d_i^2}; \\ (V_e &= \frac{4 \cdot \pi}{3} \cdot R_e^3); & u &= \sum u_i = 6 \times 10^{-2} \frac{e^2}{4 \pi \epsilon_0 d_i} (1-c); \end{aligned} \quad (3)$$

with: p_i^e - the stability pressure; m_o -molecule mean mass; M ; V_e - the BL mass and volume; $R=k_B N_A$ (the gas constant), σ being as of an ionic liquid: $\sigma=u/2d_i^2$ with: $u=\sum u_i$; $d_i \approx 3 \text{ \AA}$; $c \approx 0.545$, (repulsion coefficient). It may be argued that the ball lightning phenomenon may explain also the phenomenon of "Holy Light (Holy Fire) arrival at the God Jessus' tomb", by the conclusion that the electrizing of the church metallic roof and of the mass of aerosols formed above the tomb after 20-30 minutes of "hot" prayers of believers favor the electric discharge of the roof and the ball-lightning's forming.

Conclusion

In the paper is presented a possible explanation of the initiation of the lightning phenomenon, generated between two clouds or between a cloud and the earth, by the conclusion that the gamma-ray glows which precede and cause the lightning strikes, having low energy, (approximately a tenth the level received from a typical medical X-ray,¹¹), are generated by collisions of accelerated electrons at non-relativistic speeds ($v \ll c$) and on short distances with air molecules, by the converting of infrared and visible radiation photons into ionizing (γ , X) quanta inside the vibrated/excited electrons considered in a vortexial model, these ionizing quanta generating more free electrons and ionized discharge channels with lower electric resistance, by the repetition of the phenomenon, which explains the discharge streamers specific to narrow bipolar event (NBE), specific to weak initiatory flashes with durations of $0.5 \div 2 \mu\text{s}$ and peak VHF powers of $0.09 \text{ W} = 0.64 \text{ W}$, (which suggests charges moved at a distance of $\sim 5 \text{ m}^6$).

There are presented some arguments for the considered hypothesis

A supplementary argument for the equation (1) stating the possibility to convert n photons of lower energy into a photon of higher energy by highly excited charges is the observing of this process also to nuclei of some elements, such as hafnium-178, which has a half-life of 31 years, which can exist in a high-energy state, (nuclear isomer), that slowly decays to a low-energy state by emitting gamma rays. A team of researchers from the University of Texas demonstrated the possibility to artificially trigger the decay of the hafnium isomer Hf-178m2 by bombarding it with low-energy X-rays (*New Scientist*, 3 July 1999³¹). The experiment released 60 times as much energy as was put in, and in theory a much greater energy release could be

achieved. Regarding the ball lightning phenomenon, because the ball lightning is produced by an electrical discharge lightning of a thunderstorm, which induces a strong annular magnetic B- field in the form of rings, is possible to explain some fibrillary black ball-lightnings by the hypothesis that the annular B-field aligns locally attractively the atomic magnetic moments of N and O of the air, forming in this way positively ionized ozone molecules, i.e. $\text{O}^+-\text{O}^+-\text{O}$ and nitrogen monoxide molecules: NO^+ , and quasi-annular chains of N-O^+ linked by neutral atoms of oxygen, which attracts thereafter neutral molecules of O_2 , N_2 and H_2O -particularly, forming in this way fibers, as bunches of atomic fibrils with the central chain in the form: $\text{O}^+-\text{O}^+-\text{O}=\text{O}^+-\text{O}^+-\text{O}$ or/and $-\text{N-ONO}=\text{ONO}^+\text{O}^-$, so-with covalent and ionic links, which are resistant to usual temperatures until at least 100°C , explaining the lifetime of the ball lightning by the additional conclusion that the plasmatic sphere forming the BL is enveloped by a layer of neutral molecules generating a superficial tension σ , (as in the Stahanov's model of BL -plasma sphere with layer of water molecules).

According to previous studies, it is possible to generate not only lab lightnings, but also electric weapons generating a lightning by combining the principle of the electric microscope with the effect of gamma radiations and of high frequency electromagnetic waves, i.e.- by uni-directionally air ionizing with gamma radiations and microwaves or/and high frequency electric waves generated by the secondary of a Tesla coil whose negative high potential (over 50KV) electrode may constitute the source of electrons, emitted by the electrode's heating and accelerated with an annular positive electrode.

Acknowledgments

None.

Conflicts of interest

The author declares there is no conflict of interest.

Funding

None.

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