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A NEW HYPOTHESIS AND PHYSICAL BASES OF ORIGIN OF ROSARY LIGHTING IN THE ATMOSPHERE OF EARTH

Purpose. Development and scientific ground of new hypothesis of origin of rosary lightning (RL) is in the air atmosphere of Earth. Methodology. Electrophysics bases of technique of high (ever-higher) impulsive voltage and large (weak) impulsive currents, and also theoretical bases of quantum physics. Results. The substantive provisions of new hypothesis of origin are formulated RL. Taking into account these positions bases of close electrophysics theory of origin are developed in an air atmosphere RL. Basic electrophysics terms, resulting in the transition of linear lightning (LL) in RL, are indicated. Originality. First on the basis of conformities to the law of quantum physics the new electrophysics mechanism of education is offered RL from LL. It is set that this mechanism the wave longitudinal distributing of drifting lone electrons is underlaid in the plasma cylindrical channel of a long spark storm digit in an air atmosphere, resulting in forming in him of «light» («hot») and «dark» («cold») longitudinal areas of periodic electronic wavepackages (EWP). It is shown that for LL information the areas of EWP periodically up-diffused along the channel of lightning are characterized the small and unnoticeable for observers lengths, and for RL − by large lengths and by sight noticeable for observers from earth. Practical value. Deepening of scientific knowledges about physics of such global atmospheric phenomenon as lightning. Expansion of scientific presentations of humanity about circumferential tellurians nature and difficult natural physical processes, flowings in it. References 15, figures 4.

Key words: **linear lightning, rosary lightning, physical bases, plasma channel of a storm discharge, drifting lone electrons, electronic wavepackages, «hot» («light») and «cold» («dark») longitudinal areas of electronic wavepackages of channel of a storm discharge.**

Приведены новая гипотеза и базирующиеся на ней физические основы возникновения в воздушной атмосфере Земли чёточной молнии (ЧМ). Показано, что в основе электрофизического механизма формирования этого вида молнии находится волновое продольное распределение свободных электронов, движущихся в плазменном канале линейной молнии (ЛМ) на стадии протекания в нем длительной компоненты тока грозового разряда. Из-за малой плотности тока в плазменном канале ЛМ на данной стадии разряда в нем происходит образование таких относительно длительно существующих волновых электронных пакетов, которые характеризуются сравнительно большими и поэтому визуально видимыми наблюдателями вначале ЛМ и затем ЧМ размерами своих периодически распределенных вдоль канала молнии «горячих» («светлых») и «холодных» («темных») продольных участков. Библ. 15, рис. 4.

Ключевые слова: **линейная молния, чёточная молния, физические основы, плазменный канал грозового разряда, дрейфующие свободные электроны, волновые электронные пакеты, «горячие» («светлые») и «холодные» («темные») продольные участки волновых электронных пакетов канала грозового разряда**.

Introduction. Well-known and most studied kind of powerful natural electrical short-time spark discharge in the air atmosphere of the Earth is the linear lightning (LL) [1-4], the appearance of which is shown in Fig. 1.

Fig. 1. General view of the brightly glowing plasma channel in the atmosphere of the long spark discharge of the LL between the positive charged cloud and ground [5]

As a rule, the length of the plasma channel between LL storm cloud with a negative (positive) U_L potential to ± (30-50) MV and the ground is measured in hundreds of meters, and the limit can be up to several kilometers [1-5]. The diameter of the plasma channel of LL in air in accordance with the [1-5] can range from tens of centimeters to several meters. Currently, LL physics thanks to the results of theoretical and experimental work by domestic [2-4] and foreign scientists and experts [1], presented in the review of the monograph [5] is presented at a high scientific and technical level. However, so far in the engineering and electrophysics of high voltages, the technique of large (small) pulse currents, as well as low- and high-current technique of long (short) sparks in the gas (air) medium lacking scientific and technical data, or strictly even approximately explain the transformation (though not as often and not always) in an air atmosphere LL later in rosary lighting (RL). The emergence of the RL, or «*bead lightning*» [1] in the electrically active air

atmosphere is a well-established scientific fact, documented by numerous visual observers of this relatively rare and interesting natural atmospheric phenomena [1, 5, 6]. Existing RL theories today are based on the fact that this kind of lightning in extrahigh voltage two-electrode system «charged cloud - earth» [1, 6]:

1) is the result of periodic interruption of the plasma channel lightning cloud or rain;

2) due to the instability of the plasma lightning discharge channel with a longitudinal shock because it arises in the pinch effect, leading to its transverse «waist» and education channel of sausage type;

3) is a series of sphere-like arc discharge, appearing on the site of an earlier «waste» a large pulse current of a lightning discharge plasma channel LL in the final stage of a long course of it a small continuous current;

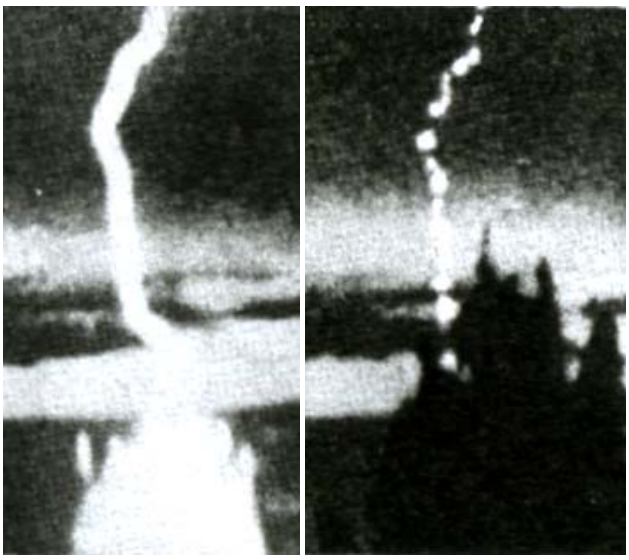
4) caused by the relatively long emission of longitudinal sections of a cylindrical plasma channel LL having an unusually large radius. The past decade with the advent of the scientific world in these RL theories have shown that these theoretical approaches have been poorly reasoned, and in the end not scientifically consistent.

In this context, the development of a new approach to scientific explanation of the origin and the short time of existence in an air atmosphere of such natural phenomena as the RL is an **actual** scientific and technical problem, research expands our knowledge of the surrounding nature and the physical processes occurring in it.

1. Problem definition. We consider from the electrophysical position the formation and flow of LL in an air atmosphere at altitudes up to 1000 m, containing in its composition many entrained upward (downward) by air currents atoms of various chemical elements, including nitrogen *N*, oxygen *O*, carbon *C*, silicon *Si*, sulfur *S*, iron *Fe*, lead *Pb* and others. Some of these atoms produced are molecules of various oxides substances are in an air atmosphere, especially by-products of combustion and the organic fuel oxidation in thermal power stations and large industrial enterprises, rising from the tall chimneys of the earth's atmosphere with the hot flue waste of their continued operation. Note that the current of LL at these altitudes the air in the atmosphere is characterized by two main components [7, 8]: pulse *A*-component (with normalized amplitude I_{mL} of up to 200 kA and a duration τ_p till 0.5 ms) and long-term *C*-component (with averaged I_{mL} value over 200 A and duration τ_p till 1000 ms). We suppose that in the event of an air atmosphere plasma channel LL these atoms (molecules) of matter and their oxides are involved in the complex physical processes occurring in the «thin» the atomic level in the core of the channel having a local cylindrical configuration. Without going at this stage in these processes, we note only that these substances will microformations due to the high temperature in the plasma channel LL (order $(20\text{-}30)\cdot10^3$ K [9]) undergo ultrafast processes of impact and thermal ionization. These atoms (molecules) of a substance will be the main «suppliers» of additional free electrons in the LL channel, the electron temperature T_e of which will support and determine its aforementioned heat flow as it pulsed stage *A*-component of the current and the flow step it prolonged the *C*-component of the current of the lightning discharge. We assume that the motion of free electrons in the plasma channel LL determines the transfer of electrical charge from both the negatively charged part of the storm cloud to ground *(«lightning of negative polarity»)*, and by the negatively charged surface of the earth to the positively charged part of the storm cloud («*lightning positive polarity*»). Required to consider on the basis of known scientific principles possibility of RL by a certain transformation in her stage LL flow in its long plasma channel *C*-components of the lightning current as well as establish the main electrical conditions in the plasma channel LL and air atmosphere, providing a transformation of one type of lightning in another.

2. The formulation of the proposed hypothesis of the RL forming in an air atmosphere. According to [10] the term «*hypothesis*» comes from the Greek word meaning «*assumption*» Applied to our case this term will mean a scientific hypothesis put forward to explain the nature of physical phenomena in the RL, sometimes flowing in electrically active air atmosphere. By definition, this assumption requires experimental verification and theoretical justification in order to be credible scientific theory. Experimental verification of the phenomenon of the RL was made earlier by his numerous foreign observers [1, 6]. According to the experimental data given in [5, 6], RL leakage occurs at the end of the LL. The RL compared to the LL is characterized by relatively large time of its existence [1, 6]. Fig. 2,*a*,*b* show the main phase flow of LL and RL, filmed by observers of natural electrophysical phenomena and presented in [5, 6]. In Fig. 3 an enlarged form on the former site of the plasma channel LL presented some «light» rosaries of RL separated in the area of the channel of lightning from each other «dark» rosary of RL. Based on the currently available conclusive experimental data obtained in direct RL observations in air [1, 6], and the set of fundamental theoretical and experimental laws wave longitudinal distribution of drifting electrons in the metal conductors with a pulsed current [11], proposed here the hypothesis of occurrence and development in the air atmosphere of the RL includes the following main provisions:

- RL is a specific kind of electrical short-long spark discharge in air arising at the final stage of the flow in the air atmosphere of LL;
- RL appears on the stage of the flow in the plasma channel LL cylindrical shape relatively large diameter long-term *C*-component of the current lightning, which is characterized by continuous currents in the hundreds and tens of Amperes at the length of their flow channel is not less than 1 s;



a *b*

Fig. 2. Main phases of flow in the area of the plasma channel curved lightning initially the LL (a), and then the RL (b) in an air atmosphere of the Earth [5, 6]

Fig. 3. General view of the individual «light» and «dark» rosaries of the RL observed from the ground in an air atmosphere [5, 6]

- zone of the RL appearance is the main plasma channel LL, and the duration of the RL of existence in an air atmosphere of the Earth is determined by the duration of the flow of small continuous current at a stage long-term *C*-component of the lightning current components;
- electronic current conduction in a plasma cylindrical channel LL and subsequently arising on its basis a modified plasma channel RL obeys the laws of quantum physics, and is characterized by the data channels corresponding wave periodic longitudinal and radial distribution of their drifting free electrons initially in the high channel LL, and then in low-current RL channel;
- RL is a result of electrophysical transformation occurring in the plasma channel LL with a large pulse current *A*- component of the wave electron packets (WEP) with small and not visible to observers LL their lengths periodically distributed along the channel of the lightning discharge on the «hot» («light») and «cold» («dark») longitudinal sections in the WEP with large and therefore visually visible from the ground observers RL lengths of its relatively «hot» («light»), and «cold» («dark») longitudinal sections periodically along a modified plasma RL channel.

3. Scientific substantiation of the proposed hypothesis of the RL origin in an air atmosphere. To begin with, the WEP in the plasma channel of the lightning discharge on its initial and final stages flow similar to the WEP, introduced and used in the study [11] the periodic wave longitudinal and radial distributions drift of free electrons in the crystal structure of metal wires with DC, AC and pulsed electric current, a relatively «hot» with length Δz_{hn} and «cold» with length Δz_{hn} quantized longitudinal portions. The sum of the lengths of these sections ($\Delta z_{hn}+\Delta z_{cn}$) forms a quantized step of WEP longitudinal periodic structures in the plasma channel of lightning. Moreover, the value of the step ($\Delta z_{hn}+\Delta z_{cn}$) is always equal to the length of the half-wave quantized $\lambda_{en}/2$ de Broglie for drifting in the channel of free electrons lightning. In turn, the value of $\lambda_{en}/2$ in the plasma lightning channel is performed as follows quantum mechanical ratio:

$$\lambda_{en}/2 = l_k/n, \qquad (1)$$

where l_k is the length of the cylindrical plasma channel of lightning; n = 1,2,3,..., n_m is the integer quantum number; $n_m=2n_k^2$ is the maximum value of the quantum number n [11]; n_k is the principal quantum number of atoms ionized matter [12] presenting in the plasma channel of the lightning discharge in the air atmosphere of the Earth in the course of the stage it pulsed *A*- and long-term *C*-components of the lightning current.

From (1) we see that the minimum value of the half-wave length of the electron de Broglie $\lambda_{en}/2$ in the plasma lightning channel will correspond to the maximum value of the quantum number $n = n_m$. Following classical quantum mechanical ratio can be used in the estimations of minimum average $\lambda_{en}/2$ de Broglie half-wave length for drift of free electrons in the plasma channel of a lightning discharge [12]:

$$\lambda_e/2 = h/2(m_e v_D), \qquad (2)$$

where $h = 6.626\cdot10^{-34}$ J·s is the Plank constant; $m_e=9.108\cdot10^{-31}$ kg is the electron rest mass; $v_D=\delta_m/(e_0 n_{e0})$ is the maximum value of the mean free electron drift velocity in the plasma channel of lightning, are formed when electric breakdown of long air gap in the discharge system «charged cloud - ground»; $\delta_m\approx4I_{mL}/(\pi d_k^2)$ is the maximum value of the current density in the plasma channel lightning of diameter d_k; $e_0=1.602\cdot10^{-19}$ C is the module of the electron's electrical charge; n_{e0} is the average value of the density of free electrons drifting in the plasma channel of lightning.

3.1. Assessment of the minimum lengths of the «hot» Δz_{hL} and «cold» Δz_{cL} longitudinal sections of WEP for LL. According to the calculated and experimental data presented in [11, 13], the «hot» WEP longitudinal sections in a round metallic conductor with a pulse current of high density in comparison with its «cold» longitudinal portions substantially different levels of electron temperature T_e (about 3.5 times). Caused by this feature is enhanced, compared with the average initial (up to the current flow) in a cylindrical volume conductor drifting concentration of free electrons in the «hot» longitudinal sections of WEP, the middle of which correspond to the amplitudes of propagating along the conductor of electronic half-waves of de Broglie. At the same time in the «cold» longitudinal sections of the conductor due to the wave nature of the distribution of its cylindrical volume drift of free electrons occurs reduced bulk density of considered microcarriers of the charge. As a result of the longitudinal wave drifting periodic distribution of free electrons in a conductor is formed by a non-uniform longitudinal periodic temperature field. In addition, according to [14], the experimental study the phenomenon of the electric explosion (EE) in the air thin round copper wires (length is 60 mm, diameter is 100 mm) by passing-of them from the high-voltage generator of impulse currents (GIC) sine decaying exponentially discharge current of high density ($\delta_m \approx 6.4 \cdot 10^{12}$ A/m^2) in the explosive destruction of the products dispersed solid copper (in fact, in «metal» plasma) by the high-speed photorecording method periodic strata were recorded, consisting of layered longitudinal periodic disk-like structures of varying luminosity containing alternating between a «light» width Δz_h and «dark» width Δz_c longitudinal sections. These areas formed in pairs in the low-current discharge air gap GIS with «metallic» plasma step periodic structure WEP length about $(\Delta z_h + \Delta z_c) \approx 1.76$ mm. Obviously, in the case of the specified EV thin copper wires «light» longitudinal sections of his «metal» of the plasma in the discharge air gap correspond to «hot» areas of WEP and its «dark» longitudinal sections - «cold» WEP areas. In this regard, quite reasonable to say that the «hot» longitudinal sections of a minimum length Δz_{hL} in the plasma channel of lightning arising in extra high discharge air gap system «charged cloud - earth», will meet his «light» longitudinal sections, and «cold «longitudinal sections Δz_{cL} minimum length of the plasma channel of lightning – its «dark» longitudinal sections. Fig. 4 schematically shows the quality «hot» («light»), and «cold» («dark») periodic longitudinal sections WEP plasma channel of lightning, which occurs in an air atmosphere of the Earth.

Minimum length Δz_{hL} of «hot» («light»), a longitudinal section of WEP in the plasma channel LL formed in the extra high discharge air gap system «charged cloud – land», on the basis of quantum mechanical uncertainty Heisenberg relations [12] with regard to drifting it (this channel) free electrons can be approximately determined from the following analytical expression [13]:

$$\Delta z_{hL} \approx e_0 n_{e0} h (m_e \delta_m)^{-1} / [8 + (\pi - 2)^2]. \qquad (3)$$

For the numerical evaluation by (3) of Δz_{hL} values we assume that the plasma channel high current flow in the LL stage it pulse *A*-components of the lightning current has the following initial geometrical and electrical parameters [1, 8, 12]: $d_k \approx 1$ m; $n_{e0} \approx 10^{25}$ m^{-3}; $I_{mL} \approx 100$ kA; $\delta_m \approx 1.27 \cdot 10^5$ A/m^2. Then from (3) follows that $\Delta z_{hL} \approx 1$ mm. With regard to (2) the minimum average length $\lambda_e/2$ of half-wave of de Broglie for the case we would be roughly equal $\lambda_e/2 \approx 0{,}5 e_0 n_{e0} h (m_e \delta_m)^{-1} \approx 4.6$ mm. As a result, the minimum length Δz_{cL} of «cold» («dark») of a longitudinal section of WEP in the plasma channel LL at this stage of development of its plasma channel will take the numerical value of about $\Delta z_{cL} \approx \lambda_e/2 - \Delta z_{hL} \approx 3.6$ mm. It is seen that values of Δz_{hL} and Δz_{cL} for «hot» («light») and «cold» («dark») periodic longitudinal sections of WEP almost three orders of magnitude smaller than the diameter of the plasma channel d_k lightning at the stage of formation and flow in it LL. Visually capture the viewer from the ground such sites WEP for LL is almost impossible.

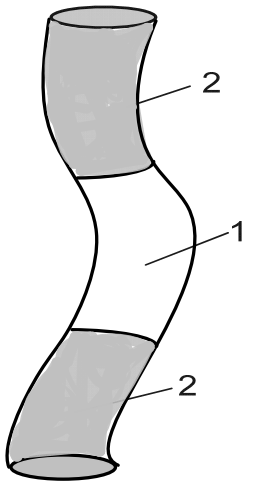


Fig. 4. Schematic scaleless image of the «hot» («light») and «cold» («dark») longitudinal sections of the periodic structure of WEP in the plasma of the curvilinear channel of lightning, developing in an air atmosphere of the Earth (1 - «light» («hot») segment of the cylindrical channel of lightning; 2 - «dark» («cold») segment of the cylindrical channel of lightning)

3.2. Assessment of the minimum lengths of the «hot» Δz_{hL} and «cold» Δz_{cL} longitudinal sections of WEP for the RL. To do this, we assume that at the stage of the flow in the plasma channel of the lightning discharge of long-term *C*-component of the lightning current adopted diameter of $d_k \approx 1$ m of the channel due to the inertia of the thermal processes in it and in the meantime the order of 0.5 ms has not had time to change and remained so same as in the previous step occurrence

on it a pulse *A*-component of the lightning current component. In addition, we believe that the average concentration (bulk density) n_{e0} free electrons in the case of flow along the plasma channel lightning long-term *C*-component of the lightning current also remained the same and approximately equal $n_{e0}\approx10^{25}$ m^{-3}. Suppose that in this case, a continuous long lightning current is characterized by the following parameters [7, 8]: $I_{mL}\approx100$ A; $\delta_m\approx1.27\cdot10^2$ A/m^2. Substituting these initial data in (3) we see that in this case the minimum length Δz_{hL} of «hot» («light»), a longitudinal section of WEP in the lightning channel will be numerically for about $\Delta z_{hL}\approx1$ m. From the calculated ratio $\lambda_e/2\approx0{,}5e_0n_{e0}h(m_e\delta_m)^{-1}$ we find that at the stage of the flow in the received plasma channel lightning long-term *C*-components of lightning current the minimum average length $\lambda_e/2$ half wave of de Broglie numerically will be approximately 4.6 m. Then, the minimum length Δz_{cL} of «cold» («dark») longitudinal section of WEP in the plasma channel of lightning at the final stage of its course will take the numerical value of about $\Delta z_{cL}\approx\lambda_e/2-\Delta z_{hL}\approx3.6$ m. The quantitative results for longitudinal WEP a plasma channel in step lightning thereon prolonged percolation of lightning current components conclusively indicate that lightning analyzed cylindrical channel may be partitioned into a relatively large and so the «bright» and «dark» detectable visually by observers from the ground surface, longitudinal portions (single rosaries, periodically along the flow path in an air atmosphere described by powerful long spark discharge. Therefore, according to forth herein approximate reporting the results of the RL «born» from the LL flowing in the extra high bit long air gap two-electrode system «charged cloud - land» in the final stages of its existence.

3.3. Evaluation of the possible number of «hot» Δz_{hL} and «cold» Δz_{cL} longitudinal sections of WEP for the RL. Number n_L of individual rosaries, each containing one «hot» («light») and one «cold» («dark») longitudinal section periodically distributed WEP in the plasma channel of the lightning discharge in the RL, taking into account (1) can be formally assessed by the following approximate formula:

$$n_L \approx 2l_k / \lambda_e . \qquad (4)$$

When $l_k\approx460$ m and $\lambda_e/2\approx4.6$ m from (4) we obtain that $n_L\approx100$. Obtained in the first approximation quantitative result for the number n_L of rosaries in the RL is in conflict with a numerical indicator of the maximum value of the quantum number n_m of (1) defined by the principal quantum number n_k of ionized atoms of matter, caught up in the flow area of the cylindrical channel of LL and then RL. Apparently, according to the data given in the above section 1 and staging in the periodic system of chemical elements by D.I. Mendeleev [12], the quantum number $n_m\geq n_L$ applied to the plasma channel of the lightning discharge in the air at $n_k\approx6$ should not exceed $2n_k^2\approx72$. This implies certain restrictions on the numerical values of the possible length l_k of the cylindrical plasma channel of the lightning discharge in the case of occurrence in it's the RL, the minimum length $\lambda_e/2$ of half-waves of de Broglie electron traveling in the channel, and the number of n_L of individual rosaries in the plasma channel of RL.

3.4. Evaluation of the temperature of «hot» Δz_{hL} longitudinal sections of WEP in the plasma channel of RL. We suppose that this temperature due to the initial non-isothermal electron and ion gas in a long high-current discharge channel LL will be determined by the electron temperature T_e of the plasma channel of the lightning discharge flow at the stage it pulse *A*-component of the lightning current. Taking into account the short duration of this stage of development of lightning (about 0.5 ms), the virtual absence of her radial heat transfer from the channel lightning into the surrounding airspace and LL relatively large inertia of thermal processes, to assess the electron temperature T_e of «hot» («light») longitudinal sections of WEP Δz_{hL} length in the plasma channel RL in the light of the approximate calculation of the thermal state of quasi-neutral ionized gas in the air gaps of high-voltage spark gaps, given in [11], we can use the following relation:

$$T_e \approx 5{,}83[I_{mL}^{1/3}/(\sigma_c t_m)]^{1/4}, \qquad (5)$$

where $\sigma_c=5.67\cdot10^{-8}$ W·(m^2·K^4)$^{-1}$ is the Stefan-Boltzmann constant [12]; t_m is the time (in seconds) corresponding amplitude I_{mL} (in Amperes) of lightning current on the electrical percolation stage in its long air spark gap pulse *A*-component of powerful lightning current.

Assuming that at the initial stage of the development of LL $I_{mL}\approx100$ kA and $t_m\approx10$ μs [4], (5) for the electron temperature T_e of «hot» («light») rosaries of RL in the first approximation, we find that it is in the present case It is about $31\cdot10^3$ K. This calculated level of the thermodynamic temperature of the plasma channels of LL and RL corresponds to a known temperature in the spark channels of high-current electrical discharges in gases [8, 9, 11].

3.5. Assessment of the duration of the existence of the RL in air atmosphere. The duration t_L of existence of RL after final stage of LL flow can be estimated from the following relationship:

$$t_L \approx q_L / I_{mL}, \qquad (6)$$

where q_L is the electric charge flowing on the stage of continuous long-term *C*-component of the lightning current with its average value I_{mL} modified due transformed longitudinal sections of WEP plasma channel of LL.

At $q_L\approx200$ C [7, 8] and adopted continuous current value $I_{mL}\approx100$ A at this current stage of formation of the RL the numerical value of the duration t_L of occurrence of this type of lightning will be by (6) of about 2 s. This value t_L is significantly longer than the flow of the LL, including the duration of its initial stage with a large pulse

current *A*-component of the current of lightning and its final stage at the beginning of the course of a long-term *C*-component of the lightning current.

3.6. Assessment of geometrical form of «hot» and «cold» longitudinal sections of WEB for the RL. The geometric shape of individual rosaries of the RL (its «light» and «dark» longitudinal sections) must follow the original configuration of the local cylindrical curved overall length of the plasma channel LL. Boundary zone of «light» and «dark» longitudinal sections of WEP in the RL channel should probably contain the ellipsoidal surface (see Fig. 3) caused no abrupt change in these areas of bulk density n_{e0} of drifting free electrons, and its smooth change of one of the main universal physical laws of our nature – exponential law [15]. Because of the possible longitudinal non-uniformity of distribution of the majority carriers of electricity (free electrons) in a plasma channel RL geometric dimensions (length and diameter) of the individual rosaries («light» and «dark» longitudinal sections periodically changing WEP) may differ from each other, and themselves rosaries acquire a deformed and non-canonical appearance.

4. The formulation of the electrophysical conditions of the emergence of the RL in air atmosphere. We give below the main electrophysical conditions under which, in the author's opinion, the transformation of LL to RL is possible flowing in air atmosphere:

- diameter d_k of the cylindrical channel of the lightning discharge in the air a long discharge gap of extrahigh voltage two-electrode system «charged cloud - land», the value of the large current to flow in this stage of the channel impulse *A*-component of the current of lightning and continuous weak current to flow through it step long-term *C*-components of the lightning current and the average bulk density n_{e0} drift of free electrons in the channel of the lightning discharge should foster it (the lightning channel) such periodic WEP, longitudinal «hot» («light»), and «cold» («dark») sites which vary respectively, in the range of thousandths parts of a meter for the LL to a few tens of meters, and for the RL;
- length l_k of the cylindrical plasma channel of the lightning discharge in the air a long discharge gap extrahigh voltage two-electrode system «charged cloud - ground» and the minimum average length of de Broglie electron half-waves $\lambda_e/2$ in the plasma channel of lightning must satisfy quantum mechanical equation (1);
- in the long air discharge gap extrahigh voltage two-electrode system «charged cloud – ground» and, respectively, in a cylindrical plasma channel lightning should mainly be present are ionized atoms of matter formed with their electronic subshells and free electrons entering the plasma channel of lightning will contribute to the implementation of (1) and $n_L \le n_m$.

In the author's view, failure to comply with the above conditions, in many cases, the flow of air in the atmosphere of the most studied species of lightning as the LL and does not cause the appearance of the RL after LL.

Conclusions.

1. A new hypothesis of such a little-studied natural atmospheric phenomena like the RL and is given in a first approximation, its scientific basis, built on the fundamental laws of quantum physics.

2. It is shown that what may occur in the plasma channel Lee on stage flow through it for at least 1000 ms of continuous long-term *C*-component of the current of lightning with its values in its decline («tail») in the hundreds and tens of Amperes.

3. On the base of the RL electrophysical formation mechanism from LL may lie the transformation of the plasma channel lightning periodic WEP and short (up to a few millimeters in length) «hot» («light») and «cold» («dark») longitudinal sections on phase flow in the «hot» («light») it a pulse *A*-component of the current of lightning discharge in the WEP with their long-term (up to tens of meters in length) and «cold» («dark») longitudinal sections in the final stages of the occurrence of a lightning discharge in its plasma channel continuous long-term *C*-component of the lightning current.

4. The basic electrophysical conditions under which the possible formation of electrically active air atmosphere of the Earth RL, appearing in a modified by this transformation of longitudinal periodic WEP plasma channel of LL at its final stage of development after the leakage of the pulse *A*-component of the lightning discharge current are formulated.

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