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Detailed Elaboration and General Model of the Electron Treatment of Surfaces of Charged Plasmoids (from Atomic Nuclei to White Dwarves, Neutron Stars, and Galactic Cores): Self-Condensation (Self-Constriction) and Classification of Charged Plasma Structures—Plasmoids

Part 1. General Analysis of the Convective Cumulative–Dissipative Processes Caused by the Violation of Neutrality: Metastable Charged Plasmoids and Plasma Lenses

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Abstract—The processes of the accumulation and dissipation of electron flows in polarizable plasma structures with spatially distributed electric charges are investigated. It is proved that a slight violation of neutrality (about 10^{-18}) because of forcing the electrons out of the structures leads to sputtering (bouncing) of neutral structures that were gravitating before. As the de Broglie wavelength of an electron is many times greater than that of a nucleon or atomic nucleus at equal temperatures, in the case of condensation of matter into quantum structures (in which there occurs degeneration of the sharing electron gas), there should happen the violation of neutrality and the generation of giant peripheral electric fields that self-focus the plasmoid thus being a dynamic surface tension. Electric fields are effective catalysts of thermonuclear reactions leading to neutronization of the substance compressed by gravitation. Einstein's idea concerning mass–energy equivalence is confirmed in a new form. The equivalence manifests itself in a similar functionality in the process of the pulsation (focusing and rebounding) of "excessive" energy in the generalized Kepler 2D-problem (for the gravitational and the electric potential) and the "excessive" mass in the Vysikaylo–Chandrasekhar 3D problem concerning the accumulation and dissipation of the de Broglie waves in quantum stars (pulsating accretion of quantum stars) with a mass greater than that of Chandrasekhar (~1.46 masses of the sun). A new mechanism (type) of a thermonuclear reactor at the surface of charged quantum stars and dense cores of ordinary stars and planets is proposed by the author. The acceleration of electrons to MeV energies in the synergistic electric fields of uncompensated for charged particles in the nuclei of giant plasmoids—quantum stars—and their transmutation into the neutrons on the surface layer in the reactions with the protons is the basis for such a mechanism. In the presence of dynamic surface tension caused by the Coulomb forces the cumulation of plasma and energy takes place during the compressing electric field jumps.

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INTRODUCTION

It is well known that the Coulomb law (and, correspondingly, the Poisson equation for an electric field in the region of charged structures with a space charge distributed in 4D space–time) operates within a great range of characteristic dimensions from $R \sim 10^{-15}$ m (the atomic nucleus dimensions) to 10^{26} m (the visible universe dimensions). These dimensions correspond to the typical frequencies of convective processes that take place at the velocity of light within the range from 10^{24} s^{-1} to 10^{-18} s^{-1}. The last frequency corresponds to the time of light's passage through the visible universe.

The violation of neutrality of nucleons in atomic nuclei is significant. The number of neutrons and protons in atomic nuclei is almost equal, and the uncompensation charge parameter is $\alpha_i = n_i/n \approx 1/2$. Here, n_i is the density of the particles with an uncompensated positive charge, and n is the density of all the nucleons (protons and neutrons).

The violation of neutrality in the structures in gas-discharge plasma is not large, and α_i in the structures presented in Figs. 1–4 is not more than 10^{-6}. However, a number of the main properties of the metastable structures charged or polarized in the 3D space (plasmoids) self-condensing in the coulomb potential wells

Fig. 1. Beaded lighting. Palm leaves with a diameter ≈0.5 m are seen at the bottom of the photograph.

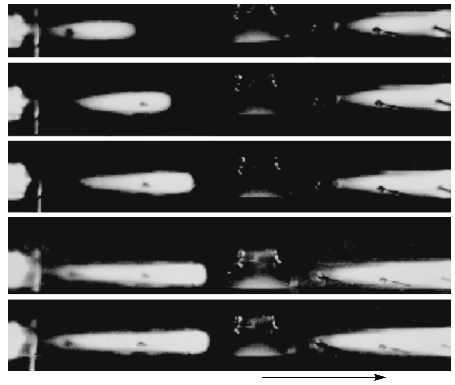

Fig. 2. A discharge in a tube in nitrogen versus the discharge current at $P = 15$ Torr [1, 2]. The cathode is on the left, while the anode is on the right. The discharge is disturbed by a bunch of fast electrons with energy of ~100 keV introduced through a window in the center of the tube. There is observed the classic Faraday dark space in the cathode spot (a bean on the cathode). Under the conditions of a low-current discharge (photos 1 and 2), behind the window there are seen small glowing regions; the following analogs of the Faraday dark space; and, along the arrow, the conic glowing regions indicating the defocusing of the electrons behind the dark area.

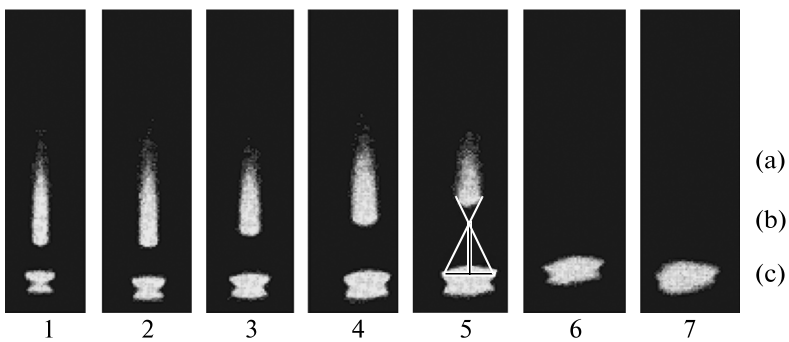

Fig. 3. The width of the cylindrical self-focusing discharge in ultraclean nitrogen versus the current [3]: $I = 0.6$ (1); 0.8 (2); 1.1 (3); 1.65 (4); 2.2 (5); determination of the libration point, 2.9 (6); and 3.25 (7) mA; $P = 5$ Torr. (a)—the positive column (with the blue glow extending to the anode and not recorded by the photo); (b)—the Faraday dark space; (c)—the negative glow or the cathode spot (the lower spot is a flare on the mirror-finished electrode).

are common. Thus, there should be generalized (at least in outline) the data accumulated in the course of the investigation of the charged structures with electric field jumps (shock waves) (Fig. 5) or potential wells for electrons (Fig. 5c–d) with dimensions from 10^{-15} m to quantum stars (10^{10} m). This generalization seems to be rather useful from the point of view of the system of fractionating specific "mysterious" 3-dimensional dynamic phenomena of generation, pulsation, and the lasting existence of various plasma structures (plasmoids), particularly in gas-discharge plasma (Figs. 1–4) and semiconductors. The author proves that it is necessary to apply, study, continuously verify, and develop the general idea presented as a diagram in Fig. 5 in different natural sciences (atomic physics, nanotechnology, astrophysics, gas-discharge plasma, etc.).

SHOCK WAVES OF THE ELECTRIC FIELD OR JUMPS FORMING THE CHARGED METASTABLE COULOMB RESERVOIRS (PLASMOIDS) FOR THE KINETIC ENERGY OF ELECTRONS

Early in the 20th century, Rutherford established through his experiments that the atomic nuclei are very small ($R \sim 10^{-15}$ m) and are charged by a positive charge; hence, they are surrounded by stationary jumps of the electric field with strength up to 10^{21} V/m (Fig. 5a). According to the nuclear drop model and the

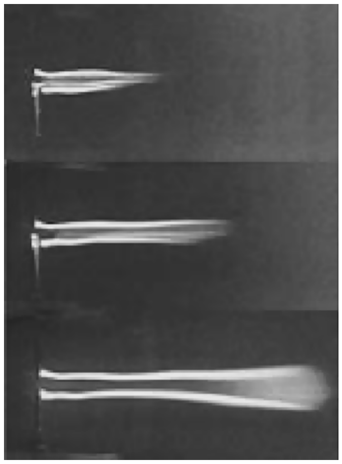
(a)
(b)
(c)

Fig. 4. The appearance of a direct current discharge between the needles in the aerodynamic tube at $M = 6$, $P_0 = 50$ atm, $p = 28$ Torr, and $D_0 = 3$ mm and at different values of the current I and the voltage U (a–c): (a)—$I = 0.2$ A, $\langle U \rangle = 2.45$ kV; (b)—$I = 0.5$ A, $\langle U \rangle = 1.95$ kV; (c)—$I = 1$ A, $\langle U \rangle = 1.7$ kV. The unclosed cylindrical electric filaments with the strata are observed down along the horizontal flow. The needle (the grounded cathode) is at the bottom. The exposition time is 1/60 s [4].

Gauss law, we obtain the following electric field profile in such stationary spherically symmetric jumps (see Fig. 5b) corresponding to the potential barrier $U(r) = \int eE(r)dr \sim r^2$; that is, $U(R) \sim R^2$ for a negatively charged particle with the energy $E_k > 0$ (Fig. 5c). At the electric field strengths ~10^{22} V/m, the electric field energy density P_E is already comparable with the mass energy density m_0 in the atomic core with volume V_0 ($P_E = \varepsilon_0 E^2/2 \sim m_0 c^2/V_0$). These are stationary jumps of the electric field or electric potential forming on the boundary of the spherically symmetric charged structures. These electric potential jumps seem to efficiently prevent the neutrons from destruction in the case of β-disintegration focusing the electrons back into the atomic nucleus.

In 1964, Gunn discovered the moving electric field jumps (the space charge layers or the shock waves with violation of neutrality) in semiconductors [11]. They are called the domains of the electric field. Visually observed shock waves with violation of neutrality in gas-discharge plasma were discovered analytically in

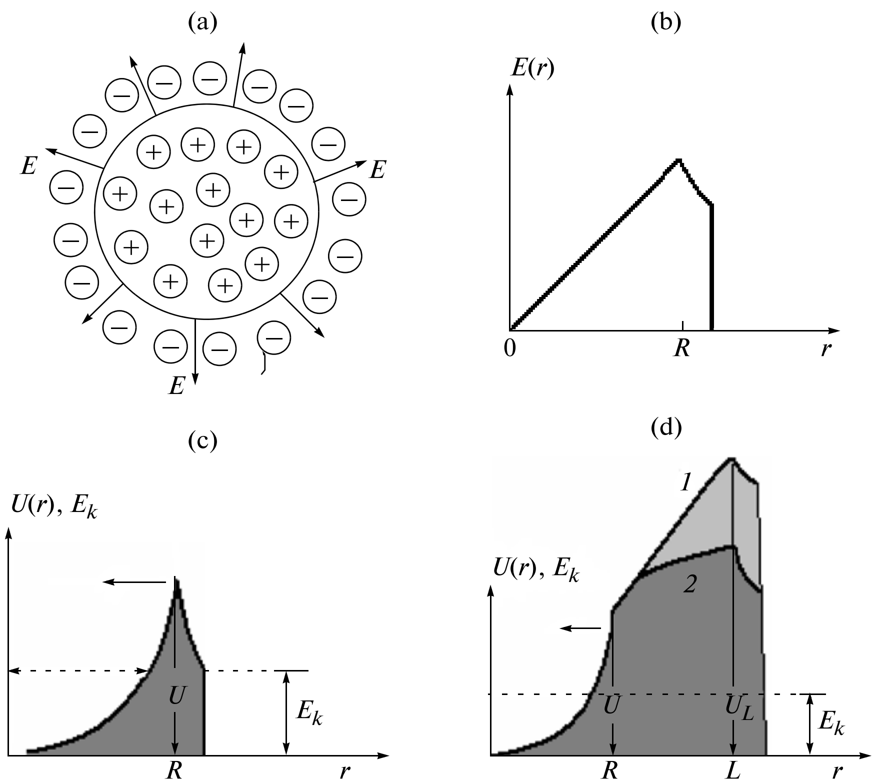

Fig. 5. (a) The model of a plasmoid with radius R as a supra-atom (used in [5–10] to define the physical principle of alloying nanocomposite materials and controlling their properties). (b) The profile with the electric field jump $E(r)$ in the charged spherical structure presented in Fig. 5a. Respectively, the dependences in the form of a jump for the parameter E/N; T_e—the temperature of the electrons ($T_e \sim (E/N)^{2/3}$); P_e—the pressure of the electrons are similar. (c) The potential barrier $U(r)$ for the free negatively charged particles in the electric field jump heating them at the periphery of the charged spherical structure up to energies of $E_k > 0$. (d) The potential barrier $U(r)$ for the free negatively charged particles in the electric field jump heating them at the periphery of the charged spherical structure with length L. The characteristic cross dimension of the potential well is more in this case than the structure's radius and is determine by its length ($\approx L$). Curve 1 corresponds to the symmetry of the surfaces (3D rectangle); curve 2 corresponds to the cylindrical symmetry (3D cylinder).

[12] in 1985 and studied numerically and experimentally in works [1–2, 13–15] (see Fig. 2). Yet, Rutherford [16] was the first to discover the bilayer of the space charge in the atom, or self-condensation of the space charge. In work [17], there is determined the common features in the generation of stationary jumps of space charges (JSC) in atoms, gas-discharge plasma, and white dwarves and neutron stars. It is shown that JSC, as discovered by Rutherford in atoms and the author in 1985 [12] in gas-discharge plasma, are similar to the shock waves discovered by Mach and the magnetic field jumps discovered by Sagdeev [18]. JSC under different conditions are determined both by the nonlinear properties of plasma and the quantum properties of elementary charged particles. Common features for JSC are the violation of neutrality, the generation of substantial electric fields focusing or dissipating the electrons, and changing their de Broglie wavelengths, thus determining the formation of convective cumulative–dissipative (CD) structures and their characteristic dimensions from 10^{-15} m up to 10^8 m and more. The squeezing of plasma by shock waves or electric field jumps with violation of neutrality is studied in this work.

The violation of neutrality in plasmoids is caused by the fact that the electrons are more movable and more quickly leave the plasmoids than massive and slow ions. The ions, uncompensated for by the electrons, form by their charge, distributed in the space, a profile of a synergetic (general) electric field that brings back (blank) the electrons that seem to be free. These very electric field profiles, self-organizing in the medium, are presented in Fig. 5b. These profiles coincide qualitatively with the profiles in an atomic nucleus. Of special note is that the characteristic dimension of the potential well for electrons in all directions is determined by the largest size of the charged structure (Fig. 5d), and the effective volume of confinement or condensation of the electron gas may be $\sim\pi L^3 \gg 4\pi R^3/3$. In such a way it shows up as the synergetic dimensional effect of the electric field of the charged structures in confining the "free" particles with the opposite charge within the region of their action. It seems to follow that the charged structures distributed in the space are more stable and their influence is more far-ranging than the charged structures with the spherical symmetry (Figs. 5c–d). This is a possible reason that, in low-current discharges, there are always formed some planar structures (strata), and then some electric filaments (Figs. 2, 4) or arcs are formed in the discharge. However, it should be remembered that there exist some external factors that considerably determine the self-organization and life activity of the charged structures between the electrodes. Consequently, without a cathode spot, the current through the discharge gap is scanty. Thus, cathode spots, being elliptic plasma structures [19], (Fig. 3) have no less unique cumulative and dissipative properties.

DIMENSIONAL EFFECTS DUE TO THE VIOLATION OF NEUTRALITY

The charged structures function equivalently within all the ranges of the characteristic dimensions due to the generation of an electric field jump at their surface (Fig. 5). The electric field magnitude at the surface of the uniformly charged 3D structure according to the Gauss law

$$E(R) = R\rho/k\varepsilon\varepsilon_0, \quad (1)$$

is determined by the charge density ρ; the size of the positively charged structure R; and the geometric factor $k = 1, 2, 3$ at the plane, cylindrical, and spherical symmetry, respectively (Fig. 5a). At large dimensions R, the peripheral electric fields (Fig. 5b) may be great (even at a negligible density of the uncompensated charge ρ) and their role in the plasma processes may be fundamental [20] as the ionization frequency depends exponentially on the parameter E/N. In this case, the potential barrier $U(r)$ confining the electrons and other negatively charged particles in the potential well (plasmoid) (Fig. 5c, d) grows with the characteristic dimension as R^2 for all kinds of symmetry from the center to the periphery of the charged structure and thus banks (cumulates, focuses) inside itself the free particles with huge kinetic energies ($0 < E_k < U(R) = \rho R^2/2k\varepsilon\varepsilon_0$ for spherically symmetric plasmoids) or with large energies (see Fig. 5d) for the case of cylindrical or plane symmetry of plasmoids, for which the potential well value is determined as $\ln L$ or L, respectively. This is a synergetic (joint) cumulative dimensional effect associated with the particular features of the 3-dimensional charged structures (plasmoids) (Fig. 5b–d). In the case of cylindrical and planar (strata) plasmoids, the volume of focusing the electrons by an electric field and the potential well size are determined by the largest characteristic dimension L (see Fig. 5d). With rotation at polarized plasmoids (Fig. 5a), there appears some magnetic field. Let us specify this Coulomb-dimensional effect for any charged plasmoids; the author of this work seems to be the first to discover it.

THE SQUEEZING OF PLASMOIDS BY ELECTRIC FIELD SHOCK WAVES OR BY THE PRESSURE OF PERIPHERAL ELECTRONS P_E

The Coulomb squeezing of atomic nuclei by negatively charged peripheral electrons or mesons, which appear to stabilize neutrons (the scheme in Fig. 5a), is a problem which has not been elaborated in detail, though the principle of the cumulation of negatively charged particles by the electric field jump back into the atomic nucleus can be diagramed (see Fig. 5, 6).

The Coulomb static squeezing proposed by the author or physical doping by free electron traps (the scheme in Figs. 5 and 6) is an accepted method in nanotechnologies [5–10], which is now being thoroughly studied. Physical doping by electron traps makes it possible to control the parameters and properties of nanocomposites. Thanks to the model, in Fig. 5c we can predict and investigate the quantum dimensional effects associated with the resonance polarization capture of electrons into hollow molecules (C_{60}, C_{70}) and nanotubes (polarizable resonators for de Broglie waves of electrons) [5–10]. It is suggested in [6] that the Coulomb squeezing of positively charged structures (the scheme in Fig. 5a) could be performed not only by negatively charged electron traps (for instance, by fullerene endoions) but also by the free electrons themselves. Such squeezing by the electrons of the charged plasma structures according to the scheme in Fig. 5a is in exact accordance with the model of an atom, molecule, supra-atom, or hypermolecule. Dynamic squeezing of the charged 3D structures by a monolayer of high energy sharing electrons results in the generation of the dynamic surface tension round a structure limited by a layer of electrons (a squeezed supra-ion) and the formation of an electric field shock wave converging to the cumulation center and compressing by a layer of electrons the whole ionized gas (see the arrow in Fig. 5c and d) or other plasma even with a slight violation of neutrality. There are no other particles in this layer, only electrons. This model corresponds to the one for atom electron shells. The compression of a supra-atom (plasmoid) will take place until the external pressure of the electrons in the electric field jump is balanced by the pressure of the electrons in the plasmoid compressed by the jump. This scheme explains in detail the stoppage of the gravitational collapse of a white dwarf by the pressure of the compressed degenerating Fermi gas of electrons and the cumulation of the plasma into spherical and cylindrical plasmoids. The work on the radial compression of the charged plasmoid within the gas discharge is eventually done by the external EMF, initially charging the plasmoid. The investigation of such dynamic surface tension or shock waves cumulating plasma in charged plasma structures is carried out in this work. First, this dynamic tension is caused by the pressure of the free external electrons (Figs. 5a, 6) heated by the synergetic electric field of the plasmoid's inner parts charged by a positive charge (Fig. 5b). The strength of the synergetic electric fields is the largest at the periphery, at R (or $\sim L$) from the center of the charged 3D structures (plasma lens) for electrons (Fig. 5b). Accordingly, here is attained the largest average energy of the free electrons captured into a trap, or their temperature T_e; thus, the electron pressure P_e is also maximum. The behavior and characteristic dimensions of the plasma structures are determined by the whole set of convection and diffusion processes going on and prevailing in the charged plasmoids (self-forming energy reservoirs for the kinetic energies of the electrons locked in these traps). Let us next classify these coulomb structures (energy self-organizing bags—traps for energy, charge, and electron mass).

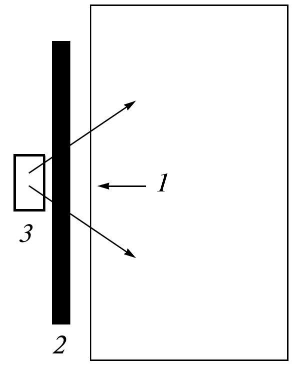

Fig. 6. The diagram of an atom (a quantum star or a coulomb focusing lens) according to Rutherford's investigations [16] and [21]: *1*—the electron shell (nanosize), *2*—the coulomb diaphragm (the coulomb force field compressing the electron De Broglie wave lengths from nanosize up to femtosize—JSC, *3*—the atomic nucleus (femtosize).

Types of Coulomb Structures

According to the information mentioned above, coulomb polarized 4D structures can be the following:

(1) cumulative, i.e., compressed by an electric field jump (Figs. 5 and 6) if the pressure of the peripheral electrons is larger than inside the plasmoid;

(2) dissipative, i.e., scattered by the spatial charge of ions (the bounce of ions from their spatial charge) or if the electron pressure inside is more than the one at the periphery;

(3) quasi-stationary or stationary, i.e., the forces of focusing and dissipation are in equilibrium (Fig. 5a); and

(4) pulsing cumulative-dissipative, i.e., when there are generated two spaced-apart reflecting mirrors (for instance, in magnetic traps) [21].

Some particular features of the behavior of charging pulsing structures show up in the similar functionality in the course of pulsations (focusing and bouncing) of the "excessive" energy in the Kepler generalized 2D problem and the "excessive" mass in the Vysikaylo–Chandrasekhar 3D problem on cumulation and dissipation of de Broglie waves in quantum stars (pulsing accretion of polarizable quantum stars) with mass more than the Chandrasekhar one (~1.46 masses of the sun) [21]. This particularity is the essence of a super powerful repetitively pulsed thermonuclear reactor, which is the most efficient in quantum stars. We consider in part 2 the operation of such a coulomb pulsing thermonuclear reactor as discovered by the author.

CLASSIFICATION OF DISTRIBUTION FUNCTIONS OF FREE ELECTRONS LIMITED BY THE COULOMB POTENTIAL BARRIER IN PLASMA STRUCTURES

Townsend has established that the parameter E/N is the main one in weakly ionized plasma (with the degree of ionization less than 10^{-6}). Here, N is the density of the neutral gas particles. In this case, the function of the electron distribution by the energies is a Boltzmann one, and all the processes of the transfer and origination are determined by the parameter E/N (or E/P, as was noted for the first time by Stoletov in 1889 in *Zhurnale Russkogo Fiziko-Khimicheskogo Obshchestva*, the Journal of the Russian Physico-Chemical Society (the physical part, vol. 21, p. 159). With the increase of the level of ionization ($\alpha_i = n_e/N \sim 10^{-(5-2)}$), the role of maxwellization grows and the function of the electron distribution by the energies becomes a Maxwell one, and the temperature of the free electrons T_e can be used as the main parameter. It is well known that, with a further increase in the degree of the gas ionization and the comparison of the characteristic length of the electron de Broglie wave with the characteristic distance between the free electrons, there takes place the degeneration of the electron gas and it obeys the Fermi–Dirac statistics. Let us estimate the concentration of the electron gas squeezing the plasmoid surface by a dense layer in this case. To excite the glow of air molecules in a normal atmosphere, the average energy of the electrons E_e should be about 1 eV, which corresponds to the d`e Broglie wave length $\lambda_{el} \approx 12.25/E_e^{0.5}$ [Å]= 1.225 nm. Here, the average energy E_e is in eV. In turn, this wave length corresponds to the critical density of the degenerated electron gas $n_{eF} = 1/\lambda_{el}^3 = 5.5 \times 10^{26}$ m^{-3}, or 5.5×10^{20} cm^{-3}. This value is by a factor of 20 more than the air's neutral gas density 2.7×10^{19} cm^{-3}. There emerges the question if there is possible the coulomb self-constriction (coulomb compression, coulomb cumulation of the spatial charge) of the ionized gas by the electric field jump to such densities, i.e., if it is possible that the movement of the coulomb barrier along the arrow to the charged structure's center (see Fig. 5c and d) is caused by the coulomb surface tension affecting the charged plasmoid surface. What EMF is capable of such compression? Such dynamic self-focusing of plasmoids seems to be possible under certain conditions (Fig. 1, 2). Such squeezing occurs in metals and other materials in which a part of the electrons are shared. The concentration of shared electrons free from atomic nuclei but localized near the surface is responsible for the skin effect in semiconductors. There are no other forces besides electromagnetic and inertial ones in condensed media. Gravitation in the mesoworld is negligible.

COULOMB IMPLOSION OF STRUCTURES OF CONDENSED MEDIA BY ELECTRON DE BROGLIE WAVES. CLASSIFICATION OF METASTABLE PLASMOIDS WITH FREE ELECTRONS

According to the de Broglie hypothesis, the particles behave as waves at the characteristic dimensions comparable with their de Broglie wave length. Such behavior is described by quantum mechanics. The mass of electrons is small; thus, the quantum properties of electrons manifest themselves when additionally nucleons and atomic nuclei behave as common particles. The difference of the masses of free electrons and atomic nuclei (the corresponding difference of their characteristic de Broglie wave lengths $\lambda_e \gg \lambda_i$) results in the quantum-mechanical separation of charges by the scheme in Fig. 5a. This quantum-mechanical separation occurs not only at the dimensions of atoms but at the dimensions of any plasmoids with free sharing electrons for which

$$n_e\lambda_e^3 \geq 1, \text{ and } n_i\lambda_i^3 \ll 1. \quad (2)$$

Conditions (2) lead to the quantum-mechanical separation of charges, the heating of electrons in the field of ions or atomic nuclei, and the cooling of positively charged nuclei and leveling of the de Broglie wave lengths of the sharing electrons and positively charged nuclei of the atoms. In the case of common discharges, the formation of charged plasmoids results from the withdrawal of a small part of the electrons from the plasmoids. Now, we can classify the metastable quasi-stationary plasmoids by the density of squeezing (free or sharing inside the plasmoid) electrons (see Fig. 7).

Classic plasmoids
- Boltzmann plasmoids $n_e < 10^{19}$ m^{-3}
- Maxwell plasmoids $n_e > 10^{19}$ m^{-3}

Quantum or Fermi–Dirac plasmoids
- Fermi plasmoids $n_e > 10^{26}$ m^{-3}
- White dwarves
- Neutron stars
- Black holes

Fig. 7. The diagram of the classification of metastable plasmoids by the function of the distribution of the electrons confined by the potential barrier with the sharing and free ones inside the coulomb barrier.

The dependence of the hydrogen plasma parameters on the kinetic energy E_e of the monolayer of the electrons squeezing the plasmoid (Fig. 5, a–d)

E_e, eV	λ_e, 10^{-10} m	λ_p, 10^{-10} m	n_e, 10^{30} m^{-3}	$\psi = E_e/E_{p,n}$	ρ_H, 10^3 kg/m^3	P_e, GPa
1	12.25		$>5.5 \times 10^{-4}$	1		$>88 \times 10^{-3}$
10	3.9	0.9×10^{-1}	$>1.7 \times 10^{-2}$	1		>28
13.6	3.34	7.6×10^{-2}	2.7×10^{-2}	1	1.7	
200	0.86	2×10^{-2}	1.6	$m_p/m_e = 1836$	10	$>51 \times 10^4$ 5×10^{13} J/m^3
400	0.61	1.4×10^{-2}	4.4	1836		
10^4	1.2×10^{-1}	2.9×10^{-3}	5.8×10^2	1836	10^3	$>9.3 \times 10^8$
10^5	3.7×10^{-2}	9.0×10^{-4}	1.9×10^4	1836		$>3.0 \times 10^{11}$
2.5×10^5	$\lambda_W \sim 2.1 \times 10^{-2}$ White dwarf		1.1×10^5	1836		$>4.4 \times 10^{12}$ 4×10^{21} J/m^3
10^6	$\lambda_W \sim 0.9 \times 10^{-3}$ White dwarf	2.9×10^{-4}	4.2×10^6	$\psi \approx 2m_pc^2/E_e$	2.6×10^6	$>6.7 \times 10^{14}$ 7×10^{26} J/m^3
10^7	$\lambda_M \sim 1.2 \times 10^{-3}$	0.9×10^{-4}	5.8×10^8	188	$\sim 10^9$	$>9.3 \times 10^{19}$ 9×10^{30} J/m^3
10^8	1.2×10^{-4}	2.7×10^{-5}	5.8×10^{11}	18.8	$\sim 10^{13}$	$>9.3 \times 10^{21}$ 9×10^{30} J/m^3
5×10^8	$\lambda_{P.N} \sim 2 \times 10^{-5}$	1.2×10^{-5}	7.2×10^{13}	3.8	$\sim 10^{14}$	$>5.8 \times 10^{24}$
10^9	1.2×10^{-5}	7.3×10^{-6}	5.8×10^{14}	1.9	$\sim 4 \times 10^{15}$	$>9.3 \times 10^{25}$ 9×10^{34} J/m^3
BH	BH	BH	BH	Black hole	$\sim 10^{16}$	
10^{10}	1.2×10^{-6}	1.2×10^{-6}	5.8×10^{17}	1	$\sim 10^{18}$	$>9.3 \times 10^{29}$

The parameters of plasmas squeezed by a monolayer of sharing electrons with kinetic energies E_e and corresponding de Broglie wave lengths λ_e on their surface by the scheme in Fig. 5 are presented in the table. The characteristic lengths of de Broglie waves λ_e at the given energies were calculated according to [16]: $\lambda_e \approx 12.25(1 - 0.489 \times 10^{-6}E_e)/E_e^{0.5}$. E_e is the energy of the electrons squeezing the charged plasmoid in eV. The relationships for the de Broglie wave length for the protons λ_p presented in the table are taken from Table 18 in [16]. In the P_e table, the electron gas pressure or the kinetic energy density in the plasmoid squeezed by a monolayer of high-energy electrons is estimated from below according to the scheme in Fig. 5. With a coulomb potential well, the free electrons (including the degenerated ones) with larger kinetic energy gather in the center of the plasmoid limited by the electric potential jump. According to the table, the Fermi–Dirac plasmoids increase the density of their inner energy (or the pressure P_e) by a factor of more than 300 ($P_e \sim E_e^{5/2}$) with only a tenfold growth of the energy of the electrons squeezing the plasmoid in the case of nonrelativistic electrons. For the relativistic ones, the density of the stored energy due to the coulomb cumulation grows to E_e^4, that is, by 10^4 when E_e increases by a factor of 10. Such relationships follow from our analysis of the energy cumulation in self-organizing energy reservoirs to store the kinetic energy of the electrons free from atomic nuclei and confined by the coulomb potential (Fig. 5c, d). Thus is formed a supra-atom—a charged metastable plasmoid with a focusing coulomb membrane. The huge kinetic energy of the electrons captured by a self-organizing coulomb barrier acts as a squeezing force. In this case, the total energy of the electrons captured and confined by the coulomb barrier is considerably larger than zero (Fig. 5). Such plasma structures are metastable (Fig. 5, c and d) and, with the coulomb membrane broken, can blow up, releasing the enormous kinetic energy (focused before by the membrane) of the confined free electrons. The collapse of quantum metastable stars can be attended by powerful gamma radiation.

According to the table, the plasma cumulation by a shock wave of an electric field, heating the electrons (the jump sweeps the plasma and inside the plasmoid $P_{e\uparrow}$), will cause the intensification of the charge separation and the enhancement of the spatial charge bilayer (Fig. 5) at the surface of any plasmoids, including collapsing stars. The author has examined the coulomb squeezing of stars with only hydrogen plasma. It is not very difficult to consider all the particular features, but the detailed examination of the star spectrum demands tedious computations. Thus, we are going to restrict ourselves to hydrogen plasma and studying the coulomb squeezing of stars and neglect the transmutation of hydrogen. The positive spatial charge of the whole star efficiently accelerates the electrons, going to its center, and retards the movement of the protons and positively charged ions to the positively charged star center, i.e., it will cool them and the neutrons colliding with them will cool down as well. The diagram of such a heater–cooler leading to a collapse of normal stars (plasma movement according to the arrow in Fig. 5c, d and Fig. 6) into white dwarves and neuron stars is presented in Fig. 6. In this case, the energy should be supplied to the plasmoid (or star) core (see the table, P_e) but not extracted as for normal stars. According to the Gauss law, $E(R) \approx Rn\alpha_{i1}/3\varepsilon_0$. Here, R is the star's radius, n is the average density of the nucleons, and α_{i1} is the degree of violation of neutrality (VN). The obtained results can be substantiated on the basis of the probabilistic approach, as well as from the viewpoint of the deterministic [22] or "Copenhagenian" approaches [16, 23]. In both approaches, the statistically average characteristic dimensions occupied by the localized particles are determined only by their impulse (energy) [16, 22, 23]. An electron with kinetic energy close to zero is situated with equal probability in the whole space; thus, it is more probable that it is out of the plasmoid, which leads to the quantum-mechanical separation of the charge in the plasmoid. Thus, there are no reasons to distinguish these approaches hereafter.

The interrelationship between the average de Broglie wave lengths of the free electrons and protons and the substance density in the cumulative–dissipative (CD) plasmoid structure squeezed by the electrons is illustrated in the table in accordance with works [16, 17, 21]. It follows from the condition of the quasi-neutrality (almost neutrality) of the whole substance with any quantum meso- or macro-CD structure (for instance, ionized by pressure) the approximate equality of the average characteristic quantum-mechanical dimensions of the free sharing electrons (λ_e) and atomic nuclei (λ_N) or their de Broglie waves in this structure with free electrons: $\lambda_e \approx \lambda_N$. If this relation is ruled out through the increase of the average de Broglie wave length for the electrons, the CD structure will force out of itself a part of the spatial electrons due to the gravitation. The generated spatial charge of the positively charged uncompensated nucleons will cool the positively charged atomic nuclei, thus increasing their λ_N. The external synergetic (joint) electric field will heat the forced out electrons (Fig. 5), thus reducing the efficient de Broglie wave length and focusing them to the star's center by the scheme in Fig. 6 and forming a nonequilibrium polarized plasmoid (Fig. 5). The approximate equality of the de Broglie wave's characteristic dimensions for the electrons and atomic nuclei imposes some condition on the characteristic energies of the electrons and atomic nuclei: $E_e \approx \psi E_N$. The parameter $\psi = E_e/E_N$, where E_e is the energy of the electrons and E_N is the energy of the nucleons, characterizes the relation of the energies of the electrons and nucleons under the condition of the dense substance's quasi-neutrality and is an indicator demonstrating the state of the plasma (equilibrium $\psi = 1$) or nonequilibrium ($\psi \neq 1$) (see the table). In the case of dense hydrogen (and nonrelativistic electron gas), the parameter $\psi = m_p/m_c = 1836$. Only in this case does the pressure of the degenerated electron gas heated in the bilayer (Fig. 6) stop the collapse of a white hydrogen dwarf, but tremendous energy in the star's core (see the table) with density $W_e > 4.4 \times 10^{22}$ J/m^{-3} is necessary for its collapse. The accumulation of the huge inner energy W_e happens due to the electron treatment of the surface of quantum stars by high energy electrons.

PLASMA LENS AND THE 3D ARRANGEMENT IN DISCHARGES

As is shown in [20, 24], the charged plasma 3D structures are a lens focusing the electrons at the bottom and their flow into plasma focuses. These focuses between the charged plasmoids are analogs of the Lagrange libration points L_1 discovered by Euler in the gravitational fields of spaced masses in 1769 and by the author [20, 24] for fields of spaced electric like charges. The flows of electrons are focused in plasma focuses and libration points where the electric field strength becomes correspondingly zero. As a result, the gas glow disappears at these points (Figs. 1–3); i.e., the discharge glow is structured by these libration points. This is the main reason for the origination of the Faraday dark space near the libration point—the Vysikaylo–Euler cumulation between the plasmoids charged by a positive charge (a cathode spot and a positive column). A rough geometric layout to determine the focus or libration point between positively charged plasmoids (a cathode spot and a positive column) is presented in Fig. 3 (photo 5). The dimensions of the focuses within the mode of nanosecond discharges with the electron drift and the gas particle ionization by the direct electron impact being the main processes are calculated analytically in [20, 24]. In the second part of this work, there will be performed the analysis of the studied processes of the cumulation and dissipation of the electron flow in the polarizable plasma structures with the charge distributed in the 3D space. We have carried out the classification of dissipative plasma structures and proved that the formation of dynamic surface tension caused by the electric field's generation, the heating of the electrons in it, and the corresponding electron pressure on the structure's periphery is possible on the charged structure's surface. In this case, the pressure of the peripheral electrons substantially exceeds the pressure of the ions ($P_i(P_e \gg P_i)$), as the ions are efficiently cooled by the neutral gas. The presence of the dynamic surface tension and the asymmetry of the external actions can lead to the formation of cumulative jets wallowing from the charged cumulative–dissipative structures squeezed by the electron pressure. The jets are formed of the charged high energy particles. These cumulative jets complete a current path between the plasma structures (Figs. 1–3) and are responsible for their 3D structurization in 4D space–time, as well as for the plasmoid pulsations.

As is mentioned in part 2 of this work, there will be for the first time investigated the electron treatment of the surfaces of quantum stars: white and other dwarves and neutron stars with jumps of electric fields near their surface. It is proved that the surface of such quantum structures is lively treated and thus hardened by the high energy electrons. Such quantum structures are hardened through the coulomb squeezing (Fig. 5a). A new mechanism (type) of a thermonuclear reactor at the surface of charged quantum stars, the dense nuclei of normal stars, and planets with a liquid polarized core will be characterized in detail in part 2 on the basis of the performed analysis. The acceleration of electrons up to the energies measured in MeV in synergetic electric fields of the uncompensated charged particles in quantum stars and their transmutation in the near-surface layer with the enormous electric fields into neutrons in reactions with protons is the fundamental principle of the new mechanism of atom transmutation in stars. The tremendous electric synergetic (total) field of all the uncompensated ions (Fig. 5b) heating the electrons up to the energies of ~1 MeV and more at the average values of their de Broglie wave lengths in the near-surface jumps of the charged plasmoids and quantum stars and the cores of normal stars and planets is the catalyst of proton neutralization and the consequent transmutation of chemical elements in these reactions (the inverse β-decay). A supra-atom (Figs. 5a, 6) is thus suggested as a model to characterize quantum stars and the dense cores of planets. This is a possible mechanism of thermonuclear reactions in other plasmoids, such as lightning discharges, jets, blue streams, etc. However, the efficiency of such transmutations of atoms seems to be little there. This model (Figs. 5a, 6) dates back to the model used by Rutherford in his experiments when studying the atomic structure. In the case of ordinary gas-discharge plasmoids, the forms of such charged structures are determined by the discharge parameters. The electric field jumps (shock waves) can both press the structure and sputter it by the space charge of positive ions. 4D structures pulsing in space and time are possible.

DETAILED ELABORATION OF SOME PROBLEMS AND REVIEW OF THE PREVIOUS SOLUTIONS

Examining the outer space structures and plasmoids in gas-discharge plasma, it is usually assumed that all these structures are absolutely neutral [20, 24]. In the case of dense stars such as white dwarves and neutron stars, this means approximate equality of the de Broglie wave lengths of the electrons and nucleons and atomic nuclei pointing to the difference of their average kinetic energies by a factor of $(M/m)^{0.5}$ (nonrelativistic case). Otherwise, a part of the electrons free from atomic nuclei forming a Fermi gas or a Fermi liquid with their large average de Broglie wave lengths will be forced out of the structure of a quantum star or a plasmoid. For example, in [25], on pp. 349–350, it is stated that the "separation of charges of both signs is rather disadvantageous in terms of energy due to the appearance of very big electric fields." That is a reason to use the neutral gas model for the simulation of quantum stars. The theory of a neutral medium is further elaborated in work [25] for white dwarves and neutron stars, in which a considerable part of the electrons are sharing ones and form a degenerated Fermi gas or Fermi liquid stopping the star's collapse. Astrophysicists do not investigate why the sharing electrons with little resting masses have an average kinetic energy much greater than large nucleons and ions (their de Broglie wave lengths should be equal in a neutral state). The source (3D heater) warming the electrons and the 3D cooler actively cooling the hot nucleons and transferring their total energy to the electrons are ignored in such a neutral consideration, which is the reason the plasma nonequilibrium in Fermi–Dirac plasmoids (quantum stars) is not examined, and the effect of the degenerated electron gas pressure on the sizes of quantum stars is considered without a detailed study of the powerful process of the energy pumping from nucleons to electrons. Such pumping can result from only the action of enormous (synergetic) electric fields or electric potential (Figs. 5 and 6).

There appears a new conception in [Physics-Uspekhi]. Here, is a statement of one of the votaries of such an approach: "One research team at the Lebedev Moscow Physics Institute with Academician Aleksandr Viktorovich Gurevich as the leader since 1992 proposed, besides objections, their own explanations for both sprites and lightning strokes in general. From this viewpoint, the lightning strokes are governed by the showers of secondary ionized charged particles forced out of air atoms by energetic particles of primary cosmic rays (ambassadors of supernovas; galaxies; and, possibly, mysterious black holes)." The authors and votaries of this conception do not explain the essence of such a notion as the breakdown and how the electrons are accelerated within the breakdown up to energies of 100 keV and more. It should be noted that, with the dimensions of lightning discharges (about hundreds of meters and even kilometers), electrons with energy even more than 2 MeV do not run far (2–4 m). The formation of a plasma channel hundreds of meters long is necessary for them to run in some direction, but no such channel is noticed in this conception or it is hidden by the authors by the term "breakdown." Therefore, in this "conception" based on the priority of cosmic rays in lightning, the author, unlike the votaries of cosmic rays, assigns the problem of the first electron (the external ionizer, UV radiation, etc.) but not the problem itself of the moving powerful mechanism of discharge and plasma self-condensation at the dimensions of hundreds of meters. The main energy source and the method of focusing its energy in linear, beaded, or globe lightning as a plasma structure charged by a positive charge are related to the problem of the mechanism of the discharge (lightning), as well as the specific way of the electron acceleration up to energies of ~2 MeV and more in the plasmoid, in which there are initially free electrons.

CONCLUSIONS

The assumption of neutrality is often used in the description of gas-discharge plasma and other ones. These assumptions of the absolute neutrality lead to the so called asymptotic paradoxes, which cannot be explained within the limits of quasi (absolute) neutrality. Even a slight violation of neutrality (about $(n_i - n_e)/n_i \sim 10^{-18}$) due to the forcing out of a small part of the electrons from the structures causes the sputtering (bouncing) of the previously cumulating (gravitating) neutral structures [21]. On the other hand, as is proved in this work, the separation of charges results in the generation of the coulomb surface tension squeezing huge plasmoids, including stars with densities up to those of quantum stars (see the table). Can such coulomb surface tension caused by coulomb forces squeezing the plasmoids be applied practically? Undoubtedly, it will be possible in the not so distant future. There fly globe lightning strokes doing only damage. It is high time for such lightings and common ones to do good, as is now useful in the nanoconstruction of the layers of a spatial charge in nanocomposites [7]. A slight violation of neutrality or polarization in the system of plasma structures results in the formation of a system of a plasma lens (strata) [20, 24]. As proved in [20, 24], the finite-dimensional 3D strata focus the electrons into focuses or libration points. These focuses are similar to the Lagrange points L_1 discovered by Euler for two gravitational attractors (for instance, between Jupiter and the Sun) in 1767. The detailed investigation of the dynamics of the self-constriction and cumulation of plasma structures can be evidently applied to free the atmosphere of dust and a number of deleterious substances. Allowance for the neutrality of giant plasmoids may make it possible to explain the quick recession of galaxies in which there are many quantum positively charged stars continuing to cumulate a positive charge. The overwhelming majority of protons in cosmic rays point to their reflection from the normal and quantum stars. It is well known the problem on the Universe's overheating due to the radiation of normal stars. This overheating should happened as the radiation energy of normal stars grows in a sphere by the law of R^3 and is thrown out of the sphere by the law of R^2. The existence of cumulation of the star radiation energy by the law of R^3 follows from the very fact that we are alive within the radiating Space. The presence in the Space of quantum stars being effective accumulators of the electromagnetic radiation (of any energy and mass) protects us from overheating.

Actual experimental investigations and an analytic study will be considered in part 2 within the framework of the model proposed for polarizable or charged plasmoids.

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