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RESEARCH ARTICLE

QUANTUM PLASMA CONDENSATE AS NEW SOURCE OF ENERGY: THE OPERATION PRINCIPLE OF THE PLASMA ULTRAVIOLET LASER

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ABSTRACT

A fundamentally new direction in the theory and technology of the non-ideal plasma was developed. Researches have made it possible to predict and confirm the existence of fundamentally new state of matter, which is quantum plasma condensate, which combines the traits inherent in normal fluid and signs characteristic of ionized plasma in the usual sense. Quantum plasma condensate is a renewable, environmentally friendly and efficient alternative energy source. This source is the only ecology clean, does not deplete and not polluting our planet, and use it cleans very planet Earth and its environment. The operation principle of quantum plasma condensate ultraviolet laser was described. The laser use industrial waste, and formed the new state of matter, which is solid plasma phase. This fact suggests the emergence of electric discharge plasma metallurgy.

INTRODUCTION

The energy problem in most developed countries is now more clearly speaks to the fore. Further development of industry and technology is directly linked to achievements in addressing this urgent problem. Natural sources of energy (minerals) are already greatly depleted. When it burned preciousorganicraw materials, which is nearly impossible to recover. Moreover, this burning is formed in a large quantity of ballast material, hardly amenable to technological processing, which forms a whopping slag discharges into three key natural areas. Slag this poisons the environment medium regardless of whether it is visible or invisible to the naked eye. Operation of modern energy "machines", as an integrated energy reproduction scheme, can be characterized by three efficiency ratios (efficiency):typical thermodynamic efficiency, proportional to the energy density of incinerated materials; efficiency of chemical factor that defines the level of reproduction of valuable chemical composites; efficiency of ecological ratio, which is the levels of purity attitude, for example, the atmosphere or water sources, made in a conventional scale and evaluated on this scale before and after the completion of the reproduction cycle. The prevailing stereotype of the engineering mindsetis evaluates the degree of excellence of energy technology basically only on the criterion of the first from the coefficients: the higher the better. This leads to the fact that the remaining two coefficients are large factor modulo, but negative in sign. A posteriori attempts to eliminate the negative aspects of production are time consuming, inefficient and with huge energy consumption. Soaviciouscirclein energy: it is produced in a cycle of a certain amount of energy, the lion's share of which must be spent on addressing the negative effects, at first glance, side. It can be argued, however, that the development of modern physics and chemistry has reached so high level that is quite justified to put a question on the establishment of such energy sources that would have been quite effective in thermodynamic terms, and at the same time, practically does not create negative impacts on nature. Energy sources of chemical type are valid due to the combustion of a given fuel type. Hydro create mechanical source. Of course, the principle of operation of such a source is extremely simple, however the possibility of this kind of sources are limited, and most importantly their use is associated with the need to solve the problem of ultra-long distance transmission. Transmission lines should be superconducting; the principle of the use of such lines is still a fundamental problem, moreover rather scientific, than applied,

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technical. Certainly effective in quantitative terms (that is on the level of specific energy output) is a nuclear power. Here, as you know, two ways: thermonuclear fission and thermonuclear fusion. Anyway, but the first path is seen usually as temporary, passing. Stage of uranium nuclear burning should continue until either will be lit artificial (manufactured) suns. Unfortunately, tangible progress in this area is not observed for historically notable dates. Natural sources of thermonuclear fusion can function at the expense of powerful gravitational forces, the equivalent of which we cannot yet create in the laboratory. Besides, more and more evidence suggests that even in the depths of the stars are implemented and other sources of energy, not nuclear type. Therefore, we need more and more *imperative to consider backup policy on obtaining of alternative energy*.

In this regard, it should be pointed out, first of all, on the physical-chemical methods of energy obtaining and transforming. These methods are still far from exhausted, moreover, the development of modern nonlinear physics, quantum theory of many particle systems, statistical physics provides the basis for the development and use of these methods. Conventional chemical energy extraction methods based on paired molecular interactions that led eventually to the formation of new molecular compounds, which are energetically more favorable, with a reduced energy state. The excess energy is caused by changes in the energy context of interacting molecules. Is it possible the connections of atoms of a substance into a single super-molecule in macroscopic scale with efficient energy output? It can be argued that such connections are possible, and relatively weak depending on the chemical composition of the source material. To some extent, already normal phase transitions in matter, for example condensation of steam into liquid, clearly demonstrate the reality of this kind of transformation. Really, power of there is not so significant, as in the case of strongly exothermic chemical reactions. However, quantitative interatomic processes are possible, and the level of the allocation of energy in it could exceed the corresponding output in reactions with specially selected chemical reagents. We have given the *plasma modifications, accompanied by the release of energy*.

Physical essence of the phenomenon is as follows. Electrons separated from atoms are moving almost as free particles in plasma. Coulombforcesare, asiswellknown, long-ranged. These forces are escaped in the so-called Debye area surrounding each of the charged particles. Outside the specified realm the field's tension generated by the particle, exponential manner with subsides; at the same time particles trapped inside the sphere, are disperse, and every act of such scattering is called a Coulomb collision. In general, the plasma is behaves almost like ideal gas of charged particles, and the interaction between particles is simply Coulombco-blows. However, when condensation of plasmathe greater role played by quantum nature. And it's not in the usual perception of the wobble hypothesis of the electrons. We found that even before the stage of degeneration, overlapping electronic wave clouds becomes essential (Kulakov, 1988). The overlap creates the effect of a *first-order* with respect at the de-Broglie wavelength relative to the inter-ions destination. If in substances that are in the normal phase condition, overlapping also exists, but exponentially falls with the growing distance between atoms in plasma, because the spectrum of quantum energy states of the electrons in it is continuous, the effect of weakening of shell overlapping with overlays of inter-particle distance is significantly *slows down* and describes by the power dependence. As a result in plasma with moderate density (ions concentration are $n \approx 10^{20} sm^{-3}$) occurs this picture of mutual adhesion of particles, which corresponds to a chain of sequentially overlapping electronic clouds, moreover each of the chain branches covers a distance of the escape radiusorder. All the chain covers the entire plasma: plasma ions, "captured" in this chain, attracted to each other, and the result is a phase transformation of plasma. *The transition to a new state accompanied by energy allocation equal to the heat of transformation.* Quantitative analysis below shows that the allocation of energy can be very significant. Nature of overlap exchange forces especially clearly evident in the increase in concentration of electrons, when the number of electrons per ion, significantly exceeds the unit. The fact of overlapping electronic shells of atoms leads to the effective coupling well known from the theory of the chemical bond. Enough, for example, point to the Heitler-London theory of molecular forces, in which such forces are detected when calculating the simplest molecules using variational method. Currently, this method is most often used for calculation and explanation of the structure of molecules and the forces acting between the constituent atoms. Variational methods in physics are refers to the category of intuitive, a posteriori. Consistent heuristic theory can only be a theory which is based on direct solution of the fundamental equations of quantum theory that is the Schrödinger equation. Exactly this is the perturbation theory taking into account exchange forces (or the principle of Pauli), first described in (Kulakov, 1988).

This theory (common in state class of continuous spectrum, which is being implemented in respect of states of electrons in plasma) helps to explain the observed features of plasma phase (Kulakov, 1991),as well as predict and use the properties of this phase, which can and should be used with modern equipment and technology. We are talking about the manifestations of not ideality plasma, moreover not ideality of quantum origin. Some aspects of this not ideality are effects in gases (Bashkin, 1986), and in electric discharges (Ayrapetyan, 1988 and Trubnikov, 1990).Thus, *we have developed a fundamentally new direction in theory and technology of the not ideal plasma*. Our researches have made it possible *to predict and confirm the existence of fundamentally new states of matter that is the quantum plasma condensate*, which combines the traits inherent in ordinary liquids (fluidity, surface tension, internal correlations), and signs characteristic of ionized plasma in the usual sense (Kulakov, 1988; Kulakov, 1990; Kulakov, 2016; Kulakov, 2015 and Kulakov, 2017). *Quantum plasma condensate is a renewable, environmentally friendly and efficient alternative energy source on the planet Earth.This source is the only ecological clean, does not deplete and not polluting our planet, and its use cleans the very planet Earth and its surrounding medium.*

Mastering the theory of quantum super-exchange forces in condensed mediums gives a key to scientists for design devices that use energy allocated in the plasma process for various applications: heating, lighting, converting into electrical energy through, for example, the photocells or MHD-movements, obtaining ultraviolet and x-ray radiation.
Confirming the above, consider the functioning principle of the *quantum plasma condensate ultraviolet laser*. Modern energy is in dire need of medium-scale energy source,

environmentally friendly and not associated with the consumption of expensive resources. It is to this kind of source should include proposed the option of a completely new energy device based on phase transitions in the plasma. In conventional laser and maser devices use atomic and molecular systems as a carrier of electromagnetic field. Pumping and radiation carried out with this due to discrete (quantum) transitions between energy levels that were selected in a certain way. We can realize optical and x-ray emission in plasma due to the use of a combination of transitions in continuous and discrete spectra of ionic and atomic states. In not degenerate plasma are possible the quantum states of a particular type, caused by electrons and ions bounding, i.e. the action of the effective force of attraction between particles, the result of which is the formation of a new stable energy levelslocated below the basic levels of isolated atoms. This is due to the action of specific quantum forces that arise in electronic exchange bars, and it turns out that the exchange effect should consider exactly in a continuous spectrum (i.e. in ionized state of substance). It is quite enough that ratio λ_b/r_e was equal to 1/3÷1/5for "plugging in" the quantum forces,i.e. it is enough just the "order" approximation of the de-Broglie wavelengthλ_b to the distance between electrons. This is the specificity of the continuous spectrum plasma: wave functions of electrons are oscillating in nature, its weakly vanishes with the distance between the atoms, and so the wave functions overlap can be considerable. It was shown that such forces could lead to the formation of new collective energy levels in systems (Kulakov, 1988; Kulakov, 1990; Kulakov, 1991; Kulakov, 2016 and Kulakov, 2017).Similar phenomena (only for external physical manifestations in relation to the properties of the energy spectrum) have a place in superconductors: conduction electrons that are initially quasi-free are clearly pronounced tendency towards mutual mate, resulting in the formation of Cooper pairs and energy gap in the spectrum, which leads to superconductivity (Kulakov, 1990). The calculated plasma level of lowering the energy of the electronic system W_1 (in order of magnitude, and based on a single electron) is equal to (Kulakov, 1988).

$$W_1 = -3 \cdot z^2 \cdot e^2 \cdot n^{1/3} \cdot \Lambda.$$

Where z is the degree of ionization ion, n is concentration, e is electron charge in *cgs*units, $\Lambda \sim 15$ is logarithmic factor (type of Coulomb logarithm).

Denote I as ionization energy calculated by one electron. Then the above interaction leads to a lower energy level of particles (relative atomic) when an inequality $I < W_1$. It is clear that this condition is relatively easy runs in fairly dense (but not yet degenerate) plasma. That is, the efforts may be significantly less than energy in the laser radiation. All of the known types of lasers do not possess such properties (except, perhaps, gamma-ray lasers, operating from the nuclear pumping).The frequency of the transition from a state of continuous spectrum in the lower energy state is equal to $\omega = W_1/\hbar$, and the efforts of substances ionization are compensated by phase allocation of energy. The best way to get excess energy, equal modulo $|W_1|$, is the creation of a dense gas discharge of a mixture of easy ionized chemical elements, such as cesium, carbon, nitrogen and others. If we take $n = 10^{19} cm^{-3}$, $z = 5$, we will get per unit volume ($1\ cm^3$) of such a mixture

$$|W_1| = 3 \cdot 10^{-16} n^{4/3} erg \approx 30\ kJ/cm^3.$$

This energy radiates mostly in the lines of the spectrum with energies of $\hbar\omega \approx 10\ EV$, i.e. in the ultraviolet range. The duration of radiation is determined by quantum transition. The characteristic times of radiation is determined by the diffusion of quanta. Thesetimeshavetheorder$\tau \approx 3R^2 n\sigma/c$, where $\sigma \approx \sigma_0 n\lambda^3$is cross-section of the inhibitory processes, $\lambda = 2\pi c/\omega \approx 10^{-5} cm$is the wavelengths of quanta emitted, $\sigma_0 \approx 10^{-24} cm^2$ is Thomson's scattering cross-section; from here $\sigma \approx 10^{-19} cm^2$. The minimum time for radiation is $\tau \approx 10^{-7}$-$10^{-8} sec$. Therefore, radiation power can make $10^{12} W/cm^2$. When the concentration is $n \approx 2 \cdot 10^{19} cm^{-3}$(barometric pressure) and a single ionization of such elements as lithium, boron, sulfur, silicon, phosphorus, copper, iron, energy is $W \approx 25\ EV$, that is several times higher than the efforts of ionization.

Thus, materials for laser can serve virtually any wastes that contain these elements in abundance. Take enough, for example, gas coming into the smoke alarm, and use it as a plasma emitter. To do this, you need the following:

- Collect the gas and heat to a temperature of a few thousand degrees at 1 *ATM* pressure. In the early stages it is advisable to use compounds from easily ionized atoms or molecules.
- Ionization can be made with pulsed electric field with such tension breakdown that would provide (when submitting the "priming" electrons with energy $\epsilon \approx 10\ kV$) thelength of run on energy $l_\varepsilon \approx I/n\sigma\varepsilon$ ($\sigma \approx 10^{-16} cm^2$ is elastic scattering cross section), where you can purchase energy order starting, which would enable the development of discharge with subsequent ionization.
- Move to the lower energy level goes under the influence of the quantum exchange forces, accompanied by radiation quanta with frequencies $\omega \geq W_1/\hbar \approx 10^{17} sec^{-1}$, i.e. already in the soft x-ray region. An increase in concentration and charge will lead to more severe radiation quanta. We are seeing this radiation, it seems, in a number of plasma elements (for example, when pinch effect, explosive or drip issue, etc.) (Ayrapetyan, 1988 and Trubnikov, 1990).

The proposed laser mechanism differs from other known primarily because pumping is carried outat frequencies less than the operating frequency. An important feature of plasma ultraviolet laser is that the *energy of the laser radiation will be charged not from an external source (pumping), but represents the internal energy phase transition in the plasma*.

It is important to keep in mind and fundamental aspect associated with the study of this new physical phenomenon: *the plasma transition accompanied by spontaneous generation of a magnetic field*.

Plasma laser devices are completely safe; safety relates only to normal working with the technique of power voltages. Materials which are used (a mixture of light elements) is very cheap, any extra costs to receive them is not required. Materials which are used (a mixture of light elements) is very cheap, any extra efforts to receive them is not required. Almost as laser fuel in the production of laser energy we can apparently use the *trash* in the literal sense of the word. It is not excluded that this (use of waste, "revaluation of values", even wrestling for waste) will be characteristic of civilization of the twenty-first century. Appliances, like nature, must be

rational. Another important circumstance is: the allocation of energy process is accompanied by phase transformation of the substance of the new species. First substance type the plasma liquid is formed from the plasma discharge, and then (if further cooling) hard conglomerate is formed that is the crystalline formations. We meet with this kind of transformations, for example, in nature, with volcanic eruptions. It seems that the *hard phase plasma is a substance with something new not predictable properties*. Anyway, if "combustion", we get new, maybe very useful materials. This area can be called *discharge plasma metallurgy* (Kulakov, 2017).

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