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Review Article

Electric currents in cumulative-dissipative structures of the Universe

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Introduction

Historians believe that China was the first civilization to create a magnetic compass that could be used for navigation. They knew 2,000 years ago that rubbing an iron needle against a natural magnet would temporarily magnetize the needle and it would point north and south. The Europeans adopted the invention of the compass from the Chinese in the late 12th century. This is reported in the 8th grade physics textbook in the Russian Federation, A. V. Peryshkin, § 61 [https://gdz.tutoronline.ru/fizika/8-klass/fizika-8-klass-a-v-peryshkin/61-magnitnoe-pole-zemli]. The compass is a very important practical application of the Earth's magnetic field for navigation. Based on this paradigm, scientists have not yet been able to determine the cause of the generation of solar and cosmic winds and the energies of positive ions in these rays. It is believed that magnetic storms come from the Sun, affecting the well-being of weather-sensitive people, and technologies for treating magnetic fields have appeared. At the same time, the influence of the arrival of a huge number of protons (during magnetic storms) on negatively charged leukocytes is ignored by representatives of this paradigm.

The author shares and explores the second paradigm in his works. It consists in the special importance of electrical forces compared to magnetic forces. In this paradigm, electric fields acting on charged particles cause their flows, and the currents, according to Maxwell's equations, form magnetic fields. (The smallness of magnetic forces compared to electrical forces is determined by the parameter v/c). In this paradigm, it is believed that Coulomb's law is true for any objects with an electric charge, from electrons to gal axies (at characteristic sizes of their interactions from 10^{-15} to 10^{26} m) [1-4]. This paradigm is not properly accepted in astrophysics. We have applied this second paradigm to describe phenomena in the heliosphere [4]. Before we list our achievements, we will dwell on the history of the development of this paradigm in physics.

The study of the interference of gravitational and electric potentials on the Earth's surface began with the work of William Gilbert in 1600 (long before the discovery of Coulomb forces in 1785). He found that the petals of his electroscope levitated near a candle flame. We now know that free electrons are born in the candle plasma. They have a small mass and are therefore very mobile. They penetrate into the petals of the electroscope and charge them with a negative charge. The petals, charged with like charges, repel each other and they levitate in the Earth's gravitational field. Perhaps viruses have learned to levitate in negatively charged water droplets above the surface of the negatively charged Earth. This raises questions about 4D virus infections. Based on the first paradigm about the importance of only magnetic fields, all these phenomena cannot be explained! Such polarization effects - the interference of Coulomb and gravitational forces - have not been well studied even in the heliosphere. Many works have been devoted to this problem. The Pannekoek-Rosseland-Eddington model took into account the difference in the masses of electrons and positive ions (protons), but did not take into account the important role of high-energy runaway (from the Sun) electrons and, accordingly, the duality of electron flows in the heliosphere (from the Sun and to the Sun due to its positive charge). According to the alternative model we have formulated, high-energy electrons (emitted from the positively charged Sun) (with energy greater than 18 keV) leave the Sun and

the heliosphere, while low-energy electrons, unable to leave the Coulomb potential hole – the positively charged Sun and the heliosphere, return to the positively charged Sun. The small difference between the opposite currents of high-energy electrons (emitted from the Sun) and low-energy electrons (returned to the Sun) is compensated by the current of positive ions and protons from the Sun. This is how the solar wind (SW) is formed (Figure 1) [4]. In this case, positively charged particles run away from +CDS, electrons (with energy less than 18 keV) are trapped in the heliosphere and form a temperature profile in the heliosphere, determined by the parameter E/n↓e, measured in Townsends (Td) [4]. All positively charged Vysikaylo's cumulative-dissipative structures [1-4] with sizes from 10^{-15} to 10^{26} m are formed in a similar manner. For this reason, +CDS have much in common and obey common laws. For example, the virial theorem holds for them [2]. In the presence of an uncompensated effective charge of the Sun, according to this model, positively charged ions are selected by the magnitude of their charge. As our analysis of experimental observations of positively charged iron ions showed, ions with a charge of Fe5+ are not recorded, while ions with a charge of Fe6+ and more are observed in the SW. In this case, lighter positive ions with a charge of C4+, O5+ are recorded. This phenomenon of selection of positive ions allows us to estimate the dynamic charge of the Sun at a level of 1400 C (all the way to the Earth's orbit and possibly further). These experimental data from the L↓2 Earth-Sun point allowed us to calculate the profile of the Vysikaylo's parameter (l↓E = E/n↓e), the profile of the electron temperature (T↓e(r)) in the entire heliosphere and allowed us to explain all the parameters of the positive ion flows and the behavior of their components. At the same time, the quasi-neutrality of the Sun and the heliosphere is well maintained up to $\alpha \sim 7.2 \cdot 10^{-36}$ ($\alpha = (n_i - n_e)/N \ll 1$, N is the density of the number of nucleons) [4]. In this case, the ratio of the charge number Z to the mass number of nucleons M in positive ions flying in the SW $Z/M > 0.107$. Stellar winds of protons are observed even for black holes at $\alpha_0 \sim 0.8 \cdot 10^{-36}$. Apparently, intergalactic lightning, like the jet from the galaxy M 87 (1781), is formed at $\alpha > \alpha_0$ (for the black hole at its center).

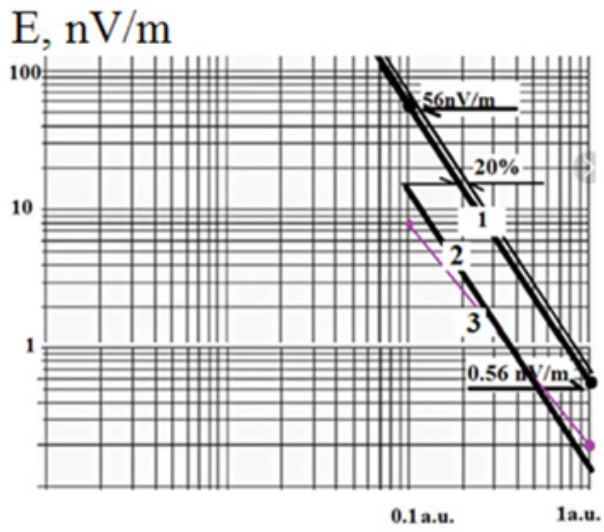

Figure 1: Calculations of electric fields in the heliosphere: 1- according to the spectrum of positive ions in the SW [4] (QS = 1,420 C; error less than 20%); 2 - according to the Eddington's calculations; 3 - according to the calculations of the electric field based on experimental observations of the electron distribution function using the Parker solar probe (QS = 200 ÷ 500 C, the dependency 3 is built by J.S. Halekas).

Within the framework of the second paradigm, we have explained all the parameters of the weak (constant) solar wind (proton velocities, electron temperature profiles throughout the heliosphere, components of positive ions with $Z/M > 0.107$ flying in the SW). Originating on the Sun, the SW (protons and positive ions with $Z/M > 0.107$) rushes past the Earth at a speed of 400 km/sec (about 1,400,000 km/hour), reaches distant planets and goes into interstellar space due to the positive charge of the Sun [4].

The presence of a negative charge of 500,000 C on the Earth and a charge of 1,400 C on the Sun allows us to substantiate the hypothesis about the possibility of a global non-uniform nonequilibrium discharge between the Sun and the Earth [4]. The positively charged Sun acts as an anode, and the negatively charged Earth acts as a cathode. This hypothesis was put forward in 1896 by the Norwegian physicist Olaf K. Birkeland. He suggested that the aurora borealis could be created by electrically charged "corpuscular rays" ejected from the Sun and "drawn" by the Earth's magnetic field near the poles. He came to this conclusion based on the fact that the aurora borealis are very similar to an electrical discharge in the then recently invented tubes generating streams of charged particles ("cathode rays").

Within the framework of a detailed development of this second paradigm, the following becomes clear [4]: 1) the parameters of SW; 2) discharges in the upper layers of the Earth's atmosphere (at altitudes above 30 km); 3) charge characteristics on the day and night sides of the Moon (during the day, protons flow to the Moon, and at night, only electrons return to the Sun), which causes longer levitation of dust on the dark side of the Moon.

The presence of intergalactic lightning, for example, in the region of the galaxy M 87 and the above considerations about electric currents in the heliosphere, allow us to assert the presence of global currents in the Universe at all sizes (from 10^{-15} to 10^{26} m) of Vysikaylo's cumulative-dissipative structures [1-4], and not only in the Earth's atmosphere, as stated in [5].

We have proposed an original method for determining the effective charge of the Sun and the inner heliosphere by the types of positive ions in the SW [4]. This method must be used in all solar, planetary and satellite probes such as the Parker probe. The author believes that the color line constructed by Halekas in Fig. 1 is more informative for most physicists than all the results given in [6].

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