International Journal of Advanced Research in Physical Science (IJARPS)
Volume 11, Issue 12, 2024, PP 32-37
ISSN (Online)-2349-7882
www.arcjournals.org

Magnetic Field and Differential Rotation of the Sun

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Abstract: *On the basis of consideration of the processes taking place in the interior of the Sun, it was shown that the use of the model of the Universe with the minimum value of the initial entropy (UMIE) allows to adequately describe a number of effects observed on the Sun, namely: (1) The Sun receives at a constant rate about 4.76•1012 kg/s of bineutrons around existing nucleons, increasing the mass of atomic nuclei; (2) the center of the Sun contains ions of heavy chemical elements according to Maxwell-Boltzmann statistics; (3) constant radiation processes and nuclear explosions take place in the core of the Sun, as a result of which an acoustic standing wave is maintained; an acoustic wave is registered on the surface of the Sun; (4) radial flows of electrons and protons, which arose as a result of radiation processes and nuclear explosions in the core and in the zone of radiative transfer, cause the appearance of double electric layers, which, due to the rotational movement of the Sun, cause the appearance of the solar magnetic field; (5) the radial flow of protons together with the rotation of the Sun causes the appearance of a mechanical moment that decelerates the inner part of the Sun and accelerates the equatorial part, and the value of this moment decreases to zero when approaching the poles, as a result of which the speed of rotation of the poles is lower than that of the surface in the region of the equator.*

Keywords: *The UMIE model, the birth of matter, radiation processes and nuclear explosions in the volume of the Sun, explosions on the surface of the Sun, the magnetic field of the Sun, and the differential rotation of the Sun.*

1. Introduction

Scientists have been studying the structure and characteristics of the Sun for a long time [13]. However, many questions remain unanswered: (1) how the Sun was created, (2) what source of energy the Sun uses, (3) what is the nature of solar magnetism, (4) what is the reason for differential rotation of the Sun and many others.

Astrophysicists discovered that the Sun rotates at different angular speeds at the poles and in the equatorial region. At the same time, it was established that the period of rotation of the Sun at the equator is 25.38 Earth days, and at the poles, it is 34.4 days. Of course, there have been many attempts to understand the reason for the Sun's differential rotation [2, 3, 13 and the references and analysis of scientific data contained therein].

I will not analyze all mechanisms of differential rotation, the nature of the magnetic field, and other issues considered in the literature since they are known to specialists and do not solve scientific problems. However, I will express my opinion regarding various aspects of the Sun's physics.

It seems that astrophysicists are trying to understand the reasons for the Sun's differential rotation with the help of a phenomenological approach, going through various known mechanisms. And above all, they use the Standard Model, which has no right to exist [8, 9].

The remarks mentioned above led to the appearance of scientific research by the author of this article. Of course, the consideration of these processes taking place on the Sun will be conducted using the model of creation of the Universe with minimum initial entropy (UMIE) [8, 9], which the author of this publication developed.

2. Creation of Matter in the UMIE Model

In the Standard Model of the creation of the Universe, it was created from a singularity due to the Big Bang at the moment of time T_U = 13.8 billion years ago [1, 12]. At the same time, all matter immediately appeared in a boiling and dense state (~10^{28} K [5]). The initial entropy was equal to S_0 =

10^{88} J/K [6]. It is clear that with such large entropy, the creation of stars, planets, and galaxies is impossible. In addition, such a model required that the Universe immediately appear inside the black hole.

In contrast to the Standard Model, the UMIE model assumes that matter in the Universe is created gradually at a constant rate. In addition, our Universe is a component of the Super-Universe, which consists of four layers: zero-dimensional space (World-1), one-dimensional space (World-2), two-dimensional space (World-3) and World-4 - our three-dimensional space. There is an information interaction between adjacent layers through one delocalized point. At the beginning of the creation of the Super-Universe, each layer is represented by a space with collapsed coordinates of fundamental dimensions [10]. All the indicated layers are branes of spaces with a dimension one unit larger. The brane radius increases over time at the speed of light.

The 12 collapsed spatial coordinates of the zero-dimensional space cover all the spatial coordinates of the stratified space, making it possible to interact between the processes occurring in the zero-dimensional space and those occurring in other spaces. The Scalar Field enters through the zero-dimensional space at a constant speed. The Scalar Field carries the program (universal code) for creating the Super-Universe. This Field gradually fills all the layers of stratified space. The Scalar Field fills our Universe with a delay of $3 \cdot 10^{-5}$ s. In three-dimensional space, the rate of filling with energy that creates matter is $1 \cdot 10^{34}$ kg/s [8, 9].

The Scalar Field is also responsible for the existence of mass in particles. At the same time, the mass of newly formed atomic nuclei will increase, reaching values that may significantly exceed the mass of uranium nuclei. Nuclear fission reactions will occur, leading to the birth of protons and electrons, and will also cause the substance to heat up. This explains why heavy chemical elements, including uranium and plutonium, are present on Earth and why the central regions of all planets and stars have high temperatures. In the center of the planets and the stars, normal nuclear processes occur, accompanied by the release of a large amount of heat and sometimes by nuclear explosions. There are no thermonuclear processes there. The birth of helium due to a thermonuclear reaction is theoretically possible only in the center of the Sun. However, during the existence of the Sun, helium atoms would hardly have been able to reach the surface in sufficient quantities. This mechanism cannot create nuclei of heavier chemical elements in the center of the Sun. In this case, it is necessary to answer the question: why the proportion of helium on the surface of the Sun is ~25%; where did oxygen (0.77%), carbon (0.29%), iron (0.16%), neon (0.12%), nitrogen (0.09%), silicon (0.07 %) and other chemical elements? [13]. The Standard Model cannot give convincing explanations of the nature of the processes of the Sun.

And what does the UMIE model provide?

The space in the Universe is immediately filled with vacuum particles, the energy of which in the ground state is zero [4]. Unlike a vector electromagnetic field, a scalar field can immediately create material particles that do not have electric charges, spins, etc. Such are only bineutrons that are formed in the vicinity of existing nucleons. At the same time, bineutrons are in a singlet state. The first nucleons appeared due to the excitation of vacuum particles by the Scalar Field. We should immediately note that the processes of particle-antiparticle annihilation are caused only by the action of the Scalar Field. It is also responsible for the excitation of vacuum particles to the state of virtual particles.

Since there were few nucleons in the newborn space, and the birth rate of new bineutrons remained constant, heavy atomic nuclei quickly appeared, the mass of which in the first moments can significantly exceed the mass of uranium nuclei. An excess of neutrons in the composition of these nuclei leads to known nuclear reactions and, in particular, to the spontaneous disintegration of nuclei into lighter fragments. Example:

$$^{236}_{92}U \rightarrow {}^{y}_{x}A + {}^{234-y}_{92-x}B + 2{}^{1}_{0}n, \qquad (1)$$

where *x* is an arbitrary number within 1÷46, which determines the charge of the daughter nucleus, *and* *y* is the mass number of the daughter nucleus. As a rule, daughter nuclei also turn out to be radioactive, so the list of born chemical elements is growing rapidly. In addition to reaction (1), there are other reactions, in particular, the release of an electron or positron, a proton or neutron, an α-particle, etc. A complete set of nuclear reactions gives rise to all current stable and unstable elements.

This is how all intermediate atomic nuclei, from hydrogen to uranium, are formed within a star's nucleus. It is also how the mass of the initial embryos of future stars increases.

The mass of the Sun increases at a constant rate (about $4.76 \cdot 10^{12}$ kg/s [8, 9]).

The second mechanism for forming atomic nuclei uses secondary nuclei born in the primary decay of heavy nuclei. In this case, the birth of a bineutron near secondary nuclei, mainly protons, will cause the appearance of tritium and light helium nuclei. This chain of reactions will continue with the formation of heavier nuclei, particularly oxygen, nitrogen, and argon, which make up the basis of the Earth's atmosphere.

The volume of the Sun contains only plasma. Atoms exist only in the Sun's atmosphere. It is clear that according to the classical Maxwell-Boltzmann thermodynamic distribution, heavy atoms will be localized mainly in the center of the Sun, and light ones will appear near the surface. Therefore, there is no reason to claim that the entire volume of the Sun consists of hydrogen and helium. As a result of convective flows, several heavier atoms move to the surface of the Sun and increase their concentration in the solar atmosphere.

The flow of radioactive decay of heavy nuclei ensures constant radiation capacity of the Sun over billions of years. The accumulation of heavy nuclei in certain areas of the volume causes nuclear explosions, which cause plasma explosions on the surface of the Sun. Such nuclear explosions are much less common than on the Sun, and they appear in the bowels of the Earth, causing deep-focus earthquakes. Note that a thermonuclear reaction in the center of the Sun cannot cause plasma explosions on the surface of the Sun.

Nuclear explosions in the center of the Sun cause the appearance of acoustic waves, which are registered on its surface.

Since the intensity of nuclear explosions in the radiative transfer zone is much lower than in the solar core, the corresponding acoustic waves that reach the surface of the Sun must have a significantly lower frequency than from explosions in the solar core. Similar observations are described in [7], but the article's authors could not explain the results obtained.

3. Mechanism of Solar Magnetism

First of all, let's pay attention to the fact that the angular speed of the Sun's rotation at the equator significantly exceeds the angular speed at the poles. At the equator, the tangential speed of the Sun's rotation is 7.189×103km/h = 1997 m/s.

Secondly, although the volume of the Sun contains only plasma, each unit of volume is electroneutral. The rotation of such an electroneutral substance cannot cause the flow of ring electric currents and, therefore, cannot create a magnetic field.

Three layers are distinguished in the structure of the Sun: the solar core, which extends to 173 thousand km from the center; the zone of radiative transfer from the solar core to 494 thousand km from the center; and the same convective zone, which extends to the very surface ($R_{\odot}$ = 696342 km). There is no anomaly in the rotation of the Sun in the convective zone.

It is easy to understand that intensive radiation processes occur in the nucleus and the zone of radiative transfer. In addition, there is an increase in the concentration of radioactive elements to critical values, accompanied by nuclear explosions, and the frequency of explosions decreases with distance from the center. There are practically no explosions in the convective zone. Suppose such explosions occur in the zone of radiative transfer. In that case, their energy wave (which resembles deep-focus earthquakes on Earth) can reach the surface of the Sun and under appropriate conditions (for example, in the region where there is an output of the magnetic field to the surface, i.e., in the region of dark spots) can cause plasma explosions on the surface. These explosions in the radiative transfer zone are also accompanied by the transfer of light nuclei to the convective zone.

Explosions occurring in the core of the Sun and the radiative transfer zone can transfer energy and light atomic nuclei to the entire surface, providing radiation of electromagnetic waves and particles (electrons and atomic nuclei), which create the solar wind.

Therefore, there is a large flow of light nuclei from the core to the radiative transfer zone and a relatively weak flow from the radiative transfer zone to the convective zone. However, explosions in the radiative transfer zone cause explosions in the equatorial zone of the Sun's surface.

Using a rough model, according to which the volume of the Sun is divided into three zones, it is easy to understand the nature of solar magnetism. For this purpose, we will use the model published in [11]. During nuclear explosions, radial flows of electrons and protons occur in the solar core, and the proton flows lag behind the electron flows. In this way, a double electric layer is created at the boundary of the core and the zone of radiative transfer: an excess of positively charged particles (mainly protons) will be made under the surface of the solar core, and an excess of electrons will be created above the surface. These layers, having the exact electrical charges and being at different distances from the center of the solar core, rotate at different linear speeds, forming ring currents. These ring currents create magnetic fields, the difference of which contributes to the Sun's magnetic field. The greater the distance between the layers, the greater the magnitude of the Sun's magnetic dipole. Similar currents should be created at the border of the radiative transfer zone and the convective zone. It is clear that such currents increase from the pole to the equator, and there are no ring currents at the pole.

Let's imagine that sometimes a powerful nuclear explosion occurs at the border of the radiative transfer zone and the convective zone, which causes turbulent flows in the equatorial zone of the Sun, that is, in the region of high magnetic field intensity. The interaction of such flows with the magnetic field can create a frozen magnetic field, which, for a long time, will manifest itself in the form of dark spots on the solar surface. The configuration of the magnetic field in the region of dark spots resembles the magnetic field around a ring superconductor with a current. However, this is a single line of force closed on itself. As the plasma density decreases towards the surface of the Sun, the density of magnetic field lines will be more significant in the lower part of the frozen magnetic field. When the frozen magnetic field reaches the surface, the density of lines of force in the upper part will decrease, and the energy of the frozen magnetic field, according to the laws of electromagnetic induction, will cause the creation of an induction current in the region under the region of the frozen magnetic field. As a result, the frozen magnetic field will switch to the lower region. At the same time, the polarity of the magnetic field in the region of the dark spot will change to the opposite, and the frozen magnetic field will appear deep under the surface of the Sun. Over time, it will rise to the surface, and the cycle of switching to the frozen magnetic field will repeat.

4. MECHANISM OF DIFFERENTIAL ROTATION OF THE SUN

And now, let's return to the Sun's differential rotation (Fig. 1).

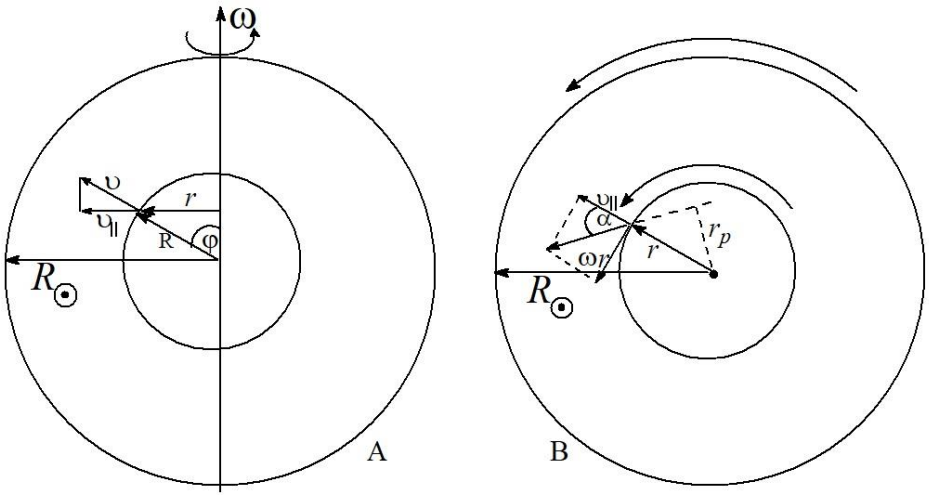

Fig1. *Processes on the surface of the solar core in two projections: (A) – in the plane containing the axis of rotation; (B) – in a plane perpendicular to the axis of rotation of the Sun.*

Even though the flows of particles born as a result of explosions spread in all directions, on average, they are directed along the radius to the surface of the Sun (velocity υ). And since the Sun rotates around its axis, the tangential speed of movement of particles on the surface of the solar core (ωr),

consisting of the radial speed (υ_l), causes the creation of an impulse moment ($F \cdot r_p$), which is transmitted to the zone of radiative transfer and inhibits the rotation of the solar core. Here, the quantity F is determined by the mass flow of particles per unit time from a unit area, multiplied by the particle velocity υ_l and the area of a ring of unit width. Similarly, light atomic nuclei created in the radiative transfer zone will transfer angular momentum to the convective zone. It can be shown that the magnitude of the angular momentum M transmitted through the ring with radius r and width ℓ to the radiative transfer zone will depend on the angle φ according to the expression:

$$M = \frac{1}{2} m \ell R \omega \cdot sin^3 \varphi, \tag{2}$$

where m is the mass of matter that moves per second across the surface of the Sun's core along the radius (kg/s), R is the radius of the core, ω is the angular speed of rotation of the core. As a result, the angular the speed of rotation of the solar core will decrease, and the zones of radiative transfer in the region of the equator will increase. At the same time, the hydrodynamic friction between the layers ($F_f = \alpha\ 2\pi\Delta\omega r^2 \ell$, $[\alpha]$=kg/(m^{2}c)) increases, which provides dynamic equilibrium and stabilizes the Sun's differential rotation:

$$\frac{\Delta\omega}{\omega} = \frac{m}{4\pi R^2 \alpha} \tag{3}$$

Similarly, due to nuclear processes in the radiative transfer zone, the angular velocity of the equatorial zone will be lower than the angular velocity of the convective zone. As a result of these processes, the speed of the Sun's rotation in the equatorial zone will exceed the speed in the region of the poles.

5. Conclusions

Based on consideration of the processes taking place in the interior of the Sun, it was shown that the use of the UMIE model allows an adequately describing several effects observed on the Sun, namely:

1. Due to the birth of bineutrons around atomic nuclei and Maxwell-Boltzmann statistics, heavy chemical elements are localized in the center of the Sun. When their mass increases to a critical level, constant radiation processes and nuclear explosions occur in the core of the Sun. Consequently, an acoustic standing wave is maintained, which is registered on the surface of the Sun.

2. Radial flows of electrons and protons, which arose as a result of radiation processes and nuclear explosions in the core, as well as in the zone of radiative transfer, cause the appearance of double electric layers, which, due to the rotational movement of the Sun, cause the appearance of ring currents and the solar magnetic field. The rotation of electroneutral plasma cannot cause the appearance of a magnetic field.

3. The radial flow of protons, together with the rotation of the Sun, causes the appearance of a mechanical moment, which slows down the inner part of the Sun and accelerates the equatorial part. The value of this moment decreases to zero when approaching the poles, as a result of which the speed of rotation of the poles is lower than that of the surface in the region of the equator.

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Citation: *Petro Oleksiyovych Kondratenko, " Magnetic Field and Differential Rotation of the Sun" International Journal of Advanced Research in Physical Science (IJARPS), vol 11, no. 12, pp. 32-37, 2024.*