The Blanket for the Sun

O.G. Verin

Abstract

The events occurring on the Sun not only determine the Earth climate and processes of planetary scale, but also immediately influence on wellbeing and health of each of us.

Therefore so much attention is given to the Sun research, and every «malfunction» of solar activity and enormous magnetic storms, threatening the operation of electrical supply networks, modern electric equipment and Internet, cause general alertness.

However «interior arrangement» and operation mechanism of the Sun are so complex, that the amount of ambiguities and questions while studying the Sun, perhaps, grows faster, than the amount of discovered solutions.

And it occurs despite of the use of modern space devices and constant progress in research techniques!

It becomes more and more evident, that in the existing physical picture of the Sun misses some key element, which would bind seeming separate facts.

1. Introduction

Speaking in technical terms, the thermonuclear reactor, which the Sun actually is, has surprising stability and reliability of operation. The solar constant (1373 W/m^2) - total output of radiation per unit area placed outside of the Earth's atmosphere at medial distance of the Earth from the Sun, really demonstrates amazing constancy and varies within one watt [1].

However the image of the «perfect» Sun in the course of its observation for over centuries became in eyes of scientists more and more mysterious, being supplemented with strange «details» and facts.

In particular, it has appeared, that on the Sun surface there are dark spots, and their quantity cyclically varies with about 11 years periodicity.

But the total radiation of the Sun, curiously enough, is augmented while there is relatively maximal dark spot quantity.

Besides, the cycle of solar activity varies within wide limits. For example, in XX century it was closer to 10 years, and in the last 300 years varied over a wide range from 7 to 17 years.

It also became clear, that the Sun has an inherent magnetic field of a rather complex configuration. It includes a dipole component and toroidal fields having opposite directions in northern and southern hemispheres.

There are also local much more intense fields at dark spots and other irregularities as turbulences and eruptions of plasma.

Most amazing seems the fact, that the magnetic field of the Sun periodically reverses the direction. It occurs also about every 11 years.

And it is not the last «curiosity» of our luminary. For example, among hard-to-explain features of the Sun there is a great difference of temperatures between rather cold surface of the Sun (~ 5800K) and extremely hot corona, heated up to millions degrees.

In this paper the attempt to discover a key factor in the physical picture of the Sun is made which would allow aggregating seeming so contradictory facts in a logical sequence.

Naturally, in view of complexity of the problem the offered interpretation of the Sun physics does not claim to be indisputable and is considered by the author as one of the possible hypotheses.

2. Global Sun convection cells

Now quite correctly it is accepted to consider, that fluctuations of solar activity essentially depend on processes in the near-surface area of the Sun.

In regard to interior volume of the Sun, its immediate examination is very much impeded, though theoretically processes occurring there are known well enough.

Approximately up to ¼ of the Sun radius occupies a core (fig. 1), where thermonuclear reactions take place, and up to 0,86 of radius there is an intermediate area, where radiation diffusion is going on [1, 2].

These two interior areas are rotating practically as a solid body.

As of convective zone, which reaches almost up to the surface of the Sun, so its description is still hotly debated.

Why the study of processes occurring in convective layer is so important for understanding of regularities of solar activity?

The fact is that these processes are determinative, as their energy is actually equal to all thermal energy evolved by the Sun.

The apparent differential rotation of a solar surface is associated with convection. At the equator the period of rotation is approximately 25 day, at poles - about 36, and upon the average - 27 day.

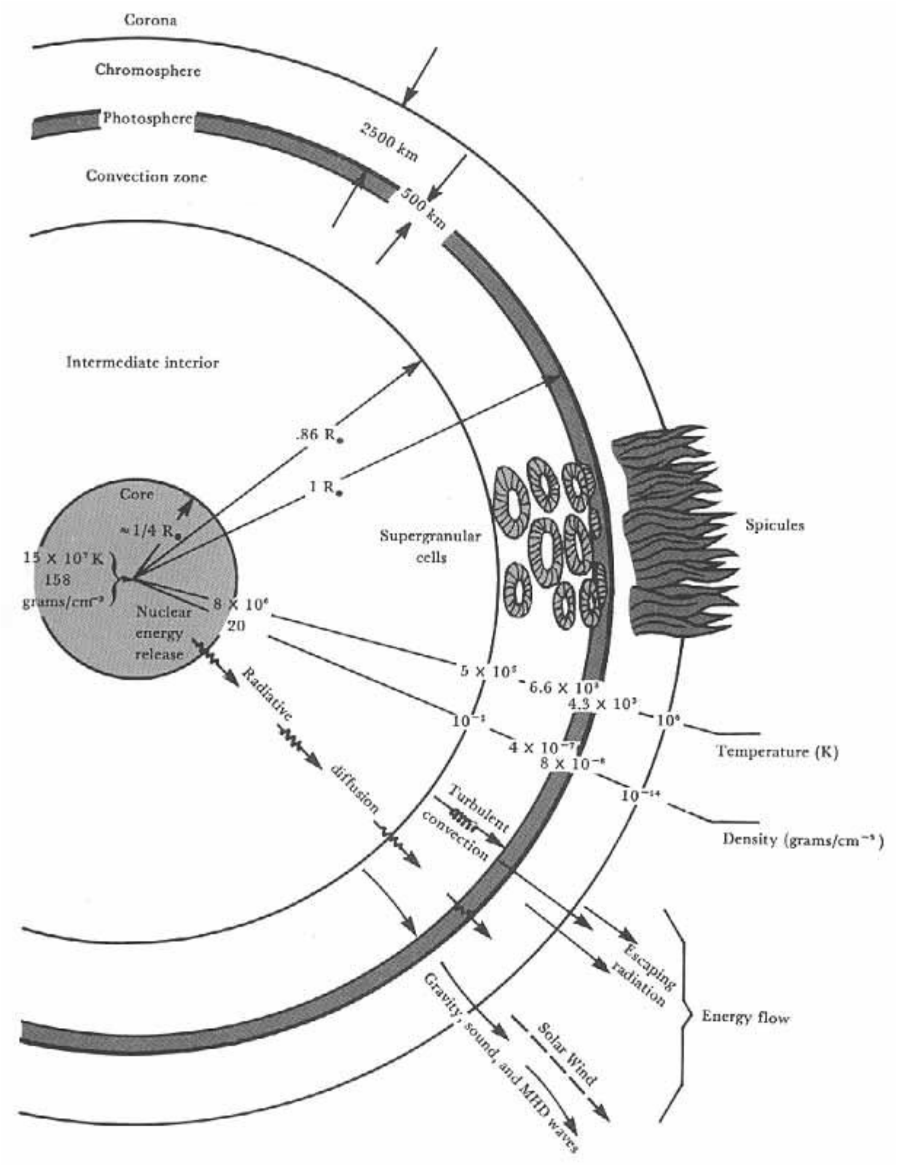

Fig. 1. The Sun structure [1, 2].

At the analysis of the Sun convection it is logical to take into account experience of study of similar processes in atmospheres of planets [3].

In particular, the rotation of the Sun should «extend» convection cells along the sense of rotation symmetrically with respect to equator similarly to that as it occurs, for example, in Earth's or Jove's atmospheres (fig. 2, 3).

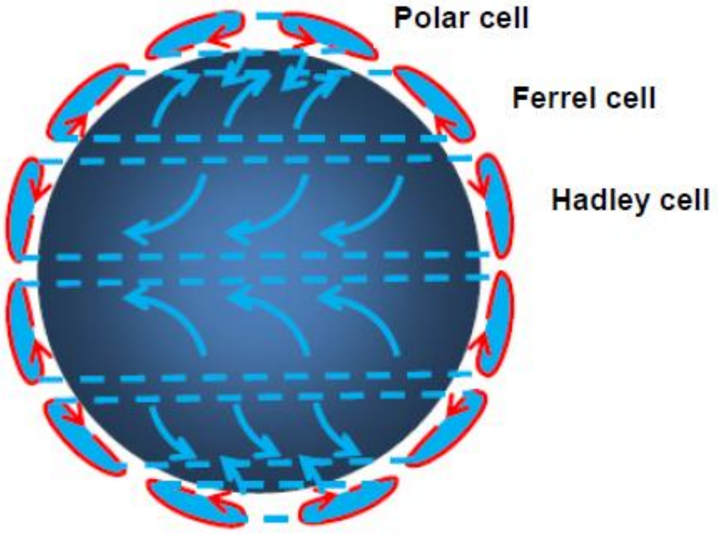

Fig. 2. Global convection cells in Earth's atmosphere.

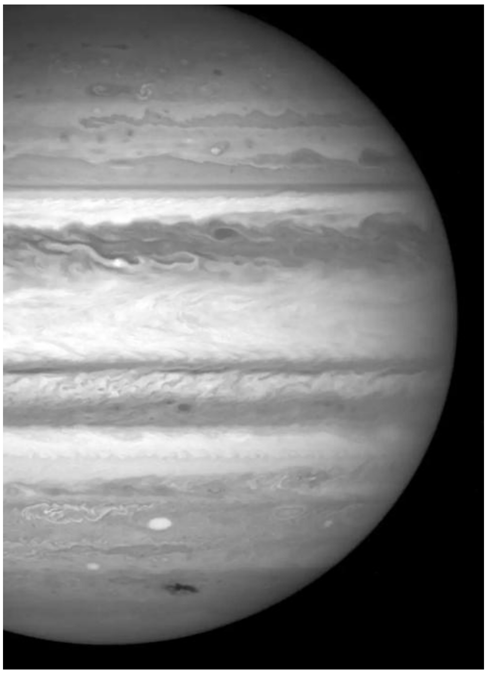

Fig. 3. The differences of velocities of contacting convection cells result in formation of vortexes in Jove's atmosphere.

The quantity of convection cells in an atmosphere of a planet substantially depends both on the atmosphere sizes and on features of energy flows.

On the Sun the quantity of global convection cells can be determined on the basis of indirect limitations.

First of all, it is necessary to try to unite features of differential rotation of the surface with convective motion.

It is essential to remember that the motion of any elementary volume of plasma occurs with observance of angular momentum conservation law.

Therefore, the motion off the axis of rotation results in slowing-down, and approach to axis of rotation results in acceleration.

On this basis it is possible to assume that in each hemisphere of the Sun there are two convection cells, as it is shown in a fig. 4. Polar cells include both poles, and equatorial cells are located symmetrically along equator.

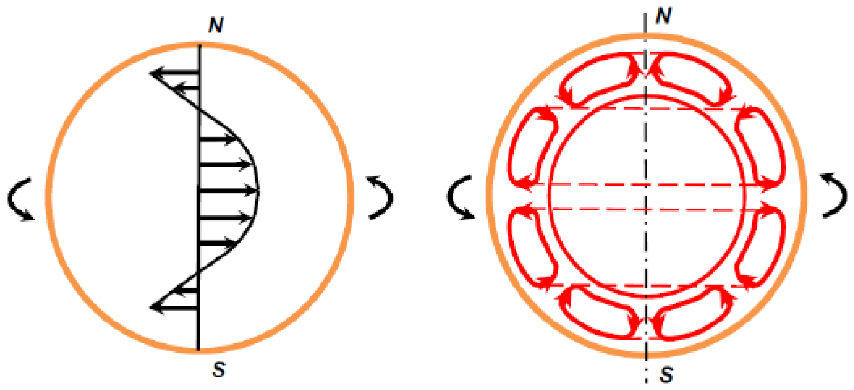

Fig. 4. Convection cells of the Sun (on the right) and differential rotation (the surface shift relative to mean displacement per single revolution).

As the second criterion, which speaks in favor of scheme shown in fig. 4, it is possible to consider a chain of perturbations on the Sun surface at middle latitudes, where the warmed up plasma overflows the surface after rising from the depth near the equator (fig. 5).

It is easy to notice that the convective cooling of poles is more effective, than in equator zone. Really, in the direction of poles the flows come from all the sides, while in equatorial convection cells the flows go only from two directions - from the south and from the north.

As a result, on poles the Sun surface is quiet and does not overheat, while equatorial cells periodically begin «to boil» [4].

Besides, poles are additionally cooled due to vertical direction of a magnetic field in these areas that favors free emission of a solar wind from poles.

The equatorial cells appear more powerful, so the hot plasma rising from depth along equator spreads over the surface and is reaching polar cells.

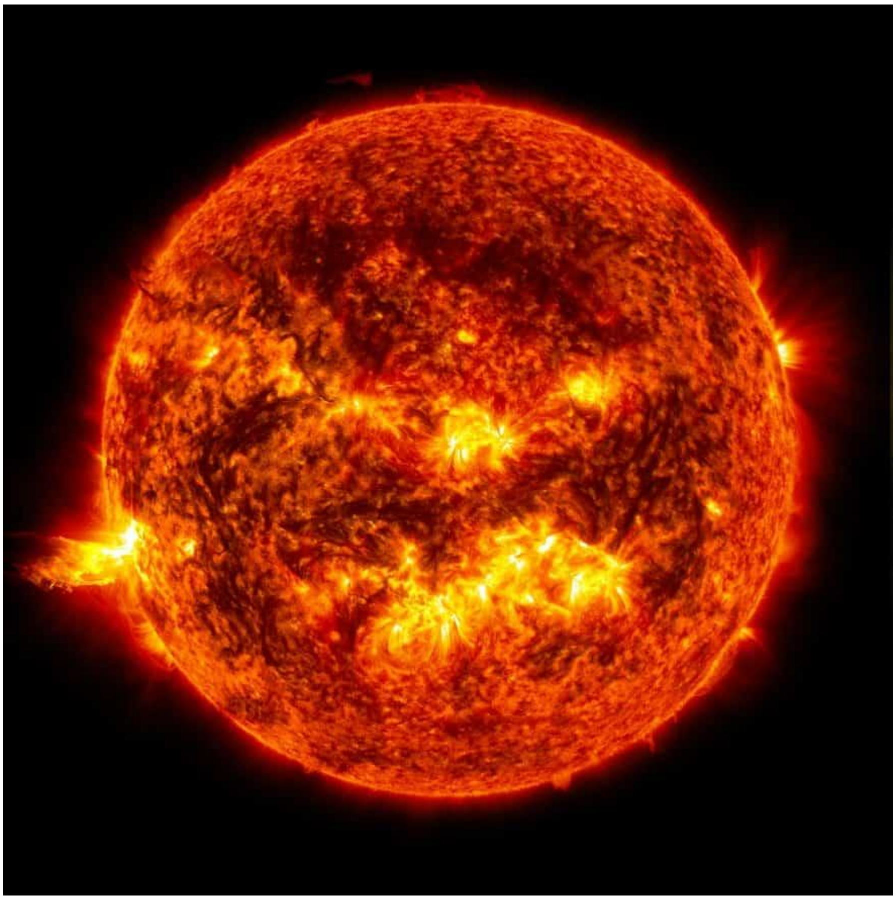

Fig. 5. On both sides from equator up to middle latitudes
the chains of turbulences and flash outs are observed [4].

In middle latitudes the gradually cooled masses of plasma sink in depth. Due to rotary movement of the Sun there occurs formation of vortexes, which at high latitudes become ever more similar to «overturned» cyclones in Earth's atmosphere [3].

The Mounder «butterfly» diagram (fig. 6) is evidence of convection process symmetry relative to equator. Apparently, in the beginning of a cycle of solar activity dark spots appear in the latitude of about 30°, and then, as plasma begins to «boil» spots come nearer to equator.

These processes of cyclic cooling and «boiling» of plasma cause alternately slowing-down and acceleration of a convective motion as a whole.

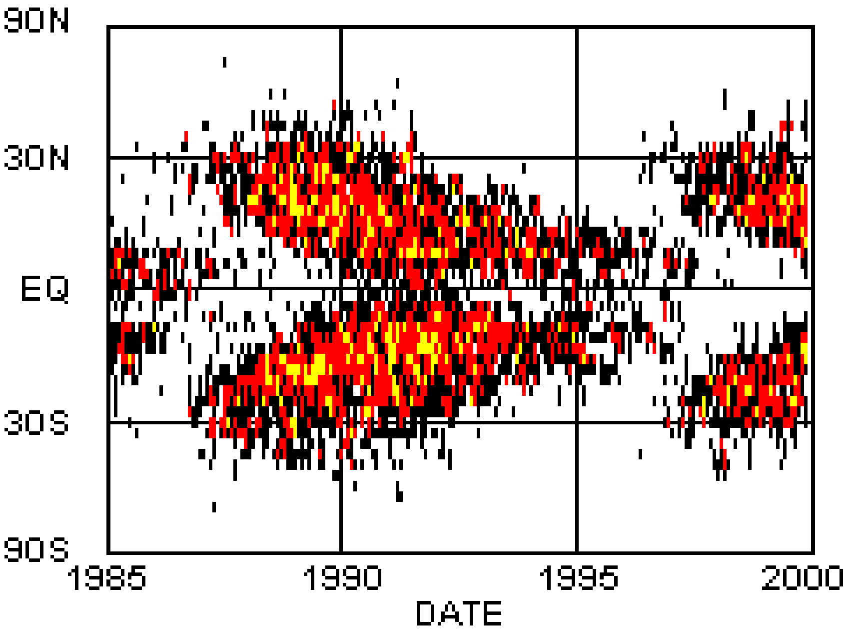

Fig. 6. The Mounder «butterfly» diagram [4].

Let's also note that the azimuth rotation of plasma in convection cells at contact area with intermediate zone of the Sun should meet the average rotational velocity at these latitudes.

Therefore, in so-called tachocline (contact area of low layers of convection cells with radiation diffusion zone) the plasma transits sites, where it undergoes successively slowing-down and acceleration of azimuth motion.

On the Sun surface the velocity differences are substantially leveled by the Sun cover - rather dense «blanket» similar to clouds, which nature will be analyzed in detail in item 4.

All visible surface of the Sun really represents something like a «blanket», consisting of hydrogen in the special energy state similar to the «substance» of a ball lightning.

This unconventional hydrogen state appears in granulation and great quantity of permanently occurring very small flashes on the Sun surface.

However the most essential effect created by «blanket» is that it really plays role of heat shield maintaining stability of the Sun temperature.

How it acts?

While overheating the seething plasma increments the quantity of ruptures in «blanket». The quantity of dark spots (vortexes), flaws and flashes increases. Therefore high solar activity results in cooling plasma.

So while the following stage the activity of the Sun is reduced, and the ruptures in «blanket» are again restored. During this relatively quiet phase the convective zone under «blanket» is gradually warmed up, and after that the process repeats itself.

That is the basic physical reason of observed cyclicity of solar activity.

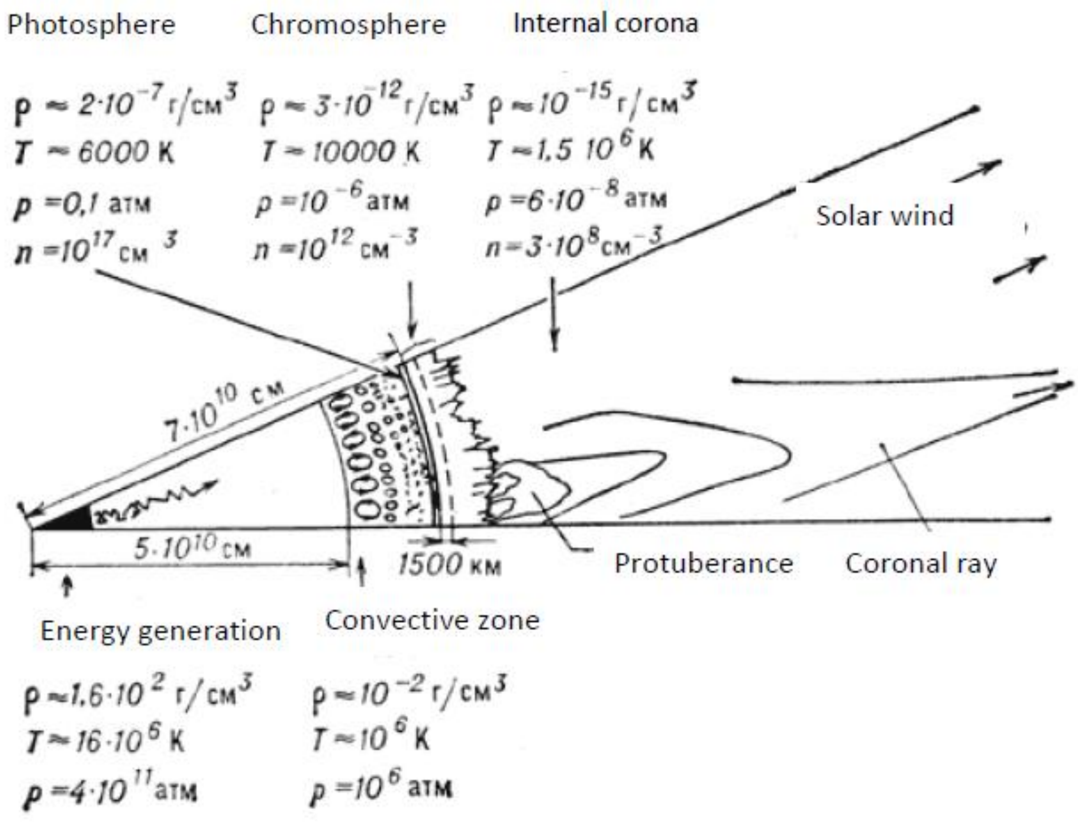

Fig. 7. Physical characteristics of different regions of the Sun [2, 4].

The effect of a heat shield is observable not only visually (how through «blanket» ruptures the radiation bursts out). An objective indicator is the quick change of basic characteristics of plasma and striking contrast of processes on both sides from a heat shield, identified with photosphere (fig. 7).

The quantity of «blanket» ruptures both in northern hemisphere and in a southern hemisphere depends on a phase of solar activity, but at the same time can take place substantial deviations.

It occurs because superheated plasma convection motion is not laminar and causes eruptions and eddying, characteristic for an «unpredictable» turbulent motion.

Therefore in northern and southern hemispheres the intensity of solar activity can differ and have relative phase shift.

Thus, the interaction of northern and southern hemispheres of the Sun gets complex nonequilibrium character.

It is necessary also to take into account that near the surface the velocity of a convective motion makes about 1 - 2 km/s, while in depth by many orders of magnitude is slower because of density increase. So plasma transits the surface of the Sun within weeks, and makes a cycle, moving in depth, for some months and even years.

Accordingly time of plasma «turnover» in different layers of the same convection cell can vary greatly, causing essential deviations from average cyclicity of solar activity and variations of its intensity (fig. 8).

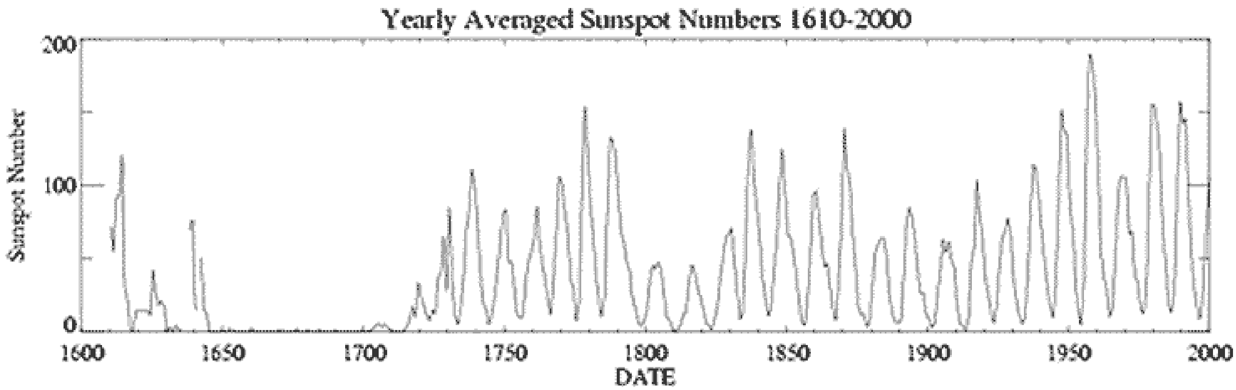

Fig. 8. Solar activity changes over all period of time of observation (http://crydee.sai.msu.ru).

In conclusion of this item let's note that for the further analysis the key value has a conclusion about influence of solar activity cyclicity upon velocity variations of convective motion of plasma.

This fact, as it will be shown in the next item, underlies the global magnetic phenomena in the Sun.

3. Structure of a general magnetic field of the Sun and cyclic changes of its polarity

Let's formulate plasma properties important for analysis of magnetic field of the Sun.

- The relative motion of electrons and ions of plasma creates a magnetic field. Hence, as plasma revolves as a whole, so the magnetic field rotates together with the Sun.
- Gas of electrons and gas of ions, being in a relative motion, «penetrate» through each other practically without «friction». Therefore process of natural decay of a magnetic field appears to be very long-lived and in consideration of the Sun size can take many decades.

The mutual influence of moving plasma and magnetic field presents great difficulties for the mathematical formulation; however analysis of a general magnetic field of the Sun becomes simpler, because in whole its structure follows a powerful convective motion, which in this case plays a role of driving process.

Really, the energy of a convective motion is determined actually by all the energy of solar radiation. Therefore convection is leading process relative to a rather weak general magnetic field of the Sun.

Besides taking in consideration «quiet character» and practically uniform convective motion in polar cells, we shall suppose that these cells do not exercise influence over a magnetic field of the Sun.

So let’s concentrate on processes in equatorial cells.

Imagine a hypothetical initial state, when in equatorial convection cells there is a uniform motion of plasma, and the magnetic field misses.

If plasma in such initial state is subjected to some supplementary temperature gradient accelerating convection and resulting in change of velocity of ion gas, then the electron gas will «lag behind» relative to the ion gas, and, thus, there will appear a magnetic field.

The structure of this magnetic field for natural reasons will correspond to a configuration of convective motion, that is, in this case there will be toroidal fields located symmetrically along equator (in two equatorial cells) and having opposite directions in azimuth.

At the same time, the violation of uniform convection motion will cause a diversion in tachocline «operation» that will attach to ions motion some resulting azimuth component of velocity. Therefore general magnetic field will have in addition to a toroidal component also a dipole component.

And even after removing of the perturbing action on convection motion and reduction of ions velocity, the magnetic field will not disappear, as the electron gas during action, though not at once, but too will get some additional velocity.

The scheme of electrical currents and corresponding magnetic fields, taking into consideration the above mentioned arguments, is shown in fig. 9.

Thus, spiral electrical currents in equatorial convection cells create general dipole magnetic field and simultaneously toroidal fields having different directions.

Therefore groups of dark spots on the opposite sides from equator have different polarities of magnetic fields, as it is shown in fig. 9 (on the right).

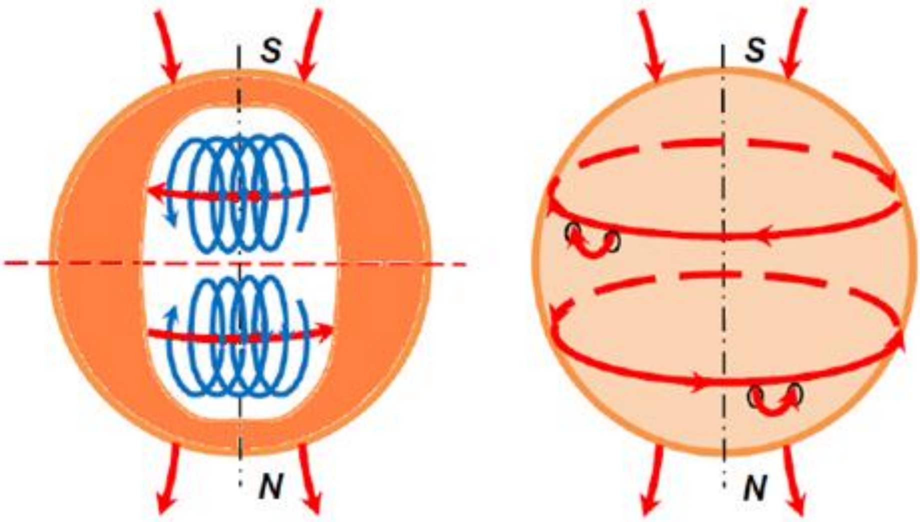

Fig. 9. The spiral electrical currents in equatorial convection cells generate toroidal magnetic fields of opposite direction in northern and southern hemispheres, and also general dipole field of the Sun.

At the same time dark spots at high latitudes, as a rule, are single and have opposite polarities in northern and southern hemispheres. As it was already mentioned above, this single spots remind «inverted» terrestrial cyclones (from the lower face of photosphere) and do exist rather long.

During each maximum of solar activity (every ~11 years) magnetic fields change its direction on the opposite one, so the period of fields change is doubled (~22 years).

Such «strange» behavior of the Sun magnetic fields is a typical example of process dependence on its previous history.

The key mechanism in this case is action of Lorentz force on moving charges, which «twists» their trajectories depending on present direction of the magnetic field.

How this mechanism works?

At increase of solar activity velocity of a convective motion rises. It creates ions motion relative to magnetic field. For that reason the Lorentz force is twisting ions trajectories round magnetic field lines so that it leads to decrease of a resultant magnetic field.

Further, because of decrease of toroidal magnetic field *B* flux, an electric field *E* circulation appears in this cross-section, which effects electrons movement.

$$rotE = -\frac{dB}{dt}, \qquad \oint Edl = -\frac{d}{dt}\oiint Bds,$$

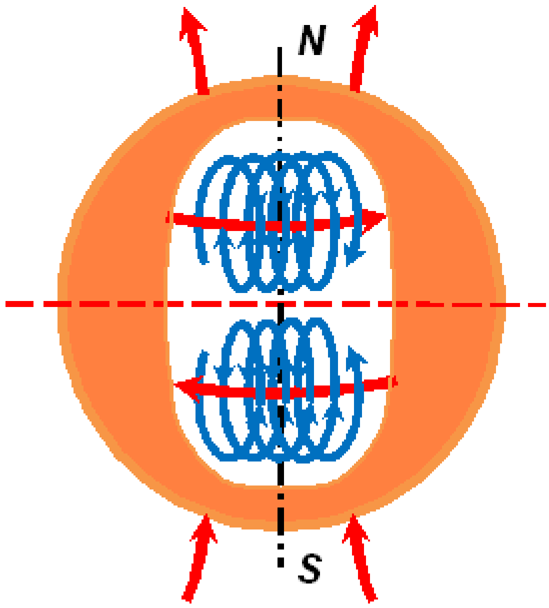

Fig. 10. The reverse of polarity of the Sun magnetic fields is caused by mirror-like change of electric currents in equatorial convection cells.

As a result electrons reverse and move backwards along the same trajectories, but in an opposite direction.

Therefore, the pattern of currents and fields changes mirror-like (fig. 10).

Actually process of reorientation of currents and magnetic fields of the Sun occurs a little bit more complex than in the given scheme.

After passing the maximum of solar activity, apparently, there will be some correction of currents and fields. However this correction is not critical, as the solar activity decay runs much more slowly than rise (~1,5 times).

Besides, as it was already mentioned, the solar activity in northern and southern hemispheres usually has different intensity and considerable «phase shift». For this reason the «double-peak» curve of solar activity with different height of maximums quite often is observed.

Thus, the polarity inversion of magnetic fields of the Sun, as a rule, occurs sequentially - at first in one hemisphere, and then in the other hemisphere.

Accordingly during 1,5 – 2 years while solar activity is maximal it is possible to observe a composite pattern of magnetic fields: the general field reminds quadrupole, and toroidal fields have the same direction (fig. 11).

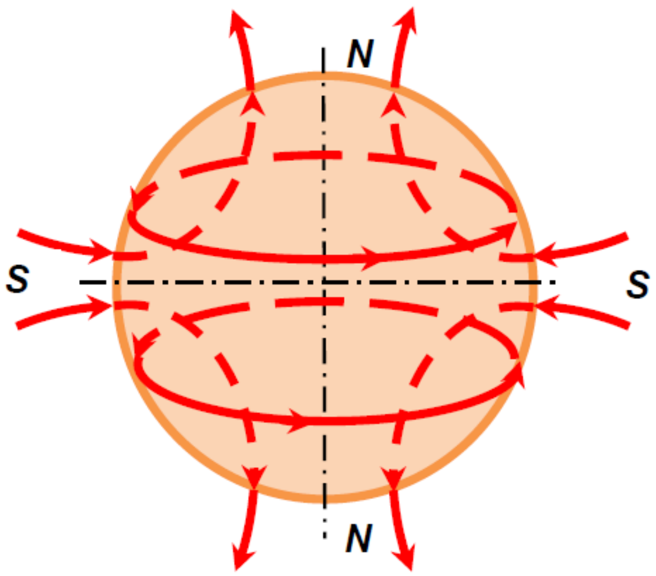

Fig. 11. Due to nonsynchronous polarity inversion of magnetic fields in northern and southern hemispheres, the general magnetic field reminds quadrupole, and toroidal fields have the same direction.

To complete this item let's notice once again that the velocity of convective motion of plasma (as well as velocity of rotary motion of the Sun) in region of equatorial convection cells by several digits exceeds ions and electrons relative velocities generating dipole and a toroidal magnetic fields.

Therefore upon the average magnetic field not only rotates with the Sun, but simultaneously moves together with the flow of plasma in convection cells.

At the same time dipole field approximately by a factor of a hundred is less, than toroidal fields. Generally it is caused by the step of a spiral electric current, which is much less than the lateral dimension of a spiral.

It is the evidence of rather small resulting effect of the differently directed tachocline action on azimuth velocity of plasma in convection cells of the Sun.

4. What is the solar «blanket» made of?

As it was already mentioned, the heat shield of the Sun (simultaneously it can be considered as the Sun «surface» or solar «blanket») reminds «substance» of a ball lightning.

The nature of phenomenon was generally surveyed in 2006 in the book [5]. There was carried out analysis, from which the conclusion followed that the substance of a ball lightning can be compared with a fluid, in which the so-called short-range order of atoms takes place. However mechanism of this short-range order in this case is different than in usual fluids.

Expressing «scientifically» it is possible to say that the ball lightning is the macroscopic quantum effect - superfluidity of excited states of atoms in atmosphere.

Therefore, for example, the ball lightning can move upwind.

And in many cases it, really, behaves as a fluid.

On the other hand, such state of gas is possible to consider as its «intermixture» with radiation (photons). The stability of such intermixture is based on collective interaction of atoms and radiation.

Electromagnetic waves, i.e. the radiation, carry out an arrangement of atoms making ordered structure, and the ordered structure of atoms, in turn, makes nonradiating system, which retains radiation inside of this special state of substance (fig. 12).

Naturally, in consequence of finiteness of sizes of these areas of the short-range order, and also because of various sort of disturbances within ordered structures, such nonradiating systems though lose energy.

For this reason the ball lightning has a restricted lifetime: or it quietly goes out, or blows up as a result of instant loss of structure stability and release from all retained energy.

In conditions of the Sun photosphere the similar state of substance behaving as a quantum fluid (QF) is permanently supported by radiation coming from depths of the Sun.

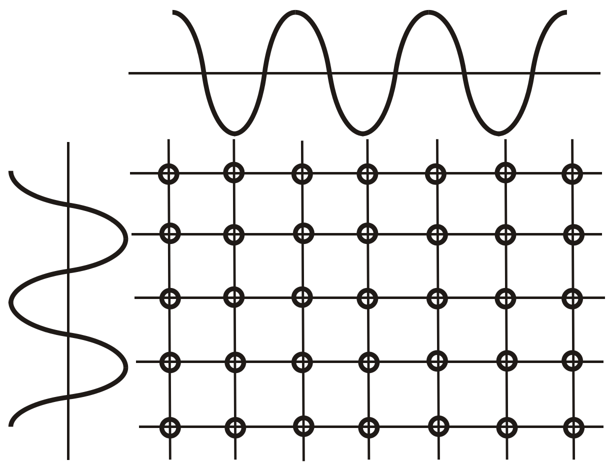

Fig. 12. Electromagnetic waves arrange atoms, and the ordered structure of atoms, in turn, retains radiation in this structure.

In the bottom of photosphere, where density is higher, and distances between atoms accordingly are shorter, quantums with smaller wave length, that is, having high energy are involved in QF formation.

As a result, the ordered QF structures in the bottom of photosphere are more stable, and the granules have major sizes (so-called «supergranules»).

Let's make estimating calculation for lower part of the photosphere, in which there is an interaction of hydrogen atoms with the short-wave radiation matching the ionization potential of hydrogen.

The wavelength of radiation quantum having energy sufficient for ionization of hydrogen can be determined using formula for quantum energy:

$$h\nu = \varphi_i e, \qquad \nu = \frac{c}{\lambda}, \qquad \lambda = \frac{hc}{\varphi_i e}.$$

Here φ_i - ionization potential of hydrogen; *λ, v* - wavelength and frequency of quantum; *h* - Planck's constant; *c* - speed of light, *e* - electron charge.

After substitution of concrete quantities, we get the wavelength of a quantum $\lambda = 0{,}94 \cdot 10^{-7}$ *m (or 94 nm)*, matching the ionization potential of hydrogen *(13,6 eV).*

Starting from the simplified scheme of the three-dimensional short-range order of atoms, shown in fig. 12 (each atom is located at electromagnetic wave crest), the approximate concentration of atoms can be estimated using formula:

$$n = \left(\frac{2}{\lambda}\right)^3 \approx 10^{22}\, м^{-3},$$

that approximately meets the available actual value of concentration of hydrogen atoms in photosphere.

The closer to the exterior side of photosphere, the less is density, and the distances between atoms are more. Therefore here more long-wave quantums with smaller energy participate in ordering structures of a quantum fluid, owing to what the interaction inside QF becomes weaker, and granules become more and more small-sized.

Thus, in formation of photosphere (~ 300-500 km) is involved almost all spectrum of the Sun radiation except for X-rays (with quantums energy exceeding an ionization energy of hydrogen).

The «forced» retention of hydrogen atoms in the fixed energy state taking place in QF is that mechanism, which provides dispersion and reflection of the most part of the Sun radiation coming from depths (role of a heat shield).

And on the other hand, the same mechanism prevents step by step excitation and ionization of hydrogen atoms, so photons actually «fill up» volume of photosphere, just as it occurs in «absolute black body».

It is evident from the radiation spectrum of the Sun (fig. 13).

Almost all spectrum coincides with radiation of an absolute black body, which role plays the photosphere, and only the most short-wave part ($\lambda \leq 94$ *nm*) is present separately, not following general regularity.

So, let’s once again draw attention to the fact that photosphere, as well as QF, of which it consists, by nature of this state of substance, has quite a number of special characteristics:

- QF has surface tension, owing to what in photosphere the so-called granules (fig. 14) are generated;
- The short-range order in QF makes the viscosity of this substance state exceeding the density of appropriate gas;
- QF is electric insulator;
- QF behaves as a nonmagnetic material;
- Photosphere has properties of an absolute black body.

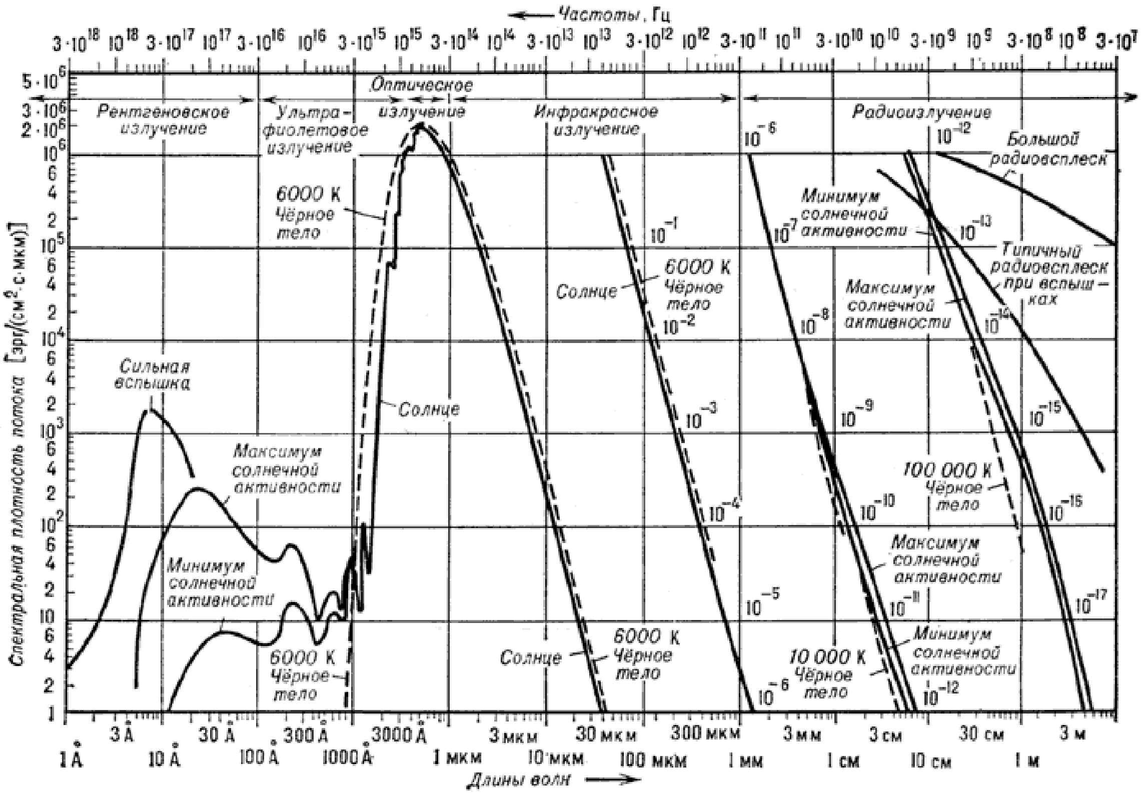

Fig. 13. Radiation spectrum of the Sun. Dotted lines indicate the spectrum of absolute black body having temperature 6000K.

All these properties of QF appear in numerous effects occurring on the Sun, which would be problematic to explain by any other physical mechanisms.

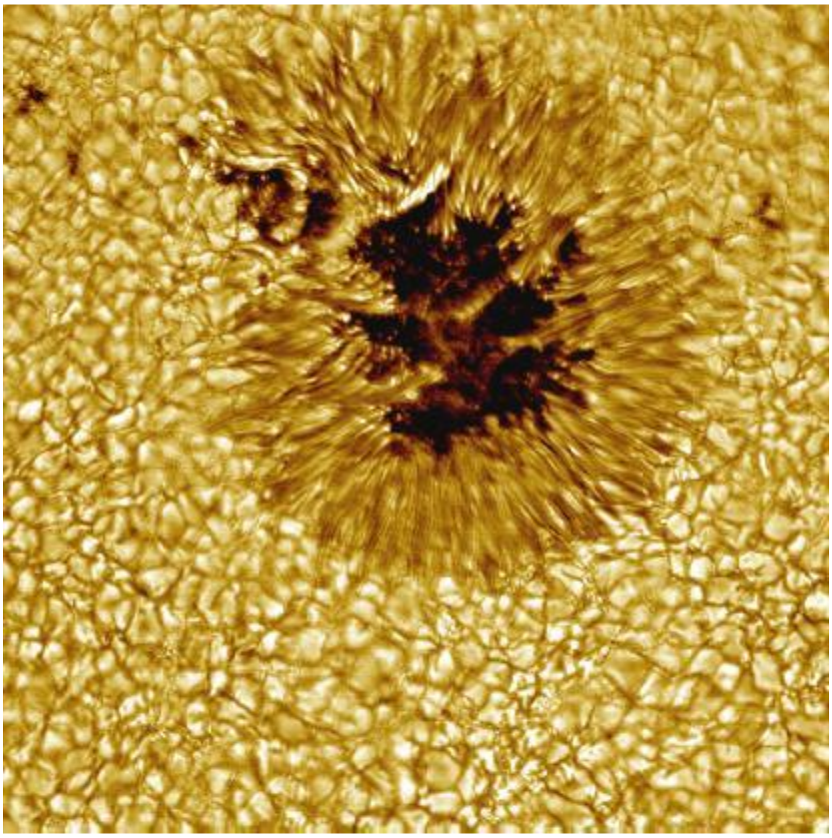

Fig. 14. A dark spot stands out sharply against the background of granular surface of photosphere.

In particular, the evidence of special properties of photosphere «substance» is the absence of interaction with magnetic fields and electrical currents. It is especially well seen, when magnetic flux «rope» with plasma (fig. 15) penetrates beyond the limits of photosphere.

Here is another blow of such sort.

The quantum fluid inside granules makes a convective motion - at centre there is movement in upward direction, and along the edges of granules there is a back motion - downward.

However, spicules consisting of plasma «force» its way upwards just along the borders between granules where a convective motion goes downwards.

To understand this «strange» phenomenon it is possible only in consideration of the fact that the granules of photosphere are isolated areas consisting of QF with high surface tension.

For this reason plasma of spicules does not mix with substance of granules, and, on the contrary, «squeezes» between granules, breaking into chromosphere with high velocity about 20 km/s, and further rises up to 5 - 20 thousand km.

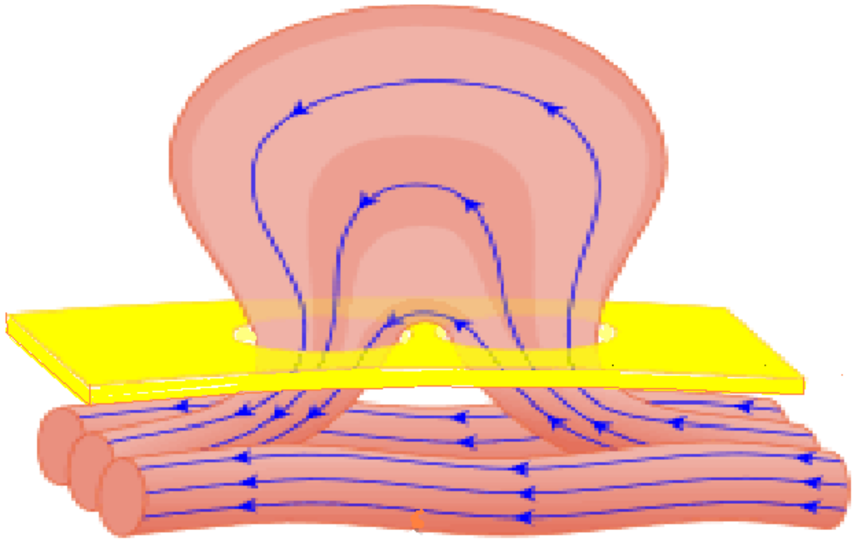

Fig. 15. Magnetic flux «rope» with plasma penetrates beyond the limits of photosphere.

Such columns of plasma by a diameter 500 - 1200 km live on the average about 5 -10 minutes that appears comparable with a period of permanent wavy oscillations all over the Sun surface.

This fact quite naturally provokes the supposition that probably there is interrelation between these phenomena.

Really, spicules, «squeezing» between granules, support oscillations of the Sun surface, and the oscillations, in turn, «help» plasma to penetrate between granules. As a result there is a positive feed-back in self-sustained oscillation system.

In this connection let’s remind that on the Sun surface simultaneously exist about one million spicules, which occupy about 1% of its surface, but, what is especially important, the majority of spicules is located along the borders of supergranules forming so-called chromospheric network covering all the Sun surface.

5. Conclusion

Thus, the solar «blanket» is the right key element of the Sun physics, which enables logically relate all the plurality of the phenomena and facts seeming at first sight so contradictory and even paradoxical.

The special state of substance making «blanket» - the superfluidity of energy states taking place in photosphere granules, gives this part of the Sun quit a number of remarkable properties:

- The special state of hydrogen in photosphere actually is «mixture» of hydrogen with radiation (with quantums). The stability of such mixture is based on mutual confinement of atoms and radiation. Electromagnetic waves (radiation) carry out ordering of atoms, and the ordered structure of atoms, in turn, is not radiating system, which retains radiation inside of the structured substance.
- In photosphere this substance state (quantum fluid - QF) is permanently supported by radiation coming from the Sun depth.
- QF has surface tension, owing to what in photosphere the granules are generated;
- The short-range order in QF makes its viscosity exceeding the viscosity of appropriate gas having the same density;
- The «forced» retaining of hydrogen atoms in a fixed energy state occurring in QF is that one physical mechanism, which provides a dispersion and reflection of the most part of the Sun radiation, coming from depths, thus, imparting to photosphere the role of the heat shield.
- The same mechanism prevents step-by-step excitation and ionization of hydrogen atoms, therefore the quantums actually «fill» the volume of photosphere, just as it occurs in absolute black body.
- QF is electric insulator;
- QF behaves as a nonmagnetic material.

Due to these properties the photosphere plays a role of the Sun «surface» and the thermal shield («blanket»). The processes occurring above and under photosphere differ greatly.

Under photosphere there are convection cells (two - polar and two - equatorial), and above photosphere there is chromosphere with spicules, passing into the solar crown.

It is important that deviations of plasma temperature and convective motion velocity mainly are occurring in external parts of convection cells, which too little interfuse with internal areas having some average characteristics.

It provokes periodic plasma «boiling» along equator; end causes some particularities of the Sun differential rotation.

The photosphere playing role of a heat shield provides relative stability of the Sun temperature, «reacting» to the plasma overheating.

At a maximum of solar activity the superheated plasma, beginning «to boil», increases a number of various sort of flaws and ruptures in «blanket». As a result, the plasma in convection cells is cooled, and comes a period of relative quiet Sun.

While this quiet phase of solar activity the ruptures of «blanket» are restored, and the plasma in a convective zone gradually heats up again. On the average in 11 years the plasma all over again overheats, and there begins a phase of high activity of the Sun. Then all the process is repeated.

The cyclic process of heating-cooling causes periodic rise of convective motion of plasma and connected with it magnetic field polarity reversal.

Here we deal with a typical example of process dependence on prehistory.

The key mechanism in this case is the influence of the Lorentz force on moving charges, which «twists» ions trajectories round the present magnetic field direction.

At solar activity rise the velocity of convective motion increases that causes motion of ions relative to the magnetic field. Accordingly the Lorentz force twists ions trajectories round magnetic force lines that always results in decrease of a total magnetic field flux.

Further, due to decrease of toroidal magnetic field flux, in a cross-section there appears electric field circulation, which makes electrons move along the same trajectories, but in an opposite direction.

Thus, the pattern of currents and fields becomes mirror-like.

The solar activity in northern hemisphere and in a southern hemisphere usually has different intensity that results in a noticeable phase shift between hemispheres activities.

Therefore the process of polarity reversal of general magnetic field of the Sun, as a rule, occurs sequentially - at first in one hemisphere, and then in the other hemisphere.

Accordingly during one and a half - two years while maximal solar activity it is possible to observe a composite pattern of magnetic fields: the general field reminds magnetic quadrupole, and toroidal fields have the same direction.

Analysis of magnetic field of the Sun was carried out subject to the base properties of interaction of a field and plasma:

- The relative motion of electrons and ions of plasma creates a magnetic field. But as the velocity of this relative motion is very small, the magnetic field not only rotates together with the Sun, but also «drifts» together with a convective motion of plasma.

- Gas of electrons and gas of ions, being in a relative motion, «penetrate» each other practically without «friction». Therefore process of natural decay of a magnetic field appears to be very long-term and on the Sun scale can last many decades.

Photosphere granular substance properties make it possible to suppose the interrelation between wavy oscillations of the Sun surface and spicules properties.

Spicules «forcing way» between granules support oscillations of the Sun surface, and the oscillations, in turn, «help» plasma penetrating between granules. So the generative feedback in this reciprocal process is formed.

As indirect confirmation of this interrelation can be considered the fact that on the Sun surface there are simultaneously about one million spicules, which occupy about 1% of the surface, but, what is especially important, the majority of spicules locates along borders of supergranules and thus form the so-called chromospheric network covering all the Sun surface.

In conclusion it is important once more to underline the main finding made in the course of analysis. In the physics of the Sun there is a key element - particular solar «blanket» consisting of a quantum fluid. The role of this key element belongs to granulated area of the Sun termed as photosphere.

The discovery of a key role of photosphere in the Sun physics enables not only to systematize and to explain available solar activities data, but also, undoubtedly, can become a basis for further study.

References

1. Physical quantities. Reference book. - M.: Energoatomizdat. 1991.
2. Edward Gibson. The quiet Sun. NASA SP (T. 303). 1973.
3. Verin O.G. Physics of atmospheric and oceanic currents. http://files.library.by/files/1484596741.pdf
4. Physical encyclopedia. The Sun. http://femto.com.ua/articles/part_2/3751.html
5. Verin O.G. Energy. Substance and Field. - M.: Contour. 2006.