SOLAR CYCLONES
(published in the magazine "Engineer" No. 1-2, 2011)

There the fiery shafts aspire and find no shores.
There fiery whirlwinds are spinning fighting
for many centuries.

M.V. Lomonosov "Morning reflection ..."

The word "cyclone" is usually associated with windy, rainy, cloudy weather, but not with the sun. However, here we will not talk about vortices in the Earth's atmosphere (which are called "cyclones"), but about vortices in the atmosphere of the Sun. It was solar cyclones and vortices that werecalled sunspots in the 19th century. Sunspots, discovered by Galileo, look like small black dots, circles, like sun freckles (or moles), periodically appearing on the bright face of the Sun (Fig. 1). These solar vortices, as we show below, play a key role in the energy of the Sun and in its impact on the Earth.

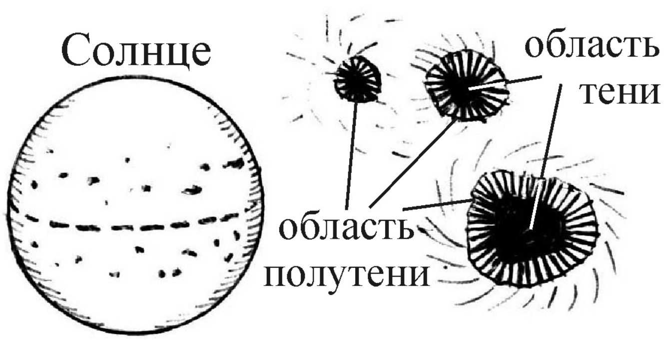

Fig. 1. Sunspots on both sides of the equator (dotted line) and sunspot structure.

First, let's find out why the Sun shines, where does its unimaginable energy come from,radiated in the form of light and heat? What source feeds this giant light bulb with rated power W=3.8 10^{26} W [1]? Once upon a time, people believed that the sun is a heavenly fire, like an earthly fire, emitting light, heat and energy due to the chemical reactions of combustion. But then they found out thatin this case the Sun would burn out in several millennia [2, 3]. Therefore, in the 19th century, Helmholtz suggested that the Sun heats up and releases energy due to gravitational contraction. As the calculation showed, a reduction in the radius of the Sun by only 75 meters per year would release as much gravitational energy as the star radiates in the form of light and heat. Since the radius of the Sun is huge and amounts to 700 million meters, the gravitational contraction could feed the luminary with energy formany millions of years.

However, the age of the Sun is several billion years. Therefore, they decided that the Sun and other stars shine due to thermonuclear reactions. Hydrogen, when its nuclei are combined into helium nuclei, releases energy sufficient to burn the star for billions of years. This long-wandering hypothesis was picked up by the English astronomer A. Eddington and substantiated by G. Gamow. But even its experience brought a harsh verdict in the 1970s: a recorded solar flux neutrino turned out to be many lower than what should arise from nuclear reactions on the Sun [2]. These and other data, includingthose obtained by Soviet astrophysicists A.B. Severny and V.A. Ambartsumyan showed that the interior of our star has a temperature insufficient for the occurrence of thermonuclear reactions on a large scale [4]. Scientists again said they do not know why the Sun shines. The thermonuclear theory of stellar combustion, as shown by Ambartsumyan, did not justify hopes: the source of stellar energy is completely different. But what? Scientists do not know this, although they continue, forgetting about inconsistencies, to repeat that this source is thermonuclear. Unexpectedly, we find the solution in the works of the ancient atomists - Democritus, Epicurus and Lucretius, who believed that the planets, the Sun and all other stars arose from the compression of cosmic vortices from atoms. The rapid vortex motion and the accompanying friction, in their opinion, caused the heating, "burning" of the Sun: the generation of solar fire follows the ancient method of producing fire by friction-rotation. The samevortex nature of the heat release of the Sun, heated up like a rotating drill in a workpiece, was also defended by the discoverers of the law of conservation of energy - M.V. Lomonosov and Yu.R. Mayer. These scientists, like Democritus, who was the first to voice the laws of conservation, understood better than others that the energy of the Sun cannot be taken from nowhere, but must be brought in from outside. Some modern physicists also think so, for example, I.I. Smulsky.

This, at first glance, naive, mechanistic hypothesis is in fact as deep as the "naive" mechanical hypothesis of the same Democritus about atoms. It is not for nothing that modern science has largely come to the same views on the leading role of vortex motion in space. The cosmic vortices of Democritus are found in the form of swirling spiral galaxies, planetary nebulae, etc. Yes, and the hypothesis of the formation of the Sun, the solar system, as well as their heating, is now also accepted as a vortex, demokritova. It is believed that the solar system was formed from a protoplanetary gas and dustcloud, which, shrinking under the influence of gravity, spun and heated up more and more: gravitational energy turned into kinetic and thermal. Almost like this, the water in the bath unwinds and slightly warms up from viscous friction, forming a vortex funnel-whirlpool around the "gravitating center" - the drain hole. The closer the water comes to the center, the faster it rotates (due to conservation of angular momentum) and the more it heats up. So, in the protoplanetary cloud, the most heated, central part of the cloud, as it compressed, condensed and warmed up, formed a hot Sun, around which the planetsgradually condensed, rotating in the same direction as the star and the protoplanetary cloud (Fig. 2).

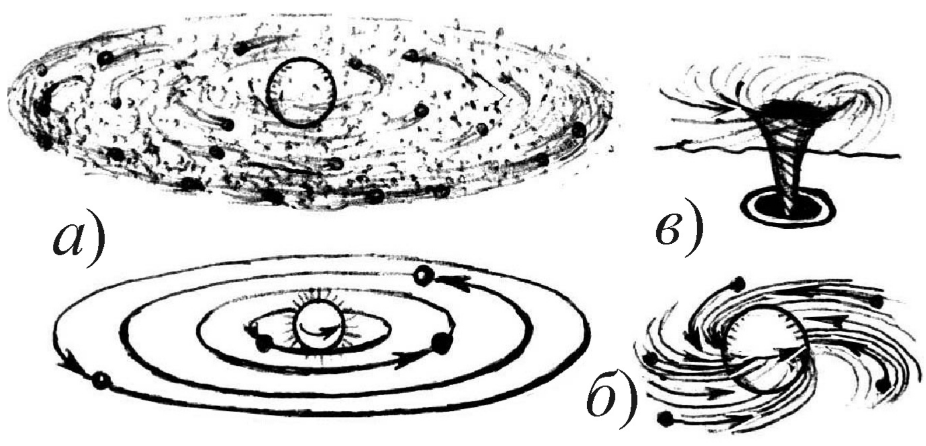

Fig. 2. The formation of the Sun and planets from a gas and dust cloud (a) during its agglomeration, compression and spin-up: the Sun (b) is like a swirling water funnel that absorbs the flows of matter (c).

But if the Sun really warmed up, as astrophysics admits, from gravitational compression and friction, then why not assume that even now its heat is supported by matter flowing towards the star in the formof a whirlwind? Indeed, in the solar system, a lot of matter is in a dispersed state. The total mass of this diffuse substance is of the order of the solar mass [1], and constantly converging towards the star, the flows of matter may well heat it up, because the speeds of the flows are cosmic, and therefore friction releases enormous energy. This is how we see how bright meteors lit up in the sky, the remains of space devices, braked by the friction of the earth's atmosphere. And in the atmosphere of the Sun, which, like avacuum cleaner, sucks in the surrounding gas and dust matter, this energy release should be immeasurably higher. It is not for nothing that the philosophers of Ancient India, from whom Democritus learned a lot, believed that the Sun feeds on cosmic gas, absorbing which it releases energy.

In this case, the energy released by the Sun will turn out to be gravitational, as Helmholtz suggested. But this energy will be released not due to a decrease in the radius of the star, but due to an increase in its mass from the influx of matter from outside. Such an influx, being inexhaustible, can feed the Sun and stars for not millions, but billions of years, since the matter absorbed by the star is replaced by new matter, including that brought by meteor showers and comets from the Oort cloud surrounding the solar system (perhaps such clouds and streams converging from them to the star we observe in planetary nebulae). Knowing the mass of the Sun $M=2\ 10^{30}$ kg and its radius $R=7\ 10^{8}$ m, it is easy to calculate that the gravitational energy GMm/R (gravitational constant $G=6.7\ 10^{-11}$ N m^2/kg^2) will be released if the mass m of matter absorbed every second by the star when falling on it is about $m=WR/GM=2\ 10^{15}$ kg (this is the mass of an average asteroid). Consequently, in a year, our luminary in total should absorb a mass of $6\ 10^{22}$ kg, which is about the mass of our Moon, which is quite realistic, given the density of coronal gases surrounding the Sun, its huge absorbing surface and giant gravitational field. Indeed, even on a relatively modest surface of the Earth, about 10^9 kg of meteorite matter falls annually [5], which increases the mass of our planet and its temperature. So, A.V. Byalko proved that it was the gravitational energy of falling meteorites that warmed up the earth's interior and is still being released [6]. Jupiter, with its powerful gravitational field and vast surface, absorbs much more matter than the Earth, as the example of its capture of fragments of the Shoemaker-Levy comet shows. This explains the resemblance of Jupiter to a star, its high rotation speed and heat release, which exceeds the heat influx from the Sun, although the temperature of Jupiter is clearly insufficient for thermonuclear processes. Therefore, there is nothing strange that the Sun also releases heat in the same mechanical way, but, having a gigantic mass, absorbs much more matter and heats up much more (up to temperatures sufficient for nuclear fusion, which, however, takes place on a much smaller scale than thought before).

From this follows an interesting conclusion that the mass of the Sun and other stars does not have a constant value, but slowly increases: from the matter that settles on the star, it gradually grows, like a snowball. If we accept the current rate of deposition of matter on the star ($6\ 10^{22}$ kg/year), then its mass $M=2\ 10^{30}$ kg should double in about 30 million years, and in a billion years it will increase 30 times. However, the increase in stellar mass is more complex, since the rate of capture of matter changes smoothly and strongly depends on the mass, radius of the star, and the concentration of the gas and dust cloud that feeds it, which is gradually depleted. This hypothesis not only explains where the giant energy of the Sun and stars comes from, but also clarifies the meaning of the main sequence on the Hertzsprung-Russell diagram (Fig. 3). Astronomers, having plotted the dependence of the luminosity of stars on their temperature, discovered an amazing thing: all the stars fit into a narrow band on the graph, called the main sequence, at the right end of which there are light stars with low brightness and temperature, and at the left end - massive stars with high temperature and brightness [5]. However, according to astrophysicists, this sequence does not reflect the successive phases of the development of stars, because in the Eddington theory of stellar evolution, the mass and the luminosity associated with it change little for the main part of the life of a star. Therefore, they considered that stars evolve not along, but across the main sequence

But, if the hypothesis of the gravitati onal source of stellar energy is correct, then over billions of years of evolution, stars would just increase their mass thousands of times (from 0.05 to 100 solar masses), passing through stages of evolution along the main sequence, similar to a noticeable increase in mass and energy release in plants and animals throughout their lives. Naturally, as the mass increases, the star attracts matter more and more and heats up more and more. This is confirmed by the mass-luminosity dependence discovered by astronomers, according to which, the higher the mass of a star, the brighter it shines [5].

Along the way, the temperature of the star also increases, and its spectral type decreases That is, as the star matures, it passes from the lower right corner of the main sequence to the upper left. And the main sequence itself is formed by stars of different ages, in different phases of evolution. After all as

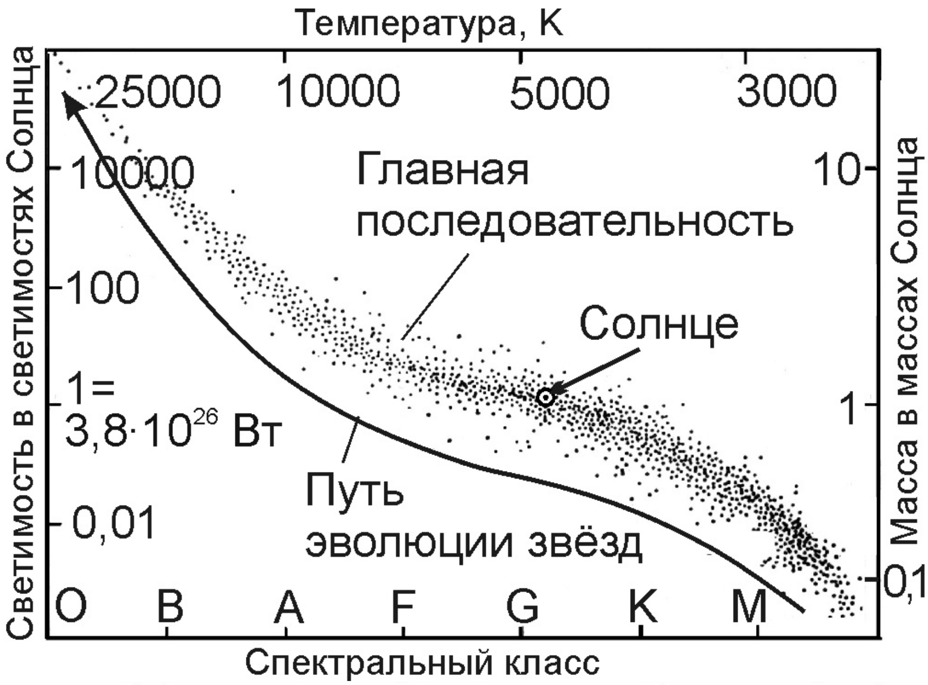

Fig. 3. The Hertzsprung-Russell diagram (spectrum-luminosity) with points plotted on it for known stars can reflect the phases of the evolution of stars along the main sequence if the mass of stars increases with their age.

Ambartsumyan proved, the stars did not arise simultaneously after the fictional Big Bang, but are constantly born and die, replacing each other, forming a closed cycle of life. But back to our native star. So, matter is constantly falling on the Sun, causing it to heat up due to friction. This process of matter falling onto gravitating bodies with the release of gravitational energy is called "accretion", and the rotating cloud that feeds the star is called "accretion disk" (Fig. 4). This cloud is very rarefied and is probably formed not so much by gas as by dust and asteroids. Therefore, we usually do not see this cloud: it noticeably thickens and heats up only near the Sun, forming its outer extended atmosphere - a hot corona, visible only during an eclipse. Traces of this cloud are also observed in the form of zodiacal light - a luminous band, sometimes visible against the background of the sunset sky along the ecliptic (the line of zodiacal constellations) and representing clouds of dust and gas glowing with reflected light, spinning in the plane of rotation of the planets. This cloud also leads to more vivid manifestations, which have not yet found an explanation.

For example, it is known that the Sun rotates, making one revolution in 27 days, but it does not

Fig. 4. Accretion and accretion disk around the Sun (a): fall of matter leading to heating and accelerated rotation of the equatorial parts of the star, as well as deceleration and reverse spin of Venus (b).

rotate as a solid body: at different latitudes, the angular velocity of rotation is different and increases with approaching the equator (Fig. 5). This, discovered by A. Belopolsky, the differential rotation of the Sun does not find an explanation, since it is not clear what supports it. After all, viscous friction should slow down the layers of the solar atmosphere, extinguishing the difference in their speeds, but in fact it is preserved. But everything will become clearer if there is an accretion disk around the star, which by its rotation maintains not only the temperature, but also the increased equatorial velocity of the Sun's rotation (Fig. 4). After all, the cosmic speed of rotation of matter falling on a star is noticeably higher than the speed of rotation of the star. Therefore, the falling matter entrains the equatorial regions of the Sun with its vortex, which is why they receive an excess angular velocity. These regions, in turn, partially entrain the higher latitude regions, which rotate at a lower speed. This is how the differential rotation of the Sun's surface is maintained. And precisely, observations have shown that at great depths the star rotates as a whole [6, p. 128], and only its surface rotates with excess speed, which would certainly be damped by friction, if there were no energy influx from outside [3]. The fact that energy comes from outside, and not from inside, is also confirmed by the inexplicable increase in the temperature of the Sun's atmosphere with distance from its surface, caused by the friction of its layers.[6]. In addition to large-scale currents along

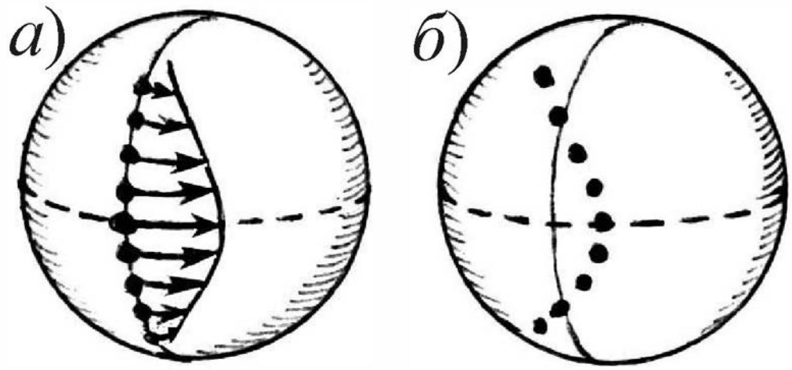

Fig. 5. Differential rotation of the Sun: due to the difference in velocities (on the diagram, a), the spots lying on the same meridian diverge after one revolution (b).

the surface, the fall of matter on the Sun also causes vertical, deep currents. The absorption and sinking of matter at the solar equator must be accompanied by the rising of gas near the poles. That is, gigantic convective cells similar to Hadley and Ferrell cells [6] in the Earth's atmosphere (Fig. 6). Such cells have long been assumed in the Sun in the dynamo theory to explain the magnetic field of the Sun and its differential rotation, but without explaining their nature and structure. Now it is clear that the Sun is like a giant cauldron with boiling soup, into which new ingredients are poured, increasing its mass, temperature

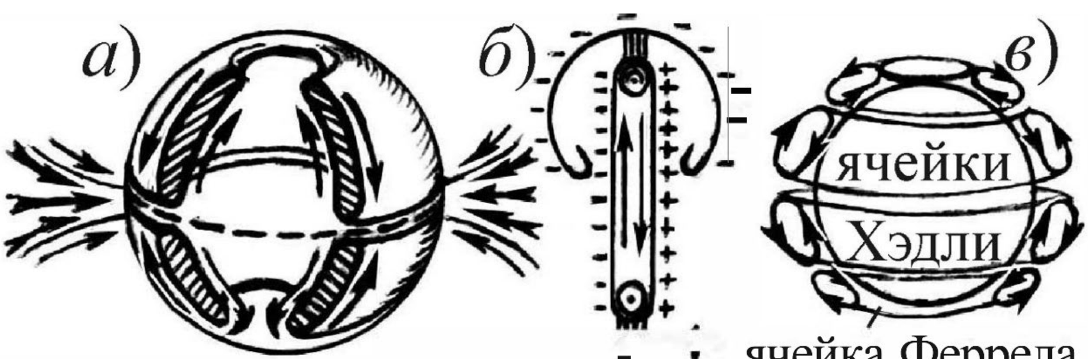

Fig. 6. Giant convective cells of the Sun (a), twisted by the fall of matter on the equator and charging the star, like a Van de Graaff generator (b). Cells in the Earth's atmosphere (c).

and mixing everything with convective currents. It is with convective currents that periodic solar activity is associated [3]. It turns out that the period of one complete revolution of matter in a convective cell sets the 11-year cycle of solar activity. However, due to the inhomogeneity of the flow of meteor matter absorbed by the Sun, the speed of its rotation and the period of circulation of the convective cell vary slightly, which is why the period of solar activity also changes slightly. This connection between the rotation of the Sun and its cells and the cycles of solar activity is confirmed by the fact of the accelerated rotation of the equatorial layers of the Sun at the minimum of solar activity [3]. Recall that solar activity, accompanied by solar flares, emissions of matter and radiation, is usually characterized by the number of sunspots. And now the circle is closed: we have returned to the spots from which we began the story.

Sunspots are less hot and bright areas of the Sun that appear dark in contrast to its brilliant background. This is due to the fact that in spots the upward movement of the atmosphere, which carries heat, is constrained by a strong magnetic field. However, scientists cannot explain the origin of the sunspots, their huge magnetic fields and the solar activity associated with the sunspots. The reason for this is that physicists forgot the classical, mechanical, visual models and began to invent intricate explanations in the form of mathematical schemes. Meanwhile, classical physicists long ago discovered the simplest model of spots, considering them to be giant vortices in the Sun's atmosphere, like vortices and cyclones in the Earth's atmosphere. This model was used by many scientists, including W. Herschel, E. Brown, Hale, Bjorknes (a specialist in terrestrial cyclones) and others [7].

Indeed, just as cyclones in the Earth's atmosphere bring cold air masses and cloudy weather in the middle of a hot summer, so cyclones in the Sun's atmosphere form cold regions. Even when viewed from a satellite, cyclones in the Earth’s atmosphere in many ways resemble sunspots: here is the fibrous structure of the cyclone clouds (resembling fibers in the penumbra of the spot), and a dark spot in the center of the cyclone (the eye of the cyclone, similar to the shadow of the spot, Fig. 1). However, scientists abandoned this hypothesis, not detecting the circular motion of gas in the spot from the Doppler effect. But this does not mean that there is no rotation, because traces of it are nevertheless revealed [7]. It is only necessary to take into account that the sizes of the spots are enormous (the Earth could "drown" in many of them), and therefore the rotation in the spots (as well as the rotation in cyclones) is not fast and is retarded by the magnetic field. And the magnetic field of spots itself, the nature of which scientists could not really understand, is explained especially simply in the vortex theory of spots. Since the atmosphere of the Sun is formed by plasma - a hot ionized gas of ions and electrons, then if some are slightly more than others (the plasma is charged), then even the slow rotation of charges in this giant vortex will create a circular electric current I, giving rise to powerful magnetic fields found near spots by the Zeeman effect.

Plasma can be charged for a number of reasons. Depending on the conditions, either hydrogen nuclei (protons), ejected by flares and forming the solar wind, or electrons, whose thermal velocity is comparable to the first cosmic velocity on the surface of a star, leave the surface of the Sun more often [6]. Accordingly, the surface is charged negatively or positively. Separation of charges also occurs on a global scale, due to the convection of the Sun's atmosphere. Let us recall how large-scale movements in the Earth's atmosphere in the same cyclones, hurricanes generate atmospheric electricity, charge clouds due to friction, the movement of dust and drops, causing electrical discharges and thunderstorms. On an even larger scale, this happens on the Sun from the circulation of its atmosphere, the friction of which not only serves as a source of solar energy, but also leads to the separation of charges, as in the friction of wool, as we see every time we take off a sweater. Then the main charge arises from the global circulation of the solar atmosphere in the convective cell (Fig. 6). At the same time, the oppositely creeping layers of cells become more and more charged with each revolution, like the disks of an electrophore machine spinning in different directions, or a closed rubber conveyor belt, a belt drive, sometimes also accumulating huge charges - this is how the Van de Graaff generator works. Oppositely charged surfaces, quickly following by, induce, attract new charges with their electric field. A small seed charge of sections of the convective cell of the Sun gradually increases and is maintained by this mechanism. Then these opposite sections, coming out to the surface in shifts, give the Sun's atmosphere either a positive or a negative charge (Fig. 7).

Apparently, it is this circulation of the convective cell that causes the cyclic activity of the Sun and the periodic change in its magnetic field. And for sure, it has long been discovered that along with solar activity, the magnitude and direction of the Sun's magnetic field changes every 11 years. The magnetic poles of a star change places after 11 years, so that the full cycle is 22 years. The convective cell model explains this easily. The sun rotates counterclockwise, so when a positive charge comes to its surface during convection, then, spinning along with the star, it generates an upward magnetic field: the upper pole of the Sun turns out to be the north magnetic pole (N), and the lower one is the south (S). When, after 11 years, the surface of the star is recharged, and electrons prevail on it, then their circular current I will create a downward magnetic field: the upper pole will become the south magnetic pole, and

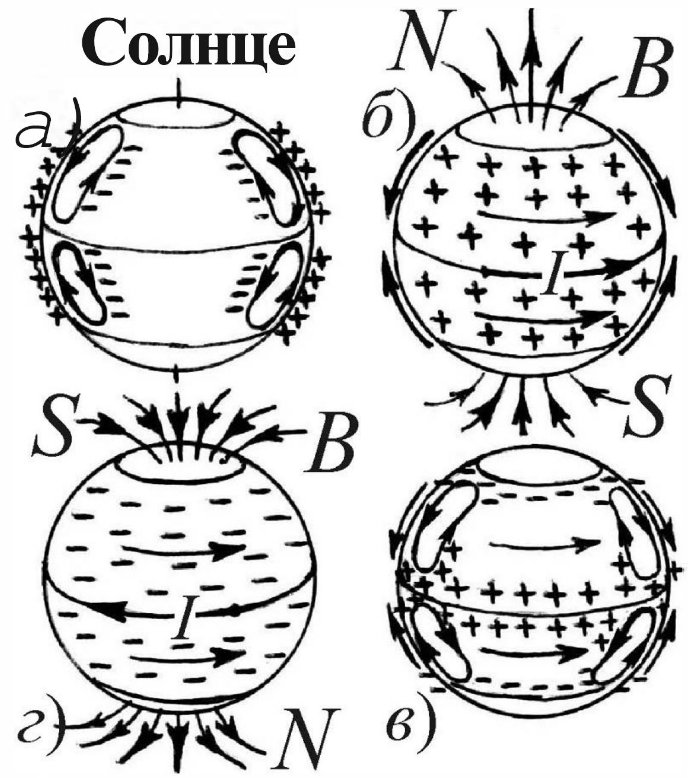

Fig 7. Oppositely charged sections of a convective cell in shifts reaching the surface (a), charge it positively (b), neutrally (c) or negatively (d), and generate a different current / and field B during the rotation of the Sun.

the lower one will become the north (Fig. 7). And after another 11 years, everything will return to normal: after 22 years, the cycle will close. That is, the convective shell makes a complete revolution in 22 years, setting the duration of a complete solar cycle. However, the period of solar cycles can vary slightly from time to time, both from the uneven rotation of the convective shell, and due to changes in the distribution of charges in it. This convective sliding of the solar atmosphere towards the equator is also fixed by the motion of sunspots, which live for about a month and noticeably drift towards the equator along the surface current [7].

Periodic fluctuations in the magnetic polarity of sunspots are also associated with a change in the sign of the charge during convection. It has long been noted that spots on the Sun usually appear in pairs, and the polarities of the spots are opposite (S and N, Fig. 8). Hale also explained this by saying that neighboring spots rotate oppositely, since the spots are in fact a single vortex tube, similar to the one that can be observed in a bath of water. If you pass a plate over the water, two funnels will appear, rotating in opposite directions and connected by their bases, as can be easily seen from the movement of their shadow at the bottom, or from colored water dropped into one of the funnels [8]. Such a pair of funnels is just half of a vortex ring like a smoke ring. Similar paired whirlpool funnels remain behind the oars of the boat. Often there is a whole group of funnels connected in several pairs. In the same way, groups of spots-vortices are often formed on the Sun. It is possible that spots-vortices originate at the site of large meteorites falling into the Sun's atmosphere, similar to funnels that appear on water from the fall of large stones, or like funnels-craters from meteorite projectiles bombarding the Earth and the Moon. This explains the concentration of spots near the equator, as well as sharp bursts of solar activity, accompanied by an increase in the number of spots from the fall of a group of meteorites (meteor showers) and forming large and small cycles of solar activity caused by the influence of planets crossing such streams. It is interesting that Yu.R. Mayer, who considered the fall of meteorites to be the cause of the energy release of the Sun, connected the growth of solar activity and the formation of spots with them.

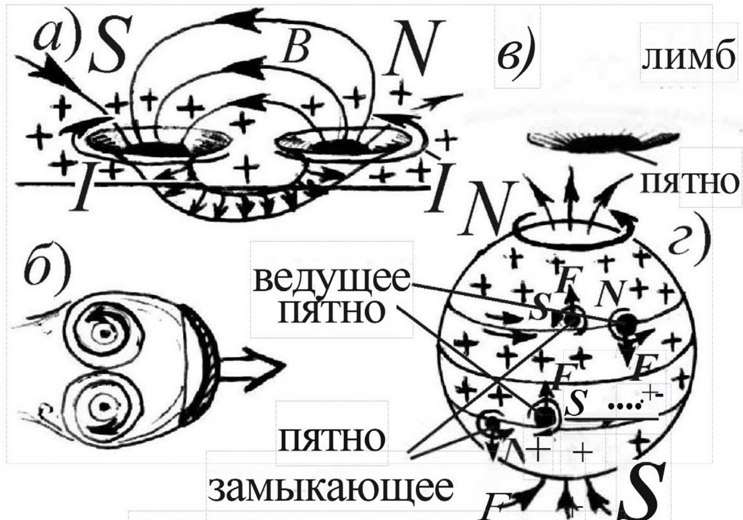

Fig. 8. Paired spots - vortices of a charged surface (a), analogues of a vortex tube (paired funnel) from an oar (b). Funnel structure of spots (c), their polarity and Coriolis force F at a positive surface charge (d).

Since the rotation in neighboring spots is opposite, like that of interlocked gears, it is natural that the magnetic field created by the rotation of charges is also opposite (it is not for nothing that it is called a vortex field): a paired vortex of sunspots resembles a horseshoe-shaped magnet (Fig. 8). At the same time, a spot should be more powerful and long-lived, where the rotation is counterclockwise in the upper hemisphere, and clockwise in the lower hemisphere, since such a rotation contributes to the differential rotation of the Sun and the Coriolis force (just like for terrestrial cyclones). For the same reason, this spot turns out to be leading and located slightly lower in latitude, while the spot, where the rotation is reversed, lags behind the rotation of the Sun and stretches to the pole, but the differential rotation stretches a pair of spots along the parallels - parallel to the equator [7]. Since the direction of rotation of the leading spot coincides with the rotation of the Sun, the polarity of this spot is the same as that of the upper pole of the Sun. So in 1956, when the south magnetic pole was located at the upper pole of the Sun, the leading spots had the same polarity S, and the trailing spots had the opposite polarity. In the southern hemisphere, on the contrary, the leading, more powerful spots rotate clockwise, which is why their polarity was north, and the trailing ones were south. In the next cycle, when the magnetic poles of the Sun changed, along with the sign of the surface charge, the polarities of the spots also changed (Fig. 8, 9): in the upper hemisphere, the leading spots had polarity N, while the trailing spots had polarity S, and vice versa in the lower hemisphere [7 , 9]. At the same time, the magnetic fields of the spots are much more powerful than the general field of the Sun, because the rotation of the spots captures only a uniquely charged surface, and the underlying layers also participate in the axial rotation of the star, which are charged back and create a field of the opposite sign, which is slightly smaller due to the smaller radius rotation. The small difference between these two fields generates the total field of the Sun with a dipole or quadrupole structure, depending on the arrangement of charges. Thus, the hypothesis of the convective cell and the vortex hypothesis of Hale easily explain the cyclical change in the polarity of the Sun and spots, mysterious to scientists.

Explains the convective cell and the periodic change in solar activity. Belts of positively and negatively charged sections of the convective cell should be separated by uncharged, neutral stripes. When the main part of the Sun's surface is neutral, its activity is minimal and the number of sunspots, which appear only on charged regions, is minimal. Therefore, it is convenient to characterize solar activity in terms of the number of sunspots expressed by the Wolf number. As the cell matter convectively circulates, positively charged regions come to the surface after the neutral regions. Then, at latitudes of 30–40º, spots begin to appear, in which the leading one has polarity N, and the trailing one has S polarity. As more and more positively charged regions come to the surface, the area of the charged surface increases, and therefore the number of sunspots and the associated solar activity. In this case, the average latitude at which spots appear gradually decreases along with the advance of the charged region towards the equator. This advance lasts just eleven years, until the spots begin to appear only near the equator and disappear completely with the last positively charged zones going under the surface. Then solar activity will again reach a minimum, and the surface of the Sun will become neutral.

In parallel, a new cycle is born, because when the last spots hide near the equator, the negatively charged belt of the convective cell is already coming to the surface at high latitudes. Therefore, at the moments when leading spots still have polarity N near the equator, at high latitudes, where the sign is reversed, leading spots with polarity S appear, gradually moving towards the equator and giving rise to a new cycle (Fig. 9). However, this intersection of the old and new solar cycles is very short-lived. So, charged areas of high solar activity circulate in the convective cell, like a conveyor belt, or a tank caterpillar. And, just like a caterpillar on asphalt, or a wheel caught in paint, like a painted roller of a printing press, the solar convective cell periodically imprints spots on the solar surface with each revolution, causing a change in solar weather (and the Earth's convective cells control its weather) .

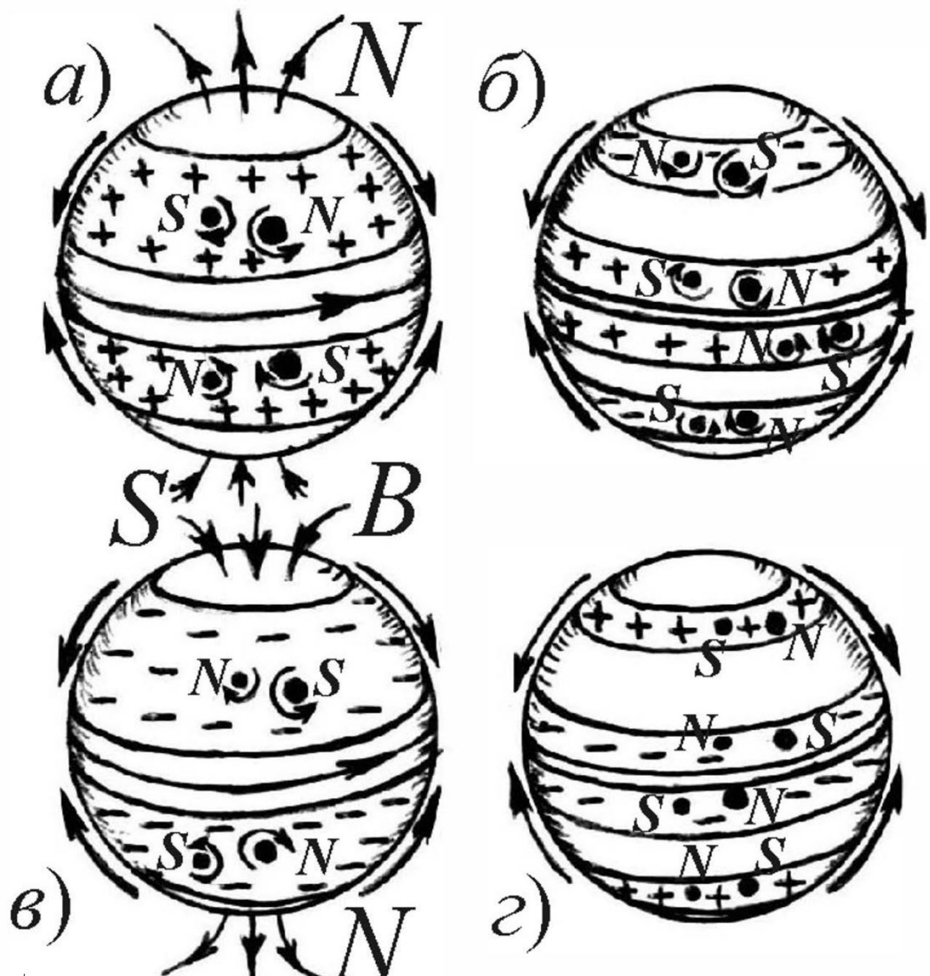

Fig. 9. Magnetic polarity of the hemispheres of the Sun and pairs of leading and trailing spots depending on the sign of the surface charge: positive (a), neutral (b, d) or negative (c).

It is clear why it is with spots and charged areas that high solar activity is associated, accompanied by frequent emissions of corpuscular ionizing radiation, which provokes vortices in the Earth's ionosphere - magnetic storms and auroras. Since sunspots are analogues of terrestrial cyclones, hurricanes and storms, their appearance in the Sun's atmosphere causes noticeable perturbations in it with the release of energy. If we remember how destructive the energy of tropical cyclones and hurricanes is, it is easy to imagine what kind of energy emissions are given in such storms by a much more powerful and extensive hot atmosphere of the Sun. Of course, in the spots themselves, the magnetic field fetters any movement and “calm” reigns here, but this calmness is as deceptive as the calm sky and sea in the center, the “eye” of the cyclone [10]. After all, around a calm cold spot, as around the eye of a cyclone, it becomes "hot", and a solar storm rages, and on Earth - a magnetic storm. Earth cyclones spin around cold regions of low pressure. The same thing happens in sunspots. A small seed vortex on the charged surface of the Sun gradually intensifies and grows, since the magnetic field created by it slows down, freezes the convective currents of plasma and heat. Therefore, the spot cools more and more, the pressure in it drops, leading to an influx of gas from the periphery and its faster and faster unwinding, like a funnel in a bath, which further increases the magnetic field, and so on in a circle (Fig. 2, 8). Even outwardly, the spot and its penumbra resemble a conical funnel, such as a tornado, tornado, typhoon.

In addition, the magnetic field of the sunspot, blocking, delaying and knocking down a number of solar processes, leads to explosive overheating. Usually, the calm "burning" of the Sun acquires an explosive character due to containment, the luminary erupts plasma flows, like an eruption of magma and steam by a volcano, a geyser, where the calm expansion of the gas is replaced by an explosive one, due to overheating [10]. It is also possible that the ejections of charged particles at the maximum of solar activity are caused by powerful electric discharges in the convective cell. The oppositely charged outer and inner sides of the cell, separated by hundreds and thousands of kilometers, should cause giant breakdowns-lightnings in the plasma of the solar atmosphere, similar to terrestrial lightning, but much larger (then the spots are the centers of not just solar, but also thunderstorm activity). In these discharges, an avalanche of ions and electrons, accelerated by the field of a convective capacitor cell, can, by inertia, fly out into in the form of a solar flash-lightning - a powerful corpuscular ejection-prominence, shot by the Sun into space and often hitting the Earth (Fig. 10). By the way, even Lucretius mentioned in his poem "On the Nature of Things" these lightnings of the Sun, swiftly rushing in the sky. He also correctly explained the nature of terrestrial lightning arising from the friction of clouds and the rapid escape of microparticles (electrons and ions) from them at the moment of breakdown.

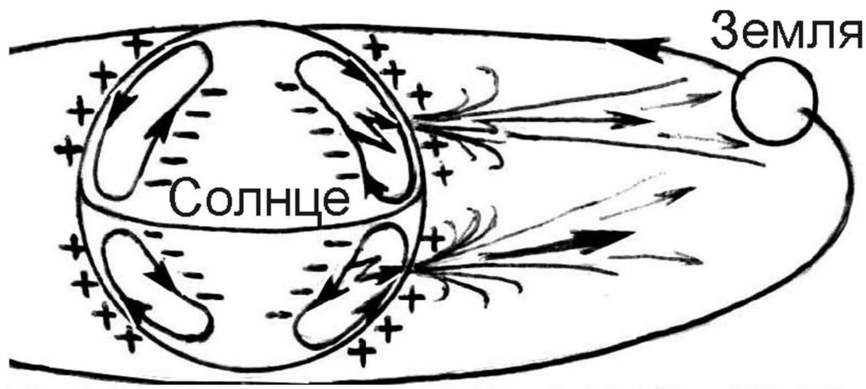

Fig. 10. Solar activity: plasma emissions of the atmosphere reaching the Earth cause magnetic storms and are lightning-breakdowns of convective cells and solar.

Or maybe the earth's magnetism, thunderstorm activity and surface charging are due to the movement of the earth's atmosphere? After all, convective cells have long been discovered near the Earth [6]. Similar cells, visible in the form of bands, were also found in the giant planets: Jupiter, Saturn, Uranus, Neptune, the motley surface of which resembles a soap bubble surrounded by sliding colored rings and vortex stains. Peculiar analogues of such vortices, terrestrial cyclones and sunspots are widely represented on the surface of giant planets: these are small short-lived vortices and Jupiter's large red spot. The mechanism of generation of the Sun's magnetic field can also be transferred to the planets, whose magnetic fields have so far been associated with currents in the planetary interiors. If, as in the Sun, the magnetic field of the planets is caused by the rotation of their charged surface, atmosphere and ionosphere, then the mechanism for generating the field and currents will not resemble a dynamo, but an electrophore machine and a Van de Graaff generator. Depending on the sign of the charge of the surface and atmosphere, the rotation imparts one or another magnetic polarity to the planet.

So, the earth's surface is negatively charged, so its rotation generates a magnetic field with a south magnetic pole in the upper (northern) hemisphere, which is actually observed (approximately the rotation of an electron generates its magnetic moment). And the periodic reversal (inversion) of the Earth's magnetic poles, which occurs on average once every 200 thousand years, is similar to the change in the polarity of the Sun once every 11 years, possibly also caused by a change in the sign of the charge of the earth's surface and atmosphere. Then it is clear why a strong magnetic field is characteristic only of planets with rapid rotation and a powerful atmosphere. These planets include only the Earth and the giant planets. The presence of a powerful magnetic field near Jupiter and Saturn is confirmed not only by direct measurements of space probes, but also by photographed auroras in the atmospheres of these planets. There is also a dense atmosphere on Venus, but it rotates slowly and inversely to the rotation of other planets. Perhaps this anomaly is also caused by the presence of a vortex cloud of dust and gas in the solar system, the inhomogeneous rotation of the layers of which, accompanied by the fall of matter on the planets, may well slow down and even reverse the rotation of the planets located near the Sun. This will explain not only the reverse rotation of Venus, but also why its atmosphere is ahead of the rotation of the planet itself [5]. As for the Sun, this is caused by falling meteor showers keeping the atmosphere spinning faster despite friction (Figure 4).

So, we see that the mechanics of rotation of cosmic bodies and the vortex motion of their atmospheres serves as a key to understanding their energy, thunderstorm and solar activity, the nature of their magnetic field and its periodic inversion. The leading role of the vortex, rotary motion in the formation of galaxies, stars, planets and the heat released in them was understood by all classical scientists and atomists, including Democritus, Epicurus, Lucretius and Lomonosov, Mendeleev. And the ancient Slavs did not just associate the Sun and its light-emitting energy with a spinning, vortex spiral structure, calling the word Kolo, which means "circle", "moving in a circle", as in the words: wheel, stake, brace. It is not for nothing that the same Belopolsky, having discovered the differential rotation of the Sun a century ago, modeled it with the help of a rotating glass ball filled with liquid. It turns out that today's scientists have lost a lot, forgetting about these vortex, hydromechanical models, which have not lost their relevance to this day. However, to describe the plasma (the main medium of space), scientists still use the hydrodynamic approximation. It remains to apply this approach in the science of motion, energy release of the Sun. Competently connecting the simplest laws of electricity with the laws of thermodynamics and vortex motion, it is possible to explain many previously mysterious phenomena and shed light on the question of the nature of sunlight and heat.

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Installation date: 02/03/2011

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