On the Nature of the Magnetic Field of the Earth and Other Planets

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This study presents a hypothesis of the origin and maintain of the magnetic field of the Earth and the planets. The mechanism of the tides on the opposite side of the Earth from the Moon is considered. The possible causes that enforce the continents to displace are discussed in couple with the causes that distort the shape of the Earth, and the causes of the jumps of the astronomical time. A mechanism of earthquakes is proposed, as well as a version of the appearance of the "magnetic tubes" in the Sun. The source of the forces causing the equatorial current and wind is shown.

Contents

> Books of physics are full of complicated mathematical formulae. But thought and ideas, not formulae, are the beginning of every physical theory.
>
> Albert Einstein

> That hypothesis which explains the current world with the fewest assumptions and means should have an advantage, because it is less arbitrary.
>
> Empedocles, *On Nature, the Law of Economy*

> The form of development of natural science, in so far as it thinks, is the hypothesis... If one should wait until the material for a law was in a pure form, it would mean suspending the process of thought in investigation until then and, if only for this, reason, the law would never come into being.
>
> Friedrich Engels, *Dialectics of Nature*

1 Introduction

The Earth's magnetic field makes our planet habitable — there would be no life on the planet without it. It protects the Earth's biological envelope from the hostile lifeless space and devastating effects of cosmic-ray particles. The habitability-determining need for a magnetic field reduces the number of potentially habitable planets. It is hard to enumerate all the effects of the field on inhabitants of the planet. Its properties are used by both humans and animals, while the scientific community has no unambiguous approach to understanding the mechanism of the field's creation and maintenance, as well as on the factors affecting its behavior.

One of the most popular hypotheses trying to explain the nature of the field is the dynamo theory. It proposes that convective and/or turbulent motions of conductive fluid in the core trigger self-excitation of a magnetic field and maintain the field stable.

However, it is hard to imagine the core steadily moving up to the surface in the same direction due to temperature — if it is convective motion; or the turbulence created by rotation being so stable that it could maintain self-excitation, and even in the same direction. Though, the nature of turbulence is not clear either. Over time, in the absence of external forces, the inner substance of the Earth will also rotate together with the shell due to its viscosity. The origin of the potentials in the core is also unclear. Why are they not compensated, if the substance is conductive? The authors of this hypothesis themselves thought it was a far cry from being proven. Although the hydrodynamic dynamo hypothesis explains many well-known facts, it is clear that the power triggering the "dynamo" has been defined incorrectly.

Another hypothesis proposes that the magnetic field is created in the ionosphere by the solar wind.

The third one says about salt-water flows in the oceans.

None of these theories can be applied to all the planets of the Solar System free of contradictions. For example, Jupiter spins in the same direction as the Earth does, but Jupiter's magnetic field is directed opposite to the Earth's one. Venus and Mars have no strong fields.

Anyway, it is not fair to believe that the Earth owns some unique features that no other planet has. After all, it is not the only planet that has a magnetic field, and it is not quite the thing to do to come up with its own mechanism for creating a magnetic field for each planet either. So what could be right? There should be a single physics of this phenomenon.

It just manifests itself somewhat differently because of different conditions of existence of different planets.

I would like to note here that the modern model of the Earth (with a hard core inside, surrounded by liquid alloy) is based on the study of behavior of acoustic (seismic) waves and their ability to pass in solid and liquid media differently. High-temperature plasma with close-packed nuclei will conduct seismic waves as a solid (crystalline) material, which is consistent with the measured data, and the adopted boundary of the solid core may be a boundary of transition to the plasma state. Generally it is hard to imagine — without inventing new forms and states — that some substance would "float" in a hard form in the same melted substance without melting itself.

This article presents a hypothesis of emergence and maintenance of the planet's magnetic field taking into account its own travel (axial inclination) in the solar ecliptic and the properties of the planet itself and its moons, if any. It shows that the outer shell of the planet is "independent" from the processes occurring in the planet's interaction with other bodies, thus allowing the magnetic poles to move, up to their inversion.

Attempts to find the answers to the following questions

1. What is the origin of the Earth's and other planets' magnetic fields?
2. Why does the far side of the Earth furthest from the Moon has tides too?
3. Why do the Moon and most moons keep the same side turned to their planets?
4. What force causes the continents to move?
5. What causes earthquakes?
6. Why is the Earth not round?
7. What are the reasons for sharp changes in astronomical time?
8. How do "killer-waves" occur?
9. Why is there a dip in the gravitation graph during the Sun's passage across the sky?
10. What are the reasons for periodic variations of geophysical fields and seismic activity?
11. What gives rise to and maintains major ocean currents and equatorial winds?

have given rise to the following hypothesis:

> The main reason for all of the above phenomena is the gravitational interaction of the Sun and moon(s) with a moving core of the planet.

The main proof of the hypothesis is the clear connection in the chain "**planet — satellite(s) — planet's magnetic field**" for various planets of the Solar System, bearing in mind that each planet is a moon of the Sun in its turn.

Thus, it can be noted that:

1. The magnetic field is effective if a planet has a moon or more. The field is small if the planet has no moons (e.g., Venus and Mercury have no moons, and their magnetic fields are very small);
2. If the planet cooled down and does not have a liquid core, it does not have a magnetic field either (e.g., the Moon);
3. Direction and shape of a planet's magnetic field depends on both the direction of rotation of the planet itself in the ecliptic plane and the orbit of the moon revolving around the planet (e.g., Mars and Uranus have reverse rotation of moons and reverse magnetic fields);
4. In the presence of multiple moons, the field becomes complex, and priority in the field's direction is determined by the more closely spaced or the more massive moon (for example, Uranus or Neptune);
5. Direction of the main winds and location of dust clouds on most of the planets in the Solar System coincides with the direction of their moons' motion.

In addition, the fact that the most moons revolve around their planets turning one side on them, and the rotation of planets such as Venus and Mercury is synchronized with the motion of the Earth (the two planets turn the same hemisphere to the Earth when approaching it), shows that cosmic bodies interact with each other not as uniform bodies, but as bodies with misplaced centers of mass. At the same time, in the case of a liquid core, the center can move within the hard shell of the planet.

Let's consider the mechanism of occurrence of a magnetic field (MF) in the example of the Earth. It will be the same for any Earth-like planet.

Imagine the Earth as a fixed sphere filled with substances of various densities and various specific gravity, and the Sun as a source of gravity affecting these substances. It is obvious that the heavier structures will gravitate to the shell of the sphere that is closest to the source of gravity, and distribution of density and mass within the Earth will be uneven not only in depth, but also towards the Sun (see Fig. 1).

According to modern theories of the Earth structure, substances below the lower mantle are in a liquid state (metallic phase) — plasma — where electrons are separated from the

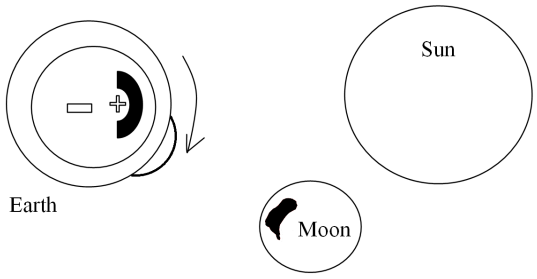

Fig. 1: Mass distribution.

nuclei. But, as the nuclei are much heavier than the electrons, it is clear that these are "precipitating" nuclei. Then a division inside the Earth's core occurs not only by mass but also by electric potential. The core of the Earth has become a dipole with the center of mass shifted significantly, where "+" and the bulk mass of the core are closer to the Sun.

While the Earth rotates, this part of the Earth's core follows the Sun and thereby create directed motion of electrically charged particles and circular, cyclic displacement of the center of mass of the Earth relative to its shell.

In 1878, Henry A. Rowland proved that charges moving on a moving conductor are identical in their magnetic effect to conduction current in a conductor at rest. Thus, in our case, the right-hand rule is generally appropriate, as evidenced by the direction of motion of the core part carrying a positive charge and the force lines of the Earth's magnetic field.

It certainly does not mean that one side of the sphere is pure "+" and the other is "−". Otherwise there would be no magnetic field formed in rotation of such a dipole because of the mutual compensation. There are just different motion radii, and different linear speeds respectively, and hence current potentials are different too. There may occur some compensation in motion of various charges, but "+" prevails.

More information on polarization of plasma in massive astronomical objects due to gravitational forces and their interaction with Coulomb forces is available in works by Igor Iosilevskiy (for example, in his publications [1, 2]).

By the way, if we accept the proposed hypothesis, the formation of the dipole inside the planet is a practical proof of the theoretical assumptions made by Iosilevskiy.

Of course, besides the Sun, the behavior of the charged core is also influenced by all the planets and the Moon in particular (see the section on tides).

Another proof of the hypothesis are daily and annual changes in the magnetic field direction, i.e., dependence of the field on the Earth's position relative to other objects affecting division by mass, charge, and trajectory of the core. (In the case of the now accepted hypothesis of a hydrodynamic dynamo, there should be no such influence.)

In fact, the heavy part of the core moves from East to West and in spirals from North to South and back with changes in axial inclination (change of season).

A very interesting measured data were provided by Yury P. Malyshkov and Sergey Yu. Malyshkov [3] on the basis of their research done in the Institute of Monitoring Climatic and Ecological Systems, Russsian Academy of Sciences.

Based on years of research on natural pulse electromagnetic fields of the Earth (NPEMFE) in seismically active areas of the Baikal Lakeside, they came to a conclusion on the motion of the planet's core and related natural phenomena — seismic activity, impact on the human body and so forth. The figures showing intensity of NPEMFE changes at different points in time exactly repeat the expected movement pattern of the dipole's heavy part.

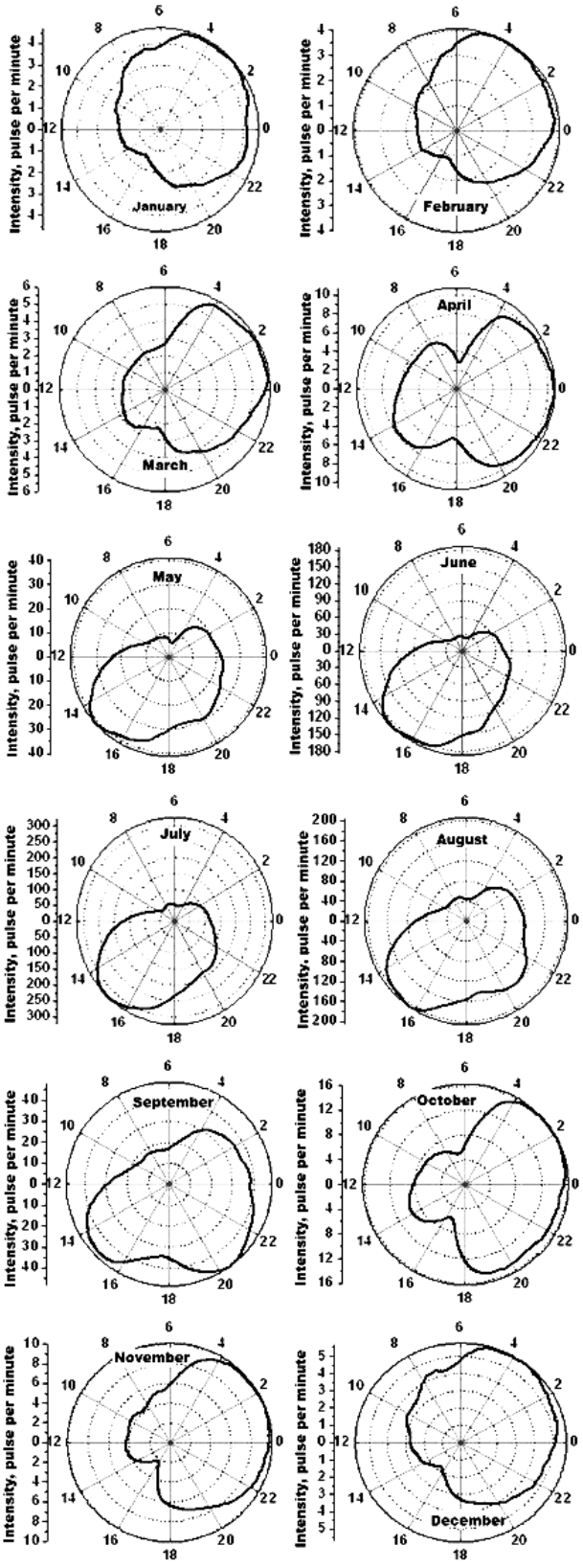

Fig. 2: Average rounded daily variations in NPEMFE in polar coordinates for the period from 1997 to 2004.

These figures show the way the intensity of the electromagnetic field disturbances is changing during the time of day depending on the season. We can see that the intensity is significantly reduced in winter months with its maximum at night, that is when it is day time and summer in the Southern Hemisphere, where the heavy part of the core is, and there are more storms.

It is very sad that such an enormous result obtained by Y.Ṗ. Malyshkov and S. Yu. Malyshkov [3] on these measurements, systematization, analysis and so on cannot be continued because of lack of funding.

It becomes clear how the Earth's magnetic field is formed and why other planets and the Sun have magnetic fields too, if they have moons, or no magnetic fields, if they don't (eg., Venus has a very slow spin — 243 Earth days — that is there are no gravitational forces to create a moving charge), or if the planet cooled down and has no liquid core (Moon), as well as reversal of polarity with reversed rotation of the moon(s) (Mars), and presence of a complex field due to the planet's complex relationship with moons (Uranus and Neptune). It is interesting that Mercury, while having no moons, has a field similar to the Earth's one, though much smaller. However, it itself is a moon of the Sun, and the closest one. It quickly orbits the Sun — in 89 Earth days. Mercury's field is symmetric and directed along the axis of rotation. Its equator is only 0.1 degree tilted to the orbit plane.

A good illustration of the influence of the planet-moon system on a magnetic field's form is a comparison of the fields of Jupiter and Earth. Jupiter's field is more like a flat disk — even most of its moons rotate in correct circular orbits in the equatorial plane — and the axis of rotation of the planet itself is negligibly tilted. There is no change of seasons. On the other hand, the form of the Earth's field resembles an apple, and the planet itself swings relative to the plane of the ecliptic. This can be compared as fields from two different electromagnetic coils — one loop-to-loop wound around the coil-tube and the other being similar to a cassette tape.

Thus, the charges forming the magnetic field of a planet having a liquid core are created and propelled by the total gravitational force from its moons, the Sun, and other planets moving nearby relative to the planet. The charges also influence on the field shape. Of course, MF depends on the distance between the planet and the Sun. Influence of the latter is paramount. For example, as shown by Alexander L. Chizhevsky, "Taking into account the diameter of the Sun equal to 1,390,891 km* and the tremendous power of physical and chemical processes occurring on the Sun, it must be recognized that the Globe is under its enormously intensive influence" [4].

A short comparison of the planets' magnetic fields depending on the number of their moons and other properties is given in Appendix.

The generated pulsating (for a point on the surface) — with a day-and-night period — magnetic field of the Earth is supported by the magnetic properties of the planet's body that smooths and stabilizes its behavior, and sometimes distorts, creating local anomalous areas.

According to the research conducted by Hrvoje Tkalčić, College of Physical and Mathematical Sciences, Australian National University [5], he found that spins of different layers of the Earth are not synchronic. The red-hot core of the Earth inexplicably begins to gain momentum and then slow down, and spins faster or slower than the Earth does. To detect the desynchronization phenomenon, the researchers used a very effort-consuming method of studying double earthquakes, i.e. the earthquakes that occur in the same place at intervals of two weeks to decades. Comparison of seismic waves made it possible to reveal changes in the deep layers of the Earth and learn about changing spin speed of the planet's core.

It is quite hard to measure the spin speed in discrete measurements as, in this case, we need some kind of a marker on the core's surface; all the more so as said that the speed is unstable and variable. We can only determine that there is a position change. If changing the model of the Earth's internal structure, the measured result change too. However, the fact that these changes take place also verifies the hypothesis, and it can broadly explain the physics of motion.

2 Tides

Let's consider the effect of gravitational force in the example of the Earth. The primary influence is caused by the Sun and the Moon. The Sun's influence is (according to various data) 30 to 200 times stronger than the Moon's. However, despite the fact that the Sun's gravitational force is almost 200 times greater for the Globe than the gravitational force of the Moon, the tidal forces generated by the Moon are almost twice as much as generated by the Sun. This is due to the fact that the tidal forces do not depend on the magnitude of the gravitational field and its degree of heterogeneity. With increasing distance from the source of the field, heterogeneity decreases more rapidly than the size of the field itself. Since the Sun is almost 400 times farther from Earth than the Moon, the tidal forces caused by the solar gravitation are weaker.

In other words we can say that the tidal force of the Moon is more "superficial", local, and more affecting the ocean and the upper mantle, whereas the solar gravity is more uniform, affecting the whole body of the planet. The solar gravity can be considered roughly equal anywhere on the Earth. It is the solar gravity that makes the core move and separate into charges. Naturally, this mechanism will slightly vary for other planets, but the physics of the phenomenon is the same.

With spin of the Earth, these two forces are added and the tidal wave, which has the shape of an ellipsoid, is a superposition of two *double-humped waves*, formed as a result

*According to recent data, the Sun's diameter is 1,392,000 kilometers, while the Earth is located at 107 Sun diameters from the Sun.

of gravitational interaction of the Earth-Moon planetary pair and the gravitational interaction of the pair with the central luminary — the Sun.

Thus, the words *lunar tide* hereinafter mean a tide caused by the cumulative influence of the Sun and Moon on the body of the planet.

In addition to the tides on the Earth's side facing the Moon, there are tides on the other side. They are about the same in magnitude. In literary sources, the existence of this phenomenon is explained by reduced gravity of the Moon and the centrifugal forces created by rotation of the Earth-Moon pair. But then there would be a tide on the other side of the Moon too, and this would happen there all the time, especially as the Moon moves at the larger distance from the center of mass than the other side of the Earth does. We know about the shifting center of mass and elongation of the Moon towards the Earth, but there are no tides on the far side. In addition, as it was said above, the tides are caused not only by the Moon, but by the Sun and the Moon together, so we have to find now the center of mass for three planets.

If we compare the forces affecting the Earth's surface in low-tide areas (Point 2) and high-tide areas of the *dark* side of the Earth (Point 1), the gravity forces in the *dark* should be stronger, as the gravity of the Earth's center is added (though weakened) the gravity of the Moon and the Sun. This means that the sea level in Point 1 should be lower than the sea level at low tide in Point 2, but it is actually almost the same as it is in Point 3. How else can it be explained?

Following the hypothesis, we can assume that the heaviest part of the Earth's core following the Moon and the Sun is displaced so far from the opposite edge of the Earth, that the square of the distance has its effect, and the gravity force of the core on the surface is weakened thus causing a tidal effect. In other words, the force of gravity at the point on the Earth depends not only on the position of the Moon and the Sun, but also the center of mass of the Earth (see Fig. 3 and Fig. 4).

Apparently, these processes occurred on the Moon too. When cooling, the heavy mass of the inner substance clustered mostly in the side of the planet facing the Earth, thus making the Moon a kind of Roly-Poly and forcing it to turn the same heavy side to us.

This is also confirmed by the fact that earlier, as it is known, it had a strong magnetic field which now exists only in residual form.

Thus, the force of the Earth's gravity (together with the Moon's gravity force) not only holds the Moon in the moon orbit, but also makes it spin thus requiring energy. Perhaps this interaction further heats the inner substance of the planet, preventing it from cooling down. This can refute the theory of a thermonuclear source maintaining the planet's core in a "warm" state. Otherwise, at least we would have long been bald.

The same core makes the Earth to "bulge" at the equator, giving it a form other than a sphere. The same bulging is a

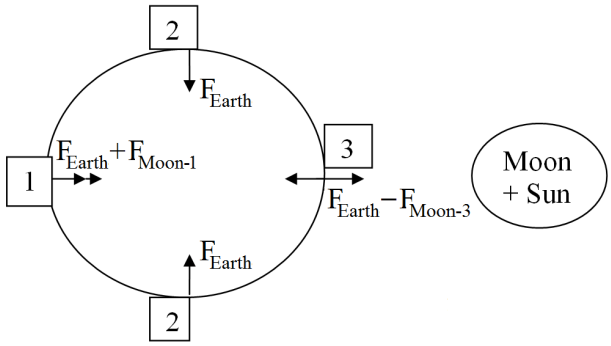

Fig. 3: The forces affecting the points on the Earth's surface with uniform mass distribution.

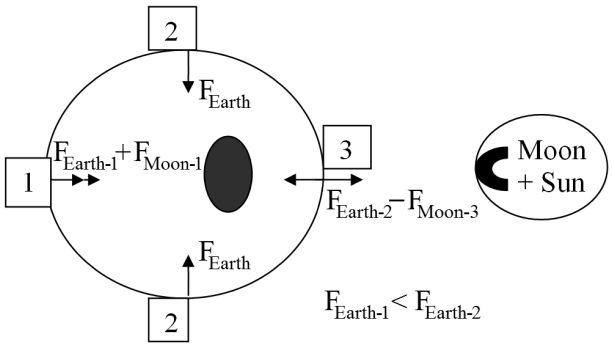

Fig. 4: The forces affecting the points on the Earth's surface with the shifted center.

characteristic of Jupiter with its high speed of spin, where this is further contributed by centrifugal forces.

A similar phenomenon seems to be happening with the Sun and its moon-planets.

If we imagine that the "heavy" center of the Sun following the moon-planets "floats" on the surface with a strong gravitational pull of planets, is charged with the electric potential, and is in motion, this may cause *magnetic flux tubes* on the surface, i.e. output points of the both poles of the magnetic field.

Over many years of research on the impact of solar activity on the biosphere, Chizhevsky has clearly shown a direct relationship of these processes, assuming that the perturbations observed as *sunspots* are causing radiation that reaches the Earth's surface and penetrates into it affecting all the living and non-living things [5]. The proposed hypothesis can explain the appearance of wide-frequency-range electromagnetic radiation as a result of abruptly changing fluxes of charged solar material.

3 Currents

Literature sources used to explain the nature of the equatorial currents by the winds constantly blowing in the same direction, while the nature of the winds was explained by surface heating and spinning of the Earth. Of course, this does affect

the ocean and the air masses too, but, in my opinion, they are primarily influenced by the gravity force from moving *Earth core — the Moon* and *Earth core — the Sun* pairs affecting everything that gets between them and that is carried from East to West by their gravity force. It should not be regarded as a process with tight fixing. It is more similar to stirring a teaspoon in a large pot in the same direction — not hard, but for a long time.

4 Earthquakes

There is still no clear definition of the nature of earthquakes. It is quite possible that it may look as follows: Employ your imagination — Where will a body located at the center of the planet gravitate at the slightest deviation from the center?

If a substance is distributed unevenly (assume that it is denser to the center), it is just like as written in textbooks. But what forces draw it in the center? It should be a substance having infinite density. It sounds more like fiction.

If the Earth had the form of an empty sphere, there would be no gravity force inside it. The point inside the Earth would be influenced by the gravity forces of external bodies — the Moon, the Sun, etc. This point would tend to follow the direction of the sum vector of the forces of these bodies.

If the Earth had uniform distribution of substance by density, then (if the substance is liquid) it would be the same.

In both cases, the substance inside the hard shell will gravitate to the shell from the inside toward the outside forces from other planets.

All the above was said without taking pressure into account, but let's consider the pressure's behavior upon submersion — naturally it increases in the beginning (as the mass "over the head" increases), but further on the gravity force decreases and the pressure gradually "stabilizes". In the end we have a closed space with approximately even pressure throughout volume, and its influence may be small compared to the gravity forces. It is just the same as in ordinary life — the atmospheric column presses down on all of us, but it still lets the gravity forces to drop an apple on the ground.

It turns out that the interior of the Earth can be similar in structure to a chicken egg and have the same distribution of substance by density as it is on the surface — solid-liquid — and all these at enormous pressure and temperature.

Now, if we imagine, the glowing mass exposed to various — addable or deductible — gravitational forces from various planets is moving in the "inner" surface of the earth, constantly blending and running into irregularities. At the same time, the interior of the Earth's shell is constantly exposed to momentum which is transmitted to the tectonic plates, forcing them to move gradually, thereby moving the continents. This is confirmed by the fact that the continents are moving in the latitudinal direction (East-West) and do not move in the longitudinal one (South-North).

Sometimes the forces are added in such a way that parts of the core get into the central zero-gravity zone and, after breaking away from the bulk mass, "fall" on the opposite side of the sphere, which might cause an earthquake. A very good illustration of such a case is behavior of water in a zero-gravity environment shot by US astronauts. Behavior of water balls in a "bubble" could well be similar to that of the inner core of the planet.

By the way, the zero-gravity zone is not fixed in a permanent place, but is following the main mass of the core in rough circles.

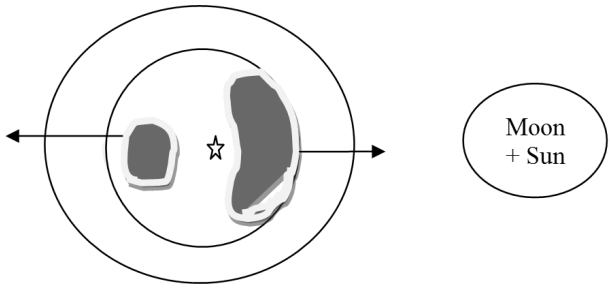

Fig. 5: A part of the core falls on the opposite side of the Earth's shell after it has separated and moved to a gravity-equilibrium zone.

There may also occur a sort of a wave with a crest when climbing an inner roughness, with a further collapse, which may also cause an earthquake.

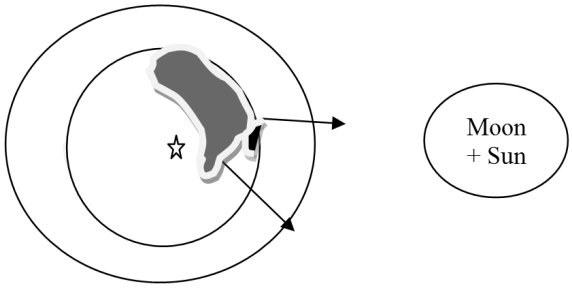

Fig. 6: Collapse of a core part.

This mechanism of earthquakes may be even more likely, since the majority of seismic focuses are located at the boundaries of tectonic plates or in areas of geological irregularities.

These two phenomena can cause shifts in the surface layers of the mantle triggering creation of additional seismic focuses and aftershocks.

It should be also noted that, as is known, magnetic storms on the Earth are accompanied with low-frequency vibrations of the Earth's body, and vice versa, earthquakes are accompanied by electromagnetic radiation, i.e. these two phenomena are interrelated. This can also serve as a verification of the suggested hypothesis, as there are surges of electric charge (current), and the transition process (as we know) has a wider range than direct current.

5 Time jumps and killer waves

With the advent of new, more precise time measuring means, it was observed that sometimes the celestial (stellar) time flows changing relative to the reference atomic one in jumps*. How can this be explained but through the Earth being exposed to forces, turning it at a certain angle? We see no external forces of such a power, so we have internal ones left.

It is quite possible that, when running into an internal "roughness", the core "pushes" the main body of the planet, altering astronomical time relative to the stable reference one.

Mariners now a natural phenomenon known as the "killer wave" (also known as periodic wave, monster wave, rogue wave, freak wave, onde scelerate, or galejade). Some ten to fifteen years ago, scientists believed that seafarers' stories about giant killer waves that emerged from nowhere and took down ships were nothing but maritime folklore.

The existence of sea waves twenty to thirty meters high contradicts the laws of physics and does not fit into any mathematical model of formation of waves. It should be noted that these waves appear on relatively calm water surface. They can be a crest or a trough, single one or coming in a set.

The proposed hypothesis can logically explain the mechanism of their occurrence through the same interactions between the moving core and the internal irregularities of the planet's body, which are carried over to the sea surface.

6 Causes of a dip appearing in the gravity graph during the Sun's passage across the sky

Following the work with a new directional gravimeter, Evgeny Orlov presented some interesting data. As shown in his article [6], round-the-clock registration of gravimeter readings made it possible to determine the original geometrical shape of the solar gravitational signal (see Fig. 7).

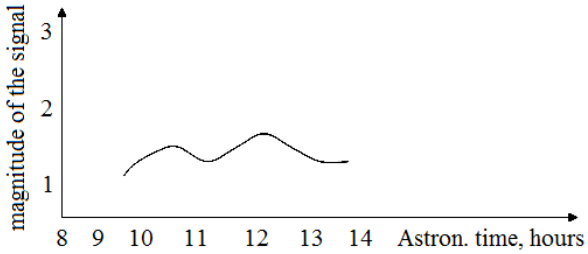

Fig. 7: The original geometrical shape of the solar gravitational signal as registered by Orlov [6].

It is registered in the daytime, in the form of double-humped curve with a dip in the range from 11 a.m. to 01 p.m., so the dip comes where the Sun would draw the load the hardest. The author of the article explains this by the fact that the volume of the gravitating mass of the planet facing the Sun on both sides of the planet exceeds the gravitating mass at its center. However, in my opinion, it is determined by the fact that the hardest part of the core comes closer to the Earth's surface and the distance to the measuring part of the gravimeter is reduced, thereby increasing the gravity to the Earth and compensating the gravity to the Sun.

*Please do not confuse it with a correction of calendar time.

7 On motion of the magnetic poles

It also turns out that the outer shell of the Earth is weakly related to the processes taking place between the planets causing appearance of a magnetic field, and therefore is "free" to move relative to the center of mass (it is similar to rotation of the outer rim of a bearing with internal one being fixed), while changing the position of the magnetic poles on the surface of the Earth, but without changing the position in space. At the same time, the position of the outer sphere of the Earth depends on the interaction strength of the core magnetic field and the magnetic properties of the sphere itself, which, among other things, may be affected by anthropogenic factors. A shift occurs before the mantle comes into one of the local stability points. It does not have to be a complete polarity reversal.

8 Conclusion

The suggested hypothesis is not loaded with mathematical calculations for yet for a number of reasons, including the following:

1. There are too many factors affecting the field;
2. One can always bring math under any theory by introducing correction factors and hiding the lack of physics of the phenomenon.

Of course, this hypothesis is presented in yet "unfledged" form and requires much to be done to verify and expand understanding of the physics of the processes.

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Appendix. A short comparison of the planets' magnetic fields depending on the number of their moons and other properties

Planet	Moons	Magnetic field
Mercury	No	One percent of the Earth's field; of dipole-type, directed along the axis of rotation which is perpendicular to the orbit plane.
Comment: The intensity of Mercury's magnetic field is 100 times smaller than that of the Earth. Mercury's magnetic field has a dipole structure and is highly symmetrical. Its axis is only two degrees tilted from the spin axis of the planet.		
Venus	No	Almost absent: the planet's spin is very slow.
Comment: Since the planet's own magnetic field is absent, it should be assumed that there is no motion of charged particles — electric current — in its iron core that could cause a magnetic field. Therefore, the core substance does not move.		
Mars	2	The planet's magnetic field is 500 times weaker than the Earth's one. The field's polarity is reverse to that of the Earth. Phobos rises in the West and goes down in the East. Its size is very small. The influence of Deimos is weaker because of its remoteness.
Comment: Mars has a magnetic field, but it is weak and extremely unstable. In various parts of the planet, its intensity may vary from 1.5 to 2 times. Its magnetic poles do not coincide with physical ones.		
Jupiter	17 + ring	Twenty times as strong as the Earth's. The polarity is reverse to that of the Earth.
Comment: Jupiter's moon system consists of at least 67 moons, including four large moons. Jupiter has a strong magnetic field. The dipole axis is tilted to the axis of rotation at 10°. Its polarity is reverse to the polarity of Earth's magnetic field. All the major moons of Jupiter rotate synchronously and always keep the same face turned to Jupiter due to the influence of powerful tidal forces of the giant planet. Jupiter's rotation speed is so high that the planet bulges along the equator.		
Saturn	18 + ring	Almost equal to the Earth's and reverse in direction.
Comment: By its strength, Saturn's magnetic field is in the middle between the magnetic field of the Earth and the more powerful field of Jupiter. The magnetic field is nearly a dipole, similar to that of the Earth, with north and south magnetic poles. The north magnetic pole is located in the northern hemisphere, and the south one is in the South, unlike Earth, where the location of the geographic poles is reverse to that of magnetic ones. Saturn has 62 known moons. Most of the moons, except Hyperion and Phoebe, spin synchronously — they always keep the same side turned to Saturn.		
Uranus	21 + ring	Less than that of the Earth and has axial tilt at 60 degrees. The polarity is reverse to the Earth's. Uranus rotates reversely. The moons rotate reversely too. The moons' orbits are steeply tilted to the ecliptic.
Comment: The equatorial plane of Uranus is tilted to the plane of its orbit at an angle of 97.86° — that is, the planet rotates "lying on its side." This gives the season changing process completely different from the other planets of the Solar System. If other planets may be compared to a spinning top, Uranus is more like a rolling ball. Uranus has a very specific magnetic field that is not directed from the geometric center of the planet, but is tilted towards the axis of rotation by 59 degrees. In fact, the magnetic dipole is shifted from the center to the south pole of the planet about one third of the planet's radius. This unusual geometry results in a very asymmetric magnetic field.		
Neptune	8	A complex magnetic field
Comment: Neptune resembles Uranus in its magnetosphere, with a magnetic field strongly tilted relative to its rotational axis at 47°. Neptune has 13 known moons. Triton is the largest Neptunian moon, comprising more than 99.5% of the mass in orbit around Neptune, and it is the only one massive enough to be spheroidal. Unlike all other large planetary moons in the Solar System, Triton has a retrograde orbit. It is close enough to Neptune to be locked into a synchronous rotation, and it is slowly spiraling inward because of tidal acceleration.		