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ON THE POSSIBILITY OF THE AGROGLYPHS EMERGENCE UNDER THE INFLUENCE OF COSMIC FACTORS

Based on the study of the phenomenon of wheat stalks regular lodging on a large area (Voznesenovsky phenomenon), the possibility of linking this and other similar phenomena (agroglyphs) of natural origin with the action of cosmic factors is analyzed. The criteria features of the phenomena under consideration and particular structural features of the phenomenon under study are determined. It is shown that in order to explain the totality of facts, the most promising is to attract the idea of a short–term radiation effect of sufficiently high energy on the entire plant array. This point of view is quite consistent with the features of the structure and physiology of cereal crops stems. The reason for the wheat stalks lodging could be the heating of their nodes under the action of a pulse of microwave radiation. The preference for microwave radiation, but not infrared radiation, is physically justified. The supposed source of the microwave radiation pulse is the development of a meteor phenomenon generated by the intrusion into the Earth's atmosphere of a meteor body containing a significant mass of water ice. The paper shows that in this case, one can expect the appearance of a pulse of forced (maser–type) radiation at a wavelength of 1,35 cm. This radiation can reach the Earth's surface quite freely. Calculations of the energy and mass of a meteor body, which capable to generat the considered effect, are in good agreement with the data of meteor astronomy. Orderliness in the lodging of stems is explained from the standpoint of heliotropism of plant development. The general aspects of the agroglyphs appearance connection with the manifestations of meteoric activity and the prospects for the development of the study are discussed.

Keywords: meteoroids, meteor phenomena, agroglyphs, instrument complex, analyzed, crop circles.

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Агроглифтердің ғарыш факторларының әсерінен пайда болу мүмкіндігі туралы

Бидай сабақтарының үлкен аумақта тұрақты орналасу құбылысын зерттеу негізінде (Вознесеновский құбылысы) осы және басқа да ұқсас табиғи құбылыстарды (агроглифтер) ғарыш факторларының әсерімен байланыстыру мүмкіндігі талданады. Қарастырылып отырған құбылыстардың критериалды белгілері және зерттелетін құбылыстың нақты құрылымдық ерекшеліктері анықталды. Фактілер жиынтығын түсіндіру үшін бүкіл өсімдік массивіне жеткілікті жоғары энергияның қысқа мерзімді радиациялық әсері туралы идеяны тарту ең перспективалы болып табылады. Бұл көзқарас дәнді дақылдар сабақтарының құрылымы мен физиологиясының ерекшеліктеріне сәйкес келеді. Бидай сабақтарының орналасуының себебі микротолқынды сәулелену импульсінің әсерінен олардың шыңдарын қыздыру болуы мүмкін. Инфрақызыл сәулеленуден гөрі микротолқынды сәулеленуге артықшылық беру физикалық тұрғыдан негізделген. Микротолқынды сәулелену импульсінің болжамды көзі-құрамында су мұзының едәуір массасы бар метеорлық дененің Жер атмосферасына енуінен туындаған метеорлық құбылыстың дамуы. Жұмыста бұл жағдайда толқын ұзындығы 1,35 см болатын мәжбүрлі сәулелену импульсінің (лазер түрінің) пайда болуын күтуге болатындығы көрсетілген. Қарастырылып отырған әсерді тудыруы мүмкін метеорлық дененің энергиясы мен массасын есептеу метеорлық астрономия деректерімен жақсы үйлеседі. Сабақтардың орналасуындағы тәртіп өсімдіктердің дамуының гелиотропизмі тұрғысынан түсіндіріледі. Агроглифтердің пайда болуының метеорлық белсенділіктің көріністерімен байланысының жалпы аспектілері және зерттеудің даму перспективалары талқыланады.

Түйін сөздер: метеороидтар, метеор құбылыстары, агроглифтер, аспаптар кешені, талдау, егістік шеңберлері.

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О возможности возникновения агроглифов под воздействием космических факторов

На основе изучения феномена регулярного полегания стеблей пшеницы на большой площади (феномен Вознесеновского) анализируется возможность связи этого и других подобных явлений (агроглифов) естественного происхождения с действием космических факторов. Определены критериальные признаки рассматриваемых явлений и конкретные структурные особенности исследуемого явления. Показано, что для объяснения совокупности фактов наиболее перспективным является привлечение идеи о кратковременном радиационном воздействии достаточно высокой энергии на весь растительный массив. Эта точка зрения вполне согласуется с особенностями строения и физиологии стеблей зерновых культур. Причиной полегания стеблей пшеницы может быть нагрев их верхушек под действием импульса микроволнового излучения. Предпочтение микроволнового излучения, а не инфракрасного, физически оправдано. Предполагаемым источником импульса микроволнового излучения является развитие метеорного явления, вызванного вторжением в атмосферу Земли метеорного тела, содержащего значительную массу водяного льда. В работе показано, что в этом случае можно ожидать появления импульса вынужденного излучения (мазерного типа) с длиной волны 1,35 см. Это излучение может достигать поверхности Земли достаточно свободно. Расчеты энергии и массы метеорного тела, которые способны вызвать рассматриваемый эффект, хорошо согласуются с данными метеорной астрономии. Упорядоченность в полегании стеблей объясняется с точки зрения гелиотропизма развития растений. Обсуждаются общие аспекты связи появления агроглифов с проявлениями метеорной активности и перспективы развития исследования.

Ключевые слова: метеороиды, метеорные явления, агроглифы, приборный комплекс, анализ, круги на полях.

Introduction

Agroglyphs are one of the phenomena that attract general attention, but remain outside the limits of scientific research due to the lack of reliable data and clear explanations. Without going into details of the phenomenon history, many provisions of which may be in doubt, we note some of its features.

Agroglyphs are understood as structures formed by fallen stems, which from time to time arise in the fields of cereal plants. Their common name is “crop circles”. At the same time, precise geometric shapes and even more complex drawings arouse reasonable suspicion of the hoaxers actions. Therefore, the authors appeal to agroglyphs with a simple structure, the randomness of which indicates the action of natural factors.

But, nevertheless, the sudden lodging of cereal stalks in fairly large areas of fields is not news for agronomy, but rather a problem from the point of view of harvesting. Agricultural specialists analyze its nature from the point of view of plant physiology and the effect of the phenomenon on grain yields [1–3]. Quite clear criteria allow to distinguish them from what is connected with human activity. A morphological study of the phenomenon showed that the stems in natural agroglyphs are flattened and twisted, but not broken. At the same time, there may be a clockwise or counterclockwise twist in the same figure. Sometimes there are layers of stems twisted in opposite directions. The curvature of the ears at the joints is characteristic. The deformation begins about 3–5 centimeters from the ground at the level of the first knee of the ear. The bending angle at this level can reach about 90 degrees. The expansion of the stem node is noticeable (Fig. 1) [4].

The appearance of cavities in the nodes of plant stems, resembling traces of internal heating, is clearly detected. The situation is more complicated with the evidence that observed:

- changes in the structure of DNA;
- increased infrared radiation inside and outside the figure;
- changing the magnetic field inside the figure;

- the increase in the radiation background is about three times compared to the normal background;
- the occurrence of “crop circles” in the fields at night, in the morning and just for a few seconds.

Figure 1 – Curved stems of cereals from agroglyphs.

The lying stems have a spiral twist, and each stem lies neatly next to the other. There may be intact tufts within the area of lying stems.

On the territory of Northern Kazakhstan, huge areas are sown with grain crops every year. In this regard, it seems strange that there are usually no reports about agroglyphs. But, as it turned out, the problem lies in the lack of attentive observers. This is confirmed by the example of an agroglyph that appeared near the village of Voznesenka at the end of July 2019. Let’s consider some details of this phenomenon.

Voznesenovsky phenomenon

We will talk about a structure that arose in a wheat field near the village of Voznesenka in the North Kazakhstan region (N 54° 40’ 16.464” E 68° 48’ 57.6”), located about 30 km southwest of the regional center – the city of Petropavlovsk (Fig. 2).

Physics teacher E.A. Lyubenkova drew attention to the appearance of the phenomenon on the morning of July 25. And the next day, a group of researchers from the North Kazakhstan University, which included the authors of this article, went to the place. The area of interest to us was not far from the village on an irrigated section of the field to the left of the road leading from Petropavlovsk to Voznesenka. The height of wheat stalks in some places reached one meter, but on average it was somewhat lower. The presence of a quadcopter made it possible not only to take pictures of the general contour of the field area with the lying stems, but also to make sure that people, large animals and vehicles did not enter the study area. Moreover, the lying stems were, as it were, laid and intertwined. The size of the area with the lying stems was approximately 100 × 110 meters.

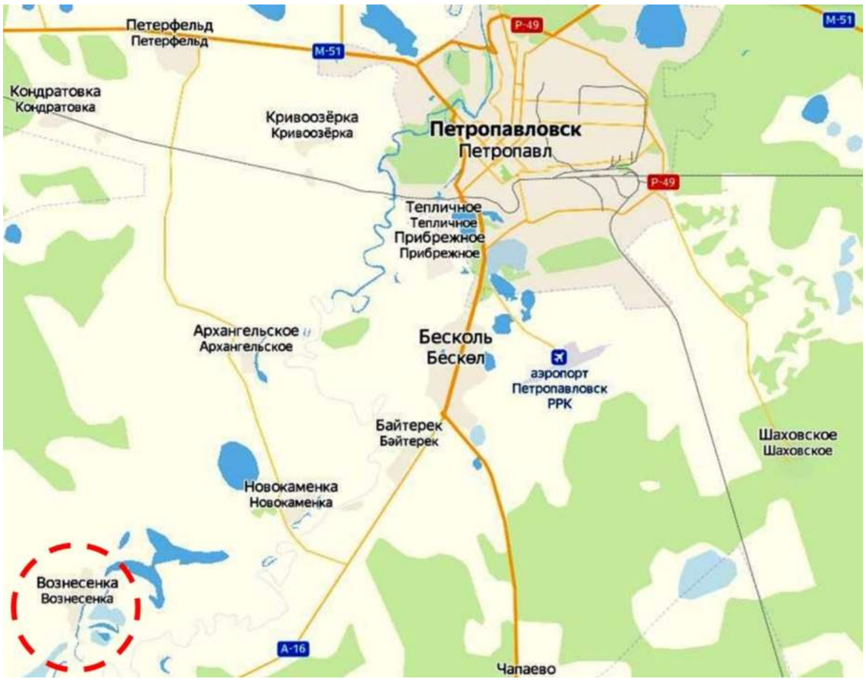

Figure 2 – Location of Voznesenka village on the map.

There are three types of sites in this area. Along with the sites where the wheat was not damaged, there were sites of wheat laid in spiral waves from the root (a "chainmail" pattern) and sites with wheat laid in half the growth of the stem. Attention is attracted to such a feature as the presence of a sharp border between sites with laid stems and completely undisturbed wheat. The width of the transition zone, if you call it that, does not exceed 1 – 2 cm (Fig. 3)

Figure 3 – Some sections of the field with wheat stalks laid.

This circumstance is hardly compatible with the idea of the participation of air vortices in the occurrence of the phenomenon. This is even more strongly contradicted by the presence of narrow (30 – 40 cm) and long (3 – 5 meters) grooves with stems laid at the bottom and very sharp edges. Obviously, the physical factor affecting the stems had the property of a sharp drop in intensity towards the geometric edge. Ordinary air vortices do not have such properties. As for the nature of stem deformation, it fully corresponds to the above description (Fig. 4).

Figure 4 – Wheat stalks from the sites with lying stems.

The bend at the basal node is the smallest, it reaches its maximum value near the second or third node of the stem. At the same time, even with a general bend of almost 180 degrees (half a circle), when laying the plants on the ground, the internodes – parts of the wheat stem, remained straight. Bending when laying the stems occurred only at their nodes. For a short period of action of a certain factor, they seemed to become plastic, and then hardened again.

The reason for the mass lying of cereal stems

Initially, there are several reliably established facts. Softening and bending of wheat stalks at their nodes; orderly position of lying stems; the presence of sharp boundaries of of an unknown physical factor action. It is premature to use some exotic mechanisms to explain them. The plasticity of plant tissues is fully explained by the heating of the cereal stem nodes. The experience of a modern physical laboratory suggests that the fastest and most gentle volumetric heating of a biomaterial is possible when it absorbs radiant energy in the infrared or microwave range. The problem lies in formulating a hypothesis about the nature and source of such radiation on the basis of reasonable physical concepts.

Let's first consider some features of infrared radiation. According to available data, liquid water absorbs infrared radiation extremely strongly (especially in the near and middle IR – range). In this case, the total absorption of the radiation flux occurs on the path of the order of tens of microns [5 – 9]. This is interesting from the point of view that a beam pulse of infrared radiation of sufficient power will not be absorbed in the total volume of plant biomass, but will generate something similar to a surface burn. In addition, IR – radiation is strongly absorbed in the atmosphere. This makes it doubtful, that flow of IR – radiation can give rise to the phenomenon under study. At the same time, microwave radiation is also well absorbed by liquid water, but the absorption coefficients are several orders of magnitude lower. That is, the heating of the cell fluid in plants during microwave irradiation will cover the entire volume of the plant. In particular, this is taken into account in the design of microwave heaters operating at a wavelength of about 122 mm (the maximum absorption coefficient of liquid water) [10–11]. So, the assumption about the occurrence of the phenomenon of agroglyphs under the action of microwave radiation fluxes looks physically justified. Before discussing possible sources of such radiation, it is necessary to estimate the energy flux densities required for the occurrence of the phenomenon.

Of course, you should first take into account the structural features of the cereal plants stems. The wheat stalk is straight and hollow inside – a straw with internal partitions. At their locations there are compacted swellings – nodes (Fig. 5). Thanks to the nodes, the stem becomes highly resistant to external influences, in particular, to the wind. Tubular internodes are located between the nodes. The growth of the wheat stem occurs due to the top of the stem and the base of the internodes. Because of the presence of several growth zones, the stem elongates very quickly [1 – 3].

Figure 5 – The structure of the wheat stem.

The stem is hollow along its entire length and consists of 5 – 6 internodes. The height varies from 70 to 150 cm. The internodes have different thicknesses: upper – 2.5 – 4.0 mm, lower – 3.0 –6.0 mm. The lower internode is the shortest. The resistance of a plant to lying is determined by the height of the stem, as well as the length and thickness of the lower internode.

The development of the plant body depends on the influence of various meteorological factors, as well as on the pressure and weight of its own parts, which constantly change during growth. The plant is also subjected to dynamic loads, including impact forces of various durations. Their sources are winds, rain, hail and others. The above – ground part of the plant has a large windage and would easily break if there were no elements of resistance. The mechanical parameters of the plant tissue play a major role in the plant strength. Straws of rye, wheat, barley give arc bends if the ears are filled with full grain. This is due to the mechanical rigidity of the internode tubes and the relative malleability of the nodes. In the nodes of cereal plants, at a certain stage, there is a rapid process of cell division – their growth. The nodes contain much more moisture than the internodes. From the point of view of bending deformation, nodes can be considered as hinges.

The increased water content in the nodes should contribute to the absorption of the microwave radiation flux. Due to the heating of the nodes, their tissues can soften, giving the "hinge" the ability to rotate, which determines the possibility of twisting and lying of the stems of cereal plants. It should be noted that the temperature of plant tissues cannot rise to more than 50 degrees Celsius, because at higher temperatures plants usually die. The results of experiments on the effect of microwave radiation on wheat stalks are presented on the Internet, and they generally confirm the assumption under consideration [12].

To calculate the amount of energy absorbed by a node during heating, we represent it as a cylinder with a diameter and a height of 5 millimeters. Its volume will be approximately 10^{-7} m^3. Let's determine the mass of water in the node of the cereal plant stem. The water content in the wheat stalk in the initial phase of grain ripening (namely, this condition is recorded) is on average 50%. In nodes, this content should be higher. Let's take it equal to 60%. Then the mass of water in the node (taking into account 25% of the voids volume) will be about 4.5×10^{-5} kg.

Using the well – known formula

$$Q_{node} = c \cdot m \cdot \Delta t,$$

and, assuming that under the influence of an external factor, the temperature of the node increased by $\Delta t = 20\ ^0C$, it is easy to estimate the energy Q_{node} absorbed by the plant node. It turns out to be equal to 0.38 J.

Based on the obvious ratio

$$w = \frac{Q_{node}}{S_{node}},$$

where S_{node} is the cross–sectional area of the stem node, it is possible to calculate w – the radiation energy flux density per unit cross–sectional area of the stem node. It will be approximately 1.5×10^4 J/m^2.

Then it is possible to calculate the total energy Q_{tot} required to create a large agroglyph with a diameter of 100 meters, comparable to the phenomenon under consideration:

$$Q_{tot} = w \cdot S_{agr}$$

This energy will be approximately 1.2×10^8 J.

However, these integral characteristics do not fully characterize the process of the phenomenon formation. It is also necessary to take into account the power of the radiation flux per unit area, which depends on the duration of the events development. Since the formation of the agroglyph takes from 1 to 10 seconds, the value of this quantity should be expected in the range from tens of thousands of W/m^2 to thousands of W/m^2. And this is very interesting, because it assumes the presence of a radiation source much brighter than the Sun. Let's consider the supposed nature of such a source and the mechanism of its emission of a microwave flux.

Meteor phenomena as a possible source of stimulated emission

Science knows only two natural phenomena in which the release of energy has a concentrated character and a value comparable to that required for the emergence of agroglyphs: these are lightning (energy $10^8 – 10^{10}$ J [13 – 14]) and meteor phenomena. Lightning can hardly be responsible for the appearance of agroglyphs, since most of the discharge energy is spent on creating a shock wave, air ionization and a light flash. Concentrated generation of microwaves from lightning has not been detected. Finally, on the eve of Voznesenovsky phenomenon no thunderstorms were observed in the nearby area. Meteor phenomena are another case. Let's call the specific energy of a typical meteoroid the kinetic energy that a body with a mass of 1 kg has, flying into the Earth's atmosphere at a speed of = 4×10^4 m/s [15 – 17]. It will be 8×10^8 J. This value is quite comparable to the energy needed to create an agroglyph. The question is a mechanism capable of generating the required density of the microwave radiation flux. To physically substantiate its essence, let's consider some aspects of meteor phenomena.

As is known, meteors are phenomena in the upper atmosphere that occur when solid particles (meteoroids) invade it with cosmic velocities. When interacting with the atmosphere, meteor bodies partially or completely lose their initial mass. In this case, the glow is excited and ionized traces are formed. Very bright meteors, the brilliance of which is greater than the brilliance of Venus, are called fireballs. The remnants of meteor bodies that generate bright bolides can fall to the surface of the Earth in the form of meteorites.When the Earth encounters compact swarms of meteor bodies, meteor showers are observed, some of which are active in the summer season [15– 17].

Meteoroids moving around the Sun enter the Earth's atmosphere at speeds from 11.3 to 73 km/s. The magnitude of their kinetic energy is much greater than the energy required for the complete evaporation of their substance, and the speeds are much higher than the thermal speed of air molecules. The mechanism of interaction of a meteor body with the atmosphere determines their mass. The air molecules fully or partially transfer their momentum and kinetic energy to the meteor body. This leads to deceleration, heating and spraying of the meteor body. Meteor bodies with masses from 10^{-12} to 0.10 kg, generating meteors from +20 to –4 of stellar magnitude, completely lose their initial mass during deceleration in the atmosphere [15 – 17]. When moving in the atmosphere of larger bodies, with which bright fireballs are associated, a shock wave is formed, leading to a decrease in heat transfer and the fraction of the initial mass lost before the body loses cosmic velocity. After the passage of meteors, an ionized meteor trail with a length from units to several tens of kilometers remains. The initial radius of the ionized meteor trail can reach several meters, and it increases with the increasing of ignition height, speed and size of the meteor body [16].

The analysis of meteor spectra made it possible to study the mechanism of their luminosity (the radiation of a plasma cloud that occurs during the moving of a meteoroid). In the optical region, meteor radiation is represented by bright emission lines of atoms and ions of iron, sodium, magnesium, calcium, silicon, nitrogen, oxygen and much weaker molecular bands. There is also a weak continuous background. The range of heights at which meteor phenomena develop extends on average from 100 to 40 kilometers. The total amount of meteoric matter per day is about 60 tons. This substance has a noticeable effect on the gas, ionic and aerosol composition of the upper atmosphere, as well as on some meteorological and geophysical processes occurring at high altitudes.

Broad prospects for scientific research are associated with the discovery of the possibility of generating stimulated emission from the region of meteor plasma tracks. The physical picture of the meteor phenomenon development is as follows. During the penetration of the meteor body into the denser layers of the atmosphere and the formation of a shock wave front, the vapors of the meteoric substance are sharply decelerated. The kinetic energy of the meteor motion is converted into thermal energy. The resulting cloud of meteor plasma is replenished due to the destruction of the meteor body. In this case, the processes of excitation of atoms, leading to their ionization, prevail over recombinations.

Theoretically, it is shown that at meteoroid speeds of more than 60 km/s, the meteor plasma moves with it, generating rapid changes in the radiation intensity. Plasma formed along the path of a meteor in a continuously thickening atmosphere is a formation similar in emission nature to a gas – dynamic laser [18]. Recall that in a gas – dynamic laser, population inversion is created in a system of vibrational energy levels of gas molecules by adiabatic cooling of heated gas masses moving at supersonic speed. The existence of a «laser» component in the optical spectrum of meteors was justified theoretically, calculations showed the possibility of developing processes similar to the emission of a gas – dynamic laser at a pressure of 0.1 Pa at a height of about 90 km and a concentration of atmospheric particles of the order of $10^{19} – 10^{20}$ m^{-3}. The theoretical conclusions are confirmed by the results of studying a large number of meteor glow spectrograms [16].

Summarizing the general ideas about the physics of meteor phenomena, we can talk about two types of processes occurring in different time scales:

1. Relatively slow processes of thermal conductivity, mechanical rotation and destruction of a meteoric body;

2. Significantly faster brightness oscillation of a radiating meteor plasma bunch (meteor track), generating a glow similar to the radiation of a gas – dynamic laser.

In our case, it is more correct to talk about maser – type radiation. The question of the molecules nature capable of generating microwave radiation and present in large numbers either in the composition of meteor bodies or in the Earth's atmosphere requires a solution. The choice is limited to water vapor emitting at a wavelength of 1.35 cm (frequency 22.2 GHz) and hydroxide molecules emitting at a wavelength of 18 cm [19 – 21]. Both types of maser sources are widely known in modern astrophysics. Moreover, if masers on the water radical were discovered somewhat earlier, then water masers turned out to be much more powerful. Maser sources have been found both in the Galaxy (circumstellar shells) and in cosmological objects (Megamasers) [22]. The lines of molecular cosmic masers correspond, in the case of hydroxyl OH, to transitions between the levels of the λ – doublets of the ground and lower rotational levels of molecules, and in the case of H_2O molecules, to transitions between the rotational levels of the ground vibrational state. The hypothesis of a maser mechanism operating on the basis of water vapor deserves preference. Their content in the atmosphere is much higher than the content of hydroxyl. In addition, water is included in the composition of meteor bodies, being in them in a bound state or in the form of an ice phase [23].

Microwave emission from meteor tracks and the formation of acroglyphs

For the appearance of a focused flow of microwave radiation, not only the mechanism of formation of the active medium itself is important, but also its size and shape. The trajectory of a meteor in the atmosphere can be taken as a straight line, and its plasma trail is close to a cylinder with a diameter ***D*** of the order of units of meters and a length ***L*** of about 10 km on average. Taking into account the finiteness of the meteor body speed (and the non – instantaneous formation of the active medium), from the point of view of signal amplification, the determining role have the quanta, generated in the initial region of the track (Fig. 6).

From the point of view of the problem under consideration, quanta that have a direction of motion far from the axis of the cylinder cause losses (scattering) of the energy of the active medium. At the same time, the quanta propagating close to the axis of the plasma track are capable of generating showers of twin quanta of the greatest intensity, that is, they can generate streams of the most concentrated radiation. Energy losses due to radiation going off in lateral directions can be roughly estimated from the ratio of the corresponding volumes – a narrow cone with an axis coinciding with the axis of the cylinder (the area of concentrated radiation is shaded) and the entire cylinder.

As follows from the diagram (Fig. 6), the ratio of these volumes, which indicates the efficiency of the formation of a directed radiation flux from the region of a cylindrical active medium, is about 30%. In this case, the sine of the angle φ of the cone, determined by the ratio of the diameter ***D*** and the track length ***L***, will be about 5×10^{-4}. This value makes it possible to estimate the diameter of the area "illuminated" by the stimulated radiation flux on the Earth's surface at a distance of 100 km, approximately 50 meters. Which is generally consistent with what we have in the case of the Voznesensky phenomenon. It should not be expected that this area will have a round shape. Due to the natural randomness of the active medium structure (a shock wave in a plasma cloud) and the distribution of energy in the radiation flux coming from it will have a random character.

It is known that microwaves propagate relatively freely in the air at frequencies below 40 GHz. The high transparency of the atmosphere for this radiation is illustrated by the fact that ground – based technical microwave communication channels are limited in range only by the visual horizon. Due to this, microwave radiation can be actively absorbed by living organisms – plants. The features of the absorption of stimulated coherent radiation fluxes include the possibility of two – photon absorption. This only increases the influence of such radiation fluxes on the physiology of plants.

One of the key points in explaining the emergence of agroglyphs is, as noted above, the regular lying of the cereal plants stems. Here, the manifestation of a completely natural phenomenon of heliotropism in plants is possible [25]. Its essence lies either in differences in the growth rate of the stem and leaves, depending on the direction to the light source, or in the turn of the plant following the daily moving of the Sun. Heliotropism, which is also characteristic of wheat, in both cases will cause mechanical stresses in the stem of the plant, which are the same in direction for the entire area of wheat exposed to microwave radiation. In the case of the nodes softening under the action of the absorbed energy of microwave radiation, these stresses are realized by a completely similar deformation (bending) of all stems.

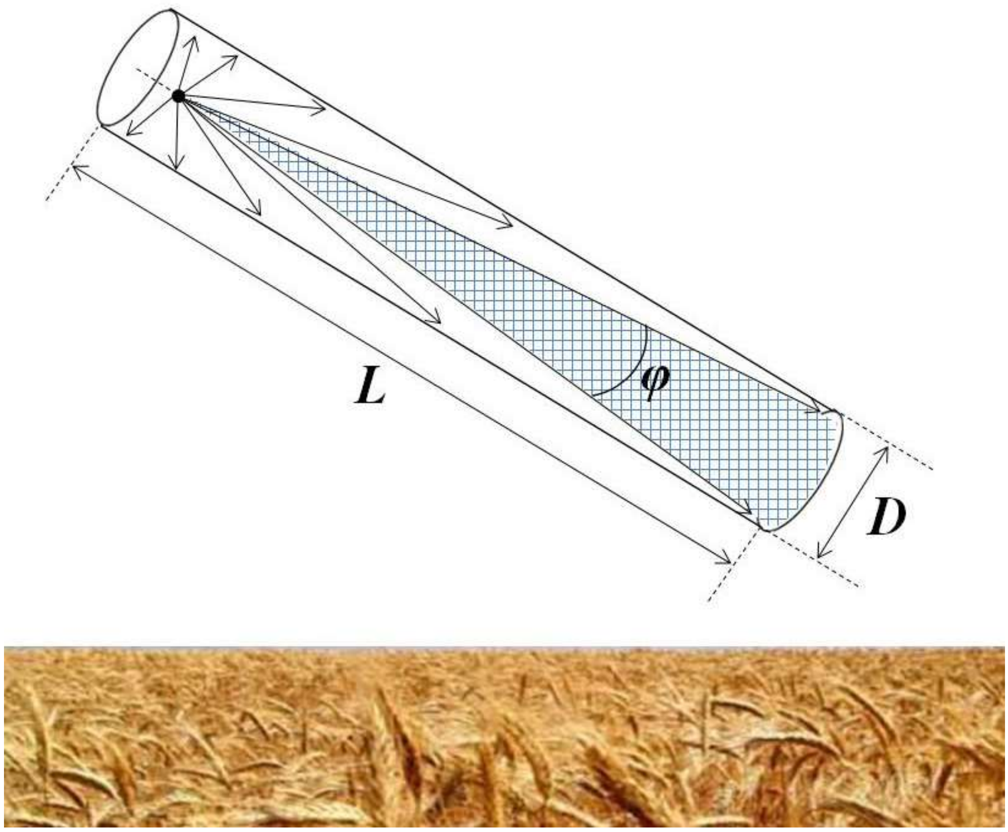

Figure 6 – Evaluation of the efficiency of stimulated radiation flux generation along the plasma track axis.

Discussion

How does the proposed mechanism agree with the circumstances of the agroglyphs appearance? Estimates of the meteor bodies specific energy are clearly not enough to answer this question. Let's look at the problem from another point of view.

Abstracting from the discussion of the water content in the atmosphere, let us estimate the total energy of microwave radiation emitted on the axis of the plasma track of a meteor, initially containing 100 kg of water ice, that is, approximately 3.33×10^{27} water molecules. Let's estimate the concentration of water molecules in the track. Assuming, as above, the diameter of the plasma track is 1 meter and the length is 10 kilometers, we determine the average concentration of water vapor molecules in it. The concentration will be approximately 10^{24} m^{-3}. In this case, the total number of molecules per unit of track cross section is about 10^{28} m^{-2}.

The total energy of all transitions (per square meter) can be found by multiplying the quantum energy (1.47×10^{-23} J) by the number of molecules per square meter. Obviously, it will be 1.47×10^{5} J/m^2. This is in good agreement with the estimate of the energy flux density required for the appearance of the agroglyph, obtained above, surpassing it only by an order of magnitude. However, in reality it is difficult to imagine a mechanism for generating microwave radiation operating with an efficiency of 10%. Most likely, much more modest estimates should be expected. But even with the microwave radiation generation efficiency of 1%, a body containing only a few tons of water ice would be enough to form an agroglyph. The latter is quite consistent with the assumptions (confirmed by experimental data) about the fairly frequent intrusion of mini–comet nuclei into the Earth's atmosphere [23].

At the same time, the question arises about the appearance of bright fireballs in the sky, but they are just not observed. The answer to this objection is seen in the fact that meteorites containing water ice can have a very loose structure and do not create a noticeable optical effect during the passage of the atmosphere and destruction. Meteoroids and meteorites consisting of ice are not at all uncommon. In addition to excess energy, they also bring into the atmosphere the components of the active medium: water vapor, hydroxyl, carbon dioxide. Note that in the summer season meteor activity is especially high – there are streams of Cassiopeids, Perseids and others. It is at the end of July and the beginning of August that agroglyphs appear.

Along with the above, there is an assumption about the connection of agroglyphs with electromagnetic radiation coming from the bowels of the earth. Its origin is associated with the deformation of rocks under the influence of seismic factors. In this case, we are talking about microwave radiation, the mechanism of action of which on the stems of cereals is discussed above [12]. The problem of such a hypothesis is a sufficiently strong absorption of microwave radiation during the passage of the Earth's layers containing water, while the water content in the atmosphere (and the absorption of microwave radiation) is small compared to the bowels of the Earth.

Conclusion

Thus, it is shown that the origin of acroglyphs can be associated with the natural process of generation of impulses of stimulated microwave radiation in the centimeter range. This radiation comes from the region of meteor tracks generated by meteor bodies containing a sufficient amount of water ice. When the radiation reaches the Earth's surface, the energy of the pulses of microwave radiation is absorbed by the stems of cereal plants. The structure of the stems and the nature of the anisotropy of their growth allows us to explain the origin of the spots of ordered lying of plant stems in acroglyphs.

Naturally, the question arises why agroglyphs appear rarely, whereas meteor phenomena, including those involving ice meteoroids, are quite frequent. Most likely, this is due both to the short duration of the time coincidence of the atmospheric factors action and a certain state of crops, and to the geometry of the microwave radiation beams passage through the atmosphere. Consideration of the totality of these circumstances, as well as the possibility of self–focusing of microwave radiation, is certainly interesting, but requires a separate detailed study and, therefore, goes far beyond the scope of this article.

The obtained results allow us to optimistically consider both the promising possibility of experimental verification of the effect of microwave radiation on wheat stalks in a physical laboratory, and the need to develop original methods for recording low–temperature meteor phenomena generated by ice bodies.

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References

1. Griguleckij V.G. (2020) O poleganii zlakovyh rastenij i metodikah ocenki ustojchivosti ih steblej [About the lodging of cereal plants and the methodology for assessing the stability of their stems] INTERNATIONAL AGRICULTURAL JOURNAL, № 1 (373), p. 62–67.
2. Burmistrova M.F., Komolkova T.K., Klemm N.V., etc. (1956) Fiziko–mekhanicheskie svojstva sel'skohozyajstvennyh rasteniya [Physical and mechanical properties of agricultural plants] M.: State Publishing House of Agricultural Literature, 344 p.
3. Arinicheva I.V. (2018) Poleganie rastenij: monografiya [Lodging of plants: a monograph] Krasnodar: Kuban State Agrarian University, 283 p.
4. What are crop circles. https://ru.wikipedia.org/wiki/Круги_на_полях (accessed on October 02, 2022)
5. Belousov Yu.I., Postnikov E.S. (2019) Infrakrasnaya fotonika. CHast' 1. Osobennosti formirovaniya i rasprostraneniya IK izlucheniya [Infrared photonics. Part 1. Features of the formation and propagation of IR radiation] Institute of Precision Mechanics and Optics, Saint-Petersburg, 82 p.
6. Yukhnevich G.V. (1973) Infrakrasnaya spektroskopiya vody [Infrared spectroscopy of water]. M. 207 p.
7. Bernath P.F. (1996). "Infrared fourier transform emission spectroscopy". Chem. Soc. Rev., Vol. 25, P.111–115.
8. Larkin P.J. (2011). "Infrared and raman spectroscopy: principles and spectral interpretation". Elsevier, 230 p.
9. Stuart B.H. (2004). "Infrared Spectroscopy: Fundamentals and Applications". Wiley, 242 p.
10. Knyazev V.Yu., Kossy I.A., Malykh N.I., Yampolsky E.S. (2003) Proniknovenie mikrovolnovogo izlucheniya v vodu (effekt «samoprosvetleniya») [Penetration of microwave radiation into water (the effect of "self-illumination")] Journal of Technical Physics, Volume 73, issue 11, p. 133–136.
11. Catalog HITRAN. www.cfa.harvard.edu/HITRAN (accessed on October 02, 2022)

12. Razgadka fenomena krugov na polyah skryta pod zemlyoj [The solution to the phenomenon of crop circles is hidden underground]. https://www.kp.ru/daily/25919/2871738/ (accessed on October 02, 2022)
13. Bazelyan E.M., Raiser Yu.P. (2001) Fizika molnii i molniezashchity [Physics of lightning and lightning protection] M.: Physical and mathematical literature, 319 p.
14. John E. Oliver. (1981) "Encyclopedia of World Climatology". National Oceanic and Atmospheric Administration.
15. Bronshten V.A. (1981) Fizika meteornyh yavlenij [Physics of meteor phenomena] M.: Science, 416 p.
16. Smirnov V.A. (1994) Spektry kratkovremennyh atmosfernyh svetovyh yavlenij: meteory. Spektry kratkovremennyh atmosfernyh svetovyh yavlenij: meteory [Spectra of short-term atmospheric light phenomena: meteors. Spectra of short-term atmospheric light phenomena: meteors] M.: Ed. firm "Phys.–mat. lit.".
17. Babadzhanov P.B. (1987) Meteory i ih nabljudenie [Meteors and their observation] M.: Science, p. 167.
18. Losev S.A. (1977) Gazodinamicheskie lazery [Gas-dynamic lasers] M.: Science, 335 p.
19. Weaver H., Williams D.R. W., Dieter N.H., Lum W.T. (1965) "Observations of a Strong Unidentified Microwave Line and of Emission from the OH Molecule". Nature, Vol. 208, no. 5005, P. 29–31.
20. Strelnitskiy V.S. (1974) Kosmicheskie mazery [Space masers] Successes of physical sciences, Russian Academy of Sciences, T. 113, № 7, P. 463–502.
21. Townes C.H. (1999) "The Rains of Orion". How the Laser Happened: Adventures of a Scientist, New York: Oxford University Press, P. 169–188.
22. Burdiuzha V.V., Vikulov K.A. (1990) "The excitation and physical nature of megamasers". Monthly Notices of the Royal Astronomical Society, Oxford University Press, May (vol. 244), P. 86–92.
23. Shulman L.M. (1987) YAdra komet [Comet nuclei] M.: Nauka. Gl. ed. phys. – mat. lit., 232 p.
24. Seybold John S. (2005) "Introduction to RF Propagation". John Wiley and Sons, P. 55–58.
25. Harmer L.S. and others. (2016) "Circadian regulation of sunflower heliotropism, floral orientation, and pollinator visits". Science, Vol. 353, Issue 6299, pp. 587–590.

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