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POSSIBLE ELECTROMAGNETIC NATURE OF THE SATURN'S RINGS: SUPERCONDUCTIVITY AND MAGNETIC LEVITATION

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Abstract—Hypothesis of possible superconductivity of the iced matter of the rings of Saturn (based on the data of Voyager and Pioneer space missions) allow us to explain many phenomena which have not been adequately understood earlier. By introducing into planetary physics the force of magnetic levitation of the superconducting iced particle of the rings, which interact with the magnetosphere of the planet, it becomes possible to explain the origin, evolution, and dynamics of the rings; to show how the consequent precipitation of the rings' matter upon the planet was concluded; how the rings began their rotation; how they were compressed by the magnetic field into the thin disc, and how this disc was fractured into hundreds of thousands of separated rings; why in the ring B do exist "spokes"; why magnetic field lines have distortion near by ring F; why there is a variable azimuth brightness of the ring A; why the rings reflected radio waves so efficiently; why there exists strong electromagnetic radiation of the rings in the 20,4 kHz–40,2 MHz range and Saturnian kilometric radiation; why there is anomalous reflection of circularly polarized microwaves; why there are spectral anomalies of the thermal radiation of the rings; why the matter of the various rings does not mix but preserves its small-scale color differences; why there is an atmosphere of unknown origin nearby the rings of Saturn; why there are waves of density and bending waves within Saturn's rings; why planetary rings in the solar system appear only after the Belt of Asteroids (and may be the Belt of Asteroids itself is a ring for the Sun); why our planet Earth has no rings of its own.

1. PREAMBLE

"And God said: Let there be a firmament in midst of the waters, and let it separate the waters from the waters. And God made the firmament and separated the waters which were under the firmament from the waters which were above the firmament. And it was so". (Torah)

Saturn's rings are the most magnificent and beautiful jewels of the solar system. They have attracted many generations of astronomers and astrophysicists [1–11]. The founder of the theory of electromagnetic waves J. C. Maxwell in the beginning of the scientific career devoted much of his attention to the question of the stability of Saturn's rings [1]. In his award winning paper on the subject, "On the stability of the motion of Saturn's rings" (1859), he deduces that the rings cannot be solid and must consist of "an indefinite number of unconnected particles" (1856). He stated that the rings could be stable only if they consisted of numerous small particles in Keplerian motion with the inner edge moving faster than the outer edge. Otherwise gravitational forces would destroy them. Maxwell's theory has been confirmed with the help of the spectroscopic analysis in 1895 and later in 1980 by the Voyager 1 space probe.

After successful launches of the Pioneer and Voyager spacecraft, we now have extensive information about the rings properties. In 1997 the Cassini space probe was launched toward the Saturn system and from 2004 it for almost four years will gather even more details about the physical characteristics of the rings. Distribution of dust and meteoroids, mapping the matter by size and composition, magnetosphere properties, and optical and microwave characteristics of the rings were measured. Despite the rich available database, we do not have a good model of the Saturn rings and mystery about their origin and shape still persists. Some of the difficult to explain data are listed below:

- Origin, evolution, and dynamics of the rings
- Considerable flattening and the sharp edges of the rings
- Thin periodic structure of the rings
- Deformation of the magnetic field lines nearby ring F
- Formation of "spokes" in the ring B
- High radio-wave reflectivity and low brightness of the rings
- Anomalous reflection of circularly polarized microwaves
- Strong electromagnetic radiation of the rings in the 20,4 kHz–40,2 MHz range

- Spectral anomalies of the thermal radiation of the rings
- Matter of the rings does not mix, but preserves its small-scale color differences
- Existence of an atmosphere of unknown origin nearby the rings of Saturn
- Existence of waves of density and bending waves within Saturn's rings
- Why planetary rings in the solar system appear only outside the Belt of Asteroids
- Why the Belt of Asteroids itself do exist, and may be it's the ring for the Sun
- Why the Earth has no rings, etc.

We do not claim that we have sufficient evidence for our superconducting model [18–20], even results of it coincident with the experimental data from Voyager and Pioneer mission. But it is a pleasing surprise, how many features of the rings such a model can explain. If applied to other systems, it has the potential to enrich our understanding of the space natural laboratory in general. Perhaps, this may help to come up with even more fantastic ideas about our space mysteries, but it would be better to have an experimental confirmation.

Hypothesis of the superconducting material state of the Saturn's (planetary) rings allows to extend classical theories of the planetary rings by non-conflicting superconducting model, and makes it possible to resolve as yet unsolved problems as will be shown below. Its helps to overcome many existing difficulties in the planetary physics by taking into account phenomena and behaviour of the electromagnetism nature [12–17], considering interaction of the superconducting particles of the rings with magnetosphere of the planet.

The problem of origin and evolution of the rings of a Saturn remains unsolved, though the majority of the experts is inclined to opinion that particles of rings - relics of early days of Solar system, they have not experienced sticking together and heating [1-11]. The question about properties of the typical particle of the rings is a key question of the planetary physics. Without detail research of the particle properties it is not possible to understand neither origin of rings, nor dynamics of the collective processes related to it.

Using experimental data from Voyager and Pioneer it is necessary to acknowledge that the complicated movement and features of the rings particles of the Saturn depend not only on gravity and mechanical forces, which were taken into account by previous researches, but also they depend on electromagnetic one [4, 18–20].

In accordance with our theory there is a possibility of "magnetic coupling" between protosun and superconducting particles in it's vicinity, that in the process of the formation of the solar system it leads to the carrying of the moment of momentum from the Sun to other planets by the electromagnetic means.

At the present time there is a set of the theories regarding nature of Saturn's rings [1–11]. Here for the first time we try to use model of electromagnetism and magnetic levitation of the superconducting particles of the Saturn's rings to explain their nature [18–20]. At the same time, gravitational and mechanical interactions were not exposed to decomposition. Auxiliary functions of the electromagnetic environment were attributed to them.

2. ORIGIN, DYNAMICS AND EVOLUTION OF THE RINGS

Let's assume that particles in a protoplanetary cloud have a superconducting properties. In this case it is possible to offer the following scenario of origin, dynamics and evolution of planetary rings, Fig. 1. Particles might be pure ice or admixtured ice. Its temperature may correspondent to the superconducting one. With occurrence at the protoplanet of the magnetic field as a result of phenomena a hydromagnetic dynamo, the superconducting particles of the protoplanetary cloud begin to display an ideal diamagnetism (Meissner-Ochsenfeld phenomenon) and actively interact with the magnetic field of a planet. Particles will be involving in a circular movement around the planet by the rotating its magnetic field, and to drift in a plane of magnetic equator of the planet, where the density of magnetic flow is less. At the end of its movement from the cloud a particle will be allocated on such a Kepler orbit, where there is a balance of the three acting forces: gravitational, centrifugal and force of levitation (diamagnetic push-out).

The protoplanetary cloud in its evolution after appearance of the magnetic field of the protoplanet will pass the following stages, Fig. 1: allocation of a protoplanet in a central part as a result of self-gravity (I), flattening of a peripheral part of the protoplanetary cloud filled by superconducting particles in a protosatellite disk (II), and formation of the modern system of the Saturn's rings in a zone named Roche (III).

The important part of this consideration is that the superdiamagnetic concept allows one to reject the very popular postulate about primary rotation of the protoplanetary cloud and explains the rotation of the protoring disc by involving particles in a circular movement in the rotating planetary magnetic field.

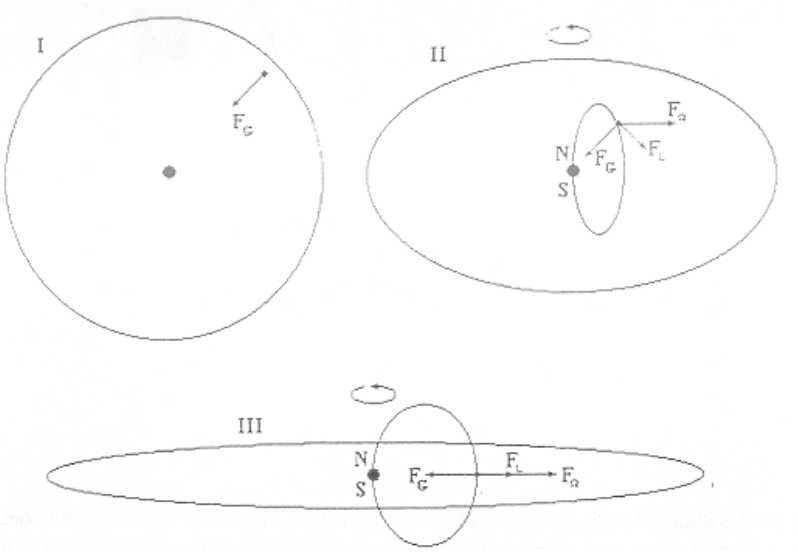

Figure 1. Dynamics of the superconducting particles under influence of gravitational and magnetic fields. I – stage of self-gravitation of the protoplanetary cloud; II – stage of occurrence of the planetary magnetic field and involving a surrounding particles in a circular movement; III – stage of planetary rings formation. FG – gravitational force, FΩ – centrifugal force, FL – force of levitation (diamagnetic push out).

3. APPEARANCE OF THE RINGS ONLY AFTER THE BELT OF ASTEROIDS. ABSENCE OF RINGS OF THE EARTH

The question of why the rings do not exist in planets of an Earthly type also refers to the problem of the ring's origin based on a presented here new concept. Presence of the rings only outside Belt of Asteroids and the absence them before it, might be explained by existence of the distance from the Sun where the Sun's radiation is not heating matter enough and temperature corresponds to one to support superconductivity. In conventional consideration it means that in space there is a distance from the Sun with correspondence temperature, T_c, relevant to the possible transition to the superconducting state of the matter. It is possible to imagine that natural superconductivity within solar system takes place at the position of the Belt of Asteroids, where temperature is about 100 K, and further from the Sun, like

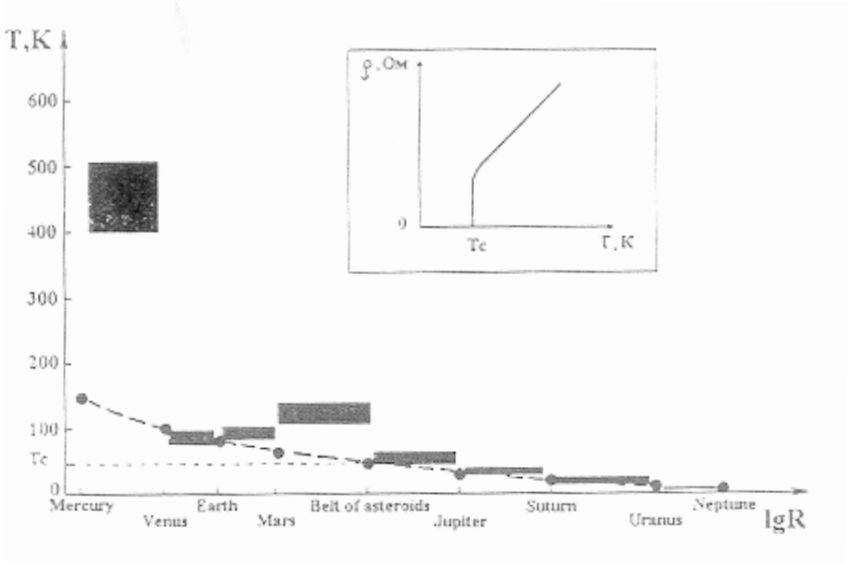

Figure 2. Dependence of the temperature of the protoplanetary disk (T, K) on the distance from the Sun (R, a.u.). The curve represents dependence of the temperature of the gas and dust disk in the central plane in accordance with Safronov [8]. The shaded rectangular areas designate temperatures, calculated on the observable arrangement of the planet [5]. On the insert picture it is showing disappearance of the resistance of the matter of the superconductor at the temperature of the superconductor transition (T_c).

its presented on the Fig. 2. The Belt of Asteroids might possess superconductivity and from that point it may be considered as a ring for the Sun. On a distance from the Sun closer than the Belt of Asteroids, superconducting rings could not appear because its existence will be destroyed by the higher sun's radiation temperature than temperature of the superconducting transition for the space admixtured iced superconductor.

4. GREAT FLATTENING OF THE RINGS SYSTEM. SHARP EDGES AND RINGS DISCONTINUITIES

Flattening of the rings' systems, their sharp edges and rings discontinuities could contain an explanation of the existence of a levitation force, force of diamagnetic pushing out of the particles with a superconducting matter from the areas with the bigger magnetic

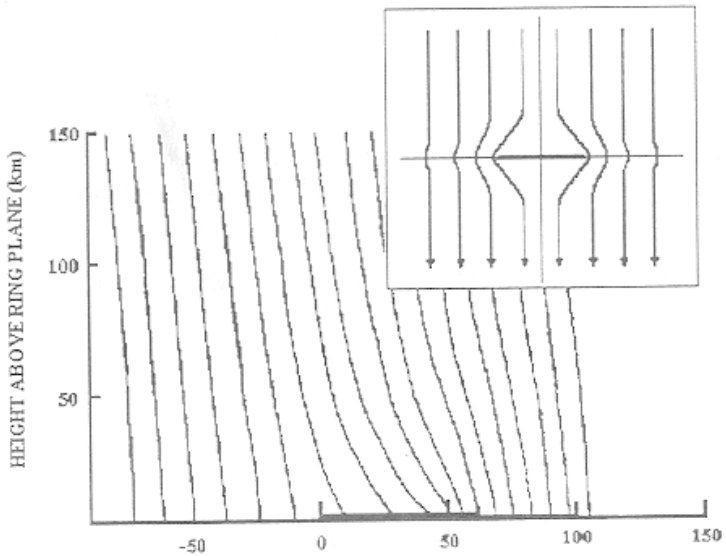

Figure 3. The structure of the magnetic field next to the ring F of Saturn [4]. The field of magnetosphere dipole is distorted. The dusty flow is located between 0 and 60 km and is directed to the page. The field of dipole is directed downward in the parallel to the negative direction of the negative axis. On the insert picture is the demonstration of the distortion of the magnetic field lines of the superconducting disk under Meissner state.

flow of the planetary magnetic field. A levitation force acting on the superconducting bodies in the non-uniform magnetic field and proportional to the gradient of the strength of the planetary magnetic field.

Part of the protoplanetary cloud which contains superdiamagnetic iced particles will collapse into thin protoplanetary disk as the result of the replacement of the particles in the area with the less density of the magnetic flow, in plane of magnetic equator, with the force: $F = -mdH/dz$, where m – magnetic moment of a particle, dH/dz – gradient of intensity of a magnetic field along an axis z of the magnetic dipole.

The force, acting on particles on the part of the crack, will form the sharp edges of the ring:

$F = -mdH/dy$, where dH/dy – gradient of intensity of a magnetic field along the radius of the ring, Fig. 3.

The casual break in a ring will be stabilized by force on the part

of break: $F = -mdH/dx$, where dH/dx – gradient of intensity of a magnetic field in tangential direction. On the Fig. 3 presented deformation of the field of magnetosphere dipole measured at the ring F of Saturn by the Pioneer mission [4]. A distortion of magnetic field lines caused by superconducting disc in a Meissner-Ochsenfeld state. The same situation happened with the conventional superconductor [11].

5. THIN STRUCTURE OF THE SATURN'S RINGS

Saturn's rings' structure looks like a gramophone record, a plate with a huge amount of circle channels with width in 100 m. This is so called thin structure of Saturn's rings. The thin structure of the Saturn's rings may be explained like phenomenon of formation of the periodic structure of the diamagnetic liquid film under influence with normal magnetic field. The movement of a huge quantity of superconducting iced particles, immersing in the rotating magnetic field of the planet will be similar to a stream of the superdiamagnetic liquid, which behaves with inverse accuracy in comparison with a magnetic liquid. It is well known fact, that under the normal arrangement of the magnetic field lines to the plane of the film of magnetic liquid, film itself becomes to be broken into periodic structure of dense and rarefied sites [14].

Under the conditions of the continuous pump of energy by the rotating magnetic field of the planet into the rings particles flow, redistribution of particles resulting in an occurrence of periodic ring structure is possible. The planetary magnetic field in a plane of the protoring disk will be essentially nonuniform, because each superdiamagnetic superconducting particle will be pushing out internal magnetic field from the its volume. The magnetic field lines will aspire to become isolated through areas with the greatest magnetic penetrability, like on the Fig. 4. Superconducting particles of the powder have property to be going in the areas with low density of a magnetic flow [15].

The speed of a magnetic field will coincide with the speed of particles, driven on Kepler orbits, only on the corotation radius and will be different from the speed of the particles at all other distance from a planet. The concentration of the magnetic field will clear away cracks in the protoring disk, pushing super diamagnetic particles to form separated rings.

The density of the magnetic flow inside each ring will be lower than within its surrounding space. The difference of density of the flow will cause directed inward magnetic pressure on the ring. This is a condition of the superconducting film in the magnetic field [16].

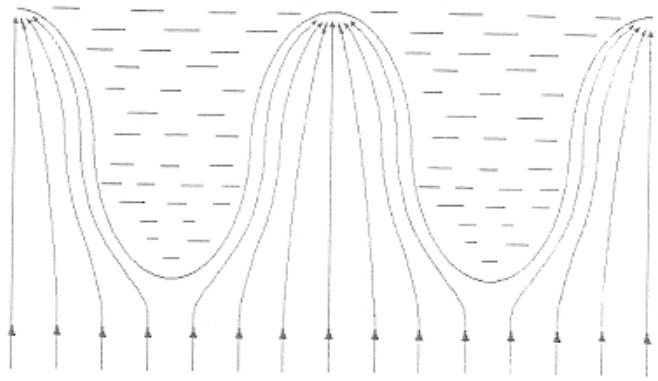

Figure 4. The distribution of the normally oriented magnetic field in the film of the superconducting liquid.

6. EXISTENCE OF THE PLANETCENTRICAL DUST FLOWS OF SUBMICRON SIZE PARTICLES IN RING'S SYSTEM

It also becomes possible to explain the existence of planetcentrical dust flows of submicron particles in rings' systems. The phenomenon of diamagnetism of superconductors is caused by microscopic superficial currents, but not by intra-atomic phenomena. For superconducting particles there is London's depth λ_L of penetration of the magnetic field inside superconductor. For various superconductors $\lambda_L = 0,05$–0,5 microns [15]. Influence of penetration of the magnetic flow becomes appreciable for particles with the size comparable with London's depth of penetration. In this case the small particle will not be ideally diamagnetic and will not cooperate with the planetary magnetic field, because they lost their superconductivity by size. Dynamics of the movement of such particles in the magnetic field of the planet will be different from dynamics of particles of a bigger size which is $> 2\lambda_L$. Those particles will fall dawn to the planet due to the gravity. Thus, existence of the planetcentrical dust flows of submicron's size particles related to disappearance of diamagnetic superconductivity of the matter of the rings particles [18–20] due to reducing their size. At the same time, it is also possible for a particle to loose it superconductivity by a fluctuation of the local temperature or magnetic field when both of them are above the critical values.

7. CHANGE OF THE AZIMUTH BRIGHTNESS OF THE SATURN'S *A* RING PARTICLES

For explanation of the phenomenon of the variable azimuth brightness of Saturn's A ring particles there are number of theories based on the assumptions of a synchronous rotation of the ring's particles with their asymmetrical form as extended ellipsoids directed under a small angle to the orbit, or with asymmetrical albedo of the surface was advanced [5].

Let's take into consideration our superconducting model. The phenomenon of diamagnetism happens if a substance is placed in the magnetic field and the additional moment directed opposite to the external field arises. The matter is magnetized, not along the external magnetic field but in opposite direction. The rod of superdiamagnetic substance of the ring particle tries to locate itself perpendicularly to the magnetic field' lines.

The magnetic field of a space particle contains, as constituents, a polhodal field component, H_p with field lines directed on meridians as at dipole and a toroidal field, H_t with lines of field directed along the parallels.

From the science about snow [13] it is known fact that at the temperature below -22°C growing snowflakes take the form of prisms. Thus, the prism of the superconducting iced particle will be oriented perpendicularly to field lines of the polhodal and toroidal constituents of the magnetic fields of the Saturn, as it shown on Fig. 5. As a consequence it's clear that variable azimuth brightness of the Saturn's rings system A related to orientation of the elongated ellipsoid of superconducting particles to the normal direction to the magnetic field of the planet.

8. FORMING AND DEVELOPMENT OF THE "SPOKES" IN THE SATURN'S *B* RING

"Spokes" in the ring B of Saturn, as well as the spokes of any wheel, are located almost along radiuses. It must be said that existence of the radial structures within a planetary ring system contradicted all traditional notions. The fact is that according to the laws of Kepler, the areas of the wide ring B which are further from a planet rotate slower than those placed nearer. Therefore any radial formation should be distorted and washed out for a few tens of minutes. However, experimental data show that lifetime of separated spoke 10^3–10^4 sec though Kepler washing outs in them are nevertheless proven. The size of spokes itself are about 10^4 km along the radius and about 10^3 km

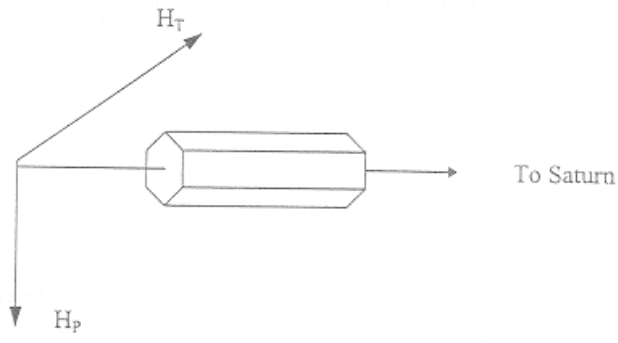

Figure 5. Orientation of the ellipsoidal prism of the superconducting iced particle of the rings in the magnetic field of the Saturn.

along the orbit of the ring. The matter of the spokes consists of micron and submicron size particles [11].

There were many attempts to explain nature of the spokes. Mostly all theories based on the action of the force of gravity. At the same time, there were some ideas that registration of rotating spokes somehow related to electromagnetic interaction because of its rotation synchronously going along with the magnetosphere of the Saturn [4, 11].

The analysis of spectral emitted radiant power of spokes provides specific periodicity about 640,6±3,5 min, which is almost coincident to the period of rotation of the magnetic field of Saturn, which is 639,4 min. Moreover, the strong correlation of maxima and minima of activity of spokes with the spectral magnetic longitudes connected to presence or absence of the radiation Saturn's Kilometric Radiation (SKR) [10]. It confirms the assumption of the dependence of the spokes dynamics on the magnetic field of Saturn and testifies to the presence of large-scale anomalies in the magnetic field of Saturn [2–4].

It is difficult to provide a detail analysis of the spokes formation and specify which script is realized. But in accordance with our superconducting model of the rings particles nature, it is definitely possible to tell that condition of the substance of the rings can work on the orientation hypothesis of formation of the spokes, as well on levitation one.

Going to superconducting model of the rings iced matter it possible to prove that formation of spokes is related to electromagnetic field phenomenon. Superconducting iced particles of the rings matter rotating in accordance with Kepler law, and at the same time magnetic

field is rotating along with the planet and has anomalies itself [2–4]. Superconducting particles during their rotation around Saturn coming to anomalies of the magnetic field positions and physical condition of the particles will change, and they experienced phase shift to a conventional matter state loosing their superconductivity, which is optically registered as a spokes.

9. HIGH REFLECTION AND LOW BRIGHTNESS OF THE RINGS PARTICLES IN THE RADIFREQUENCY RANGE

The opening of strong radar-tracking reflection from the rings of Saturn in 1973 was surprising [9]. It turned out that rings of the Saturn actually have the greatest radar-tracking section among all bodies of Solar system. Originally high reflection and small brightness of rings particles on radiowaves were explained by the metallic nature of the particles [9]. The data of the Voyager exclude this possibility.

The disk of superconducting particles completely reflects radiation with frequencies below 10^{11} Hz and poorly reflects radiation with higher frequencies. It is connected with the fact that the radiation is strongly absorbed when the energy of photon is rather great for throwing of electrons through the energetic slit. As in the case of superconductor the absorption begins at the frequencies higher than 10^{11} Hz, so the energetic slit should be about 10^{-4} eV [15, 16].

Let's apply a variable electromagnetic field to the superconductor. If the frequency of an applied field is rather high, the superconductor behaves just as a conventional substance. It occurs because at rather high frequency of an applied field the superconducting electrons conditioned with lower energy than conventional electrons, are raised by photons of the electromagnetic field and undergo a transition with higher energy where they behave as conventional electrons. It occurs on frequencies higher than 10^{11} Hz.

The superconductors have practically no resistance up to frequencies of 100 MHz. At frequencies about 100 GHz there comes a limit, above which the frequent quantum phenomena cause a fast increase of resistance, as it is shown on Fig. 6. So, specific picture of the brightness temperature of the rings depends on frequency in the range 10 μm–10 cm goes according to Kirchhoff's law of body radiation and has an analogue behavior as those for the surface resistance of superconductor.

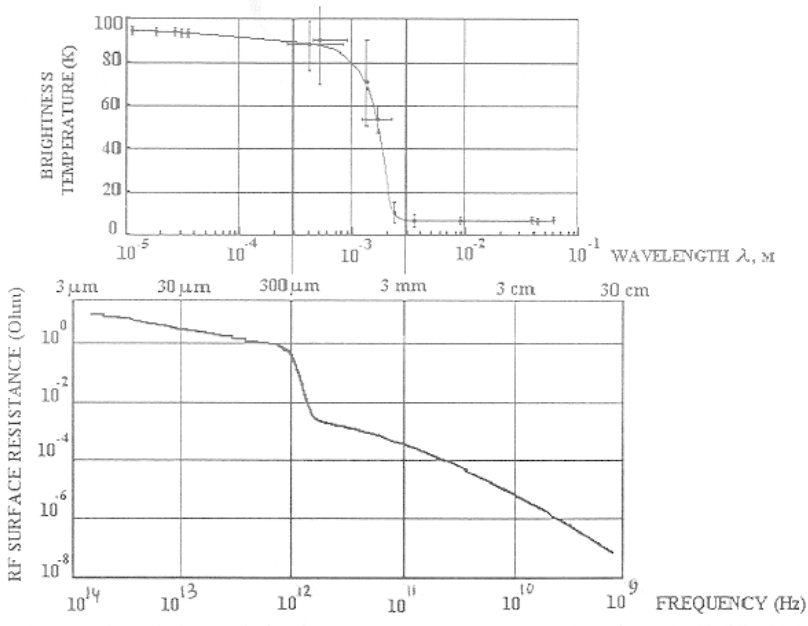

Figure 6. Top diagram is the dependence of the brightness temperature of the rings on the wavelength: transition from the radiation of the almost black body to practically complete reflection is observed [2]. Bottom diagram is the dependence of the surface resistance of the superconductor on frequency including data below superconducting transition for Nb at $T = 4,2K$ [15, 16].

10. OWN WIDE BAND PULSE RADIATION OF THE RING WITHIN THE 20 KHZ–40,2 MHZ

Researches from the Voyager have shown that the rings radiate strong electromagnetic waves. These waves, probably, are a result of interaction of charged particles with the particles of ice or destruction and friction of particles of ice when co-strikings occur. In such case it is necessary, probably, to admit that the complex movement of particles forming the rings of Saturn depends not only on mechanical forces which had been taken into account before, but also on other interactions, for example, on electromagnetic.

During both missions of Voyager to Saturn, planetary radio-astronomy experiments (PRA) have registered non-polarized, extremely discreet and very broadband radio radiation registered in all observable ranges of the experiment from 20,4 kHz to 40,2 MHzes.

These incidental radio discharges are named as Saturn's Electrostatic Discharges (SED). The average period SED is well determined and was established as 10 hour 10±5 min and 10 hour 11±5 min by Voyager 1 and 2, respectively. If the ring has a source of SED, the area of this source can be located at the distance of 107,990–109,000 km from the planet according to measured periodicity. Data of the experiments can help specify electrodynamic coupling between the planetary ring system and the magnetosphere, in which SKR, SED and activity of spokes are subordinated to longitude regulation [4, 10]. In accordance with owe superconducting model, approaching of superconducting rings' particles up to distance about 10^{-8} m, or, the existence of narrowing or dot contact will result in the formation of a weak link (superconducting transition) through which superconducting electrons can be tunneled. When the difference of phases between superconductors under action of the electrical or magnetic field occurs, the weak link will generate electromagnetic radiation with frequency proportional to power failure on this transition (nonstationary Josefson phenomenon). The radiation frequency is proportional to the voltage in the transition, $\nu = 2eV/h$, where $2e/h = 483,6\,\mathrm{MHz}/\mu\mathrm{V}$ [17], e is a charge of electron, h is a Planck constant.

11. FREQUENCY ANOMALIES IN THE THERMAL RADIATION OF SATURN'S RINGS IN THE SPECTRUM RANGE 100 μM–1 M

Thermal radiation of the rings of Saturn on the wavelengths in the range 10 μm–1 cm also has been measured. The measured brightness temperature on the short waves is less than true brightness temperature of the rings, and on the longer waves the rings look much colder than in the case when the radiation corresponds to their physical temperature [2–4, 7]. On the wavelengths 100 μm–1 mm brightness temperature of the ring (Fig. 6) sharply falls to the meanings smaller than those ones characteristic of an absolutely black body. On the wavelengths longer than 1 cm a ring behaves as the diffusion screen, reflecting planetary and cold space radiation [2, 3]. The intermediate spectral range 100 μm–1 cm actually is the most sensitive to the parameter of refraction, and may contain the important determining information of fundamental properties of the substance. In accordance with our model, under the superconducting condition the electrons do not interact with a crystal lattice and do not exchange energy with it, therefore they cannot transfer heat from one part of the body into another. Hence, when the substance passes into a superconducting condition, its heat conductivity is lowered. This effect

can be obvious under temperatures much less critical, when there are very few conventional electrons capable transferring heat [15, 16].

12. COLOR DIFFERENTIATION OF SATURN'S RINGS IN SMALL SCALE

The balance of three forces determines the position of the superconducting particle in the gravitational and magnetic planetary fields: gravitational force, centrifugal one and magnetic levitation (diamagnetic push out), Fig. 1. Going along with our model let's consider distribution of three particles (a, b, c) with equal weights on close orbits. Let a particle a be wholly superconducting, b – have an impurity clathrate-hydrates of ammonia or methane (NH_3; CH_4 H_2O), c – has an impurity of sulphur and ferrocontaining silicates (H_2S). Each impurity will give the contribution to reduction of the volume of superconducting phase and will determine the color of the particle. The quantity of the levitation force F_L depends on the volume of the superconducting phase, therefore for each of considered particles the balance of three forces will be carried out in the orbits with different radiuses.

13. PHENOMENON OF ANOMALOUS INVERSION REFLECTION OF RADIOWAVES WITH CIRCULAR POLARIZATION ABOVE 1 CM

The research of reflection from the rings of radiowaves above 1 cm was carried out with the use of ground based radio-locators. The reflection has appeared rather large, and the geometrical albedo is equal approximately to 0,34 and has no strong functional dependence on wavelength or on corner of the inclination of ring's pitch. The rings are strong depolarizers; therefore in order to get any information from the reflection it is necessary to measure separately intensity of two orthogonal polarized reflected signals. It provides information of the factor of the ring's polarization, which carries information about properties of particles. For the majority of single objects of Solar system, for example for planets, factor of reflection unobserved polarization (orthogonal to observable) is rather small. As to the rings, the supervision in some range of wavelengths and angles of inclination give us a reflection factor of unobserved polarization between 0,4–1,0 14 [9]. We shall note to the point that the quantities above 1, received for several Galilean satellites, represent while a non-authorized riddle.

Let's go to our superconducting model [18–20]. The superconductors have an essential difference from ideal conductors; besides almost

infinite conductivity they also demonstrate an ideal diamagnetism. The falling electromagnetic wave will induce in superconductor circular currents, which will completely compensate action of the magnetic field of the incident wave. So that the absence of the magnetic field in the volume of the superconductor should be carried out. Superconductor will be acting as a magnetic mirror. Thus, if the falling on superconductor electromagnetic wave has a determined direction of a circular polarization (the spirality), the direction of circular polarization (spirality) will be kept in the reflected wave.

14. PARTICLES DISTRIBUTION BY THE SIZES IN SATURN'S RINGS

The distribution of particles by the size in Saturn's rings in the radial direction have not yet been studied in detail. Experimental research of the physical effects connected with the separation of the superconducting particles by magnetic field depends on the size of the particles, intensity and radius of action of the magnetic field, predicts details yet unknown and unestablished. For example, it takes place with distribution of particles of the millimeter and micron sizes in the rings of Saturn. It is probable that the particles of the meter size are more subject to gravitational influence and a stronger magnetic field affects the particles of the millimeter and micron sizes.

15. AN ATMOSPHERE OF UNKNOWN ORIGIN AT THE RINGS OF SATURN

The atmosphere of Saturn's rings can exist as a result of thin balance of forces of gravitational attraction and diamagnetic push-out of gas molecules. The levitation of gas molecules comes true at the expense of forces of diamagnetic push-out induced in superconducting particles by molecular magnetic moment of gas. The similar situation can be observed under laboratory conditions when atmospheric water steam is precipitated on substance as white-frost at the transition moment of substance from a superconducting into a conventional one.

16. EXISTENCE OF WAVES OF DENSITY AND BENDING WAVES IN SATURN'S RINGS

The existence of waves of density and bending waves in Saturn's rings have no complete explanation based only on gravitation phenomena. Let's use our electromagnetic approach. It is possible to note that external magnetic field is directed along the free surface of diamagnetic

liquid which represents a disk of the rings. In case of periodic deformation of a free surface a normal field under a hollow decreases, and it is increased under chamber. Consequently, the ponderomotive force works on the side of restoration of the flat form of the free surface. Thus, the field increases a rigidity of a free surface.

The change of rigidity of the free surface in a field gives a chance to excite its parametrical fluctuations. When the quantity of the amplitude of intensity of a variable field is larger than critical one, the standing wave is occurred on a free surface of superconducting liquid. The constant phase lines of this wave are transverse to the vector of intensity of the field. The wavelength is determined by the condition of the parametric resonance. The constant phase lines begin to be bent when intensity of the field increases, and the excited ripple becomes casual [14].

17. CONCLUSION

We do not claim that we have sufficient evidence for our model of the magnetic levitation of superconducting iced (admixed) particles of Saturn's rings. At the same time results of this theory coincide with the experimental data from Voyager and Pioneer missions. It is a pleasing surprise, how many features of the rings can such a model explain (Table 1). Hypothesis of the superconducting material state of the Saturn's (planetary) rings allows to extend classical (gravitational and dusty plasma) theories of the planetary rings by non-conflicting superconducting model, and makes it possible to resolve as yet unsolved problems as was shown above. It helps to overcome many existing difficulties in the planetary physics by taking into account phenomena and behaviour of the electromagnetism nature in space, considering interaction of the superconducting particles of the rings with magnetosphere of the planet.

Since Galileo (1610) first observed the rings of Saturn, much research has been done examining the nature and physical properties of the rings by such a well-known scientists as Cassini (1659), Roche (1849), Maxwell (1859), Kuiper (1952), and others. It is connected to the fact that by results of structural, spectral or chemical researches it is impossible to judge unequivocally the condition of substance in the planet's rings, until the theory of high-temperature superconductivity is created.

The planning and interpreting of special experiments on search and research of possible superconductivity of the substance in Saturn's rings is obviously necessary within the framework of space expeditions "Cronos", "Cassini" (which cost is ∼$3,5 bln), and others. "Cassini"

Table 1.

	Problems of planetary rings:	Responsible Physical Phenomenon:
1	Origin, dynamics and evolution of the rings	The Meissner-Ochsenfeld phenomenon when superconducting particles of the rings demonstrate a perfect diamagnetism. Magnetic levitation of the admixtured superconducting rings substance
2	Existence of the temperature border on the certain distance from the Sun behind which planets may have rings. This border coincides with the position of the Belt of Asteroids	Existence of superconducting transition temperature (Tc) on the certain distance from the Sun behind which planets with magnetic field may have rings with superconducting matter. The Belt of Asteroids is the ring for Sun
3	Great flattening of the rings system. Sharp edges and rings discontinuities	Phenomenon of pushing out of the diamagnetic superconducting substance of the rings out of the areas with greater density of magnetic flow
4	Thin round periodical structure of the Saturn's rings.	Phenomenon of the forming of periodic structure in the diamagnetic liquid film under influence of normally oriented magnetic field
5	Existence of the planetcentrical dust flows of the submicrons size particles in the ring's system	Disappearance of the diamagnetic properties of superconducting particles with dimension close to London's depth of the magnetic field penetration in the matter
6	Change of the azimuth brightness of the Saturn *A* ring particles	Orientation of ellipsoid elongated diamagnetic particles of the ring normally to the lines of force of the magnetic field
7	Forming and development of the "spokes" of the Saturn's *B* ring	The matter of rings moves in accordance with Kepler law and magnetic field of the planet is rotating together with planet. When superconducting particles of the rings take different positions of longitudinal perturbations of the magnetic field of Saturn they loose their superconductivity experiencing phase transition of the substance
8	High reflection and low brightness of the ring particles in the radiofrequency range.	An existence of critical frequency for the superconducting matter of the particles above which electromagnetic waves is absorbed, and below which one is completely reflected
9	The wide band pulse radiation of the rings in the range 20 kHz – 40.2 MHz.	Non-stationary Josephson phenomenon: generation of electromagnetic waves by Josephson's contact with frequency 4,83594 10^{14} Hz/V

10	Frequency anomalies of the thermal radiation of Saturn's rings in the spectrum range 100 μm – 1 cm	An existence of energetic slit (~10^{-4} eV) for superconducting particles. Superconducting electrons do not interact with crystal lattice
11	Color differentiation of Saturn's rings in a small scale	Dependence of the force of magnetic levitation of admixtured superconductor particles from the volume of superconducting phase of the bulk matter
12	Phenomenon of anomalous inversion of reflection of the radiowaves with the circular polarization on $\lambda \geq 1$ cm	Phenomenon of reflection of the radiowaves with the circular polarization from the superconductor which is as a magnetic mirror
13	Possible existence of the distribution of particles by the size in the Saturn's rings bulk in the radial direction (not established yet)	Magnetic separation of the superconducting particles powder in dependence of the size, strength, extension and the range of the applied magnetic field
14	Existence of the atmosphere of the unknown origin in the vicinity of the rings of a Saturn	Magnetic levitation of gas molecules due to expense of forces of diamagnetic push-out, induced in superconducting particles by molecular magnetic moments
15	Existence of waves of density and bending waves of the matter of the rings of Saturn	Excitation of parametric fluctuations in the matter by ponderomotive forces when external magnetic field has tangential direction to the free surface of diamagnetic liquid and its normal to the lines of the same phase
16	Existence of Kilometric radiation of the Saturn rings at $\nu < 1{,}2$ MHz	Appearing electric field due to the movement of the superconducting liquid within magnetic field

was launched in 1997 October 15 and will be researching on Saturn for four years from June 2004.

Another probability is that this model has a fundamental nature, which is valid in any other star's system. Also it is important to know that until recently our representation about ice were in many respects faulty. The true nature of ice is hidden in space.

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