Laws of motion of bodies (draft)

Introduction

2. The advantages and disadvantages of the work done

2.2. The disadvantages of the work done.

Besides the advantages of the work done one can mention the following disadvantages there:

- No grounded gravitation theory and no mathematical apparatus are available;
- The investigations were carried on in insufficiently grounded way of identifying the notions of weight and mass;
- Doubtful standard of weight and mass were adopted;
- It's quite difficult to obtain the force dimension from the gravitation formula of I.Newton;
- The gravitational constant was obtained from a doubtful formula but not in the result of direct measurements with the help of dynamometer, for example;
- Physical and astrophysical constants are obtained experimentally and have no theoretical groundation;
- It is impossible to measure the same parameters of the bodies in different points of the Universe;
- The grounded parameters characterizing the gravitational field of a body aren't available;
- The body gravity acceleration was obtained from the doubtful formula;
- The first, the second, the third and the fourth cosmic velocities were obtained from doubtful formulas;
- The measurements of parallaxes is the only method of the direct definition of distances to various bodies;
- The law of Titius-Bode has no theoretical groundation;
- The body gravitational radius was obtained from the doubtful formula;
- The force of gravitation between the bodies is found from the doubtful formula;
- The body density is found from the doubtful formula;

- The body energy is found by the formulas in which the weight of a body with the dimension of the body mass was used instead of the mass of the body;

- The parameters of the black holes were obtained from the doubtful formulas;

- The parameters of atom were obtained from the doubtful formulas;

- The theoretical groundation of the dimension relationships of any physical quantities and its physical essence isn't available;

- The gravitational waves generated by different bodies in the Solar System and the Milky Way galaxy haven't been found and their parameters haven't been measured;

- The mechanism of forming "the axis of evil", galaxy accumulations, galaxies, stars, comets, planets, planetary rings, planetary satellites, the rings of planetary satellites, dwarf planets, the satellites of dwarf planets, asteroids, the satellites of asteroids and other bodies hasn't been explained;

- The mechanism of the motion of the Trojans-asteroids located in the vicinity of Lagrange points L_4 and L_5 along the orbit of Jupiter, Mars, Neptune and other bodies hasn't been explained yet;

- The mechanism of the bodies gravitation hasn't been explained;

-The distribution of torque momentum between a body with larger mass and bodies with smaller masses rotating around it hasn't been explained;

- The abnormal displacement of Mercury perihelion, irregular acceleration of Encke comet and secular Moon acceleration haven't been explained;

- The cause of the appearance of dark matter, hidden mass and dark energy hasn't been explained;

- The reason of the majority of the failures of twenty missions out of thirty-six in the period from 1960 to 2003 in investigating of Mars by space vehicles hasn't been explained;

- The "anomaly" of "Pioneers" hasn't been explained;

- The unified system of units for the Earth and for other bodies isn't available;

- The pre-requisites for creating a unified field theory and for uniting the gravitational and electromagnetic fields haven't been elaborated;

H. Huygens called the Newton's gravitation law an absurd and improbable one.

According to the figurative expression of Hegel the Newton's universal gravitation law explains the motion of planets around the Sun just like the motion of a cart along the road to the town explains the reference that the town attracts a peasant. At the time when J. Newton's fame reached its climax and nobody could call in question the gravitation law with proper groundation, H. Hegel wrote, "As to the absolute relations of measure it should be said that mathematics of nature, if it wants to be worth being called a science, must by its essence be a science of measures for which quite a lot has been done empirically, while little has been done philosophically, that is scientifically. Mathematical fundamentals of nature philosophy, as Newton called his work, if they are to fulfill their appointment in more profound sense than the sense he and Bacon generation attributed to philosophy and science, should have contained something quite different to bring light to these dark, but to the highest degree worthy of studying, areas. – It is a great merit to get acquainted with empirical numbers of nature, as for example, with distances of planets to each other; but much greater merit is to make empirical definitions for them to become the moments of law or measure, - the immortal merits which have, for example, Galilei in investigating falling bodies and Kepler in studyng the motion of celestial bodies. The laws found by them proved, having shown, that all the sphere of the perceived single accurences (singlenesses) corresponds to them. However, a more elevated proof of these laws is necessary, that is, the cognition of their quantitative definitions on the basis of the related to each other certain notions" [ ].

In 1872 E. Mach while estimating the I Newton's theory wrote, "Immediately after its appearance the Newton's gravitation theory embarrassed many scientists as it was based on non-trivial and unclear principles. The scientists tried to reduce gravitation to pressure and collisions. Nowadays, gravitation doesn't surprise anybody, it has become a usual incomprehensible phenomenon"» [p.118].

E. Mach called the Newton's definition of mass an "imaginary definition": The notion of mass doesn't become more comprehensible, if mass is treated as the product of the volume of a body by its density, because the density itself is nothing but the mass in the unit of volume. The true definition of mass may be only derived from the dynamic relations of bodies [p.209].

The theory of I. Newton was accused of being unable to explain the proportionality of inertial and gravitational masses as well as of assuming the possibility of the direct action of the given body at any long distance without the assistance of any intermediate surrounding (medium).

At present, physical and astronomical constants are the important problems of modern physics due to the absence of any theoretical groundation. It is proved by the fact that there is no definition of the notion of "physical constant". Some specialists assert that the majority of the known physical constants have nothing in common with truly fundamental constants. B. Rassel stated that the criterion of the fundamental constants is their irreducibility to each other: "It is usually (though not always) considered that none of them can be derived from the others". [1.p.33].

There are different classifications of physical constants: of micro- and macro-physics, classical and atomic; those related to the theory of I. Newton, to electrodynamics of Maxwell, to quantum theory, thermodynamics, statistical physics, cosmology, etc., characterizing gravitational, electromagnetic, weak and strong interactions; characterizing physical properties of the body, the classes of physical phenomena and the universal ones, etc. There is no difference between the notions of "physical", "universal", "fundamental", "world", "astrophysical" and other constants.

Moreover, is it reasonable to attribute to the physical and astrophysical constants the values of units of mass (a.u.m.), which is found in the result of the agreement among the people but doesn't characterize the properties of the objective reality?

At present, numerical values of physical constants are defined experimentally and have no explanation in any theories. Many specialists with a great deal of groundation attribute the problem of physical constants to the most important problems of modern physics. Without solving the given problem the very existence of physical science becomes problematic.

It is considered that the sense of the gravitational constant found by G. Cavendish, is the force of gravitation between the first body with the mass of one gram and the second body with the mass of one gram located at the distance of one centimeter. However, the dimension of the Cavendish gravitational constant $(G=6,6745\cdot10^{-8}cm^3/gs^2)$ doesn't coincide with the dimension of force. At the same time the relation of the product of masses of the gravitating bodies to the squared distance between them in the Newton's law doesn't give any opportunity to obtain the dimension of force. In order to obtain the dimension of force in the Newton's law G. Cavendish introduced dimension cm^2/g^2 to gravitational constant in addition to the dimension of force. The dimension of force gcm/s^2 in the Newton's gravitation formula would arise any doubts if there were body gravity acceleration with the dimension cm/s^2.

At present, the viewpoint, according to which H. Cavendish obtained the meaning of the gravitational constant in the course of the known experiment with torsional scales, is considered to be universally recognized. For this purpose it was necessary to find the elastic force of the winding of a thread. However, the thread was too thin and fragile for direct measuring with the help of dynamometer, for example. That's why G. Cavendish worked out the formula of the law of winding the thread taking into account the period of simple harmonic oscillations of a lath with metallic balls suspended on it, as well as its mass and dimensions. Thus, the known gravitation constant has been obtained not in the result of direct measurement with the help of a dynamometer, for example, but from the doubtful formula.

In May 18, 1899 M Plank in his report "On irreversible processes of radiation" at the sitting at the Academy of Sciences in Berlin declared that on the basis of new constants of Plank and Boltsman, the light velocity and the gravitation constant" we obtain an opportunity to define the units of length, mass, time and temperature which wouldn't depend on the choice of any bodies or substances and would keep without fail their meaning for all the times and cultures, unearthly and unhuman ones being among them, and which might be introduced as "natural units of measurement" [ ].

M. Plank suggested creating a system of length, mass and time units in order the gravitation constant, the light velocity and Plank constant be equal to unit.

To provide such an equation it might be necessary to adopt new units of measurement: for mass it should be $5{,}456 \cdot 10^{-5} g$, for length it might be $4{,}050 \cdot 10^{-33} cm$ and for time it is $1{,}351 \cdot 10^{-43} s$.

In such a case the main advantage of the absolute system of units is the simplification of writing down the main equations.

However, the idea of M.Plank to adopt "unearthly and unhuman" measurement units didn't gain any sympathy among specialists.

Before this, in the process of creation of the unified field theory there had been undertaken frequent attempts to find the relationship between gravitation constant and other physical and astrophysical constants.

Solving the problem of physical and astrophysical constants, in our opinion, is only possible in case the physical essence of each constant is found.

Now quite different methods of finding weight and masses of various bodies are used. From our point of view, only the unified methods of finding weights and masses irrespective of their size, average orbital velocity, the star size and other parameters have the right for existence.

It is considered that anomalous displacement of Mercury perihelium, irregular acceleration of comet Encke and the Moon secular acceleration have been explained within the frames of A. Einstein's relativity theory. At the same time, McVittie asserted, for example, that the replacement by A. Einstein the gravitation by the so-called "space-time curviture" says little even to physicists. A. Einstein himself was disappointed with the theory of relativity when he wrote to his friend M.Bessot in his letter in 1954: "I think it's quite possible that physics may not be based on the field conception, that is on persistent structures. Then nothing will be left over from my castle in the air including the theory of gravitation as well as from all modern physics" [ ].

From our point of view, the existence of the known anomalies is the result of using insufficiently grounded methods of finding weights and masses of various bodies.

It is considered that the problem of the dark substance (matter) appeared due to insufficient exactness of the methods of detecting various bodies in the Universe. From our point of view, the problem of dark substance appeared due to using insufficiently grounded methods of finding the weights and masses of visible bodies and their accumulations in the outer space.

In the connection with the afore-mentioned, the problems of research consist in the following:

- to work out a new gravitation theory and its mathematical apparatus;
- to measure the weight of a body;
- to elaborate the body weight standard;
- to measure the mass of a body;
- to measure the gravitation constant by objective methods;
- to measure the main physical and astrophysical constants;
- to measure the same body parameters in different points of the Universe;
- to measure the parameters of the bodies around which other bodies rotate;
- to measure the parameters of the bodies round which other bodies don't rotate;

- to measure the parameters of the gravitational field of a body;

- to measure the gravity acceleration of a body;

- to measure the velocity of a body;

- to measure the cosmic velocity;

- to measure the distance among the bodies;

- to explain the reason of the location of a planet at the known distance from the Sun;

- to measure the gravitation radius of a body;

- to measure the force of gravitation between the bodies and the centrifugal force of the body;

- to measure the density of a body;

- to measure the energy of a body;

- to measure the parameters of black holes;

- to measure the atomic parameters without using the Avagadro constant;

- to show if the dimension of any physical value is connected with its physical essence;

- to measure the parameters of the gravitational waves generated by different bodies in the Solar system and the Milky Way galaxy;

- to explain the mechanism of creating “the axis of evil”, accumulations of galaxies, galaxies, stars, comets, planets, planetary rings, planetary satellites, the rings of planetary satellites, dwarf planets, the satellites of dwarf planets, asteroids, the satellites of asteroids and other bodies;

- to explain the mechanism of the motion of Trojans-asteroids, located in the vicinity of the Lagrange points L_4 and L_5 on the orbit of Jupiter, Mars, Neptune and other bodies;

- to explain the mechanism of bodies gravitation;

- to explain the distribution of rotation momentum between the body of larger mass and the bodies of smaller masses rotating around it;

- to explain anomalous (abnormal) displacement of Mercury perihelion, irregular acceleration of Encke comet and secular acceleration of the Moon;

- to explain the reason of the appearance of the problem of dark matter, hidden mass and dark energy;

- to explain the reason of the majority of failures of twenty out of thirty-six missions from 1960 to 2003 while studying Mars by cosmic apparatuses;

- to explain why no fragments of Tungus meteorite have been found;

- to explain the “anomaly” of “Pioneers”;

- to show if the International System of Units (SI), Gauss system (GGS), the System of British units and other systems correspond to modern requirements;

- to show the reasons for creating the unified field theory and the unification of gravitational and electromagnetic fields;

3. The measurement of the properties of a body

3.1. The change of the weight of a body

Material bodies have very different properties. They may be in different aggregate states, they have odour, taste, color, density, volume, gravity acceleration, the limits (boundaries) of their action, energy and weight. The aggregate states include: solid state, liquid state, liquid crystals, gaseous state and plasma.

The properties of a body in different aggregate states are determined by the relationship of protons, neutrons and electrons. The state and the properties of material bodies in different aggregate states are determined by temperature and pressure. When temperature is low material bodies are solid. When temperature is moderate they are liquid. When temperature is high and pressure is low the bodies are in gaseous state. Any material body heated to some high temperature passes to state of plasma.

Solids consist of crystals and amorphous compounds. In crystals atoms form regular spatial structure while in amorphous compounds they are arranged at random. There is a strong connection among atoms and molecules and they do not move.

Liquid crystals occupy an intermediate state of substance between liquid bodies and crystalline ones. Liquid crystals consist of long molecules, oriented parallel to each other but able to move relative to each other.

Liquid bodies are not characterized by constant dimensions and shape and occupy a certain volume at constant temperature and are practically incompressible. There exists a strong intermolecular attraction between atoms and molecules. They can move but their freedom is limited.

Gaseous bodies do not have any constant dimensions and shape but fill all the given space. There is no stable (firm) tie among atoms and molecules and they can move freely in space. Electrons rotate along their orbits inside the atoms.

In plasma electrons came off from atoms and can move freely. Atoms and molecules, having lost some part of their electrons, turn into ions. In the result of this there is formed a mixture of positively and negatively charged ions and electrons where the negative charge of electrons neutralizes the positive charge of ions. The main mass of material bodies in the Universe is the state of plasma.

Taste is the result of the action of irritating substances on the tongue and in the throat solved in saliva and acting on special nerve ends. The main gustatory sensations include sour, salty, sweet and bitter ones.

Colour as a visual sensation is determined by the imposition of the light waves having different length and intensity and getting to eyes. From the main colours (red, green and black) it is possible to obtain all the visible colors.

Material bodies have various volumes depending on their aggregate state. Volume is the quantity characterizing a body with closed surface. Most of the material bodies when passing from solid state to liquid one and from liquid state to gaseous one increase their volume, ice, bismuth, silicon, antimony, and some other substances being among them.

The density of a body characterizes the distribution of weight of a uniform substance in a unit of volume. The unit of density is the density of the uniform body, the unit of volume of which contains the unit of the body weight.

The gravity acceleration of a body is one of the most important body characteristics. Any body having weight acquires the ability to gravitation due to its gravity acceleration. The gravity acceleration ($981\ cm/s^2$) was found by Galilei as the weighed arithmetic mean of the acceleration of different bodies falling at equal intervals of time at the latitude of 45° at sea level.

However, as I. Bernoulli stated, weight is the product of mass by the gravity acceleration, that is, it already contains in itself $980{,}665\ cm/s^2$ in the Earth conditions. Therefore, it isn't necessary to multiply the weight by the gravity acceleration once again. Thus, the gravity acceleration is related to the weight of a body but not to its mass.

We assume that the volume of a body is the boundary of weight action.

Weight is an important property of material bodies the bodies with larger weight will naturally have more ability to have gravitation towards other bodies.

In order to define more precisely the methods of measuring the weight of the body some changes have been introduced and the new method of determining weight has been elaborated. These changes have been checked on the example of finding the weight of the known mass standard of a kilogram in SI, MKS, and other systems of the units of physical quantities that is equal to one cubic decimeter of distilled water at the temperature of 4°C. All the calculations have been made in the system of units of physical quantities GHS.

The weight of a body is measured with the help of different scales. At present, a direct circular cylinder made of platinum-iridium alloy with mass equal to one kilogram is now used as the weight standard. However, weight isa force and the force has the dimension gcm/s^2. That's why it is not clear for us how such well-known specialists as J. Lagrange, P. Laplace, J. Borda, G. Monge, M. Condorcet and others could adopt the weight of one kilogram as the standard of weight and mass when they have different dimensions.

In order to remove the given disagreement there was used the I. Bernoulli hypothesis with regard to the weight of a body (   ) and it is recommended to put on the pan of the scales not only the weight equal to one kilogram, but also the gravity acceleration with the dimension cm/s^2.

In this case the fact that two opposite viewpoints as to physical essence of dimensions of physical quantities are known at present, has been taken into account.

According to one of them, the only sense of dimension is the indication how a unit of the given quantity changes at the given change of units adopted as the basic ones. Thus, M. Plank asserted: "... It is clear that the dimensions of any physical quantity is not the property tied with essence but it is a certain convention, determined by the choice of measuring system. If more attention were paid to this side of the problem, then physical literature, the one dealing with system of electromagnetic dimensions (measurements) in particular, would get free from a lot of fruitless disagreements”[ ]. At the same time “... the fact that any physical quantity has in two different systems of units not only different numerical values, but also different dimensions, was often interpreted as a certain logical disagreement to be explained and which by the way, caused putting forward the question about “true” dimension of physical quantities ... there is particular necessity to prove that such a question has no more sense than the question of the "true" name of some object “ [ ].

A.Einstein considered that there must not be any place for arbitrary constants in the ideal scientific picture of the world. The constants, expressed in metres, kilograms, seconds, etc., should be completely excluded from physics and replaced by dimensionless quantities [ ].

According to another point of view, the dimension of any physical quantity reflects it’s link with the quantities adopted as the fundamental ones in forming a system of units. A. Sommerfeld, asserted: “We do not share the viewpoint of Plunk, according to which the question about real dimension of a physical quantity has no sense” [ ]. He connected the choice of the main quantities: “... We find the fundamental difference among “force” quantities (Intensitatsgroβen) and “quantitative” quantities (Quantitatsgroβen) in the taken by us as the basis, Maxwell equations themselves. The consideration where attention is paid to the dimension of physical quantities becomes fruitful if one introduces the fourth electrical unit not depending on mechanical units ... As we differentiate the dimensions of force and quantitative quantities, dialectical and magnetic permeability must have dimension. Due to this, they must not be equated with the unit and with vacuum” [ ].

Showing the preference to the second point of view, it was assumed in the process of calculations that dimension is inseparable from the essence of a physical quantity.

So, it was considered necessary to introduce certain changes to the methods of finding the parameters of different bodies.

The mass of the body M was found by the formula:

$$M = \frac{P}{g},\qquad (\quad)$$

where M is the mass of the body, g;

P is the weight of the body, gcm/s^2;

g is the gravity acceleration, cm/s^2.

The weight P was by the formula

$$P = Mg,\qquad (\quad)$$

where M is the mass of the body, g;

P is the weight of the body, gcm/s^2;

g is the gravity acceleration, cm/s^2.

The weight of the body P was found by the formula

$$P = \rho \cdot V,\qquad (\quad)$$

where P is the weight of the body gcm/s^2;

ρ is the density of the body g/cm^2s^2 ;

V is the volume of the body, cm^3.

The results obtained below, from our point of view, show the rightness of A.Summerfeld.

The opinion of B. Ostwald was also taken into account: "If any of the quantities included in the formula is measurable by itself then we have eternal formula or the law of nature ... or, on the contrary, the formula includes the quantities that can not be measured then we deal with a hypothesis, having the form of a mathematical formula while a worm is inside the fruit" [ ].

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The weight of the body P was found by the formula

$$P = \rho \cdot V , \qquad (\quad)$$

where P is the weight of the body gcm/s^2;

ρ is the density of the body g/cm^2s^2;

V is the volume of the body, cm^3.

The density of the body ρ was found by the formula

$$\rho = \frac{P}{V} , \qquad (\quad)$$

where ρ is the density of the body g/cm^2s^2 ;

P is the weight of the body gcm/s^2;

V is the volume of the body, cm^3.

The gravity acceleration g of the body was found by the formula

$$g = \frac{P}{M} , \qquad (\quad)$$

where g is the gravity acceleration of the body, cm/s^2;

P is the weight of the body, gcm/s^2;

M is the mass of the body, g;

The density of different bodies must have the following form: water - $1{,}0\ g/cm^2s^2$ and air $0{,}0013\ g/cm^2s^2$ (at the temperature $t=0^\circ C$ and normal atmospheric pressure), iron 7,8 g/cm^2s^2 and wood - $0{,}4\text{-}1{,}4\ g/cm^2s^2$ (at $t=20^\circ C$) etc.

The weight of the weight standard P_{STA} was found proceeding from the density of water ρ_{WAT} and the volume of water V_{WAT} by the formula ( )

$$P_{STA}=\rho_{WAT}\cdot V_{WAT}\ P=1{,}0\cdot 1{,}0\cdot 1{,}0^3=1000\ \ gcm/s^2.$$

At present, measuring of the weight of the body by the formula of the second law of mechanics law proceeding from the mass of the body (M) and its gravity acceleration of the body (g) [ ]. However, the quantity which is now placed into this formula instead of mass is actually the weight with the dimension of mass. In order to avoid inaccuracy while using this method it is necessary to introduce mass M with the dimension of mass (g).

The weight of the weight standard was found proceeding from its mass *(1,02 g)* and gravity acceleration of the Earth *(980,665 cm/s²)* by he formula ( ).

The weight of the weight standard P_{STA} was found proceeding from the weight standard mass M_{STA} and the Earth mass gravity acceleration *(980,665cm/s²)* by the formula ( ).

$$P_{STA}=M_{STA}\ g_{EAR}=1{,}0197\cdot 980{,}665=1000{,}0\ gcm/s^2. \quad (\quad)$$

The new method of finding the body weight presupposes using the formula of gravitation for this purpose.

$$F = G\frac{M_1 g_2 + M_2 g_1}{R^2}, \qquad (\quad).$$

where F is the gravitation force between two bodies, gcm/s^2;

G is the gravitational constant, cm^2;

So, it is necessary to use a weight of $980{,}665\ gcm/s^2$ as the weight standard. The weight of the P_{STA} weight standard was found as the product of the density of the weight standard ρ_{STA} by the weight standard volume V_{STA} by the formula ( )

$$P_{STA}=\rho_{STA}V_{STA}=1{,}0\cdot 980{,}665= 980{,}665\ gcm/s^2.$$

The weight of the weight standard P_{STA} was found as the product of the weight standard mass M_{STA} by the Earth gravity acceleration g_{EAR} by the formula ( )

$$P_{STA}=M_{STA}\ g_{EAR}=1{,}0\cdot 980{,}665=980{,}665\ gcm/s^2.$$

Weight is the force of gravitation of a material body to the Earth or to another material body equal to the product of the mass of this nonmaterial body by the Earth gravity acceleration or another material body, determined directly with the help of dynamometer or a beam balance on the basis of the weight standard equal to 980,665 gcm/s^2, having the boundaries of the action, aggregate state, odour, taste, color, volume, ability gravitation, density, gravity acceleration and other properties having different meanings while the weight of the Earth and other heavenly bodies are determined indirectly and are expressed in gcm/s^2.

3.2. Measuring the mass of a body

Non-material bodies as well as material ones have a variety of properties. These properties are created by researchers artificially for solving different problems.

Absolutely black body completely absorbs all the radiation flow falling on it independently on the wave length, the direction of this falling and the state of radiation polarization [ ].

An ideal crystal has a perfect three-dimensionally periodic lattice in all its volume, having no vacancies, admixture atoms, dislocations and other defects of structure [ ].

In an ideal liquid, there is no internal friction, viscosity, head conductivity, structure and it is absolutely incompressible [ ].

An ideal gas decreases its volume to zero without passing to liquid state when temperature goes down [ ].

To have an opportunity to compare different bodies, A. Saxon once put forward a hypothesis about the existence of a body consisting of a homogeneous pastry or paste, which is characterized by the notion of mass *. By this he suggested the existence of an abstract non-material body with the only property that is mass. This non-material body has no properties that material bodies have. It has no geometric dimensions, aggregate state, odour, taste, colour, volume, density, gravity acceleration, energy, temperature and other properties.

Non-material body has no geometrical dimensions and form on the whole.

The aggregate state of this non-material body is the state of an abstract homogeneous pastry or paste. Due to its abstract and homogeneous character it has no colour, odour and taste. As this non-material body has no real properties it has no volume and density either. The proof of this is the fact that different amount of mass can be placed into the given volume of a body. In this case, all the mass will go into this volume and in the form of weight it will have different values of density.

The only property of the given non-material body is mass. The mass of the body is necessary for carrying out scientific calculations on the surface of the Earth and in the outer space. There is a great number of formulas including the mass of a body in physics, theoretical mechanics, strength of materials and others. From our point of view, the weight with the dimensions of mass is now introduced to these formulas, which causes errors in calculations. Thus, if we introduce the weights with dimensions of masses of the loads of stone, metal, wood and other materials rotating on a rope into the formula of Huygens centrifugal force we'll obtain the forces of different values which is inadmissible. Moreover, the attempts to form a new formula of centrifugal force only on the basis of the body weight with the dimension of weight will inevitably cause the emergence of troubles in getting the force dimension.

When introducing weight with weight dimension, to the formula of the second law of mechanics we'll get the squared gravity acceleration, which is also inadmissible. The attempts of creating a new formula of the second law of mechanics on the basis of body weight with the weight dimension will also lead to some problems in obtaining force dimension. Besides, the calculation of different parameters of material bodies in the outer space is quite difficult to perform without mass. Thus, for example, it is not easy to place such a body on a pan of the scales or to suspend it on the dynamometer. Moreover, it is difficult to find the force of gravitation between two bodies if only their weights are known due to problems in obtaining force dimension. Mass is a compound part of its weight. The mass of a body differs from the weight of a body first of all by the fact that it is impossible to have the force dimension of gcm/s^2. The dimension (g) characterizes only the amount of matter or substance. There is indissoluble tie between the mass of non-material body and the weight of material body. Mass separated from weight can not exist even in the form of non-material body. Mass, is an abstract notion and in connection with this it is deprived of individuality to sucha degree that it has no varieties. That's why the existence of gravitational, inertial, critical and other kinds of mass is a physical nonsense.

In order to define more precisely the methods of measuring the body mass some changes have been introduced to them and the methods of its definition have been elaborated. These changes have been checked on the example of obtaining mass of the known weight standard equal to *1000 gcm/s²*. At present, a straight circular cylinder made of platinum-iridium alloy with the mass equal to one kilogram is used as the mass standard. However, from our point of view, weight is a property of a material body, and mass of a non-material one. Thus, it is not clear for us how a material body can be used as the mass standard that is a property of a non-material bodies..

In order to remove this given disagreement the hypothesis of A. Saxon relatively to the mass of a body has been used and the body gravity acceleration has been separated from the mass of a body.

Now, measuring the body mass by the formula of the second law of mechanics ( ) proceeding from the body mass and its gravity acceleration is universally recognized.

However, the quantity that is now introduced to the formula ( ) instead of the body weight is actually the mass of an non-material body with the weight dimension. In order to avoid errors while using the formula ( ) it is necessary to put there the weight of a material body with the weight dimension.

Hence, it is possible to clear out the essence of the mass standard. The mass standard is the relation of a certain mass unit of a material body, for example, *1000 gcm/s²* to the Earth gravity acceleration by the formula ( ).

$$M_{STT} = \frac{P_{STT}}{g_{EAR}} = \frac{1000,0}{980,665} = 1,0197 \ g$$

M_{STA} is the mass of the standard, *g;*

$P_{ST\,A}$ is the weight of the body weight, gcm/s^2;

G is the body gravity acceleration, cm/s^2.

Mass is matter in an abstract form as a compound part of a material body equal to the relation of the weight of the Earth or another material body defined with the help of the standard equal to one gram, the value of which and its gravity acceleration of one gram for the Earth or other material bodies, having no border of action, aggregate state, odour, taste, color, volume, ability for gravitation, density, gravity acceleration, expressed in grams.

The standard of body mass is the relation of the given body weight standard to the given body gravity acceleration equal to $M_{STA} = 1g$ in all the parts of the Universe, expressed in grams.

The mass M_{STA} of the weight standard was found as the relation of the weight of the weight standard P_{STA} to the Earth gravity acceleration g_{EAR} by the formula ( )

$$M_{STT} = \frac{P_{STT}}{g_{EAR}} = \frac{980{,}665}{980{,}665} = 1\ g.$$

Mass is matter in an abstract form as a compound part of the weight of a material body, equal to the relation of the weight of the Earth or any other material body to the gravity acceleration of the Earth or of some other material body defined with the help of the standard equal to $1g=1/1{,}02\cdot 1000gcm/s^2/981cm/s^2$, the value of which, and the gravity acceleration of its one gram are invariable for the Earth and for other material bodies, doesn't have any boundaries of action, aggregate state, odour, taste, color, volume, ability for gravitation, density and gravity acceleration expressed in grams.

The standard of the body mass is the relation of the weight of the weight standard of the given body to the gravity acceleration of the given body equal to $M_{STA}=1\ g$ in all the parts of the Universe, expressed in grams.

The mass of the weight standard M_{STA} was found as the relation of the weight of the weight standard P_{STA} to the Earth gravity acceleration g_{EAR} by the formula ( )

$$M_{STT} = \frac{P_{STT}}{g_{S33T}} = \frac{980{,}665}{980{,}665} = 1{,}0\ \ g\ .$$

Hence, a weight of $980{,}665gcm/s^2$ contains one gram of mass.

The standard of mass is an abstract notion. One can not touch, smell, taste it or define its colour or put it on a pan of the scales. Due to the fact that the mass standard is a non-material body, it is impossible to measure the masses of other non-material bodies with the help of the beam balance or a dynamometer.

A non-material body has no ability for gravitation. In order a body of a certain mass should start gravitating to another non-material body, it is necessary to multiply the mass of the given body by the other body gravity acceleration thus turning it into the weight of a material body. Only after this, the given material body will be able to attract other material bodies and be attracted to other material bodies. But if we relate the Earth gravity acceleration ( ) to the Earth weight ( ), then having multiplied the Earth weight by the Earth gravity acceleration we'll obtain the squared acceleration which is inadmissible. The weight of the Earth ( ) does contains the Earth gravity acceleration ( ) in itself.

Gravity acceleration and first of all the gravity acceleration of one gram mass of a non-material body (mass standard) ( ) is one of the most important properties of a non-material body. The gravity acceleration of the mass standard g_{STA} was found as the relation of the Earth gravity acceleration g_{EAR} to the Earth mass M_{EAR}.

$$g_1 = \frac{g_{EAR}}{M_{EAR}} = \frac{981}{3{,}81 \cdot 10^{24}} = 2{,}57 \cdot 10^{-22}\, cm/gs^2 \qquad (\quad)$$

In this case the fact that the Earth gravity acceleration g_{EAR} relates to the Earth weight P_{EAR}, but not to the Earth mass M_{EAR} was taken into account

The introduction of changes to the known weight standard of a material body and creation of a new mass standard of a non-material body made it possible to exclude the errors (inaccuracies) in calculating other parameters of material bodies. Potential energy of the body mass standard, located at the altitude of ten centimeters above the Earth surface, for example, is equal to

$$E=mgh=1{,}0197 \cdot 980.665 \cdot 10=10000{,}0\ gcm^2/s^2,$$

where E is the potential energy of the body, gcm^2/s^2;

m is the mass of the body, g;

g is the Earth gravity acceleration, cm/s^2;

h is the altitude, cm.

Kinetic energy of the body mass standard of the object moving at the velocity of ten $10 cm/s$, is equal to

$$E = \frac{mV^2}{2} = \frac{1{,}0197 \cdot 10}{2} = 50{,}985 gcm^2/s^2.$$

If the mass standard of a non-material body is omitted, then having reached the Earth, it will gain the kinetic energy equal to the initial potential because its potential energy on the Earth surface is equal to zero while the total energy is to remain constant.

$$E = \frac{mV_0^2}{2} + 0 = 10000{,}0 \;\; gcm^2/s^2$$

It should be mentioned that the lack of universally recognized definitions of material bodies weight and the weight of non-material bodies is connected with neglecting the rules of stating the definitions that have been known for about two centuries. They consist in the fact that the notion being studied is to be reduced to a more general one and then it is necessary to disclose the essence of the notion in question. An acid (the notion that is studied), for example, is a chemical compound (the most general notion) which being dissociated in water leads to the formation of the abundance of hydrogen ions (the sense of the notion being studied). Weight has the dimension gcm/s^2 while mass has the dimension in g. But this difference is a speculative one.

In order to understand the essence of weight and mass specialists turned to the works “The Science of Logic” and to “The Theory of Perception”. The philosophers of the whole world headed by Hegel irrefutably proved that the transition from ignorance to knowledge is the way with stops, the categories of dialectics. In the work “Theory of Perception” the same idea is formulated in such a way: “From vivid contemplation to abstract thinking and from it to practice – such is the dialectical way of the Truth perception”. However, whichever words were used to characterize the way to the Truth, the essence of the difference between the weight of a material body and the mass of a non-material one is the following. If the man is at the level of “vivid contemplation” and is surrounded by real kinds of matter (Matter is the objective reality fixed by the organs of sensual perception), then he uses the notion of the weight of a material body.

Hence, the notions of weight and mass are conventionally equal. “Conventionally equal” means that the notion of the weight of a material body is a looking-glass reflection of the notion of the mass of a non-material body and vica versa. The weight of a material body and the mass of a non-material body may be compared with the “the left” and “the right” carving on tubes. "The left" carving practically doesn’t differ from “the right” one, but “the right” nut can not be wound on the “the left” carving and vice versa.

So it was obvious that the weight standard of a material body should be used for real matter while the mass standard should be used for abstract matter that is not one but two standards. Having adopted the mass standard as the weight standard, specialists tied the contradictions between these notions into one knot. We have only to appreciate the solution of the National Assembly of France not to issue the medal with the words: “For all the times, for all the peoples.”

It is well known that the dimension of Avogadro constant is a mole. However, according to its definition, mole is the quantity of any chemically pure substance in which the number of molecules or atoms is equal to Avogadro number. In other words, the dimension of Avogadro number included the notion defined through Avogadro number. Therefore, the Avogadro constant is the reduction coefficient between grams (g) and atomic units of mass ($a.u.m.$), which has no dimension.

4. Measuring the Earth, the Sun and the Moon parameters

4.1. The new theory of gravitation

The new theory of gravitation was based on the formula of gravitation the conclusions of which will be presented in some other work

$$F_{1-2} = \sqrt{G}\,\frac{\sqrt{G}\,\frac{M_1 g_2}{R_{1-2}} + \sqrt{G}\,\frac{M_2 g_1}{R_{1-2}}}{R_{1-2}} = G\,\frac{M_1 g_2 + M_2 g_1}{R_{1-2}^2}\ , \qquad (\ )$$

where F_{1-2} is the force of gravitation between the first and the second bodies, gcm/s^2;

G is the gravitation constant, cm^2;

M_1 is the mass of the first body, g;

M_2 is the mass of the second body, g;

g_1 is the gravity acceleration of the first body, cm/s^2;

g_2 is the gravity acceleration of the second body, cm/s^2;

R_{1-2} is the distance between the first and the second bodies, cm.

The force of gravitation F_{1-2} between two bodies is proportional to the sum of two forces: the force of gravitation of the first body to the second $\sqrt{G}\,\frac{M_1 g_2}{R_{1-2}}$ and the force of gravitation of the second body to the first $\sqrt{G}\,\frac{M_2 g_1}{R_{1-2}}$ and is inversely proportional to the distance between these bodies R_{1-2}.

The force of gravitation between the bodies obtained with the help of new formula differs significantly from the force in Newton's formula:

- the new formula gives dimension of force without taking into consideration the gravitation constant;

- the masses of gravitated bodies are not multiplied by each other but are multiplied by the corresponding gravity accelerations and are summed up only after this;

- the gravitation constant comprises only those dimensions that are included in the new gravitation formula.

4.2. Measuring the Earth parameters

With the purpose of practical checking the formula of gravitation (1) the parameters of different bodies in the Solar system and the Milky Way galaxy were found. Flinding the parameters of different bodies began with obtaining the force of gravitation between the Sun and the Earth. It was assumed that some parameters of the Sun, the Earth, the Moon and other bodies that are known at present need additional checking.

The system SYC and NASA data [ ] were used while carrying out the computation.

First, the parameters of the Earth were made more precise. The mass of the Earth M_{EAR}, could be found by the formula ( ). However, this would require to find the weight of the Earth beforehand on the basis of the assumed Earth density ρ_{EAR}.

The fact, that the density of the Earth P_{EAR} defined on the basis of Newton's gravitational theory ($5{,}515\ g/cm^2s^2$) means that the Earth core consists completely of heavy metals (iron, nickel, cobalt) was taken into consideration. From our point of view, its not true. The fact is the Earth rotates. The melted magma rotates together with it. That's why the lighest magma fractions (approximate density is $3{,}5\text{-}3{,}6\ g/cm^2s^2$, more seldom it is $3{,}8\ g/cm^2s^2$) are there in its centre as in a milk separator. At the same time the heavier fractions that appear on the surface of the Earth during earthquakes are pressed to the Earth crust by centrifugal forces. The experiments showed that the density of such magma fractions is $2{,}2\text{-}3{,}5\ g/cm^2s^2$, and more seldom it is $3{,}8\ g/cm^2s^2$. Taking into account the density of the Earth crust in the centre and in the periphery of the core the average density of the Earth crust $2{,}5\text{-}2{,}78\ g/cm^2s^2$ and that of water $1g/cm^2s^2$, it is possible to assume that the average Earth density ρ_{EAR} is less than maximal density of the erupted magma and is approximately $3{,}45\ g/cm^2s^2$, which is much less than it is according to the theory of I. Newton, that is $5{,}515\ g/cm^2s^2$.

This is also proved by the results of drilling of Kolsk super-deep borehole SD-3. Geologists used to think that according to Newton's theory the rock is to become denser with smaller number of fractures and pores depending on going away from the surface of the Earth and on pressure increasing. However, it was found out that starting from nine kilometers the rocks became more porous with a great number of fractures along which water solution circulated. The similar results were obtained on other super-deep bore-holes.

The weight of the Earth P_{EAR} was found as the product of the assumed density of the Earth ρ_{EAR} by the volume of the Earth V_{EAR} by the formula (4)

$$P_{EAR}=\rho_{EAR}V_{EAR}=3,45\cdot1,087\cdot10^{27}=3,75\cdot10^{27}gcm/s^2$$

The mass of the Earth M_{EAR} was found as the relation of the weight of the Earth P_{EAR} to the Earth gravity acceleration g_{EAR} by the formula (2)

$$M_{EAR}=\frac{P_{EAR}}{g_{EAR}}=\frac{3,75\cdot10^{27}}{980,665}=3,824\cdot10^{24}g.$$

The Earth gravity acceleration g_{EAR} was found as the relation of the weight of the Earth P_{EAR} to the mass of the Earth M_{EAR} by the formula (6)

$$g_{EAR}=\frac{P_{EAR}}{M_{EAR}}=\frac{3,75\cdot10^{27}}{3,824\cdot10^{24}}=980,665\ cm/s.$$

4.3. Measuring the gravitational constant by the Earth parameters

The Earth parameters having been found there appeared an opportunity to obtain the gravitational constant. The gravitational constant G was looked for by finding the force of gravitation $F_{1\text{-}2}$ between the mass of the first body M_1 and the mass of the second body M_2, located at the distance $R_{1\text{-}2}$ by the formula ( ).

In the process of searching the Earth parameters there was found the gravity acceleration of one gram of a body g_1^M.

The gravity acceleration of one gram of the body g_1^M was found by the formula

$$g_1^M = \frac{g}{M}, \qquad (\quad)$$

where g_1^M is the gravity acceleration of one gram of the body, *cm/gs*;

g is the body gravity acceleration, *cm/s*;

M is the mass of the body, *g*.

The gravity acceleration of one gram of the body g_1^M was found as the relation of the Earth gravity acceleration g_{EAR} to the Earth mass M_{EAR} by the formula ( )

$$g_1^M = \frac{g_{EAR}}{M_{EAR}} = \frac{980{,}665}{3{,}824 \cdot 10^{24}} = 2{,}5645 \cdot 10^{-22}\ cm/gs^2 .$$

The results obtained below show that the gravity acceleration of one gram of a body g_1^M is the physical constant characterizing the masses of all the bodies in the Universe (table). Using the gravity acceleration of one gram of a body g_1^M it became possible to find the gravity acceleration of any body g.

A body gravity acceleration g is the product of the body M mass by the gravity acceleration of one gram of the body g_1^M, expressed in cm/s^2.

Body gravity acceleration g was found by the formula

$$g = Mg_1^{\ M}, \qquad (\quad)$$

where g is the body gravity acceleration, cm/s^2;

M is the mass of the body, *g*;

g_1^M is the body gravity acceleration of one gram of the body, cm/gs^2.

The Earth gravity acceleration g_{EAR} was found as the product of the Earth mass M_{EAR} by the gravity acceleration of one gram of the body g_1^M by the formula ( )

$$g_{EAR}=M_{EAR}g_1^M=3{,}824\cdot10^{24}\cdot2{,}5645\cdot10^{-22}=980{,}665\ cm/s^2.$$

This resulted in the equation with two unknowns F_{1-2} and G. The gravitational constant G was looked for by replacing the gravitation force F_{1-2} between the first body with the mass M_1 and the second body with the mass M_2 situated at the distance R_{1-2} in the formula ( ) by the force of gravitation $F_{1-2}=6{,}67\cdot10^{-8}\ cm^3/gs^2$ between the first body with the mass M_1 equal to one gram situated at the distance of one centimeter, and found by H. Cavendish. However, the forces of gravitation between different bodies being found, the results were always absurd. It was necessary to get rid of one of these two unknowns. In this case it was assumed that any second body with a smaller mass M_2 moving along the orbit round the first central body with a larger mass M_1 experiences the action of the second body gravitation force to the first one F_{1-2}.

The force of gravitation of the second body to the first one was found by the formula

$$F_{1-2}=M_2g_{1-2}, \qquad (\ \ )$$

where F_{1-2} is the force of gravitation of the second body to the first one, gcm/s^2;

M_2 is the mass of the second body, g;

g_{1-2} is the gravity acceleration of the second body to the first one, cm/s^2.

It was taken into account that the force of gravitation F_{1-2} between the first body M_1 and the second body M_2, situated at the distance R_{1-2}, and found by the formula ( ), is equal to the force of gravitation F_{1-2} of the second body with the mass M_2 to the first body with the mass M_1, found by the formula ( ).

When comparing these two forces it was assumed that the Earth falls to the Sun. The process of falling may be imagined if one throws a stone in the parallel direction to the Earth. Having passed some distance from the place of throwing the stone will fall on the Earth. If its velocity is increased, the stone will pass a longer distance.At a certain value of its velocity the stone, while "falling" on the Earth, will fly it over along a circular orbit and will return to the place of throwing. Then the "falling" cycle will be repeated. Thus, a stone may become an artifical satellite of the Earth.

Equating these two forces leads to the equation

$$G\frac{M_1 g_2 + M_2 g_1}{R^2_{1-2}} = M_2 g_{1-2}. \qquad (\quad)$$

This resulted in obtaining the equation ( ) with one unknown, that is the gravitational constant G. Solving the equation ( ) with regard to G led to:

$$G = \frac{M_2 g_{1-2} R^2_{1-2}}{M_1 g_2 + M_2 g_1}. \qquad (\quad)$$

The gravitational constant G was looked for by finding the force of gravitation $F_{EAR\text{-}STA}$ between the Earth and the weight copy-standard located on the equator and expressed in SI units and situated at the distance of the Earth radius R_{EAR} by the formula ( ).

$$F_{EAR-STA} = G\frac{M_{EAR} g_{STA} + M_{STA} g_{EAR}}{R^2_{EAR}},$$

where
- $F_{EAR\text{-}STA}$ is the force of gravitation between the Earth and the weight copy-standard, gcm/s^2;
- G is the gravitational constant, cm^2;
- M_{EAR} is the mass of the Earth, g;
- M_{STA} is the mass of the weight copy-standard, g;
- g_{EAR} is the Earth gravity acceleration, cm/s^2;
- g_{STA} is the gravity acceleration of the weight copy-standard, cm/s^2;
- R_{EAR} is the Earth radius, cm.

The mass of the weight copy-standard M_{STA} was found as the relation of the weight copy-standard P_{STA} to the Earth gravity acceleration g_{EAR} by the formula ( )

$$M_{STA} = \frac{P_{STA}}{g_{EAR}} = \frac{1000,0}{980,665} = 1,0197\ g$$

The Earth gravity acceleration g_{EAR} was found as the product of the Earth mass M_{EAR} by the gravity acceleration of one gram of the body g_1^M by the formula ( )

$$g_{EAR}=M_{EAR}g_1^M=3,824\cdot10^{24}\cdot2,5645\cdot10^{-22}=980,665\ cm/s^2.$$

The gravity acceleration of the weight copy-standard g_{STA} was found as the product of the mass copy-standard M_{STA} by the gravity acceleration of one gram of the body g_1^M by the formula ( )

$$g_{STA}=M_{STA}g_1^M=1,0197\cdot2,5645\cdot10^{-22}=2,615\cdot10^{-22}\ cm/s^2.$$

This resulted in obtaining an equation with two unknowns: the force of gravitation $F_{EAR\text{-}STA}$ between the Earth and the weight copy-standard and the gravitation constant G. It was necessary to get rid of one of these two unknowns.

The force of gravitation of the weight copy-standard $F_{EAR\text{-}STA}$ to the Earth was found as the product of the mass of the copy-standard M_{STA} by the Earth gravity acceleration by the formula (3)

$$F_{EAR\text{-}STA}=M_{STA}g_{EAR}=1,0197\cdot980,665=1000,0\ gcm/s^2$$

The force of gravitation $F_{EAR\text{-}STA}$ between the Earth and the weight copy-standard found by the formula (1) was equated with the force of gravitation $F_{EAR\text{-}STA}$, of the weight copy-standard to the Earth found by the formula (3)

$$G\frac{M_{EAR}g_{STA}+M_{STA}g_{EAR}}{R_{3EAR}^2} = M_{STA}g_{EAR-STA}. \qquad (12)$$

This resulted in obtaining an equation with one unknown, that is gravitation constant G.

The gravitation constant G was found proceeding from the mass of the weight copy-standard M_{STA}, the Earth gravity acceleration g_{EAR}, the Earth radius R_{EAR}, the Earth mass M_{EAR} and the gravity acceleration of the weight copy-standard g_{STA} by the formula (11)

$$G = \frac{M_{STA} g_{EAR} R_{EAR}^2}{M_{EAR} g_{STA} + M_{STA} g_{EAR}} = \frac{1{,}0197 \cdot 980{,}665 \cdot 4{,}068 \cdot 10^{17}}{3{,}824 \cdot 10^{24} \cdot 2{,}615 \cdot 10^{-22} + 1{,}0197 \cdot 980{,}665} = 2{,}034 \cdot 10^{17} cm^2.$$

The gravitation constant G was found proceeding from the mass of the new weight copy-standard M_{STA}, the Earth gravity acceleration g_{EAR}, the Earth radius R_{EAR}, the mass of the Earth M_{EAR} and the gravity acceleration of the weight copy-standard g_{STA} by the formula (11)

$$G \frac{M_{STT} g_{EAR} R_{EAR}^2}{M_{EAR} g_{STT} + M_{STT} g_{EAR}} = \frac{1{,}0 \cdot 980{,}665 \cdot 4{,}068 \cdot 10^{17}}{3{,}824 \cdot 10^{24} \cdot 2{,}5645 \cdot 10^{-22} + 1{,}0 \cdot 980{,}665} = 2{,}034 \cdot 10^{17} cm^2$$

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After having found the gravitation constant one could see that no mountains, torsional scales or lead plates are necessary.

4.4. The peculiarities of measuring body parameters in different points of the Universe

When finding the parameters of the Sun and those of other bodies it was taken into account that some of their parameters remain unchanged irrespective of that point in the Universe, where they are located while the value of the other ones can change significantly. Thus, for example, the weight, the gravity acceleration and some other parameters of the given body will not change if it is replaced to some other point in the Universe. At the same time, the weight and the density, for example, may be found in the conditions of the gravity acceleration of this body. However, the same parameters may be found in the conditions of the gravity acceleration of the Earth, or any other body. Thus, the density of lunar soil, delivered by American astronauts to the Earth, found on the surface of the Earth in the conditions of the Earth gravity acceleration, was $3{,}34\ g/cm^2s^2$. The density of the same lunar soil found on the surface of the Moon in the conditions of the Moon gravity acceleration, as the calculations showed later on, was $0065\ g/cm^2s^2$. The above mentioned information may be illustrated by obtaining the weight and the density of the known mass copy-standard equal to $1000\ cm^3$ of distilled water on the surface of the Earth and in the outer space. The weight of this volume of water on the surface of the Earth in the conditions of the Earth gravity acceleration P_{WE} was equal to $1000\ gcm/s^2$

The mass of water M_{WAT} was found as the relation of the water weight on the Earth P_{WAT} to the Earth gravity acceleration g_{EAR} by the formula ( )

$$M_{WAT} = \frac{P_{WAT}}{g_{EAR}} = \frac{1000{,}0}{980{,}665} = 1{,}0197\ g$$

Then this volume of water was delivered to the outer space. The gravity acceleration of water in the outer space P_{WAT} was found in order to find the weight of water in the outer space g_{WAT}.

The gravity acceleration of water in the outer space g_{WAT} was found as the product of the mass of water M_{WAT} by the gravity acceleration of one gram of the body g_1^M by the formula ( )

$$g_{WAT}=M_{WAT}g_1^M=1{,}0197\cdot 2{,}5645\cdot 10^{-22}=2{,}615\cdot 10^{-22} cm/s^2.$$

The weight of water in the outer space $P_{WAT\text{-}SPA}$ was found as the product of the mass of water M_{WAT} by the gravity acceleration of water in the outer space g_{WAT} by the formula (3)

$$P_{WAT\text{-}SPA}=M_{WAT}g_{WAT}=1{,}0197\cdot 2.615\cdot 10^{-22}=2{,}667\cdot 10^{-22}gcm/s^2.$$

The density of water in the outer space $\rho_{WAT\text{-}SPA}$ was found as the relation of the weight of water in the outer space $P_{WAT\text{-}SPA}$ to the volume of water V_{WAT} by the formula (5)

$$\rho_{WAT-SPA}=\frac{P_{WAT-SPA}}{V_{WAT}}=\frac{2{,}667\cdot 10^{-22}}{1000{,}0}=2{,}667\cdot 10^{-25}\ g/cm^2s^2\ .$$

The density of water on the Earth ρ_{WAT} was found as the relation of the weight of water on the Earth P_{WAT} to the volume of water V_{WAT} by the formula (5)

$$\rho_{WAT}=\frac{P_{WAT}}{V_{WAT}}=\frac{1000{,}0}{1000{,}0}=1{,}0\,g/cm^2s^2.$$

The density of the first body was found by the formula:

$$\rho_1=\frac{\rho_{1-2}g_1}{g_2}, \qquad (\quad)$$

where ρ_1 is the density of the first body, g/cm^2s^2;

$\rho_{1\text{-}2}$ is the density of the first body taking into account the acceleration of the force , g/cm^2s^2;

g_1 is the gravity acceleration of the first body, cm/s^2;

g_2 is the gravity acceleration of the second body, cm/s^2.

The density of water on the Earth ρ_{WAT} was found proceeding from the density of water in the outer space $\rho_{WAT\text{-}SPA}$, the gravity acceleration of the Earth g_{EAR} and the gravity acceleration of water in the outer space g_{WAT} by the formula ( )

$$\rho_{WAT}=\frac{\rho_{WAT-SPA}g_{EAR}}{g_{WAT}}=\frac{2{,}667\cdot 10^{-25}\cdot 980{,}665}{2{,}615\cdot 10^{-22}}=1{,}0\ g/cm^2s^2.$$

Such calculations are necessary for the comparison of the parameters of different bodies with similar parameters of the Earth or of any other body.

4.5. Measuring the Sun parameters

The main parameters of the Earth and the gravitational constant having been found, there appeared the problem of finding two unknown parameters of the Sun. The parameters of the Sun, on of some other bodies of the Solar system, of the Milky Way galaxy and of the Universe on the whole could be found, for example, by the formulas ( ), ( ), ( ).

However, the delivery of the soil of all these bodies to the Earth without visiting them seems to be impossible. Besides, many bodies are in the state of plasma which makes it impossible even to approach them. So, taking into account that $g = Mg_1^M$ the formula ( ) is written in such a way

$$F_{1-2} = G\frac{M_1 g_2 + M_2 M_1 g_1^M}{R_{1-2}^2}. \qquad (\ )$$

This resulted in obtaining an equation with two unknowns: F_{1-2} and M_1. It was necessary to get rid of one of these unknowns. It was assumed in this case that any body with smaller mass, and moving along the orbit round the central body that has larger mass, experiences not only attraction of this body, but also centrifugal force that repulses the given body from the central one.

The centrifugal force F_{1-2} was found by the formula

$$F_{1-2} = \frac{M_2 V_2^2}{R_{1-2}}, \qquad (\ )$$

where F_{1-2} the is centrifugal force of the second body, *gcm/s*^{2};

M_2 is the mass of the second body, *g*;

V_2 is the average orbital velocity of the second body, *cm/s*;

R_{1-2} is the distance from the first body to the second one, *cm*.

That's why the force of gravitation F_{1-2} found by the formula (1) was equated with the centrifugal force F_{1-2} found by the formula (15).

$$G\frac{M_1 g_2 + M_2 M_1 g_1^M}{R_{1-2}^2} = \frac{M_2 V_2^2}{R_{1-2}}. \qquad (\ )$$

The equation ( ) having been solved with regard to M_1 it was obtained

$$M_1 = \frac{R_{1-2} V_2^2 M_2}{G(g_2 + M_2 g_1^M)}. \qquad (\quad)$$

It is possible to find the unknown parameters of a body by the known parameters of some other one with the help of the formula ( ).

First, there was an attempt to find out if the left side of the equation ( ) is equal to the right side. Taking into account that $g=M\, g_1^M$ the formula ( ) was written down as follows

$$G \frac{M_1 M_2 g_1^M + M_2 M_1 g_1^M}{R_{1-2}^2} = \frac{M_2 V_2^2}{R_{1-2}}. \qquad (\quad)$$

Taking into consideration that $2Gg_1^M = 1{,}04324 \cdot 10^{-4} = cm^3/gs^2$, as well as that it will be shown in another work that $V_T^M = M_1 \cdot 1{,}04324 \cdot 10^{-4}$ the formula ( ) was written down in the following way

$$V_T^M = R_{1-2} V_2^2, \qquad (\quad)$$

where V_T^M is the gravitation field constant of a body, cm^3/s^2.

Taking into account that $V_T^M = R_{1-2} V_2^2$ the formula (18) was written down in such a way .

$$\frac{M_2 R_{1-2} V_2^2}{R_{1-2}^2} = \frac{M_2 V_2^2}{R_{1-2}}. \qquad (\quad)$$

If we cancel R_{1-2} in the left side of the equation ( ) than we'll obtain two absolutely similar formulas. This means that the formula of gravitation ( ) including G, M_1, M_2, g_1, g_2 and R^2_{1-2} is equal to the formula of the centrifugal force ( ) that includes M_2, V_2^2 and R_{1-2}.

From our point of view, it confirms the correctess of the formula of gravitation (1). It is rather difficult to obtain such an equality when equating Newton's gravitation law with Huygen's centrifugal force. For practical checking the formula ( ) there was found the force of gravitation between the Sun and the Earth $F_{SUN\text{-}EAR}$. Taking into account that $g=Mg_1^M$, the formula ( ) was written down in the following way

$$F_{SUN-EAR} = G \frac{M_{SUN} g_{EAR} + M_{EAR} M_{SUN} g_1^M}{R_{SUN-EAR}^2},$$

where $F_{SUN\text{-}EAR}$ is the force of gravitation between the Sun and the

	Earth, gcm/s^2;
G	is the gravitation constant, cm^2;
M_{SUN}	is the mass of the Sun, g;
M_{EAR}	is the mass of the Earth, g;
g_{EAR}	is the Earth gravity acceleration, cm/s^2;
g_1^M	is the gravity acceleration of one gram of a body, cm/s^2;
$R_{SUN\text{-}EAR}$	is the distance from the Sun to the Earth, cm.

This resulted in obtaining an equation with two unknowns: the gravitation between the Sun and the Earth $F_{SUN\text{-}EAR}$ and the mass of the Sun M_{SUN}. It was necessary to get rid of one of these two unknowns. In this case it was assumed that the Earth, when moving along its orbit around the Sun, experiences not only the gravitation of the Sun but also the centrifugal force that repulses the Earth from the Sun.

The centrifugal force of the Earth $F_{SUN\text{-}EAR}$ was found proceeding from the mass of the Earth M_{EAR}, the average orbital velocity of the Earth V_{EAR} and the average distance from the Sun to the Earth $R_{SUN\text{-}EAR}$ by the formula (   )

$$F_{SUN-EAR} = \frac{M_{EAR}V_{EAR}^2}{R^2{}_{SUN-EAR}} = \frac{3{,}824\cdot 10^{24}\cdot 8{,}874\cdot 10^{12}}{1{,}496\cdot 10^{13}} = 2{,}268\cdot 10^{24}\, g/s^2 .$$

The force of gravitation between the Sun and the Earth $F_{SUN\text{-}EAR}$, found by the formula (   ) was equated with the Earth centrifugal force $F_{SUN\text{-}EAR}$, found by the formula (   ).

$$G\frac{M_{SUN}g_{EAR} + M_{EAR}M_{SUN}g_1^M}{R_{SUN-EAR}^2} = \frac{M_{EAR}V_{EAR}^2}{R_{SUN-EAR}} .$$

The mass of the Sun M_{SUN} was found proceeding from the average distance from the Sun to the Earth $R_{SUN\text{-}EAR}$, the average orbital velocity of the Earth V_{EAR}, the mass of the Earth M_{EAR}, gravitational constant G, the Earth gravity acceleration g_{EAR} and the gravity acceleration of $1\ g$ of the body g_1^M by the formula (   )

$$M_{SUN} = \frac{R_{SUN-EAR}V_{EAR}^2 M_{EAR}}{G(g_{EAR} + M_{EAR}g_1^M)} = \frac{1{,}496\cdot 10^{13}\cdot 8{,}874\cdot 10^{12}\cdot 3{,}824\cdot 10^{24}}{2{,}034\cdot 10^{17}(980{,}665 + 3{,}824\cdot 10^{24}\cdot 2{,}5645\cdot 10^{-22})} = 1{,}273\cdot 10^{30}\, g$$

.

The mass of the Sun M_{SUN} was also found with the help of the formula ( ). The force of the gravitation of the Earth to the Sun $F_{SUN\text{-}EAR}$ was found as the product of the Earth mass M_{EAR} by the Earth acceleration in its motion around the Sun $g_{SUN\text{-}EAR}$ by the formula ( )

$$F_{SUN\text{-}EAR} = M_{EAR}\, g_{SUN\text{-}EAR} = 3{,}824 \cdot 10^{24} \cdot 0{,}593 = 2{,}268 \cdot 10^{24} gcm/s^2.$$

The force of gravitation between the Sun and the Earth $F_{SUN\text{-}EAR}$, found by the formula ( ) was equated with the force of gravitation of the Earth to the Sun $F_{SUN\text{-}EAR}$, by the formula ( ).

$$G\frac{M_{SUN} g_{EAR} + M_{EAR} M_{SUN} g_1^M}{R^2_{SUN-EAR}} = M_{EAR}\, g_{SUN-EAR}\,. \qquad (\ \ )$$

Solving the equation (21) with regard to the mass of the Sun M_{SUN} led to

$$M_{SUN} = \frac{R^2_{SUN-EAR} M_{EAR}\, g_{SUN-EAR}}{G(g_{EAR} + M_{EAR}\, g_1^M)}\,. \qquad (\ \ )$$

The mass of the Sun M_{SUN} was found proceeding from the average distance from the Sun to the Earth $R_{SUN\text{-}EAR}$, the mass of the Earth M_{EAR}, the Earth acceleration in its motion around the Sun $g_{SUN\text{-}EAR}$, gravitational constant G, the Earth gravity acceleration g_{EAR}, and the gravity acceleration of $1\ g$ of the body g_1^M by the formula ( )

$$M_{SUN} = \frac{R^2_{SUN-EAR} M_{EAR}\, g_{SUN-EAR}}{G(g_{EAR} + M_{EAR}\, g_1^M)} = \frac{2{,}238 \cdot 10^{26} \cdot 3{,}824 \cdot 10^{24} \cdot 0{,}593}{2{,}034 \cdot 10^{17}(980{,}665 + 3{,}824 \cdot 10^{24} \cdot 2{,}5645 \cdot 10^{-22})} = 1{,}272 \cdot 10^{30}\, g.$$

After obtaining the mass of the Sun M_{SUN} some other Sun parameters were found.

The Sun gravity acceleration g_{SUN} was found as the product of the Sun mass M_{SUN} by the gravity acceleration of $1g$ of the body g_1^M by the formula ( )

$$g_{SUN} = M_{SUN}\, g_1^M = 1{,}273 \cdot 10^{30} \cdot 2{,}5645 \cdot 10^{-22} = 3{,}265 \cdot 10^8 cm/s^2.$$

The force of gravitation between the Sun and the Earth $F_{SUN\text{-}EAR}$ was found by the formula ( )

$$F_{SUN-EAR} = G\frac{M_{SUN} g_{EAR} + M_{EAR} g_{SUN}}{R^2_{SUN-EAR}} =$$

$$= 2{,}034 \cdot 10^{17} \frac{1{,}273 \cdot 10^{30} \cdot 980{,}665 + 3{,}824 \cdot 10^{24} \cdot 3{,}265 \cdot 10^8}{2{,}238 \cdot 10^{26}} = 2{,}269 \cdot 10^{24}\ gcm/s^2\,.$$

The force of gravitation between the Sun and the Earth $F_{SUN-EAR}$ ( ) turned out to be equal to the Earth centrifugal force $F_{SUN-EAR}$ ( ) and the force of gravitation of the Earth to the Sun $F_{SUN-EAR}$ ( ), which shows that the formulas (1), ( ), ( ) and ( ) are true.

The weight of the Sun P_{SUN} was found as the product of the Sun mass M_{SUN} by the Sun gravity acceleration g_{SUN} by the formula ( )

$$P_{SUN}=M_{SUN}g_{SUN}=1,273\cdot 10^{30}\cdot 3,265\cdot 10^{8}=4,156\cdot 10^{38} gcm/s^{2}.$$

The weight of the Sun taking into account the Earth gravity acceleration $P_{SUN-EAR}$ was found as the product of the Sun mass M_{SUN} by the Earth gravity acceleration g_{EAR} by the formula ( )

$$P_{SUN-EAR}=M_{SUN}g_{EAR}= 1,273\cdot 10^{30}\cdot 980,665=1,248\cdot 10^{33} gcm/s^{2}$$

The Sun density ρ_{SUN} was found as the relation of the Sun weight P_{SUN} to the volume of the Sun V_{SUN} by the formula ( )

$$\rho_{SUN} = \frac{P_{SUN}}{V_{SUN}} = \frac{4{,}156\cdot 10^{38}}{1{,}413\cdot 10^{33}} = 2{,}941\cdot 10^{5}\ gr/cm^{2}s^{2}\ .$$

The density of the Sun taking into account the Earth gravity acceleration $\rho_{CSUN-EAR}$ was found as the relation of the Sun weight taking into consideration the Earth gravity acceleration $P_{SUN-EAR}$ to the Sun volume V_{CSUN} by the formula ( )

$$\rho_{SUN-EAR} = \frac{P_{SUN-EAR}}{V_{SUN}} = \frac{1{,}248\cdot 10^{33}}{1{,}413\cdot 10^{33}} = 0{,}883\ g/cm^{2}s^{2}.$$

4.6. Measuring the Moon parameters

Finding parameters of other bodies of the Solar system and of the Milky Way galaxy was continued after obtaining the parameters of the Earth and those of the Sun. The correctness of the equality (   ) was checked up on the example of the calculations of the Moon parameters on the basis of experimental data. The Moon parameters were found in the same way as the Earth parameters on the basis of the lunar soil density delivered to the Earth by American astronauts.

The weight of the Moon, taking into account the Earth gravity acceleration $P_{MOO\text{-}EAR}$,was found as the product of the Moon density taking into consideration the Earth gravity acceleration $\rho_{MOO\text{-}EAR}$ by the Moon volume V_{MOO} by the formula (   )

$$P_{MOO\text{-}EAR}= P\rho_{MOO\text{-}EAR}V_{MOO}=3,34\cdot 2,197\cdot 10^{25}=7,338\cdot 10^{25} gcm/s^2$$

The Moon mass M_{MOO} was found as the relation of the Moon weight taking into account the forces of the Earth weight $P_{MOO\text{-}EAR}$ to the Earth gravity acceleration g_{EAR} by the formula (   )

$$M_{MOO} = \frac{P_{MOO-EAR}}{g_{EAR}} = \frac{7,338\cdot 10^{25}}{980,665} = 7,483\cdot 10^{22} g\,.$$

In this case, it was taken into account that the Moon mass M_{MOO}, found proceeding from the lunar soil density and taking into consideration the Earth gravity acceleration $\rho_{MOO\text{-}EAR}$ is equal to the Moon mass found proceeding from the lunar soil density taking into consideration the Moon gravity acceleration ρ_{MOO}.

The Moon gravity acceleration g_{MOO} was found as the product of the Moon mass M_{MOO} by the gravity acceleration of $1\ g$ of the body g_1^M by the formual (   )

$$g_{MOO} = M_{MOO} g_1^M = 7,483\cdot 10^{22}\cdot 2,5645\cdot 10^{-22} = 19,19\ cm/s^2$$

$$g_{MOO}= M_{MOO}\, g_1^M=7,483\cdot 10^{22}\cdot 2,5645\cdot 10^{-22}=19,19 cm/s^2$$

The weight of the Moon P_{MOO} was found as the product of the Moon mass M_{MOO} by the Moon gravity acceleration g_{MOO} by the formula (   )

$$P_{MOO} = M_{MOO} g_{MOO} = 7{,}483 \cdot 10^{22} \cdot 19{,}19 = 1{,}436 \cdot 10^{24} \; gcm/s^2 .$$

$P_{MOO}= M_{MOO}\, g_{MOO}=7{,}483\cdot10^{22}\cdot19{,}19=1{,}436\cdot10^{24}$ cm/s^2

The Moon density ρ_{MOO} was found as the relation of the Moon weight P_{MOO} to the Moon volume V_{MOO} by the formula ( )

$$\rho_{MOO} = \frac{P_{MOO}}{V_{MOO}} = \frac{1{,}436 \cdot 10^{24}}{2{,}197 \cdot 10^{25}} = 0{,}065 \;\; g/cm^2 s^2 .$$

The Moon density ρ_{MOO} was found proceeding from the Moon density taking into account the Earth gravity acceleration $\rho_{MOO\text{-}EAR}$, the Moon gravity acceleration g_{MOO} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{MOO} = \frac{\rho_{MOO-EAR} \cdot g_{MOO}}{g_{EAR}} = \frac{3{,}34 \cdot 19{,}19}{980{,}665} = 0{,}065 \;\; g/cm^2 s^2 .$$

The force of gravitation between the Earth and the Moon $F_{EAR\text{-}MOO}$ was found by the formula ( )

$$F_{EAR-MOO} = G \frac{M_{EAR} g_{MOO} + M_{MOO} g_{EAR}}{R^2_{EAR-MOO}} = 2{,}034 \cdot 10^{17} \frac{3{,}824 \cdot 10^{24} \cdot 19{,}19 + 7{,}483 \cdot 10^{22} \cdot 980{,}665}{1{,}4776 \cdot 10^{21}} =$$
$$= 2{,}02 \cdot 10^{22} \; gcm/s^2 .$$

The force of gravitation of the Moon to the Earth $F_{EAR\text{-}MOO}$ was found as the product of the Moon mass M_{MOO} by the Moon gravity acceleration to the Earth $g_{EAR\text{-}MOO}$ by the formula ( )

$F_{EAR\text{-}MOO}= M_{MOO}\, g_{EAR\text{-}MOO}= 7{,}483\cdot10^{22}\cdot0{,}272=2{,}035\cdot10^{22} cm/s^2$.

The force of gravitatin between the Earth and the Moon $F_{EAR\text{-}MOO}$ found by the formula ( ) appeared to be equal to the force of attraction of the Moon to the Earth $F_{EAR\text{-}MOO}$, found by the formual ( ).

The Moon centrifugal force $F_{EAR\text{-}MOO}$ was found proceeding from the Moon mass M_{MOO}, the average Moon velocity V_{MOO} and the average distance from the Earth to the Moon $R_{EAR\text{-}MOO}$ by the formula (15)

$$F_{EAR-MOO} = \frac{M_{MOO} V^2_{MOO}}{R_{EAR-MOO}} = \frac{7{,}483 \cdot 10^{22} \cdot 1{,}047 \cdot 10^{10}}{3{,}844 \cdot 10^{10}} = 2{,}038 \cdot 10^{22} g\, cm/s^2 .$$

The force of gravitation between the Earth and the Moon $F_{EAR\text{-}MOO}$, turned out to be equal to the Moon centrifugal force $F_{EAR\text{-}MOO}$, which confirms the correctness of the formulas (1), (2), (3) and (4).

The main parameters of the Earth of the Sun and of the Moon that were found, show that the experiments confirming the equivalence of the so-called gravitational and inertial masses carried out by R. von Atwash, R. Dickke and V.B. Braginskiy using different substances of which torsion pendulum consists of, have no sense.

5. Measuring the parameters of the bodies round which other bodies rotate

5.1. Measuring the main physical and astrophysical constants

In the process of studies it was established that the mass, the gravity acceleration, the distance, the velocity, the force of gravitation and other parameters of the bodies are closely connected with the major physical and astronomical constants.

The gravity acceleration of *1 g* of the body, the gravitation constant, the body gravitational field constant and other main physical and astrophysical constants were found with the help of the parameters of different bodies and vice versa.

The gravity acceleration of *1 g* of the body g_1^M is the gravity acceleration of $2{,}5645 \cdot 10^{-22} cm/s^2$ of the body with the mass of *1 g*, equal to $2{,}5645 \cdot 10^{-22} cm/s^2$, expressed in cm/s^2.

The gravity acceleration of *1 g* of the body g_1^M is the relation of gravity acceleration of the body *g* to the mass of the body *M*, equal to $2{,}5645 \cdot 10^{-22} cm/gs^2$, expressed in cm/gs^2.

The gavity acceleration of *1g* of the body g_1^M was found by the formula:

$$g_1^M = \frac{g}{M}, \qquad (\quad)$$

where g_1^M is the gravity acceleration of *1g* of the body, cm/gs^2;

g is the body gravity acceleration, *cm/s*;

M is the mass of the body, *g*.

The gravity acceleration of *1 g* of the body g_1^M is the relation of the gravitation field constant of *1 g* of the body V_1^M to the doubled gravitational constant *G*, equal to $2{,}5645 \cdot 10^{-22} cm/gs^2$, expressed in cm/gs^2.

The gravity acceleration of *1g* of the body g_1^M was found by the formula:

$$g_1^M = \frac{V_1^M}{2G}, \qquad (\quad)$$

where g_1^M is the gravity acceleration of *1 g* of the body, cm/gs^2;

V_1^M is the gravitational field constant of $1g$ of the body, cm^3/gs^2;

G is the gravitational constant, cm^2.

The body gravitational field constant V_T^M is the product of the average distance R_{1-2} from the first body to the second one by the squared average orbital velocity of the second body V_2^2, expressed in cm^3/s^2.

The body gravitational field constant V_T^M is the characteristics of the gravitational field of the first body with the mass M_1 round which at the average distance from $R_{1-2}=1\ cm$ to $R_{1-2}= V_T^M cm$, where $V_2^2=1\ cm^2/s^2$ there rotates the second body with M_2 at the average orbital velocity from $V_2^2= V_T^M cm^2/s^2$, where $R_{1-2}=1\ cm$ to $V_2^2 =1\ cm^2/s^2$ expressed in cm^3/s^2.

The body gravitational field constant V_T^M was found by the formula

$$V_T^M= R_{1-2}\, V_2^2, \qquad (\quad)$$

where V_T^M is the body gravitational field constant, cm^3/s^2;

R_{1-2} is the average distance from the first body to the second one, cm;

V_2 is the average orbital velocity of the second body, cm/s.

The value V_B^M is usually connected with the Virial theorem characterizing the relationship between the averge meaning of the summed kinetic energy of the system of the bodies moving in a limited area and by the forces acting in it and determined by R. Clausius in 1870 [ ].

The body gravitational field constant of $1\ g$ of the body V_1^M is the characteristics of the first body gravitational field with the mass $M_1 =1\ g$ round which at the average distance from $R_{1-2}=1{,}0432386\cdot10^{-4}cm$ to $R_{1-2}=1\ cm$ there rotates the second body with the mass M_2 at the average orbital velocity from $V_2^2=1\ cm^2/s^2$ to $V_2^2 =1{,}0432386\cdot10^{-4}\ cm^2/s^2$ equal to $1{,}0432386\cdot10^{-4}\ cm^2/gs^2$ exprassed in cm^2/gs^2.

The gravitational field constant of $1g$ of the body was found by the formula

$$V_1^M=2Gg_1^M, \qquad (\quad)$$

where V_1^M is the gravitational field constant of $1g$ of the body, cm^3/gs^2;

G is the gravitational constant, cm^2

g_1^M is the gravity acceleration of $1\ g$ of the body, cm/gs^2;

The body gravitational field constant V_T^M is the product of the gravitational field constant of $1\ g$ of the body V_1^M by the mass of the first body M_1 expressed in cm^3/gs^2

The gravitational field constant of the body V_T^M was found by the formula

$$V_B^M = V_1^M M_1, \qquad (\quad)$$

where V_B^M is the body gravitational field constant, cm^3/s^2;

V_1^M is the gravitational field constant of $1g$ of the body, cm^3/gs^2;

M_1 is the mass of the first body, g.

The body gravitational field constant V_B^M is the relation of the first body M_1 to the gravitational constant of $1\ cm^3/s^2$ of the body V_1^V, expressed in cm^3/s^2.

The body gravitational field constant V_B^M was found by the formula

$$V_B^M = \frac{M_1}{V_1^V}, \qquad (\quad)$$

where V_B^M is the body gravitational field constant, cm^3/s^2;

M_1 is the mass of the first body, g.

V_1^V is the gravitational field constant of $1\ cm^3/s^2$ of the body, gs^2/cm^3;

The gravitational constant G is the area of radial section of the gravitational field of the body with the mass $M=1,9497 \cdot 10^{21} g$ and with the gravity acceleration $g=0,5\ cm/s^2$, equal to $2,034 \cdot 10^{17} cm^2$, expressed in cm^2.

The gravitational constant G is the relation of the gravitational field constant of $1\ g$ of the body V_1^M to the doubled gravity acceleration of $1\ g$ of the body g_1^M, equal to $2,034 \cdot 10^{17} cm^2$, expressed in cm^2.

The gravitational constant G was found by the formula

$$G = \frac{V_1^M}{2g_1^M}, \qquad (\quad)$$

where G is the gravitational constant, cm^2

V_1^M is the gravitational field constant of $1g$ of the body, cm^3/gs^2;

g_1^M is the constant of $1\ cm/s^2$ of the body gravity acceleration , gs^2/cm;

The gravitational constant G was found by the formula

$$G = \frac{V_1^M g_T^M}{2}, \qquad (\quad)$$

where G is the gravitational constant, cm^2

V_1^M is the gravitational field constant of $1g$ of the body, cm^3/gs^2;

g_1^M is the constant of $1\ cm/s^2$ of the body gravity acceleration , gs^2/cm;

The gravitational constant G is the value that is opposite to the product of the doubled constant of $1\ cm^3/s^2$ of the body gravitational field by the gravity acceleration of $1g$ of the body equal to $2{,}034 \cdot 10^{17} cm^2$, expressed in cm^2.

The gravitational constant G was found by the formula

$$G = \frac{1}{2V_1^V g_1^M}, \qquad (\quad)$$

where G is the gravitational constant, cm^2

V_1^V is the constant of $1\ cm^3/s^2$ of the body gravitational field, gs^2/cm^3;

g_1^M is the gravity acceleration of $1\ g$ of the body, cm/gs^2;

The gravitational field constant of $1\ cm^3/s^2$ of the body V_1^V is the relation of the first body mass M_1 to the gravitational field constant of the body V_B^M equal to $9585{,}5349\ gs^2/cm^3$, expressed in gs^2/cm^3.

The gravitational field constant of $1\ cm^3/s^2$ of the body V_1^V was found by the formula

$$V_1^V = \frac{M_1}{V_T^M}, \qquad (\quad)$$

where V_1^V is the gravitational field constant of $1\ cm^3/s^2$ of the body, gs^2/cm^3;

M_1 is the mass of the first body, g.

V_B^M is the body gravitational field constant, cm^3/s^2;

The gravitational field constant of $1cm^3/s^2$ of the body V_1^V is the mass of the body of $9585{,}5349\ g$ generating the gravitational field with the gravitational field constant of the body $V_B^M = 1\ cm^3/s^2$, equal to $9585{,}5349\ gs^2/cm^3$, expressed in gs^2/cm^3 .

The gravitational field constant of $1cm^3/s^2$ of the body V_1^V was found by the formula

$$V_1^V = \frac{1}{V_1^M}, \qquad (\quad)$$

where V_1^V is the gravitational field constant of $1\ cm^3/s^2$ of the body, gs^2/cm^3;

V_1^M is the gravitational field constant of $1g$ of the body, cm^3/gs^2;

The constant of $1\ cm/s^2$ of the gravity acceleration of the body g_B^M is the mass of the first body of $3{,}8994 \cdot 10^{21} g$, having gravity acceleration of $1cm/s^2$, equal to $3{,}8994 \cdot 10^{21} gs^2/cm$, expressed in gs^2/cm .

The constant of $1\ cm/s^2$ of the gravity acceleration of the body g_B^M was found by the formula

$$g_B^M = \frac{M_1}{g_1}, \qquad (\quad)$$

where g_B^M is the constant of $1\ cm/s^2$ of the body gravity acceleration of the body, gs^2/cm ;

M_1 is the mass of the first body, g ;

g_1 is the first body gravity acceleration, $1\ cm/s^2$.

The gravitational radius of the body R_{BR} is the relation of the gravity aceeleration constant of the body V_B^M to the squared light velocity c^2, expressed in cm.

The gravitational radius of the body R_{BR} was found by the formula

$$R_{BR} = \frac{V_B^M}{c^2}, \qquad (\quad)$$

where R_{BR} is the gravitational radius of the body, cm ;

V_B^M is the gravitational field constant of the body, cm^3/s^2;

c is the light velocity, cm/s.

5.2. The peculiarities of measuring the parameters of the bodies round which other bodies rotate

After finding the parameters of the Earth of the Sun and of the Moon there was made an attempt of making up the equation (   ) relatively to Mars, Jupiter, Saturn and other bodies. However, the identities relatively to the mass of each of these bodies were obtained at once. Each identity, as it is known, has no solutions. Hence, the practical usage of the equation (   ) in the given form is limited to the Earth, to the Sun and to the Moon. To find the parameters of the other bodies in the Solar system andr in the Milky Way galaxy it was necessary to remove the identity that appeared.

For this purpose the force of gravitation F_{1-2} , found by the formula (   ) was equated with the centrifugal force F_{1-2} , found by the formula (   )

$$G\frac{M_1 g_2 + M_2 g_1}{R_{1-2}^2} = \frac{M_2 V_2^2}{R_{1-2}}. \qquad (\quad)$$

Taking into account that $g = Mg_1^M$ the equation (   ) was written down in the following way

$$G\frac{M_1 M_2 g_1^M + M_2 M_1 g_1^M}{R_{1-2}^2} = \frac{M_2 V_2^2}{R_{1-2}}. \qquad (\quad)$$

The left and the right sides of the equality (   ) were presented as the product of two factors: $\frac{M_2}{R_{1-2}}$ and other elements of this equality

$$\frac{M_2}{R_{1-2}}\left(\frac{2GM_1 g_1^M}{R_{1-2}}\right) = \frac{M_2}{R_{1-2}} V_2^2 . \qquad (\quad)$$

Due to the fact that the relations $\frac{M_2}{R_{1-2}}$ in the left and in the right sides of the equality (   ) are the same, the rest of the elements of the formulas in both sides from the equality are also to be equal.

Taking into account that $M_1 g_2 = M_2 g_1$ the left and the right sides of the equality (   ) was written down as a sum of two addends

$$\frac{GM_1 g_2}{R_{1-2}^2} + \frac{GM_2 g_1}{R_{1-2}^2} = \frac{M_2 V_2^2}{2R_{1-2}} + \frac{M_2 V_2^2}{2R_{1-2}} . \qquad (\quad)$$

Since the addends in the right side of the equality (   ) are equal, the addends in the left side of the equality (   ) are also equal.

The first addend in the left side of the equality (   ) was equated with one of the addends in the right side of the equality (   )

$$\frac{GM_1 g_2}{R_{1-2}^2} = \frac{M_2 V_2^2}{2R_{1-2}}. \qquad (\quad)$$

The second addend in the left side of the equality (   ) was equated with one of the addends in the right side of the equality (   )

$$\frac{GM_2 g_1}{R_{1-2}^2} = \frac{M_2 V_2^2}{2R_{1-2}}. \qquad (\quad)$$

Taking into account that $M_1 g_2 = M_2 g_1$ the formula (   ) was written down as follows

$$F_{1-2} = G\frac{M_1 g_2}{R_{1-2}^2} + G\frac{M_2 g_1}{R_{1-2}^2}. \qquad (\quad)$$

Taking into account that $g = Mg_1^M$ the formula (   ) was written down in the following way

$$M_1 M_2 g_1^M = M_2 M_1 g_1^M. \qquad (\quad)$$

The same parameters appeared in the left and in the right sides of the equality (   ).

The equalities (   ), (   ), (   ) and (   ) made it possible to obtain new formulas for finding the main parameters of different bodies. So, the equalities (   ), (   ), (   ), and (   ) were solved relatively to all the included parameters.

5.3. Measuring the gravitational field constant

Measuring the parameters of different bodies as well as the main physical and astrophysical constants started with measuring the gravitational field constant.

The gravitational field is a special form of matter presented as the space formed by the first body with the mass M_1 capable of rotating the second body with smaller mass M_2 around itself this second body generating gravitational waves characterized by the constant of the body gravitational field V_T^M.

Having reduced the relations $\frac{M_2}{R_{1-2}}$ in the left and in the right sides of the equality ( ), we obtained the gravitation formula

$$V_2^2 = \frac{2GM_1 g_1^M}{R_{1-2}}. \qquad (\quad)$$

Solving the formula ( ) relatively to $R_{1-2}V_2^2$ helped to obtain

$$R_{1-2}V_2^2 = 2GM_1 g_1^M. \qquad (\quad)$$

It follows from the equation ( ) that its left and right sides are constant values.

In order to perform some practical checking of the formula ( ) there were found the gravitational fields constants of different bodies in the Solar system and in the Milky Way galaxy.

The constant of the gravitational field of *1 g* of the body V_1^M is the characteristics of the gravitational field of *1* gram of the body having larger mass $M_1 = 1\ g$ around which there rotates the second body with smaller mass M_2 at the average distance $R_{1-2} = 1$ and at the average orbital velocity from V_2 to V_2 equal to $1{,}04324 \cdot 10^{-4}\ cm^3/s^2$ expressed in cm^3/s^2.

The constant of the gravitational field of *1 g* of the body V_1^M was found as the product of the average distance from the first body with larger mass M_1 to the second body with smaller mass M_2 R_{1-2} by the squared average orbital velocity of the second body V_2^2 by the formula ( )

$$V_1^M = R_{1-2} \cdot V_2^2 = 1{,}04324 \cdot 10^{-4} \cdot 1^2 = 1{,}04324^{-4}\ cm^3/s^2.$$

The constant of the gravitational field of *1 g* of the body V_1^M was found as the product of the average distance from the first body with larger mass $M_1=1g$ to the second body with smaller mass M_2 $R_{1\text{-}2}$ by the squared average orbital velocity of the second body V_2^2 by the formula (   )

$$V_1^M = R_{1-2} \cdot V_2^2 = 1 \cdot (1{,}0213912 \cdot 10^{-2})^2 = 1{,}04324 \cdot 10^{-4}\ cm^3/s^2.$$

The constant of the gravitational field of *1 g* of the body V_1^M was found as the product of the average distance from the first body with larger mass $M_1=1g$ to the second body with smaller mass M_2 $R_{1\text{-}2}$ by the squared average orbital velocity of the second body V_2^2 by the formula (   )

$$V_1^M = R_{1-2} \cdot V_2^2 = 1 \cdot (1{,}0213912 \cdot 10^{-2})^2 = 1{,}04324 \cdot 10^{-4}\ cm^3/s^2.$$

The gravitational field constant of the Sun V_{SUN}^M is the characteristics of the Sun gravitational field with larger mass $M_{SUN}=1{,}273 \cdot 10^{30}\ g$ around which the body with smaller mass M_2 rotates at the average distance from $R_{SUN\text{-}SUN1}=1\ cm$ to $R_{SUN\text{-}SUNV}=1{,}33 \cdot 10^{26}\ cm$ and at the average orbital velocity from $V_{SUNV}^2 = 1{,}33 \cdot 10^{26}\ cm^2/s^2$ too $V_2 = 1\ cm^2/s^2$ equal to $1{,}33 \cdot 10^{26}\ cm^3/s^2$.

The Sun gravitational field constant V_{SUN}^M was found as the product of the average distance from the Sun to Mercury $R_{SUN\text{-}MER}$ by the squared average orbital velocity of Mercury V_{MER}^2 by the formula (   )

$$V_{SUN}^M = R_{SUN-MER} V_{MER}^2 = 5{,}79 \cdot 10^{12} \cdot 2{,}29 \cdot 10^{13} = 1{,}326 \cdot 10^{26}\ cm^3/s^2\ .$$

The Sun gravitational field constant V_{SUN}^M was found as the product of the average distance from the Sun to Venus $R_{SUN\text{-}VEN}$ by the squared average orbital velocity of Venus V_{VEN}^2 by the formula (   )

$$V_{SUN}^M = R_{SUN-VEN} V_{VEN}^2 = 1{,}082 \cdot 10^{13} \cdot 1{,}226 \cdot 10^{13} = 1{,}327 \cdot 10^{26}\ cm^3/s^2\ .$$

The Sun gravitational field constant V_{SUN}^M was found as the product of the average distance from the Sun to the Earth $R_{SUN\text{-}EAR}$ by the squared average orbital velocity of the Earth V_{EAR}^2 by the formula (   )

$$V_{SUN}^M = R_{SUN-EAR} V_{EAR}^2 = 1{,}496 \cdot 10^{13} \cdot 8{,}874 \cdot 10^{12} = 1{,}328 \cdot 10^{26}\ cm^3/s^2\ .$$

The Sun gravitational field constant V_{SUN}^M was found as the product of the average distance from the Sun to Mercury $R_{SUN\text{-}MER}$ by the squared average orbital velocity of Mercury V_{MER}^2 by the formula (   )

$$V_{SUN}^{M} = R_{SUN-MER}V_{MER}^{2} = 5{,}79 \cdot 10^{12} \cdot 2{,}29 \cdot 10^{13} = 1{,}326 \cdot 10^{26}\, cm^{3}/s^{2}.$$

The Sun gravitational field constant V_{SUN}^{M} was found as the product of the average distance from the Sun to Venus $R_{SUN-VEN}$ by the squared average orbital velocity of Venus V_{VEN}^{2} by the formula (   )

$$V_{SUN}^{M} = R_{SUN-VEN}V_{VEN}^{2} = 1{,}082 \cdot 10^{13} \cdot 1{,}226 \cdot 10^{13} = 1{,}327 \cdot 10^{26}\, cm^{3}/s^{2}.$$

The Sun gravitational field constant V_{SUN}^{M} was found as the product of the average distance from the Sun to the Earth $R_{SUN-EAR}$ by the squared average orbital velocity of Earth V_{EAR}^{2} by the formula (   )

$$V_{SUN}^{M} = R_{SUN-EAR}V_{EAR}^{2} = 1{,}496 \cdot 10^{13} \cdot 8{,}874 \cdot 10^{12} = 1{,}328 \cdot 10^{26}\, cm^{3}/s^{2}.$$

The Sun gravitational field constant V_{SUN}^{M} was found as the product of the average distance from the Sun to Mercury $R_{SUN-MER}$ by the squared average orbital velocity of Mercury V_{MER}^{2} by the formula (   )

$$V_{SUN}^{M} = R_{SUN-MER}V_{MER}^{2} = 5{,}79 \cdot 10^{12} \cdot 2{,}29 \cdot 10^{13} = 1{,}326 \cdot 10^{26}\, cm^{3}/s^{2}.$$

The Sun gravitational field constant V_{SUN}^{M} was found as the product of the average distance from the Sun to Encke comet $R_{SUN-ENK}$ by the squared average orbital velocity of Encke comet V_{ENK}^{2} by the formula (   )

$$V_{SUN}^{M} = R_{SUN-ENK}V_{ENK}^{2} = 3{,}306 \cdot 10^{13} \cdot 3{,}976 \cdot 10^{12} = 1{,}314 \cdot 10^{26}\, cm^{3}/s^{2}.$$

The Sun gravitational field constant V_{SUN}^{M} was found as the product of the average distance from the Sun to Hyakutake $R_{-SUN-HUK}$ by the squared average orbital velocity of Hyakutake comet V_{HUK}^{2} by the formula (   )

$$V_{SUN}^{M} = R_{SUN-HUK}V_{HUK}^{2} = 1{,}743 \cdot 10^{16} \cdot 7{,}505 \cdot 10^{9} = 1{,}308 \cdot 10^{26}\, cm^{3}/s^{2}.$$

The gravitational field constant of the Sun V_{SUN}^{M} was found by the parameters of other comets (table №   ) in the same way.

The Earth gravitational field constant V_{EAR}^{M} is the characteristics of the Earth gravitational field with larger mass $M_{EAR}=3{,}824 \cdot 10^{24}\ g$ around which, at the average distance from $R_{EAR-1}=1\ cm$ to $R_{3EAR-V}=4{,}025 \cdot 10^{20}\ cm$, there rotates the second body with smaller mass M_2 at the average orbital velocity from $V_2=2{,}006 \cdot 10^{10} cm/s$ to $V_2=1\ cm/s$, that is equal to $4{,}025 \cdot 10^{20} cm^3/s^2$, expressed in cm^3/s^2.

The Earth gravitational field constant V_{EAR}^{M} was found as the product of the average distance from the Earth to Moon $R_{EAR-MOON}$ by the squared average orbital velocity of Moon V_{MOON}^{2} by the formula (   )

$$V_{EAR}^{M} = R_{EAR-MOON} V_{EAR}^{2} = 3{,}844 \cdot 10^{10} \cdot 1{,}047 \cdot 10^{10} = 4{,}025 \cdot 10^{20}\ cm^3/s^2 .$$

The gravitational field of Mars V_{MAR}^{M} is the characteristics of Mars gravitational field with larger mass $M_{MAR}=4{,}108 \cdot 10^{23}\ g$ around which, at the average distance from $R_{MAR-1}=1\ cm$ to $R_{MAP-V}=4{,}286 \cdot 10^{19}\ cm$ there rotates the second body with smaller mass M_2 at the average orbital velocity from $V_2=6{,}547 \cdot 10^{19} cm/s$ to $V_2=1\ cm/s$, equal to $4{,}286 \cdot 10^{19} cm^3/s^2$, expressed in cm^3/s^2.

The gravitational field constant of Mars V_{MAR}^{M} was found as the product of the average distance from Mars to Phobos $R_{MAR-PHO}$ by the squared average orbital velocity of Phobos V_{PHO}^{2} by the formula (   )

$$V_{MAR}^{M} = R_{MAR-PHO} V_{PHO}^{2} = 9{,}378 \cdot 10^{8} \cdot 4{,}575 \cdot 10^{10} = 4{,}29 \cdot 10^{19}\ cm^3/s^2 .$$

The gravitational field constant of Mars V_{MAR}^{M} was found as the product of the average distance from Mars to Deymos $R_{MAR-DEI}$ by the squared average orbital velocity of Deymos V_{DEY}^{2} by the formula (   )

$$V_{MAR}^{M} = R_{MAR-DEY} V_{DEY}^{2} = 2{,}3459 \cdot 10^{9} \cdot 1{,}825 \cdot 10^{10} = 4{,}281 \cdot 10^{19}\ cm^3/s^2 .$$

The gravitational field constant of any other planet can be found in the same way.

Pluto gravitational field constant V_{PLU}^{M} is the characteristics of Pluto gravitational field with larger mass $M_{PLU}=9{,}27 \cdot 10^{21}\ g$ around which at the average distance from $R_{PLU-1}=1\ cm$ to $R_{PLU-V}=9{,}671 \cdot 10^{17}\ cm$ there rotates the second body with smaller mass M_2 with the average orbital velocity from $V_2=9{,}834 \cdot 10^{8} cm/s$ to $V_2=1\ cm/s$, equal to $9{,}671 \cdot 10^{17} cm^3/s^2$, expressed in cm^3/s^2.

Pluto gravitational field constant V_{PLU}^{M} was found as the product of the average distance from Pluto to Kharon $R_{PLU-KHA}$ by the squared average orbital velocity of Kharon V_{KHA}^{2} by the formula (   )

$$V_{PLU}^{M} = R_{PLU-KHA} V_{KHA}^{2} = 1{,}957 \cdot 10^{9} \cdot (2{,}223 \cdot 10^{4}) = 9{,}671 \cdot 10^{17}\ cm^3/s^2 .$$

Pluto gravitational field constant V^M_{PLU} was found as the product of the average distance from Pluto to Nix $R_{PLU\text{-}NIX}$ by the squared average orbital velocity of Nix V^2_{NIX} by the formula ( )

$$V^M_{PLU} = R_{PLU-NIX}V^2_{NIX} = 4{,}868 \cdot 10^9 \cdot (1{,}424 \cdot 10^4)^2 = 9{,}872 \cdot 10^{17}\ cm^3/s^2 .$$

Pluto gravitational field constant V^M_{PLU} was found as the product of the average distance from Pluto to Hydra $R_{PLU\text{-}HYD}$ by the squared average orbital velocity of Hydra V^2_{HYD} by the formula ( )

$$V^M_{PLU} = R_{PLU-HYD}V^2_{HYD} = 6{,}478 \cdot 10^9 \cdot (1{,}233 \cdot 10^4)^2 = 9{,}847 \cdot 10^{17}\ cm^3/s^2 .$$

Eryde gravitational field constant V^M_{ERY} is the characteristics of Eryde gravitational field with larger mass $M_{ERY}=1{,}061\cdot10^{22}\ g$ around which, at the average distance from $R_{ERY\text{-}1}=1\ cm$ to $R_{ERY\text{-}ERY}=1{,}107\cdot10^{18}\ cm$ there rotates the second body with smaller mass M_2 at the average orbital velocity from $V_2=1{,}0524\cdot10^{9} cm/s$ to $V_2=1\ cm/s,$ equal to $1{,}107\cdot10^{18}cm^3/s^2$, expressed in cm^3/s^2.

The gravitational field constant of Eryde V^M_{ERY} was found as the product of the average distance from Eryde to Disnomy $R_{ERY\text{-}DIS}$ by the squared average orbital velocity of Disnomy V^2_{DIS} by the formula ( )

$$V^M_{ERY} = R_{ERY-DIS}V^2_{DIS} = 3{,}735 \cdot 10^9 \cdot (1{,}722 \cdot 10^4)^2 = 1{,}107 \cdot 10^{18}\ cm^3/s^2 .$$

The gravitational field constant of Dionis V^M_{DIO} is the characteristics of Dionis gravitational field with larger mass $M_{DIO}=1{,}773\cdot10^{12}\ g$ around which at the average distance from $R_{DIO\text{-}D}=1\ cm$ to $R_{DIO\text{-}DIOV}=1{,}85\cdot10^{8}\ cm$ there rotates the second body with smaller mass M_2 with the average orbital velocity from $V_2=1{,}36\cdot10^4 cm/s$ to $V_2=1\ cm/s,$ that is equal to $1{,}85\cdot10^8 cm^3/s^2$, expressed in cm^3/s^2.

Dionis gravitational field constant V^M_{DIO} was found as the product of the average distance from Dionis to S/1997(3671)1 $R_{DIO\text{-}3671}$ by the squared average orbital velocity S/1997(3671)1 V^2_{3671} by the formula ( )

$$V^M_{DIO} = R_{DIO-3671}V^2_{3671} = 3{,}6 \cdot 10^5 \cdot (22{,}67)^2 = 1{,}85 \cdot 10^8\ cm^3/s^2 .$$

The gravitational field constant of a black hole having the radius of $1\ cm$ V^M_{BH1} is the characteristics of the gravitational field of the black hole with larger mass $M_{BH1} =8{,}615\cdot10^{24}\ g$ around which, at the average distance from $R_{BH1}=1$

cm to $R_{BH1\text{-}BH1V} = 8{,}988 \cdot 10^{20} cm$ there rotates the second body with smaller mass M_2 $R_{BH1\text{-}BH1V} = 8{,}988 \cdot 10^{20} cm$ at the average orbital velocity from $V_2 = 2{,}99836 \cdot 10^{10}\ cm/s$ to $V_2 = 1\ cm/s$, equal to $8{,}988 \cdot 10^{10}\ cm^3/s^2$ and expressed in cm^3/s^2.

The gravitational field constant of the black of Sagittarius A V^M_{BHSA} is the characteristics of the gravitational field of the black hole Sagittarius A with larger mass $M_{BHSA} = 4{,}769 \cdot 10^{36}\ g$ around which, at he average distance from $R_{BHSA\text{-}BHSA1} = 1 cm$ to $R_{BHSA\text{-}BHSAV} = 4{,}975 \cdot 10^{32}\ cm$ there rotates the second body with smaller mass M_2 at the average orbital velocity from $V_2 = 2{,}23 \cdot 10^{16}\ cm/s$ to $V_2 = 1\ cm/s$, equal to $4{,}975 \cdot 10^{32}\ cm^3/s^2$, expressed in cm^3/s^2.

The gravitational field constant of Sagittarius A black hole V^M_{BHSA} was found as the product of the average distance from Sagittarius A black hole to the star $S2$ $R_{BHSA\text{-}S2}$ by the squared average orbital velocity of the star $S2$ V^2_{S2} by the formula ( )

$$V^M_{BHSA} = R_{BHSA-S2} V^2_{S2} = 1{,}426 \cdot 10^{16} \cdot 3{,}4889 \cdot 10^{16} = 4{,}975 \cdot 10^{32}\ cm^3/s^2 .$$

The gravitational field constant of the Milky Way galaxy centre V^M_{MWGC} is the characteristics of the gravitational field constant of the Milky Way galaxy centre with larger mass $M_{MWGC} = 1{,}145 \cdot 10^{41}\ g$ around which, at the average distance from $R_{MWGC\text{-}MWGCV} = 1{,}195 \cdot 10^{37} cm$ there rotates the second body with smaller mass M_2 at the average orbital velocity from $V_2 = 3{,}457 \cdot 10^{18}\ cm/s$ to $V_2 = 1\ cm/s$, equal to $1{,}195 \cdot 10^{37}\ cm^3/s^2$, expressed in cm^3/s^2.

The gravitational field constant of the Milky Way galaxy centre V^M_{MWGC} was found as the product of the average distance from the Milky Way galaxy centre to the Sun $R_{MWGC\text{-}SUN}$ by the squared average orbital velocity of the Sun V^2_{SUN} by the formula ( )

$$V_{MWGC} = R_{MWGC-SUN} V^2_{SUN} = 2{,}838 \cdot 10^{22} \cdot 4{,}84 \cdot 10^{14} = 1{,}374 \cdot 10^{37}\ cm^3/s^2 .$$

One can find the gravitational fields constants of any bodies in the same way.

The obtained gravitational fields constants of different bodies in the Solar System and the Milky Way galaxy V^M_B shows that the growth of the average distance from the first body with larger mass M_1 to rotating around it the second body with smaller mass M_2 R_{1-2} is compensated by lowering the average orbital velocity V_2, so that the value of the gravitational field constant of the body V_B^M doesn't change under such conditions.

Taking into account that $V_B^M = R_{1-2}V_2^2$ and $V_1^M = 2Gg_1^M$ the formula ( ) was written down in the following way

$$V_T^M = V_1^M M_1 \ . \qquad (\quad)$$

For practical checking up the formula ( ) there were found constants of gravitational fields of different bodies in the Solar System and the Milky Way galaxy.

The constant of the gravitational field of 1 g of the body V_1^M was found as the doubled product of the gravitational constant G by the gravity acceleration of 1 g of the body g_1^M by the formula ( )

$$V_1^M = 2Gg_1^M = 2 \cdot 2{,}034 \cdot 10^{17} \cdot 2{,}5645 \cdot 10^{-22} = 1{,}0432386 \cdot 10^{-4}\ cm^3/gs^2 \ .$$

The constant of the gravitational field of 1 g V_{B1}^M was found as the product of the constant of the gravitational field of 1 g of the body V_1^M by the mass of *1 g* M_1 by the formula ( )

$$V_{B1}^M = V_1^M M_1 = 1{,}0432386 \cdot 10^{-4} \cdot 1 = 1{,}0432386 \cdot 10^{-4}\ cm^3/s^2 \ .$$

The Sun gravitational field constant V_{SUN}^M was found as the product of the constant of the gravitational field of *1 g* of the body V_1^M by the Sun mass M_{SUN} by the formula ( )

$$V_{SUN}^M = V_1^M M_{SUN} = 1{,}04324 \cdot 10^{-4} \cdot 1{,}273 \cdot 10^{30} = 1{,}33 \cdot 10^{26}\ cm^3/s^2 \ .$$

The Earth gravitational field constant V_{EAR}^M was found as the product of the constant of the gravitational field of *1 g* of the body V_1^M by the Earth mass M_{EAR} by the formula ( )

$$V_{EAR}^M = V_1^M M_{EAR} = 1{,}04324 \cdot 10^{-4} \cdot 3{,}824 \cdot 10^{24} = 4{,}025 \cdot 10^{20}\ cm^3/s^2 \ .$$

Mars gravitational field constant V_{MAR}^M was found as the product of the constant of the gravitational field of *1 g* of the body V_1^M by the Mars mass M_{MAR} by the formula ( )

$$V_{MAR}^M = V_1^M M_{MAR} = 1{,}04324 \cdot 10^{-4} \cdot 4{,}108 \cdot 10^{23} = 4{,}286 \cdot 10^{19}\ cm^3/s^2 \ .$$

Gravitational fields constants of other planets of the Solar System have been found in the same way (table №).

The constant of the gravitational field of the black hole having the radius of *1 cm* V^M_{BH1} was found as the product of the constant of the gravitational field of *1 g* of the body V^M_1 by the found below mass of the black hole having the radius of *1 cm* M_{BH1} by the formula ( )

$$V^M_{BH1} = V^M_1 M_{BH1} = 1{,}04324 \cdot 10^{-4} \cdot 8{,}615 \cdot 10^{24} = 8{,}988 \cdot 10^{20}\ cm^3/s^2 .$$

The gravitational field constant of the Milky Way galaxy centre V^M_{MWGC} was found as the product of the constant of the gravitational field of *1 g* of the body V^M_1 by the found below mass of the Milky Way galaxy centre M_{MWGC} by the formula ( )

$$V^M_{MWGC} = V^M_1 M_{MWGC} = 1{,}04324 \cdot 10^{-4} \cdot 1{,}317 \cdot 10^{41} = 1{,}374 \cdot 10^{37}\ cm^3/s^2 .$$

Solving the equation ( ) relatively to $R_{1-2}V_2^2$ led to

$$R_{1-2}V_2^2 = \frac{2GM_1 g_2}{M_2} . \qquad (\quad)$$

Taking into account that $V^M_B = R_{1-2}V_2^2$, $g^M_1 = \frac{g_2}{M_2}$ and $V^M_1 = 2Gg^M_1$ the formula ( ) was written down in the following way

$$V^M_B = V^M_1 M_1 , \qquad (\quad)$$

where $V_B{}^M$ is the body gravitational field constant, *cm³/s²*;

M_1 is the mass of the first body, *g;*

$V_1{}^V$ is the gravitational field constant of *1 cm³/s²* of the body, *gs²/cm³*;

The obtained formula ( ) turned out to be identical to the formula ( ).

For practical checking up the formula ( ) there were found the constants of gravitational fields of different bodies in the Solar system and in the Milky Way galaxy.

The Sun gravitational field constant V^M_{SUN} was found as the product of the constant of gravitational field of *1 g* of the body V^M_1 by the Sun mass M_{SUN} by the formula ( )

$$V_{SUN}^{M} = V_1^M M_{SUN} = 1{,}04324 \cdot 10^{-4} \cdot 1{,}273 \cdot 10^{30} = 1{,}33 \cdot 10^{26}\, cm^3/s^2 .$$

Any gravitational field constant of any star can be found in the same way.

The Earth gravitational field constant V_{EAR}^{M} was found as the product of the constant of gravitational field of *1 g* of the body V_1^M by the Earth mass M_{EAR} by the formula ( )

$$V_{EAR}^{M} = V_1^M M_{EAR} = 1{,}04324 \cdot 10^{-4} \cdot 3{,}824 \cdot 10^{24} = 4{,}0 \cdot 10^{20}\, cm^3/s^2 .$$

Mars gravitational field constant V_{MAR}^{M} was found as the product of the constant of gravitational field of *1 g* of the body V_1^M by the found below Mars mass M_{MAR} by the formula ( )

$$V_{MAR}^{M} = V_1^M M_{MAR} = 1{,}04324 \cdot 10^{-4} \cdot 4{,}108 \cdot 10^{23} = 4{,}286 \cdot 10^{19}\, cm^3/s^2 .$$

It is possible to find the gravitational field constant of any planet in the same way.

The constant of the gravitational field of the black hole having the radius of *1 cm* V_{BH1}^{M} was found as the product of the constant of the gravitational field of *1 g* of the body V_1^M by the mass of the black hole with the radius of *1 cm* M_{BH1} by the formula ( )

$$V_{BH1}^{M} = V_1^M M_{BH1} = 1{,}04324 \cdot 10^{-4} \cdot 8{,}615 \cdot 10^{24} = 8{,}988 \cdot 10^{20}\, cm^3/s^2$$

The constant of the gravitational field of the black hole Sagittarius A V_{BHSA}^{M} was found as the product of the constant of the gravitational field of *1 g* of the body V_1^M by the mass of Sagittarius A black hole M_{BHSA} by the formula ( )

$$V_{BHSA}^{M} = V_1^M M_{BHSA} = 1{,}04324 \cdot 10^{-4} \cdot 4{,}769 \cdot 10^{36} = 4{,}975 \cdot 10^{32}\, cm^3/s^2 .$$

The gravitational field constant of any black hole can be found in the same way.

The constant of the gravitational field of the Milky Way galaxy centre V_{MWGC}^{M} was found as the product of the constant of the gravitational field of *1 g* of the body V_1^M by the mass of the Milky Way galaxy centre M_{MWGC} by the formula ( )

$$V_{MWGC}^{M} = V_1^M M_{MWGC} = 1{,}04324 \cdot 10^{-4} \cdot 1{,}317 \cdot 10^{41} = 1{,}374 \cdot 10^{37}\, cm^3/s^2 .$$

The gravitational field constant of the centre of any galaxy can be found in the same way.

The gravitational field constants of various bodies of the Solar system and of the Milky Way galaxy found by the formula (   ) coincided with the analogical data obtained by the formula (   ), which confirms the validity of these formulas.

After solving the formula (   ) relatively $R_{1-2}V_2^2$ it was obtained the following

$$R_{1-2}V_2^2 = 2GM_1 g_1 \;. \qquad (\quad)$$

Taking into account that $V_T^M = R_{1-2}V_2^2$, $V_1^M = 2Gg_1$ and $V_1^V = \frac{1}{V_1^M}$ the formula was written down in the following way

$$V_T^M = \frac{M_1}{V_1^V} \qquad (\quad)$$

where $V_B{}^M$ is the body gravitational field constant, cm^3/s^2;

M_1 is the mass of the first body, g.

$V_1{}^V$ is the gravitational field constant of $1\ cm^3/s^2$ of the body, gs^2/cm^3;

The Sun gravitational field constant V_{SUN}^M was found as the relation of the Sun mass M_{SUN} to the constant of the gravitational field of $1\ cm^3/s^2$ of the body V_1^V by the formula (   )

$$V_{SUN}^M = \frac{M_{SUN}}{V_1^V} = \frac{1{,}273 \cdot 10^{30}}{9585{,}5349} = 1{,}33 \cdot 10^{26}\ cm^3/s^2 \;.$$

The gravitational field constant of any star can be found in the same way.

The Earth gravitational field constant V_{EAR}^M was found as the relation of the Earth mass M_{EAR} to the constant of the gravitational field of $1\ cm^3/s^2$ in the body V_1^V by the formula (   )

$$V_{EAR}^M = \frac{M_{EAR}}{V_1^V} = \frac{3{,}824 \cdot 10^{24}}{9585{,}5349} = 4{,}025 \cdot 10^{20}\ cm^3/s^2 \;.$$

Mars gravitational field constant V_{MAR}^M was found as the relation of Mars mass V_{MAR}^M to the constant of the gravitation field of $1\ cm^3/s^2$ of the body V_1^V by the formula ( )

$$V_{MAR}^{M} = \frac{M_{MAR}}{V_1^V} = \frac{4{,}108 \cdot 10^{23}}{9585{,}5349} = 4{,}286 \cdot 10^{19}\ cm^3/s^2 \ .$$

The gravitational fields constants of any other planets can be found in the same way.

The gravitational field constant of the black hole with the radius of *1 cm* V_{BH1}^{M} was found as the relation of the mass of the black hole with the radius of *1 cm* V_{BH1}^{M} was found as the relation of the mass of the black hole with the radius of *1 cm* M_{BH1} to the constant of the gravitation field of *1* cm^3/s^2 of the body V_1^V by the formula ( )

$$V_{BH1}^{M} = \frac{M_{BH1}^{M}}{V_1^V} = \frac{8{,}615 \cdot 10^{24}}{9585{,}5349} = 9{,}88 \cdot 10^{20}\ cm^3/s^2 \ .$$

The gravitational field constant of Saggitarius A black hole V_{BHSa}^{M} was found as the relation of the mass of Saggitarius A black hole V_{BHSa}^{M} to the constant of the gravitation field of *1* cm^3/s^2 of the body V_1^V by the formula ( )

$$V_{BHSa}^{M} = \frac{M_{BHSa}^{M}}{V_1^V} = \frac{4{,}769 \cdot 10^{36}}{9585{,}5349} = 4{,}975 \cdot 10^{32}\ cm^3/s^2 \ .$$

The gravitational field constant of any other black hole can be found in the same way.

The gravitational field constant of the Milky Way galaxy centre V_{MWGC}^{M} was found as the relation of the mass of the Milky Way galaxy centre M_{MWGC} to the constant of the gravitation field of *1* cm^3/s^2 of the body V_1^V by the formula ( )

$$V_{MWGC}^{M} = \frac{M_{MWGC}^{M}}{V_1^V} = \frac{1{,}317 \cdot 10^{41}}{9585{,}5349} = 1{,}374 \cdot 10^{37}\ cm^3/s^2 \ .$$

The gravitational field constant of any other galaxy centre can be found in the same way.

The constants of the gravitational fields of any other bodies can be found in the same way.

The constants of the gravitational fields of the bodies of the Solar system and those of the Milky Way galaxy found by the formula( ) coincided with the constants of the gravitational fields of the same bodies of the Solar System and of the Milky Way galaxy by the formula (   ), which shows their validity.

Having solved the equation (   ) relatively to $R_{1-2}V_2^2$ there was obtained

$$R_{1-2}V_2^2 = 2Gg_1 . \qquad (\quad)$$

Taking into account that $V_T^M = R_{1-2}V_2^2$ the formula (   ) was written down in the following way

$$V_T^M = 2Gg_1 . \qquad (\quad)$$

The obtained formula (   ) turned out to be identical to the formula (   ).

5.4. Measuring the gravitational constant.

After solving the formula ( ) with regard to G it was obtained

$$G = \frac{R_{1-2}V_2^2}{2M_1 g_1^M} \; . \qquad (\quad)$$

The gravitational constant G is the relation of the gravitational field constant of the body V_T^M to the doubled gravity acceleration of the first body g_1, equal to $2{,}034 \cdot 10^{17} cm^2$, expressed in cm^2.

Taking into account that $V_T^M = R_{1-2}V_2^2$ and $g_1 = M_1 g_1^M$ the formula ( ) was written down in the following way

$$G = \frac{V_T^M}{2g_1}, \qquad (\quad)$$

where G is gravitational constant, cm^2;

V_T^M is the gravitational field constant of the body, cm^3/s^2;

g_1 is the gravity acceleration of the first body, cm/s^2.

On solving the equation ( ) with regard to G there was obtained

$$G = \frac{R_{1-2}V_2^2}{2g_1}. \qquad (\quad)$$

Taking into account that $V_T^M = R_{1-2}V_2^2$ the formula ( ) was written down in the following way:

$$G = \frac{V_T^M}{2g_1}. \qquad (\quad)$$

The obtained formula ( ) is identical to the formula ( ).

For the practical cheking up the formula ( ) there was found the gravitational constant by the parameters of different bodies in the Solar system and in the Milky Way galaxy.

The gravitational constant G was found as the relation of the gravitational constant of one gram of the body V_1^M to the doubled gravity acceleration of one gram of the body g_1^M by the formula ( )

$$G = \frac{V_1^M}{2g_1^M} = \frac{1{,}04324 \cdot 10^{-4}}{2 \cdot 2{,}5645 \cdot 10^{-22}} = 2{,}034 \cdot 10^{17} cm^2 .$$

The gravitational constant G was found as the relation of the Sun gravitational field constant V_{SUN}^{M} to the doubled Sun gravity acceleration g_{SUN} by the formula (   )

$$G = \frac{V_{SUN}^{M}}{2g_{SUN}} = \frac{1{,}33 \cdot 10^{26}}{2 \cdot 3{,}265 \cdot 10^{8}} = 2{,}037 \cdot 10^{17} cm^{2}.$$

One can find the gravitational constant by the parameters of any other star in the same way.

The gravitational constant G was found as the relation of the constant of the gravitational field of the Earth V_{EAR}^{M} to the doubled Earth gravity acceleration g_{EAR} by the formula (   )

$$G = \frac{V_{EAR}^{M}}{2g_{EAR}} = \frac{4{,}025 \cdot 10^{20}}{2 \cdot 980{,}665} = 2{,}052 \cdot 10^{17} cm^{2}.$$

The gravitational constant G was found as the relation of Mars gravitational field constant V_{MAR}^{M} to the doubled gravity acceleration of Mars g_{MAR} by the formula   (   )

$$G = \frac{V_{MAR}^{M}}{2g_{MAR}} = \frac{4{,}286 \cdot 10^{19}}{2 \cdot 105{,}35} = 2{,}034 \cdot 10^{17} cm^{2}.$$

The gravitational constant G was found as the relation of Jupiter gravitational constant V_{JUP}^{M} to the doubled gravity acceleration of Jupiter g_{JUP} by the formula (   )

$$G = \frac{V_{JUP}^{M}}{2g_{JUP}} = \frac{1{,}267 \cdot 10^{23}}{2 \cdot 3{,}113 \cdot 10^{5}} = 2{,}035 \cdot 10^{17} cm^{2}.$$

One can find the gravitational constant by the parameters of any other planets in the same way.

The gravitational constant G was found as the relation of Pluto gravitational field constant V_{PLU}^{M} to the doubled gravity acceleration of Pluto g_{PLU} by the formula   (   )

$$G = \frac{V_{PLU}^{M}}{2g_{PLU}} = \frac{9{,}765 \cdot 10^{17}}{2 \cdot 2{,}4} = 2{,}034 \cdot 10^{17} cm^{2}.$$

The gravitational constant G was found as the relation of Eryde gravitational field constant V_{ERY}^{M} to the doubled gravity acceleration of Eryde g_{ERY} by the formula ( )

$$G = \frac{V_{ERY}^{M}}{2g_{ERY}} = \frac{1{,}107 \cdot 10^{18}}{2 \cdot 2{,}721} = 2{,}034 \cdot 10^{17} cm^2 .$$

The gravitational constant G was found as the relation of Dionis gravitational field constant V_{DIO}^{M} to the doubled gravity acceleration of Dionis g_{DIO} by the formula ( )

$$G = \frac{V_{DIO}^{M}}{2g_{DIO}} = \frac{1{,}85 \cdot 10^{8}}{2 \cdot 4{,}547 \cdot 10^{-10}} = 2{,}034 \cdot 10^{17} cm^2 .$$

The gravitational constant G was found as the relation of the gravitational field constant of the black hole with the radius of *1 cm* V_{BH1}^{M} to the doubled gravity acceleration of the black hole with the radius of *1 cm* g_{BH1} by the formula ( )

$$G = \frac{V_{BH1}^{M}}{2g_{BH1}} = \frac{8{,}988 \cdot 10^{20}}{2 \cdot 2209{,}317} = 2{,}034 \cdot 10^{17} cm^2 .$$

The gravitational constant G was found as the relation of the gravitational field constant of Saggitarius A black hole V_{BHSA}^{M} to the doubled gravity acceleration of Saggitarius A black hole A g_{BHSA} by the formula ( )

$$G = \frac{V_{BHSA}^{M}}{2g_{BHSA}} = \frac{4{,}975 \cdot 10^{32}}{2 \cdot 1{,}223 \cdot 10^{15}} = 2{,}034 \cdot 10^{17} cm^2 .$$

The gravitational constant G was found as the relation of the gravitational field constant of the Milky Way galaxy V_{MWGC}^{M} to the doubled gravity acceleration of the Milky Way galaxy centre g_{MWGC} by the formula ( )

$$G = \frac{V_{MWGC}^{M}}{2g_{MWGC}} = \frac{1{,}374 \cdot 10^{37}}{2 \cdot 3{,}377 \cdot 10^{19}} = 2{,}034 \cdot 10^{17} cm^2 .$$

One can find the gravitational constant by the parameters of any other galaxy in the same way.

The gravitational constant G found by the formula ( ) coincided with the gravitational constant G found by the formula ( ) which confirms its validity.

One can find the gravitational constant G by the parameters of any other bodies in the same way.

Solving the equation ( ) with regard to G resulted in:

$$G = \frac{R_{1-2} V_2^2 M_2}{2 M_1 g_2}. \qquad (\quad)$$

Taking into account that $V_T^M = R_{1-2} V_2^2$, $V_1^M = \frac{V_T^M}{M_1}$ and $g_T^M = \frac{M_2}{g_2}$, the formula ( ) was written down in the following way

$$G = \frac{V_1^M g_T^M}{2}, \qquad (\quad)$$

where G is the gravitational constant, cm^2;

V_1^M is the constant of the gravitational field of *1g* of the body, cm^3/s^2;

g_T^M is the constant of $1\ cm/s^2$ of the gravity acceleration of the body, gs^2/cm .

The gravitational constant G was found proceeding from the constant of the gravitational field of one gram of the body V_1^M and the constant of $1\ cm/s^2$ of the gravity acceleration g_T^M by the formula ( )

$$G = \frac{V_1^M g_T^M}{2} = \frac{1{,}04324 \cdot 10^{-4} \cdot 3{,}8994 \cdot 10^{21}}{2} = 2{,}034 \cdot 10^{17} cm^2 .$$

5.5. Measuring the mass of a body

By solving the formula ( ) in regard to M_1 one obtains:

$$M_1 = \frac{R_{1-2}V_2^2}{2Gg_1^M}. \qquad (\quad)$$

The body mass M_1 is the relation of the body gravitational field constant V_T^M to the constant of the gravitational field of *1 g* of the body V_1^M expressed in grams.

Taking into account that $V_T^M = R_{1-2}V_2^2$ and $V_1^M = 2Gg_1^M$ the formula ( ) was written down in the following way:

$$M_1 = \frac{V_T^M}{V_1^M}, \qquad (\quad)$$

where M_1 is the mass of the first body, g;

V_B^M is the body gravitational field constant, cm^3/s^2;

V_1^M is the gravitational field constant of *1 g* of the body, cm^3/s^2.

For the practical checking up the formula ( ) there were found the masses of various bodies in the Solar system and in the Milky Way galaxy.

The mass of *1 g* was found as the relation of the gravitational field constant of *1 g* of the body V_1^M by the formula ( )

$$M_1^1 = \frac{V_{T1}^M}{V_1^M} = \frac{1{,}04324 \cdot 10^{-4}}{1{,}04324 \cdot 10^{-4}} = 1\,\text{g}.$$

The Sun mass M_{SUN} was found as the relation of the Sun gravitational field constant V_{SUN}^M to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{SUN} = \frac{V_{SUN}^M}{V_1^M} = \frac{1{,}33 \cdot 10^{26}}{1{,}04324 \cdot 10^{-4}} = 1{,}275 \cdot 10^{30}\,g.$$

The mass of any other star can be found in the same way.

The Earth mass M_{EAR} was found as the relation of the gravitational field constant V_{EAR}^M to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{EAR} = \frac{M_{EAR}^{M}}{V_1^M} = \frac{4{,}025 \cdot 10^{20}}{1{,}04324 \cdot 10^{-4}} = 3{,}858 \cdot 10^{24} g .$$

Mars mass M_{MAR} was found as the relation of Mars gravitational field constant V_{MAA}^{M} to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{MAA} = \frac{V_{MAA}^{M}}{V_1^M} = \frac{4{,}286 \cdot 10^{19}}{1{,}04324 \cdot 10^{-4}} = 4{,}108 \cdot 10^{23} g .$$

Jupiter mass M_{JUP} was found as the relation of Jupiter gravitational field constant V_{JUP}^{M} to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{JUP} = \frac{V_{JUP}^{M}}{V_1^M} = \frac{1{,}267 \cdot 10^{23}}{1{,}04324 \cdot 10^{-4}} = 1{,}214 \cdot 10^{27} g .$$

The mass of any other planet can be found in the same way.

Pluto mass M_{PLU} was found as the relation of Pluto gravitational field constant V_{PLU}^{M} to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{PLU} = \frac{V_{PLU}^{M}}{V_1^M} = \frac{9{,}765 \cdot 10^{17}}{1{,}04324 \cdot 10^{-4}} = 9{,}36 \cdot 10^{21} g .$$

Eryde mass M_{ERY} was found as the relation of Eryde gravitational field constant V_{ERY}^{M} to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{ERY} = \frac{V_{ERY}^{M}}{V_1^M} = \frac{1{,}107 \cdot 10^{18}}{1{,}04324 \cdot 10^{-4}} = 1{,}061 \cdot 10^{22} g .$$

The mass of any other planet can be found in the same way.

Dionis mass M_{DIO} was found as the relation of Dionis gravitational field constant to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{DIO} = \frac{V_{DIO}^{M}}{V_1^M} = \frac{1{,}85 \cdot 10^{8}}{1{,}04324 \cdot 10^{-4}} = 1{,}773 \cdot 10^{12} g .$$

The mass of any other asteroid can be found in the same way.

The mass of the black hole with the radius of *1 cm* M_{BH1} was found as the relation of the gravitational field constant of the black hole with the radius of *1* cm V^M_{BH1} to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{BH1} = \frac{V^M_{BH1}}{V_1^M} = \frac{8{,}988 \cdot 10^{20}}{1{,}04324 \cdot 10^{-4}} = 8{,}615 \cdot 10^{24} g \ .$$

The mass of Saggitarius A black hole M_{BHSa} was found as the relation of the gravitational field constant of Saggitarius A black hole V^M_{BHSa} to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{BHSa} = \frac{V^M_{BHSa}}{V_1^M} = \frac{4{,}975 \cdot 10^{32}}{1{,}04324 \cdot 10^{-4}} = 4{,}769 \cdot 10^{36} g \ .$$

The mass of any other black hole can be found in the same way.

The mass of the Milky Way galaxy centre M_{MWGC} was found as the relation of the gravitational field constant of the Milky Way galaxy centre V^M_{MWGC} to the gravitational field constant of *1g* of the body V_1^M by the formula ( )

$$M_{MWGC} = \frac{V^M_{MWGC}}{V_1^M} = \frac{1{,}374 \cdot 10^{37}}{1{,}04324 \cdot 10^{-4}} = 1{,}317 \cdot 10^{41} g \ .$$

The Earth mass M_{EAR} found by the formula ( ) coincided with the Earth mass M_{EAR} found by the formula ( ), which shows their validity. So, it is possible to find the mass of any body M_B in the Universe with the help of the formula ( ).

While finding the masses of different bodies in the Solar System and in the Milky Way galaxy it was cleared out that these masses may be found with the help of another physical constant.

The gravitational field constant of $1cm^3/s^2$ of the body V_1^V was found as the quantity that is opposite to the gravitational field constant of *1 g* of the body V_1^M by the formula ( )

$$V_1^V = \frac{1}{V_1^M} = \frac{1}{1{,}0432386 \cdot 10^{-4}} = 9585{,}5349\, gs^2 / cm^3 \ .$$

Taking into account that $V_1^V = \frac{1}{V_1^M}$ the formula ( ) was written in the following way

$$M_1 = V_T^M V_1^V , \qquad (\quad)$$

where M_1 is the body mass, *g*;

V_B^M is the gravitational field constant, cm^3/s^2;

V_1^V is the gravitational field constant of *1* cm^3/s^2 of the body, gs^2/cm^3.

For practical checking up the formula (   ) the mass of different bodies in the Solar System and in the Milky Way galaxy were found.

The mass of *1 g* of the body was found as the product of the gravitational field constant of *1 g* of the body V_1^M by the gravitational field constant of *1* cm^3/s^2 of the body V_1^V by the formula (   )

$$M_1 = V_1^M V_1^V = 1{,}04324 \cdot 10^{-4} \cdot 9585{,}5349 = 1 \ g \, .$$

The Sun mass M_{SUN} was found as the product of the Sun gravitational field constant V_{SUN}^M by the gravitational field constant of *1* cm^3/s^2 of the body V_1^V by the formula (   )

$$M_{SUN} = V_{SUN}^M V_1^V = 1{,}33 \cdot 10^{26} \cdot 9585{,}5349 = 1{,}275 \cdot 10^{30} g \, .$$

The mass of any other star can be found in the same way.

The Earth mass M_{EAR} was found as the product of the Earth gravitational field constant V_{EAR}^M by the gravitational field constant of *1* cm^3/s^2 of the body V_1^V by the formula (   )

$$M_{EAR} = V_{EAR}^M V_1^V = 4{,}025 \cdot 10^{20} \cdot 9585{,}5349 = 3{,}858 \cdot 10^{24} g \, .$$

Mars mass M_{MAR} was found as the product of Mars gravitational field constant V_{MAR}^M by the gravitational field constant of *1* cm^3/s^2 of the body V_1^V by the formula (   )

$$M_{MAR} = V_{MAR}^M V_1^V = 4{,}286 \cdot 10^{19} \cdot 9585{,}5349 = 4{,}108 \cdot 10^{23} g \, .$$

Jupiter mass M_{JUP} was found as the product of Jupiter gravitational field constant V_{JUP}^M by the gravitational field constant of *1* cm^3/s^2 of the body V_1^V by the formula (   )

$$M_{JUP} = V_{JUP}^M V_1^V = 1{,}267 \cdot 10^{23} \cdot 9585{,}5349 = 1{,}214 \cdot 10^{27} g \, .$$

The mass of any other planet can be found in the same way.

Pluto mass M_{PLU} was found as the product of Pluto gravitational field constant V^{M}_{PLU} by the gravitational field constant of *1 cm³/s²* of the body V^{V}_{1} by the formula ( )

$$M_{PLU} = V^{M}_{PLU} V^{V}_{1} = 9{,}765 \cdot 10^{17} \cdot 9585{,}5349 = 9{,}36 \cdot 10^{21} g .$$

Eryde mass M_{ERY} was found as the product of Eryde gravitational field constant V^{M}_{ERY} by the gravitational field constant of $1\ cm^3/s^2$ of the body V^{V}_{1} by the formula ( )

$$M_{ERY} = V^{M}_{ERY} V^{V}_{1} = 1{,}107 \cdot 10^{18} \cdot 9585{,}5349 = 1{,}061 \cdot 10^{22} g .$$

The mass of any other dwarf planet can be found in the same way.

Dionis mass M_{DIO} was found as the product of Dionis gravitational field constant V^{M}_{DIO} by the gravitational field constant of $1\ cm^3/s^2$ of the body V^{V}_{1} by the formula ( )

$$M_{DIO} = V^{M}_{DIO} V^{V}_{1} = 1{,}85 \cdot 10^{8} \cdot 9585{,}5349 = 1{,}773 \cdot 10^{12} g .$$

The mass of any other asteroid can be found in the same way.

The mass of the black hole with the radius of *1 cm* M_{BH1} was found as the product of the black hole gravitational field constant with the radius of *1 cm* V^{M}_{BH1} by the gravitational field constant of $1\ cm^3/s^2$ of the body V^{V}_{1} by the formula ( )

$$M_{BH1} = V^{M}_{BH1} V^{V}_{1} = 8{,}988 \cdot 10^{20} \cdot 9585{,}5349 = 8{,}615 \cdot 10^{24} g .$$

The mass of Saggitarius A black hole M_{BHSA} was found as the product of the gravitational field constant of Saggitarius A black hole V^{M}_{BHSA} by the gravitational field constant of $1\ cm^3/s^2$ of the body V^{V}_{1} by the formula ( )

$$M_{BHSA} = V^{M}_{BHSA} V^{V}_{1} = 4{,}975 \cdot 10^{32} \cdot 9585{,}5349 = 4{,}769 \cdot 10^{36} g .$$

The mass of any other black hole can be found in the same way.

The mass of the Milky Way galaxy centre M_{MWGC} was found as the product of the gravitational field constant of the Milky Way galaxy centre V^{M}_{MWGC} by the gravitational field constant of $1\ cm^3/s^2$ of the body V^{V}_{1} by the formula ( )

$$M_{MWGC} = V^{M}_{MWGC} V^{V}_{1} = 1{,}374 \cdot 10^{37} \cdot 9585{,}5349 = 1{,}317 \cdot 10^{41} g .$$

The mass of the centre of any other galaxy can be found in the same way.

The Earth mass M_{EAR} found by the formula ( ) coincided with the Earth mass M_{EAR}, found by the formula ( ), which shows their validity. Thus, it is possible to find the mass of any body in the Universe with the help of the formula ( ).

After solving the equation ( ) with regard to M_1 there was obtained the following

$$M_1 = \frac{R_{1-2} V_2^2 M_2}{2 G g_2}. \qquad (\quad)$$

Taking into account that $V_T^M = R_{1-2} V_2^2$ and $g_T^M = \frac{M_2}{g_2}$ the formula was written in following form

$$M_1 = \frac{V_T^M g_T^M}{2G}, \qquad (\quad)$$

where M_1 is the mass of the first body, g;

V_T^M is the body gravitational field constant, cm^3/s^2;

g_T^M is the constant of $1 cm/sc^2$ of the body gravity acceleration, gsc^2/cm ;

G is the gravitational constant, cm^2.

For practical checking up the formula ( ) there were found the masses of different bodies in the Solar system and in the Milky Way galaxy.

The mass of $1\ g$ of the body M_1^1 was found proceeding from the gravitational field constant of $1\ g$ of the body V_1^M, the constant of $1\ cm/s^2$ of gravity acceleration of the body g_B^M and the gravitational constant G by the formula ( )

$$M_1^1 = \frac{V_1^M g_B^M}{2G} = \frac{1{,}04324 \cdot 10^{-4} \cdot 3{,}8994 \cdot 10^{21}}{2 \cdot 2{,}034 \cdot 10^{17}} = 1g.$$

The mass of any other body can be found in the same way.

The Sun mass M_{SUN} was found proceeding from the Sun gravitational field constant V_{SUN}^M, the constant of $1\ cm/s^2$ of gravity acceleration of the body g_B^M and the gravitational constant G by the formula ( )

$$M_{SUN} = \frac{V_{SUN}^{M} g_{T}^{M}}{2G} = \frac{1,33 \cdot 10^{26} \cdot 3,8994 \cdot 10^{21}}{2 \cdot 2,034 \cdot 10^{17}} = 1,2749 \cdot 10^{30} g .$$

The mass of any other star can be found in the same way.

The Earth mass M_{EAR} was found proceeding from the Earth gravitational field constant V_{EAR}^{M}, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula (   )

$$M_{EAR} = \frac{V_{EAR}^{M} g_{T}^{M}}{2G} = \frac{4,025 \cdot 10^{20} \cdot 3,8994 \cdot 10^{21}}{2 \cdot 2,034 \cdot 10^{17}} = 3,8582 \cdot 10^{24} g .$$

Mars mass M_{MAR} was found proceeding from Mars gravitational field constant V_{MAA}^{M}, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula (   )

$$M_{MAR} = \frac{V_{MAR}^{M} g_{T}^{M}}{2G} = \frac{4,286 \cdot 10^{19} \cdot 3,8994 \cdot 10^{21}}{2 \cdot 2,034 \cdot 10^{17}} = 4,108 \cdot 10^{23} g \ .$$

Jupiter mass M_{IOJUP} was found proceeding from Jupiter gravitational field constant V_{JUP}^{M}, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula (   )

$$M_{JUP} = \frac{V_{JUP}^{M} g_{T}^{M}}{2G} = \frac{1,267 \cdot 10^{23} \cdot 3,8994 \cdot 10^{21}}{2 \cdot 2,034 \cdot 10^{17}} = 1,214 \cdot 10^{27} \ g.$$

The mass of any planet can be found in the same way.

Pluto mass M_{PLU} was found proceeding from the gravitational field constant of V_{PLU}^{M}, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula (   )

$$M_{PLU} = \frac{V_{PLU}^{M} g_{T}^{M}}{2G} = \frac{9,765 \cdot 10^{17} \cdot 3,8994 \cdot 10^{21}}{2 \cdot 2,034 \cdot 10^{17}} = 9,36 \cdot 10^{21} \ g.$$

Eryde mass M_{ERY} was found proceeding from Eryde gravitational field constant, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula (   )

$$M_{ERY} = \frac{V_{ERY}^{M} g_{T}^{M}}{2G} = \frac{1,107 \cdot 10^{18} \cdot 3,8994 \cdot 10^{21}}{2 \cdot 2,034 \cdot 10^{17}} = 1,061 \cdot 10^{22} \ g.$$

The mass of any other dwarf planet can be found in the same way.

Dionis mass M_{DIO} was found proceeding from Dionis gravitational field constant V_{DIO}^{M}, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula ( )

$$M_{DIO} = \frac{V_{DIO}^{M} g_{T}^{M}}{2G} = \frac{1{,}85 \cdot 10^{8} \cdot 3{,}8994 \cdot 10^{21}}{2 \cdot 2{,}034 \cdot 10^{17}} = 1{,}773 \cdot 10^{12} \quad g.$$

The mass of any other asteroid can be found in the same way.

The mass of the black hole with the radius of *1 cm* M_{BH1} was found proceeding from the gravitational field constant of the black hole with the radius of *1 cm* V_{BH1}^{M}, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula ( )

$$M_{BH1} = \frac{V_{BH1}^{M} g_{T}^{M}}{2G} = \frac{8{,}988 \cdot 10^{20} \cdot 3{,}8994 \cdot 10^{21}}{2 \cdot 2{,}034 \cdot 10^{17}} = 8{,}615 \cdot 10^{24} g\,.$$

The mass of Saggitarius A black hole M_{BHSA} was found proceeding from Saggitarius A black gravitational field constant V_{BHSA}^{M}, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula ( )

$$M_{BHSA} = \frac{V_{BHSA}^{M} g_{T}^{M}}{2G} = \frac{4{,}975 \cdot 10^{32} \cdot 3{,}8994 \cdot 10^{21}}{2 \cdot 2{,}034 \cdot 10^{17}} = 4{,}769 \cdot 10^{36} g\,.$$

The mass of any black hole can be found in the same way.

The mass of the Milky Way galaxy centre M_{MWGC} was found proceeding from the gravitational field constant of the Milky Way galaxy centre V_{MWGC}^{M}, the constant of *1 cm/s²* of gravity acceleration of the body g_{B}^{M} and the gravitational constant G by the formula ( )

$$M_{MWGC} = \frac{V_{MWGC}^{M} g_{B}^{M}}{2G} = \frac{1{,}374 \cdot 10^{37} \cdot 3{,}8994 \cdot 10^{21}}{2 \cdot 2{,}034 \cdot 10^{17}} = 1{,}3171 \cdot 10^{41} g\,.$$

The mass of any galaxy centre can be found in the same way.

After solving the equation ( ) with regard to M_2 there was obtained

$$M_2 = \frac{2GM_1 g_2}{R_{1-2} V_2^2}. \qquad (\quad)$$

Taking into account that $V_T^M = R_{1-2} V_2^2$, $V_1^V = \frac{M_1}{V_T^M}$ and $g_T^M = 2GV_1^V$ the formula ( ) was written down in the following way

$$M_2 = g_T^M g_2, \qquad (\quad)$$

where M_2 is the mass of the second body, g;

g_T^M is the constant of $1\ cm/s^2$ of the body gravity acceleration, gs^2/cm;

g_2 is the second body gravity acceleration, cm/s^2.

For practical checking up the formula ( ) there were found the masses of different bodies of the Solar System and of the Milky Way galaxy.

The mass of $1\ g$ of the body M_1^1 was found as the product of the constant of $1\ cm/s^2$ of the body gravity acceleration g_B^M by the gravity acceleration of $1\ g$ of the body g_1 by the formula ( )

$$M_1^1 = g_B^M g_1^1 = 3{,}8994 \cdot 10^{21} \cdot 2{,}5645 \cdot 10^{-22} = 1\ g.$$

The mass of any body can be found in the same way.

The Sun mass M_{SUN} was found as the product of the constant of $1\ cm/s^2$ of the body gravity acceleration g_B^M by the Sun gravity acceleration g_{SUN} by the formula ( )

$$M_{SUN} = g_B^M g_{SUN} = 3{,}8994 \cdot 10^{21} \cdot 3{,}265 \cdot 10^8 = 1{,}273 \cdot 10^{30} g.$$

The mass of any other star can be found in the same way.

The Earth mass M_{EAR} was found as the product of the constant of $1\ cm/s^2$ of the body gravity acceleration g_B^M by the Earth gravity acceleration g_{EAR} by the formula ( )

$$M_{EAR} = g_B^M g_{EAR} = 3{,}8994 \cdot 10^{21} \cdot 980{,}665 = 3{,}824 \cdot 10^{24} g$$

Mars mass M_{MAR} was found as the product of the constant of $1\ cm/s^2$ of the body gravity acceleration g_B^M by Mars gravity acceleration g_{MAR} by the formula ( )

$$M_{MAP} = g_B^M g_{MAR} = 3{,}8994 \cdot 10^{21} \cdot 105{,}35 = 4{,}108 \cdot 10^{23} g.$$

Jupiter mass M_{IOJUP} was found as the product of the constant of $1\ cm/s^2$ of the body gravity acceleration g_B^M by Jupiter gravity acceleration g_{JUP} by the formula ( )

$$M_{JUP} = g_B^M g_{JUP} = 3{,}8994 \cdot 10^{21} \cdot 3{,}113 \cdot 10^5 = 1{,}214 \cdot 10^{27} g.$$

The mass of any planet can be found in the same way.

The Moon mass M_{MOON} was found as the product of the constant of *1 cm/s²* of the body gravity acceleration g_B^M by the Moon gravity acceleration g_{MOON} by the formula (   )

$$M_{MOON} = g_B^M g_{MOON} = 3{,}8994 \cdot 10^{21} \cdot 19{,}19 = 7{,}483 \cdot 10^{22} g .$$

Phobos mass M_{PHO} was found as the product of the constant of *1 cm/s²* of the body gravity acceleration g_B^M by Phobos gravity acceleration g_{PHO} by the formula (   )

$$M_{PHO} = g_B^M g_{PHO} = 3{,}8994 \cdot 10^{21} g$$

Deymos mass M_{DEY} was found as the product of the constant of *1 cm/s²* of the body gravity accelelaration g_B^M by the Deymas gravity acceleration g_{DEY} by the formula (   )

$$M_{DEY} = g_B^M g_{DEY} = 3{,}8994 \cdot 10^{21} g$$

The mass of any satellite can be found in the same way.

The mass of the black hole with the radius of *1cm* M_{BH1} was found as the product of the constant of *1 cm/s²* of the body gravity acceleration g_B^M by the gravity acceleration of the black hole with the radius of *1cm* g_{BH1} by the formula (   )

$$M_{BH1} = g_B^M g_{BH1} = 3{,}8994 \cdot 10^{21} \cdot 2209{,}317 = 8{,}615 \cdot 10^{24} g .$$

The mass of Saggitarius A black hole M_{BHSA} was found as the product of the constant of *1 cm/s²* of the body gravity acceleration g_B^M by the gravity acceleration of Saggitarius A black hole g_{BHSA} by the formula (   )

$$M_{BHSA} = g_B^M g_{BHSA} = 3{,}8994 \cdot 10^{21} \cdot 1{,}223 \cdot 10^{15} = 4{,}769 \cdot 10^{36} g .$$

The mass of any black hole can be found in the same way.

The mass of the Milky Way galaxy centre M_{MWGC} was found as the product of the constant of *1 cm/s²* of the body gravity acceleration g_B^M by the gravity acceleration of the Milky Way galaxy centre g_{MWGC} by the formula (   )

$$M_{MWGC} = g_B^M g_{MWGC} = 3{,}8994 \cdot 10^{21} \cdot 3{,}377 \cdot 10^{19} = 1{,}317 \cdot 10^{41} g .$$

The mass of any galaxy centre can be found in the same way.

The equality (   ) made it possible to obtain new formulas for finding the parameters of different bodies.

$$M_1 = \frac{M_2 g_1}{g_2}. \qquad (\quad)$$

$$M_2 = \frac{M_1 g_2}{g_1}. \qquad (\quad)$$

For practical checking up the formulas ( ), ( ), ( ) and ( ) there were found the parameters of different bodies in the Solar system and in the Milky Way galaxy.

The Sun mass M_{SUN} was found proceeding from the Earth mass M_{EAR} the Sun gravity acceleration g_{SUN} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$M_{COO} = \frac{M_{EAR} g_{SUN}}{g_{EAR}} = \frac{3{,}824 \cdot 10^{24} \cdot 3{,}265 \cdot 10^{8}}{980{,}665} = 1{,}273 \cdot 10^{30} g.$$

The Earth mass M_{EAR} was found proceeding from the Sun mass M_{SUN}, the Earth gravity acceleration g_{EAR} and the Sun gravity acceleration g_{SUN} by the formula ( )

$$M_{EAR} = \frac{M_{SUN} g_{EAR}}{g_{SUN}} = \frac{1{,}273 \cdot 10^{30} \cdot 980{,}665}{3{,}265 \cdot 10^{8}} = 3{,}824 \cdot 10^{24} g.$$

The Sun mass M_{SUN} was found proceeding from the Mars mass M_{MAR} the Sun gravity acceleration g_{SUN} and the Mars gravity acceleration g_{MAR} by the formula ( )

$$M_{SUN} = \frac{M_{MAR} g_{SUN}}{g_{MAR}} = \frac{4{,}108 \cdot 10^{23} \cdot 3{,}265 \cdot 10^{8}}{105{,}35} = 1{,}273 \cdot 10^{30} g.$$

Mars mass M_{MAR}, was found proceeding from the Sun mass M_{SUN}, Mars gravity acceleration g_{MAR} and the Sun gravity acceleration g_{SUN} by the formula ( )

$$M_{MAR} = \frac{M_{SUN} g_{MAR}}{g_{SUN}} = \frac{1{,}273 \cdot 10^{30} \cdot 105{,}35}{3{,}265 \cdot 10^{8}} = 4{,}108 \cdot 10^{23} g.$$

The Sun mass M_{SUN} was found proceeding from the Jupiter mass M_{JUP} the Sun gravity acceleration g_{SUN} and the Jupiter gravity acceleration g_{JUP} by the formula ( )

$$M_{СОЛ} = \frac{M_{JUP} g_{СОЛ}}{g_{JUP}} = \frac{4{,}108 \cdot 10^{23} \cdot 3{,}265 \cdot 10^{8}}{105{,}35} = 1{,}273 \cdot 10^{30} g.$$

Jupiter mass M_{JUP}, was found proceeding from the Sun mass M_{SUN} Jupiter gravity acceleration g_{JUP} and the Sun gravity acceleration g_{SUN} by the formula ( )

$$M_{JUP} = \frac{M_{SUN} g_{JUP}}{g_{SUN}} = \frac{1{,}273 \cdot 10^{30} \cdot 3{,}113 \cdot 10^{5}}{3{,}265 \cdot 10^{8}} = 1{,}214 \cdot 10^{27} g .$$

The Sun mass M_{SUN} was found proceeding from Dionis mass M_{DIO} the Sun gravity acceleration g_{SUN} and Dionis gravity acceleration g_{DIO} by the formula ( )

$$M_{SUN} = \frac{M_{DIO} g_{SUN}}{g_{DIO}} = \frac{1{,}773 \cdot 10^{12} \cdot 3{,}265 \cdot 10^{8}}{4{,}547 \cdot 10^{-10}} = 1{,}273 \cdot 10^{30} g .$$

The Sun mass M_{SUN} was found proceeding from Pluto mass M_{PLU} , the Sun gravity acceleration g_{SUN} and Pluto gravity acceleration g_{PLU} by the formula ( )

$$M_{SUN} = \frac{M_{PLU} g_{SUN}}{g_{PLU}} = \frac{9{,}36 \cdot 10^{21} \cdot 3{,}265 \cdot 10^{8}}{2{,}4} = 1{,}273 \cdot 10^{30} g .$$

Pluto mass M_{PLU}, was found proceeding from the Sun mass M_{SUN}, Pluto gravity acceleration g_{PLU} and the Sun gravity acceleration g_{SUN} by the formula ( )

$$M_{PLU} = \frac{M_{SUN} g_{PLU}}{g_{SUN}} = \frac{1{,}273 \cdot 10^{30} \cdot 2{,}4}{3{,}265 \cdot 10^{8}} = 9{,}36 \cdot 10^{21} g .$$

The Sun mass M_{SUN} was found proceeding from the Eryde mass M_{ERY} the Sun gravity acceleration g_{SUN} and the Eryde gravity acceleration g_{ERY} by the formula ( )

$$M_{SUN} = \frac{M_{ERY} g_{SUN}}{g_{ERY}} = \frac{1{,}061 \cdot 10^{22} \cdot 3{,}265 \cdot 10^{8}}{2{,}721} = 1{,}273 \cdot 10^{30} g .$$

Eryde mass M_{ERY}, was found proceeding from the Sun mass M_{SUN}, Eryde gravity acceleration g_{ERY} and the Sun gravity acceleration g_{SUN} by the formula ( )

$$M_{ERY} = \frac{M_{SUN} g_{ERY}}{g_{SUN}} = \frac{1{,}273 \cdot 10^{30} \cdot 2{,}721}{3{,}265 \cdot 10^{8}} = 1{,}061 \cdot 10^{22} g .$$

The Sun mass M_{SUN} was found proceeding from the centre of the Milky Way galaxy M_{MWGC} , the Sun gravity acceleration g_{SUN} and the gravity acceleration of the Milky Way galaxy g_{MWGC} by the formula ( )

$$M_{SUN} = \frac{M_{MWGC} g_{SUN}}{g_{MWGC}} = \frac{1{,}145 \cdot 10^{41} \cdot 3{,}265 \cdot 10^{8}}{2{,}936 \cdot 10^{19}} = 1{,}273 \cdot 10^{30} g .$$

The mass of the Milky Way galaxy centre M_{MWGC}, was found proceeding from the Sun mass M_{SUN}, the gravity acceleration of the Milky Way galaxy centre g_{MWGC} and the Sun gravity acceleration g_{SUN} by the formula (   )

$$M_{MWGC} = \frac{M_{SUN} g_{MWGC}}{g_{SUN}} = \frac{1{,}273 \cdot 10^{30} \cdot 2{,}936 \cdot 10^{19}}{3{,}265 \cdot 10^{8}} = 1{,}145 \cdot 10^{41} g$$

5.6. Measuring the constant of *1cm/s²* of the body gravity acceleration

For practical checking up the formula ( ) there was found the constant of *1 cm/s²* of the gravity acceleration g_B^M of different bodies in the Solar system and in the Milky Way galaxy.

The constant of *1 cm/s²* of the body gravity acceleration was found as the relation of *1 g* of the first body mass to the gravity acceleration of *1 g* body g_1^M by the formula ( )

$$g_B^M = \frac{M_1}{g_1^M} = \frac{1}{2{,}5645 \cdot 10^{-22}} = 3{,}8994 \cdot 10^{21}\, gs^2 / cm\,.$$

The constant of *1 cm/s²* of the gravity acceleration of any body can be found in the same way.

The constant of *1 cm/s²* of the body gravity acceleration was found as the relation of the Sun mass M_{SUN} to the Sun gravity acceleration g_{SUN} by the formula ( )

$$g_B^M = \frac{M_{SUN}}{g_{SUN}} = \frac{1{,}273 \cdot 10^{30}}{3{,}265 \cdot 10^{8}} = 3{,}899 \cdot 10^{21}\, gs^2 / cm\,.$$

The constant of *1 cm/s²* of the gravity acceleration of any star can be found in the same way.

The constant of *1 cm/s²* of the body gravity acceleration was found as the relation of the Earth mass M_{EAR} to the Earth gravity acceleration g_{EAR} by the formula ( )

$$g_B^M = \frac{M_{EAR}}{g_{EAR}} = \frac{3{,}824 \cdot 10^{24}}{980{,}665} = 3{,}8994 \cdot 10^{21}\, gs^2 / cm\,.$$

The constant of *1 cm/s²* of the body gravity acceleration was found as the relation of Mars mass M_{MAR} to Mars gravity acceleration g_{MAP} by the formula ( )

$$g_B^M = \frac{M_{MAR}}{g_{MAR}} = \frac{4{,}108 \cdot 10^{23}}{105{,}35} = 3{,}8994 \cdot 10^{21}\, gs^2 / cm\,.$$

The constant of *1 cm/s²* of the body gravity acceleration was found as the relation of Jupiter mass M_{JUP} to Jupiter gravity acceleration g_{JUP} by the formula ( )

$$g_B^M = \frac{M_{JUP}}{g_{JUP}} = \frac{1{,}214 \cdot 10^{27}}{3{,}113 \cdot 10^5} = 3{,}8998 \cdot 10^{21} gs^2 / cm \,.$$

The constant of *1 cm/s*^{2} of the body gravity acceleration was found as the relation of Eryde M_{ERY} to the Eryde gravity acceleration g_{ERY} by the formula (   )

$$g_B^M = \frac{M_{ERY}}{g_{ERY}} = \frac{1{,}061 \cdot 10^{22}}{2{,}721} = 3{,}8993 \cdot 10^{21} gs^2 / cm \,.$$

The constant of *1 cm/s*^{2} of the gravity acceleration g_B^M can be found in the same way by the parameters of any other dwarf planet.

The constant of *1 cm/s*^{2} of the body gravity acceleration was found as the relation of Dionis mass M_{DIO} to Dionis gravity acceleration $g_{ДDIO}$ by the formula (   )

$$g_B^M = \frac{M_{DIO}}{g_{DIO}} = \frac{1{,}773 \cdot 10^{12}}{4{,}547 \cdot 10^{-10}} = 3{,}8993 \cdot 10^{21} gs^2 / cm \,.$$

The constant of *1 cm/s*^{2} of the gravity acceleration g_B^M can be found in the same way by the parameters of any asteroid.

The constant of *1 cm/s*^{2} of the body gravity acceleration was found as the relation of the Moon mass M_{MOON} to the Moon gravity acceleration g_{MOON} by the formula (   )

$$g_B^M = \frac{M_{MOON}}{g_{MOON}} = \frac{7{,}483 \cdot 10^{22}}{19{,}19} = 3{,}8994 \cdot 10^{21} gs^2 / cm \,.$$

The constant of *1 cm/s*^{2} of the gravity acceleration g_B^M of any satellite can be found in the same way.

The constant of *1 cm/s*^{2} of the body gravity acceleration was found as the relation of the mass of the black hole with the radius of *1 cm* M_{BH1} to the gravity acceleration of the black hole with the radius of *1 cm* g_{BH1} by the formula (   )

$$g_B^M = \frac{M_{BH1}}{g_{BH1}} = \frac{8{,}615 \cdot 10^{24}}{2209{,}317} = 3{,}8994 \cdot 10^{21} gs^2 / cm \,.$$

The constant of *1 cm/s*^{2} of the body gravity acceleration was found as the relation of Saggitarius A black hole mass M_{BHSA} to the gravity acceleration of Saggitarius A black hole g_{BHSA} by the formula (   )

$$g_B^M = \frac{M_{BHSA}}{g_{BHSA}} = \frac{4,769 \cdot 10^{36}}{1,223 \cdot 10^{15}} = 3,8994 \cdot 10^{21}\, gs^2/cm\,.$$

The constant of *1 cm/s²* of the gravity acceleration g_B^M of any black hole can be found in the same way.

The constant of *1 cm/s²* of the body gravity acceleration was found as the relation of the Milky Way galaxy M_{MWGC} to the gravity acceleration of the Milky Way galaxy centre g_{MWGC} by the formula (   )

$$g_B^M = \frac{M_{MWGC}}{g_{MWGC}} = \frac{1,317 \cdot 10^{41}}{3,377 \cdot 10^{19}} = 3,8999 \cdot 10^{21}\, gs^2/cm\,.$$

The constant of *1 cm/s²* of the gravity acceleration of any galaxy can be found in the same way.

5.7. Measuring the body gravity acceleration

After solving (   ) with regard to g_2 there was obtained

$$g_2 = \frac{R_{1-2} V_2^2 M_2}{2GM_1}. \qquad (\quad)$$

Taking into account that $V_T^M = R_{1-2} V_2^2$, $V_1^M = \frac{V_T^M}{M_1}$ and $g_1^M = \frac{V_1^M}{2G}$ the formula (   ) was written in the following way

$$g_2 = M_2 g_1^M, \qquad (\quad)$$

g_2 is the second body gravity acceleration, cm/s^2;

M_2 is the second body mass, g;

g_1^M is the gravity acceleration of $1\ g$ of the body, cm/gs^2.

The obtained formula (   ) is identical to the formula (   ).

For the practical checking up the formula (   ) there was found the gravity acceleration of different bodies both in the Solar System and in the Milky Way galaxy.

The gravity acceleration of $1\ g$ of the body g_1^1 was found as the product of the mass of $1g$ of the body M_1^1 by the gravity acceleration of $1\ g$ of the body g_1^M by the formula (   )

$$g_1^1 = M_1^1 g_1^M = 1 \cdot 2{,}5645 \cdot 10^{-22} = 2{,}5645 \cdot 10^{-22}\ cm/s^2 .$$

The gravity acceleration of any body g_B can be found in the same way.

The Sun gravity acceleration g_{SUN} was found as the product of the mass of the Sun mass M_{SUN} by the gravity acceleration of $1\ g$ of the body g_1^M by the formula (   )

$$g_{SUN} = M_{SUN} g_1^M = 1{,}273 \cdot 10^{30} \cdot 2{,}5645 \cdot 10^{-22} = 3{,}265 \cdot 10^{8}\ cm/s^2 .$$

The gravity acceleration of any star can be found in the same way.

The Earth gravity acceleration g_{EAR} was found as the product of the Earth mass M_{EAR} by the gravity acceleration of $1\ g$ of the body g_1^M by the formula (   )

$$g_{EAR} = M_{EAR} g_1^M = 3{,}824 \cdot 10^{24} \cdot 2{,}5645 \cdot 10^{-22} = 980{,}665\ \ cm/s^2 .$$

Mars gravity acceleration g_{MAR} was found as the product of Mars mass M_{MAR} by the gravity acceleration of $1\ g$ of the body g_1^M by the formula (   )

$$g_{MAR} = M_{MAR} g_1^M = 4{,}108 \cdot 10^{23} \cdot 2{,}5645 \cdot 10^{-22} = 105{,}35 \quad cm/s^2 .$$

Jupiter gravity acceleration g_{JUP} was found as the product of Jupiter mass M_{JUP} by the gravity acceleration of *1 g* of the body g_1^M by the formula (   )

$$g_{JUP} = M_{JUP} g_1^M = 1{,}214 \cdot 10^{27} \cdot 2{,}5645 \cdot 10^{-22} = 3{,}113 \cdot 10^5 cm/s^2 .$$

The gravity acceleration of any planet can be found in the same way.

The Moon gravity acceleration g_{MOON} was found as the product of the Moon mass M_{MOON} by the gravity acceleration of *1 g* of the body g_1^M by the formula (   )

$$g_{MOON} = M_{MOON} g_1^M = 7{,}483 \cdot 10^{22} \cdot 2{,}5645 \cdot 10^{-22} = 19{,}19 \quad cm/s^2 .$$

The gravity acceleration of any satellite can be found in the same way.
The gravity acceleration of the black hole with the radius of *1cm* g_{BH1} was found as the product of the mass of the black hole with the radius of *1cm* M_{BH1} by the gravity acceleration of *1 g* of the body g_1^M by the formula (   )

$$g_{BH1} = M_{BH1} g_1^M = 8{,}615 \cdot 10^{24} \cdot 2{,}5645 \cdot 10^{-22} = 2209{,}317 \quad cm/s^2 .$$

The gravity acceleration of Saggitarius A black hole g_{BHSA} was found as the product of the mass of Saggitarius A black hole M_{BHSA} by the gravity acceleration of *1 g* of the body g_1^M by the formula (   )

$$g_{BHSA} = M_{BHSA} g_1^M = 4{,}769 \cdot 10^{36} \cdot 2{,}5645 \cdot 10^{-22} = 1{,}223 \cdot 10^{15} cm/s^2 .$$

The gravity acceleration of any black hole can be found in the same way.

The gravity acceleration of the Milky Way galaxy centre g_{MWGC} was found as the product of the mass of the Milky Way galaxy centre M_{MWGC} by the gravity acceleration of *1 g* of the body g_1^M by the formula (   )

$$g_{MWGC} = M_{MWGC} g_1^M = 1{,}317 \cdot 10^{41} \cdot 2{,}5645 \cdot 10^{-22} = 3{,}377 \cdot 10^{19} cm/s^2 .$$

The gravity acceleration of any galaxy centre can be found in the same way.

After solving the equation (   ) with respect to g_1 there was obtained

$$g_1 = \frac{R_{1-2} V_2^2}{2G} . \qquad (\quad)$$

Taking into account that $V_B^M = R_{1-2} V_2^2$ the formula (   ) was written in the following way

$$g_1 = \frac{V_B^M}{2G}. \qquad (\quad)$$

The gravity acceleration of *1 g* of the body mass was found as the relation of the gravitational field constant of *1 g* of the body mass V_1^M to the doubled gravitational constant G by the formula ( )

$$g_1^M = \frac{V_1^M}{2G} = \frac{1{,}04324 \cdot 10^{-4}}{2 \cdot 2{,}034 \cdot 10^{17}} = 2{,}5645 \cdot 10^{-22}\ cm/gs^2 .$$

The Sun gravity acceleration g_{SUN} was found as the relation of the Sun gravitational field constant V_{SUN}^M to the doubled gravitational constant G by the formula ( )

$$g_{SUN}^M = \frac{V_{SUN}^M}{2G} = \frac{1{,}33 \cdot 10^{26}}{2 \cdot 2{,}034 \cdot 10^{17}} = 3{,}265 \cdot 10^8\ cm/s^2 .$$

The Earth gravity acceleration g_{EAR} was found as the relation of the Earth gravitational field constant V_{EAR}^M to the doubled gravitational constant G by the formula ( )

$$g_{EAR}^M = \frac{V_{EAR}^M}{2G} = \frac{4{,}025 \cdot 10^{20}}{2 \cdot 2{,}034 \cdot 10^{17}} = 980{,}665\ \ cm/s^2 .$$

Mars gravity acceleration g_{MAR} was found as the relation of Mars gravitational field constant V_{MAR}^M to the doubled gravitational constant G by the formula ( )

$$g_{MAR}^M = \frac{V_{MAR}^M}{2G} = \frac{4{,}286 \cdot 10^{19}}{2 \cdot 2{,}034 \cdot 10^{17}} = 105{,}35\ \ cm/s^2 .$$

Jupiter gravity acceleration g_{JUP} was found as the relation of Jupiter gravitational field constant V_{JUP}^M to the doubled gravitational constant G by the formula ( )

$$g_{JUP}^M = \frac{V_{JUP}^M}{2G} = \frac{1{,}267 \cdot 10^{23}}{2 \cdot 2{,}034 \cdot 10^{17}} = 3{,}113 \cdot 10^5\ cm/s^2 .$$

The gravity acceleration of any planet can be find in the same way.

The gravity acceleration of the black hole with the radius of *1cm* g_{BH1} was found as the relation of the gravitational field constant of the black hole with the radius of *1cm* V_{BH1}^M to the doubled gravitational constant G by the formula ( )

$$g^{M}_{BH1} = \frac{V^{M}_{BH1}}{2G} = \frac{8{,}988 \cdot 10^{20}}{2 \cdot 2{,}034 \cdot 10^{17}} = 2209{,}317 \;\; cm/s^2 \; .$$

The gravity acceleration of Saggitarius A black hole g_{BHSA} was found as the relation of the gravitational field constant of Saggitarius A black hole V^{M}_{BHSA} to the doubled gravitational constant G by the formula (   )

$$g^{M}_{BHSA} = \frac{V^{M}_{BHSA4}}{2G} = \frac{4{,}975 \cdot 10^{32}}{2 \cdot 2{,}034 \cdot 10^{17}} = 1{,}223 \cdot 10^{15} \; cm/s^2 \; .$$

The gravity acceleration of any black hole can be found in the same way.

The gravity acceleration of the Milky Way galaxy centre g_{MWGC} was found as the relation of the gravitational field constant of the Milky Way galaxy centre V^{M}_{MWGC} to the doubled gravitational constant G by the formula ( )

$$g^{M}_{MWGC} = \frac{V^{M}_{MWGC}}{2G} = \frac{1{,}374 \cdot 10^{37}}{2 \cdot 2{,}034 \cdot 10^{17}} = 3{,}377 \cdot 10^{19} \; cm/s^2 \; .$$

The gravity acceleration of the centre of any galaxy can be found in the same way.

$$g_1 = \frac{M_1 g_2}{M_2} . \qquad (\quad)$$

$$g_2 = \frac{M_2 g_1}{M_1} . \qquad (\quad)$$

The Sun gravity acceleration g_{SUN} was found proceeding from the Sun mass M_{SUN}, the Earth gravity acceleration g_{EAR} and the Earth mass M_{EAR} by the formula (   )

$$g_{SUN} = \frac{M_{SUN} g_{EAR}}{M_{EAR}} = \frac{1{,}273 \cdot 10^{30} \cdot 980{,}665}{3{,}824 \cdot 10^{24}} = 3{,}265 \cdot 10^{8} \; cm/s^2 \; .$$

The Earth gravity acceleration g_{EAR} was found proceeding from the Earth mass M_{EAR}, the Sun gravity acceleration g_{SUN} and the Sun mass M_{SUN} by the formula (   )

$$g_{EAR} = \frac{M_{EAR} g_{SUN}}{M_{SUN}} = \frac{3{,}824 \cdot 10^{24} \cdot 3{,}265 \cdot 10^{8}}{1{,}273 \cdot 10^{30}} = 980{,}665 \;\; cm/s^2 \; .$$

The gravity acceleration of other bodies in the Solar System and in the Milky Way galaxy were found in the same way (see table …) .

The Sun gravity acceleration g_{SUN} was found proceeding from the Sun mass M_{SUN}, Mars gravity acceleration g_{MAR} and Mars mass M_{MAR} by the formula ( )

$$g_{SUN} = \frac{M_{SUN} g_{MAR}}{M_{MAR}} = \frac{1,273 \cdot 10^{30} \cdot 105,35}{4,108 \cdot 10^{23}} = 3,265 \cdot 10^{8}\ cm/s^{2} .$$

Mars gravity acceleration g_{MAR} was found proceeding from Mars mass M_{MAR} , the Sun gravity acceleration g_{SUN} an the Sun mass Msun by the formula ( )

$$g_{MAR} = \frac{M_{MAR} g_{СОЛ}}{M_{СОЛ}} = \frac{4,108 \cdot 10^{23} \cdot 3,265 \cdot 10^{8}}{1,123 \cdot 10^{30}} = 105,35\ \ cm/s^{2} .$$

The Sun gravity acceleration g_{SUN} was found proceeding from the Sun mass M_{SUN}, Jupiter gravity acceleration g_{JUP} and Jupiter mass M_{JUP} by the formula ( )

$$g_{SUN} = \frac{M_{SUN} g_{MAR}}{M_{MAR}} = \frac{1,273 \cdot 10^{30} \cdot 105,35}{4,108 \cdot 10^{23}} = 3,265 \cdot 10^{8}\ cm/s^{2} .$$

Jupiter gravity acceleration g_{JUP} was found proceeding from Jupiter mass M_{JUP}, the Sun gravity acceleration g_{SUN} and the Sun mass M_{SUN} by the formula ( )

$$g_{JUP} = \frac{M_{JUP} g_{SUN}}{M_{SUN}} = \frac{1,214 \cdot 10^{27} \cdot 3,265 \cdot 10^{8}}{1,123 \cdot 10^{30}} = 3,113 \cdot 10^{5}\ cm/s^{2} .$$

The Sun gravity acceleration g_{SUN} was found proceeding from the Sun mass M_{SUN}, Dionis gravity acceleration g_{DIO} and Dionis mass M_{DIO} by the formula ( )

$$g_{SUN} = \frac{M_{SUN} g_{DIO}}{M_{DIO}} = \frac{1,273 \cdot 10^{30} \cdot 105,35}{4,108 \cdot 10^{23}} = 3,265 \cdot 10^{8}\ cm/s^{2} .$$

DIonis gravity acceleration g_{DIO} was found proceeding from Dionis mass M_{DIO}, the Sun gravity acceleration g_{SUN} and the Sun mass M_{SUN} by the formula ( )

$$g_{DIO} = \frac{M_{DIO} g_{SUN}}{M_{SUN}} = \frac{1,773 \cdot 10^{12} \cdot 3,265 \cdot 10^{8}}{1,273 \cdot 10^{30}} = 4,547 \cdot 10^{-10}\ cm/s^{2} .$$

The Sun gravity acceleration g_{SUN} was found proceeding from the Sun mass M_{SUN}, Plyto gravity acceleration g_{JUP} and Pluto mass M_{PLU} by the formula ( )

$$g_{PLU} = \frac{M_{SUN} g_{PLU}}{M_{PLU}} = \frac{1{,}273 \cdot 10^{30} \cdot 2{,}4}{9{,}36 \cdot 10^{21}} = 3{,}265 \cdot 10^{8}\ cm/s^2 .$$

Pluto gravity acceleration g_{PLU} was found proceeding from Pluto mass M_{PLU}, the Sun gravity acceleration g_{SUN} and the Sun mass M_{SUN} by the formula ( )

$$g_{PLU} = \frac{M_{PLU} g_{SUN}}{M_{SUN}} = \frac{9{,}36 \cdot 10^{21} \cdot 3{,}265 \cdot 10^{8}}{1{,}273 \cdot 10^{30}} = 2{,}4\, cm/s^2 .$$

The Sun gravity acceleration g_{SUN} was found proceeding from the Sun mass M_{SUN}, Eryde gravity acceleration g_{JERY} and Eryde mass M_{ERY} y the formula ( )

$$g_{SUN} = \frac{M_{SUN} g_{ERY}}{M_{ERY}} = \frac{1{,}273 \cdot 10^{30} \cdot 2{,}721}{1{,}061 \cdot 10^{22}} = 3{,}265 \cdot 10^{8}\ cm/s^2 .$$

Eryde gravity acceleration g_{ERY} was found proceeding from Eryde mass M_{ERY} the Sun gravity acceleration g_{SUN} and the Sun mass M_{SUN} by the formula ( )

$$g_{ERY} = \frac{M_{ERY} g_{SUN}}{M_{SUN}} = \frac{1{,}061 \cdot 10^{22} \cdot 3{,}265 \cdot 10^{8}}{1{,}273 \cdot 10^{30}} = 2{,}721\, cm/s^2 .$$

The Sun gravity acceleration g_{SUN} was found proceeding from the Sun mass M_{SUN}, the gravity acceleration of the Milky Way galaxy centre g_{MWGC} and the mass of the Milky Way galaxy centre M_{MWGC} by the formula ( )

$$g_{SUN} = \frac{M_{SUN} g_{MWGC}}{M_{MWGC}} = \frac{1{,}273 \cdot 10^{30} \cdot 2{,}936 \cdot 10^{19}}{1{,}145 \cdot 10^{41}} = 3{,}265 \cdot 10^{8}\ cm/s^2 .$$

The gravity acceleration of the Milky Way galaxy centre g_{JMWGC} was found proceeding from the mass of the Milky Way galaxy centre M_{JMWGC} the Sun gravity acceleration g_{SUN} and the Sun mass M_{SUN} by the formula ( )

$$g_{MWGC} = \frac{M_{MWGC} g_{SUN}}{M_{SUN}} = \frac{1{,}145 \cdot 10^{41} \cdot 3{,}265 \cdot 10^{8}}{1{,}273 \cdot 10^{30}} = 2{,}936 \cdot 10^{19}\ cm/s^2 .$$

5.8. Measuring the weight of the body

The weight of *1 g* P_1^1 was found as the product of the mass of *1g* M_1 by the gravity acceleration of *g* body g_1 by the formula (   )

$$P_1=M_1\, g_1^M =1\cdot 2{,}5645\cdot 10^{-22}=2{,}5645\cdot 10^{-22}.$$

The Sun weight P_{SUN} was found as the product of the Sun mass M_{SUN} by the Sun gravity acceleration g_{SUN} by the formula (   )

$$P_{SUN}=M_{CSUN}\cdot g_{SUN}=1{,}273\cdot 10^{30}\cdot 3{,}265\cdot 10^{8}=4{,}156\cdot 10^{38}\ gcm/s^2.$$

The Sun weight taking into account the Earth gravity acceleration $P_{SUN-EAR}$ was found as the product of the Sun mass M_{SUN} by the Earth gravity acceleration g_{EAR} by the formula (   )

$$P_{SUN-EARM}=M_{SUN}\cdot g_{EAR}=1{,}273\cdot 10^{30}\cdot 980{,}665=1{,}248\cdot 10^{33}\ gcm/s^2.$$

The Earth weight taking into account the Sun gravity acceleration $P_{EAR-SUN}$ was found as the product of the Earth mass M_{EAR} by the Sun gravity acceleration g_{SUN} by the formula (   )

$$P_{EAR-SUN}=M_{EAR}\cdot g_{SUN}=3{,}824\cdot 10^{24}\cdot 3{,}265\cdot 10^{8}=1{,}249\cdot 10^{33}\ gcm/s^2.$$

The weight of any star taking into account the gravity acceleration of the planet and the weight of any planet taking into account the gravity acceleration of the star may be found in the same way.

Mars weight P_{MAR} was found as the product of Mars M_{MAR} by Mars gravity acceleration g_{MAR} by the formula (   )

$$P_{MAR}=M_{MAR}\cdot g_{MAR}=4{,}108\cdot 10^{23}\cdot 105{,}35=4{,}328\cdot 10^{25}\ gcm/s^2.$$

Mars weight taking into account the Earth gravity acceleration $P_{MAR-EAR}$ wa found as the product of Mars mass M_{MAR} by the gravity acceleration g_{MAR} by the formula (   )

$$P_{MAR-EAR}=M_{MAR}\cdot g_{EAR}=4{,}108\cdot 10^{23}\cdot 980{,}665=4{,}029\cdot 10^{26}\ gcm/s^2.$$

The Earth weight taking into account Mars gravity acceleration $P_{EAR-MAR}$ was found as the product of the Earth mass M_{EAR} by Mars gravity acceleration g_{MAR} by the formula (   )

$$P_{EAR-MAR}=M_{EAR}\cdot g_{EAR}=3{,}824\cdot 10^{24}\cdot 105{,}35=4{,}029\cdot 10^{26}\ gcm/s^2.$$

Jupiter weight P_{JUP} was found as the product of Jupiter mass M_{JUP} by Jupiter gravity acceleration g_{JUP} by the formula ( )

$$P_{JUP}=M_{JUP}\cdot g_{JUP}=1,214\cdot 10^{27}\cdot 3,113\cdot 10^{5}=3,779\cdot 10^{5}\ gcm/s^{2}.$$

Jupiter weight P_{JUP} taking into account the Earth gravity acceleration $P_{JUP-EAR}$ was found as the product of Jupiter mass M_{JUP} by the Earth gravity acceleration g_{EAR} by the formula ( )

$$P_{JUP-EAR}=M_{JUP}\cdot g_{EAR}=1,214\cdot 10^{27}\cdot 980,665=1,191\cdot 10^{30}\ gcm/s^{2}.$$

The Earth weight taking into account Jupiter gravity acceleration $P_{EAR-JUP}$ was found as the product of the Earth mass M_{EAR} by the Jupiter gravity acceleration g_{JUP} by the formula ( )

$$P_{EAR-JUP}=M_{3EAR}\cdot g_{JUP}=3,824\cdot 10^{24}\cdot 3,113\cdot 10^{5}=1,19\cdot 10^{30}\ gcm/s^{2}.$$

Saturn weight P_{SAT} was found as the product of Saturn mass M_{SAT} by Saturn gravity acceleration g_{SAT} by the formula ( )

$$P_{SAT}=M_{SAT}\cdot g_{SAT}=3,643\cdot 10^{26}\cdot 9,342\cdot 10^{4}=3,403\cdot 10^{31}\ gcm/s^{2}.$$

The weight of any planet can be found in the same way.

Saturn weight taking into account the Earth gravity acceleration $P_{SAT-EAR}$ was found as the product of Saturn mass M_{SAT} by the Earth gravity acceleration g_{EAR} by the formula ( )

$$P_{SAT-EAR}=M_{SAT}\cdot g_{EAR}=3,643\cdot 10^{26}\cdot 980,665=3,573\cdot 10^{29}\ gcm/s^{2}.$$

The Earth weight taking into account Saturn gravity acceleration $P_{EAR-SAT}$ was found as the product of the Earth mass M_{EAR} by the Saturn gravity acceleration g_{SAT} by the formula ( )

$$P_{EAR-SAT}=M_{EAR}\cdot g_{SAT}=3,824\cdot 10^{24}\cdot 9,342\cdot 10^{4}=3,572\cdot 10^{29}\ gcm/s^{2}.$$

The weight of any planet and the weight of any planet taking into account the gravity acceleration of any other planet can be found in the same way.

Pluto weight P_{PLU} was found as the product of Pluto mass M_{PLU} by Pluto gravity acceleration g_{PLU} by the formula ( )

$$P_{PLU}=M_{PLU}\cdot g_{PLU}=9,36\cdot 10^{21}\cdot 2,4=2,246\cdot 10^{22}\ gcm/s^{2}.$$

Pluto weight taking into account the Earth gravity acceleration $P_{PLU-EAR}$ was found as the product of Pluto mass M_{PLU} by the Earth gravity acceleration g_{EAR} by the formula ( )

$$P_{PLU\text{-}EAR}=M_{PLU}\cdot g_{EAR}=9,36\cdot 10^{21}\cdot 980,665=9,179\cdot 10^{24}\ gcm/s^2.$$

The Earth weight taking into account Pluto gravity acceleration $P_{EAR\text{-}PLU}$ was found as the product of the Earth mass M_{EAR} by Pluto gravity acceleration g_{PLU} by the formula (   )

$$P_{EAR\text{-}PLU}=M_{EAR}\cdot g_{PLU}=3,824\cdot 10^{24}\cdot 2,4^4=9,178\cdot 10^{24}\ \ gcm/s^2.$$

Eryde mass P_{ERY} was found as the product of Eryde mass M_{ERY} by Eryde gravity acceleration g_{ERY} by the formula (   )

$$P_{ERY}=M_{ERY}\cdot g_{ERY}=1,061\cdot 10^{22}\cdot 2,721=2,887\cdot 10^{22}\ gcm/s^2.$$

Eryde weight taking into account the Earth gravity acceleration $P_{ERY\text{-}EAR}$ was found as the product of Eryde mass M_{ERY} by the Earth gravity acceleration g_{EAR} by the formula (   )

$$P_{ERY\text{-}EAR}=M_{ERY}\cdot g_{EAR}=1,061\cdot 10^{22}\cdot 980,665=1,04\cdot 10^{25}\ \ gcm/s^2.$$

The Earth weight taking into account Eryde gravity acceleration $P_{EAR\text{-}ERY}$ was found as the product of the Earth mass M_{EAR} by Eryde gravity acceleration g_{ERY} by the formula (   )

$$P_{EAR\text{-}ERY}=M_{EAR}\cdot g_{ERY}=3,824\cdot 10^{24}\cdot 2,721=1,041\cdot 10^{25}\ \ gcm/s^2.$$

The weight of any dwarf planet, the weight of a dwarf planet taking into account the gravity acceleration of any planet and the planet weight taking into account the gravity acceleration of any dwarf planet can be found in the same way.

Dionis weight P_{DIO} was found as the product of Dionis mass M_{DIO} by Dionis gravity acceleration g_{DIO} by the formula (   )

$$P_{DIO}=M_{DIO}\cdot g_{DIO}=1,773\cdot 10^{12}\cdot 4,547\cdot 10^{-10}=806,183\ gcm/s^2.$$

Dionis weight taking into account the Earth gravity acceleration $P_{DIO\text{-}EAR}$ was found as the product of Dionis mass M_{DIO} by the Earth gravity acceleration g_{EAR} by the formula (   )

$$P_{DIO\text{-}EAR}=M_{DIO}\cdot g_{EAR}=1,773\cdot 10^{12}\cdot 980,665=1,739\cdot 10^{15}\ \ gcm/s^2.$$

The Earth weight taking into account Dionis gravity acceleration $P_{EAR\text{-}DIO}$ was found as the product of the Earth mass M_{EAR} by Dionis gravity acceleration g_{DIO} by the formula (   )

$$P_{EAR\text{-}DIO}=M_{EAR}\cdot g_{DIO}=3,824\cdot 10^{24}\cdot 4,547\cdot 10^{-10}=1,739\cdot 10^{15}\ \ gcm/s^2.$$

The weight of any asteroid, the weight of any asteroid taking into account the gravity acceleration of any asteroid and the weight of any planet taking into account the gravity acceleration of any planet and the weight of any planet taking into account the gravity acceleration of any asteroid.

The weight of the black hole with the radius of $1\ cm$ P_{BH1} was found as the product of the mass of the black hole with the radius of $1\ cm$ M_{BH1} by the gravity acceleration of the black hole with the radius of $1\ cm$ g_{BH1} by the formula ( )

$$P_{BH1}=M_{BH1}g_{BH1}=8,615\cdot 10^{24}\cdot 2209,317=1,903\cdot 10^{28}\ gcm/s^2.$$

The weight of the black hole of $1\ cm$ taking into the Earth gravity acceleration $P_{BH1\text{-}EAR}$ was found as the product of the mass of the black hole with the radius of $1\ cm$ M_{BH1} by the Earth gravity acceleration g_{EAR} by the formula ( )

$$P_{BH1\text{-}EAR}=M_{BH1}\cdot g_{EAR}=8,615\cdot 10^{24}\cdot 980,665=8,448\cdot 10^{27}\ gcm/s^2.$$

The weight of Sagittarius A black hole P_{BHSA} was found as the product of the mass of Sagittarius A black hole M_{BHSA} by the gravity acceleration of Sagittarius A black hole g_{BHSA} by the formula ( )

$$P_{BHSA}=M_{BHSA}g_{BHSA}=4,769\cdot 10^{36}\cdot 1,223\cdot 10^{15}=5,832\cdot 10^{51}\ gcm/s^2.$$

The weight of Sagittarius A black hole taking into account the Earth gravity acceleration $P_{BHSA\text{-}EAR}$ was found as the product of the mass of the Sagittarius A black hole M_{BHSA} by the Earth gravity acceleration g_{3EAR} by the formula ( )

$$P_{BHSA\text{-}EAR}=M_{BHSA}\cdot g_{EAR}=4,769\cdot 10^{36}\cdot 980,665=4,677\cdot 10^{39}\ gcm/s^2.$$

The Earth weight taking into account the gravity acceleration of Sagittarius A black hole $P_{EAR\text{-}BHSA}$ was found as the product of the Earth mass M_{EAR} by the gravity acceleration of Sagittarius A black hole g_{BHSA} by the formula ( )

$$P_{EAR\text{-}BHSA}=M_{EAR}\cdot g_{BHSA}=3,824\cdot 10^{24}\cdot 1,223\cdot 10^{15}=4,677\cdot 10^{39}\ gcm/s^2.$$

The weight of any black hole, taking into account the gravity acceleration of any planet and the weight of any planet taking into consideration gravity acceleration of any black hole can be found in the same way.

The weight of the Milky Way galaxy centre P_{MWGC} was found as the product of the mass of the Milky Way galaxy centre M_{MWGC} by the gravity acceleration of the Milky Way galaxy centre g_{MWGC} by the formula ( )

$$P_{MWGC}=M_{MWGC}g_{MWGC}=1{,}145\cdot10^{41}\cdot2{,}936\cdot10^{19}=3{,}362\cdot10^{60}\ gcm/s^2.$$

The weight of the centre of any galaxy can be found in the same way.

The weight of the Milky Way galaxy centre taking into account the Earth gravity acceleration $P_{MWGC\text{-}EAR}$ was found as the product of the mass of the Milky Way galaxy centre M_{MWGC} by the Earth gravity acceleration g_{EAR} by the formula ( )

$$P_{ЦГМП\text{-}ЗЕМ}=M_{ЦГМП}\cdot g_{ЗЕМ}=1{,}145\cdot10^{41}\cdot980{,}665=1{,}123\cdot10^{44}\ gcm/s^2.$$

The Earth weight taking into account the gravity acceleration of the Milky Way galaxy centre $P_{EAR\text{-}MWGC}$ was found as the product of the Earth mass M_{EAR} by the gravity acceleration of the Milky Way galaxy centre g_{MWGC} by the formula ( )

$$P_{EAR\text{-}MWGC}=M_{EAR}\cdot g_{MWGC}=3{,}824\cdot10^{24}\cdot2{,}936\cdot10^{19}=1{,}123\cdot10^{44}\ gcm/s^2.$$

The weight of any galaxy centre, taking into account the gravity acceleration of any planet and the weight of any planet taking into account the gravity acceleration of the centre of any galaxy.

5.9. Measuring the body velocity

Taking into account that $V_1^M=2Gg_1^M$ and $V_B^M=V_1^M M_1$ the formula ( ) was written in the following way

$$V_2 = \sqrt{\frac{V_B^M}{R_{1-2}}}, \qquad (\quad)$$

where V_2 is the average orbital velocity of the second body cm/s;

V_B^M is the body gravitational field constant, cm^3/s^2;

R_{1-2} is the distance from the first body to the second one, cm;

After solving the equation ( ) with regard to V_2^2 there was received

$$V_2^2 = \frac{2GM_1 g_2}{R_{1-2} M_2}. \qquad (\quad)$$

Taking into account that $g_1^M = \frac{g_2}{M_2}$, $V_1^M=2Gg^M$ and $V_B^M=V_1^M M_1$ the formula was written in the following way

$$V_2 = \sqrt{\frac{V_B^M}{R_{1-2}}}, \qquad (\quad)$$

where V_2 is the average orbital velocity of the second body cm/s;

V_B^M is the body gravitational field constant, cm^3/s^2;

R_{1-2} is the distance from the first body to the second one, cm;

The obtained formula ( ) is identical to the formula ( )

Having solved the equation ( ) with regard to V_2 we obtained

$$V_2 = \sqrt{\frac{2Gg_1}{R_{1-2}}}. \qquad (\quad)$$

Taking into account that $V_T^M=2Gg_1$ the formula ( ) was written in the following way

$$V_2 = \sqrt{\frac{V_B^M}{R_{1-2}}}. \qquad (\quad)$$

The obtained formula ( ) is identical to the formula ( )

For practical checking up the formula ( ) there were found the average orbital velocity of different bodies in the Solar system and the Milky Way galaxy.

The average orbital Sun velocity V_{SUN} was found as the square root of the relation of the gravitational field constant of the Milky Way galaxy centre V^M_{MWGC} to the average distance of the Milky Way galaxy centre to the Sun $R_{MWGC\text{-}SUN}$ by the formula ( )

$$V_{SUN} = \sqrt{\frac{V^M_{MWGC}}{R_{MWGC-SUN}}} = \sqrt{\frac{1{,}374 \cdot 10^{37}}{2{,}838 \cdot 10^{22}}} = 2{,}2 \cdot 10^7 \ \ cm/s\,.$$

The average orbital velocity of any star can be found in the same way.

The average orbital Mercury velocity V_{MER} was found as the square root of the relation of the Sun gravitational field constant V^M_{SUN} to the average distance from the Sun to Mercury $R_{SUN\text{-}MER}$ by the formula ( )

$$V_{MER} = \sqrt{\frac{V^M_{SUN}}{R_{SUN-MER}}} = \sqrt{\frac{1{,}33 \cdot 10^{26}}{5{,}79 \cdot 10^{12}}} = 4{,}793 \cdot 10^6 \ \ cm/s\,.$$

The average orbital Venus velocity V_{VEN} was found as the square root of the relation of the Sun gravitational field constant V^M_{SUN} to the average distance from the Sun to Venus $R_{SUN\text{-}VEN}$ by the formula ( )

$$V_{VEN} = \sqrt{\frac{V^M_{SUN}}{R_{SUN-VEN}}} = \sqrt{\frac{1{,}33 \cdot 10^{26}}{1{,}082 \cdot 10^{13}}} = 3{,}506 \cdot 10^6 \ cm/s\,.$$

The average orbital Earth velocity V_{EAR} was found as the square root of the relation of the Sun gravitational field constant V^M_{SUN} to the average distance from the Sun to the Earth $R_{SUN\text{-}EAR}$ by the formula ( )

$$V_{EAR} = \sqrt{\frac{V^M_{SUN}}{R_{SUN-EAR}}} = \sqrt{\frac{1{,}33 \cdot 10^{26}}{1{,}496 \cdot 10^{13}}} = 2{,}982 \cdot 10^6 \ \ cm/s\,.$$

The average orbital velocity of any other planet can be found in the same way.

The average orbital Moon velocity V_{MOO} was found as the square root of the relation of the Earth gravitational field constant V^M_{EAR} to the average distance from the Earth to the Moon $R_{EAR\text{-}MOO}$ by the formula ( )

$$V_{MOO} = \sqrt{\frac{V_{EAR}^{M}}{R_{EAR-MOO}}} = \sqrt{\frac{4,025 \cdot 10^{20}}{3,844 \cdot 10^{10}}} = 1,023 \cdot 10^{5} \ \ cm/s .$$

The average orbital Phobos velocity V_{PHO} was found as the square root of the relation of the Mars gravitational field constant V_{MAR}^{M} to the average distance from Mars to Phobos $R_{MAR\text{-}PHO}$ by the formula (   )

$$V_{PHO} = \sqrt{\frac{V_{MAR}^{M}}{R_{MAR-PHO}}} = \sqrt{\frac{4,286 \cdot 10^{19}}{9,378 \cdot 10^{8}}} = 2,138 \cdot 10^{5} \ \ cm/s .$$

The average orbital Deimos velocity V_{DEI} was found as the square root of the relation of the Mars gravitational field constant V_{MAR}^{M} to the average distance from Mars to Deimos $R_{MAR\text{-}DEI}$ by the formula (   )

$$V_{DEI} = \sqrt{\frac{V_{MAR}^{M}}{R_{MAR-DEI}}} = \sqrt{\frac{4,286 \cdot 10^{19}}{2,3459 \cdot 10^{9}}} = 1,352 \cdot 10^{5} \ \ cm/s .$$

The average orbital velocities of any other planetary satellites can be found in the same way.

The average orbital velocity of any other planet can be found in the same way.

The average orbital Ceres velocity V_{CER} was found as the square root of the relation of the Sun gravitational field constant V_{SUN}^{M} to the average distance from the Sun to Ceres $R_{SUN\text{-}CER}$ by the formula (   )

$$V_{CER} = \sqrt{\frac{V_{SUN}^{M}}{R_{SUN-CER}}} = \sqrt{\frac{1,33 \cdot 10^{26}}{4,139 \cdot 10^{13}}} = 1,792 \cdot 10^{6} \ \ cm/s .$$

The average orbital Pallas velocity V_{PAL} was found as the square root of the relation of the Sun gravitational field constant V_{SUN}^{M} to the average distance from the Sun to Pallas $R_{SUN\text{-}PAL}$ by the formula (   )

$$V_{PAL} = \sqrt{\frac{V_{SUN}^{M}}{R_{SUN-PAL}}} = \sqrt{\frac{1,33 \cdot 10^{26}}{4,15 \cdot 10^{13}}} = 1,79 \cdot 10^{6} \ \ cm/s .$$

The average orbital Juno velocity V_{JUN} was found as the square root of the relation of the Sun gravitational field constant V_{SUN}^{M} to the average distance from the Sun to Juno $R_{SUN\text{-}JUN}$ by the formula (   )

$$V_{JUN} = \sqrt{\frac{V_{SUN}^{M}}{R_{SUN-JUN}}} = \sqrt{\frac{1,33 \cdot 10^{26}}{3,993 \cdot 10^{13}}} = 1,825 \cdot 10^{6} \ \ cm/s .$$

The average orbital velocity of any other asteroid can be found in the same way.

The average orbital Gallus comet velocity V_{GAL} was found as the square root of the relation of the Sun gravitational field constant V_{SUN}^{M} to the average distance from the Sun to Gallus comet $R_{SUN\text{-}GAL}$ by the formula ( )

$$V_{GASL} = \sqrt{\frac{V_{SUN}^{M}}{R_{SUN-GAL}}} = \sqrt{\frac{1{,}33 \cdot 10^{26}}{2{,}684 \cdot 10^{14}}} = 7{,}039 \cdot 10^{5} \quad cm/s\,.$$

The average orbital Encke comet velocity V_{ENC} was found as the square root of the relation of the Sun gravitational field constant V_{SUN}^{M} to the average distance from the Sun to Encke comet $R_{SUN\text{-}ENC}$ by the formula ( )

$$V_{ENC} = \sqrt{\frac{V_{SUN}^{M}}{R_{SUN-ENC}}} = \sqrt{\frac{1{,}33 \cdot 10^{26}}{3{,}306 \cdot 10^{13}}} = 2{,}006 \cdot 10^{6} \quad cm/s\,.$$

The average orbital comet Hyakutake velocity V_{HYA} was found as the square root of the relation of the Sun gravitational field constant V_{SUN}^{M} to the average distance from the Sun to Hyakutake comet $R_{SUN\text{-}HYA}$ by the formula ( )

$$V_{HYA} = \sqrt{\frac{V_{SUN}^{M}}{R_{SUN-HYA}}} = \sqrt{\frac{1{,}33 \cdot 10^{26}}{1{,}743 \cdot 10^{16}}} = 8{,}736 \cdot 10^{4} \quad cm/s\,.$$

The average orbital velocity of any other comet can be found in the same way.

The average orbital of S2 star velocity V_{S2} was found as the square root of the relation of the gravitational field constant of Saggitarius A black hole V_{BHSA}^{M} to the average distance from the black hole Saggitarius A to S2 star $R_{BHSA\text{-}S2}$ by the formula ( )

$$V_{SA} = \sqrt{\frac{V_{BHSA}^{M}}{R_{BHSA-S2}}} = \sqrt{\frac{4{,}975 \cdot 10^{32}}{1{,}426 \cdot 10^{16}}} = 1{,}868 \cdot 10^{8} \quad cm/s\,.$$

The average orbital velocity of any other star can be found in the same way.

The average orbital velocities of different bodies in the Solar system and in the Milky Way galaxy found by the formula ( ) coincided with the average orbital velocities of different bodies in the Solar system and in the Milky Way were found with the help of other methods, which proves its validity.

Some insignificant differences between the results found by the formula ( ) and the latest data of NASA may be explained by insufficient exactness of the known methods of finding the distances between the bodies.

5.10. Measuring the body cosmic velocity

The body cosmic velocity V_B^{COS} is the square root of the relation of the Body gravitational field constant V_B^M to the body radius R_B

$$V_B^{COS} = \sqrt{\frac{V_B^M}{R_B}} .$$

The first cosmic velocities of different bodies in the Solar system and in the Milky Way galaxy were found with the help of the formula ( ).

The Sun cosmic velocity for the Sun radius R_{SUN} V_{SUN} was found as the square root of the relation of the Sun gravitational field constant V_{SUN}^M to the Sun radius R_{SUN} by the formula ( ):

$$V_{SUN}^{COS-R} = \sqrt{\frac{V_{SUN}^M}{R_{SUN}}} = \sqrt{\frac{1{,}33 \cdot 10^{26}}{6{,}961 \cdot 10^{10}}} = 4{,}371 \cdot 10^7\ cm/s .$$

The first cosmic velocity of any other star can be found in the same way.

The cosmic velocity of the Sun gravitational field for the radius of the Sun gravitational field $R_{SUN\text{-}V}$ V_{SUN}^{COS-R} was found as the square root of the relation of the Sun gravitational field constant V_{SUN}^M to the radius of the Sun gravitational field $R_{SUN\text{-}V}$ by the formula ( )

$$V_{SUN}^{COS-V} = \sqrt{\frac{V_{SUN}^M}{R_{SUN-V}}} = \sqrt{\frac{1{,}33 \cdot 10^{26}}{1{,}33 \cdot 10^{26}}} = 1 cm/s .$$

The cosmic velocity of $1\ cm/s$ of the gravitational field of any body, for the altitude that is equal to the radius of this body gravitational field, can be found in the same way.

The cosmic velocity of the Earth for the Earth radius R_{EAR} V_{EAR}^{COS-R} was found as the square root of the relation of the Earth gravitational field constant V_{EAR}^M to the Earth radius R_{EAR} by the formula ( ):

$$V_{EAR}^{COS-R} = \sqrt{\frac{V_{EAR}^M}{R_{EAR}}} = \sqrt{\frac{4{,}025 \cdot 10^{20}}{6{,}378 \cdot 10^8}} = 7{,}944 \cdot 10^5\ cm/s .$$

The cosmic velocity of the Earth gravitational field for the radius of the Earth gravitational field radius $R_{EAR\text{-}V}$ was found as the square root of the relation of the Earth gravitational field constant V_{EAR}^{M} to the Earth gravitational field radius $R_{EAR\text{-}V}$ by the formula ( )

$$V_{EAR}^{COS-V} = \sqrt{\frac{V_{EAR}^{M}}{R_{EAR-V}}} = \sqrt{\frac{4{,}025\cdot 10^{20}}{4{,}025\cdot 10^{20}}} = 1 cm/s \,.$$

The cosmic velocity of Mars for Mars radius V_{MAR}^{COS-R} was found as the square root of the relation of Mars gravitational field constant V_{MAR}^{M} to Mars radius R_{MAR} by the formula ( ):

$$V_{MAR}^{COS-R} = \sqrt{\frac{V_{MAR}^{M}}{R_{MAR}}} = \sqrt{\frac{4{,}286\cdot 10^{19}}{3{,}397\cdot 10^{8}}} = 3{,}552\cdot 10^{5}\ cm/s \,.$$

The cosmic velocity of Mars gravitational field for Mars gravitational field radius $R_{MAR\text{-}V}$ V_{MAR}^{COS-V} was found as the square root of the relation of Mars gravitational field constant V_{MAR}^{M} to the radius of Mars gravitational field $R_{MAR\text{-}V}$ by the formula ( )

$$V_{MAR}^{COS-V} = \sqrt{\frac{V_{MAR}^{M}}{R_{MAR-V}}} = \sqrt{\frac{4{,}286\cdot 10^{19}}{4{,}286\cdot 10^{19}}} = 1 cm/s$$

The cosmic velocity of Jupiter for Jupiter radius R_{JUP} V_{JUP}^{COS-R} was found as the square root of the relation of Jupiter gravitational field constant V_{JUP}^{M} to Jupiter radius R_{JUP} by the formula ( ):

$$V_{JUP}^{COS-R} = \sqrt{\frac{V_{JUP}^{M}}{R_{JUP-R}}} = \sqrt{\frac{1{,}267\cdot 10^{23}}{7{,}1492\cdot 10^{9}}} = 4{,}2097818\cdot 10^{6}\ cm/s \,.$$

The cosmic velocity of Jupiter gravitational field for the radius of Jupiter gravitational field $R_{JUP\text{-}V}$ V_{JUP}^{COS-V} was found as the square root of the relation of Jupiter gravitational field constant V_{JUP}^{M} to the radius of Jupiter gravitational field $R_{JUP\text{-}V}$ by the formula ( )

$$V_{JUP}^{COS-V} = \sqrt{\frac{V_{JUP}^{M}}{R_{JUP-V}}} = \sqrt{\frac{1{,}267\cdot 10^{23}}{1{,}267\cdot 10^{23}}} = 1 cm/s \,.$$

The cosmic velocity of any other planet can be found in the same way.

The cosmic velocity of Pluto for Pluto radius R_{PLU} V_{PLU}^{COS-R} was found as the square root of the relation of Pluto gravitational field constant V_{PLU}^{M} to Pluto radius R_{PLU} by the formula ( )

$$V_{PLU}^{COS-R} = \sqrt{\frac{V_{PLU}^{M}}{R_{PLU}}} = \sqrt{\frac{9,765 \cdot 10^{17}}{1,195 \cdot 10^{8}}} = 9,04 \cdot 10^{4}\ cm/s.$$

The cosmic velocity of Pluto gravitational field for the radius of Pluto gravitational field R_{PLU-V} V_{PLU}^{COS-V} was found as the square root of the relation of Pluto gravitational field V_{PLU}^{M} to the radius of Pluto gravitational field R_{PLU-V} by the formula ( )

$$V_{PLU}^{COS-V} = \sqrt{\frac{V_{PLU}^{M}}{R_{PLU-V}}} = \sqrt{\frac{9,765 \cdot 10^{17}}{9,765 \cdot 10^{17}}} = 1 cm/s.$$

The cosmic velocity of Eryde for Eryde radius R_{ERY} V_{ERY}^{COS-R} was found as the square root of the relation of Eryde gravitational field constant V_{ERY}^{M} to Eryde radius R_{ERY} by the formula ( )

$$V_{ERY}^{COS-R} = \sqrt{\frac{V_{ERY}^{M}}{R_{ERY}}} = \sqrt{\frac{1,107 \cdot 10^{18}}{1,2 \cdot 10^{8}}} = 9,605 \cdot 10^{4}\ cm/s.$$

The cosmic velocity of Eryde gravitational field for the radius of Eryde gravitational field R_{ERY-V} V_{ERY}^{COS-V} was found as the square root of the relation of Eryde gravitational field constant V_{ERY}^{M} to the radius of Eryde gravitational field R_{ERY-V} by the formula ( )

$$V_{ERY}^{COS-V} = \sqrt{\frac{V_{ERY}^{M}}{R_{ERY-V}}} = \sqrt{\frac{1,107 \cdot 10^{18}}{1,107 \cdot 10^{18}}} = 1 cm/s.$$

The cosmic velocity of Dionis for Dionis radius R_{DIO} V_{DIO}^{COS-R} was found as the square root of the relation of Dionis gravitational field constant V_{DIO}^{M} to Dionis radius R_{DIO} by the formula ( )

$$V_{DIO}^{COS-R} = \sqrt{\frac{V_{DIO}^{M}}{R_{DIO}}} = \sqrt{\frac{1,85 \cdot 10^{8}}{7,5 \cdot 10^{4}}} = 49,665548\, cm/s.$$

The cosmic velocity of Dionis gravitational field for the radius of Dionis gravitational field R_{DIO-V} V_{DIO}^{COS-V} was found as the square root of the relation of

Dionis gravitational field constant V_{DIO}^{M} to the radius of Dionis gravitational field $R_{DIO\text{-}V}$ by the formula ( )

$$V_{DIO}^{COS-V} = \sqrt{\frac{V_{DIO}^{M}}{R_{DIO-V}}} = \sqrt{\frac{1{,}85 \cdot 10^{8}}{1{,}85 \cdot 10^{8}}} = 1 cm/s .$$

The cosmic velocity of the black hole with the radius of *1 cm* for the radius of *1 cm* R_1 V_{BH1}^{COS-R} was found as the square root of the relation of the gravitational constant of the black hole with the radius of *1 cm* V_{BH1}^{M} to the radius equal to *1 cm* of R_{BH1} by the formula ( )

$$V_{BH1}^{COS-1} = \sqrt{\frac{V_{BH1}^{M}}{R_{BH1}}} = \sqrt{\frac{8{,}988 \cdot 10^{20}}{1}} = 2{,}9979 \cdot 10^{10}\, cm/s .$$

The cosmic velocity of the gravitational field of the black hole with the radius of *1 cm* R_1 V_{BH1}^{COS-1} was found as the square root of the relation of the gravitational field constant of the black hole with the radius of *1 cm* V_{BH1}^{M} to the radius equal to *1 cm* $R_{\text{-}BH1}$ by the formula ( )

$$V_{BH1}^{COS-1} = \sqrt{\frac{V_{BH1}^{M}}{R_{BH1}}} = \sqrt{\frac{8{,}988 \cdot 10^{20}}{8{,}988 \cdot 10^{20}}} = 1 cm/s .$$

The cosmic velocity of Saggitarius A black hole for the radius of Saggitarius A black hole R_{BHSA} V_{BHSA}^{KOC-R} was found as the square root of the relation of the gravitational field of Saggitarius A black hole V_{BHSA}^{M} to the radius of Saggitarius A black hole R_{HSA} by the formula ( )

$$V_{BHSA}^{COS-R} = \sqrt{\frac{V_{BHSA}^{M}}{R_{BHSA}}} = \sqrt{\frac{4{,}975 \cdot 10^{32}}{5{,}5357 \cdot 10^{11}}} = 2{,}99785 \cdot 10^{10}\, cm/s .$$

The cosmic velocity of any other black hole can be found in the same way.

The cosmic velocity of the gravitational field of Saggitarius A black hole for gravitational field radius of Saggitarius A black hole $R_{BHSA\text{-}V}$ V_{BHSA}^{COS-V} was found as the square root of the relation of gravitational field constant of Saggitarius A black hole V_{BHSA}^{M} to the gravitational field radius of Saggitarius A black hole $R_{BHSA\text{-}V}$ by the formula ( )

$$V_{BHSA}^{COS-V} = \sqrt{\frac{V_{BHSA}^{M}}{R_{BHSA-V}}} = \sqrt{\frac{4{,}975 \cdot 10^{32}}{4{,}975 \cdot 10^{32}}} = 1 cm/s .$$

The cosmic velocity of the Milky Way galaxy centre for the radius of the Milky Way galaxy centre R_{MWGC} V_{MWGC}^{COS-R} was found as the square root of the relation of the gravitational field constant of the Milky Way galaxy centre V_{DIO}^{M} to the gravitational field radius of the Milky Way galaxy centre R_{DIO} by the formula ( )

$$V_{MWGC}^{COS-R} = \sqrt{\frac{V_{MWGC}^{M}}{R_{MWGC}}} = \sqrt{\frac{1{,}374 \cdot 10^{37}}{3{,}0857 \cdot 10^{24}}} = 2{,}1102 \cdot 10^{6}\ cm/s .$$

The cosmic velocity of any other galaxy centre can be found in the same way.

The cosmic velocity of the gravitational field of the Milky Way galaxy centre for the gravitational field radius of the Milky Way galaxy centre $R_{MWGC\text{-}V}$ V_{MWGC}^{COS-V} was found as the square root of the relation of the gravitational field constant of the Milky Way galaxy centre V_{MWGC}^{M} to the gravitational field radius of the Milky Way galaxy centre $R_{MWGC\text{-}V}$ by the formula ( )

$$V_{MWGC}^{COS-V} = \sqrt{\frac{V_{MWGC}^{M}}{R_{MWGC-R}}} = \sqrt{\frac{1{,}374 \cdot 10^{37}}{1{,}374 \cdot 10^{37}}} = 1 cm/s .$$

The cosmic velocity of any distances from any other bodies can be found in the same way.

5.11. Measuring the distances between the bodies

After solving the formula ( ) with regard to $R_{1\text{-}2}$ there was obtained

$$R_{1-2} = \frac{2GM_1 g_1^M}{V_2^2}. \qquad (\ \ )$$

Taking into account that $V_1^M = 2Gg_1^M$ and $V_T^M = V_1^M M_1$ the formula ( ) was written down in the following way

$$R_{1-2} = \frac{V_T^M}{V_2^2}, \qquad (\ \ )$$

where $R_{1\text{-}2}$ is the distance from the first body to the second one, *cm*;

V_B^M is the body gravitational field constant, cm^3/s^2;

V_2 is the average orbital velocity of the second body *cm/s*.

For practical checking up the formula (1) there were found the average distances between different bodies in the Solar system and in the Milky Way galaxy.

The average distance from the Sun to Mercury $R_{SUN\text{-}MER}$ was found as the relation of the Sun gravitational field constant V_{SUN}^M to the squared average orbital velocity of Mercury V_{MER}^2 by the formula (1)

$$R_{SUN-MEE} = \frac{V_{SUN}^M}{V_{MER}^2} = \frac{1{,}33 \cdot 10^{26}}{2{,}29 \cdot 10^{13}} = 5{,}808 \cdot 10^{12}\, cm.$$

The average distance from the Sun to Venus $R_{SUN\text{-}VEN}$ was found as the relation of the Sun gravitational field constant V_{SUN}^M to the squared average orbital velocity of Venus V_{VEN}^2 by the formula (1)

$$R_{SUN-VEN} = \frac{V_{SUN}^M}{V_{VEN}^2} = \frac{1{,}33 \cdot 10^{26}}{1{,}226 \cdot 10^{13}} = 1{,}085 \cdot 10^{13}\, cm.$$

The average distance from the Sun to the Earth $R_{SUN\text{-}EAR}$ was found as the relation of the Sun gravitational field constant V_{SUN}^M to the squared average orbital Earth velocity V_{EAR}^2 by the formula (1)

$$R_{SUN-EAR} = \frac{V_{SUN}^M}{V_{EAR}^2} = \frac{1{,}33 \cdot 10^{26}}{8{,}874 \cdot 10^{12}} = 1{,}499 \cdot 10^{13}\, cm.$$

The average distance from a star to its planets can be found in the same way.

The average distance from the Sun to Juno $R_{SUN\text{-}JUN}$ was found as the relation of the Sun gravitational field constant V_{SUN}^{M} to the squared average orbital velocity of Juno V_{JUN}^{2} by the formula (1)

$$R_{SUN-JUN} = \frac{V_{SUN}^{M}}{V_{JUN}^{2}} = \frac{1{,}33\cdot 10^{26}}{3{,}316\cdot 10^{12}} = 4{,}011\cdot 10^{13}\,cm\,.$$

The average distance from the Sun to Pallas $R_{SUN\text{-}PAL}$ was found as the relation of the Sun gravitational field constant V_{SUN}^{M} to the squared average orbital velocity of Pallas V_{PAL}^{2} by the formula (1)

$$R_{SUN-PAL} = \frac{V_{SUN}^{M}}{V_{PAL}^{2}} = \frac{1{,}33\cdot 10^{26}}{3{,}204\cdot 10^{12}} = 4{,}151\cdot 10^{13}\,cm\,.$$

The average distance from the Sun to Ceres $R_{SUN\text{-}CER}$ was found as the relation of the Sun gravitational field constant V_{SUN}^{M} to the squared average orbital velocity of Ceres V_{CER}^{2} by the formula (1)

$$R_{SUN-CER} = \frac{V_{SUN}^{M}}{V_{CER}^{2}} = \frac{1{,}33\cdot 10^{26}}{3{,}201\cdot 10^{12}} = 4{,}155\cdot 10^{13}\,cm\,.$$

The average distance from a star to any other asteroids can be found in the same way.

The average distance from the Sun to Gallus $R_{SUN\text{-}GAL}$ was found as the relation of the Sun gravitational field constant V_{SUN}^{M} to the squared average orbital velocity of Gallus V_{GAL}^{2} by the formula (1)

$$R_{SUN-GAL} = \frac{V_{SUN}^{M}}{V_{GAL}^{2}} = \frac{1{,}33\cdot 10^{26}}{4{,}914\cdot 10^{11}} = 2{,}707\cdot 10^{14}\,cm\,.$$

The average distance from the Sun to Encke comet $R_{SUN\text{-}ENK}$ was found as the relation of the Sun gravitational field constant V_{SUN}^{M} to the squared average orbital velocity of Enke comet V_{ENK}^{2} by the formula (1)

$$R_{SUN-ENK} = \frac{V_{SUN}^{M}}{V_{ENK}^{2}} = \frac{1{,}33\cdot 10^{26}}{3{,}976\cdot 10^{12}} = 3{,}345\cdot 10^{13}\,cm\,.$$

The average distance from the Sun to Hyakutake $R_{SUN\text{-}HYA}$ was found as the relation of the Sun gravitational field constant V_{SUN}^{M} to the squared average orbital velocity of Hyakutake V_{HYA}^{2} by the formula (1)

$$R_{SUN-HYA} = \frac{V_{SUN}^{M}}{V_{HYA}^{2}} = \frac{1{,}33 \cdot 10^{26}}{7{,}505 \cdot 10^{9}} = 1{,}772 \cdot 10^{16}\, cm .$$

The average distance from the Earth to the Moon $R_{EAR\text{-}MOO}$ was found as the relation of the Earth gravitational field constant V_{EAR}^{M} to the squared average orbital Moon velocity V_{MOO}^{2} by the formula (1)

$$R_{EAR-MOON} = \frac{V_{EAR}^{M}}{V_{MOO}^{2}} = \frac{4{,}025 \cdot 10^{20}}{1{,}047 \cdot 10^{10}} = 3{,}844 \cdot 10^{10}\, cm .$$

The average distance from Mars to Phobos $R_{MAR\text{-}PHO}$ was found as the relation of Mars gravitational field constant V_{MAR}^{M} to the squared average orbital Phobos velocity V_{PHO}^{2} by the formula (1)

$$R_{MAR-PHO} = \frac{V_{MAR}^{M}}{V_{PHO}^{2}} = \frac{4{,}286 \cdot 10^{19}}{4{,}575 \cdot 10^{10}} = 9{,}368 \cdot 10^{8}\, cm .$$

The average distance from the Mars to Deymos $R_{MAR\text{-}DEY}$ was found as the relation of Mars gravitational field constant V_{MAR}^{M} to the squared average orbital Deymos velocity V_{DEY}^{2} by the formula (1)

$$R_{MAR-DEY} = \frac{V_{MAR}^{M}}{V_{DEY}^{2}} = \frac{4{,}286 \cdot 10^{19}}{1{,}825 \cdot 10^{10}} = 2{,}348 \cdot 10^{9}\, cm .$$

The average distance from any other planets to their satellites can be found in the same way.

The average distance from Saggitarius A black hole to S2 star $R_{BHSA\text{-}S2}$ was found as the relation of Saggitarius A black hole V_{BHSA}^{M} to the squared average orbital velocity of S2 star V_{S2}^{2} by the formula (1)

$$R_{BHSA-S2} = \frac{V_{BHSA}^{M}}{V_{S2}^{2}} = \frac{4{,}975 \cdot 10^{32}}{3{,}489 \cdot 10^{16}} = 1{,}426 \cdot 10^{16}\, cm .$$

The average distance from the Milky Way galaxy centre to the Sun $R_{MWGC\text{-}SUN}$ was found as the relation of the gravitational field constant of the Milky Way Galaxy centre V_{MWGC}^{M} to the squared average orbital velocity of the Sun V_{SUN}^{2} by the formula (1)

$$R_{MWGC-SUN} = \frac{V_{MWGC}^{M}}{V_{SUN}^{2}} = \frac{1{,}374 \cdot 10^{37}}{4{,}84 \cdot 10^{14}} = 2{,}839 \cdot 10^{22}\, cm\,.$$

5.12. Measuring the gravitational radius of a body.

The gravitational radius of *1 g* of the body mass R_{1R} was found as the relation of the gravitational field constant of *1g* of the body V_1^M to the squared light velocity c^2 by the formula (1)

$$R_{1-R} = \frac{V_1^M}{c^2} = \frac{1{,}0432386 \cdot 10^{-4}}{8{,}988 \cdot 10^{20}} = 1{,}1607016 \cdot 10^{-25} cm .$$

The Sun gravitational radius $R_{SUN\text{-}R}$ was found as the relation of the Sun gravitational field constant V_{SUN}^M to the squared light velocity c^2 by the formula ( )

$$R_{SUN-R} = \frac{V_{SUN}^M}{c^2} = \frac{1{,}33 \cdot 10^{26}}{8{,}988 \cdot 10^{20}} = 1{,}47975 \cdot 10^5 cm .$$

The Earth gravitational radius $R_{EAR\text{-}R}$ was found as the relation of the Earth gravitational field constant V_{EAR}^M to the squared light velocity c^2 by the formula ( )

$$R_{EAR-R} = \frac{V_{EAR}^M}{c^2} = \frac{4{,}025 \cdot 10^{20}}{8{,}988 \cdot 10^{20}} = 0{,}4478193 \quad cm .$$

Mars gravitational radius $R_{MAR\text{-}R}$ was found as the relation of Mars gravitational field constant V_{MAR}^M to the squared light velocity c^2 by the formula ( )

$$R_{MAR-R} = \frac{V_{MAR}^M}{c^2} = \frac{4{,}2865 \cdot 10^{19}}{8{,}988 \cdot 10^{20}} = 0{,}0476858 \quad cm .$$

Jupiter gravitational radius $R_{JUP\text{-}R}$ was found as the relation of Jupiter gravitational field constant V_{JUP}^M to the squared light velocity c^2 by the formula ( )

$$R_{JUP-R} = \frac{V_{JUP}^M}{c^2} = \frac{1{,}267 \cdot 10^{23}}{8{,}988 \cdot 10^{20}} = 140{,}965732 \quad cm .$$

The Moon gravitational radius $R_{MOO\text{-}R}$ was found as the relation of the Moon gravitational field constant V_{MOO}^M to the squared light velocity c^2 by the formula ( )

$$R_{MOO-R} = \frac{V_{MOO}^M}{c^2} = \frac{7{,}807 \cdot 10^{18}}{8{,}988 \cdot 10^{20}} = 8{,}686 \cdot 10^{-3} \quad cm .$$

Dionis gravitational radius R_{DIO-R} was found as the relation of Dionis gravitational V_{DIO}^{M} to the squared light velocity c^2 by the formula ( )

$$R_{DIO-R} = \frac{V_{DIO}^{M}}{c^2} = \frac{1{,}85 \cdot 10^{18}}{8{,}988 \cdot 10^{20}} = 2{,}058 \cdot 10^{-13} \quad cm\,.$$

Pluto gravitational radius R_{PLU-R} was found as the relation of Pluto gravitational field constant V_{PLU}^{M} to the squared light velocity c^2 by the formula ( )

$$R_{PLU-R} = \frac{V_{PLU}^{M}}{c^2} = \frac{9{,}765 \cdot 10^{17}}{8{,}988 \cdot 10^{20}} = 1{,}086 \cdot 10^{-3} \quad cm\,.$$

Eryde gravitational radius R_{ERY-R} was found as the relation of Eryde gravitational field constant V_{ERY}^{M} to the squared light velocity c^2 by the formula ( )

$$R_{ERY-R} = \frac{V_{ERY}^{M}}{c^2} = \frac{1{,}107 \cdot 10^{18}}{8{,}988 \cdot 10^{20}} = 1{,}232 \cdot 10^{-3} \quad cm\,.$$

The gravitational radius of the black hole with the radius of *1 cm* R_{BH1-R} was found as the relation of the constant of the gravitational field of the black hole with the radius of *1 cm* V_{BH1}^{M} to the squared light velocity c^2 by the formula (1)

$$R_{BH1-R} = \frac{V_{BH1}^{M}}{c^2} = \frac{8{,}988 \cdot 10^{20}}{8{,}988 \cdot 10^{20}} = 1 \ cm\,.$$

The gravitational radius of Saggitarius A black hole R_{BHSA-R} was found as the relation of Saggitarius A black hole of the gravitational field constant V_{BHSA}^{M} to the squared light velocity c^2 by the formula (1)

$$R_{BHSA-R} = \frac{V_{BHSA}^{M}}{c^2} = \frac{4{,}975 \cdot 10^{32}}{8{,}988 \cdot 10^{20}} = 5{,}535 \cdot 10^{11} cm\,.$$

The gravitational radius of any body can be found in the same way.

The results that were obtained show that in 1916 C. Schwarzschild, while defining the gravitational radius of the Earth and that of the Sun, made 2 mistakes. The average distance from other central bodies to any other bodies rotating around them can be found in the same way. The obtained average distances between different bodies within the Solar system and Milky Way Galaxy coincided with the similar data found with the help of radio location, parallaxes, photometric method and other ones [ ], which proves the validity of the elaborated method and formula (1)

Having solved the equation ( ) with regard to $R_{1\text{-}2}$ there was found:

$$R_{1-2}G = \frac{2GM_1 g_2}{V_2^2 M_2}. \qquad (\ )$$

Taking into account that $g_1^M = \frac{g_2}{M_2}$, $V_1^M = 2G_1^M$ and $V_B^M = V_1^M M_1$, the formula ( ) was written down in the following way

$$R_{1-2} = \frac{V_B^M}{V_2^2}, \qquad (\ )$$

where $R_{1\text{-}2}$ is the average distance from the first to the second body, *cm*;

V_B^M is the gravitational field constant of the body, cm^3/s^2;

g_T^M is the average orbital velocity of the second body, *cm/c* .

Having solved the equation ( ) with regard to $R_{1\text{-}2}$ there was found

$$R_{1-2} = \frac{2Gg_1}{V_2^2}. \qquad (\ )$$

Taking into account that $V_B^M = 2Gg_1$ the formula ( ) was written down in the following way

$$R_{1-2} = \frac{V_B^M}{V_2^2}. \qquad (\ )$$

The obtained formula (3) is identical to the formula (3).

5.13. Measuring the force of gravitation between the bodies and the body centrifugal force.

After working out the gravitation formula (   ) and obtaining gravitational constant G (   ) there appeared a chance to check up the correctness of finding by the G. Cavendish the force of gravitation between the first ball with the mass of $1g$ and the second ball with the mass of $1g$, placed at the distance of $1cm$, and equal to $6{,}6742\cdot 10^{-8}\ gcm/s^2$. Due to the fact that G. Cavendish carrying out his calculations in grains used the units of weight with the dimension of mass, the mass of each ball was found first of all.

The mass of the ball M_{BALL} was found as the relation of the ball P_{BALL} weight to the Earth gravity acceleration g_{EAR} by the formula (   )

$$M_{BALL} = \frac{P_{BALL}}{g_{EAR}} = \frac{1}{980{,}665} = 1{,}0197\cdot 10^{-3}\, g$$

The gravity acceleration of the ball g_{BALL} was found as the product of the ball mass M_{BALL} by the gravity acceleration of $1g$ of the body g_1^M by the formula (   )

$$g_{BALL} = M_{BALL}\, g_1^M = 1{,}0197\cdot 10^{-3}\cdot 2{,}5645\cdot 10^{-22} = 2{,}615\cdot 10^{-25}\, cm/s^2\ .$$

The force of gravitation between the first ball with the mass $M_1=1{,}0197\cdot 10^{-3}\ g$ and the second ball with the mass $M_2=1{,}0197\cdot 10^{-3}\ g$, placed at the distance $R_{BALL\text{-}BALLP}=1\ cm$ was found by the formula (   )

$$F_{BALL-BALL} = G\frac{M_{BALL}\,g_{BALL} + M_{BALL}\,g_{BALL}}{R^2_{BALL-BALL}} = 2{,}034\cdot 10^{17}\times$$

$$\times\frac{1{,}0197\cdot 10^{-3}\cdot 2{,}615\cdot 10^{-25} + 1{,}0197\cdot 10^{-3}\cdot 2{,}615\cdot 10^{-25}}{1^2} = 1{,}0847\cdot 10^{-10}\, gcm/s^2\ .$$

Thus, the force of gravitation between two balls in the experiment of G. Cavendish was $1{,}0847\cdot 10^{-10}\ gcm/s^2$, and not $6{,}6742\cdot 10^{-8}\ gcm/s^2$ that is appeared to be 615 less.

The force of gravitation between the first mass standard $M_{STA}=1\ g$ and the second mass standard $M_{STA}=1\ g$, placed at the distance $R_{STA\text{-}STA}=1\ cm$ was found by the formula (   )

$$F_{STT-STT} = G\frac{M_{STT}g_1^M + M_{STT}g_1^M}{R^2_{STT-STT}} = 2{,}034\cdot 10^{17}\frac{1\cdot 2{,}5645\cdot 10^{-22} + 1\cdot 2{,}5645\cdot 10^{-22}}{1^2} =$$
$$= 1{,}0432386\cdot 10^{-4}\ gcm/s^2 .$$

The centrifugal force of the first mass standard F_{STA} was found proceeding from the mass of the first mass standard M_{STA}, the average orbital velocity of the first mass standard V_{STA} and the average distance from the first mass standard to the second mass standard $R_{STA-STA}$ by the formula ( )

$$F_{STT-STT} = \frac{M_{STT}V^2_{STT}}{R_{STT-STT}} = \frac{1{,}0\cdot 1{,}0432\cdot 10^{-4}}{1{,}0} = 1{,}0432\cdot 10^{-4}\ gcm/s^2 .$$

The constant of the gravitation force is the force of the first mass standard of *1 g* and the second mass standard of *1 g*, placed at the distance of *1cm* equal to $1{,}0432386\cdot 10^{-4}\ gcm/s^2$, expressed in gcm/s^2.

The force of gravitation between the first body with the mass $M_2=1\ g$ placed at the distance $R_{1-2}=1{,}043\cdot 10^{-4}\ cm$ was found by the formula ( )

$$F_{1-2} = G\frac{M_1g_2 + M_2g_1}{R^2_{1-2}} = 2{,}034\cdot 10^{17}\frac{1{,}0\cdot 2{,}5645\cdot 10^{-22} + 1{,}0\cdot 2{,}5645\cdot 10^{-22}}{(1{,}043\cdot 10^{-4})^2} =$$
$$= 9585{,}5349\ gcm/s^2 .$$

The centrifugal force of the second body F_{1-2} was found proceeding from the mass of the second body $M_2=1g$, the average orbital velocity of the second body $V_2=1cm/s$ and the average distance from the first body to the second one $R_{1-2}=1{,}043\cdot 10^{-4}cm$ by the formula ( )

$$F_{1-2} = \frac{M_2V_2^2}{R_{1-2}} = \frac{1{,}0\cdot 1{,}0}{1{,}043\cdot 10^{-4}} = 9585{,}5349\ gcm/s^2 .$$

The force of gravitation between the first body with the mass $M_1=2{,}034\cdot 10^{17}\ g$ and the second body with the mass $M_2=2{,}034\cdot 10^{17}\ g$ F_{1-2}, placed at the distance $R_{1-2}=2{,}034\cdot 10^{17}\ cm$ was found by the formula ( )

$$F_{1-2} = G\frac{M_1g_2 + M_2g_1}{R^2_{1-2}} = 2{,}034\cdot 10^{17}\frac{2{,}034\cdot 10^{17}\cdot 5{,}216\cdot 10^{-5} + 2{,}034\cdot 10^{17}\cdot 5{,}216\cdot 10^{-5}}{(2{,}034\cdot 10^{17})^2} =$$
$$= 1{,}0432\cdot 10^{-4}\ gcm/s^2 .$$

Centrifugal force of the second body F_{1-2} found based on the weight of the second body $M_2=2{,}034\cdot 10^{17}\ g,$ mean orbital velocity of the second body V_2

and average distance from the first body to the second $R_{1-2}=2,034\cdot10^{17}$ *cm* by the formula ( )

$$F_{1-2}=\frac{M_2V_2^2}{R_{1-2}}=\frac{2,034\cdot10^{17}\cdot1,0432\cdot10^{-4}}{2,043\cdot10^{17}}=1,0432\,gcm/s^2.$$

Gravitational force between the first body with mass $M_1=9585,5349$ *g* and the second body with mass $M_2=9585,5349$ *g* F_{1-2} located at a distance $R_{1-2}=1$ *cm*, found by the formula ( )

$$F_{1-2}=G\frac{M_1g_2+M_2g_1}{R_{1-2}^2}=2,034\cdot10^{17}\frac{9585,5349\cdot2,458\cdot10^{-18}+9585,5349\cdot2,458\cdot10^{-18}}{1^2}=$$
$$=9585,5349\,gcm/s^2.$$

Centrifugal force of the second body F_{1-2} found based on the weight of the second body $M_2=9585,5349$ *g,* mean orbital velocity of the second body $V_2=1cm/s$ V_2 and average distance from the first body to the second $R_{1-2}=1$ by the formula ( )

$$F_{1-2}=\frac{M_2V_2^2}{R_{1-2}}=\frac{9585,5349\cdot(1,0)^2}{1,0}=9585,5349\,gcm/s^2.$$

Gravitational force between the first body with mass $M_1=9585,5349$ *г* and the second body with mass $M_2=9585,5349$ *g* F_{1-2} located at a distance $R_{1-2}=9585,5349$ *cm*, found by the formula ( )

$$F_{1-2}=G\frac{M_1g_2+M_2g_1}{R_{1-2}^2}=2,034\cdot10^{17}\frac{9585,5349\cdot2,458\cdot10^{-18}+9585,5349\cdot2,458\cdot10^{-18}}{9585,5349^2}=$$
$$=1,0432\cdot10^{-4}\,gcm/s^2.$$

Centrifugal force of the second body F_{1-2} found based on the weight of the second body $M_2=9585,5349$ *g* mean orbital velocity of the second body V_2 and average distance from the first body to the second $R_{1-2}=9585,5349cm$ by the formula ( )

$$F_{1-2}=\frac{M_2V_2^2}{R_{1-2}}=\frac{9585,5349\cdot1,0432\cdot10^{-4}}{9585,5349}=1,0432\cdot10^{-4}\,gcm/s^2.$$

The force of gravitation between the first body with the mass $M_1=3,8994\cdot10^{21}$ *g* and the second body with the mass $M_2=3,8994\cdot10^{21}$ *g* F_{1-2} placed at the distance $R_{1-2}=4,068\cdot10^{17}$ *cm*, was found by the formula ( )

$$F_{1-2}=G\frac{M_1g_2+M_2g_1}{R_{1-2}^2}=2{,}034\cdot10^{17}\frac{3{,}8994\cdot10^{21}\cdot1{,}0+3{,}8994\cdot10^{21}\cdot1{,}0}{(4{,}068\cdot10^{17})^2}=9585{,}5349\ \ gcm/s$$

The centrifugal force of the second body F_{1-2} was found proceeding from the mass of the second body $M_2=3{,}8994\cdot10^{21}\ g$ of the average orbital velocity of the second body $V_2=1cm/s$ and the average distance from the first body to the second one $R_{1-2}=4{,}068\cdot10^{17}cm$ by the formula ( )

$$F_{1-2}=\frac{M_2V_2^2}{R_{1-2}}=\frac{3{,}8994\cdot10^{21}\cdot(1{,}0)^2}{4{,}068\cdot10^{17}}=9585{,}5349\,gcm/s^2.$$

The force of gravitation between the first body with the mass $M_1=3{,}8994\cdot10^{21}\ g$ and the second body with the mass $M_2=3{,}8994\cdot10^{21}\ g$, placed at the distance $R_{1-2}=3{,}8994\cdot10^{21}\ cm$ was found by th formula ( )

$$F_{1-2}=G\frac{M_1g_2+M_2g_1}{R_{1-2}^2}=2{,}034\cdot10^{17}\frac{3{,}8994\cdot10^{21}\cdot1{,}0+3{,}8994\cdot10^{21}\cdot1{,}0}{(3{,}8994\cdot10^{21})^2}=1{,}043\cdot10^{-4}\,gcm/s^2$$

The centrifugal force of the second body F_{1-2} was found proceeding from the mass of the second body $M_2=3{,}8994\cdot10^{21}\ g$ of the average orbital velocity of the second body $V_2=$ and the average distance from the first body to the second body $R_{1-2}=3{,}8994\cdot10^{21}\ cm$ by the formula ( )

$$F_{1-2}=\frac{M_2V_2^2}{R_{1-2}}=\frac{3{,}8994\cdot10^{21}\cdot1{,}0432\cdot10^{-4}}{3{,}8994\cdot10^{21}}=1{,}043\cdot10^{-4}\ gcm/s^2.$$

The force of gravitation between the Sun and Mars $F_{SUN\text{-}MAR}$ was found proceeding from the Sun mass M_{SUN}, Mars gravity aceeleration g_{MAR}, Mars mass M_{MAR}, the Sun gravity acceleration g_{SUN} and the average distance from the Sun to Mars $R_{SUN-MAR}$ by the formula ( )

$$F_{SUN-MAR}=G\frac{M_{SUN}g_{MAR}+M_{MAR}g_{SUN}}{R_{SUN-MAR}^2}=2{,}034\cdot10^{17}\frac{1{,}273\cdot10^{30}\cdot105{,}35+4{,}108\cdot10^{23}\cdot3{,}265\cdot10^{8}}{(2{,}279\cdot10^{13})^2}=$$
$$=1{,}05\cdot10^{23}\,gcm/s^2.$$

The centrifugal force of Mars $F_{SUN\text{-}MAR}$ was found proceeding from Mars mass M_{MAR}, the average orbital velocity of Mars V_{MAR} and the average distance from the Sun to Mars $R_{SUN\text{-}MAR}$ by the formula ( )

$$F_{SUN-MAR}=\frac{M_{MAR}V_{MAR}}{R_{SUN-MAR}}=\frac{4{,}108\cdot10^{23}\cdot(2{,}412\cdot10^{6})^2}{2{,}279\cdot10^{13}}=1{,}05\cdot10^{23}\,gcm/s^2$$

The force of gravitation between the Sun and Jupiter $F_{SUN\text{-}JUP}$ was found proceeding from the Sun mass M_{SUN}, Jupiter gravity aceeleration g_{JUP}, Jupiter mass M_{JUP} , the Sun gravity acceleration g_{SUN} and the average distance from the Sun to Jupiter $R_{SUN-JUP}$ by the formula (   )

$$F_{SUN-JUP} = G\frac{M_{SUN}g_{JUP} + M_{JUP}g_{SUN}}{R^2_{SUN-JUP}} =$$
$$= 2{,}034\cdot 10^{17}\frac{1{,}273\cdot 10^{30}\cdot 3{,}113\cdot 10^5 + 1{,}214\cdot 10^{27}\cdot 3{,}265\cdot 10^8}{(7{,}786\cdot 10^{13})^2} = 2{,}66\cdot 10^{25}\, gcm/s^2$$

The centrifugal force of Jupiter $F_{SUN\text{-}JUP}$ was found proceeding from Jupiter mass M_{JUP}, the average orbital velocity of Jupiter V_{JUP} and the average distance from the Sun to Jupiter $R_{SUN\text{-}JUP}$ by the formula (   )

$$F_{SUN-JUP} = \frac{M_{JUP}V^2_{JUP}}{R_{SUN-JUP}} = \frac{1{,}214\cdot 10^{27}\cdot (1{,}307\cdot 10^6)^2}{7{,}786\cdot 10^{13}} = 2{,}66\cdot 10^{25}\, gcm/s^2$$

The force of gravitation between the Sun and Saturn $F_{SUN\text{-}SAT}$ was found proceeding from the Sun mass M_{SUN}, Saturn gravity aceeleration g_{SAT} , Saturn mass M_{SAT} , the Sun gravity acceleration g_{SUN} and the average distance from the Sun to Saturn $R_{SUN-SAT}$ by the formula (   )

$$F_{SUN-SAT} = G\frac{M_{SUN}g_{SAT} + M_{SAT}g_{SUN}}{R^2_{SUN-SAT}} = 2{,}034\cdot 10^{17}\frac{1{,}273\cdot 10^{30}\cdot 9{,}342\cdot 10^4 + 3{,}643\cdot 10^{26}\cdot 3{,}265\cdot}{(1{,}4335\cdot 10^{14})^2}$$
$$= 2{,}354\cdot 10^{24}\, gcm/s^2.$$

The centrifugal force of Saturn $F_{SUN\text{-}SAT}$ was found proceeding from Saturn mass M_{SAT}, the average orbital velocity of Saturn V_{SAT} and the average distance from the Sun toSaturn $R_{SUN\text{-}SAT}$ by the formula (   )

$$F_{SUN-SAT} = \frac{M_{SAT}V^2{}_{SAA}}{R_{SUN-SAA}} = \frac{3{,}643\cdot 10^{26}\cdot (9{,}701\cdot 10^5)^2}{1{,}434\cdot 10^{14}} = 2{,}391\cdot 10^{24}\, gcm/s^2 .$$

The force of gravitation between any star and a planet as well as the centrifugal force of any planet can be found in the same way.

The force of gravitation between any planet and a satellite as well as the centrifugal force of any satellite can be found in the same way.

The force of gravitation between the Sun and Pluto $F_{SUN\text{-}PLU}$ was found proceeding from the Sun mass M_{SUN}, Pluto gravity aceeleration g_{PLU}, Pluto mass M_{PLU} the Sun gravity acceleration g_{SUN} and the average distance from the Sun to Pluto $R_{SUN-PLU}$ by the formula (   )

$$F_{SUN-PLU} = G\frac{M_{SUN}g_{PLU} + M_{PLU}g_{SUN}}{R^2_{SUN-PLU}} = 2{,}034\cdot 10^{17}\frac{1{,}273\cdot 10^{30}\cdot 2{,}4 + 9{,}36\cdot 10^{21}\cdot 3{,}265\cdot 10^{8}}{(5{,}87\cdot 10^{14})^2} =$$
$$= 3{,}607\cdot 10^{18}\, gcm/s^2.$$

The centrifugal force of Pluto $F_{SUN\text{-}PLU}$ was found proceeding from Pluto mass M_{PLU}, the average orbital velocity of Pluto $V_{PLU\,IO}$ and the average distance from the Sun to Pluto $R_{SUN\text{-}PLU}$ by the formula (   )

$$F_{SUN-PLU} = \frac{M_{PLU}V^2_{PLU}}{R_{SUN-PLU}} = \frac{9{,}36\cdot 10^{21}\cdot (4{,}712\cdot 10^{5})^2}{5{,}87\cdot 10^{14}} = 3{,}6\cdot 10^{18}\, gcm/s^2.$$

The force of gravitation between the Sun and Eryde $F_{SUN\text{-}ERY}$ was found proceeding from the Sun mass M_{SUN}, Eryde gravity aceeleration g_{DIO}, Eryde mass M_{ERY}, the Sun gravity acceleration g_{SUN} and the average distance from the Sun to Eryde $R_{SUN-ERY}$ by the formula (   )

$$F_{SUN-ERY} = G\frac{M_{SUN}g_{ERY} + M_{ERY}g_{SUN}}{R^2_{SUN-ERY}} = 2{,}034\cdot 10^{17}\frac{1{,}273\cdot 10^{30}\cdot 2{,}721 + 1{,}061\cdot 10^{22}\cdot 3{,}265\cdot 10^{8}}{(1{,}01\cdot 10^{15})^2} =$$
$$= 1{,}382\cdot 10^{18}\, gcm/s^2.$$

The centrifugal force of Eryde $F_{SUN\text{-}ERY}$ was found proceeding from Eryde mass M_{ERY}, the average orbital velocity of Eryde V_{ERY} and the average distance from the Sun to Eryde $R_{SUN\text{-}ERY}$ by the formula (   )

$$F_{SUN-ERY} = \frac{M_{ERY}V_{ERY}}{R_{SUN-ERY}} = \frac{1{,}061\cdot 10^{22}\cdot (3{,}585\cdot 10^{5})^2}{1{,}01\cdot 10^{15}} = 1{,}35\cdot 10^{18}\, gcm/s^2.$$

The force of gravitation between any dwarf planet and a satellite as well as the centrifugal force of any satellite can be found in the same way.

The force of gravitation between the Sun and Dionis $F_{SUN\text{-}DIO}$ was found proceeding from the Sun mass M_{SUN}, Dionis gravity aceeleration g_{DIO}, Dionis mass M_{DIO} the Sun gravity acceleration g_{SUN} and the average distance from the Sun to Dionis $R_{SUN-DIO}$ by the formula (   )

$$F_{SUN-DIO} = G\frac{M_{SUN}g_{DIO} + M_{DIO}g_{SUN}}{R^2_{SUN-DIO}} =$$
$$= 2{,}034\cdot 10^{17}\frac{1{,}273\cdot 10^{30}\cdot 4{,}547\cdot 10^{-10} + 1{,}773\cdot 10^{12}\cdot 3{,}265\cdot 10^{8}}{(3{,}288\cdot 10^{13})^2} = 2{,}178\cdot 10^{11}\, gcm/s^2.$$

The centrifugal force of Dionis $F_{SUN\text{-}DIO}$ was found proceeding from Dionis mass M_{DIO}, the average orbital velocity of Dionis V_{DIO} and the average distance from the Sun to Dionis $R_{SUN\text{-}DIO}$ by the formula (   )

$$F_{SUN-DIO} = \frac{M_{DIO}V_{DIO}}{R_{SUN-DIO}} = \frac{1{,}773\cdot 10^{12}\cdot(2{,}01\cdot 10^{6})^{2}}{3{,}288\cdot 10^{13}} = 2{,}178\cdot 10^{11}\,gcm/s^{2}.$$

The force of gravitation between any asteroid and a satellite as well as the centrifugal force of any satellite can be found in the same way.

The force of gravitation between the Milky Way galaxy centre and the Sun $F_{MWGC\text{-}SUN}$ was found proceeding from the mass of the Milky Way galaxy centre M_{MWGC}, the Sun gravity aceeleration g_{SUN}, the Sun mass M_{SUN}, the gravity acceleration of the Milky Way galaxy centre g_{MWGC} and the squared average distance from the Milky Way galaxy centre to the Sun $R^{2}_{MWGC-SUN}$ by the formula (   )

$$F_{MWGC-SUN} = G\frac{M_{MWGC}g_{SUN} + M_{SUN}g_{MWGC}}{R^{2}_{MWGC-SUN}} =$$

$$= 2{,}034\cdot 10^{17}\frac{1{,}145\cdot 10^{41}\cdot 3{,}265\cdot 10^{8} + 1{,}273\cdot 10^{30}\cdot 2{,}936\cdot 10^{19}}{(2{,}469\cdot 10^{22})^{2}} = 2{,}494\cdot 10^{22}\,gcm/s^{2}$$

The centrifugal froce of the Sun $F_{MWGC\text{-}SUN}$ was found proceeding from the Sun mass M_{SUN}, the squared average orbital velocity of the Sun V^{2}_{SUN} and the average distance from the centre of the Milky Way galaxy to the Sun $R_{MWGC\text{-}SUN}$ by the formula (   )

$$F_{MWGC-SUN} = \frac{M_{SUN}V^{2}_{SUN}}{R_{MWGC-SUN}} = \frac{1{,}273\cdot 10^{30}(2{,}2\cdot 10^{7})^{2}}{2{,}469\cdot 10^{22}} = 2{,}495\cdot 10^{22}\,gcm/s^{2}.$$

The force of gravitation between the centre of any galaxy and a star as well as the centrifugal force of any star.

The force of gravitation between two Suns located at the distance $R_{1\text{-}2} = 1{,}273\cdot 10^{30}cm$ by the formula (   )

$$F_{1-2} = G\frac{M_{SUN}g_{SUN} + M_{SUN}g_{SUN}}{R^{2}_{SUN-SUN}} =$$

$$= 2{,}034\cdot 10^{17}\frac{1{,}273\cdot 10^{30}\cdot 3{,}265\cdot 10^{8} + 1{,}273\cdot 10^{30}\cdot 3{,}265\cdot 10^{8}}{(1{,}273\cdot 10^{13})^{2}} = 1{,}0432\cdot 10^{-4}\,gcm/s^{2}.$$

The force of gravitation of the Sun $F_{SUN-SUN}$ was found proceeding from the Sun mass M_{SUN}, the Sun average orbital velocity V_{SUN} and the average distance between two Suns $R_{SUN-SUN} = 1,273 \cdot 10^{30}$ by the formula (   )

$$F_{SUN-SUN} = \frac{M_{SUN} V_{SUN}}{R_{SUN-SUN}} = \frac{1,273 \cdot 10^{30} \cdot 1,0432 \cdot 10^{-4}}{1,273 \cdot 10^{30}} = 1,04328 \cdot 10^{-4}\, gcm/s^2 .$$

The force of gravitation between two Suns located at the distance $R_{1-2} = 1,33 \cdot 10^{26} cm$ by the formula (   )

$$F_{1-2} = G \frac{M_{SUN} g_{SUN} + M_{SUN} g_{SUN}}{R^2_{SUN-SUN}} =$$

$$= 2,034 \cdot 10^{17} \frac{1,273 \cdot 10^{30} \cdot 3,265 \cdot 10^{8} + 1,273 \cdot 10^{30} \cdot 3,265 \cdot 10^{8}}{(1,33 \cdot 10^{26})^2} = 9585,5349 gcm/s^2 .$$

The centrifugal force of the Sun $F_{SUN-SUN}$ was found proceeding from the mass of the Sun M_{SUN}, the average orbital velocity of the Sun V_{SUN} and the average distance between two Suns $R_{SUN-SUN} = 1,33 \cdot 10^{26}$ by the formula (   )

$$F_{SUN-SUN} = \frac{M_{SUN} V^2{}_{SUN}}{R_{SUN-SUN}} = \frac{1,273 \cdot 10^{30} \cdot 1,0}{1,33 \cdot 10^{26}} = 9585,5349 \cdot 10^{-4}\, gcm/s^2 .$$

5.15. The measurement of the body density

The density of Mars ρ_{MAR} was found as the relation of Mars weight P_{MAR} to Mars volume V_{MAR} by the formula ( )

$$\rho_{MAR} = \frac{P_{MAR}}{V_{MAR}} = \frac{4{,}328 \cdot 10^{25}}{1{,}642 \cdot 10^{26}} = 0{,}264 \;\; g/cm^2 s^2 .$$

The density of Mars on the Earth surface $\rho_{MAR\text{-}EAR}$ was found proceeding from Mars density ρ_{MAR}, the Earth gravity acceleration g_{EAR} and Mars gravity acceleration g_{MAR} by the formula ( )

$$\rho_{MAR-EAR} = \frac{\rho_{MAR} g_{EAR}}{g_{MAR}} = \frac{0{,}264 \cdot 980{,}665}{105{,}35} = 2{,}457 \;\; g/cm^2 s^2 .$$

The density of the Earth on Mars surface $\rho_{EAR\text{-}MAR}$ was found proceeding from the Earth density ρ_{EAR}, Mars gravity acceleration g_{MAR} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{MAR} = \frac{\rho_{MAR-EAR} g_{MAR}}{g_{EAR}} = \frac{2{,}457 \cdot 105{,}35}{980{,}665} = 0{,}264 \;\; g/cm^2 s^2 .$$

The density of Jupiter ρ_{JUP} was found as the relation of Jupiter weight P_{JUP} to Jupiter volume V_{MAR} by the formula ( )

$$\rho_{JUP} = \frac{P_{JUP}}{V_{JUP}} = \frac{3{,}779 \cdot 10^{32}}{1{,}53 \cdot 10^{30}} = 246{,}99 \;\; g/cm^2 s^2 .$$

The density of Jupiter on the Earth surface $\rho_{JUP\text{-}EAR}$ was found proceeding from Jupiter density ρ_{JUP}, the Earth gravity acceleration g_{EAR} and Jupiter gravity acceleration g_{JUP} by the formula ( )

$$\rho_{JUP-EAR} = \frac{\rho_{JUP} g_{EAR}}{g_{JUP}} = \frac{246{,}99 \cdot 980{,}665}{3{,}113 \cdot 10^5} = 0{,}778 \;\; g/cm^2 s^2 .$$

The density of the Earth on the surface of Jupiter $\rho_{EAR\text{-}JUP}$ was found proceeding from the Earth density ρ_{EAR}, Jupiter gravity acceleration g_{JUP} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{EAR-JUP} = \frac{\rho_{EAR} g_{JUP}}{g_{EAR}} = \frac{3{,}45 \cdot 3{,}113 \cdot 10^5}{980{,}665} = 1095{,}16 \;\; g/cm^2 s^2 .$$

The density of Jupiter ρ_{JUP} was found proceeding from Jupiter density on the Earth $\rho_{JUP\text{-}EAR}$, Jupiter gravity acceleration g_{JUP} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{JUP} = \frac{\rho_{JUP-EAR}\, g_{JUP}}{g_{EAR}} = \frac{0,778 \cdot 3,113 \cdot 10^5}{980,665} = 246,99 \ \ g/cm^2 s^2 .$$

The density of Saturn ρ_{SAT} was found as the relation of Saturn weight P_{SAT} to Saturn volume V_{SAT} by the formula ( )

$$\rho_{SAT} = \frac{P_{SAT}}{V_{SAT}} = \frac{3,403 \cdot 10^{31}}{9,167 \cdot 10^{29}} = 37,122 \ \ g/cm^2 s^2 .$$

The density of the Earth on the surface of Saturn $\rho_{EAR\text{-}SAT}$ was found proceeding from the Earth density ρ_{EAR}, Saturn gravity acceleration g_{SAT} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{EAR-SAA} = \frac{\rho_{EAR}\, g_{SAA}}{g_{EAR}} = \frac{3,45 \cdot 9,342 \cdot 10^4}{980,665} = 328,654 \ \ g/cm^2 s^2 .$$

The density of Saturn ρ_{SAT} was found proceeding from

The density of Saturn on the surface the Earth $\rho_{SAT\text{-}EAR}$, Saturn gravity acceleration g_{SAT} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{SAT} = \frac{\rho_{SAT-EAR}\, g_{SAT}}{g_{EAR}} = \frac{0,3897 \cdot 9,342 \cdot 10^4}{980,665} = 37,122 \ \ g/cm^2 s^2 .$$

The density of Uranus ρ_{URA} was found as the relation of Uranus weight P_{URA} to Uranus volume V_{URA} by the formula ( )

$$\rho_{URA} = \frac{P_{URA}}{V_{URA}} = \frac{7,929 \cdot 10^{29}}{6,994 \cdot 10^{28}} = 11,337 \ \ g/cm^2 s^2 .$$

The density of Uranus on the surface of the Earth $\rho_{URA\text{-}EAR}$ was found proceeding from Uranus density ρ_{URA}, the Earth gravity acceleration g_{EAR} and Uranus gravity acceleration g_{URA} by the formula ( )

$$\rho_{URA-EAR} = \frac{\rho_{URA}\, g_{EAR}}{g_{URA}} = \frac{11,337 \cdot 980,665}{1,426 \cdot 10^4} = 0,7796 \ \ g/cm^2 s^2 .$$

The density of the Earth on the surface of Uranus $\rho_{EAR\text{-}URA}$ was found proceeding from the Earth density ρ_{EAR}, Uranus gravity acceleration g_{URA} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{EAR-URA} = \frac{\rho_{EAR}\, g_{URA}}{g_{EAR}} = \frac{3,45 \cdot 1,126 \cdot 10^4}{980,665} = 39,613 \ \ g/cm^2 s^2 .$$

The density of Uranus ρ_{URA} was found proceeding from Uranus density on thesurface of the Earth $\rho_{URA\text{-}EAR}$, Uranus gravity acceleration g_{URA} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{URA} = \frac{\rho_{URA-EAR}\, g_{URA}}{g_{EAR}} = \frac{0{,}7796 \cdot 1{,}426 \cdot 10^{4}}{980{,}665} = 11{,}337 \;\; g/cm^{2}s^{2}.$$

The density of Neptune ρ_{NEP} was found as the relation of Neptune weight P_{NEP} to Neptune volume V_{NEP} by the formula (   )

$$\rho_{NEP} = \frac{P_{NEP}}{V_{NEP}} = \frac{1{,}102 \cdot 10^{30}}{6{,}361 \cdot 10^{28}} = 17{,}324 \;\; g/cm^{2}s^{2}.$$

The density of Neptune on the surface of the Earth $\rho_{NEP\text{-}EAR}$ was found proceeding from Neptune density ρ_{NEP}, the Earth gravity acceleration g_{EAR} and Neptune gravity acceleration g_{NEP} by the formula (   )

$$\rho_{NEP-EAR} = \frac{\rho_{NEP}\, g_{EAR}}{g_{NEP}} = \frac{17{,}324 \cdot 980{,}665}{1{,}681 \cdot 10^{4}} = 1{,}011 \;\; g/cm^{2}s^{2}.$$

The density of the Earth on the surface of Neptune $\rho_{EAR\text{-}NEP}$ was found proceeding from the Earth density ρ_{EAR}, Neptune gravity acceleration g_{NEP} and the Earth gravity acceleration g_{EAR} by the formula (   )

$$\rho_{EAR-NEP} = \frac{\rho_{EAR}\, g_{NEP}}{g_{EAR}} = \frac{3{,}45 \cdot 1{,}126 \cdot 10^{4}}{980{,}665} = 39{,}613 \;\; g/cm^{2}s^{2}.$$

The density of Neptune ρ_{NEP} was found proceeding from Neptune density on the Earth $\rho_{NEP\text{-}EAR}$, Neptune gravity acceleration g_{NEP} and the Earth gravity acceleration g_{EAR} by the formula (   )

$$\rho_{NEP} = \frac{\rho_{NEP-EAR}\, g_{NEP}}{g_{EAR}} = \frac{1{,}011 \cdot 1{,}681 \cdot 10^{4}}{980{,}665} = 17{,}324 \;\; g/cm^{2}s^{2}.$$

The density of any other planet as well as the density of one planet on the surface of any other planet can be found in the same way.

The density of Pluto ρ_{PLU} was found as the relation of Pluto weight P_{PLU} to Pluto volume V_{PLU} by the formula (   )

$$\rho_{PLU} = \frac{P_{PLU}}{V_{PLU}} = \frac{2{,}246 \cdot 10^{22}}{7{,}144 \cdot 10^{24}} = 3{,}144 \cdot 10^{-3} \;\; g/cm^{2}s^{2}.$$

The density of Pluto on the surface of the Earth $\rho_{PLU\text{-}EAR}$ was found proceeding from Pluto density ρ_{PLU}, the Earth gravity acceleration g_{EAR} and Pluto gravity acceleration g_{PLU} by the formula (   )

$$\rho_{PLU-EAR} = \frac{\rho_{PLU}\, g_{EAR}}{g_{PLU}} = \frac{3{,}144 \cdot 10^{-3} \cdot 980{,}665}{2{,}4} = 1{,}285 \;\; g/cm^{2}s^{2}.$$

The density of the Earth on the surface of Pluto $\rho_{EAR\text{-}PLU}$ was found proceeding from the Earth density ρ_{EAR}, Pluto gravity acceleration g_{PLU} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{EAR-PLU} = \frac{\rho_{EAR} g_{PLU}}{g_{EAR}} = \frac{3{,}45 \cdot 2{,}4}{980{,}665} = 8{,}443 \cdot 10^{-3} \;\; g/cm^2 s^2 .$$

The density of Pluto ρ_{PLU} was found as the relation of Pluto weight P_{PLU} to Pluto volume V_{PLU} by the formula ( )

$$\rho_{PLU} = \frac{\rho_{PLU-EAR} g_{PLU}}{g_{EAR}} = \frac{1{,}285 \cdot 2{,}4}{980{,}665} = 3{,}144 \cdot 10^{-3} \;\; g/cm^2 s^2 .$$

The density of Eryde ρ_{ERY} was found as the relation of Eryde weight P_{ERY} to Eryde volume V_{ERY} by the formula ( )

$$\rho_{ERY} = \frac{P_{ERY}}{V_{ERY}} = \frac{2{,}887 \cdot 10^{22}}{7{,}238 \cdot 10^{24}} = 3{,}989 \cdot 10^{-3} \;\; g/cm^2 s^2 .$$

The density of Eryde on the surface of the Earth $\rho_{ERY\text{-}EAR}$ was found proceeding from Eryde density ρ_{ERY}, the Earth gravity acceleration g_{EAR} and Eryde gravity acceleration g_{ERY} by the formula ( )

$$\rho_{ERY-EAR} = \frac{\rho_{ERY} g_{EAR}}{g_{ERY}} = \frac{3{,}989 \cdot 10^{-3} \cdot 980{,}665}{2{,}721} = 1{,}43 \;\; g/cm^2 s^2 .$$

The density of the Earth on the surface of Eryde $\rho_{EAR\text{-}ERY}$ was found proceeding from the Earth density ρ_{EAR}, Eryde gravity acceleration g_{ERY} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{EAR-ERY} = \frac{\rho_{EAR} g_{ERY}}{g_{EAR}} = \frac{3{,}45 \cdot 2{,}721}{980{,}665} = 9{,}573 \cdot 10^{-3} \;\; g/cm^2 s^2 .$$

The density of Eryde ρ_{ERY} was found proceeding from Eryde density on the surface of the Earth $\rho_{ERY\text{-}EAR}$, Eryder gravity acceleration g_{ERY} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{ERY} = \frac{\rho_{ERY-EAR} g_{ERY}}{g_{EAR}} = \frac{1{,}43 \cdot 2{,}721}{980{,}665} = 3{,}898 \cdot 10^{-3} \;\; g/cm^2 s^2 .$$

The density of any other dwarf planet as well as the density of one dwarf planet on the surface of any other planet and the density of one planet on the surface of any other dwarf planet can be found in the same way.

The density of Dionis ρ_{DIO} was found as the relation of Dionis weight P_{DIO} to Dionis volume V_{DIO} by the formula ( )

$$\rho_{DIO} = \frac{P_{DIO}}{V_{DIO}} = \frac{806{,}183}{1{,}768 \cdot 10^{15}} = 4{,}56 \cdot 10^{-13} g / cm^2 s^2 .$$

The density of Dionis on the surface of the Earth $\rho_{DIO\text{-}EAR}$ was found proceeding from Dionis density ρ_{DIO}, the Earth gravity acceleration g_{EAR} and Dionis gravity acceleration g_{DIO} by the formula ( )

$$\rho_{DIO-EAR} = \frac{\rho_{DIO} g_{EAR}}{g_{DIO}} = \frac{4{,}56 \cdot 10^{-3} \cdot 980{,}665}{4{,}547 \cdot 10^{-10}} = 0{,}983 \;\; g / cm^2 s^2 .$$

The density of the Earth on the surface of Dionis $\rho_{EAR\text{-}DIO}$ was found proceeding from the Earth density ρ_{EAR}, Dionis gravity acceleration g_{DIO} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{EAR-DIO} = \frac{\rho_{EAR} g_{DIO}}{g_{EAR}} = \frac{3{,}45 \cdot 4{,}56 \cdot 10^{-13}}{980{,}665} = 1{,}604 \cdot 10^{-11} \;\; g / cm^2 s^2 .$$

The density of Dionis ρ_{DIO} was found proceeding from Dionis density on the Earth $\rho_{DIO\text{-}EAR}$, Dionis gravity acceleration g_{DIO} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{DIO} = \frac{\rho_{DIO-EAR} g_{DIO}}{g_{EAR}} = \frac{0{,}983 \cdot 4{,}547 \cdot 10^{-10}}{980{,}665} = 4{,}56 \cdot 10^{-13} \;\; g / cm^2 s^2 .$$

The density of any other asteroid as well as the density of one asteroid on the surface of any other planet and the density of one planet on the surface of any other asteroid can be found in the same way.

The density of the black hole with the radius of *1cm* ρ_{BH1} was found as the relation of the weight of the black hole with the radius of *1cm* P_{BH1} to the volumeof the black hole with the radius of *1cm* V_{BH1} by the formula ( )

$$\rho_{BH1} = \frac{P_{BH1}}{V_{BH1}} = \frac{1{,}903 \cdot 10^{28}}{4{,}189} = 4{,}544 \cdot 10^{27} g / cm^2 s^2 .$$

The density of the black hole with the radius of *1cm* on the surface of the Earth $\rho_{BH1\text{-}EAR}$ was found proceeding from the density of the black hole ρ_{BH1}, the Earth gravity acceleration g_{EAR} and the gravity acceleration of the black hole with the radius of *1cm* g_{BH1} by the formula ( )

$$\rho_{BH1-EAR} = \frac{\rho_{BH1} g_{EAR}}{g_{BH1}} = \frac{4{,}544 \cdot 10^{27} \cdot 980{,}665}{2209{,}317} = 2{,}017 \cdot 10^{27} \;\; g / cm^2 s^2 .$$

The density of Saggitarius A black hole ρ_{BHSA} was found as the relation of the weight of Saggitarius A black hole P_{BHSA} to the volume of Saggitarius A black hole V_{BHSA} by the formula ( )

$$\rho_{BHSA} = \frac{P_{BHSA}}{V_{BHSA}} = \frac{5{,}832 \cdot 10^{51}}{1{,}696 \cdot 10^{35}} = 3{,}439 \cdot 10^{16} g / cm^2 s^2 .$$

The density of the Saggitarius A black hole on the surface of the Earth ρ_{BHSA} was found proceeding from the density of the Saggitarius A black hole ρ_{BHSA}, the Earth gravity acceleration g_{EAR} and the gravity acceleration of Saggitarius A black hole g_{BHSA} by the formula ( )

$$\rho_{BHSA-EAR} = \frac{\rho_{BHSA} \cdot g_{EAR}}{g_{BHSA}} = \frac{3{,}439 \cdot 10^{16} \cdot 980{,}665}{1{,}223 \cdot 10^{15}} = 27575{,}69 \ \ g / cm^2 s^2 .$$

The density of the Earth on the surface of Saggitarius A black hole $\rho_{EAR-BHSA}$ was found proceeding from the Earth density ρ_{EAR}, the gravity acceleration of Saggitarius A black hole g_{BHSA} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{EAR-BHSA} = \frac{\rho_{EAR} g_{BHSA}}{g_{EAR}} = \frac{3{,}45 \cdot 1{,}223 \cdot 10^{15}}{980{,}665} = 4{,}303 \cdot 10^{12} \ \ g / cm^2 s^2 .$$

The density of Saggitarius A black hole ρ_{BHSA} was found proceeding from the density of Saggitarius A black hole on the surface of the Earth $\rho_{BHSA-EAR}$, the gravity acceleration of Saggitarius A black hole g_{BHSA} and the Earth gravity acceleration g_{EAR} by the formula ( )

$$\rho_{BHSA} = \frac{\rho_{BHSA-EAR} g_{BHSA}}{g_{EAR}} = \frac{27575{,}69 \cdot 1{,}223 \cdot 10^{15}}{980{,}665} = 3{,}439 \cdot 10^{16} \ \ g / cm^2 s^2 .$$

The density of any other black hole, the density of oneblack hole on the surface of any other planet as well as the density of one planet on the surface of any other black hole can be found in the same way.

The density of the centre of any other galaxy as well as the density of one galaxy centre on the surface of any other planet and the density of one planet on the surface of any other galaxy can be found in the same way.

5.16. The measurement of the body energy.

The kinetic energy of the Sun W_{SUN} found proceeding from the Sun mass M_{SUN} and the average orbital velocity V_{SUN} by the formula ( )

$$W_{SUN} = \frac{M_{SUN} \cdot V_{SUN}^2}{2} = \frac{1{,}273 \cdot 10^{30} \cdot (2{,}2 \cdot 10^7)^2}{2} = 3{,}081 \cdot 10^{44}\, gcm^2/s^2$$

The kinetic energy of any other star can be found in the same way.

The kinetic energy of the Earth W_{EAR} was found proceeded from the Earth mass M_{EAR} and the average orbital velocity of the Earth V_{EAR} by the formula ( )

$$W_{EAR} = \frac{M_{EAR} \cdot V_{EAR}^2}{2} = \frac{3{,}824 \cdot 10^{24} \cdot (2{,}979 \cdot 10^6)^2}{2} = 1{,}697 \cdot 10^{37}\, gcm^2/s^2$$

The kinetic energy of Mars W_{MAR} was found proceeding from the mass of Mars M_{MAR} and the average orbital velocity V_{MAR} by the formula ( )

$$W_{MAR} = \frac{M_{MAR} \cdot V_{MAR}^2}{2} = \frac{4{,}108 \cdot 10^{23} \cdot (2{,}412 \cdot 10^6)^2}{2} = 1{,}195 \cdot 10^{36}\, gcm^2/s^2$$

The kinetic energy of Jupiter W_{JUP} was found proceeding from Jupiter mass M_{JUP} and the average orbital Jupiter velocity V_{JUP} by the formula ( )

$$W_{JUP} = \frac{M_{JUP} \cdot V_{JUP}^2}{2} = \frac{1{,}214 \cdot 10^{27} \cdot (1{,}307 \cdot 10^6)^2}{2} = 1{,}037 \cdot 10^{39}\, gcm^2/s^2$$

The kinetic energy of Saturn W_{SAT} was found proceeding from Saturn mass M_{SAT} and the average orbital Saturn velocity V_{SAT} by the formula ( )

$$W_{SAA} = \frac{M_{SAA} \cdot V_{SAA}^2}{2} = \frac{3{,}643 \cdot 10^{26} \cdot (9{,}701 \cdot 10^5)^2}{2} = 1{,}714 \cdot 10^{38}\, gcm^2/s^2$$

The kinetic energy of any other planet can be found in the same way.

The kinetic energy of Pluto W_{PLU} was found proceeding from Pluto mass M_{PLU} and the average orbital velocity of Pluto V_{PLU} by the formula ( )

$$W_{PLU} = \frac{M_{PLU} \cdot V_{PLU}^2}{2} = \frac{9{,}36 \cdot 10^{21} \cdot (4{,}712 \cdot 10^5)^2}{2} = 1{,}039 \cdot 10^{33}\, gcm^2/s^2$$

The kinetic energy of Eryde W_{ERY} was found proceeding from Eryde mass M_{ERY} and the average orbital velocity of Eryde V_{ERY} by the formula ( )

$$W_{ERY} = \frac{M_{ERY} \cdot V_{ERY}^2}{2} = \frac{1{,}061 \cdot 10^{22} \cdot (3{,}585 \cdot 10^5)^2}{2} = 6{,}817 \cdot 10^{32}\, gcm^2/s^2$$

The kinetic energy of any other dwarf planet can be found in the same way.

The kinetic energy of Dionis W_{DIO} was found proceeding from Dionis mass M_{DIO} and tha average orbital velocity of Dionis V_{DIO} by the formula ( )

$$W_{DIO} = \frac{M_{DIO} \cdot V_{DIO}^2}{2} = \frac{1{,}773 \cdot 10^{12} \cdot (2{,}01 \cdot 10^6)^2}{2} = 3{,}581 \cdot 10^{24}\, gcm^2 / s^2$$

The kinetic energy of any other asteroid can be found in the same way.

The potential energy of the mass copy-standard of a body located at the altitude of *10 cm* above the surface of the mass-copy standard of the body $E_{STA-STA}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, the gravity acceleration of the mass copy-standard of the body g_{STA} and the altitude of lifting the body mass copy-standard h_{STA} by the formula ( )

$$E_{STA-STA}=M_{STA} \cdot g_{STA} \cdot h_{STA} = 1{,}0 \cdot 2{,}5645 \cdot 10^{-22} \cdot 10{,}0=2{,}5645 \cdot 10^{21}\, gcm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of *10 cm* above the surface of the Sun $E_{STA-SUN}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, the Sun gravity acceleration g_{SUN} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA-SUN}=M_{STA} \cdot g_{SUN} \cdot h_{STA} = 1{,}0 \cdot 3{,}265 \cdot 10^{8} \cdot 10{,}0=3{,}265 \cdot 10^{9}\, gcm^2/s^2.$$

The potential energy of any other body located at any altitude above the surface of any star can be found in the same way.

The potential energy of the mass copy-standard of a body located at the altitude of *10 cm* above the surface of the Earth $E_{STA-EAR}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, the Earth gravity acceleration g_{EAR} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA-EAR}=M_{STA} \cdot g_{EAR} \cdot h_{STA} = 1{,}0 \cdot 980{,}665 \cdot 10{,}0=9806{,}65\, gcm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of *10 cm* above the surface of Mars $E_{STA-MAR}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, Mars gravity acceleration g_{MAR} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA-MAR}=M_{STA} \cdot g_{MAR} \cdot h_{STA} = 1{,}0 \cdot 105{,}35 \cdot 10{,}0=1053{,}5\ gcm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of *10 cm* above the surface of Jupiter $E_{STA-JUP}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, Jupiter gravity acceleration g_{JUP} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA-JUP}=M_{STA} \cdot g_{JUP} \cdot h_{STA} = 1{,}0 \cdot 3{,}113 \cdot 10^{5} \cdot 10{,}0=3{,}113 \cdot 10^{6}\ gcm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of 10 cm above the surface of the Moon $E_{STA-MOO}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, the Moon gravity acceleration g_{MOO} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA-MOO}=M_{STA} \cdot g_{MOO} \cdot h_{STA} = 1{,}0 \cdot 19{,}19 \cdot 10{,}0=191{,}9\ gcm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of 10 cm above the surface of Pluto $E_{STA-PLU}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, Pluto gravity acceleration g_{PLU} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA-PLU}=M_{STA} \cdot g_{PLU} \cdot h_{STA} = 1{,}0 \cdot 2{,}4 \cdot 10{,}0=24{,}0\ ^{G}cm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of 10 cm above the surface of Eryde $E_{STA-ERY}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, Eryde gravity acceleration g_{ERY} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA-ERY}=M_{STA} \cdot g_{ERY} \cdot h_{STA} = 1{,}0 \cdot 2{,}721 \cdot 10{,}0=27{,}0\ gcm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of 10 cm above the surface of Dionis $E_{STA-DIO}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, Dionis gravity acceleration g_{DIO} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA-DIO}=M_{STA} \cdot g_{DIO} \cdot h_{STA} = 1{,}0 \cdot 4{,}5471 \cdot 10{,}0^{-10} \cdot 10{,}0=4{,}547 \cdot 10^{-9}\ gcm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of 10 cm above the surface of the black hole with the radius of *1 cm* $E_{STA\text{-}BH1}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, the gravity acceleration of the black hole with the radius of *1 cm* g_{BH1} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA\text{-}BH1}=M_{STA} \cdot g_{BH1} \cdot h_{STA} = 1,0 \cdot 2209,317 \cdot 10,0=33093,17 \ gcm^2/s^2.$$

The potential energy of the mass copy-standard of a body located at the altitude of 10 cm above the surface of Saggitarius A black hole $E_{STA\text{-}BHSA}$ was found as the product of the mass of the mass copy-standard of the body M_{STA}, the gravity acceleration of Saggitarius A black hole g_{BHSA} and the altitude of lifting of the mass copy-standard of the body h_{STA} by the formula ( )

$$E_{STA\text{-}BHSA}=M_{STA} \cdot g_{BHSA} \cdot h_{STA} = 1,0 \cdot 1,223 \cdot 10^{15} \cdot 10,0=1,223 \cdot 10^{16} \ gcm^2/s^2.$$

The energy of *1 g* of the body E_1 was found as the product of mass of *1 gr* M_1 by the squared velocity c^2 by the formula ( )

$$E_1=M_1 \cdot c^2 = 1,0 \cdot (2,998 \cdot 10^{10})^2=8,988 \cdot 10^{20} \ gcm^2/s^2.$$

The energy of the Sun E_{SUN} was found as the product of the Sun mass M_{SUN} by the squared velocity c^2 by the formula ( )

$$E_{SUN}=M_{SUN} \cdot c^2 = 1,273 \cdot 10^{30} \cdot (2,99 \cdot 10^{10})^2=1,144 \cdot 10^{51} \ gcm^2/s^2.$$

The energy of any other star can be found in the same way.

The energy of the Earth E_{EAR} was found as the product of the Earth M_{EAR} by the squared velocity c^2 by the formula ( )

$$E_{EAR}=M_{EAR} \cdot c^2 = 3,824 \cdot 10^{24} \cdot (2,998 \cdot 10^{10})^2=3,437 \cdot 10^{45} \ gcm^2/s^2.$$

The energy of Mars E_{MAR} was found as the product of Mars mass M_{MAR} by the squared velocity c^2 by the formula ( )

$$E_{MAR}=M_{MAR} \cdot c^2 = 4,1082 \cdot 10^{23} \cdot (2,998 \cdot 10^{10})^2=3,692 \cdot 10^{44} \ gcm^2/s^2.$$

The energy of Jupiter E_{JUP} was found as the product of Jupiter mass M_{JUP} by the squared velocity c^2 by the formula ( )

$$E_{JUP}=M_{JUP} \cdot c^2 = 1,214 \cdot 10^{27} \cdot (2,998 \cdot 10^{10})^2=1,091 \cdot 10^{48} \ gcm^2/s^2.$$

The energy of any other planet can be found in the same way.

The energy of Pluto E_{PLU} was found as the product of Pluto mass M_{PLU} by the squared velocity c^2 by the formula ( )

$$E_{PLU}=M_{PLU}\cdot c^2 = 9{,}36\cdot10^{21}\cdot(2{,}998\cdot10^{10})^2=8{,}413\cdot10^{42}\ gcm^2/s^2 .$$

The energy of Eryde E_{ERY} was found as the product of Eryde mass M_{ERY} by the squared velocity c^2 by the formula ( )

$$E_{ERY}=M_{ERY}\cdot c^2 = 1{,}061\cdot10^{22}\cdot(2{,}998\cdot10^{10})^2=9{,}536\cdot10^{42}\ gcm^2/s^2.$$

The energy of any other dwarf planet can be found in the same way.

The energy of Dionis E_{DIO} was found as the product of Dionis mass M_{DIO} by the squared velocity c^2 by the formula ( )

$$E_{DIO}=M_{DIO}\cdot c^2 = 1{,}773\cdot10^{12}\cdot(2{,}998\cdot10^{10})^2=1{,}594\cdot10^{33}\ gcm^2/s^2.$$

The energy of any other asteroid can be found in the same way.

The energy of the black hole with the radius of $1cm$ E_{BH1} was found as the product of the mass of the black hole with the radius of $1\ cm$ M_{BH} by the squared velocity c^2 by the formula ( )

$$E_{BH1}=M_{BH1}\cdot c^2 = 8{,}615\cdot10^{24}\cdot(2{,}998\cdot10^{10})^2=7{,}743\cdot10^{45}\ gcm^2/s^2.$$

The energy of saggitarius A E_{BHSA} was found as the product of the mass of Saggitarius A black hole M_{BHSA} by the squared velocity c^2 by the formula ( )

$$E_{BHSA}=M_{BHSA}\cdot c^2 = 4{,}769\cdot10^{36}\cdot(2{,}998\cdot10^{10})^2=4{,}286\cdot10^{57}\ gcm^2/s^2.$$

The energy of any other black hole can be found in the same way.

The energy of any other galaxy can be found in the same way.