Discovery
of the wave nature
of
GRAVITATION

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Contents:

1. Introduction

I continue to talk about

key discoveries
that we made in the framework of theories of
the Wave Model (WM)

The WM is developing by us to **replace** the **Standard Model** of modern physics.

It is the **only such** a theory that **relies on the axioms of dialectics** (dialectical philosophy and its logic).

In this sense, WM is unique.

All discoveries of the WM, including the discovery of the wave nature of gravity, were made mainly when analyzing solutions of:

(*a*) **classical wave equation,**

$$\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0, \qquad (1)$$

and

(*b*) an **equation previously unknown in physics,**

$$\hat{F}_s = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k^2 r^2}(1 - ikr)\hat{\upsilon}i\omega, \qquad (2)$$

that we first obtained. This equation describes the **behavior** of elementary particles, **considered** in the **WM** as **pulsating wave** formations [1, 2].

About the discovery
of the wave nature of gravity and its fundamental frequency
I have repeatedly reported,

in particular, in 2017 at a conference in Brussels (*keynote speech on the **Dynamic Model** [2] - which is **part** of **WM**):
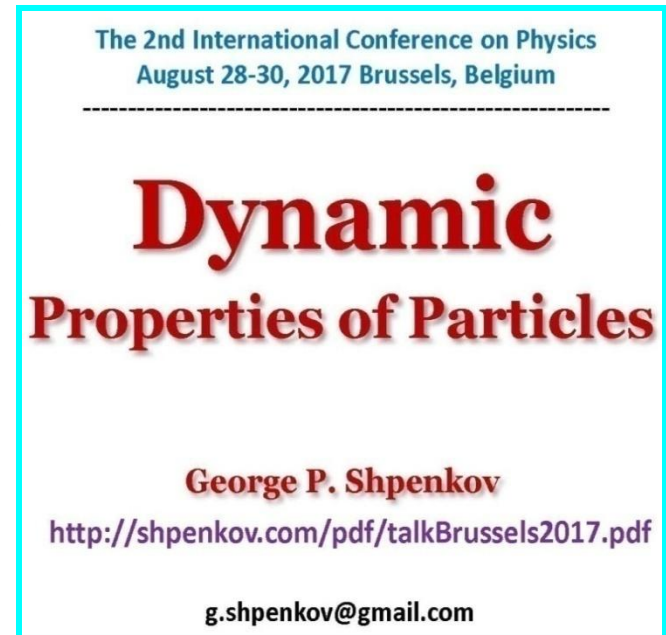
shpenkov.com/pdf/talkBrussels2017.pdf

youtube.com/watch?v=jzIixlsFDuY

Yet earlier, in 2010, material on this discovery was **presented** at the 19th International Conference on **General Theory** of **Relativity** and **Gravity** in Mexico City [4].

Generally, our **first publications** on this subject began to appear **since 1996** [3].

The 2nd International Conference on Physics
August 28-30, 2017 Brussels, Belgium

Dynamic
Properties of Particles

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Since 2016, I started publishing videos about WM discoveries on YouTube:

youtube.com/channel/UCMc6igBG0cEYh2YCZiyVXPA/videos

According to the
Dynamic Model (DM):

Elementary particles

are **finite-infinite formations** of the wave field-space of the Universe, **having** micro (**subatomic**) and mega (**gravitational**) spherical **wave** shells, **pulsating**, respectively, at the **fundamental frequencies** inherent in the particles:

$$\omega_e = 1.869162505 \times 10^{18} \; s^{-1} \quad \text{and} \quad \omega_g = 9.158082264 \times 10^{-4} \; s^{-1}$$

Gravitational interaction of bodies

is **the result of resonant wave exchange (interaction) of all elementary particles, which make up the bodies, occurring at the frequency** ω_g.

<u>In modern physics</u>

Gravitational interaction

is described, partially, by the **Newton theory** of gravitation, and, in a general case, by the **general theory** of **relativity**, and, in the so-called quantum limit, by unfinished yet the **quantum theory** of gravitation [5, 6].

However, the **above theories**, starting with Newton's theory,

unable to explain

the **nature** of gravity. They all **focus on the description** of experimental facts related to gravity.

Newton, in his commentary (General Scholium, 1713) to the 2nd edition of his Principia, wrote,

"... *I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses* [*hypotheses non fingo*]; ...».

<u>For this reason:</u>

All attempts of theoretical physics

to find the relationship between

gravitational interaction,

described by the **general theory** of **relativity**, and the other **two types** of fundamental interactions considering in modern physics, **strong** and **electromagnetic**, that is, to **create** a **unified field theory** (the "theory of everything", including the so-called "weak interaction"),

end in failure

despite the **great efforts** of theorists.

Gravity is still one of the most **incomprehensible phenomena** in natural science.

In-depth analysis conducted by us showed that the **gap** in understanding the phenomenon of gravitation is due to an **inadequacy** of **basic concepts** of the **Standard Model** (SM) and theories, that adhere SM, to **reality** (**general relativity** relates to such theories**)** [5].

Everything in Nature
is in natural harmony and interconnected.

Therefore, if the theories are **correct**, the indicated **harmony** and **interconnection must necessarily be present** in the description of various types of fundamental interactions considered in physics.

The description should be unit, universal for all interactions.

Judging by the **results** of studies that we **first started** publishing in 1996
(a book "*Alternative Picture of the World*" in three volumes [3]),

the Wave Model
fully meets the above requirements.

The Wave Model

relies on dialectics. It includes two theories (models):

1) The Dynamic Model of elementary particles and

2) The Shell-Nodal Model of atoms.

To day, we have obtained enough data to say, without exaggeration, that **WM**

correctly describes reality

compared to **modern theories adhering to the Standard Model and formal logic, and based on abstract-mathematical (fictional) postulates**.

Within the WM, we **were able to solve some of the problems** (including the problem of gravity)**,** which are

unsolvable in principle

by existing basic theories of physics.

I will show it here on an example
of solving a number of problems related to gravity.

2. Universal Law of the Central Exchange

Recall the two basic laws of physics,

а) **Newton's law** of gravitation (1686) and

б) **Coulomb's law** of interaction of point electric charges (1785-1788):

$$F = G\frac{m_1 m_2}{r^2} \qquad (3)$$

and

$$F = k\frac{q_1 q_2}{r^2} \qquad (4)$$

Both of the above laws refer to

opposite worlds:
mega and *micro*

They **apply** to **phenomena** occurring at different levels of the Universe.

Being **similar** in **form**, they have the **same functional dependence**: both for interacting giant **masses** and for tiny elementary **charges**.

However, **since** their **discovery,** these laws are considered **different**, **completely unrelated**.

This is due to the fact that **the nature** of the **interactions** described by the laws is still

not understood properly by modern physics.

First of all, such a lack of understanding is due to

ignorance of the nature
of the mass **(m)** [7] **and** *electric charge* **(q).**

Thus, modern physics, which relies on the **Standard Model**, so far has *not been able* to *uncover* the *nature* of the **basic** physical **parameters**: *mass* and *charge*.

The **great mystery** is also what parameters determine the ***proportionality factors*** G and k.

The **factor** entering **Newton's law**, called the ***gravitational constant***, $G = 6.67384(80) \times 10^{-8} \ cm^3 g^{-1} s^{-2}$, is a parameter whose **magnitude** and **dimensionality** have been determined **experimentally**.

The **magnitude** and **dimensionality** of the **coefficient** of proportionality k in the **Coulomb law** are **unknown**:

In the **objective** system of units **CGS** (*cm, g, s*), k **was taken** as a **dimensionless unit**, $k = 1$.

This led to the **absurd dimensionality** of charge q, because it is expressed by **fractional powers** at the units of length and masses, $[q] = g^{1/2} cm^{3/2} s^{-1}$.

In the **international SI system**, the Coulomb law has the form,

$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2} \qquad (4a)$$

where $\varepsilon_0 = 8.854187817... \times 10^{-12} \ F \times m^{-1}$. However, the situation with the **dimensionality** in objective units of matter-space-time is **similar** (absurd). It is convincingly shown, for example, in [8, 9].

Recognizing
the wave nature of all objects,

**harmony and interrelation of all processes and phenomena
in the Universe,**

we came to the **conclusion**, following the elementary logic, that **both laws,** (3) and (4), are **particular cases** of a **single law**, which defines **wave interactions** and to which all objects of different levels of the Universe obey.

Indeed, **as we expected**, a study within the WM led us to the
discovery
of the
Universal Law of the Central Exchange!
(interaction)

How we have come to this discovery?

The Wave Model

is based on the fundamental concept

according to which

all objects, processes and phenomena in the Universe have
the wave nature.

This naturally means that

Newton and **Coulomb laws:** $\quad F = G\dfrac{m_1 m_2}{r^2}\quad$ and $\quad F = k\dfrac{q_1 q_2}{r^2}\quad$,

describe
wave interactions

(!)

of objects ,
masses and **charges,**
having a wave nature
and behaving like wave formations.

To find out the form of the

Universal Law of the Central Exchange,

obviously, it was **necessary** to **understand** the **nature** of the **four** basic **parameters**, included in both laws, and **interrelation** between them. Namely, we had to find out:

1) **what** is **mass** m, what is **its nature**;

2) **what** is **charge** q, what is **its nature** and, therefore, the **true dimensionality** (in objective units of matter-space-time with integer powers);

3) **what** parameters determine the **gravitational constant** G;

4) **what** parameters determine the proportionality **coefficient** k in the Coulomb law **what** is its **magnitude** and **dimensionality**;

5) **what** is the **relationship** exists **between mass** m and **charge** Q;

6) **what** is the **relationship** exists **between** the proportionality **coefficients** G and k.

    Modern physics, adhering to the **Standard Model,** is **not able** to **deal with** these problems.

    In the **framework** of **modern theories** of physics, **these problems** are **unsolvable** **in principle**.

The nature of basic parameters,

including in the laws of Newton and Coulomb, revealed thanks to the Wave Model,
is as follows:

1) The **mass** of particles m is

associated,

has a **dynamic wave character** (see [2]). The **rest mass** of the particles **does not exist**.

2) **Electric, magnetic** and **gravitational charges** (q_e , q_m and q_g) are

exchange charges.

They **determine** the **rate** of the corresponding **wave exchange** (interaction). Their **dimensionality** is $g \times s^{-1}$.

3) **Gravitational constant G** is a quantity **depending on** the **fundamental frequency** of elementary particles at the **mega level** ω_g (this frequency **determines gravitational exchange**, interaction, of particles):

$$G = \omega_g^2 \, / \, 4\pi\varepsilon_0 \quad !\qquad\qquad (5)$$

The **constant** G is **known** from experiment, $G = 6.67384 \times 10^{-8} \ cm^3 g^{-1} s^{-2}$; ε_0 is, in the WM, the **absolute unit** of **density**, $\varepsilon_0 = 1 \ g \times cm^{-3}$.

Hence, the **fundamental frequency** of the **gravitational wave field** ω_g is equal to

$$\boxed{\omega_g = \sqrt{4\pi\varepsilon_0 G} = 9.158082264 \times 10^{-4} \ s^{-1}} \ \textbf{!} \qquad (6)$$

4) The **coefficient** of proportionality k in the **Coulomb law** is equal to $1/4\pi\varepsilon_0$; its **dimensionality** is **inverse** to the dimensionality of **density**:

$$\boxed{k = \frac{1}{4\pi\varepsilon_0} \ cm^3 \times g^{-1}} \ \textbf{!} \qquad (7)$$

5) The **parameters** G and k, as can be seen from (5) - (7), **are interconnected** by the relation

$$\boxed{G = k\omega_g^2} \qquad (8)$$

6) The **mass** m and the **charge** Q are **related** as follows:

$$Q = m\omega \qquad (9)$$

a) at the **gravitational level** by the relation

$$q_g = m\omega_g \qquad (10)$$

б) at the **atomic** and **subatomic levels** in a similar way

$$q_e = m\omega_e \qquad (10a)$$

(7) The **fundamental frequency** of atomic and subatomic levels,

$$\omega_e = e/m_e = 1.869162559 \times 10^{18} \ s^{-1} \qquad (11)$$

(e – electron charge, m_e – associated **electron mass)**
This frequency is **responsible** for **electric** and **strong** interactions.

8) **Electron charge**

$$\boxed{e = m_e\omega_e = 1.702691627 \times 10^{-9} \ g \cdot s^{-1}} \qquad (12)$$

is the elementary quantum of the rate of mass exchange (interaction).

Thus, as can be seen,

A new concept

on the structure of elementary particles, underlying the Wave Model,

led to the discovery
of
basic parameters of the particles
and
the relationship between them,

previously unknown in physics.

**Such parameters are characteristic just
for particles that have a wave nature and behave
*like wave formations*** [2, 6].

Having revealed, thanks to the Wave Model, the physical meaning of the enumerated above fundamental parameters, we have come to the discovery of the

Universal Law of the Central Exchange

which describes **three types** of fundamental interactions – **electric**, **gravitational** and **strong**. Here is its **explicit form**:

$$\langle F \rangle = \omega_f^2 \, \frac{m_1 m_2}{4\pi\varepsilon_0 \varepsilon_r r^2} \tag{13}$$

where $\langle F \rangle$ is the **average value** of the exchange power ("force"), for the inphase and antiphase ($\Delta\varphi = 0; \pi$) cases, **modulo**;

m_1 and m_2 are **associated masses** of interacting objects;

$\varepsilon_0 = 1 \; g \times cm^{-3}$ is the **absolute unit** of **density**; ε_r is the relative density (for basis space $\varepsilon_r = 1$).

ω_f is one of the two **fundamental** frequencies, ω_e (11) or ω_g (6).

Because $Q = m\omega$ (9), law (13) can be presented in the form, which accurately repeats the spelling of Coulomb's law (in SI system) (see (4a)):

$$F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 \varepsilon_r r^2} \tag{13a}$$

But it is clear that in **essence** and the **physical meaning** of the parameters ε_0 and Q, equation (13a) **differs significantly** from (4a). In (13a), Q represents one of the three **exchange charges** − q_{el}, q_{gr}, q_{str} (**electric**, **gravitational** and **strong**); ε_0=1 $g \cdot cm^3$.

3. Particular cases of the Universal Law of the Central Exchange

Laws of **electric and gravitational exchange** – **Coulomb** and **Newton,**

as particular cases [5, 6, 10 - 12] of the Universal Law of the Central Exchange, take the following forms:

Coulomb's law

$$\left\langle F_e \right\rangle = \omega_e^2 \frac{(zm_e)(Zm_e)}{4\pi\varepsilon_0 r^2} \qquad (14)$$

$\omega_e = 1.869162559 \times 10^{18} \ s^{-1}$, m_e – **electron** mass, z and Z – the number of interacting electrons.

Coulomb's law (14) describes the **exchange interaction** (at the level of the wave "electric" field) by **elementary quanta** of "**electric**" **exchange charges** q_{el} .

These quanta are equal to the product of the associated mass of the electron m_e *and the fundamental frequency of the atomic and subatomic levels* ω_e :

$$q_{el} = e = m_e \omega_e \qquad (15)$$

Newton's law

$$\langle F_g \rangle = \omega_g^2 \, \frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \qquad (16)$$

$\omega_g = 9.158082264 \times 10^{-4} \, s^{-1}$,

m_1 and m_2 are *associated masses* of interacting *objects* (neglecting the mass of the electron, $m = zm_n$, where m_n is the *nucleon mass*).

Newton's law (16) describes the *exchange interaction* at the level of the wave *gravitational field* mainly by *elementary quanta* of *gravitational exchange charges* q_{gr} *(gravitons-nucleons)* (since $m_e << m_n$) [12].

These quanta are *equal* to the product of the *associated mass* of the *nucleon* m_n and the *fundamental frequency* of the *gravitational wave field* ω_g:

$$q_{gr} = m_n \omega_g \qquad (17)$$

At the *phase difference* $\Delta\varphi = 0$, the *objects* are *attracted*. This may be marked with a "–" sign.

$$\langle F \rangle = -\,\omega_f^2 \, \frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \qquad (16a)$$

The Law of Strong Interaction

Strong ("nuclear") interaction (exchange), as a particular case of the *Universal Law of the Central Exchange (13), obeys the following formula:*

Strong interaction

$$F_{strong} = \omega_e^2 \frac{(zm_n)(Zm_n)}{4\pi\varepsilon_0 r^2}$$ (18)

$\omega_e = 1.869162559 \times 10^{18} \, s^{-1}$, m_n - **nucleon** mass.

The ***strong exchange*** is realized at the subatomic level by ***elementary quanta*** of ***strong exchange charges*** q_{str} [13].

These quanta **equal** to the product of the **associated mass** of the **nucleon** m_n and the **fundamental frequency** of the **atomic** and **subatomic** levels ω_e:

$$q_{str} = m_n \omega_e$$ (19)

Thus, the Law of Central exchange (13) describes **three types** of **fundamental** interactions:
electric, gravitational and ***strong***.

4. The fundamental frequency and fundamental wave radius of the gravitational wave field

Fundamental frequency of the wave field of gravity

of particles (6) **follows from the Universal Law of exchange** *(13, 15)* **when comparing** *it with Newton's law of gravitation (3) :*

$$\langle F \rangle = \omega_g^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \qquad \rightleftarrows \qquad F = G \frac{m_1 m_2}{r^2}$$

$$\boxed{\omega_g = \sqrt{4\pi\varepsilon_0 G} = 9.158 \times 10^{-4} \, s^{-1}}$$

$G = 6.67408 \times 10^{-11} \, m^3 kg^{-1} s^{-2}$ *is the Newtonian constant of gravitation (experimental);*

$\varepsilon_0 = 1 \, g \cdot cm^{-3}$ *is the absolute unit of density.*

ω_g *is the* **proper frequency** *of elementary particles, responsible for their* **gravitational exchange** *(interaction) at the* **mega level** *of the Universe.*

Gravitational wave radius
of elementary particles λ_g,

(*elementary radial gravitational wave*)

corresponding to the fundamental frequency ω_g, is

$$\lambda_g = \frac{\lambda_g}{2\pi} = \frac{c}{\omega_g} = 3.2736 \times 10^{13} \ cm \qquad (20)$$

5. The role of two fundamental frequencies on particle behaviour

In accordance with the Dynamic Model,

particles pulsate

at two fundamental frequencies simultaneously, ω_e and ω_g.

At **these frequencies**, following the Universal Law of Exchange (13), their wave **exchange interaction** (**electric, gravitational** and **strong**) is **realized**, both with the surrounding **field** and with other **particles**.

The first,

extremely high fundamental **frequency** $\omega_e = 1.869162559 \times 10^{18} \, s^{-1}$ of particle pulsations, is responsible for **electromagnetic** and **strong interactions**.

For example, this frequency **determines** the **order** in the **arrangement** of interacting **atoms** (which are wave formations in accordance with DM) in crystals with an **average step** (inter-nodal distance, lattice parameter) of the order $3.2 \times 10^{-8} cm$ exactly **equal** to **twice** the wave radius $2\lambdabar_e$, where

$$\lambdabar_e = \frac{c}{\omega_e} = 1.603886492 \times 10^{-8} \, cm \qquad (21)$$

The second,

extremely low fundamental frequency of particle pulsations (6)

$$\omega_g = 9.158082264 \times 10^{-4} \ s^{-1}$$

is **responsible** for their **gravitational interaction**.

Confirmation of the **reality** of particle **pulsations** with frequency ω_g , and their **interaction** at this frequency, is the **coincidence** of **theoretical calculations** (we first performed) of the **average radii** of the **orbits** of the **planets** and their **satellites** with **astronomical data** [10, 13]. Orbit spectrum formula and other details are shown further.

The **correlation** between the **results** of our **calculations** and the **data** of **astronomical observations** turned out to be **quite satisfactory**.

At a **distance** from the Sun, **equal** to the average **gravitational wave radius** (20),

$$\lambda_g = \frac{c}{\omega_g} = 3.274 \times 10^{13} \ cm = 327.4 \times 10^6 \ km ,$$

is the **ring** of **asteroids**. The **gravitational wave radius** λ_g is the **boundary separating** the **vibrational** and **wave zones** of **particles** that make up the Sun. Therefore, the **neighbourhood** of this **boundary** is a spatial **region-sphere** of **intensive movement**.

The **power** of **gravitational exchange** ("force" of gravity) for **individual particles**, as follows from the Universal Law of Exchange [6, 11], is negligible value.

But a **huge number** of particles (the Sun consists of approximately 10^{57} nucleons) **compensates** for this **negligibly small** value and, in **sum**, at the **mega level**, leads to a very **significant effect** – gravitational attraction.

So, **spherical objects** in **star systems** (stars, planets and their satellites) can be considered as **atoms** of the **megaworld**.

<u>Thus</u>

The wave shell of the gravitational wave radius $\lambdabar_g$ (20) in star systems

separates the

vibrational region

of the spherical field-space of a star and its

wave region.

We on Earth and in near-Earth space are inside a giant gravitational wave, $\lambdabar_g = 327.4 \times 10^6 \ km$, and, therefore, perceive the gravitational field not as a wave field, but as stationary.

6. Problems with the derivation of the radii of orbits in stellar systems

The nature
of the existing order in the arrangement of the
orbits of the planets

at strictly certain average distances from the Sun, and the
orbits of their satellites,
is still
an **insoluble problem** *for modern physics and astrophysics,*
one of their
greatest mysteries.

How does modern physics, for all that, explain this fact?

Newton's law and **Kepler's** laws allow us to find the **relationship of** the **size** of the **orbits** of the planets **with** their **periods** of **revolution.**

However, the radii of the orbits is impossible to calculate by these laws.

The Standard Model is also helpless here, as in many other cases.

Therefore, **until now**, the **distance** of planets from the **Sun** (average radii of orbits) is **calculated** using a simple **empirical formula** proposed by J. D. Titius **250 years ago**, in 1766, and further popularized by J. E. Bode in his works in 1772.

This **formula** is named in their honour by the **Rule of Titius-Bode** (or Bode's Law).

According to the Titius-Bode rule,

The average radius of orbits

(in astronomical units) **obeys** the formula

$$R_i = \frac{D_i + 4}{10} \tag{22}$$

where $D_{-1} = 0$, $D_i = 3 \times 2^i$, $i \geq 0$.

The **calculated** values **correlate** in a **certain range** of variation of the **values** with **astronomical data**, but not for all planets.

For example, in a **calculated orbit** for $i = 3$, instead of a planet, **there is** an **asteroid belt**. Why? Unknown. The orbits of **Neptune** and **Pluto** also fall out of the calculations performed by this empirical formula.

And **most importantly**, the **empirical rule** of **Titius-Bode**

has no theoretical substantiation.

There is no any conceptual framework for the derivation of formula (22).

There is only a **trivial verbal explanation** (essentially, a **statement** of a **fact taken for granted**) according to which at the stage of **formation** of the **Solar System** a **regular structure** was **formed** from **alternating areas** in which **stable orbits** could or could not exist according to the so-called **rule** of **orbital resonances** (a certain ratio of the radii of neighbouring orbits).

We have solved the above problem. This turned out to be not so difficult.

One of the **proofs** of the **validity** of the concept of the WM, according to which the **gravity field** is **wave,** and its frequency is equal to ω_g (6), is the discovery, thanks to the WM, of the **spectrum** of **gravitational wave shells** of bodies.

Consider this.

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7. Spectra of wave shells of particles

Spectra of wave shells of particles of ***atomic*** *and* ***gravitational levels*** follow from the **wave equation** (1),

$$\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0$$

The general solution for the **spatial component** of the equation, in spherical polar coordinates, has the form,

$$\hat{\psi} = \hat{R}_l(\rho)\Theta_{l,m}(\theta)\hat{\Phi}_m(\varphi) \qquad (23)$$

where $\hat{R}_l(\rho)$, $\Theta_{l,m}(\theta)$, $\hat{\Phi}_m(\varphi)$ are **radial**, **polar** and **azimuthal solutions**, respectively.

Radial solutions take the following form:

$$\hat{R}_l(\rho)/A = \sqrt{\pi/2\rho}\,(J_{l+\frac{1}{2}}(\rho) \pm iY_{l+\frac{1}{2}}(\rho)) \qquad (24)$$

$$l = 0,1,2,...; \qquad m = 0, \pm 1, \pm 2, ..., \pm l$$

$\rho = kr = r/\lambdabar$ – **relative radius** of wave **characteristic shells**, determined by **roots** $z_{\nu,q}$ (**zeros** and **extreme** values) of the **Bessel functions**:

$$z_{\nu,q} = \rho = kr_{\nu,q} \qquad (25)$$

$\nu = l + \frac{1}{2}$ is the **order** of the functions, q is the **number** of **zero** or **extremum**,

$$k = \omega/c \text{ is the wave number } (\omega = \omega_e \text{ or } \omega_g).$$

For **subatomic** and **atomic** levels: $k = k_e = \omega_e/c = 1/\lambdabar_e$. Hence, the **spectrum** of wave shells of **elementary particles** for these levels has the form:

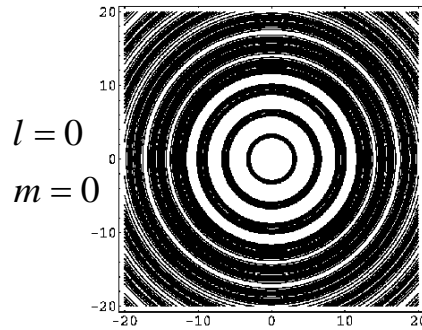$$r_{\nu,q} = \lambdabar_e z_{\nu,q} \qquad (26)$$

For the gravitational level:

hence,

$$k = k_g = \frac{\omega_g}{c} = \frac{1}{\lambdabar_g}$$
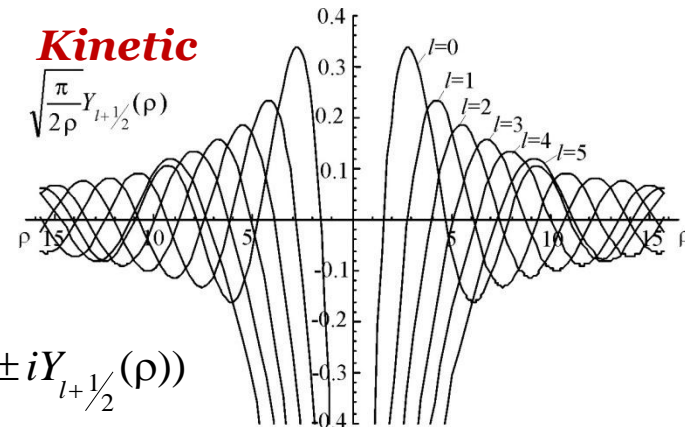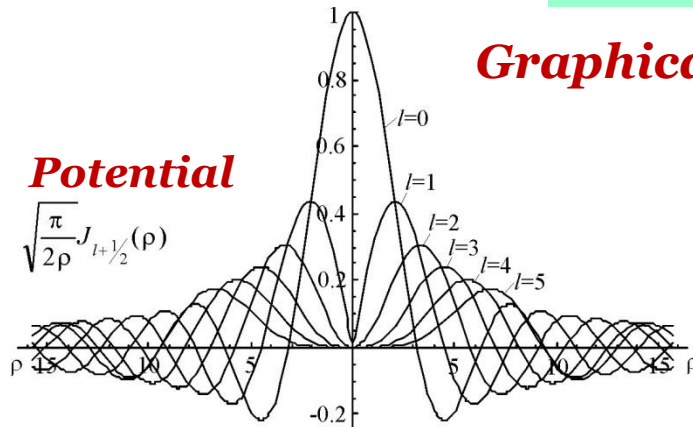
the gravitational spectrum of wave shells of elementary particles has the form:

$$r_{\nu,q} = \lambdabar_g \, z_{\nu,q} \qquad (27)$$

Graphical presentation of radial solutions

$$\hat{R}_l(\rho) / A = \sqrt{\pi / 2\rho}\,(J_{l+\frac{1}{2}}(\rho) \pm i Y_{l+\frac{1}{2}}(\rho))$$

Fig. 1. Plots of the first six radial spherical functions.

So, we **came** to the **discovery** of the

Spectrum
of equilibrium gravitational wave
shells of particles

$$r_{\nu,q} = \lambdabar_{g}\, z_{\nu,q} = 327.4 \cdot 10^{6} \cdot z_{\nu,q} \quad km$$ **!** (27)

Roots $z_{\nu,q}$ (zeros) of **Bessel functions** (25) [14] are **solutions** of the **radial component** of the wave equation (1).

Gravitational wave radius of particles (20) $\lambdabar_{g}$ is defined by the **frequency** ω_{g} of the **gravitational wave field**, $\lambdabar_{g} = c / \omega_{g}$. This frequency was not discovered immediately. When developing WM, this became the **result** of several **other key discoveries** of the WM.

The **frequency** ω_g was **determined** thanks to the **solutions** of the **equation** for the **central exchange**

$$\hat{F}_s = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k^2 r^2}(1 - ikr)\hat{\upsilon} i\omega \qquad (2)$$

we **first obtained** (см. [2, 7]), which revealed, among others, the fundamental **relation between** the **charge** and **mass**:

$$q = m\omega \qquad (9)$$

And as a **consequence** of that, the discovered **Law** of **Central Exchange** took the form,

$$\langle F \rangle = \omega_f^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \qquad (13)$$

Thus, we came to the **true form** of the **Newton law** of **gravitation**, which follows from the Universal Law of Central Exchange (13) as its particular case:

$$\langle F_g \rangle = \omega_g^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \qquad (16)$$

Only on the above grounds, comparing finally the law (16) with Newton's law in its original form (3), we **came** to the **discovery** of the **fundamental frequency** of the **gravitational** wave field ω_g.

Compared to the size λ_g , ordinary **bodies** can be considered as **negligible points**. Hence, **all** identical **shells** of a giant number of **elementary particles** that make up the bodies **practically coincide**.

They are **overlapped**, forming the **united spectrum** of shells-orbits **around bodies**, **identical** to the **spectrum of one atom**.

For example, the **mass** of the **Earth** is approximately $5.9736 \cdot 10^{24}$ kg. The **total numbers of atoms** that make up the Earth is $\approx 1.3 - 1.4 \cdot 10^{50}$.

Thus, solution (27) for wave shells of individual elementary particles is, in fact, the solution for the shells-orbits of massive (compact) space objects such as stars, planets and their satellites.

8. Gravitational spectra of the orbits of the planets and their satellites

(WM solutions (27), comparison with astronomical, experimental data)

The **spectrum** $r_{v,q} = 327.4 \cdot z_{v,q}\ Mkm$ (27), of the wave spherical **shells** of **particles** is **implemented** to a **first approximation** in the **spectrum** of **Kepler's shells-orbits** (Table 1) of **planets**, if we **assume** that these **shells** are **spherical** and, therefore, the **orbits** are **circular**.

Table 1

Gravitational spectrum of H-atomic wave spherical shells.

s	$z_{v,q} = j_{0,s}$	r_s, Mkm	Planets*	
1	2.4048	787.3	Jupiter	(778.57)
2	5.5201	1807.3	Saturn	(1433.45)
3	8.6537	2833.2	Uranus	(2876.68)
4	11.7915	3860.5		
5	14.9309	4888.4	Neptune	(4503.4)
6	18.0711	5916.5	Pluto	(5906.5)

*) Planets located in relative proximity to the spherical shells.
In round brackets are the semi-major axes of the elliptical orbits of the planets
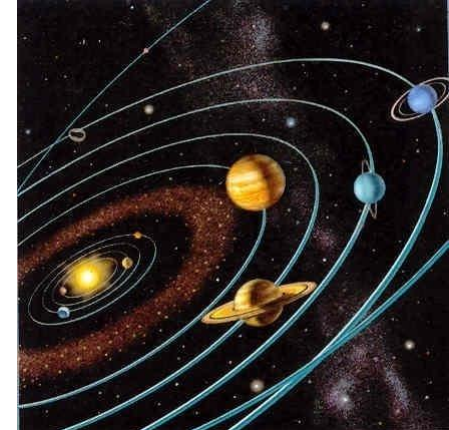
Under conditions of interplanetary gravitational interaction (causing disturbances), the planets do not move along ideal circular orbits, to which they constantly strive, since circular orbits are equilibrium.

Mutual perturbation eventually turned the circular orbits into elliptical, and since the eccentricity is insignificant, the orbits of the planets can be considered in the first approximation (in the analysis) as circular.

The following relation, important in a practical sense, comes from (27):

$$r_s = r_1 \frac{z_{m,s}}{z_{m,1}} \quad ! \tag{28}$$

If we take as a basis the first gravitational wave shell of the Sun, where the orbit of the planet Mercury is located, $r_1 = 57.91\,Mkm$, then we arrive at the following gravitational spectrum r_s , corresponding to the solutions of the first-order Bessel functions $z_{1,s}$ (Table 2).

Table 2
Gravitational spectrum of spherical wave shells of particles.

s	$z_{m,n} = j_{1,s}$	r_s, Mkm	Planets
1	3.831706	57.91	Mercury
2	7.015587	106.03 (108.2)	Venus
3	10.17347	153.76 (149.6)	Earth
4	13.32369	201.36 (204.5)	Toro (asteroid)
5	16.47063	248.93 (227.9)	Mars
9	29.04683	438.96	413.77 (Ceres)
16	51.04354	771.44 (778.57)	Jupiter
30	95.02923	1436.2 (1433.45)	Saturn

In round brackets are the semi-major axes of the elliptical orbits of the planets. For Toro, the average distance from the Sun is shown in brackets.
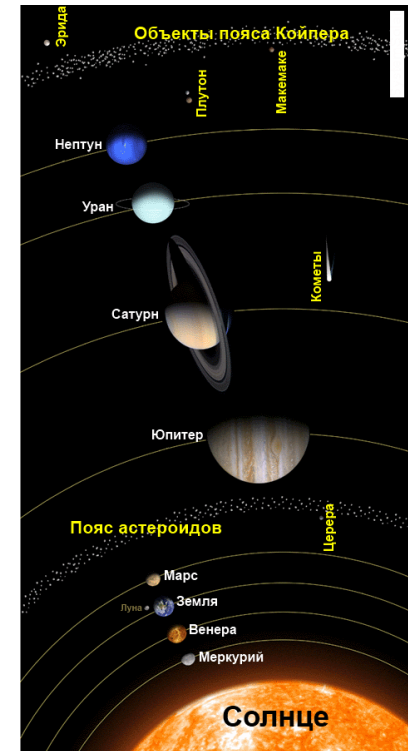
The **transition region** between the **vibrational** and **wave** regions, **separated** by a **gravitational wave radius** $\lambda_g = 327.4\ Mkm$, is **represented** by an **asteroid belt** around the Sun (on average, the radius of the asteroid belt is within 329.12 - 538.56 Mkm).

Among the **asteroids** in the center of this **region** is the only dwarf planet **Ceres**. Large planets are absent here, because in the process of the formation of the solar system, the **transition region** was the site of the most **intensive motion**.

The spectra:

$$r_s(\,j_{1,s}\,) = r_1 \frac{j_{1,s}}{j_{1,1}} \qquad \text{and} \qquad r_s(\,y_{1,s}\,) = r_1 \frac{y_{1,s}}{j_{1,1}} \qquad\qquad (29)$$

following from the relation (28), $r_s = r_1(z_{m,s}/z_{m,1})$, where $j_{1,s}$ and $y_{1,s}$ – the first order **roots** of **Bessel functions** [14], lead to **gravitational** wave **spectra of**

shells-orbits of satellites of the planets.

For **Jupiter**, **Saturn** and **Uranus**, they are presented in Tables 3, 4, and 5, respectively.

Table 3
The spectrum of gravitational wave shells of Jupiter; r_s *kkm*.

s	$r_s(\,j_{1,s}\,)$	$r_s(\,y_{1,s}\,)$	$<r_s>$, semi-major axes
1	71.492		
2	130.9	101.3	129,0 (Adrastea), 128 (Metis)
3	189.8	160.38	181.4 (Amalthea)
4	248.6	219.2	221.9 (Thebe)
7	424.7	395.3	421.8 (Jo)
11	659.2	629.9	671.1 (Europa)
18	1069.6	1040.3	1070.4 (Ganymede)
32	1890.29	1860.98	1882.7 (Callisto)

$r_1 = 71.492$ *kkm* – equatorial radius of the planet Jupiter; $<r_s>$ are the semi-major axes of the orbits known from astronomical observations.
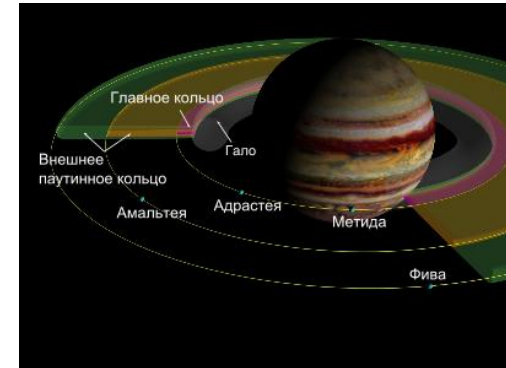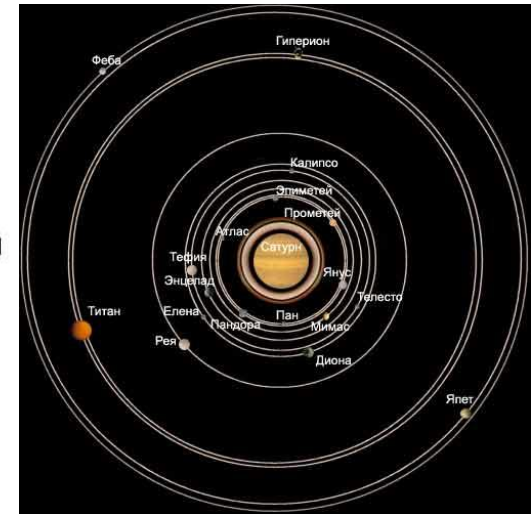
Table 4

The spectrum of gravitational wave shells of Saturn; r_s kkm.

| s	r_s ($j_{1,s}$)	r_s ($y_{1,s}$)	$<r_s>$ (experiment); semi-major axes
1	60.268		
2	110.346	85.40	74.5-92.0 (Ring C)
			92.0-117.5 (Ring B)
3	160.0	135.20	137.67 (Atlas), 139.38 (Prometheus)
			133.58 (Pan), 136.5 (Daphnis)
			122.2-136.8 (Ring A)
			140.210 (Ring F)
			165.8-173.8 (Ring G)
4	209.56	184.8	185.539 (Minas)
5	259.06	234.3	238.037 (Enceladus)
6	308.53	283.8	294.67 (Tethys)
			294,71 (Telesto, Calypso)
7	357.99	333.26	180.0-480.0 (Ring E)
8	407.43	382.71	377.42 (Dione, Helene)
			377.2 (Polydeuces)
...	...	...	...
11	555.73	531.02	527.04 (Rhea)
25	1247,61	1222.9	1221.865 (Titan)
30	1494.69	1469.98	1500.934 (Hyperion)

r_1 = 60.268 kkm – equatorial radius of the planet Saturn.
For rings, the distances to the center of Saturn are indicated.

Table 5

The spectrum of gravitational wave shells of Uranus; r_s *kkm*.

s	$r_s\,(\,j_{1,s}\,)$	$r_s\,(\,y_{1,s}\,)$	$<r_s>$ (experiment); semi-major axes
1	25.559		
2	46.8	36.2	49.8 (Cardelia)
3	67.85	57.34	59.2 (Bianka), 66.1 (Portia) 69.9 (Rosalind)
4	88.87	78.37	86.0 (Puck), 76.42 (Perdita) 74.39 (Cupid)
5	109.86	99.36	97.736 (Mab)
6	130.84	120.36	129.9 (Miranda)
9	193.75	183.27	190.9 (Ariel)
13	277.6	267.12	266.0 (Umbriel)
21	445.27	434.79	436.3 (Titania)
28	591.97	581.5	583.5 (Oberon)
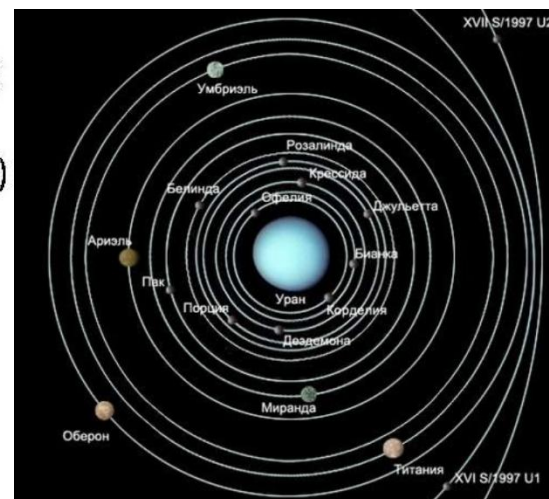
$r_1 = 25.559$ *kkm* – equatorial radius of the planet Uranus

As we see,

The correlation between

(1) the **radii** of the **gravitational spherical wave shells** of the **Sun,** as well as the radii of the **shells** of **its planets, calculated** by the formulas (27) and (29), respectively, and

(2) the **semi-major axes** of the elliptical orbits of the **planets** of the solar system and the orbits of their **satellites**, **estimated** from **astronomical observations**,

is quite satisfactory.

Thus, the mystery

of the **existing order** in the **arrangement** of the **orbits** of the **planets** at strictly defined average distances from the Sun and the **order** in the **arrangement** of the **orbits** of the **satellites** of these planets **was** at last **unravelled**.

Planets and **satellites** move in space around **stars** and **planets**, respectively, **along** their **wave shells-orbits**.

Their spectra are identical to the gravity spectrum of one particle (27).

As has been convincingly shown,

Equilibrium orbits
of planets of stellar systems and their satellites

are determined by a simple, in form, spectral formula (27):

$$r_{v,q} = \lambdabar_g \, z_{v,q}$$

Theoretical foundations of the discovery of the spectrum are:

a) **Solutions of equation** (2) of the **Dynamic Model** of elementary particles, resulted in the **discovery** of the characteristic **fundamental frequency** (6),

$$\omega_g = 9.158082264 \times 10^{-4} \; s^{-1}$$

of the **gravitational field** of **particles**, and, hence, the fundamental **gravitational wave radius** of particles (20), corresponding to this frequency:

$$\lambdabar_g = c / \omega_g = 327.4 \times 10^{6} \; km$$

b) **Radial solutions** of the universal (classical) **wave equation** (1):

$$\text{\textit{roots of Bessel functions}}, \; z_{v,q}$$

<u>Towards the end, it makes sense to pay attention to the following key features</u> :

(I) The similarity
of two spectra of wave shells of particles:

(*a*) **The spectrum**

➡ $$r_{\nu,q} = \lambdabar_e z_{\nu,q} \qquad (26)$$

of the **atomic** **wave** **shells** of particles, corresponding to the **relatively high fundamental frequency** ω_e (characteristic for **atomic** and **subatomic levels)**, and

(*b*) **The spectrum**

➡ $$r_{\nu,q} = \lambdabar_g z_{\nu,q} \qquad (27)$$

of the **gravitational** **wave** **shells** of particles (and, respectively, of **stars** and **planets**), corresponding to the low fundamental **frequency** ω_g.

Particles, being **extremely small** and **infinitely large** at the same time, in full accordance with the DM, are described at both levels by the **same wave equation** (1),

$$\Delta \hat{\Psi} - \frac{1}{c^2} \frac{\partial^2 \hat{\Psi}}{\partial t^2} = 0$$

Therefore, its **solutions** for both the **atomic** (26) and **gravitational** (27) levels are **similar**. The **difference** in **frequencies** and, accordingly, in the **wave radii**: in (26), the wave radius is $\lambdabar_e$, and in (27) $- \lambdabar_g$.

(II) The similarity
of the fundamental laws of the central exchange

The **laws of the *central exchange interaction* of particles** at **different levels** of the Universe: ***subatomic***, ***atomic*** and ***gravitational***, to which they **belong simultaneously** being ***finite-infinite*** in size [2], are ***similar*** both in ***form*** and ***content*** (difference in frequencies and masses):

➤ ***Electric***

$$(14) \quad F_{elec} = \omega_e^2 \frac{(Z_1 m_e)(Z_2 m_e)}{4\pi\varepsilon_0 r^2}$$

➤ ***Gravitational***

$$F_{grav} = \omega_g^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \quad (15)$$

➤ ***Strong* ("nuclear")**

$$F_{strong} = \omega_e^2 \frac{(Z_1 m_n)(Z_2 m_n)}{4\pi\varepsilon_0 r^2} \quad (19)$$

All the above laws are particular cases of ***the Universal Law of the Central Exchange***:

$$\langle F \rangle = \omega_f^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \quad (13)$$

The **fundamental features** noted above fully **confirm** the following **words** of the **text** on the

Emerald Tablet

that was found in the tomb of Hermes Trismegistus (Tabula Smaragdina Hermetis):

Verum est sine mendacio, certum et verissimum:

Quod est inferius est sicut id quod est superius.

Et quod est superius est sicut id quod est inferius, ad perpetranda (praeparanda, penetranda) miracula rei unius [15]….

This true without lying, certain & most true.

That which is below is like that which is above &

that which is above is like that which is below, to do the miracles of one only thing…

9. Definition of the phenomenon of gravitation

So, gravitation

has a wave nature, like everything else in the Universe!

Definition

(in accordance with the WM)

The phenomenon of gravity is the resonant wave exchange (interaction) of all elementary particles, which make up the bodies, carried out at extremely low proper fundamental frequency $\omega_g = 9.158 \times 10^{-4} \ s^{-1}$ **, inherent in each particle.**

Additional confirmation
of the reality of the discovery

of the wave nature of gravity and the numerical value of its fundamental frequency:

The **gravitational frequency** ω_g (6) determines the ***radial time wave-period***,

$$T_g = 2\pi / \omega_g = 0.686080898 \times 10^4 \; s \qquad (30)$$

In an **orbit** with one node, only one **half-wave** of the **fundamental tone** is **placed** (see, for example, [16]). Therefore, the following

Azimuthal time wave

of the fundamental tone,

$$\boxed{T_{azim} = 4\pi T_g = 8.621546841 \times 10^4 \; s} \quad \textbf{!} \qquad (31)$$

corresponds to the **radial wave period** (30). The value (31) practically **coincides** with the **Solar Day**

$$\boxed{T_{orb,Earth} = 23 \; hours \; 56 \; min \; 4 \; s = 8.6164 \times 10^4 \; s}$$

The **azimuthal time wave** $T_{azim} = 4\pi T_g$ ***repeats the structure*** of a **spatial wave** λ of the **fundamental tone** in the Bohr orbit of a hydrogen atom: $\lambda = 4\pi r_0$.

The above relationships show

that the **Earth** is in ***harmonic resonance coupling*** with the ***fundamental frequency*** of the ***gravitational field*** ω_g.

  Similarly, an **electron** in the Bohr orbit in a hydrogen atom is in ***harmonic resonance coupling*** with the ***fundamental frequency*** of the ***atomic*** and ***subatomic*** levels ω_e.

10. <u>Conclusion</u>

**The following key discoveries
related to the *problem of gravity* were made in the framework of
the Wave Model:**

1) The **associated nature** of the **origin of mass** m.

2) The **wave nature of gravity.**
   The **source of origin of gravity waves** are pulsating spherical
   wave shells of elementary particles which are
   dynamic (wave) formations.

3) The **fundamental frequency** ω_g and the **fundamental wave
   radius** $\lambdabar_g$ of the gravitational wave field.

4) The rate of the **gravitational wave exchange** of particles – the
   gravitational charge q_g .

5) The **dependence of gravitational constant** G **on the fundamental frequency** ω_g **of the gravitational wave field.**

6) The **relation of the gravitational constant** G **with the constant factor** k **in the Coulomb law.**

7) The **Universal Law of the Central Exchange.**

8) The **true form of Newton's and Coulomb's laws and the meaning of all the physical parameters included in these laws.**

9) **Gravitational spectrum** $r_{\nu,q}$ **of equilibrium spherical wave shells of elementary particles, its coincidence with the spectrum of the orbital radii of planets and satellites of the planets in stellar systems.**

The key discoveries

of the **WM**, along with other discoveries, derivative from key ones, **stimulate** the **revision** of established **dogmas** in the description of phenomena and **rejection** of **inadequate** theoretical constructs.

Thus, with the development of the WM,

the **process of updating began**, consisting in

replacing the subjective approach

adopted in physics, based on the use of **abstract-mathematical (fictional) postulates,** with concepts that are **adequate** to reality**.**

Adequate paradigm of physics,
laid down in the foundation of WM , provided
a breakthrough
in solving the problems accumulated in physics!

Discovery of the wave nature

of gravitational field and its

fundamental frequency,

as well as cognition of the mechanism of the

gravitational wave exchange interaction,

thanks to the discovery of the

Universal Law of the Central Exchange,

opens the way for

solving the problem
*of controlling the direction and power ("force")
of the gravitational interaction of bodies!*

(allows to make a fairy tale about the "carpet-plane" come true)

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Thank you
for your attention!