Some words about fundamental problems of physics

Part 6: Planetary orbits

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One of the unsolved mysteries of modern physics and astrophysics is still the nature of the existing order in an arrangement of the orbits of planets at certain mean distances from the Sun. Newton's law of universal gravitation and Kepler's laws even though give us interrelation between the size of planetary orbits and their periods, but do not allow to calculate these orbits. The Standard Model is also helpless here, as in many other cases. Therefore, so far, distances of the planets from the Sun (average radii of the orbits) are calculated by a simple empirical formula proposed by J. D. Titius 245 years ago, in 1766, and further popularized by J. E. Bode, in his works of 1772. The formula is called in their honour the Titius – Bode Law (sometimes just Bode's Law). In one version of the writing the law, the average radii of the orbits (in astronomical units) are subordinate to the formula

$$R_i = \frac{D_i + 4}{10}, \qquad (1)$$

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

The values, calculated by this formula, correlate to the astronomical data within the spread of data, but not for all the planets. For example, on the calculated orbit for i = 3 there is an asteroid belt instead of a planet. Why? It is unknown. The orbits of Neptune and Pluto also fall out of the calculations performed by this empirical formula.

And most importantly, the Titius-Bode empirical law has no theoretical justification, i.e., a conceptual framework for the derivation of the formula is missing. There is only a trivial verbal explanation, actually, a statement of a self-evident fact. According to the latter, in the early stage of the formation of the Solar System, the regular structure was forming from alternating regions, in which may or may not stable orbits exist, according to the so-called rule of orbital resonances (a certain ratio of the radii of the neighbouring orbits).

In this Part of the article I give the first theoretical explanation of the order in an arrangement of the stationary orbits, reveal causes of the phenomenon, which turned out to be possible on the basis of theories within the Wave Model (WM): the Dynamic Model of elementary particles (DM) [1, 2] and the Shell-Wave Model of atoms (SWM) [3].

One of the results obtained in the DM is a discovery of the fundamental frequency of an ultimately low value,

$$\omega_g = 9.158082264 \times 10^{-4}\, s^{-1}, \qquad (2)$$

which is characteristic for the wave field of elementary particles. As it turned out, on this frequency it is realised their gravitational exchange (interaction). In accordance with the postulate, upon which the DM rests, all processes and objects in the Universe have a wave nature and, therefore, subordinate to the universal (classical) wave equation,

$$\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0 . \quad (3)$$

A solution [3] of the radial component of this equation and the discovery [1] of the gravitational frequency ω_g (2) led us to the discovery of the spectrum of wave gravitational shells (will be shown below). This spectrum allowed understanding, as was mentioned in Part 5, the reason for the location of the planetary orbits within regions around well-defined distances from the star, as well as the location of the orbits of planetary satellites.

This is an extremely important theoretical result [4 - 6] for the first time obtained in physics in the framework of the WM. So I decided to bring it to the attention of the readers by this publication, provided in a series of short notes (Parts) devoted to the fundamental problems of physics.

The gravitational frequency (see Part 5) determines the gravitational radius of elementary particles, which is also the elementary radial gravitational wave

$$\lambda\!\!\!^{-}_g = \frac{c}{\omega_g} = 327.4\times10^{11}\ m = 327.4\ \ Mkm. \quad (4)$$

The wave shell of the gravitational radius (4) of a particle in stellar systems, which in turn are spherical objects of mega space (atoms of mega world), separates the oscillating region of a spherical field-space of a star and its wave region.

We on the Earth are inside a giant gravitational wave and, therefore, perceive the gravitational wave field as stationary. As follows from the Universal Law of Exchange (see Eqs. (12) and (14) in Part 5), the power of gravitational exchange (the "force" of gravity) of individual particles,

$$F_{grav} = \omega_g^2\,\frac{(Z_1 m_n)(Z_2 m_n)}{4\pi\varepsilon_0 r^2}, \quad (5)$$

is negligible. But a huge number of particles (e.g., the Sun consists approximately of 10^{57} nucleons) compensates for this negligible amount, and in sum, leads to a very significant effect – the gravitational attraction.

In accordance with the solutions of the wave equation (3), the gravitational wave radius (4) of elementary particles determines the radii of their wave equilibrium spherical shells by the following equation:

$$r = \lambda\!\!\!^{-}_g z_{m,n} = 327.4\times10^6\times z_{m,n}\ \ km; \quad (6)$$

where $z_{m,n}$ are solutions of the wave equation (3) (roots, zeros, of Bessel functions) [7].

This is simple but at the same time a fundamental relationship and it has a deep physical sense. Namely it reflects the wave nature of objects and their interaction at the mega (gravitational) level. Eq. (6) includes only two parameters. One of them, the roots of Bessel functions, $z_{m,n}$, is the result of solving the wave equation (3), to be more precise, its radial component. The second parameter, the wave gravitational radius of elementary particles, λ_g, corresponding to the extremely low frequency of their intrinsic pulsations, ω_g, is the result of solutions obtained in a theory of the DM.

The solution (6) is realized in the first approximation in a spectrum of the Keplerian shells-orbits, assuming that the gravitational shells are spherical and, therefore, the orbits are circular (see Table 1). Under the conditions of interplanetary gravitational interaction (perturbation), the planets cannot move strictly along circular orbits, to which they naturally aspire constantly as to equilibrium. Mutual perturbations eventually have turned the circular orbits in elliptic. However, because of relatively small eccentricities, the orbits of the planets can be considered in the first approximation (for analysis) as a circular.

Table 1

A gravitational spectrum of *H*-atomic wave spherical shells

s	$z_{m,n} = j_{0,s}$	r, 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 brackets there are semi-major axes of elliptical orbits of the planets.

The elliptic orbits of Saturn and Neptune are closer to circular of spherical shells, corresponding to the roots of the extremes of Bessel functions [7], $z_{m,n} = a'_{0,2} = 4.49341$ and $z_{m,n} = a'_{0,5} = 14.0662$: $r = 1471.1 Mkm$ and $r = 4605.3 Mkm$, respectively.

From formula (6) the following important, in a practical meaning, relation originates:

$$r_s = r_1 \frac{z_{m,s}}{z_{m,1}} \tag{7}$$

In this expression there is not the characteristic fundamental frequency of the gravitational field, ω_g, which, of course, was changing during the historical period of the formation of the Universe. If we take, as the basic, a gravitational wave shell of the Sun, e.g., on which is an orbit of the planet Mercury, we arrive at the gravitational spectrum, conditioned by the solutions of the Bessel functions of the first order (Table 2).

A transient region, between oscillatory and wave, limited by the wave gravitational radius, $\lambda_g = 327.4\ Mkm$, is presented by the asteroid belt around the Sun (the orbital radius of the belt is in average within 329.12 - 538.56 *Mkm*). In the center of the field of asteroids, there is the only dwarf planet, 1 Ceres. No large planets are there, since in the formation of the Solar System, the transient region was a place of the most intense motion.

Table 2

A gravitational spectrum of wave spherical shells of elementary 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
5	16.47063	248.93 (227.9)	Mars
6	19.61586	296.46	Asteroids
7	22.76008	339.45	Asteroids
8	25.90367	391.49	Asteroids
9	29.04683	438.96	413.77 (1 Ceres Asteroids
10	32.18968	486.49	Asteroids
11	35.33231	533.99	Asteroids
12	38.47476	581.48	Asteroids
13	41.61709	628.97	1 asteroid
14	44.75932	676.46	
15	47.90146	723.95	
16	51.04354	771.44 (778.57)	Jupiter
...			
30	95.02923	1436.2 (1433.45)	Saturn

Semi-major axes of elliptical orbits of the planets are in brackets. For a small planet Toro, in brackets, an average distance from the Sun is indicated.

In addition, in Tables 3, 4 and 5, there are shown the spectra, $r_s(j_{1,s})$ and $r_s(y_{1,s})$, of the wave gravitational shells of Jupiter, Saturn and Uranus. They were obtained from the relations,

$$r_s(j_{1,s}) = r_1 \frac{j_{1,s}}{j_{1,1}} \qquad \text{и} \qquad r_s(y_{1,s}) = r_1 \frac{y_{1,s}}{j_{1,1}}, \tag{8}$$

originated from Eq. (7), where $j_{1,s}$ and $y_{1,s}$ are roots of Bessel functions [7]; $\langle r_s \rangle$ are semi-major axes of orbits (*a*) of planetary satellites known from the astronomic observational data.

Table 3

A spectrum of wave gravitational shells of Jupiter; r_s *kkm.*

s	r_s ($j_{1,s}$)	r_s ($y_{1,s}$)	<r_s> (experimental); semi-major axes, *a*
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* is an equatorial radius of Jupiter

Table 4

A spectrum of wave gravitational shells of Saturn; r_s *kkm.*

s	r_s ($j_{1,s}$)	r_s ($y_{1,s}$)	<r_s> (experimental); semi-major axes, *a*
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* is an equatorial radius of Saturn. For rings, the distances to the center of Saturn are indicated.

Table 5
A spectrum of wave gravitational shells of Uranus; r_s *kkm.*

s	r_s ($j_{1,s}$)	r_s ($y_{1,s}$)	<r_s> (experimental); semi-major axes, *a*
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* is an equatorial radius of Uranus

The correlation between the shown above results of theoretically derived gravitational wave shells of the Sun and observed experimentally semi-major axes of elliptical orbits of its planets, as well as the correlation between gravitational wave shells of the planets derived theoretically and semi-major axes of their satellites taken from the astronomical data, is quite satisfactory.

It should be noted the similarity of the spectrum of gravitational wave shells of elementary particles (6) and, hence, planetary and satellite orbits in our Solar System with the derived theoretically spectrum of wave shells of atomic and subatomic levels of exchange (e.g., with optical spectra). The difference is in their different, in scale, characteristic frequencies, ω_g and ω_e, related to the mega (gravitational) level and the atomic and subatomic levels, respectively. Please, compare

$$\omega_g = 9.158082264\times10^{-4}\,s^{-1} \quad \text{and} \quad \omega_e = 1.869162559\times10^{18}\,s^{-1}.$$

Elementary particles, in particular, nucleons (protons and neutrons), being extremely small and infinitely large at the same time, in full agreement with the DM (see Part 5), representing thus both micro and mega world simultaneously, are described at both levels by the same wave equation (3). The solutions for micro and mega levels of the Universe are similar in many ways. For example, the equation for the radii of the wave shells at the atomic and subatomic levels

$$r = \lambda\!\!\!^{-}_e z_{m,n}, \tag{9}$$

has the same form as Eq. (6) for the radii of the wave shells of the gravitational level. Only one difference is: in (6) there is the wave radius $\lambda\!\!\!^{-}_g$, and in (9) $\lambda\!\!\!^{-}_e$. This is not surprising, since the exchange interaction of the particles at both levels of the Universe, to which they belong at the same time, is subject to the Universal Law of Exchange (see Eq. (12) in Part 5).

To summarize. The mysteries of an existing order in an arrangement of the orbits of the planets at certain average distances from the Sun, as well as the orbits of satellites of these planets, are unravelled. As it turned out, the planets and their satellites, mutually influencing each other, move along the orbits formed in discrete regions of wave space in full conformance with the derived spectrum (6) of gravitational wave spherical shells of the particles, from which the Sun and planets of our Solar System are made up.

A theoretical basis for the derivation of the spectrum (6) is the wave approach. Herewith, one should be distinguished once again the following two independent sources in the framework of the WM that led to the spectrum.

(a) The solutions within a theory of the DM, which led to the discoveries of the wave nature of elementary particles and the wave nature of their exchange (fundamental interactions) at all levels of the Universe, including gravitational with the characteristic frequency of the gravitational exchange, $\omega_g = 9.158082264 \times 10^{-4} s^{-1}$.

(b) The radial solutions of the universal (classical) wave equation (3), expressed by the roots of Bessel functions.

Thus, the Wave Model, including theories of the DM and SWM, confirming once again its advantage in comparison with the Standard Model accepted in modern physics, this time in ability to explain the nature of gravity and the phenomena caused by it, can be considered as a real alternative to the latter.

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