Registration of wake gravitational waves using pulsar timing.

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*Gravitational astronomy, based on pulsar timing, opens up the possibility of registering **Wake gravitational waves** that can be generated by the **Sun** and **Moon**. When these waves are exposed to the Earth, a "**purple**" shift in the pulse frequency of pulsars should be observed.*
Preliminary estimates of the physical and geometric characteristics for the search for such waves are presented.

1. Preliminary remarks.

Articles [1]-[4] set out in sufficient detail our point of view on the entire cycle of issues discussed below.
In particular, it is shown in [1] that:
- the modern interpretation of the "relativity of simultaneity" in the Special Theory of Relativity INEVITABLY leads to a COMPLETE rejection of the concept of Time as a phenomenon
- to overcome this obvious absurdity and return the phenomenon of Time to Physics, we have proposed several options,
- the simplest, logically consistent and scientifically acceptable solution seems to be the return to Physics of the updated concept of **Absolute Space-Time** as the ONLY PHYSICALLY REAL hyperplane in Minkowski space-time [1].
- Since ANY space-like hyperplane is COMPLETELY equal to all others, it is clear that each of them falls under ALL mathematical and physical laws and conclusions of the Special Theory of Relativity. Thus, the allocation of one of them, from a theoretical point of view, is quite acceptable and consistent. The experimental results already obtained are not affected either. As for modern, purely theoretical constructions, here, in each specific case, an analysis is required.
- Specifying a specific hyperplane as an Absolute one is a matter of PURELY experimental efforts, since mathematics itself does not contain an internal mechanism for verifying its consequences.-
- Such a dedicated, space-like hyperplane in the real World is the physical Universe in its ABSOLUTE COMPLETENESS of objects and events that exist and occur at a GLOBAL, SYNCHRONOUS, SINGLE moment tj of one's own "now".
- The history of the Universe, in this case, will be represented by an ordered set of disjoint hyperplanes in Minkowski space, where EACH of these hyperplanes corresponds to the Universe at the corresponding moment tj.
- Time plays its usual role, ordering the movement of objects and the flow of processes, ensuring the ABSOLUTE simultaneity of ALL events and objects of the Universe at the moment tj [2].

One of the experimental facts that would be an extremely strong argument in favor of Absolute Space-Time (hereinafter **APV**) would be the detection of Wake gravitational waves (hereinafter **KV**). The idea of the existence of such waves was expressed by us in [3], as a consequence of the hypothesis of Absolute Space-Time and the idea of geometrization of gravity.

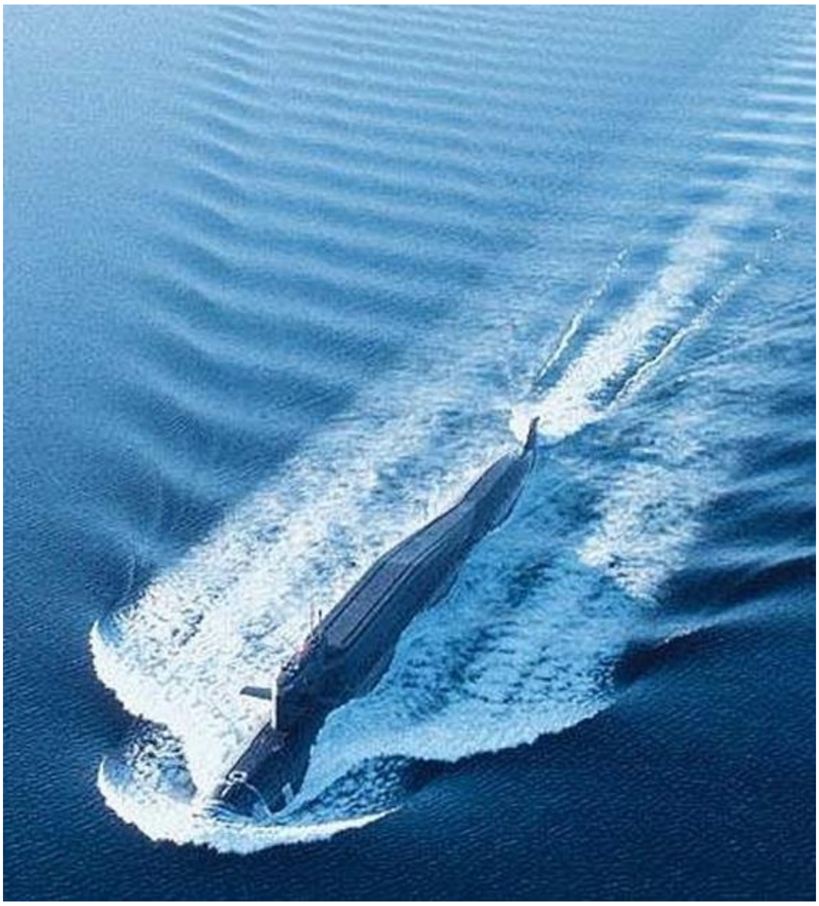

Fig.1 Wake waves on the water.

A general view of the Wake waves on the water is shown in Fig.1.
Due to, as already mentioned, the incorrect interpretation of the concept of "relativity of simultaneity", modern Physics uses the erroneous thesis of the complete physical equality of all permissible reference frames, which does not allow it to consider such phenomena as Wake gravitational waves in any of the modern gravitational theories.
Indeed, if all frames of reference are physically equal, then waves, such as Wake waves, are even logically contradictory already due to the fact that any object can be considered from other frames of reference both as stationary and as moving at any speed and in any direction. A wake wave is a specific, observable physical phenomenon with unambiguous characteristics and cannot exist or not exist depending on the conditions of observation.
For Absolute Space-Time, the phenomenon of Wake gravitational waves seems to us quite natural, based on analogies with the movement of bodies "in" or "through" a certain medium – for example, in a gas and / or liquid. Absolute Space-Time, in a peculiar form, is such an "environment". Wake gravitational waves are expected to be generated by ALL bodies moving relative to the **APV**.

Since relict 2.7 degree radiation may well turn out to be an isotropic filling of the **APV**, we consider such a hypothesis as the basic one and build further arguments on it.
In this case, the Solar system, actually flat (with an angle of attack of about 7 angular degrees), moves at a speed of (369.82 +/- 0.11) km/s in the direction α= 167.942 +/- 0.007 [deg], δ= -6.944 +/- 0.007 [deg] (J2000) [5], which makes it possible to roughly estimate where the **KV** is located relative to a particular celestial body and when the **KV** from this body reaches the Earth laboratory.

Due to the fact that the Wake wave is gravitational, its effect on the laboratory fully corresponds to the expected effect of a gravitational wave, which has been studied theoretically well enough. However, the degree of **KV** impact on the laboratory is an ABSOLUTELY unknown value, so our further arguments are, of necessity, mainly qualitative in nature.

Note that in this article we consider the effect of the Wake wave, associated only with the gravitational frequency shift. We plan to consider the tidal effect in another article.

Figure 2 shows a general view of what the Wake gravitational wave of the Sun looks like in the light of our assumptions.
The specific characteristics of the **KV**, as we have already noted, are unknown. Therefore, even the location of the **KV** relative to the Sun is a question that only an experiment can answer. In preliminary calculations, we consider the Wake wave passing through the center of the body that creates it. At the same time, it seems logical to us to keep "in mind" that the **KV** is formed somewhat ahead (in the course of movement) of this body.

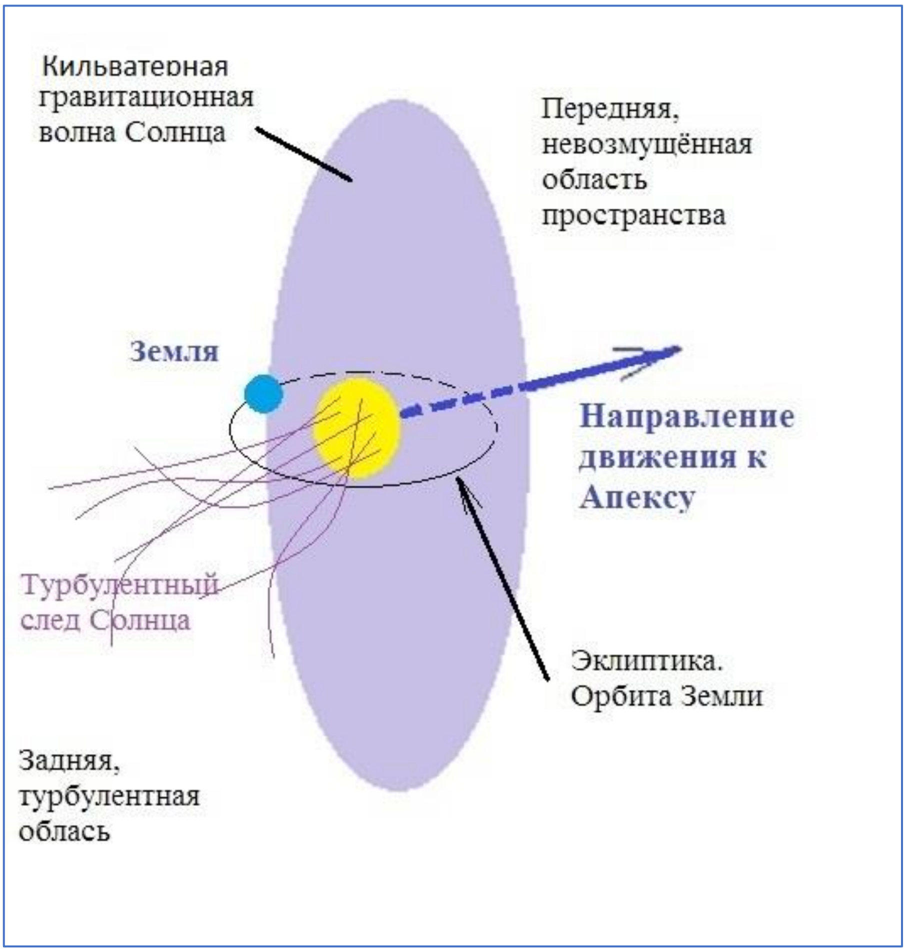

Fig.2 General view of the Wake of the gravitational wave of the Sun and the orbit of the Earth (ecliptic).
translation of inscriptions: from left to right, from top to bottom:
- the wake of the gravitational wave of the Sun
- an anterior, undisturbed area of space
- Earth

- the direction of movement towards the Apex
- the turbulent trail of the Sun
- The ecliptic. Earth's Orbit
- The posterior, turbulent area
(The wake of the gravitational wave of the Sun is depicted as a disk, i.e. as an object with a boundary, for a simpler understanding of its idea. In reality, it weakens with distance from the Sun, but it is not limited to anything, i.e., FORMALLY, it extends to Infinity.)

Due to the fact that **KV** is a gravitational wave and the speed of the "agent creating it" is equal to the speed of light, it is practically flat due to the low speed of the Solar System relative to Absolute Space—Time.
More precisely, **KV** is a cone, but taking into account the fact that the speed of the Sun is 370 km/s, i.e., of the order (1 e-3) of the speed of light, we neglect the taper in the future.
Secondary gravitational waves, which are analogs of the secondary waves in Fig.3 (photo of a ball in a gas), certainly require experimental confirmation. The turbulent wake behind the Sun also requires experimental confirmation. However, in general, such a configuration: the main wave, secondary waves, and a turbulent wake seems to us very logical.

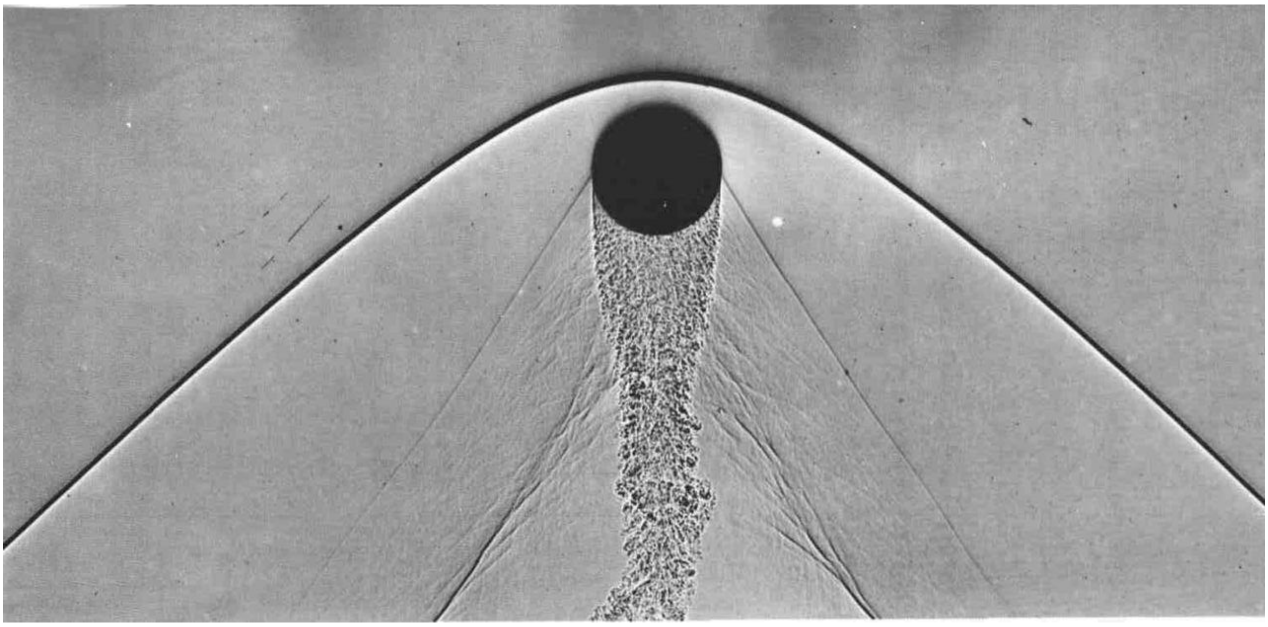

Fig.3 Photo of wave disturbances in the gas generated by a fast-moving ball.

2. Estimation of the magnitude of the gravitational frequency shift and the dates of impact on the Earth laboratory for the Wake gravitational wave.

Wake waves of galactic and extragalactic origin seem to us much less powerful than those generated in the Solar System. Therefore, at the moment we are considering the latter.
It is clear that since the gravitational field is weak, estimates of the effects in the Earth laboratory are quite acceptable using the linearized theory of gravity (General Relativity).
In this approximation, the solution of the gravitational frequency shift problem is well known, for example [6] and [7]. The formula for the gravitational frequency shift is written as:

$$\Delta\boldsymbol{\nu} = \boldsymbol{\nu}_* (\phi_i - \phi_f)/c^2 \qquad (1)$$

where ϕi and ϕf are the gravitational potential, respectively, at the point of emission of the signal and at the point of its registration, and c is the speed of light.
Accordingly, for a body with mass M, the potential is

ϕ= **(-)G*M/r**, (2)

that is, it is always negative. Here G is the classical gravitational constant, r is the distance from the body creating the gravitational field to the potential registration point. We remind you that the gravitational potential at Infinity is 0.

As is known, the frequency shift is a consequence of the different velocity of time at the radiation point and at the observation point. The speed of the passage of time is a function of the gravitational potential at each point. Because of this, formula (1) refers to ANY periodic process and, in particular, to the observed pulse repetition rate from pulsars.

The variability of the pulsar frequency was proposed to be used in order to register gravitational waves of long duration back in 1978 [8]. But it is only now (June 2023) that the first confident reports of the registration of so-called "nanohertz" gravitational waves have appeared. [9] - [12]. We believe that the general technique used in data processing for the purposes of nHz gravitational astronomy will be able to detect Wake waves from objects in the Solar System. Of course, at the first stage, we pin our hopes on the detection of a Wake gravitational wave from the Sun.

As for the direction of the frequency shift, the situation is such that while the Earth is outside the **KV**, we receive signals with a frequency of **ν**. When the Earth enters the **KV**, the gravitational potential increases (modulo). Thus, we should observe an INCREASE in the frequency of arrival of pulses, i.e. a "purple" shift (see section 3).

The maximum amplitude of the Wake wave (for bodies of the Solar System), i.e. its maximum modulo gravitational potential, cannot be objectively estimated at the moment. This is due to the lack of both theoretical and, above all, experimental work in the field of Absolute Space-Time. As a result, the characteristics of the **APV**, which play the same role for Space-Time as the elasticity or Poisson's coefficients, compressibility or viscosity for ordinary bodies, are currently unknown and are not considered scientific.

Thus, we are forced to determine the specified maximum amplitude, simply as
A= k*ϕ(m,r) (3),
where k is a coefficient <1, and ϕ(m,r) is the gravitational potential according to formula (2) created by a body generating **KV** at a distance r (which is equal to the distance to the maximum **KV** in this direction).
For the Sun and Moon, the usual gravitational potentials on Earth are, respectively, (1e-8)*c^2 and (1.4e-15))*c^2. (c is the speed of light). Thus, the maximum amplitudes of Wake waves from the Sun and Moon are expected on Earth to be equal to k*(1e-8)*c^2 and k*(1.4e-15))*c^2 (k <1).
Thus, unlike tidal forces, in this case the Sun acts on the Earth much more strongly than the Moon. This fact somewhat narrows the possibilities of the experiment, since the passage of the Earth through the Wake wave of the Sun occurs once every six months, and the passage of the Moon through the Earth every half a month.

We assume that the characteristic size (thickness) of the **KV** in the direction of movement to the Apex (relative to the relic radiation) is commensurate with the size of the celestial body creating this wave. As for the dependence of the thickness on the radius of the "pancake" it is determined for, we believe that the thickness of the "pancake" is **KV** at the radius of the Earth's orbit (1 astronomical unit)., also commensurate with the size of the celestial body creating this wave, i.e., in the Earth's orbit in the direction of the Apex, the thickness **KV** is ASSUMED to be on the order of (1e+5...1e+7) km for the Sun and (1e+3...1e+5) km for the Moon.

The mutual movement of the Earth and the Wake waves of the Sun and Moon is of a different nature. The fact is that through the **KV** of the Sun, the Earth passes through its orbit with its orbital velocity of 30 km/s, and the **KV** of the Moon moves relative to the Earth in accordance with the movement of the Moon, i.e. at a speed of 1 km/s. Thus, taking the thickness of the **KV**, as indicated above, we expect that the **KV** from the Sun affects the Earth's laboratory for a period of time, on the order of (1...100) hours. The **KV** from the Moon affects the terrestrial laboratory for about (0.3...30) hours.

If we take into account the absolute values of the amplitudes of Wake waves created by various sources and indicated in several paragraphs above, then this fact, of course, significantly reduces the possibility of registering the Moon's **KV**. Therefore, first of all, we focus on the Wake wave of the Sun.
At the same time, it should be noted that due to the smaller geometric dimensions of the Moon's Wake wave, the possibility of a differential experiment is being considered, i.e., observing its passage through the Earth at different points at different times.

Despite all the uncertainty of the physical characteristics of Gravitational Wake Waves, there is sufficient certainty about the dates of their impact on the Earth Laboratory. We have already indicated that we are making a specific assumption about the direction of the drift of the Solar System in Absolute Space-Time. This direction is taken to be the direction of movement towards the Apex, relative to the Relic radiation. Today, this point is well known and, therefore, fairly accurate estimates of the dates of the impact of Wake waves on the terrestrial laboratory can be made.

For the Sun, such almost constant dates are the dates of the Earth's ENTRY into the REAR, turbulent hemisphere of the Sun on about June 13 of each year and the Earth's EXIT from the turbulent zone on about December 14 of each year.
The movement of the moon is much more complicated and the moments of events must be calculated. As an example, it can be indicated that the Earth exited the turbulent hemisphere of the Moon on 13-12-2023 03:11:03 UT and entered it again on 26-12-2023 01:53:42 UT (calculations were performed in accordance with [13]).

3.The ability to detect wake gravitational waves using pulsar timing.

Pulsar timing is a rather complex and specific area of scientific research. Therefore, first of all, we hope that the competent scientific communities already engaged in nanohertz gravitational astronomy will show interest in our hypothesis.
We believe that scientific collaborations: CPTA, EPTA, NANOGrav, PTA and others, possessing both the necessary personnel and archival information on pulsar timing, will be able to carry out a cycle of work in order to detect Wake gravitational waves.

When passing through the laboratory, the expected effect is to SYNCHRONOUSLY change the frequency for ALL (ANY) pulsars by the SAME relative value $\varepsilon = \Delta\boldsymbol{\nu}/\boldsymbol{\nu}$.

The value of ε will vary over a short period of time – from hours to days - according to (APPROXIMATELY) a sinusoidal law, i.e. from 0 to the maximum value and again to 0.
We expect a "purple" shift.

Indeed, during the passage of **KV**, the potential at the observation point increases (modulo). In the case under consideration, ϕi is the potential in the absence of **KV**, and k*ϕ(m,r) is the additional potential during the passage of **KV** (see formula (3)), i.e. the total potential is
ϕi + k*ϕ(m,r).
From here we have: Δ**ν**= **ν*** (-k*ϕ(m,r))/c^2 and, remembering that ϕ is ALWAYS <0, we get a "purple" offset.
The magnitude of such a shift for the Sun: Δ**ν** = k*(1e-8), where k is most likely SIGNIFICANTLY less than 1 (see the numbers after formula (3)).
Intuitively, we estimate the magnitude of the "purple" shift Δ**ν** for the Sun starting from (1e-9)***ν** with a very likely tendency to decrease by orders of magnitude.

The events of the impact of Wake gravitational waves on the Earth, as we expect, occur in the area of the pre-calculated dates.
For the Sun, such impacts are expected twice a year, for the Moon – every two weeks.
The theoretical dates presented by us are the dates when the spatial angle: Apex – the body creating the Wake gravitational wave – the Earth, is equal to 90 degrees of angle.
However, most likely, the **KV** is formed somewhat ahead of the body creating it. Thus, for example, the wake wave of the Sun crosses the Earth a little EARLIER on June 13 of each year and a little LATER on December 14 of each year.

It must be constantly remembered that our hypothesis contains the assumption that the relic radiation is an isotropic filling of the Absolute PV.
Therefore, NOT detecting a purple shift in pulsar frequencies on these dates does not put an end to the hypothesis. It may turn out that either the maximum amplitude of the **KV** is extremely small and is not "caught" by modern means of observation, or the relic radiation is not an isotropic filling of the **APV**.
To solve the problem with a low amplitude of **KV**, it is necessary to increase the sensitivity of the equipment, which gradually occurs simply due to the development of surveillance tools. Thus, in case of initial failure, it is desirable to return to processing more accurate data after some reasonable time.

In case of an error regarding the role of relic radiation, it would be reasonable to search for synchronous changes in pulsar frequencies (as described above) for a full year. Such a complete scan of the Earth's orbit, at the first stage, does not require analysis of ALL pulsars. We believe that in order to pay attention to "suspicious" dates (when a synchronous violet shift occurs), 3...5 pulsars located far from each other on the celestial sphere are enough.

Regarding the theoretical dates proposed above, it is additionally necessary to note the following. We analyzed the assumption that a certain number of earthquakes are initiated by tidal forces arising from the impact of Wake gravitational waves on the Earth. [4] presents the results of the analysis of the number of earthquakes over 23 years (more than (1e+5) events).
According to the results of the analysis (using the method of combining epochs), we obtained a fairly smooth monotonous dependence of the number of earthquakes on the day of the year with the dates of minimum and maximum: June 05 and December 05, respectively. These dates are close to the dates calculated based on astronomical considerations, i.e. June 13 and December

14, but do not coincide with them. Thus, previously, when analyzing the timing of pulsars, it is necessary to focus on several "blurred" periods: "the first half of June" and "the first half of December".

In general, we hope that the accuracy already achieved in the nascent nanohertz gravitational astronomy is sufficient to detect the Wake gravitational waves of the Sun and possibly the Moon in the near future.

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