Corollary 3. Let $A, B$ be two rational groups containing $\mathbb{Z}$ such that $\tau(A) \leq \tau(B)$. If the groups $\text{Hom}(A, B)$ and $A$ are isomorphic, then there is $b \in B$ such that for any prime numbers $p, q$, relatively prime, there is $c \in A$ and we have the equality $b = c(p, q) p^{\lambda(p, 1)} q^{\mu(q, 1)}$, where we denote $\lambda(p, 1) = 2h^p_q(1)$ and $\mu(q, 1) = 2h^q_p(1)$.

**Proof.** With the isomorphism $\text{Hom}(A, B) \cong A$, it results from the theorem 1 that there is $b \in B$ such that $h^p(b) = 2h^p(1)$. By Bézout classical relation, we establish that $\frac{b}{p^{\lambda(p, 1)} q^{\mu(q, 1)}} \in B$. Indeed, as $p^{\lambda(p, 1)}$ and $q^{\mu(q, 1)}$ are relatively prime, from Bézout relation, there are natural numbers $u$ and $v$ such that $up^{\lambda(p, 1)} + vq^{\mu(q, 1)} = 1$. We deduce that $\frac{u}{p^{\lambda(p, 1)}} + \frac{v}{q^{\mu(q, 1)}} = \frac{1}{p^{\lambda(p, 1)} q^{\mu(q, 1)}}$, and we have $b = u \frac{b}{p^{\lambda(p, 1)} q^{\mu(q, 1)}} + v \frac{b}{q^{\mu(q, 1)}} \in B$ because we know that $h^p_q(p, 1) = 2h^p_q(1) = h^p_q(b)$ and $\lambda(q, 1) = 2h^p_q(1) = h^q_p(b)$. It follows that there is $c(p, q) \in B$, and we have $b = c(p, q) p^{\lambda(p, 1)} q^{\mu(q, 1)}$.

Notice. The corollary 3 can be generalized to an arbitrary finite number of primes such that any two of them are relatively prime.

**Bibliography**


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**INVESTIGATION OF THE ABSOLUTENESS OF TIME**

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**ABSTRACT**

In classical physics, time is considered absolute. It is believed that all processes, regardless of their complexity, do not affect the flow of time. The theory of relativity determines that the flow of time for bodies depends both on the speed of movement of bodies and on the magnitude of the gravitational potential. It is believed that time in space orbit passes slower due to the high speed of the spacecraft, and faster due to the lower gravitational potential than on the surface of the Earth. Currently, the dependence of time on the magnitude of the gravitational potential and velocity (relativistic effect) is taken into account in global positioning systems.

However, studying the relativistic effect, scientists have made a wrong interpretation of the difference between the clock frequency of an orbiting satellite and the clock frequency on the Earth's surface. All further studies to explain the relativistic effect were carried out according to a similar scenario, that is, only the difference in clock frequencies under conditions of different gravitational potentials was investigated.

While conducting theoretical research, I found that the frequency of the signal changes along the way from the satellite to the receiver due to the influence of Earth's gravity. It was found that the readings of two high-precision clocks located at different heights will not differ after any period of time, that is, it is shown that the flow of time does not depend on the gravitational potential. It is proposed to conduct full-scale experiments, during which some high-precision clocks are sent aboard the space station, while others remain in the laboratory on the surface of the earth. It is expected that the readings of the satellite clock will be absolutely identical to the readings of the clock in the Earth laboratory.

**Keywords:** time flow, relativistic effect, frequency generator, gravitational potential.

**Introduction**

For the first time, the magnitude of the relativistic effect was experimentally determined in the USA in experiments on the NTS-2 space satellite [1]. The idea of using a spacecraft to navigate mobile objects in the United States began to develop after the launch of the first artificial Earth satellite in the USSR in 1957. In 1964, the first-generation Transit satellite radio navigation system (SRNS) was created to provide navigation support for launching Polaris ballistic missiles from submarines [2]. For commercial use, this system was introduced in 1967. The coordinates of the consumer were calculated based on the reception and extraction of the Doppler frequency change of the transmitter of one of the 7 spacecraft.

With the development of atomic clocks in 1960, it became possible to use a network of precisely synchronized transmitters transmitting coded messages for navigation purposes. The measurement of the corresponding time delays by the receiver made it possible to calculate the coordinates of the receiver. For the first time this principle was implemented on the US Navy satellite TIMANTION-I (05/31/1967). Work in this direction was continued and marked by the launch of the TIMANTION-II-82B satellite (30.09.1969). Both satellites were initially equipped with onboard time and frequency standards based on a quartz oscillator to develop common principles [3].

In 1973, the navigation programs of the US Air Force and Navy were combined into a common navigation technology program, which later turned into the NAVSTAR-GPS program. The TIMANTION-III satellite was converted into a general spacecraft NTS-
1, launched on July 14, 1974 with a frequency standard based on quartz and rubidium generators.

This was followed by the creation of NTS-2 and NTS-3 devices, respectively, with cesium and hydrogen standards. During this period, the synchronization accuracy increased from $10^{-11}$ to $10^{-12}$...$10^{-13}$ and higher. The height of the satellites' orbits increased (from 925 km to 13,000 km, and then 20,000 km), the carrier frequency of the transmitters changed (from 400 MHz to 1227 and 1575 MHz).

On the eve of the launch of NTS-2, there were numerous discussions among the developers of the NAVSTAR-GPS system about the limits of which values the relativistic effect would be observed. It was decided to measure the accumulated error over a long time relative to terrestrial standards.

200 days after the launch of the two standards on the satellite, the comparison showed that the clock on the satellite “went ahead” by 0.0076 seconds. Consequently, the time on the clock of the NTS-2 satellite increased by 38 microseconds during the day compared to the Earth clock.

Therefore, NTS-2 is considered as the first NAVSTAR-GPS SRNS satellite.

The results of the analysis of the NTS-2 laid an exhaustive foundation for further efforts aimed at creating SRNS NAVSTAR-GPS. Thanks to NTS-2, there was no need to manufacture and launch NTS-3 and NTS-4 satellites. The success of the launch of the NTS-2 satellite brought the era of SRNS NAVSTAR-GPS closer [4].

**Results**

In [4], it is reported about the difference between the readings of the satellite clock and the ground clock for the day and for the time period under study, however, I clarify that the readings of the satellite clock were obtained by calculating on the ground based on the received signals.

The NRL report [5, 6] emphasized the paramount importance of NTS-2 in solving the problem of relativistic effects when creating GPS. It seems that everything is precisely and unambiguously defined – the flow of time in space orbit is different from the flow of time on the surface of the earth. At the same time, they reported a difference in the readings of the clocks in space orbit compared to the readings of the clocks on the surface of the earth, however, provided that the readings of the orbital clocks were calculated in a laboratory on the surface of the earth.

The source [7] reports that if two identical molecular generators are synchronized, and then one of them is placed on an artificial satellite of the Earth, and the other is left on Earth, then the frequency of the first of them, measured on the satellite, will be equal to the frequency of the second, measured on Earth. However, the frequency of the molecular generator placed on the satellite, measured by an observer on Earth, will be changed due to the Doppler effect of the 1st and 2nd orders and the effect of gravitational frequency shift.

Therefore, to measure the gravitational frequency shift, it is necessary to exclude, first of all, the influence of the Doppler effect of the 1st order.

In the source [8], for this purpose, a method is proposed for accurately measuring large periods of time on the Earth's surface and on a satellite, followed by comparing them with each other using radio communication. The essence of the method is as follows. The satellite has a highly stable generator of the set frequency (for example, a molecular generator), which produces short electrical pulses following one after another through a strictly defined number of oscillation periods of the generator. These pulses are transmitted to Earth and recorded simultaneously with the same pulses of a similar installation available on Earth. It is shown that with long-term fixation of pulses (not necessarily continuous), it is possible to notice a difference in the duration of large periods of time elapsed on Earth and on the satellite between two pairs of corresponding pulses received from the Earth's surface and from the satellite. According to the theory of relativity, this time difference is caused by the gravitational field and the 2nd order Doppler effect.

In general, the article [8] is devoted to an overview of all existing at that time and, accordingly, used in practice, including in the USA, methods for comparing the frequencies of two time variables of periodic signals spaced in space. And first of all, comparing the signals coming from the satellite to the earth with the signals emitted by the ground device. Considering that the devices are synchronized in frequency.

The latest materials on measuring the frequency difference with a small difference in the height of the clock are shown in [9 and 10].

In a new study [9], physicist Jun Ye of GIL in Boulder, Colorado, and his colleagues used a clock consisting of approximately 100,000 ultracold strontium atoms. These atoms were arranged in a lattice pattern, which meant that the atoms were positioned at different heights, as if they were standing on the steps of a ladder. Displaying how the frequency changed at these heights revealed a shift. After adjusting for non-gravitational effects that can change the frequency, the clock frequency changed by about one hundredth of a quadrillionth of a percent per millimeter, just the amount expected according to general relativity.

In the source [10], Shimon Kolkovits from the University of Wisconsin-Madison and his colleagues measured the relative ticking speed of two clocks separated by about six millimeters, with an accuracy of 8.9 millionth of a trillion percent. Thanks to this sensitivity, scientists were able to detect the difference between two clocks that tick at a speed so slightly different that they will diverge by just one second in about 300 billion years.

**Discussion**

In all experiments, in all theoretical studies shown above, the relative ticking speed of two clocks separated by height in a gravitational field is compared.

At the same time, the difference in frequencies is indeed detected. Because of this difference, it is concluded that the oscillation frequency of the clocks located above is greater than the oscillation frequency of the clocks located below. Therefore, in order to align the frequency of the orbital clock with the frequency of the ground clock, it is proposed to reduce the frequency
of the orbital clock. In the course of further operation, GPS and GLONASS really began to delay the orbital clocks before launching satellites into orbit.

Neither in the experimental results nor in theoretical studies could I find a physical comparison of the readings of the satellite's onboard clock with the readings of the ground-based laboratory clock. For example, we will ask an astronaut on the radio what the clock on his atomic clock shows, and we will see that the Earth clock shows the same time. Or we send the clock into orbit, and after a certain period we remove the clock from orbit. We compare the readings of the orbital clock and the readings of the Earth clock. We will see that the readings of the ground and orbital clocks will be identical.

This means that since the experiments on NTS-2, the readings of the orbital clocks have never been compared with the readings of the ground clocks. This means that no one has ever compared the readings of clocks spaced by height in a gravitational field.

However, what about the Hefele-Keating experiment (1971) [11], which is considered as a test of relativity theory? According to the authors, this experiment directly shows the reality of the time delay of moving objects predicted by the theory of relativity. It should be noted that some publications indicate the fallacy of the Hefele-Keating experiment due to the discrepancy between the accuracy of measuring instruments and the measured parameter.

It follows from the article [12] that the frequency of the clock on the satellite differs from the frequency of the Earth clock, and, accordingly, the readings of the clock, which will not slow down before launching into space orbit, will be increased compared to the readings of the Earth clock. If you reduce the speed of the satellite clock (in fact, this is done in GPS and GLONASS), then the numerical values of the satellite clock and the clock on earth will coincide.

Similar conclusions are also made in the article [13], where it is stated that in the case of atomic clocks, when they rise in a gravitational field, the distance between the energy levels of an electron in an atom increases, and in the case of nuclear clocks, the distance between the energy levels of the nucleus increases. With an increase in the energy difference between the levels in the atom (nucleus), the frequency of radiation increases, and the oscillation period decreases. This means that such atomic (nuclear) clocks will go faster.

Thus, assuming that the last two articles [12, 13] were released after (1999 and 2012) in relation to article [7] (1961), we can say that today it is recognized in science that the readings of satellite clocks will differ after a certain period from the readings of terrestrial clocks (naturally, the clocks must be synchronized before sending a satellite into space orbit).

I believe that in order to verify the correctness of the current conclusions of science, it is necessary to check the correspondence of the readings of the satellite clock and the readings of the Earth clock, which should be done with the help of the space station.

I will also say a forecast - the readings of the space station clock and the ground clock will absolutely coincide at any time.

I claim that the passage of time does not depend on either the gravitational potential or the speed of motion of bodies. In this case, the difference in the frequency of the received signal from the frequency of the satellite transmitter occurs due to an increase in the speed of the signal on the way from the satellite to the ground receiver.

**Methods**

We will consider how the flow of time changes under conditions of different gravitational potential, assuming that the speed of photons changes under the influence of a gravitational field.

Consider, for example, the GLONASS satellite (H = 19,100 km), which constantly sends radio signals to receivers on earth.

By calculation, it was determined that the radio signal on the way from orbit receives a velocity increment of 0.16 m/s in the gravitational field of the Earth.

The signal from the GLONASS satellite is sent with a frequency of fo = 1609 MHz, received in a receiver on earth with a frequency of f = fo / (1 + z) = 1 609.00000084 MHz. At the same time, there is a shift in the signal spectrum to the purple side:

$$ z = (f_0-f') / f' = (C-C') / C' = (299792458-299792458.16)/299792458.16 = -5.25 \times 10^{-10} $$

Where: C = 299,792,458 m/s, C' = 299,792,458.16 m/s.

It should be noted that to compensate for presumably relativistic effects, the frequency generated by the onboard frequency generator from the point of view of the observer located on the GLONASS satellite changes when the satellite is launched into orbit relative to the base frequency by the amount:

$$ \Delta f/fo = -4.36 \times 10^{-10} \text{ (almost coincides with } -5.25 \times 10^{-10}). $$

Next, we will look at the difference between the expected arrival time of a signal from orbit to Earth and its actual arrival time (relative to the travel time from orbit to Earth). The signal arrives on earth from the GLONASS satellite after a while:

$$ t1 = 19100000/299792458.16 = 0.0673710742149 \text{ s}. $$

An observer on the Ground calculated that the signal should arrive within time

$$ t2 = 19100000/299792458 = 0.0673710742183 \text{ s}. $$

The relative difference in signal travel time is:

$$ (t1 - t2) / t2 = - 5.25 \times 10^{-10} \text{ times}. $$

Thus, the estimated difference in the passage of time in space orbit due to the difference in gravitational potentials is exactly equal to the difference between the expected arrival time of a signal from orbit to Earth and its actual arrival time relative to the time spent on the path. In this case, it is important for the observer not to change the time of arrival of the radio signal, but to change the frequency of the radio signal at the receiver in comparison with the frequency of the satellite radio signal in accordance with the expression \( \Gamma = fo/(1+z) \).

**Conclusions**

Proper consideration of the relationship between the speed and frequency of the radio signal wave allows
us to talk about the independence of the flow of time from the gravitational potential.

Given that the speed of a photon changes in a gravitational field, there is no room in further reasoning for the difference in the flow of time in regions of space with different gravitational potentials.

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