Short Reports

THE INFLUENCE OF THE EARTH'S MOVEMENT TO THE RESULTS OF THE TRACKING OF THE COSMIC FLYING APPARATUSES

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In the work there is substantiated the necessity of taking of into account the influence of Earth's movement on the facts, which are received while the surface observations of the trajectory of cosmic apparatuses (spacecraft, satellite). At the process of the tracking of the geostationary satellite there was revealed that even movement of the Earth influences the aberration of electromagnetic waves from the established at the satellite generator. The measuring of apparent abnormalities from the factual position of satellite, which were caused by this effect, allowed directly defining the parameters of movements of Earth and Solar system (speed, declination and direct ascent of the apex of the Sun). The trustworthiness of received extent is confirmed by their coincidence with known meanings from the observational astronomy.

As it's known, the trajectory of cosmic flying apparatuses is calculated by the methods of celestial mechanics with a very high degree of exactness. While the control of their behavior from the Earth there are practically always observed divergences with the calculation. The divergences between the measured position of satellite and calculated, which were caused by technical reasons, as, for example, drift while the calibration, are usually easily removed by technical corrections. Other divergences, which are connected with the conditions of spreading of the electromagnetic wave in the heterogeneous sphere, are also rather good studied and are taken into consideration. But there are observed anomalies, the essence of which is often can be unknown, and we should do rather artificial correction with the aim of removal of these divergences. One of the serious reasons of these anomalies can be the influence of the Earth's movement on the results of tracking of its satellite. Though at the observational astronomy there is long ago known such influence on the apparent position of stars (the phenomenon star aberration, opened Bradley [1]), it is still not taken into consideration while the observation of the artificial satellites. The enquiry id that the satellites belong to the system of coordinates of Earth, that means they evenly fly with it in a space. And in this situation, as it's considered, there is no such influence. This view point was formed over many years of unsuccessful experimental attempts to revel the movement of the Earth not by the astronomic observations, but with the help of carried out experiments on it (1818 Aragou, 1838 Babinet, 1859 Fizeau, 1865 Angstrom, 1881 Michelson, 1887 Michelson and Morley, 1887 Michelson, Morley, 1921–1925 Miller, 1926 Picar, Stael, 1955 Essen, 1959 Townes and Cedarholm, 1979 Brillet and Hall and many others). All in all in the 1904 year, H. Poincare in the work [2] made a suggestion that the impossibility to reveal the bsolute movement of the Earth presents the general law of nature. But while this he didn't except the possibility of disproof of it by future experiments. And at the conference in the Pasadena [3] H.A. Lorenzt categorically declared: «*So far there was question of first order effect only, i.e. of effects that would be proportional to the first power of the ratio between the velocity of the Earth and the speed of light. In almost all cases in which astronomers and physicist have tried to detect an influence of the Earth motion on optical and electromagnetic phenomena , only effects of this order of magnitude could have been observed. The fact that all these attempts have been fruitless led by and by to the conviction that the motion of the Earth can never produce the first order effect*.»

But not so long ago in the works [4–7] while the tracking of the behavior of the satellite at the geostationary orbit the even movement of Earth was experimentally revealed without attraction of astronomic observations of the stars. Here was scientifically proved, that even movement of Earth is revealed in the aberration of electromagnetic waves (effect of first order), which are spread from the source of radiation, which was fixed relatively the receiver and the Earth itself, and it allowed directly measuring the parameters of its movement.

The source was established at the geostationary satellite Intelsat704 (USSPACECOM Catalog №23461), and the receiver in the antenna of surface radio telescope (surface station TAT-01B in Kazan, Russia). In the situation when satellite is motionlessly «hung» above the Earth, the relative speed of source and receiver is equal to zero and their coordinates (geocentric length and width of satellite, geodesic coordinates of telescope) are still practically constant during the long time. Some real periodical shift of the satellite with an amplitude of deviation of the azimuth about 0,04° should been observed by the influence of light pressure during the twenty-four hours. But because of the influence of the aberration the antenna fixed not this factual position of the satellite (length and width), which is clearly calculated geometrically, but apparent one. As it was revealed at the experiment, these apparent coordinates change because of daily and yearly changes of the corners of aberration, which were caused by the movement of the Earth in an orbit, what caused supplementary change of measured by the surface station corners (azimuth and height). The dynamic of the behav-

ior of apparent position of the satellite is defined by temporal behavior of aberrational additions (Δξ и Δφ) to its real geocentric ξ and width φ. The dependence of this additions of the parameters of the Earth's movement for the private situation, when satellite is at the meridian of station and has zero inclination, was mathematically described in the works [4, 6]. Here we cite such correlations for the general case of unconditioned position of satellite

$$\begin{aligned}
\Delta\xi_{orb}(t) &= \beta_{orb}\sqrt{1-(\sin\varepsilon\cos\gamma)^2}\cos(\omega t+\Xi);\\
\Delta\xi_{apx}(t) &= -\beta_{apx}\cos\delta\cdot\sin(\omega t+\Xi+\gamma-\alpha_{apx});\\
\Delta\varphi_{orb}(\tau) &= \beta_{orb}\sin\varepsilon\cdot\cos\gamma\cdot\cos\varphi;\\
\Delta\varphi_{apx} &= \beta_{apx}\sin\delta\cdot\cos\varphi,
\end{aligned} \qquad (1)$$

where the difference between lengths of sputnik and telescopes $\Xi = \xi - \xi_{telescope}$; ω – corner frequency of Earth's rotation; t – solar local time of surface station (telescope); $\beta_{orb} = (V_{orb}/c)$; $\beta_{apx} = (V_{apx}/c)$; V_{orb} – speed of the orbital movement of Earth; V_{apx} – speed of the movement of the Solar system; c – speed of light; ε = 23,45° – corner of the inclination of Earth axis to the axis of ecliptic; γ = γτ – slowly changing during the year phase of the orbital movement of the Earth; τ – number of days from the beginning of new tropical year (00:00:00 GMT 23 of September); Ω = 2π/T, T = 365,2444 days – duration of the tropical year in our epoch; δ and α_{apx}, correspondingly, declination and direct ascent of the apex of the Sun.

These expressions (1) can be used while the transition from the geocentric equatorial system of coordinates, which is connected with the meridian of telescope, into any other, in which there are measured their defined corners. In the works [4–7] there were measured azimuth and the corner of height of sputnik in the horizontal system of coordinates and was showed in detail as aberrational additions (1) change the behavior of azimuth and height of geostationary sputnik while the preservation of its factual coordinates. The main difference between the experiment and calculation without taking into consideration of aberration prediction in all these observations was the presence of the displacement of the experimental sinusoid of azimuth by the phase because of aberration to the corner ϑ into the sphere of more late times. The reason of this displacement, as it was established [4], consists in addition of two periodical processes of the similar frequency: real displacement of the sputnik under the influence of the light's pressure and apparent because of aberration. These two processes in such situation are always moved by the phase to the 90°, because vector of pressure of solar stream is directed by the radius of the Earth's orbit, and vector of orbital speed of Earth by the tangent to it. As it was shown in [4, 6] the measured in the experiment amplitude α_{obs} and displacement of the phase ϑ for the sinusoid of azimuth are connected with the parameters of movement of Earth and Sun. In the general case this correlation has a view

$$\alpha_{obs}\sin\vartheta = q_1\left[\beta_{orb}\cos\Xi\left(\sqrt{1-(\sin\varepsilon\cos\gamma)^2}\right)+p\sin(\gamma+\Xi-\alpha_{apx})\right], \qquad (2)$$

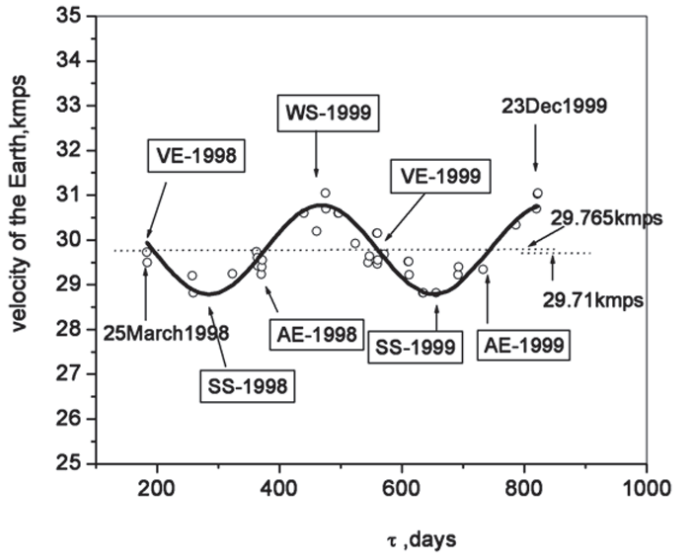
where $q_1 = \dfrac{\sin\Phi-\cos\Xi\cdot\mathrm{tg}\varphi\cdot\cos\Phi}{(\cos\Xi\cdot\sin\Phi-\mathrm{tg}\varphi\cdot\cos\Phi)^2+\sin^2\Xi}$;

Φ – geodesic width of telescope), and $p = \beta_{apx}\cos\delta$.

While the use of experimental meanings α_{obs} and ϑ, which were measured three different times, from the decision (2) were defined β_{obs}, α_{apx} and p, and all in all the speed of movement of Earth and the parameters of the Solar system's movement. In the picture there is presented seasonal dynamic of carrying out the orbital speed of Earth, which was measured by this method.

As we in the graphs, the behavior of its values is similar to the behavior from the observational astronomy. Firstly, their averaged for the year values (29,71 kmps and 29,765 kmps, correspondingly) practically coincide. On the other hand their values in winter (the Earth is in perihelion) are a little above the average, and in the summer (the Earth is in aphelion), are correspondingly lower. Thereby, here takes a place the full aberration ($\beta_{orb} = 10^{-4}$ rad), that means such as for stars (20,5″). Received in the experiment direct ascent of the sun's apex α_{apx} was equal to 270°. This value with the high precision coincides with the hour angle of the sun's apex, which was accepted at the astronomy 18^h59^{min}, that means 269,75°. Received in [4] values of the declination of the sun's apex (89,5°), and also the speeds of absolute movement of Solar system (600 km/s) are also rather well conformed to known. Practically clear coincidence of results with the facts from the observational astronomy confirms their trustworthiness. Thereby while the tracking of the trajectory of satellites it's perfectly necessary to take into consideration the influence of the movement of Earth to the results of observation. It becomes especially important while the moving of flying cosmic apparatuses to the big distances, when the apparent abnormalities from the factual position could be rather considerable. Possibly, for example, that the nature of

still unexplained mysterious «anomaly of Pioneer», which declined the course of apparatus Pioneer10 to the hundreds of thousands kilometers from the calculation while its going out of the orbit of the last planet of Solar system, can be explained by this aberration. While the angle (20,5″) and such distances of just this order there should take place the apparent abnormality. While such explanation there is no place for the influence of inexplicable strength, and for the presence of the mistakes in the development of transmitter. The division of factual and apparent divergences is especially important in the GPS navigation, where high precision is reached by big number of corrections, for the receiving of the experimental facts of which there are working numerous stations of tracking all over the world.



Seasonal behavior of the orbital velocity of the Earth during the period March 1998 – December 1999. Open-this experiment (averaged 29,71 km/s); solid-astronomical observations (averaged 29,77 km/s)
τ – amount of days from start of 1997 tropical year (00:00:00 GMT September, 23, 1997),
VE – vernal equinox, SS – summer solstice, WS – winter solstice, AE – autumnal equinox

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