Pseudo-acceleration of NASA space vehicles: ADEQUATE INTERPRETATION "PIONEER EFFECT"

It is possible that the so-called "anomaly of the Pioneers" is actually caused by the "blue shift", that is, gradually as the approach to the ground transmitter changes in the frequency of the returned signals of the radar tracking of space vehicles, the cause of which may be the weakly refracting properties of the near-solar space. Considering the near space as an optical medium that is inhomogeneous in the direction "from" the Sun or "to" the Sun, we supplement the calculation using the Doppler formula by the Michelson rule.

On March 1972 the spacecraft Pioneer 10 was launched on ballistic trajectory. Since 1980 the parameters of its motion are being evaluated by the Doppler method. The measurements performed from 1987 to 1995 permitted to observe monotoneous increment of frequency of the radio signal sent off from the Earth and actively retransmitted by the spacecraft, i. e. on the background of the usual Doppler effect the drift of the measured frequency towards its growth displayed itself [1]. Processing of the acquired in this way data with the use of special programs allowed to concude, that Pioneer 10 slows down. However analysis of all possible causes of this drag action showed, that no one of them contributes notably to the anomal acceleration [2]. Alongside with that the Doppler measurements of Pioneer 11 course revealed a pseudacceleration of the same denotation and magnitude. So it would be appropriate to ask, whether the gradual growth of the radio signal frequency emitted by the receding transmitter can be caused by the properties of the interplanetary vacuum?

Thus presenting the perihelion space as similar to the faintly refractive medium and considering the discovered effect as a hitherto unknown phenomenon of astrophisics, let`s evaluate it by using the V. Mikhelson [3] formula

$$\nu = \nu_0 \left[1 - \frac{1}{c}\left(n\frac{dl}{dt} \pm l\frac{dn}{dt}\right)\right].$$

Here the component $\nu_0\left(1-\frac{n}{c}\frac{dl}{dt}\right)$ complies with the Doppler`s frequency $\nu_\mathrm{D} = \nu_0\left(1-\frac{v}{c_\mathrm{n}}\right)$ of the radio signal emitted by the transmitter moving with the velocity of $v = \frac{dl}{dt}$ in the direction «from» the receiver and through the medium with the coefficient of refraction $n > 1$. It is also presumed, that the signal velocity $c_\mathrm{n} = \frac{c}{n}$ differs from the speed of light c in vacuum only insignificantly, while index $n \approx 1$ is the averaged characteristic of the refractive layer (between a transmitter and receiver) thickness of which increases by the law: $l = vt$.

The second term $\pm\nu_0\frac{l}{c}\frac{dn}{dt} = \Delta\nu$ of the formula relates to the case the main feature of which is the alteration of optical conditions on the way of the radio signal propagation: $n = var$. Therewith the sign of increment $\pm\,\Delta\nu$ to the Doppler`s frequency ν_D is determinated by the transmitter and receiver interposition in a heterogeneous medium while its magnitude depends on distance l or time $\tau = \frac{l}{c}$ of the radio signal travel under condition that its speed c_n practically equal to $c = 3{\cdot}10^5$ km s^{-1}.

Moreover, from the Doppler-Mikhelson`s law the gradual growth of the refraction index of the medium along the radio signal velocity vector is accompanied by increment of the additional term $\Delta\nu$ within the frequency ν of receive. The follow-up for Pioneer 10 permitted to detect that the quantity $\Delta\nu$ is positive and that it increased by 1.5 Hz for 8 years of flight along the radially oriented trajectory with the beginning at the point remote from the Sun by 40 AU.

Thus, the Doppler`s measurements have recorded increment of the coefficient of the interplanetary medium refraction in the direction of the Sun. But in this case the perihelion medium refractive properties may be stipulated by its magnetic field the influence of which on the distant space communication was noted by some authors [1], [2].

It may be demonstrated that the growth $\Delta\nu$ (proportional to time τ) during the Pioneer 10 and Pioneer 11 receding into the interstellar space does not mean, that the magnetic field refractive properties are also transformed in a linear mode.

Let`s assume, that coefficient n at the distance r_0 from the Sun is equal to $1 + \eta_0$ and diminishes in the direction «from» it by the rule $n = 1 + \eta_0 \frac{r_0}{r}$, similarly to the relationship between the gravitational potential and polar coordinate r. Then the variable component

$$\Delta\nu = \nu_0 \frac{l}{c} \frac{d\left(1 + \eta_0 \frac{r_0}{r}\right)}{dt} = \nu_0 \frac{r - r_0}{c} \frac{d\left(1 + \eta_0 \frac{r_0}{r_0 + ct}\right)}{dt} = \nu_0 \eta_0 \frac{r_0^2 - r_0 r}{r^2}$$

of the Doppler-Mikhelson formula will vary insignificantly if the $r = r_1$ distance, greatly exceeding r_0, rises to r_2.

For example, the non-linear alteration $\Delta\nu$ on the distance of 20 AU between r_1 = 40 AU and r_2 = 60 AU covered by Pioneer 10 for 8 years of its flight, does not exceed 1% if r_0 = 1 AU. Thus, at the given accuracy of Doppler`s measurements the $\Delta\nu$ growth during the investigated period (1987-1995) only seems to be linear one.

Let us determine the refraction coefficient $n_2 = 1 + \eta_2 = 1 + \frac{\Delta\nu}{\nu_0} \frac{r_1^2}{r_2^2 - r_1 r_2}$ of the magnetic field at the distance of 60 AU from the Sun. As $\Delta\nu$ = 1.50 Hz, $\nu_0 = 2.29 \cdot 10^9$ Hz and r_1 = 40 AU, then $n_2 = 1 + 0.87 \cdot 10^{-9}$. In this case the surplus η_1 of the refraction index n_1 over n = 1 has to be 60 times more great than η_2 according to the above accepted rule $n = 1 + \eta_0 \frac{r_0}{r}$, i. e. $n_1 = 1 + \eta_1 = 1 + 60\eta_2 = 1 + 5.22 \cdot 10^{-8}$. That means, that at the displacement from 60 AU by the distance of 1 AU from the Sun the radio signal velocity decrease will take place – by $\Delta c = \left(\frac{1}{n_2} - \frac{1}{n_1}\right) c \approx (\eta_1 - \eta_2) c =$ $(5.22 \cdot 10^{-8} - 0.87 \cdot 10^{-9}) \times 3 \cdot 10^5 = 1.54 \cdot 10^{-2}$ km s^{-1} or $\Delta c < 15.4$ m s^{-1}, i. e. by the rather insignificant quantity if compared with the speed of light in vacuum.

So it is obvious that the Earth`s magnetism also contributes to the alteration of frequency and velocity of the distant space communication signals. However this contribution seems to be of a negligible guantity and it is very difficult to detect. Nevertheless it is amenable to calculation by the Doppler-Mikhelson formula, supplemented with the relationship $n = 1 + \eta_0 \frac{r_0}{r}$, the latter though still has to be proved.

Moreover, I proved theoretically and tested experimentally the statement that speed is not a measure of the movement of light, and the true characteristic of its propagation in transparent bodies (both resting and moving) is quadrospeed - a concept new to theoretical physics and the observed mechanics of natural phenomena [4], [5].

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