Bronislaw Maciag
Jan Maciag

THE AETHER & THE GALILEAN TRANSFORMATION

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Authors:
Bronislaw Maciag
Jan Maciag

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PREFACE

In the 19th century physicists were convinced that there exists a medium, called **the aether**(1) , with respect to which light and all objects are in motion. James Clerk Maxwell believed that with the use of light, it is possible to determine Earth's speed in relation to **the aether**. Under the Galilean transformation his equations link the speed of light (c) in the inertial frame of reference with the frame's velocity with respect to **the aether**.

Having become familiar with J. C. Maxwell's deliberations, Albert A. Michelson came up with an idea for an experiment by which the Earth's motion with respect to **the aether** could be measured with adequate precision and thereby the applicability of the Galilean transformation to the motion of light could be verified. With an interferometer of his own design he made calculations from which he obtained the relationship between 'the shift of interference fringes' and the interferometer speed with respect to **the aether**. After applying the relative speed of the interferometer against **thhe aether** as equal to the orbital speed of the Earth (approximately 30 km/s) he obtained a specific shift value of about 0.04 of a fringe, and he expected that the shift he was to observe during the experiment would be no smaller than the value he had calculated. However, in the experiment which he performed in 1881 – after J. C. Maxwell had already passed away – he observed no such shift. In 1887 Albert Michelson and Edward Morley jointly repeated the experiments using a more advanced interferometer with very much the same result as in 1881 i.e. no shift of interference fringes was observed.

While Albert Michelson's calculations raised no doubts among physicists though the fact that Michelson-Morley's experiments failed to provide the observance of the shift of interference fringes was weakening their faith in the existence of the aether. Ultimately the aether concept was abandoned altogether. In 1905 the Galilean transformation was replaced by Hendrik A. Lorentz's transformation after Albert Einstein's presentation of the Special Relativity (SR) theory that was based on two key postulates. The first assumes that no preferred inertial frame of reference exists, which effectively means that **the aether** does not exist, and the second assumes that the speed of light in a vacuum is the same in all inertial frames of reference. The Galilean transformation holds when relative speeds of objects in inertial frames are negligibly small compared to the speed of light c.

In this work a mathematical model of Albert Michelson's interferometer was designed assuming that the aether does exists and that the Galilean transformation is in operation. The authors have created this model to explain exactly why no shift of interference fringes was observed with the interferometer used in Michelson's experiments.

Based on the data from the Michelson's experiments and the values of the interference fringe shifts resulting from the mathematical model which incorporated a variety of angles that the interferometer was positioned at and considered its different speeds against the aether, the speed of the interferometer on the Earth's surface was determined with respect to the aether. Then given the interferometer speed on the Earth with respect to the aether and the speed at which the Sun revolves around the center of our Galaxy as well as having taken into consideration the aberration of starlight, the relative speeds of the Earth, the Sun and the Galaxy centers with respect to the aether were determined.

(1) In this work, the authors denoted ' **the aether** ' (in bold) as defined by the 19th century physicists, and 'the aether' as appears throughout this work and is described on p. 103.

For experimental purposes such as investigating particles in linear accelerators, the coordinates of the absolute velocity of the interferometer, and therefore of any object on the Earth's surface, in the horizontal frames of reference were determined. Then, according to Newton's second law, the motion of a particle was investigated with its speed-related mass changes considered.

Finally, the decay of unstable particles was researched and it was shown that the elongation of the Earth's sidereal day with respect to the time measured by atomic clocks is merely apparent. The relationship between the time measured by atomic clocks and the clocks' speed with respect to the aether was determined. This was applied for calculating the Earth's and the Sun's speeds with respect to the aether with the use of atomic clocks.

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Bronislaw Maciag
Jan Maciag

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CHAPTER I

MATHEMATICAL MODEL

I.1 ALBERT MICHELSON'S INTERFEROMETER

I.1.1 ASSUMPTIONS AND THE COORDINATE SYSTEMS

Let us assume that a medium, called the aether exists. Light and the interferometer move with respect to the aether. In our considerations, in order to establish the motion of light and the interferometer with respect to this medium, we introduce three coordinate systems placed on one plane (Figs. 2, 3 & 4), namely:

1) A preferred absolute inertial coordinate system OXoYo, motionless with respect to the aether (a frame of reference).

2) An OXY coordinate system.
Its initial point always corresponds to the OXoYo initial point. The OXY coordinate system can rotate by any Φ angle with respect to the OXoYo system.

2) An O'EQ coordinate system fixed to the interferometer. The interferometer's velocity $\vec{V}_o$ is always parallel to the OXo axis. The O'E axis is always parallel to the OX axis.
The system's origin corresponds to the origin of the OXoYo system only at the initial time t=0 of an interferometer motion under consideration.

The O'EQ is an inertial system which moves togaether with the interferometer along the OXo axis at a constant velocity $\vec{V}_o$ in relation to the OXoYo system. Another inertial system will be obtained when the value of the $\vec{V}_o$ velocity modulus is changed and fixed. Thus, if we keep on applying this procedure, any number of O'EQ inertial systems can be obtained. The $\vec{V}_o$ velocities are the absolute velocities of the O'EQ systems. The light is an electromagnetic wave that with respect to the aether travels in a vacuum with the $\vec{C}_o$ velocity which modulus (the absolute speed) C_o = const.

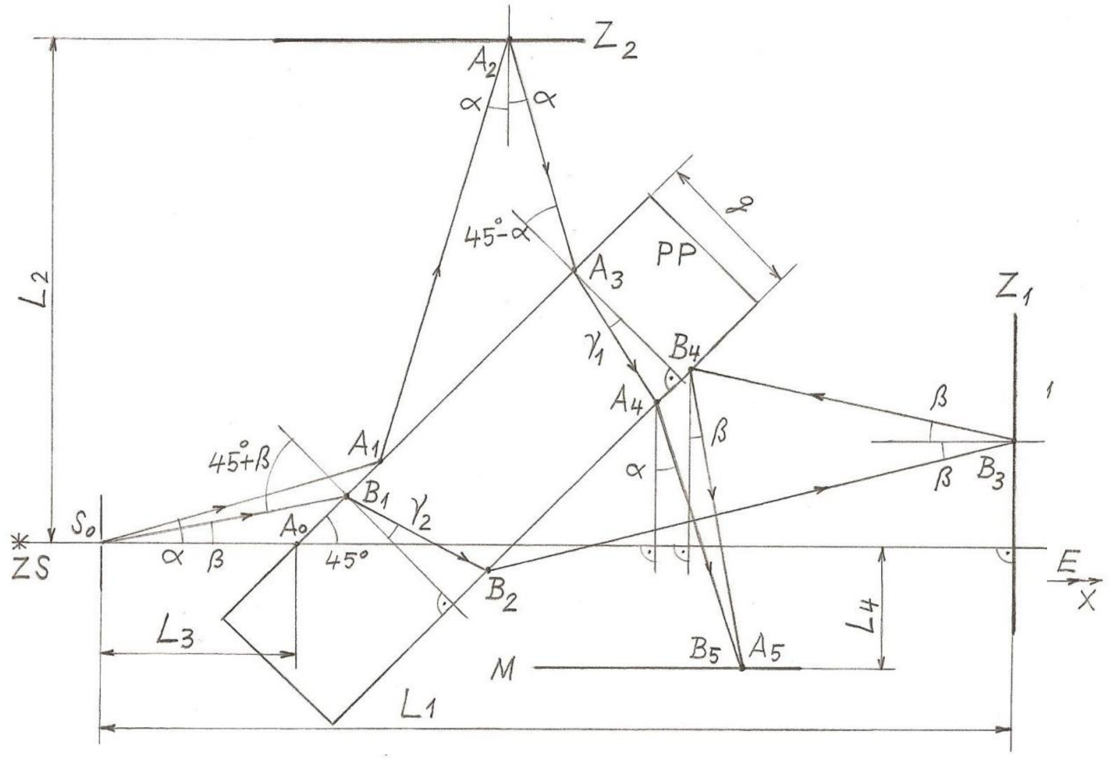

Fig. 1 Diagram of Albert Michelson's interferometer and the trajectory of light rays in the interferometer.

SYMBOLS:

ZS	source of light,
S_0	slit,
Z_1, Z_2	mirrors,
PP	semi-transparent plate,
M	screen,
$A_1,\ldots,A_5$	points successively reached by a ray of light after leaving the slit S_0 at the angle α ,
$B_1,\ldots,B_5$	points successively reached by a ray of light after leaving the slit S_0 at the angle β ,
γ_1, γ_2	angles of the light rays refraction in the semi-transparent plate PP.

BASIC DIMENSIONS:

L_1 , L_2 , L_3 , L_4 ,

g thickness of the semi-transparent plate PP.

The values of basic dimensions and the wavelength of light in a vacuum, can be found on page 74.

Herein two phenomena i.e. the light diffraction on the slit S_0 and the interference of those rays which after leaving the slit S_0 at α, β angles reach one point on the screen M were exploited. Points A_5, B_5 coincide.

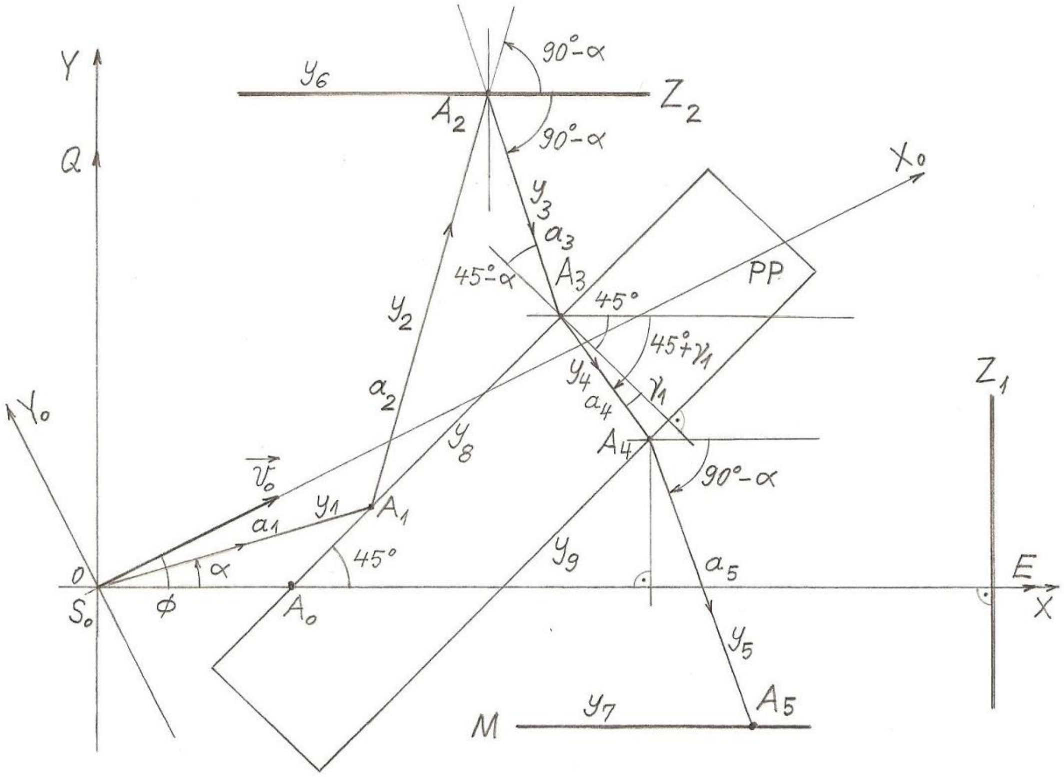

Fig. 2 The trajectory of light rays reaching point A_5 on screen M after leaving the slit S_0 at the angle α .

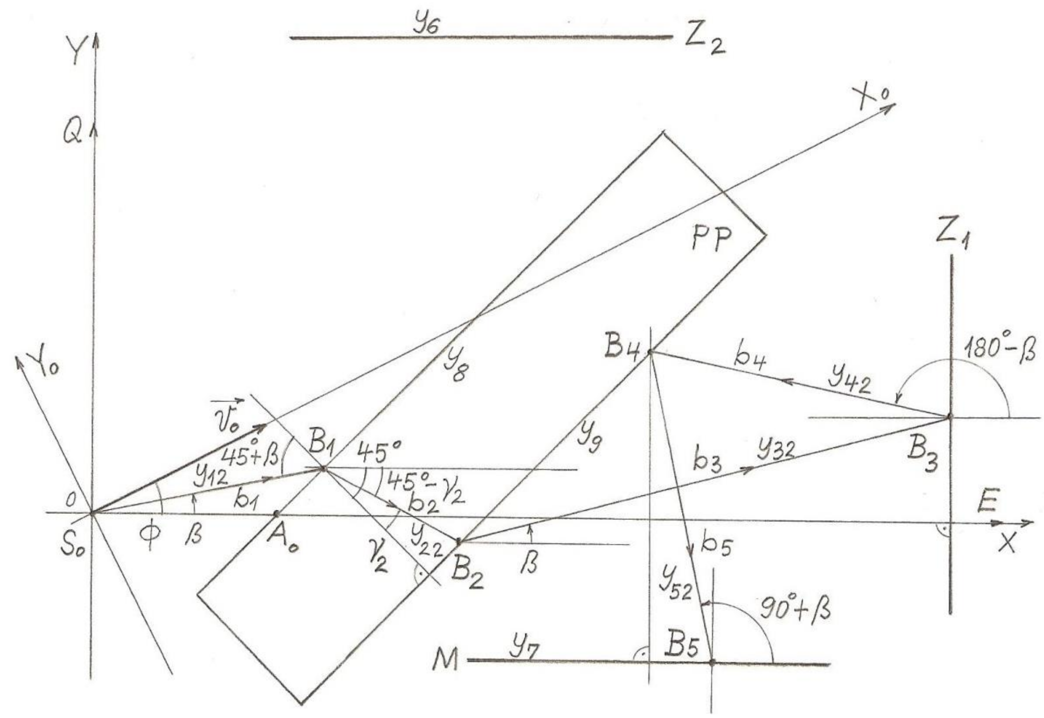

Fig. 3 The trajectory of light rays reaching point B_5 on screen M after leaving the slit S_0 at the angle β .

I.1.2 RAYS OF LIGHT IN SEMI-TRANSPARENT PLATE

(Figs. 1, 2 & 3)

According to Snell's law the following equations can be obtained:

$$\frac{\sin(45^o - \alpha)}{\sin\gamma_1} = \frac{\sin(45^o + \beta)}{\sin\gamma_2} = \frac{C_o}{C_p} = \frac{\lambda_0}{\lambda_p} = n_2$$

Where: γ_1, γ_2 the angles of refraction of the light rays in the PP plate,
n_2 the index of refraction for the PP plate with respect to a vacuum,
C_o the speed of light in a vacuum with respect to the aether,
C_p the speed of light in the PP plate with respect to the aether,
λ_o the wavelength of light in a vacuum,
λ_p the wavelength of light in the PP plate.

The following defines a vacuum:

Vacuum is space filled with the aether and devoid of material particles.

This is an absolute vacuum. In reality such a space or a given volume that is absolutely matter-free does not exist.

From the above equations we have:

(1.1) $$\gamma_1 = \arcsin\frac{\sin(45^o - \alpha)}{n_2}$$

(1.2) $$\gamma_2 = \arcsin\frac{\sin(45^o + \beta)}{n_2}$$

(1.3) $$C_p = C_o / n_2$$

(1.4) $$\lambda_p = \lambda_o / n_2$$

I.1.3 LINE EQUATIONS IN THE OXY COORDINATE SYSTEM

(Figs. 1, 2, 3 & 4)

The straight line equations of the trajectory of light rays:

y_1, y_2, y_3, y_4, y_5

y_{12}, y_{22}, y_{32}, y_{42}, y_{52}

The line equation of the mirror Z_1:

(1.5) $$x = L_1 + tV_o \cos\Phi$$

The y_6 line equation of the mirror Z_2:

(1.6) $$y_6 = L_2 + tV_o \sin\Phi$$

The y_7 line equation of the screen M:

(1.7) $$y_7 = -L_4 + tV_o \sin\Phi$$

The y_8 line equation of the PP plate on the side of the S_0 slit.

The coordinates of the point $A_0(x_{a0}, y_{a0})$ are:

(1**) $$x_{a0} = L_3 + tV_o \cos\Phi$$

(2**) $$y_{a0} = tV_o \sin\Phi$$

The line y_8 passes through point A_0 hence its equation takes the following form:

$$y_8 = tg45^o\ x - tg45^o\ x_{a0} + y_{a0}$$

Having considered equations (1**) & (2**) we obtain:

(1.8) $$y_8 = x - L_3 - tV_o(\cos\Phi - \sin\Phi)$$

The y_9 line equation of the other side of the PP plate.

$$y_9 = y_8 - \sqrt{2}\,g \qquad \text{therefore}$$

(1.9) $$y_9 = x - L_3 - \sqrt{2}\,g - tV_o(\cos\Phi - \sin\Phi)$$

In equations (1.5) - (1.9) the variable t represents the motion absolute time of the interferometer.

I.1.4 THE COORDINATES OF THE $A_1, \ldots, A_5$ POINTS AND THE LENGTHS OF THE $a_1, \ldots, a_5$ SEGMENTS IN THE OXY COORDINATE SYSTEM

The lengths of segments of the distance traveled by a ray of light leaving the slit S_0 at the angle α:

$$a_1 = S_0A_1, \quad a_2 = A_1A_2, \quad a_3 = A_2A_3, \quad a_4 = A_3A_4, \quad a_5 = A_4A_5.$$

1. POINT A_1 AND THE LENGTH OF THE a_1 SEGMENT

The coordinates of point $A_1(x_{a1}, y_{a1})$ are determined by straight line equations:

$$y_1 = tg\alpha\ x \quad , \quad (1.8)\ \ y_8 = x - L_3 - tV_o(\cos\Phi - \sin\Phi) \quad , \quad t = t_{a1} = \frac{a_1}{C_o} \quad (1*) \quad \text{so}$$

(1.10) $$x_{a1} = [L_3 + a_1 \frac{V_o}{C_o}(\cos\Phi - \sin\Phi)] \frac{\cos\alpha}{\cos\alpha - \sin\alpha}$$

(1.11) $$y_{a1} = [L_3 + a_1 \frac{V_o}{C_o}(\cos\Phi - \sin\Phi)] \frac{\sin\alpha}{\cos\alpha - \sin\alpha}$$

The coordinates of the S_0A_1 segment are: $S_0A_1[x_{a1} - 0, \quad y_{a1} - 0]$

We can write an equation: $a_1^2 = x_{a1}^2 + y_{a1}^2$

which after applying formulae (1.10) and (1.11) takes the following form:

(1.12) $$a_1 = \frac{L_3}{\cos\alpha - \sin\alpha - (\cos\Phi - \sin\Phi)\dfrac{V_o}{C_o}}$$

2. POINT A_2 AND THE LENGTH OF THE a_2 SEGMENT

The equation of the y_2 straight line which passes through the point A_1 is:

$$y_2 = tg(90^o - \alpha)\ x + y_{a1} - tg(90^o - \alpha)\ x_{a1}$$

The coordinates of $A_2(x_{a2}, y_{a2})$ point are determined by straight lines equations:

y_2, (1.6) $y_6 = L_2 + tV_o \sin\Phi$, $t = t_{a2} = \dfrac{a_1 + a_2}{C_o}$ (2*) thus

(1.13) $$x_{a2} = x_{a1} + \frac{\sin\alpha}{\cos\alpha}[L_2 - y_{a1} + (a_1 + a_2)\frac{V_o}{C_o}\sin\Phi]$$

(1.14) $$y_{a2} = L_2 + (a_1 + a_2)\frac{V_o}{C_o}\sin\Phi$$

The coordinates of the A_1A_2 segment are: $A_1A_2[x_{a2} - x_{a1}\ ,\ \ y_{a2} - y_{a1}]$

$$x_{a2} - x_{a1} = x_{a21} + \frac{\sin\alpha}{\cos\alpha} a_2 \frac{V_o}{C_o}\sin\Phi$$

$$y_{a2} - y_{a1} = y_{a21} + a_2 \frac{V_o}{C_o}\sin\Phi$$ where:

(1.15) $$x_{a21} = \frac{\sin\alpha}{\cos\alpha}(L_2 - y_{a1} + a_1 \frac{V_o}{C_o}\sin\Phi)$$

(1.16) $$y_{a21} = L_2 + a_1 \frac{V_o}{C_o}\sin\Phi - y_{a1}$$

We can now write the following equation:

$$a_2^2 = (x_{a2} - x_{a1})^2 + (y_{a2} - y_{a1})^2$$ which when solved, gives the following:

(1.17) $$a_2 = \frac{r_{21} + \sqrt{r_{23}}}{r_{22}}$$ where:

(1.18) $$r_{21} = \frac{V_o}{C_o}\sin\Phi\left(x_{a21}\frac{\sin\alpha}{\cos\alpha} + y_{a21}\right),$$ (1.19) $$r_{22} = 1 - \left(\frac{V_o}{C_o}\frac{\sin\Phi}{\cos\alpha}\right)^2$$

(1.20) $$r_{23} = r_{21}^2 + r_{22}(x_{a21}^2 + y_{a21}^2)$$

3. POINT A_3 AND THE LENGTH OF THE a_3 SEGMENT

The equation of the straight line y_3 which passes through the point A_2 is given by:

$$y_3 = -tg(90^o - \alpha)\ x + y_{a2} + tg(90^o - \alpha)\ x_{a2}$$

The coordinates of the $A_3(x_{a3}, y_{a3})$ point are determined by the equations of straight lines:

y_3, (1.8) $y_8 = x - L_3 - tV_o(\cos\Phi - \sin\Phi)$, $t = t_{a3} = \dfrac{a_1 + a_2 + a_3}{C_o}$ (3*) thus

(1.21) $$x_{a3} = \frac{\sin\alpha}{\sin\alpha + \cos\alpha}[L_3 + y_{a2} + (a_1 + a_2 + a_3)\frac{V_o}{C_o}(\cos\Phi - \sin\Phi)] + \frac{\cos\alpha}{\sin\alpha + \cos\alpha}x_{a2}$$

(1.22) $$y_{a3} = \frac{\sin\alpha}{\sin\alpha + \cos\alpha}[L_3 + y_{a2} + (a_1 + a_2)\frac{V_o}{C_o}(\cos\Phi - \sin\Phi)] + \frac{\cos\alpha}{\sin\alpha + \cos\alpha}x_{a2} - L_3 +$$

$$-(a_1 + a_2)\frac{V_o}{C_o}(\cos\Phi - \sin\Phi)\ -\ \frac{\cos\alpha}{\sin\alpha + \cos\alpha}a_3\frac{V_o}{C_o}(\cos\Phi - \sin\Phi)$$

The coordinates of the A_2A_3 segment are: $A_2A_3[x_{a3}-x_{a2}, \quad y_{a3}-y_{a2}]$

$$x_{a3}-x_{a2}=x_{a31}+\frac{\sin\alpha}{\sin\alpha+\cos\alpha}a_3\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)$$

$$y_{a3}-y_{a2}=y_{a31}-\frac{\cos\alpha}{\sin\alpha+\cos\alpha}a_3\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)$$ where:

(1.23) $$x_{a31}=\frac{\sin\alpha}{\sin\alpha+\cos\alpha}[L_3+y_{a2}+(a_1+a_2)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)]+\frac{\cos\alpha}{\sin\alpha+\cos\alpha}x_{a2}-x_{a2}$$

(1.24) $$y_{a31}=\frac{\sin\alpha}{\sin\alpha+\cos\alpha}[L_3+y_{a2}+(a_1+a_2)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)]+\frac{\cos\alpha}{\sin\alpha+\cos\alpha}x_{a2}-L_3+$$
$$-(a_1+a_2)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)-y_{a2}$$

$$a_3^2=(x_{a3}-x_{a2})^2+(y_{a3}-y_{a2})^2$$

Having solved the above equation, we obtain:

(1.25) $$a_3=\frac{r_{31}+\sqrt{r_{33}}}{r_{32}}$$ where:

(1.26) $$r_{31}=\left(x_{a31}\sin\alpha-y_{a31}\cos\alpha\right)\frac{V_o}{C_o}\frac{\cos\Phi-\sin\Phi}{\sin\alpha+\cos\alpha}$$

(1.27) $$r_{32}=1-\left(\frac{V_o}{C_o}\frac{\cos\Phi-\sin\Phi}{\sin\alpha+\cos\alpha}\right)^2$$

(1.28) $$r_{33}=r_{31}^2+r_{32}(x_{a31}^2+y_{a31}^2)$$

4. POINT A_4 AND THE LENGTH OF THE a_4 SEGMENT

The equation of the y_4 straight line which runs through the A_3 point is given by:

$$y_4=-tg(45^o+\gamma_1)\ x+y_{a3}+tg(45^o+\gamma_1)\ x_{a3}$$

Through the plate, light travels with the speed of $C_p=C_o/n_2$ (1.3), hence to travel the distance a_4 in the plate it requires the following time: $\frac{a_4}{C_p}=\frac{n_2a_4}{C_o}$

The coordinates of the $A_4(x_{a4},y_{a4})$ point are determined by the equations of straight lines:

y_4, (1.9) $y_9=x-L_3-\sqrt{2}\ g-tV_o(\cos\Phi-\sin\Phi)$, $t=t_{a4}=\frac{a_1+a_2+a_3+n_2a_4}{C_0}$ (4*) thus

(1.29) $$x_{a4}=\frac{\cos(45^o+\gamma_1)}{\sin(45^o+\gamma_1)+\cos(45^o+\gamma_1)}[L_3+\sqrt{2}\,g+(a_1+a_2+a_3+n_2a_4)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)+$$
$$+tg(45^o+\gamma_1)\ x_{a3}+y_{a3}]$$

(1.30) $$y_{a4}=-\frac{\sin(45^o+\gamma_1)}{\sin(45^o+\gamma_1)+\cos(45^o+\gamma_1)}[L_3+\sqrt{2}\,g+(a_1+a_2+a_3+n_2a_4)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)+$$
$$+tg(45^o+\gamma_1)\ x_{a3}+y_{a3}]+y_{a3}+tg(45^o+\gamma_1)\ x_{a3}$$

The coordinates of the A_3A_4 segment are: $A_3A_4[x_{a4}-x_{a3}, \quad y_{a4}-y_{a3}]$ with

$$x_{a4}-x_{a3}=x_{a41}+\frac{\cos(45^o+\gamma_1)}{\sin(45^o+\gamma_1)+\cos(45^o+\gamma_1)}n_2a_4\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)$$

$$y_{a4}-y_{a3}=y_{a41}-\frac{\sin(45^o+\gamma_1)}{\sin(45^o+\gamma_1)+\cos(45^o+\gamma_1)}n_2a_4\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)$$ where:

(1.31) $$x_{a41}=\frac{\cos(45^o+\gamma_1)}{\sin(45^o+\gamma_1)+\cos(45^o+\gamma_1)}[L_3+\sqrt{2}\,g+(a_1+a_2+a_3)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)+ +tg(45^o+\gamma_1)\ x_{a3}+y_{a3}]-x_{a3}$$

(1.32) $$y_{a41}=-\frac{\sin(45^o+\gamma_1)}{\sin(45^o+\gamma_1)+\cos(45^o+\gamma_1)}[L_3+\sqrt{2}\,g+(a_1+a_2+a_3)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)+ +tg(45^o+\gamma_1)\ x_{a3}+y_{a3}]+tg(45^o+\gamma_1)\ x_{a3}$$

$$a_4^2=(x_{a4}-x_{a3})^2+(y_{a4}-y_{a3})^2$$

Having solved the above equation, we obtain:

(1.33) $$a_4=\frac{r_{41}+\sqrt{r_{43}}}{r_{42}}$$ where:

(1.34) $$r_{41}=[x_{a41}\cos(45^o+\gamma_1)-y_{a41}\sin(45^o+\gamma_1)]n_2\frac{V_o}{C_o}\ \frac{\cos\Phi-\sin\Phi}{\sin(45^o+\gamma_1)+\cos(45^o+\gamma_1)}$$

(1.35) $$r_{42}=1-\left(n_2\frac{V_o}{C_o}\ \frac{\cos\Phi-\sin\Phi}{\sin(45^o+\gamma_1)+\cos(45^o+\gamma_1)}\right)^2$$

(1.35.1) $$r_{43}=r_{41}^2+r_{42}(x_{a41}^2+y_{a41}^2)$$

5. POINT A_5 AND THE LENGTH OF THE a_5 SEGMENT

The equation of the y_5 straight line which passes through the A_4 point is given by:

$$y_5=-tg(90^o-\alpha)\ x+y_{a4}+tg(90^o-\alpha)\ x_{a4}$$

The coordinates of the $A_5(x_{a5},y_{a5})$ point are determined by the equations of straight lines:

y_5, (1.7) $y_7=-L_4+tV_o\sin\Phi$, $t=t_{a5}=\dfrac{a_1+a_2+a_3+n_2a_4+a_5}{C_o}$ (5*) thus

(1.36) $$x_{a5}=\frac{\sin\alpha}{\cos\alpha}[L_4-(a_1+a_2+a_3+n_2a_4+a_5)\frac{V_o}{C_o}\sin\Phi+y_{a4}]+x_{a4}$$

(1.37) $$y_{a5}=-L_4+(a_1+a_2+a_3+n_2a_4+a_5)\frac{V_o}{C_o}\sin\Phi$$

The coordinates of the A_4A_5 segment are: $A_4A_5[x_{a5}-x_{a4}\ ,\ y_{a5}-y_{a4}]$ with

$$x_{a5}-x_{a4}=x_{a51}-\frac{\sin\alpha}{\cos\alpha}a_5\frac{V_o}{C_o}\sin\Phi$$

$$y_{a5}-y_{a4}=y_{a51}+a_5\frac{V_o}{C_o}\sin\Phi$$ where:

(1.38) $$x_{a51}=\frac{\sin\alpha}{\cos\alpha}[L_4-(a_1+a_2+a_3+n_2a_4)\frac{V_o}{C_o}\sin\Phi+y_{a4}]$$

(1.39) $$y_{a51} = -L_4 + (a_1 + a_2 + a_3 + n_2 a_4)\frac{V_o}{C_o}\sin\Phi - y_{a4}$$

$$a_5^2 = (x_{a5} - x_{a4})^2 + (y_{a5} - y_{a4})^2$$

Having solved this equation we obtain:

(1.40) $$a_5 = \frac{r_{51} + \sqrt{r_{53}}}{r_{52}}$$ where:

(1.41) $$r_{51} = \left(y_{a51} - x_{a51}\frac{\sin\alpha}{\cos\alpha} \right)\frac{V_o}{C_o}\sin\Phi ,$$ (1.42) $$r_{52} = 1 - \left(\frac{V_o}{C_o}\frac{\sin\Phi}{\cos\alpha} \right)^2 ,$$

(1.43) $$r_{53} = r_{51}^2 + r_{52}(x_{a51}^2 + y_{a51}^2)$$

I.1.5 THE COORDINATES OF THE $B_1,...,B_5$ POINTS AND THE LENGTHS OF THE $b_1,...,b_5$ SEGMENTS IN THE OXY COORDINATE SYSTEM

The lengths of distances traveled by the ray of light after leaving the S_0 slit at the angle β are:

$$b_1 = S_0 B_1 , \quad b_2 = B_1 B_2 , \quad b_3 = B_2 B_3 , \quad b_4 = B_3 B_4 , \quad b_5 = B_4 B_5 .$$

6. POINT B_1 AND THE LENGTH OF THE b_1 SEGMENT

The coordinates of the $B_1(x_{b1}, y_{b1})$ point are determined by the straight lines equations:

$y_{12} = tg\beta\ x$, (1.8) $y_8 = x - L_3 - tV_o(\cos\Phi - \sin\Phi)$, $t = t_{b1} = \frac{b_1}{C_o}$ (6*) thus

(1.44) $$x_{b1} = [L_3 + b_1\frac{V_o}{C_o}(\cos\Phi - \sin\Phi)]\frac{\cos\beta}{\cos\beta - \sin\beta}$$

(1.45) $$y_{b1} = [L_3 + b_1\frac{V_o}{C_o}(\cos\Phi - \sin\Phi)]\frac{\sin\beta}{\cos\beta - \sin\beta}$$

The coordinates of the $S_0 B_1$ segment are: $S_0 B_1 [x_{b1} - 0 , \quad y_{b1} - 0]$

$$b_1^2 = x_{b1}^2 + y_{b1}^2 .$$

Having solved this equation we obtain:

(1.46) $$b_1 = \frac{L_3}{\cos\beta - \sin\beta - (\cos\Phi - \sin\Phi)\frac{V_o}{C_o}}$$

7. POINT B_2 AND THE LENGTH THE b_2 SEGMENT

The equation of the y_{22} straight line which passes through the B_1 point is:

$$y_{22} = -tg(45^o - \gamma_2)\ x + y_{b1} + tg(45^o - \gamma_2)\ x_{b1}$$

Light travels the distance b_2 within a time interval $\frac{b_2}{C_p} = \frac{n_2 b_2}{C_o}$.

The coordinates of the $B_2(x_{b2}, y_{b2})$ point are determined by the straight lines equations:

y_{22}, (1.9) $y_9 = x - L_3 - \sqrt{2}\ g - tV_o(\cos\Phi - \sin\Phi)$, $t = t_{b2} = \frac{b_1 + n_2 b_2}{C_o}$ (7*) thus

(1.47) $$x_{b2} = \frac{\cos(45^o - \gamma_2)}{\sin(45^o - \gamma_2) + \cos(45^0 - \gamma_2)} [L_3 + \sqrt{2}\, g + (b_1 + n_2 b_2) \frac{V_o}{C_o} (\cos\Phi - \sin\Phi) + y_{b1} + tg(45^o - \gamma_2)\ x_{b1}]$$

(1.48) $$y_{b2} = -\frac{\sin(45^o - \gamma_2)}{\sin(45^o - \gamma_2) + \cos(45^0 - \gamma_2)} [L_3 + \sqrt{2}\, g + (b_1 + n_2 b_2) \frac{V_o}{C_o} (\cos\Phi - \sin\Phi) + y_{b1} + tg(45^o - \gamma_2)\ x_{b1}] + y_{b1} + tg(45^o - \gamma_2)\ x_{b1}$$

The coordinates of the B_1B_2 segment are: $B_1B_2[x_{b2} - x_{b1}\ ,\ \ y_{b2} - y_{b1}]$

$$x_{b2} - x_{b1} = x_{b21} + \frac{\cos(45^o - \gamma_2)}{\sin(45^o - \gamma_2) + \cos(45^o - \gamma_2)} n_2 b_2 \frac{V_o}{C_o} (\cos\Phi - \sin\Phi)$$

$$y_{b2} - y_{b1} = y_{b21} - \frac{\sin(45^o - \gamma_2)}{\sin(45^o - \gamma_2) + \cos(45^o - \gamma_2)} n_2 b_2 \frac{V_o}{C_o} (\cos\Phi - \sin\Phi)$$ where:

(1.49) $$x_{b21} = \frac{\cos(45^o - \gamma_2)}{\sin(45^o - \gamma_2) + \cos(45^o - \gamma_2)} [L_3 + \sqrt{2}\ g + b_1 \frac{V_o}{C_o} (\cos\Phi - \sin\Phi) + y_{b1} + tg(45^o - \gamma_2)\ x_{b1}] - x_{b1}$$

(1.50) $$y_{b21} = -\frac{\sin(45^o - \gamma_2)}{\sin(45^o - \gamma_2) + \cos(45^o - \gamma_2)} [L_3 + \sqrt{2}\ g + b_1 \frac{V_o}{C_o} (\cos\Phi - \sin\Phi) + y_{b1} + tg(45^o - \gamma_2)\ x_{b1}] + tg(45^o - \gamma_2)\ x_{b1}$$

$$b_2^2 = (x_{b2} - x_{b1})^2 + (y_{b2} - y_{b1})^2$$

Having solved the above equation we obtain:

(1.51) $$b_2 = \frac{s_{21} + \sqrt{s_{23}}}{s_{22}}$$ where:

(1.52) $$s_{21} = [x_{b21} \cos(45^o - \gamma_2) - y_{b21} \sin(45^o - \gamma_2)]\ n_2 \frac{V_o}{c_o} \frac{\cos\Phi - \sin\Phi}{\sin(45^o - \gamma_2) + \cos(45^o - \gamma_2)}$$

(1.53) $$s_{22} = 1 - \left(n_2 \frac{V_o}{C_o} \frac{\cos\Phi - \sin\Phi}{\sin(45^o - \gamma_2) + \cos(45^o - \gamma_2)} \right)^2$$

(1.54) $$s_{23} = s_{21}^2 + s_{22}(x_{b21}^2 + y_{b21}^2)$$

8. POINT B_3 AND THE LENGTH OF THE b_3 SEGMENT

The equation of the y_{32} straight line which passes through the B_2 point is:

$$y_{32} = tg\beta\ x + y_{b2} - tg\beta\ x_{b2}$$

The coordinates of $B_3(x_{b3}, y_{b3})$ are determined by the following equations of straight lines:

y_{32}, (1.5) $x = L_1 + tV_o\ \cos\Phi$, $t = t_{b3} = \dfrac{b_1 + n_2 b_2 + b_3}{C_o}$ (8*) thus

(1.55) $$x_{b3} = L_1 + (b_1 + n_2 b_2 + b_3)\frac{V_o}{C_o}\cos\Phi$$

(1.56) $$y_{b3} = tg\beta\,[L_1 + (b_1 + n_2 b_2 + b_3)\frac{V_o}{C_o}\cos\Phi] + y_{b2} - tg\beta\; x_{b2}$$

The coordinates of the B_2B_3 segment are: $B_2B_3[x_{b3} - x_{b2} \quad , \quad y_{b3} - y_{b2}]$

$$x_{b3} - x_{b2} = x_{b31} + b_3\frac{V_o}{C_o}\cos\Phi$$

$$y_{b3} - y_{b2} = y_{b31} + \frac{\sin\beta}{\cos\beta} b_3 \frac{V_o}{C_o}\cos\Phi$$ where:

(1.57) $$x_{b31} = L_1 + (b_1 + n_2 b_2)\frac{V_o}{C_o}\cos\Phi - x_{b2}$$

(1.58) $$y_{b31} = tg\beta\,[L_1 + (b_1 + n_2 b_2)\frac{V_o}{C_o}\cos\Phi] - tg\beta\; x_{b2}$$

$$b_3^2 = (x_{b3} - x_{b2})^2 + (y_{b3} - y_{b2})^2$$

Having solved the above equation we obtain:

(1.59) $$b_3 = \frac{s_{31} + \sqrt{s_{33}}}{s_{32}}$$ where:

(1.60) $$s_{31} = \left(x_{b31} + y_{b31}\frac{\sin\beta}{\cos\beta}\right)\frac{V_o}{C_o}\cos\Phi$$

(1.61) $$s_{32} = 1 - \left(\frac{V_o}{C_o}\frac{\cos\Phi}{\cos\beta}\right)^2$$

(1.62) $$s_{33} = s_{31}^2 + s_{32}(x_{b31}^2 + y_{b31}^2)$$

9. POINT B_4 AND THE LENGTH OF THE b_4 SEGMENT

The equation of the y_{42} straight line which passes through the B_3 point is:

$$y_{42} = tg(180^o - \beta)\; x + y_{b3} - tg(180^o - \beta)\; x_{b3}$$
$$y_{42} = -tg\beta\; x + y_{b3} + tg\beta\; x_{b3}$$

The coordinates of the $B_4(x_{b4}, y_{b4})$ point are given by the straight line equations:

y_{42}, (1.9) $y_9 = x - L_3 - \sqrt{2}\,g - tV_o(\cos\Phi - \sin\Phi)$, $t = t_{b4} = \dfrac{b_1 + n_2 b_2 + b_3 + b_4}{C_o}$ (9*)

thus

(1.63) $$x_{b4} = \frac{\cos\beta}{\sin\beta + \cos\beta}[L_3 + \sqrt{2}\,g + (b_1 + n_2 b_2 + b_3 + b_4)\frac{V_o}{C_o}(\cos\Phi - \sin\Phi) + y_{b3} + tg\beta\; x_{b3}]$$

(1.64) $$y_{b4} = -\frac{\sin\beta}{\sin\beta + \cos\beta}[L_3 + \sqrt{2}\,g + (b_1 + n_2 b_2 + b_3 + b_4)\frac{V_o}{C_o}(\cos\Phi - \sin\Phi) + y_{b3} + tg\beta\; x_{b3}] + y_{b3} + tg\beta\; x_{b3}$$

The coordinates of the B_3B_4 segment are: $B_3B_4[x_{b4} - x_{b3} \quad , \quad y_{b4} - y_{b3}]$

$$x_{b4}-x_{b3}=x_{b41}+\frac{\cos\beta}{\sin\beta+\cos\beta}b_4\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)$$

$$y_{b4}-y_{b3}=y_{b41}-\frac{\sin\beta}{\sin\beta+\cos\beta}b_4\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)$$ where:

(1.65) $$x_{b41}=\frac{\cos\beta}{\sin\beta+\cos\beta}[L_3+\sqrt{2}\,g+(b_1+n_2b_2+b_3)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)+y_{b3}+ +tg\beta\ x_{b3}]-x_{b3}$$

(1.66) $$y_{b41}=-\frac{\sin\beta}{\sin\beta+\cos\beta}[L_3+\sqrt{2}\,g+(b_1+n_2b_2+b_3)\frac{V_o}{C_o}(\cos\Phi-\sin\Phi)+y_{b3}+ +tg\beta\ x_{b3}]+tg\beta\ x_{b3}$$

$$b_4^2=(x_{b4}-x_{b3})^2+(y_{b4}-y_{b3})^2$$

Having solved the above equation we obtain:

(1.67) $$b_4=\frac{s_{41}+\sqrt{s_{43}}}{s_{42}}$$ where:

(1.68) $$s_{41}=\left(x_{b41}\cos\beta-y_{b41}\sin\beta\right)\frac{V_o}{C_o}\ \frac{\cos\Phi-\sin\Phi}{\sin\beta+\cos\beta}$$

(1.69) $$s_{42}=1-\left(\frac{V_o}{C_o}\ \frac{\cos\Phi-\sin\Phi}{\sin\beta+\cos\beta}\right)^2$$

(1.70) $$s_{43}=s_{41}^2+s_{42}(x_{b41}^2+y_{b41}^2)$$

10. POINT B_5 AND THE LENGTH OF THE b_5 SEGMENT

The equation of the y_{52} straight line which passes through the B_4 point is:

$$y_{52}=tg(90^o+\beta)\ x+y_{b4}-tg(90^o+\beta)\ x_{b4}$$

The coordinates of $B_5(x_{b5},y_{b5})$ are determined by the straight line equations:

y_{52} , (1.7) $y_7=-L_4+tV_o\sin\Phi$, $t=t_{b5}=\dfrac{b_1+n_2b_2+b_3+b_4+b_5}{C_o}$ (10*) thus

(1.71) $$x_{b5}=\frac{\sin\beta}{\cos\beta}[L_4-(b_1+n_2b_2+b_3+b_4+b_5)\frac{V_o}{C_o}\sin\Phi+y_{b4}]+x_{b4}$$

(1.72) $$y_{b5}=-L_4+(b_1+n_2b_2+b_3+b_4+b_5)\frac{V_o}{C_o}\sin\Phi$$

The coordinates of the B_4B_5 segment are: $B_4B_5[x_{b5}-x_{b4},\ \ y_{b5}-y_{b4}]$

$$x_{b5}-x_{b4}=x_{b51}-\frac{\sin\beta}{\cos\beta}b_5\frac{V_o}{C_o}\sin\Phi$$

$$y_{b5}-y_{b4}=y_{b51}+b_5\frac{V_o}{C_o}\sin\Phi$$ where:

(1.73) $$x_{b51}=\frac{\sin\beta}{\cos\beta}[L_4-(b_1+n_2b_2+b_3+b_4)\frac{V_o}{C_o}\sin\Phi+y_{b4}]$$

(1.74) $$y_{b51}=-L_4+(b_1+n_2b_2+b_3+b_4)\frac{V_o}{C_o}\sin\Phi-y_{b4}$$

$$b_5^2 = (x_{b5} - x_{b4})^2 + (y_{b5} - y_{b4})^2$$

Having solved the above equation we obtain:

(1.75) $$b_5 = \frac{s_{51} + \sqrt{s_{53}}}{s_{52}}$$ where:

(1.76) $$s_{51} = \left(y_{b51} - x_{b51} \frac{\sin\beta}{\cos\beta} \right) \frac{V_o}{C_o} \sin\Phi$$

(1.77) $$s_{52} = 1 - \left(\frac{V_o}{C_o} \frac{\sin\Phi}{\cos\beta} \right)^2$$

(1.78) $$s_{53} = s_{51}^2 + s_{52}(x_{b51}^2 + y_{b51}^2)$$

THE GALILEAN TRANSFORMATION

When recalculating points $A_1,...,A_5$, $B_1,...,B_5$ from the OXY inertial system into another inertial system O'EQ, the Galilean transformation is applied.

I.1.6 THE COORDINATES OF THE $A_1,...,A_5$ POINTS IN THE O'EQ SYSTEM

POINT $A_1(e_{a1}, q_{a1})$, $t_{a1} = \frac{a_1}{C_o}$ relationship (1*)

(1.79) $$e_{a1} = x_{a1} - t_{a1} V_o \cos\Phi = x_{a1} - a_1 \frac{V_o}{C_o} \cos\Phi$$

(1.80) $$q_{a1} = y_{a1} - t_{a1} V_o \sin\Phi = y_{a1} - a_1 \frac{V_o}{C_o} \sin\Phi$$

POINT $A_2(e_{a2}, q_{a2})$, $t_{a2} = \frac{a_1 + a_2}{C_o}$ relationship (2*)

(1.81) $$e_{a2} = x_{a2} - t_{a2} V_o \cos\Phi = x_{a2} - (a_1 + a_2) \frac{V_o}{C_o} \cos\Phi$$

(1.82) $$q_{a2} = y_{a2} - t_{a2} V_o \sin\Phi = y_{a2} - (a_1 + a_2) \frac{V_o}{C_o} \sin\Phi = L_2$$

POINT $A_3(e_{a3}, q_{a3})$, $t_{a3} = \frac{a_1 + a_2 + a_3}{C_o}$ relationship (3*)

(1.83) $$e_{a3} = x_{a3} - t_{a3} V_o \cos\Phi = x_{a3} - (a_1 + a_2 + a_3) \frac{V_o}{C_o} \cos\Phi$$

(1.84) $$q_{a3} = y_{a3} - t_{a3} V_o \sin\Phi = y_{a3} - (a_1 + a_2 + a_3) \frac{V_o}{C_o} \sin\Phi$$

POINT $A_4(e_{a4}, q_{a4})$, $t_{a4} = \frac{a_1 + a_2 + a_3 + n_2 a_4}{C_o}$ relationship (4*)

(1.85) $$e_{a4} = x_{a4} - t_{a4} V_o \cos\Phi = x_{a4} - (a_1 + a_2 + a_3 + n_2 a_4) \frac{V_o}{C_o} \cos\Phi$$

(1.86) $$q_{a4} = y_{a4} - t_{a4} V_o \sin\Phi = y_{a4} - (a_1 + a_2 + a_3 + n_2 a_4) \frac{V_o}{C_o} \sin\Phi$$

POINT $A_5(e_{a5}, q_{a5})$, $t_{a5} = \dfrac{a_1 + a_2 + a_3 + n_2 a_4 + a_5}{C_o}$ relationship (5*)

(1.87) $$e_{a5} = x_{a5} - t_{a5} V_o \cos\Phi = x_{a5} - (a_1 + a_2 + a_3 + n_2 a_4 + a_5)\frac{V_o}{C_o}\cos\Phi$$

(1.88) $$q_{a5} = y_{a5} - t_{a5} V_o \sin\Phi = y_{a5} - (a_1 + a_2 + a_3 + n_2 a_4 + a_5)\frac{V_o}{C_o}\sin\Phi = -L_4$$

I.1.7 THE COORDINATES OF THE $B_1, \ldots, B_5$ POINTS IN THE O'EQ SYSTEM

POINT $B_1(e_{b1}, q_{b1})$, $t_{b1} = \dfrac{b_1}{C_o}$ relationship (6*)

(1.89) $$e_{b1} = x_{b1} - t_{b1} V_o \cos\Phi = x_{b1} - b_1 \frac{V_o}{C_o}\cos\Phi$$

(1.90) $$q_{b1} = y_{b1} - t_{b1} V_o \sin\Phi = y_{b1} - b_1 \frac{V_o}{C_o}\sin\Phi$$

POINT $B_2(e_{b2}, q_{b2})$, $t_{b2} = \dfrac{b_1 + n_2 b_2}{C_o}$ relationship (7*)

(1.91) $$e_{b2} = x_{b2} - t_{b2} V_o \cos\Phi = x_{b2} - (b_1 + n_2 b_2)\frac{V_o}{C_o}\cos\Phi$$

(1.92) $$q_{b2} = y_{b2} - t_{b2} V_o \sin\Phi = y_{b2} - (b_1 + n_2 b_2)\frac{V_o}{C_o}\sin\Phi$$

POINT $B_3(e_{b3}, q_{b3})$, $t_{b3} = \dfrac{b_1 + n_2 b_2 + b_3}{C_o}$ relationship (8*)

(1.93) $$e_{b3} = x_{b3} - t_{b3} V_o \cos\Phi = x_{b3} - (b_1 + n_2 b_2 + b_3)\frac{V_o}{C_o}\cos\Phi = L_1$$

(1.94) $$q_{b3} = y_{b3} - t_{b3} V_o \sin\Phi = y_{b3} - (b_1 + n_2 b_2 + b_3)\frac{V_o}{C_o}\sin\Phi$$

POINT $B_4(e_{b4}, q_{b4})$, $t_{b4} = \dfrac{b_1 + n_2 b_2 + b_3 + b_4}{C_o}$ relationship (9*)

(1.95) $$e_{b4} = x_{b4} - t_{b4} V_o \cos\Phi = x_{b4} - (b_1 + n_2 b_2 + b_3 + b_4)\frac{V_o}{C_o}\cos\Phi$$

(1.96) $$q_{b4} = y_{b4} - t_{b4} V_o \sin\Phi = y_{b4} - (b_1 + n_2 b_2 + b_3 + b_4)\frac{V_o}{C_o}\sin\Phi$$

POINT $B_5(e_{b5}, q_{b5})$, $t_{b5} = \dfrac{b_1 + n_2 b_2 + b_3 + b_4 + b_5}{C_o}$ relationship (10*)

(1.97) $$e_{b5} = x_{b5} - t_{b5} V_o \cos\Phi = x_{b5} - (b_1 + n_2 b_2 + b_3 + b_4 + b_5)\frac{V_o}{C_o}\cos\Phi$$

(1.98) $$q_{b5} = y_{b5} - t_{b5} V_o \sin\Phi = y_{b5} - (b_1 + n_2 b_2 + b_3 + b_4 + b_5)\frac{V_o}{C_o}\sin\Phi = -L_4$$

I.1.8 THE LENGTHS OF DISTANCES TRAVELED BY A RAY OF LIGHT AFTER LEAVING THE S_0 SLIT AT THE ANGLE α IN THE O'EQ SYSTEM

(1.99) $$a_{1u} = (e_{a1}^2 + q_{a1}^2)^{1/2}$$

(1.100) $$a_{2u} = [(e_{a2} - e_{a1})^2 + (q_{a2} - q_{a1})^2]^{1/2}$$

(1.101) $$a_{3u} = [(e_{a3} - e_{a2})^2 + (q_{a3} - q_{a2})^2]^{1/2}$$

(1.102) $$a_{4u} = [(e_{a4} - e_{a3})^2 + (q_{a4} - q_{a3})^2]^{1/2}$$

(1.103) $$a_{5u} = [(e_{a5} - e_{a4})^2 + (q_{a5} - q_{a4})^2]^{1/2}$$

I.1.9 THE LENGTHS OF DISTANCES TRAVELED BY A RAY OF LIGHT AFTER LEAVING THE S_0 SLIT AT THE ANGLE β IN THE O'EQ SYSTEM

(1.104) $$b_{1u} = (e_{b1}^2 + q_{b1}^2)^{1/2}$$

(1.105) $$b_{2u} = [(e_{b2} - e_{b1})^2 + (q_{b2} - q_{b1})^2]^{1/2}$$

(1.106) $$b_{3u} = [(e_{b3} - e_{b2})^2 + (q_{b3} - q_{b2})^2]^{1/2}$$

(1.107) $$b_{4u} = [(e_{b4} - e_{b3})^2 + (q_{b4} - q_{b3})^2]^{1/2}$$

(1.108) $$b_{5u} = [(e_{b5} - e_{b4})^2 + (q_{b5} - q_{b4})^2]^{1/2}$$

I.1.10 THE RELATIVE DIFFERENCE OF THE DISTANCES TRAVELED BY THE RAYS OF LIGHT REACHING ONE POINT ON THE SCREEN M

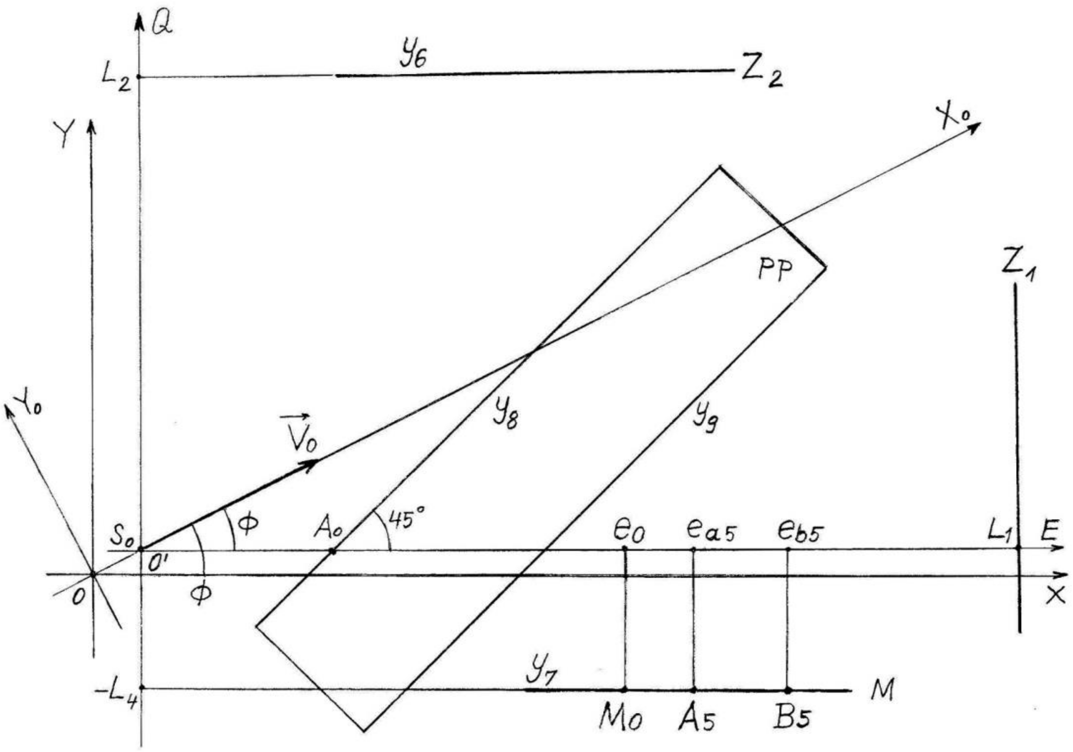

Fig. 4 The points A_5, B_5 of the screen M, togaether with their coordinates e_{a5}, e_{b5}, which were reached by the rays of light after leaving the slit S_0 at the angles α, β.

The shift of the interference fringes is calculated with respect to point Mo with its coordinate e_o on the screen M.

The coordinates e_{a5}, e_{b5} of the points A_5, B_5 of screen M are dependent upon the variables α, β, Φ, V_w, thus the coordinates e_{a5}, e_{b5} take on the form of the following functions:

$e_{a5} = e_{a5}(\alpha, \Phi, V_w)$ relationship (1.87),

$e_{b5} = e_{b5}(\beta, \Phi, V_w)$ relationship (1.97),

where: $V_w = \dfrac{V_o}{C_o}$.

The interference of the rays of light which have left the slit S_0 at the angles α, β will only take place on the screen M (fig. 4) when points A_5 and B_5 coincide. This means the coordinates are equal: $e_{a5} = e_{b5}$

The relative difference of distances traveled by the rays of light in a vacuum is:

$$\Delta l_o / \lambda_o = [a_{1u} + a_{2u} + a_{3u} + a_{5u} - (b_{1u} + b_{3u} + b_{4u} + b_{5u})] / \lambda_o$$

The relative difference of distances traveled by the rays of light in the PP plate is:

$\Delta l_p / \lambda_p = (a_{4u} - b_{2u}) / \lambda_p$ where:

$\lambda_p = \lambda_o / n_2$ relationship (1.4)

Thus the total relative difference of distances traveled by the rays of light:

$$\Delta l / \lambda_o = \Delta l_o / \lambda_o + \Delta l_p / \lambda_p$$

After transformation of the relationship we obtain:

(1.109) $$\Delta l / \lambda_o = [a_{1u} + a_{2u} + a_{3u} + n_2 a_{4u} + a_{5u} - (b_{1u} + n_2 b_{2u} + b_{3u} + b_{4u} + b_{5u})] / \lambda_o$$

Let us introduce a symbol R_w:

(1.109a) $$R_w = \Delta l / \lambda_o$$

The relative difference of distances R_w depends upon the variables α, β, Φ, V_w and therefore it is defined by the function:

(1.109b) $$R_w = R_w(\alpha, \beta, \Phi, V_w)$$

We need to calculate the R_w value at any Mo point with its coordinate e_0 on the screen M, given the angle $\Phi = \Phi_n$ and at a fixed value $V_w = V_o / C_o$

In order to do this we write the following equations:

(11*) $$e_{a5} = e_{a5}(\alpha_n, \Phi_n, V_w) = e_o$$

(12*) $$e_{b5} = e_{b5}(\beta_n, \Phi_n, V_w) = e_o$$

Then by applying the appropriate computational software, we can compute such a pair of angles (α_n, β_n) which satisfies the equations (11*) and (12*). Knowing the pair of angles (α_n, β_n) at fixed values of Φ_n, V_w we calculate the value of R_w:

(1.109c) $$R_w = \Delta l / \lambda_o = R_w(\alpha_n, \beta_n, \Phi_n, V_w)$$

I.1.11 THE DIFFERENCE IN PHASES OF THE LIGHT RAYS REACHING ONE POINT ON THE SCREEN M

Reaching one point on the screen the light rays may be identical or may vary in their phases. The phase difference $\Delta\varphi$ of the light rays equals:

(1.110) $$\Delta\varphi = 2\pi \; frac(R_w)$$

where : $frac(R_w)$ is a function denoting the fractional part of the R_w value.

I.1.12 THE INTERFERENCE FRINGES SHIFTS' VALUES

On the screen M let us select a point Mo (Fig. 4) with the e_0 coordinate (a fixed line in the telescope), in relation to which we will calculate the shift of interference fringes.

Corresponding to both the angle $\Phi = \Phi_1 = 0$ and the coordinate e_0, the pair of angles (α_1, β_1) satisfies the following equations:

$$e_{a5} = e_{a5}(\alpha_1, \Phi_1, V_w) = e_0$$

$$e_{b5} = e_{b5}(\beta_1, \Phi_1, V_w) = e_0 \qquad \text{so}$$

(1.111) $$R_{w1} = R_w(\alpha_1, \beta_1, \Phi_1, V_w)$$

Corresponding to both the angle $\Phi = \Phi_2$ and the coordinate e_0, the pair of angles (α_2, β_2) satisfies the following equations:

$$e_{a5} = e_{a5}(\alpha_2, \Phi_2, V_w) = e_0$$

$$e_{b5} = e_{b5}(\beta_2, \Phi_2, V_w) = e_0 \qquad \text{so}$$

(1.112) $$R_{w2} = R_w(\alpha_2, \beta_2, \Phi_2, V_w)$$

Leaving the slit S_0 at angles $(\alpha_1, \beta_1), (\alpha_2, \beta_2)$ the rays of light reach the Mo point of the e_0 coordinate.

Calculated with respect to the Mo point, the value k of the interference fringe shift depending upon the angle Φ_2 and a fixed value V_w is given by the following:

(1.113) $$k(\Phi_2, V_w) = R_{w2} - R_{w1}$$

The formula (1.113) can be applied to calculate the values of interference fringe shifts with respect to any Mo point on the screen M, after rotating the interferometer by any angle Φ_2 and with the $V_w = V_o / C_o$ fixed at any value.
Tables 2 – 7 give the values of the interference fringe shifts with respect to point Mo of the coordinate

$e_0 = 0.1508323849500$ m for different values of Φ_2, V_w .

The calculations were carried out using PROGRAM abIM presented in Chapter IV of this work.

In the calculations – the relative approximations of points A_5, B_5 to point M_0 are described by the following inequalities of coordinates (Fig.4):

$$|\,(e_{a5} - e_0)/\lambda_o\,| < 10^{-7}, \qquad |\,(e_{b5} - e_0)/\lambda_o\,| < 10^{-7}$$

The abovementioned approximations of points A_5, B_5, M_0 are presented in tables 1 to 7.

$e_0 = 0.1508323849500$ m $\Phi_1 = 0$		$V_w = V_o / C_o$ $R_{w1} = R_w(\alpha_1, \beta_1, \Phi_1, V_w)$	
1	2	3	4
V_w	α_1	β_1	R_{w1}
–	rad	rad	–
$5 \cdot 10^{-5}$	$3.9927724200 \cdot 10^{-3}$	$3.5979062811 \cdot 10^{-3}$	3002.131191320
10^{-4}	$4.0401177788 \cdot 10^{-3}$	$3.5999661255 \cdot 10^{-3}$	3002.131389021
$1.5 \cdot 10^{-4}$	$4.0874626306 \cdot 10^{-3}$	$3.6020261381 \cdot 10^{-3}$	3002.131715822
$2 \cdot 10^{-4}$	$4.1348069753 \cdot 10^{-3}$	$3.6040863191 \cdot 10^{-3}$	3002.132187332
$5 \cdot 10^{-4}$	$4.4188623939 \cdot 10^{-3}$	$3.6164509390 \cdot 10^{-3}$	3002.137796524
10^{-3}	$4.8922475042 \cdot 10^{-3}$	$3.6370720997 \cdot 10^{-3}$	3002.157966110
10^{-2}	$1.3404460634 \cdot 10^{-2}$	$4.0111245783 \cdot 10^{-3}$	3005.035276114
0.1	$9.7524614853 \cdot 10^{-2}$	$8.0443961357 \cdot 10^{-3}$	3591.873337429

TABLE 1
Relative differences of distances $R_{w1} = R_w(\alpha_1, \beta_1, \Phi_1, V_w)$ at $\Phi = \Phi_1 = 0$

$e_0 = 0{,}1508323849500$ m $\Phi_2 = \pi / 4$		$R_{w2} = R_w(\alpha_2, \beta_2, \Phi_2, V_w)$		$V_w = V_o / C_o$ $k(\Phi_2, V_w) = R_{w2} - R_{w1}$
1	2	3	4	5
V_w	α_2	β_2	R_{w2}	$k\ (\Phi_2, V_w)$
–	rad	rad	–	–
$5 \cdot 10^{-5}$	$3.9808002849 \cdot 10^{-3}$	$3.6312205475 \cdot 10^{-3}$	3002.131123494	$-6.7826 \cdot 10^{-5}$
10^{-4}	$4.0161740048 \cdot 10^{-3}$	$3.6665944817 \cdot 10^{-3}$	3002.131130047	$-2.5897 \cdot 10^{-4}$
$1.5 \cdot 10^{-4}$	$4.0515477145 \cdot 10^{-3}$	$3.7019684075 \cdot 10^{-3}$	3002.131130624	$-5.8519 \cdot 10^{-4}$
$2 \cdot 10^{-4}$	$4.0869214137 \cdot 10^{-3}$	$3.7373423250 \cdot 10^{-3}$	3002.131127927	$-1{,}0594 \cdot 10^{-3}$
$5 \cdot 10^{-4}$	$4.2991633943 \cdot 10^{-3}$	$3.9495856587 \cdot 10^{-3}$	3002.131133321	$-6.6632 \cdot 10^{-3}$
10^{-3}	$4.6528992281 \cdot 10^{-3}$	$4.3033239157 \cdot 10^{-3}$	3002.131122723	$-2.6843 \cdot 10^{-2}$
10^{-2}	$1.1020022430 \cdot 10^{-2}$	$1.0670526531 \cdot 10^{-2}$	3002.127546019	-2.9077
0.1	$7.4730696699 \cdot 10^{-2}$	$7.438571775 \cdot 10^{-2}$	2998.359887719	-593.5134
Values of $R_{w1} = R_w(\alpha_1, \beta_1, \Phi_1, V_w)$ are presented in Table 1				

TABLE 2
Values of the interference fringe shifts $k(\Phi_2, V_w)$ at $\Phi_2 = \pi / 4$.

$e_0 = 0{,}1508323849500$ m $\Phi_2 = \pi/2$		$R_{w2} = R_w(\alpha_2, \beta_2, \Phi_2, V_w)$	$V_w = V_o / C_o$ $k\ (\Phi_2, V_w) = R_{w2} - R_{w1}$	
1	2	3	4	5
V_w	α_2	β_2	R_{w2}	$k\ (\Phi_2, V_w)$
–	rad	rad	–	–
$5 \cdot 10^{-5}$	$3.9481063201 \cdot 10^{-3}$	$3.6438135238 \cdot 10^{-3}$	3002.131174750	$-1.6570 \cdot 10^{-5}$
10^{-4}	$3{,}9507858220 \cdot 10^{-3}$	$3.6917808334 \cdot 10^{-3}$	3002.131358381	$-3.0640 \cdot 10^{-5}$
$1.5 \cdot 10^{-4}$	$3.9534650605 \cdot 10^{-3}$	$3.7394485340 \cdot 10^{-3}$	3002.131651654	$-6.4168 \cdot 10^{-5}$
$2 \cdot 10^{-4}$	$3.9561440353 \cdot 10^{-3}$	$3.7877166255 \cdot 10^{-3}$	3002,132074803	$-1.1252 \cdot 10^{-4}$
$5 \cdot 10^{-4}$	$3.9722123456 \cdot 10^{-3}$	$4.0755333837 \cdot 10^{-3}$	3002.137086849	$-7.0967 \cdot 10^{-4}$
10^{-3}	$3.9989717621 \cdot 10^{-3}$	$4.5552592553 \cdot 10^{-3}$	3002.155067484	$-2.8986 \cdot 10^{-3}$
10^{-2}	$4.4761228482 \cdot 10^{-3}$	$1.3197013721 \cdot 10^{-2}$	3004.654317494	-0.3809
0,1	No light interference.			
Values of $R_{w1} = R_w(\alpha_1, \beta_1, \Phi_1, V_w)$ are presented in Table 1				

TABLE 3
Values of the interference fringe shifts $k(\Phi_2, V_w)$ at $\Phi_2 = \pi/2$.

$e_0 = 0\ .1508323849500$ m $\Phi_2 = -\pi/4$		$R_{w2} = R_w(\alpha_2, \beta_2, \Phi_2, V_w)$	$V_w = V_o / C_o$ $k\ (\Phi_2, V_w) = R_{w2} - R_{w1}$	
1	2	3	4	5
V_w	α_2	β_2	R_{w2}	$k\ (\Phi_2, V_w)$
–	rad	rad	–	–
$5 \cdot 10^{-5}$	$3.9770099624 \cdot 10^{-3}$	$3.5633856451 \cdot 10^{-3}$	3002.131245467	$5.4147 \cdot 10^{-5}$
10^{-4}	$4.0085926102 \cdot 10^{-3}$	$3.5309252527 \cdot 10^{-3}$	3002.131621789	$2.3276 \cdot 10^{-4}$
$1.5 \cdot 10^{-4}$	$4.0401744976 \cdot 10^{-3}$	$3.4984654283 \cdot 10^{-3}$	3002.132255159	$5.3933 \cdot 10^{-4}$
$2 \cdot 10^{-4}$	$4.0717556242 \cdot 10^{-3}$	$3.4660061717 \cdot 10^{-3}$	3002.133149623	$9.6229 \cdot 10^{-4}$
$5 \cdot 10^{-4}$	$4.2612264039 \cdot 10^{-3}$	$3.2712625612 \cdot 10^{-3}$	3002.143733676	$5.9371 \cdot 10^{-3}$
10^{-3}	$4.5769500845 \cdot 10^{-3}$	$2.9467354079 \cdot 10^{-3}$	3002.181635327	$2{,}3669 \cdot 10^{-2}$
10^{-2}	$1.0246766501 \cdot 10^{-2}$	$-2.8848934357 \cdot 10^{-3}$	3007.295667190	2.2603
0.1	$6.5318706130 \cdot 10^{-2}$	$-5.9987865247 \cdot 10^{-2}$	3656.388665504	64.5153
Values of $R_{w1} = R_w(\alpha_1, \beta_1, \Phi_1, V_w)$ are presented in Table 1				

TABLE 4
Values of the interference fringe shifts $k(\Phi_2, V_w)$ at $\Phi_2 = -\pi/4$.

$e_0 = 0.1508323849500$ m			$V_w = V_o / C_o$	
$\Phi_2 = -\pi/2$	$R_{w2} = R_w(\alpha_2, \beta_2, \Phi_2, V_w)$		$k(\Phi_2, V_w) = R_{w2} - R_{w1}$	
1	2	3	4	5
V_w	α_2	β_2	R_{w2}	$k(\Phi_2, V_w)$
–	rad	rad	–	–
$5 \cdot 10^{-5}$	$3.9427465247 \cdot 10^{-3}$	$3.5478800773 \cdot 10^{-3}$	3002.131185539	$-5.7810 \cdot 10^{-6}$
10^{-4}	$3.9400662317 \cdot 10^{-3}$	$3.4999139404 \cdot 10^{-3}$	3002.131360117	$-2.8904 \cdot 10^{-5}$
$1.5 \cdot 10^{-4}$	$3.9373856748 \cdot 10^{-3}$	$3,4519481943 \cdot 10^{-3}$	3002,131657823	$-5.7999 \cdot 10^{-5}$
$2 \cdot 10^{-4}$	$3.9347048543 \cdot 10^{-3}$	$3.4039828393 \cdot 10^{-3}$	3002.132070757	$-1.1657 \cdot 10^{-4}$
$5 \cdot 10^{-4}$	$3.9186143951 \cdot 10^{-3}$	$3.1161989182 \cdot 10^{-3}$	3002.137057367	$-7.3915 \cdot 10^{-4}$
10^{-3}	$3.8917758758 \cdot 10^{-3}$	$2.6365903231 \cdot 10^{-3}$	3002.154764384	$-3.2017 \cdot 10^{-3}$
10^{-2}	$3.4041833711 \cdot 10^{-3}$	$-5.9896769791 \cdot 10^{-3}$	3004.355161566	-0.6801
0.1	$-1.9309811291 \cdot 10^{-3}$	$-9.1514853874 \cdot 10^{-2}$	3024.098078500	-567.7752
Values of $R_{w1} = R_w(\alpha_1, \beta_1, \Phi_1, V_w)$ are presented in Table 1				

TABLE 5
Values of the interference fringe shifts $k(\Phi_2, V_w)$ at $\Phi_2 = -\pi/2$.

When the interferometer's relative speed reaches the value of $V_w = 2 \cdot 10^{-4}$ (see Table 2), the shift of interference fringes takes its maximum value of $|k| = 1.0594 \cdot 10^{-3}$. At any lower relative speed values $V_w < 2 \cdot 10^{-4}$ the shifts are not observable.

The value of the interferometer's relative speed cannot be lower than the value of the Earth's relative rotation speed, which is about 10^{-4}. Hence the relative speed of the interferometer located on the Earth's surface takes values within the following range:

(1.114) $$10^{-4} \leq V_w < 2 \cdot 10^{-4}$$

I.1.13 VALUES OF THE INTERFERENCE FRINGE SHIFTS AFTER CHANGING THE MIRROR-SLIT DISTANCE

We will calculate the values of the interference fringe shifts with respect to the Mo point at a given angle Φ_n after the distance between the mirror Z_2 and the slit S_0 has been changed. The distance L_2 is replaced by the distance $L_2 + \Delta L_2$.

A pair of angles (α_2, β_2), which corresponds to: the angle $\Phi = \Phi_n$, the coordinate e_0 and the distance L_2, satisfies the following equations:

$$e_{a5} = e_{a5}(\alpha_2, \Phi_n, V_w) = e_0$$

$$e_{b5} = e_{b5}(\beta_2, \Phi_n, V_w) = e_0$$

The relative difference of distances traveled by rays of light equals:

(1.115) $$R_{w2} = R_w(\alpha_2, \beta_2, \Phi_n, V_w)$$

A pair of angles $(\alpha_{2\Delta L2}, \beta_{2\Delta L2})$, which corresponds to: the angle $\Phi = \Phi_n$, the coordinate e_0 and the distance $L_2 + \Delta L_2$, satisfies the following equations:

$$e_{a5} = e_{a5}(\alpha_{2\Delta L2}, \Phi_n, V_w, \Delta L_2) = e_0$$

$$e_{b5} = e_{b5}(\beta_{2\Delta L2}, \Phi_n, V_w, \Delta L_2) = e_o$$

The relative difference of distances traveled by rays of light equals:

(1.116) $$R_{w2\Delta L2} = R_w(\alpha_{2\Delta L2}, \beta_{2\Delta L2}, \Phi_n, V_w, \Delta L_2)$$

The rays of light leaving the slit S_0 at angles (α_2, β_2) and $(\alpha_{2\Delta L2}, \beta_{2\Delta L2})$ reach the Mo point on the screen M.

Depending on the distance increment ΔL_2 the k value of the interference fringe shift with respect to the Mo point equals:

(1.117) $$k = k(\Phi_n, V_w, \Delta L_2) = R_{w2\Delta L2} - R_{w2}$$

In Tables 6 and 7 the values of interference fringe shifts were given with respect to the Mo point of the coordinate $e_0 = 0.1508323849500$ m at the distance $L_2 + 1.25 \cdot \lambda_o$ and at the angles $\Phi_n = \pi/4$ and $\Phi_n = \pi/2$.

MEASURING LENGTH WITH THE MICHELSON'S INTERFEROMETER

The evaluation of the measured length.

ΔL_2 the real length,

$\Delta L_f = (k/2)\,\lambda_o$ the length determined with the physical model,

In the mathematical model the length ΔL_2 is known by assumption, whereas in the physical model the length ΔL_2 is the length that is measured.

The accuracy of the measured length ΔL_f is specified by the following formula:

$$\left| \frac{\Delta L_2 - \Delta L_f}{\Delta L_2} \right|$$

$e_0 = 0{,}1508323849500$ m	$L_2 = 1.2\ m$	$\Delta L_2 = 1.25 \cdot \lambda_o$	$V_w = V_o / C_o$	
$\Phi_n = \Phi_2 = \pi / 4$		$R_{w2\Delta L2} = R_w(\alpha_{2\Delta L2}, \beta_{2\Delta L2}, \Phi_2, V_w, \Delta L_2)$ $k = k(\Phi_2, V_w, \Delta L_2) = R_{w2\Delta L2} - R_{w2}$		
1	2	3	4	5
V_w	$\alpha_{2\Delta L2}$	$\beta_{2\Delta L2}$	$R_{w2\Delta L2}$	k
–	rad	rad	–	–
$5 \cdot 10^{-5}$	$3.9807980798 \cdot 10^{-3}$	$3.6312205475 \cdot 10^{-3}$	3004.631105534	2.4999
10^{-4}	$4.0161717998 \cdot 10^{-3}$	$3.6665944817 \cdot 10^{-3}$	3004.631112083	2.4999
$1.5 \cdot 10^{-4}$	$4.0515455094 \cdot 10^{-3}$	$3.7019684075 \cdot 10^{-3}$	3004.631112664	2.4999
$2 \cdot 10^{-4}$	$4.0869192088 \cdot 10^{-3}$	$3.7373423250 \cdot 10^{-3}$	3004.631103798	2.4999
$5 \cdot 10^{-4}$	$4.2991611891 \cdot 10^{-3}$	$3.9495856587 \cdot 10^{-3}$	3004.631109196	2.4999
10^{-3}	$4.6528970232 \cdot 10^{-3}$	$4.3033239157 \cdot 10^{-3}$	3004.631104763	2.4999
10^{-2}	$1.1020020223 \cdot 10^{-2}$	$1.0670526531 \cdot 10^{-2}$	3004.627534225	2.4999
Values of $R_{w2} = R_w(\alpha_2, \beta_2, \Phi_2, V_w)$ are presented in Table 2				

TABLE 6
Values of the interference fringe shifts $k = k(\Phi_2, V_w, \Delta L_2) = R_{w2\Delta L2} - R_{w2}$ at $\Phi_n = \Phi_2 = \pi / 4$.

$e_0 = 0\ .1508323849500$ m	$L_2 = 1.2\ m$	$\Delta L_2 = 1.25 \cdot \lambda_o$	$V_w = V_o / C_o$	
$\Phi_n = \Phi_2 = \pi / 2$		$R_{w2\Delta L2} = R_w(\alpha_{2\Delta L2}, \beta_{2\Delta L2}, \Phi_2, V_w, \Delta L_2)$ $k = k(\Phi_2, V_w, \Delta L_2) = R_{w2\Delta L2} - R_{w2}$		
1	2	3	4	5
V_w	$\alpha_{2\Delta L2}$	$\beta_{2\Delta L2}$	$R_{w2\Delta L2}$	k
–	rad	rad	–	–
$5 \cdot 10^{-5}$	$3.9481041137 \cdot 10^{-3}$	$3.6438135238 \cdot 10^{-3}$	3004.631162956	2.4999
10^{-4}	$3.9507836142 \cdot 10^{-3}$	$3.6917808334 \cdot 10^{-3}$	3004.631340421	2.4999
$1.5 \cdot 10^{-4}$	$3.9534628511 \cdot 10^{-3}$	$3.7397485340 \cdot 10^{-3}$	3004.631639860	2.4999
$2 \cdot 10^{-4}$	$3.9561418243 \cdot 10^{-3}$	$3.7877166255 \cdot 10^{-3}$	3004.632056843	2.4999
$5 \cdot 10^{-4}$	$3.9722101257 \cdot 10^{-3}$	$4.0755333837 \cdot 10^{-3}$	3004.637068890	2.4999
10^{-3}	$3.9989695271 \cdot 10^{-3}$	$4.5552592553 \cdot 10^{-3}$	3004.655043356	2.4999
10^{-2}	$4.4761203444 \cdot 10^{-3}$	$1.3197013721 \cdot 10^{-2}$	3007.154293369	2.4999
Values of $R_{w2} = R_w(\alpha_2, \beta_2, \Phi_2, V_w)$ are presented in Table 3				

TABLE 7
Values of the interference fringe shifts $k = k(\Phi_2, V_w, \Delta L_2) = R_{w2\Delta L2} - R_{w2}$ at $\Phi_n = \Phi_2 = \pi / 2$.

An Example.
The accuracy of the measured length.
Tables 6, 7:

$$k \approx 2.4999\,, \quad \Delta L_2 = 1.25\lambda_0\,, \quad \Delta L_f = (k/2)\,\lambda_0\,.$$

So

$$\left|\frac{\Delta L_2 - \Delta L_f}{\Delta L_2}\right| = \frac{(1.25 - 2.4999/2)\,\lambda_0}{1.25\lambda_0} \approx 4\cdot 10^{-5}$$

I.2 WHY WERE THERE NO SHIFTS OF INTERFERENCE FRINGES OBSERVED IN THE MICHELSON'S EXPERIMENTS?

The relative speed V_w of the interferometer located on the Earth is specified by the relationship (1.114): $10^{-4} \le V_w < 2\cdot 10^{-4}$

Within this range of relative speeds V_w, the shift values are very small $|k| < 1.0594\cdot 10^{-3}$ (see Table 2), hence non-observable.

I.3 WHY WAS 'THE VALUE OF THE INTERFERENCE FRINGES SHIFT' CALCULATED BY ALBERT MICHELSON NOT CONFIRMED DURING THE EXPERIMENTS?

With the aim of calculating the values of the interference fringe shifts, Albert Michelson considered the mutually perpendicular rays of light that were reaching the Z_1, Z_2 mirrors. This happens when the rays of light leave the slit S_0 at the angles $\alpha = 0$, $\beta = 0$.

Table 8 contains calculations which indicate that the rays of light that leave the slit S_0 at the angles $\alpha = 0$, $\beta = 0$ reach distant points A_5, B_5 of the screen M. The distance between the two points amount to over one thousand wavelengths of light, therefore no interference of the light waves occurs.

Let us introduce the following symbols:

(1.118) $R_{rw} = R_{rw}(\Phi, V_w) = \Delta l/\lambda_o$ the relative difference of distances traveled by the rays of light, reaching distant points A_5, B_5 of the screen M in the O'EQ system,

(1.119) $K_r = R_{rw}(\Phi_2, V_w) - R_{rw}(\Phi_1, V_w)$ the difference of relative differences of distances R_{rw}.

In accordance with the results of calculations contained in Table 8 at $\Phi_2 = \pi/2$ and $V_w = 10^{-4}$, the K_r takes the value:

$$K_r = R_{rw}(\Phi_2, V_w) - R_{rw}(\Phi_1, V_w) = 2996.1948224790 - 2996.2355474159 = -0.040724 .$$

The calculated value of $K_r = -0.040724$ is not the shift value k. The distance $| e_{a5} - e_{b5} |$ between the points A_5 and B_5 on the screen M which were reached by the rays of light equals: $1168.0425749\,\lambda_0$ when $\Phi_2 = \pi/2$ and $1981.4151451\lambda_o$ at $\Phi_1 = 0$.

It is evident that by assuming perpendicularity between the light rays and the Z_1, Z_2 mirrors, Albert Michelson actually calculated the value of $| K_r | \approx 0.04$ (1.119) **and not the shift value** k (1.113).

$\alpha = 0$, $\beta = 0$		$V_w = V_o / C_o = 10^{-4}$ $K_r = R_{rw}(\Phi_2, V_w) - R_{rw}(\Phi_1, V_w)$		
1	2	3	4	5
Φ_1	$e_{a5}(\alpha = 0, \Phi_1, V_w)$	$e_{b5}(\beta = 0, \Phi_1, V_w)$	$\| e_{a5} - e_{b5} \| / \lambda_o$	$R_{rw}(\Phi_1, V_w)$
rad	m	m	–	–
0	0.1401693470 7	0.1413383820 1	1981.4151451	2996.2355474159
Φ_2	$e_{a5}(\alpha = 0, \Phi_2, V_w)$	$e_{b5}(\beta = 0, \Phi_2, V_w)$	$\| e_{a5} - e_{b5} \| / \lambda_o$	$R_{rw}(\Phi_2, V_w)$
rad	m	m	–	–
$\pi / 2$	0.1404053264 5	0.1410944715 6	1168.04255749	2996.1948224790

TABLE 8

The table presents the values of: $R_{rw}(\Phi_1, V_w)$, $R_{rw}(\Phi_2, V_w)$ and $| e_{a5} - e_{b5} | / \lambda_o$ together with the coordinates e_{a5}, e_{b5} of the A_5, B_5 points reached by the light rays that have left the slit S_0 at the angles $\alpha = 0$, $\beta = 0$ and $V_w = V_o / C_o = 10^{-4}$. These calculations were carried out with the computational program PROGRAM IntM (see Chapter IV).

I.4 THE VELOCITIES AT WHICH THE CENTERS OF THE EARTH AND THE SUN TRAVEL WITH RESPECT TO THE AETHER

(in relation to a specific absolute OXoYoZo system)

In relation to the aether, the interferometer velocity $\vec{V}_o$ on the Earth's surface is the sum of three vectors:

(1.120) $$\vec{V}_o = \vec{V}_r + \vec{V}_{zs} + \vec{V}_{se}$$

The vector $\vec{V}_r$ is the peripheral velocity of a point i.e. a place on the Earth's surface where the interferometer (observer) is located. The plane of this vector is parallel to the one at the equator.
Its modulus value equals: $V_r = 0.464\cos\varphi \ km/s$, where:
φ is the latitude of the interferometer's position.

The vector $\vec{V}_{zs}$ is the velocity of the Earth's center around the Sun. This vector is located on the Earth's ecliptic plane.

$$V_{zs\,min} = 29.29 \ km/s \ , \qquad V_{zs\,max} = 30.28 \ km/s$$

In our considerations an approximate modulus value of the vector $\vec{V}_{zs}$ will be adopted, namely

$$V_{zs} \approx 30 \ km/s$$

(1.121) $$V_{zs}/C_o \approx 10^{-4}$$

The vector $\vec{V}_{se}$ is the velocity of the Sun's center with respect to the aether. This vector is perpendicular to the ecliptic plane, which is conclusive from starlight aberration.
The vector $\vec{V}_r$ can be omitted due to its small modulus value compared to that of the $\vec{V}_{zs}$ vector.
Consequently the equation (1.120) takes the following form:

(1.122) $$\vec{V}_o \approx \vec{V}_{zs} + \vec{V}_{se}$$

Since the vectors $\vec{V}_{zs}, \vec{V}_{se}$ are mutually perpendicular, the following equation can be written:

(1.123) $$V_o^2 \approx V_{zs}^2 + V_{se}^2$$

According to (1.114): $10^{-4} \le V_w < 2\cdot 10^{-4}$, $V_w = V_o/C_o$ and therefore

(1.124) $$10^{-4} \le V_o/C_o < 2\cdot 10^{-4}$$

The interferometer is located on the Earth's surface so its velocity $\vec{V}_o$ is equal to the velocity of the point on the Earth's surface (a laboratory) with respect to the aether, which is approximately the velocity $\vec{V}_{ze}$ of the Earth's center with respect to the aether:

(1.125) $$\vec{V}_o \approx \vec{V}_{ze}$$

After considering the inequality (1.124) we obtain:

(1.126) $$10^{-4} \le V_{ze}/C_o < 2\cdot 10^{-4} \ , \qquad V_{ze} \approx V_o$$

This inequality (1.126) specifies the speed of the Earth's center relative to the aether, expressed with respect to the speed of light C_o.

The speed V_{se} of the Sun center with respect to the aether can be determined from the four relations i.e. (1.121), ((1.123), (1.125) and (1.126).

From the equation (1.123): $V_{se}^2 \approx V_o^2 - V_{zs}^2$
and the equation (1.125) we obtain:

$$V_{se}^2 \approx V_{ze}^2 - V_{zs}^2$$

consequently after applying (1.121) and (1.126), we further obtain:

(1.127) $$0 \le V_{se}/C_o < 1.73\cdot 10^{-4}$$

The inequality (1.127) specifies the speed of the Sun's center relative to the aether, expressed with respect to the speed of light C_o.

I.5 THE VELOCITY AT WHICH THE CENTER OF OUR GALAXY TRAVELS WITH RESPECT TO THE AETHER
(with respect to a specific absolute OXoYoZo system)

With respect to the aether, the center of the Sun travels at the velocity $\vec{V}_{se}$ which is the sum of the following vectors:

(1.128) $$\vec{V}_{se} = \vec{V}_{sg} + \vec{V}_{ge}$$

The vector $\vec{V}_{sg}$ is the velocity with which the Sun center rotates around the center of our Galaxy. It takes an approximate modulus value of: $V_{sg} \approx 250\ km/s$

(1.129) $$V_{sg} / C_o \approx 8.33 \cdot 10^{-4}$$

The vector $\vec{V}_{ge}$ is the velocity at which the center of our Galaxy moves with respect to the aether.

From the equation (1.128) we obtain:

(1.130) $$\vec{V}_{ge} = - \vec{V}_{sg} + \vec{V}_{se}$$

Then from (1.127) , (1.129) and (1.130) we can determine the speed V_{ge} of the Galaxy center with respect to the aether:

(1.131) $$(8.33-1.73) \cdot 10^{-4} < V_{ge} / C_o < (8.33+1.73) \cdot 10^{-4}$$

The inequality (1.131) specifies the speed of the Galaxy center relative to the aether, expressed with respect to the speed of light C_o.

Knowing the apex $A_{sg}(\delta_{sg}, \alpha_{sg})$ of solar motion around the Galaxy center, we can estimate approximately the apex $A_{ge}(\delta_{ge}, \alpha_{ge})$ of the Galaxy center's motion with respect to the aether:

$$\delta_{ge} \approx -\delta_{sg} \ ,$$

$$\alpha_{ge} \approx \alpha_{sg} + 180^o \ ,$$

where: δ_{sg}, δ_{ge} declination of apexes,

α_{sg}, α_{ge} right ascension of apexes.

CHAPTER II

THE VELOCITY OF THE INTERFEROMETER

The interferometer absolute velocity $\vec{V}_o$ is the sum of three vectors:

$$\vec{V}_o = \vec{V}_r + \vec{V}_{zs} + \vec{V}_{se} \quad \text{as in relation (1.120)}$$

where: $\vec{V}_r$ peripheral velocity of the point U on the Earth's surface where the interferometer (the observer) is located,

$\vec{V}_{zs}$ the velocity at which the Earth's center revolves around the Sun,

$\vec{V}_{se}$ the velocity at which the Sun's center travels relative to the aether.

The aether-relative velocity $\vec{V}_{se}$ of the Sun center is perpendicular to the plane of the ecliptic. However, the direction of that velocity (a vector) is not known. Hence in our deliberations, we will consider two vectors perpendicular to the ecliptic plane, namely:

vector $\vec{V}_{se}$ and vector $\vec{V}_{se1} = -\vec{V}_{se}$ (Fig. 8).

Thus two vectors are obtained:

(2.1) $\vec{V}_{01} = \vec{V}_r + \vec{V}_{zs} + \vec{V}_{se}$

(2.2) $\vec{V}_{02} = \vec{V}_r + \vec{V}_{zs} + \vec{V}_{se1}$

Therefore the interferometer absolute velocity $\vec{V}_o$ is:

either the vector $\vec{V}_0 = \vec{V}_{01}$ or the vector $\vec{V}_0 = \vec{V}_{02}$

In this chapter the coordinates of the vectors $\vec{V}_{01}$ and $\vec{V}_{02}$ were established in the horizontal coordinate system.

II.1 THE PERIPHERAL VELOCITY $\vec{V}_r$ OF THE U(φ,λ) POINT ON THE EARTH'S SURFACE

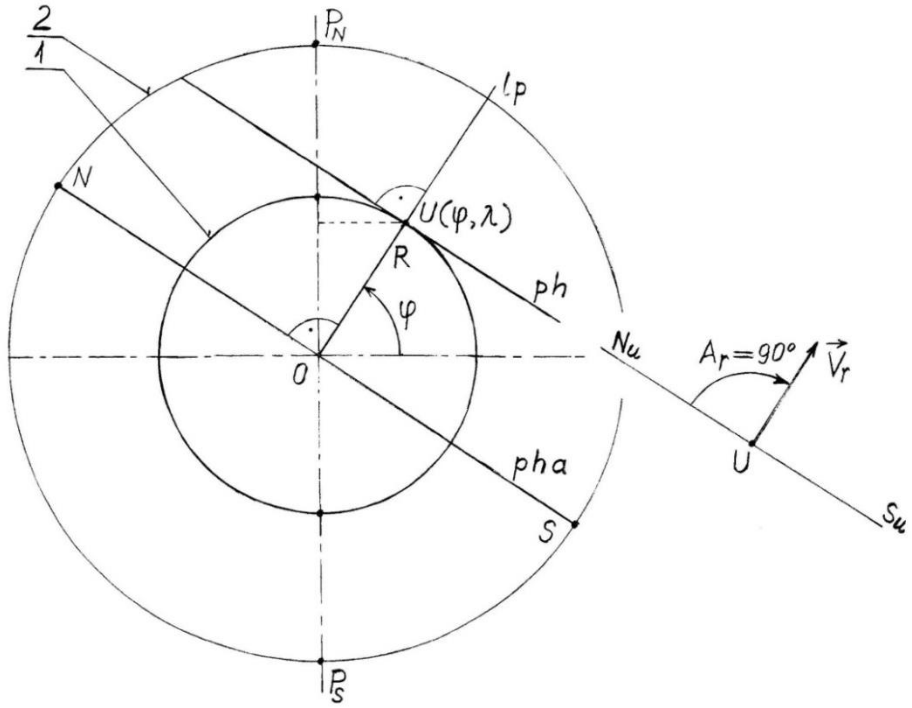

Fig. 5 Peripheral velocity $\vec{V}_r$ and its azimuth A_r

SYMBOLS:

1 the globe,

2 the celestial meridian of the observer,

U(φ,λ) a location (point) with geographical coordinates φ,λ, at which the interferometer (the observer) has been located,

lp a vertical line which runs through the point U(φ,λ) and the center of the globe O,

pha the plane of celestial horizon i.e. its projection, which runs through the globe center O and is perpendicular to the vertical line lp,

ph the plane of the horizon i.e. its projection, which runs through the point U(φ,λ) and is perpendicular to the vertical line lp,

N the northern point of the horizon,

S the southern point of the horizon,

$N_u S_u$ line the line of intersection between the horizon plane and the celestial meridian plane, both of which run through the U(φ,λ) point,

R the radius of the globe,

A_r the azimuth of the Earth's peripheral velocity $\vec{V}_r$.

The peripheral speed V_r of the point U(φ,λ):

(2.3) $V_r = \omega R \cos\varphi$, where:

ω the angular speed of the Earth's rotation.

The peripheral velocity $\vec{V}_r$ is located on the horizon plane which runs through the point U(φ,λ).

II.2 THE VELOCITY $\vec{V}_{zs}$ AT WHICH THE EARTH'S CENTER REVOLVES AROUND THE SUN

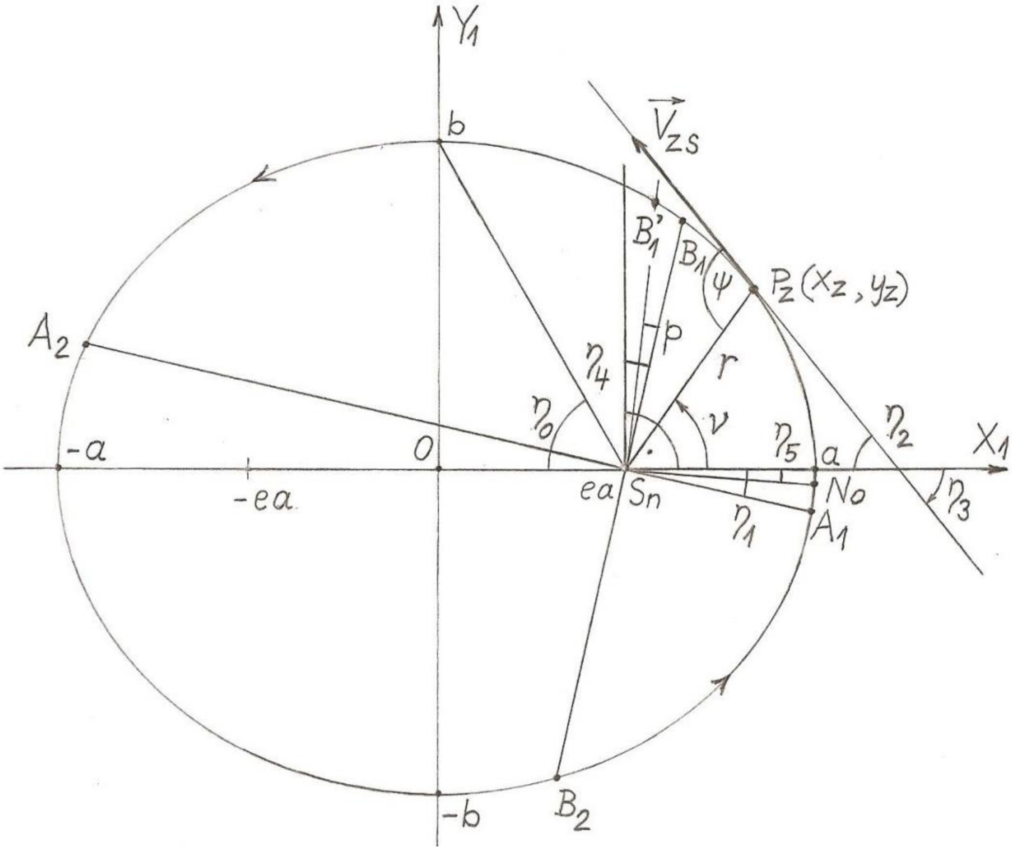

Fig. 6 The Earth's motion on its orbit around the Sun.

SYMBOLS:

a	an average Earth-Sun distance,
b	a small semi-axis of the Earth's orbit,
r	a radius vector,
ν	true anomaly,
ψ	an angle $\measuredangle(r, \vec{V}_{zs})$,
p	annual precession within ecliptic (in longitude),
e	the eccentricity of the Earth's orbit,
Sn	the center of the Sun,
Pz	a point on the orbit in which the center of the Earth is located,
$\vec{V}_{zs}$	the velocity at which the center of the Earth revolves around the Sun,
A1	Winter's position (Earth's location when astronomical winter starts),
A2	Summer's position (Earth's location when astronomical summer starts),
B1	Earth's location at the time of spring equinox,
B1'	Earth's location at the time of spring equinox of previous tropical year,
B2	Earth's location at the time of autumn equinox,
No	Earth's location at the beginning of a new calendar year of the UT time,
UT	Universal Time.

B1'A2	spring,	A2 B2	summer,
B2 A1	autumn,	A1 B1	winter.

II.2.1 DETERMINING THE ψ ANGLE

In the OX1Y1 system the coordinates of the Earth's center on the orbit are defined as follows:

(13*) $$x_z = ea + r\cos\nu = ea + \frac{a\cos\nu\ (1-e^2)}{1+e\cos\nu}\ , \qquad r = \frac{a\,(1-e^2)}{1+e\cos\nu}$$

(14*) $$y_z = r\sin\nu = \frac{a\sin\nu\ (1-e^2)}{1+e\cos\nu}$$

The equation of the line tangent to the Earth's orbit in the $P_z(x_z, y_z)$ point is:

$$\frac{x_1 x_z}{a^2} + \frac{y_1 y_z}{b^2} = 1, \qquad b = \sqrt{a^2 - (ea)^2}$$

After transformation we obtain: $y_1 = -\dfrac{b^2 x_z}{a^2 y_z} x_1 + \dfrac{b^2}{y_z}$

Thus the angular coefficient of the line tangent to the orbit in point $P_z(x_z, y_z)$ equals:

(15*) $$tg\eta_3 = -\frac{b^2 x_z}{a^2 y_z} = -(b/a)^2 \frac{x_z}{y_z}$$

Applying equations (13*), (14*) we obtain a quotient:

$$\frac{x_z}{y_z} = \frac{e\,(1+e\cos\nu)}{\sin\nu\ (1-e^2)} + \frac{1}{tg\nu}$$

From the equation (15*) we obtain:

(2.4) $$\eta_3 = arctg\left[-(b/a)^2\left(\frac{e\,(1+e\cos\nu)}{\sin\nu\ (1-e^2)} + \frac{1}{tg\nu}\right)\right], \qquad \nu \neq 0, \qquad \nu \neq 180^o, \qquad \nu \neq 360^o$$

(2.5) $\eta_2 = |\,\eta_3\,|$ (Fig. 6)

(2.6) $\eta_0 = arctg\,\dfrac{b}{ea}$ (Fig. 6) so

(2.7) $\psi = \nu + \eta_2$ when $0 < \nu \leq 180^o - \eta_0$

(2.8) $\psi = \nu - \eta_2$ when $180^o - \eta_0 < \nu < 180^o$

(2.9) $\psi = -180^o + \nu + \eta_2$ when $180^o < \nu \leq 180^o + \eta_0$

(2.10) $\psi = -180^o + \nu - \eta_2$ when $180^o + \eta_0 < \nu < 360^o$

where: ν true anomaly (Fig. 6).

II.2.2 DETERMINING THE ν ANGLE

The true anomaly ν is the angle between the radius vector r and the direction from the Sun center towards the point on the orbit nearest to the Sun i.e. the perihelion.
Corresponding to a specific time, the ν angle can be determined from the Kepler second law:

$$r^2\frac{d\nu}{dt} = C_1 = const$$

$$r = \frac{a\,(1-e^2)}{1+e\cos\nu} \qquad \text{(the modulus of the radius vector)}$$

From the above the following integral is obtained:

$$t(\nu) = \frac{[a(1-e^2)]^2}{C_1}\int \frac{d\nu}{(1+e\cos\nu)^2}$$

After integration we have:

(2.11) $$t(\nu)=\frac{[a\,(1-e^2)]^2}{C_1}\Big[-\frac{e\sin\nu}{(1-e^2)(1+e\cos\nu)}+\frac{1}{1-e^2}\Big(\frac{2}{\sqrt{1-e^2}}arctg\frac{\sqrt{1-e^2}\,tg(\nu/2)}{1+e}\Big)\Big]+C_2$$

Let us adopt an initial condition:

$\nu=0 \;\Rightarrow\; t=0$, hence the integration constant $C_2=0$, so

$$t(\nu)=\frac{a^2(1-e^2)e}{C_1}\Big(\frac{2}{e\sqrt{1-e^2}}arctg\frac{\sqrt{1-e^2}\,tg(\nu/2)}{1+e}-\frac{\sin\nu}{1+e\cos\nu}\Big)$$

From the condition that $\nu=180^o \;\Rightarrow\; t(\nu)=\frac{T_{rg}}{2}$ where: T_{rg} is the stellar year, we can determine the C_1 constant

$$\frac{T_{rg}}{2}=\frac{a^2e\,(1-e^2)}{C_1}\frac{2}{e\sqrt{1-e^2}}\frac{\pi}{2}$$ hence:

(2.12) $$C_1=\frac{2\pi\,a^2(1-e^2)}{T_{rg}\sqrt{1-e^2}}$$ then

(2.13) $$t(\nu)=\frac{e\sqrt{1-e^2}\,T_{rg}}{2\pi}\Big(\frac{2}{e\sqrt{1-e^2}}arctg\frac{\sqrt{1-e^2}\,tg(\nu/2)}{1+e}-\frac{\sin\nu}{1+e\cos\nu}\Big)$$

The $t(\nu)$ function is of negative value when $\nu>180^o$.
In order to avoid negative time values we introduce two functions:

(2.14) $t_1(\nu)=t(\nu)$ when $0\le\nu<180^o$

(2.15) $t_2(\nu)=T_{rg}+t(\nu)$ when $180^o<\nu<360^o$

Then we define the following symbols:

T_{rz} tropical year

T_z the duration of astronomical winter.

$T_z=t_1(90^o-\eta_4)+T_{rg}-t_2(360^o-\eta_1)$ (Fig. 6) which after transformation

$T_z=t(90^o-\eta_4)-t(360^o-\eta_1)$

Angle $\eta_4=\eta_1+\Delta p$ (Fig. 6), where:

(2.16) $\Delta p=(T_z/T_{rz})p$ precession in the ecliptic (in longitude) during the time of astronomical winter.

Therefore

(2.17) $T_z=t(90^o-\Delta p-\eta_1)-t(360^o-\eta_1)$.

If the astronomical winter duration time T_z is known, the η_1 angle can be determined from the equation (2.17) by the method of successive approximations.
Let us say that T_a means the time which has elapsed from the moment the astronomical winter of the UT time started (point A_1, Fig. 6) up to the moment the Earth is nearest to the Sun (the perihelion).
T_a can be determined from the relationship:

$T_a=T_{rg}-t_2(360^o-\eta_1)=-t(360^o-\eta_1)=t(\eta_1)$

(2.18) $T_a=t(\eta_1)$

Then let us say that T_b means the time which has passed from the start of astronomical winter up to the end of a calendar year of the UT time (point No, Fig. 6).

$T_b<T_a$

The difference of the T_a, T_b times equals:

$$T_a - T_b = T_{rg} - t_2(360^o - \eta_5) \ .$$

After transforming the equation, the following is obtained:

$$T_a - T_b = -\ t(360^o - \eta_5) = t(\eta_5) \qquad \text{so}$$

(16*) $\quad T_a - T_b = t(\eta_5)$

Referring to equation (2.11) and adopting an initial condition:

$$\nu = -\ \eta_5 \quad \Rightarrow \quad t(\nu) = 0$$

with a constant value C_1 specified by the relationship (2.12),

an integration constant C_2 can be calculated:

$$C_2 = \frac{e\sqrt{1-e^2}\,T_{rg}}{2\pi}\left(\frac{2}{e\sqrt{1-e^2}}\,arctg\,\frac{\sqrt{1-e^2}\,tg(\eta_5/2)}{1+e} - \frac{\sin\eta_5}{1+e\cos\eta_5}\right) = t(\eta_5)\ ,$$

$$C_2 = t(\eta_5)\,.$$

Having considered the equation (16*) we obtain:

(2.19) $\quad C_2 = T_a - T_b$

Now we can specify the relationship between the UT time and the ν angle i.e. true anomaly:

(2.20) $\quad t_3(\nu) = t(\nu) + (T_a - T_b) \quad$ when $\quad 0 \le \nu < 180^o$

(2.21) $\quad t_4(\nu) = T_{rg} + t(\nu) + (T_a - T_b) \quad$ when $\quad 180^o < \nu < 360^o$

From equations (2.20) and (2.21) the value of the ν angle for any given time UT can be calculated with the use of the method of successive approximations.

II.2.3 AZIMUTH AND THE ALTITUDE OF THE EARTH'S CENTER VELOCITY $\vec{V}_{zs}$

The definitions that follow refer to to the following vectors: $\vec{V}_{zs}$, $\vec{V}_{se}$ and $\vec{V}_{se1} = -\vec{V}_{se}$.

The $\vec{V}_{se}$ and $\vec{V}_{se1}$ vectors are also the velocities of the Earth's center.

The declination δ of a vector is the angle between the vector and the plane of the celestial equator.

The Greenwich hour angle GHA of a vector is a dihedral angle between the semi-circle of the celestial meridian in Greenwich and the hour semi-circle which runs through the vector. The GHA angle counting starts at the semi-circle of the celestial meridian in Greenwich and up towards the West.

The local hour angle LHA of a vector is a dihedral angle between the celestial meridian semi-circle of the observer and the hour semi-circle which runs through the vector.

The right ascension α of a vector is a dihedral angle between the hour semi-circle which runs through the spring equinoctial point i.e. the Aries point and the hour semi-circle which runs through the vector. The right ascension counting starts at the Aries point up towards the East.

The altitude H of a vector is an angle between the vector and the horizon plane.

Starting from the northern point of the horizon, the azimuth A of a vector is a dihedral angle between the celestial meridian of the observer and the semi-circle which runs through the vertical line and the vector; whereas starting from the northern direction (N_u , Fig. 9) the azimuth A of a vector is an angle between the $N_u S_u$ line and the projection of the vector on the horizon plane that runs through the point U(φ, λ).

The observer is located in the same place as the interferometer.

The above definitions correspond to the definitions which refer to celestial bodies.

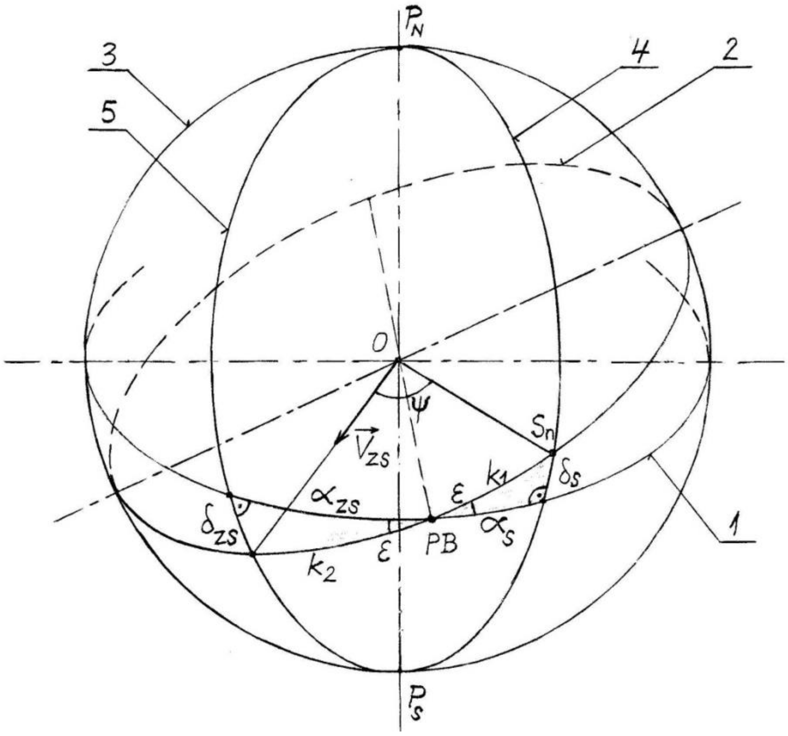

Fig. 7 Coordinates of the equatorial system: declinations, right ascensions.

SYMBOLS:	O	the center of the globe,
	1	celestial equator,
	2	ecliptic,
	3	celestial zone,
	4, 5	hour semi-circles,
	Sn	the center of the Sun,
	PB	the Aries point,
	ε	inclination of the ecliptic to the equator,
	α_s	right ascension of the Sun,
	δ_s	declination of the Sun,
	α_{zs}	right ascension of the $\vec{V}_{zs}$ velocity,
	δ_{zs}	declination of the $\vec{V}_{zs}$ velocity,
	ψ	an angle $\measuredangle(r, \vec{V}_{zs})$ relationships (2.7 – 2.10)

From two perpendicular spherical triangles, shown in Fig. 7, the right ascension α_{zs} as well as the declination δ_{zs} of the Earth's center velocity $\vec{V}_{zs}$ will be determined.

$$tg\alpha_s = tgk_1 \cos\varepsilon \text{ ,} \quad \text{hence}$$

(2.22) $$k_1 = arctg \frac{tg\alpha_s}{\cos\varepsilon} \quad \text{when} \quad 0 \le \alpha_s < 90^o \text{ ,} \quad (2.28a)$$

(2.23) $$k_1 = 180^o + arctg \frac{tg\alpha_s}{\cos\varepsilon} \quad \text{when} \quad 90^o < \alpha_s < 270^o$$

(2.24) $$k_1 = 360^o + arctg \frac{tg\alpha_s}{\cos\varepsilon} \quad \text{when} \quad 270^o < \alpha_s < 360^o$$

(2.25) $$k_2 = k_1 - \psi \quad \text{(Fig. 7).}$$

$$tg\alpha_{zs} = tgk_2 \cos\varepsilon \text{ ,} \quad \text{hence}$$

(2.26) $\alpha_{zs} = arctg(tgk_2 \cos\varepsilon)$ when $-90^o < k_2 < 90^o$

(2.27) $\alpha_{zs} = 180^o + arctg(tgk_2 \cos\varepsilon)$ when $90^o < k_2 < 270^o$

$\sin\delta_{zs} = \sin k_2 \sin\varepsilon$, hence

(2.28) $\delta_{zs} = \arcsin(\sin k_2 \sin\varepsilon)$

If the value of α_s is very small, then $\psi \approx 90^o,9286$ as the true anomaly $\nu \approx 76^0,846$.

The interval (2.26) is satisfied if $k_1 > frac(\psi) = frac\ (90.9286) \approx 0^0.9286$.

$\alpha_s = arctg(tg0^0.9286\ \cos\varepsilon) \approx 0^0.852$. Hence the interval (2.22) takes the form as follows:

(2.28a) $0^0.852 < \alpha_s < 90^0$

The angles in the equatorial system which are necessary to determine the coordinates of the vector $\vec{V}_{zs}$ in the horizontal system are:

(2.29) $GHA_{zs} = GHAaries - \alpha_{zs}$

$LHA_{zs} = GHA_{zs} + \lambda$ so

(2.30) $LHA_{zs} = GHAaries - \alpha_{zs} + \lambda$, where:

$GHAaries$ Greenwich Hour Angle of the Aries Point,

GHA_{zs} Greenwich Hour Angle of the $\vec{V}_{zs}$ velocity,

LHA_{zs} Local Hour Angle of the $\vec{V}_{zs}$ velocity,

α_{zs} right ascension of the $\vec{V}_{zs}$ velocity,

λ longitude of a place (point U, Fig. 5) where the interferometer (the observer) Is located.

The altitude H_{zs} of velocity $\vec{V}_{zs}$ in the horizontal system:

$\sin H_{zs} = \cos\delta_{zs} \cos\varphi \cos LHA_{zs} + \sin\delta_{zs} \sin\varphi$, where:

φ the latitude of a place (point U, Fig. 5) where the interferometer (the observer) Is located. Hence:

(2.31) $H_{zs} = \arcsin(\cos\delta_{zs} \cos\varphi \cos LHA_{zs} + \sin\delta_{zs} \sin\varphi)$

The azimuth A_{zs} of velocity $\vec{V}_{zs}$, calculated within the range from 0 to 360^o starting from the northern point of the horizon, is expressed as:

$$\sin A_{zs} = \frac{-\cos\delta_{zs}}{\cos H_{zs}} \sin LHA_{zs}$$ supplement (S.31).

$$\cos A_{zs} = \frac{\sin\delta_{zs} - \sin H_{zs} \sin\varphi}{\cos H_{zs} \cos\varphi}$$

Let us introduce the following symbols:

(2.32) $d_{zs} = \dfrac{\sin\delta_{zs} - \sin H_{zs} \sin\varphi}{\cos H_{zs} \cos\varphi}$, ($d_{zs} = \cos A_{zs}$)

(2.33) $z_{zs} = d_{zs} / | d_{zs} |$, $A_{zs} \neq 90^0$, $A_{zs} \neq 270^0$. Therefore

(2.34) $A_{zs} = 90^o(3 + z_{zs}) - z_{zs} \arcsin\ \left(\dfrac{\cos\delta_{zs}}{\cos H_{zs}} \sin LHA_{zs} \right)$

II.2.4 THE SPEED V_{zs} AT WHICH THE EARTH'S CENTER REVOLVES AROUND THE SUN

The speed V_{zs} at which the center of the Earth revolves around the Sun can be calculated from the Kepler second law: $r^2 \dfrac{d\nu}{dt} = C_1$

We can write $r\,(r\,\frac{d\nu}{dt})\,M = C_1 M$, where: M the mass of the planet.

$$r\,\frac{d\nu}{dt} = V_{zs}\cos(\psi - 90^0) = V_{zs}\sin(180^0 - \psi)\ ,\qquad \text{so}$$

(17*) $$r\ V_{zs}\ M\sin(180^0 - \psi) = C_1 M$$

The left-hand side of the equation (17*) expresses the modulus of the planet's angular momentum (Fig. 6). From the equation (17*) we obtain:

$$V_{zs} = \frac{C_1}{r\sin\psi}\ ,\quad \text{where: } C_1 = \frac{2\pi\,a^2(1-e^2)}{T_{rg}\sqrt{1-e^2}}\quad \text{relationship (2.12),}$$

$r = \frac{a\,(1-e^2)}{1+e\cos\nu}$ the modulus of the radius vector,

angle ψ relationships (2.7 - 2.10),

Hence T_{rg} stellar year.

(2.35) $$V_{zs} = \frac{2\pi a\ (1+e\ \cos\nu)}{T_{rg}\sqrt{1-e^2}\ \sin\psi}$$

II.3 THE VELOCITIES $\vec{V}_{se}$ AND $\vec{V}_{se1} = -\vec{V}_{se}$ AT WHICH THE SUN CENTER MOVES WITH RESPECT TO THE AETHER

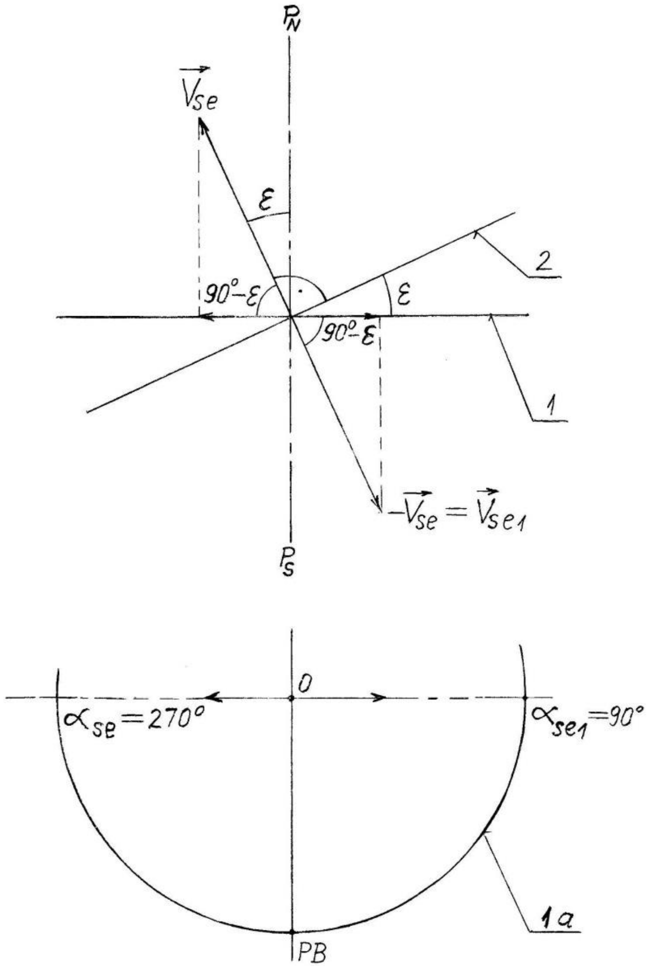

Fig. 8 The coordinates of the vectors $\vec{V}_{se}$ and $\vec{V}_{se1} = -\vec{V}_{se}$ (declinations, right ascensions). The $\vec{V}_{se}$ and $\vec{V}_{se1}$ vectors are also the velocities of the Earth's centre.

SYMBOLS IN FIG. 8:

- 0 the center of the globe,
- 1 plane of the celestial equator (its projection),
- 1 a the celestial equator,
- 2 plane of the ecliptic (its projection),
- ε the inclination of the ecliptic to the equator,
- PB the Aries point,
- $\vec{V}_{se}$ the velocity at which the Sun center moves with respect to the aether,
- $\vec{V}_{se1} = -\vec{V}_{se}$ the velocity at which the Sun center moves with respect to the aether,
- α_{se} right ascension of the $\vec{V}_{se}$ velocity,
- α_{se1} right ascension of the $\vec{V}_{se1} = -\vec{V}_{se}$ velocity.

Vector	Modulus of the vector	Right ascension of the vector	Declination of the vector
$\vec{V}_{se}$	V_{se}	$\alpha_{se} = 270^o \ (-90^o)$	$\delta_{se} = 90^o - \varepsilon$
$\vec{V}_{se1}$	V_{se}	$\alpha_{se1} = 90^o$	$\delta_{se1} = -(90^o - \varepsilon)$

TABLE 9 (refers to Fig. 8)

The following relationship specifies the speed of the Sun's center relative to the aether, expressed with respect to the speed of light C_0:

$$0 \leq V_{se} / C_0 < 1.73 \ .10^{-4} \qquad (1.127).$$

II.3.1 AZIMUTH AND THE ALTITUDE OF THE $\vec{V}_{se}$ VELOCITY

The Local Hour Angle LHA_{se} of the $\vec{V}_{se}$ velocity:

(2.36) $$LHA_{se} = GHAaries - \alpha_{se} + \lambda$$

The altitude H_{se} of the $\vec{V}_{se}$ velocity:

(2.37) $$H_{se} = \arcsin(\cos\delta_{se} \cos\varphi \cos LHA_{se} + \sin\delta_{se} \sin\varphi)$$

The azimuth of the $\vec{V}_{se}$ velocity, calculated within the range from 0 to 360^o starting from the northern point of the horizon is:

$$\sin A_{se} = \frac{-\cos\delta_{se}}{\cos H_{se}} \sin LHA_{se}$$

$$\cos A_{se} = \frac{\sin\delta_{se} - \sin H_{se} \sin\varphi}{\cos H_{se} \cos\varphi}$$

Let us introduce the following symbols:

(2.38) $$d_{se} = \frac{\sin\delta_{se} - \sin H_{se} \sin\varphi}{\cos H_{se} \cos\varphi}, \qquad (d_{se} = \cos A_{se})$$

(2.39) $$z_{se} = d_{se} / \mid d_{se} \mid, \qquad A_{se} \neq 90^0, \quad A_{se} \neq 270^0.$$ Therefore

(2.40) $$A_{se} = 90^o (3 + z_{se}) - z_{se} \arcsin\left(\frac{\cos\delta_{se}}{\cos H_{se}} \sin LHA_{se}\right).$$

II.3.2 THE AZIMUTH AND THE ALTITUDE OF THE $\vec{V}_{se1}$ VELOCITY

The Local Hour Angle LHA_{se1} of the velocity $\vec{V}_{se1} = -\vec{V}_{se}$:

(2.41) $$LHA_{se1} = GHAaries - \alpha_{se1} + \lambda$$

The altitude H_{se1} of the $\vec{V}_{se1}$ velocity:

(2.42) $$H_{se1} = \arcsin(\cos\delta_{se1} \cos\varphi \cos LHA_{se1} + \sin\delta_{se1} \sin\varphi)$$

The azimuth of the $\vec{V}_{se1}$ velocity is calculated within the range from 0 to 360^o starting from the northern point of the horizon as follows:

$$\sin A_{se1} = \frac{-\cos\delta_{se1}}{\cos H_{se1}} \sin LHA_{se1}$$

$$\cos A_{se1} = \frac{\sin\delta_{se1} - \sin H_{se1} \sin\varphi}{\cos H_{se1} \cos\varphi}$$

We introduce the following notations:

(2.43) $$d_{se1} = \frac{\sin\delta_{se1} - \sin H_{se1} \sin\varphi}{\cos H_{se1} \cos\varphi}, \qquad (d_{se1} = \cos A_{se1})$$

(2.44) $$z_{se1} = d_{se1} / |\, d_{se1} \,| , \qquad A_{se1} \neq 90^0, \qquad A_{se1} \neq 270^0 . \qquad \text{so}$$

(2.45) $$A_{se1} = 90^o(3 + z_{se1}) - z_{se1} \arcsin\left(\frac{\cos\delta_{se1}}{\cos H_{se1}} \sin LHA_{se1}\right)$$

The angles φ, λ are the geographical coordinates of the U point (Fig. 5) in which the interferometer (the observer) is located.

The previously introduced relationships (2.31), (2.34), (2.37), (2.40), (2.42) and (2.45) for calculating the altitudes and the azimuths of velocities relate to the astronomical horizon plane which runs through the globe center.

This plane is perpendicular to the vertical line running through the U(φ, λ) point (Fig. 5).

The abovementioned relationships apply as well as to the horizon plane which runs through the U(φ, λ) point and is also perpendicular to the vertical line.

II.4 SUM OF VELOCITIES IN THE HORIZONTAL SYSTEM

Let us introduce a rectangular system of coordinates O' U1U2U3 (Fig. 9) with the two axes O' U1 and O' U2 on the horizontal plane which runs through the point U(φ, λ). The O' U1 axis coincides with the $N_u S_u$ line. The O' U3 axis coincides with the vertical line which runs through the point U(φ, λ) (Fig. 5).

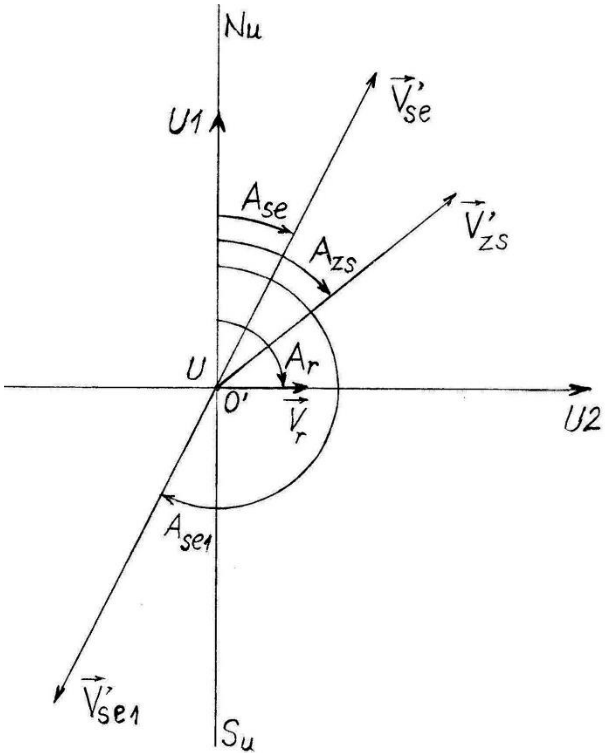

Fig.9 The rectangular system of coordinates O' U1U2U3

The $\vec{V}'_{zs}$, $\vec{V}'_{se}$, $\vec{V}'_{se1}$ vectors represent the projections of these vectors on the horizon plane which runs through the point U(φ, λ).
The coordinates of the velocities:

$$\vec{V}_r = [\ 0, \quad V_{ru2}, \quad 0\ ]$$
$$\vec{V}_{zs} = [\ V_{zs\,u1}, \quad V_{zs\,u2}, \quad V_{zs\,u3}\ ]$$
$$\vec{V}_{se} = [\ V_{se\,u1}, \quad V_{se\,u2}, \quad V_{se\,u3}\ ]$$
$$\vec{V}_{se1} = [\ V_{se1\,u1}, \quad V_{se1\,u2}, \quad V_{se1\,u3}\ ]$$

(2.46) $V_{ru2} = V_r = \omega\ R \cos\varphi$ (2.3),

(2.47) $V_{zs\,u1} = V_{zs} \cos H_{zs} \cos A_{zs}$ (2.31), (2.34),

(2.48) $V_{zs\,u2} = V_{zs} \cos H_{zs} \sin A_{zs}$

(2.49) $V_{zs\,u3} = V_{zs} \sin H_{zs}$,

(2.50) $V_{se\,u1} = V_{se} \cos H_{se} \cos A_{se}$ (2.37), (2.40),

(2.51) $V_{se\,u2} = V_{se} \cos H_{se} \sin A_{se}$

(2.52) $V_{se\,u3} = V_{se} \sin H_{se}$

(2.53) $V_{se1\,u1} = V_{se} \cos H_{se1} \cos A_{se1}$ (2.42), (2.45),

(2.54) $V_{se1\,u2} = V_{se} \cos H_{se1} \sin A_{se1}$

(2.55) $V_{se1\,u3} = V_{se} \sin H_{se1}$

II.4.1 VELOCITY $\vec{V}_0 = \vec{V}_{01}$

$$\vec{V}_{01} = \vec{V}_r + \vec{V}_{zs} + \vec{V}_{se} \qquad (2.1)$$

The coordinates of the velocity $\vec{V}_{01}$: $\vec{V}_{01} = [\ V_{01\,u1},\quad V_{01\,u2},\quad V_{01\,u3}\ ]$

(2.56) $V_{01\,u1} = V_{zs\,u1} + V_{se\,u1}$

(2.57) $V_{01\,u2} = V_{r\,u2} + V_{zs\,u2} + V_{se\,u2}$

(2.58) $V_{01\,u3} = V_{zs\,u3} + V_{se\,u3}$

The modulus of the velocity $\vec{V}_{01}$:

(2.59) $V_{01} = \sqrt{V_{01\,u1}^2 + V_{01\,u2}^2 + V_{01\,u3}^2}$

The altitude H_{01} and the azimuth A_{01} of the $\vec{V}_{01}$ velocity:

(18*) $V_{01\,u1} = V_{01}\cos H_{01}\cos A_{01}$

(19*) $V_{01\,u2} = V_{01}\cos H_{01}\sin A_{01}$

(20*) $V_{01\,u3} = V_{01}\sin H_{01}$

From the equation (20*) the altitude H_{01} of the velocity $\vec{V}_{01}$ can be determined:

(2.60) $H_{01} = \arcsin\dfrac{V_{01\,u3}}{V_{01}}$

From the equation (19*) we obtain: $\sin A_{01} = \dfrac{V_{01\,u2}}{V_{01}\cos H_{01}}$

Let us introduce the following notation:

(2.61) $z_{01} = V_{01\,u1} / |\ V_{01\,u1}\ |,\quad A_{01} \neq 90^0,\quad A_{01} \neq 270^0$.

The azimuth A_{01} of the velocity $\vec{V}_{01}$ calculated within the range from 0 to 360^o starting from the northern point of the horizon is:

(2.62) $A_{01} = 90^0\,(3 + z_{01}) + z_{01}\arcsin\dfrac{V_{01\,u2}}{V_{01}\cos H_{01}}$

II.4.2 VELOCITY $\vec{V}_0 = \vec{V}_{02}$

$$\vec{V}_{02} = \vec{V}_r + \vec{V}_{zs} + \vec{V}_{se1},\qquad (2.2)$$

The coordinates of velocity $\vec{V}_{02}$:

$$\vec{V}_{02} = [\ V_{02\,u1},\quad V_{02\,u2},\quad V_{02\,u3}\ ]$$

(2.63) $V_{02\,u1} = V_{zs\,u1} + V_{se1\,u1}$

(2.64) $V_{02\,u2} = V_{r\,u2} + V_{zs\,u2} + V_{se1\,u2}$

(2.65) $V_{02\,u3} = V_{zs\,u3} + V_{se1\,u3}$

The modulus of the velocity $\vec{V}_{02}$:

(2.66) $V_{02} = \sqrt{V_{02\,u1}^2 + V_{02\,u2}^2 + V_{02\,u3}^2}$

The altitude H_{02} and the azimuth A_{02} of the velocity $\vec{V}_{02}$.

(21*) $V_{02\,u1} = V_{01}\cos H_{02}\cos A_{02}$

(22*) $V_{01\,u2} = V_{02}\cos H_{02}\sin A_{02}$

(23*) $V_{02\,u3} = V_{02}\sin H_{02}$

From the equation (23*) the altitude H_{02} of the vector $\vec{V}_{02}$ can be determined:

(2.67) $$H_{02} = \arcsin \frac{V_{02\,u3}}{V_{02}}$$

From the equation (22*) we obtain: $\sin A_{02} = \dfrac{V_{02\,u2}}{V_{02} \cos H_{02}}$

Let us introduce the following notation:

(2.68) $$z_{02} = V_{02\,u1} / | V_{02\,u1} | \qquad A_{02} \neq 90^0 , \qquad A_{02} \neq 270^0 .$$

The azimuth A_{02} of the velocity $\vec{V}_{02}$ calculated within the range from 0 to 360^o starting from the northern point of the horizon is:

(2.69) $$A_{02} = 90^0 (3 + z_{02}) + z_{02} \arcsin \frac{V_{02\,u2}}{V_{02} \cos H_{02}}$$

Parameter	The value of the parameter
a	$149597 \cdot 10^3\ km$
e	0.01671
ε	$23^o.439 \approx 0.4090877\ rad$
p	$50''.292$
T_{rg}	$365^d.256366$
T_{rz}	$365^d.242199$
R	$6378.1\ km$
ω	$7.292115 \cdot 10^{-5}\ rad / s$

TABLE 10

Table 10 gives the values of astronomical parameters, used in a computation program, referred to as PROGRAM Vo1Vo2 in Chapter IV, to calculate the coordinates of velocities: $\vec{V}_{zs}$, $\vec{V}_{01}$ (2.1), $\vec{V}_{02}$ (2.2).

II.5 AN EXAMPLE

We are to calculate the coordinates of the $\vec{V}_{zs}$, $\vec{V}_{01}$ (2.1) and $\vec{V}_{02}$ velocities (2.2) at the U point (Fig. 5) with its geographical coordinates $\varphi = 50^o 34'$, $\lambda = 21^o 41'$ on 15th December 2009 at 10.30 UT. The coordinates of the vectors should be determined in a horizontal system.

In order to solve the problem we will use the previously mentioned PROGRAM Vo1Vo2 (see Chapter IV). In addition to the astronomical quantities, contained in Table 10 and introduced into the program, we also need to introduce the values of the angles corresponding to the case-specific time, namely:

- Greenwich Hour Angle of the Aries point $GHAaries$,
- right ascension α_s of the Sun,
- angle ν (true anomaly).

The values of both i.e. the Greenwich Hour Angle of the Aries point and the sun right ascension can be found in The Nautical Almanac and they read as follows:

$GHAaries = 238^0.7166666$, $GHAsun = 338.70416666$,

where: $GHAsun$ Greenwich Hour Angle of the Sun.

$\alpha_s = GHAaries - GHAsun = 238.7166666 - 338.70416666 = -99^0.9875$, so

$\alpha_s = 360^0 - 99^0.9875 = 260^0.0125$.

The value of the angle ν can be calculated from relationships (2.13) – (2.21).

Astronomical winter duration time T_z.

Astronomical winter started on 21st December 2008 at $12^h 3^m.7$ UT.

Astronomical spring started on 20th March 2009 at $11^h 43^m.7$ UT.

Hence the astronomical winter duration time T_z in the years 2008 – 2009 equals:

$$T_z = 88^d 23^h 40^m = 88.986111 \; days.$$

Precession (in longitude) during astronomical winter:

from the relationship (2.16) $\Delta p = (T_z - T_{rz})\, 50''.292 = 12''.252 = 0^0.003403$.

From the equation (2.17) $88.986111 = t(90^o - 0^o.003403 - \eta_1) - t(360^0 - \eta_1)$ and with the use of the method of successive approximation, the value of the angle η_1 can be calculated:

$$\eta_1 = 13^o.212402$$

From the relationship (2.18): $T_a = t(\eta_1) = 12.966631 \; days$.

T_b is the time that elapsed from the start of the 2008 astronomical winter until the end of the 2008 calendar year i.e. $T_b = 10^d 11^h 56^m.3 = 10.497430 \; days$,

hence $T_a - T_b = 2.469201 \; days$.

$$180^o < \nu < 360^o$$

The time $t_4(\nu)$ that elapses from the start of the 2009 calendar year until 10.30 UT on 15th December 2009 will amount to:

$$t_4(\nu) = 349^d 10^h.5 = 349.4375 \; days$$

From the equation (2.21) we have:

$349.4375 = T_{rg} + t(\nu) + 2.469201$ and with the use of the method of successive approximations, the value of the angle ν can be calculated:

$$\nu = 341^0.37062$$

Having introduced to PROGRAM Vo1Vo2 the values of the following angles:

$\varphi = 50^0.566666$, $\alpha_s = 260^0.0125$,

$\lambda = 21^0.683333$, $GHAaries = 238^0.7166666$,

$\nu = 341^0.37062$

and $V_{se} = 0.7546 \cdot 10^{-4} C_0$ (the speed of the Sun's center relative to the aether – Tables 14 & 15, no. 3),

we obtain the coordinates of velocities $\vec{V}_{zs}$, $\vec{V}_{01}$ and $\vec{V}_{02}$ in the horizontal system.

THE RESULTS OF CALCULATIONS:

Vector $\vec{V}_{zs}$
$V_{zs} = 30.260827 \; km/s$
$H_{zs} = 3^0.634934$
$A_{zs} = 271^0.711221$

Vector $\vec{V}_0 = \vec{V}_{01}$ (2.1)	*Vector* $\vec{V}_0 = \vec{V}_{02}$ (2.2)
$V_{01} = 37.567689 \; km/s$	$V_{02} = 37.544063 \; km/s$
$H_{01} = 38^0.917536$	$H_{02} = -31^0.762285$
$A_{01} = 283^0.707819$	$A_{02} = 259^0.634191$

CHAPTER III

NEWTON'S SECOND LAW OF MOTION

Michelson experiments and the values of the interference fringe shifts, calculated from the mathematical model, confirm the premise of the existence of the aether and the applicability of the Galilean transformation.
Therefore let us apply the Galilean transformation.

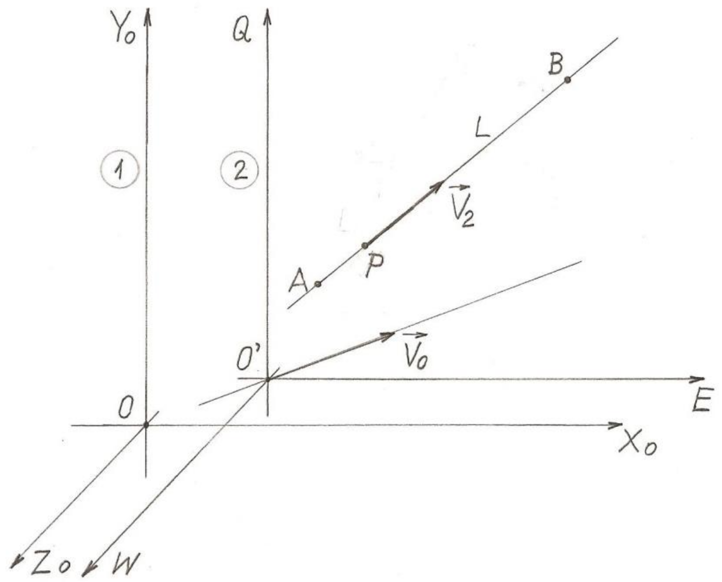

Fig. 10

Then let us introduce two rectangular coordinate systems (Fig. 10).

1) Preferred absolute inertial rectangular coordinate system 1, named OXoYoZo, motionless with respect to the aether.
2) An inertial system 2 i.e. the O'EQW system that is in motion relative to the system 1 with constant absolute velocity $\vec{V}_o$.

   Axis O'E is parallel to axis OXo.
   Axis O'Q is parallel to axis OYo.

The times in both inertial systems 1 and 2 are equal: $t_2 = t_1 = t$ (the absolute time (3.51)).

The velocity $\vec{V}_1$ of particle P relative to the inertial system 1 (Fig. 10) equals:

(3.0) $$\vec{V}_1 = \vec{V}_o + \vec{V}_2 \ ,$$

where: $\vec{V}_2$ the velocity of particle P in the inertial system 2.

The accelerations of particle P in inertial system 1 and 2 respectively:

$$\frac{d\vec{V}_1}{dt} = \vec{a}_1 \ , \qquad \frac{d\vec{V}_1}{dt} = \frac{d(\vec{V}_o + \vec{V}_2)}{dt} = \frac{d\vec{V}_2}{dt} = \vec{a}_2 \ , \qquad \text{then} \qquad \vec{a}_2 = \vec{a}_1 \, .$$

Isaac Newton adopted a constant mass for the particle:

$$m_2 = m_1 = const$$

According to Newton's second law of motion, the equations of motion for particle P have the following form:

(3.1) $\vec{F}_1 = \frac{d(m_1\vec{V}_1)}{dt} = m_1\frac{d\vec{V}_1}{dt} = m_1\vec{a}_1$, $\vec{F}_2 = \frac{d(m_2\vec{V}_2)}{dt} = m_2\frac{d\vec{V}_2}{dt} = m_2\vec{a}_2$, hence

$$\vec{F}_2 = \vec{F}_1$$

Therefore Newton's second law of motion is invariant with respect to the Galilean transformation. This means that Newton's laws of mechanics are the same for both inertial systems 1 and 2.

III.1 VARIABLE MASS OF PARTICLE CONSIDERED IN NEWTON'S SECOND LAW OF MOTION

The existence of the aether and the applicability of the Galilean transformation have been described in Chapter I. Experimental data indicate that the mass of a particle depends upon its speed. Then let us consider the variability of the particle mass in Newton's second law of motion.

INERTIAL SYSTEM 1 (motionless with respect to the aether)

The expression given by H. A. Lorentz for γ is defined by:

(3.2) $$\gamma = \frac{1}{\sqrt{1-(V_1/C_o)^2}}$$

where: V_1 the speed of particle P in the inertial system 1,

C_o the speed of light in a vacuum with respect to the aether.

(3.3) $V_{1\max} = C_o$, $V_1 < V_{1\max}$, $V_1 \rightarrow V_{1\max}$

The speed $V_{1\max} = C_o$ is the limit speed of the particle P in the inertial system 1. That speed is identical in all directions.

The condition (3.3) limits the speed of particle P with respect to the aether.

We assume:

(3.4) $m_1 = m_1(V_1) = m_{o1}\gamma$

where: $m_{o1} = m_1(V_1 = 0)$ rest mass of particle P in the inertial system 1,

$m_1(V_1)$ the mass of moving particle P in the inertial system 1,

γ the Lorentz relation (3.2).

Then let us introduce the variable mass of particle P into Newton's second law of motion (3.1). The mass can be defined by (3.4):

(3.5a) $\vec{F}_1 = \frac{d(m_1\vec{V}_1)}{dt}$ where: $m_1 = m_1(V_1) = m_{o1}\gamma$ relationship (3.4)

(3.5b) $\vec{F}_1 = \frac{d(m_{o1}\gamma\vec{V}_1)}{dt}$ which after differentiation takes the following form:

(3.5c) $\vec{F}_1 = m_{o1}\gamma\frac{d\vec{V}_1}{dt} + m_{o1}\frac{d\gamma}{dt}\vec{V}_1$

(3.5d) $\vec{F}_1 = m_{o1}\gamma\,\vec{a}_1 + m_{o1}\frac{d\gamma}{dt}\vec{V}_1$

Relationships (3.5a – d) express Newton's second law of motion in the inertial system 1 after the variable mass of particle P has been introduced.

INERTIAL SYSTEM 2 (O'EQW system)

The limit speed $V_{2\max}$ of the accelerating particle P depends upon the angle $\alpha_{0,2}$ between vectors $\vec{V}_0$ and $\vec{V}_2$.

(3.6) $\alpha_{0,2} = \measuredangle(\vec{V}_0,\vec{V}_2)$ so $V_{2\max} = V_{2\max}(\alpha_{0,2})$

DETERMINING THE SPEED $V_{2\max}$

The speed $V_{2\max}$ is the limit speed of the particle P in the system 2 which moves at a fixed speed V_0 in a given direction (angle $\alpha_{0,2}$) with respect to the velocity $\vec{V}_0$.

ASSUMPTIONS.

The particle P is accelerated in any given direction in relation to the $\vec{V}_0$ velocity (Fig.11).

1) The velocity $\vec{V}_0$ is parallel to the OXo axis.
   The coordinate of the velocity: V_0, where: $0 < V_0 < C_0$.
2) The force $\vec{F}_2$ acts on the particle in any given direction. The angle $\alpha_{0,2}$ represents any angle.
3) The velocity $\vec{V}_2(t=0) = 0$.

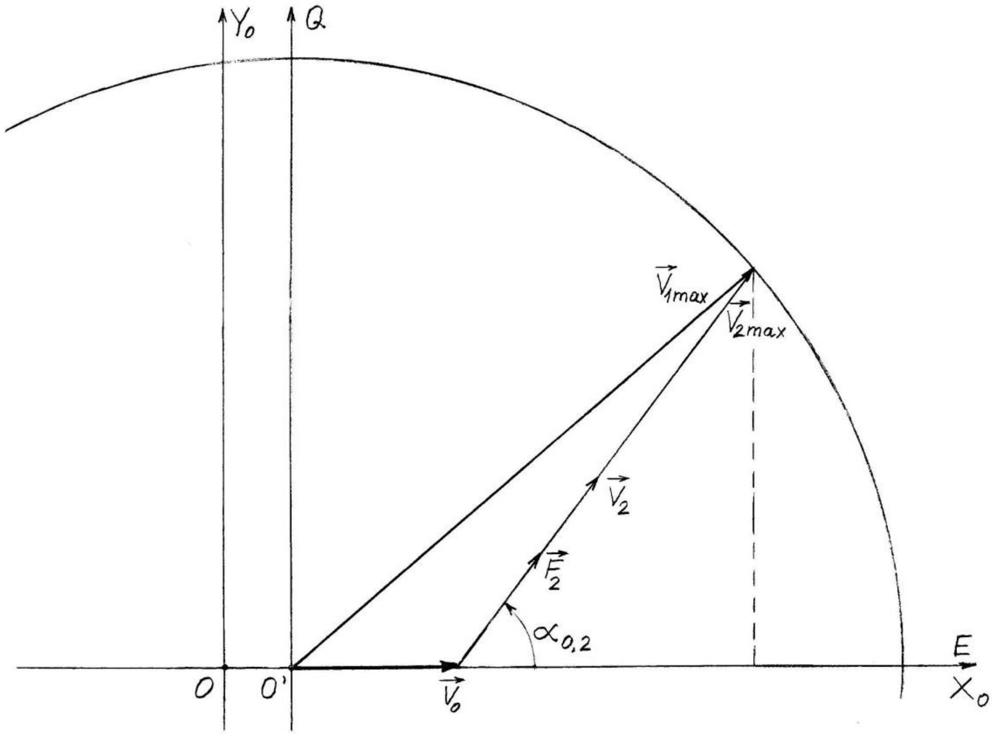

Fig.11 The force $\vec{F}_2$ acts on the particle in any given direction (angle $\alpha_{0,2}$) in relation to the velocity $\vec{V}_0$.

Coordinates of the velocity $\vec{V}_{2\max}$:

$\vec{V}_{2\max} = [V_{2\max}\cos\alpha_{0,2}\,,\quad V_{2\max}\sin\alpha_{0,2}\,,\quad 0]$

$V_{2\max} > 0$.

Coordinates of the velocity $\vec{V}_0$:

$\vec{V}_0 = [V_0\,,\quad 0\,,\quad 0]$

According to the Galilean transformation: $\vec{V}_0 + \vec{V}_{2\max} = \vec{V}_{1\max}$ so the following equations can be written: $(V_0 + V_{2\max}\cos\alpha_{0,2})^2 + (V_{2\max}\sin\alpha_{0,2})^2 = V_{1\max}^2$, $V_{1\max} = C_0 = const$ (3.3).

Hence the $V_{2\max}(\alpha_{0,2})$ is obtained as follows:

(3.7) $$V_{2\max} = C_0[\sqrt{1-(V_0 / C_0)^2 \sin^2 \alpha_{0,2}} - (V_0 / C_0)\cos\alpha_{0,2}],$$ hence

(3.7a) $$V_{2\max}(\alpha_{0,2} = 0) = C_0 - V_0,$$

(3.7b) $$V_{2\max}(\alpha_{0,2} = 180^0) = C_0 + V_0.$$

From the equation (3.7) we obtain the inequality: $C_0 - V_0 \le V_{2\max}(\alpha_{0,2}) \le C_0 + V_0$.

If the particle P is accelerated in any given direction (3.6) then the Lorentz relation (3.2) takes the form as follows:

(3.8) $$\gamma_a = \frac{1}{\sqrt{1-(V_2 / V_{2\max})^2}},$$ where: $V_{2\max}$ relationship (3.7).

$$V_2 < V_{2\max}, \qquad V_2 \to V_{2\max}$$

When the particle P is accelerating along in the direction of the vector $\vec{V}_o$ ($\alpha_{0,2} = 0$), then the relation (3.8) takes the form of γ_b:

(3.9) $$\gamma_b = \frac{1}{\sqrt{1-[V_2 /(C_o - V_o)]^2}}$$ according to the equation (3.7a).

When particle P is accelerating in the direction opposite to that of the vector $\vec{V}_o$ ($\alpha_{0,2} = 180^o$), then the relation (3.8) takes the form of γ_c:

(3.10) $$\gamma_c = \frac{1}{\sqrt{1-[V_2 /(C_o + V_o)]^2}}$$ according to the equation (3.7b).

Let us assume:

(3.11) $$m_2 = m_2(V_{2\max}, V_2) = m_{o2}\gamma_a$$

where:

$m_2(V_{2\max}, V_2)$ the mass of the moving particle P in the system 2,

$m_{o2} = m_2(V_2 = 0)$ the rest mass of the particle P in the system 2,

γ_a formula (3.8).

Let us introduce to Newton's second law of motion (3.1) the variable mass of particle P. Its mass is determined by the relationship (3.11):

(3.12a) $$\vec{F}_2 = \frac{d(m_2\vec{V}_2)}{dt}$$ where: $m_2 = m_2(V_{2\max}, V_2) = m_{o2}\gamma_a$ relationship (3.11).

(3.12b) $$\vec{F}_2 = \frac{d(m_{o2}\gamma_a\vec{V}_2)}{dt}$$ which after differentiation takes the form of:

(3.12c) $$\vec{F}_2 = m_{o2}\gamma_a \frac{d\vec{V}_2}{dt} + m_{o2}\frac{d\gamma_a}{dt}\vec{V}_2$$

(3.12d) $$\vec{F}_2 = m_{o2}\gamma_a \vec{a}_2 + m_{o2}\frac{d\gamma_a}{dt}\vec{V}_2$$

Relationships (3.12 a - d) express Newton's second law of motion in system 2 after introducing a variable mass of the particle P.

III.1.1 THE VELOCITY OF THE PARTICLE

THE VELOCITY OF THE PARTICLE IN SYSTEM 2, (in the O' EQW system)

When the particle P is accelerated in system 2, then its speed V_2 depends upon the direction the particle is accelerating towards with respect to the vector $\vec{V}_o$.

If we assume $\vec{F}_2 = const$ then from equation (3.12b) we obtain:

$$d[\gamma_a V_2(t)] = \frac{F_2}{m_{o2}} dt , \qquad \int d[\gamma_a V_2(t)] = \frac{F_2}{m_{o2}} \int dt .$$

After integration $V_2(t)\gamma_a = \frac{F_2}{m_{o2}} t + C_4$.

From the premise that $t = 0 \Rightarrow V_2 = 0$ we obtain the integration constant $C_4 = 0$.

Hence $V_2(t)\gamma_a = \frac{F_2}{m_{o2}} t$, $V_2(t)\gamma_a = k_4 t$, where: $k_4 = \frac{F_2}{m_{o2}}$.

The $V_2(t)$ speed we define as follows:

(3.13a) $V_2(t)\gamma_a = k_4 t$ when the particle P is being accelerated in any given direction (3.6) with respect to the vector $\vec{V}_o$

(3.13b) $V_2(t)\gamma_b = k_4 t$ when the particle P is being accelerated from rest along the direction of the vector $\vec{V}_o$ $(\alpha_{0,2} = 0)$,

(3.13c) $V_2(t)\gamma_c = k_4 t$ when the particle P is being accelerated in the direction opposite to that of the vector $\vec{V}_o$ $(\alpha_{0,2} = 180^o)$.

Where: γ_a formula (3.8), γ_b formula (3.9), γ_c formula (3.10),

t time in which a constant force $\vec{F}_2$ is acting on the particle P.

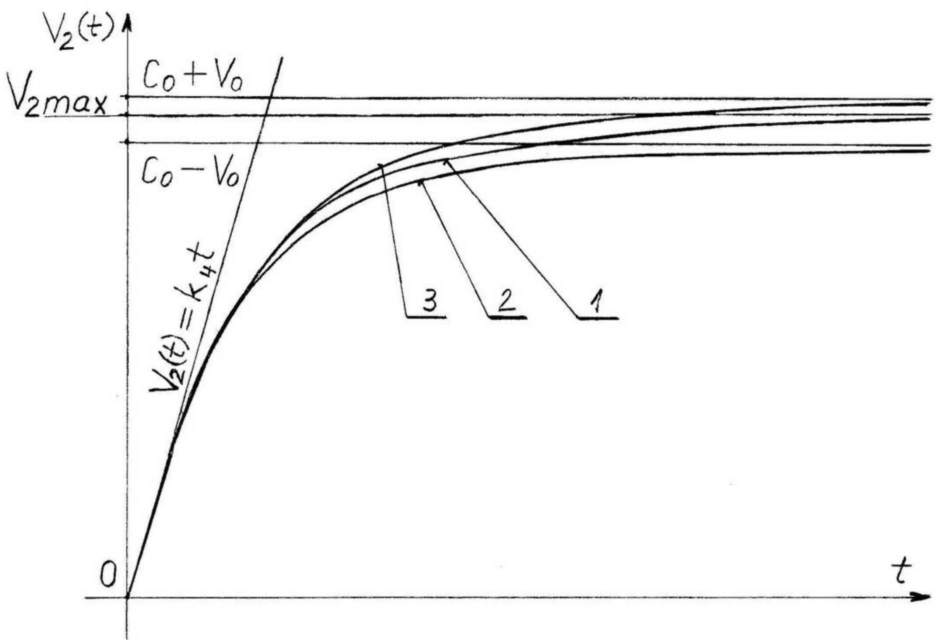

Fig. 12

The relationship between the speed $V_2(t)$ and the time in which a constant force $\vec{F}_2$ is acting on the particle P.

SYMBOLS: 1 equation (3.13a),

2 equation (3.13b),

3 equation (3.13c).

III.1.2 THE ENERGY OF THE PARTICLE

THE ENERGY OF PARTICLE IN SYSTEM 2 (in the O'EQW system)

We assume that $\alpha_{0,2} = \measuredangle(\vec{V}_0,\vec{V}_2) = const$ (3.6), $V_2(t=0)=0$

When a force $\vec{F}_2$ acts on particle P in system 2 then the elementary work performed within a distance $d\vec{L}$ is equal to: $dE_2 = \vec{F}_2 \cdot d\vec{L}$, where: $\vec{F}_2 = \frac{d(m_{o2}\gamma_a\vec{V}_2)}{dt}$ (3.12b)

$d\vec{L} = \vec{V}_2 dt$

Then $dE_2 = \frac{d(m_{o2}\gamma_a\vec{V}_2)}{dt} \cdot \vec{V}_2 dt = m_{o2} d(\gamma_a \vec{V}_2)\cdot\vec{V}_2 = m_{o2}(d\gamma_a \vec{V}_2 + \gamma_a\, d\vec{V}_2)\cdot\vec{V}_2 =$

$= m_{o2}(d\gamma_a \vec{V}_2\cdot\vec{V}_2 + \gamma_a\, d\vec{V}_2\cdot\vec{V}_2) = m_{o2}(d\gamma_a V_2^2 + \gamma_a\, V_2 dV_2)$.

Hence $dE_2 = m_{o2}(d\gamma_a V_2^2 + \gamma_a V_2 dV_2)$

The differential $d\gamma_a$ of the formula (3.8) equals:

$$d\gamma_a = \frac{V_2 dV_2}{V_{2\max}^2[1-(V_2/V_{2\max})^2]^{3/2}} \quad \text{so}$$

$$dE_2 = m_{o2}\left(\frac{V_2^3 dV_2}{V_{2\max}^2[1-(V_2/V_{2\max})^2]^{3/2}} + \frac{V_2 dV_2}{[1-(V_2/V_{2\max})^2]^{1/2}}\right)$$

Total work which needs to be performed in order to move the particle P from rest point A in system 2 to point B over the distance L at velocity $\vec{V}_2$ (Fig. 10) equals:

$$E_2 = m_{o2}\int\left(\frac{V_2^3 dV_2}{V_{2\max}^2[1-(V_2/V_{2\max})^2]^{3/2}} + \frac{V_2 dV_2}{[1-(V_2/V_{2\max})^2]^{1/2}}\right)$$

After integration we obtain: $E_2 = \frac{m_{o2}V_{2\max}^2}{\sqrt{1-(V_2/V_{2\max})^2}} + C_6$

From the assumption that $V_2 = 0 \Rightarrow E_2 = 0$ we obtain the equation:

$0 = m_{o2}V_{2\max}^2 + C_6$ so the integration constant $C_6 = -m_{o2}V_{2\max}^2$. Hence

(3.14) $E_2 = \frac{m_{o2}V_{2\max}^2}{\sqrt{1-(V_2/V_{2\max})^2}} - m_{o2}V_{2\max}^2$, $E_2 = m_{o2}V_{2\max}^2\gamma_a - m_{o2}V_{2\max}^2$

Work E_2 equals the kinetic energy E_k of the particle P.

(3.15) $E_2 = E_k = m_{o2}V_{2\max}^2\gamma_a - m_{o2}V_{2\max}^2$

The speed $V_{2\max}$ is defined by relationships (3.7).

The expression $m_{02}V_{2\max}^2$ in (3.15) represents the rest energy E_o of the particle P for a given direction (3.6).

(3.16) $E_o = m_{o2}V_{2\max}^2$

The expression $m_{o2}V_{2\max}^2\gamma_a$ in (3.15) represents total energy E_s of the particle P in system 2.

(3.17) $E_s = m_{o2}V_{2\max}^2\gamma_a$.

Hence (3.15) takes the following form: $E_k = E_s - E_o = m_{o2}V_{2\max}^2(\gamma_a - 1)$

(3.18) $E_k = m_{o2}V_{2\max}^2(\gamma_a - 1)$ is the kinetic energy of the particle P in system 2.

After expanding the formula for γ_a (3.8) in a power series we obtain:

$$\gamma_a = 1 + \frac{1}{2}(V_2 / V_{2\max})^2 + \frac{1\cdot 3}{2\cdot 4}(V_2 / V_{2\max})^4 + \ldots$$

For small speeds V_2 of the particle P: $\gamma_a \approx 1 + \frac{1}{2}(V_2 / V_{2\max})^2$, hence the kinetic energy E_k specified by the formula (3.18) equals:

$$E_k \approx m_{o2} V_{2\max}^2 [1 + \frac{1}{2}(V_2 / V_{2\max})^2 - 1] = \frac{1}{2} m_{o2} V_2^2$$

(3.19) $$E_k \approx \frac{1}{2} m_{o2} V_2^2$$

The formula (3.19) defines kinetic energy of the particle P, which results from Newton's second law of motion when the mass of the particle P is constant.

The experiments with particles are carried out in laboratories that are located on the Earth and it is where system 2 (O'EQW) is also located. Despite Earth's rotary and orbital motion round the Sun, for adequately small time intervals it can be assumed that system 2 is inertial and it moves with respect to system 1 (OXoYoZo system) at a constant velocity $\vec{V}_o$ which modulus is defined by the inequality (1.124):

$$10^{-4} \leq V_0 / C_0 < 2 \cdot 10^{-4}$$

Hence $$10^{-4}\, C_o \leq V_0 < 2 \cdot 10^{-4}\, C_0$$

The value of the V_o speed is small when compared with C_o and therefore it can be omitted in formulae (3.8), (3.9) and (3.10). Having done that, the speed $V_{2\max} = C_o$ and consequently the formulae (3.8), (3.9) and (3.10) take the following form:

(3.20) $$\gamma_a = \gamma_b = \gamma_c \approx \frac{1}{\sqrt{1 - (V_2 / C_o)^2}} \quad .$$

From relationships (3.16), (3.17) and (3.18) we obtain relationships that give approximate values of energies of the particle P in system 2:

(3.21) $E_o \approx m_{o2} C_o^2$ rest energy,

(3.22) $E_s \approx m_{o2} C_o^2 \gamma_a = m_2 C_o^2$ total energy,

(3.23) $E_k \approx m_{o2} C_o^2 (\gamma_a - 1)$ kinetic energy.

Where: γ_a formula (3.20).

Now the relationship between total energy E_s of the particle and its momentum $\vec{p}_2$ needs to be expressed.

From the equation (3.22) we obtain: $E_s^2 \approx m_{02}^2 C_0^4 \gamma_a^2$

Then the following can be written: $E_s^2 \approx m_{02}^2 C_0^4 \gamma_a^2 + (p_2^2 C_0^2 - p_2^2 C_0^2)$

The modulus of the particle's momentum is: $p_2 = m_{02} \gamma_a V_2$, so

$$E_s^2 \approx m_{02}^2 C_0^4 \gamma_a^2 - m_{02}^2 \gamma_a^2 V_2^2 C_0^2 + p_2^2 C_0^2 .$$

After transforming this equation, we obtain the following:

$$E_s^2 \approx m_{02}^2 C_0^4 \gamma_a^2 (1 - V_2^2 / C_0^2) + p_2^2 C_0^2 ,$$ where: γ_a relationship (3.20).

Hence $E_s^2 \approx m_{02}^2 C_0^4 + p_2^2 C_0^2$, because $\gamma_a^2 (1 - V_2^2 / C_0^2) \approx 1.$

The ultimate relationship between total energy E_s of the particle and its momentum $\vec{p}_2$ takes the form as follows:

(3.22a) $$E_s \approx \sqrt{m_{02}^2 C_0^4 + p_2^2 C_0^2} .$$

PARTICLE'S ENERGY IN SYSTEM 1 (in the OXoYoZo system)
The energies of the particle P in system 1 can be determined in the same manner as those in system 2, with the use of formula (3.5b).

The following relationships determine the energies of the particle P:

(3.24) $E_o = m_{o1} C_o^2$ rest energy,

(3.25) $E_s = m_{o1} C_o^2 \gamma = m_1 C_o^2$ total energy,

(3.26) $E_k = m_{o1} C_o^2 (\gamma - 1)$ kinetic energy,

where: γ formula (3.2).

III.1.3 REST MASS OF THE PARTICLE WITH RESPECT TO THE AETHER

Let us consider the mass of the particle P in systems 1 and 2:

$$m_1(V_1) = \frac{m_{o1}}{\sqrt{1-(V_1/C_o)^2}} \quad \text{so} \quad m_1(V_1 = V_o) = \frac{m_{o1}}{\sqrt{1-(V_o/C_o)^2}}$$

$$m_2(V_{2\max}, V_2) = \frac{m_{o2}}{\sqrt{1-(V_2/V_{2\max})^2}} \quad \text{so} \quad m_2(V_2 = 0) = m_{o2}$$

$$m_1(V_1 = V_o) = m_2(V_2 = 0) \quad , \quad \text{hence}$$

(3.27) $m_{o2} = \dfrac{m_{o1}}{\sqrt{1-(V_o/C_o)^2}}$, then the rest mass of the particle P with respect to system 1 (with respect to the aether) equals:

(3.27a) $m_{o1} = m_{o2}\sqrt{1-(V_o/C_o)^2} \approx m_{o2}[1-\frac{1}{2}(V_o/C_o)^2]$ because $V_o/C_o << 1$

The quotient V_o/C_o is defined by the relationship (1.124):

$10^{-4} \leq V_0/C_0 < 2 \cdot 10^{-4}$. Hence

$[1-\frac{1}{2}(2 \cdot 10^{-4})^2]\, m_{o2} < m_{o1} \leq [1-\frac{1}{2}(10^{-4})^2] m_{o2}$ and after reduction

$(1-2 \cdot 10^{-8})\, m_{o2} < m_{o1} \leq (1-0.5 \cdot 10^{-8}) \cdot m_{o2}$.

III.1.4 THE LAWS OF MECHANICS

Velocities and accelerations of the particle P in inertial systems 1 and 2 are:

$$\vec{V}_1 = \vec{V}_o + \vec{V}_2, \quad \vec{a}_2 = \vec{a}_1, \quad t_2 = t_1 = t$$

The mass of the particle P in systems 1 and 2 are respectively:

$$m_1 = \frac{m_{o1}}{\sqrt{1-(V_1/C_o)^2}}, \quad m_2 = \frac{m_{o2}}{\sqrt{1-(V_2/V_{2\max})^2}}$$

$$m_2 \neq m_1$$

The forces acting upon particle P in systems 1 and 2 are:

$$\vec{F}_1 = m_{o1}\gamma \cdot \vec{a}_1 + m_{o1}\frac{d\gamma}{dt}\vec{V}_1 \quad (3.5d), \qquad \vec{F}_2 = m_{o2}\gamma_a \vec{a}_2 + m_{o2}\frac{d\gamma_a}{dt}\vec{V}_2 \quad (3.12d),$$

$$\vec{F}_1 = m_{o1}\gamma \cdot \vec{a}_1 + m_{o1}\frac{d\gamma}{dt}(\vec{V}_o + \vec{V}_2). \qquad \text{Hence} \quad \vec{F}_2 \neq \vec{F}_1.$$

After including the variable mass of the particle P, Newton's second law of motion (3.5a-d), (3.12a-d) has the form which is non-invariant with respect to the Galilean transformation. Hence Newton's laws of mechanics are different in inertial systems 1 and 2.

III.1.5 DETERMINING THE $\vec{F}_1$ FORCE

We determine the $\vec{F}_1$ force acting on the particle P in the system 1 when the same particle is acted on by the force $\vec{F}_2 = const$ in system 2.

ASSUMPTIONS A.

The particle P is accelerated in the direction of the $\vec{V}_0$ absolute velocity.

The angle $\alpha_{0,2} = \measuredangle(\vec{V}_0, \vec{V}_2) = 0$ relationship (3.6).

1) The absolute velocity $\vec{V}_0$ is parallel to the OXo axis (Fig.10).
   The coordinate of the velocity: V_0, where: $0 < V_0 < C_0$.
2) The force $\vec{F}_2 = const$ acting on the particle P is parallel to the O'E axis (Fig.10).
   The coordinate of the force: F_2; $F_2 > 0$.
3) The velocity $\vec{V}_2(t=0) = 0$.

The vectors $\vec{F}_1$, $\vec{V}_1$, $\vec{V}_2$ are parallel to those axes, which also results from these assumptions.

The coordinates of forces:

$\vec{F}_2 = [\ F_2,\ 0,\ 0\ ]$

$\vec{F}_1 = [\ F_1(t),\ 0,\ 0\ ]$

$F_2 = const$

The coordinates of velocities:

$\vec{V}_0 = [\ V_0,\ 0,\ 0\ ]$

$\vec{V}_2 = [\ V_2(t),\ 0,\ 0\ ]$

$\vec{V}_1 = [\ V_1(t),\ 0,\ 0\ ]$

$V_{2\max} = C_0 - V_0$ relationship (3.7a).

$\vec{V}_1 = \vec{V}_2 + \vec{V}_o$ so $\vec{V}_1 = [\ V_2(t) + V_0,\ 0,\ 0\ ]$

$V_1(t) = V_2(t) + V_0$

The $V_2(t)$ coordinate of the $\vec{V}_2$ velocity is defined by the relationship (3.13b).

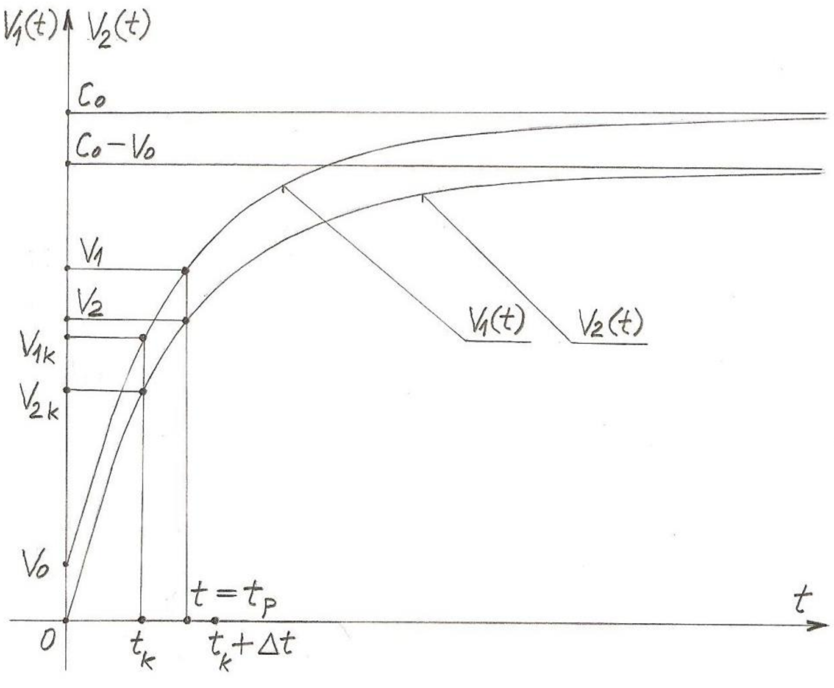

Fig.13 The coordinates $V_1 = V_1(t = t_p)$, $V_{1k} = V_1(t = t_k)$, $V_2 = V_2(t = t_p)$, $V_{2k} = V_2(t = t_k)$ of the $\vec{V}_1$, $\vec{V}_2$ velocities of the accelerated particle P.
According to the Galilean transformation $V_1 = V_2 + V_0$, $V_{1k} = V_{2k} + V_0$.

From the (3.5b) equation we obtain:

$$d(\vec{V}_1\gamma)=\frac{\vec{F}_1}{m_{01}}dt$$ where: γ relationship (3.2). Hence

(3.28) $$\int d\,[V_1(t)\ \ \gamma]=\int\frac{F_1(t)}{m_{01}}\ dt$$

Let us take any given time t_k of the particle motion under consideration (Fig. 13).

We set a time interval:

(3.29) $$t_k \le t < t_k+\Delta t\,,\qquad \Delta t>0$$

If the set time interval is very small, it can be assumed that the coordinate value of the $\vec{F}_1$ force which is acting on the particle within this interval is constant: $F_1=const$.

Then the equation (3.28) takes the form as follows:

$$\int d\,[V_1(t)\ \ \gamma]=\frac{F_1}{m_{01}}\int dt\ .$$ After integration we obtain:

(3.30) $$V_1(t)\ \ \gamma=\frac{F_1}{m_{01}}\ t+C_k$$

From the condition: $t=t_k \ \Rightarrow\ V_1(t=t_k)=V_{1k}$, $\gamma=\gamma_{1k}$ we obtain the following equation:

$$V_{1k}\gamma_{1k}=\frac{F_1}{m_{01}}t_k+C_k$$ hence the integration constant C_k equals:

(3.30a) $$C_k=V_{1k}\gamma_{1k}-\frac{F_1}{m_{01}}\,t_k$$ where:

(3.31) $$\gamma_{1k}=\frac{1}{\sqrt{1-(V_{1k}/C_0)^2}}$$

(3.32) $V_1(t=t_p)=V_1$, where: t_p is within the time interval (3.29) $t_k<t_p<t_k+\Delta t$.

From the equations (3.30), (3.32) at $t=t_p$:

(3.33) $$V_1\gamma=\frac{F_1}{m_{01}}t_p+C_k$$

And from the equations (3.33) and (3.30a):

(3.34) $$\frac{V_1\gamma-V_{1k}\gamma_{1k}+\dfrac{F_1}{m_{01}}t_k}{\dfrac{F_1}{m_{01}}}=t_p$$

From the equation (3.13b) at $t=t_p$:

(3.35) $$\frac{V_2\gamma_b}{\dfrac{F_2}{m_{02}}}=t_p$$ where: $V_2=V_2(t=t_p)$, γ_b relationship (3.9).

From the equation (3.13b) at $t=t_k$:

(3.36) $$t_k=\frac{V_{2k}\gamma_{bk}}{\dfrac{F_2}{m_{02}}}$$ where: $V_{2k}=V_2(t=t_k)$,

(3.37) $$\gamma_{bk}=\frac{1}{\sqrt{1-[V_{2k}/(C_0-V_0)]^2}}$$

Because the Galilean transformation is in operation, the times in both frames of reference 1 and 2 are equal: $t_2 = t_1 = t = t_p$. After comparing the left-hand sides of the equations (3.34) and (3.35) the following is obtained:

(3.38) $$\frac{V_1\gamma - V_{1k}\gamma_{1k} + \frac{F_1}{m_{01}} t_k}{\frac{F_1}{m_{01}}} = \frac{V_2\gamma_b}{\frac{F_2}{m_{02}}},$$ where: $m_{01} = m_{02}\sqrt{1-(V_0 / C_0)^2}$ relationship (3.27a).

From the equations (3.36) and (3.38) we obtain:

(3.39) $$\frac{F_1}{F_2} = \frac{(V_1\gamma - V_{1k}\gamma_{1k})\sqrt{1-(V_0 / C_0)^2}}{V_2\gamma_b - V_{2k}\gamma_{bk}},$$ where: $F_2 = const$,

(3.40) $V_1 = V_2 + V_0$,

(3.41) $V_{1k} = V_{2k} + V_0$.

By assumption, the time interval in (3.29) is very small and the inequality $V_2 > V_{2k}$ is fulfilled within, therefore the value of the V_{2k} / V_2 quotient is virtually equal to 1 and is less than 1.

If we define: $V_{2k} / V_2 = a_k$ then

(3.42) $V_{2k} = a_k V_2$; $a_k = 0.999999$ was adopted for calculations.

The quotient (3.39) F_1 / F_2 is the function of the V_0 and V_2 coordinate values:

$$\frac{F_1}{F_2} = f_A(V_0, V_2)$$ relationship (3.39)

For a given coordinate value V_0 of the $\vec{V}_0$ velocity, the value of the quotient F_1 / F_2 determined from the relationship (3.39) corresponds with every V_2 coordinate value of the $\vec{V}_2$ velocity. Table 11 presents the values of the F_1 / F_2 quotient for different values of V_0 / C_0 and V_2 / C_0.

V_0 / C_0	V_2 / C_0				
	1	2	3	4	5
	0.00001	0.2	0.49	0.69	0.97
$1.5 \cdot 10^{-4}$	0,99999998	1.0000737	1.0001475	1.0001833	1.0002215
10^{-3}	0.99991068	1.0005030	1.0009883	1.0012262	1.0014788
10^{-2}	1.00039406	1.0051134	1.0100151	1.0124266	1.0149834
0.1	1.01805269	1.0623422	1.1156201	1.1426304	-
	$\frac{F_1}{F_2} = f_A(V_0 / C_0, V_2 / C_0)$ (3.39).			The angle $\alpha_{0,2} = 0$	
	$F_2 = const$			$a_k = 0.999999$	

TABLE 11 The values of the F_1 / F_2 quotient, $F_2 = const$

$F_1 = F_2 f_A(V_0 / C_0, V_2 / C_0)$.

Following (3.13b) $V_2(t)$ is known, then consequently $F_1 = f(V_0 / C_0, t)$ is known too.

From the results of calculations show in Table 11, it can be concluded that the quotient F_1 / F_2 takes different values.

ASSUMPTIONS B.

The particle P is accelerated in the direction opposite to the $\vec{V}_0$ absolute velocity.

The angle $\alpha_{0,2} = \measuredangle(\vec{V}_0, \vec{V}_2) = 180^o$ relationship (3.6).

1) The absolute velocity $\vec{V}_0$ is parallel to the OXo axis (Fig.10).
   The coordinate of the velocity: $-V_0$, where: $0 < V_0 < C_0$.
2) The force $\vec{F}_2 = const$ acting on the particle P is parallel to the O'E axis (Fig.10).
   The coordinate of the force: F_2, $F_2 > 0$.
3) The velocity $\vec{V}_2(t=0) = 0$.

Following the above assumptions B, the vectors $\vec{F}_1$, $\vec{V}_1$ and $\vec{V}_2$ are parallel to these axes.

Coordinates of forces:

$\vec{F}_2 = [\ F_2,\ 0,\ 0\ ]$

$\vec{F}_1 = [\ F_1(\mathrm{t}),\ 0,\ 0\ ]$

$F_2 = const$

Coordinates of velocities:

$\vec{V}_0 = [-V_0,\ 0,\ 0\ ]$

$\vec{V}_2 = [\ V_2(\mathrm{t}),\ 0,\ 0\ ]$

$\vec{V}_1 = [\ V_1(\mathrm{t}),\ 0,\ 0\ ]$

$V_{2\max} = C_0 + V_0$ relationship (3.7b).

$\vec{V}_1 = \vec{V}_2 + \vec{V}_o$, so $\vec{V}_1 = [\ V_2(t) - V_0,\ 0,\ 0\ ]$

$V_1(t) = V_2(t) - V_0$

The $V_2(t)$ coordinate of the $\vec{V}_2$ velocity is defined by the relationship (3.13c).

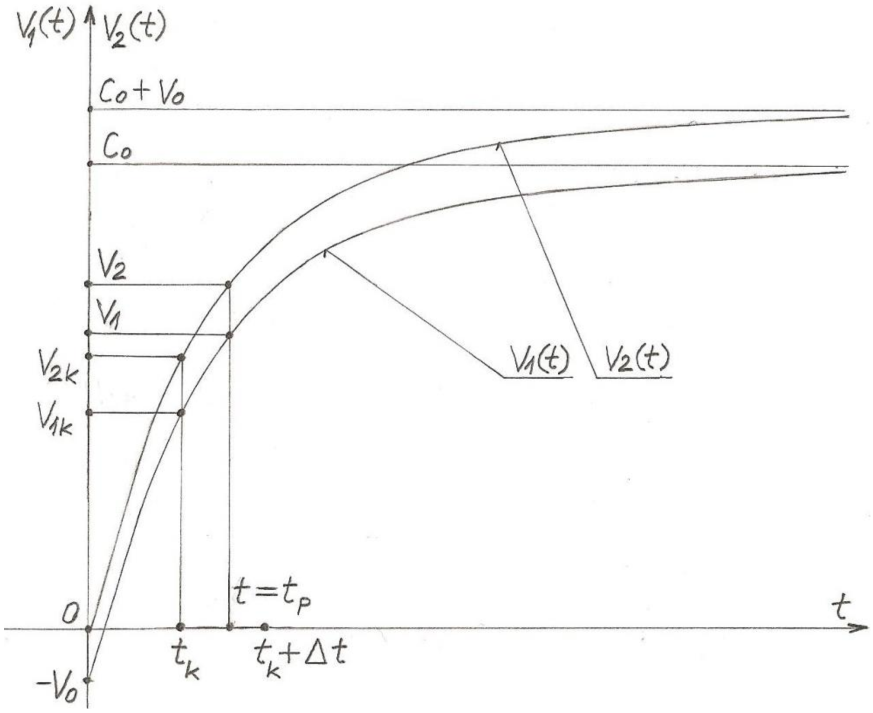

Fig.14 The coordinate $V_1 = V_1(t = t_p)$, $V_{1k} = V_1(t = t_k)$, $V_2 = V_2(t = t_p)$, $V_{2k} = V_2(t = t_k)$ of the $\vec{V}_1$, $\vec{V}_2$ velocities of the accelerated particle P.
According to the Galilean transformation $V_1 = V_2 - V_0$, $V_{1k} = V_{2k} - V_0$.

The quotient F_1 / F_2 of coordinate values of the $\vec{F}_1$, $\vec{F}_2$ forces can be determined as shown under assumptions A.

Under assumptions B, the quotient F_1 / F_2 is defined by the equation (3.43):

(3.43) $$\frac{F_1}{F_2} = \frac{(V_1\gamma - V_{1k}\gamma_{1k})\sqrt{1-(V_0/C_0)^2}}{V_2\gamma_c - V_{2k}\gamma_{ck}}, \quad \text{where:} \quad F_2 = const,$$

γ relationship (3.2), γ_{1k} relationship (3.31), γ_c relationship (3.10),

(3.44) $$\gamma_{ck} = \frac{1}{\sqrt{1-[V_{2k}/(C_0+V_0)]^2}},$$

(3.45) $V_1 = V_2 - V_0$,

(3.46) $V_{1k} = V_{2k} - V_0$,

$V_{2k} = a_k V_2$ relationship (3.42)

$a_k = 0.999999$ was adopted for calculations.

$F_1/F_2 = f_B(V_0, C_0)$ relationship (3.43).

For a given value of the coordinate $-V_0$ of the $\vec{V}_0$ velocity, the quotient F_1/F_2 determined from the relationship (3.43) corresponds with every V_2 coordinate of the $\vec{V}_2$ velocity.

Table 14 presents the F_1/F_2 quotients for different values of V_0/C_0 and V_2/C_0.

V_0/C_0	V_2/C_0				
	1	2	3	4	5
	0.00001	0.2	0.49	0.69	0.97
$1.5 \cdot 10^{-4}$	0.99999998	0.9999283	0.9998536	0.9998164	0.9997786
10^{-3}	0.99991068	0.9995032	0.9990161	0.9987770	0.9985242
10^{-2}	1.00039406	0.9951119	0.9902803	0.9879245	0.9854337
0.1	1.01805269	0.9604290	0.9145631	0.8929439	0.8706278

$\frac{F_1}{F_2} = f_B(V_0/C_0, V_2/C_0)$ (3.43). The angle $\alpha_{0,2} = 180^0$

$F_2 = const$ $a_k = 0.999999$

TABLE 12 The values of the F_1/F_2 quotient, $F_2 = const$

III.2 TIME MEASURED BY ATOMIC CLOCKS

Let us introduce the following notations:

$\Delta\tau_1$ time measured by the clock in the inertial system 1,

$\Delta\tau_2$ time measured by the identical clock in the inertial system 2.

Then we adopt the assumptions:

1) The clocks are located in the origins O and O'of the systems 1 and 2 respectively.
2) The origin O of system 2 is in motion with constant velocity $\vec{V}_o$ along a straight line running through the origin O of system 1 (Fig 10).
3) The clocks were synchronized $\Delta\tau_1 = \Delta\tau_2 = 0$ when the origins of the two systems overlapped.

Time measured by the atomic clock depends on the rest mass of its particles, therefore the following equations can be written:

(3.48) $$\frac{\Delta\tau_2}{\Delta\tau_1} = \frac{\omega_{A2}}{\omega_{A1}} = \frac{\sqrt{m_{01}}}{\sqrt{m_{02}}} = (\frac{m_{01}}{m_{02}})^{1/2},$$

where: ω_{A1}, ω_{A2} are atom vibration frequencies in systems 1and 2 respectively

and $m_{01} = m_{02}\sqrt{1-(V_o/C_o)^2}$ relationship (3.27a).

From the equations (3.48) and the relationship (3.27a):

$$\Delta\tau_2 = \Delta\tau_1 (\sqrt{1-(V_o/C_o)^2})^{1/2} = \Delta\tau_1[1-(V_o/C_o)^2]^{1/4},$$ then

(3.49) $$\Delta\tau_2 = \Delta\tau_1[1-(V_o/C_o)^2]^{1/4}$$

There is a dilation in the times measured by the clocks (3.49). The clock in system 2 is delayed with respect to the clock in system 1.

The time measured by the clock in the inertial system 1, which presents a preferred absolute system, defines the absolute time t.

(3.50) $$t = \Delta\tau_1$$

Then applying (3.49) and (3.50) we obtain:

(3.51) $$t = \Delta\tau_1 = \frac{\Delta\tau_2}{[1-(V_o/C_o)^2]^{1/4}}$$

Hence knowing the time $\Delta\tau_2$ that has been measured by the clock in the inertial system 2 and the value of the system's absolute speed V_o, the absolute time can be calculated from the relationship (3.51).

And as the values of the modulus of clock's velocity $\vec{V}_o$ vary (relationship (1.120)), the times measured by the clocks on the Earth's surface are subject to continuous changes.

III.3 DECAY OF PARTICLES

An unstable particle is subject to a decay process which course can be described by the following equations:

(3.52) $$m_1(t) = m_{01} N_0 \exp(-\frac{t}{\tau_1}),$$

(3.53) $$m_2(t) = m_{02} N_0 \exp(-\frac{t}{\tau_2}),$$ where:

m_{01}, m_{02} rest masses of the particle in inertial systems 1 and 2,

N_0 initial number of particles (at $t = 0$), which is identical in inertial systems 1and 2,

$m_1(t)$, $m_2(t)$ masses of particles undecayed during t period in inertial systems 1 and 2,

τ_1, τ_2 average life of particles in inertial systems 1 and 2.

Let us write equations: $$\frac{\tau_2}{\tau_1} = \frac{m_{02}}{m_{01}} = \frac{1}{\sqrt{1-(V_o/C_o)^2}}, \qquad \tau_1 = const$$

Hence average life τ_2 of particles in the inertial system 2:

(3.54) $$\tau_2 = \frac{\tau_1}{\sqrt{1-(V_o/C_o)^2}}$$

The equations that define the number of undecayed particles during the decay time are:

(3.56) $$N_1(t) = N_0 \exp(-\frac{t}{\tau_1}),$$

(3.57) $$N_2(t) = N_0 \exp(-\frac{t}{\tau_2}),$$

where: $N_1(t)$, $N_2(t)$ number of particles undecayed during t period in the inertial systems 1 and 2,

τ_1, τ_2 relationship (3.54).

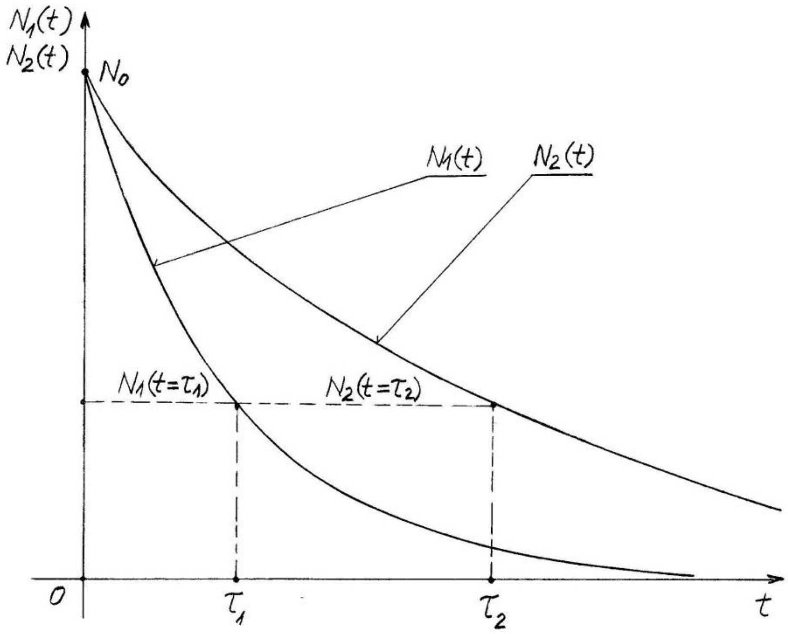

Fig.15 Graphic representation of equations (3.56) and (3.57).

A laboratory can be regarded as the reference system 1, resulting from the absolute speed of the Earth being very small (1.126).
The average life time τ_1 of mezons π^+ that are motionless in relation to the laboratory is:

$$\tau_1 = 2.603 \cdot 10^{-8} s .$$

When the relative speed of mezons π^+ reaches value $V_0 / C_0 = 0.99$, their average life time τ_2 in system 2 i.e. where these particles actually are, can be calculated from the equation (3.54): $\tau_2 = \frac{\tau_1}{\sqrt{1-0.99^2}} = 2.603 \cdot 10^{-8} \cdot 7.088 = 1.845 \cdot 10^{-7} s$, then $\tau_2 > \tau_1$.

Experimental results [3], [5] are in agreement with the average life time τ_2 of mezons π^+ as calculated above. A compliance with relationship (3.54) is also confirmed by experiments with other unstable particles [1].

Equations (3.52), (3.53), (3.56) and (3.57) imply that the decay process of particles in the inertial system 2 is slower than the decay of identical particles in the inertial system 1. The life time of particles in an inertial system that is in motion in relation to the aether is longer than the life time of identical particles in a preferred reference system which is motionless in relation to the aether.

III.4 DETERMINING A SIDEREAL DAY WITH ATOMIC CLOCKS

We start with the following equation: $J_1 \omega_1 = J_2 \omega_2$ which implies that

(3.58) $$\frac{\omega_1}{\omega_2} = \frac{J_2}{J_1} = \frac{m_{02}}{m_{01}} = \frac{1}{\sqrt{1-(V_0 / C_0)^2}} ,$$ where:

$m_{01} = m_{02} \sqrt{1-(V_o / C_o)^2}$ relationship (3.27a),

J_1, J_2 Earth's moment of inertia in systems 1 and 2 respectively,

ω_1, ω_2 angular speed with which the Earth rotates in systems 1 and 2,

m_{01}, m_{02} rest mass of particles on the Earth in systems 1 and 2,

$V_{ze} \approx V_0$ the speed at which the Earth's center travels with respect to the aether (1.126).

From the relationship: $\frac{T_2}{T_1} = \frac{\omega_1}{\omega_2}$, we have $T_2 = \frac{\omega_1}{\omega_2} T_1$, where:

T_1, T_2 Earth's sidereal day in systems 1 and 2.

By applying equations (3.58) and inequality $V_0 / C_0 << 1$, we obtain:

(3.59) $$T_2 = \frac{1}{\sqrt{1-(V_0 / C_0)^2}} T_1 \approx [1+\frac{1}{2}(V_0 / C_0)^2] T_1 .$$

The time measured by an atomic clock on the Earth's surface i.e. in system 2 is:

$$\Delta\tau_2 = [1-(V_0/C_0)^2]^{1/4}\,\Delta\tau_1 \approx [1-\frac{1}{4}(V_0/C_0)^2]\,\Delta\tau_1 \qquad \text{relationship (3.49).}$$

Time $\Delta\tau_2$ that is measured by the clock at $\Delta\tau_1 = T_1$ is:

(3.60) $$\Delta\tau_{2(T1)} \approx [1-\frac{1}{4}(V_0/C_{0)})^2]\,\Delta\tau_1$$

The difference R_T of the duration of the two times:

$$R_T = T_2 - \Delta\tau_{2(T1)},$$

which after taking into consideration equations (3.59) and (3.60) becomes:

(3.60a) $$R_T = \frac{3}{4}(V_0/C_0)^2 T_1 \ .$$ From equation (3.59) we obtain:

(3.60b): $$T_1 = T_2\sqrt{1-(V_0/C_0)^2}$$

Hence the R_T of the time between the duration of the Earth's sidereal day and the time measured by the atomic clock after the day elapsed:

(3.61) $$R_T = \frac{3}{4}(V_0/C_0)^2\sqrt{1-(V_0/C_0)^2}\ T$$; from the equations (3.60a) and (3.60b), where:

$$T_2 = T \approx 86164.091 s .$$

The R_{Trg} of the time between the duration of the Earth's stellar year and the time measured by the atomic clock after the year elapsed:

(3.62) $$R_{Trg} = \frac{3}{4}(V_0/C_0)^2\sqrt{1-(V_0/C_0)^2}\ T_{rg} ,$$ where:

$$T_{rg} = 365.256366\ \ days .$$

V_0/C_0	R_T (3.61)	R_{Trg} (3.62)
	s	s
10^{-4}	$0.646\cdot10^{-3}$	0.236
$1.244\cdot10^{-4}$	10^{-3}	0.365
$1.5\cdot10^{-4}$	$1.454\cdot10^{-3}$	0.532
$2\cdot10^{-4}$	$2.584\cdot10^{-3}$	0.946
$5\cdot10^{-4}$	$16.155\cdot10^{-3}$	5.917

TABLE 13

The inequality $\Delta\tau_{2(T1)} < T_2$ results from equations (3.59) and (3.60). Hence the elongation of the Earth's sidereal day with respect to the time measured by an atomic clock is only apparent (see Table 13). In reality the time measured by the clock is shorter with respect to the time determined by the Earth's rotation which angular speed varies slightly not only due to the movement of masses such as water, snow and lava but also due to the fact that the Earth's speed on its orbit constantly changes.

III.5 DETERMINING THE ABSOLUTE VELOCITIES OF THE EARTH AND THE SUN WITH ATOMIC CLOCKS

There are two methods for determining the absolute velocities of the Earth and the Sun. Both of them involve the use of atomic clocks.

METHOD I:

In which the difference in times that have been measured by two identical atomic clocks ZA_a, ZA_p is exploited.

Assumptions: 1) Clock ZA_a is situated along any given Earth's parallel.

2) Clock ZA_p is situated at the South Pole.

Clock's velocity $\vec{V}_0$ on Earth's surface with respect to the aether is the sum of three vectors:

(3.63) $\vec{V}_0 = \vec{V}_{ra} + \vec{V}_{zs} \pm \vec{V}_{se}$ relationships (2.1), (2.2).

Vector $\vec{V}_{ra}$ is the velocity of the ZA_a clock on the plane of Earth's parallel.

The Earth's center travels with respect to the aether with velocity:

(3.64) $\vec{V}_{ze} = \vec{V}_{zs} \pm \vec{V}_{se}$ so

(3.65) $\vec{V}_0 = \vec{V}_{ra} + \vec{V}_{ze}$

(3.66) $V_{ze} = \sqrt{V_{zs}^2 + V_{se}^2}$

In the coordinate system $OX_2Y_2Z_2$ (Fig. 16) vector $\vec{V}_{ze}$ is located on the Y_2Z_2 plane. The Earth's parallel with clock ZA_a coincides with the X_2Y_2 plane. Thus vector $\vec{V}_{ra}$ is located on the plane X_2Y_2.

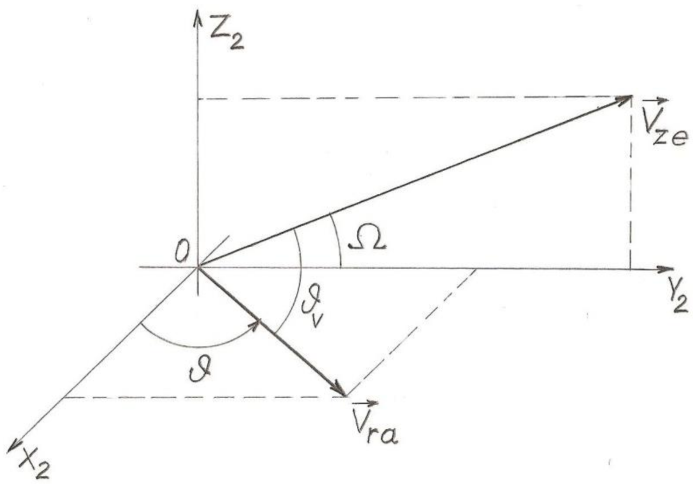

Fig.16 The position of vector $\vec{V}_{ra}$ with respect to $\vec{V}_{ze}$ vector .

SYMBOLS:

Ω an angle between vector $\vec{V}_{ze}$ and the Earth's parallel (plane X_2Y_2),

ϑ an angle between OX_2 axis and vector $\vec{V}_{ra}$,

ϑ_V an angle between vectors $\vec{V}_{ra}$ and $\vec{V}_{ze}$, $\vartheta_V = \measuredangle(\vec{V}_{ra}, \vec{V}_{ze})$

The direction of vector $\vec{V}_{ra}$ varies as a result of changes in the values of angle $\vartheta = \omega_2 \, \Delta\tau_2$.

Clocks are synchronized at the time when vector $\vec{V}_{ra}$ is perpendicular to vector $\vec{V}_{ze}$ i.e. $\vartheta = 0$ (Fig. 16). On the clocks' synchronization day the UT needs to be determined when the vectors $\vec{V}_{ra}$ and $\vec{V}_{ze}$ become perpendicular to each other.
The angles in Fig. 17 follow the equation:

$$\vartheta_{ZAa} = 360^0 - (GHA_s + \psi_R + \lambda)$$

Vector $\vec{V}'_{ra}$ is perpendicular to both vector $\vec{V}'_{zs}$ and $\vec{V}'_{ze}$ when angle $\vartheta_{ZAa} = 180^0$,

thus $180^0 = 360^0 - (GHA_s + \psi_R + \lambda)$. Hence

(3.67) $GHA_s = 180^0 - \psi_R - \lambda$

If the expression $180^0 - \psi_R - \lambda$ takes a negative value then GHA_s :

(3.68) $GHA_s = 360^0 + 180^0 - \psi_R - \lambda$

(3.69) $\psi_R = \alpha_s - \alpha_{zs}$, where:

3.69a) $\alpha_s \approx arctg\,[\,tg\,(\,\psi - 90^0\,)\cos\varepsilon\,]$, $\alpha_{zs} = -\,90^0$ (270^0), ψ relationship (2.7)
the right ascensions after spring equinox, or

(3.69b) $\alpha_s \approx 180^0 - arctg\,[\,tg(90^0 - \psi)\;\cos\varepsilon\,]$, $\alpha_{zs} = 90^0$, ψ relationship (2.10).
the right ascensions before autumn equinox.

True anomaly ν can be obtained from relationship (2.20) or (2.21) adopting for calculations the time UT of the equinox.
We can determine the UT of the clocks synchronization time T_{syn} only on the day of the equinox (spring or autumn), because at that time the projection $\vec{V}'_{ze}$ of vector $\vec{V}_{ze}$ on the equator's plane is the same as the projection $\vec{V}'_{zs}$ of vector $\vec{V}_{zs}$ (Fig. 17).
Knowing the synchronization day and the value of the GHA_s angle obtained from relationships (3.67) or (3.68), the UT of clocks synchronization time T_{syn} can be found in The Nautical Almanac.

The coordinates of vectors $\vec{V}_{ra}$ and $\vec{V}_{ze}$ in the $OX_2Y_2Z_2$ system (Fig.16) are as follows:

$$\vec{V}_{ra} = [V_{ra}\cos\vartheta, \quad V_{ra}\sin\vartheta, \quad 0 \quad]$$

$$\vec{V}_{ze} = [0, \quad V_{ze}\cos\Omega, \quad V_{ze}\sin\Omega\,]$$

Scalar product of vectors $\vec{V}_{ra}$ and $\vec{V}_{ze}$ implies:

$$\cos\vartheta_V = \frac{\vec{V}_{ra}\cdot\vec{V}_{ze}}{V_{ra}V_{ze}} = \frac{V_{ze}\cos\Omega\;V_{ra}\sin\vartheta}{V_{ra}V_{ze}} = \cos\Omega\;\sin\vartheta \;.$$ Therefore

(3.70) $\cos\vartheta_V = \cos\Omega\;\sin\vartheta$

The absolute speed V_{0ra} of the clock located on a parallel can be obtained from the following expression:

$$V_{0ra}^2 = (V_{ze} + V_{ra}\cos\vartheta_V)^2 + (V_{ra}\sin\vartheta_V)^2 = V_{ze}^2 + V_{ra}^2 + 2V_{ra}V_{ze}\cos\vartheta_V \;.$$

Applying (3.70) we have:

(3.71) $V_{0ra}^2 = V_{ze}^2 + V_{ra}^2 + 2\,V_{ra}\,V_{ze}\cos\Omega\;\sin\vartheta$

The absolute speed V_{0p} of the clock located at the South Pole:

(3.72) $V_{0p} = V_{ze}$

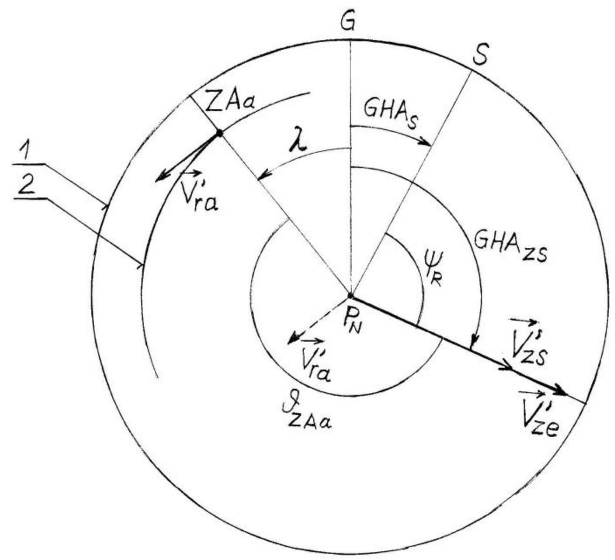

Fig. 17 Angles in the equatorial coordinate system.

SYMBOLS:

P_N	the North Pole,	$\vec{V}'_{ra}$	projection of vector $\vec{V}_{ra}$ on the equator's plane,
1	equator,	$\vec{V}'_{zs}$	projection of vector $\vec{V}_{zs}$ on the equator's plane,
2	parallel (of altitude),	$\vec{V}'_{ze}$	projection of vector $\vec{V}_{ze}$ on the equator's plane,
G	Greenwich,	λ	the longitude of clock's position,
S	the Sun,	ψ_R	the ψ angle in equatorial system (Fig. 7),
ZA_a	atomic clock,	GHA_s	Greenwich Hour Angle of the Sun,
		GHA_{zs}	Greenwich Hour Angle of the $\vec{V}_{zs}$ vector.

Relationship (3.49) determines the times measured by the clocks in systems 1 and 2

$$\Delta\tau_2 = \Delta\tau_1 [1-(V_0/C_0)^2]^{1/4} \approx [1-\frac{1}{4}(V_0/C_0)^2]\,\Delta\tau_1$$

The time measured by the ZA_a clock at a selected point on the parallel:

$$\Delta\tau_{2ra} \approx [1-\frac{1}{4}(V_{0ra}/C_0)^2]\,\Delta\tau_1$$

The time measured by the ZA_p clock at the North Pole:

$$\Delta\tau_{2p} \approx [1-\frac{1}{4}(V_{0p}/C_0)^2]\,\Delta\tau_1$$

The difference in times measured by the clocks $R_{pa} = \Delta\tau_{2p} - \Delta\tau_{2ra} = \frac{1}{4C_0^2}(V_{0ra}^2 - V_{0p}^2)\,\Delta\tau_1$

which, after applying relationships (3.71) and (3.72), takes the following form:

$$R_{pa} = \frac{1}{4C_0^2}[V_{ra}^2 + 2V_{ra}\cos\Omega\,\sin\vartheta]\,\Delta\tau_1$$

The value of the ϑ angle varies, hence very small values of time increments $\Delta\tau_1$ should be considered.

As a result: $dR_{pa} = \frac{1}{4C_0^2}[V_{ra}^2 + 2V_{ra}V_{ze}\cos\Omega\,\sin\vartheta]\,d(\Delta\tau_1)$, $\vartheta = \omega_2\Delta\tau_2$.

Earth's sidereal day $T_2 = T = 86164.091\ s$, $\omega_2 = \frac{2\pi}{T_2} = \frac{2\pi}{T}$. So $\vartheta = \frac{2\pi}{T}\Delta\tau_2$.

According to (3.51) $\Delta\tau_1 = \frac{\Delta\tau_2}{[1-(V_0/C_0)^2]^{1/4}} \approx \Delta\tau_2$, since the value V_0/C_0 is very small.

We now have the following equation: $dR_{pa} = \frac{1}{4C_0^2}[V_{ra}^2 + 2V_{ra}V_{ze}\cos\Omega\ \sin(\frac{2\pi}{T}\Delta\tau_2)]\,d(\Delta\tau_2)$.

The difference in times that have been measured by the clocks during a sidereal half-a-day which commenced at the time of their synchronization:

$$R_{pa(T/2)} = \frac{1}{4C_0^2}[V_{ra}^2 \int_0^{T/2} d(\Delta\tau_2) + 2V_{ra}V_{ze}\cos\Omega \int_0^{T/2} \sin(\frac{2\pi}{T}\Delta\tau_2)\,d(\Delta\tau_2)]$$ and after integration

(3.73) $$R_{pa(T/2)} = \frac{V_{ra}^2 T}{8C_0^2} + \frac{V_{ra}T}{2\pi C_0^2} V_{ze}\cos\Omega$$

The difference in times that have been measured by the clocks during one sidereal day which commenced at the time of their synchronization:

$$R_{pa(T)} = \frac{1}{4C_0^2}[V_{ra}^2 \int_0^{T} d(\Delta\tau_2) + 2V_{ra}V_{ze}\cos\Omega \int_0^{T} \sin(\frac{2\pi}{T}\Delta\tau_2)d(\Delta\tau_2)]$$. After integration

(3.74) $$R_{pa(T)} = \frac{V_{ra}^2}{4C_0^2}T$$

Half-a-day fluctuations of difference in times that have been measured by atomic clocks are observed.
After equation (3.73) has been transformed and relationship (3.66) introduced the following equation appears:

(3.75) $$\frac{2\pi C_0^2\ R_{pa(T/2)}}{V_{ra}\ T} - \frac{\pi V_{ra}}{4} = \sqrt{V_{zs}^2 + V_{se}^2}\ \cos\Omega$$

Now the value of $\cos\Omega$ that appears in equation (3.75) needs to be determined. It can be done by following this procedure:
Vector $\vec{V}_{ze}$ is the sum of two vectors perpendicular to each other:

$$\vec{V}_{ze} = \vec{V}_{zs} \pm \vec{V}_{se}$$ relationship (3.64).

Vector $\vec{V}_{zs}$ is situated on the plane of the ecliptic (Fig.6).

Vectors $+\vec{V}_{se}$ and $-\vec{V}_{se}$ are both perpendicular to the plane of the ecliptic (Fig. 8).

In the $OX_1Y_1Z_1$ system, the coordinates of vector $\vec{V}_{ze}$ are (Fig. 6):

(3.76) $\vec{V}_{ze} = [V_{zs}\cos\eta\ , \quad V_{zs}\sin\eta\ , \quad \pm V_{se}\ ]$, where:

(3.77) $\eta = 180^0 - \eta_2$ when $0 < \nu \le 180^0 - \eta_0$

(3.78) $\eta = 180^0 + \eta_2$ when $180^0 - \eta_0 < \nu < 180^0$

(3.79) $\eta = \eta_3$ when $180^0 < \nu < 360^0$, where:

η_3 relationship (2.4), η_0 relationship (2.6),

η_2 relationship (2.5), ν true anomaly.

Let $\vec{W}$ be a unit vector situated along the Earth's axis and pointing north. This vector is therefore perpendicular to the plane of the parallel.
The coordinates of vector $\vec{W}$ in system $OX_1Y_1Z_1$ are (Fig. 6):

$\vec{W} = [\cos(90^0 - \varepsilon)\ \cos(-\eta_1)\ , \quad \cos(90^0 - \varepsilon)\sin(-\eta_1)\ , \quad \sin(90^0 - \varepsilon)\ ]$. After reduction

(3.80) $\vec{W} = [\sin\varepsilon\ \cos\eta_1\ , \quad -\sin\varepsilon\ \sin\eta_1\ , \quad \cos\varepsilon\ ]$, where:

ε the inclination of the ecliptic to the equator,
η_1 an angle obtained from equation (2.17), (Fig.6).

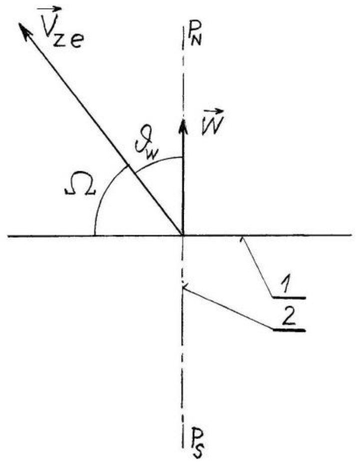

Fig. 18a Position of vector $\vec{V}_{ze} = \vec{V}_{zs} + \vec{V}_{se}$

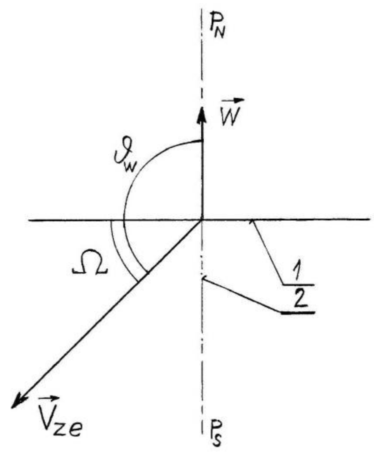

Fig. 18b Position of vector $\vec{V}_{ze} = \vec{V}_{zs} - \vec{V}_{se}$

SYMBOLS:

1 parallel plane i.e. its projection,

2 Earth's axis,

$\vec{W}$ a unit vector.

ϑ_W the angle between vectors $\vec{W}$ and $\vec{V}_{ze}$, $\vartheta_W = \measuredangle(\vec{W}, \vec{V}_{ze})$

Scalar product of vectors (3.76) and (3.80) gives:

$$\cos\vartheta_W = \frac{\vec{W}\cdot\vec{V}_{ze}}{WV_{ze}} \;, \qquad W = 1. \qquad \text{This implies that}$$

$$\cos\vartheta_W = \frac{1}{V_{ze}}\,(V_{zs}\cos\eta\,\sin\varepsilon\,\cos\eta_1 - V_{zs}\sin\eta\,\sin\varepsilon\,\sin\eta_1 \pm V_{se}\cos\varepsilon\,)$$

which, after transformation and with relationship (3.66) included, makes:

$$\text{(3.81)} \qquad \cos\vartheta_W = \frac{V_{zs}\sin\varepsilon\;\cos(\eta+\eta_1)\;\pm V_{se}\cos\varepsilon}{\sqrt{V_{zs}^2 + V_{se}^2}}$$

According to Figures 18a and 18b the following expressions can be written respectively:

$$\vartheta_W = 90^0 - \Omega\;,$$

$$\vartheta_W = 90^0 + \Omega\;. \qquad \text{Hence}$$

$$\cos\vartheta_W = \cos(90^0 \mp \Omega) = \pm\sin\Omega\;. \quad \text{In this way} \qquad \sin\Omega = \pm\cos\vartheta_W\,. \quad \text{So}$$

$$\Omega = \arcsin(\pm\cos\vartheta_W) = \pm\arcsin(\cos\vartheta_W)\,. \quad \text{Hence}$$

$$\cos\Omega = \cos[\pm\arcsin(\cos\vartheta_W)] = \cos[\arcsin(\cos\vartheta_W)]\,.$$

Then after applying equation (3.81):

$$\text{(3.82)} \qquad \cos\Omega = \cos[\,\arcsin\frac{V_{zs}\sin\varepsilon\;\cos(\eta+\eta_1)\;\pm V_{se}\cos\varepsilon}{\sqrt{V_{zs}^2 + V_{se}^2}}\,]$$

If relationship (3.82) is used in equation (3.75), the following expression appears:

$$\text{(3.83)} \qquad \frac{2\,\pi\,C_0^2\;R_{pa(T/2)}}{V_{ra}\,T} - \frac{\pi\,V_{ra}}{4} = \sqrt{V_{zs}^2 + V_{se}^2}\;\cos[\,\arcsin\frac{V_{zs}\sin\varepsilon\;\cos(\eta+\eta_1)\;\pm V_{se}\;\cos\varepsilon}{\sqrt{V_{zs}^2 + V_{se}^2}}\,]$$

Now we have two equations for calculating the speed V_{se} of the Sun with respect to the aether:

$$\text{(3.84)} \qquad \frac{2\,\pi\,C_0^2\;R_{pa(T/2)}}{V_{ra}\,T} - \frac{\pi\,V_{ra}}{4} = \sqrt{V_{zs}^2 + V_{se}^2}\;\cos[\,\arcsin\frac{V_{zs}\sin\varepsilon\;\cos(\eta+\eta_1)\;+ V_{se}\;\cos\varepsilon}{\sqrt{V_{zs}^2 + V_{se}^2}}\,],$$

when $\vec{V}_{ze} = \vec{V}_{zs} + \vec{V}_{se}$, or

(3.85) $$\frac{2\pi C_0^2\, R_{pa\,(T/2)}}{V_{ra}\,T} - \frac{\pi V_{ra}}{4} = \sqrt{V_{zs}^2 + V_{se}^2}\ \cos[\ \arcsin\frac{V_{zs}\sin\varepsilon\ \cos(\eta+\eta_1)\ - V_{se}\ \cos\varepsilon}{\sqrt{V_{zs}^2+V_{se}^2}}\ ]\ ,$$

when $\vec{V}_{ze} = \vec{V}_{zs} - \vec{V}_{se}$

Knowing $R_{pa(T/2)}$, the absolute speed V_{se} of the Sun can be calculated from equations (3.84) or (3.85) by the method of successive approximations. The $R_{pa(T/2)}$ is the absolute value of the difference in times that have been measured by atomic clocks after half a sidereal day has elapsed since the time of their synchronization.

Having calculated V_{se} , the absolute speed V_{ze} of the Earth can be obtained as follows:

$V_{ze} = \sqrt{V_{zs}^2 + V_{se}^2}$ relationship (3.66), where:

V_{zs} relationship (2.35).

The speed of clock: $V_{ra} = \omega R \cos\varphi$ relationship (2.3).

Cconsequently the speeds are: V_{ze} , V_{se} (Table 14) from equations (3.84) & (3.66) or (3.85) & (3.66).

No.	$R_{pa\,(T/2)}$ For equation (3.84), $+\vec{V}_{se}$	$R_{pa\,(T/2)}$ For equation (3.85), $-\vec{V}_{se}$	Values obtained from equations: (3.84) & (3.66) or (3.85) & (3.66)	
			V_{ze}/C_0	V_{se}/C_0
	s	s	–	–
1	$1.0567\cdot10^{-6}$	$1.4148\cdot10^{-6}$	$1.0436\cdot10^{-4}$	$0.3333\cdot10^{-4}$
2	$0.8806\cdot10^{-6}$	$1.5910\cdot10^{-6}$	$1.1897\cdot10^{-4}$	$0.6613\cdot10^{-4}$
3	$0{,}8305\cdot10^{-6}$	$1.6421\cdot10^{-6}$	$1.2440\cdot10^{-4}$	$0.7546\cdot10^{-4}$
4	$0.6360\cdot10^{-6}$	$1.8356\cdot10^{-6}$	$1.4916\cdot10^{-4}$	$1.1166\cdot10^{-4}$
5	$0.5439\cdot10^{-6}$	$1.9277\cdot10^{-6}$	$1.6239\cdot10^{-4}$	$1.2880\cdot10^{-4}$
6	$0.1196\cdot10^{-6}$	$2.3520\cdot10^{-6}$	$2.3014\cdot10^{-4}$	$2.0780\cdot10^{-4}$

$R_{pa(T/2)}$ values adopted for calculations,

V_{ze}/C_0 absolute speed of the Earth's center relative to the speed of the light C_0,

V_{se}/C_0 absolute speed of the Sun's center relative to the speed of the light C_0 .

TABLE 14.

Table 14 provides the results of calculations of the V_{ze}/C_0 and V_{se}/C_0 values which correspond to the $R_{pa(T/2)}$ values adopted for calculations.

The values in no. 6 cannot be accepted for two reasons:

1. If V_{ze}/C_0 took value given in no. 6, the shifts of interference fringes in the Michelson's interferometer would be visible (Table 2).

2. Apparent elongation of the Earth's sidereal day would take a few milliseconds (Table 13).

Given $R_{pa(T/2)}$, the value calculated from the experiment, the absolute speed of the Earth's center and the absolute speed of the Sun's center can be obtained with the use of method I.

Given $R_{pa(T/2)}$,the direction of the absolute velocity of the Sun's center ($+\vec{V}_{se}$ or $-\vec{V}_{se}$, Fig. 8) can also be determined if we know from which equation ((3.84) or (3.85)) the value of V_{se}/C_0 was obtained .

PROGRAM VzeVse was applied for calculations (for results – see Table 14).

METHOD II.

In which the difference in times that have been measured by two identical atomic clocks ZA_a, ZA_b, that are located along any given Earth's parallel, is exploited.

Assumptions: 1) The distance clock-Earth's center is identical.

2) Clock ZA_a is placed in location of λ longitude.

Clock ZA_b is placed in location of $\lambda + 180^0$ longitude.

The clocks are synchronized at the time when velocity $\vec{V}_{ra}$ of the ZA_a clock is perpendicular to vector $\vec{V}_{ze}$ (Fig. 17). Method I discussed above describes procedures for determining the UT of synchronization time.

The absolute speed V_{0ra} of the ZAa clock:

$$V_{0ra}^2 = V_{ze}^2 + V_{ra}^2 + 2\, V_{ra}\, V_{ze} \cos\Omega \ \sin\vartheta \qquad \text{equation (3.71).}$$

Hence the absolute speed V_{0rb} of the ZA_b clock:

(3.86) $$V_{0rb}^2 = V_{ze}^2 + V_{rb}^2 + 2\ V_{rb}\, V_{ze} \cos\Omega \ \sin(\vartheta + \pi) \quad , \qquad V_{rb} = V_{ra}$$

Time measured by the ZA_a clock:

$$\Delta\tau_{2ra} \approx [1 - \frac{1}{4}(V_{0ra} / C_0)^2]\, \Delta\tau_1$$

Time measured by the ZA_b clock:

$$\Delta\tau_{2rb} \approx [1 - \frac{1}{4}(V_{0rb} / C_0)^2]\, \Delta\tau_1$$

The difference in times measured by the clocks: $R_{ba} = \Delta\tau_{2rb} - \Delta\tau_{2ra} = \dfrac{1}{4\, C_0^2}(V_{0ra}^2 - V_{0rb}^2)\ \Delta\tau_1$

After applying equations (3.71) and (3.86): $R_{ba} = \dfrac{1}{2\, C_0^2} V_{ra}\, V_{ze} \cos\Omega\, [\sin\vartheta - \sin(\vartheta + \pi)\,]\, \Delta\tau_1$

If $\Delta\tau_1$ are the values of very small time increments, then:

$$dR_{ba} = \frac{1}{2\, C_0^2} V_{ra}\, V_{ze} \cos\Omega\ [\sin\vartheta - \sin(\vartheta + \pi)\,]\ d(\Delta\tau_1)\ .$$

According to relationship (3.51) $\Delta\tau_1 = \dfrac{\Delta\tau_2}{[1 - (V_0 / C_0)^2\,]^{1/4}} \approx \Delta\tau_2$ as the V_0 / C_0 value is very small.

The angles $\vartheta = \dfrac{2\pi}{T}\Delta\tau_2$, $\quad \vartheta + \pi = \dfrac{2\pi}{T}(\Delta\tau_2 + \dfrac{T}{2})$.

Hence $$dR_{ba} = \frac{1}{2\, C_0^2} V_{ra}\, V_{ze} \cos\Omega\ \{ \sin(\frac{2\pi}{T}\Delta\tau_2) - \sin[\frac{2\pi}{T}(\Delta\tau_2 + \frac{T}{2})]\}\ d(\Delta\tau_2)$$

Difference in times measured by the clocks during a sidereal half-a-day that commenced at the synchronization time:

$$R_{ba\,(T/2\,)} = \frac{1}{2\, C_0^2} V_{ra}\, V_{ze} \cos\Omega \int_0^{T/2} \{ \sin(\frac{2\pi}{T}\Delta\tau_2) - \sin[\frac{2\pi}{T}(\Delta\tau_2 + \frac{T}{2})]\}\ d(\Delta\tau_2)\,.$$ After integration

(3.87) $$R_{ba\,(T/2\,)} = \frac{V_{ra}\, T}{\pi\, C_0^2} V_{ze}\ \cos\Omega\ .$$

Difference in times measured by the clocks during a sidereal day that commenced at the synchronization time:

$$R_{ba\,(T\,)} = \frac{1}{2\, C_0^2} V_{ra}\, V_{ze} \cos\Omega \int_0^{T} \{ \sin(\frac{2\pi}{T}\Delta\tau_2) - \sin[\frac{2\pi}{T}(\Delta\tau_2 + \frac{T}{2})]\}\ d(\Delta\tau_2)\,.$$ After integration

(3.88) $$R_{ba\,(T\,)} = 0$$

After equation (3.87) has been transformed and relationships (3.66) and (3.82) implemented:

$$\frac{\pi\, C_0^2\ R_{ba\,(T/2\,)}}{V_{ra}\, T} = \sqrt{V_{zs}^2 + V_{se}^2}\ \cos[\arcsin\frac{V_{zs}\sin\varepsilon\ \cos(\eta + \eta_1)\ \pm V_{se}\cos\varepsilon}{\sqrt{V_{zs}^2 + V_{se}^2}}\ ]$$

That provides two equations for calculating the speed V_{se} of the Sun with respect to the aether:

(3.89) $$\frac{\pi C_0^2 R_{ba(T/2)}}{V_{ra} T} = \sqrt{V_{zs}^2 + V_{se}^2} \cos[\arcsin \frac{V_{zs} \sin\varepsilon \cos(\eta+\eta_1) + V_{se}\cos\varepsilon}{\sqrt{V_{zs}^2+V_{se}^2}}] ,$$

when $\vec{V}_{ze} = \vec{V}_{zs} + \vec{V}_{se}$, or

(3.90) $$\frac{\pi C_0^2 R_{ba(T/2)}}{V_{ra} T} = \sqrt{V_{zs}^2 + V_{se}^2} \cos[\arcsin \frac{V_{zs} \sin\varepsilon \cos(\eta+\eta_1) - V_{se}\cos\varepsilon}{\sqrt{V_{zs}^2+V_{se}^2}}] ,$$

when $\vec{V}_{ze} = \vec{V}_{zs} - \vec{V}_{se}$

Knowing $R_{ba(T/2)}$, the absolute speed V_{se} of the Sun can be calculated from equations (3.89) or (3.90) by the method of successive approximations. The $R_{ba(T/2)}$ is the absolute value of the difference in times that have been measured by the atomic clocks after half a sidereal day elapsed since the synchronization time.

Having V_{se} , the absolute speed V_{ze} of the Earth can be obtained as follows:

$V_{ze} = \sqrt{V_{zs}^2 + V_{se}^2}$ relationship (3.66), where:

V_{zs} relationship (2.35),

The speed of the clock : $V_{ra} = \omega R \cos\varphi$ relationship (2.3).

Consequently the speeds are: V_{ze} , V_{se} (Table 15) from equations (3.89) & (3.66) or (3.90) & (3.66)

No.	$R_{ba\,(T/2)}$ For equation (3.89), $+\vec{V}_{se}$	$R_{ba\,(T/2)}$ For equation (3.90), $-\vec{V}_{se}$	Values obtained from equations: (3.89) & (3.66) or (3.90) & (3.66)	
			V_{ze}/C_0	V_{se}/C_0
	s	s	–	–
1	$2.0927 \cdot 10^{-6}$	$2.8089 \cdot 10^{-6}$	$1.0436 \cdot 10^{-4}$	$0.3333 \cdot 10^{-4}$
2	$1.7403 \cdot 10^{-6}$	$3.1612 \cdot 10^{-6}$	$1.1897 \cdot 10^{-4}$	$0.6613 \cdot 10^{-4}$
3	$1.6401 \cdot 10^{-6}$	$3.2615 \cdot 10^{-6}$	$1.2440 \cdot 10^{-4}$	$0,7546 \cdot 10^{-4}$
4	$1.2511 \cdot 10^{-6}$	$3.6504 \cdot 10^{-6}$	$1.4916 \cdot 10^{-4}$	$1.1166 \cdot 10^{-4}$
5	$1.0670 \cdot 10^{-6}$	$3.8345 \cdot 10^{-6}$	$1.6239 \cdot 10^{-4}$	$1.2880 \cdot 10^{-4}$
6	$0.2183 \cdot 10^{-6}$	$4.6832 \cdot 10^{-6}$	$2.3014 \cdot 10^{-4}$	$2.0780 \cdot 10^{-4}$
$R_{ba(T/2)}$ values adopted for calculations, V_{ze}/C_0 absolute speed of the Earth's center relative to the speed of the light C_0, V_{se}/C_0 absolute speed of the Sun's center relative to the speed of the light C_0 .				

TABLE 15.

Table 15 provides the results of calculations of the V_{ze}/C_0 , V_{se}/C_0 values which correspond to the $R_{ba(T/2)}$ values that were adopted for calculations.The values in no. 6 cannot be accepted due to reasons described in method I.

Given $R_{ba(T/2)}$, the value calculated from the experiment, the absolute speed of the Earth's center and the absolute speed of the Sun's center can be obtained with the use of method II.

Given $R_{ba(T/2)}$, the direction of the absolute velocity of the Sun's center ($+\vec{V}_{se}$ or $-\vec{V}_{se}$, Fig. 8) can also be determined if we know from which equation ((3.89) or (3.90)) the value of V_{se}/C_0 was obtained.

PROGRAM VzeVse was applied for calculations (for results – see Table 15).

III.5.1 CALCULATING ABSOLUTE VELOCITIES OF THE EARTH AND THE SUN
(Example)

Assumptions:

1) Atomic clock ZA_a is located in a place with geographical coordinates:

   $\varphi = 50^o 34^{'}$, $\lambda = 21^o 41^{'}$ (Tarnobrzeg city, Poland)

2) Experiment begins on 23rd September 2011 with the aim to obtain the difference in times that have been measured by the atomic clocks.

First, the synchronization time of atomic clocks needs to be calculated as follows:
Year 2010. Astronomical winter starts on 21st December $23^h 38^m.5$ of the UT.
Year 2011. Astronomical spring starts on 20th March, $23^h 20^m.7$ of the UT.
From that it can be inferred that the duration of astronomical winter in 2010-2011:
$T_z = 88^d 23^h 42^m.2 = 88.9876388$ *days*. Precession in longitude during astronomical winter (2.16) is: $\Delta p = (T_z / T_{rz})\, 50^{''}.292 = 5.9404049 \cdot 10^{-5}$ *rad*.
From equation (2.17) i.e.: $88.9876388 = t(\pi/2 - 5.9404049 \cdot 10^{-5} - \eta_1) - t(2\pi - \eta_1)$ the value of the angle η_1 (Fig. 6) can be calculated by the method of successive approximations:

$$\eta_1 = 0.2295109 \; rad = 13^0.1501154$$

From relationship (2.18) we have: $T_a = t(\eta_1) = 12.9054648$ *days*.
The period of time that elapsed from the start of astronomical winter of 2010 until the end of the calendar year: $T_b = 9^d 21^m.5 = 9.0149305$ *days*.
Difference of the two times: $T_a - T_b = 3.8905379$ *days*.
Autumn equinox: 23rd September, $9^h 4^m.6$ UT.
Time $t_4(\nu)$ which elapsed from the start of the calendar year of 2011 until $9^h 4^m.6$ o'clock UT on 23rd September 2011 is $t_4(\nu) = 265^d 9^h 4^m.6 = 265.3781944$ *days*. Given the inequality $180^o < \nu < 360^o$ and the equation (2.21), in which $265.3781944 = T_{rg} + t(\nu) + 3.8905379$, the value of true anomaly can be calculated by the method of successive approximations:

$$\nu = 4.465626 \; rad = 255^0.8621.$$

From equation (2.10) we have: $\psi = 89^0.0678643$.
From equation (3.69b): $\alpha_s \approx 180^0 - arctg\,[tg(90^0 - \psi)\; \cos\varepsilon\,] = 179^0.1448396$, $\alpha_{zs} = 90^0$
From equation (3.69): $\psi_R = \alpha_s - \alpha_{zs} = 89^0.1448396$
From equation (3.67): $GHA_s = 180^0 - \psi_R - \lambda = 69^0.1718271$ ($\lambda = 21^0\, 41' = 21^0.6833333$).
According to The Nautical Almanac, the time that corresponds with that GHA_s angle is: $16^h 29^m 5^s$ UT.
The UT of clocks synchronization time: $T_{syn} = 16^h 29^m 5^s$ UT.
Thus the clocks need to be synchronized at $16^h 29^m 5^s$ of UT on 23rd September.
Then after half a sidereal day has elapsed since the synchronization time of the clocks i.e. at $4^h 27^m 7^s$ of UT on 24th September, the difference in times that had been measured by the atomic clocks has to be taken and used in calculations.
PROGRAM VzeVse, detailed in this work, was used to calculate the absolute speed values of the Earth and the Sun. After the values $R_{pa(T/2)}$ or $R_{ba(T/2)}$ were applied to the program together with the value of true anomaly $\nu = 255^0.8621$, the absolute speed values of the Earth and the Sun were obtained (see method I and method II).

The results for values of $R_{pa(T/2)}$, $R_{ba(T/2)}$ are presented in tables 14 and 15.

CHAPTER IV

PROGRAMS

IV.1 PROGRAM: abIM

The following symbols were adopted and used in the program:

Vw $= V_o / C_o$, ew1 = $(e_{a5} - e_0)/\lambda_0$, ew2 = $(e_{b5} - e_0)/\lambda_0$, L0 $= \lambda_o$

- g thickness of the semi-transparent PP plate,
- g1 angle γ_1,
- g2 angle γ_2,
- ap adopted value of angle a,
- a angle α ,
- b angle β ,
- h increment of α , β angles,
- F angle Φ ,
- de a very small positive number used for calculations.

Angles given in radian measure.

In PROGRAM abIM the following values were used:

ap = 0.1 rad , h $= 10^{-14}$ rad , de = 10^{-7} .

Shifts of interference fringes are determined with respect to point Mo with a coordinate

$e_0 = 0.1508323849500$ m .

After introducing the values of F, Vw variables into the program, the calculations end when the conditions of the approximations of points A_5, B_5 to point M_0 are satisfied:

ew1 ≤ de and ew2 ≤ de .

Then $|$ ew1 $| = | (e_{a5} - e_0) / \lambda_0 | < 10^{-7}$ and $|$ ew2 $| = | (e_{b5} - e_0) / \lambda_0 | < 10^{-7}$

Following values were used in calculations:

1) Basic dimensions of the Michelson's interferometer.

   $L_1 = L_3 + 1.2\ m$, $L_3 = 0.14\ m$,

   $L_2 = 1.2\ m$, $L_4 = 0.10\ m$,

   $g = 1.25 \cdot 10^{-3}\ m$ (thickness of PP plate).

2) The wavelength of light in a vacuum $\lambda_o = 5.9 \cdot 10^{-7}\ m$.
3) The PP plate refractive index with respect to a vacuum $n_2 = 1.52$.

Programs are written in TURBO PASCAL 7.

```
PROGRAM abIM;
        Var
    a, ap, b,Vw,  h, de, ew, ew1, ew2,  Rw, g1, g2, g11, g22,
    a1, a2, a3, a4, a5, b1, b2, b3, b4, b5,
    xa1, xa2, xa3, xa4, xa5, xa21, xa31, xa41, xa51,
    xb1, xb2, xb3, xb4, xb5, xb21, xb31, xb41, xb51,
    ya1, ya2, ya3, ya4, ya5, ya21, ya31, ya41, ya51,
    yb1, yb2, yb3, yb4, yb5, yb21, yb31, yb41, yb51,
    xya1, xya31, xya4, xya41,
    xyb1, xyb2, xyb4, xyb21, xyb41,
    r21, r22, r221, r23, r31, r32, r321, r33,
    r41, r411, r42, r421, r43, r51, r52, r521, r53,
    s21, s211, s22, s221, s23, s31, s32, s321, s33,
    s41, s411, s42, s421, s43, s51, s52, s521, s53,
    ea1, ea2, ea3, ea4, ea5, eb1, eb2, eb3, eb4, eb5,
    qa1, qa2, qa3, qa4, qa5, qb1, qb2, qb3, qb4, qb5,
    a1u, a2u, a3u, a4u, a5u, b1u, b2u, b3u, b4u, b5u: real;

        Const
    L1=0.14+1.2;   L2=1.2;   L3=0.14;   L4=0.1;   L0=5.9E-7;   g=1.25E-3;
    Pi=3.14159265358;  ap=0.1;  de=1e-7;  h=1e-14; e0=0.15083238495;

BEGIN   write('ap=');          read(ap);
        write('F=');           read(F);
        write('Vw=');          read(Vw);

              a:=ap;     ew1:=0;

REPEAT        a:=a-(ABS(ew1)/de)*h;

              g11:=sin(Pi/4-a)/n2;
               g1:=arctan(g11/sqrt(1-g11*g11));

    a1:=L3/(cos(a)-sin(a)-Vw*(cos(F)-sin(F)));
                    xya1:=L3+a1*Vw*(cos(F)-sin(F));
   xa1:=xya1*cos(a)/(cos(a)-sin(a));
   ya1:=xya1*sin(a)/(cos(a)-sin(a));

             xa21:=(L2-ya1+a1*Vw*sin(F))*sin(a)/cos(a);
             ya21:=L2+a1*Vw*sin(F)-ya1;
                  r21:=Vw*sin(F)*(xa21*sin(a)/cos(a)+ya21);
                 r221:=Vw*sin(F)/cos(a);
                  r22:=1-r221*r221;
                  r23:=r21*r21+r22*(xa21*xa21+ya21*ya21);
    a2:=(r21+sqrt(r23))/r22;
   xa2:=xa1+(L2-ya1+(a1+a2)*Vw*sin(F))*sin(a)/cos(a);
   ya2:=L2+(a1+a2)*Vw*sin(F);

        xya31:=L3+ya2+(a1+a2)*Vw*(cos(F)-sin(F));
         xa31:=sin(a)*xya31/(sin(a)+cos(a))+cos(a)*xa2/(sin(a)+cos(a))-xa2;
         ya31:=sin(a)*xya31/(sin(a)+cos(a))+cos(a)*xa2/(sin(a)+cos(a))+
              -L3-(a1+a2)*Vw*(cos(F)-sin(F))-ya2;
          r31:=(xa31*sin(a)-ya31*cos(a))*Vw*(cos(F)-sin(F))/(sin(a)+cos(a));
         r321:=Vw*(cos(F)-sin(F))/(sin(a)+cos(a));
           r32:=1-r321*r321;
           r33:=r31*r31+r32*(xa31*xa31+ya31*ya31);
```

```
                    a3:=(r31+sqrt(r33))/r32;
                   xa3:=(sin(a)/(sin(a)+cos(a)))*(L3+ya2+(a1+a2+a3)*Vw*(cos(F)-sin(F)))+
                           +cos(a)*xa2/(sin(a)+cos(a));
                   ya3:=(sin(a)/(sin(a)+cos(a)))*xya31+cos(a)*xa2/(sin(a)+cos(a))+
                           -L3-(a1+a2)*Vw*(cos(F)-sin(F))+
                           -(cos(a)/(sin(a)+cos(a)))*a3*Vw*(cos(F)-sin(F));

                                  xya41:=L3+sqrt(2)*g+(a1+a2+a3)*Vw*(cos(F)-sin(F))+
                                           +sin(Pi/4+g1)*xa3/cos(Pi/4+g1)+ya3;
                               xa41:=(cos(Pi/4+g1)/(sin(Pi/4+g1)+cos(Pi/4+g1)))*xya41-xa3;
                               ya41:=-(sin(Pi/4+g1)/(sin(Pi/4+g1)+cos(Pi/4+g1)))*xya41+
                                       +sin(Pi/4+g1)*xa3/cos(Pi/4+g1);
                            r411:=xa41*cos(Pi/4+g1)-ya41*sin(Pi/4+g1);
                             r41:=r411*n2*Vw*(cos(F)-sin(F))/(sin(Pi/4+g1)+cos(Pi/4+g1));
                            r421:=n2*Vw*(cos(F)-sin(F))/(sin(Pi/4+g1)+cos(Pi/4+g1));
                             r42:=1-r421*r421;
                             r43:=r41*r41+r42*(xa41*xa41+ya41*ya41);
                    a4:=(r41+sqrt(r43))/r42;
                          xya4:=L3+sqrt(2)*g+(a1+a2+a3+n2*a4)*Vw*(cos(F)-sin(F))+
                                  +sin(Pi/4+g1)*xa3/cos(Pi/4+g1)+ya3;
                   xa4:=cos(Pi/4+g1)*xya4/(sin(Pi/4+g1)+cos(Pi/4+g1));
                   ya4:=-sin(Pi/4+g1)*xya4/(sin(Pi/4+g1)+cos(Pi/4+g1))+
                           +ya3+sin(Pi/4+g1)*xa3/cos(Pi/4+g1);

                            xa51:=(L4-(a1+a2+a3+n2*a4)*Vw*sin(F)+ya4)*sin(a)/cos(a);
                            ya51:=-L4+(a1+a2+a3+n2*a4)*Vw*sin(F)-ya4;
                               r51:=(ya51-xa51*sin(a)/cos(a))*Vw*sin(F);
                              r521:=Vw*sin(F)/cos(a);
                               r52:=1-r521*r521;
                               r53:=r51*r51+r52*(xa51*xa51+ya51*ya51);
                     a5:=(r51+sqrt(r53))/r52;
                    xa5:=(L4-(a1+a2+a3+n2*a4+a5)*Vw*sin(F)+ya4)*sin(a)/cos(a)+xa4;
                    ya5:=-L4+(a1+a2+a3+n2*a4+a5)*Vw*sin(F);
                              ea5:=xa5-(a1+a2+a3+n2*a4+a5)*Vw*cos(F);

                              ew1:=(ea5-e0)/L0;
                    if  a<-0.4   then   ew1:=de;

UNTIL  ew1<=de;

                              b:=ap;     ew2:=0;

REPEAT  b:=b-(ABS(ew2)/de)*h;

                              g22:=sin(Pi/4+b)/n2;
                               g2:=arctan(g22/sqrt(1-g22*g22));

                     b1:=L3/(cos(b)-sin(b)-Vw*(cos(F)-sin(F)));
                                          xyb1:=L3+b1*Vw*(cos(F)-sin(F));
                    xb1:=xyb1*cos(b)/(cos(b)-sin(b));
                    yb1:=xyb1*sin(b)/(cos(b)-sin(b));

                                 xyb21:=L3+sqrt(2)*g+b1*Vw*(cos(F)-sin(F))+yb1+
                                          +sin(Pi/4-g2)*xb1/cos(Pi/4-g2);
                           xb21:=cos(Pi/4-g2)*xyb21/(sin(Pi/4-g2)+cos(Pi/4-g2))-xb1;
                           yb21:=-sin(Pi/4-g2)*xyb21/(sin(Pi/4-g2)+cos(Pi/4-g2))+
```

```
                              + sin(Pi/4-g2)*xb1/cos(Pi/4-g2);
                        s211:=xb21*cos(Pi/4-g2)-yb21*sin(Pi/4-g2);
                         s21:=s211*n2*Vw*(cos(F)-sin(F))/(sin(Pi/4-g2)+cos(Pi/4-g2));
                        s221:=n2*Vw*(cos(F)-sin(F))/(sin(Pi/4-g2)+cos(Pi/4-g2));
                        s22:=1-s221*s221;
                          s23:=s21*s21+s22*(xb21*xb21+yb21*yb21);
              b2:=(s21+sqrt(s23))/s22;
                         xyb2:=L3+sqrt(2)*g+(b1+n2*b2)*Vw*(cos(F)-sin(F))+yb1+
                              + sin(Pi/4-g2)*xb1/cos(Pi/4-g2);
              xb2:= cos(Pi/4-g2)*xyb2/(sin(Pi/4-g2)+cos(Pi/4-g2));
              yb2:=-sin(Pi/4-g2)*xyb2/(sin(Pi/4-g2)+cos(Pi/4-g2))+yb1+
                     + sin(Pi/4-g2)*xb1/cos(Pi/4-g2);
                      xb31:=L1+(b1+n2*b2))*Vw*cos(F)-xb2;
                      yb31:=(L1+(b1+n2*b2)*Vw*cos(F))*sin(b)/cos(b)-sin(b)*xb2/cos(b);
                              s31:=(xb31+yb31*sin(b)/cos(b))*Vw*cos(F);
                            s321:=Vw*cos(F)/cos(b);
                              s32:=1-s321*s321;
                              s33:= s31*s31+s32*(xb31*xb31+yb31*yb31);
           b3:=(s31+sqrt(s33))/s32;
         xb3:=L1+(b1+n2*b2+b3)*Vw*cos(F);
         yb3:=(sin(b)/cos(b))*(L1+(b1+n2*b2+b3)*Vw*cos(F))+yb2-sin(b)*xb2/cos(b);

                            xyb41:=L3+sqrt(2)*g+(b1+n2*b2+b3)*Vw*(cos(F)-sin(F))+yb3+
                                   + sin(b)*xb3/cos(b);
                             xb41:= (cos(b)/(sin(b)+cos(b)))*xyb41-xb3;
                             yb41:=-(sin(b)/(sin(b)+cos(b)))*xyb41+sin(b)*xb3/cos(b);
                            s 411:=xb41*cos(b)-yb41*sin(b);
                               s41:=s411*Vw*(cos(F)-sin(F))/(sin(b)+cos(b));
                             s421:=Vw*(cos(F)-sin(F))/(sin(b)+cos(b));
                               s42:=1-s421*s421;
                               s43:=s41*s41+s42*(xb41*xb41+yb41*yb41);
     b4:=(s41+sqrt(s43))/s42;
             xyb4:=L3+sqrt(2)*g+(b1+n2*b2+b3+b4)*Vw*(cos(F)-sin(F))+yb3+
                   + sin(b)*xb3/cos(b);
    xb4:= cos(b)*xyb4/(sin(b)+cos(b));
    yb4:=-sin(b)*xyb4/(sin(b)+cos(b))+yb3+sin(b)*xb3/cos(b);

              xb51:=(L4-(b1+n2*b2+b3+b4)*Vw*sin(F)+yb4)*sin(b)/cos(b);
              yb51:=-L4+(b1+n2*b2+b3+b4)*Vw*sin(F)-yb4;
                              s51:=(yb51-xb51*sin(b)/cos(b))*Vw*sin(F);
                            s521:=Vw*sin(F)/cos(b);
                              s52:=1-s521*s521;
                              s53:=s51*s51+s52*(xb51*xb51+yb51*yb51);
     b5:=(s51+sqrt(s53))/s52;
    xb5:=(L4-(b1+n2*b2+b3+b4+b5)*Vw*sin(F)+yb4)*(sin(b)/cos(b))+xb4;
    yb5:=-L4+(b1+n2*b2+b3+b4+b5)*Vw*sin(F);

                 eb5:=xb5-(b1+n2*b2+b3+b4+b5)*Vw*cos(F);
                               ew2:=(eb5-e0)/L0;

               if  a< -0.4  then  ew2:=de;

UNTIL  ew2<=de;
                        ea1:=xa1-a1*Vw*cos(F);
                        qa1:=ya1-a1*Vw*sin(F);
                                ea2:=xa2-(a1+a2)*Vw*cos(F);
```

```
qa2:=ya2-(a1+ a2)*Vw*sin(F);
ea3:=xa3-(a1+ a2+ a3)*Vw*cos(F);
qa3:=ya3-(a1+ a2+ a3)*Vw*sin(F);
ea4:=xa4-(a1+ a2+ a3+ n2*a4)*Vw*cos(F);
qa4:=ya4-(a1+ a2+ a3+ n2*a4)*Vw*sin(F);   qa5:= -L4
eb1:=xb1-b1*Vw*cos(F);
qb1:=yb1-b1*Vw*sin(F);
eb2:=xb2-(b1+ n2*b2)*Vw*cos(F);
qb2:=yb2-(b1+ n2*b2)*Vw*sin(F);
eb3:=xb3-(b1+ n2*b2+ b3)*Vw*cos(F);
qb3:=yb3-(b1+ n2*b2+ b3)*Vw*sin(F);
eb4:=xb4-(b1+ n2*b2+ b3+ b4)*Vw*cos(F);
qb4:=yb4-(b1+ n2*b2+ b3+ b4)*Vw*sin(F);    qb5:= -L4;
a1u:=sqrt(ea1*ea1+ qa1*qa1);
a2u:=sqrt((ea2-ea1)*(ea2-ea1)+ (qa2-qa1)*(qa2-qa1));
a3u:=sqrt((ea3-ea2)*(ea3-ea2)+ (qa3-qa2)*(qa3-qa2));
a4u:=sqrt((ea4-ea3)*(ea4-ea3)+ (qa4-qa3)*(qa4-qa3));
a5u:=sqrt((ea5-ea4)*(ea5-ea4)+ (qa5-qa4)*(qa5-qa4));

b1u:=sqrt(eb1*eb1+ qb1*qb1);
b2u:=sqrt((eb2-eb1)*(eb2-eb1)+ (qb2-qb1)*(qb2-qb1));
b3u:=sqrt((eb3-eb2)*(eb3-eb2)+ (qb3-qb2)*(qb3-qb2));
b4u:=sqrt((eb4-eb3)*(eb4-eb3)+ (qb4-qb3)*(qb4-qb3));
b5u:=sqrt((eb5-eb4)*(eb5-eb4)+ (qb5-qb4)*(qb5-qb4));

Rw:=(a1u+ a2u+ a3u+ n2*a4u+ a5u-b1u-n2*b2u-b3u-b4u-5u)/L0;

write('a=',a);                          writeln;
write('b=',b);                          writeln;
write('ea5=',ea5);                      writeln;
write('eb5=',eb5);                      writeln;
write('ew1=',ew1);                      writeln;
write('ew2=',ew2);                      writeln
write('Rw=',Rw);                        writeln;
write('frac(Rw)=',frac(Rw));            writeln;writeln;
END.
```

Program abIM is designed to calculate pairs of angles (α, β) and the relative difference R_w of distances travelled by the rays of light..

IV.2 PROGRAM IntM;

```
Var
+--------------------------------------------+
|               PROGRAM abIM                 |
+--------------------------------------------+

Const
+--------------------------------------------+
|               PROGRAM abIM                 |
+--------------------------------------------+

BEGIN   write('a=');          read(a);
        write('b=');          read(b);
        write('F=');          read(F);
        write('Vw=');         read(Vw);
```

```
g11:=sin(Pi/4-a)/n2;
 g1:=arctan(g11/sqrt(1-g11*g11));
```

PROGRAM abIM

```
xa5:=(L4-(a1+ a2+ a3+ n2*a4+ a5)*Vw*sin(F)+ ya4)*sin(a)/cos(a)+ xa4;
ya5:=-L4+ (a1+ a2+ a3+ n2*a4+ a5)*Vw*sin(F);
     ea5:=xa5-(a1+ a2+ a3+ n2*a4+ a5)*Vw*cos(F);

     g22:=sin(Pi/4+ b)/n2;
      g2:=arctan(g22/sqrt(1-g22*g22));

b1:=L3/(cos(b)-sin(b)-Vw*(cos(F)-sin(F)));
```

PROGRAM abIM

```
xb5:=(L4-(b1+ n2*b2+ b3+ b4+ b5)*Vw*sin(F)+ yb4)*(sin(b)/cos(b))+ xb4;
yb5:=-L4+ (b1+ n2*b2+ b3+ b4+ b5)*Vw*sin(F);

   eb5:=xb5-(b1+ n2*b2+ b3+ b4+ b5)*Vw*cos(F);

        ea1:=xa1-a1*Vw*cos(F);
        qa1:=ya1-a1*Vw*sin(F);
```

PROGRAM abIM

```
Rrw:=(a1u+ a2u+ a3u+ n2*a4u+ a5u-b1u-n2*b2u-b3u-b4u-b5u)/L0;

   ew:=ABS(ea5-eb5)/L0;

      write('ea5=',ea5);          writeln;
      write('eb5=',eb5);          writeln;
      write('ew=',ew);            writeln;
      write('Rrw=',Rrw);          writeln;writeln;
END.
```

PROGRAM IntM is designed to calculate the following (Table 8):

1) The coordinates e_{a5}, e_{b5} of non-approximated points A_5, B_5.
2) Relative distance $| e_{a5} - e_{b5} | / \lambda_o$ of points A_5, B_5.
3) Relative difference R_{rw} of distances travelled by the light rays reaching mutually distant points A_5, B_5 of the screen M.

IV.3 PROGRAM: abIn

The following symbols were adopted and used in the program:

Vw $= V_o / C_o$, qw1 = $(q_{a3} - q_0)/\lambda_0$, qw2 = $(q_{b3} - q_0)/\lambda_0$, L0 $= \lambda_o$,

g thickness of the semi-transparent PP plate,
g2 angle γ_2 ,
ap adopted value of angle a,
a angle α ,
b angle β ,
h increment of α , β angles,
F angle Φ ,
de a very small positive number used for calculations.

Angles given in radian measure.

In PROGRAM abIn the following values were used:

ap = 0.2 rad , h $= 10^{-14}$ rad , de = 10^{-7}. $V_w = 1.244 \cdot 10^{-4}$.

Shifts of interference fringes are determined with respect to point Mo with a coordinate

$q_0 = 0.0314$ m.

After introducing the value of F variable into the program, the calculations end when the conditions of the approximations of points A_3, B_3 to point M_0 are satisfied:

qw1 $\leq$ de and qw2 $\leq$ de .

Then | qw1 | = | $(q_{a3} - q_0)/\lambda_0$ | $< 10^{-7}$ and | qw2 | = | $(q_{b3} - q_0)/\lambda_0$ | $< 10^{-7}$

Following values were used in calculations:

1) Basic dimensions of the interferometer-Fig.Sd1:
   $L_1 = L_3 + 1.2$ m , $L_2 = 0.8$ m , $L_3 = 0.14$ m ,
   $e_z = 0.15$ m,
   $\alpha_z = 25^0$ inclination of the mirror Z to the arm L_1 ,
   $g = 1.25 \cdot 10^{-3}$ m thickness of PP plate,
2) The wavelength of light in a vacuum $\lambda_o = 5.9 \cdot 10^{-7}$ m ,
3) The PP plate refractive index with respect to a vacuum $n_2 = 1.52$.

Programs are written in TURBO PASCAL 7.

```
           PROGRAM abIn;
                   Var
               a, ap, b,Vw,  h, de, ew, ew1,ew2,  Rw,  g2, g22,
               a1, a2, a3,  b1, b2, b3, a21, a22, a31, a32,
               xa1, xa2, xa3,  xa21, xa31, xb1, xb2, xb3,  xb21, xb31,
               ya1, ya2, ya3,  ya21, ya31, yb1, yb2, yb3,  yb21, yb31,
               xya1, xya31, xyb1, xyb2,
               r21, r22, r221, r23, r31, r32, r321, r33,
               s21, s211, s22, s221, s23, s31, s32, s321, s33,
               ea1, ea2, ea3,  eb1, eb2, eb3,   qa1, qa2, qa3, qb1, qb2, qb3,
               a1u, a2u, a3u,  b1u, b2u, b3u : real;

                    Const
               L1=0.14+1.2;    L2=0.8;   L3=0.14;   L0=5.9E-7;   g=1.25E-3;
               q0=0,0314;    az=0,436332313;       ez=0,15;
               Pi=3.14159265358;   ap=0,2;   h=1E-14; de=1E-7;
BEGIN
               write('F=');              read(F);

REPEAT                    a:=ap;      qw1:=0;
               a:=a-(ABS(qw1)/de)*h;
                   a1:=L3/(cos(a)-sin(a)-Vw*(cos(F)-sin(F)));
                         xya1:=L3+a1*Vw*(cos(F)-sin(F));
                 xa1:=xya1*cos(a)/(cos(a)-sin(a));
                ya1:=xya1*sin(a)/(cos(a)-sin(a));
        a21:=ya1-L2-a1*Vw*sin(F)+sin(az)*(ez-xa1+a1*Vw*cos(F))/cos(az);
        a22:=sin(az)*(sin(a)-Vw*cos(F))/cos(az)+Vw*sin(F)-cos(A);
   a2:=a21/a22;
                xa2:=xa1+a2*sin(a);
                ya2:=cos(a)*(xa2-xa1)/sin(a)+ya1;
         a31:=cos(2*az+a)*(xa2-L1-(a1+a2)*Vw*cos(F))/sin(2*az+a);
         a32:=cos(2*az+a)*Vw*cos(F)/sin(2*az+a)-cos(2*az+a);
   a3:=a31/a32:
            xa3:=L1+(a1+a2+a3)*Vw*cos(F);
            ya3:=ya2-a3*cos(2*az+a);
                                        qa3:=ya3-(a1+a2+a3)*sin(F);
                           qw1:=(qa3-q0)/L0;
                if  a<1e-6   then   qw1:=de;
UNTIL  qw1<=de;

                          b:=ap;     qw2:=0;
REPEAT  b:=b-(ABS(qw2)/de)*h;
                       g22:=sin(Pi/4+b)/n2;
                        g2:=arctan(g22/sqrt(1-g22*g22));
                 b1:=L3/(cos(b)-sin(b)-Vw*(cos(F)-sin(F)));
                           xyb1:=L3+b1*Vw*(cos(F)-sin(F));
                  xb1:=xyb1*cos(b)/(cos(b)-sin(b));
                  yb1:=xyb1*sin(b)/(cos(b)-sin(b));
                 xyb21:=L3+sqrt(2)*g+b1*Vw*(cos(F)-sin(F))+yb1+
                                     +sin(Pi/4-g2)*xb1/cos(Pi/4-g2);
                 xb21:=cos(Pi/4-g2)*xyb21/(sin(Pi/4-g2)+cos(Pi/4-g2))-xb1;
                 yb21:=-sin(Pi/4-g2)*xyb21/(sin(Pi/4-g2)+cos(Pi/4-g2))+
                                      +sin(Pi/4-g2)*xb1/cos(Pi/4-g2);
                    s211:=xb21*cos(Pi/4-g2)-yb21*sin(Pi/4-g2);
                     s21:=s211*n2*Vw*(cos(F)-sin(F))/(sin(Pi/4-g2)+cos(Pi/4-g2));
                    s221:=n2*Vw*(cos(F)-sin(F))/(sin(Pi/4-g2)+cos(Pi/4-g2));
```

```
s22:=1-s221*s221;
s23:=s21*s21+ s22*(xb21*xb21+ yb21*yb21);
b2:=(s21+ sqrt(s23))/s22;
xyb2:=L3+ sqrt(2)*g+ (b1+ n2*b2)*Vw*(cos(F)-sin(F))+ yb1+
    + sin(Pi/4-g2)*xb1/cos(Pi/4-g2);
xb2:= cos(Pi/4-g2)*xyb2/(sin(Pi/4-g2)+ cos(Pi/4-g2));
yb2:=-sin(Pi/4-g2)*xyb2/(sin(Pi/4-g2)+ cos(Pi/4-g2))+ yb1+
    + sin(Pi/4-g2)*xb1/cos(Pi/4-g2);
xb31:=L1+ (b1+ n2*b2))*Vw*cos(F)-xb2;
yb31:=(L1+ (b1+ n2*b2)*Vw*cos(F))*sin(b)/cos(b)-sin(b)*xb2/cos(b);
s31:=(xb31+ yb31*sin(b)/cos(b))*Vw*cos(F);
s321:=Vw*cos(F)/cos(b);
s32:=1-s321*s321;
s33:= s31*s31+ s32*(xb31*xb31+ yb31*yb31);
b3:=(s31+ sqrt(s33))/s32;
xb3:=L1+ (b1+ n2*b2+ b3)*Vw*cos(F);
yb3:=(sin(b)/cos(b))*(L1+ (b1+ n2*b2+ b3)*Vw*cos(F))+ yb2+ sin(b)*xb2/cos(b);
qb3:=yb3-(b1+ n2*b2+ b3)*Vw*sin(F);
qw2:=(qb3-q0)/L0;
if  a< 1e-6   then  qw2:=de;
UNTIL  qw2<=de;
ea1:=xa1-a1*Vw*cos(F);
qa1:=ya1-a1*Vw*sin(F);
ea2:=xa2-(a1+ a2)*Vw*cos(F);
qa2:=ya2-(a1+ a2)*Vw*sin(F);
ea3:=xa3-(a1+ a2+ a3)*Vw*cos(F);
qa3:=ya3-(a1+ a2+ a3)*Vw*sin(F);
eb1:=xb1-b1*Vw*cos(F);
qb1:=yb1-b1*Vw*sin(F);
eb2:=xb2-(b1+ n2*b2)*Vw*cos(F);
qb2:=yb2-(b1+ n2*b2)*Vw*sin(F);
eb3:=xb3-(b1+ n2*b2+ b3)*Vw*cos(F);
qb3:=yb3-(b1+ n2*b2+ b3)*Vw*sin(F);
a1u:=sqrt(ea1*ea1+ qa1*qa1);
a2u:=sqrt((ea2-ea1)*(ea2-ea1)+ (qa2-qa1)*(qa2-qa1));
a3u:=sqrt((ea3-ea2)*(ea3-ea2)+ (qa3-qa2)*(qa3-qa2));
b1u:=sqrt(eb1*eb1+ qb1*qb1);
b2u:=sqrt((eb2-eb1)*(eb2-eb1)+ (qb2-qb1)*(qb2-qb1));
b3u:=sqrt((eb3-eb2)*(eb3-eb2)+ (qb3-qb2)*(qb3-qb2));
Rw:=(a1u+ a2u+ a3u-b1u-n2*b2u-b3u)/L0;

write('a=',a);                 writeln;
write('b=',b);                 writeln;
write('qa3=',qa3);             writeln;
write(qeb3=',qb3);             writeln;
write('Rw=',Rw);               writeln;
write('frac(Rw)=',frac(Rw));   writeln; writeln;
END.
```

Program abIn is designed to calculate pairs of angles (α, β) and the relative difference R_w of distances travelled by the rays of light (interferometer-Fig.Sd1).

IV.4 PROGRAM Vo1Vo2

Symbols used in the program:

α_s	ALFAs,	ν	NI (true anomaly),
α_{zs}	ALFAzs,	φ	FI,
α_{se}	ALFAse,	λ	LAMBDA,
α_{se1}	ALFAse1,	η_1	ETA1,
δ_{zs}	DELTAzs	η_2	ETA2,
δ_{se}	DELTAse,	η_3	ETA3,
δ_{se1}	DELTAse1,	η_0	ETA0
ε	EPSILON,		
ψ	PSI,		
ω	OMEGA,		

In this program angles were given in degree $...^o$ measures in decimal system .

Program was written in TURBO PASCAL 7.

```
PROGRAM Vo1Vo2;
     Var
b, ETA0, ETA1, ETA2, ETA3, NI, PSI, g3, k1, k2, k11, k22, k33,
ALFAs, ALFAzs, ALFAse, ALFAse1,
DELTAse, DELTAse1,  DELTAzs, GHAaries, LHAzs, LHAse, LHAse1,
Hzs, Hse, Hse1, H01, H02,
Azs,  Ase, Ase1, A01, A02,
dzs, dse, dse1,
zzs, zse, zse1, z01, z02,
Vzs, Vse,
Vru2, Vzsu1, Vzsu2, Vzsu3, Vseu1, Vseu2, Vseu3,
Vse1u1, Vse1u2, Vse1u3,
V01u1, V01u2, V01u3, V02u1, V02u2, V02u3, V01, V02,
h1, h2, h3, h4, h5, az1, az2, az3, az4, az5 : real;

      Const
Pi=3.14159265358;  C0=3E5;
a=149597E3;  e=0.01671;  EPSILON=0.4090877;
R=6378.1;  OMEGA=7.292115E-5;  Trg=365.256366;   Trz=365.242199;
ALFAse=3*Pi/2;   ALFAse1=Pi/2;  DELTAse=Pi/2-EPSILON;
                                        DELTAse1= -(Pi/2-EPSILON);
 BEGIN        write('FI=');                        read(FI);
              write('LAMBDA=');                    read(LAMBDA);
              write('ALFAs=');                     read(ALFAs);
              write('GHAaries=');                  read(GHAaries);
              write('NI=');                        read(NI);

      FI:=FI*Pi/180;     LAMBDA:=LAMBDA*Pi/180;
      ALFAs:=ALFAs*Pi/180;   GHAaries:=GHAaries*Pi/180;  NI:=NI*Pi/180;
              b:=sqrt(a*a-sqr(e*a));
             g3:=e*(1+ e*cos(NI))/(sin(NI)*(1-e*e));
        ETA3:=arctan(-sqr(b/a)*(g3+ cos(NI)/sin(NI)));
        ETA2:=ABS(ETA3);                      ETA0:=arctan(b/(e*a));
```

```
if  NI>0  then     begin   if NI<=Pi-ETA0     then     PSI:=NI+ETA2;         end;
if  NI>Pi-ETA0  then  begin  if  NI<Pi        then     PSI:=NI-ETA2;         end;
if  NI>Pi  then    begin   if  NI<=Pi+ETA0   then     PSI:=-Pi+NI+ETA2;  end;
if  NI>Pi+ETA0  then  begin   if  NI<2*Pi    then     PSI:=-Pi+NI-ETA2;   end;

          k11:=arctan(sin(ALFAs)/(cos(ALFAs)*cos(EPSILON)));
 if  ALFAs>1.487E-2 then  begin   if   ALFAs<Pi/2        then   k1:=k11; end;
 if  ALFAs>Pi/2     then  begin   if   ALFAs<3*Pi/2 then   k1:=Pi+k11;     end;
 if  ALFAs>3*Pi/2  then  begin   if   ALFAs<2*Pi     then   k1:=2*Pi+k11;  end;

           k2:=k1-PSI;
          k22:=arctan(sin(k2)*cos(EPSILON)/cos(k2));
 if  k2>-Pi/2     then    begin     if    k2<Pi/2     then   ALFAzs:=k22;        end;
 if  k2> Pi/2     then    begin     if    k2<3*Pi/2  then   ALFAzs:=Pi+k22;   end;

            k33:=sin(k2)*sin(EPSILON);
         DELTAzs:=arctan(k33/sqrt(1-k33*k33));
            LHAzs:=GHAaries-ALFAzs+LAMBDA;
       h1:=cos(DELTAzs)*cos(FI)*cos(LHAzs)+sin(DELTAzs)*sin(FI);
  Hzs:=arctan(h1/sqrt(1-h1*h1));
             dzs:=(sin(DELTAzs)-sin(Hzs)*sin(FI))/(cos(Hzs)*cos(FI));
             zzs:=dzs/ABS(dzs);
             az1:=cos(DELTAzs)*sin(LHAzs)/cos(Hzs);
  Azs;=(Pi/2)*(3+zzs)-zzs*arctan(az1/sqrt(1-az1*az1));
  Vzs:=2*Pi*a*(1+e*cos(NI))/(Trg*24*3600*sqrt(1-e*e)*sin(PSI));

            LHAse:=GHAaries-ALFAse+LAMBDA;
        h2:=cos(DELTAse)*cos(FI)*cos(LHAse)+sin(DELTAse)*sin(FI);
  Hse:=arctan(h2/sqrt(1-h2*h2);

            dse:=(sin(DELTAse)-sin(Hse)*sin(FI))/(cos(Hse)*cos(FI));
            zse:=dse/ABS(dse);
            az2:=cos(DELTAse)*sin(LHAse)/cos(Hse);
   Ase:=(Pi/2)*(3+zse)-zse*arctan(az2/sqrt(1-az2*az2));

             LHAse1:=GHAaries-ALFAse1+LAMBDA;
        h3:=cos(DELTAse1)*cos(FI)*cos(LHAse1)+sin(DELTAse1)*sin(FI);
  Hse1:=arctan(h3/sqrt(1-h3*h3));
             dse1:=(sin(DELTAse1)-sin(Hse1)*sin(FI))/(cos(Hse1)*cos(FI));
             zse1:=dse1/ABS(dse1);
               az3:=cos(DELTAse1)*sin(LHAse1)/cos(Hse1);
   Ase1:=(Pi/2)*(3+zse1)-zse1*arctan(az3/sqrt(1-az3*az3));

                           Vse:=Co*0.748E-4;
                                          Vru2:=OMEGA*R*cos(FI);
               Vzsu1:=Vzs*cos(Hzs)*cos(Azs);
               Vzsu2:=Vzs*cos(Hzs)*sin(Azs);
               Vzsu3:=Vzs*sin(Hzs);
                                          Vseu1:=Vse*cos(Hse)*cos(Ase);
                                          Vseu2:=Vse*cos(Hse)*sin(Ase);
                                          Vseu3:=Vse*sin(Hse);
               Vse1u1:=Vse*cos(Hse1)*cos(Ase1);
               Vse1u2:=Vse*cos(Hse1)*sin(Ase1);
               Vse1u3:=Vse*sin(Hse1);
```

```
                V01u1:=Vzsu1+ Vseu1;
                V01u2:=Vru2+ Vzsu2+ Vseu2;
                V01u3:=Vzsu3+ Vseu3;
    V01:=sqrt(sqr(V01u1)+ sqr(V01u2)+ sqr(V01u3));
                                            h4:=V01u3/V01;
    H01:=arctan(h4/sqrt(1-h4*h4));
                                            z01:=V01u1/ABS(V01u1);
                                            az4:=V01u2/(V01*cos(H01));
    A01:=(Pi/2)*(3+ z01)+ z01*arctan(az4/sqrt(1-az4*az4));

                V02u1:=Vzsu1+ Vse1u1;
                V02u2:=Vru2+ Vzsu2+ Vse1u2;
                V02u3:=Vzsu3+ Vse1u3;
    V02:=sqrt(sqr(V02u1)+ sqr(V02u2)+ sqr(V02u3)):
                                            h5:=V02u3/V02;
    H02:=arctan(h5/sqrt(1-h5*h5));
                                            z02:=V02u1/ABS(V02u1);
                                            az5:=V02u2/(V02*cos(H02));
    A02:=(Pi/2)*(3+ z02)+ z02*arctan(az5/sqrt(1-az5*az5));

        H01:=H01*180/Pi;            A01:=A01*180/Pi;
        H02:=H02*180/Pi;            A02:=A02*180/Pi;
                                     if  A01>360  then  A01:=A01-360;
                                     if  A02>360  then  A02:=A02-360;

    write('Vzs=',Vzs);      writeln;
    write('Hzs=',Hzs);      writeln;
    write('Azs=',Azs);      writeln;writeln;
                                  write('Vo=V01=',V01);    writeln;
                                  write('H01=',H01);       writeln;
                                  write('A01=',A01);       writeln;writeln
    write('Vo=V02=',V02);     writeln;
    write('H02=',H02);        writeln;
    write('A02=',A02);        writeln;writeln;

END.
```

PROGRAM Vo1Vo2 is designed to calculate the coordinates of velocities $\vec{V}_{zs}$, $\vec{V}_{01}$ (2.1) and $\vec{V}_{02}$ (2.2) in the horizontal system.

IV.5 PROGRAM VzeVse

Symbols used in this program:

ε	EPS ,	η_0	ETA0 ,	ω	OMEGA,
ψ	PSI ,	η_2	ETA2 ,	$R_{pa(T/2)}$	Rpa ,
φ	FI ,	η_3	ETA3 ,	$R_{ba(T/2)}$	Rba .
		ν	NI (true anomaly),		

```
PROGRAM VzeVse;
   Var
b, g3, ETA0, ETA, ETA2, ETA3, NI, PSI,
Vzs, Vze, Vse, Vra, d, d1, d0, Rpa, Rba : Real;
   Const
Pi=3.14159265358;
a=149597E3; e=0.01671;  EPS=0.4090877; R=6378.1; Trg=365.256366; T=86164.1;
OMEGA=7.292115E-5; Co=3E5; ETA1=0.2295132;  FI=0.882554825;

BEGIN    write('Rpa=');            read(Rpa);
         write('NI=');             read(NI);          NI:=NI*Pi/180;

             b:=sqrt(a*a-sqr(e*a));
            g3:=e*(1+e*cos(NI))/(sin(NI)*(1-e*e));
     ETA3:=arctan(-sqr(b/a)*(g3+cos(NI)/sin(NI)));
     ETA2:=ABS(ETA3);                          ETA0:=arctan(b/(e*a));
        if NI>0 then     begin  if NI<=Pi-ETA0    then   PSI:=NI+ETA2;       end;
        if NI>Pi-ETA0 then begin if NI<Pi         then   PSI:=NI-ETA2;       end;
        if NI>Pi then    begin  if NI<=Pi+ETA0    then   PSI:=-Pi+NI+ETA2;   end;
        if NI>Pi+ETA0 then begin if NI<2*Pi       then   PSI:=-Pi+NI-ETA2;   end;
    Vzs:=2*Pi*a(1+e*cos(NI))/(Trg*24*3600*sqrt(1-e*e)*sin(PSI));
    Vra:=OMEGA*R*cos(FI);
        if NI>0   then   begin  if   NI<=Pi-ETA0 then    ETA:=Pi-ETA2;      end;
        if NI>Pi-ETA0  then  begin  if NI<Pi     then    ETA:=Pi+ETA2;      end;
        if NI>Pi   then   begin   if  NI<2*Pi    then    ETA:=ETA3;         end;

    Vse:=0;     d0:=1E-5;
REPEAT    Vse:=Vse+d*1E-1;

     d1:=(Vzs*sin(EPS)*cos(ETA+ETA1)+Vse*cos(EPS))/sqrt(Vzs*Vzs+Vse*Vse);
      d:=ABS(2*Pi*Co*Co*Rpa/(Vra*T)-Pi*Vra/4-sqrt(Vzs*Vzs+Vse*Vse)*
        cos(arctan(d1/sqrt(1-d1*d1))));
                                   if d>25  then  d:=0.5*d0;
UNTIL  d<d0;        Vze:= sqrt(Vzs*Vzs+Vse*Vse);

                    write(' Vze=',Vze);   writeln;
                    write(' Vse=',Vse);   writeln;  writeln;
END.
```

PROGRAM VzeVse calculates the absolute speeds of the Earth (Vze) and the Sun (Vse).
The variables d1, d in REPEAT should correspond to individual equations (3.84), (3.85), (3.89), (3.90).
In REPEAT the equations (3.84) was included.
Table 14 contains results obtained from equations (3.84), (3.85) (calculated with method I).
Table 15 contains results obtained from equations (3.89), (3.90) (calculated with method II).

RESULTS AND CONCLUSIONS

Michelson's experiments and the values of interference fringe shifts calculated with the mathematical model confirm the notion of both the existence of the aether and the applicability of the Galilean transformation. The speed of light in an inertial system depends upon the velocity of that system with respect to the aether. By observing shifts of interference fringes, the absolute speed V_o of the interferometer can be determined. Hence it is possible to build a speedometer which can measure the absolute speed of an inertial system (of a spaceship, for example) with no need for the system be linked with any external frame for reference.

Based on the calculation results, which can be found in the tables, the absolute speed of the interferometer on the Earth's surface was determined and expressed with respect to the speed of light as follows:

$$10^{-4} \leq V_0 / C_0 < 2 \cdot 10^{-4} \qquad (1.124).$$

Just as J. C. Maxwell had predicted, the speeds of the Earth, the Sun and our Galaxy centers with respect to the aether were determined by measuring optical phenomena alone.

The values of the interference fringe shifts (see Tables 2-5) can be tested in a very simple experiment. All that needs to be done is to place the Michelson's interferometer in a spaceship traveling at the absolute speed that is specified and linked to the speed of light by the inequality:

$$V_0 / C_0 > 2 \cdot 10^{-4}$$

If we consider a changeable mass of a particle (Chapter III), Newton's second law of motion is non-invariant with respect to the Galilean transformation, which effectively means that Newton's laws of mechanics are different in systems 1 and 2 if the variable mass of a particle is considered. Hence the absolute speed of an inertial system can be determined with the help of mechanical experiments performed inside that system (the spaceship).
The above results from the equations (3.13a), (3.13b) and (3.13c) see Fig. 12.

In this work it was also shown that knowing the difference in times measured by atomic clocks situated on the Earth's surface, the absolute velocities of the Earth and the Sun can be calculated. The elongation of the Earth's sidereal day with respect to the time measured by atomic clocks was evidenced as being merely apparent. The clock in system 2 runs slower when compared to an identical clock in the preferred system 1. The lifetime of unstable particles in system 2 is longer than the lifetime of identical particles in the preferred system 1.

SUPPLEMENT

S.I THE VELOCITIES OF THE EARTH AND THE SUN'S CENTERS WITH RESPECT TO THE AETHER

The changes in the length of the Earth's day [9] include the following:

- a linear trend, which brings about the elongation of the Earth's day by about $1.8\,s$ per 100 years i.e. $18\,s$ per million years.
- long-term component of around $1\,ms$. amplitude.

The remaining components of the day's length variability are periodical (oscillating).

In our opinion, in reality the long-term component of the Earth's day variability is only apparent and follows the equation (3.61):

$$R_T = \frac{3}{4}(V_0 / C_0)^2 \sqrt{1-(V_0 / C_0)^2}\ T .$$ Then it needs to be assumed: $R_T = 1\,ms$

$T = 86164.091\,s$

After the equation (3.61) is transformed, we obtain:

$V_0 / C_o \approx 2\sqrt{\frac{R_T}{3\,T}}$, because $\sqrt{1-(V_0 / C_0)^2} \approx 1$, as $V_0 / C_0 << 1$. Hence

$V_0 / C_0 \approx 2\sqrt{\frac{10^{-3}}{3 \cdot 86164.091}} \approx 1.244 \cdot 10^{-4}$, $V_0 \approx V_{ze}$, so

(S.1) $V_{ze} / C_0 \approx 1.244 \cdot 10^{-4}$

The quotient V_{ze} / C_0 specifies the speed of the Earth's center with respect to the aether, expressed in relation to the speed of light C_0.

The value obtained from calculation $V_{ze} / C_0 \approx 1.244 \cdot 10^{-4}$ fits the interval (1.126): $10^{-4} \le V_{ze} / C_0 < 2 \cdot 10^{-4}$, determined with the use of Albert Michelson's interferometer.

Therefore, by using the results of the Earth's rotation observation with atomic clocks the speed of the Earth's center can be calculated with relation to the aether.

The speed V_{se} of the Sun's center with respect to the aether, expressed in relation to the speed of light C_0 , equals:

(S.2) $V_{se} / C_0 \approx 0.7546 \cdot 10^{-4}$ (Tables 14 and 15, item 3).

The given value $V_{se} / C_0 \approx 0.7546 \cdot 10^{-4}$ fits the interval (1.127): $0 \le V_{se} / C_0 < 1.73 \cdot 10^{-4}$, determined with the use of the Albert Michelson's interferometer.

Now the direction of both the absolute Sun's velocity ($+\vec{V}_{se}$, $-\vec{V}_{se}$, Fig. 8) and of the velocities $\vec{V}_{01}$ (2.1), $\vec{V}_{02}$ (2.2) can be calculated.

Method I (Table 14, item 3):

There are velocities $+\vec{V}_{se}$, $\vec{V}_{01}$ (2.1), when the difference of times measured by atomic clocks during the experiment equals $R_{pa(T/2)} = 0.8305 \cdot 10^{-6}\ s$, or

there are velocities $-\vec{V}_{se}$, $\vec{V}_{02}$ (2.2), when the difference of times equals $R_{pa(T/2)} \approx 1.6421 \cdot 10^{-6}\ s$.

Method II (Table 15, item 3):

There are velocities $+\vec{V}_{se}$, $\vec{V}_{01}$ (2.1), when the difference of times measured by atomic clocks during the experiment equals $R_{ba(T/2)} = 1.6401 \cdot 10^{-6}\ s$, or

there are velocities $-\vec{V}_{se}$, $\vec{V}_{02}$ (2.2), when the difference of times equals $R_{ba(T/2)} = 3.2615 \cdot 10^{-6}\ s$.

S.II THE DURATION OF ASTRONOMICAL WINTER

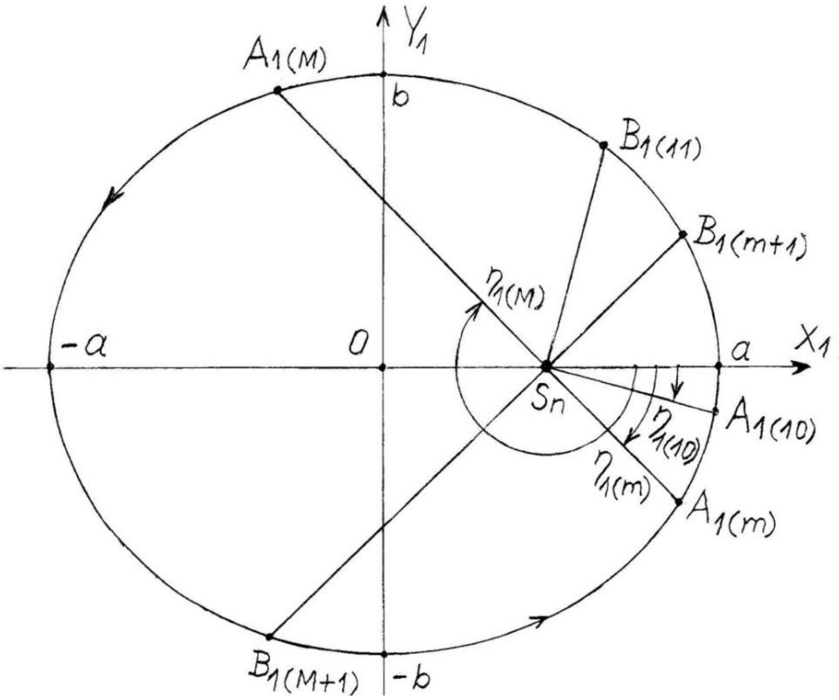

Fig. Sa The locations of the Earth at the start of astronomical winters and at spring equinoxes.

SYMBOLS:

a	average distance Earth-Sun,
b	small semi-axis of the Earth's orbit,
S_n	the center of the Sun,
A_1	location of the Earth at the start of astronomical winter,
B_1	location of the Earth at spring equinox,
(10)	year 2010, (11) year 2011,
(m)	a year, when the duration of astronomical winter is the shortest,
$(m+1)$	the following year,
(M)	a year, when the duration astronomical winter is the longest,
$(M+1)$	the following year.

Angles: $\measuredangle(A_{1(10)}\ S_n\ B_{1(11)}) \approx 90^0$, $\measuredangle(A_{1(m)}\ S_n\ B_{1(m+1)}) \approx 90^0$, $\measuredangle(A_{1(M)}\ S_n\ B_{1(M+1)}) \approx 90^0$.

The above angles are smaller than 90^0 by the precession angle in the eclipse during astronomical winter.

Angle $\eta_1 = \measuredangle(a\ S_n\ A_1)$ determines the Earth's location on its orbit around the Sun at the start of astronomical winter.

Angle η_1 increases every year by the precession angle p.

Annual precession p in ecliptic (in longitude) equals: $p \approx 50''.292 / T_{rz} = 0^0.01397 / T_{rz}$,
where: T_{rz} tropical year.

Year 2008, 2009 (example on page 46):

(S.3) $\eta_{1(8)} = 13^0.212402$,

(S.4) $T_{z(8)} = 88^d\, 23^h\, 40^m = 88.986111\ days$

where: T_z the duration of astronomical winter.

Year 2010, 2011 (example on page 73):

(S.5) $\eta_{1(10)} = 13^0.1501154,$

(S.6) $T_{z(10)} = 88^d\, 23^h\, 42^m.2 = 88.9876388\ days$

Year m, $m+1$:

(S.7) $\eta_{1(m)} = 45^0\,,\qquad p\dfrac{\eta_{1(m)} - \eta_{1(10)}}{p} = \dfrac{45^0 - 13^0.1501154}{0^0.01397/T_{rz}} = 2280\ T_{rz}$, so

(S.8) $m = 2010 + 2280 = 4290$

The duration of astronomical winter can be determined from the equation (2.17):

$T_{z(m)} = t(90^0 - \Delta p - \eta_{1(m)}) - t(360^0 - \eta_{1(m)})$, hence

(S.9) $T_{z(m)} = 88.587430398\ days$

Therefore 4290 will be the year when the duration of astronomical winter will be the shortest: $88.587430398\ days$

Up to the year 4290 the duration of astronomical winters will be diminishing, thus for each year n throughout that period the following inequalities are fulfilled:

(S.10) $\eta_{1(n+1)} > \eta_{1(n)}$

(S.11) $T_{z(n+1)} < T_{z(n)}$

Angles (S.3), (S.5) as well as the times (S.4), (S.6) have been determined with the astronomical winters and spring equinoxes starting time known and given in the Astronomical Annals of the Instytut Geodezji i Kartografii [Institute of Geodesy and Cartography]:

$\eta_{1(10)} < \eta_{1(8)}$

$T_{z(10)} > T_{z(8)}$

These inequalities are in opposition to inequalities (S.10), (S.11), which leads to the conclusion of possible discrepancies in the Annals.
The discrepancies affect the accuracy of the results of calculations on page 46 and 73.

Year M, $M+1$:

(S.12) $\eta_{1(M)} = 225^0,\qquad \dfrac{\eta_{1(M)} - \eta_{1(10)}}{p} = \dfrac{225^0 - 13^0.1501154}{0^0.01397/T_{rz}} \approx 15165\,T_{rz}$, then

(S.13) $M = 2010 + 15165 = 17175$

The duration of astronomical winter can be determined from the equation:

(S.14) $T_{z(M)} \approx T_{rg} - t(\nu) + t(\nu + 90^0)$, where: $\nu = 360^0 - \eta_{1(M)} = 135^0$,

$t(\nu)$ function (2.13)

T_{rg} stellar year.

Therefore

(S.15) $T_{z(M)} \approx 94.086078982\ days$.

Thus 17175 will be the year when the duration of astronomical winter will be the longest:. $94.086078982\ days$.

From 4290 to 17175 the durations of astronomical winters will be increasing, so for each year n during that period the following inequalities are fulfilled:

(S.16) $\eta_{1(n+1)} > \eta_{1(n)}$

(S.17) $T_{z(n+1)} > T_{z(n)}$

The calculations were carried out assuming constant parameters of the Earth's movement on its orbit.

S.III DETERMINING THE ALTITUDE AND THE AZIMUTH OF THE EARTH'S CENTER VELOCITY

Pages 40, 42, 43 give the formulas to calculate the altitudes and the azimuths of the Earth's center velocity: $\vec{V}_{zs}$, $\vec{V}_{se}$, $\vec{V}_{se1}$. These will be marked as $\vec{V}$ velocity.
The formulae will be derived with the letter H denoting the altitude of the Earth's center velocity $\vec{V}$ (Fig.Sb2) and the letter A denoting the azimuth of the velocity.

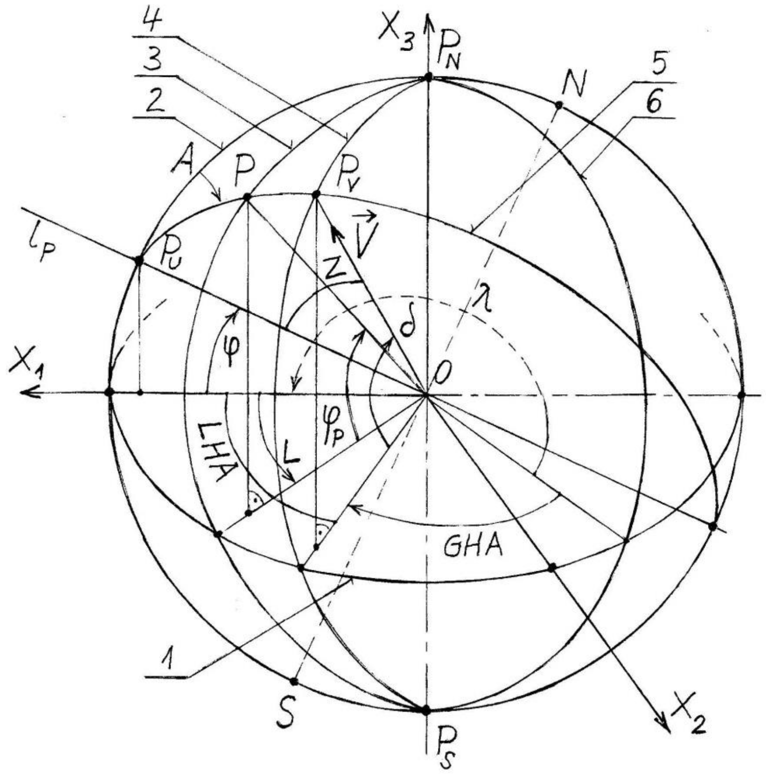

Fig.Sb1 Azimuth A and zenith altitude Z of the Earth's center velocity $\vec{V}$.

SYMBOLS:

- O the center of the globe,
- lp vertical line running through the center of the globe and the U point on the globe (Fig. Sb2) in whih the observer is located,
- $\vec{V}$ velocity $\vec{V}_{zs}$ at which the Earth's center travels around the Sun (Fig. 6, 7) or velocities $\vec{V}_{se}$, $\vec{V}_{se1}$ of the Sun's center with respect to the aether, which are also the velocities of the Earth's center (Fig. 8),
- A azimuth of the Earth's center velocity $\vec{V}$,
- P_U a point at which the vertical line lp cuts through the celestial sphere,
- P_V a point at which the direction line of velocity $\vec{V}$ cuts through the celestial sphere,
- φ, λ coordinates of the P_U point,
- GHA Greenwich Hour Angle of the Earth's center velocity $\vec{V}$,
- LHA Local Hour Angle of the Earth's center velocity $\vec{V}$,
- δ declination of the Earth's velocity $\vec{V}$,
- Z zenith altitude (angle) of the Earth's center velocity $\vec{V}$,
- 1 celestial equator,
- 2 celestial meridian of the observer, which runs through the P_U point,
- 3 meridian which runs through the P point,
- 4 hour semi-circle which runs through the P_V point,
- 5 semi-circle which runs through the vertical line lp and point P_V ,

6 Greenwich meridian,
P point located on the circumference of the semi-circle (item 5),
φ_p, L coordinates of the P point,

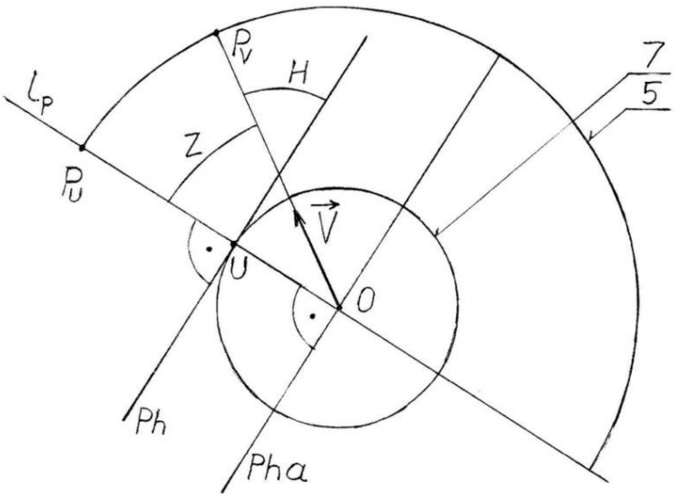

Fig.Sb2 Zenith altitude Z and the altitude H of the Earth's velocity $\vec{V}$.

SYMBOLS:
O the globe center,
7 the globe,
Z zenith altitude of the Earth's center velocity $\vec{V}$,
H altitude of the Earth's center velocity $\vec{V}$,
U point (location) on the globe in which the observer is located,
Pha plane of celestial horizon (plane's projection),
Ph plane of the Horizon, which runs through the U point (plane's projection),
5, lp , P_U , P_V as described in Fig.Sb1 .

The following unit vectors can be defined (Fig.Sb1):

(S.18) $\vec{OP_N} = [\ 0\ ,\ \ 0\ ,\ \ 1\ ]$

(S.19) $\vec{OP_U} = [\ \cos\varphi\ ,\ \ 0\ ,\ \ \sin\varphi\ ]$

(S.20) $\vec{OP_V} = [\ \cos\delta \cos LHA\ ,\ \ \cos\delta \sin LHA\ ,\ \ \sin\delta\ ]$,

where: $LHA = GHA + \lambda$

The modulus of the unit vectors:

(S.21) $OP_N = OP_U = OP_V = 1$

THE ALTITUDE H OF THE EARTH'S VELOCITY $\vec{V}$.

Zenith altitude Z of the Earth's center velocity $\vec{V}$ can be determined from the scalar product of the vectors (S.19), (S.20).

$$\cos Z = \frac{\vec{OP_U} \cdot \vec{OP_V}}{OP_U OP_V} = \cos\delta\ \cos\varphi\ \cos LHA + \sin\delta\ \sin\varphi$$

Fig.Sb2 shows the relationship:

$Z = 90^0 - H$, then

$\cos Z = \cos(90^0 - H) = \sin H$, so

(S.22) $\sin H = \cos\delta\ \cos\varphi\ \cos LHA + \sin\delta\ \sin\varphi$

Hence the altitude H of the Earth's center velocity $\vec{V}$ is equal to:

(S.23) $H = \arcsin(\cos\delta\ \cos\varphi\ \cos LHA + \sin\delta\ \sin\varphi)$

AZIMUTH A OF THE EARTH'S VELOCITY $\vec{V}$.

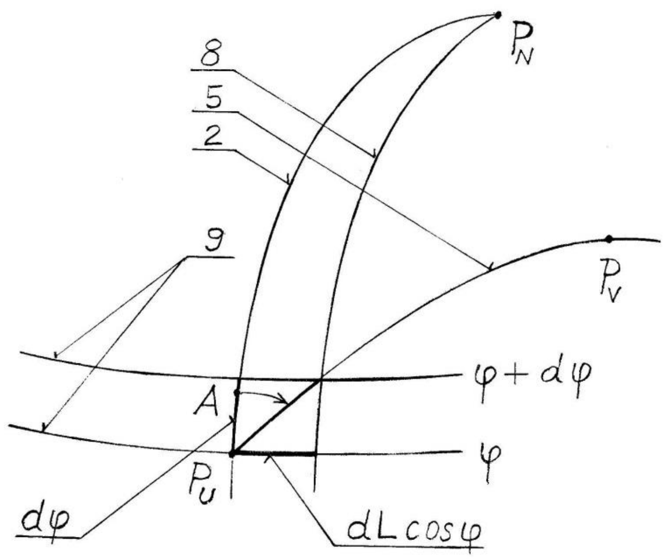

Fig.Sb3 Azimuth A of the Earth's velocity $\vec{V}$.

SYMBOLS:

A	azimuth of the Earth's center velocity $\vec{V}$ (Fig.Sb1),
8	meridian,
9	parallels of altitude,
2, 5, P_U, P_V	as described in Fig.Sb1.

We select any point P on the circumference of the semi-circle (Fig.Sb1, item 5) near the $P_U(\varphi,\lambda)$ point.

The coordinates of point P are φ_p, L. Hence we have point $P(\varphi_p, L)$.

A unit vector $\vec{OP}$:

(U.24) $\vec{OP} = [\ \cos\varphi_p \cos L ,\quad \cos\varphi_p \sin L ,\quad \sin\varphi_p\ ]$

Let us draw a vector $\vec{W}_V$ perpendicular to semi-circle which runs through points P_U , P_V , P and the vertical line lp . Vector $\vec{W}_V$ is hence perpendicular to vectors $\vec{OP}_U$, $\vec{OP}_V$, $\vec{OP}$.

Vector $\vec{W}_V$ can be obtained with the vector product of the vectors (S.19), (S.20):

(S.25) $\vec{W}_V = \vec{OP}_U \times \vec{OP}_V = [\ W_{V1} ,\quad W_{V2} ,\quad W_{V3}\ ]$, where:

(S.26) $W_{V1} = -\cos\delta \sin\varphi \sin LHA$

(S.27) $W_{V2} = \cos\delta \sin\varphi \cos LHA - \sin\delta \cos\varphi$

(S.28) $W_{V3} = \cos\delta \cos\varphi \sin LHA$

Then, by applying the scalar product of vector $\vec{W}_V$ and vector $\vec{OP}$ the equation of the semi-circle circumference can be obtained: $\vec{W}_V \cdot \vec{OP} = 0$, so

$W_{V1} \cos\varphi_p \cos L + W_{V2} \cos\varphi_p \sin L + W_{V3} \sin\varphi_p = 0$, which after transformation takes the form of the following equation: $W_{V1} \cos L + W_{V2} \sin L + W_{V3}\, tg\varphi_p = 0$.

After the above is differentiated, we obtain:

(S.29) $(-W_{V1} \sin L + W_{V2} \cos L) dL + W_{V3} \dfrac{1}{\cos^2 \varphi_p} d\varphi_p = 0$

If the $P(\varphi_p, L)$ point (Fig.Sb1) heads towards $P_U(\varphi,\lambda)$, then $\varphi_p \to \varphi$ i $L \to 0$, so

$\sin L \to 0$, $\cos L \to 1$

Consequently the equation (S.29) takes the form:

$$W_{V2}dL + W_{V3}\frac{1}{\cos^2\varphi}d\varphi = 0$$, hence after transformation:

(S.30) $$dL = \frac{-W_{V3}}{W_{V2}\cos^2\varphi}d\varphi$$

From Fig.Sb3 results the following relationship:

$$\sin A = \frac{dL\cos\varphi}{\sqrt{(dL\cos\varphi)^2 + (d\varphi)^2}}$$, where: A azimuth of the Earth's center velocity $\vec{V}$.

Having considered the (S.30) equation and transformed the above equation we have:

$$\sin A = \frac{-W_{V3}}{\sqrt{W_{V3}^2 + W_{V2}^2\cos^2\varphi}}$$

After considering coordinates (S.27), (S.28) we obtain:

$$\sin A = \frac{-\cos\delta\cos\varphi\sin LHA}{\sqrt{(\cos\delta\cos\varphi\sin LHA)^2 + (\cos\delta\sin\varphi\cos LHA - \sin\delta\cos\varphi)^2\cos^2\varphi}} =$$

$$= \frac{-\cos\delta\cos\varphi\sin LHA}{\sqrt{\cos^2 H\ \cos^2\varphi}} = \frac{-\cos\delta}{\cos H}\sin LHA$$

and ultimately :

(S.31) $$\sin A = \frac{-\cos\delta}{\cos H}\sin LHA$$

Let us now determine $\cos A$.

We start with drawing a vector $\vec{W}_N$ perpendicular to the plane of the celestial meridian of the observer. This meridian runs through points P_U, P_N . Vector $\vec{W}_N$ is therefore perpendicular to vectors $O\vec{P}_U, O\vec{P}_N$. Vector $\vec{W}_N$ can be obtain by applying the vector product of vectors (S.18), (S19).

(S.32) $$\vec{W}_N = O\vec{P}_U \times O\vec{P}_N = [\ W_{N1},\quad W_{N2},\quad W_{N3}\ ]$$, where:

$$W_{N1} = 0,\quad W_{N2} = -\cos\varphi,\quad W_{N3} = 0$$, then

(S.33) $$\vec{W}_N = [\ 0,\quad -\cos\varphi,\quad 0\ ]$$

The azimuth of the Earth's velocity $\vec{V}$ is the angle between the plane of the observer's celestial meridian and the semi-circle that runs through points P_U, P_V and the vertical line lp . The azimuth of the Earth's center velocity $\vec{V}$ is then also an angle between vectors $\vec{W}_V$ (S.25), $\vec{W}_N$ (S.32). Hence

(S.34) $$\cos A = \frac{\vec{W}_V \cdot \vec{W}_N}{W_V W_N}$$

The scalar product of vectors (S.25), (S.33): $\vec{W}_V \cdot \vec{W}_N = (\cos\delta\sin\varphi\cos LHA - \sin\delta\cos\varphi)(-\cos\varphi)$. Hence after transformation and adoption of equation (S.22) we obtain:

(S.35) $$\vec{W}_V \cdot \vec{W}_N = \sin\delta - \sin H\sin\varphi$$

The modulus of the vector $\vec{W}_V$ (S.25): $W_V = \sqrt{W_{V1}^2 + W_{V2}^2 + W_{V3}^2}$

After considering the coordinates from (S.26), (S.27), (U.28) and the relationship (S.22), the following can be obtained:

(S.36) $$W_V = \sqrt{\cos^2 H} = \cos H$$

The modulus of the vector $\vec{W}_N$ (S.33): $W_N = \sqrt{W_{N1}^2 + W_{N2}^2 + W_{N3}^2} = \sqrt{(-\cos\varphi)^2} = \cos\varphi$, so

(S.37) $$W_N = \cos\varphi$$

Ultimately, after introducing scalar product (S.35) and modulus (S.36) and (S.37) to equation (S.34), we obtain:

(S.38) $$\cos A = \frac{\sin\delta - \sin H\ \sin\varphi}{\cos H\ \cos\varphi}$$

S.IV THE SPEEDS OF THE EARTH AND THE LIGHT WITH RESPECT TO THE AETHER

The speed of light C in a vacuum with respect to an inertial system depends on the system's speed V_0 with respect to the aether and to the direction light is travelling in that system. The C speed can be defined by the equation (3.7):

(S.39) $$C(\alpha_{o,2}) = C_0 \, [\sqrt{1-(V_0/C_0)^2 \sin^2 \alpha_{o,2}} - (V_0/C_0)\cos\alpha_{o,2}] \, , \quad \text{as} \quad V_{2\max} = C \, ,$$

where: C_0 speed of light in a vacuum with respect to the aether,
$\alpha_{o,2}$ angle that determines the direction in which light is travelling, Fig. 11.

When the V_0 speed equals the V_{ze} speed of the Earth's center with respect to the aether, the equation (S.39) takes the following form:

(S.40) $$C(\alpha_{o,2}) = C_0 \, [\sqrt{1-(V_{ze}/C_0)^2 \sin^2 \alpha_{o,2}} - (V_{ze}/C_0)\cos\alpha_{o,2}]$$

According to existing experimental data [1] the light speed C in vacuum, measured on the Earth takes the value: $C = (299\,792\,458 \ \pm 1.2) \ m/s$, hence

$$(299\,792\,458 - 1.2) \ m/s \ \leq \ C \ \leq \ (299\,792\,458 + 1.2) \ m/s$$

In nearly all experiments concerning light speed measurements, the light travels in two directions i.e. there and back. Therefore the light speed value obtained is the value for both directions of the light movement.

It can be concluded from the equation (S.40) that the highest measured value of light speed $C_{\max}$ occurs when the velocity of light is perpendicular ($\alpha_{o,2} = \pm 90^0$) to the Earth's velocity $\vec{V}_{ze}$ and is the same in both directions ($\vec{V}_{ze} \approx \vec{V}_{01}$ (2.1) or $\vec{V}_{ze} \approx \vec{V}_{02}$ (2.2)). Hence it can be concluded that the speed $(299\,792\,458 \ + 1.2) \ m/s$ means that the measurements of the light speed were taken at the angles $\alpha_{o,2} = \pm 90^0$ and thereabouts. Thus the highest value of the speed of light $C_{\max}$ in relation to the Earth and in terms of absolute time is:

(S.41) $$C_{\max} = C(\alpha_{o,2} = \pm 90^0) = C_0 \sqrt{1-(V_{ze}/C_0)^2} \approx \frac{\Delta\tau_2}{\Delta\tau_1}(299\,792\,458 + 1.2) \ m/s \ .$$

From the relationship (3.49):

(S.42) $$\frac{\Delta\tau_2}{\Delta\tau_1} = [1-(V_{ze}/C_0)^2]^{1/4} \approx 1 - \frac{1}{4}(V_{ze}/C_0)^2 \, , \qquad \text{as} \qquad V_{ze}/C_0 \ << 1$$

From the equation (S.40) it can also be concluded that the lowest measured value of the light speed $C_{\min}$ occurs when the velocity of light is parallel to the velocity of the Earth $\vec{V}_{ze}$. Hence it can be concluded that the speed $(299\,792\,458 \ - 1.2) \ m/s$ means that the measurements of the light speed were taken at angles $\alpha_{o,2} = 0$, $\alpha_{o,2} = 180^0$ and thereabouts. Thus the lowest value of the light speed $C_{\min}$ in relation to the Earth and in terms of absolute time is:

(S.43) $$C_{\min} = \frac{2 \ l}{l/(C_0 - V_{ze}) + l/(C_0 + V_{ze})} = C_0 \, [1 - (V_{ze}/C_0)^2] \approx \frac{\Delta\tau_2}{\Delta\tau_1}(299\,792\,458 - 1.2) \ m/s$$

where: l distance travelled by light in one direction during the measurement.

From the (S.41) equations, we obtain:

(S.44) $$C_0 \approx \frac{\Delta\tau_2}{\Delta\tau_1}(299\,792\,458 + 1.2) \frac{1}{\sqrt{1-(V_{ze}/C_0)^2}} \ m/s \ .$$

From the (S.43), (U.44) equations, we obtain:

$$(299\,792\,458 + 1.2)\,\frac{1 - (V_{ze}/V_0)^2}{\sqrt{1-(V_{ze}/C_0)^2}} \approx (299\,792\,458 - 1.2) \quad , \quad \text{thus}$$

(S.45) $$(299\,792\,458 + 1.2)\,\sqrt{1-(V_{ze}/C_0)^2} \approx (299\,792\,458 - 1.2) \quad , \quad \text{hence}$$

(S.46) $$(299\,792\,458 + 1.2)\,[1 - \frac{1}{2}(V_{ze}/C_0)^2] \approx (299\,792\,458 - 1.2) \quad , \quad \text{as} \quad V_{ze}/C_0 << 1$$

After transformation of the above, the following is obtained:

$$V_{ze}/C_0 \approx \sqrt{\frac{2\cdot 2.4}{299\,792\,458 + 1.2}} = 1.265\cdot 10^{-4} \quad , \quad \text{hence}$$

(S.47) $$V_{ze}/C_0 \approx 1.265\cdot 10^{-4}$$

The quotient (S.47) defines the speed V_{ze} of the Earth's center with respect to the aether, expressed in terms of the light speed C_0 and takes values, determined with the use of Albert Michelson's interferometer, ranging (1.126): $10^{-4} \leq V_{ze}/C_0 < 2\cdot 10^{-4}$

Having considered the relationship (S.42) and $V_{ze}/C_0 << 1$, the equation (S.44) takes the following form: $C_0 \approx [1 - \frac{1}{4}(V_{ze}/C_0)^2]\,(299\,792\,458 + 1.2)\,[1 + \frac{1}{2}(V_{ze}/C_0)^2]\ m/s$

Then after considering the relationship (S.47) we obtain:

$$C_0 \approx [1 - \frac{1}{4}(1.265\cdot 10^{-4})^2]\,(299\,792\,458 + 1.2)\,[1 + \frac{1}{2}(1.265\cdot 10^{-4})^2]\ m/s = 299\,792\,460.4\ m/s$$

Hence the speed of light C_0 in vacuum and with respect to the aether, expressed in terms of absolute time, is:

(S.48) $$C_0 \approx 299\,792\,460.4\ m/s$$

A unit of measurement – a meter – used herein, corresponds to the definition of a meter that was in operations up to 1983 and was based upon the light wavelength measured with the use of Albert Michelson's interferometer.

S.V VALUES OF THE SHIFTS OF INTERFERENCE FRINGES

When calculating values of the shifts of interference fringes with Albert Michelson's interferometer (Tables 1 - 7) a constant value of the light wavelength emitted by the light source was adopted $\lambda_0 = 5.9\cdot 10^{-7}\ m$. This source is placed inside the interferometer and has the absolute speed V_0 of the interferometer.

Let us write the following equations:

(S.49) $$\frac{\lambda_{01}}{\lambda_{02}} = \frac{\omega_{A2}}{\omega_{A1}} = \frac{\sqrt{m_{01}}}{\sqrt{m_{02}}} = (\frac{m_{01}}{m_{02}})^{1/2} = [1 - (V_0/C_0)^2]^{1/4} \quad ,$$

where: λ_{01} light wavelength, at the source of light absolute speed $V_0 = 0$ - system 1,

λ_{02} light wavelength, at the source of light absolute speed V_0 - system 2,

ω_{A1}, ω_{A2} frequencies of vibration of the source of light atoms in systems 1 and 2,

m_{01}, m_{02} rest masses of the source of light atoms in systems 1 and 2.

$$m_{01} = m_{02}\,\sqrt{1-(V_0/C_0)^2} \quad \text{relationship (3.27a).}$$

Systems 1 and 2 are presented in Fig. 10.

From the equations (S.49) we obtain:

(S.50) $$\lambda_{02} = \frac{\lambda_{01}}{[1-(V_0/C_0)^2]^{1/4}}$$

Hence, the relative difference of the distances travelled by the light rays in the interferometer is described by the following relationship:

(S.51) $$\frac{\Delta l}{\lambda_{02}} = \frac{\Delta l}{\lambda_{01}}[1-(V_0/C_0)^2]^{1/4}$$

According to relationship (1.109a): $\Delta l/\lambda_0 = R_w$, therefore the following is obtained:

(S.52) $$\frac{\Delta l}{\lambda_{02}} = R_w\,[1-(V_0/C_0)^2]^{1/4}$$

According to relationship (1.113) the interference fringes shift value: $k(\Phi_2, V_w) = R_{w2} - R_{w1}$. Having considered (S.52) the equation (1.113) takes the following form:

(S.53) $$k(\Phi_2, V_w) = (R_{w2} - R_{w1})\,[1-(V_0/C_0)^2]^{1/4}$$

(S.54) $$k(\Phi_2, V_w) = (R_{w2} - R_{w1})\,[1-\frac{1}{4}(V_0/C_0)^2], \quad \text{when} \quad V_0/C_0 \ll 1 .$$

The equation (1.117) which defines the value of k depending on distance increment Δl_2 takes the form as follows:

(S.55) $$k(\Phi_n, V_w, \Delta l_2) = (R_{w2\Delta l2} - R_{w2})\,[1-(V_0/C_0)^2]^{1/4}$$

(S.56) $$k(\Phi_n, V_w, \Delta l_2) = (R_{w2\Delta l2} - R_{w2})\,[1-\frac{1}{4}(V_0/C_0)^2], \quad \text{when} \quad V_0/C_0 \ll 1$$

The values of the interference fringes shifts in Tables 2, 3, 4, 5 (without the last item) and in Tables 6, 7, are subject to very small changes, as the expressions: $[1-(V_0/C_0)^2]^{1/4}$, $1-\frac{1}{4}(V_0/C_0)^2$ feature values very close to 1 for given values of $V_w = V_0/C_0$ that are presented in these tables.

Different values of the shifts of interference fringes at $V_w = 0{,}1$:

$$k(\Phi_2, V_w) = (R_{w2} - R_{w1})\,[1-(0.1)^2]^{1/4} \approx (R_{w2} - R_{w1})\,0.99749$$

While determining the values of the interference fringes shifts in the interferometer, the relationship between the light wavelength (S.50) of the source and its absolute speed V_0 should be considered.

S.VI UNITS OF MEASUREMENT

Since 1983 the following definition of a unit of length has been in operation:
The meter is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second. This study indicates that the speed of light is constant in the absolute (preferred) system only. In vacuum the speed of light in the inertial system depends on the absolute speed of the system and a direction towards which light is travelling. Times measured by atomic clocks depend on the absolute speed of the clocks.
Hence the length determined in laboratory experiments following the above mentioned definition varies as it depends on the Earth's speed on its orbit and its circumvolution. Consequently derivative units expressed in terms of meters and seconds cannot be constant.

Due to the above, the units of measurement should be defined for the preferred system.

S.VII THE MOTION OF MERCURY PERIHELION

In 1859 a French astronomer Urbain Le Verrier noticed that the motion of the Mercury perihelion differs from its theoretical assessments. Exploiting Newton's celestial mechanics he calculated the contributions of each individual planet to the rotation of the Mercury elliptic orbit. The sum of the perturbation effect of all external planets amounted to about $526''.7$ within a period of one hundred years, which means about $0''.267$ per annum. He analyzed the records of astronomical observations since 1697. That enabled a very precise assessment of Mercury's locations and made the calculation of the value of the observed perihelion motion possible. The value was equal to $565''$ within a period of one hundred years. There was a discrepancy between the observed and the calculated values of the perihelion movement of about $38''.3$ within a period of one hundred years, which means about $0''.383$ per annum. This additional shift of $0''.383$ in Mercury's motion on its orbit can be explained by the elongation of a terrestrial day.

If the angular speed of the Earth's revolution was constant, the observed annual motion of the Mercury perihelion would be equal to $5''.267$ as a result of the planets' perturbation. However due to the elongation of a terrestrial day by Δt_a per year, the observer saw Mercury shifted in its direction of orbital motion by an additional angle of $0''.383$ that is a true anomaly: $\nu = 0''.383 = 0^0.000106388$. We apply a function $t(\nu)$ that defines the time after which Mercury takes a position on its elliptic trajectory determined by the angle ν (true anomaly). The function $t(\nu)$ is defined by the relationship (2.13), Fig. 6.

$$t(\nu) = \frac{e\sqrt{1-e^2}\,T_{rg}}{2\pi}\left(\frac{2}{e\sqrt{1-e^2}}\,arctg\,\frac{\sqrt{1-e^2}\,tg(\nu/2)}{1+e} - \frac{\sin\nu}{1+e\cos\nu}\right) \qquad (2.13),$$

where:

$T_{rg} = 87^d\,23^h\,15^m\,44^s = 7600544s$ (Mercury's stellar year),

$e = 0.20563069$ (eccentricity of Mercury's orbit).

With the angle $\nu = 0^0.000106388$, the annual elongation of a terrestrial day Δt_a in the period from 1697 to 1859 can be calculated from the relationship (2.13):

$\Delta t_a = t(\nu = 0^0.000106388) \approx 1.448\ s$.

Very precise observations of the Earth's rotary motion started in the second half of the 20th century after atomic clocks began to be used and the elongation of a terrestrial day had been evidenced. From 1972 to 2012 i.e. over the course of 40 years, a day length has extended by $25\ s$. Thus the annual average elongation of a terrestrial day in that period of time is: $25\ s/40 = 0.625\ s$. Apparent annual elongation of a terrestrial day with respect to the time measured by atomic clocks is about $0.365\ s$ (see Table 13). Then the real annual elongation of a terrestrial day Δt_b from 1972 to 2012 is: $\Delta t_b = 0.625\ s - 0.365\ s = 0.26\ s$.

From the above it is evident that the value of a terrestrial day elongation is diminishing: $\Delta t_b < \Delta t_a$. This process will stop after the melt down of the glaciers (S.9). Then the small oscillating and seasonal changes of the terrestrial day will occur. The advent of the next ice age will see a considerable increase in the speed of the Earth's rotary motion due to a rapid decrease of the Earth's moment of inertia.

The Moon and the Sun exert impact on the Earth's motion. As a result the energy of its rotary motion wears away, which causes the elongation of a terrestrial day by about $1.8\ ms$ per century [9].

S.VIII PLANCK CONSTANT?

In quantum physics the frequency ν of the hydrogen atom spectrum lines takes the following form:

(S.57) $$\nu = \frac{m\, e^4}{8\, \varepsilon_0^2\, h^3} \left(\frac{1}{j^2} - \frac{1}{k^2} \right) \quad , \qquad \text{where:}$$

- j , k integers describing a lower and higher steady state respectively,
- m mass of an electron,
- e electric charge of an electron,
- ε_0 permeability of vacuum,
- h Planck constant ($h = 6.626176 \cdot 10^{-34}\ J\,s$).

Let us consider a motion of a hydrogen atom in a preferred system i.e. absolute.
When the atom moves at the absolute speed V_0 , the electron mass is:

(S.58) $$m = m_{02} = m_{01}\, \gamma$$ relationship (3.27), where:

m_{01} electron rest mass in the preferred system,

(S.58a) $$\gamma = \frac{1}{\sqrt{1 - (V_0 / C_0)^2}}$$ relationship (3.2),

C_0 speed of light with respect to the preferred system i.e with respect to the aether.

According to quantum physics the electron's angular momentum is linked with Planck constant h . Then the presence of electron's mass in the angular momentum, as described by formula (S.58a), prompts the application of the H_p factor in the equation (S.57) instead of constant h :

(S.59) $$H_p = h_{01}\, \gamma \quad , \qquad \text{where:}$$

- h_{01} a constant defined by **(∗),**
- γ expression (S.58a).

Max Planck determined the h value by analysing the spectrum of the perfect black-body radiation, exploiting the observation results of this body on the Earth. The Earth has a minute absolute speed $V_0 \approx 1.244 \cdot 10^{-4}\, C_0$ (S.1), thus the value of the h_{01} constant at the absolute speed $V_0 = 0$ can be calculated with Planck constant h that was determined on the Earth.

$$h = h_{01} \left(1/\sqrt{1 - (1.244 \cdot 10^{-4})^2} \right) \quad , \qquad \text{therefore}$$

(∗) $$h_{01} \approx h = 6.626176 \cdot 10^{-34}\ J\,s\,.$$

The absolute speed of the Centre of our Galaxy V_{0g} is small $V_{0g} \approx 10^{-3} C_0$ (1.131), hence the H_p factor for the entire Galaxy is defined by the following equation:

$$H_p \approx h_{01} \left(1/\sqrt{1 - (10^{-3})^2} \right) \approx h_{01} \left(1 + \frac{1}{2} 10^{-6} \right)$$, thus it can be assumed that:

$$H_p \approx h_{01} \approx 6.626176 \cdot 10^{-34}\ J\,s$$

The equation (S.57) for the atom absolute speed V_0 , now takes the following form:

(S.60) $$\nu_H = \frac{m_{02}\, e^4}{8\, \varepsilon_0^2\, H_p^3} \left(\frac{1}{j^2} - \frac{1}{k^2} \right)$$

Having considered equations (S.58), (S.59) we obtain:

(S.61) $$\nu_H = \frac{m_{01}\, \gamma\, e^4}{8\, \varepsilon_0^2\, (h_{01}\, \gamma)^3} \left(\frac{1}{j^2} - \frac{1}{k^2} \right) = \frac{m_{01}\, e^4}{8\, \varepsilon_0^2\, h_{01}^3\, \gamma^2} \left(\frac{1}{j^2} - \frac{1}{k^2} \right)$$

At the atom's absolute speed $V_0 = 0$, the frequency of emitted light is described by the equation:

(S.62) $$\nu_{0H} = \frac{m_{01}\, e^4}{8\, \varepsilon_0^2\, h_{01}^3} \left(\frac{1}{j^2} - \frac{1}{k^2} \right), \quad \text{because} \quad \gamma = 1$$

Using equations (S.61) and (S.62) we obtain:

$$\nu_H = \nu_{0H} \frac{1}{\gamma^2} = \nu_{0H} [1 - (V_0 / C_0)^2], \quad \text{hence}$$

(S.63) $$\nu_H = \nu_{0H} [1 - (V_0 / C_0)^2]$$

Therefore the frequency of the hydrogen atom spectrum lines ν_H depends on the atom's absolute speed V_0 .

When the atom make a transition from the E_k energy level to the E_j level of lower energy, it emits energy:

$$E = E_k - E_j = H_p\ \nu_H = h_{01}\, \gamma\ \nu_{0H} \frac{1}{\gamma^2} = h_{01}\, \nu_{0H} \frac{1}{\gamma} = h_{01}\, \nu_{0H} \sqrt{1 - (V_0 / C_0)^2},$$

therefore

(S.64) $$E = h_{01}\, \nu_{0H} \sqrt{1 - (V_0 / C_0)^2}, \quad \text{where:} \quad \nu_{0H} \quad \text{relationship (S.62).}$$

$$V_0 \to C_0 \quad \Rightarrow \quad E \to 0$$

The relationship (S.64) also implies that the atom emits the highest amount of energy (a quantum of energy) while motionless ($V_0 = 0$) with respect to the absolute system i.e. with respect to the aether.

The distance r between the nucleus and the electron on its elementary state of lowest energy level:

(S.65) $$r = \frac{\varepsilon_0\, h^2}{\pi\, m\, e^2}$$

Considering (S.58) and (S.59) the following is obtained:

(S.66) $$r = \frac{\varepsilon_0\, (h_{01}\, \gamma)^2}{\pi\, m_{01}\, \gamma\, e^2} = \frac{\varepsilon_0\, h_{01}^2\, \gamma}{\pi\, m_{01}\, e^2} = \frac{\varepsilon_0\, h_{01}^2}{\pi\, m_{01}\, e^2 \sqrt{1 - (V_0 / C_0)^2}}$$

At the hydrogen atom absolute speed V_0

(S.67) $$r_0 = \frac{\varepsilon_0\, h_{01}^2}{\pi\, m_{01}\, e^2} \approx 0.529 \cdot 10^{-10}\ m$$

From (S.66) and (S.67) results the following relationship:

(S.68) $$r = \frac{r_0}{\sqrt{1 - (V_0 / C_0)^2}}, \qquad V_0 \to C_0 \ \Rightarrow \ r \to \infty$$

Therefore it can be concluded that for atoms there exists such an absolute speed V_0 above which no chemical bond can occur. Hence in galaxies speeding across the Universe with the absolute speeds exceeding the speed of our Galaxy, living organisms cannot exist.

DOPPLER'S EFFECT

Two cases of motion of the source of light ZS in a preferred (absolute) system $OX_0Y_0Z_0$, Fig.Sc1, will be examined and the absolute speed of each motion will be specified.

The Observer is located in the origin of the coordinate system $OX_0Y_0Z_0$.

According to Doppler's effect, the spectrum lines frequencies of an atom that moves at an absolute speed V_o, which can be observed by the motionless Observer in the preferred system are:

(S.69) $\nu_{obs} = \nu_H \dfrac{C_0}{C_0 \pm V_0} = \nu_H \dfrac{1}{1 \pm V_0 / C_0}$, where:

ν_{obs} observed frequency of spectrum lines,

ν_H frequency of spectrum lines of a moving atom (relationship (S.63)),

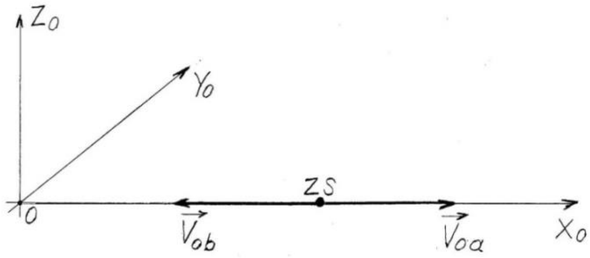

Fig. Sc1 Preferred (absolute) system, motionless with respect to the aether.

Symbols: ZS source of light (hydrogen atoms).

Absolute velocities: $\vec{V}_{0a} = [\ V_{0a}\ ,\ 0,\ 0\ ]$,

$\vec{V}_{0b} = [\ -V_{0b}\ ,\ 0,\ 0\ ]$,

Absolute speed V_{0a} is a module of $\vec{V}_{0a}$ velocity.

Absolute speed V_{0b} is a module of $\vec{V}_{0b}$ velocity.

a) The source of light ZS is moving away from the observer along OX_0 axis at $\vec{V}_{0a}$ velocity.

The equations (S.63), (S.69) take the following form:

(S.70) $\nu_H = \nu_{0H} [1 - (V_{0a} / C_0)^2]$

(S.71) $\nu_{obs} = \nu_H \dfrac{1}{1 + V_{0a} / C_0}$

From the equations (S.70), (S.71) we have:

(S.72) $\nu_{obs} = \nu_{0H} \dfrac{1 - (V_{0a} / C_0)^2}{1 + V_{0a} / C_0} = \nu_{0H}\ (1 - V_{0a} / C_0)$

The lengths of spectrum lines are:

(S.73) $\lambda_{obs} = C_0 / \nu_{obs}$, $\lambda_{0H} = C_0 / \nu_{0H}$

Where: λ_{obs} the observed length of the spectrum lines,

λ_{0H} the length of spectrum lines when atom's absolute speed $V_0 = 0$.

The relative shift of the spectrum lines lengths:

$Z_a = \dfrac{\lambda_{obs} - \lambda_{0H}}{\lambda_{0H}}$. After considering relationship (S.73) we obtain:

$Z_a = (\dfrac{C_0}{\nu_{obs}} - \dfrac{C_0}{\nu_{0H}}) \dfrac{\nu_{0H}}{C_0}$, thus $Z_a = \dfrac{\nu_{0H}}{\nu_{obs}} - 1$

Then considering (S.72) we have: $Z_a = \dfrac{1}{1 - V_{0a} / C_0} - 1$. Hence ultimately the speed V_{0a} :

(S.74) $V_{0a} = C_0 \dfrac{Z_a}{Z_a + 1}$, where: $Z_a \geq 0$, Fig. Sc2

$Za \to \infty \ \Rightarrow\ V_{0a} \to C_0$

b) The source of light ZS is moving towards the observer along OX_0 axis at $\vec{V}_{0b}$ velocity.

Equations (S.63) and (S.69) now take the following form:

(S.75) $$\nu_H = \nu_{0H} [1 - (V_{0b} / C_0)^2]$$

(S.76) $$\nu_{obs} = \nu_H \frac{1}{1 - V_{0b} / C_0}$$

From equations (S.75) and (S.76) we have:

(S.77) $$\nu_{obs} = \nu_{0H} \frac{1 - (V_{0b} / C_0)^2}{1 - V_{0b} / C_0} = \nu_{0H} (1 + V_{0b} / C_0)$$

The relative shift of the spectrum lines lengths:

$$Z_b = \frac{\lambda_{obs} - \lambda_{0H}}{\lambda_{0H}} .$$ After considering equations (S.73) we obtain:

$$Z_b = \left(\frac{C_0}{\nu_{obs}} - \frac{C_0}{\nu_{0H}} \right) \frac{\nu_{0H}}{C_0} ,$$ thus $$Z_b = \frac{\nu_{0H}}{\nu_{obs}} - 1$$

Having considered (S.77) we have:

$$Z_b = \frac{1}{1 + V_{0b} / C_0} - 1 .$$ Hence ultimately the speed V_{0b} :

(S.78) $$V_{0b} = C_0 \frac{-Z_b}{Z_b + 1} ,$$ where: $-0.5 < Z_b \le 0$, Fig. Sc2

$$Z_b \to -0.5 \Rightarrow V_{0b} \to C_0$$

The speed of the Earth with respect to the aether i.e. with respect to the preferred (absolute) system is very small (appx. $1.244 \cdot 10^{-4} C_0$) , therefore the specified absolute speeds (S.74) and (S.78) of the light source ZS apply also to the observer that is located on the Earth.

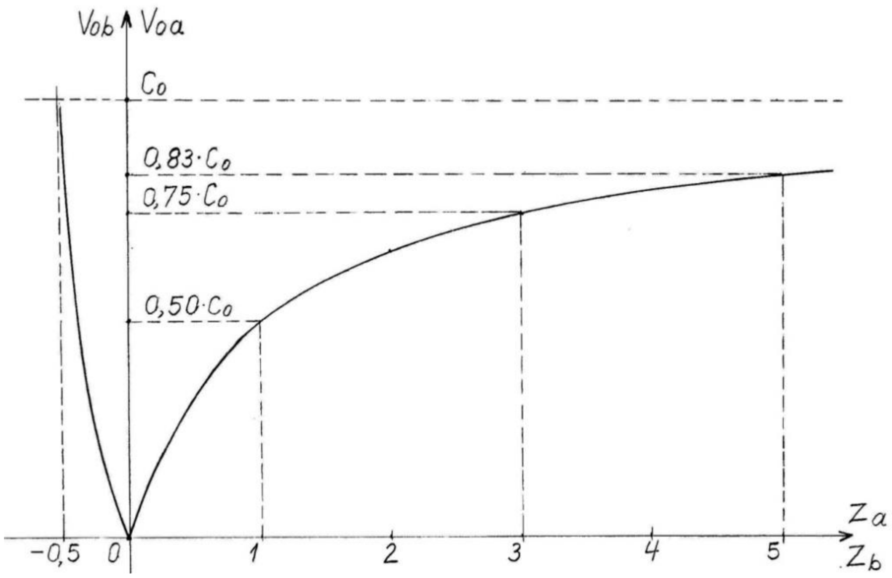

Fig. Sc2 Absolute speeds V_{0a} , V_{0b} of the light sources ZS (hydrogen atoms). The relative shifts Z_a , Z_b of the lengths of the atom's spectrum lines.

$$V_{0a} = C_0 \frac{Z_a}{Z_a + 1} , \qquad Z_a \ge 0 , \qquad Z_a \to \infty \Rightarrow V_{0a} \to C_0 .$$

$$V_{0b} = C_0 \frac{-Z_b}{Z_b + 1} , \qquad -0.5 < Z_b \le 0 , \qquad Z_b \to -0.5 \Rightarrow V_{0b} \to C_0 .$$

Absolute speeds V_{0a}, V_{0b} of atoms in distant galaxies, can take values close to the speed of light C_0 .

The observed length λ_{obs} of the spectrum lines for hydrogen atoms is expressed by the following relationship (S.73):

$\lambda_{obs} = C_0 / \nu_{obs}$. After considering (S.72) we obtain:

$$\lambda_{obs} = \frac{C_0}{\nu_{0H}(1 - V_{0a}/C_0)} = \frac{\lambda_{0H}}{1 - V_{0a}/C_0} \quad , \quad \text{thus} \quad \frac{\lambda_{obs}}{\lambda_{0H}} = \frac{1}{1 - V_{0a}/C_0} \ ,$$

where $\lambda_{0H} = C_0 / \nu_{0H}$ is the length of the spectrum lines of motionless atoms ($V_0 = 0$) with respect to the absolute system, relationship (S.73).

thus $V_{0a} \to C_0 \Rightarrow \lambda_{obs} / \lambda_{0H} \to \infty$.

Example: If $V_{0a} / C_0 = 0.98$, then $\lambda_{obs} / \lambda_{0H} = 50$.

Therefore there is such an absolute speed V_{0a} of atoms that are moving away from the observer, above which the atoms' spectrum lines cannot be observed or their observation, at present, is impossible if only due to technical reasons. These atoms constitute invisible (dark) matter.

Having considered the relationship (S.77) we have:

$$\lambda_{obs} = \frac{C_0}{\nu_{obs}} = \frac{C_0}{\nu_{0H}(1 + V_{0b}/C_0)} = \frac{\lambda_{0H}}{1 + V_{0b}/C_0} \quad , \quad \text{thus}$$

$$V_{0b} \to C_0 \Rightarrow \lambda_{obs} \to \frac{\lambda_{0H}}{2}$$

Therefore the spectrum lines of the atoms moving towards the observer are visible at every absolute speed V_{0b} .

S.IX THE AETHER

In this work no definition of the aether is provided. However, the existence of a static medium that fills up the entire 3D cosmic space was assumed together with its name 'the aether' adopted due to historical reasons.

The authors do not presume the medium is identical to **the aether** defined by the 19th century physicists. To define the aether, broad research is required.

A frame of reference that is motionless in relation to this medium has been assumed. Consequently, the presence of the frame of reference has been evidenced and therefore the aether's very existence proven. This is the preferred inertial and absolute frame of reference in relation to which absolute velocities and speeds are determined. The speed of light in a vacuum, in relation to the absolute frame of reference (i.e. in relation to the aether) equals ' C_0 ' and is the same in all directions.

Vacuum is space filled with the aether and devoid of material particles . Therefore ' nothingness' does not exist as the omnipresent aether constitutes unity with the space.

S.X THE PURPOSE-BUILT INTERFEROMETER TO SHOW EARTH'S MOTION WITH RESPECT TO THE AETHER

The interferometer shown in Fig.Sd1. allows us to evidence the Earth's motion in relation to the preferred coordinate system i.e. the aether.

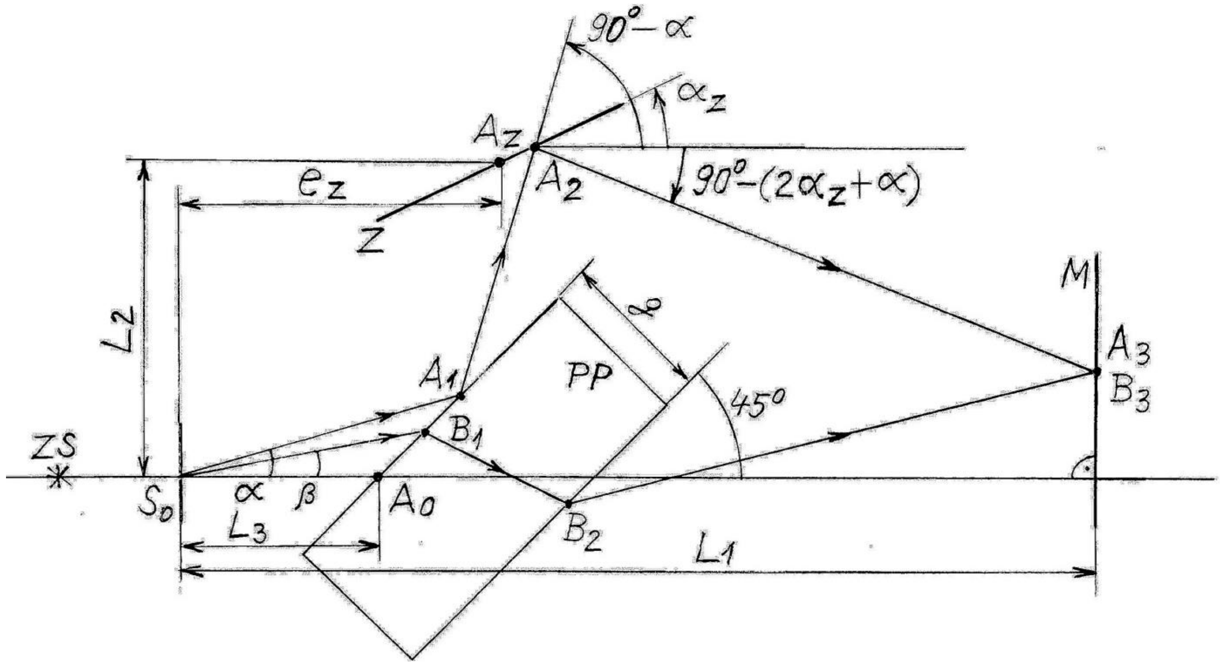

Fig.Sd1 Diagram of interferometer and the trajectory of light in the interferometer.

SYMBOLS:
- ZS source of light,
- S_0 slit,
- Z mirror,
- M screen,
- PP semi-transparent plate,
- A_1, A_2, A_3 points successively reached by a ray of light after leaving the slit S_0 at the angle α ,
- B_1, B_2, B_3 points successively reached by a ray of light after leaving the slit S_0 at the angle β ,
- $A_z\,(e_z\,,L_2)$ mirror Z half-length point

Following values were used in calculations:

$L_1 = L_3 + 1.2\ m$, $L_2 = 0.8\ m$, $L_3 = 0.14\ m$, $e_z = 0.15\ m$,

$g = 1.25 \cdot 10^{-3}\ m$ thickness of PP plate,

$\alpha_z = 25^0$ inclination of the mirror Z to the arm L_1 ,

$\lambda_0 = 5.9 \cdot 10^{-7}\ m$ the wavelength of light in a vacuum,

$n_2 = 1.52$ the PP plate refractive index with respect to a vacuum.

The calculations of the interference fringe shifts values were performed with the use of computer software abIn (Chapter IV).

The length of segments a_1, b_1, b_2, b_3 and the coordinates of points A_1, B_1, B_2, B_3 (Fig.Sd2) were determined via the mathematical model of Michelson's interferometer (Chapter I).

Now we are going to determine the length of segments a_2, a_3 and the coordinates of points A_2, A_3 .

THE MOTION OF INTERFERONETER IN THE OXY COORDINATE SYSTEM:

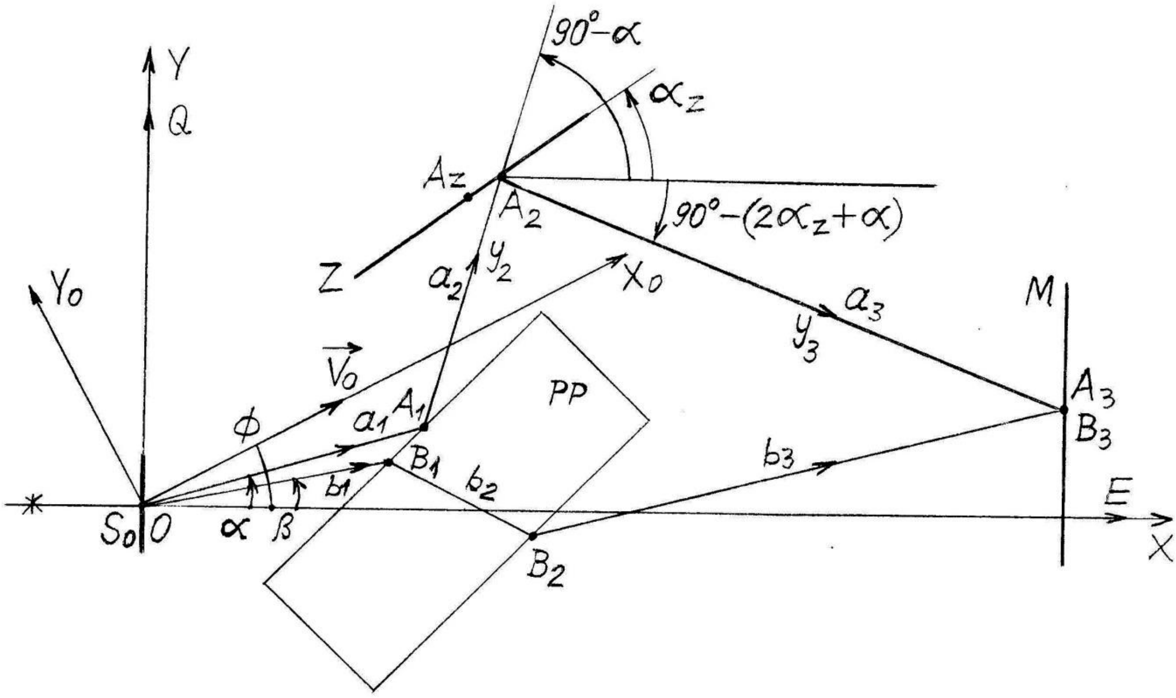

Fig.Sd2 The trajectory of light rays reaching points A_3, B_3 on screen M after leaving the slit S_0 at the angles α, β.

The line equation of the mirror Z :

(S.79) $$y = tg\alpha_z \ x \ + L_2 + t\,V_0 \sin\Phi - tg\alpha_z \ (e_z + t\,V_0 \cos\Phi)$$

The equation of the y_2 straight line which passes through the point $A_1(x_{a1}, y_{a1})$ is:

(S.80) $$y_2 = tg(90^0 - \alpha) \ x \ + y_{a1} - tg(90^0 - \alpha) \ x_{a1}$$

Lines (S.79), (S.80) pass through the point $A_2(x_{a2}, y_{a2})$, therefore after considering $t = (a_1 + a_2)/C_0$ and $V_0/C_0 = V_w$, the following is obtained:

(S.81) $$y_{a2} = tg\alpha_z \ x_{a2} \ + L_2 + (a_1 + a_2)\,V_w \sin\Phi - tg\alpha_z \ [e_z + (a_1 + a_2)\,V_w \cos\Phi\,]$$

(S.82) $$y_{a2} = tg(90^0 - \alpha) \ x_{a2} \ + y_{a1} - tg(90^0 - \alpha) \ x_{a1}$$

The following relationship applies:

(S.83) $$x_{a2} = x_{a1} + a_2 \sin\alpha$$

From the equations (S.81), (S.82), (S.83) the length of the a_2 segment can be calculated:

(S.84) $$a_2 = \frac{y_{a1} - L_2 - a_1 V_w \sin\Phi + tg\alpha_z \ (e_z - x_{a1} + a_1 V_w \cos\Phi)}{tg\alpha_z \ (\sin\alpha - V_w \cos\Phi) \ + V_w \sin\Phi - \cos\alpha} ,$$ thus

the x_{a2} coordinate of the point A_2 can be obtained from equation (S.83).

and the y_{a2} coordinate of the point A_2 can be obtained from equation (S.82):

(S.85) $$y_{a2} = ctg\alpha \ (x_{a2} - x_{a1}) \ + y_{a1}$$

The equation of the y_3 straight line which passes through the point $A_2(x_{a2}, y_{a2})$ is:

(S.86) $$y_3 = - \ tg[90^0 - (2\,\alpha_z + \alpha)] \ x \ + y_{a2} + tg[90^0 - (2\alpha_z + \alpha)] \ x_{a2}$$

The line equation of the screen M :

(S.87) $$x = L_1 + t\,V_0 \ \cos\Phi$$

Lines (S.86), (S.87) pass through the point $A_3(x_{a3}, y_{a3})$, therefore after considering $t = (a_1 + a_2 + a_3)/C_0$ and $V_0/C_0 = V_w$, the following is obtained:

(S.88) $$y_{a3} = - ctg(2\,\alpha_z + \alpha) \ x_{a3} + y_{a2} + ctg(2\,\alpha_z + \alpha) \ x_{a2}$$

(S.89) $$x_{a3} = L_1 + (a_1 + a_2 + a_3)\,V_w \cos\Phi$$

The following relationship applies:

(S.90) $$y_{a3} = y_{a2} - a_3 \sin[90^0 - (2\alpha_z + \alpha)]$$

From the equations (S.88), (S.89), (S.90) the length of the a_3 segment can be calculated:

(U.91) $$a_3 = \frac{ctg(2\alpha_z + \alpha)\ [x_{a2} - L_1 - (a_1 + a_2) V_w \cos\Phi]}{ctg(2\alpha_z + \alpha)\ V_w \cos\Phi - \cos(2\alpha_z + \alpha)}$$, thus

the x_{a3} coordinate of the point A_3 is obtained from the equation (S.89).

the y_{a3} coordinate of the point A_3 is obtained from the equation (S.90):

(S.92) $$y_{a3} = y_{a2} - a_3 \cos(2\alpha_z + \alpha)$$

THE O'EQ COORDINATE SYSTEM:

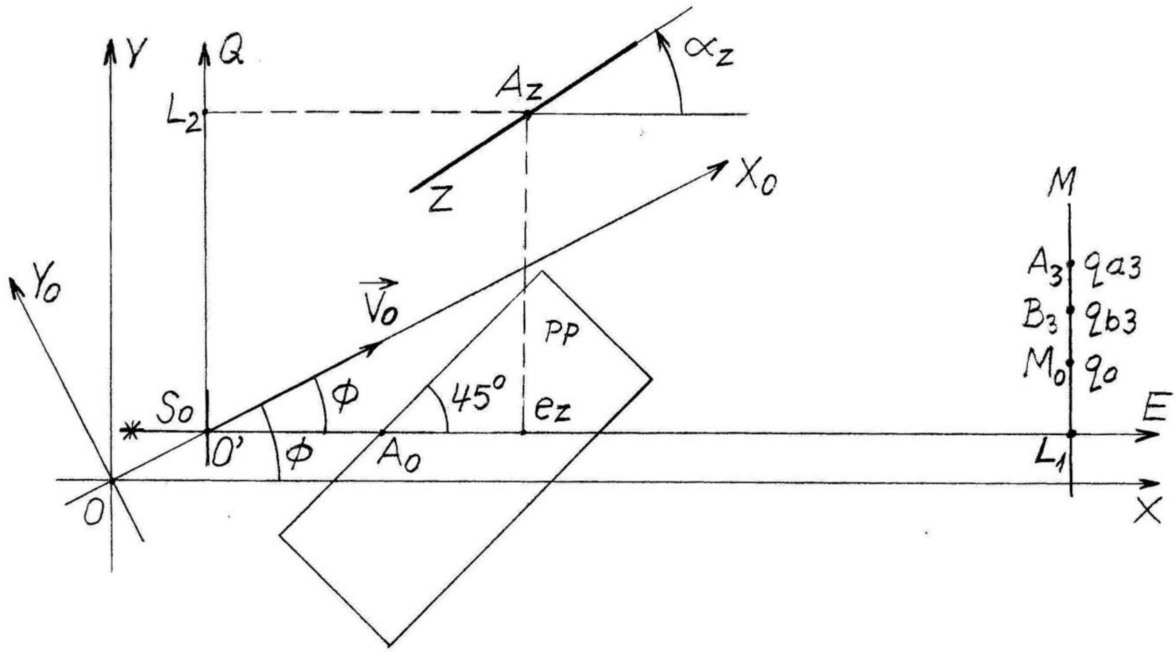

Fig.Sd3 The points A_3, B_3 of the screen M, together with their coordinates q_{a3}, q_{b3}, which were reached by the rays of light after leaving the slit S_0 at the angles α, β.

The coordinates of points A_1, A_2, A_3 are defined by equations (1.79),...,(1.84).
The coordinates of points B_1, B_2, B_3 are defined by equations (1.89),...,(1.94).

The total relative difference of distances travelled by the rays of light:

(S.93) $$R_w = (a_{1u} + a_{2u} + a_{3u} - b_{1u} - n_2 b_{2u} - b_{3u}) / \lambda_0$$, where:

a_{1u}, a_{2u}, a_{3u} relationships (1.99), (1.100), (1.101),
b_{1u}, b_{2u}, b_{3u} relationships (1.104), (1.105), (1.106).

The shift of the interference fringes is calculated with respect to point Mo with its coordinate q_o on the screen M.
In the calculations – the relative approximations of points A_3, B_3 to point M_0 are described by the following inequalities of coordinates (Fig.Sd3):

$$|\ q_{a3} - q_0\ | / \lambda_0 < 10^{-7}, \qquad |\ q_{b3} - q_0\ | / \lambda_0 < 10^{-7}$$

The value of $q_0 = 0.0314m$ was adopted for calculations.
The formula (1.113) can be applied to calculate the values of interference fringe shifts with respect to any Mo point on the screen M, after rotating the interferometer by any angle Φ_2 and with the $V_w = V_o / C_o$ fixed at any value.

Φ_1	α_1 β_1	R_{w1}	Interferometer Fig.Sd1
rad	*rad*	–	
0	$7.9272859700 \cdot 10^{-2}$ $2.3752096417 \cdot 10^{-2}$	1714978.275369	
Φ_2	α_2 β_2	R_{w2}	$k = R_{w2} - R_{w1}$
rad	*rad*	–	–
$\pi / 4$	$7.9293210486 \cdot 10^{-2}$ $2.3840956517 \cdot 10^{-2}$	1714978.273784	$-1.585 \cdot 10^{-3}$
$\pi / 2$	$7.9251864917 \cdot 10^{-2}$ $2.3879467438 \cdot 10^{-2}$	1714978.278831	$3.462 \cdot 10^{-3}$
$-\pi / 4$	$7.9202736003 \cdot 10^{-2}$ $2.3664940169 \cdot 10^{-2}$	1714978.280410	$5.041 \cdot 10^{-3}$
$-\pi / 2$	$7.9123925013 \cdot 10^{-2}$ $2.3630542726 \cdot 10^{-2}$	1714978.278820	$3.451 \cdot 10^{-3}$

TABLE 1S Values of the interference fringe shifts obtained in the interferometer-Fig.Sd1 at Earth's relative speed $V_w = 1.244 \cdot 10^{-4}$.

Φ_1	α_1 β_1	R_{w1}	Michelson's interferometer Fig.1
rad	*rad*	–	
0	$4.0632221297 \cdot 10^{-3}$ $3.6009713906 \cdot 10^{-3}$	3002.1315414	
Φ_2	α_2 β_2	R_{w2}	$k = R_{w2} - R_{w1}$
rad	*rad*	–	–
$\pi / 4$	$4.0334363765 \cdot 10^{-3}$ $3.6838569584 \cdot 10^{-3}$	3002.1311184	$-4.23 \cdot 10^{-4}$
$\pi / 2$	$3.9520933235 \cdot 10^{-3}$ $3.7151890224 \cdot 10^{-2}$	3002.1314894	$-5.20 \cdot 10^{-5}$
$-\pi / 4$	$4.0240046661 \cdot 10^{-3}$ $3.5150847874 \cdot 10^{-3}$	3002.1318969	$3.55 \cdot 10^{-4}$
$-\pi / 2$	$3.9387581529 \cdot 10^{-3}$ $3.4765066075 \cdot 10^{-3}$	3002.1314913	$-5.01 \cdot 10^{-5}$

TABLE 2S Values of interference fringe shifts obtained in Michelson's interferometer (Fig.1) at Earth's relative speed $V_w = 1.244 \cdot 10^{-4}$.

Values of the interference fringe shifts obtained in the interferometer in Fig.Sd1 are greater than the values obtained in the Michelson's interferometer.

$5.041 \cdot 10^{-3} / \mid -4.23 \cdot 10^{-4} \mid \approx 12$ (see Tables 1S, 2S).

CARRYING OUT THE MEASUREMENTS:

The supporting structure of the interferometer should enable the interferometer to be set up in relation to its absolute velocity $\vec{V}_0$ (Fig.Sd4).

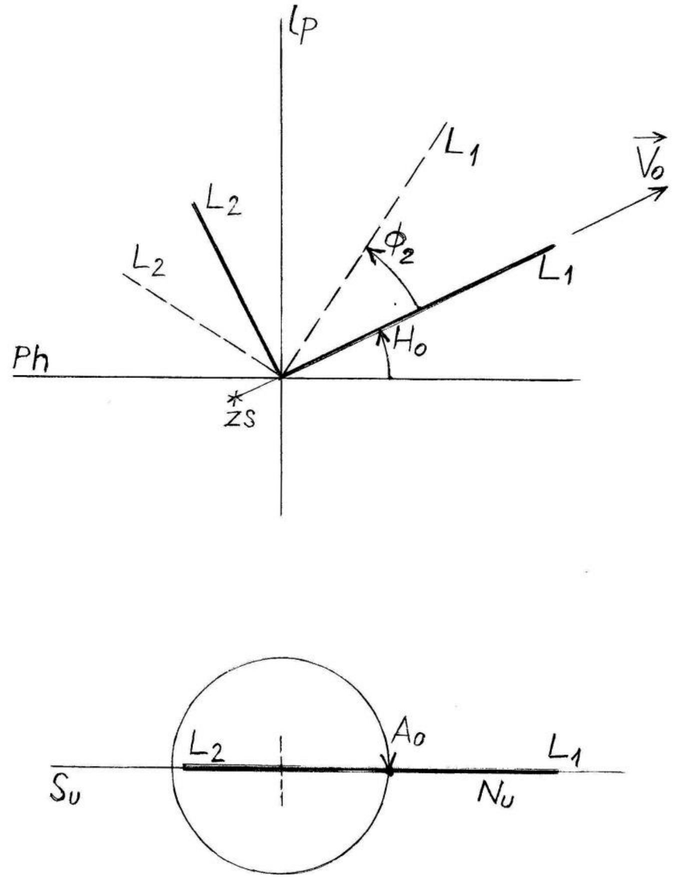

Fig.Sd4 Positioning the interferometer in relation to velocity $\vec{V}_0$.
Schematic diagram

SYMBOLS:

L_1, L_2 arms of the interferometer,

lp vertical line,

ph plane of the horizon (its projection),

$N_u S_u$ North-South line ,

$\vec{V}_0$ absolute velocity $\vec{V}_{01}$ (2.1) of the interferometer or absolute velocity $\vec{V}_{02}$ (2.2),

A_0 azimuth A_{01} (2.62) of $\vec{V}_{01}$ velocity within angle range from 0^0 to 360^0, or azimuth A_{02} (2.69) of $\vec{V}_{02}$ velocity within the same range of angles,

H_0 altitude H_{01} (2.60) of $\vec{V}_{01}$ velocity within angle ranges from 0^0 to 180^0 and rom 0^0 to -180^0, or altitude H_{02} (2.67) of velocity $\vec{V}_{02}$ within the same ranges of angles,

Φ_2 angle between $\vec{V}_0$ velocity and the interferometer's arm L_1 within angle ranges from 0^0 to180^0 and from 0^0 to -180^0.

To calculate the values of A_0, H_0 angles, the computer software Vo1Vo2 (Chapter IV) can be used. It allows the values of A_0, H_0 angles to be calculated for any given point on the Globe and for any given time UT (see the example on page 46).

Due to the Earth's simultaneous rotary and orbital motions, the A_0, H_0 angles are subject to constant change. Consequently, having calculated the values of those angles and having set up the interferometer at those angles with respect to the $N_u\, S_u$ line and the ph plane, the change of the Φ_2 angle and the observation of the interference fringe shifts k are restricted to just a few minute's time period.

SEMI-TRANSPARENT PLATE THICKNESS g AND INTERFERENCE FRINGE SHIFTS k IN THE INTERFEROMETER:

	Φ_2	g	k
	rad	m	−
Interferometer Fig.Sd1	$-\pi/4$	$0.2 \cdot 10^{-3}$	$5.032 \cdot 10^{-3}$
		$5 \cdot 10^{-3}$	$5.043 \cdot 10^{-3}$
		10^{-2}	$5.051 \cdot 10^{-3}$
		$2 \cdot 10^{-2}$	$5.072 \cdot 10^{-3}$

TABLE 3S The interference fringe shifts values k for different g thickness values of the semi-transparent plate PP at $V_w = 1.244 \cdot 10^{-4}$.

Thickness g of semi-transparent plate PP only slightly influences the values k of interference fringe shifts (see Table 3S).

INDEX OF SYMBOLS

$\vec{C}_0$	The velocity of the light in a vacuum with respect to the aether,
C_0	the speed of light in a vacuum with respect to the aether,
C	the speed of light in a vacuum with respect to the system 2 (O'EQW),
C_p	the speed of light in the semi-transparent plate PP with respect to the aether,
$\vec{V}_o$	the absolute velocity of the interferometer and the system 2 (O'EQW),
V_o	the absolute speed of the interferometer and the system 2 (O'EQW),
$V_w = V_o / C_o$	the absolute speed of the interferometer, expressed with respect to the speed of light C_0,
λ_0	the wavelength of light in a vacuum,
λ_p	the wavelength of light in the semi-transparent plate PP,
n_2	the refractive index for the semi-transparent plate PP with respect to a vacuum,
α, β	angles at which rays of light leave slit S_0,
γ_1, γ_2	angles of the light rays refraction in a semi-transparent plate,
Φ	angle between the OXo and the OX axes and also the angle at which the interferometer is situated with respect to its absolute velocity $\vec{V}_0$,
$t_{a1},...,t_{a5}$	time intervals in which a ray of light reaches successively points $A_1,...,A_5$ after leaving slit S_0,
$t_{b1},...,t_{b5}$	time intervals in which a ray of light reaches successively points $B_1,...,B_5$ after leaving slit S_0,
$a_1,...,a_5$	distances between contiguous points So , $A_1,...,A_5$ in the OXY system,
$b_1,...,b_5$	distances between contiguous points So , $B_1,...,B_5$ in the OXY system,
$a_{1u},...,a_{5u}$	distances between contiguous points So , $A_1,...,A_5$ in the O'EQ system,
$b_{1u},...,b_{5u}$	distances between contiguous points So , $B_1,...,B_5$ in the O'EQ system,
e_{a5}	the coordinate of point A_5 of the screen M reached by a ray of light after leaving slit S_0 at angle α,
e_{b5}	the coordinate of point B_5 of the screen M reached by a ray of light after leaving slit S_0 at angle β,
Mo	a point on the screen M (a fixed line in the telescope) in relation to which the shift of interference fringes is calculated,
e_o	the coordinate of the Mo point on the screen M in the O'EQ system.
$R_w = \Delta l / \lambda_o$	the relative difference of distances traveled by the rays of light reaching one point of screen M in the O'EQ system,
k	the value of interference fringes shift,
$R_{rw} = \Delta l / \lambda_o$	the relative difference of distances traveled by the rays of light reaching distant points A_5, B_5 of screen M in the O'EQ system,
K_r	the difference of relative differences of distances R_{rw},
$\vec{V}_r$	the peripheral velocity of a point i.e. a place on the Earth's surface where the interferometer (the observer) is located .
V_r	the peripheral speed of a point i.e. a place on the Earth's surface where the interferometer (the observer) is located .

$\vec{V}_{zs}$ the velocity at which the Earth's center travels around the Sun,
V_{zs} the speed at which the Earth's center travels around the Sun.
$\vec{V}_{ze}$ the velocity at which the Earth's center travels with respect to the aether,
V_{ze} the speed at which the Earth's center travels with respect to the aether,
$\vec{V}_{se}$ the velocity at which the Sun's center travels with respect to the aether,
V_{se} the speed at which the Sun's center travels with respect to the aether,
$\vec{V}_{sg}$ the velocity at which the Sun's center travels around the center of our Galaxy,
V_{sg} the speed at which the Sun's center travels around the center of our Galaxy,
$\vec{V}_{ge}$ the velocity at which the center of our Galaxy moves with respect to the aether,
V_{ge} the speed at which the center of our Galaxy moves with respect to the aether,
N Northern point of the horizon,
S Southern point of the horizon,
P_N The North Pole,
P_S The South Pole,
N S line the line of intersection between the horizon plane and the celestial meridian plane which run through the point U(φ, λ),
ω the angular speed of the Earth's rotation,
ε inclination of the ecliptic to the celestial equator,
p annual precession within ecliptic (in longitude),
v true anomaly,
r a radius vector,
a an average Earth-Sun distance,
b a small semi-axis of the Earth's orbit,
T_{rg} stellar year,
T_{rz} tropical year,
T_z the duration of astronomical winter,
$\vec{V}_{01}, \vec{V}_{02}$ the absolute velocities of the interferometer in the horizontal system.
$\vec{V}_o = \vec{V}_{01}$ or $\vec{V}_o = \vec{V}_{02}$,
α_s right ascension of the Sun,
α_{se} right ascension of the $\vec{V}_{se}$ velocity,
α_{se1} right ascension of the $\vec{V}_{se1} = -\vec{V}_{se}$ velocity,
α_{zs} right ascension of the $\vec{V}_{zs}$ velocity,
GHA_{zs} Greenwich Hour Angle of velocity $\vec{V}_{zs}$,
GHA_s Greenwich Hour Angle of the Sun
GHAaries Greenwich Hour Angle of the Aries point,
LHA_{zs} Local Hour Angle of velocity $\vec{V}_{zs}$,
LHA_{se} Local Hour Angle of velocity $\vec{V}_{se}$,
LHA_{se1} Local Hour Angle of velocity $\vec{V}_{se1} = -\vec{V}_{se}$,
δ_{zs} declination of velocity $\vec{V}_{zs}$,
δ_{se} declination of velocity $\vec{V}_{se}$,

δ_{se1}	declination of velocity $\vec{V}_{se1} = -\vec{V}_{se}$,
H_{zs}	altitude of velocity $\vec{V}_{zs}$,
H_{se}	altitude of velocity $\vec{V}_{se}$,
H_{se1}	altitude of velocity $\vec{V}_{se1} = -\vec{V}_{se}$,
H_{01}	altitude of velocity $\vec{V}_{01}$,
H_{02}	altitude of velocity $\vec{V}_{02}$,
A_{zs}	azimuth of velocity $\vec{V}_{zs}$,
A_{se}	azimuth of velocity $\vec{V}_{se}$,
A_{se1}	azimuth of velocity $\vec{V}_{se1} = -\vec{V}_{se}$,
A_{01}	azimuth of velocity $\vec{V}_{01}$,
A_{02}	azimuth of velocity $\vec{V}_{02}$,
$U(\varphi, \lambda)$	point U of geographical coordinates φ, λ in which the interferometer (the observer) is situated,
m_{01}, m_{02}	rest mass of particle in systems 1 and 2 respectively (Fig.10),
m_1, m_2	mass of a particle in motion in systems 1 and 2,
$\vec{F}_1, \vec{F}_2$	forces acting on a particle in systems 1 and 2,
$\vec{V}_1, \vec{V}_2$	particle's velocity in systems 1 and 2,
τ_1, τ_2	average life time of unstable particles in system 1 and 2,
ω_{A1}, ω_{A2}	frequency of atom vibrations in systems 1 and 2,
ω_1, ω_2	angular speed of the Earth's rotation in systems 1 and 2,
J_1, J_2	Earth's moment of inertia in systems 1 and 2,
$\Delta\tau_1, \Delta\tau_2$	times measured by atomic clocks in systems 1 and 2,
T_1, T_2	Earth's sidereal days in systems 1 and 2,
$\Delta\tau_{2(T1)}$	time measured by the atomic clock in system 2 at $\Delta\tau_1 = T_1$,
R_T	difference of the times $T_2 - \Delta\tau_{2(T1)}$,
ZA_a, ZA_b	atomic clocks situated along an Earth's parallel,
ZA_p	an atomic clock situated at the South Pole,
V_{ra}, V_{rb}	the speeds of the ZA_a, ZA_b clocks situated on the parallel's plane,
V_{0ra}, V_{0rb}	the absolute speeds of the ZA_a, ZA_b clocks,
V_{0p}	the absolute speed of the ZA_p clock,
$\Delta\tau_{2ra}, \Delta\tau_{2rb}$	times measured by the ZA_a, ZA_b clocks situated on the Earth's parallel,
$\Delta\tau_{2p}$	time measured by the ZA_p clock situated at the South Pole,
$R_{pa(T/2)}$	the absolute value of the difference in times measured by the ZA_a, ZA_p clocks during half-a-sidereal day since the time of their synchronization.
$R_{ba(T/2)}$	the absolute value of the difference in times measured by the ZA_a, ZA_b clocks during half-a-sidereal day since the time of their synchronization,
T_{syn}	the UT of the clocks synchronization time.

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