Vol. 3, No. 1, 2018

THE LIFE PATH AND SCIENTIFIC PRIORITIES OF PROFESSOR OLEKSANDR MOROZ

Zoriana Tartachynska, Liubov Luchyt

Lviv Polytechnic National University
79013, 12, S.Bandery Str., Lviv, Ukraine
ztartachynska@yahoo.com

Received: 10.02.2018

Abstract. The life path and the range of scientific interests of Professor Oleksandr Moroz are described. The main results of scientific research in the field of the influence of vertical refraction on the accuracy of astronomical and geodetic measurements are shown.

Key words: atmosphere, leveling, fluctuations of images, refraction, temperature gradients.

Oleksandr Moroz was born on July 3, 1955 in the village of Ilinka Khankai district, Primorsky Territory, Russia in the family of Ukrainians. In 1959, the family returned to Ukraine to the village of Petrivka-Romenska in Gadyach district of Poltava region. His father, Ivan Danylovych, worked as a driller at the Glinsko-Rozbyshiv Drilling Office, and his mother, Anna Ivanivna, was a housewife.

After graduating from Petrivka-Romenska secondary school in 1972, Oleksandr Ivanovych entered Poltava Oil Exploration College and in 1973, he joined the Soviet Army. He served in Strategic Missile Forces as a geodesist, which determined his further life path.

After demobilization in the autumn of 1975, he entered the preparatory department of Lviv Polytechnic Institute. In 1976, O. I. Moroz became a first-year student of the Geodesy faculty in the field of Applied Geodesy. During his studies he was actively engaged in social and scientific work, and since the third year of his study he has worked as a part-time worker at the MNDL-18, where he performed field and office geodetic works. He was a Leninist scholarship holder and a Komsomol organizer of Lviv Polytechnic. After graduating from Institute in 1981, he was directed to work at the MNDL-18 as an engineer.

In 1984 Oleksandr Ivanovych Moroz entered the postgraduate course at Lviv Polytechnic Institute and was sent to study at Dresden Technical University, where in 1987 he defended his Ph.D. thesis on the topic "Investigation of Leveling Refraction in the Surface Layer of the Atmosphere on the Basis of Oscillations of Images". On returning to Lviv, he worked as an assistant, senior lecturer and assistant professor at the Department of Geodesy of Lviv Polytechnic. In 1988, by the order of the rector, O. I. Moroz was appointed Head of the Educational Department of Polytechnic Institute, where he has worked for five years. On April 1, 1993, he was selected by competition for the post of Head of the Department of Geodesy. Oleksandr Ivanovych has worked in this post for 21 years.

In 2003 he defended his doctoral dissertation on the topic "Theoretical Foundations of Vertical Refraction, Methods of Its Determination, Calculation and Forecasting", and in the following year he received the title of Professor of Geodesy.

In 2011, O. I. Moroz was appointed, and subsequently elected Director of V. Chornovil Institute of Ecology, Environmental Protection and Tourism, which in 2017 was renamed the Vyacheslav Chornovil Training and Research Institute of Sustainable

Development of Lviv Polytechnic National University, where he works until now.

The range of scientific interests of Oleksandr Ivanovych is related to the study of the influence of the atmosphere on the accuracy of astronomical and geodetic measurements, namely the definition and calculation of vertical refraction during geodetic measurements. They revealed the patterns of fluctuations of abnormal vertical temperature gradients.

The Earth's atmosphere is an optically heterogeneous medium, so the ray of light between two points does not pass directly but through rather complex spatial curve. During the angular measurements, the refractive index is the angle between the tangent to the beam at the starting point and the chord connecting the initial and final points of the beam. The projection of this angle into a sloping plane passing through the initial and final points of the beam is called the angle of vertical refraction or vertical refraction, and its planned projection is the angle of horizontal refraction or horizontal refraction. The value of vertical refraction, usually, is several orders of magnitude higher than the horizontal one.

The general vertical refraction is determined by the formula of the following differential equation:

$$d\sigma_B = \frac{1}{n}\frac{dn}{dz} cos\alpha d\ l \quad (1)$$

which indicates that the common refractive angle $d\sigma_B$ is the function of the gradient of the order index in the direction of the straight line (Fig. 1).

By formula (1) the total vertical refraction, as well as partial refraction angles can be defined, if we assume that the ray is refracted at one point. During the propagation in the atmosphere, the light beam continuously and alternately refracts on its path. In order not to build many auxiliary spheres for defining refraction, it is expedient to have its integral equation.

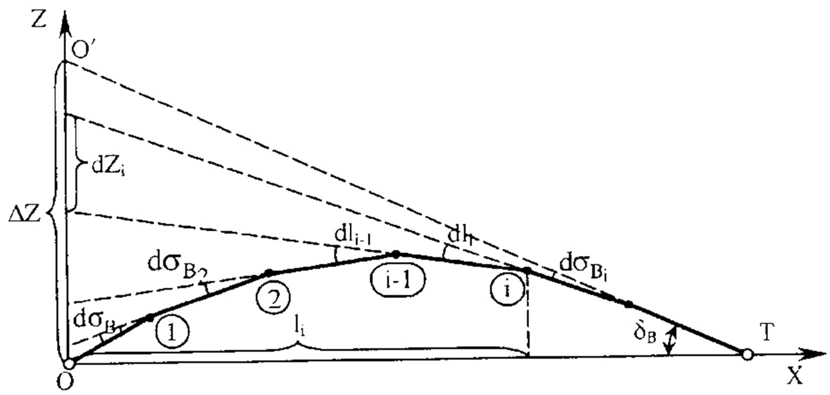

Fig. 1

At the point O of the origin of the coordinates there is a sight target, and at the point T a receiver is installed – an optical device, for example, a theodolite. Due to the curvature of the beam in the vertical plane, the point O due to the refraction will be visible through the optical tube in the position O '. Due to the fact that OO' and angle σ_B are small, with a sufficient degree of accuracy it can be assumed, that $X_T = L$, a $x_i = l_i$. The change in the direction of the beam by the angle $d\sigma_B$ due to the movement of light from the point (i-1) to the point i and projection on the OZ axis is like the change of the apparent position of the point O on OZ_i and

$$dZ_i = l_i d\sigma_{B_i}. \quad (2)$$

Substituting in (2) the value $d\sigma_{B_i}$ from (1) we get

$$dZ_i = \frac{1}{n}\frac{dn}{dZ} l_i cos\alpha dl_i. \quad (3)$$

Moving the beam of light along the trajectory from the point O to T corresponds to the segment on the OZ axis,

$$\Delta Z = \int_O^L \frac{1}{n}\frac{dn}{dZ} lcos\alpha dl\,, \quad (4)$$

which is an angular partial refraction δ_B. Since the angle δ_B is small, you can write

$$\sigma_B = \frac{\rho\Delta Z}{L}. \quad (5)$$

Taking into account (4), the equation of the partial angle of the vertical refraction has the form

$$\delta_B = \rho\frac{\cos\alpha}{L}\int_O^L \frac{1}{n}\frac{dn}{dZ} ldl. \quad (6)$$

For the trails close to the horizon |α|≤6°, that's why

$$\sigma_B = \frac{\rho}{L}\int_O^L \frac{1}{n}\frac{dn}{dZ} ldl. \quad (7)$$

It is expedient to express the change in the refractive index in the functions of temperature T and pressure P. The humidity is usually neglected. To do this, you need to differentiate the equation of the refractive index of the air ($n - 1 = 78.85\frac{P}{T}10^{-6}$).

In this case, the influence of humidity is neglected. We'll get

$$\frac{dn}{dZ} = \frac{78.85}{T}\frac{dP}{dZ}10^{-6} - \frac{78.85}{T^2}P\frac{dT}{dZ}10^{-6}. \quad (8)$$

As $\frac{dP}{dZ} = \frac{dP}{dh}$i $\frac{dT}{dZ} = \frac{dT}{dh}$, taking into account that $\frac{dP}{dZ} = 0{,}0342\frac{P}{T}$ GPA/m, dependence (8) will be

$$\frac{dn}{dZ} = -78.85 \cdot 10^{-6}\frac{P}{T^2}\left(0.0342 + \frac{dT}{dh}\right). \quad (9)$$

Substituting (9) into (7), assuming that n≈1 with an accuracy of 0.0001, it can be recorded

$$\delta_B = -\frac{\rho}{L}\int_O^L 78.85 \cdot 10^{-6}\frac{P}{T^2}\left(0.0342 - \frac{dT}{dh}\right) l dl, \quad (10)$$

or

$$\delta_B = -0{,}278\frac{P}{T^2}L - \frac{\rho}{L}\int_O^L 78.85 \cdot 10^{-6}\frac{P}{T^2}\gamma l dl. \quad (11)$$

As usual, the temperature gradient is divided into a normal and abnormal components, ie, $\gamma = \gamma_{\text{н}} + \gamma_{\text{ан}}$, therefore (11) will be

$$\delta_B = -0.278\frac{P}{T^2}L) -$$

$$-\frac{\rho}{L}\int_O^L 78.85 \cdot 10^{-6}\frac{P}{T^2}(\gamma_{\text{н}} + \gamma_{\text{ан}}) l dl. \quad (12)$$

Because $\gamma_{\text{н}} = const$

$$\delta_B = -0.278\frac{P}{T^2}L - 8.13\frac{P}{T^2}L\gamma_{\text{н}}) -$$

$$-\frac{\rho}{L}\int_O^L 78.85 \cdot 10^{-6}\frac{P}{T^2}\gamma_{a\text{н}} l dl. \quad (13)$$

Taking into account that $\gamma_{\text{н}}$=0.098 grad/m, and also, having multiplied and divided the last summand (13) by *2L*, we get

$$\delta_B = -0.278\frac{P}{T^2}L - \frac{0.080P}{T^2}L -$$

$$-78.85 \cdot 10^{-6}\rho\frac{2L}{2L^2}\frac{P}{T^2}\int_O^L \gamma_{a\text{н}} l dl. \quad (14)$$

After introducing the notion of abnormal equivalent mean temperature gradient $\gamma_{\text{ан.е.сер}}$, which can be expressed as

$$\gamma_{\text{ан.е.сер}} = \frac{2}{L^2}\int_O^L \gamma_{a\text{н}} l dl. \quad (15)$$

dependence (14) can be written as follows

$$\delta_B = -0.278\frac{P}{T^2}L - 0.080\frac{P}{T^2}L -$$

$$-8.132\frac{P}{T^2}L\gamma_{\text{ан.е.сер}}. \quad (16)$$

The first term on the right side of equation (16) expresses the share of refraction, which depends on the vertical pressure gradient; the second is a component due to the normal temperature gradient; and the third component is due to an abnormal temperature gradient.

In short, taking into account the value of $\gamma_{\text{н}}$ the dependence (16) looks like this

$$\delta_B = 8.132\frac{P}{T^2}L\left(0.0244 + \gamma_{\text{ан.е.сер}}\right), \quad (17)$$

or

$$\delta_B = 0.198\frac{P}{T^2}L - 8.132\frac{P}{T^2}L\gamma_{\text{ан.е.сер}}. \quad (18)$$

In (18), an abnormal refraction sign in a thermally turbulent atmosphere is taken into account.

In addition, the relationship between abnormal refraction and the thermal turbulence of the atmosphere has been established.

Thermal turbulence and abnormal refraction exist only simultaneously, because they are caused by the same physical phenomena, and they are based on natural processes.

Visible swings of fluctuations of the images of sight targets in sight of the visual tube of a geodesic device or the trace of a laser beam are equivalent, that is, medium-wave fluctuations, which inform about fluctuations of temperature gradients along the entire path of the beam from the sight target or from the source of radiation to the receiver.

The reason for the vertical fluctuations of the images of sight targets in the optic tubes or the generated beam is, for the most part, the fluctuations of the vertical abnormal equivalent temperature gradient – $\gamma_{\text{ан.е}}$.

The geometric content of the theory of determining abnormal vertical refraction by the fluctuations of images of sight targets is shown in Fig. 2 where $\delta''_{\text{ан.сер}} = \frac{\Delta\delta''_{max}}{2}$.

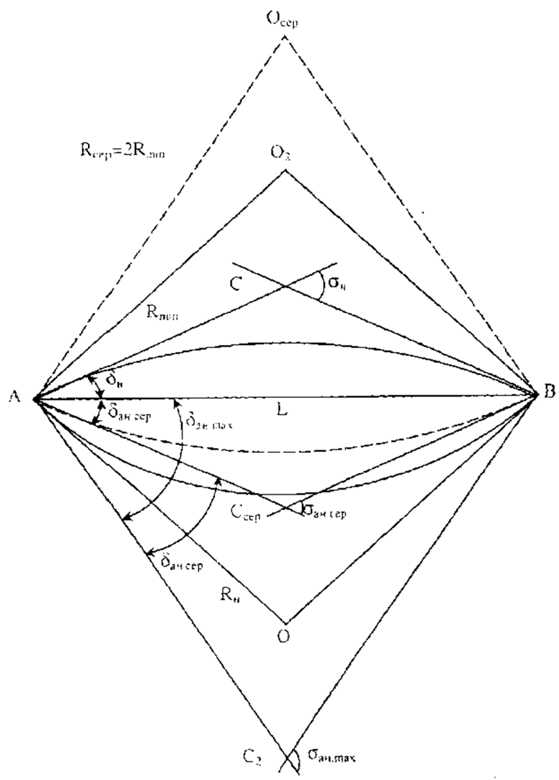

Fig. 2

Based on the above stated, a general conclusion is made that abnormal vertical refraction is based on the laws of fluctuations of abnormal vertical temperature gradients, which justifies the unity of atmospheric turbulence and abnormal vertical refraction.

Professor O. I. Moroz is the author of 6 textbooks, monographs, 120 scientific articles and 40 methodological developments. He has got 25 author's certificates for inventions. He lectures on Geodesy and Topography for students of the Institute of Geodesy, as well as Tourist Topography for students of the V. Chornovil Institute of Sustainable Development of Lviv Polytechnic National University. O. I. Moroz supervises the training of postgraduate students; under his supervision two theses were defended.

He was awarded the breastplate of the State Service of Geodesy, Cartography and Cadastre “Honorary Geodesist of Ukraine” (2005), and the honorary title “Honoured Worker of Science and Technology of Ukraine” by the Decree of the President of Ukraine in 2008.

References

[1] Moroz O. I. Vyznachennya ta vrakhuvannya vertykal'noyi refraktsiyi pid chas heodezychnykh vymiryuvan'. Monohrafiya. – L'viv: Vydavnytstvo Natsional'noho universytetu «L'vivs'ka politekhnika», 2003. – 224 s.

[2] Moroz O. Osnovni polozhennya teoriyi fluktuatsiynoho metodu vyznachennya anomal'noyi vertykal'noyi refraktsiyi / O. Moroz, O.Ostrovs'kyy. – L'viv: Zbirnyk naukovykh prats' “Suchasni dosyahnennya heodezychnoyi nauky ta vyrobnytstva”, 2002. – S. 110-120.

[3] Moroz O. Y. Teoryya y praktyka fluktatsyonnoho metoda opredelenyya vertykal'noy refraktsyy. / O. Y. Moroz, A. L. Ostrovs'kyy. – Moskva: Yzvestyya vuzov. Heodezyya y aérofotos"ëmka, 2000. – № 3 – S. 11–39.