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Tadeusz Banachiewicz's scientific activity at Engelhardt Astronomical Observatory of Kazan University

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This paper describes the scientific activities of Tadeusz Banachiewicz (1882–1954) during his work at Engelhardt Astronomical Observatory from 1910 to 1915.

Dieser Beitrag beschreibt die wissenschaftlichen Aktivitäten von Tadeusz Banachiewicz (1882–1954) während seiner Tätigkeit an der Engelhardt-Sternwarte zwischen 1910 und 1915.

Dedication

One of us (Piotr Flin) collaborated with Hilmar Duerbeck in several scientific projects. Among them there was one concerning the history of astronomy. We also planned several other projects. Unfortunately, cruel fate stopped this fruitful collaboration and the projects remain unfinished.

When writing papers dealing with the early years of Tadeusz Banachiewicz's scientific career, we quite often asked Hilmar for help. He always demonstrated deep interest in the subject, and answered our questions quickly and promptly with his great and charming sense of humour.

The present paper is dedicated to the memory of our late and much lamented friend, Professor Hilmar W. Duerbeck.

1 Introduction

In 1901, in a forest near Kazan, the Astronomical Observatory of Kazan Imperial University was established (Martinoff 1951). It was created on the basis of donations, to Kazan University, of the scientific equipment of V. P. Engelhardt's private astronomical observatory in Dresden. The construction was managed under the direction of D. I. Dubyago, director of the City Astronomical Observatory's managing faculty, and rector of Kazan Imperial University. The new observatory was given Engelhardt's name. A number of telescopes was deployed in the observatory, among them Engelhardt's 12-inch visual refractor manufactured by the Grubb company, a Repsold meridian circle, a Bamberg zenith telescope, and in 1908 a Repsold heliometer (Nefedyev 1958). With the refractor, visual micrometric observations of solar system bodies were conducted, and at the heliometer the Moesting A crater was measured with the purpose of studying the Moon's physical libration. These observations were started in 1895 in the City Astronomical Observatory of Kazan University. In 1908 the heliometer was transferred to the Engelhardt Observatory (Nefedyev 1951).

Tadeusz Banachiewicz obtained his education at the Faculty of Mathematics at Warsaw University in 1900–1905 (Flin and Panko 2011). His teacher, A. V. Krasnov, came to Warsaw from Kazan in 1898. During his work in Kazan from 1894 to 1898, Krasnov carried out a first series of heliometer observations of the lunar craters Moesting A, Proclus and Aristarchus; this way he put a beginning in Kazan to studies of the Moon's physical libration and selenodetic researches. He also observed the positions of solar system bodies, especially of Minor Planet (247) *Eukrate,* and he worked in gravimetry as well.

T. Banachiewicz grasped Krasnov's ideas. On 22 April 1904 he was awarded the university's gold medal for his thesis "An Investigation of the Reduction Constants for the Heliometer at Pulkovo Observatory".

Banachiewicz's scientific activity at Engelhardt observatory can be subdivided into two parts: 1) scheduled works (observations with the heliometer, reduction of observations, derivation of gravity in different areas of Russia, observation of solar eclipses, and so on); 2) works initiated by himself in different fields of astronomy and geodesy.

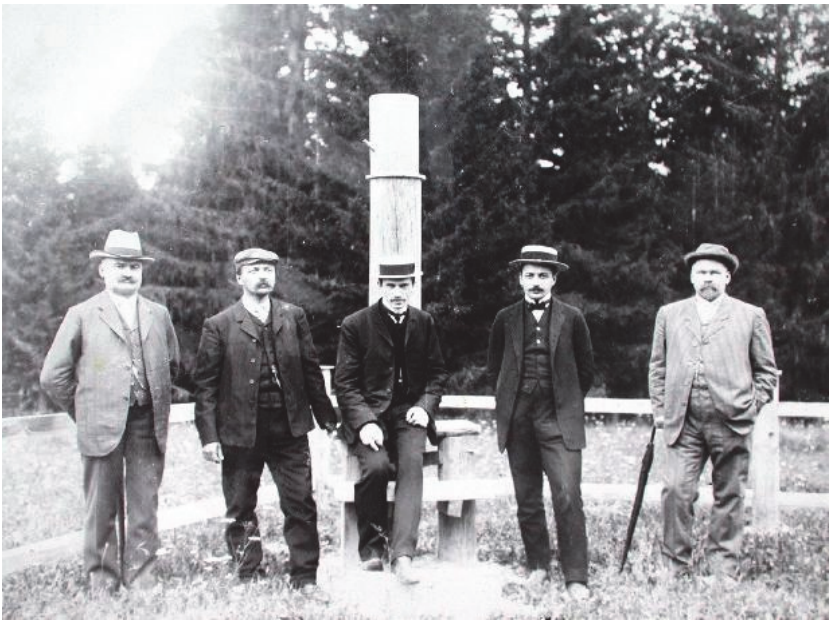

Figure 1. From left to right: M. A. Grachev, Unknown person, A. A. Mikhailovsky, T. Banachiewicz, V. A. Baranov in 1914.

2 T. Banachiewicz's scientific work at Engelhardt Observatory

2.1 An observation with the Repsold heliometer

For further heliometric observations at Engelhardt Observatory, a permanent observer was required, as from 1905 there was no observer for the heliometer (Habibullin 1958). A graduate of Warsaw University was invited to take this position – T. Banachiewicz, a professorial grant-aided student. After his magister's examination, he started to work in July 1910 as assistant at Engelhardt Observatory. The heliometer was transferred to him for continuation of works on the study of physical libration. A skilful observer, T. Banachiewicz executed between 1910 and 1915 133 fine and accurate observations (994 measurements concerning points of edge) of crater Moesting A. These observations constitute the third Kazan series. These data initiated at Engelhardt Observatory more than forty-years of continuous observations of the physical libration of the Moon. In total, at

Kazan University and Engelhardt Observatory, the heliometer performed 8 series of observations of crater Moesting A for studying physical libration. Thus T. Banachiewicz brought a considerable contribution to the theory of studying physical libration. A. A. Yakovkin (1925) wrote about Banachiewicz's observation on the heliometer that "… *T. A. Banachiewicz's five years of observations were executed with greater art and with high accuracy; they make significant progress in so difficult and a delicate question, as a question on indignations in rotational movement of the Moon*". It is necessary to note the detailed work (Mietelski 1968) devoted to the analysis of Banachiewicz's heliometric observations at Engelhardt Observatory. These observations have been reduced by A. A. Yakovkin (1928) and I. V. Belkovich (1949). In Table 1 the constants of the Moon's physical libration are given. They were accordingly obtained by A. A. Yakovkin (1928), I. V. Belkovich (1949) and J. Mietelski (1968) by analysing observations by Banachiewicz. Belkovich separately solved measurements of the east edge of the lunar disk (λ1, β1) and the west edge (λ2, β2) with the purpose of estimating the influence of asymmetry of the lunar disk on the conclusive values of the constants of the Moon's physical librations.

Table 1. The constants of the Moon's physical libration.

Yakovkin		Belkovich		Mietelski	
λ	–50°10'19"±11"	λ1	–50°10'46"	λ	–50°10'05"±6".2
β	–30°10'56"±10"	λ2	–50°11'10"	β	–30°10'52"±6".3
		β1	–30°11'15"		
		β2	–30°11'24"		
h	15'35".5±0".5	h	15'32"	h	15'31.82"±0".281
I	10°32'02"±17"	I	10°38'51"	I	10°32'37"±10".9
R	15'32".68±0".040			R	15'32".834±0".0193
f	0.74±0.03	f	0.70	f	0.628±0.0191

The Krakow astronomers brought a large contribution to the study of physical libration, in particular T. Banachiewicz. He was an expert on questions of the theory and methods of calculating the constants of the Moon's libration. During all his life he was especially interested in work in this area. Being long time the President of IAU Commission 17 (Movements and Figure of the Moon), in reports of this commission, Banachiewicz often dealt with important and pressing questions of rotation and figure of the Moon. His essential contribution was the introduction in practice of calculating the constants of the Moon's physical libra-

tion matrix (*cracovian*) calculations. It is necessary to emphasise that T. Banachiewicz, the great scientist and organizer of science, brought a large contribution to astronomy, geodesy, and mathematics. From 1919 up to the end of his life he was director of the Krakow Astronomical Observatory. In 1925 he founded the scientific magazine "Acta Astronomica" (Kolchinskiy et al. 1986, Zawada 2004, Witkowski 1955).

2.2 Observations at the meridian circle and the refraction constant

Besides observations with the heliometer, T. Banachiewicz was engaged in a number of other research projects, for example, analysing the observations of 188 stars measured by M. A. Grachev with a meridian circle.

In 1907 M. A. Grachev finished the observation at the meridian circle of 188 stars with the purpose of defining the latitude of Engelhardt's observatory, as well as the determination of the constant of refraction. Because of the shortage of qualified processing he could not reduce these observations at once. This was done only in 1915 by T. Banachiewicz (Grachev and Banachiewicz 1925). Analysing results of processing, T. Banachiewicz and M. A. Grachev came to the conclusion about the existence of an anomaly of refraction. The anomaly appeared to be due to the inclination of the topographical relief to the south. They also revealed a substantial residual bend of the meridian circle instrument. The refraction constant obtained was $\rho = 60".411$, and the geographic latitude $\varphi = 55°50'20".52$. This value of latitude practically corresponds to the modern standard value of latitude of the Engelhardt Observatory.

2.3 Gravimetric expeditions

In 1896, gravimetric expeditions were started with the purpose of defining gravity values at selected sites by observations with Sterneck pendulum apparatuses. Originally they were conceived with a purely scientific purpose for defining the figure of the Earth (Banachiewicz 1912b, 1915). Furthermore these observations have appeared extremely important as one kind of geophysical investigation. It seems that only astronomers were capable of such observations. Therefore astronomers trained the numerous staff of geophysicists in gravimetric work.

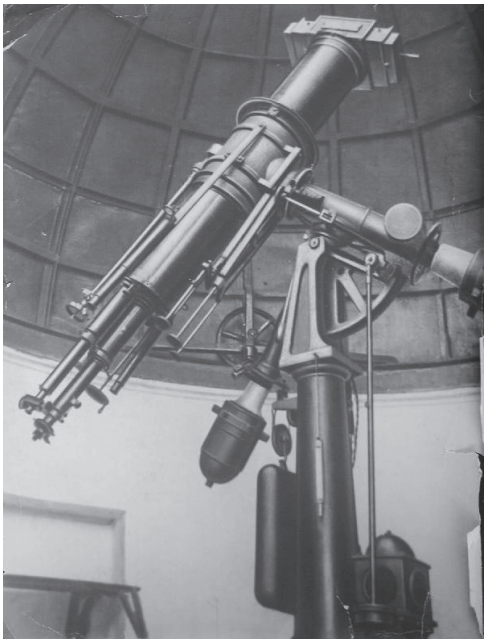

Figure 2. The heliometer (1910).

2.4 The eclipse of the Sun on April 17, 1912: the Kazan expedition

The expedition sent by the Kazan University to station Leshchevo ($\lambda = 2^h40^m48^s.2$ east longitude, $\varphi = +60°03'30".4$), consisted of M. A. Grachev, T. Banachiewicz, A. A. Mihajlovski and A. A. Jakovkin. The expedition had several telescopes, universal tools for geodetic works, and a number of auxiliary devices. The observing procedure consisted of recording the times of the four contacts of the edges of the Sun and the Moon, visual observations of the chromosphere and of the corona. After the third contact, within five minutes, Venus was observed. Observations were made at three stations (Grachev et al. 1915).

2.5 Other research

T. Banachiewicz carried out other researches in various fields of astronomy: 1) Precalculations of occultations of stars by major planets (Banachiewicz 1910a, 1910b, 1911a, 1913a, 1913b), 2) Calculation of visible places of satellites of

planets (Banachiewicz 1912c), 3) Amendment of the longitude of the Moon according to observations of occultations of the Pleiades by M. A. Grachev (Banachiewicz 1914), 4) Observation of zodiacal light (Banachiewicz 1911b), 5) Correction of the Moon's declination, as given by the American Ephemeris 1912, p. 560 in the elements of the solar eclipse 1912, April 16–17, which had to be read 11° 00' 53".1 instead of 11° 00' 47".9 (Banachiewicz 1912a), 6) On celestial mechanics, and so forth. T. Banachiewicz, during his work at Engelhardt Observatory, published over 25 articles and notes in Publications de l'Observatoire Engelhardt de l'Université de Kasan and other foreign editions.

2.6 Magister thesis "About Longitude and Refraction"

Banachiewicz regarded his work in Kazan both as a possibility to prepare and defend a magister's work, and as a chance to start teaching at the university. His degree after Warsaw University was the "Candidate of physical and mathematical sciences of the Warsaw University" in accordance with the system of scientific degrees in Russia before 1917 (Sharshunov and Gulko 2004). This degree is similar to a modern Master of Science degree.

At Warsaw and Moscow Universities (1909–1910), Banachiewicz passed all examinations required for partial fulfilment of regulations for the Magister degree in astronomy. This degree was similar to the PhD degree conferred in Western Europe. In Kazan, Banachiewicz prepared the dissertation for the magister degree entitled: "The constant of refraction and the geographical latitude of the Engelhardt Observatory on the basis of observations through the meridian circle made by M. Grachov".

M. A. Grachev and T. Banachiewicz worked on the determination of the refraction constants as well as on the systematic errors due to anomalous refraction. During the years 1903–1909 Grachev made observations of 188 star pairs. Calculations were executed by Banachiewicz, who derived a formula to account for the refractive error due to, as he believed, the slope of the terrain to the south. As it turned out half a century later, the slope from north to south does exist, but not the area and air layers of equal density in the Earth's atmosphere (Nefedjev and Nefedjeva, 2005). Later he also derived a formula to take into account the scintillation effect which is caused by the turbulence of the Earth's atmosphere (Nefedyeva 1968).

Unfortunately, some confusion has arisen in this matter: Grachev insisted that he had the exclusive right to use the results of his own observations, Banachiewicz, in turn, believed that his original method of processing allows him to consider his calculated results his "Literary Property", as in those days Intellectual Property was called. Professor Dubyago took a neutral stance in general, but Banachiewicz

lost his initial mighty support. This is evident from Banachiewicz's correspondence. The magister thesis was not published then, and accordingly there was no defense. In addition, Banachiewicz attempted to obtain a private-docent position at the Kazan University with a course entitled "The Basis of Celestial Mechanics" in 1915. Prof. Dubyago raised a formal objection associated with "omissions of work at the observatory". The objection was very formal, because the academic course demanded only one lecture per week.

All these circumstances formed Banachiewicz's idea to look for work elsewhere. And he found a new position of "junior assistant" at the Astronomical Observatory at Yuryev University in 1915, and never returned to Kazan. Banachiewicz ended his work in Yuryev (today Tartu) in 1918 as professor. For the position of private docent, giving him *venia legendi*, the right to lecture, he presented the thesis prepared in Kazan "Three essays on refraction theory" (Dworak et al. 2000).

3 Conclusion

Banachiewicz was invited to Engelhardt Observatory as a young promising scientist. V. P. Engelhardt named him as grandson, keeping in mind that Banachiewicz was Krasnov's student who, in turn, was educated in Kazan. As Banachiewicz wrote in letters to his mother, both his conditions for work and accommodation in Kazan were very good. The Kazan years formed Banachiewicz as an astronomer. In his further work he studied librations of the Moon, which became one of the subjects of Krakow Observatory under his directorship. His famous statement was: "*observe ergo sum*". In Krakow occultations of stars by the Moon were observed, and a long-running project of eclipsing variable star observations was started. A comparison of Banachiewicz's papers written during his stay in Kazan with the full list of his papers (Kreiner and Piotrowska 2006) shows that Banachiewicz closely followed his scientific projects originated in Kazan. Therefore, when in some historical works, the outstanding Polish scientist Banachiewicz is counted as a Kazan astronomer, this is a partially correct statement. Banachiewicz can be regarded as a product of Kazan astronomy.

Acknowledgments

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AN = Astronomische Nachrichten
Izv. AOE = Izvestiya Astronomicheskoj Observatorii Engel'gardta
POEUK = Publications de l'Observatoire Engelhardt de l'Université de Kasan

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