**Renata Bujakiewicz-Korońska**
Pedagogical University of Cracow, Institute of Physics, Poland
sfbujaki@cyf-kr.edu.pl

**Jan Koroński**
Cracow University of Technology, Institute of Mathematics, Poland
jkorons@pk.edu.pl

# The life of Tadeusz Banachiewicz and his scientific activity[1]

## Abstract

This paper is a synthetic biography of Tadeusz Banachiewicz (1882–1954), which takes into account his most important scientific achievements. Its aim is to present the achievements of this Polish scientist to the foreign reader.

**Keywords:** *astronomy* • *Tadeusz Banachiewicz* • *Cracovian calculus* • *Cracovians*

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[1] This article develops the information given in the lecture titled "Professor Thaddeus Banachiewicz (1882–1954): His life and work" delivered during the conference *Exact sciences and mathematics in Central-Eastern Europe from the mid-19th century until WW II*, Kraków, Poland, 11–13.06.2015.

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# Życie i działalność naukowa Tadeusza Banachiewicza

**Streszczenie**

Niniejszy artykuł jest syntetyczną biografią Tadeusza Banachiewicza (1882–1954), uwzględniającą jego najważniejsze wyniki naukowe. Jego celem jest przedstawienie zagranicznemu Czytelnikowi osiągnięć tego polskiego naukowca.

**Słowa kluczowe:** *astronomia* • *Tadeusz Banachiewicz* • *rachunek krakowianowy* • *krakowiany*

## 1. Tadeusz Julian Banachiewicz (1882–1954) – more important biographical facts from his life

Fig. 1. Tadeusz Julian Banachiewicz
(Private collection of Jerzy M. Kreiner; published, respectively, in: Zawada 2004, p. 23; Strzałkowski 2012, p. 2; Koroński 2015, p. 21)

Tadeusz Julian Banachiewicz (Fig. 1) was born in Warsaw on 13 February 1882. His father, Artur (1840–1910), was a landowner with an estate in the village of Cychry (near Grójec) near Warsaw. Banachiewicz's mother was Zofia née Rzeszotarska (1852–1920). Tadeusz Banachiewicz was the youngest of three siblings. He had an older brother, Ignacy Jan (1875–1940), who died in the concentration lager at Dachau, and a sister, Zofia Anna (1878–1961). In 1931, at the age of 49, Banachiewicz married Laura de Sołohub Dikyj, a Ukrainian painter and poet, the widow of Nicholas Dikyj. Their marriage was childless. The outbreak of the World War II found Banachiewicz in Kraków (Cracow). On 6.11.1939 he was arrested together with other professors of the Jagiellonian University during *Sonderaktion Krakau* and was transported to the Sachsenhausen camp near Berlin, whence he returned extremely exhausted on 9.02.1940.

During the Second World War, after his imprisonment in the concentration camp, he took a job at the Cracow Observatory, but at the end of 1941 his place was taken by Dr. Kurt Walter, the receivership manager of the observatory. However, albeit in a limited manner, Banachiewicz was still able to continue his research work in the observatory, but was forced to leave his apartment. After the war, Tadeusz Banachiewicz returned to the position of the Director of the Observatory, which he held until his death. In the years 1945–1951, Tadeusz Banachiewicz was also a professor and head of the Department of Geodesy and Astronomy at the Academy of Mining (Akademia Górniczo-Hutnicza) in Kraków, which in 1949 was renamed as the Academy of Mining and Metallurgy.

## 2. First steps in astronomy

Tadeusz Banachiewicz spent the first years of his life in an estate of his parents. Already at an early age, he showed outstanding intellectual ability. At the age of four he could count to a thousand, and at the age of five he was a well-read child. In 1900 he graduated from high school and received an award in Warsaw – a silver medal for academic achievement. Already at school he showed great talent for mathematics.

After graduating from high school, Banachiewicz enrolled in the University of Warsaw. From 1901 (still as a student) he conducted systematic studies in astronomy, mathematics and physics at the University of Warsaw. He wrote a thesis titled "Studies into reduction constants of the Repsold's heliometer in the Pulkovo Observatory"[2] and graduated in 1904 with a degree of a candidate of mathematico-physical sciences of the University of Warsaw. Pursuant to that, the Senate proposed

[2] Title in Polish of the diploma paper: *Badania stałych redukcyjnych heliometru Repsolda Obserwatorium Pułkowskiego*, cf. Dworak & Kreiner & Mietelski 2000.

that he stayed at the university in the Department of Astronomy and Geodesy as a bursar, who should also prepare himself to become a lecturer. Unfortunately, in 1905 the University of Warsaw was closed by the Russian authorities in retaliation for the first independence movements. This fact destroyed Banachiewicz's scientific plans.

He was fascinated by astronomical observations and therefore paraphrased the Descartes's sentence *Cogito ergo sum* into *Observo ergo sum*. It became the motto of his whole life and work.

Banachiewicz had his first observational achievement during his studies. In 1903 he predicted a star's occultation by Jupiter. He informed the world about it by writing a telegram to *Astronomische Nachrichten* (Fig. 2). He subsequently published a report from his observations of this occultation in the same journal (Fig. 3).

**Bedeckung eines helleren Sterns durch Jupiter.**

Am 19. September früh ging der Centralstelle folgendes Telegramm aus Warschau zu:

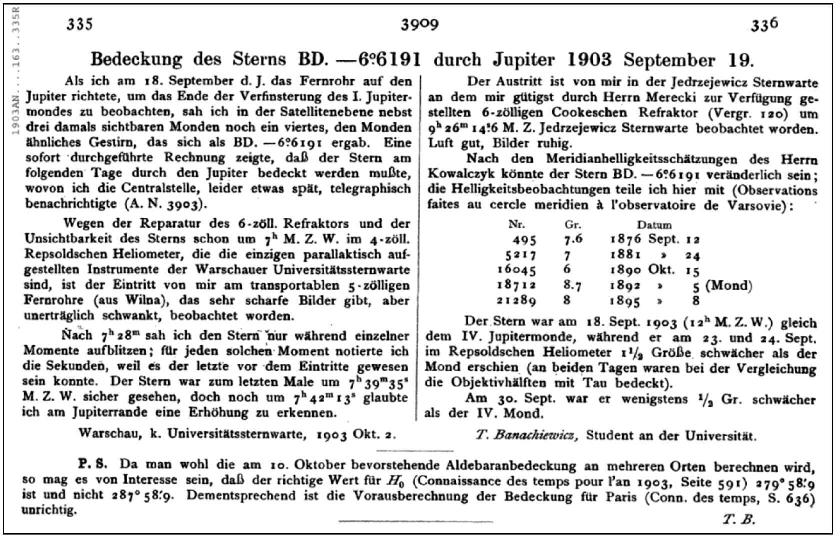
»Perhaps unknown September 19 about $7^h 10^m$ Berlin BD. $-6°.6191$ $6^m.5$ Conjunction Jupiter. Occultation. *T. Banachiewicz.*«

Da die Bedeckung im Berl. Jahrbuch und im Naut. Alm. nicht aufgeführt war, wurde bei der Seltenheit eines solchen Phänomens den Mitgliedern der Centralstelle umgehend telegraphisch Mitteilung gemacht. *E.*

Fig. 2. Telegram of T. Banachiewicz to *Astronomische Nachrichten* about a star's occultation by Jupiter (Banachiewicz 1903a)

These observations were then continued for many years until the end of Banachiewicz's life, when he was a director of the Astronomical Observatory of Cracow. They were conducted with such precision that they even gained recognition in the Greenwich Observatory.

Between 1906 and 1907 he studied astrophysics at Göttingen, mainly under prof. Karl Schwarzschild. In 1908–1909 he worked as an assistant of Oscar Backlund at the Astronomical Observatory in Pulkovo, conducting astronomical observations and advancing in his studies of mathematics. In 1909 Banachiewicz returned to Warsaw, where he was appointed as junior assistant at the reopened Astronomical Observatory of the University of Warsaw. However, after a year, despite his scientific success, he did not obtain the job at the university. The main reason was the death of Professor Alexander Vasilevich Krasnov (1866–1907), who had previously supported Banachiewicz's efforts. In such a situation Banachiewicz moved to his home in Cychry. In 1910, he



1903AN....163..335R

335 3909 336

**Bedeckung des Sterns BD. —6°6191 durch Jupiter 1903 September 19.**

Als ich am 18. September d. J. das Fernrohr auf den Jupiter richtete, um das Ende der Verfinsterung des I. Jupitermondes zu beobachten, sah ich in der Satellitenebene nebst drei damals sichtbaren Monden noch ein viertes, den Monden ähnliches Gestirn, das sich als BD. —6°6191 ergab. Eine sofort durchgeführte Rechnung zeigte, daß der Stern am folgenden Tage durch den Jupiter bedeckt werden mußte, wovon ich die Centralstelle, leider etwas spät, telegraphisch benachrichtigte (A. N. 3903).

Wegen der Reparatur des 6-zöll. Refraktors und der Unsichtbarkeit des Sterns schon um $7^h$ M. Z. W. im 4-zöll. Repsoldschen Heliometer, die die einzigen parallaktisch aufgestellten Instrumente der Warschauer Universitätssternwarte sind, ist der Eintritt von mir am transportablen 5-zölligen Fernrohre (aus Wilna), das sehr scharfe Bilder gibt, aber unerträglich schwankt, beobachtet worden.

Nach $7^h 28^m$ sah ich den Stern nur während einzelner Momente aufblitzen; für jeden solchen Moment notierte ich die Sekunden, weil es der letzte vor dem Eintritte gewesen sein konnte. Der Stern war zum letzten Male um $7^h 39^m 35^s$ M. Z. W. sicher gesehen, doch noch um $7^h 42^m 13^s$ glaubte ich am Jupiterrande eine Erhöhung zu erkennen.

Der Austritt ist von mir in der Jedrzejewicz Sternwarte an dem mir gütigst durch Herrn Merecki zur Verfügung gestellten 6-zölligen Cookeschen Refraktor (Vergr. 120) um $9^h 26^m 14^s.6$ M. Z. Jedrzejewicz Sternwarte beobachtet worden. Luft gut, Bilder ruhig.

Nach den Meridianhelligkeitsschätzungen des Herrn Kowalczyk könnte der Stern BD. —6°6191 veränderlich sein; die Helligkeitsbeobachtungen teile ich hier mit (Observations faites au cercle meridien à l'observatoire de Varsovie):

| Nr. | Gr. | Datum |
|---|---|---|
| 495 | 7.6 | 1876 Sept. 12 |
| 5217 | 7 | 1881 » 24 |
| 16045 | 6 | 1890 Okt. 15 |
| 18712 | 8.7 | 1892 » 5 (Mond) |
| 21289 | 8 | 1895 » 8 |

Der Stern war am 18. Sept. 1903 ($12^h$ M. Z. W.) gleich dem IV. Jupitermonde, während er am 23. und 24. Sept. im Repsoldschen Heliometer 1½ Größe schwächer als der Mond erschien (an beiden Tagen waren bei der Vergleichung die Objektivhälften mit Tau bedeckt).

Am 30. Sept. war er wenigstens ½ Gr. schwächer als der IV. Mond.

Warschau, k. Universitätssternwarte, 1903 Okt. 2.

*T. Banachiewicz,* Student an der Universität.

P. S. Da man wohl die am 10. Oktober bevorstehende Aldebaranbedeckung an mehreren Orten berechnen wird, so mag es von Interesse sein, daß der richtige Wert für $H_0$ (Connaissance des temps pour l'an 1903, Seite 591) 279° 58'.9 ist und nicht 287° 58'.9. Dementsprechend ist die Vorausberechnung der Bedeckung für Paris (Conn. des temps, S. 636) unrichtig.

*T. B.*

Fig. 3. Report from observations of a star's occultation by Jupiter published in *Astronomische Nachtrichen* (Banachiewicz 1903b)

passed his master's degree examinations in Moscow (earlier, in 1909, he had passed two exams in Warsaw). After his master's degree exam in 1910 he started to work as an assistant at the Engelhardt Astronomical Observatory in Kazan, where he spent five years conducting heliometric observations of the Moon.

In 1915 he habilitated at the University of Kazan. In the same year he left Kazan and habilitated again in Tartu (Estonia) with the article "Three sketches on the theory of refraction". He then became assistant professor at the University of Tartu, where he delivered lectures. In 1917 he defended there his thesis titled "The Gauss equation" and received a master's degree in astronomy.

He was then appointed assistant professor of astronomy, and in March 1918 full professor of astronomy at the University of Tartu. Since the beginning of March until the end of May 1918 he was the director of the Astronomical Observatory in Tartu. On 31.05.1918 the German occupiers closed down the University of Tartu, already free of Bolsheviks.

In July 1918, on the occasion of the evacuation of the University of Tartu to Russia, Banachiewicz was invited as professor of astronomy


Fig. 4. The building of the Astronomical Observatory in Cracow at number 27 in the Kopernika, seen from the north side (The Jerzy M. Kreiner private collection)

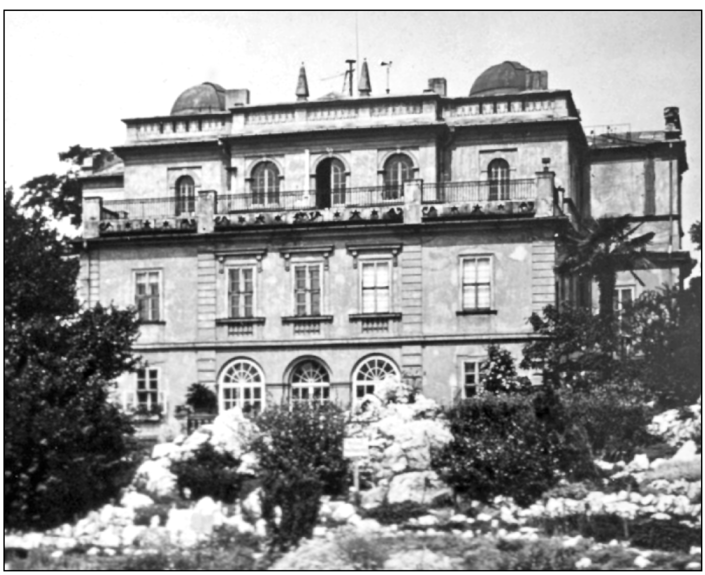


Fig. 5. The building of the Astronomical Observatory in Cracow at number 27 in the Kopernika, seen from the south side and a botanical garden in front of it (The Jerzy M. Kreiner private collection)

to Voronezh. He did not take advantage of this proposal, because he decided to return to Poland.

After a short stay in Warsaw (October 1918 – March 1919), where he worked as assistant professor of geodesy at the Technical University of Warsaw, Banachiewicz moved to Kraków in 1919 to take up the post of professor at the Jagiellonian University and the director of the Astronomical Observatory of the Jagiellonian University. Professor Banachiewicz lived and worked there until his death. The archival photos of the Astronomical Observatory at number 27 on the Kopernika are presented in Figures 4 and 5.

The Kraków period of the Banachiewicz's life, which lasted 35 years, was filled with scientific, educational and organizational successes.

The state of astronomy in  at the time was disastrous. At the beginning of the 20th century the Cracow Observatory was headed by Prof. Maurycy Pius Rudzki and after his death by Prof. Marian Smoluchowski. Because of the war and conquests the observatory for many years was underinvested in equipment. During this time, the observa-

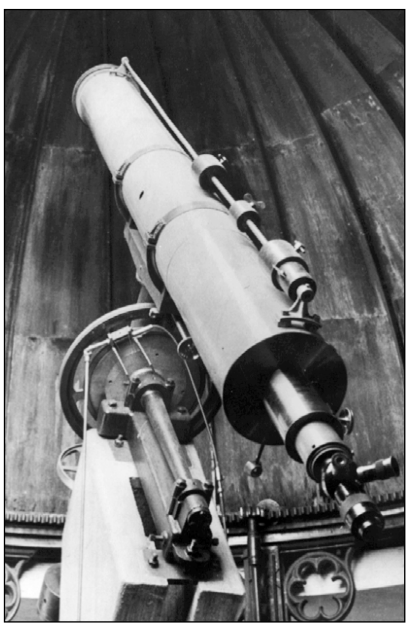


Fig. 6. 203/285 mm refractor at the Cracow Astronomical Observatory (The Jerzy M. Kreiner private collection)

tory owned two larger telescopes, a few smaller ones and two portable chronometers, as well as several outdated and not-in-use older instruments. The observatory building in the Kopernika required renovation. Banachiewicz began to organize astronomical activity in Kraków from scratch. He employed Józef Witkowski, Jan Gadomski, Lucjan Orkisz, and later Eugeniusz Rybka. Banachiewicz immediately began to make efforts to equip the observatory in astronomical instruments, in which he succeeded. He borrowed a refractor from the Harvard Observatory in the 1920s (Fig. 6). It was the main instrument in the Cracow Observatory for many years. He proposed two observational programmes to his colleagues: observations of eclipsing variable stars (these served mainly to determine the times of brightness minima of these stars), and observations of stars' occultation by the Moon.

## 3. Journals

In 1922 Banachiewicz began to publish these observations in *The Astronomical Annual of Cracow Observatory* and a year later in *The International Supplement*, which contained the ephemeris (times of minima) brightness

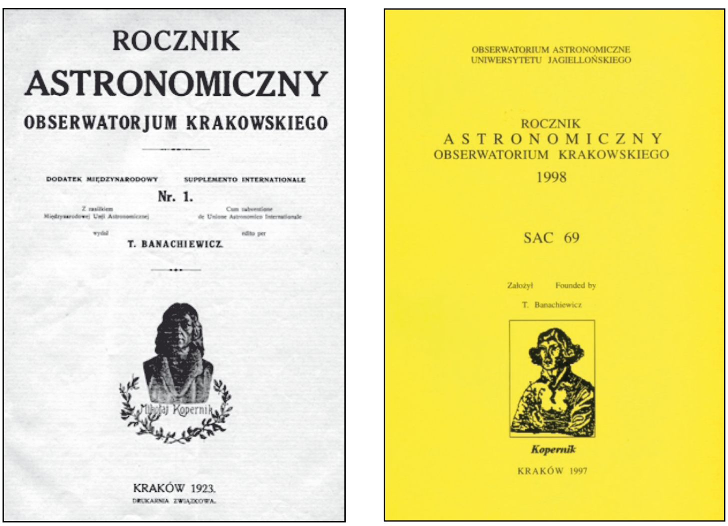



Fig. 7. *Astronomical Annual of Cracow Observatory – Supplemento*
(The Jerzy M. Kreiner private collection)

(VII). Julio 1923. — Minima de stellas variabile.

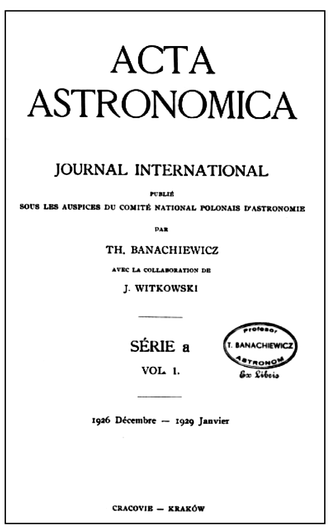
| 1923 | 1* TV Cas | 2* U Cep | 3 X Tri | 4 Z Per | 5* RZ Cas | 6 RY Per | 7* β Per | 8* RW Tau | 9 RW Per | 10 RZ Eri | 11 Z Ori | 12 RW Mon | 13 RY Gem | 14 S Cnc | 15 RX Hya | 16* RS CVn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 097 | — | 029 | 245 | 311 | — | — | — | — | — | — | — | — | 845 | 929 | — |
| 2. | 910 | 494 | 000 973 | — | 506 | 025 | 767 | 311 | — | — | — | 412 | — | — | — | 836 |
| 3. | — | — | 943 | — | 701 | — | — | — | — | — | 326 | — | — | — | — | — |
| 4. | 722 | 987 | 915 | 300 | 897 | — | — | — | — | — | — | 318 | 424 | — | — | — |
| 5. | — | — | 887 | — | — | — | 635 | 080 | — | — | — | — | — | — | — | — |
| 6. | 535 | — | 858 | — | 092 | — | — | — | — | — | — | 224 | — | — | 492 | — |
| 7. | — | 479 | 830 | 357 | 287 | — | — | 849 | 702 | — | — | — | — | — | — | 634 |
| 8. | 348 | — | 801 | — | 482 | 888 | 502 | — | — | — | 529 | 130 | — | — | — | — |
| 9. | — | 972 | 773 | — | 678 | — | — | — | — | — | — | — | — | — | — | — |
| 10. | 160 | — | 744 | 413 | 873 | — | — | 618 | — | — | — | 036 | — | — | — | — |
| 11. | 973 | — | 716 | — | — | — | 309 | — | — | — | — | 342 | — | 330 | 055 | — |
| 12. | — | 465 | 688 | — | 068 | — | — | — | — | — | — | — | — | — | — | 432 |
| 13. | 786 | — | 059 | 470 | 263 | — | — | 387 | — | — | 732 | 848 | 725 | — | — | — |
| 14. | — | 958 | 631 | — | 459 | — | 237 | — | — | — | — | — | — | — | — | — |
| 15. | 598 | — | 602 | — | 654 | 752 | — | — | — | — | — | 755 | — | — | 618 | — |
| 16. | — | — | 574 | 526 | 849 | — | — | 156 | — | — | — | — | — | — | — | — |
| 17. | 411 | 451 | 545 | — | — | — | 104 | — | — | — | — | 661 | — | — | — | 230 |
| 18. | — | — | 517 | — | 044 | — | — | 925 | — | 10 | 936 | — | — | — | — | — |
| 19. | 224 | 944 | 488 | 582 | 240 | — | 971 | — | — | — | — | 567 | — | — | — | — |
| 20. | — | — | 460 | — | 435 | — | — | — | 901 | — | — | — | — | 814 | 182 | — |
| 21. | 036 | — | 432 | — | 630 | — | — | 694 | — | — | — | 473 | — | — | — | — |
| 22. | 849 | 437 | 403 | 639 | 825 | 616 | 839 | — | — | — | — | — | — | — | — | 028 |
| 23. | — | — | 375 | — | — | — | — | — | — | — | — | 379 | 026 | — | — | — |
| 24. | 662 | 930 | 346 | — | 021 | — | — | 463 | — | — | 139 | — | — | — | 745 | — |
| 25. | — | — | 318 | 695 | 216 | — | 706 | — | — | — | — | 285 | — | — | — | — |
| 26. | 474 | — | 289 | — | 411 | — | — | — | — | — | — | — | — | — | — | 826 |
| 27. | — | 422 | 261 | — | 607 | — | — | 231 | — | — | — | 191 | — | — | — | — |
| 28. | 287 | — | 232 | 752 | 802 | — | 573 | — | — | — | — | — | — | — | — | — |
| 29. | — | 915 | 204 | — | 997 | 479 | — | — | — | — | 342 | 097 | — | — | 308 | — |
| 30. | 100 | — | 176 | — | — | — | — | 000 | — | — | — | — | — | 299 | — | — |
| 31. | 012 | — | 147 | 808 | 192 | — | 440 | — | — | — | — | 003 | — | — | — | 624 |

| 1923 | 17* δ Lib | 18* U CrB | 19* TW Dra | 20 RV Oph | 21 UX Her | 22 WX Sgr | 23* Z Her | 24 RZ Sct | 25 U Sgt | 26* Z Vul | 27 RW Cap | 28 RR Vul | 29 S Equ | 30 RY Aqr | 31 TW And | Dies de n. e. a. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 264 | — | 158 | — | — | — | — | — | — | — | 662 | — | 671 | 328 | — | 44741 |
| 2. | — | — | — | 361 | 499 | 622 | 881 | — | — | 136 | — | — | — | — | — | 44742 |
| 3. | 592 | 539 | 965 | — | — | — | — | — | 820 | — | — | — | — | 296 | — | 43 |
| 4. | — | — | — | — | 018 | 751 | — | — | — | 591 | — | — | — | — | 932 | 44 |
| 5. | 919 | — | — | — | 597 | — | — | 185 | — | — | 054 | 895 | 107 | 263 | — | 45 |
| 6. | — | 931 | 772 | 018 | — | 880 | 874 | — | — | — | — | — | — | — | — | 46 |
| 7. | — | — | — | — | 146 | — | — | — | 200 | 046 | — | — | — | 230 | — | 47 |
| 8. | 246 | — | — | — | 695 | — | — | — | — | — | 146 | — | 541 | — | — | 48 |
| 9. | — | — | 578 | 735 | — | 010 | — | — | — | 501 | — | — | — | 197 | 055 | 44749 |
| 10. | 574 | 443 | — | — | 243 | — | 867 | — | 581 | — | — | 916 | — | — | — | 50 |
| 11. | — | — | — | — | 792 | 139 | — | — | — | 956 | 838 | — | 980 | 164 | — | 51 |
| 12. | 901 | — | 385 | — | — | — | — | — | — | — | — | — | — | — | — | 52 |
| 13. | — | 806 | — | 422 | 341 | 268 | — | — | 962 | — | — | — | — | 131 | 178 | 53 |
| 14. | — | — | — | — | 890 | — | 860 | — | — | 411 | — | — | — | — | — | 54 |
| 15. | 228 | — | 131 | — | — | 397 | — | — | — | — | 230 | 997 | 416 | 098 | — | 55 |
| 16. | — | — | — | — | 439 | — | — | — | — | 865 | — | — | — | — | — | 44756 |
| 17. | 556 | 348 | 998 | 110 | 988 | 526 | — | — | 342 | — | — | — | — | 065 | 361 | 57 |
| 18. | — | — | — | — | — | — | 852 | — | — | — | 622 | — | 852 | — | — | 58 |
| 19. | 883 | — | — | — | 536 | 655 | — | — | — | 320 | — | — | — | 032 | — | 59 |
| 20. | — | 800 | 804 | 797 | — | — | — | 376 | 723 | — | — | — | — | — | — | 60 |
| 21. | — | — | — | — | 085 | 784 | — | — | — | 775 | — | 049 | — | 000 | 424 | 61 |
| 22. | 210 | — | — | — | 634 | — | 845 | — | — | — | 014 | — | 288 | 967 | — | 62 |
| 23. | — | — | 611 | — | — | 913 | — | — | — | — | — | — | — | — | — | 44763 |
| 24. | 538 | 252 | — | 484 | 183 | — | — | — | 104 | 230 | — | — | — | 934 | — | 64 |
| 25. | — | — | — | — | 732 | — | — | — | — | — | 406 | — | 724 | — | 546 | 65 |
| 26. | 865 | — | 417 | — | — | 042 | 838 | — | — | 685 | — | 100 | — | 901 | — | 66 |
| 27. | — | 705 | — | — | 281 | — | — | — | 484 | — | — | — | — | — | — | 67 |
| 28. | — | — | — | 171 | 830 | 172 | — | — | — | — | 798 | — | — | 868 | — | 68 |
| 29. | 192 | — | 224 | — | — | — | — | — | — | 140 | — | — | 160 | — | 669 | 69 |
| 30. | — | — | — | — | 378 | 301 | 831 | — | 865 | — | — | — | — | 835 | — | 44770 |
| 31. | 520 | 157 | — | 858 | 927 | — | — | — | — | 595 | — | 151 | — | — | — | 71 |

| Fractiones de die (d) | Horae (h) |
|---|---|
| 0.0 | 0.0 |
| .1 | 2.4 |
| .2 | 4.8 |
| .3 | 7.2 |
| .4 | 9.6 |
| 0.5 | 12.0 |
| .6 | 14.4 |
| .7 | 16.8 |
| .8 | 19.2 |
| .9 | 21.6 |
| 0.00 | 0.00 |
| .01 | 0.24 |
| .02 | 0.48 |
| .03 | 0.72 |
| .04 | 0.96 |
| .05 | 1.20 |
| .06 | 1.44 |
| .07 | 1.68 |
| .08 | 1.92 |
| .09 | 2.16 |

Tempore Universale.

Fig. 8. Exemplary table of observational data printed in the first astronomical annual in 1923 (The Jerzy M. Kreiner private collection)


ACTA ASTRONOMICA

JOURNAL INTERNATIONAL

PUBLIÉ SOUS LES AUSPICES DU COMITÉ NATIONAL POLONAIS D'ASTRONOMIE

PAR

TH. BANACHIEWICZ

AVEC LA COLLABORATION DE

J. WITKOWSKI

SÉRIE a

VOL. 1.

1926 Décembre — 1929 Janvier

CRACOVIE — KRAKÓW



Fig. 9. The first volume of *Acta Astronomica*, 1925 (The Jerzy M. Kreiner private collection)

minima of eclipsing variable stars. Tadeusz Banachiewicz was the founder of these journals. The international part *Supplemento* became very famous almost instantaneously (Fig. 7). It was written in interlingua (e.g. *Latino sine flexione* which was created by Peano in 1903). The first volume was published in 1923. *The Supplement* was published until 1999.

The ephemerides of the eclipsing binaries were presented in the annual. They are required by astronomers for planning photometric and spectroscopic observations. Moreover, in order to reduce the number of observations, precise knowledge is necessary as to the period resulting from the O-C diagram. The Figure 8 shows an example of a table with such data printed in the first astronomical annual in 1923.

On the initiative of Banachiewicz a new scientific journal named *Acta Astronomica* (Fig. 9) was published in 1925. It gained international recognition and is continued until now.

## 4. Solar eclipses

Professor Banachiewicz expressed great interest in total solar eclipses. He personally designed a special instrument called chronocinematograph (Fig. 10) used to obtain a special film during a solar eclipse. To our best knowledge he was a pioneer in making a film from a solar

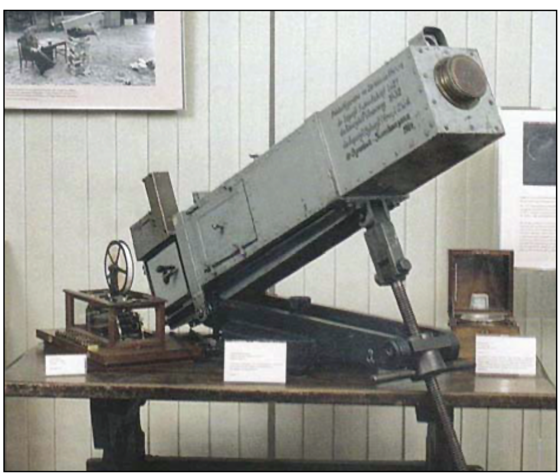


Fig. 10. On the table from the left: chronograph, chronocinematograph and chronometer; these three devices connected together allow for precise observations of a solar eclipse (From the collection of the Museum Collegium Maius. Photo: G. Zygier)

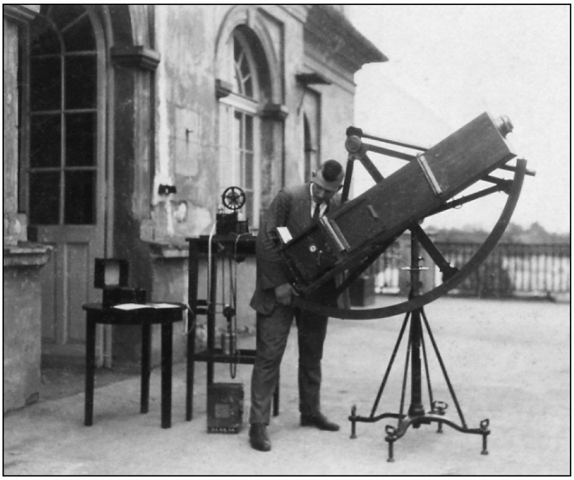


Fig. 11. Chronocinematograph – a tool to obtain a special film during a solar eclipse. Kazimierz Kordylewski on the terrace of the Astronomical Observatory in Kraków, 1926 (The Jerzy M. Kreiner private collection)

Fig. 12. Tadeusz Banachiewicz and the chronocinematograph, 1932 (The Jerzy M. Kreiner private collection)

eclipse (Fig. 11, 12). It allowed for registering different phases of a total solar eclipse by means of a stop-frame method together with the registration of time in order to determine the beginning and the end of a total eclipse accurately. These instruments were used during the expeditions organized by Tadeusz Banachiewicz in 1927 to Swedish Lapland, in 1932 to the U.S.A. and in 1936 to Greece, Siberia and Japan.

## 5. New place for astronomical observations

Kraków had been expanding and astronomical observations in the centre of the city became more and more unsatisfactory. Banachiewicz therefore started to search for a good localization outside of Kraków for astronomical observations. After considering different possibilities he chose Mt. Łysina in the Beskid Mountains near Myślenice (Fig. 13) because it provided the best meteorological conditions. The new astronomical observatory was operational in the period 1922–1944. The scientific activity finished when the observatory had been destroyed and totally burnt by German gendarmerie on 15.09.1944 as a part of pacification of Myślenice.

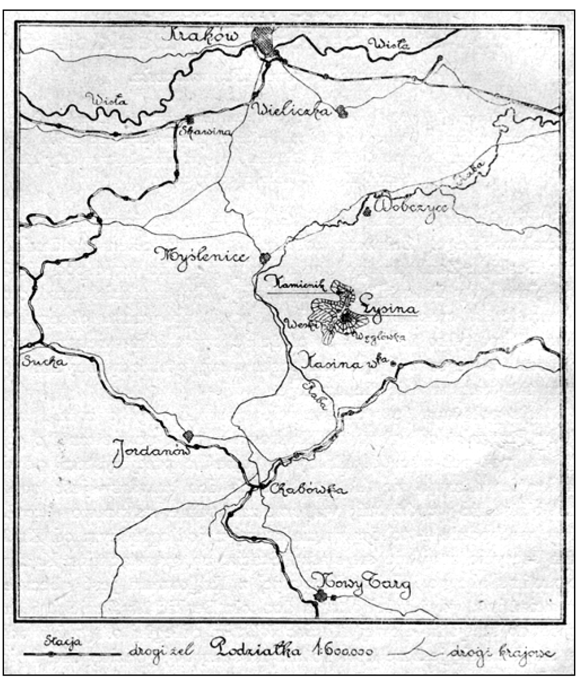



Fig. 13. Mt. Łysina (912 m) in the Beskid Mountains near Myślenice
(The Jerzy M. Kreiner private collection)

He organized the observational station in 1922 (Fig. 14), which was later called Lubomir.

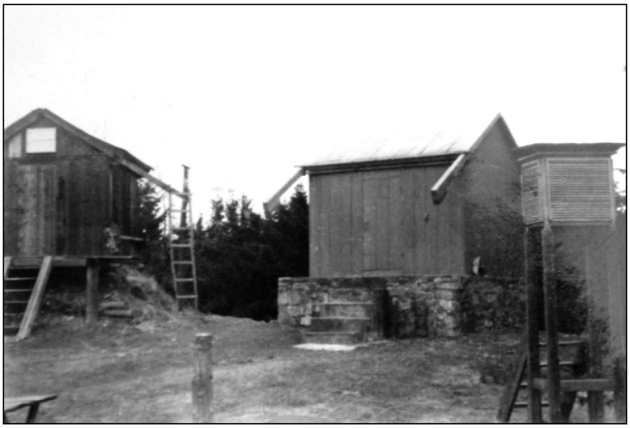


Fig. 14. Observational pavilions on Lubomir (912 m)
(The Jerzy M. Kreiner private collection)

Apart from the telescope, the location also had a meteorological station (Fig. 15).

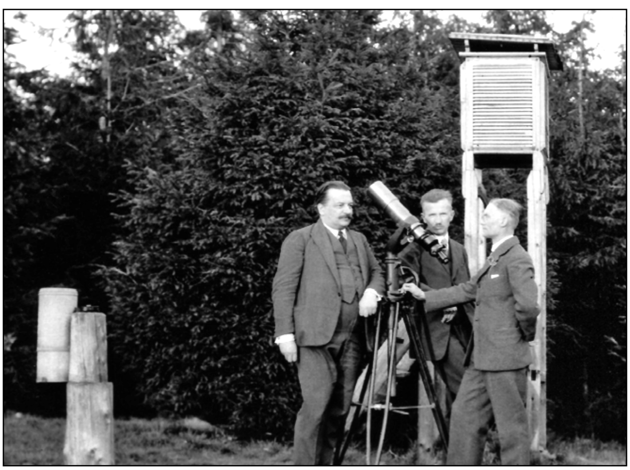


Fig. 15. Prof. Banachiewicz (left) and Dr. Antoni Wilk (right)
near the meteorological measurement point, 1937
(The Jerzy M. Kreiner private collection)

Fig. 16. On the way to Lubomir (*ca* 1937)
(The Jerzy M. Kreiner private collection)

During the period of the activity of the observatory, namely 1922–1944, two comets were discovered: on 3.04.1925 a comet in the *Pegasus* constellation – by Lucjan Orkisz (1900–1973), and on 17.07.1936 a comet in the *Leo Minor* constellation – by Władyslaw Lis (1911–1980). Moreover, many thousands of visual observations of the brightness of eclipsing binaries were performed on Lubomir.

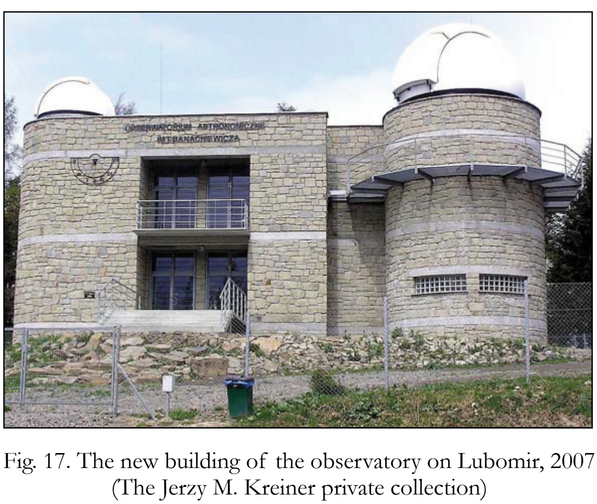


Fig. 17. The new building of the observatory on Lubomir, 2007
(The Jerzy M. Kreiner private collection)

Fig. 18. Tadeusz Banachiewicz near the observation pavilion.
The opened the roof of the observation pavilion and the meteorological equipment.
Stefan Szczyrbak near the telescope (The Jerzy M. Kreiner private collection)

The new building of the observatory on Lubomir (Fig. 17) was built and open for use by young people in 2007.

## 6. Fort Skała – a new astronomical observatory of the Jagiellonian University

After 1946 Tadeusz Banachiewicz started to look for another new location for the observatory. After much effort and searching he decided to

Fig. 19. Ceremony at Fort Skała 24.05.1953. From the left: M. Kamieński (astronomer); E. Rybka (astronomer); B. Drobner; T. Banachiewicz; unknown; T. Marchlewski (Rector of the Jagiellonian University); unknown; H. Niewodniczański (physicist, Director of the Institute of Physics at the Jagiellonian University) (The Jerzy M. Kreiner private collection)

Fig. 20. Ceremony at Fort Skała, 24.05.1953.
From the left: Tadeusz Banachiewicz, Bolesław Drobner, Kazimierz Kordylewski
(The Jerzy M. Kreiner private collection)

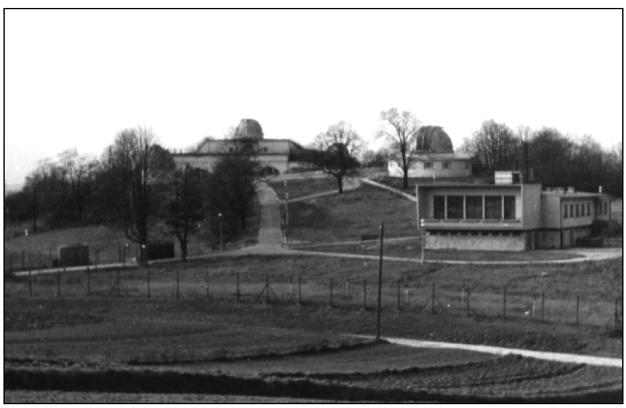


Fig. 21. Fort Skała, Astronomical Observatory of the Jagiellonian University (*ca* 1965)
(The Jerzy M. Kreiner private collection)

build a new observatory in Fort Skała near Bielany, 12 km to the west of Kraków, about 300 m above the sea level. The opening ceremony took place on May 24, 1953 (Fig. 19).

The intent document was signed by Tadeusz Banachiewicz and Bolesław Drobner – (Fig. 20). Unfortunately, a year later prof. Banachiewicz died. The astronomical observatory in Fort Skała was opened in 1964 (Fig. 21) and has been functional until today.

 DOI: 10.4467/23921749SHS.16.011.6154

## 7. Awards and memberships

In 1922 Banachiewicz became an active member of the Polish Academy of Arts and Sciences in Kraków as well as an ordinary member of the Warsaw Scientific Society.

Since 1923 Banachiewicz served for 10 years as president of the Polish Astronomical Society.

In the years 1924–1926 he was vice president of the Baltic Geodetic Committee.

In 1928, the University of Warsaw endowed Banachiewicz with a *honoris causa* doctorate in philosophy, and ten years later the same title was bestowed upon him by the University of Poznań. In 1948 he received an honorary doctorate from the University of Sofia.

In the years 1932–1938 Banachiewicz was vice president of the International Astronomical Union, and in 1938 he was elected president of the IAU Commission 17[3] (movements and figure of the Moon), chaired until 1952. In 1939 he became a member of the Academy of Padua, and was nominated in 1946 as a correspondent member of the Royal Astronomical Society in London.

In 1953, at the age of 71, less than a year before his death, by virtue of the law he received a doctorate in mathematics at the Jagiellonian University.[4]

## 8. Scientific achievements of Tadeusz Banachiewicz

Tadeusz Banachiewicz often discussed mathematics at scientific meetings. He repeatedly expressed his views on the nature of mathematical theorems and proofs. He complained that students lose the ability to approximate mathematical description and reality, which is a prerequisite for solving many specific and difficult problems (Archive OA UJ). He also noticed the relativity of mathematical theories. It is illustrated by the following words of Banachiewicz:

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[3] Hockey *at all* 2007, p. 91a.

[4] This case is explained by the signed statement CK-III-3b-2/53, 22 XII 1953 found in the Archive of the Jagiellonian University, Koroński, Bujakiewicz-Korońska 2010.

> Gdyby na Ziemi pojawił się matematyk z Marsa, to pewnych naszych twierdzeń nie mógłby wcale zrozumieć, dla większości zaś udowodniłby ich błędność już z tego powodu, że zwyczajnie twierdzenia matematyczne wymagają całego szeregu założeń.[5]

> If a mathematician from Mars came to Earth, he could not understand some of our theorems at all, and for most of them he would prove their fallacy already for the reason that mathematical theorems simply require an entire series of assumptions.[6]

Constructive mathematics has developed long after Banachiewicz's death. Today he could have many supporters.

He claimed that an axiom is the fundamental theorem of algebra and that many mathematical proofs are false. An important accent for mathematics was noted by Banachiewicz in 1909, namely that one of the so-called Chinese assertions that relate to the arithmetic of natural numbers is not satisfied for seven odd numbers smaller than 2000. On this basis, forty years later the famous Polish mathematician, Wacław Sierpiński, showed that there were infinitely many such numbers. Banachiewicz showed that if one of Chinese theorems had been true, it would also have proved the false Fermat's theorem which said that the number $2^{2^n}+1$ was a prime (Archive OA UJ).

Banachiewicz repeatedly called for the creation of the International Mathematical Union. This project was realized in 1950. Prior to the UNESCO convention in Copenhagen, under Banachiewicz's influence, Sierpiński spoke about the project to found the International Mathematical Union.

Professor Tadeusz Banachiewicz for many years carried out very intensive scientific works to specify the conditions which would be adequate to mathematical applications in astronomy and physics. Previously, at the beginning of the twentieth century he introduced Cracovians calculations. This new method of calculations was better

[5] Banachiewicz's comment from the protocol of the scientific meeting on 8.11.1941, Archive OA UJ.

[6] Translated by Renata Bujakiewicz-Korońska.

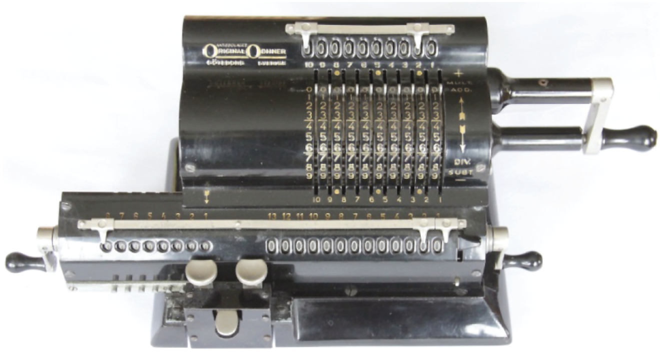

Fig. 22. Arithmometer, the main tool for astronomical calculations. Fot. J. M. Kreiner (The Jerzy M. Kreiner private collection)

that the traditional one done by means of matrices. He improved new computable algorithms, which also greatly benefited the work carried out on arithmometers (Fig. 22).

This idea initially appeared to be crazy for mathematicians who represented purely theoretical mathematics. Nevertheless, some scientists believed that the idea of Cracovians is indeed valuable.

## 9. The greatest scientific achievement of Banachiewicz – Cracovians

The biggest T. Banachiewicz's achievement was making a theory of the Cracovians calculus. His monograph *Cracovians calculus and its applications* was published in 1959, after his death. When, in 1930 Clyde Tombaugh discovered Pluto, Banachiewicz determined the elements of its orbit by means of Cracovians, thus confirming the planetary nature of Pluto despite very sparse observational data.

Thanks to Cracovians he obtained general formulas of the spherical poligonometry in 1927 and later many other important scientific results. Derived by Banachiewicz, the general formula of spherical poligonometry was, albeit unsuccessfully, sought by mathematicians for about a hundred years. Applying it to spherical trigonometry highlighted previously unknown but important peculiarities and properties of its formulas, which were unnoticed even by mathematicians of high caliber such as Gauss, Euler, Monge, Delambre and others.

Comparing the basic properties of matrices and Cracovians operations, it can be noted that matrix multiplication is associative whereas Cracovians multiplication is not. This causes that Cracovians multiplication operation does not create an algebraic group while matrices with the matrices multiplication constitute semigroups. This shows that Cracovians have a different algebraic structure than the matrix. Therefore, matrices and Cracovians are two autonomous calculations.

## 10. Summary

The time showed that the concept of Cracovians helped to formulate and solve many specific problems of theoretical astronomy, theoretical mechanics, geodesy and geophysics. In those areas Tadeusz Banachiewicz had particularly significant achievements. The idea of Cracovians carried something more, beyond the theoretical statement. Tadeusz Banachiewicz's greatest scientific achievements were theoretical, in particular in the theory of Cracovians calculus which he developed on his own. Also in celestial mechanics, particularly with regard to the theory of determining orbits, Banachiewicz had many major achievements. When in 1930 Clyde Tombaugh discovered Pluto, Banachiewicz calculated the elements of its orbit with the use of Cracovians, thus confirming the planetary nature of Pluto despite very sparse observational data.

For some time, Banachiewicz, using this new method of Cracovians, also carried out calculations of the libration of the Moon. Thanks to Cracovians he obtained a general poligonometric spherical model in 1927. Although Banachiewicz completed writing the manuscript of "Cracovians calculus", the highest achievements of his life, in 1949, it was only printed in 1959.

The scientific interests of Banachiewicz in the years 1945–1954 focused mainly on three issues: 1. The theory of determining orbits, 2. Problems of lunar libration and figure, 3. Issues related to Cracovians calculus. This was the time when logarithmic sliders were widely used in scientific computing. Just like Krüger adapted some Gaussian models to logarithmic calculus performed on sliders, by the same token Banachiewicz defined Cracovians[7] designed for calculations on arith-

[7] Protocol from the scientific meeting on 28.03.1947 (Archive OA UJ).

mometers. Banachiewicz foresaw the development of computational techniques. He was a follower of the idea of using "the brain of steel" and promoted the idea in Poland. He correctly saw the development of computing techniques as the condition of the development of science. In 1952, two years before his death, Banachiewicz became an ordinary member of the Polish Academy of Sciences, founded in the same year.

Tadeusz Banachiewicz is the author of more than 500 scientific papers, scientific and popular press communications, telegraph scientific reports, polemics, reviews, reports and editorial works, which concern astronomy, mathematics, mechanics, geodesy, geophysics and other fields of science; as well as two monographs (Kreiner & Piotrowska 2006).

In addition to research papers, from 1932 to May 1954 Tadeusz Banachiewicz kept a diary, which he called *Notaty codzienne* (*Daily notes*). The diary shows his relationships with others, including his wife, and show how he was struggling with many problems of science on which he was working. They give a testimony to the activities on the international arena as well as in organizations, e.g. as the director of the Astronomical Observatory of the Jagiellonian University. *Notaty codzienne* contains many observations and comments on the issues that intrigued Banachiewicz at the time.

Professor Tadeusz Banachiewicz died on 17.11.1954 of pneumonia, as a complication after a surgery. In 1955 his remains were transferred and buried in a crypt underneath the church of St Michael the


Fig. 23. Tomb of Tadeusz Banachiewicz in a crypt underneath the church of St Michael the Archangel and St Stanislaus Bishop and Martyr and Pauline Fathers Monastery, Skałka, Kraków (The Jerzy M. Kreiner private collection)

Archangel and St Stanislaus Bishop and Martyr at the Pauline Fathers Monastery, Skałka[8] (Fig. 23).

Certain biographical information for T. Banachiewicz and information on the history of astronomy in Poland can be found *inter alia* in the publications mentioned in the references.

At the end of his life, on 15.03.1954, a little over half a year before his death, during a solemn meeting dedicated to his 50$^{th}$ anniversary of scientific activity, he said the following words:

> Fakt, że w ciągu 50-ciu lat pracowałem naukowo, nie stanowi specjalnej zasługi, gdyż pracowałem dlatego, że podobała mi się ta praca, która wydawała mi się użyteczną dla nauki, narodu i państwa; co się zaś tyczy znaczenia mych prac, to dopiero przyszłość wypowie o nich ostatnie słowo.[9]

> The fact that I worked in science for 50 years does not merit much credit, since I worked because I liked this work, which seemed to me useful for science, the nation and the state. As regards the significance of my work, only the future will have the last word.[10]

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[8] This place serves as a "national Panthéon", a burial place for some of the most distinguished Poles.

[9] Quoted in: Witkowski 1969, p. 17.

[10] Translated by Renata Bujakiewicz-Korońska. For further information about the life and scientific achievements of Tadeusz Banachiewicz cf. e.g.: Witkowski & Kordylewski 1953; Witkowski 1955; 1969; Dworak, Kreiner & Mietelski 2000; Mietelski 2002; 2010; Kreiner & Piotrowska 2006. In the last mentioned paper, an axiomatic definition of Cracovians and a discussion on their connection with matrix are presented.

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