

SERBIAN ASTRONOMICAL WORKS IN THE VIRTUAL LIBRARY OF THE FACULTY OF MATHEMATICS IN BELGRADE

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Abstract. The Virtual Library of the Faculty of Mathematics, <http://elibrary.matf.bg.ac.rs>, contains more than 50 digitized books on astronomy written by Serbian scientists. This article presents a selection of books written in the 18th and 19th century by the authors: Ruđer Bošković, Zaharije Orfelin, Atanasije Stojković, Đorđe Stanojević, Milan Andonović and Kosta Stojanović. For each of these authors a short biography is included.

INTRODUCTION

The Virtual Library of the Faculty of Mathematics is the largest database of digitized texts in Serbia which is open for public use. At the time of writing this article, it contains nearly 1500 books mostly in mathematical sciences of old Serbian scientists (e.g. N. Pejović, 2009). Important collections in this library are a collection of 360 doctoral dissertations in mathematical science, most of them defended at the Faculty of Mathematics of the University of Belgrade and rare books from the 18th and 19th century. Most of these books are rather rare; some of them exist only in one copy and in fact are unavailable to the general public. First steps in building of the Virtual Library were done in 2004 (see Mijajlović at al., 2004).

In this paper we present a collection of books on astronomy written by Serbian authors and printed in the 18th and 19th century that are digitized and uploaded into the Virtual library. These books are the first Serbian astronomical books, and we can also say that they are the first scientific works of Serbian writers. Let us note here a general feature of these first Serbian scientists. They were universal in

their research interest and in other respects as well, so astronomy was not their only specialty. They were successful in other sciences, too: in mathematics, physics or philosophy, for example. For them, science mostly was the view of a unique being - Nature. The language of science was used by them to describe the nature of this being. Besides, they were often successful politicians, artists, travelers and writers of novels and poems. Their importance for the development of Serbian culture, language and science is enormous. Therefore, in addition to their manuscripts from astronomy we present here their brief biographies and other works as well. The good source for the history of astronomy in Serbia is Simovljević's (1980) article *Astronomy*.

BOOKS IN ASTRONOMY FROM THE EIGHTEENTH AND NINETEENTH CENTURIES.

In the Virtual Library there are 15 digitized books from this period by the following authors:

Ruđer Bošković (1711-1787), *Elementorum Universal Matheseos*, T. I-III, 1757, Venetis.

Zechariah Orfelin Stefanović (1726-1785), *Perpetual Calendar*, 1783, Vienna.

Atanasije Stojković (1773 -1832), *Physics*, 1810, Buda.

Đorđe Stanojević (1858 -1921), most of his works (8) is digitized, including: *The starry sky of independent of Serbia*, 1882, Belgrade.

Milan Andonović (1849 -1926), *Cosmography* (1888), *On the Cosmos* (1889), Belgrade.

Kosta Stojanović (1867 - 1921), *Atomistics by Ruđer Bošković*, 1892, Niš.

Ruđer Bošković



Ruđer Bošković (1711-1787) is a famous mathematician and astronomer of Dubrovnik and one of the most important scientists of his time. He is included among one hundred most prominent Serbs of all time. He was a university professor, founder of the Milano Observatory and the director of the French Navy Optical Institute. He was an universal creator: philosopher, mathematician, astronomer, scholar, geologist, architect, archaeologist, diplomat, writer, professor, poet and polyglot.

He was born on 18th May 1711 as the seventh child of Nikola Bošković (a Serb from Orahov Do, a village near Trebinje in Herzegovina) and mother Paola (of

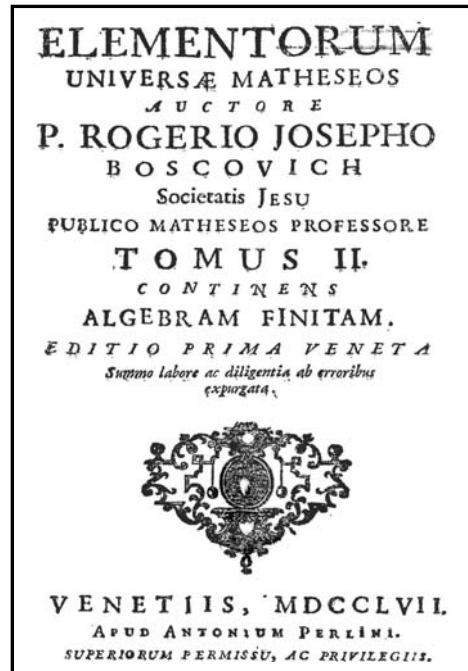
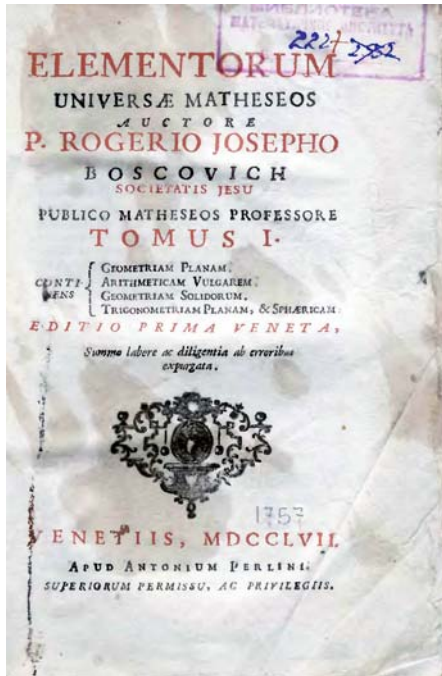
Italian descent, from the family of Baro Bettera, a notable poet from Dubrovnik). He lived mostly in Italy, where he gained world fame. Bošković died on February 13, 1787.

Bošković formulated the Unified Law of Forces, assuming that there is not only an attracting force (as Newton's law states), but that there is also repulsion which alternately changes with attraction at small distances between bodies. According to him, an elementary dimensionless particle is the source of the force, and time and space are relative, unlike in Newtonian theory. Hence, he is often considered as the forerunner of Albert Einstein.

Ruđer Bošković had numerous contributions to astronomy, among others: he introduced two geometric methods for determining the elements of the rotation of the Sun by observing the positions of three bodies, calculated the dimensions and the flatness of the Earth and discovered the comets. He was the first (1782) who accurately determined the trajectory of Uranus based on the measurement of coordinates of Uranus obtained by Messier and Méchain. It should be said that at the time of discovery it was thought that Uranus was a comet. By calculating the trajectory of Uranus, he perfected the method for determining the orbits of comets on the basis of four measured positions. In the 1800th it was one of the most accurate methods. He also studied the atmosphere of Jupiter and the nature of the Aurora.

Ruđer Bošković published numerous numbers of paper sheets in mathematics, astronomy and physics. His well-known books are *Theoria philosophiae naturalis redacta ad unicam legem virium in natura existentium*, *Opera pertinentia ad opticam et astronomia* and *Elementorum universae matheseos*.

In the Virtual library there are the following books by him: *Elements of Mathematics (Elementorum Universal Matheseos - Tomus I-III, 1757, Venetis)*, *Diary on the Journey from Constantinople to Poland (1762)*, translated by D. Neljeković, 1937, Belgrade, *On the law of continuity and its consequences in respect to the basic elements of matter and their forces*, printed in 1754, translated into Serbian by E. Stipanić, 1975, Belgrade.



Zechariah Stefanović Orfelin

Zechariah Stefanović Orfelin (1726 - 1785) was a prominent Serbian poet, historian, engraver, baroque educator, calligrapher and writer of textbooks. He was born into a Serbian family in Vukovar (Slavonia).

Among his most important works is *Slavenoserbski magazine* printed in Venice in 1768. This is the first South Slavic magazine. Although it was printed just in one volume, its importance is great. In the preface he presented the idea of civil enlightenment, and he also said that science, literature and philosophy should leave the narrow circle of educated people and that it must become available to everyone. In 1768 Zechariah Orfelin introduced into Serbian literature a language which was a mixture of Church and common language. He also included many Russian words. In this way he practically founded the Slavoserbian language. Because of his artistic works, primarily in the copper plate, he was elected a member of the Art Academy in Vienna.

Orfelin is the author of the first Serbian primer (*bukvar*) which was used since 1767 in teaching many generations of students in writing and reading. He is also the author of the first Serbian-Latin textbook. His most comprehensive work was *The Life of Peter the Great* (Venice, 1772), which he had seen as the enlightened monarch. He also wrote *Perpetual* (eternal) *calendar*. This book includes a comprehensive chapter on astronomy.

Orfelin's *Perpetual Calendar* was printed in Vienna in 1783. The book has 366 pages and 9 astronomical drawings at the end of the book. Its content concerns mainly natural sciences and astronomical phenomena and contains, as well, description of historical events since the creation of the World in a chronological order. Chapters on astronomy bear the names: *Space, The Moon and the Planets, Comets, Solar Eclipse and Moon Eclipse*. It includes information on weather cycles, tables with information about the Sun and the Moon (needed for the calculation of the date of Easter according to the Big indicium), tables on the length of day and night, moon phase tables, and more. Therefore *Perpetual calendar* is the first book on astronomy written in the Slavic language, how Orfelin said "to the benefit of the Slavic-Serbian (*slovenoserbskim*) people". More details about Orfelin's Calendar, the reader can find in Milovanović (2007).



The cover pages from the Orfelin's *Perpetual Calendar*

Atanasije Stojković



Atanasije Stojković was born in 1773 in Ruma, Vojvodina. In this town he finished Ascension school (Serbian Grammar school). He went soon to Šopron where in 1794 completed the first six grades of high school and then enrolled in a secondary school in Szeged, where in 1796 graduated philosophy. In Vienna, in July 1797th, he met Dositej Obradović and introduces himself with Dositej's enlightenment ideas. In the fall of this year he managed to obtain support from Metropolitan Stratimirović for studies in Göttingen, at that time one of the most famous universities. There he obtained PhD degree in philosophy (1799), and began intensive studies in various sciences (physics, mathematics,

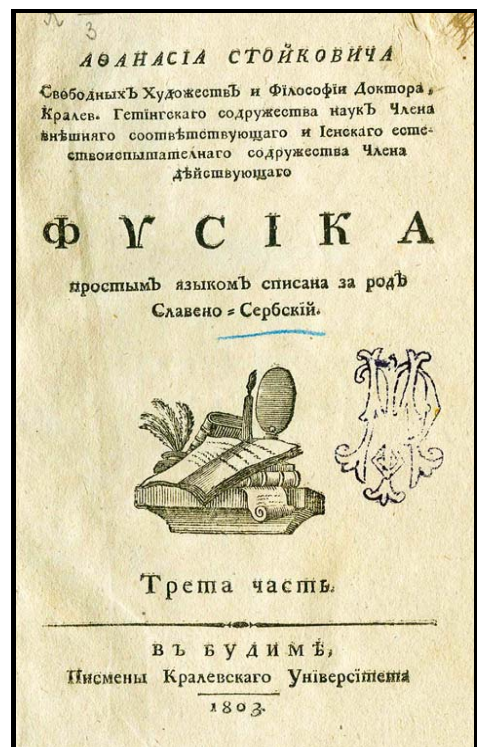
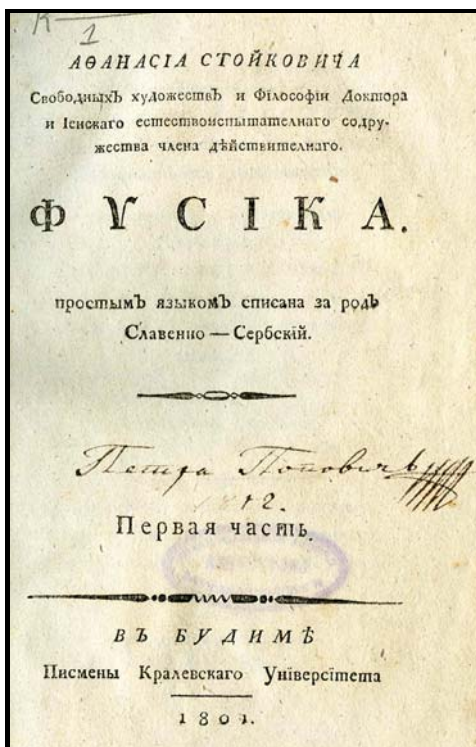
astronomy, history). After a brief stay in Ruma (1799) he moved to Budapest, where he published his main work *Physics* (1801-1803), printed in 3 volumes.

In the Habsburg monarchy it was difficult to obtain a civil job, so after the call of Severin Osipovič Potocki, the future Minister of Education of Russia, Atanasije accepted the position of regular professor of physics at newly established Kharkov University. He soon became the dean of the Department of Physics and Mathematics and on two occasions (1807-1808 and 1811-1813) he was the Rector of the University of Kharkov. He is the founder of the Kharkov Learned Society and he also received many honors and decorations. He became a member of the Imperial Academy of Sciences, obtained many material privileges, became a national consultant and Tsar Alexander I gave him the Medal of St. Vladimir of the third degree.

Atanasije Stojković was a hardworking and capable man, of wild spirit, very successful and was appreciated in his surroundings. He spoke several languages: German, Latin, French, Italian, English, Greek, Hungarian, and almost all Slavic languages. He had interesting and exciting life that next to science was marked by an affair that ended his professorial career. He was also engaged in a secret mission and diplomacy. He died in Kharkov in 1832.

With his versatility, ambition and intelligence, probably under the influence of enlightenment ideas of Dositej Obradović, Stojković was trying to educate his people, to improve their science and culture, at a time when barely was foreseen the emergence of a new Serbian state.

The Stojkvić's book *Фисика* (Physics) was printed in 3 volumes. The first two volumes have 320 pages while the third was written in 284 pages. The book presents an overview of the knowledge at that time of nature and natural phenomena. At the beginning of the first volume there is a chapter on mechanics (the properties and movements of the body). The most of the first volume (the second and the third chapter) is devoted to astronomy. There are described celestial bodies, apparently moving spheres of the sky, stars, solar system, the Sun, planets, comets, the Moon, the eclipses. The third chapter describes our planet Earth. Also, the concepts of celestial equator, horizon, zenith, and nadir are introduced. He also explains the geographical coordinates, the size of Earth, the Earth's movement, the change of the day and night on the Earth and the Earth's interior. The rest of the book is devoted to the description of geographical notions and meteorological phenomena.



The book is written in the common language, without complex mathematical formulas and equations, having the aim to present knowledge about astronomy and nature to ordinary people.

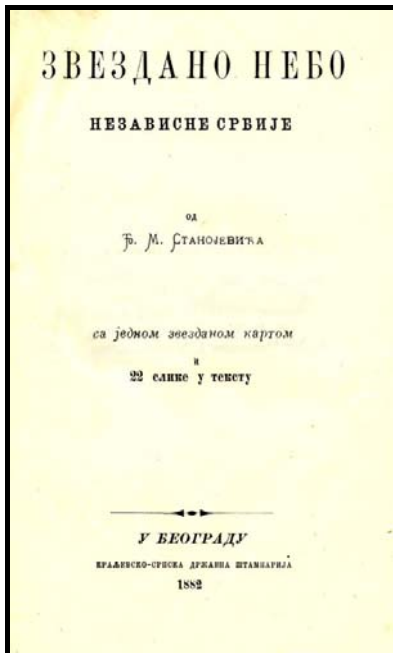
Dorđe Stanojević



Dorđe Stanojević (1858-1921) was born in Negotin. He completed the Grand School in Belgrade. After that he became an assistant at High School, working with his teacher Kosta Alkovića (1836-1909) and then as the professor at the First Belgrade Gymnasium (1883). Having the scholarship of the Ministry of Defense (1883-1887), he studied in the most famous astronomical and meteorological observatories in Europe (Potsdam, Hamburg, Meudon, Greenwich, Pulkovo).

On behalf of his results he received a call from the Paris Observatory to participate in scientific research expedition to study the Sun and in the Petrovsk where he participated in the study of the full eclipse of

the Sun. Two years later he joined another scientific-research expedition to the Sahara to study the thermal spectrum of the Sun. At that time and later, he published several research papers in astronomy in the publications of the Paris Academy of Sciences. These are the first scientific works in astronomy among the Serbs.



Stanojević was a versatile, knowledgeable man with a lot of active interest in many fields of science and technology. His interest in physics was great. Upon his return to Serbia he devoted himself to the study of modern physics. In the same time, he became the lecturer in physics and mechanics at the Military Academy. Also, he taught applied physics and mechanics at the High School and at the Belgrade University after establishing it in 1905. He was responsible for the construction of hydroelectric power plants in Serbia (Vučje, Negotin, Užice, Ivanjica and other places) and for the electrification of Belgrade. This put Belgrade among the first European capitals with full electric lighting. He died in Paris in 1921.

In Negotin there is “Đorđe Stanojević” Square and the museum is dedicated to him. In New Belgrade there is “Đorđe Stanojević” street. The Electric Power Industry of Serbia on the occasion of its day, 6th October, gives recognition “Đorđe Stanojević” for contributions to the development of Serbian electric power industry.

The Virtual Library contains eight digitized books of Đorđe Stanojević: *The starry sky of independent of Serbia*, 1882, Belgrade; *A walk across the clouds*, 1884, Belgrade; *Cosmic energy of modern physics* (introductory lecture, 22nd September, 1887, Department of Physics at the Military Academy in Belgrade); *Nikola Tesla and his discoveries*, 1894, Belgrade; *Science of light*, 1895, Belgrade; *Central forces in nature*, 1906, Belgrade; *Industry of coldness*, 1909, Belgrade; *Inaccurate celebration of the Easter in the Orthodox Church and the reform of the calendar*, 1908, Belgrade.

Stanojević works are characterized by the simplicity and easiness of writing when exposed to often complex astronomical phenomena. These phenomena, however complex, are mostly descriptively presented, without mathematical expressions and using very fine drawings. Therefore, this book is primarily intended for general education and general readers. In this regard, Stanojević scored his goal, to bring the basic knowledge of astronomy to the general reader. It is our great pleasure to have this precious book out of the darkness of library storage into the light through the Virtual Library and made it easily accessible to the future readers.

More details about Stanojević life and works the reader can find in Pejović (2008ab, 2009).

Milan Andonović

Milan Andonović (1849-1926) was born in Požarevac where he finished high school. He was educated in Belgrade at the engineering departments of the Great School in Belgrade and at the German Universities in Karlsruhe, Aachen and Munich under the supervision of famous professors Ritter, Jordan, and Helmert. There he specialized in mechanics, geodesy and astronomy. Upon his return to Serbia in 1880, he was appointed as the professor of geodesy at the Great School in Belgrade. He was responsible for the introduction and enforcement of the cadastre in Serbia in the late 19th century. He founded the Geodetic Institute under whose auspices were surveyed many towns in Serbia. In 1907 he founded the Surveying and Building Academy where many Serbian surveyors and civil engineers were trained. Together with John Dragašević, Milan Nedeljković and Djordje Stanojević he is bearing the credit for introducing the teaching of astronomy in Serbian schools and promotion of science in Serbia. He died in Vienna in 1926.



МИЛАН Ј. АНДОНОВИЋ

Andonović had published a number of scientific papers, books (all printed in Belgrade), and discussions related to surveying, astronomy, shape and size of the Earth, the theory of least squares, survey and cadastre:

Basics probability and the theory of least squares, 1886; *The shape and size of the Earth*, 1886; *Cosmography with basic astronomical notes for high school teachers*, 1888; *The volume and size of our Earth*, 1889; *The Universe*, 1889; *Basic geodesy with distinctive view of the cadastral question*, 1890-1897 (1st part 1890, p.368, 2nd part 1897 vol. 1, p. 369-1390; vol. 2, p.1391-1641); *The cadastre*, 1889.

He also wrote during the First World War, political discussions and articles (in German and French) in favor of Serbia.

There are the following digital copies of his books in the Virtual Library: *Cosmography*, 1888, and *The Universe*, 1889, both printed in Belgrade

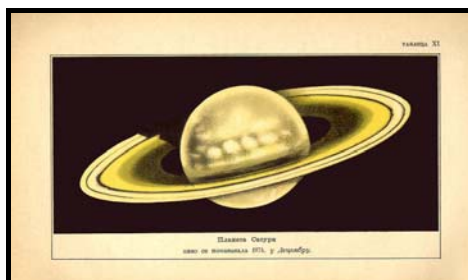
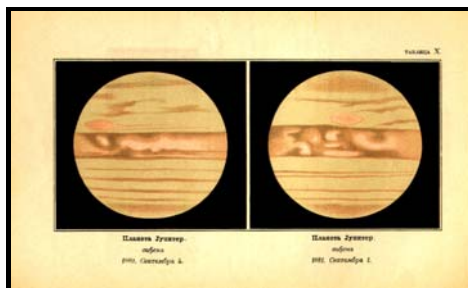
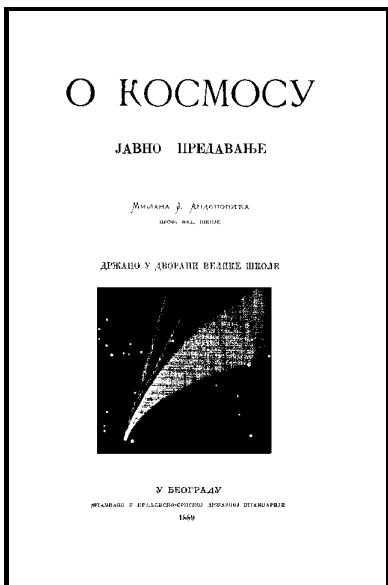
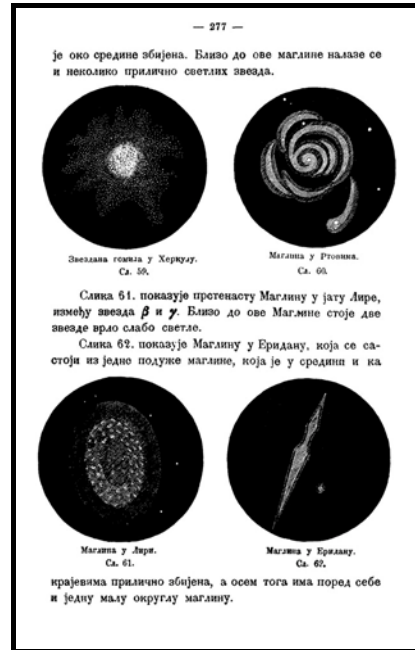
Hard copies of both books are in the Library of Astronomical Observatory of Belgrade. Books are digitized by the courtesy of Vojislava Protić-Benišek.

Cosmography was intended for high school students and students of other secondary schools. Probably, it was used as a secondary textbook at the Military Academy and the Grand School, the forerunner of the Belgrade University. In addition to the foreign literature, Andonović mentioned in the bibliography two Serbian authors: *Trigonometry* of Dimitrije Nešić and *Cosmometry* by Jovan Dragašević. The book has many illustrations: 141 photos and drawings, 17 tables and a large star map. He took most of these drawings, with permission, from a book of E. Weiss, then the director of the Vienna Observatory.

Cosmography is an extensive (533 pages) and quite comprehensive book. It describes celestial sphere, constellations, the shape and size of the Earth, the Earth's rotation and revolution, the apparent movement of the Sun, coordinate systems, time, calendars, Solar system, stars, tides, precession, Cosmogony and among other things, Kant-Laplace's theory about the origin of the World (i.e. the Solar system). Besides all that, there are twenty fully solved astronomical problems with detailed explanations.

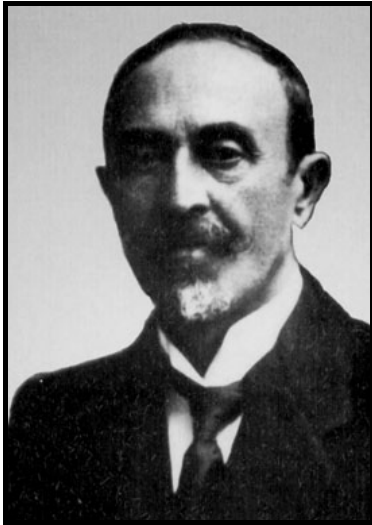
The book is written in a very beautiful style, almost as a literary work, and is worth reading also from that point of view. There we find many forgotten words and terms whose meaning were forgotten or had changed since today. For example, the cluster (Serb. *zvezdano jato*) there means constellation, stardust

(Serb. *ozvezdina*) - meteorite, comet star (Serb. *zvezda repatica*) - comet, the inflow and outflow (Serb. *priliv i odliv*) – the tide. Also, for each constellation he introduces the *alinjman* – having the meaning similar to asterism.



For example the *alinjman* of Big Bear (in Serbian also called *Velika kola* - Big Chariot) has four stars – the asterism trapeze of the constellation Big Bear, while the *alinjman* of North Star is the line that passes through the rear wheels of the Big Chariot towards to the North Star. The Virtual Library contains digital copies of his books: *Cosmography* (1888) and *The Universe* (1889), both published in Belgrade.

Kosta Stojanović



Kosta Stojanović (1867-1921) was born in Aleksinac. There he finished elementary school and lower secondary school, while the high school he completed in Niš. He graduated in mathematical sciences at the Grand School in Belgrade. For some time he was working as a high school teacher in Niš and Belgrade. He went to Paris in 1893 where he studied mathematics, astronomy, mechanics and physics under the supervision of famous professors Poincaré, Picard and Appel. There he became a member of the Historical Society of France and the French Astronomical Society. He went to Leipzig in 1897 where he entered doctoral studies in mathematics. Unfortunately, he returned to Serbia after three months because of his illness.



Kosta Stojanović was a university professor, but he had a very rich political career, too. At the beginning of 1900th he became a deputy as the representative of the Niš district.

Since the 1903rd he taught applied mathematics at the Grand School and at the Belgrade University after it was established in 1905. Whereupon he abruptly interrupted academic career and 1906 he became the Minister of Commerce, at the time of the custom war between Belgrade and Vienna.

Around that time, Kosta Stojanović wrote the book *Fundamentals of economy value*. This book is a work in mathematical economics and Stojanović there used very

advanced mathematical apparatus, for example, the theory of partial differential equations to describe economic models. Even today there is an interest for this book, not only in Serbia but also in the other parts of former Yugoslavia. This is probably the most advanced book in economics ever printed in Serbia due to the mathematical tools that were used in.

He was the Minister of Agriculture (1919-1920) and the Minister of Finance in 1921 in the government of Nikola Pašić. A few days after the appointment as the minister of finance, he suddenly died.

The book *Mechanics* is actually a university textbook in applied mathematics. Let us mention that at this time, under the term applied mathematics it was assumed mechanics, mathematical physics and celestial mechanics. The most of the book is related to the vector calculus, then the kinematics, statics, dynamics, analytical mechanics and the theory of differential equations. Chapter Ten of this book is dedicated to astronomy. There he gave the basics of celestial mechanics and the theory of differential equations of the motion of planets, comets and satellites. Also, the theory of elliptical movement, the method of variation of constants and parabolic motion of comets are presented.

CONCLUSION

The Virtual Library of the Faculty of Mathematics has a significant place in the presentation of old and rare books to the Serb scientific and professional community and general public wide-world. This fact we can convince, for example, by the choice of books from the collection of astronomical works of the Serbian scholars presented in this article.

Acknowledgements

This paper is written under the project “Application of information technologies in digitization of scientific and cultural heritage”, IT 13 017, funded by the Serbian Ministry of Education and Science.

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