Преглед НЦД 22 (2013), 118–124

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WORKS OF RUĐER BOŠKOVIĆ IN VIRTUAL LIBRARY OF THE FACULTY OF MATHEMATICS IN BELGRADE

Abstract. Four books written by Ruđer Bošković deposited in the *Virtual library* of the Faculty of Mathematics in Belgrade are presented. Contents of this works are analyzed and reviewed, particularly of book *Elementorum Universale Matheseos.* An overview of the Virtual library itself is given and its objectives, collections and related projects are explained.

Keywords: virtual library, Ruđer Bošković, Faculty of Mathematics

1. Virtual Library

The overall objective of the *Virtual Library of the Faculty of Mathematics*, University of Belgrade,[1] is to create a comprehensive collection of retro-digitized books and other digital documents from the past, see [5]. The main part of this project relates to an electronic archive which contains primarily all old manuscripts electronic form, and to present them to the general public.

The project initially aimed at mathematics, but since 2009 the books from other areas are also deposited in the Library. The priority will be Serbian authors, and works related to scientific and cultural works of the Southeast Europe. Some of the books in the Library are rare; only a few copies of them are available in printed form, and are practically inaccessible to the general public. We considered that they should be somehow preserved, not only as a Serbian cultural and scientific heritage important, but also as part of the World Heritage. We decided to preserve these books, and present them to the general public in an electronic, digitized form.

Several volunteers started the project in 2007. Now, the Library has strong support from the Faculty of Mathematics, University of Belgrade, the Mathematical Institute of the Serbian Academy of Sciences and Arts (SASA), the National Center for Digitization and the Ministry of Science of Serbia.

Virtual Library of the Faculty of Mathematics is the largest Internet oriented database in Serbia of digitized texts with free access. The library also keeps 2,000 books, and several important collections, for example, an important collection of 400 doctoral dissertations in mathematical sciences (most of them defended at the Faculty of Mathematics). Another important collection consists of rare books from the 18th and 19th century. There are also small collections of digitized books from all of the former Yugoslav republics.

The important part of the Library are collected works of some leading Serbian scientists from the past: Atanasije Stojković, Bogdan Gavrilović, Milutin Milanković, Đuro Kurepa, Đorđe Stanojević and several others.

Works related to the archive of the Virtual Library are published in the journal NCD Review (SEEDI Communication), issued by the Faculty of Mathematics in Belgrade.

[1] Virtual Library of the Faculty of Mathematics webpage: http://elibrary.matf.bg.ac.rs

We will present a collection of books written by Ruđer Bošković (1711-1787); works have been digitized and deposited in the Virtual Library. These are the first scientific works of an author of the Serbian origin (his father Nikola was a Serb, mother Paola Bettera was Italian).

The Virtual Library comprises books of other Serbian writers of that period, as well. In fact, shortly after the publication of Bošković's books, in the second half of the eighteenth century, the first scientific works written in Old Serbian were written (see [1] and [2]):

- **Vasilije Damjanović** (1734-1792), *Arithmetic*, 1767, Venice. This is the first Serbian book on mathematics. There is only one known printed copy left and it is kept in the Library of ***Matica Srpska*** in Novi Sad.
- **Zechariah Orfelin Stefanović** (1726-1785), *Eternal Calendar*, 1783, Vienna. Much of this book is devoted to descriptions and explanations of astronomical phenomena. Hence we can consider that this work is the first Serbian book on astronomy. Printed copy of this book is in the Library of the Astronomical Observatory in Belgrade.
- **Atanasije Stojković** (1773-1832), *Physics*, 1800, Budapest. This three-volume book is the first Serbian work in physics. Printed copy of this book is in the Library of the Serbian Academy of Science and Art.

Let us note here the general characteristic of the first Serbian scientists, particularly those from the XVIII and XIX century. They were universal in their research interests, and in other aspects as well, so mathematics, for example, was not their only activity field. They were successful in other sciences, too: in astronomy, physics and philosophy. For them, science was primarily an insight into a unique creature - Nature. Besides, they were often successful politicians, artists, travelers, writers and poets. These books have primary the enlightening character. The writers dedicated their works to the Serbian people, or as Orfelin says in his *Calendar*, "*to the benefit of the Slavo-Serbian people"*.

Their importance for the development of Serbian culture, language and science is enormous.

2. Bošković's works in Virtual Library

On this occasion, we will not discuss the biography of Ruđer Bošković (1711-1787). There are many extensive books on his biography. However, it should be stressed that Bošković was a great mathematician and astronomer, one of the most important scientists of his days; he is listed as one of the 100 most significant Serbs of all time.

He was a university professor, the founder and of the Milan Observatory and the director of the French Navy Optical Institute. He was a universal creator: theologian, philosopher, mathematician, astronomer, physicist, geologist, architect, archeologist, designer, optometrist, diplomat, traveler, teacher, poet and polyglot. Bošković wrote his books mainly in Latin and Italian.

In the history of the Catholic Church he is mentioned as an important member of the Jesuit order. Bošković was born on 18 May in the year 1711 as the seventh child of the merchant Nikola Bošković, a Serb from Herzegovina: His mother Paola was of Italian origin, a member of the family of Baro Bettera, a poet from Dubrovnik. He lived mainly in Italy, where he gained international fame. He died on 13 February 1787 in Milan.

In the Virtual Library there are four digitized works written by Bošković. In addition to the basic bibliographic information about these books, there is also a more detailed review of the book *Elementorum Universale Matheseos*. The reason that we moved into a rather professional discussion about the content of this book, beyond librarian domain and style, is best explained by Mícheál Mac

an Airchinnigh in his article [3]. At least, it is reasonable to assume that Bošković's books have nothing to do with computer technologies and standards that were used to produce their digital copies.

- *Elementorum Universale Matheseos* - Tomus I-III (*Elements of General Mathematics*), Venetis, 1757. The printed copy of this three-volume book is located in the Library of the Mathematical Institute SASA.
- *A dissertation on the law of continuity and its consequences pertaining to the first elements of matter and of its powers*, translated by Darinka Nevenić-Grabovac, the preface and comments written by Ernest Stipanić, 1975, Belgrade. This book is a translation from Latin *De lege continuitatis et eius consectariis pertinentibus ad receives materiae element eorumque vires Dissertatio*, Roma, 1754.
- *A Theory of Natural Philosophy*, Latin-English edition, London, translated by J. M. Child, London, 1922, including *Life of Rudjer Boscovich,* written by B. Petronijević. This book is a parallel of the Latin-English edition of *Theoria Philosophiae Naturalis*, Venetis, 2nd edition, 1763. The printed copy of the London edition of Boscovich theory is in the library of the Astronomical Observatory of Belgrade.
- *Diary of the journey from Constantinople to Poland*, translated by Dušan Neljeković, 1937, Belgrade, (translation of French edition *Journal D'Un Voyage De Constantinople En Pologne*, original *Giornale di un viaggio to Constantinople in Polonia* Dell'Abate Ruggiero Giuseppe Boscovich, 1762).
- The manuscript *Law or Principle of Continuity* is the main starting point and the guide to Bošković's development of the theory of forces that exists in nature; it is also related to the theory about the composition of matter. Therefore, the discussion on the *Law of continuity and its consequences with regard to the basic elements of matter and their forces* is closely related to his theory of natural philosophy.

In addition to the other discussions (*On living forces*, Rome, 1745; *A dissertation on light*, 1748; *A dissertation on the law of continuity and its consequences pertaining to the first elements of matter and of its powers*, Rome, 1754; *On the law of powers in the nature of existing things*, 1755), it is the basis from which emerged the main Bošković's work *A theory of natural philosophy* (*Theoria Phylosophiae naturalis redacta ad Unicam legem virium in natura existentium*, 1758). Hence, immediately in the second paragraph, Bošković said that the debate on "*analysis of the whole is carefully prepared to lead us from the simplest principles of nature and the necessary combination of spontaneous conclusions to the theory itself*". This speaks itself about the importance of this discussion for Boskovic's scientific and philosophical work. According to professor Ernest Stipanić, it was the reason that the Mathematical Institute decided to publish translation of this book into Serbian with comments.

Bošković's *magnum opus*, *Theory of Natural Philosophy*, is undoubtedly his most important work. The first edition of this book was printed in 1758th in Vienna. The Virtual Library has the digital copy of the English - Latin edition, printed in London 1922.

This book is edited and translated by Mark James Child according to the second edition of Bošković's book printed in Venice, 1763.

The second edition of *Theory of Natural Philosophy* is extended and completed version of the first edition. It was printed under Bošković's supervision. There is a short Bošković's biography written by a distinguished Serbian philosopher Branislav Petronijević.

The book *Elements of general mathematics* was obviously a textbook intended for Bošković's students. Many examples and a number of problems scattered through the book confirm this claim. It is interesting that in many papers and in many places on the Internet it is said that the book was printed in 1754 in Rome; however there is no such information in Bošković's bibliography. Digital copy of this book comes from the 1757 edition, printed in Venice (imprint: Editio Prima Veneta, MDCCLVII). The same is with digital copies that are available in the large digital library Europeana and Google books.

Part of the first volume of *Elements* is related to elementary geometry, but the exposition mostly follows the Euclid's elements. The other chapters are related to the basic properties of arithmetical operations, rational numbers, the properties of proportions, arithmetical and geometrical progressions, logarithms, and finally to the elements of plain and spherical trigonometry.

The second volume, *Algebra finite*, is completely devoted to then known procedure of solving algebraic equations. The properties of polynomials and the arithmetic of the radicals are also described. The Cardano (Gerolamo Cardano, 1501-1576) method for solving cubic equations and Ferrari (Lodovico Ferrari, 1522-1565) solution of algebraic equations of the fourth degree are presented. There he used complex numbers (*quantitates imaginarae*) what was rare at that time. Bošković also gave approximate, numerical methods for solving some algebraic equations of a higher degree for which it was later proved that they cannot be solved algebraically (using radicals, Niels Abell, Evaristo Galois, first half of the 19th century).

The third volume of the *Elements* is certainly the most interesting. Bošković's theory of second order curves, presented in this part of the *Elements* was the first complete and systematic theory of conics (conic sections). In the presentation of this subject in which purely geometrical arguments were used there were many new ideas. Although already the method of Decartes's system of coordinates had been developed, Bošković did not use this analytical approach. In particular, for the definition of the conic sections he chose the following one: *the conic is the locus of points in the plane for which the ratio of the distance to the fixed point (focus) and the given line* (*directrix*) *is a constant*. He called this quotient the conic's *ratio determinans*. Today, this ratio is usually called the eccentricity of the conic. Although this property had been known to ancient Greek mathematicians, particularly to Pappus of Alexandria, it had never been taken for a definition previously. In modern analytic geometry, the definition of second-order curves, in most cases exactly follows Bošković's approach. Before Bošković, the conics were intersections of the cone and the plane, therefore the definition of three-dimensional space must be assumed. Hence, his theory of conics becomes the theory of conic curves in the plane.

He introduced a very useful tool for proving various statements about conic sections. This is the wellknown Bošković's *eccentric circle*, i.e. circle with arbitrary center which has the property that the ratio of its radius and the distance of the center to the directrix is equal to the eccentricity. Using this notion, Bošković described various constructions and proved many properties of conic sections. He deduced them using the properties of circles and the correspondence between the eccentric circle and the conics. In the addendum *De transformatione locorom geometricorum* to the third volume of the *Elements*, Bošković presented an entirely new theory of geometric transformations which are essentially collinear, and therefore he can be considered as the forerunner of the development of projective geometry; it emerged much later, in the 19th century.

3. Other authors in Virtual Library on Bošković's work

The Virtual Library also contains books and manuscripts related to the life and work of Ruđer Bošković. The most interesting is the book written by Kosta Stojanović, *Atomism - a part of the philosophy of Joseph Ruđer Bošković*, Niš, 1891. The book is actually a comparative analysis of Bošković's natural philosophy.

In the Virtual Library there are also other books written by Kosta Stojanović. Stojanović was a versatile scholar and professor at the Great School in Belgrade. He founded theoretical mechanics in Serbia, and is the author of The *Basis of the theory of economic value,* probably the best book on economics in Serbian. He was a MP and a cabinet minister of the government Nikola Pašić.

References

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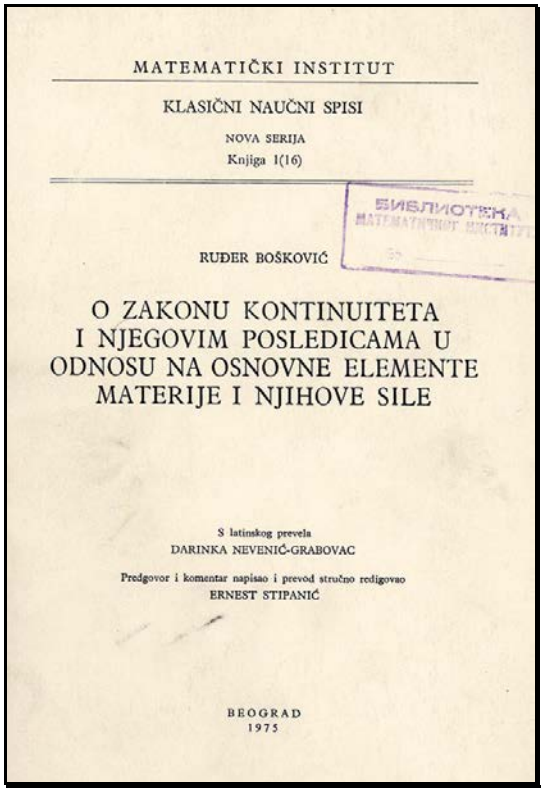
[7] Virtual Library, http://elibrary.matf.bg.ac.rs; NCD Review, http://elib.mi.sanu.ac.rs.

zarkom@matf.bg.ac.yu
nada@matf.bg.ac.yu


MATEMATIČKI INSTITUT

KLASIČNI NAUČNI SPISI

NOVA SERIJA
Knjiga 1(16)

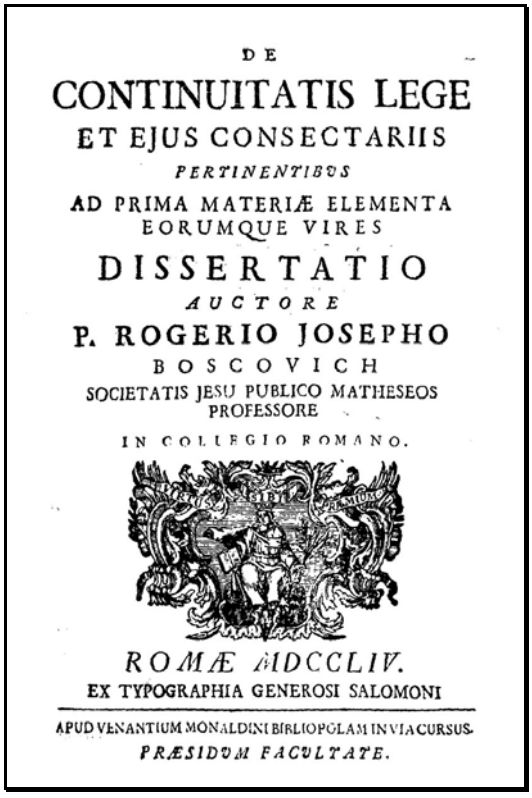
RUĐER BOŠKOVIĆ

O ZAKONU KONTINUITETA
I NJEGOVIM POSLEDICAMA U
ODNOSU NA OSNOVNE ELEMENTE
MATERIJE I NJIHOVE SILE

S latinskog prevela
DARINKA NEVENIĆ-GRABOVAC

Predgovor i komentar napisao i prevod stručno redigovao
ERNEST STIPANIĆ

BEOGRAD
1975


DE

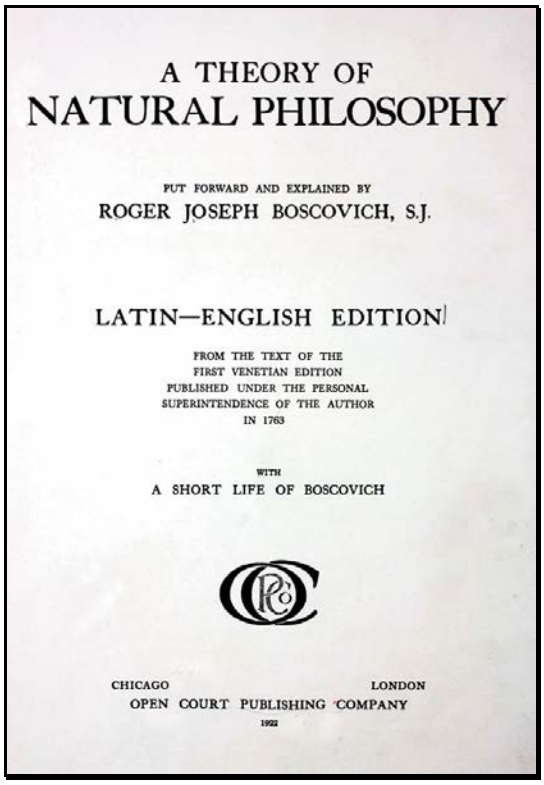
CONTINUITATIS LEGE
ET EJUS CONSECTARIIS
PERTINENTIBUS
AD PRIMA MATERIÆ ELEMENTA
EORUMQUE VIRES

DISSERTATIO
AUCTORE
P. ROGERIO JOSEPHO
BOSCOVICH
SOCIETATIS JESU PUBLICO MATHESEOS
PROFESSORE
IN COLLEGIO ROMANO.

ROMÆ MDCCLIV.
EX TYPOGRAPHIA GENEROSI SALOMONI

APUD VENANTIUM MONALDINI BIBLIOPOLAM INVIA CURSUS.
PRÆSIDUM FACULTATE.

***О закону континуитета и његовим последицама у односу на основне елементе материје и њихове силе*, приредио Е.Стипанић, 1975, Београд**


A THEORY OF
NATURAL PHILOSOPHY

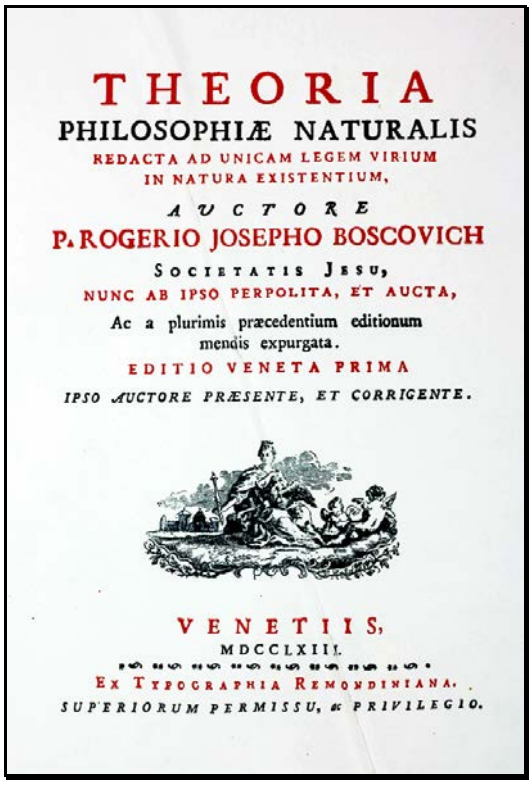
PUT FORWARD AND EXPLAINED BY
ROGER JOSEPH BOSCOVICH, S.J.

LATIN—ENGLISH EDITION

FROM THE TEXT OF THE
FIRST VENETIAN EDITION
PUBLISHED UNDER THE PERSONAL
SUPERINTENDENCE OF THE AUTHOR
IN 1763

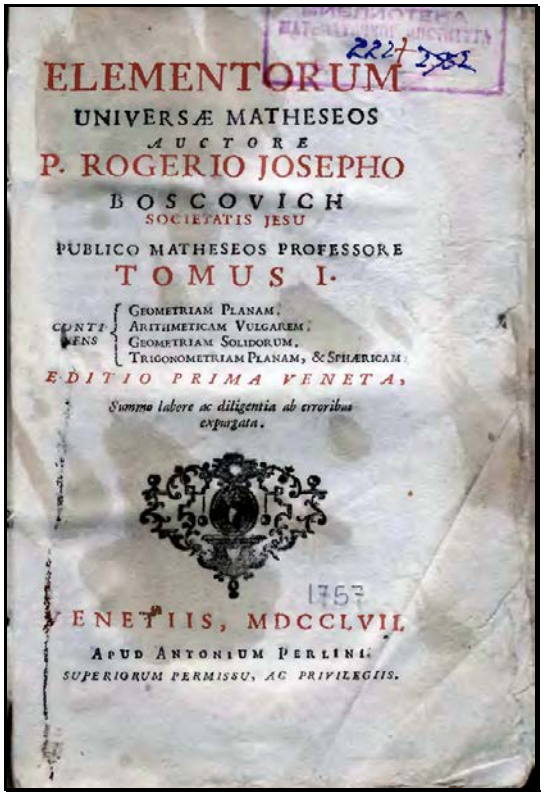
WITH
A SHORT LIFE OF BOSCOVICH

CHICAGO LONDON
OPEN COURT PUBLISHING COMPANY
1922


THEORIA
PHILOSOPHIÆ NATURALIS
REDACTA AD UNICAM LEGEM VIRIUM
IN NATURA EXISTENTIUM,
AUCTORE
P. ROGERIO JOSEPHO BOSCOVICH
SOCIETATIS JESU,
NUNC AB IPSO PERPOLITA, ET AUCTA,
Ac a plurimis præcedentium editionum
mendis expurgata.
EDITIO VENETA PRIMA
IPSO AUCTORE PRÆSENTE, ET CORRIGENTE.

VENETIIS,
MDCCLXIII.
EX TYPOGRAPHIA REMONDINIANA.
SUPERIORUM PERMISSU, ac PRIVILEGIO.

Упоредно латинско-енглеско издање Теорије природне филозофије приредио J. M. Child, Лондон, 1922

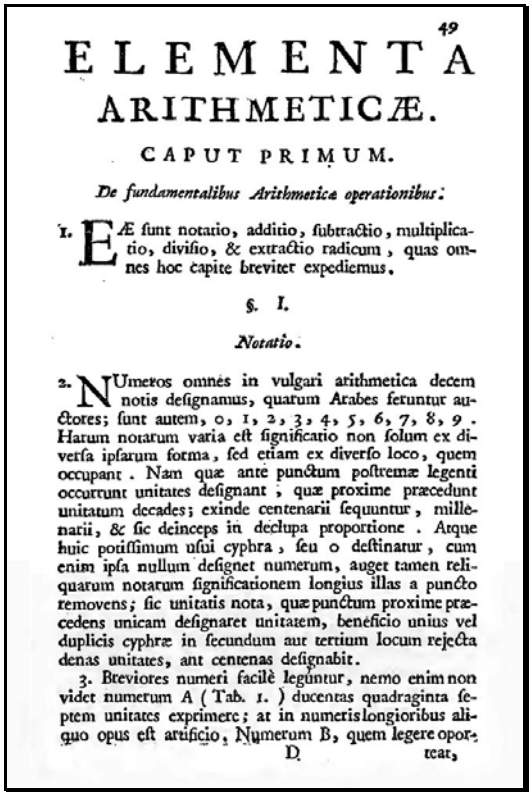


ELEMENTORUM
UNIVERSÆ MATHESEOS
AUCTORE
P. ROGERIO JOSEPHO
BOSCOVICH
SOCIETATIS JESU
PUBLICO MATHESEOS PROFESSORE
TOMUS I.

CONTINENS
GEOMETRIAM PLANAM,
ARITHMETICAM VULGAREM,
GEOMETRIAM SOLIDORUM,
TRIGONOMETRIAM PLANAM, & SPHÆRICAM

EDITIO PRIMA VENETA,
Summo labore ac diligentia ab erroribus expurgata.

VENETIIS, MDCCLVII.
APUD ANTONIUM PERLINI.
SUPERIORUM PERMISSU, AC PRIVILEGIIS.



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ELEMENTA
ARITHMETICÆ.

CAPUT PRIMUM.

De fundamentalibus Arithmeticæ operationibus:

1. EÆ sunt notatio, additio, subtractio, multiplicatio, divisio, & extractio radicum, quas omnes hoc capite breviter expediemus.

§. I.

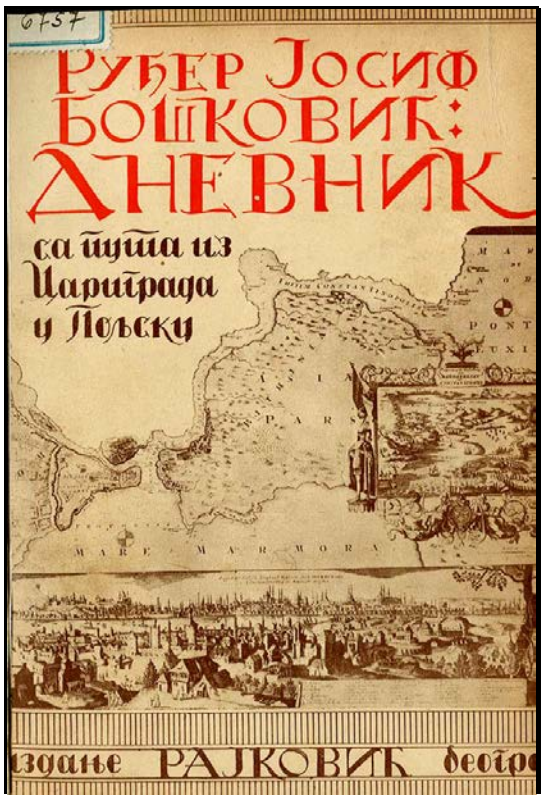
Notatio.

2. NUmeros omnes in vulgari arithmetica decem notis designamus, quarum Arabes ferunt auctores; sunt autem, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Harum notarum varia est significatio non solum ex diversa ipsarum forma, sed etiam ex diverso loco, quem occupant. Nam quæ ante punctum postremæ legenti occurrunt unitates designant; quæ proxime præcedunt unitatum decades; exinde centenarii sequuntur, millenarii, & sic deinceps in declupa proportione. Atque huic potissimum usui cyphra, seu 0 destinatur, cum enim ipsa nullum designet numerum, auget tamen reliquarum notarum significationem longius illas a puncto removens; sic unitatis nota, quæ punctum proxime præcedens unicam designaret unitatem, beneficio unius vel duplicis cyphræ in secundum aut tertium locum rejecta denas unitates, aut centenas designabit.

3. Breviores numeri facilè leguntur, nemo enim non videt numerum A (Tab. 1.) ducentas quadraginta septem unitates exprimere; at in numeris longioribus aliquo opus est artificio, Numerum B, quem legere oportet,

D

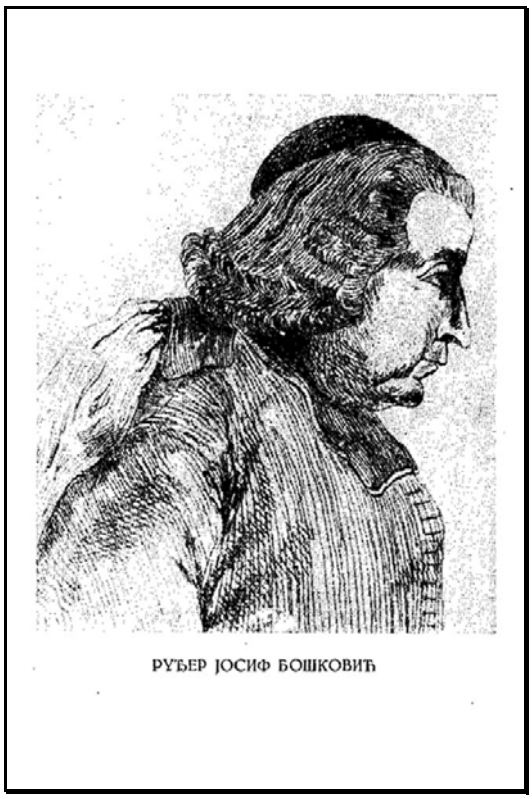
Елементи опште математике, Венеција, 1757



РУЂЕР ЈОСИФ
БОШКОВИЋ:
ДНЕВНИК
са пута из
Цариграда
у Пољску

MARE MARMORA

издање РАЈКОВИЋ београ



РУЂЕР ЈОСИФ БОШКОВИЋ

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