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# DIGITISATION OF BOOK *ЦЕНТРАЛНЕ СИЛЕ У ПРИРОДИ* ВУ **ĐORĐE STANOJEVIĆ**

**Abstract**. We present one of the first university books in physics written in the beginning of the XX century. The topic concerns a book written by Professor Đorđe Stanojević entitled *Централне силе у Приподи* (Central Forces in Nature) which was printed in 1906 in Belgrade. The book has been digitised and it is available through the Virtual Library of the National Digitisation Centre (Virtual Library, http://elibrary.matf.bg.ac.rs/).

Keywords: Central forces, magnetic field, electric field, Stanojević

### Introduction

Book Централне силе у Природи (Central Forces in Nature), the author is Đorđe Stanojević, was published by the Royal Printing House of Serbia (Државна штампарија Краљевине Србије) in 1906 in Belgrade. The copy of this book kept in the Library of the Serbian Academy of Sciences and Arts has been digitised. Stanojević dedicated this book to his retired physics teacher at the Grand School Kosta Alković. Since Stanojević improved his knowledge in Western Europe and knew important languages very well, he was able to use the literature in these languages in the process of writing this book. At its end he gave works of foreign authors as references.

## Đorđe Stanojević's Biography

Đorđe Stanojević was born in 1858 in Negotin, he died in 1921 in Paris. He took degree at the Grand School in Belgrade. Afterwards he was a Grand-School assistant working with Kosta Alković (1836–1909) who taught physics, to be assigned in 1883 to teach at First Belgrade Gymnasium.

Đorđe Stanojević was interested in spreading his knowledge acquired during his activity in the important European science centres in Serbia which, at that time, was economically and culturally an undeveloped country.

Stanojević's interest in electrical engineering and friendship with Nikola Tesla resulted in using electricity for the purpose of illumination of Belgrade. In this way Belgrade in 1893 became one of the first European cities illuminated by electricity. Đorđe Stanojević was active in building first hydroelectric power plants in Serbia at the rivers of Đetinja near the town of Užice and Vučje near the town of Leskovac. After this he was active at power plants situated at: Niš (town) – Nišava (river), Veliko Gradište (town) – Pek (river), Vlasotince (townlet) – Vlasina (river), Ivanjica (townlet) – Moravica (river), Zaječar (town) – Timok (river) and also in the town of Čačak. By building these hydroelectric power plants Stanojević put Serbia among the first countries which used electric energy. This made an important influence on the industry modernisation and progress in the culture of life. The Electric-Energy Distribution Centre in Negotin was named after him and inside the building of this centre there is a museum exhibition devoted to life and activity of Đorđe Stanojević. In Belgrade in front of the local Electric-Energy Distribution Centre there is a monument of Đorđe Stanojević and a Belgrade street has been named after him.



A photograph of Đorđe Stanojević

As a fellow of the Ministry of Defense he spent the period 1883-1887 in studying and improving his knowledge at the best known European centres. During this time interval, in Paris, he published a few papers on solar physics. These papers were the first scientific articles in astrophysics among Serbs. His interest in physics was large, for instance, teaching physics at the Military Academy, after he had returned to the home country in 1887, he devoted his lecture to the most contemporaneous physics. In the period to come he was mainly active in physics and its applications. He taught at the Grand School and taught applied physics at the University of Belgrade where he became a Professor and Rector.

## **Contents of the book**

Централне силе у Природи was written on 88 pages and it consists of two parts. The first one Onume одредбе (General) is short and contains only three chapters, whereas the second part Примене (Applications) is presented in more details. It has eight chapters, full of characteristic examples, schemes and illustrations. The text contains 74 figures offering a very good presentation of lines of forces and isopotential surfaces being the topic of the book. At the end of the book there is a list of references containing 15 units written by foreign authors.



Scan of front cover page

First Part Onume odpedde. It contains three chapters: Сила и рад (Force and Work), Потенцијал (Potential) and Поља централних сила (Fields of Central Forces). In them one defines general notions and derives the corresponding equations. As a matter of special interest I would mention Stanojević's short historical review concerning the потенцијална функција (potential function) named *потенцијал* (potential) by Gauss. In this way we can learn that important properties of potential to the studying of central forces were firstly indicated by Laplace in his Celestial Mechanics and that only afterwards they were used in studying of electricity and magnetism. It is of interest that some words that have been forgotten till our days (or have been given a different meaning), were used throughout Stanojević's book, for instance: nonowah (positive for work), today nosumubah, одречан (negative for work), today негативан, смисао (sense of force), today *cmep*.

Second Part Примене. The second part contains eight chapters: *Телурично поље* (Telluric Field), *Магнетско поље* (Magnetic Field), *Електрично поље* (Electric Field), *Електромагнетско поље* (Electromagnetic Field), *Оптичко поље* (Optical Field), *Келијчно поље* (Cell Field), *Планетско поље* (Planet Field) and *Закључак* (Conclusion). These fields were described and largely given by means of figures, whereas for some of them lines of force were calculated and schematic presentations were also given.

The notions of *cell field and telluric field*, very interesting in my opinion, deserve additional comments. According to Stanojević any plant or a tree contains some kind of current. This current in its whole streaming forms a field - *cell field* because it governs the distribution of cells. For simplicity Stanojević assumes that the direction of this current coincides with the tree axis. Its nature is further no topic to him. The notion of *telluric field* is used by Stanojević for the Earth's gravitation field so that he names the rest surface of terrestrial oceans the telluric isopotential surface. The word telluric has been lost.

Of a special interest is the analogy between lines of force for magnetic and cell fields found by Stanojević. Fig. 16 presents lines of force of a magnetic field, Fig. 54 the same for a cell field on cross-section of radish. These two figures serve to Stanojević to show a similarity. Further on Stanojević says that lines of force are invisible for some plants, but the isopotential surfaces are visible, examples are cross-sections of fir (Fig. 55). Stanojević emphasizes that lines of force in this case become visible if a tree has clefts. Fig. 55 shows such a case; a cleft always follows the direction of lines of force.



Scan of Fig. 16 Magnetic field

Scan of Fig. 54 Cross-section of radish

Scan of Fig. 55 Cross-section of fir

In the book, Fig. 20 we see a magnetic field of two magnetic poles, Fig. 33 we have a theoretically drawn isopotential surfaces of two electric fields, Fig. 39 the electromagnetic field of two currents, Fig. 48 contains the optical field of biaxial crystal and Fig. 60 shows a cell field on the cross-section of a tree. Stanojević on the basis of these figures comes to an interesting conclusion concerning the similarity of fields of magnetic dipole, electric dipole, electromagnetic dipole, optical dipole and cell dipole. This similarity is obvious.

The similarity between magnetic, electric, electromagnetic and optical fields with the cell one Stanojević illustrates also for the case field perturbation, i.e. when in a field we have hindrances. Figs. 37, 68, 69 and 70 show lines of force in avoiding a hindrance and how the isopotential surfaces become denser around the hindrance. In the cell field hindrances are knots on the trunk (68 and 70).

It is interesting that at the end of the book Stanojević forms a conclusion concerning, not only the overall mater in nature, but also including the organic matter. For the latter one he says: Cells interacts proportionally to their masses and inversely proportionally to the squares of the distances. The cells move and stop following the lines of force and isopotential surfaces.



## Conclusion

Based on book *Централне силе у Природи* one can conclude that Stanojević was well acquainted with the contemporary scientific trends, as seen from analogies studied by him in the book. He showed that there should be a strong analogy between telluric field, magnetic field, electric field, electromagnetic field, optical field and cell one. The book is interesting, in some way it offers a view of the state of arts in the science for that time, but also showing the wide scope of the scientist considering all of that science. In the present paper some of interesting points which can be found in the book are presented. To anyone interested in studying the book in more details I recommend the digital copy easily available at the Virtual Library.

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### ДИГИТАЛИЗАЦИЈА КЊИГЕ *ЦЕНТРАЛНЕ СИЛЕ У ПРИРОДИ* БОРЂА СТАНОЈЕВИЋА

Сажетак. У овом раду представљамо једну од првих универзитетских књига из физике написану почетком 20. века. Наиме, реч је о књизи професора Ђорђа Станојевића Централне силе у Приподи која је штампана 1906. у Београду. Књига је дигитализована и налази се у Виртуелној библиотеци Националног центра за дигитализацију (Virtual Library, <u>http://elibrary.matf.bg.ac.rs/</u>).

Кључне речи: Централне силе, магнетно поље, електрично поље, Станојевић

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