

ASTRONOMICAL SUBJECTS IN THE PHYSICS TEXTBOOKS IN THE SECOND HALF OF THE 19TH CENTURY IN SERBIA

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Abstract. A review is given of the astronomical subjects contained in the physics textbooks in the second half of the 19th century in Serbia. The review covers 30 textbooks for the secondary schools and the schools for advanced education. It has been established that astronomy, within the educational system in Serbia in the period concerned, was taught mainly within the courses of physics and geography.

1. INTRODUCTION

During the first half of the 19th century foundation was laid in Serbia for the development of natural sciences: astronomy, physics and meteorology. In the second half of that century social conditions were created which made it possible to follow the European scientific thought. Exactly in this period the astronomy experienced its all-out advancement, which continued steadily into the 20th century. Astronomical subjects were dealt with within the scope of physics, geography, geodesy and meteorology, the book of purely astronomical contents having also been published.

In his public lecture "On Cosmos" held at the Grand School (University) in Belgrade in 1889, professor Milan J. Andonović held forth: "The science of the Universe is a progressive science. It advances from day to day, its contents grow, results it achieves get more complete and more accurate every day. The science of the Universe as a natural science puts and leads the man into the nature. It elevates and makes lofty by its very substance everyone engaged in it and by putting him into the nature it provides him such a standpoint at which natural, healthy and true understanding of things is only possible".

"Not a single pupil, not a single, even a little educated man, and not a single teacher in particular, may be ignorant of the science of Universe".

"Those not cultivating the natural sciences, those not interested in them, are below that level on which the progress is possible at all..."

More serious educational policy opens on 23 September 1844, when "Organisation of Public Teaching" was enacted, providing for, among other things, teaching of mathematical and physical geography in primary schools, the astronomical matters being dealt within their framework. Later on, the "Organisation of Primary Schools" from 1857 and "Law on Organisation of Primary Schools" from 1863 also provided for teaching of the subjects indicated.

As for secondary schools the teaching programme envisaged also astronomy with mathematical geography and meteorology, alongside some fields of physics. By the modified "Law on Organisation of Secondary Schools" from 12 December 1873 it was regulated geography to be taught conjointly with cosmography. Subsequently, in 1884, by a regulation by "Ministry's Council for Education" the cosmography was separated from geography. From 1898 on, the "Fundamentals of Astronomy" enter into the framework of physics, a reference to which is found in the foreword to the textbook "Physics for Higher Classes of Secondary Schools" by Johman and Hermes, wherein the translators Borisav B. Todorović and Vladimir Zdelar write: "In the course of printing of the present book the teaching plan and programme for the secondary schools were changed and therefore Mr. Minister for Education regulated the "Fundamentals of Astronomy" to be incorporated into this book, which we subsequently translated".

From 1866 on the mathematical and physical geography was envisaged for the "Higher School for Women" and from 1879 on cosmography was taken out, being taught in the framework of physics.

Cosmography was taught also at the Military Academy.

With such a programme in the educational system a great role and significance belonged to the textbooks. Some of their editions are exceptionally conceived, containing many illustrations and tables, constituting veritable editorial achievements of that time.

In the present paper the author will dwell solely on astronomical contents in the textbooks of physics.

2. ASTRONOMICAL SUBSTANCE IN THE TEXTBOOKS OF PHYSICS

Perused were 30 textbooks of physics from the second half in the 19th century, astronomical contents having been found in 22 of them.

"Physics for Higher Classes of Secondary Schools" by Dr A. Handl, professor of physics at the university of Chernovice (translated upon author's permission by Djordje. P. Roknić, professor at the III Belgrade Gymnasium and Djura Milijašević, director of the same Gymnasium), with 208 wood engravings, Belgrade, 1892" in its Eight Section (pages 322 to 334) includes "Fundamentals of Astronomy". The following items are dealt with: "349. Celestial sphere horizon; 350. Equatorial coordinate system; 351. Diurnal motion of stars; 352. Determination of meridian and the polar altitude; 353. Annual motion of the Sun; 354. True and mean solar time; 355. Ecliptical coordinate system. Motion of the vernal point. Year; 356. Fixed stars; 357. Planets; 358. Comets; 359. meteors; 360. The Moon; 361. The Earth; 362. Foucault's experiment with the pendulum; 363. High tides and low tides; 364. Density of the Earth."

"Physics for Higher Classes of Secondary Schools" by Johman and Hermes, translated by professors Borislav B. Todorović and Vladimir Zdelar (Belgrade, 1898), contains 6 sections of physics and 5 sections of "Fundamentals of Astronomy" and mathematical geography. Within the latter dealt with in detail on 82 pages are: Earth's

rotation on its axis; Solar system: the Sun, Planets, the Moon. Satellites of the planets, Comets, Meteors; Fixed stars."

In the Third Section of the book explanation is given of the basic notions of the mathematical geography (Equator, Poles, Parallel circles, Meridian, Geographical longitude and latitude, diurnal and annual times).

In the part relating to physics, in the section "Mechanics" dealt with are: "Laws of central motion; Effects of the Earth's rotation on its figure and its gravity; gravitation or universal attraction; Planetary motion (Kepler's laws). In the Fourth Section "Optics or Theory of light" specially elaborated are subjects concerning telescopes (illustrated by Figures 134 to 139): "1. Astronomical and Keplerian refracting telescopes; 2. Terrestrial telescope; 3. Hallandian or Galilean telescope;" thereupon considered are "Newtonian, Gregorian, Herschelian and Rosse's refracting telescopes". In the same section there is a reference to the Roemer's determination of the velocity of light by means of transits of Jovian satellites (illustrated in Fig. 93).

"Physics. Notes From Lectures given to my Students, written by Borisav Bogić, professor at the teacher-training school, temporary professor at Theological School and the Higher School for Girls, member of the Standing Commission for phylloxera and extraordinary member of the Main Council for Education - second complemented and remodeled edition (Belgrade, 1886)" in its second part contains cosmography outlined by: "I. the Earth and the Moon: 1. Telescope; 2. The figure of the Earth; 3. The rotation of the Earth on its axis; 4. Earth's revolution around the Sun; 5. the Moon; 6. Time and the Calendar; II. Solar system: 1. The Sun; 2. Planets; III. The Earth and physical phenomena."

In Part II "The Light and Optics" the author writes about the eclipse, about the notions such as the day and the night, the seasons, the phases of the Moon, the velocity of light and the photometry".

In his "Approach" to "Physics for the Upper Classes of Secondary Schools" elaborated by Stevan Milovanov, supported by Royal Hungarian Ministry and Parliament's Council in Novi Sad (1897) included into physics is also "Cosmic physics" or "Cosmography" which, by its physical laws "explains the phenomena in the sky and the atmosphere, being therefore divided into astronomy, concerned with the phenomena in the sky and meteorology, dealing with the phenomena in the atmosphere". The textbook, on pages 261 to 308 in section XIV, presents "Fundamentals of Astronomy" in paragraphs: "260. Apparent diurnal rotation of celestial sphere; 261. Horizontal and equatorial systems; 262. Geographical longitude and latitude; 263. Distance of two places A1 and A2; 264. The figure of the Earth. Its dimensions; 265. The Earth revolving on its axis - it rotates; 266. The Sun's apparent motion during a year; 267. The connection between the horizontal and the equatorial systems and between other astronomical quantities; 268. Zodiac; 269. Ecliptical system; 270. The connection between the ecliptical and the equatorial systems; 271. The consequences of the Earth's revolving around the Sun and of constant inclination of its axis; 272. The Earth's distance from the Sun; 273. The time; 274. The Calendar; 275. Precession and nutation; 276. The planets; 277. Planetary system. Individual planets; 278. The Sun; 279. The stars; 280. The Moon. The moons; 281. Meteorites and the fiery balls". Only five illustrations are given within these paragraphs.

In the "Approach" to "Experimental Physics for the Students of the Faculty of Philosophy and the Faculty of Engineering", (Belgrade, 1897), Dj. M. Stanojević, professor at the Belgrade Grand School, states: "At astronomical observations notes are taken, as accurate as possible, of the positions of individual stars in the sky at particular times. By so doing continually since the earliest time until our days we learned how the stars are moving. From these notes we are able to determine the positions of a star after a certain time. We are able to determine with certainly and highly accurately when eclipses of the Sun and the Moon will take place..." In further presentation the author gives in condensed from the essentials of the theoretical astronomy.

In the Second Part of the textbook detailed account is given of the instruments and the accessories, among others also of those used in astronomical observations (eye-piece micrometer, micrometric screw, levels).

In the Third Section, on pages 99 to 104, there is the section "I. The Time" with paragraphs §111 and §112. "The difference between the sidereal and solar days, §113. "About the equation of time", §114. "The year" (referring to the solar tropical year) and §115. "About Julian and Gregorian calendars". There follows the section about the accurate time measuring (the clock, the chronometer, the chronograph, the chronoscope).

On pages 120 to 125 of the section "Paths and Velocity of Motion" there are interesting examples of the "observed velocities" in nature of which 80 are taken from astronomy.

In his inaugural lecture "Energy in the Universe and Modern Physics" delivered on 22 September 1897 on the occasion of his accession to the chair of physics at the Military Academy in Belgrade, professor Stanojević spoke among other things about the spectral analysis: "Immediately upon the discovery of the spectral analysis the foremost concern was the investigation of the spectrum of the Sun" and about the photography of stars: "The most tremendous task the photography has to accomplish in the sky is the photographing of the entire sky and the photographic construction of celestial maps".

"Natural science or Physics for the Young - Serbianized by Konstantin Branković - regular member of the Society of Serbian Consciousness (Beograd, 1850)" - a small booklet of 62 pages of pocket format - contains on 6 pages explanation of "Bodies in Universe", meant thereby the Sun, the Moon and the stars (Earth included). About the planets known by that time the author writes: "Revolving around our Sun are so far known eighteen planets: Mercury, Venus, Mars, Flora, Vesta, Iris, Astrea, Metis, Junona, Heba, Ceres, Palada* (* all of these minor planets between Mars and Jupiter are extremely small, being termed asteroids. The last of them, not adduced here, was discovered in 1849, is still without a name), Jupiter, Saturn, Uranus and Neptun". The comets are mentioned too: "... besides ordinary planets there are also comets or tailed stars".

The book "Principles of Physics for my Students and Self-educated Men" written by Vuk Marinković "medical doctor and professor of physics at the Serbian Princedom's Lyceum, regular member of the Society of Serbian Consciousness" edited in Belgrade in 1851 in two parts: "First Half - about the measurable and unmeasurable stuffs" and "Second Half - about the natural large scale phenomena". In the Second Half

there is on 66 pages (a fourth of the volume) a more comprehensive astronomical content in the section "Physical Astronomy". The two remaining parts are related to the "Physical Geography" and "Meteorology".

"Physical Astronomy" comprises 11 sections: "Celestial bodies in general; Diurnal motion of celestial sphere; The form and the size of the Earth; apparent motion of the Sun and annual motion of the Earth; The planets and their motion around the Sun; The motion of satellites and the eclipses; Tailed stars and their motion; Closer observation of the Sun and the planets; The cause of the planetary motion; Fixed stars; The size of the Universe"

An exhaustive description of telescopes is given in the section "On the light" of the first half of the book, on pages 338 to 347, while on page 292 an interpretation is found of Roemer's determination of the velocity of light by way of Jovian satellites.

The book "Physics for Women", "arranged" according to Evdjenije Netoločki by E. Joksimović, published in Belgrade in 1866, is pocket-sized, comprising 270 pages. A presentation of the telescopes is given in §60 on pages 201 to 204, without illustrations.

Presentations only of telescopes and the velocity of light are also given in the following books:

"From the Theory of Light" by Dj. M. Stanojević, Serbian Literary Cooperative" (Belgrade, 1895);

"Fundamentals of Physics for Secondary Schools - written by Mita Petrović (with 74 illustrations), third improved edition, Pančevo, 1885";

"Fundamental of Physics for High People's Schools, Girls Schools and related Institutions - written by Mita Petrović (with 47 illustrations), Pančevo, 1876";

"Popular Physics for Secondary Schools by Gosen, Belgrade, 1873";

"Physics for Lower Gymnasium Schools and Every Friend of Natural Sciences - written by Damjan Pavlović, printed in the State printing House in Belgrade, 1872";

"Physics for Lower Classes of Secondary Schools by Vasmut, translated and adjusted for our schools by V. Zdelar, professor at the I Belgrade Gymnasium, second improved edition, Belgrade, 1897";

"Physics, written by Balfur Stewart - professor of physics in Manchester, translated by Steva V. Popović, eparchial school administrator (with 48 illustrations), Novi Sad, 1879";

"Lessons of Physics by Dukić Milan D., Belgrade, 1896".

Professor Jelenko Mihajlović, assistant at the Observatory of Grand School writes in the textbook "Physics with the Elementary Notions of Chemistry - the subject adjusted according to the programme for civil girls schools for 1st class, Belgrade, 1899" in the framework of 9th Discourse ("Something from the theory of light") on eclipses, on the notions of day and night as well as on the velocity of light propagation.

In the book "Experimental Physics with a Short Review of Meteorological Phenomena, translated by Svetozar D. Vidaković, professor, published by the State Printing House in Belgrade, 1876" in Chapter II "Universal Attraction" the law of gravitation is interpreted in this way: "Universal attraction is a force making for all bodies in the Universe continuously tending to each other".

The book "Physics for Primary School Teachers, prepared by Nikola J. Petrović, (with 50 wood-engraved illustrations), printed in the State Printing House in Belgrade,

1874" is a manual for teachers, precedence being given by the author to the teaching with visual aids. On page 45 in the section dealing with the light, the author writes about what is necessary for such teaching: "1. Two candles, 2. Matches, 3. Two apples or quinces, 4. A piece of glass, 5. A piece of mirror, 6. A bottle full of water, 7. Spectacles". Thus, easily reachable things are suggested by the author for teaching with visual aids.

3. CONCLUSION

In view of the editions issued in Serbia in the period here considered it may be concluded that a great deal of attention was paid to natural sciences. Particularly the progress of astronomy was followed with singular enthusiasm by a great number of educated men of that time. Astronomical contents are mostly presented in the textbooks of physics and geography, along with those dealing with the related fields of geodesy and meteorology. There were also separate editions with purely astronomical contents.

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