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COLLECTIONS OF ASTRONOMICAL PROBLEMS IN SERBIAN

Abstract. The very low, i. e. insufficient, presence of astronomy in secondary schools is evident. In order to improve the knowledge level of secondary school pupils and also to enable them to be prepared for contests inside Serbia and international ones as well as possible, the National Astronomical Olympiad Committee (NAOC) has been organising preparations as an astronomy extra-teaching. Since the proper literature, especially collections of problems, in Serbian do not exist, an effort has been done to fill these gaps, at least, partially. For that purpose the NAOC members have translated from Russian and English the most important collections and textbooks to make an easier unattended work of the pupils. An overview of the translated literature with accompanying commentary and content is given.
Key words. astronomy contests, collections of problems.

1. Introduction

The National Astronomical Olympiad Committee (NAOC) has been organising preparations in the form of an extra-teaching, i. e. preparing of secondary school pupils for contests in astronomy [1,2]. The reason is that the very low, in fact, insufficient presence of astronomy in secondary schools is evident, as well as that interested pupils are left to themselves. In order to improve the knowledge level in astronomy of secondary school pupils and make their preparedness level for both national and international contests as high as possible, sources, from which they would learn and prepare themselves unattendedly, as well as test their knowledge, are necessary. Since there had been almost no literature, especially collections of problems in Serbian, an effort was done to fill these gaps, at least partially. To this end the NAOC members have translated from Russian and English the most important problem collections and textbooks in order to facilitate unattended work to the pupils.

In what follows we present five collections of solved problems of astronomy and astrophysics published between 2014 and 2019, as well as one university textbook published in 1998. Clearly, in the meantime many university textbooks have been published, but this is important because it largely deals with spherical astronomy which appears as a problem to our pupils. Each reference is followed by a short comment, bibliographical and catalogue descriptions of the translation and original are given, too.

2. Collections of problems

The collections are presented in the order methodologically most suitable for unattended work.

1) Astronomy: A Collection of Problems and Practical Exercises by V. A. Vorontsov-Vel'yaminov; translated from Russian by Stevo Šegan and Slobodan

Ninković Belgrade: Društvo astronoma Srbije 2017 – II. 216 pages: illustr. 25 cm. ISBN 978-86-912445—4-5. The source: *Сборник задач и практических упражнений по астрономии* / Воронцов - Вельяминов Борис Александрович – Москва: Наука, 1977, 271+[1] стр. с 12 стр. илл. ; 21 см.

The first collection presented here had its first edition long ago, in 1939 (Boris Aleksandrovich Vorontsov-Vel'yaminov 1904-1994). Although this took place more than eighty years ago during which time astronomy has had and intense development and yielded great both observational and theoretical results, according to our information, the world still lacks a more complete and methodologically better conceived collection of problems, which from the standpoint of logical deducing and concrete numerical computations would so well comprise all astronomical fields on the secondary school level based on technical and scientific fundaments. Every chapter is preceded by a short theoretical review with the corresponding definitions and formulae and concerns a different field. Only some of them are mentioned here: Celestial Sphere, Systems of Celestial Coordinates Culminations of Celestial Bodies, Refraction, Apparent Motion of the Sun, Time and Geographic Longitude, Calendar, Rising and Setting of Celestial Bodies, Precession, Tasks including Celestial Globe, Motion of the Planets, Parallax and Aberration, The Earth, Motion of the Moon and its Phases, Eclipses, Gravitation, Astronomical Instruments and Methods, Moon, Planets, Comets, Meteors and Meteorites, Sun, Motion and Structure of Stars, Double Stars, Variable Stars and Novae, Structure of the Universe, Astronautics, etc.

Also, the problems are divided in two "rings" where for those of the first one knowledge from the framework of secondary school curricula, whereas those of the second one are more difficult, but the knowledge levels from mathematics and physics needed for their solving seldom go beyond elementary trigonometry and physics. According to the data of site http://www.astronet.ru/db/msg/1196500 in Russia the seventh edition was published in 1997. It has been translated into English, French and Spanish, and now we have it in Serbian!

2) Astronomy Olympiads: Problems with Solutions by V. G. Surdin; translated from Russian by Sonja Vidojević - Belgrade: Društvo astronoma Srbije 2017 – XX. 206 pages: illustr. 24 cm. ISBN 978-86-912445—3-8.The source: *Астрономические олимпиады : задачи с решениями* / Сурдин Владимир Георгиевич – Москва: Учебно – научный центр довузовского образования МГУ имени М. В. Ломоносова, 1995, 321 стр. илл.: 24 см, ISBN 5-888000-009-4.

This is another pearl from the treasury of the Russian astronomy literature. The preparations of the pupils for any astronomy contest level, both national or international, cannot be imagined without the collection by Surdin – collection of problems now available to teachers and pupils in Serbian. The book contains about 450 best problems from Astronomy Olympiads taking place in Moscow from 1947 together with comprehensive solutions and explanations Practical astronomy, astrodynamics, astrophysics, planetology and astronautics are the main fields contained in the collection. All solutions presented by the author often complete and even correct the classical solutions. The knowledge level required at an Olympiad exceeds the average one so that some problems will involve a hard work. The majority of problems contain a hidden hint. Therefore, there is no need to hurry up with the answer, even if the solution at first glance seems simple. Due to the courtesy of the author - Vladimir Georgievich Surdin (b. 1953) - we were allowed to translate his collection and we are proud to say that, following the author's words, Serbian was the first language into which it was translated. Afterwards it was also translated into English. The correspondence with the author (http://lnfm1.sai.msu.ru/~surdin/) was done by e-mail during 2015/2016.

3) Zadaci iz astronomije i astrofizike: zbirka zadataka sa Međunarodne olimpijade iz astronomije i astrofizike (2007-2012) edit. by Aniket Sule; translated from English by Sonja Vidojević - Belgrade: Društvo astronoma Srbije 2014 (Beograd – Instant System) – XXI. 182 pages: illustr. 24 cm. ISBN 978-86-912445—2-1.The source : *A Problem Book in Astronomy and Astrophysics : Compilation of Problems from International Olympiad on Astronomy and Astrophysics (2007-2012)* / Aniket Sule, editor - Suceava: Cygnus, 2014 – XVII. 236 pages: illustr.: 24 cm, ISBN 978-973-1768-60-1.

The International Olympiad on Astronomy and Astrophysics (IOAA) was held for the first time in 207 in Thailand. In this year (2023), in August, in Poland the XVI IOAA was held. The collection contains the problems from six Olympiads held between 2007 and 2012 (Thailand, Indonesia, Iran, China, Poland and Brazil). The IOAA International Board obliged Aniket Sule, team leader from India, to collect all the problems and prepare them for publishing. This resulted in a book entitled "A Problem Book in Astronomy and Astrophysics", which was very soon translated into Serbian – was published in 2014. The problems cover seven fields in accordance with the Olympiad Syllabus: 1) Fundaments of Astrophysics; 2) Coordinates and Time; 3) Solar System; 4) Stars; 5) Stellar Systems; 6) Cosmology; 7) Instruments and Cosmic Technology. They are distributed within more particular fields: Celestial Mechanics, Coordinate Systems, Positional Astronomy and Time, Optics and Detectors, Physics of Stars and Planets, Observations of Stars, Double and Variable Stars, Galactic Astrophysics, Extragalactic Astrophysics and Observations of Sky. Each of them consists of three parts: theoretical one, data analysis and observational part. At the end of the text of every problem there is a designation (e. g. I10-T16-D) which indicates the year when the problem was given, its second part indicates the contest round – theory (T), data analysis (D) and observations (O) followed by the problem number. The last letter indicates the complexity degree of the problem, according to the editor's estimate, this degree increases from A to D. The collection contains a list of constants and useful mathematical formulae. This material during the contest is given to every contestant together with the text of problems. There is also an appendix containing the Olympiad programme.

4) Zadaci iz astronomije i astrofizike: zbirka zadataka sa Međunarodne olimpijade iz astronomije i astrofizike (2007-2014) edit. by Aniket Sule; translated from English by Sonja Vidojević - Belgrade: Društvo astronoma Srbije 2019 (Beograd – Instant System) – XXI. 245 pages: illustr. 24 cm. ISBN 978-86-912445—8-3. The source:*A Problem Book in Astronomy and Astrophysics : Compilation of Problems from International Olympiad on Astronomy and Astrophysics (2007-2014)* / Aniket Sule, editor - Hyderabad: Universities Press India, 2015 – XVII. 236 pages: illustr.: 24 cm, ISBN 978-817-3719-80-6.

Here everything what is said under number 3) is applicable. Only one to add is that this collection includes two Olympiads held afterwards – in 2013 in Greece and in 2014 in Romania. The editor, Aniket Sule, wrote in the preamble of the English edition: First edition: July 2014 Updated edition: July 2015". Therefore, this collection may be regarded as an extended version of the previous one.

5) Astrofizički zabavnik (Astrophysical Entertainment Book): *zadaci i vežbe iz astronomije i astrofizike* (*problems and exercises from astronomy and astrophysics*): *nastavno-metodički priručnik* (*teaching-methodological handbook*) / edit. by I. A. Uteshev, translated from Russian by Sonja Vidojević - Belgrade: Društvo astronoma Srbije 2019 – 161 pages: illustr. 24 cm. ISBN 978-86-912445—7-6. The source: *Астрофизический дивертисмент : Задачи и упражнения по астрономии и*

астрофизике / Под ред. И. А. Утешева. – Москва : ООО «Сам Полиграфист», 2018. – 154 стр.: илл.: 24 см. ISBN 978-5-00077-697-1.
The translator, also team leader of Serbia, Dr Sonja Vidojević got a copy of Entertainment Book in Russian during the XII IOAA (Beijing, 2018) by the editor in person followed by the copyright for Serbian translation. The Entertainment Book was published in Russian in 2018 and already in the subsequent year (2019) it was published in Serbian.

The title of this collection is interesting, but anyone who takes it literally will be disappointed. The problems comprised by this collection are largely those which were created at special centres and camps organised for the purpose of preparations of talented pupils for contests. The most successful pupils are concentrated twice a year in Saint Petersburg. Parallelly with this concentrating schools of astronomy, among others, also led by the Entertainment Book editor are organised. Selected problems from international contests are also included. The problems are conditionally distributed into seven parts. Some of them are followed by exercises to be solved unatendedly. Among them there very difficult ones, even for a professional. "Entertainment" will be only to those who are curious enough and ready to take adventure of finding a solution to most distinctive astronomical problems and questions. Such readers will enjoy and really find entertainment in the solving and discovering the mysteries of the Universe. Entertainment can be also reflected in the fact that every problem is named so that the reader can guess the topic; for instance Phantom Star, A Small Weir in Fog, Crimson Horror, Alcohol in Cosmos, Forbidden Zone, etc.

A special curiosity is that the Entertainment Book editor Ivan Aleksandrovich Uteshev got the first gold medal for Russia only in 2015 at the IX IOAA held in Indonesia, though Russia had taken part in IOAA six times before, but without any gold medal.

Then a textbook:
1) Astronomija, klasika u novom ruhu (Astronomy, the Classics in New Clothes) / by Robin M. Green : translated from English by Stevo Šegan, Nadežda Pejović and Zlatko Ćatović – Belgrade VESTA Company, 1998 – IX. 398 pages : ill. : 24 cm. ISBN 86-7212-009-4. The source: Spherical Astronomy / Robin. M. Green : Cambridge University Press. 1985 – 536 pages : ill. : 24 cm. ISBN 0-521-31779-7.

The textbook is foreseen for undergraduate students, but because of using a sufficiently simple mathematical apparatus it can be also used by those who are not professional astronomers, a preknowledge of classical astronomy is not necessary.

In the middle of the last century an abrupt rise of observational instruments took place and accuracy of 1 arcsecond in earlier positional measurements of celestial bodies was quite sufficient to classical techniques of spherical trigonometry. However, due to the accuracy improving these techniques became imprecise so that their revision and modernisation were required. In that time it was also planned to introduce a new system of astronomical constants. This procedure required adoption of a new standard equinox, as well as of a new fundamental star catalogue. The most important was recognising the fundamental significance of relativity in positional astronomy. This new situation is reflected in the Astronomical Almanac which was completely revised in order to bring into accordance the data with the new and more precise measurements which attained an accuracy of 0.001 arcseconds. Radio telescopes (e. g. Very Long Baseline Interferometry, VLBI) provide positions with 0.001 arcseconds accuracy, whereas the optical methods can offer a comparable resolving power. The old classical methods were no longer adequate for the necessities of modern astronomy so that astronomers had to learn anew the fundaments of positional astronomy. However, a written material

which could serve as an introduction into the modern precise astrometry did not exist. The book by Green has excellently accomplished this role. Its first edition was entitled *Spherical Astronomy* / Robin M. Green : Cambridge University Press, 1985 – 536 pages: illustr.: 23 cm. In 1988 and 1993 reprints appeared, in 1999 it was digitised.

The first three chapters are devoted to the basic fundaments: mathematical techniques and formulae, coordinate systems and reference frames. The chapters to come deal with refraction, aberration, annual parallax, precession, nutation, proper motion, astrophotography, radio astrometry and others. An entire chapter is devoted to the tensor calculus because of its use in the calculation of relativistic effects. Every chapter contains examples and problems the purpose of which is to improve the reader's understanding of the matter.

For the sake of completeness we also mention two university collections, more precisely a single collection consisting of two different parts.

1) Zbirka rešenih zadataka iz opšte astronomije (A collection of solved problems) : First part / Vojislav Mišković – Beograd: Naučna knjiga, 1956 (Beograd : Grafičko preduzeće "Akademija") – 150 pages : illustr.: [24] cm.

2) Zbirka rešenih zadataka iz opšte astronomije : Second part - / Vojislav Mišković [a manuscript].

The first part of this collection was printed in 1956. For the second part the author's

intention was to print it by the beginning of the subsequent semester of that academic year. Unfortunately, this has not been done, even till today. The author gave detailed instructions how to form a single collection from this material. This work would need an enthusiast. Though almost seventy years has passed from its first edition, the contents of the book is still of interest. The problems cover six different topics out of which I. Spherical Trigonometry, II. Earth as a Celestial Body, III. Apparent Diurnal Motion of the Celestail Sphere belong to the first part, the other ones: IV. Astronomical Refraction, V. Elements of Theory of Planetary and Cometary Motion and VI. Apparent Annual Motion of the Sun belong to the second part.

Thanks to Prof. Nadežda Pejović [3,4], who taught at the Astronomy Department of the Faculty of Mathematics (Belgrade University) the subject of General Astronomy for years, this entire material was rescued from oblivion. Namely, it has been digitized and its PDF can be downloaded from the Electronic Library of the Faculty of Mathematics at the following site: http://elibrary.matf.bg.ac.rs/handle/123456789/650 . The electronic library contains surpassingly great collection of astronomical units. Anyone can find there something for himself. Much better is the fact that they could be downloaded for free. You can search until you find what you want, the address is http://elibrary.matf.bg.ac.rs/ .

3. Conclusion

Lack of astronomical literature, especially collection of problems, in Serbian had been a big problem for talented pupils because astronomy has been almost only formally present in the curricula of schools. Bearing this in mind an action was undertaken by NAOC which resulted in five collections of astronomical problems translated from Russian and English within a relatively short time interval. The work on an original collection (not a translation) is currently carried out. Its temporary title is Methodic Collection of Astronomy Problems and it is foreseen to contain many new problems and exercises. Composing problems is a responsible and hard work. First of all, the author should be familiar with astronomical facts, to possess teaching experience, as well as experience in organising and carrying out astronomical contests. The text of a problem

must be very clear, also correct grammatically and physically; the usual standards concerning the mathematical apparatus must be followed and the problem itself must be solvable within a realistic time interval. There are other details which should be taken into account. A thorough testing of the solution also requires a lot of work, because in spite of the author's endeavour to avoid the possibility of alternative solutions, not rarely there have been contestants capable of finding another correct solution (different from the official one), which leads to difficulties for the jury.

At the end to say: "A duly posed question – half answer".

4. Literature

The most comprehensive list of references concerning contests in astronomy can be found in:
[1] Sonja Vidojević, Vera Prokić, Slobodan Ninković and Branko Simonović: Serbia in Astronomical Contests between 2017-202, Proceedings of the XIX Serbian Astronomical Conference, Belgrade, October 13-17, 2020.
[2] Sonja Vidojević, Slobodan Ninković et al.: Dodatna nastava i takmičenja iz astronomije 2017. i 2018. Zbornik radova „Razvoj astronomije kod Srba X", Beograd, 21-26. april 2019.
[3] Nadežda Pejović and Žarko Mijajlović: Early Astronomical Heritage in Virtual Library of Faculty of Mathematics in Belgrade. NCD Review,19(2011), 11–25.
[4] Nadežda Pejović and Žarko Mijajlović: Digitized Works of Academician Vojislav Mišković. NCD Review, 15(2009), 8–8.

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