

## ASTRONOMY EDUCATION IN FR YUGOSLAVIA

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General Information. Astronomy education in Yugoslavia follows the pattern of education in general: it is a subject upon which each republic decides independently. Generally, astronomy education has longer and larger tradition in Serbia.

Historical Development. Astronomy education was following progress in general teaching. In Serbia, elements of astronomy were taught in elementary schools, within mathematical geography, since 1844, although in a very limited amount. More was taught in secondary schools: in Gimnazija in Sremski Karlovci since 1791, in Gimnazija in Novi Sad since 1816 and in Liceum in Beograd since 1839. Astronomy was often called cosmography then. There was a lot of changes in teaching plans later but, nevertheless, Serbian pupils were never left without elementary astronomical contents.

Recently, educational reformation of 1969 introduced astronomy as a separate subject in the fourth year of secondary schools oriented to mathematics and natural sciences, with one lesson weekly. Reformation in 1978 allocated 2 lessons weekly to astronomy in the same type of schools. Reformation in 1987 did not change substantially teaching of astronomy; it was mainly concerning classification of schools.

The real and unfortunate change came in 1990 when astronomy was joined to physics with only one lesson weekly. It lost its independence, the program got to be shrunk and the position of astronomy teachers worsened considerably. Astronomers and physicists tried to stop such a law, but in vain.

The textbooks of astronomy for secondary schools in this period have been written mainly by Serbian writers; only one was translated.

It is very likely that some astronomical subjects were taught at the High School from its foundation in 1863. Several higher level textbooks ("Cosmometry" and "Cosmography" by Jovan Andonovich) and papers of Serbian writers witness it. The first professor of astronomy and meteorology on the High School was appointed in 1884. It was Milan Nedeljkovich who got an up-to-date astronomy education spending several years at the Paris observatory. He founded the Astronomical observatory in Belgrade in 1887. Soon after the foundation of the University of Beograd in 1905, astronomy education was improved by Milutin Milankovich who was appointed as the professor of applied mathematics and the director of the Department of rational mechanics, theoretical physics and celestial mechanics in 1909. Astronomy was separated for the first time as a study group in 1925-1927 due to the initiative of profesor Vojislav Mishkovich. Foundation of the Faculty of sciences in 1947 brought new changes in organization of teaching of astronomy. In 1951 the Department of mechanics and astronomy was founded and in 1962 the Department of astronomy became independent. Astrophysics started as a teaching subject at the Department of physics in 1954 and in 1958 was shifted to the Department of mechanics and astronomy. First doctoral theses in astronomy at the University of Beograd were defended in 1956. The postgraduate studies in astronomy and astrophysics were introduced in 1966. The Department of astronomy transformed into the Institute of astronomy in 1971.

The major changes in the education plans happened in 1961 when two study groups: astronomy and astrophysics group were introduced bringing many new astronomical subjects and in 1990 when astronomy group oriented their study plans towards mathematics and computer science. About half of the astronomical subjects have been covered with textbooks written by University professors. Some of them still wait publishing.

The amateur Astronomical Society "Ruđer Boskovich" founded in 1934 from the very beginning has worked on public education. It was publishing the popular astronomical journal "Saturn" from 1935 to 1941 and "Vasiona" (Universe) from 1953 till today. It has been also organizing courses, lectures and observations.

Elementary Schools. Elementary school now is a compulsory eight years school. Selected astronomical topics are taught in elementary schools within the course named "Knowledge of Nature" (IV year), within geography (V) and within physics (later than VI). Details can vary from one republic to the other.

Secondary Schools. Secondary school is not a compulsory one. There is a large variety of types of secondary schools. Some of them are very specialized, preparing pupils for the work. Majority of better pupils is likely to choose "gimnazija". In Serbia, "gimnazija" type schools are 27 percents of the total number of secondary schools. It lasts four years.

Astronomy is not a separate course, due to the law passed in 1990; it is incorporated in physics and partly in geography. Astronomy within "gimnazija" is placed into the last year of physics. Number of lessons depends on a model. There are 2 models:

*I* model. (General type)

*II* model.

- a.* Natural sciences and mathematics oriented type,
- b.* Social sciences and languages oriented type.

In the type *I* and *IIb* astronomy is included in physics, in the last year, with 5 lessons (or about 10 lessons if all subjects related to astronomy are counted). In the type *IIa* astronomy is also included in the last year physics but with 32 lessons, out of which 21 are used for teaching of new subjects and 11 are used for repetition and exercises. Schools are allowed to organize astronomy course as a voluntary course, in the last year, with 70 lessons. The course is voluntary in the sense that it represents an extra course which, once chosen, has to be followed by a pupil till the end. Astronomy will be taught according to this law from the autumn 1993.

The textbook for such a program has been prepared by M. S. Dimitrijevič and A. Tomich. It is expected to be printed in spring 1994.

Some elements of astronomy are taught in majority of other types of schools within the II year physics. The suggested subjects are neutron stars, black holes, ideas of the general theory of relativity, the origin and evolution of celestial bodies. In medical schools 3 hours are given to astronomical subjects within physics.

In order to help secondary schools professors to keep in touch with new achievements in astronomy and with ways of teaching astronomy special lectures are presented at regular yearly meetings of professors.

University Education. There are 6 universities in Yugoslavia (in Beograd, Novi Sad, Kragujevac, Nish, Prishtina and Podgorica).

The University of Beograd is the only one which has astronomy as a study group. It has two divisions:

1. Astrophysical department which has a study program containing many courses in physics, two courses in mathematics, some general courses: such as foreign languages, pedagogy etc. and the following astronomical courses: general astronomy (I), general astrophysics (II year), practical astrophysics (III), reduction of astronomical observations (III), theoretical astrophysics (IV), structure and evolution of stars (IV), radio astronomy (IV), stellar astronomy (IV), methods of teaching astronomy and history of astronomy (IV). At the end of the third year students have a summer practice at the Astronomical observatory in Belgrade and during the fourth year teaching practice in the Belgrade Planetarium, University, Youth Research Station in Petnica, popular astronomical journal and secondary schools. Graduated astrophysicists have a right to teach astronomy and physics in secondary schools.
2. Astronomical department has a study program which contains a lot of mathematical courses particularly those related to programming, some general courses (as in the astrophysical department), course in theoretical mechanics (III) and the following astronomical courses: general astronomy (I), general astrophysics (II), positional astronomy (II), practical astronomy (III), reduction of astronomical observations (III), ephemeridal astronomy (IV), theoretical astronomy (IV), celestial mechanics and the motion of artificial satellites (IV) and stellar systems (IV).

Graduated astronomers obtained in 1990 the right to teach mathematics in secondary schools. They have also a right to teach astronomy but not physics what makes their position very awkward.

The undergraduate studies last four years. The average number of graduations is 3-5 per year.

There are 4 divisions on postgraduate studies (M.Sc. courses) at the University of Beograd:

1. Positional astronomy,
2. Astronomy and celestial mechanics,
3. Stellar astronomy,
4. Astrophysics.

The postgraduate studies last two years. A candidate has to pass exams and to do a M. Sc. thesis. The average number of graduations is about one per year.

There is also geodetic astronomy (IV) at the Faculty of Civil Engineering and one semester course of basics of astrophysics (III) for students of the teaching branch on the Faculty of Physics, in Beograd.

Some elements of astronomy are taught within mathematical geography.

Public Education. Public astronomy education in Yugoslavia is done by lectures at popular universities, on Radio and TV programs, in popular journals and books, in Planetariums, in popular observatories and amateur astronomical societies.

A long tradition in organization of lectures on recent discoveries in astronomy has Kolarchev Popular University in Beograd. It organizes every year, since 1964, at least one cycle of astronomy lectures. Particularly active institutions in public education are the Astronomical Society "Rudjer Boshkovich" in Beograd and the

Astronomical Society Novi Sad (ADNOS). Both are amateur societies whose members are professional astronomers as well, helping in popularization of astronomy.

There are two planetariums in Yugoslavia. One in Beograd was officially open in 1970 and had about 225 000 visitors until now. One in Novi Sad is in the phase of installation. The Planetarium in Beograd works mainly with schools. Both planetariums are small Carl Zeiss (Jena) instruments.

An interesting form of astronomical education are courses and summer schools for pupils interested in astronomy. The Youth Research Station in Petnica (founded in 1982) has been organizing 5 courses every year already several years. The first course is an introductory one, the second course is introduction into practical work, the third course is used for work on small research projects, the fourth is devoted to some higher forms of work and on the fifth one the projects are finalized. The best projects are stimulated to be published. The series starts with 50 candidates, number decreasing later to few best participants. The courses last several days (up to 10). The participants come to Petnica after the selection of best pupils interested in astronomy. The Astronomical Society "Rudjer Boshkovich" and ADNOS organize autumn and spring courses (in Belgrade and Novi Sad, respectively) for all who wish to come. Those who wish to become collaborators of the Astronomical Society "Rudjer Boshkovich" have to pass a final examination. There have been 325 of them. The Astronomical Society "Rudjer Boshkovich" organizes also yearly the Belgrade Astronomical Weekend, with lectures, visits to observatories and observations. All the courses are run by the staff of these institutions although professional astronomers often give lectures as well.

There are also some other forms for teaching of astronomy in Yugoslavia. One of them is the regular yearly competition of pupils in tests and astronomical projects within the organization "Nauku mladima" (Science to the Youth). The projects are chosen by pupils while the examining committee consists of teachers and at the higher level of professional astronomers. It started in 1964. More than a hundred thousands of pupils were participating in competition by tests, about 3400 pupils continued doing astronomical projects out of which about 50 were good quality ones. 38 projects have been published in parts or as a whole. There have been other competitions of pupils in astronomy but with much less participants. One organized by Clubs of Young Technicians started in 1986, with a program similar to "Nauku mladima", having 7 -30 competitors yearly. The Union of organization for scientific and technical education of the youth of Serbia published in 1988 a handbook for participants of this last competition.

The Astronomical observatory in Belgrade, the popular observatories of the Astronomical Society "Rudjer Boshkovich" in Beograd and the Astronomical Society Novi Sad, the Belerofont observatory of the Faculty of sciences in Kragujevac and the small observatory of the Youth Research Station in Petnica receive visitors.

The Astronomical Society "Rudjer Boshkovich" publishes a non profit journal for popularization of astronomy "Vasiona". 166 numbers were published in which 23 articles were written by students as a part of teaching practice.

The Youth Research Station in Petnica publishes "Petnichke sveske" (Petnica Notes). There have been 31 numbers printed out of which 15 have been at least partly devoted to astronomical subjects.

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