Astronomy education and popularization in Serbia

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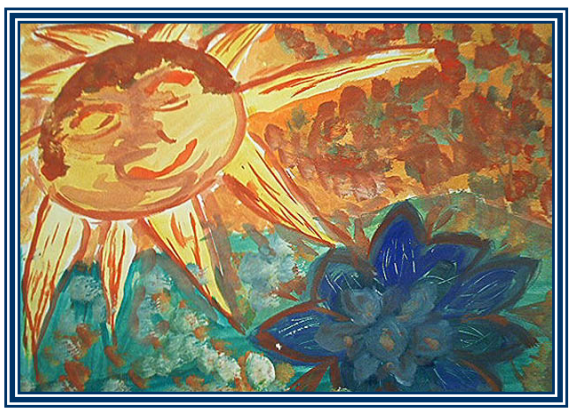
Outline

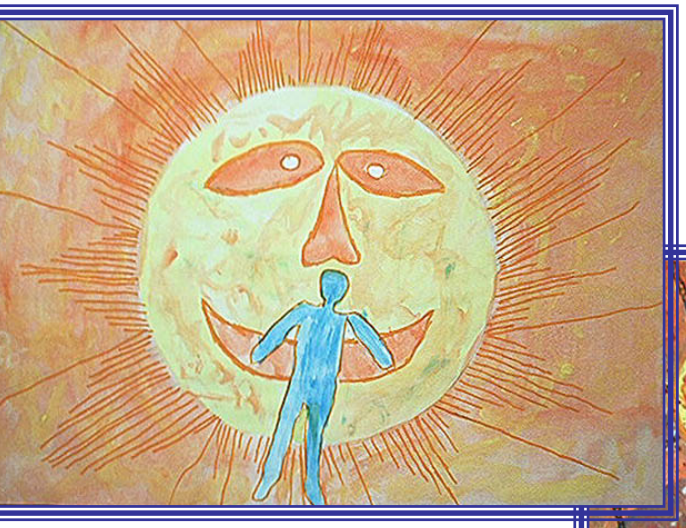
- Elementary and secondary school education
  - Petnica Science Center
  - International Astronomy Olympiad
- University education and research
- Public outreach

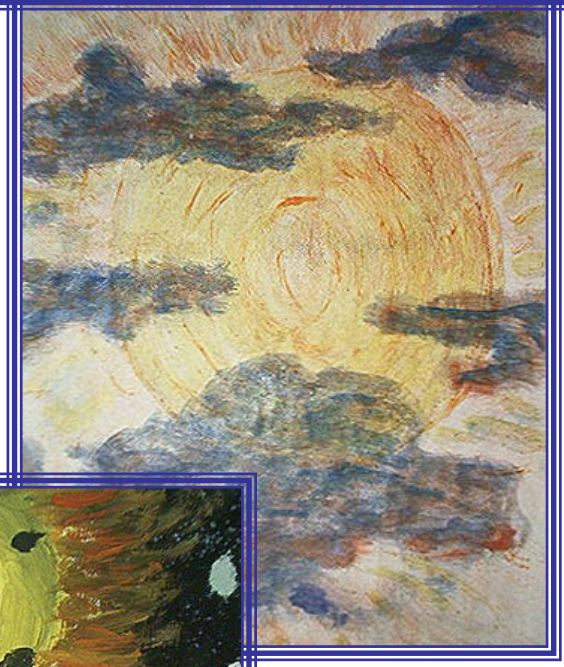
Elementary school education

In the elementary school curricula astronomy topics are taught as part of the courses of Natural History, Geography and Physics.

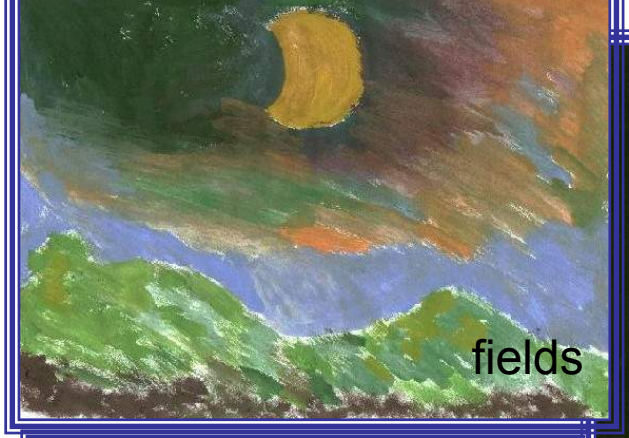


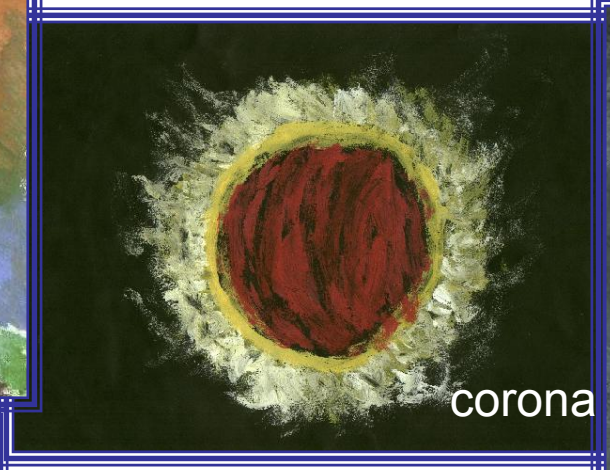
Paintings made by the pupils of the elementary schools in Zrenjanin (Bracić), Pančevo, Kikinda





The Sun – my star!





The total solar eclipse in 1999

Science education at the younger years is crucial for developing scientific literacy among the general population.

Secondary school education

For 25 years (1969 -1994) astronomy was taught as a separate and compulsory, one hour per week, course in the final year of the secondary schools.

Since 1994 astronomy topics have been incorporated within the final year physics courses. Astronomy is taught as a separate course only in the Mathematical High School of Belgrade and in other few high schools in Serbia.

Many attempts have been made to reintroduce astronomy as a separate subject, but still with no success.

Petnica Science Center

http://pi.petnica.rs

PSC is the biggest and the oldest center for extracurricular (informal) education in SE Europe.

Petnica Science Center

Since 1982, Petnica has organized more than 2,500 programs (seminars, workshops, research camps…) for students and science teachers in 15 disciplines of science, technology and humanities.

Majority of programs are designed for secondary-school students although there are a lot of programs for primary-school pupils, university students and science teachers.

Main concept is Learning through Research.

Seven astronomy seminars are held per year, lasting 8 days with about 25 participants on the average. Participants of advanced programs do research projects. The best research works are presented at the conferences and published in "Petnica notebooks".

Goals of PSC programs

- to give the gifted students an intensive extracurricular education,
- to enable students to learn through research and to do scientific projects under the supervision of scientists and science teachers,
- to instruct young science teachers on how to apply up-to-date scientific knowledge, educational methods and technology,
- to initiate co-operation among students interested in different science disciplines and
- to establish rich international and intercultural contacts

International Astronomy Olympiad

Serbian teams participate at two International astronomy olympiads:

- since 2002 at IAO (International Astronomy Olympiad, founded in Russia in 1996) and
- since 2007 at IOAA (International Olympiad on Astronomy and Astrophysics, founded on the initiative of Tailand, Indonesia,Iran, China and Poland in 2007).

- Serbian teams won 6 gold, 14 silver and 22 bronze medals, as well as 2 special prizes and 4 recognitions in total.

International Astronomy Olympiad

year	Olympiad	participants	I diploma (gold)	II diploma (silver)	III diploma (bronze)	special prize+recogn.
2002	IAO	2+0	0	0	2	0
2004	IAO	2+0	0	1	1	0
2005	IAO	2+3	0	0	2	0
2006	IAO	2+3	2	0	2	1+0
2007	IAO	2+3+2	2	2	3	0
2008	IAO	2+3	0	2	3	0
2009	IOAA	4	0	3	0	1+1
2009	IAO	2+2	0	0	1	0
2010	IOAA	5	1	2	1	0+1
2010	IAO	2+3	1	1	2	0
2011	IOAA	5	0	2	1	0+1
2011	IAO	2+1+2	0	0	3	0
2012	IOAA	3	0	1	1	0+1
		total	6	14	22	2+4

University education in astronomy in Serbia

- 1838 - Licej was founded in Kragujevac - teaching of mathematics and physics.
- 1841 - Licej moved to Belgrade
- 1863 – Licej was transformed to Velika škola (the Great School)
- 1884 - astronomy teaching introduced at the Great School when Milan Nedeljković (the first director of the Astronomical and Meteorological Observatory of Belgrade) was elected professor for the courses of astronomy and meteorology
- 1905 - the University of Belgrade was founded (the Chair of Astronomy - within the Faculty of Philosophy)
- 1947 - Faculty of Natural Sciences and Mathematics founded
- 1995 - Faculty of Mathematics (Mathematics, Informatics, Astronomy)

Milan Nedeljković

(1857-1950)

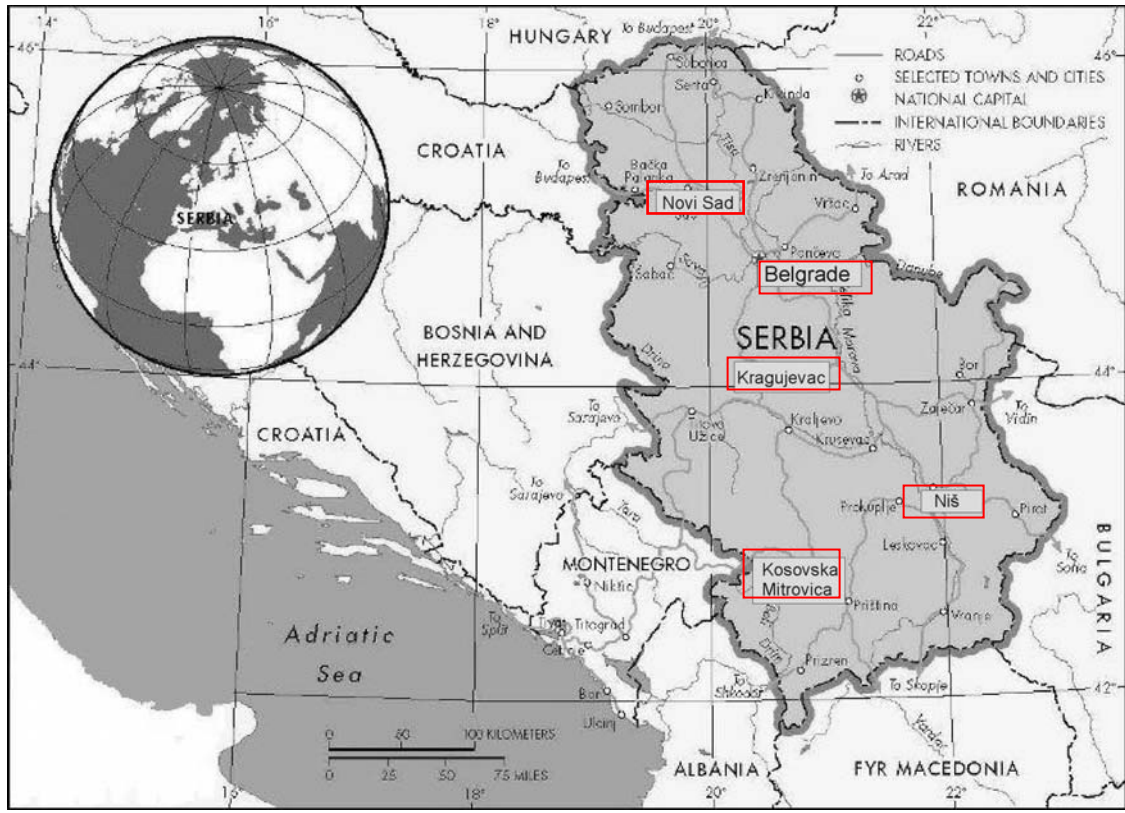
University education in astronomy in Serbia

128 years of Serbian university education in astronomy

Astronomy courses are taught at five state universities in Serbia

- University of Belgrade,
- University of Novi Sad,
- University of Niš,
- University of Kragujevac and
- University of Priština in Kosovska Mitrovica

In 2005, the European Credit Transfer System (ECTS) is introduced and within the past three years the studies have been accredited at all state universities in Serbia.



University of Belgrade

Department of Astronomy (I)
(Faculty of Mathematics)

Since early 1960's students can major in Astronomy and Astrophysics from the first study year (more than 15 one-semester astronomy courses)

So far, from the Dept. of Astronomy:

- **265** students have graduated (46% are women),
- **69** students received MSc degree (39% are women) and
- **42** students received PhD degree (29% are women)

Since 2006/2007 academic year study programs of Astronomy and Astrophysics have been adjusted to the new ECTS. Model 4+1 for the first two degrees (bachelor and master) was accepted.

- **15** students received master degree (60% are women),

The third (PhD) degree consists of elective courses at the first two years and the work on PhD thesis.

Since 2009/2010 the studies have been accredited at the Faculty of Mathematics and the study program ”Astronomy and Astrophysics” changed.

UNDERGRADUATE ACADEMIC STUDIES
ASTRONOMY AND ASTROPHYSICS

3 modules:

- Computational Mechanics and Astrodynamics
- Astrophysics
- Astroinformatics

DURATION: 4 YEARS
Total Number of ECTS: 240

Bachelor in Astronomy

Courses in Astrophysics

General Astronomy A/B

General Astrophysics A/B

Astronomical Data Reduction
Observing Techniques in Astrophysics
Cosmic Electrodynamics

Physical Principles of Stellar Structure
Stellar Statistics
History of Astronomy
Theory of Stellar Spectra
Radio-astronomy
Stellar Kinematics and Dynamics of Stellar Systems
Stellar Evolution
Radio-astrophysics
Teaching of Astronomy

MASTER'S ACADEMIC STUDIES
ASTRONOMY AND ASTROPHYSICS

2 modules:

- Astronomy
- Astrophysics

DURATION: 1 YEAR

Total Number of ECTS: 60

Master astronomer

LIST OF Elective Courses

Introduction to Extragalactic Astronomy

General Theory of Relativity and Cosmological Models

Interpretation of Astronomical Spectra

Interstellar Matter

Theory of the Galactic Spiral Structure

Celestial Mechanics

Internet and Software Packages in Astronomy

PhD STUDIES
ASTRONOMY AND ASTROPHYSICS

DURATION: 3 YEARS TOTAL ECTS: 180

PhD in Astronomy

LIST OF Elective Courses

Special Methods of Reduction of Astronomical Observations

Magnetohydrodynamics

Methods and Techniques of the Sun Observations

Solar Physics

Stellar Atmosphere

Physics of Stars

Astronomical Spectroscopy

Selected Topics of Radio Astronomy

Introduction to the Theory of Relativity

Selected Topics of Extragalactic Astronomy

Active Galactic Nuclei

Classical Cosmology

Selected Topics of Modern Cosmology

Astrobiology

Physics of Interstellar Matter

Evolution of Supernova Remnants

Numerical Methods in the Radiation Transfer

Close Binaries

Dynamic Astronomy

Differential Geometry

Analytical Mechanics

Satellite Astrogeodesy

Stellar Catalogs and Fundamental Astronomical Constants

Theory of the Earth's Rotation

Galactic Astronomy

New Instruments and Methods in Astronomy

Analytical Methods of Celestial Mechanics

Numerical Methods of Celestial Mechanics

Theory of Motion of Artificial Earth Satellites

Binary and Multiple Star Systems

Archaeoastronomy

Dynamics of the Systems of Bodies

Fluid Mechanics

University of Belgrade

Department of Astronomy (II)
(Faculty of Mathematics)

- Organization of the International summer schools in astronomy and astrophysics (2007, 2008, 2010)

- Regular seminars on different topics in astronomy on every second Tuesday during the academic year

- Organization of Astronomy Students Workshops (ASW)

Astronomy Students Workshops (ASWs)

- The Astronomy Students Workshops (ASWs) have been organized since 2007 by the Department of Astronomy in Belgrade, the Department of Physics in Novi Sad and Astronomical Observatory in Belgrade, aimed at improving contacts between the students of astronomy from Belgrade and Novi Sad.

University of Belgrade

Department of Astronomy (III)
(Faculty of Mathematics)

AstroMundus

In 2011/2012 AstroMundus - a 2-year master program in astronomy and astrophysics in the framework of the ERASMUS MUNDUS Programme of the EU (5 universities: Innsbruck (coordinator), Rome, Padova, Gottingen and Belgrade) started in Belgrade.

- Spectroscopy of Astrophysical Plasmas
- Physics of Gaseous Nebulae and Active Galactic Nuclei
- Physics of Interstellar Matter
- Astrobiology
- Line Shapes in Astrophysics
- Introduction to Nucleosynthesis and Particle Astrophysics
- Numerical Astrophysics - Modelling Stellar Atmospheres
- Gravitational Lenses
- Supernovae and Their Remnants
- Serbian as a Foreign Language

University of Belgrade

At the University of Belgrade courses of astronomy are also taught:

- at the Faculty of Mathematics for the students of mathematics and informatics
- a compulsory course ”Introduction to astronomy” (III) for the students of L division (mathematics and informatics teachers);
- an elective course ”Selected topics in astronomy” (IV) for all students of Mathematics;
- two elective courses ”Stellar astronomy” and ”Ephemeris astronomy” (I/II) for the students of Informatics;

- at the Faculty of Physics for the students of physics
- a compulsory one-semester course ”Fundamentals of Astrophysics” at the 1st year of master studies for physics teachers division;
- an elective one-semester course ”Fundamentals of Astrophysics” for the students of the 1st year of B (theoretical) division and for the students of the 2nd or the 3rd year of A (general) division.

- at the Faculty of Civil Engineering for the students of geodesy
- a compulsory course ”Geodetic astronomy” (IV).

University of Novi Sad

- Since 2002/2003 academic year the Department of Physics of the Faculty of Natural Sciences at the University of Novi Sad has founded the astronomy study group simultaneously with the European Credit Transfer System (ECTS). The model 3+1+1 was accepted.

- Since 2008/2009 new accredited studies are of the model 3+2.

- After 3 study years - 180 ECTS (Physicist – astronomer)
- After 5 study years - 300 ECTS (Graduated physicist - astronomer – Master)

- **17** students got 3-years diploma,
- **8** students got 4-years diploma and
- **3** students got master degree.

- At the University of Niš several astronomy courses are taught at the Departments of Physics, Biology and Geography.

  Department of Physics:
  - Undergraduate studies: elective course ”Introduction to Cosmology” (III)
  - Master studies: a compulsory course ”Fundamentals of Astrophysics” (II) for the students of General Physics (the same course is elective for the students (I) of Physics - Informatics).
  - PhD studies: elective courses ”Cosmic plasma” and ”Fundamentals of cosmology”.

  Department of Biology:
  - undergraduate studies: ”Fundamentals of astrophysics with astrobiology” (I)

  Department of Geography:
  - elective course ”Astronomy” (I)

- At the University of Kragujevac - one-semester compulsory course ”Astrophysics and Astronomy” (5th study year)

- At the University of Kosovska Mitrovica - one-semester compulsory course ”Fundamentals of Astronomy and Astrophysics” (2nd study year)

Summer practice / Training in observations at Ondrejov Observatory

- Since 2007 the students of the University of Belgrade and Novi Sad have 3-weeks summer practice in observations and data reduction at the Ondrejov Observatory (Czech Republic).
- Agreement between Ondrejov Observatory and Faculty of Mathematics, University of Belgrade was signed in 2008.
- The students are included in research work at the following four departments: Stellar department (physics of hot stars), Solar physics department (solar flares and prominences), Department for interplanetary matter (asteroids) and Department for galaxies and planetary systems.

2m telescope

Training in observations at the Astronomical Station Vidojevica

Since 2012 students are also trained to use the facilities (60cm reflector) of the Astronomical Station at mountain Vidojevica (Serbia).

Research in astronomy

- Astronomy research in Serbia is mainly performed in two astronomical institutions:
  - Astronomical Observatory in Belgrade (42 researchers)
  - Department of Astronomy, Faculty of Mathematics, University of Belgrade (11+4 researchers)

- With researchers from the Institutes of Physics (Zemun and Vinča), University of Novi Sad, Kragujevac and Niš, there are about 70 researchers in astronomy in Serbia and about as many in abroad.

- The researchers participate in 8 scientific projects financed by the Ministry of Education and Science of Serbia and in several international cooperations and projects (SREAC, VAMDC, Belissima (recruitment of experienced expatries researches, purchase of the telescope), Astromundus, LSST).

- The researchers of the Astronomical Observatory participate in the undergraduate study programs at the University of Novi Sad, as well as in the Master and PhD study programs of Astronomy and Astrophysics at the Belgrade University.

Astronomical Observatory Belgrade

65cm refractor

Astronomical Observatory in Belgrade

Equipment:

- Refractor - equatorial Zeiss 650/10550 mm
- Solar spectrograph Littrow type, collimator lens 200/9000 mm
- Large Meridian Circle Askania 190/2578 mm (burned out in 1999)
- Large Vertical Circle Askania 190/2578 mm
- Large Transit Instrument Askania 190/2578 mm
- Astrograph Zeiss 160/800 mm
- Photovisual Refractor Askania 135/1000 and 125/1000 mm
- Transit Instrument Bamberg 100/1000 mm
- Zenith telescope Askania 110/1287 mm
- Telescope Meade (D=40cm)
- 60cm reflector at mountain Vidojevica

Main research topics

- Astrometry and dynamical astronomy:
  - Earth rotation
  - Solar system dynamics
  - Celestial mechanics
  - Double stars
- Astrophysics:
  - Astrophysical spectroscopy
  - Solar physics
  - Radiative transfer
  - Close binary stars
  - Stellar kinematics and dynamics
  - Interstellar medium
  - Supernova remnants
  - Galactic astronomy
  - Extragalactic astronomy (AGN, grav. lensing)
  - Cosmology
- Astrobiology
- Astroinformatics
- History of astronomy

Serbian Astronomical Journal since 1936

Publications

Serbian Astronomical Journal

(since 1936)

Publications of the Astronomical Observatory of Belgrade

(since 1947)

Bulletin de l'Observatoire astronomique de Belgrade (1936-1992)
Bulletin astronomique de Belgrade (1992-1998)
Serbian Astronomical Journal (1998-)
(http://saj.matf.bg.ac.yu)

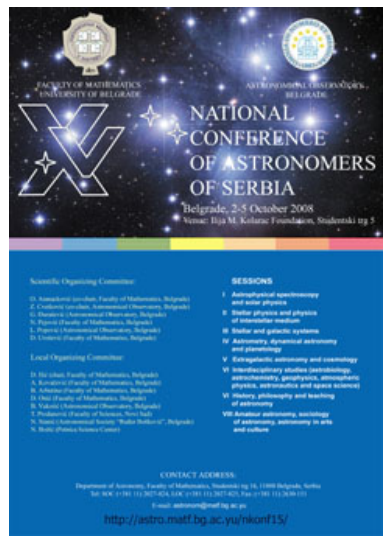
Astronomical Station Vidojevica (ASV)

ASV is situated on the mountain Vidojevica (southern Serbia, h=1155m).

Reflector Astro Optik (D=60 cm) is operational. Plan is to purchase 1.5m class telescope and mount it at the same site in the next 3 years.

National conferences of astronomers of Serbia (NCAS)

- Organized every 3 years by Astronomical Observatory, Belgrade and Department of Astronomy, Faculty of Mathematics, Belgrade
- More than 100 participants (with about 10 guests from abroad)



Public outreach

Public astronomy education in Serbia is realized through various lectures, radio and TV programmes, popular journals and books, lectures in two Planetaria (Belgrade and Novi Sad) and in public observatories, as well as by means of various activities (public observations of all major events, courses, conferences, schools and camps) of 20 amateur astronomical societies.

In January 2010 the Association of astronomical societies and astronomical sections of Vojvodina was founded. Amateur astronomers association of Serbia (SAAS, www.saasr.org) was founded in February 2010.

A nice example of an intensive collaboration among the amateur societies is Letenka camp organized every year on the mountain Fruska gora.

Journals/magazines

- “Vasiona” (“The Universe”) (since 1952)
- Internet Astronomical Magazine (since 1998)
- “Astronomija” (2003-2009)
- “GEA”
- “Young Physicist” - magazine for the elementary and secondary school pupils (since 1977).

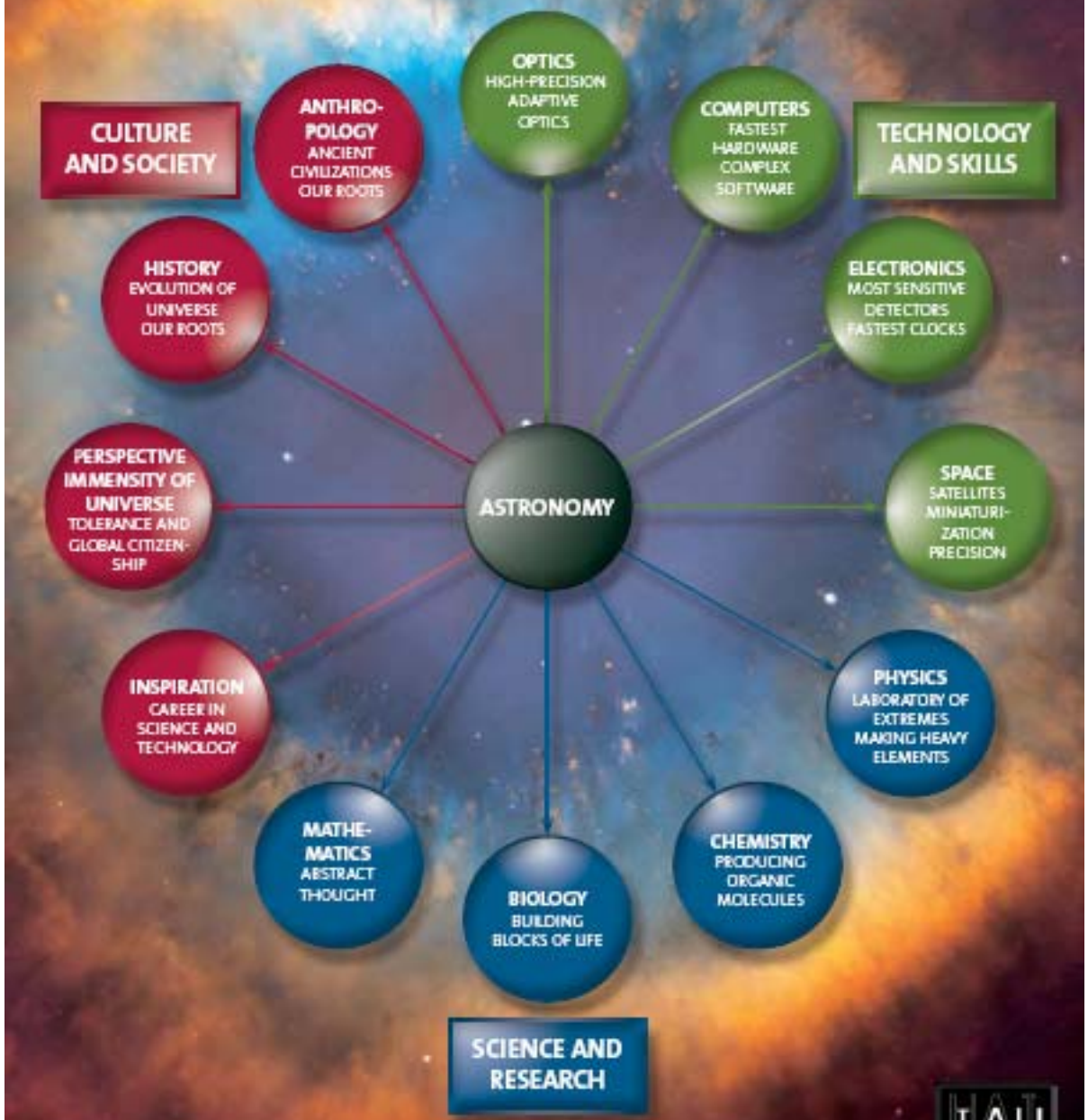
Amateur astronomical societies

- AS “Rudjer Bošković” (1934), Belgrade; Planetarium (since 1970)
- The Astronomical Group of the “Vladimir Mandić-Manda” Organization of Young Researchers (1973), Valjevo
- AS “Novi Sad” (ADNOS) (1974), Novi Sad; Planetarium (since 2001)
- AS “Alpha” (1996), Nis
- AS “Milutin Milankovic” (1996), Zrenjanin
- AS “Lira” (“Lyra”) (1998), Novi Sad
- Astronomical group within the Natural History Society “Gea” (1999), Vršac
- The Society for Radio Astronomy Research “Aurora” (2000), Bor
- AS "Magelanov oblak” (“Magellanic Cloud”) (2001), Prokuplje
- AS “Andromeda”(2003), Knjaževac
- AS Novi Pazar (2004), Novi Pazar
- The Belgrade Radio Astronomical Society “Tesla” (2004), Belgrade
- AS "Univerzum“ (2006), Bačka Palanka
- AS "Orion“ (2007), Ivanjica
- AS "Milutin Milankovi\'c“ (2007), Pančevo
- AS "Aristarh“ (2007), Kragujevac
- AS "Eureka“ (2010),Kruševac
- AS "Bor“ (2011), Bor
- AS "Kasiopeja“ (2011), Leskovac
- AS "Vlasina“ (2011), Vlasotinci

Astronomical society “Rudjer Boskovic” (1934)

- ”Astronomy courses for beginners” (one at each autumn and spring)
- Belgrade astronomical weekends (BAW) at the end of June
- Summer Schools of Astronomy at the beginning of August
- A special topical meetings ”Summer Astronomical Meetings” held at the end of August/beginning of September.
- Galileo Teacher Training Program

Strategic Plan 2010–2020



Classification of the Office for Astronomy Development (OAD)

a useful basis for an overall view of the degree of professional astronomy development (tertiary education and research) throughout the world

Group 1A: Developed astronomy research countries A. These are • IAU member states with more than 4 IAU members per million population, indicative of a thriving astronomy research community.

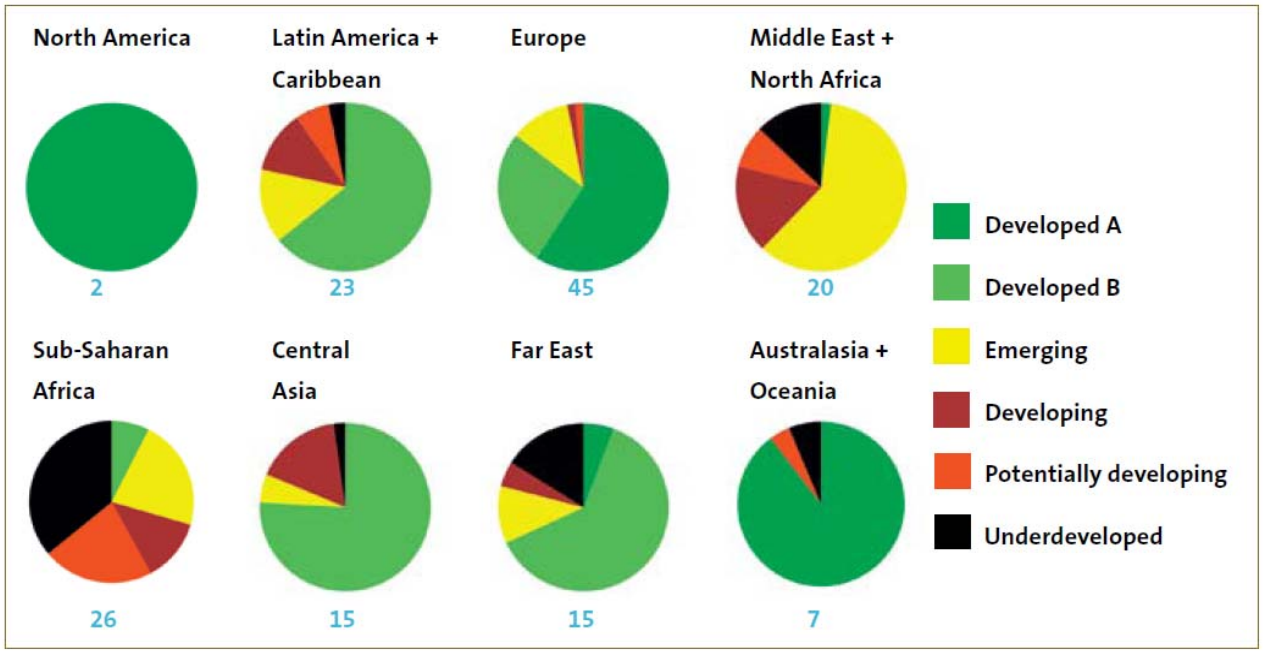
Group 1B: Developed astronomy research countries B. These are IAU member states with fewer than 4 members per million population that participate in, or host, frontline astronomy research facilities.

Group 2: Emerging astronomy research countries. These are IAU member states with between 0.5 and 4 IAU members per million population that do not participate in frontline astronomy research facilities. They are targets for stimulating the growth of their astronomical research.

Group 3: Developing astronomy research countries. These are countries that do not adhere to the IAU, but have at least one individual IAU member, indicative of limited involvement in astronomical research. They are targets for stimulating the growth of their astronomical research.

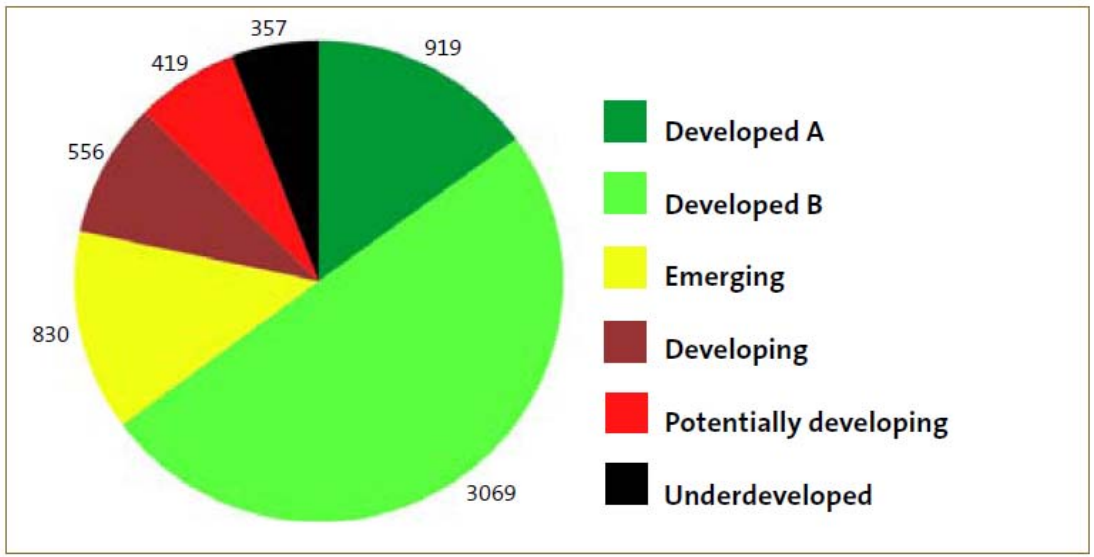
Group 4: Potential developing astronomy research countries. These • are countries with well-developed tertiary education that neither adhere to the IAU nor contain individual IAU members. They are targets for stimulating the establishment of astronomy-oriented research groups.

Group 5: Underdeveloped astronomy countries. These are countries that neither adhere to the IAU nor contain individual IAU members whose tertiary education is only weakly developed. They are targets for stimulating the dissemination of astronomy education within their schools.

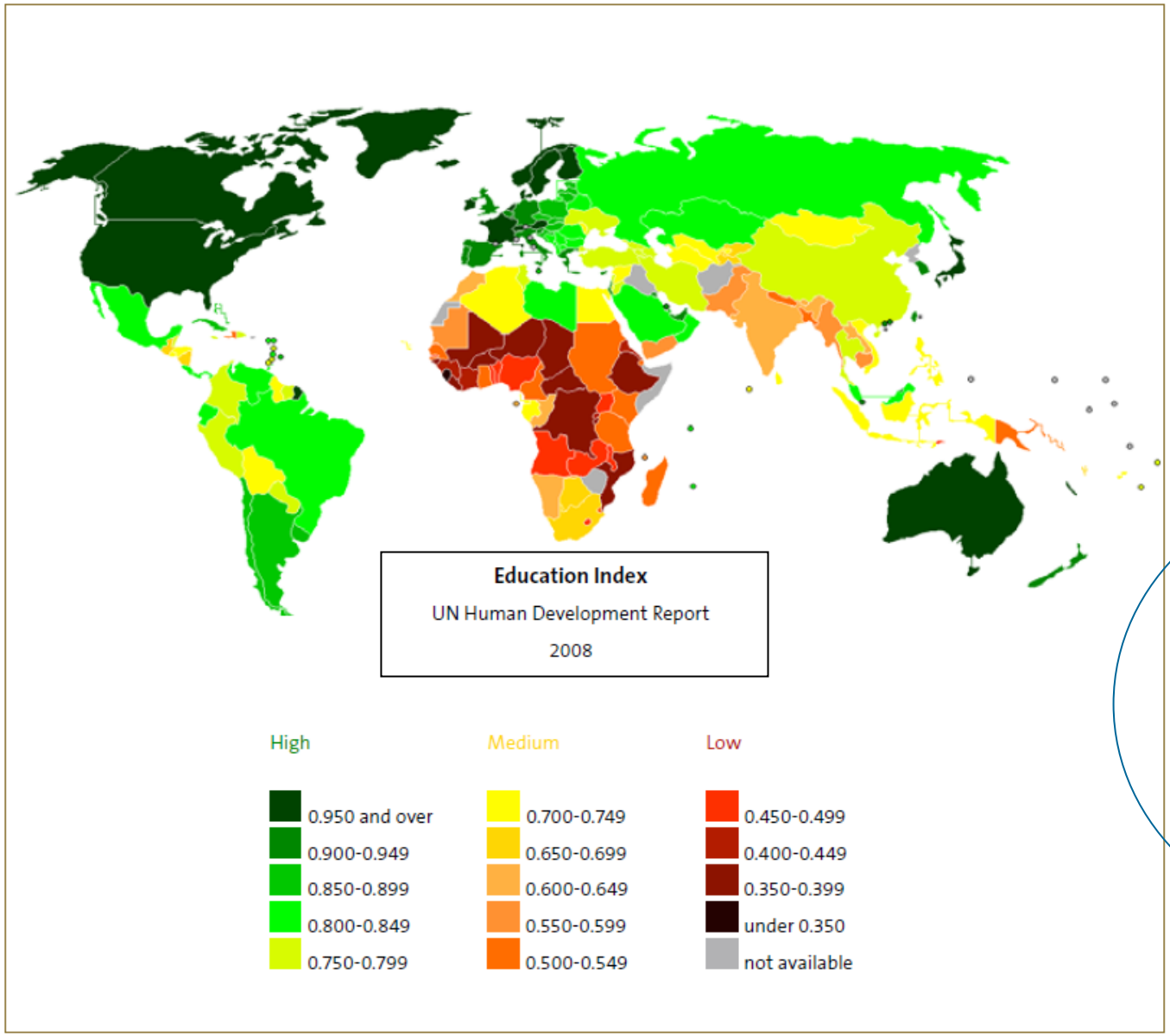


Astronomy research development by region

Number of countries included in each region is given in blue.



Population in millions that inhabit countries at various stages of astronomy development in different regions of the world (on the basis of data from Hearshaw, 2008)



Education index

E = (2/3)L + (1/3)C

L – literacy rate

C – combined gross school enrolment ratio

About two thirds of the world's population are developed in astronomical research !

Figure 13

GLOBAL DISTRIBUTION OF EDUCATION INDEX

The education index is defined by E = 2/3 (L) + 1/3 (C), where L is the literacy rate and C is the combined gross school enrolment ratio. This is taken from the 2008 update to the 2007/2008 edition of the UN Human Development Report (2007, ISBN 978-0-230-54704-9).

SERBIA

South East Europe (SEE) country

IAU member state (42 individual members)

According to IAU Strategic Plan:

- it is a developed astronomy research country (group 1)
- with high education index : 0.8-0.849

Main goals in the future

- Primary and secondary education:
  - reintroduction of astronomy as a separate subject in the school curricula
  - education of teachers through courses, seminars and workshops
  - training best pupils for the astronomical olympiads
- University education and research:
  - strengthening of relations with other universities in the SEE region and worldwide (twinning between universities)
- Public outreach:
  - intensification of the public education in astronomy via lectures, articles, radio and TV programs