DEPARTMENT OF PHYSICS
University of Split
Faculty of Natural Sciences and Kinesiology

SVEUČILIŠTE U SPLITU
FAKULTET PRIRODOSLOVNO MATEMATIČKIH ZNANOSTI I KINEZIOLOGIJE
ASTROFIZIKA
ZAVOD ZA FIZIKU

APhyID.org

Astrophysics Initiative in Dalmatia

Business Strategy for 2006-2011

znanost.org

Approved by the Executive Board of Society znanost.org

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Business Strategy for 2006-2011

- APhyID.org -

Department of Physics
University of Split, Croatia

Society znanost.org, Croatia

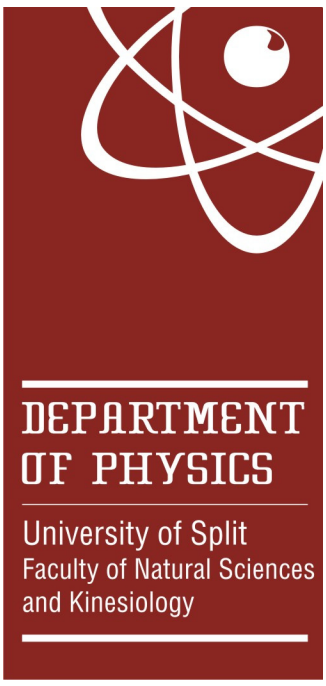

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Table of contents

1 Executive summary 1
2 Introduction 2
3 Objectives 5
3.1 Human capital development (technically trained work-force) 5
3.2 Attraction of young people to careers in science and technology 6
3.3 Fostering interdisciplinary connections between astronomy and other disciplines 7
3.4 Cutting edge scientific research 8
3.5 Knowledge development and its dissemination 9
3.6 Improvement of education systems in South Eastern Europe 10
4 Vision 11
5 Mission 12
6 The case for astrophysics in Croatia 12
6.1 Suitability of Split as a new astrophysics center in Croatia 12
6.2 What does the Croatian public gain by supporting ApID? 13
6.3 Impact of ApID on primary and secondary education 13
6.4 Impact of ApID on higher education 13
6.5 How does ApID relate to the economy of Croatia? 14
6.6 The contribution of ApID to the empowerment of Croatia as a future EU member 15
6.7 ApID as a part of Croatia's brain gain 16
7 The concept 16
7.1 Department of physics 16
7.2 Society znanost.org 19
7.3 Faculty 20
7.4 Students 21
7.5 Distance learning 22
7.6 Research 22
7.7 Alumni 24
7.8 International collaboration 25
7.9 Professional astronomy and astrophysics in the region of South Eastern Europe 25
7.10 Amateur astronomy in the region of South Eastern Europe 29
7.11 Outreach 31
8 Implementing the vision 32
8.1 Formal organizational structure 32
8.2 Work carried out to date 33
8.3 Graduate (Master's Degree) program in astrophysics at the University of Split 37
8.4 Faculty and staff development 41
8.5 Administration 45
8.6 Student entrance principles 45
8.7 Student recruitment 46
8.8 Student exchange program 47
8.9 Fostering international collaborations 47
8.10 Research 48

8.11 Outreach activities 50
8.12 Milestones 51
9 Finances 55
9.1 Funding plan 55
9.2 Fundraising 56
9.3 Detailed Budget 57
10 Risks and contingencies 60
11 Expectations, deliverables and measurable indicators of success 60
12 References 69
13 Appendix 70
13.1 Departmental contact information 70
13.2 Endorsements 71
13.3 CREATE Project: Round table conclusions 78
13.4 General information on the physics graduate program at the Department of Physics 80
13.5 Detailed curriculum of the Physics Graduate Program at the Department of Physics 81
13.6 Description of graduate astronomy and astrophysics courses at the Department of Physics 86

"Each problem that I solved became a rule which served afterwards to solve other problems."

- Rene Descartes (1596-1650), "Discours de la Methode"

1. Executive summary

The Astrophysics Initiative in Dalmatia (ApID) is a collaboration of scientists and educators who share the common goal of advancing astronomy and astrophysics in the region of Dalmatia. The core ApID activities include the astrophysics graduate program at the University of Split, research projects that complement and enhance the graduate program, and logistical support to educational and outreach projects. The graduate program is approved by the Croatian Ministry of Science and Education and hosted by the Department of Physics at the University of Split. It is scheduled to begin in the fall of 2008 and will conform to the highest quality standards in science and education.

Designed from the beginning to follow the best international practices, this program will help minimize the loss of highly skilled and educated people from Croatia and enable a brain gain of both Croatian and foreign scientists. ApID will further enhance these achievements by bringing international research projects and collaborations to Croatia. Two highly interdisciplinary research directions in modern astrophysics will be pursued: "From dust to life" with topics concerning extrasolar planets and astrobiology, and "Large-scale computations and data mining" with topics bridging astrophysics and computer science. The experience gained through ApID programs will be applicable to other disciplines, and in the wider region of South Eastern Europe. Its success will set an example of how to initiate, organize and manage similar projects at other institutions in Croatia and in transitional countries in general.

The education and research programs will be combined with strong outreach activities to increase the ApID's public visibility and enhance fundraising opportunities. Several outreach projects are already underway in collaboration with the non-government non-profit organization Society znanost.org.

In the next five years, ApID will help create conditions for establishing two senior astrophysics faculty positions, at least four postdoctoral positions, and several visiting scientist positions at the Department of Physics of the University of Split. The hiring plan also includes support staff for fund-raising, public relations, and outreach activities. The projected annual operation costs for ApID are 500,000€, with one third of the budget already secured through the University of Split.

2. Introduction

The knowledge-based economy is based on discoveries and innovations; hence, the power of a nation is measured by its ability to stimulate discoveries and by its capacity to innovate. A nation cannot achieve this without increasing its educational level and intellectual competence. Moreover, for a small nation like Croatia, building a knowledge-based society is more than an economic necessity – it is also a strategy for preserving its culture and identity.

The fields of astronomy and astrophysics are scientific enterprises that rely heavily on a high level of interdisciplinary research activity. They are valuable incubators for new ideas, discoveries and enterprises, driven by the synergy of sophisticated technologies and exploration of the Universe. But astronomy and astrophysics also have a unique public appeal, which enables them to inspire young generations and stimulate curiosity, creativity and an appreciation for science.

Croatia, like other countries in the region of South Eastern Europe, is not capitalizing enough on these virtues of astronomy and astrophysics. **Astrophysics Initiative in Dalmatia** (**ApID**) is an attempt to change this and to promote the growth and development of this scientific field in the region. Briefly:

- ApID is a collaboration of projects, institutions, and individuals, from professional scientists to amateur astronomers, sharing the common interest in advancing astronomy and astrophysics in Dalmatia
- ApID helps collaboration members to coordinate their work, research, and outreach activities, to reduce operational costs, and to increase their public visibility and enhance fundraising opportunities.

In order to set a roadmap for ApID's development in the next 5 years, a group of Croatian astronomers and astrophysicists, assisted by experts from other disciplines, designed this business strategy. The strategy is a result of input and advice received from many scientists, business people, and decision makers. It is a comprehensive review of ApID's objectives, benefits to the local and regional community, details of operation, and budgetary requirements.

Legally, ApID is a project of the Society znanost.org (non-government non-profit organization), conducted in collaboration with the Department of Physics at the University of Split, Croatia. Fiscally, ApID is responsible to the Executive Board of znanost.org. The "backbone" of ApID is the **graduate program in astrophysics** at the Department of Physics. The department also promotes the **research component** of ApID, which will be additionally enhanced by the proposed astronomy and astrophysics institute. The **outreach and logistics** of ApID are also supported by the non-governmental organization Society znanost.org (registered in Croatia).

The basic objectives of ApID can be summarized as follows:

- Provide the ApID graduates with the know-how to continue in diverse career paths as well as to make them attractive candidates for a range of employers in different branches of business, government and finances.
- Attract young people for careers in science and technology.
- Establish connections with other disciplines present at the University of Split and other Universities in Croatia and abroad in order to actively promote interdisciplinary sciences.
- Promote top level research in astronomy in Croatia.
- Ensure ApID's sustainability by promoting excellence in research and teaching, while creating an inspiring place that incubates and stimulates new ideas and builds upon them.
- Enhance the quality of existing graduate level education in the region and set an example to other educational institutions in South Eastern Europe.

ApID is sustainable only if it has genuine support from the general public. Therefore, this document speaks not only to scientists and decision makers, but also to the general public by making the case for astrophysics in Croatia. It addresses the following issues:

- Economic growth of Dalmatia and the town of Split, combined with large ongoing investments in the new campus and infrastructure at the University of Split, makes Split a very attractive place for students, teachers, and researchers, hence, ideal for ApID.

- ApID strives to set the example of excellence to be followed by other existing higher education programs in the region and demonstrating to the public that investing in science is the right thing to do.

- The impact of ApID on schools in Split and Dalmatia will be tremendous, and will serve as a foundation for students eager to learn more about our planet, the universe, and science in general.

- ApID will significantly contribute to the welfare of the region and the nation by promoting excellence in high-level education, by preparing advanced students for professional career paths ranging from academia to industry, and by providing scientific education designed to satisfy various levels of scientific and technological sophistication.

- ApID will bring the top science and technology research to Croatia, enhance the transfer of technology to Croatia through international collaborations and joint projects with international centers of excellence, and will help disseminate the skills and knowledge necessary for the establishment of similar world-class centers of excellence in the region.

- ApID's full compatibility with the European educational standards, its international orientation (curriculum, language and lecturers) and research excellence will serve as a bridge between the existing and future EU member states, hence, empowering Croatia as a future EU member.

- ApID actively participates in the process of "brain gain" by attracting Croatian science diaspora and foreign scientists to actively participate in the Croatian education system through the transfer of their skills and knowledge to Croatia.

The Croatian government is investing significant efforts into mitigating negative consequences of Croatia's "brain-drain". Therefore, ApID is of a great interest to policy makers, since the success of ApID as a model of brain gain would set an invaluable practical example of how to initiate, organize and manage a similar project in other disciplines at other institutions in Croatia and in transitional countries in general.

Research strategy of ApID includes founding a new astronomy and astrophysics institute, which will enable more efficient incubation of internationally competitive research projects. Two major interdisciplinary research programs are identified as strategically important for ApID:

- "**From dust to life**": a study of the origin of planets and their evolution, the search for extrasolar planets, the transport of organic and inorganic material to the Earth, astrobiology and the search for life on other planets.

- "**Large-scale computations and data mining**": a synergy of computer science and astronomy and astrophysics, where scientific needs of astronomers and astrophysicists for supercomputing and management of huge datasets stimulate advancements in computer technologies.

It is important to emphasize that ApID has already started with its activities. It was these activities that created the immediate need for the business strategy. Briefly, some of the work carried out to date includes:

- Design of the curriculum for the master's degree in astrophysics (officially approved by the Croatian Ministry of Science, Education and Sport in spring 2005).
- Collaborations with several international institutions have been established.

- Croatian National Science Foundation granted a one-year research stipend to one of the ApID founders to work in Split.

- More than 80 books and 100 textbooks have been collected through donations for the future astrophysics library, together with a large set of journals (over 2 tons in total).

- A dedicated Web/IT server has been obtained from the Society znanost.org through their signed contract with the Department of Physics in Split.

- Meetings of the Forum of Croatian Astronomers (an informal assembly of professional Croatian astronomers) are held on annual basis in Split to provide support for ApID.

- Several workshops are organized as a part of ApID activities:
  - (Sep 2006) "Astronomical Image Processing" workshop
  - (Feb-Mar 2007) "Split International Winter Schools of Astrophysics (SIWA) – 2007"
  - (Aug 2007) "A software Framework for Simulating Stellar Systems (MODEST 7a)"

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- ApID personnel are actively involved in the outreach project "The Sky as a Gift", which includes more than 45 teachers and 500 pupils in schools from all parts of Croatia.

- A videoconference on the topic of "Setting up a World-Class Science Institute: Difficulties and Possibilities" was organized bringing together representatives of the Croatian government, major research institutions from Croatia, and the Science Initiative Group (an international team of scientific leaders and supporters dedicated to fostering science in developing countries).

This business strategy outlines a list of milestones for the next five years. The categories covered by the milestones include:

- Scientific Development
- Educational Activity
- Human Resources
- Infrastructure

The business strategy also includes conservative estimates of **senior faculty and postdoc projections** (excluding the proposed institute):

- Two senior faculty positions (one in 2006 and one in 2008).
- Four postdoc positions every year.

It is estimated that the total budgetary requirement of the graduate program is about **220k€**. Providing conditions for conducting research and teaching in Split will cost about **520k€** annually (conservative estimate; excluding additional individual research grants). **One third of this budget is secured** through the Department of Physics in Split. Support activities (outreach, fundraising, PR, distance learning) will require at least additional **200k€** per year.

This document summarizes the planned activities and their expected outcomes, dates, outputs, targets, deliverables, performance standards and indicators that can be used for measuring the activities' success

3. Objectives

Astronomy makes humanistic, educational and technical contributions to our society. It is self-evident that training in science opens doors to a scientific career. It is, however, often not clear to the general public that the same training can be very attractive to industry and different businesses as potential employers of skilled people. The aim of ApID is to recognize the areas in which astronomy and astrophysics can serve as a national asset and to use them to prepare young people for real life challenges. Here we focus on the objectives laid down by ApID that enable graduated students to enter the modern society as a skilled and attractive work-force.

3.1 Human capital development (technically trained work-force)

The objective is to provide the ApID graduates with know-how to continue in diverse career paths as well as to make them attractive targets for a range of employers in different branches of business, government and finances. This way, ApID will contribute to technically trained work force in the region. ApID aims at producing graduates who will become leaders, not followers.

Rationale

The founding idea of ApID lays in the recognition that a growing human capital is critical to economic development. An objective of ApID is to produce world-class graduates

The Sky as a Gift" project (http://nebo.znanost.org, see §7.2) uses astronomy as the medium for hands-on science experience in elementary schools in Croatia. More than 500 pupils and teachers have participated in the project so far within the last three years. ApID scientists are also involved in this project, which will serve as the seed for ApID's outreach activities.

with the necessary skills to become local and global leaders and entrepreneurs within their area of expertise. This will be achieved by making young ApID graduates' skills look attractive to different types of employers, from academia based scientific instates (PhD and a career in science) to different sectors of industry.

The curriculum for the master's degree is designed to introduce current topics in astrophysics to students and provide students the opportunity to participate in top-level scientific research. Industry and finances are, however, generally not concerned about the specialization of an academic course. They are more interested in broader skills obtained by students, which can be transferred to the work place. A number of transferable skills will be developed at ApID:

- mathematical skills and understanding of complex problems
- numeric and scientific literacy
- computing and modeling
- executing projects (often on tight deadlines)
- cooperating in international teams
- preparing operational plans
- optimizing the use of resources (as in large computer calculations)
- handling incomplete and large data sets
- presenting an account of work to colleagues and to broader audiences

These skills provide a solid base not only for a career in science, but also in different branches of business. The ApID curriculum aims at providing students with learning experiences and a broad range of skills that will enable them to pursue multiple career trajectories.

3.2 Attraction of young people to careers in science and technology

ApID's objective is to attract young people for careers in science and technology. ApID recognizes that the subject of astronomy is inherently interesting to young people, thereby keeping them interested in science, whilst they learn fundamentals of mathematics, statistics, physics, chemistry, etc. A master's degree in Astrophysics at the University of Split will provide a highly educated and scientifically literate work force required by their home country for its future development.

Rationale

Introducing students to astronomy at the undergraduate level can influence students' decision to pursue a degree in science or technology. Physics departments in developed countries have observed this trend when they offered astronomy options in their curriculum. It has also resulted in an increased interest in bachelor and master degree programs in astronomy.

According to the latest statistical research by the American Institute of Physics, astronomy and astrophysics has become the most popular subfield chosen by US PhD-seeking first-year physics students. Moreover, astronomy and astrophysics has an impressive rise of all statistical measures (the latest

The tremendous popularity of astronomy among the general public can be used for educating people about the role of science in society. This is extremely important in modern democratic societies where public investments in science and technology depend on the vote of the general public. Astronomy is especially popular among children and can be used for teaching children how to use the scientific method in their daily life, work in a team and develop a critical and responsible thinking.

available statistics is for 2003). Especially noticeable is the rise of degrees awarded to women, where they participate with 46% of bachelor's degrees awarded and 26% of PhDs. In comparison, in the rest of physics subfields women earned 22% of the bachelor's degrees in total and 18% of the PhDs. This shows that astronomy plays a critical role in attracting women to physics. It is also a clear message for policy makers that they should seek ways to capitalize on these trends.

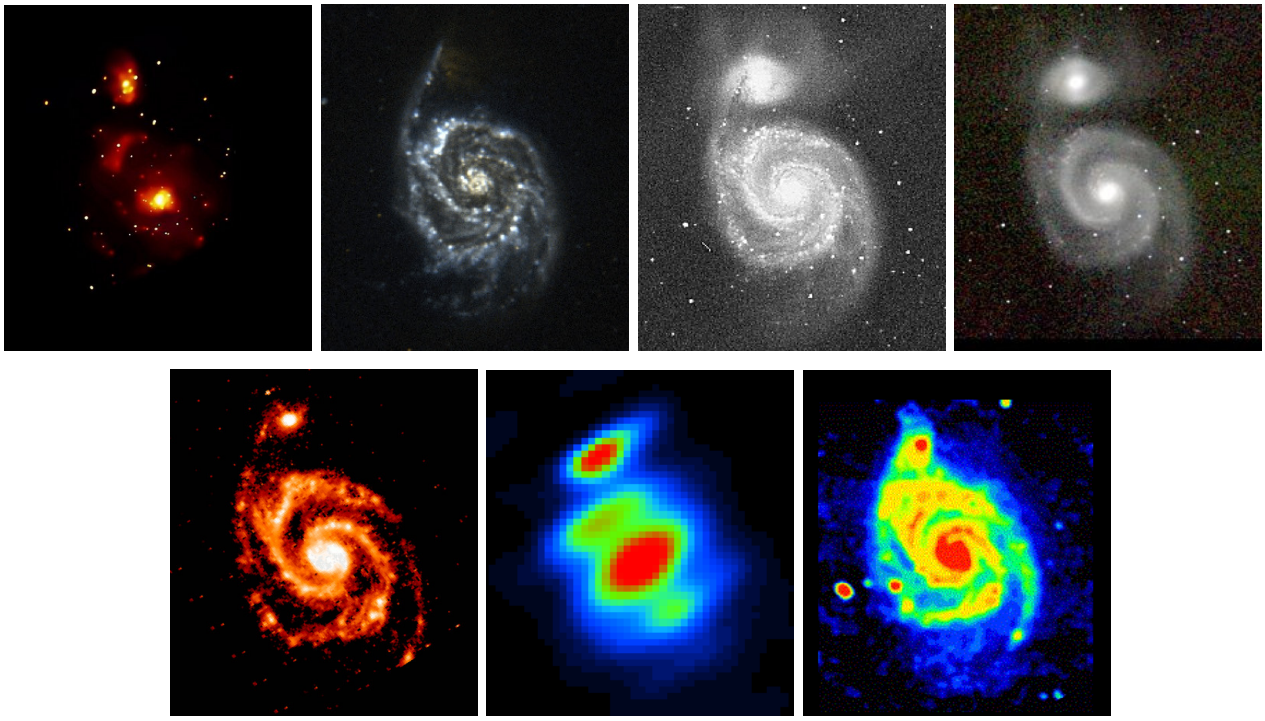
On a more pedagogical level within higher education, the interdisciplinary nature of astronomy provides a full framework for illustrating the unity of natural phenomena and the evolution of scientific paradigms that explain them. Teaching astronomy to master's students prepares them for a broad range of scientific disciplines ranging from purely academic, such as astrophysics, to widely applicable tasks of engineering and computer science.

3.3 Fostering interdisciplinary connections between astronomy and other disciplines

An objective of ApID is to establish connections with other disciplines present at the University of Split and other Universities in Croatia and abroad. ApID will actively promote interdisciplinary sciences through its curriculum, lecturers and research topics offered to students. ApID will specifically focus on establishing links with mathematics, computer science, chemistry and biology departments as well as the mother department of physics.

Rationale

Understanding the universe, whether on a small or large-scale, requires tools and insights from many disciplines, such as physics, chemistry, biology, computer science, and electrical engineering. For this reason, modern science is moving towards establishing interdisciplinary activities. Astronomy's record in linking with other disciplines is well known. It is the astronomical discoveries as well as the need to develop new instruments and computational techniques that often provide



Astronomical observations in different parts of spectrum require entirely different sets of detectors and physical concepts. This makes astronomy a highly interdisciplinary field of science. These images show the Whirlpool Galaxy observed in: X- ray (Chandra), ultraviolet (GALEX), visible (SDSS), near-infrared (2MASS), mid-infrared (ISO), far-infrared (IRAS), radio (VLA).

strong impetus for developments in other scientific branches. Here we list three well-established links between astronomy and other disciplines that will dominate in the next decade, and as such, will be the focus of the ApID curriculum.

The strongest links exist between astronomy and modern physics. The major goal of physics is to understand the basic constituents of matter and the forces between these constituents. Astronomy offers insights into new science by operating on scales unachievable in a terrestrial laboratory. These include very high energies, densities and pressures common in astronomical objects and provide opportunities to test the known laws of physics in extreme environments as well as to search for new particles, forces and the unifying picture of the Universe. Thanks to astronomy we know that our current understanding of elementary particles and forces can account for only about 5% of the Universe, while the rest consists of still unexplained dark matter and dark energy.

The link between astronomy and computational science changed the 20th century and will mark 21st century astronomical observations. New silicon-based detectors revolutionized astronomy in the 1970s. Their ability to collect vast quantities of data through different surveys was continuously testing the limits of available computational speed and storage media. In the modern era of publicly available large data sets, even institutions without direct access to state-of-the-art telescopes and instruments are able to mine the large databases. The development of software tools to enable the discovery of new patterns in the multi-terabyte or petabyte databases is possible only in connection with mathematics and computer science trained scientists. Astronomy achieved one of the milestones in scientific computing by developing methods for mining huge astronomical data sets.

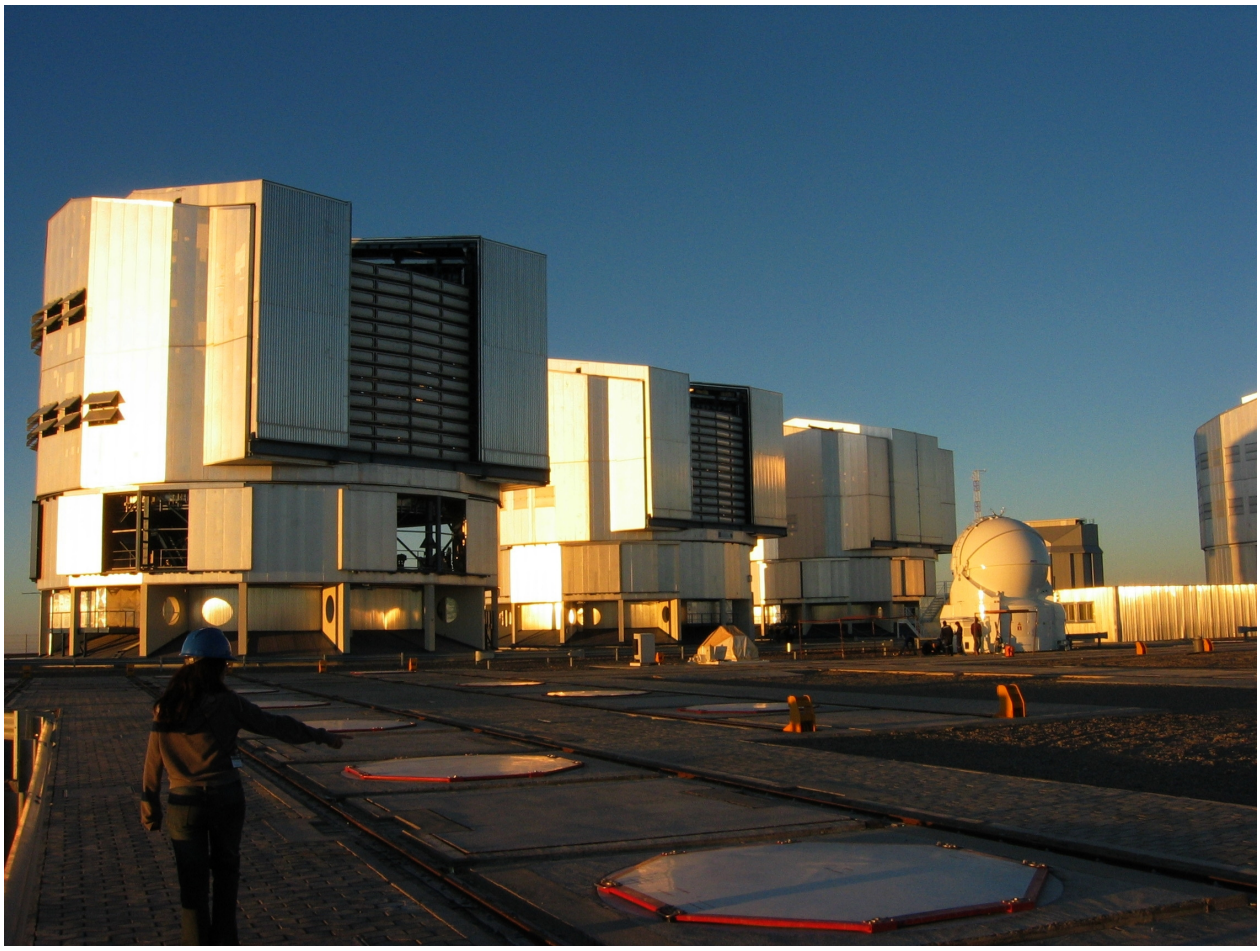
Recent decades have also seen a new synergy between astronomy, biology and planetary science: astrobiology. Modern astronomy and space science can make an important contribution to answering fundamental questions related to the origin and distribution of life in the universe. Astronomers are discovering planets around other stars and are able to describe the key events in the evolution of planetary systems. In the near future, astronomers expect to see the first spectroscopic signatures of biogenic gases that provide evidences of life. The questions posed by astrobiology are: what is the origin and evolution of life? Is there life elsewhere in the universe? What is the future of life in space? To answer these questions requires tight links between different sciences and technology. It is astronomy that can provide the evidence of life in space, its diversity and potential.

3.4 Cutting edge scientific research

An objective of ApID it to promote top level research in astronomy in Croatia. This research will be lead by the staff of ApID (lecturers and future postdocs), followed by undergraduate students being enrolled in the ApID Master's program through their mandatory research assignments. ApID recognizes that integrating research and education is the best way to keep the curriculum on a high level and transfer knowledge to younger generations as well as to the general public.

Rationale

Astronomers of the past were concerned more with charting the objects in a permanent cosmos, but astronomers today study evolution and change in an infinite Universe. Modern astronomy is at the cutting edge of 21st century science. Its objective is to elucidate the origins and properties of planets, stars, galaxies and the Universe itself. The astronomical research is spread between elementary particles and the large-scale structures, spanning orders of magnitude in size, but also versatile phenomena. The past century of astronomical research taught us that if we want to understand our human beginnings, we must first understand the life history of stars, galaxies and the Universe. With this in mind, it is clear that astronomy plays an important social role in modern society. One purpose of ApID is to bring high-level astronomical research to Split and the region, thereby increasing regional excellence in the field.



Scientists involved in ApID work on projects that utilize the most advanced astronomical instruments and telescopes, including the Paranal Observatory in Chile. Students from Split will have opportunities to work on these projects and at such facilities.

Traditional astronomical research was carried out by individuals or small teams of scientists who either worked on theoretical models or had links to observatories. The advent of space observatories, service observations and legacy surveys, which provide the large databases freely to the scientific community, is changing this dated picture dramatically. The large (all sky) projects favored in modern astronomy require large international teams. From the design phase to construction of (the next generation) instruments, to archiving, mining and scientifically using collected data sets, the collaboration of numerous individuals and institutions is imperative.

ApID sees an opportunity to play a leading regional role in the future landscape of international astronomical research. It aims to support research areas which are financially sustainable and focus on establishing connections to other disciplines whose members have expertise in computational techniques, data-mining and algorithmic skills, and team and project management. Taking this approach ApID will provide a solid basis for its primary role as a high-level educational center.

3.5 Knowledge development and its dissemination

ApID will ensure its sustainability by promoting excellence in research and teaching. It will be an inspiring place that incubates and stimulates new ideas and builds upon them. Special emphasis will be given to multidisciplinary approaches, with a broad view of science and its role in society. The knowledge developed by ApID will be disseminated to the local and regional community through teaching, outreach activities and cooperation with amateur astronomers and the industry.

Rationale

The knowledge offered by the ApID curriculum consists of specialized and transferable skills. Modern astronomers must be proficient in novel ways of manipulating and interpreting different sorts of problems. Astronomy provides modern answers to questions about humanity's place in the universe, and it introduces young people to quantitative reasoning and helps attract them to scientific or technical careers. Astronomy also contributes to areas of more immediate practicality, including industry, medicine and defense.

Dissemination of knowledge to a broader public is thus a natural result of ApID existence. ApID has an obligation to build a sense of responsibility in its students to contribute to public understanding of science in return for public investments in the research enterprise. ApID aims to:

- disseminate astronomical discoveries to its students and train students on how to further disseminate their knowledge
- use outreach activities and interest that astronomy generates in the public arena to increase the general understanding of science
- profit on the empirical nature of astronomy to train technically able work-force
- prepare future generations of professional astronomers who will further develop astronomy in Croatia and South-East Europe, as well as contribute to a scientifically literate nation.

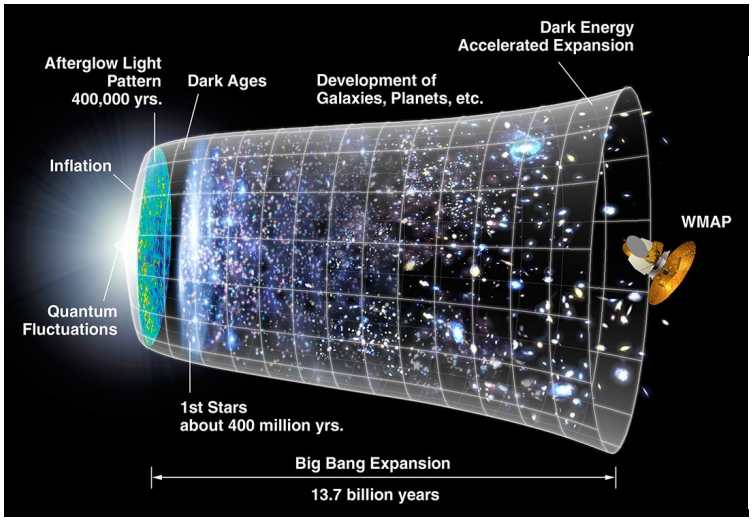
3.6 Improvement of education systems in South Eastern Europe

ApID aims to enhance the quality of existing graduate level education in the region and set an example to other educational institutions in South Eastern Europe. This will be achieved by:

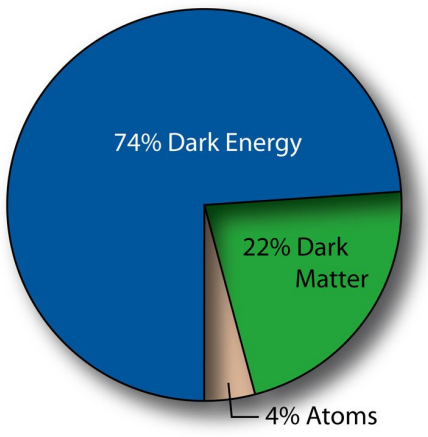
- **the competitive admission process**
- **bringing an international suite of lecturers to complement the local teaching efforts**
- **collaborations with other educational and research institutions**
- **offering to students research projects within international collaborations**
- **knowledge-dissemination to the public**
- **providing leadership in the promotion of excellence in education in South Eastern Europe through work with regional and national learning institutions (including primary and secondary education) to promote excellence in education**

Rationale

The long-term sustainability of ApID depends



Credit: NASA/WMAP Science Team



New frontiers in physics are opened through explorations of the Universe. Data from the WMAP space telescope reveal that only 4% of the Universe consists of atoms, the building blocks of stars and planets. The rest belongs to dark matter, 22%, and "dark energy", 74%., both still unexplained and mysterious. In order to make further progress, scientists have to push the limits of theoretical and experimental research. This is why cutting edge astronomy and astrophysics go hand in hand with advancements in technology.

on, among other things, advancements in education and research in the region. The main pool of students and researchers for ApID will mainly come from the region of South Eastern Europe, which, despite all its problems, still has an advanced primary and secondary educational system. Unfortunately, its inability at the tertiary level to adapt to ever changing scientific, technological, economic and political changes in the global market has hurt the local economies the most. Tertiary education is still locked in decades old teaching and curriculum models, resulting in either a large "brain drain" or a workforce unable to comprehend forces shaping the world today.

ApID pedagogy will move away from the currently used approaches and methodologies. It will emphasize critical thinking, analysis, synthesis, problem solving, project management, awareness of the role of outreach initiatives in the sustainability of research funds and awareness of the importance of outreach in the dissemination of knowledge. The goal of ApID is to be an inspiring place that stimulates new ideas and builds upon them. Special emphasis will be given to multidisciplinary approach linking different departments of the University of Split, with a broad view of science and its role in society (see §3.3). The knowledge developed by ApID will be disseminated to the local and regional community through teaching, outreach activities and cooperation with the industry.

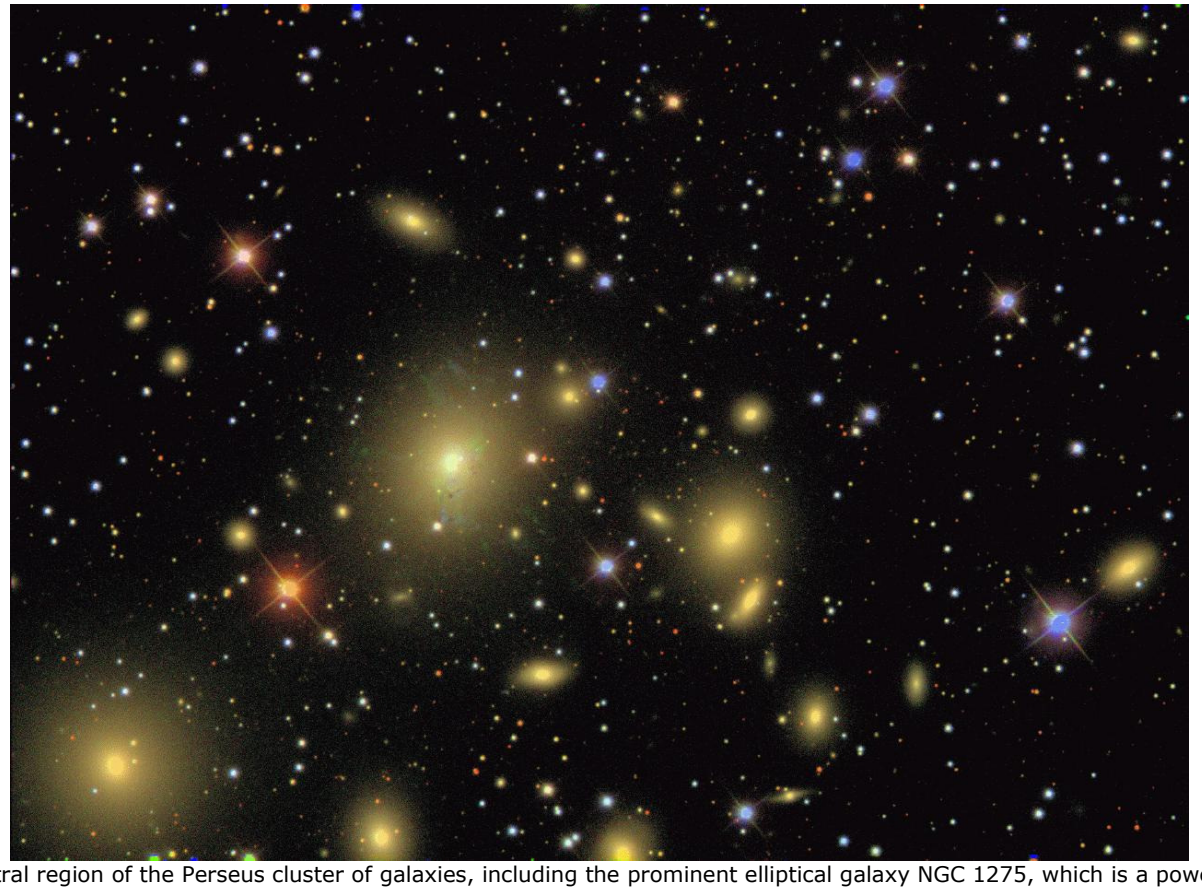
4. Vision

ApID is envisioned as a center of excellence in modern aspects of tertiary teaching, research in astronomy and astrophysics, implementation of information technology, advancement of multidisciplinary studies, and the production of a technically trained work force.

The region of South Eastern Europe is of strategic interest for APID, which aims at setting an example to other educational institutions in the region.

5. Mission

ApID will develop a strong, internationally competitive teaching program. Its exciting and innovative higher education program will be combined with world-class research and outreach programs. This will enable ApID to produce outstanding scientists and entrepreneurs who will have the skills and knowledge needed to excel in the global market economy. They will also be leaders capable of adopting and disseminating new knowledge for the benefit of their local communities.



Central region of the Perseus cluster of galaxies, including the prominent elliptical galaxy NGC 1275, which is a powerful radio source. This images was made by the Sloan Digital Sky Survey, which is the most ambitious astronomical survey ever undertaken. Croatian scientists have been actively participating in the project from its beginnings.

6. The case for astrophysics in Croatia

6.1 Suitability of Split as a new astrophysics center in Croatia

Split is the second largest city in Croatia and its largest passenger seaport. It is also the administrative, economic, cultural and communication center of Dalmatia - a coastal province undergoing rapid industrial and tourist development. Split is currently developing the large residential, commercial and industrial zone, Dugopolje, in its hinterland. Dugopolje's potential economic growth combined with improved accessibility from the north, via newly finished highways and modernized railroads, makes Split a very attractive place for students, teachers and researchers from Croatia and neighboring countries of southeastern and central Europe.

Significant investments in the new campus and infrastructure at the University of Split signify new initiatives toward science and technology in Croatia. The vision of the

Ministry of Science, Education and Sport, and the Croatian government is to transform Croatia into a knowledge based society. Investments in the university are one of the initial phases of this policy; investments in human resources have also already started and will be highly enhanced once the new local resources become available. ApID is trying to position itself early in this process as an important developmental partner in the future excellence of science and technology in the region.

6.2 What does the Croatian public gain by supporting ApID?

Initiating ApID will have significant impact on more than just the physics community. ApID will set the example of excellence to be followed by other existing graduate programs in the region, while representing a case study for a new concept of graduate studies in natural sciences in South Eastern Europe. In addition, it will align itself with other notable astrophysical institutions throughout the world that are becoming more visible to the public (partly owing to their efforts to popularize science, partly to the attractiveness of astronomy and space research topics to the general public). In this context ApID will be a natural target of public interest in science in this part of Croatia, as well as a promoter of the idea that investing in science is the right thing to do.

6.3 Impact of ApID on primary and secondary education

Astronomy is recognized as an ideal model through which students, regardless of age, can become attracted to science and its workings. Astronomy is intriguing and can be used in teaching as an excellent example of the scientific method, thus promoting interest in astrophysics and science in general. The goals of teaching science and scientific methods are: to acquire knowledge about more efficient ways to make everyday decisions, to promote creative, responsible thinking, develop critical thinking skills, and to participate in cooperative learning and research opportunities. The impact of ApID on schools in Split and Dalmatia will be tremendous, and will serve as a foundation for students eager to learn more about our planet, the universe, and science in general.

The general popularity of astronomy and astrophysics make them very effective in promoting science and scientific method. They also attract students, regardless of age, to a career in science and technology, hence particularly beneficial for the country.

6.4 Impact of ApID on higher education

Higher education institutions play a critical role in supporting knowledge-driven economic growth. These institutions assist in the improvement of the public sector and its organizations through the training of competent, creative and forward thinking individuals. Furthermore, institutions of this type often constitute the backbone of a country's information infrastructure, provide crucial support for national innovation, and imbue upon its students the necessary values, attitudes, and ethics that help them become contributing members of society.

Human resources in science and technology are especially important for development of Croatia. Astronomy is very effective in attracting students at all levels to a career in science and technology, hence particularly beneficial for the country. The reasons for this

attractiveness range from the aesthetic appeal of the night sky, images of planets, nebulae and galaxies in the distant universe, to the fact that astronomy encompasses the full range of natural phenomena - from the physics of invisible elementary particles to the nature of space and time or the question of the origin of life. The "heavens" offer a unique ability to enlighten abstract laws of the Universe to the excited and always knowledge-thirsty layman. By building on such fertile ground, ApID will significantly contribute to the welfare of the region and the nation by promoting excellence in high-level education.

ApID aims to prepare advanced students for professional career paths ranging from academia to industry. An extensive range of multidisciplinary courses will be offered that will enable students to meet their individual career goals. ApID will provide scientific education designed to enable young individuals to join diverse projects requiring various levels of scientific and technological sophistication. It will also encourage research and advanced training in such highly prized natural- and computer-science skills as:

- computation fluid dynamics
- probability theory and statistics, which is useful in a wide variety of activities related to economy and business development, such as risk management/assessment, market analysis, marketing etc.
- object-oriented programming languages, which is an excellent choice for all crucial real-time industrial applications
- use of large databases and computer networks, extremely useful in modern commercial and educational software development

Students at ApID will receive training in three additional areas:

- foreign language training
- project management

use of computers in distributed development

Multidisciplinary of ApID will enable students to meet their individual career goals, enabling young individuals to join diverse projects requiring various levels of scientific and technological sophistication.

6.5 How does ApID relate to the economy of Croatia?

The world is changing at a rapid pace, driven largely by developments in science and technology. Science and technology are critical to the economic growth of a country. Modern economy of a nation depends on its ability to compete technologically with other nations. The quality of environment depends on developing safe, clean industries and sources of energy. This can be accomplished only by imaginative and highly trained scientists and engineers. Governments of developed countries recognize the steadily decreasing number of students interested in pursuing technical careers as a major concern for the future development of their nations. To overcome this downward trend it will be necessary to support those activities that stimulate young people toward scientific thinking and the development of mathematical and technical skills. Since the whole region of South Eastern Europe suffers from a shortage of human capital with scientific and technological skills, ApID can help produce the needed human capital.

ApID will bring the world-class standards in higher education to Croatia and the region, together with the top science and technology research.

Astronomy and astrophysics are among the leaders in this development driven by the latest scientific and technological discoveries. ApID will bring the world-class standards in higher education to Croatia (and to South Eastern Europe as well), together with the top science and technology research. Moreover, ApID can help disseminate the skills and knowledge necessary for the establishment of similar world-class centers of excellence in the region. ApID will also enhance the transfer of technology to Croatia through international collaborations and joint projects with international centers of excellence.

6.6 The contribution of ApID to the empowerment of Croatia as a future EU member

In the Lisbon Agenda, signed in March 2000, the EU has recognized the challenges it faces when it comes to science and technology. In order to compete with the US economy, but also to stay ahead of the rising Asian economies such as India and China, Europe has set as the goal to become "... the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion". This view is based on the realization that development is increasingly dependent on a country's ability to understand, interpret, select, adapt, use, transmit, diffuse, produce and commercialize scientific and technological knowledge in ways appropriate to its culture, aspirations and level of development.

ApID fits into these EU goals and will contribute to the development of the EU through research, education, and outreach. There is a demand in industry of EU countries for professionals who have broad training in basic astrophysics, but not the specialized knowledge associated with a research-based PhD. They look for a technically trained work force and offer them a range of careers that require creative approaches to solving challenging technical problems. The mission on ApID is to transfer the highly valued skills in project and database management, computational analysis, technical writing and effective collaboration within teams.

A more general ApID's mission is to meet the challenges of the post-communist and post-war multicultural societies in South Eastern Europe. ApID's full compatibility with the European educational standards, its international orientation (curriculum, language and lecturers) and research excellence will serve as a bridge between the existing and future EU member states. A long-term

Split is the second largest city in Croatia and its largest passenger seaport. It is also the administrative, economic, cultural, and communication center of Dalmatia.

ApID fosters the "brain gain" by attracting Croatian diaspora and foreign scientists to actively participate in the Croatian science and education system.

stability of South Eastern Europe requires, among other things, improvements in science and education. Hence, ApID aims at becoming a catalyst of these changes, with Croatia as geopolitically ideal location for hosting ApID.

6.7 ApID as a part of Croatia's brain gain

Brain drain is becoming one of the major economic problems in the world today. Globalization puts pressure on less developed countries to compete in the global market with countries that are very efficient in harvesting scientific and technological advancements thanks to their strong human capital. Since human capital is also a dynamic entity that seeks favorable environments, brain drain from less developed to developed countries leads to an even bigger economic gap between them. As a recent World Bank report points out, "*the logic of national innovation systems favors the strong becoming stronger. In other words, countries such as the United States, on the basis of their existing strength as centers of intellectual excellence, attract the world's brightest individuals, thereby increasing that strength. On the other hand, those countries not considered to have a strong intellectual culture find their brightest individuals leaving in search of opportunities elsewhere. Thus, they are becoming even weaker*".

Croatia has also experienced a dramatic brain drain and faces a bleak future unless it finds ways to reverse this process. Fortunately, large brain drain also means a large pool of skillful and highly trained expatriates working at the world's centers of excellence. Thanks to advancements in communication technologies, a country with a good information technology infrastructure like Croatia can be very efficient in attracting its scientific and business diaspora, transforming "brain drain" into "brain gain". Croatia can also exploit a great advantage it has in the form of an attractive coastline, which has made Croatia one of the world's top tourist destinations.

ApID embodies all these qualities of brain gain. The core of ApID personnel are young Croatian scientists working abroad at various world class centers of excellence. They bring not only their knowledge and skills to Croatia, but also a new worldview and modern approaches to education, research and science policy. In general, ApID fosters the "brain gain" by attracting Croatian diaspora to actively participate in the Croatian science and education system through the transfer of their skills and knowledge to Croatia. Moreover, ApID also brings numerous foreign scientists to Croatia, thus extending the "brain gain" beyond the Croatian diaspora. The success of ApID as a model of brain gain would set an example of how to initiate, organize and manage a similar project in other disciplines at other institutions in Croatia and in transitional countries in general.

The success of ApID as a model of brain gain would set an example of how to initiate, organize and manage a similar project in other disciplines at other institutions in Croatia and in transitional countries in general.

7. The concept

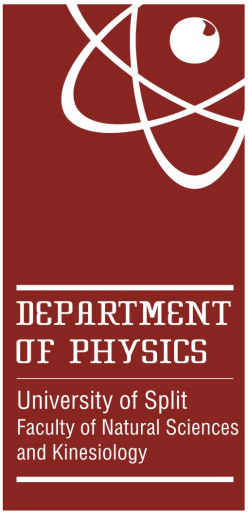
This describes the main concepts behind the implementation plan described in §8.

7.1 Department of Physics in Split

ApID is centered around the Department of Physics at the University of Split, Faculty of Natural Sciences, Mathematics and Kinesiology, with the graduate program of astrophysics at the department as the backbone of ApID. In addition, the

interdisciplinary agenda set by ApID is based on the existing interdisciplinary program at the department. Hence, the expansion and development of the department is of crucial importance for the sustainability and expansion of ApID.

In the fall of 2007, the department will be energized by the new building and accompanying infrastructural expansion. This is a part of the expansion of the university, worth about $60 million. In a nutshell, university life is the backbone of ApID and its future expansion.



Logo of the Department of Physics at the University of Split, WWW: http://fizika.pmfst.hr

The department of physics offers three-year undergraduate and two-year MSc (master's degree) graduate study programs in accordance to the Bologna processes (standardization of higher education in Europe). All courses have an option to be given in English. The next phase of expansion will also include PhD graduate programs. The current list of graduate majors within the two-year MSc in physics include:

- Astrophysics
- Biophysics
- Computational Physics
- Environmental Physics
- Educational Physics

In addition, two engineering physics majors are offered in a collaboration with the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture:

- Thermodynamic Devices
- Mechanical Systems

For future high school physics teachers, there is a possibility to obtain the following double majors in collaboration with other departments:

- Mathematics and Physics
- Physics and Computer Science

PhD programs in preparation include the following majors and collaborations:

- Physics
- Biophysics, in a collaboration with the Institute Rudjer Boskovic in Zagreb (the largest research institute in Croatia)
- International Doctoral Joint Study in Environmental Science, in collaboration with the Institute of Oceanography and Fisheries (Croatia), University of Malise (Italy), Valahia University of Targoviste (Rumania), University of Alicante (Spain), and University of Hamburg (Germany)

The department currently has:

- 10 tenured professors (4 assistant, 2 associate, 4 full), with one new tenure position already approved, but currently vacant,
- 2 postdocs,
- 7 PhD research students (they are also teaching and research assistants; they are enrolled at the University of Zagreb to receive the PhD certificate),
- one lecturer
- one laboratory assistant.

It is important to emphasize that this department is currently undergoing a significant expansion not only in its infrastructural resources, but also in human resources. The table below shows the growth in teaching and research staff for the last three years and plans for the future (next 5 years).

	2004	2005	2006	goal
tenure	4	7	10	20
postdoc	2	0	2	>10*
PhD students	5	6	7	20

* The exact number of postdocs depends on the funds available through research projects.

The new graduate program will commence during fall 2008. Currently, the department has about 100 undergraduate students. The plan is to have about 200 undergraduate students in total (about 70 at each of three undergraduate years of study) and about 120 graduates in total (about 60 at each of two graduate years of study). The exact numbers will depend on available classroom space and the number of teaching staff, as well as on the interest of students to enroll at the physics program in Split and the department's ability to attract enough funding to support high quality teaching.

Research activities at the department currently consist of:

- 5 projects funded by the Croatian Ministry of Science, Education and Sport
- 2 international research projects,
- 2 international developmental projects, and
- participating in 4 international research collaborations

Their major research topics are condensed matter, nuclear physics, high energy physics, biophysics and solid state physics. Major research collaborations include CMS (Compact Muon Solenoid) at CERN (Switzerland) and FOPI (4π heavy ion detector) and CBM (Compressed Baryonic Matter) at GSI (Germany). The goal is to greatly expand the list of collaborations and research projects, commensurate with the expansion of the department.

Major funding resources to date include:
- Croatian Ministry of Science, Education and Sport
- Croatian Science Foundation (NZZ)
- EU Commission (through Tempus and Interreg programs)
- CERN
- FP6 (through individual collaborations)
- UNESCO
- Hewlett-Packard
- Italian Ministry of Science

The department is also participating in projects of a strategic importance for Split, Croatia and the whole region of South Eastern Europe. For example, it is participating in designing the Croatian Qualification Framework and in monitoring the Bologna process in Croatia. It is interesting to notice that one such project called "*Piloting Solutions for Alleviating Brain-Drain in Croatia*", financed by UNESCO and Hewlett-Packard, helped to establish collaborations between the department and Croatian astrophysicists abroad, which eventually resulted in the development of ApID.

On a larger scale, the department coordinates two important Tempus projects:
- "Stimulating Croatia's Entrepreneurial Activities and Technology Transfer in Education – CREATE"
- "Training of Croatian and BIH Educational Institutions - CREDIT"

"Stimulating Croatia's Entrepreneurial Activities and Technology Transfer in Education– CREATE"
www.create-project.info

Project partners:
University of Rijeka (Croatia), Croatian Science Foundation, Croatian Employers' Association, Saarland University (Germany), University of Alicante (Spain), Ministry of Economy and Labor of Saarland (Germany), European Research and Project Office GmbH (Germany)

CREATE is a project within the Tempus - Erasmus Mundus Programme - Life Long Learning: Education and Training, Programmes and Actions of the European Commission. The CREATE project unites 10 institutions from three different countries for a period of three years, starting in September 2005. The consortium aims to create a national university system of support to entrepreneurial activities and technology transfer in Croatia, especially in the field of applied natural sciences. All relevant parties - Government, Education, and Business - create a unique opportunity to implement a nation-wide project and to reform the whole cluster of University Management in Croatia. Appendix §13.3 shows conclusions of the round table held at the University of Alicante, Spain, May 09, 2006, signed by representatives from 10 institutions within the CREATE project. This document defines upcoming immediate goals and obligations of the undersigned participants of the project.

"Training of Croatian and BIH Educational Institutions - CREDIT"
www.credit-project.info

Project partners:
University of Split (Croatia), University of Mostar (Bosnia and Herzegovina), Saarland University (Germany), European Research and Project Office GmbH (Germany), University of Alicante (Spain)

The project idea is to support and complement various Tempus projects in the field of internationalization of Croatian/Bosnian-Herzegovinian higher education and to strengthen the impact of the Tempus program. Therefore the project pursues the following specific objectives: 1) To provide training in partner countries for university administrators dealing with international affairs and mobility as well as for university administrators dealing with quality assurance. The objective of the training will be to improve their professional skills. 2) To develop and promote in the partner countries' Higher Education Institutions (HEIs) a set of teaching materials and a guide suitable for further training and implementation

They are also participating in **Gelato** (www.gelato.org). The Gelato Federation is the global technical community dedicated to advancing Linux on the Intel Itanium platform through collaboration, education, and leadership. It is co-founded by HP and seven of the world's leading research institutions, the Gelato Federation, also known as Gelato, is working to fulfill this mission by bringing together those developing and using Linux on Itanium for the purpose of fostering Itanium-specific research, focus groups, and collaborative discussions. An open exchange of ideas and solutions is nurtured through diverse lines of communication, including interactive areas of the Gelato portal, several interest-specific mailing lists, and regular meetings and conferences. Finally, Gelato facilitates the development and dissemination of Itanium-specific, open-source solutions, including a complete and robust tool chain.

7.2 Society znanost.org

Society znanost.org is a nonprofit nongovernmental organization registered in Croatia. It was founded in 2002 by Croatian scientists, professionals and expatriates as a nongovernmental organization whose function is to promote education, science and knowledge-based values in the society through direct action. Currently they have 21 members affiliated with institutions in Germany, USA, Italy, Great Britain and Croatia. They have organized educational programs, published scientific journals, prepared workshops for scientists and science journalists. They also founded an internet portal that connects almost 1,000 scientists and professionals with the government and the media. They aim to make their experience a useful reference for other developing societies, especially for transitional countries.

Their activities include:

- network building for knowledge professionals; reversing the brain-drain into the skills-gain
- publishing: scientific journals, books, popular articles
- education and science communication
- promoting their mission at the policy making level
- expansion of their experience and activities into other developing societies

Logo of the Society znanost.org
WWW: www.znanost.org

Znanost.org is already participating as a partner in some activities of ApID. It also has its own projects of interest to ApID. Here we describe these projects.

Nebo na Poklon
(The Sky as a Gift)
http://nebo.znanost.org
Introducing the scientific method to pupils in Croatia through astronomy

This is a unique project in Croatia of cooperation between schools, amateurs and professional astronomers. It is organized in collaboration with the Astronomical Section of the Physical Society – Split. In 2004 the project included only schools from Split-Dalmatia county. It trained 14 teachers to organize astronomy groups in their schools and helped more than 100 pupils to take their first steps in science through small astronomy projects. The 2005 projects included more than 45 teachers and 500 pupils in schools from all parts of Croatia. The project is free of charge for involved schools. Summer workshops for the best pupils in the project were organized in 2005 and 2006. These workshops were led by professional astronomers who worked with participants on small projects during the workshop or gave seminars for participants.

Connect Program
http://connect.znanost.org
Networking of Croatian scientists, educators, experts and students home and abroad

As of May 22 2006, there were 946 members. Connect's foundation is its database of scientists, educators and professionals. Members are mutually connected and communicate through Connect::Portal (portal.connect.znanost.org - online forum for Connect members), Connect::WikiFokusForum (wiki.connect.znanost.org - tool for a collaborative online work on documents), and specialized e-Connect networking mailing lists. Forum of Croatian Astronomers (FCA) is one e-Connect activity, which directly participated in creating ApID. Connect::ScienceInitiatives (csi.connect.znanost.org) is another e-Connect activity of a great importance for ApID.

Split International Winter Schools of Astrophysics SIWA
http://fizika.pmfst.hr/siwa

They are a co-organizer of the Split International Winter Schools of Astrophysics (SIWA) 2007, together with the Faculty of Natural Sciences and Kinesiology at the University of Split. This is a two-week course on extrasolar planets and astrobiology aimed at graduate and senior undergraduate students. Details of this project are given in the subsection §8.2 "Work carried out to date" below.

7.3 Faculty

Since the backbone of ApID is the astrophysics graduate program at the physics department, it is important to have a pool of competent, knowledgeable, and skillful faculty and research personnel. Establishing such a group of people is both expensive and time consuming. Hence, the initial phase of ApID is largely based on visiting professors, while long term plans also include full time astrophysics faculty positions at the physics department. An alternative source of faculty and advisors in the future may come from institutions semi-affiliated with the university, such as a prospective astrophysics institute in Split.

In general, the ApID faculty at the physics department will be:

- **visiting professors** : scientists affiliated with other institutions who will also teach in Split if their home institutions permit. Since the lectures are scheduled in blocks of a single course, visiting professors will not need to spend a whole semester in Split, but rather a few weeks necessary for completing their course. Additional curriculum activities can be performed over the Internet within the distance learning methods. Visiting professors are recruited from:
  - **foreign scientists**

• **Croatian science diaspora**
Recruitment of visiting professors affiliated with international centers of excellence and prestigious universities also helps in bringing high quality teaching to Split, enhances the international visibility of ApID, and establishes collaborations between Split and the home institutions of visiting professors.

- **local faculty at the University of Split** : in the long run, the astrophysics graduate program in Split requires local astrophysics faculty. The plan is to have at least two astrophysics faculty members working in Split in five years. Additional teaching and research staff may be present if more extensive plans become operational.
- **local non-astro faculty at the University of Split** : the list of offered courses in the astrophysics graduate program is highly interdisciplinary, where students can chose from a list of non-astrophysics topics. Such courses are covered by local faculty not related to ApID.

7.4 Students

ApID is an international program open to students from all countries. The goal is to attract the best students, irrespective of their country of origin, home institution and undergraduate background. Students participating in the graduate study program will have access to ongoing research projects and various telescopes at collaborating institutions. These types of collaborative opportunities provide students with the experience necessary to embark on successful careers after graduating. Students will also have the opportunity to chose from a series of comprehensive courses designed to greatly enhance their knowledge and skills in astrophysics, thereby making them more competitive in the field.

In addition to hands-on research experience and work visits to leading institutes and observatories, students will have opportunities to develop communication skills through a specially designed course and presentations at scientific conferences. All these activities will enable students to become competitive in the global science market

In order to attract the best students, it will be important to develop an attractive "branding" through outreach activities and advertisements of ApID. Hence, outreach and communication with the public is one of the crucial components of ApID's sustainability. This includes popular science lectures for elementary and high schools students, which is important not only for attracting some of them to professional astronomy later in their life, but mostly to build a positive view of astronomy irrespective of their later choice of career. Outreach activities should also target parents of schoolchildren because parents have a strong influence on their children's plans for the future. ApID has to offer an easy access to all relevant information to prospect students about ApID and astrophysics graduate program. This can be achieved through up-to-date information on the Web and the contact e-mail address and phone number where everyone can get a prompt answer to all questions they may have.

A large pool of prospect students is available in the region of South Eastern Europe, especially in the region of former Yugoslavia (because of language similarities). An active collaboration with amateur astronomers in the region is of great importance in that respect because they can promote ApID in their local communities and have future prospective students as their current members. Such students, who already have some astronomy experience thanks to their activities as amateur astronomers, would have a great level of basic knowledge about astronomy and astrophysics, thus also a natural advantage as prospective ApID students.

Finally, thanks to the Bologna agreement, students from other European universities can attend individual courses in Split and earn ECTS points that they can use at their home universities.

7.5 Distance learning

ApID will depend heavily, at least in the beginning, on visiting faculty. ApID should also attract students from other universities who are interested in attending one or a small number of courses offered in Split. There are also activities including conferences, workshops and science forums that will have a wide audience not limited to the personnel and visitors present in Split. It is, therefore, necessary to consider possibilities for distance learning methods that could engage participation of people in ApID activities over the Internet.

In general, Distance Learning is a model of training or education that is distributed in ways beyond the traditional classroom setting. Over the years, in developed countries, distance learning has become popular with primary, secondary, and postsecondary institutions for the enhancement of education. Individual courses and entire programs have been provided and utilized by students who wish to further their education while not returning to campus, be it by choice or circumstance. Distance learning has taken many shapes over the years, with changes driven by new technologies. Some of the latest technological advancements include the usage of handheld mobile devices – Palm Pilots®, Blackberry®, etc., and podcast audio lectures for IPods® or other MP3 players. This enables students and event participants to replay or be a part of a live event no matter how far and where they are, as long as they have the appropriate technology at hand.

Many questions and issues must be address when implementing a distance learning program. For starters, is the institution providing the program a traditional higher education institution, a consortium or another organization? When a degree program is offered electronically, does it meet the same accreditation requirements as the traditional programs? Adequate faculty support is imperative to the success of any distance learning program. Faculty are expected to be content experts in their field, but not necessarily experts in information technology, computer technical support, audio visual services, or even curriculum design experts. It is important to provide training for faculty who teach via technology. Also, determining the minimum standards for the students to have and what type of production and delivery method are a few of the keys to success. Different types of delivery may include: PowerPoint Lectures, Threaded Discussions, Audio and Visual Media, Interactive Audio and Video. A prudent line of action would be to provide distance learning modules in a mixed media format. The power of technology can be used for connecting students to one another and to the instructor via e-mail lists, chat features, and/or blogs. ApID will create an environment conducive to as much interaction with the instructor as possible.

7.6 Research

In addition to a strong focus on the graduate program in Split, that is, teaching, ApID also has a goal to develop a strong astrophysics research center in Split. Initially, research will be conducted at the physics department, as a part of its Astrophysics Initiative. However, preparations for setting up an astronomy and astrophysics institute in Split should start immediately. The institute would start with its official work when appropriate financial and infrastructural preparatory conditions are fulfilled, which means sufficient start up funds and office space. Even though the institute is a part of ApID, the work on the institute requires a separate business plan and funding because of the scope and specific challenges of such a project. The legal framework of the institute is currently not clear. The institute can be founded as (options considered so far):

1. an entirely independent institution
2. affiliated with the nonprofit nongovernmental organization (NGO) "Society znanost.org"
3. affiliated with the University of Split
4. semi-affiliated with the university and the Society znanost.org

The currently favored option is #4, but the final decision will be made after careful analysis by a team in charge of setting up the institute. Also, Croatian legislation regarding such institutions is expected to be changed in

the near future, hence, this has to be taken into consideration.

Due to limited initial resources, ApID can not afford a large spectrum of research topics. It would be prudent to collect research staff with similar research interests, so that they have an incentive to collaborate and build a strong center of excellence. Surveying professional interests of the Croatian astronomy and astrophysics diasopra reveals two potential major research programs:

- "**From dust to life**": study of the origin of planets and their evolution. This is a highly interdisciplinary program that includes topics like interstellar and interplanetary dust, protoplanetary disks and planet formation, search for extrasolar planets and evolution of planetary systems, meteors and transport of organic and inorganic material to the Earth, astrobiology and search for life on other planets in the Solar System. All these topics share a common interest in exploring how the Earth was formed and how it evolved, which also raises the question about the possibility of the existence of other Earth-like planets in the Galaxy

- "**Large-scale computations and data mining**": high-speed computations are introducing dramatic changes to modern astronomy and astrophysics. The scale and scope of modern large-scale computer simulations became so large that we have started investigating amazingly complicated natural phenomena such as the evolution of the Universe, collisions between galaxies containing millions of stars, explosions of supernovae, and many others. Computer simulations give us virtual control over various aspects of nature and produce results that can then be compared with observations through telescopes. But this complexity of computer simulations transformed them into a new branch of science. It is still a young field, where the burning issue is how to manage and develop big computer simulation codes. High-speed computers are also revolutionizing astronomy through entirely new types of astronomical projects – large-scale sky surveys. Such survey projects have to cope with a tremendous amount of data produced in a single night of observations. Extracting a particular piece of useful information out of this sea of data is a huge problem that requires new computational and statistical tools. Although this line of business requires investments into computational facilities, it is an interesting field for ApID for two reasons: i) it is a young field where ApID could find its place in the world science market, ii) all the knowledge, skills and problems related to astronomy and astrophysics can be directly utilized in other scientific fields and, most importantly, in commercial applications. In addition, the region of South Eastern Europe is lagging behind developed countries in supercomputing business,

Forum of Croatian Astronomers meets every summer in Split and contributes greatly to APID. This is a group photo from 2005 meeting: (standing, from left to right) Dario Maričić, Leandra Vranješ, Tomislav Jurkić, Dejan Vinković, Branimir Sesar, Cvitan Maro, Marin Treselj, Duje Bonacci, Bojan Pečnik. Petar Mimica, (seating, from left to right) Drago Roša, Željko Ivezić, Tomislav Prokopec, Larisa Zoranić, Marina Skender, Ana Babić, Mirela Obrić, Davor Krajnović, Ana Bedalov.

hence, ApID may find commercial partners willing to invest into ApID as a regional center for supercomputing. If ApID and the future institute evolve toward this topic, then collaborations with local and regional computational centers and computer departments will be a necessity. It would also require close collaboration with other science disciplines interested in large-scale supercomputing and data mining (such as computational chemistry and biology, neuroscience, statistical genetics, computer vision, graphics and animation, various engineering fields, etc.)

The most probable strategy for research development within ApID is a mixture of these two programs. This approach would be based on the need for supercomputing in the research on "from dust to life" program. The boost to local research can also come from specially designed lecture series at the Department of Physics. For example, a series of lectures on the topic of large-scale computer simulations would bring to Split world experts on computer simulations from various fields of astrophysics and create a highly acclaimed graduate program. Such a success can then be used as a good starting point for local research projects. Hence, creating a high quality teaching center is beneficial for the local research programs. The opposite is also true: high quality research can attract and cultivate a high quality human capital that can be recruited for teaching and mentoring.

7.7 Alumni

Alumni coming out of the graduate program at the Department of Physics are of great importance for ApID. The success of ApID will also be measured by the success of its alumni, whatever the choice of their career once they leave Split. Alumni should benefit greatly from the skills and knowledge gained during their study in Split since ApID aims at producing graduates who will become leaders, not followers. Alumni can also be a great asset for ApID if they are actively involved in the process of supporting or improving the quality of ApID. In order to capitalize on this asset, ApID has to invest in keeping close ties with its alumni. The alumni should be considered for participating in:

- quality evaluations of various ApID activities
- promotion of ApID and information dissemination
- recruitment of new high quality students and personnel for ApID
- lobbying in favor of ApID at various instances
- advising ApID on various topics
- fostering international collaborations with ApID
- providing science and technology intelligence information for ApID
- bringing new activities to ApID
- actively supporting existing ApID activities

One has to bare in mind that the role of alumni in the European system of higher education and research centers is substantially different from the approach used in the United States. While alumni are an integral part of the life and development of US institutions, European institutions are less oriented toward their alumni. Without going into a discussion on why this happens, it is important to acknowledge the situation and prepare ApID for problems that may arise from this cultural difference, considering that ApID will put a strong emphasis on its alumni.

This is especially important in the context of transitional countries like Croatia where people who have remained working at their home institutions often consider alumni as a threat. Attempts made by Croatia to boost brain gain have escalated this problem because Croatian alumni, who often emigrated and became expatriates, are naturally the first to participate in the process of brain gain. Such alumni also bring a new worldview to Croatia, which collides with the local scientific and education culture. The result is a strong cultural shock where both the alumni and the alma mater have to learn how to anticipate and then mitigate negative side effects of this shock. The advantage of ApID is that it can incorporate a positive view toward its alumni into its founding principles. Hence, ApID students will be thought about the importance of alumni and how they can benefit in their careers from such a long lasting collaboration with ApID.

7.8 International collaboration

Since ApID aims at creating a center of excellence in research and teaching, international collaborations on both institutional and individual level are the integral part of ApID. Such collaborations should be encouraged and supported because sustainability and development of ApID requires a growing number of international links. These links cover a range of issues including curriculum development, student exchange, cutting-edge research, and staff development and exchange. Such collaborations are also actively supported by funding agencies around the world. In short, ApID is in its essence an international collaboration and only as such can survive and excel.

The 2006 Summer Meeting of the Forum of Croatian Astronomers was mostly devoted to discussing the ApID's business strategy and various components of its implementation. Participants: Ana Babić, Ana Bedalov, Alen Brković, Dijana Dominis, Mile Dželalija, Željko Ivezić, Davor Krajnović, Robert Lupton, Petar Mimica, Mirela Obrić, Bojan Pečnik, Tomislav Prokopec, Branimir Sesar, Marin Treselj, Dejan Vinković, Leandra Vranješ, Larisa Zoranić

7.9 Professional astronomy and astrophysics in the region of South Eastern Europe

A brief review of professional astronomy and astrophysics institutions and research centers in South Eastern Europe (August 2006 - data may be incomplete).

CROATIA

When compared to other regional countries of comparable economic and political development, Croatia is lagging dramatically behind many of them in the status of its astronomy and astrophysics. This makes ApID an important developmental component of Croatian science. This also provides opportunities for regional scientific collaborations, especially when competing for funds within the EU. Although Croatia is still a candidate country for joining the EU, it is already a full member of the European Framework Program (FP) 6 and the upcoming FP7.

Observatory Hvar
http://www.geof.hr/oh

- 4 astronomers, 4 graduate students, 1 technical staff
- the main field of research is plasma physics, solar astrophysics, stellar astrophysics (variable stars, early type stars)
- publications: *Hvar Observatory Bulletin*, http://www.geof.hr/oh/hob

- telescopes: 1m ("Austrian-Croatian Telescope"), 0.65m, and a solar telescope

Physics Department, University of Zagreb
http://www.phy.hr
- Two astrophysicists, 1 graduate student
- stellar astrophysics
- 9 undergraduate and 5 graduate astrophysics courses offered
- this is the biggest and most influential physics department in Croatia (all Croatian astrophysics lecturers in Split are alumni of this department)

Department of Physics, University of Rijeka
- 3 scientists and 2 graduate students working in astrophysics, but officially they are affiliated with other disciplines (Department of Physics will officially become operational in the end of 2006)
- stellar astrophysics, spectroscopy
- 1 undergraduate course offered, but several other courses cover some aspects of astronomy and astrophysics

CROATEA observatory
http://www.irb.hr/-PIND-/en/research/projects/mztprojects/fizika/0098144/
- High energy cosmic gamma-ray research: CROATEA (Cosmic Ray Observatory At The Eastern Adriatic)
- They are currently prospecting a suitable location for these telescopes.

Višnjan Observatory
http://www.astro.hr
- initially started as an amateur observatory, now it has one astronomer employed
- it became world renown for more than 1400 asteroids discovered mostly in the late 1990's
- now it is active mostly in education of elementary and high school pupils
- 1m telescope under construction

Croatian Astronomical Society
- represents Croatian professional astronomy and astrophysics in international organizations

Forum of Croatian Astronomers
http://astro.connect.znanost.org
- an informal on-line assembly of professional Croatian astronomers with the goal of exchanging useful professional information and connecting the growing number of Croatian astronomers around the world and in the country
- FCA participated in the creation of ApID

OTHER COUNTRIES

ALBANIA
- No significant professional activity

BOSNIA AND HERZEGOVINA
- No significant professional activity

BULGARIA

Institute of Astronomy at the Bulgarian Academy of Sciences
- It carries out education and fundamental research in astronomy and astrophysics
- Two modern observatories for optical observations and research belong to the Institute - the National Astronomical Observatory at Rozhen and the Astronomical Observatory in Belogradchik.

National Astronomical Observatory (NAO) – Rozhen
  - Telescopes: 2-meter Ritchey-Chretien-Coude, 50/70 cm Schmidt, and 60 cm Cassegrain
  - About 50 astronomers who work on:
    - Small bodies in the Solar system (physics and chemistry of asteroids, comets, planet satelites)
    - Solar astrophysics (computer simulations of active processes, magnetohydrodynamical modelling)
    - Stellar astrophysics (symbiotic stars, peculiar stars, cataclismic variables, flare stars)
    - Extragalactic research (active galactic nuclei, large scale structures in the Universe, cosmology)

Astronomical Observatory - Belogradchik
  - Telescopes: Cassegrain 60cm - Zeiss. Schmidt-Cassegrain 14inch - Celestron. Cassegrain 15cm – Zeiss.
  - 4 scientists and 2 staff

Department of Astronomy, Faculty of Physics, Sofia University
- 9 scientists

GREECE

- *Probably the most advanced professional astronomy and astrophysics in the region of South Eastern Europe*
- Nearly 100 teaching and research personnel at some eight departments and institutes are active in astronomy and astrophysics in Greece.
- A comprehensive review of this field is given in the report of External Committee of Experts: "Astronomy in Greece at the Gates of the 21st Century" http://www.astro.noa.gr/gnca/NEWS/Astro2000rept.pdf
- A weakly updated web-page with a list of astronomy activities, news and resources directly related to the professional and amateur astronomical community of Greece: http://www.astro.auth.gr/elaset/events.html
- Review of telescope facilities (the largest has 2.3m): http://www.astro.auth.gr/elaset/telescopes.html
- Greek National Committee for Astronomy: http://www.astro.noa.gr/gnca/
- Hellenic Astronomical Society: http://www.astro.auth.gr/elaset

HUNGARY

Konkoly Observatory of the Hungarian Academy of Sciences

- http://www.konkoly.hu
- 34 scientists, 10 managers and support staff
- Telescopes: 60 cm Cassegrain telescope, 50cm Cassegrain telescope, 60/90 cm Schmidt telescope, and 1m RCC telescope
- Research:
  - Stellar structure and evolution (pulsating variables, spotted variables, eclipsing binaries, theoretical studies of pulsations)
  - Galactic structure, interstellar matter and star formation
  - Upper atmosphere research
  - Solar system
- Publications:
  - Communications/Mitteilungen the Konkoly Observatory - papers with large amounts of observational data, and proceedings of workshops and meetings held in the Observatory
  - Works from the field of History of Astronomy are published in the "Monographs" series.
  - The "Occasional Technical Notes" series contains user guides for the various technical facilities of the Konkoly Observatory, and software developed at the Observatory.
- The Konkoly Observatory and the Department of Astronomy, Eötvös Loránd University, operate a joint astrophysical laboratory. The Observatory staff members also teach at the Szeged University.

Szeged Observatory at the University of Szeged

- http://astro.u-szeged.hu
- 10 astronomers/researchers
- Telescopes: 40 cm Cassegrain, 28 cm CG-11 Celestron, 20cm Newtonian, 80/1200 and 63/840 Zeiss refractors
- Research interest: photometry and spectroscopy of variable stars (delta Scuti, RR Lyrae, pulsating stars in binary systems, Cepheids, supernovae, eclipsing binaries, variable stars in stellar clusters), CCD photometry and astrometry of minor planets and comets, automation of telescopes
- Education: undergraduate and graduate (PhD) courses
- Outreach: lectures for high-school students, "open hours" and presentations for the general public,

Department of Astronomy at the Eötvös Loránd University

- http://astro.elte.hu
- 7 scientists/researchers, 7 PhD students. several guest researchers
- Research: celestial mechanics, solar and astrophysical magnetohydrodynamics, galactic astronomy, cosmology
- Education: MSc program in astronomy

Other public observatories: *Gothard Observatory at the Eötvös Loránd University, Baja Astronomical Observatory, Szekszárd Public Observatory, Kiskunhalas Public Observatory, Satellite Geodetic Observatory in Penc, Debrecen Heliophysical Observatory*

MACEDONIA

- No professional observatories
- A limited astrophysics activity at the Institute for Physics (Faculty of Natural Sciences & Mathematics, Sts. Cyril & Methodius University, Skopje)
- One specialized astronomy course was introduced at the Institute in 2005.

MONTENEGRO

- Two astronomy courses are taught at the University of Montenegro:
  - http://www.ucg.cg.ac.yu/index_en.htm

ROMANIA

Institute of Space Sciences (ISS)

- http://venus.nipne.ro
- laboratories:
  - Space Research Laboratory (groups: 1. theoretical physics and astrophysics; mathematical physics, 2. cosmology, 3. cosmic rays and nuclear astrophysics)
  - Space Engineering Laboratory (Fundamental and advanced technological research in space magnetometry and plasmas, remote sensing and space technology. Development of special computational and treatment techniques for satellite data processing)
  - Gravitational Laboratory (1. Gravitation - theoretical methods for the investigation of gravitation and space-time structures, 2. Microgravity - advanced and applied research in high sensitivity inertial sensors, low-g statistical and dynamical accelerometers, 3. Celestial mechanics - the study of the trajectories of cosmic objects)
- ISS National Center of Excellence: http://venus.nipne.ro/ce/

Astronomical Institute of the Romanian Academy

- http://www.astro.ro
- observatories: http://www.astro.ro/adr.htm
- publications: Romanian Astronomical Journal

Romanian Space Agency

- http://www.rosa.ro
- Romania develops significant activity in Aeronautics and Space, as for science, industry and education: http://portal.rosa.ro/index.php?item_id=-3
- ROSA projects: http://portal.rosa.ro/index.php?category_id=4

SERBIA

This review is mostly based on the presentation "Astronomy in Serbia and Montenegro" by Olga Atanacković-Vukmanović given at the XXVIth General Assembly of the International Astronomical Union in Prague, Czech Republic, 14-25 August 2006

- Astronomy topics are taught at five universities in Serbia: Belgrade, Novi Sad, Niš, Kragujevac and Priština (Kosovska Mitrovica).
- The University of Belgrade is the only university with a department of astronomy.

University of Belgrade: Department of Astronomy (at the Faculty of Mathematics)

- http://astro.matf.bg.ac.yu/eng2.htm
- About 4-6 students graduate each year
- So far 220 students received BSc degree, 58 received MSc degree, and 28 students received PhD degree.
- Staff: 6 professors, 3 assistants
- Fields of research interest: Earth rotation, dynamics of asteroids, stellar kinematics and dynamics, solar physics, stellar structure, radiative transfer, interstellar medium, supernova remnants, active galactic nuclei

Astronomical Observatory, Belgrade

- http://www.aob.bg.ac.yu
- Staff: 49 (35 researches)
- Equipment:
  - Refractor - equatorial Zeiss 650/10550 mm
  - Solar spectrograph Littrow type, collimator lens 200/9000 mm
  - Large Meridian Circle Askania 190/2578 mm
  - 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)
- Research fields of interest: astrometry and dynamical astronomy (solar system, double stars, Earth rotation), astrophysics (variable stars, Solar physics, close binary stars, astronomical spectroscopy, galactic astronomy, extragalactic astronomy, cosmology, astrobiology), history of astronomy
- Publications:
  - Since 1936: Bulletin de l'Observatoire astronomique de Belgrade, since 1992 titled Bulletin astronomique de Belgrade,

since 1998 titled Serbian Astronomical Journal (http://saj.matf.bg.ac.yu)
  - Since 1947: Publications of the Astronomical Observatory of Belgrade

SLOVENIA

Astronomical Observatory at the Department of Physics, University of Ljubljana

- http://www.fiz.uni-lj.si/astro
- 6 astronomers/researchers, several PhD students
- Telescopes: 70cm Cassegrain, 36-cm Schmidt-Cassegrain and robotic 25cm Schmidt-Cassegrain
- Research: radial velocity survey, gamma ray bursts, cosmology, theory and observation of eclipsing binaries, observations of variable stars, accretion process around black holes ,etc.
- Education: undergraduate and graduate level programs in astronomy and astrophysics at the Department of Physics

Črni Vrh Observatory

- http://www.observatorij.org
- semi-professional institution, collaborating with the Department of Physics, University of Ljubljana
- 5 research/operation staff
- Telescopes: robotic 60cm Deltagraph, 19-cm Automatic Comet Imaging Telescope, 36-cm Automatic Imaging Telescope
- Research: asteroid and comet search, asteroid and comet observations

7.10 Amateur astronomy in the region of South Eastern Europe

Current status of amateur astronomy in South Eastern Europe (May 2006 - data may be incomplete).

CROATIA

- Croatia has one of the largest and best organized amateur astronomers' communities in SE Europe. There are more than 20 active AA clubs and their numbers are growing year by year.
- Most of the clubs actively work with school children, both in practical astronomy and in theoretical work (preparing pupils for school astronomy competitions).
- Almost all clubs hold more or less regular public observations with telescopes and, somewhat less often, public lectures.
- A few clubs have observatories. Several individuals also have small private observatories. Few other observatories are being built or are still in planning phase. Many Croatian astronomers build their own telescopes, activity known as Amateur Telescope Making (ATM).
- There are two major astronomy journals in Croatia - "Čovjek i svemir" ("Man and the universe") and "Polaris" (monthly). A few other journals are published irregularly.
- Light pollution is becoming a serious problem in the last few years and many amateur astronomers are trying to present this problem to the public.
- Other areas of interest to Croatian amateur astronomers are meteors, variable stars, astrophotography, radio-astronomy, etc. Višnjan Observatory is very famous for their discovery of more than 1400 asteroids to date (mostly in the late 1990's).
- Croatian amateur astronomers are very well connected, primarily through the newsgroup "hr.sci.astronomija" (former "hr.fido.astronomija"). This newsgroup is a central place for organizing all kind of meetings, star parties, selling and buying of equipment, etc. Some clubs communicate internally through mailing-lists.
- Star parties are organized regularly (up to 30 participants from Croatia and Slovenia, sometimes from Italy, Serbia and Macedonia)
- Astro-clubs from NW part of Croatia are members of informal international coordination of amateur societies "Alpe-Adria" that also includes clubs from Slovenia and the Italian region Friuli-Venezia-Giulia.
- In the year 2004, Society "znanost.org" and the Astronomical section of the Physical Society - Split started "Nebo na poklon" (The sky as a Gift) – see text about Society znanost.org in §7.2 to learn more about this project.

OTHER COUNTRIES

ALBANIA

- There is no information on amateur astronomy activities in Albania. This may be due to actual non-existence of amateur astronomers or due to very low Albanian presence on the Internet.

BOSNIA AND HERZEGOVINA

- According to available data, there are no active amateur astronomer clubs.
- There are some unconfirmed reports of revival of astronomy groups in Sarajevo - once one of the best organized astronomical communities in the region.

BULGARIA

- There are several astro-clubs in Bulgaria.
- Activities: star parties, observations of meteors, variable stars and asteroids, education (in schools).
- Cooperation between amateurs and professionals exists, but is not very common.

GREECE

- There are several astro-clubs in Greece.
- Prominent activities: the Pan-Hellenic Student competition in Astronomy and Space Science, Pan-Hellenic Amateur Astronomy conferences, and lately there are attempts to organize the "Balkan Olympiad in Astronomy".
- Other activities: astronomy lessons for beginners, public lectures, observations, astro-parties, occasional weekend excursions.

HUNGARY

- Hungarian astronomers, both amateurs and professionals, are organized in "Hungarian Astronomical Association (HAA)" (in Hungarian: MCSE), with astro-groups in Budapest and 16 other cities.
- HAA members receive free copies of "Meteor", the monthly journal of the HAA, and astronomical almanacs containing ephemerides, data tables, astronomical news and review articles written by professional astronomers.
- The association is divided into interest groups: Planets, Sun, Moon, Comets, Meteor observations, Double stars, Variable stars, Deep-sky objects, Occultations, Sundials, Astronomical History, CCD technology and Informatics. Observations and results of these interest groups are published in "Meteor" and, in lesser extent, on HAA WebPages.
- HAA organizes summer camps for high school students interested in astronomy. Also, there are yearly observing and telescope-building meetings aimed at amateur astronomers.

MACEDONIA

- There are 3 active astro-clubs in Macedonia.
- Outreach: cooperation with the media – providing astronomy information, participating on radio or TV shows and on programs of informative and educational character.
- Activities: public lectures, public astronomy courses, astronomy-camps, observing sessions for public or just for club members, observing astronomical phenomena such as eclipses, meteor showers, comets, oppositions, conjunctions, etc.
- Three issues so far of the magazine "Vselena" ("Space") as feuilleton in the daily newspaper "Vest". Now, the bulletin called "Merak" is published regularly.
- Macedonian Astronomical society is a top-level organization that represents Macedonian astronomers internationally.

MONTENEGRO

- There is just one amateur astronomy society in Montenegro, founded in 2004.
- Some schools in the city of Herceg-Novi have astronomy groups and, generally, amateur astronomy seems to be on the rise.

SERBIA

- There are 10 to 15 active AA clubs in Serbia.
- Activities: public lectures, public star parties (participation of up to 80 astronomers from Serbia, Croatia, Bosnia-Herzegovina and Macedonia), radio-astronomy, ethno-astronomy (traditional stories related to astronomy).
- Few clubs have observatories and/or planetaria where they can organize public observing sessions with telescopes.
- Petnica research station (Istraživačka stanica "Petnica") in Valjevo organizes a school of astronomy for tens of secondary school pupils every year. Research station is equipped with laboratories, cabinets and observatory.
- Two astronomy periodicals - "Vasiona" and "Astronomija". "Astronomija" is also read in

Croatia, Bosnia-Herzegovina and Macedonia and is probably the most popular astronomy magazine in the region.
- Cooperation between amateur and professional astronomers is very good. Lack of support from the government and local authorities is the main reason for lack of funds that inhibits faster development.

SLOVAKIA
- Slovak amateur astronomers are organized in the hobby association "Slovak Union of Amateur Astronomers" (SVAA), founded in 1970. At present it has over 250 members. SVAA members work in 17 local organizations.
- Activities: meteor observations, lunar occultations, occultation of minor planets, graze occultations, comets, variable stars, Sun observing, eclipses and astrophotography.
- Outreach activities: youth program, public lectures, discussion meetings, public observation with telescopes, etc.
- SUAA cooperates with the Slovak Astronomical Society, Astronomical Institute of the Slovak Academy of Sciences, Comenius University - Department of Astronomy, public observatories, etc.

SLOVENIA
- There are a few astro-clubs in Slovenia.
- Their primary activities are comets, solar activity and meteor astronomy. Building of an observatory near Ljubljana is planned for the near future. The only existing observatory in Slovenia is "Črni Vrh".

Some Slovenian amateur astronomers are very active and prominent members of the International Meteor Organization.

7.11 Outreach

Advancements in science and technology require an environment that understands the importance of science for society and supports investments in scientific research. It is, therefore, in the best interest of scientists to contrive outreach activities that disseminate the information about their work. Moreover so, astronomy and astrophysics are scientific disciplines supported mostly from public funds. This creates an obligation for these scientists to engage in outreach activities and promote the public understanding of science.

Only in this manner initiatives like ApID will become sustainable and thrive. Outreach is, therefore, together with research and education, the foundation of ApID. For maximum effect these three basic components have to function synergistically with each other. Considering such a large scope and importance of ApID, efficient implementation and coordination of outreach activities requires specialized personnel and considerable budgetary expenditures.

In a more general context, outreach provides science education to the general public. This is an essential component of a democratic society in which the public makes decisions related to science and technology that shape the modern economies. Hence, outreach also serves as an indirect tool of public policy-making. Often methods and channels of communication resulting in such long-term effects are not obvious. For example, if ApID helps teachers learn how to communicate science literacy, he or she will pass on that knowledge to the pupils and the local community. Through such a two-step approach ApID will often achieve a greater long-lasting impact on the general public than through direct engagement under the same budgetary constraints.

Outreach is, together with research and education, the foundation of ApID.

For maximum effect these three basic components have to function synergistically with each other.

8. Implementing the vision

8.1 Formal organizational structure

What is ApID?:

- ApID is a collaboration of activities, institutions, and individuals, from professional scientists to amateur astronomers, sharing the common interest in advancing astronomy and astrophysics in the region of Dalmatia.
- ApID helps collaboration members
  - coordinate their research, education, and outreach activities,
  - reduce operational costs through synergies and common logistical resources,
  - increase public visibility,
  - and enhance fundraising opportunities.
- Legally, ApID is a project of the Society znanost.org (non-government non-profit organization), conducted in collaboration with the Department of Physics at the University of Split.
- Fiscally, ApID is responsible to the Executive Board of znanost.org.

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Modular approach: ApID is a collaboration of activities organized as stand-alone projects (see e.g. §8.12), with each project having its own project leader. This enables targeted fundraising, accountable system of operation and minimization of negative side-effects of unsuccessful projects (e.g. budget overruns on one project have no impact on other projects; one project cannot take over all resources).

Implementation and Coordination Board (ICB): ApID is governed by the Implementation and Coordination Board (ICB). ICB is a group of scientists and administrators (4-6 members) responsible for coordinating the work on ApID and overseeing its overall implementation. Members of ICB are elected annually (during Summer Meetings of the Forum of Croatian Astronomers) from scientists and collaborators involved in ApID, and confirmed by the Executive Board of znanost.org. One ICB member is always appointed by the Department of Physics as their representative. ICB members for 2006/2007 term are:

- *Ana Bedalov* (Astrophysical Institute and University Observatory, Jena, Germany)
- *Bojan Pečnik* (Astrophysical Institute, University of Jena, Germany & Department of Physics, University of Split, Croatia)
- *Mile Dželalija* (Department of Physics, University of Split, Croatia)
- *Dejan Vinković* (Institute for Advanced Study, Princeton)

ApID consists of individual projects with their own project leaders.

ApID primarily serves as a common unifying framework and a provider of logistical support and coordination to individual projects.

Advisory Board (AB): AB provides independent scientific and business advice on the implementation of shared vision and governance of ApID. The AB consists of a mix of people from industry, research, and academia, as well as scientific and public policy experts, with experience in similar types of initiatives.

Fiscal responsibilities: ApID is a project of znanost.org. ICB as the governing body of ApID is fiscally responsible to the Executive Board of znanost.org. Responsibilities of individual projects towards collaborating institutions are defined on a per project basis according to the needs of those projects.

ApID acquires funding in two ways:

i) Direct fundraising
ii) Donations from

excess revenues of individual ApID projects.

All funds accumulated by ApID will be used for supporting the needs of ApID projects and logistics.

8.2 Work carried out to date

Design of the curriculum for the master's degree in astrophysics

A completely new/novel curriculum for the astrophysics program at the University of Split was developed in the winter of 2005. The curriculum was officially approved by the Ministry of Science, Education, and Sport in the spring of 2005. The first students will enter the program in fall 2008. The curriculum is compatible with the Bologna convention. Details of the curriculum are given in the section "Graduate (Master's Degree) program in astrophysics at the University of Split" below.

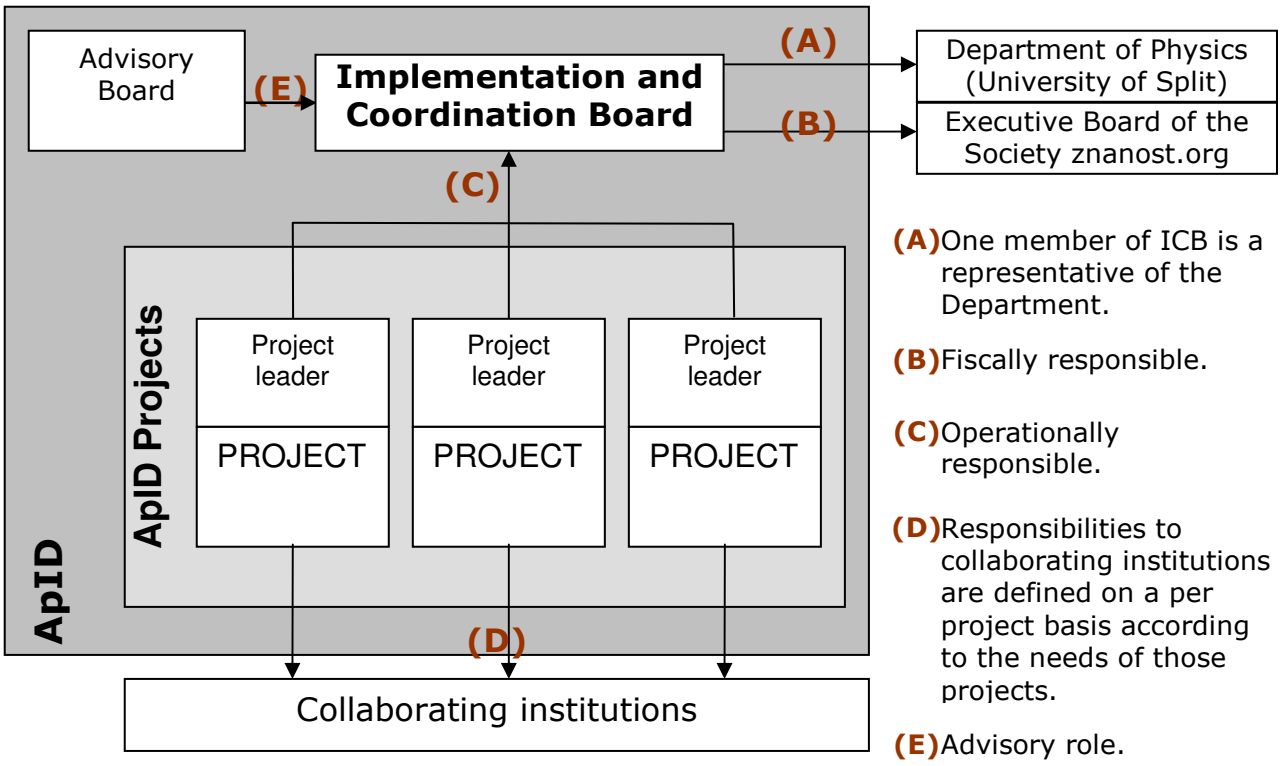
Web pages of the master's degree program in Split: http://fizika.pmfst.hr/astro

Setup of web infrastructure

Fully functional and professionally designed WebPages of the astrophysics graduate program have been set at: http://fizika.pmfst.hr/astro

Presenting the graduate program in astrophysics in Split at the IAU XXVIth General Assembly

Davor Krajnović (University of Oxford, UK) talked about studying astrophysics in Split at the

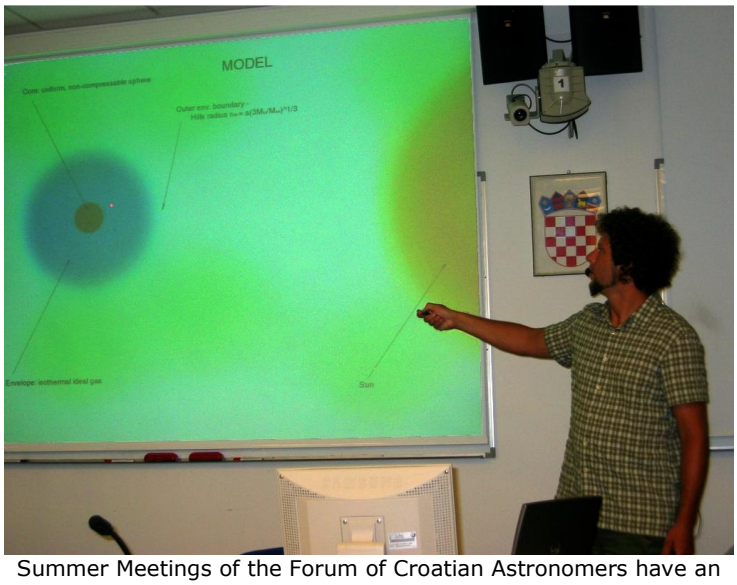


Flowchart of operational and fiscal responsibilities (directions of responsibility are marked with arrows).

XXVIth General Assembly of the International Astronomical Union in Prague on August 22nd, 2006. His presentation about the astrophysics graduate program at the University of Split is also featured in the proceedings of the General Assembly. A preprint of this presentation is available at:
http://www.arxiv.org/abs/physics/0610062

Collaborations with international institutions established

Collaborations with the Department of Astrophysics at the University of Washington, USA, the Astrophysical Institute at the University of Jena, Germany and the Department of Physics and Astronomy at the University of Kentucky, USA, were established with the purpose of student exchange program.



Summer Meetings of the Forum of Croatian Astronomers have an important role in APID.

Croatian National Science Foundation (NZZ) support

Croatian NZZ recognized the vision of the develop-ment of astrophysics in Split and granted a one-year research stipend to Dr. Bojan Pečnik for his work on the project "Mass-Determining Processes for Pegazi-Planets". This is a collaborative project with the Astronomy Institute at the University of Jena and the Department of Physics in Split. In addition, as a part of this support, a professorship position at the Department of Physics in Split is already allocated for dr. Pečnik after the completion of this project.
http://www.nzz.hr/docs/postdoc_rezultati.php#pecnik

Obtaining a dedicated Web/IT server

The Society znanost.org has signed a contract with the Department of Physics in Split to have their web-server located at the department and, in return, the astrophysics program at the department can use it freely for its Web/IT needs.

Donations for a new astrophysics library

One crucial component for success is the availability of literature. More than 80 books and 100 textbooks have already been donated together with a large set of journals (over 2 tons in total): all issues of the Astrophysical Journal and the Astronomical Journal since 1960, Monthly Notices of the Royal Astronomical Society since 1965, and Publications of the Astronomical Society of the Pacific since 1971. Books and textbooks were donated by a number of people, while the journals were donated by Dr. *Bruce*

The team of volunteers packing and transporting Dr. Baum's donation of journals and books to the Department of Physics in Split. Standing (left to right): Amy Kimball, William Baum, Bill's wife, Marko Pavić, Oliver Fraser; lower row (left to right): Mirela Obrić, Jill Meyer, Branimir Sesar. Željko Ivezić is taking the photo.

Partridge, Professor of Astronomy at Haverford College, USA, and Dr. *William Baum*, Research Professor at the Astronomy Department, University of Washington, USA. Transportation from the US to Croatia was courtesy of Fr. *Gio Belanich* and Croatian Relief Services, Fairview, USA. These donations enable the startup of an astrophysics library at the University of Split.

Dr. Bruce Partridge donated a large volume of astronomical journals to the future astrophysical institute in Split.

Annual meetings of the Forum of Croatian Astronomers

Croatian astronomers, both domestic and expatriates, meet in Split annually and have round table discussions, on topics ranging from professional presentations and networking, to collaborations on the future of astrophysics in Split. They also play a crucial role in designing ApID.
2006: astro.connect.znanost.org/2006_Summer_meeting
2005: connect.znanost.org/astro/2005_Summer_meeting_FCA.html

Flyer of the Split International Winter school of Astrophysics 2007

Split International Winter Schools of Astrophysics (SIWA)

Split (February 19 - March 3, 2007) – the first in a series of SIWA projects has been set up by the Faculty of Natural Sciences and Kinesiology and the Society znanost.org. SIWA 2007 is a two-week course on extrasolar planets and astrobiology aimed at graduate and senior undergraduate students. The winter school will also present to students the concept of the astrophysics MSc program in Split. Attendees are awarded 4 ECTS points for successful completion of the school.
Web: http://fizika.pmfst.hr/siwa

Press conference in Split in the summer 2005 when the new astrophysics graduate program was introduced to the public.

Media coverage

Information about ApID activities and the new astrophysics graduate program in Split have been presented in the media on several occasions. In the summer of 2005, a press conference was organized together with a

representative of the Ministry of Science, Education and Sport to announce the new astrophysics graduate program in Split. Since then representatives of ApID have often been featured in the Croatian news talking about astrophysics and ApID activities.

There have been a number of articles in daily newspapers, magazines, and TV featuring APID activities and personnel.

Collaboration with "The Sky as a Gift" project

ApID personnel have been actively involved in the project "The Sky as a Gift". This is a unique project in Croatia of cooperation between schools and amateur and professional astronomers. It is organized by the Society znanost.org and the Astronomical Section of the Physical Society – Split.
Web: http://nebo.znanost.org

"Astronomical Image Processing" workshop

Dubrovnik (September 4-9, 2006) – This workshop provided participants with the skills needed to understand the outputs of current and next-generation surveys, and to be in a position to contribute to the algorithm development needed to make new data-intensive projects a reality. Around 30 lectures were given by lecturers including: Peter Stetson (DAOPhot), Emmanuel Bertin (SExtractor), Robert Lupton (SDSS photo), Eugene Magnier (PanSTARRS photo), and Jim Gunn (Princeton).
Web: http://www.astro.washington.edu/aipw/

A software Framework for Simulating Stellar Systems (MODEST 7a)

Split (August 24 – September 1, 2007) - MOdeling DEnse STellar systems (MODEST, www.manybody.org/modest) is a collaboration between various groups working in stellar dynamics, stellar evolution, and stellar hydrodynamics. They hold renowned workshops at locations around the world on the topic of N-body simulations. The workshop will focus on the development of a software framework for simulations of dense stellar systems, such as globular clusters and galactic nuclei.
Web: http://conferences.znanost.org/n-body2007

Videoconference about setting up an institute

In a collaboration with the e-Connect activity *Connect::Science Initiatives*, a video-conference entitled "*Setting up a World-Class Science Institute: Difficulties and Possibilities*" was organized on June 08, 2006. This was a two-hour forum on problems and possibili-ties surrounding the start-up of a modern science institute in developing countries, with a special focus on the country of Croatia. This panel brought together representatives of:

- **Science Initiative Group** (msi-sig.org)
- **Croatian Ministry of Science and Education** (mzos.hr)

- **Rudjer Bošković Institute** (www.irb.hr)
- **University of Rijeka** (www.uniri.hr)
- **University of Split** (www.unist.hr)
- **Croatian National Foundation for Science** (www.nzz.hr)
- **Mediterranean Institute for Life Sciences** (medils.hr)
- **ApID**

Video recording of the whole event is available online at: http://csi.connect.znanost.org

A videoconference entitled "*Setting up a World-Class Science Institute: Difficulties and Possibilities*" was organized in June 2006 to discuss options for setting up an astronomy institute in Croatia.

8.3 Graduate (Master's Degree) program in astrophysics at the University of Split

The astrophysics graduate program is organized as a part of the two-year master's degree program at the Department of Physics within the Faculty of Natural Sciences, Mathematics and Kinesiology. This graduate program follows the specifications and guidelines of the Bologna Process, which is based on the Bologna declaration of the European Ministers of Education, signed in June 1999. In this declaration, Ministers agreed on important joint objectives for the development of a coherent and cohesive European Higher Education Area by 2010. In 2005 Croatia officially adopted the Bologna Process guidelines as a model for its higher education system. Therefore, all higher education programs in Croatia are to be organized in accordance to the Bologna Process and adopt the European Credit Transfer and Accumulation System (ECTS). According to the ECTS, students receive ECTS points after successfully completing each course or any other activity specified in the curriculum. These points are then transferable to other higher education institutions across Europe, which allows standardization of higher education programs and stimulates student mobility.

Logo of the Astrophysics Program at the Department of Physics at the University of Split http://fizika.pmfst.hr/astro

Physics studies at the Department of Physics in Split consist of three-year undergraduate and two year master's degree graduate study programs. All courses have an option to be given in English. Astrophysics is one of the majors offered for the two year master's degree study. The astrophysics curriculum was designed by Croatian astronomers and astrophysicists working abroad at institutions such as Princeton University (Princeton, USA), University of Washington (Seattle, USA), Institute for Advanced Study (Princeton, USA), Astrophysical Institute and University Observatory at the University of Jena (Jena, Germany), European Southern Observatory (Garching, Germany), University of Oxford (Oxford, UK), Max-Planck-Institut für extraterrestrische Physik (Garching, Germany), Universitat de Valencia (Spain), etc. The curriculum was approved by the Croatian Ministry of Science, Education and Sport in spring 2005.

The first students will enter the

astrophysics major in fall 2008, when the first generation of "Bologna students", who enrolled in fall 2005, will be finishing their undergraduate studies. Students will have required courses and elective courses. Astrophysics lectures are organized in blocks of 2-4 weeks, with exams included within a block. Between the blocks students can attend elective courses, which include courses from non-astrophysics majors.

Since the whole astrophysics program was built from scratch, there was no local astrophysics faculty. Hence, all lecturers were visitors from other institutions. Currently there is one local prospective astrophysics faculty at the Department of Physics, with more to come. However, even if there is enough local faculty to cover all astrophysics courses, the plan is to always have a significant fraction of visiting faculty from other institutions. This would establish the astrophysics graduate program in Split as a very dynamic place. All costs for visiting faculty will be covered by the University of Split. In order to constantly improve the quality of the graduate program, all lecturers should be evaluated by students, independent agencies, and/or by a qualified person from the university.

Students will have to complete at least two research projects during the two-year period in order to graduate. At least one of these projects has to be done abroad. Hence, international collaborations and external faculty are an integral part of the astrophysics program. The department will have to secure additional funds to support these student travels. It would be also prudent to secure additional funds for free textbooks for each student. Student will also have free access to computer facilities, which is crucial for the quality of their education.

Details of the curriculum and individual astrophysics courses are described in Appendix §13.5 and §13.6, while here we list only their titles and accompanying lecturers. It is worth of mentioning that one of the required courses is "Science Communication: An introduction to press relations, public promotion and project management in science". This is a unique example in this part of Europe of a graduate program in natural sciences that requires students to learn science communication skills.

Type of program	Graduate
Program title	Physics, Orientation (Major): astrophysics
Duration	2 years
ECTS points	120 in total
Admission requirements	Completed Undergraduate study program in Physics, or some similar study program. Students who do not have all the necessary competences are required to attend the prerequisite courses.
Learning outcomes and competences	Students acquire: • modeling skills • problem solving skills by applying acquired knowledge • ability to absorb new knowledge • skills of efficient adjustment to new problems and situations. These competences, together with a deep understanding of physics, enable students to continue postgraduate studies of physics, participate in scientific projects and work in occupations that require both basic and applied knowledge of physics. Acquired competences within the astrophysics major enable: - work in astronomical observatories - work in institutes and institutions on astronomical or astrophysical research - work in occupations that demand wide knowledge of natural sciences, especially young interdisciplinary scientific disciplines.
Access to further studies	Students can continue education at postgraduate studies in physics or in similar study programs.
Qualification awarded	Master of Science in Physics, orientation astrophysics

1.Semester

Required courses:

Course title	Course structure* L+S+E+P	ECTS points	Lecturers
Quantum physics II	30+0+15+0	5	
Modern astrophysics I	30+0+30+0	5	M.Elitzur M.Rejkuba
Methods of observational astronomy I	10+0+20+0	3	R.Neuhauser A.Bedalov
Research	0+20+0+0	5	
Elective courses		12	

* Hours: L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

Elective Courses:

Course title	Course structure* L+S+E+P	ECTS points	Lecturers
History of astronomy	30+15+0+0	3	G. Wuchterl
Optics	0+15+0+30	4	B. Balick A. Bedalov
Astrobiology and extra-solar planets	30+15+0+0	4	K. Hand B. Pečnik
Hydrodynamics in astrophysics	30+0+15+0	4	G. Wuchterl P. Mimica
Solid state physics	30+0+15+0	4	
Experimental methods of modern physics	30+0+15+0	4	
Basics of relativistic physics	30+0+0+0	3	
Chaos and fractals	30+0+0+0	3	
Dynamics of atoms in gas and liquid phase	30+0+15+15	5	
Electronic basics I	30+0+15+0	4	
Object oriented programming	30+0+30+0	5	
Bioinformatics	20+10+0+10	5	
Introduction to meteorology	30+0+10+0	4	
Psychology of self-confidence and positive thinking	15+15+0+0	2	
Rhetoric	15+15+0+0	2	
Logic	15+15+0+0	2	
German language I	0+30+0+0	2	

* Hours: L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

2.Semester

Required courses:

Course title	Course structure* L+S+E+P	ECTS points	Lecturers
Modern astrophysics II	30+0+30+0	5	Ž. Ivezić M. Rejkuba M. Jurić
Methods of observational astronomy II	10+0+20+0	3	R. Neuhauser A. Bedalov
Research	0+20+0+0	5	
Elective courses		17	

* Hours: L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

Elective Courses:

Course title	Course structure* L+S+E+P	ECTS points	Lecturers
Physics of disordered matter	30+0+15+0	4	
Biophysics	30+0+15+0	5	
Environmental science	30+0+10+0	4	
Celestial mechanics	30+0+15+0	4	G. Wuchterl M. Jurić
Interstellar matter	30+0+15+0	3	B. Balick D. Vinković
Nuclear physics	30+0+15+0	4	
Electronic basics II	30+0+15+0	4	
History of modern physics	30+0+0+0	3	
Research methods in natural sciences	15+0+0+15	3	
Life and physical environment	15+0+0+0	2	
Ecosystem ecology	15+0+0+0	2	
Atomic and molecular quantum mechanics	20+15+15+0	5	
Mathematical methods in signal processing	30+0+30+0	5	
Computer graphics	30+0+30+0	5	
Partial differential equations	30+0+30+0	6	
Philosophy of science	15+15+0+0	2	
Sociology of science	15+15+0+0	2	
Language culture	15+15+0+0	2	
Media in education	15+15+0+0	2	
Psychology of self motivation	15+15+0+0	2	
German language II	0+30+0+0	2	

* Hours: L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

3.Semester

Required courses:

Course title	Course structure* L+S+E+P	ECTS points	Lecturers
Modern astrophysics III	30+0+30+0	5	D. Krajnović T. Prokopec
Science communication	20+10+0	2	M. Elizur D. Bonacci
Research	0+30+0+0	10	
Elective courses		13	

* Hours: L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

Elective coursers:

Course title	Course structure* L+S+E+P	ECTS points	Lecturers
History of astronomy	30+15+0+0	3	G. Wuchterl
Solid state physics	30+15+0+0	4	
Optics	0+15+0+30	4	B. Balick A. Bedalov
Astrobiology and extra-solar planets	30+15+0+0	4	K. Hand B. Pečnik

Hydrodynamics in astrophysics	30+0+15+0	4	G. Wuchterl P. Mimica
Elementary particles	30+0+15+0	4	
Numerical methods in high energy physics	20+20+30+0	8	
Basics of relativistic physics	30+0+0+0	3	
Chaos and fractals	30+0+0+0	3	
Introduction to superconductivity	30+0+0+0	3	
Environmental microbiology	30+0+30+0	5	
Dynamics of atoms in gas and liquid phase	30+0+15+15	5	
Object oriented programming	30+0+30+0	5	
Psychology of self-confidence and positive thinking	15+15+0+0	2	
Rhetoric	15+15+0+0	2	
Logic	15+15+0+0	2	

4.Semester

Course title	Course structure* L+S+E+P	ECTS points	Lecturers
Diploma thesis	0+10+0+0	30	

8.4 Faculty and staff development

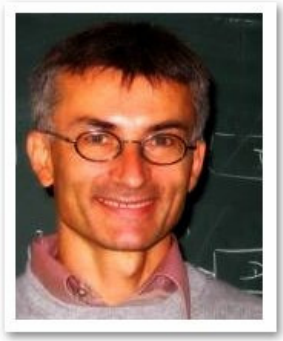
Introduction of astrophysics graduate program in Split presents a challenge, since the University of Split does not have professional astronomers or astrophysicists. Hence, until new astrophysics faculty are recruited locally at the Department of Physics (or at a prospect research institute), the astrophysics part of the curriculum is covered exclusively by visiting faculty. Here we list their names and a brief description of their personal interests:

Latest Update: August 2006

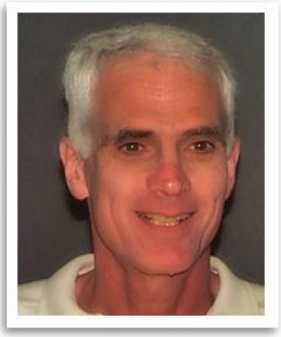
Željko Ivezić is a professor in the Astronomy Department at the University of Washington. He holds a PhD in physics from the University Kentucky. His research interests are in detection, analysis, and interpretation of electromagnetic emission from astronomical objects. During his seven years in Princeton, he earned the status of SDSS "builder" (sdss.org) for his software development. Željko currently serves as the Project Scientist for LSST, a next generation survey (lsst.org).

Bruce Balick is professor and former Chair of the Astronomy department at the University of Washington. His interests range from star formation to the final theories of stellar evolution. He and his collaborators focus on the nebular hydrodynamics and the construction of numerical models in which detailed physical processes are included. Balick is an active user of large optical and radio telescopes and the Hubble Space Telescope. He serves on the design team for the next generation camera, WFC3, to be installed in HST in 2006.

Ralph Neuhäuser is professor of astrophysics and director of the astrophysical institute and university observatory at the University of Jena in Germany. He obtained his undergraduate work in physics at Bochum at Sussex Universities and his PhD at München University. He was a Postdoc at the Max-Planck-Institute for extraterrestrial physics from 1996 to 2002. His main research interests are the formation of low-mass stars, brown dwarfs, and planets, studied observationally.



Tomislav Prokopec is a professor at the Institute for Theoretical Physics and Spinoza Institute at the Faculty of Physics and Astronomy of Utrecht University. His main research interest is in cosmology, where he is mostly interested in studying how the process of cosmic inflation can influence formation of large-scale structures in The Universe. Equally interesting to Tomislav are the origins of the baryonic matter of the Universe, known also as baryogenesis.



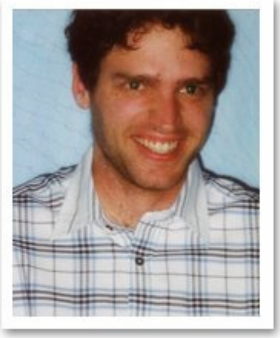
Moshe Elitzur is Professor of Physics and Astronomy at the University of Kentucky, where he conducts research in theoretical astrophysics. His areas of expertise include analysis of maser radiation from interstellar molecules (he is the author of the book "Astronomical Masers") and infrared radiation from interstellar dust. He is employing methods developed together with students and colleagues toward understanding how stars form and how they die, the structure of interstellar clouds, circumstellar winds and the surroundings of super massive black holes at the centers of active galaxies.

Günther Wuchterl was born and studied in Vienna (Astronomy, Zoology). He has been a scientist at the University of Heidelberg, University of California Santa Barbara, Technical University Vienna, University of Vienna, and at the Max-Planck-Institute for extraterrestrial physics in Garching. Presently he is working at the Astrophysical Institute and University Observatory in Jena, Germany. His main work includes the theory of the emergence of celestial bodies, star and planet formation. Günther is working on the search for extra-solar planets with Eike Günther, Thuringer Landessternwarte Tautenburg (search for planets with brown dwarves) and Ralph Neuhäuser (AIU Jena) on the first direct imaging of a planet orbiting another star. Günther participated in the rescue of the historical Kuffner observatory in Vienna, and a national public campaign for the determination of light contamination in Austria.

Marina Rejkuba is an astronomer at the European Southern Observatory. She obtained her Ph.D. in Physics from Pontificia Universidad Católica de Chile. Her research interests are quite versatile and include stellar populations in nearby galaxies, a detailed study of Centaurus A galaxy, globular cluster systems and observations of all sorts of variable stars.

Dejan Vinković is a postdoctoral member at the Institute for Advanced Study in Princeton. The main topic of his research is radiative transfer in dusty clouds. For that purpose he developed a special code named LELUYA, which has a very versatile applicability ranging from the formation of stars and planets to the dust formation around old dying stars. Dejan is also studying meteors and was a member of the meteor expedition to Mongolia. He is currently coordinating the continuation of this project. In addition, Dejan is the main editor of Connect::Portal, an Internet media (run by the NGO Znanost.org) for Croatian scientists and educators.

Davor Krajnović is a postdoc at the department for Physics and Astrophysics of the University of Oxford. He obtained his PhD from the Leiden University in The Netherlands. He works on the formation and evolution of galaxies through a combined observational and theoretical study of nearby galaxies. His specific research interests are on: the dynamics and internal structure of galaxies, supermassive black holes and observations with integral-field spectrographs and adaptive optics techniques.



Petar Mimica obtained his PhD at the Max-Planck-Institute for Astrophysics in Garching, Germany. His interests in astrophysics include numerical hydrodynamics, mostly numerical simulations of relativistic jets from active galactic nuclei, and especially the creation of synthetic radio and X-ray images which are then compared with real observations. Currently he is collaborating with the University of Valencia's observers and theoreticians, with the aim of significantly improving numerical simulations. Apart from that, he is interested in popularizing astronomy and astrophysics among people, especially students and school children.

Kevin Hand (Planetary Scientist/Astrobiologist) Kevin is finishing his PhD at the Department of Geological & Environmental Sciences at Stanford University. He is President/Founder of Cosmos Education, an international non-profit organization dedicated to grass-roots science education in developing regions of the world. Kevin's research focuses on the origin, evolution, and distribution of life in the solar system. Specifically, his PhD dissertation involves both theoretical and experimental work on the habitability of the putative European ocean. He was born and raised in Manchester, Vermont, and has bachelors degrees in physics and psychology from Dartmoth College and a master's in mechanical engineering from Stanford University.

Bojan Pečnik obtained his PhD at the Astrophysical Institute, University of Jena, Germany. He started his research at the Max-Planck-Institute for extraterrestrial physics, München, Germany. Bojan received his diploma in physics in Zagreb in 2001. His main research interests are the formation of planetary systems, and development of numerical models. He is also involved in projects that popularize science (Nebo na poklon, CosmosEducation), popularization of the future peaceful exploration of space (www. unsgac.org), and development of an open society based on knowledge in NGO znanost.org.

Mario Jurić obtained his PhD at the Department of Astrophysical Sciences, Princeton University. He is currently a postdoctoral member at the Institute for Advanced Study in Princeton. He holds a B.Sc. in physics from the University of Zagreb. His research interests include small bodies of the Solar System, planetary dynamics, galactic structure and general problems of computational astrophysics and applied mathematics (integration algorithms). At the moment he is studying the long-term evolution and properties of extrasolar planetary systems, with the goal of explaining the observed properties of exoplanets and constraining planet formation theories. In his spare time. Mario enjoys open-source programming and working in znanost.org (a non-profit organization).

Ana Bedalov is a PhD student at the Astrophysical Institute and University Observatory, Jena, Germany. Her research includes formation and detection of brown dwarfs and planets around young stars. She would like to work after her PhD on some of the biggest ESO telescopes. Apart from science, Ana is active in the science education through astronomy project, "Nebo na poklon" (http://nebo.znanost.org).

The sustainability of the graduate program and ApID in general depends on the ability of these programs to follow the latest trends and advancements in science, technology, and education. It is, therefore, important to have a significant fraction of the faculty from other world-class institutions, no matter how many astrophysics faculty work at the Department of Physics. The graduate program has to be a very dynamic place, capable of quick adaptations to the latest scientific advancements. One has to keep in mind that astronomy is currently undergoing its golden age due to a large number of ground and space telescopes in operation or under construction. This proliferation of observational capabilities produces a huge stream of data, with many dramatic discoveries happening so often that astronomy textbooks have to be updated on a yearly basis. Openness of ApID to external faculty is, therefore, of strategic importance for the implementation of the ApID vision.

Additional advantages to the sharing of faculty between the Department of Physics and another university are:

- enables people to maintain their research and professional careers at internationally recognized centers of excellence
- mitigates risks of ApID becoming scientifically isolated and directly connects ApID to international projects, collaborations and the entire scientific community
- helps bring international students to Split and vice versa
- reduces career risks for this faculty in the case ApID fails to reach its objectives

The quality of teaching and mentoring will be constantly monitored and evaluated. A special Faculty Quality Assurance Team will be assembled to coordinate and enforce performance evaluations of all faculty. This team will also explore the best methods for evaluation through consultations with external scientific advisors. Although internal and external evaluations are required by the higher education standards of the Bologna process in Croatia, ApID will insist on its own additional quality assurances and evaluations. The astrophysics graduate program aims to compete with graduate programs from other European institutions and, therefore, should set higher quality standards than other similar institutions.

Achieving these ambitious goals will take time. The short-term goal is to become the best graduate program within 5 years among similar programs in physical sciences in

Croatia. This is the timeframe in which the first generation of "Bologna students" needs to complete their diploma studies. After that the performance of these first students in the job market becomes part of the quality measure of the graduate program in Split.

Recruitment of the new faculty should follow a set of criteria enforced by the Faculty Quality Assurance Team, such as the candidate's professional achievements, teaching skills, quality of interaction with students, ability to attract funding, social skills, enthusiasm about working in Split, etc. The existing faculty, both local and visiting, should also follow advice from the Faculty Quality Assurance Team on how to improve their lectures or supervisory skills. One very important component is also the use of technology in teaching. The department should provide the necessary training of its teaching staff in Web/IT skills and use of new technology in teaching, especially if distance learning is used in the classroom.

Strategic goals on faculty recruitment are:

- basic goals (achievable in 5 years):
  - *at least four* senior faculty (including visiting faculty) present in Split at any time
  - *at least two* full time faculty employed by the Department of Physics
  - *several* research scientists working in Split at the department or at a new astronomy institute
- advanced goals (require a major increase in funding or more than 5 years):
  - *six or more* senior faculty (including visiting faculty) present in Split at any time
  - *four or more* full time faculty employed by the Department of Physics (enough to start with the PhD program)
  - *several* research *groups* working in Split at the department or at a new astronomy institute

8.5 Administration (technical staff)

ApID needs a skillful and technically knowledgeable administration that can not only perform given tasks, but also be innovative and forthcoming about their ideas on how to improve ApID. A successful administration is an equally important component for the success of ApID.

Initially, ApID will use services offered through the Department of Physics and Society znanost.org. After a year ApID will need to employ at least one part-time administrator, hence fundraising should immediately include this into its budgetary assessments. The process of employing additional personnel will depend on the availability of funds. ApID would highly benefit from:

- **a fundraising officer**: focuses on organizing and administering fundraising activities
- **an outreach coordinator**: focuses on organizing and administering outreach activities
- **a computer system administrator**: oversees, organizes and administers Web/IT, network, software and hardware requirements of ApID
- **a public relation officer**: works on promoting ApID and its activities
-

8.6 Student entrance principles

The graduate program is open to students who graduated from any university in Croatia or abroad and have completed an undergraduate program in physics or a related area. Students who do not have all the necessary competences will be required to attend the prerequisite courses. The goal of the graduate program in Split is to compete internationally for the most skillful and knowledgeable students. The very first step, however, will be a competition within Croatia to immediately attract the best science and engineering students.

Decisions about the acceptance of prospective students will be made by July 1. A special *Student Admission Committee* will be formed. Deadline for applications differs for students

already studying in Split from students at other places. If they are coming from the undergraduate program in Split then the deadline for their applications is June 15. They will be required to complete the BSc degree program before applying. Students from other undergraduate institutions (including Croatian) will have to send their applications in March and will *not* be required to complete the BSc degree by that deadline. This earlier deadline allows screening of applicants who were not part of the undergraduate program in Split, while students from Split can be screen already during their undergraduate study.

The application forms will include: ECTS points, grades, customized CV (to identify students with special skills), and at least one letter of recommendation. Interviews with students are also possible if the Committee finds it necessary (the traveling and accommodation costs should be covered either by the Department of Physics in Split or ApID).

An extra problem emerges for students who study either at an institution not following the Bologna Process or at a program that has adopted 0+5 scheme (skipping BSc diploma, receiving MSc after 5 years of study) instead of 3+2 (3 years for BSc and 2 years for MSc). For example, the Department of Physics at the University of Zagreb (the largest physics department in Croatia) adopted the 0+5 scheme. A special detailed description of exams that students from these institutions have to complete before coming to Split will be designed. This will allow students to receive the BSc diploma in Split prior to entering the graduate program. Since this transition process may delay a student's entrance into the graduate program, they will be allowed initially attend classes in the graduate program if they do not have too many extra exams for completion of their BSc. A deadline for passing these extra exams will be established.

8.7 Student recruitment

In order to attract the best students, information about the graduate program in Split and research opportunities available to students through ApID activities will need to reach a wide undergraduate student population. This will be achieved in two ways:

- general public relation (PR) efforts, with the purpose of promoting ApID
- direct "head-hunting" activities aimed at identifying individual students to be recruited later on as graduate students

All the necessary information about the admission process will be available on the Web, including phone and e-mail contact information ensuring prompt answers to inquiry.

The PR activities have already started with the establishment of professionally designed WebPages, articles in newspapers and discussions on Internet forums. The graduate program will be advertised in the following ways:

- **news articles about the graduate program**: setting up an astrophysics graduate program that brings world-class astronomy and astrophysics to Croatia has a news appeal because of the general context of Croatia's desire to build a knowledge-based society and to reform its higher education system and the science and technology sector. But this appeal attracts a very limited media interest because the media needs events to talk and write about.
- **paid advertisements**: too expensive for now, but it should be considered in the future. The targeted audience for student recruitment are undergraduate and high school students and young amateur astronomers (although creating a positive image of ApID in the general public is also desirable). Students can be reached through adds in student magazines, online student forums and news sites, popular science books (ApID as a book's sponsor) and magazines, etc.
- **"piggybacking" in the news about ApID activities**: ApID activities are an attractive target for the media to write about. Since ApID plans to have various types of activities during a year, the strategy is to keep the information about the graduate program as a side note (hence, "piggybacking") in the news covering these events.

Direct "head-hunting" is a more targeted approach, where prospective students are monitored by the ApID staff well before they actually apply for graduate study in Split. Students are identified either directly by the ApID staff (e.g. during visits to other institutions or during workshops and conferences with student attendees) or through personal recommendations. This can be a short, medium or long term approach, depending on how much time remains until the student makes the actual decision.

- **short-term hunting**: focuses on undergraduate students who are close to the moment of deciding where to apply for their graduate study. Such students are contacted directly by someone from the ApID and solicited to join the astrophysics program in Split.

- **medium-term hunting**: it focuses on undergraduate students or even high school students who are close to deciding where to apply for undergraduate study. In addition to monitoring their academic performance, ApID researchers will offer them opportunities to collaborate on small research projects. These projects will provide a real-life test of the students' skills and abilities. Successful students can then be offered more challenging and rewarding research collaborations, so that they eventually find the graduate program in Split as a natural continuation of their educational career.

- **long-term hunting**: deals with elementary and high school pupils. The primary reason for work with pupils of such a young age is outreach, where the side benefit of this effort is identification of pupils with a talent for natural sciences. The motivation here is not to lure them into astronomy or astrophysics per se, but rather to show them the benefits of the higher education degree. A small fraction of such talented pupils may end up as graduate students in Split, but all pupils should end up with positive impressions of ApID and promote it later in their life. Hence, ApID staff should be involved in outreach activates or support them in other ways.

The underlying message here is that the student recruitment process requires investments in time and money because it has to be done by actively searching for the best candidates even before they actually think about considering Split for their undergraduate or graduate studies.

8.8 Student exchange program

It is very important for graduate students to visit other institutions and experience cultural and organizational differences between institutions. It is also important that they meet with other students, professors and researchers at these institutions. Science benefits from collaborative work and students should experience that first hand. Since working on a research project with someone from outside of the University of Split is among the requirements for graduation, the Department of Physics and ApID have to create a system of student exchange between Split and other institutions engaged in astronomy and astrophysics.

The plan is to establish official student exchange programs with such institutions to allow exchanges of students on research projects. When it come to collaborations with university departments, this can be extended to the level of collaboration where students from collaborative departments attend individual courses in Split and vice versa. After the successful completion of a course, students would get ECTS points transferable to their home institution. Such arrangements are allowed and encouraged by the Bologna Process. The cost of their visit should be covered by the host institution.

8.9 Fostering international collaborations

International collaborations can be facilitated in many different ways. ApID in its essence is an international collaboration and only as such it can have a meaningful and sustainable existence. Here we list some types of collaborations, from small meetings to large

research collaborations that have already started or will be initiated within the next 5 years.

- **Visits, lectures, seminars, and colloquia**: inviting international visitors to spend time in Split as lecturers or guest speakers. In case of prestigious visitors, public lectures and events can be organized. A special fund for such prestigious visitors' talks should be established.

- **Meetings**: ApID should help in organizing various meetings related to astronomy and astrophysics and try to bring them to Split or Dalmatia. One example of meetings that have already greatly benefited ApID are Summer Meetings of the Forum of Croatian Astronomers:
  2006:
  astro.connect.znanost.org/2006_Summer_meeting
  2005:
  astro.connect.znanost.org/2005_Summer_meeting_FCA.html

- **Workshops and conferences**: Split and Dalamtia can provide a great venue for international workshops and conferences. The following such events have already been arranged through ApID:

  - **Astronomical Image Processing Workshop** (September 4-9, 2006, Dubrovnik):
    http://www.astro.washington.edu/aipw/
    The workshop provided participants with the skills needed to understand the outputs of current and next-generation surveys, and to be in a position to contribute to the algorithm development needed to make new data-intensive projects, such as LSST and Pan-STARRS, a reality.

  - **Split International Winter Schools of Astrophysics** (SIWA): designed to provide insight into current topics in astrophysics for graduate and senior undergraduate students.
    2007: Winter School on Extrasolar Planets & Astrobiology
    (Feb.19-Mar.03, 2007, Split)
    http://fizika.pmfst.hr/siwa
    modeled upon the "Extrasolar Planets & Astrobiology" course offered in the astrophysics program at the University of Split. The attendees are awarded 6 ECTS points for successful completion of the school.

  - **A software Framework for Simulating Stellar Systems**
    (Aug.19-Sep.01, 2007, Split)
    http://conferences.znanost.org/n-body2007
    A workshop of the MODEST collaboration, which works on problems in stellar dynamics, stellar evolution, and stellar hydrodynamics
    (www.manybody.org/modest).
    The workshop will focus on the development of a software framework for simulations of dense stellar systems, such as globular clusters and galactic nuclei. It will be the first comprehensive attempt to gather a significant group of researchers to work on the construction of a dense stellar systems framework as a team.

- **Student exchange collaborations**: So far the following institutions have expressesed interest in official institutional collaboration in student exchange (research projects) and teaching:
  - Department of Astrophysics, University of Washington ,USA (http://www.astro.washington.edu)
  - Astrophysical Institute, University of Jena, Germany (http://www.astro.uni-jena.de)
  - Department of Physics and Astronomy, University of Kentucky, USA (http://www.pa.uky.edu)

- **Research collaborations**: They can be established either with individual laboratories (individual research projects) or with institutions (institutes, departments, universities, private companies). People teaching astronomy and astrophysics courses in Split are already involved in many research projects. This will be the starting point for more formal research collaborations.

8.10 Research

People involved in ApID already participate in various world-class research projects at their home institutions (see the list of lecturers in §8.4). This is of great advantage

to ApID because it simplifies the process of bringing high quality scientific research to Split. ApID is open to any suggestion that can help at improving conditions for research in Split. ApID has the role of a catalyst, bringing people together and actively seeking solutions for a better infrastructural and administrative support of their research projects.

It is difficult for a small country like Croatia to invest in large astronomical infrastructure, especially when it is still in transition toward modern economy. ApID is, therefore, strategically oriented towards *data-intensive astronomy*. This field of astronomy emerged as a result of the current explosive growth of information (e.g. Large Synoptic Survey Telescope will produce 30TB of data every night!). It created new research challenges dealing with exploration and analysis of large publicly available astronomical datasets. This strategic choice brings numerous positive aspects that maximize scientific and infrastructural gains while utilizing the existing ApID resources:

- This research field has outstandingly bright future
- It is a good complement to the other ApID strategic directions, but at the same time there are possibilities for synergy
- The ApID astronomers, including those who may (wish to) return to Split, have substantial expertise in this field
- The initial investment is fairly small (e.g. a decent computer cluster costs 100 times less than the fee to join ESO)
- Interdisciplinary aspects (e.g. computer science, statistics, physics, chemistry) are attractive both at the University level, and at the national level
- It shares many technological challenges with applied computer science, statistics and software algorithms; hence, it opens a door for cooperation between ApID and computer industry.

The goal is to have research financed from international funds. This will include mostly EU

ApID is strategically oriented towards data-intensive astronomy.

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funds due to the geopolitical location of Split and the region, but support from the NSF and other US sources will be needed for collaborations with US scientists and institutions. Local sources of funding will be used for improving infrastructure and administrative support: office space, computers, Web/IT infrastructure, accommodation, various indirect costs, etc.

Examples of research ventures considered for ApID are:

- **Visiting Research Scientists Program**: ApID will prepare working conditions required by scientists who have their own research funds already available and have no constraints on the location where they actually conduct their research. ApID will aim to attract such scientists to Split as visitors and through consultations find ways to include them in other ApID activities.

- **Summer Research Program**: A special program within ApID will be established for scientists who can spend several months working in Split during non-teaching periods at their home institution. They typically have their own grant money for research support and seek students to assist them on their projects. ApID will also organize students to participate in such summer research programs abroad, but also offer the same opportunity in Split for researchers who want to conduct a part of this research in Split (similar to the Visiting Research Scientists Program, except that students must be involved and it happens during the non-teaching season).

- **International research collaborations**: People involved in ApID already participate in large international collaborations. ApID will seek ways to institutionalize its participation in such collaborations. Especially interesting are collaborations that work on new novel observational tools capable of dramatic astronomical breakthroughs. The Large Synoptic Survey Telescope (LSST; www.lsst.org) is such an

example. Scheduled to see "first light" in 2012, the 8.4-meter LSST will be able to survey the entire visible sky every three nights with its three-billion pixel digital camera. LSST will explore mysteries behind Dark Matter and Dark Energy, and open a movie-like window on objects that change or move on rapid timescales: exploding supernovae, potentially hazardous near-Earth asteroids as small as 100 meters, and distant Kuiper Belt Objects.

- **Research at the Department of Physics**: New astronomy and astrophysics faculty positions at the Department of Physics will require candidates to actively work on research projects and apply for research grants.

- **Postdoctoral Research Program**: ApID will seek ways to establish its own program for attracting innovative and skillful young scientists who are capable of establishing their own independent research projects in astronomy and astrophysics. These scientists will be affiliated with the Department of Physics or the astronomical institute that ApID plans to start.

- **Astronomical Institute**: ApID will actively pursue the idea of creating its own astronomical institute in Split. The concept of the institute is briefly discussed in §7.6 above. The level of affiliation with the University of Split is still not clear, but such an institute would be of tremendous importance for ApID. It would focus on research and seek all possible ways of funding. Of course, it would be working closely with the astrophysics program at the Physics Department, as two institutions complement each other.

8.11 Outreach activities

Outreach activities will promote ApID to primary and secondary education, to the public, to amateur astronomers, and to the media. Students will learn the importance of outreach through the required course "Science Communication: An introduction to press relations, public promotion and project management in science". As a part of practical work they will have to enroll into one of the existing outreach projects or initiate their own.

Examples of the ApID outreach activities:

- Collaboration with existing educational astronomy projects in Croatia and in the region
- Collaboration with amateur astronomical organizations in the region
  - Sponsoring meetings and events organized by amateur astronomers
  - Providing scientific and technological support for the work of such organizations
  - Employing (part-time) one amateur astronomer who will take care of this particular component of ApID
- Organizing public events
  - Holding public lectures of various format and scope
  - Establishing a special fund for public lectures (prestigious public lectures that will attract various important people in public life)
  - Establishing a special "astronomy open day" at the university
- Publishing books, textbooks, proceedings, etc.
- Holding events targeting elementary and secondary teachers and school principals (like a symposium for teachers)
- Providing contacts with the media, especially TV:
  - Writing popular science articles
  - Issuing press releases
  - Employing a contact person for journalists (PR officer)
  - Publishing regular columns in local newspapers (e.g. daily positions of planets on the sky and other astronomy trivia information available on the ApID WebPages and daily in the newspaper with the link to the ApID web)
- Participating in Science Festivals, University Days, Science Bars, etc.

One comprehensive outreach project that has already produced tangible outcomes is "The Sky as a Gif", described in §7.2. This project has laid the foundation (networks of teachers and amateur astronomers, media contacts, educational materials, etc.) for outreach activities that will continue in ApID.

8.12 Milestones

Important milestones in ApID fall under the following categories:

- Scientific Development
- Educational Activity
- Human Resources
- Infrastructure.

Here we exclude from the list additional activities that can be initiated at any time if necessary funds and personnel are secured. Most noticeably, this includes:

- **Individual research grants**: faculty and postdocs can initiate their research projects and activities according to their individual preferences, timetable and funds. The goal is, however, to have such projects initiated as soon as possible and as many as possible.
- **Astronomy and astrophysics institute**: establishing such an institution is of a great importance for ApID, but the securement of its financial and personnel resources (liquidity) is too precarious at this time to set a strict timetable. Nonetheless, it is imperative to found this institute as soon as possible.

Other planned activities not listed here include a series of public lectures, additional workshops and conferences, special lecture series not yet listed in the official graduate program curriculum, visiting scientists, a summer research program for graduate and undergraduate students, Distance Learning program, etc.

Scientific Development Summary:

- Founding of "From dust to life" research collaboration in the fall 2007.
- Founding of "Large-scale computations and data mining" research collaboration in the fall 2008.
- These collaborations will create their own timetable for pursuing international collaborative research projects and seek ways of funding researchers who would work in Split for a long or short time periods.
- Other research groups can also be formed, but are not considered of a strategic importance for ApID in the next 5 years.

Educational Activity Summary:

- Preliminary MSc astrophysics courses offered in the fall 2007.
- Full MSc graduate program starts in the fall 2008.
- Additional educational activities are offered through workshops (e.g. SIWA is held every winter, starting from 2007).

Human Resources Summary:

- **Initial senior position** – second half of 2006, **followed by two postdoc positions** (postdocs can be independent of the senior position); senior position becomes tenure track after some (TBD) trial period; postdoc positions are for 3 years; outstanding postdocs may apply for a more permanent position
- **Additional senior position** – second half of 2008, **followed by two postdoc positions** (postdocs can be independent of the senior position); senior position becomes tenure track after some (TBD) trial period; postdoc positions are non-permanent and for 3 years

Infrastructure Summary:

- Every senior position requires a minimum of 2 two-desk offices (for the faculty and for his/her visitors and research assistants) and additional office space for potential PhD students (TBD).
- Yearly upgrading of computational infrastructure.
- Employment of dedicated IT and administrative workers no later than 2009/2010 (part time services will be used before that).

The table below summarizes milestones of ApID. A **priority level** is given to each item:

- 1 (critical): all ApID activities critically affected
- 2 (important): makes a strong impact on ApID
- 3 (beneficial): makes a significant contribution to ApID

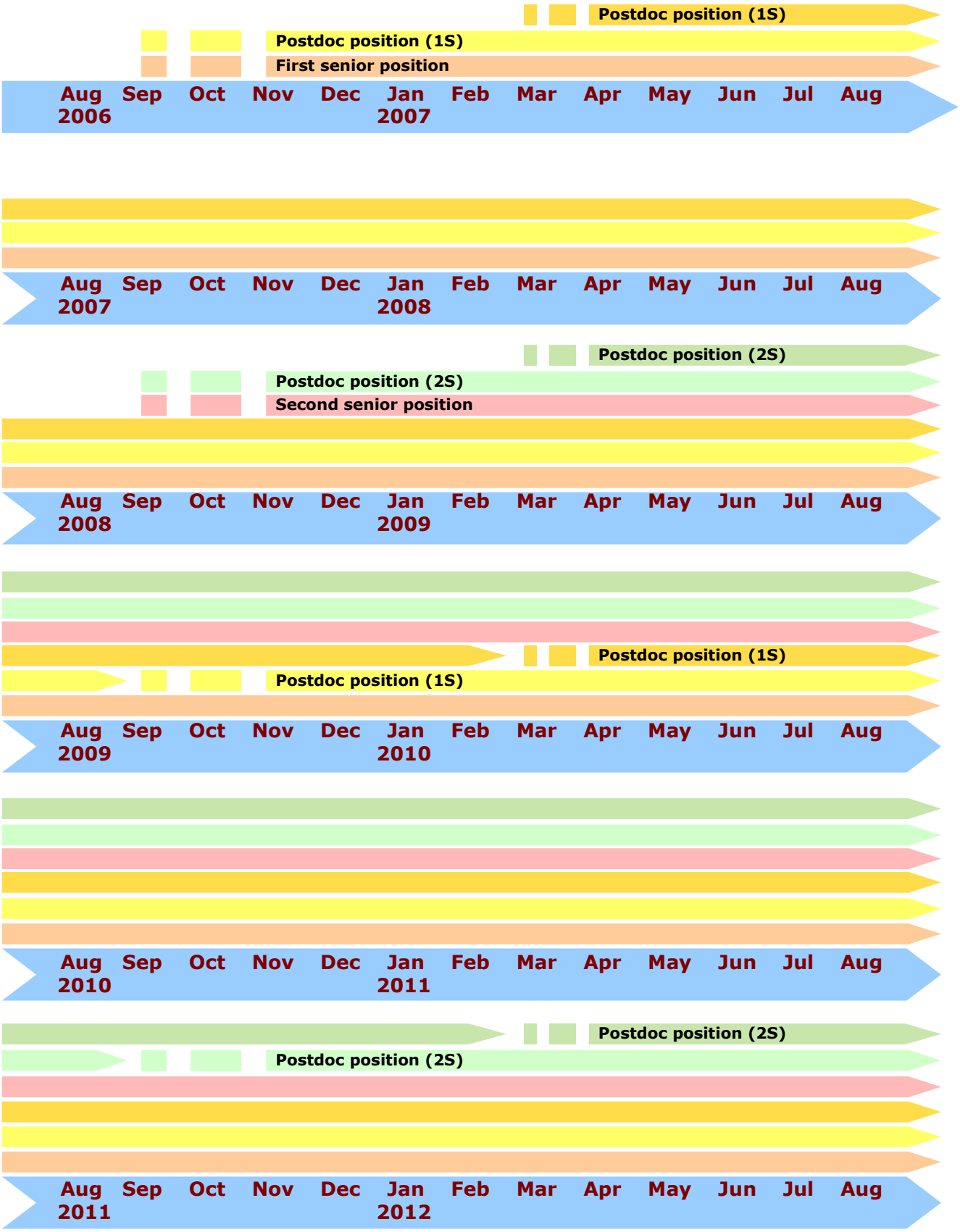
When	Priority Level	What	Category	Approximate Cost
Aug. 2006.	3 beneficial	2nd Forum of Croatian Astronomers	Scientific Development	5k €
Aug./Sep. 2006.	2 important	ApID "Implementation and Coordination Board" formed	Human Resources	0 €
Sep. 2006.	3 beneficial	Astronomical Image Processing workshop	Scientific Development	20k €
Sep./Oct. 2006.	1 critical	ApID office space[1] + Furniture[2] + Hardware[3]	Infrastructure	30k €
Sep./Nov. 2006.	1 critical	First Senior Position (tenure after a trial period)	Human Resources	36k €/yr
Sep./Nov. 2006.	2 important	Postdoc Position (3-year, 1S[4])	Human Resources	18k €/yr
Sep./Dec. 2006.	2 important	ApID "Advisory Board" formed	Human Resources	0 €
Feb. 2007.	1 critical	part-time administrative employee[5]	Human Resources	2.4k €/yr
Feb./Mar. 2007.	3 beneficial	SIWA 2007 winter school	Educational Activity	20k €
Mar./May 2007.	2 important	Postdoc Position (3-year, 1S)	Human Resources	18k €/yr
Feb. 2007.	1 critical	Initial computational grid	Infrastructure	10k €
Aug. 2007.	3 beneficial	MODEST 7a workshop	Educational Activity	20k €
Aug. 2007.	3 beneficial	3rd Forum of Croatian Astronomers	Scientific Development	5k €
Sep. 2007.	2 important	Preliminary MSc astrophysics courses	Educational Activity	50k €
Sep./Nov. 2007.	2 important	Sci Group Foundation: "From dust to life"	Scientific Development	0 €
Feb. 2008.	1 critical	Additional computational grid	Infrastructure	20k €
Feb./Mar. 2008.	3 beneficial	SIWA 2008 winter school	Educational Activity	20k €
August 2008.	3 beneficial	4th Forum of Croatian Astronomers	Scientific Development	5k €
August 2008.	1 critical	ApID office space[6] + Furniture[2] + Hardware[3]	Infrastructure	30k €
Sep./Nov. 2008.	1 critical	Second Senior Position (tenure after a trial period)	Human Resources	36k €/yr
Sep. 2008.	1 critical	Initiation of all MSc astrophysics courses	Educational Activity	140k €
Sep./Nov. 2008.	2 important	Sci Group Foundation: "Large-scale computations and data mining"	Scientific Development	0 €

[1] Initial APID office space: 2 offices (2 persons each) - 2x20 m^2; additional space shared with the Physics Department: server room, lecture room, IT lab.
[2] Furniture: Offices: desks, drawers, chairs, drawing board; lecture room: desks, chairs, drawing board, beamer/screen, digital camera (netcast, lecture repository).
[3] Hardware for 3 (resident) + 1 (guest) people: 4 personal computers, 2 telephones, fax, individual internet connection, printer.
[4] Postdoc position in-sync with the first (1S) or with the second (2S) senior position .
[5] Accounting, Bookkeeping, Auditing .
[6] Additional APID office space: 2 offices (2 persons each office) – 2x20 m^2.

Sep./Nov. 2008.	2 important	Postdoc Position (3-year, 2S)	Human Resources	18k €/yr
Feb. 2009.	1 critical	Additional computational grid	Infrastructure	30k €
Feb./Mar. 2009.	3 beneficial	SIWA 2009 winter school	Educational Activity	20k €
Mar./May 2009.	2 important	Postdoc Position (3-year, 2S)	Human Resources	18k €/yr
Aug. 2009.	3 beneficial	5th Forum of Croatian Astronomers	Scientific Development	5k €
Sep./Nov. 2009.	2 important	Postdoc Position (3-year, 1S)	Human Resources	18k €/yr
Feb. 2010.	1 critical	Additional computational grid	Infrastructure	40k €
Feb./Mar. 2010.	3 beneficial	SIWA 2010 winter school	Educational Activity	20k €
Mar./May 2010.	2 important	Postdoc Position (3-year, 1S)	Human Resources	18k €/yr
2009.-2010.	1 critical	Dedicated IT employee	Infrastructure	15k €/yr
2009.-2010.	1 critical	Dedicated administrative employee	Infrastructure	10k €/yr
August 2010.	3 beneficial	6th Forum of Croatian Astronomers	Scientific Development	5k €
Feb. 2011.	1 critical	Additional computational grid	Infrastructure	50k €
Feb./Mar. 2011.	3 beneficial	SIWA 2011 winter school	Educational Activity	20k €
Aug. 2011.	3 beneficial	7th Forum of Croatian Astronomers	Scientific Development	5k €
Sep./Nov. 2011.	1 critical	Postdoc Position (3-year, 2S)	Human Resources	18k €/yr
Feb. 2012.	1 critical	Additional computational grid	Infrastructure	60k €
Feb./Mar. 2012.	3 beneficial	SIWA 2012 winter school	Educational Activity	20k €
Mar./May 2012.	1 critical	Postdoc Position (3-year, 2S)	Human Resources	18k €/yr
Aug. 2012.	3 beneficial	8th Forum of Croatian Astronomers	Scientific Development	5k €

SENIOR FACULTY AND POSTDOC PROJECTIONS

conservative estimates (and excluding the prospective institute)



9. Finances

9.1 Funding plan

ApID has two primary financial goals in the next 5 years:

i) Secure enough funds to fulfill the projected budgetary requirements (see detailed budget in §9.3).

ii) Develop a sound financial base to ensure the long term financial sustainability.

Croatia's transitional economy creates substantial environmental uncertainties that could have an adverse effect on ApID's financial condition. The following funding strategies are chosen to alleviate these uncertainties:

- **Modularity**: ApID is a collaboration of stand-alone projects, with each project having its own funding plan and fiscal responsibilities. In addition to targeted fundraising and accountable system of operation, this approach minimizes risks of unbalancing ApID's budget. Namely, when one project overruns its budget, it cannot use funds from other projects, unless an agreement is achieved between project leaders. In the most drastic case projects with overrunning budgets may be discontinued. Projects, however, have different levels of importance to ApID (see §8.12). Projects that are critical for the sustainability of ApID should not be terminated, but only scaled down in scope and helped by balancing ApID's budget.
- **Diversification**: funding of ApID projects should not rely on one financial source, but instead strive for seeking multiple sources of funding. Even in cases where sufficient funding can be secured form a single source, a project should strive for further fundraising. In case of a budget surplus, project leaders are encouraged to work with ApID's Implementation and Coordination Board on finding ways how to apply the excess funds towards other ApID projects. Diversification is also a useful method of extending the network of potential future donors.
- **Independent fundraising**: ApID will establish its own fundraising office that will work on attracting funds to individual projects and ApID in general. This office will also provide help in writing grants and project proposals, and organize fundraising training courses for ApID researchers and personnel. See §9,2 for more details.

Seed funding for ApID comes from the Department of Physics at the University of Split and the Society znanost.org.:

- The Department hosts the Master's Degree program (this is a state university; hence, this funding comes from the state budget).
- The Department provides a basic infrastructure in the form of *offices and their running costs*.
- Society znanost.org provides additional infrastructure in the form of *information technology and accounting services*.
- Project "The Sky as a Gif" (see §7.2) of Society znanost.org already has extensive outreach activities that will serve as the seed for ApID's outreach activities.

Although the main emphasis of the funding plan is to acquire funding through individual projects, ApID also needs **discretionary funds.** These will be acquired through:

i) Direct fundraising

ii) Donations from excess revenues of individual ApID projects

Discretionary funds are allocated by the Implementation and Coordination Board to ApID projects according to the projects' priorities.

The fundraising sources and plans are structured as follows:

- **Education**: The Master's Degree program at the Department of Physics is supported primarily through the University of Split. This support covers costs of visiting professors and running costs of lecture rooms and teaching facilities. Additional funds needed for student travel and research is anticipated to come from national, regional (mobility funds for South Eastern Europe), European (mobility funds for EU) or worldwide (e.g. student exchange funds) sources. These will be combined with resources available through collaborating institutions and research groups.
- **Research**: Considering that nationally available funding sources (the Ministry of Science, Croatian Science Foundation) are rather limited, research grants should focus on funds available through EU programs

and cooperation with the industry. This strategy is an imperative not only because of the volume of funds, but also for the long-term sustainability of research projects. Namely, competing on the European level and cooperating with the industry will help raise ad maintain the level of research excellence needed to attract high qualified researchers and additional funds.

- **Outreach**: Outreach activities are primarily oriented toward local (Dalmatia, Croatia) community. Hence, funds and support for these activities will come dominantly from local sources. Outreach is also a very useful topic for fundraising and diversification of funding sources. Some outreach projects (e.g. public events) are also a potential source of excess funds that can be used for other projects. A part of outreach activity will target a wider audience in the region of South Eastern Europe (and potentially globally). Collaborations with international outreach projects (e.g. ESO outreach activities) will be actively pursued, accompanied with a search for international funding opportunities.

As time progresses, we anticipate that ApID may need to adjust its fundraising plans to accommodate changes in fiscal environment.

A separate funding plan is needed for an astronomy and astrophysics institute considered in §7.6. The scope and specific challenges of this institute dictate a more centralized and hierarchical mode of operation than ApID. The institute also requires large endowments that can be used as the initial investment into the institute's endowment fund.

9.2 Fundraising

The scope of ApID activities requires dedicated fundraising personnel. Therefore, one of the priorities in the 2006/2007 fiscal year is opening the **position of fundraising officer**. The priorities of the fundraising officer will be:

- Establishing a **fundraising office** that will, in addition to fundraising, work on providing advisory and operational support to ApID personnel in idea development, grant application writing, project management, and general fundraising.
- Creating a fundraising scheme for ApID and working on its implementation.
- Establish a **public-relation (PR) office** and work together with the PR officer on transforming ApID into a brand name.
- Representing ApID in matters related to fundraising and communication with potential donors.

Although many components of this work can be outsourced to professional PR and fundraising agencies, it is strategically prudent to develop these skills and knowledge within ApID. The fundraising is expected to operate on self-sustainable basis.

Fundraising activities will be conducted in two ways:

- **Targeted fundraising**: Project leaders of individual projects are expected and encouraged to search for funds required for their specific project activities. Such fundraising is limited to these individual projects only. The project leader may decide to contribute with his/her fundraising to ApID discretionary funds and/or help support other ApID projects.
- **Discretionary fundraising**: Fundraising officer (or members of the Implementation and Coordination Board until such an officer is appointed) will look for discretionary funding opportunities (writing grant proposals or organizing fundraising events).

Types of funding sources for ApID are very diverse due to the variety of interests and activities pursued within ApID. Ways of supporting ApID are also versatile:

- Grants
- Sponsorships
- Fellowships
- Scholarships
- Matching funds and gifts
- Donations/Gifts (in money, equipment, property, stock)
- In kind support

Examples of sources to which ApID will apply for funding	Type of costs				
	Research	Education	Outreach	Overhead (general)	Discreti-onary
Public source of funds					
Croatian Ministry of Science, Education and Sport	X	X	X	X	
Croatian National Foundation for Science	X			X	
Croatian Academic and Research Network				X	
EU funds and programmes (FP7, TEMPUS, COST, ESF, Marie Curie Program, Erasmus Mundus, etc.)	X	X	X	X	
Central European Exchange Program For University Studies		X		X	
Central European Initiative		X	X	X	
UNESCO		X	X		
International funds in other countries (e.g. NSF, DAAD,etc.)	X	X			
Croatian Ministry of Sea, Tourism, Transport and Development			X		
Splitsko-Dalmatinska Municipality			X	X	
Town of Split			X	X	
Private source of funds					
Small donors/gifts			X	X	X
Big donors/gifts	X	X	X	X	X
Private foundations	X	X	X	X	
Sponsors			X	X	X
Joint R&D projects with corporations and other business	X			X	
In kind support	X	X	X	X	X

9.3 Detailed Budget

Estimated expenses[7] of the MSc program (astrophysics courses)

Lecturing part includes:

- teaching (~44€/hour),
- 15 hours of presented lectures = 1 week stay in Split
- accommodation (~17€/day),
- living expenses (~25€/day),
- travel (~500€ per person in average),
- operating expenses (~200€/month/person)

Student research includes (irrespective of the location of the host institutions):

- 5 ECTS credits include:
  - lessons: 15 hours (20 school hours) ~ 0,5 ECTS
  - practical work on defined topic: around 135 hours ~ 4,5 ECTS
  - all together = 4 weeks stay at the research institution
- travel (~500€/student/semester in average),
- accommodation (~17€/day),
- living expenses (~25€/day),
- operating expenses (~200€/month/person)

[7] Based on the curriculum described in §8.3.

	Lecturing				
	accomm. + living expenses	operating expenses	lectures	travel	total
1. semester	5.29k €	0.84k €	11.88k €	4k €	22.01k €
2.semester	3.52k €	0.56k €	7.92k €	4k €	16.00k €
3.semester	5.29k €	0.84k €	11.88k €	4k €	22.01k €
4.semester	-		-	-	-
				TOTAL=	60.02k €
	Student Research (assuming 10 students)				
1. semester	11.76k €	2.00k €	-	5k €	18.76k €
2. semester	11.76k €	2.00k €	-	5k €	18.76k €
3. semester	23.52k €	4.00k €	-	5k €	32.52k €
4. semester	70.56k €	12.00k €	-	5k €	87.56k €
				TOTAL=	157.60k €
	TOTAL (lecturing + student research) =				**217.62k €**

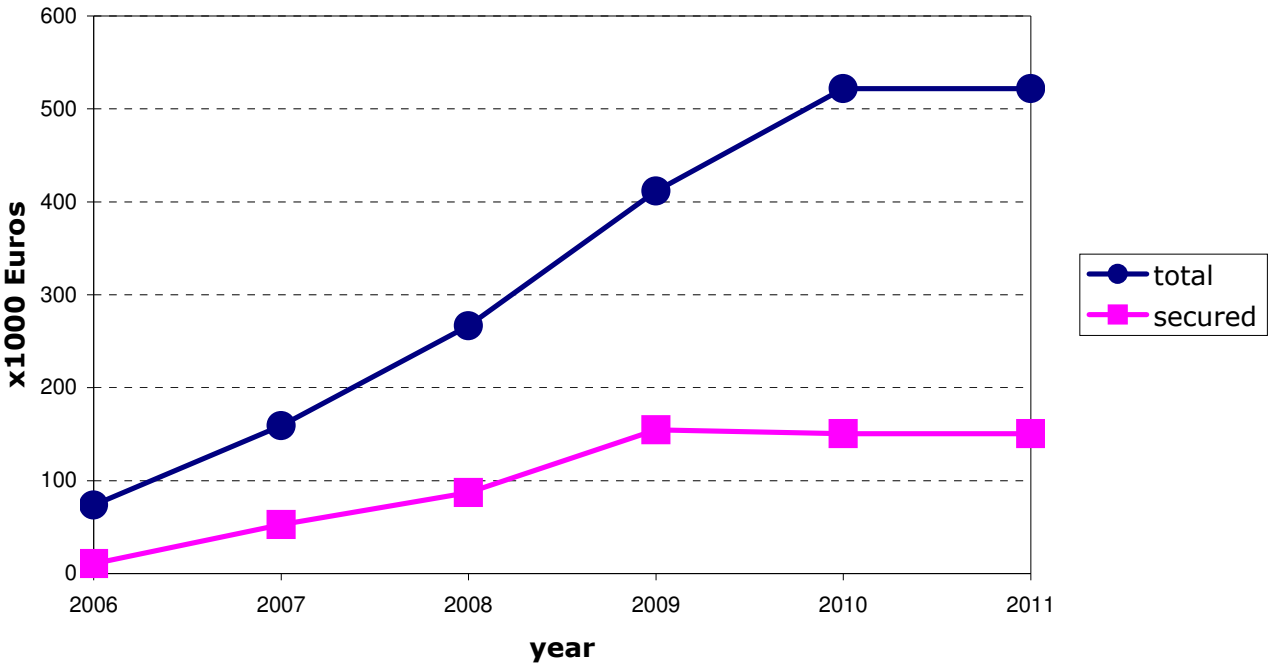
Estimated budget for research and teaching

→ secured through the Department of Physics in Split

	2006	2007[8]	2008[9]	2009[10]	2010[11]	2011[11]
	x1000 €					
Research and teaching staff						
senior positions[12]						
salary	9	36	36+9	2x36	2x36	2x36
travel expenses	0.5	2	2+0.5	2x2	2x2	2x2
operating expenses	0.6	2.4	2.4+0.6	2x2.4	2x2.4	2x2.4
postdoc positions[12]						
salary	5	18+14	2x18+5	3x18+14	4x18	4x18
travel expenses	0.5	2	2+0.5	2x2	2x2	2x2
operating expenses	0.6	2.4+1.8	2x2.4+0.6	3x2.4+1.8	4x2.4	4x2.4
visiting faculty[13]						
teaching salary	-	3.96	15.84	31.68	31.68	31.68
accom. and living expenses	-	1.76	7.05	14.10	14.10	14.10
travel expenses	-	1	5	12	12	12
operating expenses	-	0.28	1.12	2.24	2.24	2.24
Student research[14]						
accom. and living expenses	-	-	11.76	47.04	117.6	117.6
travel expenses	-	-	5	15	20	20
operating expenses	-	-	2	8	20	20
Workshops and conferences[15]	25	45	45	45	45	45
Administrative staff[16]	-	1.2[17]	2.4[17]	4.8[17]	10	10
Web/IT staff	0.45[17]	1.8[17]	3.6[17]	7.2[17]	15	15

[8] Two preliminary courses in the fall of 2007.
[9] Two preliminary courses in the spring of 2008, complete 1. semester in the fall of 2008.
[10] 2. semester in the spring and 1. and 3. semester in the fall of 2009.
[11] 2. and 4. semester in the spring and 1. and 3. semesters in the fall.
[12] See senior faculty and postdoc projections in §8.13.
[13] See "Lecturing part" costs estimates above.
[14] See "Student research" costs estimates above.
[15] Assuming two workshops organized every year + Summer Meeting of the Forum of Croatian Astronomers + Annual Meetings of the Implementation and Coordination Board.
[16] Accounting, bookkeeping, auditing.
[17] Part-time.

Infrastructure upgrades[18]	30	-	30	-	-	-
Computational grid upgrades	-	10	20	30	40	50
Astrophysics library	1.9[19]	10	10	10	10	10
Guest speakers[20]	-	5x0.85	10x0.85	20x0.85	20x0.85	20x0.85
Visiting research scientists[21]	-	2x0.7	4x0.7	8x0.7	8x0.7	8x0.7
TOTAL=	73.55	159.25	266.47	411.46	521.82	521.82
Total secured =	10.7	52.8	87.31	154.62	150.42	150.42



Estimated budget for research and teaching per year (Department of Physics in Split provides the secured part of the budget)

Estimated budget for support activities

It is difficult to derive precise estimates of costs of support activities, such as outreach and distance learning, because they **can be scaled to accommodate available funds**. Therefore, here we provide **conservative minimum estimates** that are designed to yield noticeable results. This budget is also very flexible because **individual budget items can be added, removed, or reprioritized**.

	Minimum
Outreach	
Personnel (outreach coordinator)	15k €/year
Primary and secondary schools	20k €/year
Amateur astronomers (Meetings, events, collaboration on research projects)	20k €/year
Publishing (Popular science articles and books, conference proceedings, teaching materials, etc.)	5k €/year
Public lectures (Includes travel and accommodation costs of invited speakers)	20k €/year
Science fairs, science bars, open days = cost of 7€/visitor x 2000 visitors	14k €/year

[18] Office space, furniture, lecture rooms, Web/IT hardware, etc.
[19] Transportation costs of donations to date, see §8.2.
[20] Assuming one-week stay (travel + visiting costs ~850€) in Split per visitor.
[21] Assuming one-month stay in Split (travel+operational expenses ~700€) and visitors having their own funds.

Fundraising and PR office	
Basic operational expenses	5k €/year
Design + web-support (serves the outreach office too)	15k €/year
Fundraiser (The fundraiser can work on a percentage basis.)	15k €/year
Traveling and fundraising events	50k €/year
Distance Learning	
Operational expenses (Including Web/IT infrastructure)	5k €/year
Personnel	15k €/year
TOTAL=	**199k €/year**

10. Risks and contingencies

Nature of risk	Description of risk	Measure to mitigate/manage risk
Environment risk	Change of government.	High level of financial independence. High level of independent quality control. Establish a transparent and accountable system of operation.
	Existing higher education community is alienated and therefore not supportive of ApID (culture shock). This could affect the conferment of the degrees and so forth.	Existing higher education community will be consulted throughout the development stages of ApID. Also, faculty from existing universities will be offered opportunities to visit ApID and participate in the life of ApID.
Internal risk	Inferior faculty is recruited. Without superior faculty, ApID will fail to attract first-class students and adequate funds.	Financial incentives, additional to the official university salary, will be offered.
	Leadership is inferior.	Involvement of the international scientific advisory board in the process of hiring and firing of the managerial staff.
	Appropriate institutional support is not adequate, leading to the failure of ApID.	Enhancing international collaborations and establishing external funding sources.
	Lack of diversity. There is a risk that ApID will not be attractive to international students.	Strong involvement of Alumni in the international promotion of ApID. Collaborations with international institutions.

11. Expectations, deliverables and measurable indicators of success

ApID is primarily a collaboration of individual projects. Hence, expectations and deliverables of ApID are oriented toward securing or improving logistical and technical support for individual ApID activities and projects. In general, ApID is expected to host scientists working (in various capacities) in Dalmatia, create new knowledge and discoveries, bring new skills to the region, engage in outreach and produce various types of publications.

The following tables summarize the most important ApID activities and their expected outcomes, target dates, outputs / targets / deliverables / performance standards and indicators that can be used for measuring the activities' success.

Activity	Expected outcome	Target date	Outputs - targets – deliverables – performance standards	Measurable indicators of success
Hiring new faculty (basic goal: at least two; advanced goal: at least four)	Substantial advancement in internationally recognized astrophysics research and education in Split; Substantial scientific and logistical support for ApID; Incubation of new activities, projects, ideas, collaborations and postdoctoral positions.	Job opening no later than Dec.31.2006 Dec.31.2008 Candidate selection by Jun.30.2007 Jun.30.2009	At least one major research or development grant every year; Achieving high quality in research, teaching, outreach and work with students; Attracting new students and postdocs to Split; Organizing at least two international events (workshops, meetings, etc.) per year.	Scientometric evaluation; Organizational performance; Feedback from students, collaborating scientists, and public; Progress reports; Grant money; Reviews of completed projects; Engagement in ApID activities.
Hiring postdocs (basic goal: at least four; advanced goal: at least eight)	Substantial advancement in internationally recognized astrophysics research in Split; Substantial scientific support for ApID.	Job openings no later than Dec.31.2006 Jun.30.2007 Dec.31.2008 Jun.30.2009 Candidate selection by Jun.30.2007 Dec.31.2007 Jun.30.2009 Dec.31.2007	Achieving high quality in research, teaching, outreach and work with students; Independent projects initiated by postdocs; Attracting new students to Split; Teaching opportunities provided to postdocs; Recruiting the very best postdocs for faculty positions.	Scientometric evaluation; Feedback from the faculty, students, collaborating scientists, and public; Progress reports; Reviews of completed projects; Engagement in teaching and outreach.
Hiring a fundraising officer	Consolidation and expansion of fundraising capabilities; Substantial advancements in the quality and performance of ApID's fundraising activities.	No later than Jun.30.2007	Achieving high quality and efficiency in fundraising activities; Creation of a successful fundraising scheme; Setup of a fundraising office; Providing high quality advisory and operational support to ApID personnel; Creating an efficient network of contacts with funding sources.	Amount of collected funds; Feedback from ApID personnel, visitors, students, general public, donors and sponsors; Review/evaluation of fundraising activities; Performance reports from the fundraising office.

Activity	Expected outcome	Target date	Outputs - targets – deliverables – performance standards	Measurable indicators of success
Hiring an outreach coordinator	Consolidation and expansion of outreach capabilities; Substantial advancements in the quality and performance of ApID's outreach activities.	No later than Jun.30.2008	Achieving high quality and efficiency in outreach activities; Setup of an outreach office; Providing high quality advisory and operational support to ApID personnel; Implementing outreach collaborations with various institutions and organizations; Prolific publishing activities; Achieving quality and affluence in outreach events.	Number of outreach activities and events; Number of published items (articles, books, etc.); Number of participants in outreach activities; Number of outreach collaborations; Feedback (including surveys) from ApID personnel, visitors, students, and general public; Review and evaluation of outreach activities; Performance reports from the outreach office.
Hiring a public-relation officer	Significant increase of public visibility; Organized and coherent promotion of ApID and its activities and projects; Transforming ApID into a brand name.	No later than Jun.30.2008	Achieving quality, competence and effectiveness in communication with the general public; Creating an efficient network of media contacts; Setup of a PR office; Creating a PR strategy of ApID; Coordinating PR coverage of ApID events; Creating a complete (web, memos, logos, posters, videos, multimedia, adds, etc.) visual identity of ApID; Providing high quality advisory and operational support to ApID personnel; Training of ApID personnel in PR methods.	Number and positiveness of news articles about ApID; Feedback (including surveys) from ApID personnel, visitors, students, journalists, funding sources, and general public; Review (and number) of created PR material (web, print, video, etc.); Review and evaluation of PR activities; Performance reports from the PR office.

Activity	Expected outcome	Target date	Outputs - targets – deliverables – performance standards	Measurable indicators of success
Hiring a computer system administrator	Consolidation and expansion of computational and Web/IT infrastructure of ApID; Substantial technical and logistical support for ApID; Incubation of new ideas and solutions for keeping the technological edge of ApID.	No later than Dec.31.2007	Achieving high quality and efficiency in overseeing, organizing, and administering Web/IT, network, software and hardware requirements of ApID; Setting up a computer system administration office; Pursuing cutting-edge technologies and implementing them in ApID; Providing high quality advisory and operational support to ApID personnel; Training of ApID personnel in utilization of software and hardware.	Quantity and quality of acquired equipment; Statistics of computer and Web/IT usage; Feedback (including surveys) from users about their level of service satisfaction; Promptness in resolving computer problems; Quantity and quality of technical upgrades; Review and evaluation of the technical support; Performance reports from the system administrator.
Accounting, bookkeeping and auditing staff and services	Consolidation and maintenance of administrative needs of ApID.	Basic support: Immediate Jun 30.2007 One part-time administrator Full time administrator: Dependable on available funds	Achieving high quality and efficiency of the administrative support; Sharing of the administrative staff with the Society znanost.org and the Department of Physics when possible; Hiring dedicated administrative staff when possible and necessary.	Feedback (including surveys) from users about their level of service satisfaction; Promptness and success in resolving administrative requests and problems; Review and evaluation of the administrative support; Performance reports from the hired staff.
"From dust to life" and "Large-scale computations" Collaborations	Substantial advancement in internationally recognized astrophysics research and education in Split; Transfer of skills and knowledge to Split.	"From dust to life": begin no later than: Dec.31.2007 "Large-scale computations" begin no later than: Dec.31.2008	Formation of international research collaborations; Creating timetable of collaboration activities; Preparing grant proposals; Mobility of scientists and students within the collaborations; Organizing collaboration meetings.	Number of scientists and institutions involved; Scientometric evaluation; Organizational performance; Feedback from students and collaborating scientists; Progress reports; Grant money; Reviews of completed projects; Engagement in ApID activities.

Activity	Expected outcome	Target date	Outputs - targets – deliverables – performance standards	Measurable indicators of success
Visiting lecturers program	Basic support for the Master's Degree program in astrophysics at the University of Split; Internationally competitive graduate program; Transfer of skills and knowledge to Split.	Initial recruitment of lecturers: Completed Start of lectures: Fall 2008 Recruitment of additional lecturers: Continuously	Recruiting a significant fraction of visiting lecturers from world-class institutions; Organizing local logistical support for visiting lecturers (lecture scheduling, travel, accommodation, working conditions, Web/IT support for distance learning, etc.).	Internal and external evaluations required by the higher-education standards of the Bologna process in Croatia; Additional quality evaluations by ApID (constantly monitored and evaluated by the Faculty Quality Assurance Team); Feedback (including surveys) from the faculty and students; Performance of students on exams.
Faculty Quality Assurance Team	Increased quality of teaching and mentoring at the astrophysics graduate program in Split.	Begin no later than: Dec 31. 2007.	Establishing a set of criteria for faculty quality assurance; Providing advice and help in teaching to the permanent and visiting faculty staff; Perform quality evaluations of the lecturers and their teaching materials.	Quality performance of the graduate program; Quantitative measures of the Team's productivity; Feedback (including surveys) from the faculty; Correlations between the student performance and recommended improvements in teaching; Performance reports from the Team.
Procurement of basic infrastructure and supplies for research, education and outreach	Securement of basic working conditions necessary for achieving ApID goals; Creation of a convenient and inspiring working environment beneficial for ApID.	Startup procurement: Dec.31.2006 After that maintain constant growth	Sufficient office space and supplies for ApID activities; Technologically advanced computational infrastructure; Advanced audio/visual infrastructure; Advanced Web/IT infrastructure.	Amount of office space; Quantity of office supplies; Number of computers and other devices; Statistics of infrastructural usage; Feedback from ApID personnel, visitors and students.

Activity	Expected outcome	Target date	Outputs - targets – deliverables – performance standards	Measurable indicators of success
Procurement of infrastructure and supplies for the fundraising office	Increased fundraising efficiency.	Startup: no late than Jun.30.2007 After that: Maintain constant growth	Sufficient infrastructure and supplies needed by the fundraising officer and fundraising office.	Amount of office space; Amount of funds invested into fundraising compared to financial gains by ApID; Statistics of the infrastructure usage.
Procurement of infrastructure and supplies for the PR office	Increased quality and efficiency of public relation operations.	Startup: no late than Jun.30.2008 After that: Maintain constant growth	Sufficient infrastructure and supplies needed by the PR officer and PR office.	Amount of office space; Amount of funds invested into PR compared to gains in ApID's visibility; Statistics of the infrastructure usage.
Procurement of infrastructure and supplies for the outreach office	Increased quality and efficiency of outreach activities.	Startup: no late than Jun.30.2008 After that: Maintain constant growth	Sufficient infrastructure and supplies needed by the outreach officer and outreach office.	Amount of office space; Amount of funds invested into outreach compared to augmentation of outreach activities; Statistics of the infrastructure usage.
Websites	Securement of basic channels of communication with the general pubic, potential investors, students, etc.	Initial: Completed Additional: Continuously	Web-server(s); Web-pages for each activity and project.	Number of web-pages; Amount and diversity of published material; Number of visitors and their geographical distribution; Feedback (including surveys) from webpage users.

Activity	Expected outcome	Target date	Outputs - targets – deliverables – performance standards	Measurable indicators of success
Master 's Degree program in astrophysics	Sustainable graduate program in astrophysics in Split; The best graduate program among similar programs in Croatia by 2011.	Preliminary courses (test of logistics): Fall 2007 Full program: Fall 2008	Achieving high quality of teaching materials and lectures; Implementation of the graduate program curriculum; Implementation of the latest trends and advancements in science, technology and education; Recruiting visiting lecturers from world-class institutions; Organizing local logistical support (lecture scheduling, lecturers' travel and accommodation, students' and lecturers' working conditions, etc.); Provide training of lecturers in Web/IT skills and use of new technologies in classrooms; Organize student services (administrative help, mentoring, financial support, computer facilities, access to textbooks and teaching materials, student accommodation, etc.).	Number of lectures, lecturers, students, classrooms, laboratories, offices, student projects; Number of applicants and their distribution by age,, geography, nationality, and income; Comparison of students' skills and knowledge before and after attending the program; Internal and external evaluations required by the higher-education standards of the Bologna process in Croatia; Feedback (including surveys) from the faculty and students; Performance of students on exams; Performance of students on research and outreach projects; Performance of alumni.
Program of student mobility (research projects and education)	Basic support for the Master's Degree program in astrophysics at the University of Split; Internationally competitive graduate program.	Begin no later than: Fall 2008 After that maintain constant growth	Involvement of students in research; Creating a portal for advertising student research and travel opportunities; Transfer of skills and knowledge from project leaders to students; Research papers published by students; Travel of students to international centers of excellence.	Number of involved students, mentors and institutions; Number of publications with students as coauthors; Number of institutions visited by students; Feedback (including surveys) from students and mentors.

Activity	Expected outcome	Target date	Outputs - targets – deliverables – performance standards	Measurable indicators of success
Student Admission Committee	Increased quality of student admission; Increased quality of the Master's Degree program in Split.	Begin no later than: Dec.31.2007.	Creating application forms and application process; Web pages; Establishing methods and criteria for screening and evaluation of applications; Interviewing prospective students; Selection of students for the graduate program.	Number of created public documents related to the admission process; Speed of processing student applications; Correlations between the committee's evaluation of a student and his later performance in the graduate program; Feedback (including surveys) from candidates and professors involved in the graduate program.
Student recruitment program	Increased quality of student admission; Increased quality of the Master's Degree program in Split.	Preliminary recruitment: Immediately Extensive work on recruitment: No later than Dec.31.2007.	Coordinating recruitment efforts; Creating presentation materials; Creating "head-hunting" strategies and logistics; Working with outreach and PR offices on recruitment activities (promotion of the graduate program among potential candidates, early work with possible candidates, etc.).	Number of given lectures, published material, adds, prepared presentations, approached potential candidates, inquires about the program; Size of the reached targeted audience; Number, diverseness and quality of applicants.
Visiting Research Scientists Program	Increased quality of astrophysics research in Spit; Incubation of new research activities, projects, ideas, and collaborations; Transfer of skills and knowledge to Split.	Begin no later than: Fall 2007	At least one visiting scientist in Split at any time; Organizing local logistical support for visiting scientists (travel, accommodation, working conditions, Web/IT support, etc.); Incorporating visiting scientists into ApID activities.	Number of visiting scientists; Length of their stay in Split; Number of publications with the Physics department as a co-affiliation or in the acknowledgment; Feedback from involved scientists; Number of ApID activities with visiting scientist involved.

Activity	Expected outcome	Target date	Outputs - targets – deliverables – performance standards	Measurable indicators of success
Summer Research Program	Increased quality of astrophysics research, teaching and mentoring in Split; Incubation of new research activities, projects, ideas, and collaborations; Transfer of skills and knowledge to Split.	Begin no later than: Summer 2008	At least two scientists in Split during summer working on their research together with local students; Organizing local logistical support for visiting scientists (travel, accommodation, working conditions, Web/IT support, etc.).	Number of visiting scientists; Number of involved students; Length of their stay in Split; Number of publications with the Physics department as a co-affiliation or in the acknowledgment; Feedback from involved scientists and students.
Seminars and colloquia	Increased quality of astrophysics research and teaching in Split; Incubation of new research activities, projects, ideas, and collaborations; Transfer of skills and knowledge to Split.	Begin no later than: Fall 2008	At least four visitors during a semester; Organizing local logistical support for visiting scientists (travel, accommodation, Web/IT support, etc.); Collaborating with the outreach, PR and fundraising offices to create a public series of prestigious lectures.	Number of visiting scientists and given seminars and colloquia; Number of attendees at lectures; Length of their stay in Split; Feedback (including surveys) from involved scientists, students and general public.
International Meetings, Workshops and Conferences	Increased quality of astrophysics research and teaching in Split; Incubation of new research activities, projects, ideas, and collaborations; Transfer of skills and knowledge to Split.	Immediately	At least one meeting and two workshops or conferences in Split per year; Organizing local logistical support for event participants (travel, accommodation, working conditions, Web/IT support, etc.); Incorporating visitors into other ApID activities.	Number of events; Number and professional profile of participants; Relation of events with out ApID activities; Number of local students organizing and participating in the events; Feedback (including surveys) from involved scientists-organizers and scientists-participants.

12. References

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13. Appendix

13.1 Departmental contact information

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http: //www.fizika.pmfst.hr
http: //www.fizika.pmfst.hr/astro
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Useful links

Croatia: www.hr, www.croatia.hr
Dalmatia: www.dalmatia.hr, www.dalmatia.info
Split: www.split.info, www.split.hr
City transportation: www.promet-split.hr
Student center www.scst.hr

How to find us if you travel by …

airplane: www.split-airport.hr
bus: www.ak-split.hr
ferryboat: www.portsplit.com
train: www.hznet.hr
car: www.hac.hr, www.hak.hr

13.2 Endorsements

REPUBLIC OF CROATIA
MINISTRY OF SCIENCE, EDUCATION AND SPORTS
MINISTER

Prof. Mile Dželalija, Ph.D.
Physics Department
Faculty of Natural Sciences, Mathematics and Education
University of Split
Nikole Tesle 12
21000 Split

Zagreb, August 1, 2006

Dear Professor Dželalija,

I write in strong support of the Astrophysics Initiative in Dalmatia (ApID) as it represents an excellent model for the development of this scientific field, based on promoting linkages between higher education and science, interdisciplinary approach, international cooperation and a fundraising policy relying on both national and international sources.

The Ministry of Science, Education and Sports is committed to its policy of transforming Croatia into a science and technology oriented country and the creation of a knowledge based society. In this context we consider that your initiative plays an important role in the promotion of excellence in research and teaching as well as in transfer of technology. In addition, it facilitates the process of "brain-gain" and the promotion of careers in science and technology among youth. Your proposal clearly shows that ApID is committed not only to world-class scientific excellence in teaching and research but also to the development of the local community.

As the fields of astronomy and astrophysics rely on a high level of interdisciplinary research we welcome ApID's plans to establish connections with other disciplines at the University of Split and other Croatian universities, as well as international institutions. ApID aims to become an incubator of new ideas, discoveries and enterprises as well as a promoter of science in society. ApID's staff have participated in the outreach project "The Sky as a Gift", an excellent project aimed at popularization of science that includes more than 45 teachers and 500 pupils from all parts of Croatia.

The Astrophysics graduate study programme at the Department for Physics, Faculty of Natural Sciences, Mathematics and Education, University of Split, is a very good example of the new Bologna structured programme. It has been accredited by the Ministry of Science, Education and Sports and as such will receive regular funding from the state budget. Additional funding for ApID's activities is available through research grants and grants for early stage researchers provided by our Ministry, in accordance with standard procedures.

Considering your achievements so far and a sound business strategy plan for 2006–2011 period I believe that the ApID and the Department for Physics at the Faculty of Natural Sciences, Mathematics and Education, University of Split, will grow into a strong and internationally recognized scientific community.

Sincerely yours,

Prof. Dragan Primorac, M.D., Ph.D.

Princeton University

Department of Astrophysical Sciences
Peyton Hall
Princeton, New Jersey 08544-1001

6 April 2007

Prof. Mile Dzelalija
Physics Department
Faculty of Natural Sciences, Mathematics and Education
University of Split
Nikole Tesle 12
21 000 Split
CROATIA

Dear Professor Dzelalija

I would like to add my voice to those who have expressed very strong support for the establishment of the new Astrophysics Center, the Astrophysics Initiative in Dalmatia.

I have known and have been very impressed for many years by the work of the Croatian astronomer Zeljko Ivezic, who has been one of the most outstanding researchers in a project very dear to my heart, the Sloan Digital Sky Survey, SDSS. This last summer I was fortunate enough to be asked to take part in a workshop he helped organize in Dubrovnik, and had a chance to meet and get to know a number of other Croatian astronomers and some excellent students. It is quite clear to me that there is a strong tradition already in astrophysics and a large number of really intelligent and hard-working young people who would like to enter the field--in other words, the raw materials, smart people with interest, are already in place.

An institute like ApID would give them a center and a place to work and grow in Croatia, and I believe would very soon form a formidable intellectual center for the discipline--and not incidentally, be a significant achievement for Croatian science. Your country is so incredibly beautiful that such a center would be a powerful magnet for visiting scientists from around the world. Given some reasonable and modest resources, I believe that such a center would soon become a hub for the whole discipline in addition to its beneficial purely local effects. Given this head start, I find it difficult to imagine a better and easier way to foster Croatian science, and I would like to register my very strong and enthusiastic support.

Sincerely

James E. Gunn
Eugene Higgins Professor
Astrophysics
Princeton University
Project Scientist, Sloan Digital Sky Survey

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY 08540

PROGRAM IN INTERDISCIPLINARY STUDIES

PIET HUT: Room D209 tel.: (609) 734-8075; fax: (609) 951-4489

September 27, 2006

Prof. Mile Dzelalija
Physics Department
Faculty of Natural Sciences, Mathematics
and Education
University of Split
Nikole Tesle 12
21 000 Split
CROATIA

Dear Prof. Dzelalija

I am writing to express my strong support for the Astrophysics Initiative in Dalmatia (ApID). I am very impressed with the business strategy of ApID for 2006-2011 as it is a great example of organizing a new center of excellence and ensuring its sustainability through a carefully designed combination of educational, research, and outreach programs.

ApID is also impressive for its potential to contribute significantly to the development of the region, on the scale of both Dalmatia and Croatia. I have met several young and promising Croatian astrophysicists during the last few years, some of whom may be connected directly or indirectly with the ApID project. Their scientific abilities and achievements are first-rate, and their enthusiasm for supporting fresh activities in their home country seems boundless. In general, the long list of young scientists from various prestigious institutions around the world, who are involved in the implementation of ApID, is a testimony for the sound and promising setup of this new initiative.

For a relatively young country like Croatia, the fastest and most robust way to make lasting ties with other countries, in my opinion, is through scientific collaborations, especially on the level of pure science, where immediate concerns of existing protective political and business ties are not forming any road blocks. Pure science is the ultimate open gate for collaborations.

Astrophysics is a truly international endeavor, as I have personally witnessed again during the General Assembly meeting of the International Astronomical Union in Prague, this last summer, where several new countries were admitted to the Union. Astrophysics, among the sciences, has a unique chance to cement collaborations between countries precisely because its emphasis on pure research, driven by curiosity. Yet, at the same time pure research in astrophysics, and in space science in general, has often let to very practical benefits in areas as diverse as the development of new materials and technologies for the optics industry, and invention of new software algorithms and techniques.

The success of ApID would be a great example to young generations of scientists around the world to show that they can contribute greatly to their own community, even if they happen to lie outside the traditional circles of political power. Coming from a small country myself, I am very sympathetic to the ApID initiative. I received my PhD in Amsterdam, Holland, 25 years ago, before emigrating to the United States. Yet, I continue to nurture collaborations with my colleagues in Amsterdam and elsewhere in Holland, to mutual benefit. I look forward to being able to contribute to ApID through research and educational projects and I am more than happy to assist ApID with my expertise in astrophysics, especially in the computational aspects of large-scale simulations in astrophysics.

Please do not hesitate to contact me, if you would like to receive more information about my work and/or my opinion of the ApID program.

Sincerely,

Piet Hut
Prof. of Astrophysics and
chair of the program in
Interdisciplinary Studies

STANFORD UNIVERSITY
Stanford Linear Accelerator Center
Kavli Institute for Particle Astrophysics and Cosmology

December 14, 2006

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Prof. Mile Dzelalija
Physics Department
Faculty of Natural Sciences, Mathematics and Education
University of Split
Nikole Tesle 12
21 000 Split CROATIA

Dear Prof. Dzelalija

I have been asked to comment on the Astrophysics Initiative in Dalmatia (ApID). I am most pleased to do so. I became aware of ApID during an international conference on processing of astronomical images held recently in Dubrovnik where I had the opportunity to speak with several of the organizers of this proposal. This is an enthusiastic group quite committed to helping develop science, and particularly astronomy, in Croatia.

The ApID program will stimulate Croatian participation in a highly visible and exciting area of basic scientific research that historically has had strong European leadership. It will provide an attractive organization and place for scientists to obtain graduate training and carry on research within Croatia. ApID would be natural conduit for Croatian roles in the present-day EU research efforts of the European Southern Observatory (ESO) and the European Space Agency (ESA), and would be a useful framework for attracting foreign scientists to Croatia.

As a scientist who has spent a career doing research in high energy physics, accelerator science, and now astrophysics and cosmology, I know science as a truly international enterprise. One that creates invaluable connections between people and countries. It is perhaps no coincidence that applying for membership in CERN has been one of the first steps taken by former Soviet Block countries as they have emerged on the international scene. The ApID proposal is an excellent step for Croatian science. I urge you to consider it positively.

Sincerely,

David L. Burke
Professor of Physics

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March 28, 2007

Prof. Mile Dželalija
Physics Department
University of Split
Nikole Tesle 12
21000-Split, CROATIA

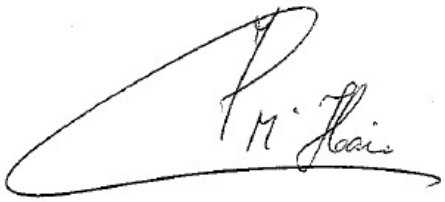
Dear Prof. Dželalija:

It is my wish to express a strong support for the Astrophysics Initiative in Dalmatia (ApID). Such a broad program encompassing education, research and public outreach is an excellent basis for a new centre of excellence in Croatia.

The business strategy for a period 2006–2011 is an impressive plan, with the aim to create and sustain ApID through its initial phase. I am confident that this program has a huge potential to significantly contribute to the development of this part of Croatia, and to attract young students and scientists not only from Croatia, but from the neighbouring countries as well. I was impressed by a list of Croatia astrophysicists involved in the creation ApID, some of which I am personally acquainted with. These people and the prestigious institutions they work at are both the cornerstone of ApID and a measure of the objectivity and professionalism with which the program was designed.

Finally, I wish to express my view that programs such as these are an excellent way for Croatia to get integrated into tight scientific collaboration with other countries, especially its neighbours and the European Union. There is no better way to form long-lasting ties with other nations than by allowing young people to exchange scientific ideas and obtain education in other countries, because this overcomes national barriers and raises awareness among younger generations.

Sincerely Yours,



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Организация
Объединенных Наций по
вопросам образования,
науки и культуры

منظمة الأمم المتحدة
للتربية والعلم والثقافة

联合国教育、
科学及文化组织

UNESCO Office in Venice
UNESCO Regional Bureau for Science and Culture in Europe (BRESCE)

Venice, 15 February 2006

TO WHOM IT MAY CONCERN

This is to acknowledge that Mr **Mile DZELALJA**, Professor at the Faculty of Natural Sciences at the University of Split, has been the Croatian coordinator of the project entitled 'Piloting Solutions for Alleviating Brain Drain in South Eastern Europe'. This Croatian Project was part of a dedicated programme that UNESCO has implemented in 2004-2005 in five countries and seven Universities in South Eastern Europe with an aim of reducing the brain drain phenomenon. The project has responded to the request of the UNESCO's Member States of the region and to the UNESCO's Director-General Strategy for Enhancing cooperation with Member States from South Eastern Europe. It was funded by Hewlett Packard who has provided latest technology equipment and financial resources that was allocated to each of the Universities for various training activities, short term visits abroad, mobility of researchers from the diaspora, websites creation, etc. Detailed information about the project is available at: *www.unesco.org/venice*, *science policy*.

During the implementation of the project in Croatia (2004-2005), *Prof. Dzelalija* has proved excellent leadership qualities. His action was a model for the project-coordinators from the other six Universities. He has succeeded to involve in the Croatian project an impressive number of colleagues and students from many faculties at the University of Split and thus to create the biggest country-project team. He has also most profitably succeeded to use the UNESCO project as a lever for attracting major financial resources from European funding institutions, in particular the European Commission, for an important number of projects developed with international partnership.

Due to the high quality of the results obtained by the Croatian team and as a recognition of his high scientific profile, Prof. Dzelalja was invited to participate as guest speaker in a major event organized by UNESCO and CERN and funded by Hewlett Packard entitled 'GRID: the Key to Scientific Collaboration', organized at CERN, on 29 September 2005, which brought together major players at European and international level concerned with the development of Grid infrastructures.

UNESCO highly appreciates Prof. Dzelalja's contribution to the overall success of this project. The very good results obtained in South Eastern Europe have convinced Hewlett Packard to agree in funding a similar project in the African countries where the brain drain phenomenon constitutes a major threat for national and regional development.

Howard Moore
Director

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13.3 CREATE Project: Round table conclusions

Stimulating Croatia's Entrepreneurial Activities

and Technology Transfer in Education

ROUND TABLE CONCLUSIONS

Date: May 09, 2006
Time: 15:30 – 17:15 h
Place: University of Alicante, Spain

Conclusions:

- Define objectives and core activities of the Technology Transfer Offices at the Universities
  - Objectives
    - to create a support to technology transfer, according to the project proposal
    - to promote links between universities and industry
  - Activities
    - formal establishment of TT offices (decision of the University bodies)
    - nomination of management
    - definition of internal organisation and staffing
    - definition of competences (promotion of entrepreneurship, advice on IP matters, training, dissemination of information, collection and analysis of data (about IP, research expertise, facilities, interested companies, EU programs)
    - entrepreneurial course (our activities)
    - joining networks (IRC)
  - Legal framework
    - It is an urgent necessity to formulate propositions on IP and relationships between researchers, universities, companies and state and local government bodies. All actions will be done taking into account existing national documents and actions plans
    - National level
      - initiate amendments to the act of Science and Higher Education-end of May (Dželalija, Bjeliš, Zeković, Lučin (Trkulja, Lenac), Vranješ Markić, Nagy, Novak – the end of May 2006). To state specifically IP matters
    - Regional level
      - if necessary changing some local county acts (Marušić – July 1, 2006. for analysis)
    - University level
      - corresponding changes at the University Statutes and accompanying rules
      - IP unit (Zeković – in 2006) visits all three Universities at the rector level
  - Financing
    - as a first phase office within the Universities
    - all three Universities in the same way
    - employees paid by University (at the beginning) by a one-year employment contract
    - investigate what is the possibility for financing through University by the support of Ministry and/or government bodies (Dželalija, Lenac, Zadro)
- Create a platform/network to further develop initiatives to support university-industry cooperation
  - Project national committee (Dželalija, Vranješ Markić, Lenac, Zadro, Lučin (Trkulja), Ivić-Šimetin, Nagy, Zeković, Bjeliš, Novak, Marušić, Ministry (Petrovečki – Dželalija upitati)) – meetings: four times a year
  - Disseminate (Project national committee) at the CREDIT seminar in Split – June 2006

- Potential members of network
  - clusters, IRC,Science parks, development agency, buisiness associations, chamber of commerce

- Mapping of training required for TTO staff
  - Required competences
    - every University develops its set of competences (Dželalija, Lenac, Zadro, Kovačević – May 15, 2006)
    - recommendable: master level, competence in research and innovation, communication skills
  - Training
    - in June 2006 in Saarland and Alicante (the committee will decide topics in a week: in Alicante training through IPR helpdesk (legal matters), IRC (technology transfer agreements, negotiations, establishing contacts)
    - through the CARDS IP project (Zeković min. 3 persons, details by the end of May 2006)

Place and date: Madrid, May 10, 2006

Prof. dr. sc. Mile Dželalija
Prof. dr. sc. Zdravko Lenac
Janja Trkulja, prof.
Prof. dr. sc. Melita Kovačević
Goran Zeković, dipl. iur.
Dr. sc. Ivana Nagy
Mr. sc. Ante Katavić

Doc. dr. sc. Leandra Vranješ Markić
Prof. dr. sc. Krešo Zadro
Prof. dr. sc. Aleksa Bjeliš
Prof. dr. sc. Srđan Novak
Robert Markt, dipl. oecc.
Mr. sc. Hrvoje Marušić

13.4 General information on the physics graduate program at the Department of Physics

NOTE: This is an excerpt from the document called "Proposal for the Graduate Study Programme in Physics" that the Department of Physics at the University of Split submitted to the Ministry of Science, Education and Sport on March 15th, 2005. The proposed graduate program was approved by the Ministry in June 2006.

University of Split

Faculty of Natural Sciences, Mathematics and Education

PROPOSAL FOR THE GRADUATE STUDY PROGRAMME

Physics

Split, March 15th, 2005

1. Introduction

1.1. General information on the programme

In global economy based on knowledge, the development of one country depends, among other things, on the number of the highly qualified experts. In this context, experts with knowledge of high technologies are of special interest. Irish and Finnish examples of investments in high technologies are clear proof of how economy of a country can be wisely developed in today's global competitive conditions. Today EU investments are focused on biotechnology, computer technology and space industry. Considerable investments are also directed into education and into research in the field of environment preservation, which is precondition for the sustainable development. Physics, with its knowledge, techniques, methods and tools has unavoidable role in these research fields.

- All physicists in Croatia find employment very quickly. Many find work in the system of education or in the scientific institutions, but more and more of them employ in different fields of Croatian economy. Physicists have analytical way of thinking and excellent computer science knowledge that can be applied in solving extraordinary large variety of problems. These competences are recognised by the Croatian employers. Also, the truth is that in many cases because of the insufficient communication of physicists with society, or because the number of physicists is not sufficient, people who are not adequately qualified perform physicist's jobs. One evident example is the field of environmental physics, which lacks adequately educated professionals. Proposed graduate study of physics with orientations in astrophysics, biophysics, environmental physics and computer physics does not exist in Croatia and will satisfy some of the above-mentioned society needs.

- Within this flexibly organised graduate study several orientations are proposed: astrophysics, biophysics, environmental physics, computational physics and physics teaching orientation. The interdisciplinary approach is emphasised throughout the study programme. Students have possibility of participating in modern science research through seminars, laboratory experiments and computer modelling under the guidance of the international experts. Many courses have been proposed for the first time in Croatia, and variety of elective courses provides broad education and insight into most recent trends. Depending on the chosen orientation, students can perform part of research at other University departments and science institutes in Split, some other institutions in Croatia and abroad. Students' education includes also science communication and choice of humanities courses. Because our Faculty has many years of tradition in education of physics teachers, besides interdisciplinary approach, special attention is dedicated to the most modern teaching methods.

- Similar study programmes, adjusted to the Bologna system, with similar orientations exist in several European countries, United States of America, Australia and Japan. We mention several examples because we propose several orientations within this

study programme. Similar studies exist in Italy (Universita' di Bologna, Facolta' di scienze matematiche, fisiche e naturali, Università degli Studi di Udine), Germany (University of Bremen, Institute of Environmental Physics), Great Britain (University of Strathclyde, Faculty of Science). Comparable study programmes also exist in some European countries with heritage similar to ours, which have successfully adjusted their educational system to the labour market needs. Examples are Slovakia (Comenius University in Bratislava, Faculty of Mathematics, Physics and Informatics) and Poland (Adam Mickiewicz Univeristy in Poznan, Faculty of Physics).

1.2. Previous experience in the field

There is a long tradition of the physics study in the frame of studies for teachers at our Faculty. It has been known that studies with mathematics and physics background show some common problems like small number of students and the long average duration of study. In order to improve the quality of studying and attract more students, in the last couple of years some measures have been undertaken at our Faculty. The system of students' mentors and advisors has been introduced. There has also been a constant enrichment of literature and improvement of experimental exercises. One of the indicators of the success is a trend of raising interest of the matriculates for the study of physics. Also, on average, the quality of enrolled students is rising, too.

1.3. Student mobility scheme

In order to create prerequisites for the student mobility, exclusively one-semester courses are introduced. Also, the time required for completing the study will be considerably shortened by several measures.

Based on agreement with the study co-ordinator, students will be able to attend part of their study programme on other faculties of the University of Split, as well as other universities in Croatia and abroad. The mobility is especially highlighted in the astrophysics orientation, where part of study programme will be realised through participation in international scientific projects. Students from other institutions will be able to attend part of the proposed Study.

To ensure the mobility, contacts have been established with the universities in Croatia and abroad (Universities of Rijeka, Zagreb, Osijek, Hradec Kralove, Molise, Targoviste, Uppsala, Poznan, Jena, Lille, Saarland, Sarajevo, Mostar, Trieste, and Bordeaux).
The mobility will be stimulated by variety of the different elective courses.

1.4. Other elements

The enrolment of students to particular orientations within the Study will be approved according to current demands of the labour market, student interests and the Study capacities.
The proposed Study programme will be interesting to medical institutions, pharmaceutical companies, R&D institutes/teams, different authorities for environmental protection and planning of the sustainable development, as well as to financial institutions (banks, investment funds, and insurance companies). Also, in the educational system there is a need for students who will finish teaching orientation of the proposed Study.

13.5 Detailed curriculum of the Physics Graduate Program at the Department of Physics

	1st Semester		
	Course title	**Course structure* L+S+E+P**	**ECTS**
	Quantum physics II	30+0+15+0	5
	Teaching orientation (T)		
	Solid state physics	30+0+15+0	4
	Experimental methods of modern physics	30+0+15+0	4
	History of physics	30+0+0+0	3
	Physics education I	30+30+0+30	7
	Educational psychology I	30+15+0+0	3
	Elective courses		4
Total:		**Max. 375**	**30**
	Orientation astrophysics (A)		
	Modern Astrophysics I	30+0+30+0	5
	Methods of Observational Astronomy I	10+0+20+0	3
	Research	0+20+0+0	5
	Elective courses		12
Total:		**Max. 375**	**30**
	Orientation biophysics (B)		
	Molecular genetics	24+10+0+12	5

	Physics of medical diagnostics	7+8+0+15	3
	Bioinformatics	20+10+0+10	5
	Experimental methods of modern physics	30+0+15+0	4
	Elective courses		8
Total:		**Max. 375**	**30**
	Orientation environmental physics (E)		
	Essentials of ecology	30+15+0+0	3
	Measurement techniques in environmental research	30+0+0+30	5
	Physics in forest fire	24+0+12+4	4
	Social ecology	30+0+0+0	2
	Elective courses		11
Total:		**Max. 375**	**30**
	Orientation computational physics (C)		
	Solid state physics	30+0+15+0	4
	Experimental methods of modern physics	30+0+15+0	4
	Dynamics of atoms in gas and liquid phase	30+0+15+15	5
	Elective courses		12
Total:		**Max. 375**	**30**

* L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

1st Semester

ELECTIVE COURSES

	Course title	**Orientation**					**Course structure*** **L+S+E+P**	**ECTS**
	Astronomy and astrophysics	T				C	30+0+15+0	4
	Introduction to geophysics	T		B		C	30+0+15+0	4
	Physics in forest fire	T				C	24+0+12+0	4
	History of Astronomy		A				30+15+0+0	3
	Optics		A				0+15+0+30	4
	Astrobiology and extra-solar planets		A	B	E		30+15+0+0	4
	Hydrodynamics in Astrophysics		A	B			30+0+15+0	4
	Solid state physics		A	B	E		30+0+15+0	4
	Experimental methods of modern physics		A				30+0+15+0	4
	Basics of Relativistic Physics		A			C	30+0+0+0	3
	Chaos and fractals		A	B		C	30+0+0+0	3
	Environmental microbiology			B	E		30+0+30+0	5
	Dynamics of atoms in gas and liquid phase		A	B			30+0+15+15	5
	Electronic basics I		A	B	E	C	30+0+15+0	4
	Physicochemical Basis of Radiation Biology			B			24+6+6+0	4
	Global climate changes			B			30+0+0+0	3
	History of physics			B			30+0+0+0	3
	Fuel Cells			B			30+0+15+0	4
	Physical Chemistry 1			B			30+0+15+0	4
	Object oriented programming		A	B	E		30+0+30+0	5
	Bioinformatics					C	20+10+0+10	5
	Introduction to meteorology		A			C	30+0+10+0	4
	Mathematical Foundation of Computing					C	30+0+30+0	5
	Optimization					C	30+0+30+0	5
	Computer networks					C	30+0+30+0	5
	Network application programming					C	15+0+15+0	3
	Psychology of self-confidence and positive thinking		A	B	E	C	15+15+0+0	2
	Rhetoric		A	B	E	C	15+15+0+0	2
	Logic		A		E	C	15+15+0+0	2
	German Language I		A		E	C	0+30+0+0	2

* L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

2nd Semester		
Course title	**Course structure* L+S+E+P**	**ECTS**
Teaching orientation (T)		
Nuclear Physics	30+0+15+0	4
Introduction to atomic and molecular physics	15+15+0+0	3
History of modern physics	30+0+0+0	3
Electronics Laboratory	0+0+0+30	3
Physics education II	30+30+0+30	7
Educational psychology II	30+15+0+0	3
Elective courses		7
Total:	**Max. 375**	**30**
Orientation astrophysics (A)		
Modern Astrophysics II	30+0+30+0	5
Methods of Observational Astronomy II	10+0+20+0	3
Research	0+20+0+0	5
Elective courses		17
Total:	**Max. 375**	**30**
Orientation biophysics (B)		
Principles of Neural Science	10+15+0+15	5
Environmental Science	30+0+10+0	4
Biophysics	30+0+15+0	5
Modelling in Biology and Medicine	20+0+10+10	5
Introduction to atomic and molecular physics	15+15+0+0	3
Elective courses		8
Total:	**Max. 375**	**30**
Orientation environmental physics (E)		
Ionised Radiation in the Biosphere	30+0+15+15	5
Introduction to atomic and molecular physics	15+15+0+0	3
Environmental Science	30+0+10+0	4
Remote sensing	30+0+10+0	4
Research Methods in Natural Sciences	15+0+0+15	3
Elective courses		11
Total:	**Max. 375**	**30**
Orientation computational physics (C)		
Nuclear Physics	30+0+15+0	4
Introduction to atomic and molecular physics	15+15+0+0	3
Stochastic simulations in classical and quantum physics	20+10+30+0	6
Research Methods in Natural Sciences	15+0+0+15	3
Elective courses		14
Total:	**Max. 375**	**30**

* L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

2nd Semester ELECTIVE COURSES							
Course title	**Orientation**					**Course structure* L+S+E+P**	**ECTS**
Physics of disordered matter	T	A			C	30+0+15+0	4
Biophysics	T	A				30+0+15+0	5
Physics of the Seas and Oceans	T				C	20+0+10+0	3
Environmental Science	T	A				30+0+10+0	4
Physics of nanostructures	T		B		C	30+0+0+0	2
Celestial Mechanics		A				30+0+15+0	4
Interstellar matter		A				30+0+15+0	3
Nuclear Physics		A				30+0+15+0	4
Electronic basics II		A		E	C	30+0+15+0	4
History of modern physics		A				30+0+0+0	3

	Research Methods in Natural Sciences		A	B			15+0+0+15	3
	Physical Chemistry 2			B			30+0+15+45	6
	Natural Products			B			45+0+0+30	6
	Life and physical environment	T	A	B			15+0+0+0	2
	Ecosystem ecology		A	B			15+0+0+0	2
	Biostatistics			B			14+0+0+26	4
	Atomic and Molecular Quantum Mechanics		A	B			20+15+15+0	5
	Physics in Medicine			B			20+0+0+0	2
	Computer analysis of oncological data			B		C	4+0+4+8	2
	Basic principles of immunochemical methods			B			12+2+2+0	2
	Renewable Energy and Sustainable Development			B	E		30+0+0+0	3
	Environmental change and hazards	T		B	E		30+0+15+0	4
	Stochastic simulations in classical and quantum physics			B			20+10+30+0	6
	Mathematical Methods in Signal Processing		A	B		C	30+0+30+0	5
	Modelling of the Atmosphere Pollution				E	C	20+0+10+0	3
	Physics of the Adriatic and Mediterranean Seas				E	C	30+0+15+0	4
	Modelling in Biology and Medicine					C	20+0+10+0	5
	Principles of Neural Science					C	10+15+0+15	5
	Operating Systems					C	30+0+30+0	5
	Databases				E	C	30+0+30+0	5
	Computer graphics		A			C	30+0+30+0	5
	Multiprocessor computing			B		C	30+0+30+0	5
	Partial Differential Equations		A			C	30+0+30+0	6
	Numerical Linear Algebra					C	30+0+30+0	5
	Multicriterial decision making					C	30+0+30+0	5
	Philosophy of science	T	A	B	E	C	15+15+0+0	2
	Sociology of science	T	A		E	C	15+15+0+0	2
	Language Culture	T	A	B	E	C	15+15+0+0	2
	Media in education	T	A	B	E	C	15+15+0+0	2
	Psychology of self motivation	T	A	B	E	C	15+15+0+0	2
	Research Methodology in Education	T					15+15+0+0	2
	German Language II		A		E	C	0+30+0+0	2
* L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)								

3rd Semester			
	Course title	**Course structure* L+S+E+P**	**ECTS**
Teaching orientation (T)			
	Elementary particles	30+0+15+0	4
	Seminar in physics education	0+45+0+0	3
	Physics education III	30+30+0+30	7
	Research in physics education	15+30+0+0	3
	Elective courses		13
Total:		**Max. 375**	**30**
Orientation astrophysics (A)			
	Modern Astrophysics III	30+0+30+0	5
	Science communication	20+10+0	2
	Research	0+30+0+0	10
	Elective courses		13
Total:		**Max. 375**	**30**
Orientation biophysics (B)			
	Biophysics of organs: the selected topics	10+15+0+15	5
	Physics of DNA, chromatin and viruses	20+0+20+0	5
	Bioenergetics	30+0+15+0	5
	Thermodynamics of irreversible processes	30+0+15+0	3

	Elective courses		12
Total:		**Max. 375**	**30**
	Orientation environmental physics (E)		
	Numerical modelling of Geophysical Fluid Dynamics	20+0+15+0	4
	Global climate changes	30+0+0+0	3
	Marine optics	20+0+10+0	3
	Research	0+20+0+0	5
	Elective courses		15
Total:		**Max. 375**	**30**
	Orientation computational physics (C)		
	Elementary particles	30+0+15+0	4
	Numerical Methods in High Energy Physics	20+20+30+0	8
	Programming in biosciences	20+0+15+15	5
	Research	0+20+0+0	5
	Elective courses		8
Total:		**Max. 375**	**30**

* L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)

3rd Semester

ELECTIVE COURSES

	Course title	**Orientation**					**Course structure* L+S+E+P**	**ECTS**
	Astronomy and astrophysics	T				C	30+0+15+0	4
	Introduction to geophysics	T		B		C	30+0+15+0	4
	Physics in forest fire	T				C	24+0+12+0	4
	History of Astronomy		A				30+15+0+0	3
	Solid state physics		A	B	E		30+15+0+0	4
	Optics		A				0+15+0+30	4
	Astrobiology and extra-solar planets		A		E		30+15+0+0	4
	Hydrodynamics in Astrophysics		A				30+0+15+0	4
	Elementary particles		A				30+0+15+0	4
	Numerical Methods in High Energy Physics		A				20+20+30+0	8
	Basics of Relativistic Physics	T	A			C	30+0+0+0	3
	Chaos and fractals	T	A	B	E	C	30+0+0+0	3
	Introduction to Superconductivity	T	A			C	30+0+0+0	3
	Environmental microbiology			B	E		30+0+30+0	5
	Dynamics of atoms in gas and liquid phase		A	B			30+0+15+15	5
	Physicochemical Basis of Radiation Biology			B	E		24+6+6+0	4
	Global climate changes			B			30+0+0+0	3
	Functional brain imaging methods			B			20+15+0+10	6
	Selected Chapters of Medical Physics			B			20+15+0+0	5
	Research			B			0+20+0+0	5
	Molecular modelling			B		C	15+0+15+0	5
	Programming in biosciences			B			20+0+15+15	5
	Atomic and Molecular Spectroscopy			B	E		20+0+10+0	4
	History of physics			B			30+0+0+0	3
	Object oriented programming		A	B	E		30+0+30+0	5
	Bioinformatics	T				C	20+10+0+10	5
	Numerical modelling of the Dynamics of the Atmosphere				E	C	20+0+15+0	4
	Numerical modelling of Geophysical Fluid Dynamics					C	20+0+15+0	4
	Hazards				E		30+0+0+0	3
	Science communication	T			E	C	20+10+0+0	2
	Mathematical Foundation of Computing						30+0+30+0	5

	Optimization			B		C	30+0+30+0	5
	Computer networks					C	30+0+30+0	5
	Psychology of self-confidence and positive thinking	T	A	B	E	C	15+15+0+0	2
	Rhetoric	T	A	B	E	C	15+15+0+0	2
	Logic		A		E	C	15+15+0+0	2
	Sociology of teachers	T					15+15+0+0	2
	Docimology	T					15+15+0+0	2
	Research Methodology in Education	T					15+15+0+0	2
* L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)								

4th Semester			
	Course title	**Course structure* L+S+E+P**	**ECTS**
	Diploma thesis	0+10+0+0	30
Total:		**135+180**	**30**
* L=Lectures, S=Seminars, E= exercises, P=Practical (Laboratory)			

13.6 Description of graduate astronomy and astrophysics courses at the Department of Physics

Course title	**Astronomy and astrophysics**		
Course code			
Type of course	Theoretical and practical		
Level of course	Basic		
Year of study	1st (or 2nd)	**Semester**	1st (or 3rd)
ECTS (Number of credits allocated)	4 ECTS - 30+10+5 (lectures + exercises+ fieldwork) class units ~ 33 contact hours ~ 1.1 ECTS - about 85 h of independent student work with consultations ~ 2.9 ECTS		
Name of lecturer	Leandra Vranješ, Assistant Professor		
Learning outcomes and competences	Orientation on the celestial sphere. Knowledge about matter in cosmic dimensions. Ability to explain the structure and development of celestial bodies and universe as a whole. Understanding of the basis of research methods in astrophysics.		
Prerequisites	Competences acquired in general physics courses.		
Course contents	History of astronomy. Earth motion and movements on the celestial sphere. Gravitation and celestial mechanics. Solar system. Telescopes. Stars, determining general properties. Spectral classification of stars. Hertzsprung- Russell diagram. Formation and development of stars. Interstellar matter. Milky way. Methods for determining distances. Galaxies and cosmology.		
Recommended reading	1. V. Vujnović, Astronomija I, Školska knjiga Zagreb, 1993 2. V. Vujnović, Astronomija II, Školska knjiga Zagreb, 1994		
Supplementary reading	1. various www pages 2. M. Zeilik, Astronomy: The Evolving Universe, Cambridge University Press; 9 edition, 2002 3. Carl Sagan, Kozmos, Sveučilišna knjižara-Zagreb, 2004.		
Teaching methods	Lectures with Power Point presentations, interactive simulations, demonstration experiments, discussions, solving of sample problems individually and in group. In ten exercise classes students solve problems using simulation software that illustrates modern astrophysical techniques. Students get experience in observational astronomy during field work.		

Assessment methods	Oral examination. Reports for each exercise class.
Language of instruction	Croatian, English (possible)
Quality assurance methods	Student survey

Course title	**Astrobiology and extra-solar planets**		
Course code			
Type of course	lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st or 2nd	**Semester**	1st or 3rd
ECTS (Number of credits allocated)	4 (equivalent 120 hours student time, meaning that, once lectures and seminars are subtracted, about 21 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	K. Hand, B. Pecnik		
Learning outcomes and competences	This course deals with the definition and the search for extra-solar planets, as well as with the search for extraterrestrial life. At the end of the course student is expected to be able to describe and know the basic of exoplanets theory and detection methods, understand conditions for development of life on Earth and elsewhere.		
Prerequisites			
Course contents	• **planets:** definition of a planet, formation and evolution of planetary systems • **extra-solar planets:** direct/indirect detection techniques, properties • **geology of volcanism:** plate tectonics, erosion • **what makes a planet habitable?** • **life:** reaction of a ecosystem to changes in the environment, biochemical principles of living systems, boundary conditions for the existence of life • **biological evolution on Earth:** biochemical principles • **how to recognize extraterrestrial life?**		
Recommended reading	• B. W. Jones, "Life in the Solar System and Beyond", (Springer-Praxis, 2004) • Jakosky, "The Search for Life on other Planets", (Cambridge University Press, 1998)		
Supplementary reading	• C. de Duve, "Vital Dust: Life as a Cosmic Imperative", (Basic Books, 1995) • G. Horneck and C. Baumstark-Khan, eds., "Astrobiology: The Quest for the Conditions of Life", (Springer, 2002) • Lecture notes and handouts		
Teaching methods	Course will be composed from lectures, seminars and practical classroom exercises, field trip, observing, individual and team project work.		
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small projects, and through the final exam/student project work (40% of the grade).		
Language of instruction	English, Croatian		
Quality assurance methods	Students will fill out the questionnaire upon completing the course.		

Course title	**Modern Astrophysics I**		
Course code			
Type of course	lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st	**Semester**	1st

ECTS (Number of credits allocated)	5 (equivalent 150 hours student time, meaning that, once lectures and seminars are subtracted, about 30 4-hour weekdays are left to learn and memorize course material
Name of lecturer	Prof Dr Moshe Elizur, Dr M. Rejkuba
Learning outcomes and competences	Students are expected to be able to deal with the basics of the radiation transport, to know the stellar structure and evolution (especially nuclear reactions), and also to know how black holes and neutron stars form.
Prerequisites	
Course contents	• **macroscopic description of radiation**: radiation intensity, flux, energy density and radiation pressure • **radiation transport: c**oefficients of absorption, emission and scattering, blackbody radiation, radiation transport equation • **spectral lines:** origin of spectral lines, influence of temperature, motion and magnetic field on the line profiles, • **equation of state of stellar mater:** Maxwell velocity distribution, Boltzmann and Saha equation • **nuclear reactions in stars:** thermonuclear reaction (general discussion on energetics and reaction rates), fusion of hydrogen (pp-chain and CNO-cycle) • **stellar models:** basic equations (mass distribution, hydrostatic equilibrium, energy transport equation), boundary conditions, virial theorem, time scales, polytrophic model • **observations of stars:** absorption and emission lines, stellar spectra, absolute and apparent magnitudes, distance measurement, Hertzsprung-Russell diagram • **stellar evolution:** early stages (star formation and coming to main sequence), discussion on the evolution of stars with different initial masses, post-main-sequence evolution • **stellar pulsations:** observations, physics of pulsations, modeling, non-radial pulsations, helioseismology • **degenerate stellar remnants:** degenerate matter, white dwarves, neutron stars, pulsars • **black holes** • **binary stars:** close binaries, cataclysmic variables
Recommended reading	• R. Kippenhahn and A. Weigert, "Stellar Structure and Evolution", Springer-Verlag, Study edition (August, 1994)
Supplementary reading	• D. A. Ostlie and B. W. Carrol, "An Introduction to Modern Stellar Astrophysics", Addison Wesley (1995)
Teaching methods	Course will be composed from lectures, seminars, and practical classroom exercises.
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small projects, and through the final exam/student project work (40% of the grade).
Language of instruction	English, Croatian
Quality assurance methods	Students will fill out the questionnaire upon completing the course.

Course title	**Modern Astrophysics II**		
Course code			
Type of course	Lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st	**Semester**	2nd
ECTS (Number of credits allocated)	5 (equivalent 150 hours student time, meaning that, once lectures and seminars are subtracted, about 30 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr Ž. Ivezić, Assistant Professor, Dr M. Rejkuba, Dr M. Juric		
Learning outcomes and competences	After completing the course students have an overview of the potential theory, stellar kinematics (including Boltzmann and Jeans equations), dynamics of stellar systems; and the detailed analysis of the structure of our Galaxy		
Prerequisites			

Course contents	• **potential theory:** spherical, axi-symmetric, tri-axial systems • **stellar kinematics:** orbits, integrals of motion, Jeans theorem, Boltzmann and Jeans equations, phase mixing • **dynamics of stellar systems:** analytic models, stability, disks (spiral structure, bars, warps), slow processes (diffusion of orbits, Fokker-Planck equation, dynamic friction) • **Milky Way Galaxy:** structure, detailed analysis of kinematics and dynamics
Recommended reading	• Binney & Tremaine, "Galactic Dynamics", Princeton University Press, 1987
Supplementary reading	• Binney and Merrifield, "Galactic Astronomy", Princeton University Press, 1988 • Sparke and Gallagher, "Galaxies in the Universe", Cambridge University Press • Giuseppe Bertin, "Dynamics of Galaxies", Cambridge University Press, 2000
Teaching methods	Course will be composed from lectures, seminars, and practical classroom exercises.
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small projects, and through the final exam/student project work (40% of the grade).
Language of instruction	English, Croatian
Quality assurance methods	Students will fill out the questionnaire upon completing the course.

Course title	**Modern Astrophysics III**		
Course code			
Type of course	lectures, seminars, exercises		
Level of course	basic course		
Year of study	2nd	**Semester**	3rd
ECTS Number of credits	5 (equivalent 150 hours student time, meaning that, once lectures and seminars are subtracted, about 30 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr D. Krajnovic, Dr D. Vinkovic		
Learning outcomes and competences	In this course students are acquainted with the theory of galaxy formation and evolution, and with the basics of cosmology and cosmological models of the Universe At the end of the course the student is expected to have a working knowledge of FRW cosmology and related GR equations, the Big Bang theory, the general picture of hierarchical structure formation, large scale structure of the universe and the galactic structure (with emphasis on observational classification of galaxies and galaxy properties).		
Prerequisites			
Course contents	• **galaxy formation and evolution:** gravitational instability, hierarchical structure formation, influence of the gas • **first stars** • **galaxy clusters** • **galaxies:** classification and observations, galaxy composition, stellar population, Tully-Fisher relation, Faber-Jackson relation, fundamental plane, evidences for the presence of a dark matter in galaxies, active galaxies – super-massive black holes • **basics of relativity theory** • **basics of cosmology:** what is cosmology, cosmological principle, metric (Friedmann-Robertson-Walker metric), cosmological problems (horizon, curvature, monopole, inflation), experimental cosmology • **cosmological model:** Big Bang, expanding universe, nucleosynthesis and the synthesis of the first chemical elements, cosmic background radiation, redshift, Hubble's law and Hubble expansion. cosmological distance scale, Lambda CDM model, dark matter		
Recommended reading	•Binney and Merrifield, "Galactic Astronomy", Princeton University Press, 1988 •L. Sparke and S. Gallagher, "Galaxies in the Universe", Cambridge University Press, 2000		

Supplementary reading	• P. Coles and F. Lucchin, "Cosmology", John Wiley & Sons, LTD, 2002
Teaching methods	Course will be composed from lectures and seminars.
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small projects, and through the final exam/student project work (40% of the grade).
Language of instruction	Croatian, English
Quality assurance Methods	Students will fill out the questionnaire upon completing the course.

Course title	**Methods of Observational Astronomy I**		
Course code			
Type of course	Lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st	**Semester**	1st
ECTS (Number of credits allocated)	3 (equivalent 90 hours student time), meaning that, once lectures and seminars are subtracted, about 16 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr R. Neuhauser, Full Professor, A. Bedalov		
Learning outcomes and competences	After taking this course, students are expected to know the principles of astronomical observations, catalogues, coordinate systems, types of telescopes, and the influence of the atmosphere on the quality of observations.		
Prerequisites			
Course contents	• **catalogues and coordinate systems** • **Fourier transform and the propagation of errors** • **types of telescopes** • **atmosphere:** absorption, transmission, turbulence and seeing • **adaptive optics**		
Recommended reading	• P. Lena, F. Lebrun & F. Mignard, 'Observational Astrophysics' (Springer Verlag, 1998)		
Supplementary reading			
Teaching methods	Lectures, seminars and practical classroom exercises, observing, individual and team project work.		
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small projects, and through the final exam/student project work (40% of the grade).		
Language of instruction	English, Croatian		
Quality assurance methods	Students will fill out the questionnaire upon completing the course.		

Course title	**Methods of Observational Astronomy II**		
Course code			
Type of course	lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st	**Semester**	2nd
ECTS (Number of credits)	3 (equivalent 90 hours student time), meaning that, once lectures and seminars are subtracted, about 16 4-hour weekdays are left to learn and memorize course material		

Name of lecturer	Dr R. Neuhauser, Full Professor, A. Bedalov
Learning outcomes and competences	After completing this course students should know the basics of optical and infrared detectors, image processing and spectroscopy.
Prerequisites	
Course contents	• **optical and infrared detectors** • **image processing** • **spectroscopy** • **photometry** • **time series analysis**
Recommended reading	• P. Lena, F. Lebrun and F. Mignard, 'Observational Astrophysics' (Springer Verlag, 1998)
Supplementary reading	
Teaching methods	Lectures, seminars, and practical classroom exercises; observing, individual and team project work.
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small projects, and through the final exam/student project work (40% of the grade).
Language of instruction	English, Croatian
Quality assurance methods	Students will fill out the questionnaire upon completing the course.

Course title	**History of Astronomy**		
Course code			
Type of course	lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st or 2nd	**Semester**	1st or 3rd
ECTS (Number of credits allocated)	3 (equivalent 90 hours student time, meaning that, once lectures and seminars are subtracted, about 16 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr G. Wuchterl, Full Professor		
Learning outcomes and competences	In this course students learn about the history of astronomy, from the first myths of creation, which early civilizations used to explain the universe, till modern models of the Universe. At the end of the course student is expected to demonstrate his/her ability to comment and annotate texts and documents correctly according to the critical canons of the discipline.		
Prerequisites	None		
Course contents	• **myths:** an overview of various creation myths used by early civilizations and the paradigms they used in order to explain the dynamics and the structure of the Universe • **astronomy in the antique:** astronomy practiced by old civilizations • **paradigm shifts and telescope observations: C**opernicus, Galileo, discovery of outer planets, Kepler, Newton • **modern astronomy:** general theory of relativity, cosmological distance scale, Hubble, expansion of the universe, observations of background radiation, cosmological models		
Recommended reading	• M. Hoskin, ed., "The Cambridge Concise History of Astronomy", Cambridge University Press (1999) • E. Harrison, "Masks of the Universe : Changing Ideas on the Nature of the Cosmos", Cambridge University Press (2003)		

Supplementary reading	• Lecture notes and handouts
Teaching methods	Course will be composed from lectures, seminars, and field trip.
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) –seminars, and through the final exam (40% of the grade).
Language of instruction	English
Quality assurance methods	Students will fill out the questionnaire upon completing the course.

Course title	**Optics**		
Course code			
Type of course	lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st (or 2nd)	**Semester**	1st (or 3rd)
ECTS (Number of credits allocated)	4 (equivalent 120 hours student time, meaning that, once lectures and seminars are subtracted, about 21 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr B. Balick, Full Professor, A. Bedalov		
Learning outcomes and competences	The course deals with the optics, the principles on which telescopes and astronomical instruments operate. At the end of the course student is expected to be able to describe and explain the function of the basic and more complex devices of physical optics; imaging, spectrometry - be able to carry out both simple and complex measurements, while correctly evaluating the involved errors.		
Prerequisites			
Course contents	• **Thin lens:** image production using thin lens, principles on which various telescopes and microscopes operate • **diffraction and interference:** telescope resolution, interferometer • **Michelson's interferometer** • **Fabry-Perot etalon** • **polarization:** partial and complete polarization, interference of the polarized light, using polarized light • **coherence:** laser and its applications • **adaptive optics**		
Recommended reading	Lecture notes and exercise handouts		
Supplementary reading			
Teaching methods	Course will be composed from lectures, and practical classroom exercises, field trip, observing, and individual project work.		
Assessment methods	Students will be graded through the exercises (70% of the grade), and through the final exam (30% of the grade).		
Language of instruction	English, Croatian		
Quality assurance methods	Students will fill out the questionnaire upon completing the course.		

Course title	**Hydrodynamics in Astrophysics**		
Course code			
Type of course	lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st or 2nd	**Semester**	1st or 3rd
ECTS (Number of credits allocated)	4 (equivalent 120 hours student time, meaning that, once lectures and seminars are subtracted, about 25 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr G. Wuchterl, Full Professor, Dr P. Mimica		
Learning outcomes and competences	In this course, students get to know basic equations of hydrodynamics, details of physics of ideal fluids, relativistic hydrodynamics and some applications in astrophysics. At the end of the course the student is expected to have a working understanding of basic hydrodynamical concepts, to know where and how hydrodynamical phenomena appear in astrophysics and to be able to work out shock equations for the most common shock boundary conditions.		
Prerequisites			
Course contents	• **equations of hydrodynamics:** continuity equation, Euler equation, hydrostatics, Bernoulli equation, energy and momentum flux, ideal fluid • **non-ideal fluid:** viscosity, turbulence, boundary layer • **shocks:** propagation of perturbations in a gas, shocks (discontinuities, shock adiabat) in ideal gas • **hydrodynamics of combustion:** slow combustion, detonations • **relativistic hydrodynamics:** energy-momentum tensor, equations of relativistic hydrodynamics • **applications – relativistic jets:** observations, formation (AGN, XRB, GRB), simulations • **applications – supernovae:** theory of explosions (Sedov solution), Supernova Ia • **applications – planet formation** • **applications – galaxy clusters:** gas in galaxy clusters, formation of galaxy clusters		
Recommended reading	• R. Courant and K. O. Friedrichs, "Supersonic Flow and Shocks", Springer-Verlag, 1991 • R. J. LeVeque, D. Mihalas, E. A. Dorfi, and E. Müller, "Computational Methods for Astrophysical Fluid Flow", Springer, 1997		
Supplementary reading	• K.-H. A. Winkler, and M. L. Norman, "Astrophysical Radiation Hydrodynamics", D. Reidel, 1986 • D. Mihalas, B. W. Mihalas, "Foundation of Radiative Hydrodynamics", Dover Publications (2000)		
Teaching methods	Course will be composed from lectures, practical classroom exercises, and individual project work.		
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small projects, and through the final exam/student project work (40% of the grade).		
Language of instruction	English, Croatian		
Quality assurance methods	Students will fill out the questionnaire upon completing the course.		

Course title	**Celestial Mechanics**
Course code	
Type of course	lectures, seminars, exercises

Level of course	basic course		
Year of study	1st or 2nd	**Semester**	1st or 3rd
ECTS (Number of credits allocated)	4 (equivalent 120 hours student time, meaning that, once lectures and seminars are subtracted, about 25 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr G. Wuchterl, Full Professor, Dr M. Juric		
Learning outcomes and competence	In this course students learn the basics of gravitational interaction of two and more masses At the end of the course, the student is expected to have mastered the basic concepts of Newtonian mechanics, properties of two and three-body Keplerian systems, and extensions due to non-gravitational forces (friction, tides, etc.)		
Prerequisites	Classical Mechanics		
Course contents	• **apparent motions:** spherical trigonometry, celestial sphere, apparent motions of planets • **two-body problem:** the use of Newton's Laws in celestial mechanics, orbital elements, Kepler's Laws • **binary systems:** Lagrange points, tidal forces, rotation and revolution of the Moon • **perturbations of Kepler orbits:** the influence of the atmosphere on the motion of artificial satellites, motion of probes in the Solar system, orbits of the asteroids		
Recommended reading	• C. D. Murray and S. F. Dermott, "Solar System Dynamics", Cambridge University Press (2000)		
Supplementary reading	• Binney & Tremaine, "Galactic Dynamics", Princeton University Press, 1987 • H. Goldstein, C. P. Poole and J. L. Safko, "Classical Mechanics", Addison Wesley (2002)		
Teaching methods	Course will be composed from lectures, seminars, practical classroom exercises, and individual project work.		
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small software projects, and through the final exam/student project work (40% of the grade).		
Language of instruction	English, Croatian		
Quality assurance methods	Students will fill out the questionnaire upon completing the course.		

Course title	**Interstellar matter**		
Course code			
Type of course	lectures, seminars, exercises		
Level of course	basic course		
Year of study	1st	**Semester**	2nd
ECTS (Number of credits allocated)	3 (equivalent 90 hours student time, meaning that, once lectures and seminars are subtracted, about 16 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr B. Balick, Full Professor, Dr D. Vinković		
Learning outcomes and competences	The aim of this course is to present to students basic information about the interstellar matter, molecular and gas dynamics and its influence on the star formation. Following the completion of the course, the student is expected to comprehend and be able to describe the properties (composition, abundance, etc.) and role of interstellar matter in structure, star and planet formation in the universe. The student shall be able to reproduce and use basic dust and gas dynamics equations (thermal and statistical equilibrium, line strengths as dust/gas diagnostics, etc).		
Prerequisites			

Course contents	• **basic information on interstellar matter** • **interstellar dust, HII regions** • **gas dynamics** • **photo dissociation regions** • **molecular astrophysics** • **gravitational instability:** star formation
Recommended reading	• E. Kruegel, The Physics of Interstellar Dust, Institute of Physics Publishing (December, 2002)
Supplementary reading	• L. Spitzer, Physical Processes in the Interstellar Medium, Wiley, John & Sons, Inc. (1998)
Teaching methods	Course will be composed from lectures, seminars and practical classroom exercises, and individual project work.
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small software projects, and through the final exam/student project work (40% of the grade).
Language of instruction	English
Quality assurance methods	Students will fill out the questionnaire upon completing the course.

Course title	**Science Communication**		
Course code			
Type of course	Lectures		
Level of course	Introductory course		
Year of study	2nd	**Semester**	3rd
ECTS (Number of credits allocated)	3 (equivalent 90 hours student time), meaning that, once lectures and seminars are subtracted, about 16 4-hour weekdays are left to learn and memorize course material		
Name of lecturer	Dr M. Elizur, Full Professor, M. Sc. D. Bonacci		
Learning outcomes and competences	The aim of this course is to theoretically introduce and practically train students in three non-scientific, yet extremely important skills required from a successful modern research scientist. Additionally, non-verbal communication and methods of verbal communications would be developed. The first of the skills is dealing with the public media. Students will be taught how to establish the fruitful, systematic and efficient collaboration with the press and how to employ it to positively promote the research they are involved with. The second skill is direct public promotion of their scientific work. Such promotion includes a broad range of activities such as public lectures, public workshops, presentations and demonstrations, exhibitions and interactive artifacts. The third skill relates to the management of the scientific project, from its technical and financial design, through team building and human resource management, to its summative and formative evaluation.		
Prerequisites	None		
Course contents	• **historical and theoretical introduction into PR and the media** • **practical elements of media production: newspaper, radio, TV, web** • **organizing and running a press relation office** • **direct public promotion methods: lectures, workshops, exhibitions, interactives** • **project proposal design: formulating the proposal, activities timeline, budget** • **selecting and managing the project team** • **formative and summative project evaluation methods and project report writing**		
Recommended reading	• Lecture notes and handouts		

Supplementary reading	
Teaching methods	Course will be composed from lectures, seminars and practical classroom exercises, field trips, individual and team project work
Assessment methods	Students will be graded through the individual student course portfolio (60% of the grade) – home work, seminars, small projects, and through the final exam/student project work (40% of the grade).
Language of instruction	English, Croatian
Quality assurance methods	The web pages accompanying the course will be developed through which anonymous student comments and suggestions will be collected throughout the course. Also, on-line questionnaires will be developed and presented to students after each of the three sections of the course.