Development strategy

of the Faculty of Science of the University of Zagreb

for the 2015–2020 period

Zagreb, 2015.

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PMF and its environment

University of Zagreb Faculty of Science (PMF)

The Faculty of Science (**PMF**) of the University of Zagreb is the leading scientific and teaching institutions in the Republic of Croatia in the field of natural sciences and mathematics. Even though it was formally founded in 1946, the teaching and research activities started in 1876 at the *Department for Natural Science and Mathematics* of the Faculty of Philosophy. Over its long history, **PMF** had a significant contribution to the development of not only the University of Zagreb, but to Croatian science in general, and by education teachers in the field of natural sciences and mathematics, it continuously contributes to the Croatian education system.

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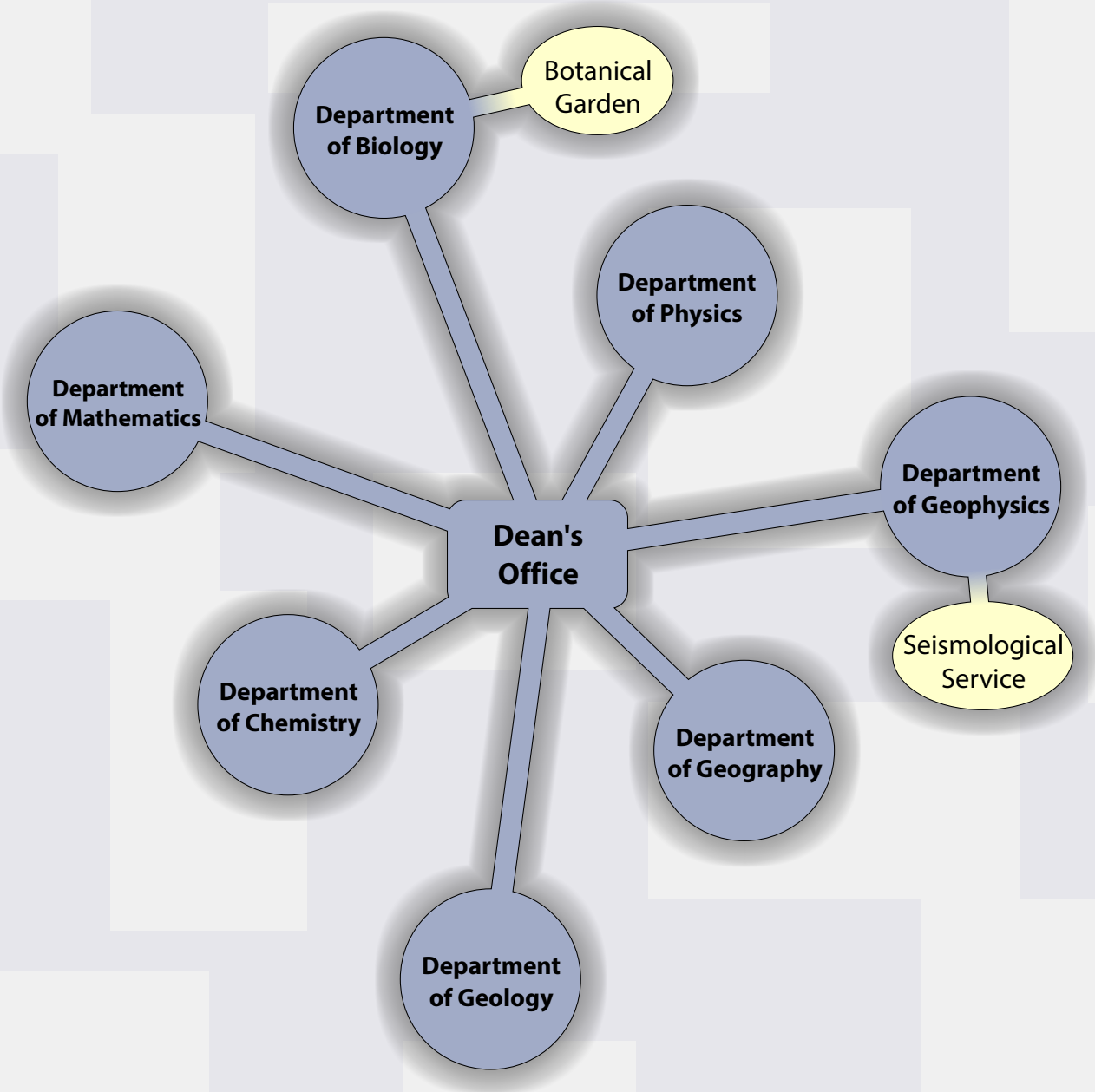
When the Republic of Croatia acceded to the European Union, numerous options were made available to the science and high education sector, but at the same time, certain challenges arose for the institutions to tackle. This is particularly true for developing the scientific and teaching infrastructure using Structural Funds, presuming a joint response from the related institutions and a consolidation of the research capacities. On the other hand, the lasting recession that Croatia is going through and inadequate state funds designated for science and high education also require the institutions to be far more active and find the funds required for further development and, in addition to international sources, this means a closer cooperation with the business sector. This document was drafted according to that, and it represents the strategic framework for the development of scientific and teaching activity and academic activities of **PMF** and provides guidelines for the development of organisation and business activities, infrastructure and quality assurance system of **PMF** in the 2015–2020 period.

PMF will direct its efforts to develop the research infrastructure and create a large number of research groups that will be competitive at the international level, to initiate interdisciplinary and multidisciplinary research in the field of natural sciences and interdisciplinary science, to increase the quality of the teaching activities and to encourage innovation activities and establish a life-long learning system. As a special advantage, **PMF** will use the option of synergic activities with related institutions that are located at the future *Northern Campus* of the University of Zagreb.

This ***Strategy*** was adopted on the 5th regular meeting of the Faculty Board of **PMF**, held on 26 February 2015, and all employees and students' representatives of **PMF** participated in its production. It is a symbol of our perception of the future, with our ***Mission*** unchanged, and our approach and ***Vision*** continuously adapted and improved according to the environment.

Prof. Zoran Curić, PhD
PMF Dean

PMF Structure



PMF activities

- organisation and performance of university studies of mathematics, physics, chemistry, biology, geology, geography, geophysics and computer science
- scientific and research activities
- producing scientific and professional projects, technical documentation, analysis, certificates and expertises
- professional activities in protecting the environment
- professional expertise, standardisation of measurement procedures, quality measurement and control
- library activities for scientific and teaching purposes in mathematics, physics, chemistry, biology, geology, geography and geophysics
- organisation and performance of various forms of continuous or occasional improvement for students, *i.e.* attendees
- growing laboratory animals, plants, fungi, plant and animal cell cultures and microorganism cultures, and keeping experimental and wild animals, plants, fungi, plant and animal cell cultures and microorganism cultures
- performing experiments on animals for the purposes of the teaching and research activities
- organising and hosting scientific and professional conferences
- publishing and IT activities for the purposes of teaching, scientific or professional activities
- selling course books and other printed materials required to carry out Faculty activities
- performing expert evaluations for the appropriate activities in the fields of mathematics, physics, chemistry, biology, geology, geography, geophysics and computer science
- providing services to companies and other organisations when it is used to develop the core activity and use space and equipment more rationally
- life-long learning in the fields of mathematics, physics, chemistry, biology, geology, geography, geophysics and computer science
- carrying out professional courses and lectures in the fields of mathematics, physics, chemistry, biology, geology, geography, geophysics and computer science

PMF teaching activities

As an organisational unit of the University of Zagreb, PMF provides a quality and efficient university education in the field of natural sciences and mathematics through all three university studies. The study programmes of PMF are based on research and the current scientific knowledge, and courses also have a large component of innovativeness and international cooperation. Quality and motivated students that will use their knowledge and skills to lead the social and economic development of the Republic of Croatia are among the highest values of PMF.

- više od 4700 studenata
- više od 200 nastavnika

Total number of studies and enrolled students at PMF in the academic year 2013/2014

Study level	Number of studies	Number of students
Undergraduate university studies	9	1928
Integrated undergraduate and graduate university studies	8	829
Graduate university studies	18	1185
Postgraduate university (doctoral) studies	8	768
Postgraduate specialist studies	1	24

Total number of students that graduated or got a doctor's degree at PMF university studies in the academic year 2013/2014

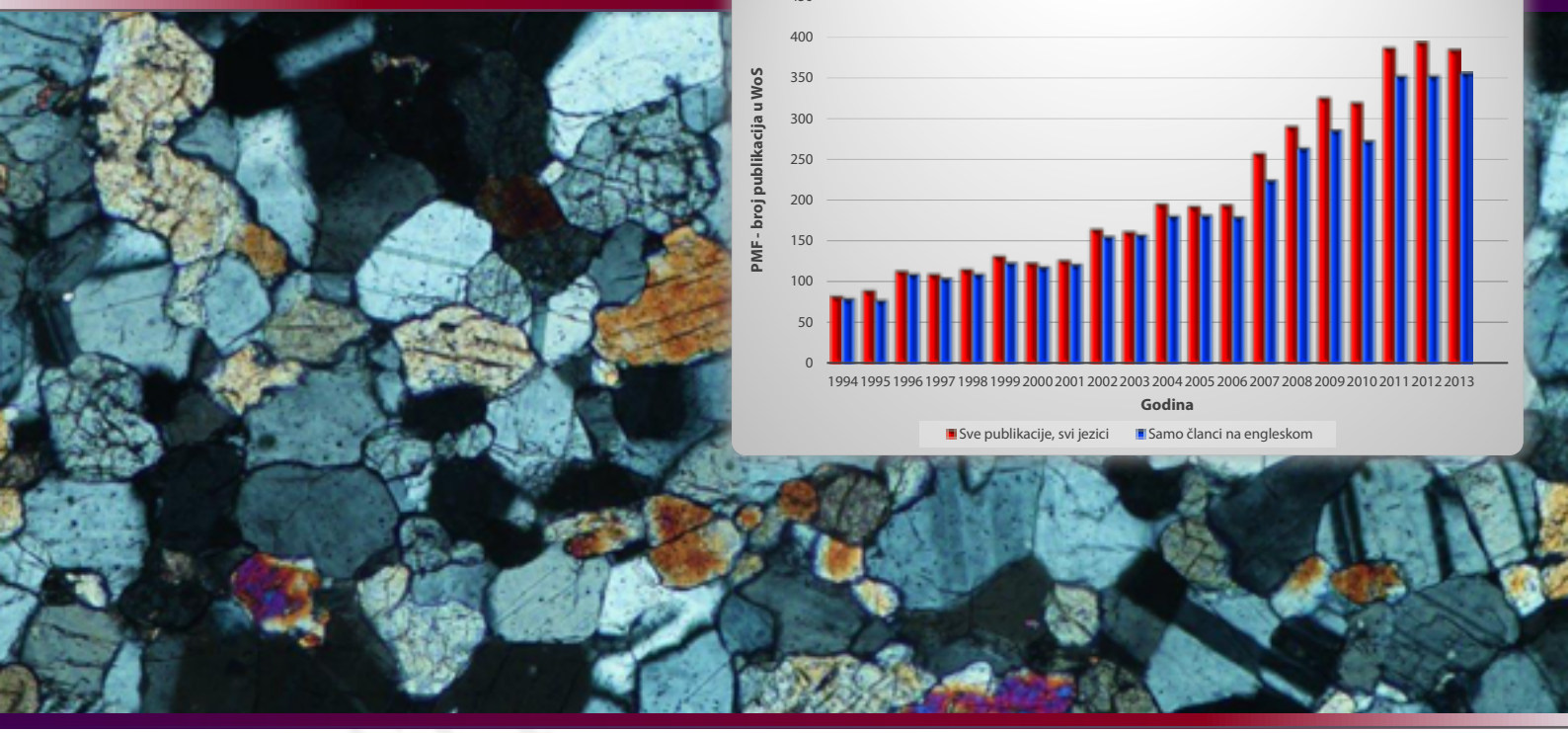
Undergraduate university studies	425
Integrated undergraduate and graduate university studies	115
Graduate university studies	405
Postgraduate university (doctoral) studies	106
Postgraduate specialist studies	

PMF research activity

Scientific research at **PMF** is carried out within the field of *Natural sciences* (fields: Mathematics, Physics, Geology, Chemistry, Biology, Geophysics and Interdisciplinary natural sciences) and *Interdisciplinary scientific fields* (Geography) and they make up around 20 % of the total research production of the University of Zagreb. The research aspect of **PMF** is reflected in scientific publications published in leading scientific journals, in the cooperation with the leading international research groups and institutions, a significant number of national and international scientific projects and the appropriate scientific infrastructure, library stock and periodicals. **PMF** is one of the two institutions in the Republic of Croatia bearers of the ERC (European Research Committee) scientific project.

PMF – approximately 20 % of the research production of the University of Zagreb

Scientific papers of PMF employees published over the past 5 years and scientific projects	
Scientific papers in journals represented in the CC, WoS (SSCI, SCI-Expanded and A&HCI) and Scopus databases	2024
Total number of active scientific and developmental projects awarded by the Ministry of Science, Education and Sports	180
Total number of active scientific and developmental projects from other national sources	42
Total number of active scientific and developmental projects from international sources	27



The academic activities of PMF, knowledge and technology transfer

PMF is recognised and acknowledged as an institution whose researchers use their expertise and professional studies to solve various problems from various aspects of the social life in the Republic of Croatia. Numerous professional projects have been initiated and successfully completed at **PMF** in cooperation with public and state institutions and many economic subjects, and several projects are currently ongoing. The professional work of **PMF** employees serves the development and general progress of society in general and it needs to be continuously improved.

Professional work of PMF employees published over the past 5 years, and professional projects	
Total number of published professional work	194
Total number of professional projects	82

PMF's international cooperation

International cooperation at PMF is carried out within inter-university cooperation, common international bilateral and multilateral projects (*e.g.* FP7, COST, NATO) and direct contacts of teachers with foreign universities and research institutions in Europe and the world. The funding for the cooperation was mostly realised through special international cooperation of the University of Zagreb or via research projects.

The total number of visits abroad of PMF employees in the 2009–2014 period

Type of visit	1–3 months	3–6 months	>6 months
Scientific	178	13	31
Professional	2		
Teaching	4		

Total number of visits from foreign researchers in the 2009–2014 period

Type of visit	1–3 months	3–6 months	>6 months
Scientific	18	1	7

Total number of scientific conferences organised by PMF and the number of employees involved in the organisation in the 2009–2014 period

Type of conference	Number of employees	Number of conferences
International scientific conferences in Croatia and abroad	39	74

Popularisation of science

The Botanical Garden of the Department of Biology of **PMF**, a monument of park architecture and part of the protected cultural property of the Republic of Croatia.
The specific activities of the Botanical Garden, 'an open museum', are different from the basic scientific and teaching activities of **PMF**: the Garden is the only part of **PMF** that is constantly open for the general public. Numerous events, educational and popularisation contents and publications are aimed at additional and life-long learning of all visitors, especially pupils and students. Ranging from stories on plants and the *Children's Vegetable Garden and Flower Garden for the Youngest*, Garden tours with a professional guide, promotional and concert events, to educational exhibitions, workshops and lectures for the slightly older visitors – during the season, the Garden is visited by up to 100 000 visitors. For example, during the five days of the regular *Week of Botanical Gardens and Arboreta* in May, over 1200 visitors who register in advance attend the various events, and the number of interested persons is many times greater!

The Department of Biology organises the traditional manifestation of *Night of Biology*. A long and exciting night that presents visitors with scientific facts from biology and life in all its forms and beauty through experiments, presentations and playgroups. It was first held in 30 March 2012 when the leadership of **PMF** recognised the best thing about *Night of Biology* – great effort and unity from teachers and students.

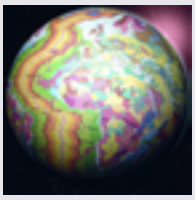
The Summer School of Young Physicists is organised each year by the Croatian Physical Society, and this year's, the 30th such event will be organised. It is aimed at providing additional education to talented primary and secondary school pupils who are invited based on their results in state competitions in physics. The School lasts for a week and pupils are introduced to the latest research in physics in lectures held by renowned and active researchers from our (and sometimes from foreign) universities and institutes.

The Open Door Day "Physics Today", organised by the Department of Physics, is a one-day popular scientific event organised each spring at the Department of Physics. We aim to establish a better contact between the visitors and the exciting world of physics through a series of popular lectures, workshops, demonstrations of interesting physical phenomena and visits to research laboratories. Visitors can attend in groups or individually, talk to the researchers, find out which fields host the newest research and find out a lot of details that are usually out of reach.

Physics Express is a project by the Student Section of the Croatian Physical Society. It was initiated in 2005 and it promotes physics and natural sciences in general among the young people in Croatia. The project is carried out by physics students who wish to share their interest for physics with younger persons – primary and secondary school pupils from all over the country. During the visits to schools, interesting experiments are shown, lectures are held and interactive participation in scientific activities is encouraged. School visits can be arranged via the Internet.

Geophysics live is a traditional one-day even when the teachers and students of the Department of Geophysics introduce in an interesting and approachable way the visitors to the world of geophysics –a world constantly around us, a world sometimes dangerous, sometimes beautiful and definitely a world that we must explore so as to protect it. In addition to interesting experiments, workshops and lectures, visitors have a chance to see how it all started – over 100 years ago.

Primatijada is a scientific and sports meeting between the students and employees in the field of natural sciences and mathematics. It promotes these sciences, gathers and encourages the scientists' varied scientific and mathematic professions to cooperate in order to support the efficient scientific and economic development of Croatia.



The Department of Geology organizes the Geology Afternoon as a part of the "open door" even. On this occasion, a series of popular lectures and workshops are held for people of all ages, from kindergarten children to students, the visitors are allowed to enter collections and they are shown fossils and minerals under a microscope. The Department of Geology has organised the University for Kids event in cooperation with the TonkicaPalonkicaFrrr association since 2012. Workshops in geology are organised on this day for children in the initial classes of primary schools.

DAN OTVORENIH VRATA
Geografskog Odsjeka

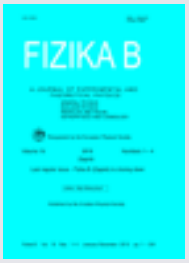
Open Day of the Department of Geography is a one-day popular scientific event which is held annually. The main goal of this event is to inform the public, and especially secondary school pupils about the scientific research at the Department, as well as to promote geography as a profession. Through a series of popular lectures about the recent subjects in geography and workshops (e.g. orientation, use of geography maps and geography information system (GIS)) participants can find out why and in what way geography can be studied.

The Open Day of the Department of Chemistry is a traditional one-day popular science event, organised every spring since 2008 at the Department of Chemistry. It includes numerous lectures, educational workshops and a tour of the fascinating World of Chemistry, and its purpose is to bring chemistry closer to all our visitors through a fun and happy approach. In 2004, around four thousand people visited the Open Day of the Department of Chemistry, mostly pupils from primary and secondary schools.

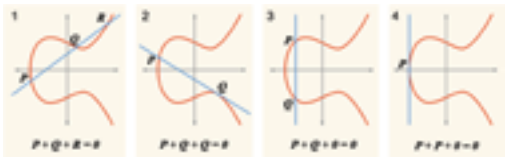
The Magic in Chemistry show is a project of the Department of Chemistry, carried out once per year since 2007. The shows present attractive chemistry experiments, and the objective is to popularise chemistry among the children of a preschool and young school age. The sixteen shows held so far were visited by over 3000 children from numerous primary schools and kindergartens, both from Zagreb and the neighbouring counties. Workshops are frequently organised, in addition to the show, and children have the opportunity to perform simple chemical experiments on their own.

Open Day of the Department of Mathematics
Open Day is held annually at the Department of Mathematics. It is an event aimed at secondary school pupils, especially at pupils in the third or fourth year who are interested in enrolling in a mathematics study. The event plans for introducing study programmes and talking to teachers, assistants and students, so that the attendees can find out how and why to study mathematics at PMF in Zagreb. As of this year, additional activities and workshops are planned.

PMF's publishing activities

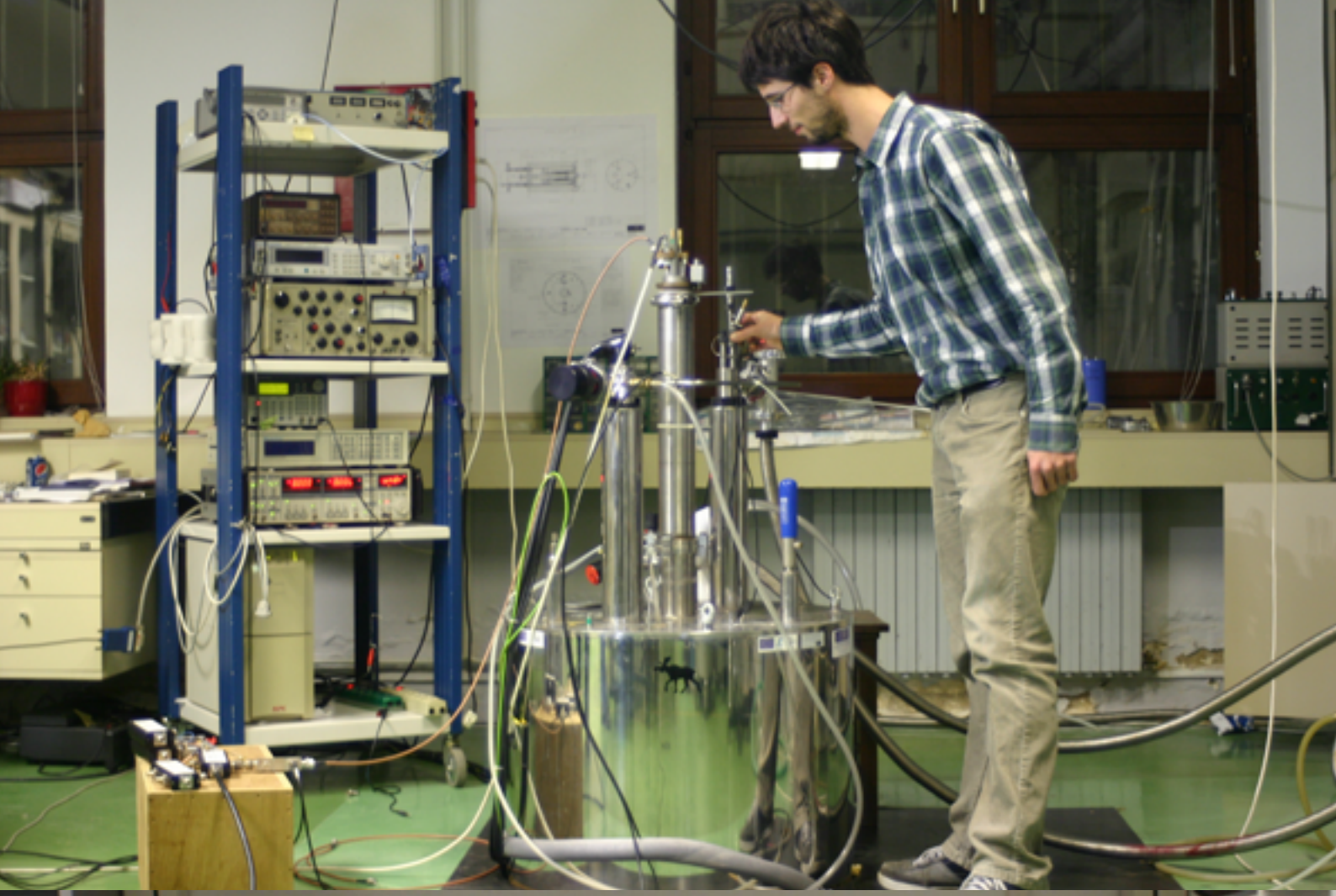
In addition to editorial duties for PMF's journals, the researchers of PMF are also members of the editorial offices of other publishers, among which are 21 journals quoted in the *Web of Science* database. PMF has a significant contribution in publishing six professional journals (one is published electronically) and one professional portal, aimed primarily at the popularisation of natural sciences and mathematics among primary and secondary school pupils, at life-long learning for teachers of natural sciences – geography, mathematics and computing/computer science in primary and secondary schools and at being a supplementary source of information for students. The professional portal and all six journals are active within these professional associations: *Croatian Mathematical Society*, *Croatian Physical Society*, *Croatian Geographical Society* and *Croatian Society for Natural Sciences*. These associations carry out their activities primarily at PMF. The professional papers are published in Croatia and are reviewed.

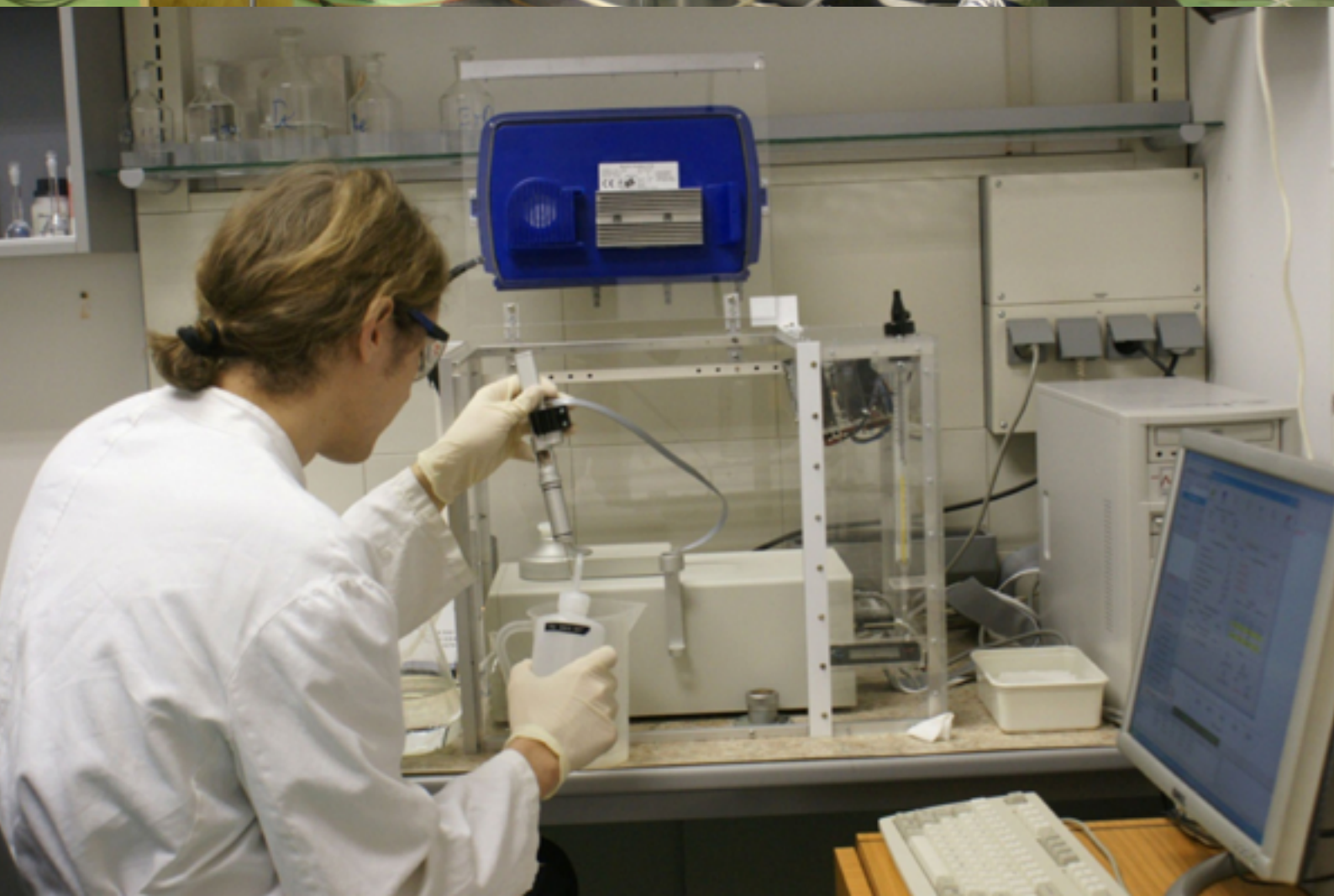


Mission

- Excellent university education in the field of natural sciences and mathematics and the development of innovative educational programmes and techniques based on research and the latest scientific knowledge.
- Life-long learning in the field of natural sciences and mathematics pursuant to the Bologna Process and the Lisbon Declaration, and pursuant to societal needs.
- High-quality, internationally relevant and competitive basic scientific research in the field of natural sciences and mathematics and the promotion of new interdisciplinary and multidisciplinary research fields.
- A contribution to the development of the economy and the society as a whole through applied and developmental scientific research within the national knowledge triangle, realised through the cooperation with the business sector, especially with the industry and the financial institutions.
- Recognising and encouraging excellence in all segments of the activities and nurturing academic freedom with personal responsibility.
- Promoting and popularising natural sciences and mathematics in all social segments in order for the younger generations to appreciate and be oriented towards natural sciences.
- Contributing to solving scientific problems, popularising science and raising the awareness of **PMF** students on global social issues.
- Promoting ethical principles and affirmative and critical consideration, accepting social responsibility and initiating and being open to social changes.

Developing and promoting natural sciences and mathematics at the University of Zagreb by participating in internationally relevant and competitive basic, applied and developmental research. Conducting and improving innovative educational programmes based on research. Contributing to science and education in the Republic of Croatia and the world, through all of our activities.





Vision

- **PMF** is the leading regional university institution dealing with scientific, educational and academic activities in the field of natural sciences and mathematics, and it is the leader in the development of natural sciences and mathematics in the Republic of Croatia.
- **PMF** employees conduct internationally relevant and competitive basic research, thus creating the foundation for a further development of natural sciences and mathematics and for initiating applied and developmental research.
- A high quality of the study programmes, research and professional work at **PMF** is ensured by continuously improving the scientific and organisational infrastructure.
- For the greatest part, **PMF** is located at the *Northern Campus* of the University of Zagreb where mutual cooperation and synergy with other organisational units and public research institutes is realised.
- The university study programmes of **PMF** within the University of Zagreb are based on science, innovativeness and new realised knowledge, and they contribute to the social and economic development of the Republic of Croatia.
- The students and employees of **PMF** are an academic community with freedom of research and productivity, mutual trust and respect and cooperation.

***PMF** is an internationally recognised and relevant centre of excellence for scientific, teaching and academic work in the field of natural sciences and mathematics, and **PMF**'s students and employees participate as equal participants in the European Research Area.*

Botanički vrt PMF-a

SWOT Analysis

Strengths

- A long tradition and reputation of **PMF** in university education, scientific, research and academic work in the field of natural sciences and mathematics.
- Scientific excellence and international recognisability of individual researchers, competitive research groups and the results of their research.
- The intellectual potential of a great number of highly competent and motivated employees with scientific, teaching and associate titles and a good teacher - student ratio.
- Networking on the national and international level with a significant number of national and international scientific projects and the appropriate scientific infrastructure, library stock and periodicals.
- The vicinity of other organisational units of the University of Zagreb and the public scientific institutes, ensuring a stimulating environment for scientific, teaching and academic work.
- Dialogue and taking into consideration the needs of certain regions of the Republic of Croatia (Osijek, Split, Dubrovnik *etc.*) for expanding natural sciences, and primarily developing these regions in scientific fields and teaching activities.
- Established strong connections on the local and regional level in cooperating with public institutions (*e.g.* Croatian Waters, National parks, IRB, IF *etc.*) in the field of sustainable development and computerisation.
- Active participation in the everyday life of the citizens of Zagreb and the Republic of Croatia (Seismological Service, Botanical Garden *etc.*).
- Highly motivated, studious and diligent students at all study levels.

Weaknesses

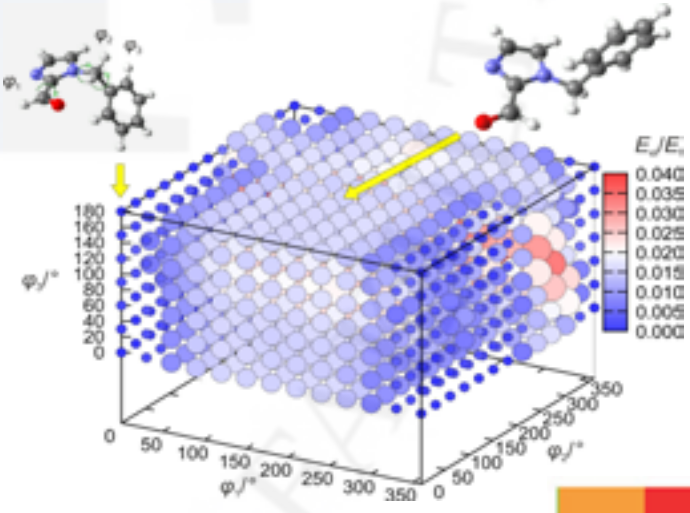
- The current spatial detachment and inadequacy of the spatial position of some of the elements for natural sciences complicate the scientific and teaching activities and adequate administrative activities.
- The fragmentation of resources leads to a reduced connection between professions and scientific fields, which complicates severely the introduction of common standards and criteria, has a negative effect on indicator (quality) effects, encouraging interdisciplinarity and establishing joint research in natural sciences.
- A lack of synergy among Departments weakens the possibilities to initiate interdisciplinary and multidisciplinary research.
- A lack of harmonisation among Departments in terms of study programmes leads to an illogical organisation of classes.
- An insufficient number of scientific, teaching, assistant and postdoctoral positions causes a working overload for teachers due to teaching and administrative obligations.
- A complex organisation that often leads to increases in the number of procedures and additional administrative obligations.
- Insufficient connection with former students.
- Too few strategic partner relationships with Croatian and international scientific institutions and the economy.
- A small interest among enrolment candidates for teaching programmes.

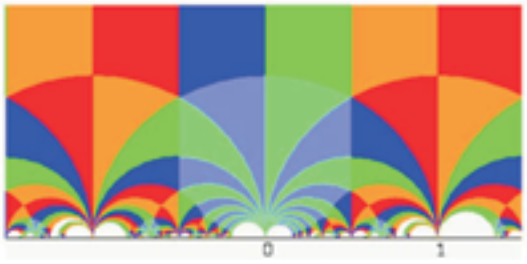
Opportunities

- Modernising the teaching and research programmes and balancing the existing enrolment capacities pursuant to modern achievements and societal needs.
- Harmonization with European systems in higher education, an internationalisation and increase in the competitiveness of educational programmes at the international level.
- Financing research projects and PhD students with the funds of the *Croatian Science Foundation*.
- Financing research projects with European Funds and joint project registrations with other Croatian or foreign institutions.
- Improving the scientific infrastructure by turning in projects for European Structural Funds and by turning in joint projects with the industry (*e.g.* Met4Pharm).
- Increasing the number of arrival and departure mobilities of students and employees at the level of the university, the national and international level.
- Establishing functional connections to other stakeholders in the educational system, the economy and the media.
- Unifying the research capacities in natural sciences, mathematics and biomedicine in the *Northern Campus* of the University of Zagreb.

Threats

- Lack of spatial integration of the professions of Biology, Geology and Geography within a single location at Horvatovac.
- Reduced funding from the state budget and inadequate funds from non-budget sources.
- Insufficient number of new scientific, teaching and assistant and postdoctoral positions.
- Inadequate investment from the state budget for the maintenance of the existing infrastructure
- Prolonging the project of constructing the *Northern Campus* of the University of Zagreb.
- Unfinished legal framework for developing research work.
- Departure of quality personnel outside the Republic of Croatia.
- Loss of interest for studying natural sciences and lack of attractiveness and bad social status of teacher professions.



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Basic strategic goals

❶. Improving the quality of teaching and promoting the importance of the educational process.

PMF will continuously improve the existing and develop new innovative university study programmes and life-long learning programmes based on the latest scientific knowledge. These programmes will provide excellent university education in the field of natural sciences and mathematics as a foundation of future scientific development and society as a whole.

❷. Improving the quality of scientific research.

PMF will encourage excellence in scientific research as a basis for attracting funds from competitive national and international sources, and it will provide an equal footing for its employees to get involved in the European Research Area. **PMF** will produce and turn in structural EU projects in order to improve and modernise the experimental basis for competitive scientific research.

❸. Improving the quality of academic work, transfer of knowledge and technology.

PMF has been recognised and acknowledged as an institution whose researchers help in solving various problems in various aspects of the social life in the Republic of Croatia, by using their expertise and professional studies. Numerous professional projects have been initiated and carried out at **PMF**, in cooperation with public and state institutions and a series of business subjects. The professional work of **PMF** employees serves the development and general well-being of society as a whole and it needs to be continuously improved.

❹. Improving infrastructure, organisation and management and the self-control system.

Improving all types of infrastructure, especially the spatial capacities and research infrastructure. It is necessary to improve the organisation and management and the self-control system, as it is necessary to carry out business activities optimally and develop **PMF** in the future. To this end, we need to produce a detailed analysis and optimisation of the Faculty organisation and management.

❺. Increasing the influence on the development of society as a whole and accepting social responsibility.

The duty of **PMF** is to take part in the development of the society of the Republic of Croatia. This can be realised by continuously holding and participating in scientific and popular events, self-promotion in order to achieve a greater appreciation for natural sciences and mathematics, and by being represented in the media on the personal and Faculty level.

Areas of strategic work and activities

❶. Improving the quality of teaching and promoting the importance of the educational process.

SPECIAL OBJECTIVE	❶.①.	Harmonizing the existing and developing new study programmes.
@CTIVITY	❶.①.@1.	*Harmonising and adjusting teaching contents at the Institute, Department and Faculty level.*
@CTIVITY	❶.①.@2.	*Improving the existing study programmes.*
@CTIVITY	❶.①.@3.	*Developing new study programmes.*
@CTIVITY	❶.①.@4.	*IProducing a* Profession Standard *and a* Qualification Standard.

Activity	Key indicators	Time frame	Responsible persons or bodies
❶.①.@1.	Report* on the conducted analysis of study programmes at the Faculty level with a special overview of rationalization options.	annually/continuously	Vice Dean for Academic Affairs.† Committee for Academic Affairs.
❶.①.@2.	Report on the number of study programmes and courses with changed course contents and/or learning outcomes.	annually/continuously	Vice Dean for Academic Affairs. Committee for Quality Assurance.
	Report on the number of teaching activities in cooperation with the economy and the public sector.	jannually/continuously	Vice Dean for Academic Affairs. Committee for Quality Assurance.
❶.①.@3.	Report on the number of new study programmes.	annually/continuously	Vice Dean for Academic Affairs. Committee for Academic Affairs. Committee for Quality Assurance.
❶.①.@4.	Documents related to Profession standard and Qualification Standard sent to be evaluated by the competent bodies on the national level.	once	Faculty Board Vice Dean for Academic Affairs. Department Boards.

*All reports are submitted verbally or in written. †All terms with a gender importance are used both for males and females.

SPECIAL OBJECTIVE ❶.②.	Improving the quality assurance system and continuous implementation of external evaluation and self-evaluation.
@CTIVITY ❶.②.@1.	*Monitoring the success rate of students during and after studying.*
@CTIVITY ❶.②.@2.	*Monitoring the employment rate of graduated students.*
@CTIVITY ❶.②.@3.	*Carrying out student surveys.*
@CTIVITY ❶.②.@4.	*Establishing the PMF Alumni.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❶.②.@1.	Report on study success rate.	annually/continuously	Vice Dean for Academic Affairs. Committee for Quality Assurance. ISVU coordinators.
❶.②.@2.	Report on monitoring the employment rate of graduated students.	annually/continuously	Vice Dean for Academic Affairs. Committee for Quality Assurance.
❶.②.@3.	Produced annual survey plan.	annually/continuously	Vice Dean for Academic Affairs. Committee for Quality Assurance. Professional services.
	Annual report on the results of the student surveys.	annually/continuously	Vice Dean for Academic Affairs. Committee for Quality Assurance. Professional services.
❶.②.@4.	Establishing the PMF Alumni.	once	Dean. Faculty Collegium. Vice Dean for Academic Affairs.

SPECIAL OBJECTIVE ❶.③.	Improving the mobility of students and employees of PMF.
@CTIVITY ❶.③.@1.	*Increasing the availability of information for students and employees of PMF and foreign students, teachers and researchers.*
@CTIVITY ❶.③.@2.	*Increasing the international exchange of students and employees of PMF and foreign students, teachers and researchers.*
@CTIVITY ❶.③.@3.	*Increasing the number of courses held in the English language and producing and holding study programmes that are held entirely in English.*
@CTIVITY ❶.③.@4.	*Modifying enrolment quotas pursuant to the environment.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❶.③.@1.	Analyzing the availability of information relevant for the mobility of students and employees of PMF.	2015./2016.	Vice Dean for International Cooperation.
	Analyzing the availability of information relevant for the mobility of foreign students, teachers and researchers.	2015./2016.	Vice Dean for International Cooperation.
❶.③.@2.	Report on the number of students and employees of PMF that participated in international cooperation.	annually/continuously	Vice Dean for Academic Affairs. Vice Dean for International Cooperation.
	Report on the total number of foreign students, teachers and researchers that participated in international cooperation.	annually/continuously	Vice Dean for Academic Affairs. Vice Dean for International Cooperation.
	Report on the number of lectures held by foreign lecturers.	annually/continuously	Vice Dean for Academic Affairs. Vice Dean for International Cooperation.
❶.③.@3.	Report on the total number of courses held in English or in another foreign language.	annually/continuously	Vice Dean for Academic Affairs. Vice Dean for International Cooperation.
	Report on the conducted procedure of evaluating the study programmes held entirely in English or in another foreign language.	annually/continuously	Vice Dean for Academic Affairs. Committee for Quality Assurance.
❶.③.@4.	Analyzing the enrolment quotas in time dependency.	annually/continuously	Vice Dean for Academic Affairs.

SPECIAL OBJECTIVE ❶.④.	Establishing a sustainable system for life-long learning.
@CTIVITY ❶.④.@1.	*Carrying out professional development courses for teachers in primary and secondary schools.*
@CTIVITY ❶.④.@2.	*Organising theme workshops, courses and e-courses for the general public (smart specialization).*
@CTIVITY ❶.④.@3.	*Recognising gifted pupils in primary and secondary schools and including them in advanced workshops, summer schools and preparations for international competitions.*
@CTIVITY ❶.④.@4.	*Producing educational materials for primary and secondary school pupils.*
@CTIVITY ❶.④.@5.	*Providing scientific and professional support for popular scientific journals aimed at primary and secondary school pupils.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❶.④.@1.	Report on the total number of held theme workshops aimed at improving teachers in primary and secondary schools.	annually/continuously	Vice Dean for Academic Affairs. Committee for Teaching Methodology. Leader of PriMaTeh.*
❶.④.@2.	Report on the carried out procedure of evaluating new life-long learning programmes.	annually/continuously	Vice Dean for Academic Affairs. Committee for Quality Assurance.
	Report on the number of held programmes for life-long learning.	annually/continuously	Vice Dean for Academic Affairs.
❶.④.@3.	Report on held workshops, summer schools and preparations for competitions.	annually/continuously	Vice Dean for Academic Affairs. Committee for Teaching Methodology. Leader of PriMaTeh.
❶.④.@4.	Report on the total number and type of educational materials written for primary and secondary school pupils.	annually/continuously	Vice Dean for Academic Affairs. Committee for Teaching Methodology. Leader of PriMaTeh.
❶.④.@5.	Report on the addendums in popular scientific journals authored by PMF employees.	annually/continuously	Vice Dean for Academic Affairs. Committee for Teaching Methodology.

*PriMaTeh – *Center for improving education in the fields of natural sciences, mathematics and technic*, an organisational unit of PMF.

SPECIAL OBJECTIVE ❶.⑤.	Improving the educational infrastructure.
@CTIVITY ❶.⑤.@1.	*Analysing and monitoring the application of e-learning and introducing modern technologies in classes at PMF.*
@CTIVITY ❶.⑤.@2.	*E-learning support for students and teachers of PMF.*
@CTIVITY ❶.⑤.@3.	*Increasing the number of textbooks, scientific and professional reading materials.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❶.⑤.@1.	Report on the number of courses that implement e-learning pursuant to the classification of the University of Zagreb.	annually/continuously	Vice Dean for Academic Affairs. Committee for Academic Affairs.
	Report on the funds spent for introducing ICT in classes at PMF.	annually/continuously	Vice Dean for Investment and Development.
❶.⑤.@2.	Establishing a standardisation system for teacher work for producing e-materials.	once	Dean. Faculty Collegium. Vice Dean for Academic Affairs.
	Report on the number of workshops held for introducing ICT in the teaching process for PMF employees.	annually/continuously	Vice Dean for Academic Affairs. Leader of PriMaTeh.
❶.⑤.@3.	Report on the total number of new course books, scientific and professional literature.	annually/continuously	Vice Dean for Academic Affairs. Library managers.
	IReport on the availability of scientific and professional journals.	annually/continuously	Vice Dean for Research and Doctoral Studies.

❷. Improving the quality of scientific research

SPECIAL OBJECTIVE ❷.①.	Improving the research and innovation activities.
@CTIVITY ❷.①.@1.	*Increasing the number of scientific projects received at tenders in the Republic of Croatia.*
@CTIVITY ❷.①.@2.	*Increasing the number of scientific projects received at European tenders.*
@CTIVITY ❷.①.@3.	*Increasing the number of scientific projects in cooperation with the industry.*
@CTIVITY ❷.①.@4.	*Raising the innovation potential and establishing knowledge transfer mechanisms towards the economy.*
@CTIVITY ❷.①.@5.	*Increasing the number of lectures held by summoned foreign researchers.*
@CTIVITY ❷.①.@6.	*Publicly available display of scientific projects, along with funding amounts, final results and an analysis of usefulness for the community.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❷.①.@1.	Report on turning in scientific projects at tenders in the Republic of Croatia, categorised based on basic, applied and developmental research.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❷.①.@2.	Report on turning in scientific projects at European tenders, categorised based on basic, applied and developmental research.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❷.①.@3.	Report on scientific projects in cooperation with the industry, categorised based on basic, applied and developmental research.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❷.①.@4.	Report on innovations and patents.	annually/continuously	Vice Dean for Research and Doctoral Studies.
	Report on applications for open platform innovations in economic operators.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❷.①.@5.	Report on the lectures held by summoned foreign lecturers.	annually/continuously	Vice Dean for Research and Doctoral Studies. Vice Dean for International Cooperation.
❷.①.@6.	Report on the availability of data published at the web site and in the annual reports of PMF.	annually/continuously	Vice Dean for Research and Doctoral Studies.

SPECIAL OBJECTIVE ❷.②.	Improving the systematic support when turning in and carrying out projects.
@CTIVITY ❷.②.@1.	*Optimising the operations of professional services in order to provide for easier administrative management of projects.*
@CTIVITY ❷.②.@2.	*Establishing a financial system to provide support for turning in and carrying out projects.*
@CTIVITY ❷.②.@3.	*Charge more persons with systematic support during the turning in and carrying out of the project.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❷.②.@1.	The work analysis of professional service carried out.	once	Dean Faculty Collegium. Faculty Board.
	Reorganisation of the work of professional services carried out.	once	Dean Faculty Collegium. Faculty Board.
❷.②.@2.	Establishing a common financial fund for supporting turning in and carrying out projects.	once	Dean Faculty Collegium. Vice Dean for Finances.
	Report on the total funds deposited in the common financial fund.	annually/continuously	Dean Faculty Collegium. Vice Dean for Finances.
❷.②.@3.	Total number of persons charged with systematic support.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.

SPECIAL OBJECTIVE ❷.③.	Encouraging and recognising excellence in scientific activities.
@CTIVITY ❷.③.@1.	*Establishing and awarding credit for excellence in scientific work to research and teaching employees of **PMF**.*
@CTIVITY ❷.③.@2.	*Establishing and awarding credit for excellence in the scientific work of doctoral students.*
@CTIVITY ❷.③.@3.	*Including students in scientific work during studies.*
@CTIVITY ❷.③.@4.	*Awarding credit for excellence in the scientific work of students.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❷.③.@1.	Report on the awarded credit for excellence in the scientific work to research and teaching employees of PMF.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.
❷.③.@2.	Report on the awarded credit for excellence in the scientific work of doctoral students.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.
❷.③.@3.	Report on students involved in scientific work during their studies.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.
	Report on the awarded credit at the contests for the Rector's Award and the Dean's Award.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.
❷.③.@4.	Report on the awarded credit for excellence in the scientific work of students.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.

SPECIAL OBJECTIVE ❷.④.	Encouraging the creation of local, interdisciplinary and multidisciplinary competitive research groups.
@CTIVITY ❷.④.@1.	*Encouraging continuous cooperation between employees and research groups, and scientists from the best domestic and global universities and scientific institutes.*
@CTIVITY ❷.④.@2.	*Networking the scientific groups of **PMF** in regional and global research centres.*
@CTIVITY ❷.④.@3.	*Including a greater number of scientists from **PMF** in the preparation of the project for the Centre for advanced nanomaterials and nanotechnology in cooperation with the Ruđer Bošković institute and the Institute for Physics for the tender of the European Regional Development Fund 2014-2020.*
@CTIVITY ❷.④.@4.	*Encouraging the creation of excellent local research groups.*
@CTIVITY ❷.④.@5.	*Encouraging the creating of interdisciplinary and multidisciplinary research groups for excellence in interdisciplinary and multidisciplinary research.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❷.④.@1.	Report on the realised cooperation of employees and research groups with researchers from domestic and global universities and scientific institutes.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.
❷.④.@2.	Report on the number of regional and global research centres with which cooperation has been realized.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.
❷.④.@3.	Report on the number of **PMF** researchers involved in producing the feasibility study.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❷.④.@4.	Report on excellent local research groups.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.
❷.④.@5.	Report on the number of interdisciplinary and multidisciplinary research groups for excellence in interdisciplinary and multidisciplinary research.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.

SPECIAL OBJECTIVE ❷.⑤.		Improving the doctoral studies of PMF.
@CTIVITY	❷.⑤.@1.	*Improving the existing and developing new study programmes at doctoral studies.*
@CTIVITY	❷.⑤.@2.	*Encouraging the realisation of double doctoral theses and joined doctoral programmes with other domestic and foreign HEIs.*
@CTIVITY	❷.⑤.@3.	*Encouraging the mobility of doctoral students and teachers at doctoral studies.*
@CTIVITY	❷.⑤.@4.	*Encouraging the mobility of foreign teachers and researchers for the purpose of holding lectures at doctoral studies.*
@CTIVITY	❷.⑤.@5.	*Encouraging the realisation of doctoral theses in cooperation with the economic and public sector.*
@CTIVITY	❷.⑤.@6.	*Improving the existing and founding new specialist postgraduate studies.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❷.⑤.@1.	Report on the number of changed courses at the doctoral studies of PMF.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.
	Report on the number of changed study programmes at the doctoral studies of PMF.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.
	Report on the number of new study programmes at the doctoral studies of PMF.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.
❷.⑤.@2.	Report on the number of new joined doctoral programmes at the doctoral studies of PMF.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.
❷.⑤.@3.	IReport on the number of students and teachers at the doctoral studies of PMF who participated in international exchanges.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.
❷.⑤.@4.	Report on the number of foreign teachers and researchers who participated in international exchanges.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.
❷.⑤.@5.	Report on the number of doctoral dissertations realized in cooperation with the economic and public sector.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.
❷.⑤.@6.	Report on the number of changed specialist postgraduate studies.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.
	Report on new specialist postgraduate studies.	annually/continuously	Vice Dean for Research and Doctoral Studies. Leaders of doctoral studies.

❸. Improving the quality of academic work, transfer of knowledge and technology.

SPECIAL OBJECTIVE ❸.①.	Improving the expert activities.
@CTIVITY ❸.①.@1.	*Increasing the number of expert projects.*
@CTIVITY ❸.①.@2.	*Encouraging the protection of intellectual property and copyright and related rights.*
@CTIVITY ❸.①.@3.	*Held with founding spin-off companies.*
@CTIVITY ❸.①.@4.	*Establishing and awarding credits for excellence in the expert activities of the scientific and teaching employees of PMF.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❸.①.@1.	Report on the number of expert projects.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❸.①.@2.	Report on the protection of intellectual property and copyright and related rights.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❸.①.@3.	Report on founding spin-off companies.	once	Professional services. Vice Dean for Research and Doctoral Studies.
❸.①.@4.	Report on awarded credits for excellence in the expert activities of the scientific and teaching employees of PMF.	annually/continuously	Dean Faculty Collegium. Vice Dean for Research and Doctoral Studies.

❹. Improving infrastructure, organisation and management and the self-control system.

SPECIAL OBJECTIVE ❹.①.	Constructing and improving the spatial infrastructure within the Northern Campus project
@CTIVITY ❹.①.@1.	*Solving property affairs for constructing the building of the complex for the Departments of Biology, Geography and Geology (BGG).*
@CTIVITY ❹.①.@2.	*Solving the property affairs for upgrading and expanding the buildings of Physics and Geophysics.*
@CTIVITY ❹.①.@3.	*Active cooperation with the University of Zagreb in preparing the location permit for the Center for advanced materials and nanotechnology (C2AMN).*
@CTIVITY ❹.①.@4.	*Preparing the documentation for turning in the Northern Campus project in the part related to **PMF**.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❹.①.@1.	Report on the property affairs related to constructing the BGG building.	annually	Vice Dean for Investment and Development.
❹.①.@2.	Report on the property affairs related to upgrading and expanding the buildings of Physics and Geophysics.	annually	Vice Dean for Investment and Development.
❹.①.@3.	Report on preparing the location permit for C2AMN.	annually	Vice Dean for Investment and Development.
❹.①.@4.	Report on preparing the documentation for turning in the Northern Campus project.	annually	Vice Dean for Investment and Development.

SPECIAL OBJECTIVE ❹.②.	Improving and modernising the research infrastructure.
@CTIVITY ❹.②.@1.	*Active cooperation on the feasibility study for turning in the C2AMN project to the tender for structural funds (partners: University of Zagreb, Ruđer Bošković institute, Physics Institute).*
@CTIVITY ❹.②.@2.	*Preparing the projects for equipping **PMF** research laboratories for applying to tenders for infrastructure projects for the European Regional Development Fund 2014–2020.*
@CTIVITY ❹.②.@3.	*Connecting with the business sector for the purpose of turning in projects of industrial research and experimental development as a foundation to develop the Croatian economy within the Operational Programme of Regional Competitiveness 2014–2020 from the European Regional Development Fund.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❹.②.@1.	Report on cooperating on the feasibility study to turn in the C2AMN project.	annually	Vice Dean for Research and Doctoral Studies.
❹.②.@2.	Report on turning in projects for equipping the research laboratories of **PMF** to tenders for infrastructural projects for the European Regional Development Fund 2014–2020.	annually	Vice Dean for Research and Doctoral Studies.
❹.②.@3.	Report on connecting with the business sector for the purpose of turning in projects of industrial research and experimental development as a foundation to develop the Croatian economy within the Operational Programme of Regional Competitiveness 2014–2020 from the European Regional Development Fund	annually	Vice Dean for Research and Doctoral Studies.

SPECIAL OBJECTIVE ❹.③.	Analysing and optimising the Faculty organisation and management.
@CTIVITY ❹.③.@1.	*Detailed analysis of the organisational and management structure.*
@CTIVITY ❹.③.@2.	*Producing a plan for the reorganisation of the organisational and management structure and other legal acts*
@CTIVITY ❹.③.@3.	*Improving the coordination of activities, efficiency and strengthening the information flow system.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❹.③.@1.	Produced detailed analysis of the organisational and management structure.	2015./2016.	Dean. Faculty Collegium. Professional services.
❹.③.@2.	Produced plan for the reorganisation of the organisational and management structure.	2015./2016.	Dean. Faculty Collegium. Professional services.
❹.③.@3.	Report on improving activity coordination.	annually/continuously	Dean. Faculty Collegium. Professional services.
	Report on improving efficiency.	annually/continuously	Dean. Faculty Collegium. Professional services.
	Report on strengthening the information flow system.	annually/continuously	Dean. Faculty Collegium. Professional services.

SPECIAL OBJECTIVE ❹.④.	Improving the IT structure.
@CTIVITY ❹.④.@1.	*Better computerisation of business activities and focus on web pages.*
@CTIVITY ❹.④.@2.	*Creating and maintaining web pages in foreign languages.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❹.④.@1.	Report on the funds spent for computerisation.	annually/continuously	Vice Dean for Finances.
	Report on the availability of information via web pages.	annually/continuously	Vice Dean for International Cooperation.
❹.④.@2.	Report on creating and maintaining web pages in foreign languages.	annually/continuously	Vice Dean for International Cooperation.

SPECIAL OBJECTIVE ❹.⑤.	**Improving the self-examination system.**
@CTIVITY ❹.⑤.@1.	*Improving the existing ordinances.*
@CTIVITY ❹.⑤.@2.	*Internal and external evaluation.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❹.⑤.@1.	Annual plan of normative activities with an impact assessment.	annually/continuously	Dean. Faculty Collegium. Professional services.
❹.⑤.@2.	Report on internal evaluation.	annually/continuously	Dean. Faculty Collegium. Committee for Quality Assurance.
	Carried out analysis on external evaluation.	annually/continuously	Dean. Faculty Collegium. Committee for Quality Assurance.

❺. Increasing the influence on the development of society as a whole and accepting social responsibility.

SPECIAL OBJECTIVE ❺.①.	Holding and participating continuously in popular scientific events.
@CTIVITY ❺.①.@1.	*Organising the events: Open Day, Night of Biology, Magic in Chemistry etc.*
@CTIVITY ❺.①.@2.	*Participating in other popular scientific events (Science Festival etc.).*
@CTIVITY ❺.①.@3.	*Supporting professional associations.*
@CTIVITY ❺.①.@4.	*Supporting popular scientific journals.*
@CTIVITY ❺.①.@5.	*Supporting student associations.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❺.①.@1.	Report on organised events.	annually/continuously	Vice Dean for Academic Affairs. Vice Dean for Research and Doctoral Studies. Leader of PriMaTeh.
❺.①.@2.	Report on participating in other popular scientific events.	annually/continuously	Vice Dean for Academic Affairs. Vice Dean for Research and Doctoral Studies. Leader of PriMaTeh.
❺.①.@3.	Report on supporting professional associations.	annually/continuously	Vice Dean for Academic Affairs. Vice Dean for Research and Doctoral Studies.
❺.①.@4.	Report on supporting popular scientific journals.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❺.①.@5.	Report on supporting student associations.	annually/continuously	Vice Dean for Academic Affairs. Vice Dean for Research and Doctoral Studies.

POSEBAN CILJ ❺.②.	Improving self-promotion and the visual identity.
@KTIVNOST ❺.②.@1.	*Producing various promotion materials.*
@KTIVNOST ❺.②.@2.	*Redesigning the visual identity of* ***PMF****.*
@KTIVNOST ❺.②.@3.	*Creating the web sites of* ***PMF*** *and continuous presence (Wikipedia, Facebook, Twitter etc.).*

Activity	Key indicators	Time frame	Responsible persons or bodies
❺.②.@1.	Report on the produced promotion materials.	annually/continuously	Dean. Faculty Collegium.
❺.②.@2.	Report on the carried out redesign of the visual identity.	annually/continuously	Dean. Faculty Collegium.
❺.②.@3.	Report on creating web sites and continuous presence.	annually/continuously	Dean. Faculty Collegium.

SPECIAL OBJECTIVE ❺.③.	Ensuring presence in the media.
@CTIVITY ❺.③.@1.	*Ensuring media presence at important events and popular scientific public social events.*
@CTIVITY ❺.③.@2.	*Continuous sending of report on important events and popular scientific public social events to the media.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❺.③.@1.	Report on the media presence at important events and popular scientific public social events.	annually/continuously	Dean. Faculty Collegium.
❺.③.@2.	Analysing the media reports on important events and popular scientific public social events.	annually/continuously	Dean. Faculty Collegium.

SPECIAL OBJECTIVE ❺.④.	Supporting and encouraging publishing activities.
@CTIVITY ❺.④.@1.	*Working in international institutions and professional societies.*
@CTIVITY ❺.④.@2.	*Supporting the presentation of international and domestic scientific journals.*

Activity	Key indicators	Time frame	Responsible persons or bodies
❺.③.@1.	Report on employees involved in working in international institutions and professional societies.	annually/continuously	Vice Dean for Research and Doctoral Studies.
❺.③.@2.	Report on employees involved in working in the editorial offices of domestic scientific journals.	annually/continuously	Vice Dean for Research and Doctoral Studies. Committee for Publishing Activities.
	Report on employees involved in working in the editorial offices of international scientific journals.	annually/continuously	Vice Dean for Research and Doctoral Studies. Committee for Publishing Activities.

Scientific research programmes

Department of Biology

Division of Botany

Scientific research groups are exploring algae and plants from different aspects: molecular and genetic, chemical and biochemical, physiological and pathophysiological, phylogenetic and evolutionary, geobotanical and ecological. The studies that range from analyses of the distribution, habitat and environmental conditions in which algae and plants live, through investigations of bioactive substances in plants with possible applications in phytotherapy to the analyses of the genetic diversity of populations and species are carried out in the laboratory, as well as on the field. A surprisingly large number of different, especially endemic plants in such a small area as Croatia, inevitably influenced the direction of our investigations. Knowledge on the structure and function of algae and plants, as well as on their living conditions and way of life is essential for the understanding of fundamental life processes, food production, manufacturing of drugs of plant origin, prevention and protection of plant allergens, promotion of touristic offer of specific areas. According to the achieved results, the scientists has profiled into the leading Croatian botanists, recognizable at the international scientific scene. Within the global list of herbarium collections officially are registered two herbarium collections: "Herbarium Croaticum" and Herbarium "Ivo and Marija Horvat".

Goals:

- to raise awareness on the importance of plants and their biodiversity to sustain life on Earth
- insight into the current condition, vulnerability and potential problems in biodiversity conservation
- to propose measures to manage and protect certain species and specific botanical important areas for quality of life on Earth
- to affect food production, production of drugs of plant origin, prevention and protection of plant allergens, promotion of tourist offer of specific areas by the research results
- preservation and promotion of Croatian cultural heritage, as well as education in the field of plants knowledge through the maintenance and work on herbarium collections

Division of Animal Physiology

The research is focused on prevention of tumour and metastasis growth by inhibition of angiogenesis, by investigation of interaction between VEGF, macrophage polarization, oxidative stress and angiogenesis. Studies will include DNA damage in tumour cells and lymphocytes and key molecular mechanisms of anti-inflammatory, antioxidative, phytoestrogen and regenerative potential of bioactive compounds of plant and honey-bee products in diabetes, osteoporosis, inflammatory diseases of skin and bowel as well as its modulatory effects on gut microorganisms and in processes of detoxification of carcinogenic compounds and toxins. In the field of neurophysiology future research will focus on (Long)-lasting consequences of perinatal exposure to altered serotonin concentrations explored on animal model in rats prenatally treated with an inhibitor of serotonin degradation (tranylcypromine) and in human population (subjects with autism spectrum disorder). In rat, immunohistochemical methods will be used to determine the consequences of altered central serotonin homeostasis on structural organization of somatosensory cortex, and of altered peripheral serotonin in bone marrow, kidney and liver structure. In humans, bone and blood parameters will be measured to determine the influence of altered peripheral serotonin homeostasis on glucose, lipid and bone metabolism. In the field of endocrinology and reproduction research of influence of different in vitro procedures on level of oxidative stress and genome stability of reproductive cells will be conducted. In the field of dietary and metabolic physiology we will conduct research of intracellular and organ cholesterol accumulation on antioxidative defence mechanisms. Toxicological in vivo and in vitro research on food safety due to presence of different xenobiotics and bioactive compounds will be conducted. As a part the ecophysiology the population research of wild mammals of Croatia (wolf, jackal, wild pig, deer, otter, and dolphins) by use of neutral and adaptive genetic markers will continue. Behavioural-cognitive research of animal behaviour that allows survival on the model Balkan Snow vole. We are planning to apply behavioural-cognitive research methods in current and future studies on impact of bioactive substances on animal model (the laboratory mice or/and rats).

Division of Microbiology

Division of Microbiology will continue the scientific research on bacteria, viruses, subviral agents, and fungi. Main planned research topics will include:

1. Diversity and interactions of chestnut, chestnut blight fungus and biocontrol agent – virus: implications on chestnut recovery.
2. Epidemiology of clinically important bacteria Acinetobacter baumannii.
3. Molecular epidemiology, diversity and genotyping of phytoplasmas (genus "Candidatus Phytoplasma') of economically important crops in Croatia
4. Comparative and functional genomics of phytoplasmas: genome plasticity, interactions with plant and insect hosts and pathogenicity mechanisms/strategies.
5. Genetic structure, molecular diversity and evolution of plant viruses having single- or double-stranded RNA genomes.
6. Molecular diversity and epidemiology of environmental viruses.
7. Viroid molecular diversity and population structures.
8. Application of monolith chromatography in research of virus particles and nucleic acids.

Division of Molecular Biology

Department of molecular biology consist is heterogeneous and consist of several research groups with independent research programs. The research interest of the Group for stress biology is the effects of abiotic stress on plants and the mechanisms of their response to stress, analyzed on cellular, chromosome, gene-expression and protein level. The oldest Group of the Department of Molecular Biology is interested in plant genome organization and evolution studied on cytogenetic and molecular level. The aim of this group in further investigations is application of chromosome markers in phylogeny studies as well as the organization and evolution of repetitive sequences and their implications in speciation. The research interests of the Group for plant development are the mechanisms of sexual and asexual reproduction in plants and their application in biotechnology. The prospective studies aim to understand regulation of the reproductive capacities of the egg cell and somatic cells and try to use the potential of somatic embryogenesis in establishment of the new agronomically desirable properties. The Biomedicine group have several different research interests: a) to explore potential of the stem cells in regenerative orthopeadics; b) transcriptional regulation in animal cells, and c) investigation of communication network between cancerous cells and their microenvironment. The aim of the future research is regulation of plasminogen activation system which governs tissue remodelling, and investigation of biopathology of hematological neoplasms using multidisciplinary approach. The research topic of Bioinfo group is bioinformatics and metagenomics in systems biology. Using computational tools and methods they aim to discover knowledge in life processes at the level of entire biological systems. The research topic of Epigenetic group is regulation of protein glycosylation in normal physiology and in various human complex diseases. The future aim is to understand how variability in protein glycosylation, governed by epigenetic regulation, is involved in different susceptibility and progression of the disease. The aim is also to reveal functional relevance of GWAS hits for IgG glycosylation by approach of genetic/epigenetic editing using TALEN/CRISPR methodology.

Division of Zoology

Department of Zoology strives to promote the study of basic and applied aspects of Zoology through teaching and research. Research is focused on the several main topics:

1. Ecotoxicological studies aim at improving environmental risk assessment and are mainly focused on the effects of environmental contaminants on cellular and genetic structure of aquatic or soil organisms. Several methods are applied for the evaluation of DNA damage and genome variability and analyses are carried out in vitro and in vivo using a variety of model organisms (cnidarians, planarians, molluscs, crayfish, earthworms). Analyses are performed in laboratory or in situ field exposed organisms as well as in organisms belonging to native populations.

2. Phylogeographic research is directed on the study of the historical processes that may be responsible for the contemporary geographic distributions of individuals in light of the patterns associated with a gene genealogy and climatic change. The subjects of these investigations are mostly aquatic organisms spread in the Dinaric karst of Balkan Peninsula. Of special interests are molecular phylogeny, evolution and symbiosis of freshwater invertebrates, with an intention to provide clear insight into the significance of symbiogenesis in speciation process, and determination of divergence time and mechanisms of symbiosis in freshwater cnidarians.

3. Present ecological research a mixture of laboratory and field-based studies and it addresses fundamental questions, as well as diversity and conservation. The research involves a wide range of organisms; it spans areas of basic and applied ecology, ranging from individual and population to community level, with special emphasis on freshwater ecology and control of invasive species. Applied researches are focused on biological water assessment in accordance with the Water Framework Directive of the European commission; implementation of the composition of aquatic fauna in evaluation of environment: developing lists of indicators for different types of habitats and the establishment of monitoring surveys.

Experimental Physics Division

Experimental research in condensed matter physics includes the preparation and investigation of structural, macroscopic and microscopic properties of a broad spectrum of modern materials. These include organic and inorganic materials, low dimensional conductors, oxide heterostructures, topological insulators, as well as materials that exhibit collective phenomena such as superconductivity and quantum magnetism, magnetic nano particles, single molecule magnets, complexes of magnetic ions, molecule-based magnets, multiferoics, alloys, ionic conductors, ferromagnetic graphite, soft matter, metal cluster complexes and other materials of importance for basic or applied physics. Such a wide field of study requires various techniques to determine the microscopic structure (X-ray scattering, electronic microscopy), local features (nuclear magnetic and quadrupole resonance) and macroscopic properties (magnetic and electrical characteristics, magnetotransport, thermoelectric and thermodynamic properties, high-frequency transport) in a wide span of external conditions (including extreme conditions such as very high and low temperatures and intense magnetic fields). Macroscopic properties are deduced from measurements of static magnetisation, AC susceptibility, resistance and magneto-resistance , Hall and Nernst effects, thermopower, microwave conductivity, nonlinear radio-frequent conductivity and magnetic properties in the electrical field.

Experimental research in atomic and molecular physics are focused on the study of atomic and molecular processes in the high-pressure discharge in metal vapors in the high-frequency discharges in noble gases , using conventional and laser spectroscopic methods .

Experimental nuclear physics research includes investigations of nuclear structure and properties of nuclei and hadrons, nuclear reactions of astrophysical and technological importance, and nuclear and particle processes of interest to the fundamental questions of quantum mechanics and the standard model. Studies are carried out in laboratories in Croatia as well as in specialized European and world accelerator centers. An important component are applications of nuclear methods in the study of materials, environment and medicine. Studies in experimental physics of elementary particles at high energies are focused on the research of Quark-Gluon Plasma (QGP) at RHIC and LHC colliders and spin structure of nucleons at RHIC. Research in the field of Astrophysics is focused on the following topics : (a) the structure, development and interaction of stars , (b) the origin and development of galaxies , and (c) the properties of interstellar matter.

Physics education research includes investigations of high school and university students' understanding of fundamental physics concepts, investigations in the field of educational neuroscience and development and testing of the new teaching strategies and materials.

Neurobiophysical research uses neurodynamic methods for functional brain imaging to explore sensory and cognitive processes, multi-sensory integration, and cortical plasticity in basic and translational studies.

Theoretical Physics Division of Particles and Fields

Gravitation and black holes

Theoretical investigations General research on parity violating effects in gravity by studying holography, anomalies, entropy, black holes. The focus will be in particular on the natural candidates for parity violating gravity interactions – the Chern-Simons terms, both pure gravitational and mixed gauge-gravitational ones - using extra-dimension models such as those inspired by the string theory. The expected outcome is a significant increase in understanding the consequences of parity violating gravitational interactions, not only in relation with possible CP violations, but also for other effects, e.g. for corrections to black hole entropy.

Also, research on general properties of classical scalar and electromagneticfield in a curved spacetime: question of symmetry inheritance and the interaction between the fields and black holes.

Phenomenology of elementary particles and fields

Goal of this research is to study the fundamental strong force, as described by the theory of quantum chromodynamics (QCD) and physical processes happening at hadron accelerators, including electroweak production of as-yet-unseen particles at the large hadron collider (LHC). Thereby, we will investigate models of new physics in which such new particles are introduced in attempts to explain neutrino masses and abundance of dark matter in the universe. To achieve these objectives we will study specific hadronic processes, both in the high-energy regime where strong force is weak enough for perturbative approach, as well as in regimes where non-perturbative features of QCD, such as confinement and chiral symmetry breaking come to the fore. Our focus will be on processes measured by the range of experimental collaborations which will facilitate close contact with reality and immediate testing of our results and ideas.

Division of Theoretical Condensed Matter Physics

History of physics

The main subject of research will be Croatian natural sciences communities, especially the community of physicists, in the period 1875-1950. The goal is to elucidate the scope, the structure and the dynamics of the community, in particular the influence of the development of natural sciences and mathematics studies on the Croatian society.

Graphene and related materials

This research is dedicated to graphene modeling, single and multi-layered systems, undoped, intercalated and doped systems, in particular doped with alkali and alkaline earth metals, mechanical deformed systems, graphene nanoribbons, carbon nanotubes and graphene-based compounds (eg. CaC6). The research will include band structure and excitation spectrum calculations, transport and optical properties calculations (including ballistic conductivity, and plasmon excitations), Raman spectra and magnetic properties calculations, a study of pseudomagnetic fields effects created by mechanical deformation, a study of spatially inhomogeneous systems leading to charge/spin confinement. One part of this research is also related to studies of nanoelectromechanical systems (NEMS) where magnetic and pseudomagnetic fields affect the magnetic coupling and nanomechanics controlled via spin.

High temperature superconductors and related materials

It is a part of longstanding efforts to understand the physical mechanisms that govern in these materials. Our study will include the modeling of collective, transport and electromechanical properties, calculations of the dynamical conductivity and the dependence of the relaxation functions on frequency and temperature, temperature dependence of various transport coefficients, calculations of the imaginary part of the memory function, review how the electron-phonon scattering affects the electronic spectrum, the conductivity and Raman scattering. Our efforts will be dedicated to understand i) the mechanism of doping and the emergence of free charge, (ii) the nature of the metallic response, (iii) the pseudogap appearance in the spectroscopic data (iv) and the nature of the magnetic response function. This is also related to the research of transition metal oxides, e.g. nickelates and iridates, aiming to design a technologically desirable materials, and to better understand the superconductivity phenomenon in different groups of high temperature superconductors.

Organic compounds deposited on surfaces and on small metal clusters

This research includes the band structure calculations and how it affects spectroscopic data (optical absorption, EELS, photoemission, etc.) for organic molecules (benzene, terilen, fullerene, etc.) deposited on the surfaces of noble metals (eg. Au (111)), or on metal clusters such as

Au147. The strong Coulomb interaction requires a solution of the Bethe-Salpeter equation that takes into account exciton creation and excited electron-hole interaction.

Layered transition metal dichalcogenides

In low-dimensional materials, including layered transition metal dichalcogenides, electron-electron and electron-phonon interactions give rise to various low temperature phases and phase transitions (e.g. charge/spin density waves, superconductivity, metal-insulator transition, Peierls instability, structural superstructure, different magnetic phases, etc.) making them interesting to theoretical and experimental studies, but also for a possible technological application. This research will include ground state calculations, crystal structure optimization, band structure and excitation spectra calculations (phonon, magnon), and calculations of optical, transport and magnetic properties.

Theoretical research of novel, mostly low-dimensional materials

The aim of this research is to understand basic properties and new phenomena important for technological application, as well as their modeling which allows the synthesis of future class materials having impact on technological development.

Division of Theoretical Physics

Nuclear structure

The goal of our research is to develop and apply a novel theoretical framework, based on nuclear Density Functional Theory (DFT) that enables microscopic modeling of the structure of quantum systems at the femtometer scale, and provides accurate predictions for exotic femtosystems far from stability that are not yet accessible in experiment. The objectives include the development and application of a universal microscopic framework for the description and modeling of exotic quantum many-body systems at the femtometer scale, thus establishing a link between quantum chromodynamics and the rich phenomenology of nuclear structure. For spectroscopic applications the EDF-based approach will be extended to models that include collective correlations related to the restoration of broken symmetries in finite nuclei, and take into account fluctuations of collective variables around mean-field minima.The EDF based generator coordinate method and the collective Hamiltonian model will be applied to describe quantum shape phase transitions, shell evolution in exotic nuclei, structure of superheavy nuclei and properties of low-lying exotic modes of excitations.

The complexity of the nuclear many-body problem necessitates the development of new methods of advanced mathematical modeling. Computationally intensive simulations will be performed for hundreds of exotic systems across the entire chart of nuclides.

Nuclear astrophysics

Nuclear astrophysics, as a meeting point of nuclear physics, elementary particle physics and astrophysics studies various processes within the stars. A particularly important question is when and under what conditions are the elements heavier than iron created, which is the key to understanding the creation and properties of the Earth, and the chemical evolution of galaxies as well as the fundamental properties and interactions within the atomic nucleus. Our main research goal is development and application of a fully self-consistent theoretical framework, based on the relativistic nuclear energy density functional, for description of nuclear structure, excitations and decays, from the valley of stability to the nuclear drip-lines. In the research agenda are reactions of relevance for the heavy element nucleosynthesis – rapid neutron capture, neutrino induced reactions, beta decay of unstable nuclei and electron capture. Their detailed description is a necessary condition for the understanding of the final stages of stellar evolution – supernova explosions and the creation of neutron stars.

Optics and photonics

Theoretical investigations within optics and photonics are aimed at the design and development of novel photonic structures with intriguing properties. These properties are manifested in the propagation of light (electromagnetic waves) within the structures. The desired

properties include emulation of artificial magnetic fields, discovery of novel nonlinear phenomena, and development of structures with plasmonic excitations aimed to control and increase the density of electromagnetic energy on scales smaller than the vacuum wavelength of light, keeping the losses as small as possible.

The aforementioned goals are at the forefront of investigations within optics and photonics today. Scientists from the Department of Physics of the Faculty of Science plan to maintain the established links with prestigious institutions and scientist in the world in these topics, via collaboration grants and joint publications. The planned investigations encompass classical electrodynamics, condensed matter physics, and laser physics. We investigate electro-magnetic waves within or at the surface of versatile materials, design novel phenomena and seek for new effects with intriguing properties, with potential for applications. Our investigations follow the developments of new materials (e.g., graphene) and utilize their properties to design new (nano)photonic structures.

Ultracold atomic gases

Theoretical investigations within ultracold atomic gases are aimed at the design of novel methods for creating synthetic magnetic fields and understanding out-of-equilibrium quantum many-body dynamics of isolated systems.

The aforementioned goals are at the forefront of investigations within ultracold atomic gases today. Our investigations encompass many-body quantum physics, light-matter interactions, laser physics, and foundations of quantum physics. We have established collaboration with the experimental group at the Institute of Physics in Zagreb and plan to intensify it in the future. We theoretically (and experimentally in collaboration) investigate new techniques for creating artificial magnetic fields for cold gases. In addition, we theoretically investigate quantum many-body dynamics in low dimensional systems (dominantly one-dimensional) which are well isolated from the environment, which is not possible in condensed matter physics, and where integrable regime is achievable experimentally. In all our studies we explore analogies with optical systems where we have expertise.

Biophysics of cells

The goal of our research in the field of theoretical biophysics is discovering and understanding the physical principles that lead to self-organization within the living cell, which is the underlying principle of the functioning of all living organisms. For example, formation and functioning of the mitotic spindle, positioning and transport of organelles within the cell as well as the movement of cells are vital processes for functioning of living cells. In all of these processes, the main actors are molecular motors, which interact with microtubules and actin. To study these processes, we develop theoretical models by employing the known physical properties

of molecular motors and microtubules, which are obtained by in vitro experimentation, and a fundamental knowledge of classical mechanics, statistical and nonlinear physics. Once the models are introduced, we solve them analytically and numerically, yielding theoretical predictions. Afterwards, our collaborators at the Ruđer Bošković Institute and international institutions validate those predictions of the model experimentally.

Bioinformatics

Tandem repeats constitute a large portion of eukaryotic genomes and could be found in centromeric and pericentromeric regions of heterochromatin. In human and higher primate genome tandem repeats are organized in the symmetric higher order repeat structures. Recent studies reveal that tandem repeats play an important role in the structural organization of chromosomes, cell metabolism, speciation, and gene expression regulation. However, the mechanism of tandem repeats origin as well as modes of their activity largely remains a mystery. The research of bioinformatics group is focused on development of algorithms and computer applications for identification, classification, and analyses of all kind of repetitions within the eukaryotic genome assemblies, with a focus on human, higher primates, and Neanderthal tandem repeats. The analysis includes development of new theoretical models of tandem repeats evolution, with emphasis on regions of abrupt structural changes and higher order structures. These models help us to gain deeper insight into the evolution of whole genome assembly, genome structural organization, and the role of non-coding regions in the regulatory network of gene expression. This insight could lead to application of abovementioned algorithms as clinical tools for disease detection and diagnosis.

Meteorology and Climatology

Deploying all three main geophysical approaches, namely, measurements and observations, numerical simulations and theoretical developments, we shall continue studies of atmospheric micro- meso- and macroscale processes and phenomena. Among others, these include generation, transport, dispersion and deposition of airborne pollutants, vertical structure of the urban and suburban boundary layer, dissipation of turbulent eddies, turbulent kinetic and potential energy budgets over complex terrain and three major classes of anomalous refraction of radiowaves. Furthermore, we will address the airflow over complex coastal mountains including phenomena such as, bora, sirocco, and Adriatic mistral, deep convection and fog formation. Due to existing air-sea interactions, some of the studies of local and regional weather and climate will be performed in cooperation with oceanographers, using advanced statistical methods and climate models of various levels of complexity. Moreover, we will modify some of the numerical models (simulators) in order to improve their turbulence parameterization schemes. Further, we will investigate climate variability and climate change. Particular interest will be addressed to the assessment of the impact of large-scale atmospheric modes on climate variability of the European region as well as to the role of slower components of the climate system (e.g., sea, soil, ice) in potential time-lagged effect of those modes. Physical mechanisms enabling such teleconnections will be investigated using both, global and regional climate models, and statistical analyses of observed data.

Oceanography

Concerning the oceanographic research, it is envisaged that the data collection will continue, not only at the permanent tide-gauge station in Bakar (founded in 1929) but also in the scope of specially organized experiments that will allow pressure tide gauges, yo-yo profiler and other available equipment to be used. All the data collected will be analyzed using adequate statistical methods, both those widely accepted and purposefully developed. While analyzing the data, a wide spectrum of processes will be addressed, ranging from long-term changes of sea level, via storm surges and coastal seiches, to river plumes in the sea. Finally, various models will be developed or used in order to reproduce observations. Thus, for example, semi-empirical models will continue to be developed while considering sea-level trends, two-dimensional barotropic models will be utilized in the analysis of response of the sea to the atmospheric forcing, and three-dimensional baroclinic models will be used when reproducing properties and motion of the sea in front of the river mouths.

Seismology

As Department of Geophysics is the only place in Croatia where seismological research is done, the research plan – although focused on seismicity of Croatia – is necessarily quite diverse. De-

pending on available funds from the state budget, the Croatian Seismological Survey will continue to increase the density of the network of Croatian seismological stations, and will keep recording, analysing and cataloguing earthquakes, archiving the digital seismograms, and exchanging data with international partner organizations. The research will be focused on detailed studies of selected areas (e.g. the Mt. Velebit region) with the goal to identify seismogenic faults, their properties and the role they play in the seismotectonic framework of the area. The studies of velocity anisotropy, attenuation and constitution of the crust and upper mantle in Croatia will continue using advanced methods of data inversion (e.g. receiver function analyses, ambient noise and body-wave tomography...). As far as research in the fields of engineering seismology and earthquake engineering is concerned, it is planned to continue with systematic measurements of dynamical parameters of important buildings in order to identify those buildings which are prone to soil-structure resonance, as well as with all activities related to the revision of the probabilistic hazard estimation for the Croatian territory.

Geomagnetism

Study of the geomagnetic field on the Croatian territory will continue by collecting data on the only Croatian geomagnetic observatory, which is operational from the beginning of July 2012 in Lonjsko Polje. Data from this observatory will be used for theoretical analysis of the distribution of magnetic elements, compilation of geomagnetic maps, modelling and interpretation of anomalous fields on the Croatian territory. Intensification of scientific work in geomagnetism will enable modelling of the geomagnetic field by the method of spherical cap harmonic analysis. In addition, special attention would be focused on the development of sophisticated techniques for the construction of base lines that are used for calibration of observatory data when there is significant degradation of the data originating mainly from temperature instabilities and errors in absolute observations. Usually, this is the case in observatories that, like ours, have no stable temperature conditions needed for high-quality measurements. An effort will be made to raise the quality and standards of measurement at the observatory so that the measurements are done in accordance with the requirements of INTERMAGNET.

Geomorphology and paleoenvironment

The research group at the Department of Geography has traditionally been engaged in karst research from the geomorphological and paleoenvironmental point of view, i. e. dealing with questions of genesis, evolution, and recent dynamics of karst relief. The most important research topics center around the study of the influence of geological structure on development of karst relief forms, climatic geomorphology research (e. g. measuring denudation intensity), development of morphometric methods, and geomorphological mapping in GIS environment. Karst relief is also often modified by other morphogenetic processes, such as glacial processes, which have occurred in the past. Consequently the analysis of the past glacial environment is also one of the research goals, on the surface and also underground. These periods are directly related to different sea and land distribution in the Adriatic area which plays a major role in reconstructing paleoenvironmental properties during the late Pleistocene and Holocene. That is why different markers (geomorphological, biological, archaeological, etc.) are used to reconstruct paleoclimatic properties and to define and explain the past sea level fluctuations. Changes of environment and climate are also researched through analysis of speleothems and tufa. Research is based on field work; however, isotopic methods applied in cooperation with the Ruđer Bošković Institute are of major importance. A very important goal within this research group is also further development of the physical geography/geomorphology laboratory and its equipping.

Climatological, hydrogeographical, and geoecological research

The research is focused on the planning of functional spatial organisation and sustainable development. The strategy is focused on basic and applied research, personnel development, knowledge transfer, technological development, on acquiring computer, GIS, and research equipment, and strengthening cooperation with domestic and international partners.

Research topics:

- Influence of abiotic factors on ecosystems
- Using geomorphological, pedological, hydrochemical, anthropogenic, and biological indicators in environmental research and monitoring
- Inventory and assessment of hydromorphic state of rivers, riparian zones, and runoff regimes in implementation of EU WFD
- Developing a hydrological atlas of Croatia
- Water resources and water supply management as a part of the sustainable development of regions
- Natural risks research
- Microclimatic research

- Geodiversity and geoheritage research
- Ecosystems of settlements and anthropogenic geomorphology
- Geographic aspects of nature protection and ecosystem services
- Regionalisation on the basis of physical geographical landscape components
- Regional climate analysis
- Climate of cities
- Climate change and variability of climate elements in the instrumental period
- Influence of climate on geographic valorisation of space

Urbanisation and regional development

Regional development of Croatia is based on the urban system; for this reason research will focus specifically on the urban network, functional classification, and the role of cities in administrative-territorial organisation of the country. Furthermore, efforts will go to determining different characteristics, development potentials and limitations of surroundings of cities. Recommendations and development measures for evaluating the potential of suburban areas in future development of urban regions will be formed. The research is also focused on urban spaces and their spatial structure (functional, morphological, social, and cultural characteristics), including following topics: quality of life, urban problem areas, sustainable development of cities, specifically sustainable (alternative) transport, spatial mobility, socio-spatial and cultural differentiation, segregation, and everyday environment.

Methodological instruments are twofold, going from exact (GIS, field work) to qualitative methods (interviews, focus groups). We are specifically pointing to spatial imagination and mental maps as products of daily spatial practices and therefore an important element of urban areas research. The results are important for improvements in spatial planning and regional development, valorisation of spatial resources, functional integration and problem solving approaches regarding imbalanced regional development of Croatia. Potential lies in the wide spectrum of application of research results in private and public sectors and contributing to quality and well-informed public policy.

Sustainable development and planning of rural and peri-urban areas of Croatia

Between 42 and 48 percent of total population live in rural and peri-urban settlements of Croatia which cover 86 to 89 percent of the total area of the country. Except for such areas in larger urban regions, the Croatian countryside is marked largely by unfavourable development characteristics, negative demographic state and processes (depopulation, ageing), and weaker infrastructural and economic development in comparison to urban areas. At the same time, rural and peri-urban areas are of strategic interest because they are the most important food-pro-

duction areas and locations of key natural resources. They are home to other important functions, such as housing, diverse businesses, nature protection, locations of large infrastructural and energy facilities, and recreation. Predominantly negative development trends on the one hand, and balancing different functions on the other hand, often cause dilemmas and conflicts concerning their planning and sustainable development. Previous research also points to their extraordinary typological diversity in relation to development processes (from rural periphery to dynamic areas in urban regions). Therefore a systematic, integral, multidimensional and area type-based approach to planning and development is increasingly important. Accordingly, research topics will encompass developing a conceptual frame for understanding different developments of rural and peri-urban areas of Croatia, making alternative scenarios of their future developments, and forming models of efficient planning and sustainable development.

Demographic aspects of the development of Croatia

- Contemporary demographic development of Croatia is marked by unfavourable processes and structural characteristics, which contributed to a decrease in total "human capital" as the carrier of social-economic development. Consequences of these processes are visible in imbalanced regional development, large, and even increasing inequalities between rural and urban areas, peripheries and centres, in an imbalanced settlement network, etc.
- Demographic potential, i. e. total qualitative and quantitative, real and potential social and biological characteristics of the population are of major importance in (re)valorisation of Croatian national territory on all spatial levels. Hence research will focus on:
- - Recent changes in spatial distribution, dynamic and structural characteristics of population on all spatial levels;
- - Demographic development of marginal and problem areas;
- - Tendencies of population development in settlements within urban regions;
- - Impact of demographic processes on educational planning.
- The aims of this research are as follows:
- - Identifying, evaluating and projecting the demographic potential of Croatia and its regions;
- - Defining guidelines for a population policy and a strategy for more balanced regional development of Croatia;
- - Proposing intervening measures for primary and secondary school networks and catchment areas organisation, which would ensure the sustainability and rational organisation of education.

Cultural landscapes and spatial identities

Research on environmental change in Croatia is planned, principally in relation to land use and land cover changes. Research will focus on landscape change, especially change recognisable through remote sensing. The goal of the research is to develop a deductive model which will include physical change of the environment (landscape), but also human-geographic and physical-geographic factors that influence the observed change. Possibilities of including human behaviour and decision making processes in land use and land cover change research will also be explored.

Cultural landscapes combine past and present and material and nonmaterial values, and are a part of heritage. Spatial identities (local, regional, national) are built on the basis of these values. Research will also include perspective aspects of spatial, primarily regional identities. On the one hand, on the basis of historical maps as research sources, the existing research of borders, ambivalent regional identities in the past i. e. in the period since the early modern period will continue. On the other hand, based on questionnaire survey and interviews, and media content analysis, the research of perceptive borders and structural elements of today's traditional regions of Croatia will continue.

Tourism and spatial development of Croatia

Tourism is one of the most important sectors of the Croatian economy with tendencies for quantitative and qualitative increase, as well as a larger spatial dispersion from main coastal tourist destinations inland. Within interdisciplinary approaches to tourism research, the interaction of space and tourism is of outmost importance, being that all tourist attractions are strongly territorialised.

Therefore the key goal of research within this research topic is exploring the two way interrelation of space and tourism, which encompasses: a) identifying and evaluating natural and anthropogenic spatial resources in the attraction base of Croatian tourism, b) analysing spatial characteristics of tourist trends, and c) determining spatial implications of tourism in transforming tourist spaces of Croatia – tourist localities, tourist places, tourist regions, i. e. Croatian tourist destinations on all hierarchical levels.

The significance of previously defined research is visible in possibilities of optimal development of tourist products in the tourist offerings of Croatian destinations, as well as steering spatial development of Croatia in context of tourism, in accordance with ideas of desired sustainable development. Rational planning and management of space and its resources is of major importance in this turbulent period of transition of Croatian tourism in relation to increased globalisation in the European Union context, with increased interest in using space in many, primarily touristically most developed parts of Croatia, on the part of an increasing number of interested potential users.

Cognition processes in geography teaching and organisation of education

In this research area four topics will be dealt with:

1. Cognition in geographic education. Goal: to explore the efficiency of learning and teaching strategies, suitability of means of teaching in fulfilling learning outcomes, and forms and criteria of evaluating achievement. Research results should be implemented in geography curriculum in all educational cycles.
2. Geography subject curriculum for primary and secondary education. Goal: to adjust geographic education in primary and secondary schools within the Croatian Qualifications Framework and development of geography as a scientific field. To determine sets of learning outcomes based on analysis of the system, needs of the job market, and in accordance with goals of the Strategy for Education, Science and Technology. To contribute to implementing the Croatian Qualifications Framework in the education system.
3. Initial education, professional training and professional development of geography teachers. Goal: to contribute to development of professional standards, qualification standards, and improved competences regarding organisation of learning and teaching focused on pupils.
4. Educational resources and human resources in geography teaching. Goal: to continue research of influences of demographic development on the change of utilisation index and burden coefficient of human resources in geography teaching on the catchment areas level, as well as the level of certain regions. By applying GIS analysis to create models applicable in redefining school network, initial education of geography teachers, managing human resources, and in regional development.

The Division of Geology and Paleontology

Programme of scientific research for the next five years within the Division is based on achievement obtained so far, and it can be classified into several related and complementary topics. Basically, it includes stratigraphic, paleontological, sedimentological and palaeoecological research in Dinaric and Pannonian area with the aim to contribute to the understanding of its structure, formation and evolution during geological history. It will particularly include exploration of the lithological and paleontological characteristics of carbonate and clastic sediment succession in Dinarides (Phanerozoic) and Paratethys (Neogene and Quaternary), detrital sediments in Dinarides (flysch, molasse), stress events in the geological past (asteroidal impacts, glaciations, sea level changes...) and their impact on life (extinctions), depositional discontinuities in carbonate rocks and detailed research off shallow water carbonate environment during the Jurassic, Cretaceous and Paleogene. The study of the fossil record in the Paleozoic, Mesozoic and Cenozoic rocks will contribute to the understanding of the evolution of life on Earth. In order to understand environmental changes in the geological past, using uniformitarian principles, recent sediments and sedimentation in the Adriatic will be investigated. Moreover, the dynamics of coastal change due to climate and sea level change along with coastal processes will be investigated. Research will include remote sensing, field work, sampling, laboratory analysis and microscopic investigations.

Division of Mineralogy and Petrology

At the Division of Mineralogy and Petrology the following research problems will be addressed in the next few years: crystal-chemical properties of minerals and their application in solving various geological, mineralogical and environmental problems, genesis and metamorphic processes in a range of rock types from Croatia and neighboring areas, and geochemical investigations related to the formation of minerals and rocks as well as to environmental issues.

Main research topics:

1. Crystal-chemical properties of minerals with application in mineralogy, geology, material science and environmental studies. In particular clay minerals and zeolites are to be investigated.
2. Genesis and metamorphic processes in rocks from Croatia and neighboring areas with reference to evolutionary models of Pannonian, Dinaric and Adriatic area. Geochemical investigations of lithostratigraphic units, geological structures and mineral deposits will be conducted, too.
3. Geoarchaeology – characterization of archaeological materials using mineralogical methods.
4. Geochemically based environmental studies in order to distinguish between geogenic and anthropogenic influences on distribution of metals as well as other relevant substances in environment. The purpose of these studies is optimal characterization of geochemical properties applicable to remediation and management of endangered and vulnerable environments.

Division of analytical chemistry

It is planned to perform different investigations. Sensitive and selective analytical methods, which are based on metal-ligand interactions, will be developed. The physicochemical properties of newly synthesized ligands will be determined in solid state and in solution by spectroscopic methods (MS, NMR, UV-Vis, IR, Raman), and the ligands will be applied for extraction and spectrophotometric/spectrofluorimetric determination of metal ions. In order to fulfil the prerequisites for speciation of bioactive elements, the fundamental scientific investigations in the field of analytical atomic spectrometry will be focused on development of plasma spectrometry determinations of metals and semi-metals. Plasma spectrometric characterizations of elemental composition of bio-inorganic materials will be directed on tracking of incorporation of metals in mineral structures. Food samples, biological, geological, and archaeological samples as well as nanomaterials will be analysed by atomic spectrometry (AAS, ICP-AES, ICP-MS). The analytical method for analysing metal content in real samples will be developed in order to assess the quality and safety or nutritional value of the sample and to estimate metal bioavailability. Furthermore, the investigations will be expand to study relationship between content of metals and antioxidative capacity. Special effort will be focused on the optimization of sample preparation, such as separation/preconcentration steps prior to analysis. The high performance liquid chromatography methods for analysing different samples (food, dyes, pharmaceutical products etc.) will be developed. The drug's impurities will be analysed by hyphenated methods (LC-NMR, LC-MS). The conformation analysis will be conducted, and new bioactive compounds will be designed. The hydrogen bonds and their influences on stability, structure and reactivity of molecules will be studied as well. Surface-enhanced Raman scattering spectroscopy will be applied in a study of interactions between small organic molecules and nucleic acids, whereby influence of morphological properties, size and shape, of silver and gold nanoparticles on scattered radiation enhancement will be investigated.

Division of biochemistry

Within several ongoing scientific projects, the structure, function and interactions of proteins and nucleic acids involved in translation of the genetic message will be investigated. Research will be directed towards aminoacyl-tRNA synthetases, enzymes that catalyze esterification of transfer RNA with cognate amino acids. Efficient and correct synthesis of aminoacyl-tRNA is the key step in the process of protein biosynthesis in the cells of all organisms. Aminoacyl-tRNA synthetases from selected organisms, such as bacteria, methanogenic archaea, plants and human, representing all three domains of life will be studied. Mechanisms of aminoacylation, as well as proofreading functions that enable high degree of fidelity of the catalysis will be explored. Mechanistic interpretations will be made on the basis of kinetic parameters of biochemical reactions (determined using methods of steady-state and presteady-state kinetics), determination of substrate binding constants, and by studying inhibitor action. The importance of proofreading mechanisms will be also analyzed in vivo in different physiological conditions. Interactions of aminoacyl-tRNA synthetases with small molecules, proteins, nucleic acids and macromolecular complexes such as ribosome will be studied using various methods and techniques for macromolecular interactions analysis (thermophoresis, fluorescence spectrometry, isothermal titration calorimetry). Enzymes and other proteins in natural or modified forms will be produced using genetic and protein engineering methods. Besides their standard role in protein biosynthesis special emphasis will be made towards additional noncanonical functions of aminoacyl-tRNA synthetases. Role of plant enzymes in response to abiotic stress will be investigated. In our previous research new protein family was discovered. These proteins, named amino acid:[carrier protein] ligases, are homologous to seryl-tRNA synthetase of methanogenic type but they aminoacylate carrier proteins instead of tRNA. Representative members of this protein family from endosymbiotic bacteria will be selected and studied. The aim is to reveal the metabolic pathway that these proteins participate in and to determine their biological role in the cell. Towards this goal deletion mutants will be made using genetic methods and their phenotypes and metabolomic profiles will be determined. Besides the fundamental importance of these investigations for explanation of important biochemical processes, these topics are also interesting from the pharmacological aspect.

Division of Physical Chemistry

Scientific research of the Division of Physical Chemistry is an inseparable part of the teaching process and includes research in the fields of theoretical and computational chemistry, thermodynamics, chemical kinetics, electrochemistry, colloid and interface chemistry, macromolecular chemistry, atmospheric chemistry, chemometrics and education. In theoretical chemistry, quantum-chemical methods are used to calculate potential energy surfaces and dipole moment surfaces, which enable conformational analysis, highly accurate determination of molecular spectroscopic properties and study of reaction mechanisms. Force field-based methods will be used for the computational investigations of the interactions, structural and dynamical properties of macromolecules in order to understand biochemical processes at the molecular level. Thermodynamic investigations will involve equilibria of ion associations and complexation reactions in solutions and at the surface. Structures of the complexes and the corresponding thermodynamic reaction parameters will be determined experimentally and computationally. Kinetic studies will provide an insight into the reaction mechanisms. Colloid and interface chemistry investigations will deal with the development of theoretical models and experimental techniques. The electrodes for surface potential measurements will be developed. Aggregation, adsorption, metal oxide/aqueous electrolyte solution and inert surface/aqueous electrolyte solution interfaces will be studied. In the framework of physical chemistry of macromolecules, properties of polyelectrolytes and proteins in solution will be studied as well as their adsorption on solid substrates. The formation and properties of polyelectrolyte complexes and multilayers will be explored. Atmospheric processes will be studied by physico-chemical methods. Chemometric techniques will be developed and applied to the interpretation of complex experimental data and their reduction to significant parameters. In the course of the research activities, modern computational methods, spectrometry, (micro)calorimetry, potentiometry, conductometry, optical reflectometry, electrokinetics, and acoustophoresis will be employed. Work in the field of chemical education will be dedicated to developing a quantitative approach to chemical problems, based on clearly defined quantities and their interrelations.

Division of General and Inorganic Chemistry

The research strategy of the Division of General and Inorganic Chemistry is based on the results of the knowledge acquired and adopted the last ten years from research on domestic and international projects. We plan to continue our research on new organic and coordination compounds, solid state, supramolecular and protein chemistry (H. pylori proteins, derivatives of insulin, PKD proteins) and other biologically active compounds. The investigations will include design, synthesis and complete structural, spectroscopic and thermal characterization of new compounds and in the case of protein chemistry cloning, purification, crystallization and structural characterization. Different experimental methods will be used in investigation of inter- and intramolecular interactions and their influences on structure and properties. The main goals of the mentioned investigations are:

- the basic research in development of new environmentally-friendly methods in synthesis of organic, bioinorganic and organometallic materials;
- potential application in industry of new synthetic methodologies and materials of specific properties (e. g. optical, thermal or magnetic);
- new knowledge on the influence of intra- and intermolecular interactions on the structure of solid state materials;
- structural characterization of proteins and new knowledge on the relations between structure and their function;
- the transfer of new knoweledge in all levels of education process;
- strengthening the international collaborations through European and bilateral projects.

Division of organic chemistry

The research program of the Laboratory comprises two fields, the synthesis of the bioacive organic moledules, and the research of the organic reaction mechanisms in condensed phase.

The first project is focused to the synthesis of new bioactive compounds containing heterocyclic aromatic and non-aromatic substructures (imidazole and quinuclidine derivatives) and their interaction with butyrycholinesterases in the context of their potential use as enzyme inhibitors (drugs for Alzheimer's disease). Pyridinone derivatives containing adamantane substructures will be tested as antitumour agents on several lines of cancer cells. Immunomodulating peptides, cell wall peptidoglycan fragments modified by adamantane or mannose, will be prepared. Mannosylation is expected to enhance and direct the immunological reaction. Mannosylation of heterocycles leads to the preparation of antiadhesion agents capable of blocking E. coli, preventing thus the bacterial infection of healthy cells. Molecular modelling will be performed and used as a tool to predict possible structural changes leading to the synthesis of new, more efficient bioactive compounds.

In the second project we develop the new conceptual framework for rationalization of the thermal organic reaction in condensed phase. Knowledge about the principles of condensed phase reactions is of broad interest especially for chemists who use solvent-free synthetic methods.

Methodology that we propose is based on our recent discoveries and explanations of mechanisms of dimerizations of nitroso compounds. Since these molecular systems afford also photochromic/thermochromic behavior, we expect that the synthesized macromolecular aggregates will have dynamical properties that could be externally controlled and applied in the future in molecular electronics. The building blocs for supramolecular structures (particles of nanometer dimensions and self-assembly mono- of polylayers on metal surfaces) will include nitroso and polynitroso compounds with aromatic and metallocene molecular frameworks.

Divison of Algebra and Mathematical Logic

Aktivnost Zavoda se odnosi na sljedeće teme:

1. Recent and major breakthrough in the Langlands programme is a proof of existence of endoscopic transfer of discrete representations of both local and global of split classical groups to GL(n) proved mainly by Arthur. Our research fits well with this recent development. We compute the Jacquet modules of discrete series representations completely.This will help us understand representations parabolically induced from those discrete series (generalized principal series) completely. In the theory of automorphic forms, we study the construction of Arthur and Moeglin more explicitly. This constructs new series of square integrable representations and local isolated unitary representations.
2. The main research topics of the number theory group are elliptic curves, modular forms, Diophantine equations, Diophantine approximations and applications of number theory in cryptography. We study the structure of the group of elliptic curves over rationals and over number fields. We investigate connections between arithmetical properties of Fourier's coefficients of modular forms and arithmetic geometry. We study Diophantine m-tuples are their various generalizations, in partucular in the rings of integers of number fields of small degree. Within Diophantine approximations, we consider the polynomial root separation problem and its connections with classification of transcendental numbers. We also consider applications of elliptic curves and Diophantine approximations in cryptography.
3. One group investigates the theory of vertex algebras and related infinite-dimensional Lie algebras. We investigate C_2 cofinite vertex algebras which are closely related with mathematical physics and the theory of quantum groups. A particular emphasis is put on the construction of new vertex algebras, their representations and intertwining operators. We apply the theory of vertex algebras for the construction of new combinatorial bases of modules of affine Kac--Moody Lie algebras, and proving related combinatorial identities. We investigate embeddings of finite-dimensional Lie algebras and related conformal embeddings of vertex algebras of affine type.

Division of Geometry

The main objectives of scientific research in the Division of Geometry in the forthcoming period of time can be formulated in three thematic groups, representing a continuation of corresponding research directions in the previous five-year period.

1. Differential geometry of curves and surfaces in special ambient spaces

The aim of the research is to study differential-geometric properties of curves and surfaces in special ambient spaces. These include pseudo-Riemann manifolds such as the Lorentz-Minkowski space, Lorentzian space forms and, more generally, affine manifolds, also spaces with degenerate metrics, such as isotropic spaces, and a family of three-dimensional manifolds, so called Thurston spaces will be considered. A better understanding of these spaces can be achieved by studying their submanifolds with certain assumed properties, e.g. special classes of surfaces with prescribed curvatures.

2. Finite geometries and design theory

In this area, the problems of existence and classification of certain block designs and t-designs, symmetric configurations, difference sets and designs over finite fields will be studied. In order to reduce the combinatorial complexity of such problems, additional assumptions in the form of the action of a suitable automorphism groups will be used. Furthermore, various regular substructures of finite projective and polar spaces will be investigated. Besides algebraic and other theoretical methods, the research will heavily rely on computational techniques and methods. The development of algorithms and computer programs for the construction and classification of finite structures is an important part of this research.

3. Geometric properties and models of special classes of quasigroups

Further investigation of geometric properties of some especially interesting subclasses of idempotent medial (IM) quasigroups will be carried out. The emphasis will be set on pentagonal quasigroups. One of the main goals will be to determine the spectrum of all possible orders of finite pentagonal quasigroups and to derive similar results of similar type for some other subclasses. Another goal is to establish connections with combinatorial structures such as graphs, directed graphs and designs.

Division of Mathematical Analysis

Activities of the Division for Mathematical Analysis include the following topics:

1. Various types of orthogonality in Hilbert C*-modules

The main aim of this subject is to continue the study of various types of orthogonality in Hilbert C*-modules, especially the Birkhoff-James orthogonality, the strong Birkhoff-James orthogonality and the orthogonality with respect to the inner product. This topic includes the study of characterizations of various classes of elements of Hilbert C*-modules in terms of orthogonality, characterizations of mappings between modules which preserve a certain type of orthogonality, relations between different orthogonalities and similar problems.

2. Frames for Hilbert spaces and Hilbert C*-modules

The main goal is twofold: to continue a study of general frame theory for Hilbert spaces and to extend the existing theory of frames for Hilbert C*-modules. In particular, we plan to develop the interrelations between frames and strict/outer frames for Hilbert C*-modules, and to extend to the module context results on frame perturbations, finite extensions of Bessel sequences to frames and, in particular, to Parseval frames, Riesz bases etc.

3. Dirac cohomology of Harish-Chandra modules and applications

Dirac cohomology is a relatively new invariant of Harish-Chandra modules, which is turning out to contain a lot of interesting information. The investigation will be centered around the following problems: the study of representations obtained by Dirac induction, in particular the discrete series representations; applying Dirac cohomology to problems of restricting representations; trying to strengthen the Dirac inequality, which should have implications for the study of unitary representations; calculating the Dirac cohomology of unipotent representations; calculating the Dirac cohomology of unitary highest weight modules.

4. Inequalities for isotonic linear functionals

The goal is to investigate inequalities given in language of theory of isotonic linear functionals such as Čebišev's and Grüss's inequalities for two linear functionals etc. Various properties of differences related to these inequalities such as quasilinearity and monotonicity are also researched. Furthermore, investigations on different properties of h-convex functions will be continued.

Division of Numerical Mathematics and Scientific Computing

Scientific interest of the Division is divided into two groups: those who work on the numerical linear algebra, in particular the (generalized) eigenvalue and singular value decompositions and their applications, and researchers working on the approximation theory, with emphasis on spline functions.

1. Eigenvalue and singular value decompositions and applications

In the last twenty-five years, new algorithms for the (generalized) singular and the (generalized) eigenvalue decompositions have been developed, that are accurate in the relative sense. From the beginning, the members of the Division are involved in world trends and develop accurate algorithms for these problems. The development of algorithms is always accompanied by the appropriate perturbation theory, proofs of convergence, and the development of numerical software (for sequential, and more recently, for parallel computers). Some parts of the software have been incorporated into the well-known algorithm libraries, such as LAPACK and SLICOT. Several members are also working on similar problems in infinite-dimensional spaces. Given the success and recognition of our group in the world, and a very developed cooperation with universities worldwide, the development of accurate algorithms in numerical linear algebra remains as our primary goal in the next five years.

2. Spline approximation

A few of the members work on various approximation problems, related to different classes of spline functions, such as Chebyshev, cycloidal, tension, and q-splines. In addition to the development of new numerical algorithms for efficient computation of these splines, the theory of their approximation properties is also developed. These algorithms are applied to various problems of advection and diffusion, picture processing, and in medicine. This research group has very close ties with several local universities, as well as with the University of Ljubljana. In the next five years the group will continue the theoretical and practical work on the same problems, aiming to improve the appropriate algorithms.

Division of Applied Mathematics

Research activities of the Division of Applied Mathematics refers to the development of mathematical methods used in the natural and biomedical sciences and engineering. Division activity is related to mathematical modeling and mathematical analysis in problems described by ordinary and partial differential equations, which typically arise from continuum mechanics. This includes setting up, analysis of the properties (existence, uniqueness/non-uniqueness, well-posedness...), and numerical analysis of models. Directions of research at the Division are:

1. Development of techniques for partial differential equations (PDEs)

We will study: the theory of homogenization and applications in optimal design and inverse problems for PDEs; Friedrichs systems as a framework for the study of PDEs of different types; analytical objects and tools for studying the fundamental questions in the theory of PDEs; weak topologies on function spaces and distributions, and applications in PDEs; properties of pseudodifferential operators and other techniques in microlocal analysis; applications to velocity averaging, averaged controllability, compensated compactness, semiclassical limits etc.

2. Fluid mechanics

Research in this area is related to mathematical modelling, analysis and numerical simulations of fluid flow in thin domains (pipes, fractures…) as well as porous media. The fluids will be Newtonian or micropolar, monophase or multiphase, while physical processes will be convective, diffusive, dispersive, conductive, isothermal or non-isothermal. Theoretical analysis is based on a priori estimates for governing differential equations, different notions of convergence and compactness. Asymptotic analysis and homogenization will be employed.

3. Theory of elasticity

In this research we derive and justify lower-dimensional models starting from three-dimensional elasticity. Models for visco-elastic, plastic or biodegradable materials are of interest as well. These models are used in the formulation of complex models of several structures which can be of different sizes (systems of rods or shells).

4. Fluid-structure interaction

Because of the biomedical applications it is interesting to analyze interaction of the Newtonian fluid and the elastic body modeled as thin (lower dimensional model) or thick (the three-dimensional model) body. We will consider the following topics: existence, uniqueness, stability and regularity of solutions; design, implementation and analysis of numerical schemes; analysis of systems of parabolic-hyperbolic type.

Division of Computer Science

1. *On-line* algorithms for combinatorial optimization

Objective: Development of new deterministic or randomized algorithms for some well-known on-line problems, especially the k-server problem. The new algorithms should be superior to the existing ones with regard to their competitiveness or computational complexity. For the new algorithms, mathematical analysis of their competitiveness and computational complexity will be conducted. The same parameters will also be evaluated experimentally on a computer.

2. Distributed heuristics for NP-hard problems

Objective: Development of new distributed heuristics for problems such as vehicle routing, Hamilton completion, etc. Thanks to collaboration of several parallel processes, such heuristics should be able to solve very large problem instances in reasonable time. The new heuristics will be evaluated experimentally on a computer network. Their accuracy (deviation from optimum), computing time and speedup will be measured.

3. Robust algorithms for combinatorial optimization

Objective: Development of robust algorithms for selected optimization problems on graphs and networks. Robust algorithms produce acceptable solutions in situations when there is uncertainty in input data expressed by a list of possible "scenarios". For each considered robust variant of an optimization problem, the corresponding computational complexity class will be determined. For each algorithm, a mathematical analysis of its computational complexity will be conducted. The algorithms will also be evaluated on a computer.

4. Automated translation

Objective: Preparation of monolingual and bilingual resources needed for automated translation. Analysis and evaluation of the prepared resources by using graph algorithms and relational databases. Development of a system for universal tagging of dictionary words in order to enable correct tagging of word occurrences in a text.

5. State-of-the art competence in computer science

Objective: Tracking new trends and advancements in areas that are relevant for computer science teaching at the Department of Mathematics. Emphasis is put on: programming languages, data structures and algorithms, database systems, computer networks, software engineering, parallel and distributed computing, formal languages and automata.

Division of Probability Theory and Mathematical Statistics

Many phenomena in science and everyday life exhibit inherent uncertainty. The researchers in the Division commonly use stochastic and dynamical models to describe such behavior and rely on stochastic methods to gain insights, make forecasts or inference about them.

The goal of the Division's research projects is to advance understanding of the role of randomness in each of the following five research problem groups:

1. Analysis and potential theory of Markov processes

We plan to study several questions related to potential theory and analysis of path properties of Lévy, Lévy-type and Feller processes.

2. Stochastic methods in modelling heavy tailed phenomena

We plan to study the tail behavior of stationary processes, limit theorems for extremes and sums of random observations, and applications of those results in time series analysis, nonlife insurance and other areas.

3. Stochastic methods in harmonic analysis

We plan to obtain a complete theory for more general "entangled" multilinear singular integral operators, and to use martingale methods in characterization of low-pass filters in wavelets.

4. Stochastic methods in biomedical and social sciences problems

We plan to work (in collaboration): on developing a mathematical model of a growth of a biological lens (with S. Bassnett, WU in St. Louis), on analyzing modified branching process of telomere shortening (with I. Rubelj, IRB), to investigate local asymptotic properties of approximate MLE of diffusion drift parameters and to apply them in fitting the general von Bertalanffy model to the tumour spheroids data (with Ž. Bajzer, Mayo Clinic), and to improve collaborations from previous researches related to the problems from behavioral economy and innovation processes (with J. Cvitanić, CALTECH, D. Prelec, MIT, and S. Radas, EI in Zagreb).

5. Ergodic properties of extended dynamical systems

The goal is to fully describe invariant probability measures of discrete- and contionuous-space extended differential equations, such as Frenkel-Kontovora models, reaction-diffusion equations, and the Navier-Stokes equation, and statistically describe their dynamics.

Division of Topology

The research interests of the Division belong to the fundamental investiga-tions in some areas of topology and geometry. The intended investigations are concentrated around the following topics:

1. 1. Dynamics and models of folding-patterns of horseshoe-like maps:

Symbolic dynamics and models of folding-patterns of horseshoe-like maps. Periodic orbits. Dependence of topological entropy on parameters.

Objective: To study strange attractors in chaotic dynamical systems of two-parameter families (Henon-like, Lozi-like) and in general horseshoe-like maps of the plane. The fact that Henon-like attractors are models for the behavior of diffeomorphisms with homoclinic tangents, makes them a universal structure in the formation of chaos. (The horseshoe-like strange attractors are still understood poorly).

2. The geometry of point sets in Euclidean and non-Euclidean spaces

Solving the three conjectures of M.Atiyah and P.Sutcliffe (from 2001.) on the hypotetical equivariant continuous map from the configuration space of n points Cn into complex flag manifold $Fl_n=U(n)/U(1)\times\ldots\times U(1)$. This Atiyah's map relates directly classical mechanics to the quantum mechanics(how n spin particles move in space) We have introduced mixed Atiyah determinants and prove that their sum is =n! (eight new fundamental quantities in the geometry of hyperbolic triangles for n=3) and proved that their sum is =n!.

Objective: To prove Atiyah-Sutcliffe conjectures in the Euclidean ($n\geq5$), hyperbolic ($n\geq4$) and Minkowsky geometry ($n\geq3$).

3. Topology and computability

Study of aspects of computable topology such as the theories of (semi)computable metric and topological spaces, manifolds , polyhedra and CW-complexes.

Objective: Finding conditions under which the intersection of a co-recursively enumerable set and a computable continuum contains a computable point and certain problems related to computability in the Hilbert cube.

4. Homotopy and shape of topological semigroups

Objective:To continue investigations , on homotopy and shape theory of topological semigroups , initiated in a paper with the same title published in 2002.

4.a A topic in number theory

Objective: To study certain classes of special sums of generalized Fibonacci numbers with the aim to discover new Diophantine quadruples.

5. Connections between Hopf algebroids and noncommutative differential calculus in the sense of Tsygan and examples from topology of loop spaces.

Objective: Developing a geometrical theory of characteristic classes for A-infinity algebras and applications, especially on moduli spaces, invariants in low dimensional topology related to the quantum field theory.

Chair of Mathematics and Informatics Education

The main interest of the Chair of Mathematics and Informatics Education are the fundamental research in mathematics and informatics education at all levels. The interest also includes research of understanding and application of fundamental mathematical concepts in the context of mathematics and other subjects, especially subjects of natural sciences.

1. Research in mathematics and informatics education

OBJECTIVE: The aim is to identify, characterize and understand the phenomena and processes that occur or could occur in learning and teaching mathematics and computer science at all educational levels, by applying the existing or developing new theoretical frameworks. An emphasis will be put on curriculum studies (planned and implemented curriculum) and studies of conceptions (including preconceptions and misconceptions) and cognitive processes developed by students and student teachers while learning mathematics and programming and during problem solving.

2. Research of understanding of fundamental mathematical concepts in the context of science

OBJECTIVE: In educational research worldwide, many fundamental mathematical concepts and skills are identified which present a significant problem for students. At the same time, their understanding and application are equally important for mathematics and physics, i.e. for other subjects of natural sciences. In terms of better connections of mathematics to other subjects, and development of appropriate teaching contents and methods that allow meaningful teaching, the goal is to explore these issues within mathematics and other subjects of natural sciences, especially physics.