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Ruđer Bošković Institute

Annual Report 2010

Ruđer Bošković Institute

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Zagreb, 2013.

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Dear reader,

Welcome to the 2010 Annual Report of the Ruđer Bošković Institute. The aim of this report is to provide a succinct overview of the most important activities and top achievements made at the Ruđer Bošković Institute during 2010. As such, the report covers exemplary performance in high-quality fundamental research, published in top journals or scientific books, and shows the strong involvement of scientists of the Ruđer Bošković Institute in higher education. The report also highlights selected awards, recognitions, patents, domestic and international projects and collaborations, important invited lectures, and international conferences organized by the Institute during the year.

On behalf of the Editorial Board, I would like to take this opportunity to sincerely thank the RBI staff for their cooperation during the preparation of this report. We would also like to thank you, the reader, for your interest and take pleasure in inviting you to share with us your comments and suggestions regarding future editions of this report.

Editor
Nela Pivac

Introduction

OVERVIEW

The year of 2010 saw the Ruđer Bošković Institute (RBI) celebrate its 60th Anniversary. From its foundation in 1950, on the initiative of Ivan Supek and colleagues who chose to name the Institute after the renowned Croatian physicist Ruđer Bošković, the Institute has come a long way. Today, the RBI is regarded as Croatia's leading scientific institute in the natural and biomedical sciences as well as marine and environmental research, owing to its size, scientific productivity, international reputation in research, and the quality of its scientific personnel and research facilities. The Institute is the leading and most internationally competitive Croatian institute by virtue of its participation in international research projects, such as the IPA, IAEA and FP5-7 programs funded by the European Commis-

sion, NATO, Cogito, COST, UNESCO and other international scientific foundations.

Today, the RBI has over 550 scientists and researchers in more than 80 laboratories pursuing research in theoretical and experimental physics, material physics and chemistry, electronics, physical chemistry, organic chemistry and biochemistry, molecular biology and medicine, marine science and the environment, informational and computer sciences, laser and nuclear research and development.

In addition to basic research, the RBI is strongly involved with the development of innovative research, participation in higher education and increasing public awareness of the importance of knowledge and science in modern society. These tasks are conducted in cooperation with universities, scientific institutes and other similar institutions in Croatia and all over the world.

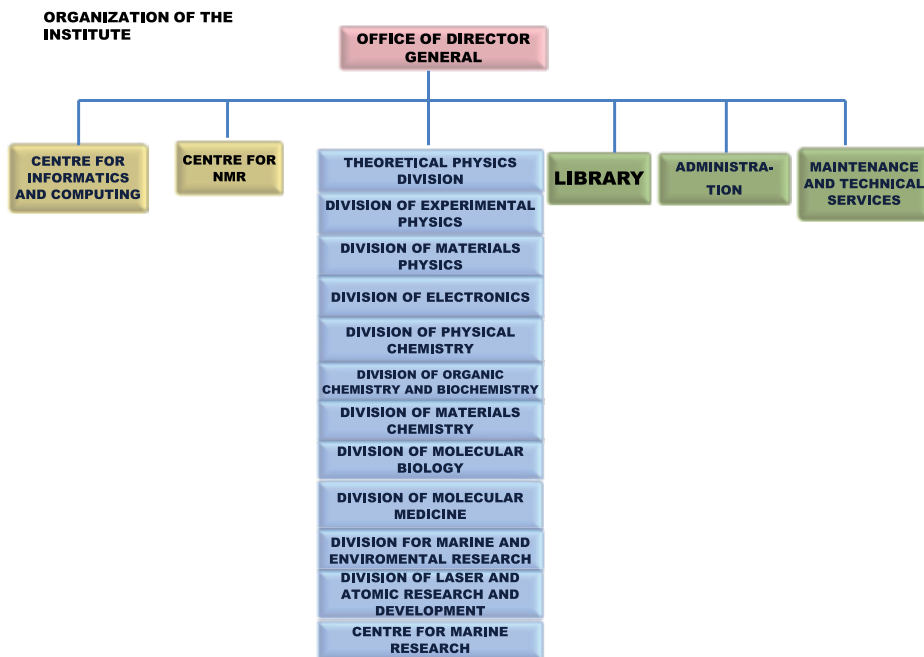


Figure 1. The organizational structure of the RBI

ORGANIZATION OF THE INSTITUTE

Organizationally, the RBI consists of twelve divisions, three centres, a library, the office of the Director General, as well as sections for maintenance and technical services and administration (Figure 1).

The administrative structure of the Institute sees central roles for the Board of

Governors, the Director General and the Scientific Council. Important input is derived from the Heads of the Divisions and Centres (via their Divisional Councils), the Assistant Directors, as well as the Heads of the Administration, the Maintenance and Technical Services and the Library (Figure 2). The International advisory board provides vital external advice and guidance.

ORGANIZATIONAL SCHEME

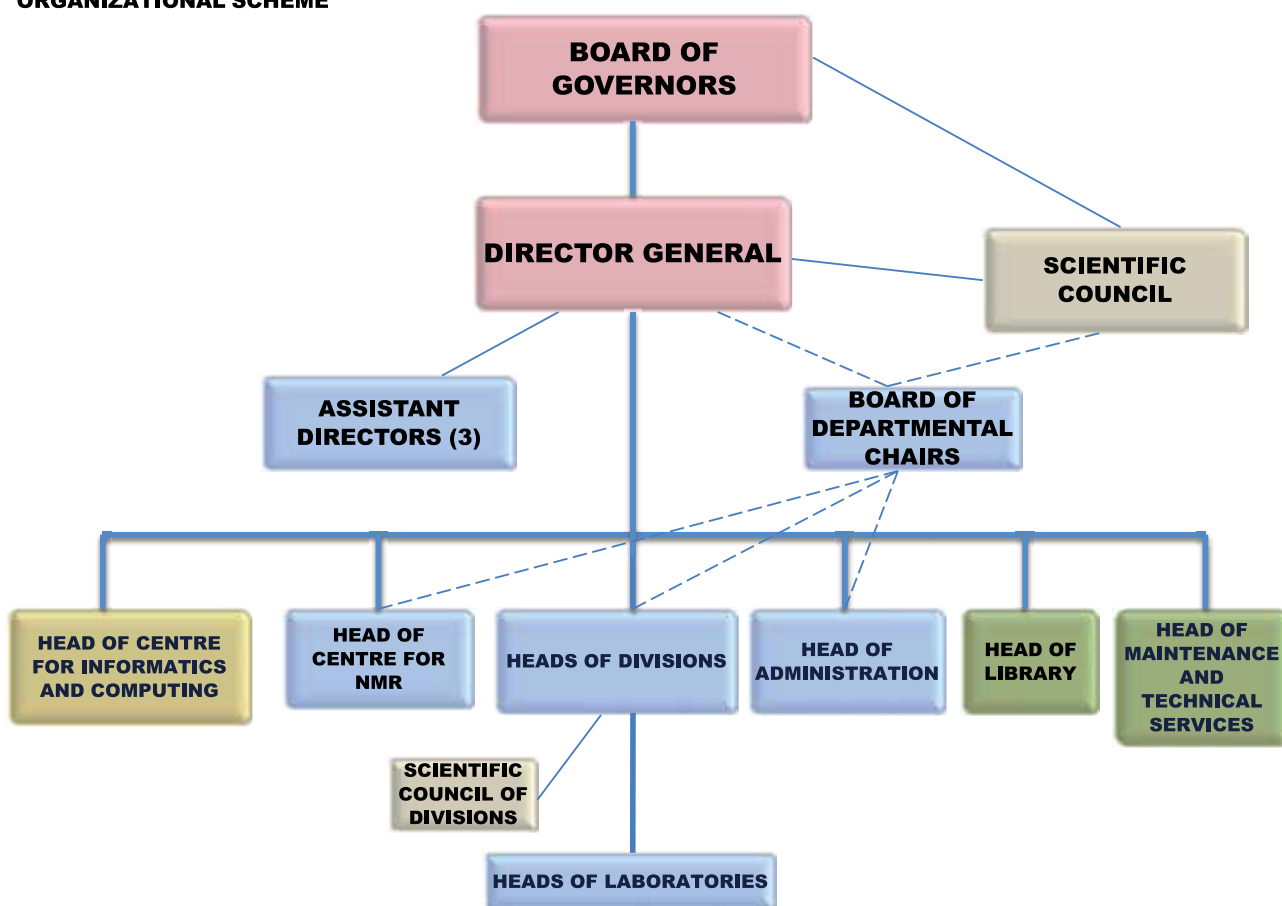


Figure 2. The administrative structure of the RBI

Director General: Danica Ramljak
Head of the Scientific Council: Neven Bilić
Chairman of the Board of Governors:
Slavko Krajcar

International Scientific Board:

Jean-Marie Lehn, Laboratoire de Chimie
Supramoléculaire, ISIS/ULP, France
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USA
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Slovenia
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Germany
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Werner E.G. Müller, Johannes Gutenberg
Universität, Mainz, Germany
Nadia Pinardi, University of Bologna,
Ravenna, Italy

ACTIVITIES

Fundamental research

The total number of research articles published by RBI scientists in 2010 was 613. Among these, 477 were published in journals cited by Current Contents, the majority of which were published in high ranking international Journals.

The details of the many important discoveries made by RBI scientists in 2010 are to be found in the subsequent sections of this report. Nevertheless, we present here a small section of highlights in order to convey a general impression of the kind research carried out at the Institute.

Ideas that development of embryos mirrors evolutionary history are well known even outside biological circles. However, due to the lack of tools that would allow explicit quantitative testing, the scientific status of this elusive concept has been unclear. Evolutionary geneticist, Tomislav Domazet-Lošo, from the Division of Molecular Biology, together with Diethard Tautz, from the Max Planck Institute for Evolutionary Biology, devised a new approach that measures phylogenetic age of the expressed genes across ontogeny and showed that phylogeny-ontogeny correlation is real. In a broader perspective, this study shows that the correlation between phylogeny and ontogeny is not a myth, and that the once disputed ideas of von Baer, Darwin

and Haeckel have to be revisited. The results were published in the 9th December issue of Nature as a cover story.

Nela Pivac, Matea Nikolac, Gordana Nedić and Dorotea Mueck-Šeler from the Laboratory of Molecular Neuropsychiatry in the Division of Molecular Medicine, together with associates from the Faculty of Pharmacy and Biochemistry at the University of Zagreb discovered a major advance in the diagnosis of the attention-deficit hyperactive disorder (ADHD). Their research article entitled *Human plasma glycome in attention-deficit hyperactivity disorder and autism spectrum disorders* was published in the prestigious journal Molecular and Cellular Proteomics. The article details for the first time changes in specific glycan structures found in the plasma of 99 children suffering from ADHD. These results indicate the possibility of clinical applications and the elaboration of new potential biomarkers for diagnosing ADHD through a simple blood test.

RBI Scientists Anamaria Brozović, Andreja Ambriović-Ristov, and Maja Osmak, from the Laboratory for Genotoxic Agents in the Department of Molecular Biology have published a review article entitled *The relationship between cisplatin-induced reactive oxygen species, glutathione, and BCL-2 and resistance to cisplatin* in the journal Critical Reviews in Toxicology, which is one of the most respected journals in the field of toxicology. This review article describes the role and relationship of the anti-apoptotic protein BCL-2 and glutathione in cisplatin-induced oxidative stress as well as the role these molecules play in cisplatin resistant tumour cells. Despite the generally accepted fact that DNA damage is a key for the harmful effects of cytostatics, this review article presents the results of recent studies that show that cisplatin can induce production of lethal reactive oxidative radicals (ROS) that are not primarily related to DNA damage.

Scientists from the Division of Electronics, Fran Supek, Nives Skunca, Jelena Repar and Tomislav Šmuc, published an extensive computational study entitled *Translational selection is ubiquitous in prokaryotes* in the

prestigious journal PLoS Genetics. The study describes how natural selection acts to improve speed and accuracy of protein translation, as evidenced in biased codon usage in prokaryotic genomes. The study represents a significant step forward in terms of its breadth, computational methodology and this work points to a universal regularity - the contents of 'silent' sites of a group of genes in all bacteria and archaea are not determined randomly. Rather, they are shaped by translational selection, which is a new and significant finding from many perspectives. For instance, gene expression levels can be predicted from codon usage and the expression level correlated to environmental conditions, enabling further in silico research of mechanisms of microbial adaptation.

Irena Dokli, and Zdenko Hameršak, from the Laboratory for Stereoselective Catalysis and Biocatalysis in the Division of Organic Chemistry and Biochemistry, in collaboration with Ivana Matanović from the Theoretical Chemistry Group, in the Division of Physical Chemistry, have published an article entitled *Sulfur Ylide Promoted Synthesis of N-Protected Aziridines: A Combined Experimental and Computational Approach* in Chemistry - A European Journal. The article describes the asymmetric synthesis of N-protected aziridines in high enantiomeric excess, using a chiral benzyl sulfonium salt. The diastereoselectivities of the reactions are influenced by the N-protecting group, the imine substituent, and the sulfide structure. In the case of tert-butyl substituted aziridines, an unusual cis selectivity was observed and subsequently explained using computational models.

Analytical Chemistry, the world's leading journal in the field of the same name, published a paper entitled *Blind separation of analytes in nuclear magnetic resonance spectroscopy and mass spectrometry: sparseness-based robust multicomponent analysis* by Ivica Kopriva (Division of Laser and Atomic Research and Development) and Ivanka Jerić (Division of Organic Chemistry and Biochemistry). The paper describes a method for blind extraction

of analytes from mixtures. The method is exemplified on the examples in NMR spectroscopy and mass spectrometry. The original contribution of the paper is theoretical and experimental demonstration of the extraction of analytes the number of which exceeds the number of mixtures. It has been considered within the chemometrics community so far that this problem is too ill-posed and, thus, insolvable. Potential application of obtained result is in biomarker detection, natural product analysis and metabolomics. The paper is a result of two years of collaborative efforts that have already yielded three scientific papers and two international patent applications.

Projects and other revenue

The RBI has 132 projects in basic research, which are funded by the Ministry of Science Education and Sport. Additional domestic com-

petitive projects are provided by the Croatian Science Foundation and the Unity Through Knowledge Fund (UKF), from which RBI has 13 active projects, respectively. The Institute is involved with almost 100 international projects (including 7 FP7, 1 FP6, 6 IAEA, 3 NATO, 1 COST, 1 UNESCO, 1 SCOPES, and 58 bilateral projects), as well as 61 applied and technological contracts (including 6 HRZZ, 1 National Park Plitvice, 3 iProject, 2 VIP, 1 HIT and 1 BICRO). The total financial value of these projects can be seen in Table 1, as well as the funding trends since 2006.

Table 1 also shows that the largest non-competitive source of revenue continues to be derived from the Ministry of Science, Education and Sports, which directly contributed almost € 23 M in 2010. A significant part of this revenue is dedicated to staff salaries (ca. 75%), while the remained is related to various running costs (Table 2). This so-called block grant was reduced in 2010.

REVENUE	2006	%	2007	%	2008	%	2009	%	2010	%
Funding from the Ministry of Science, Education and Sports (MSES)	20.842.974	88,05%	23.770.518	83,61%	25.755.013	86,37%	24.030.178	83,82%	23.372.730	81,61%
National Projects funding (Croatian Science Foundation, Croatian Institute of Technology, etc.)	172.490	0,73%	1.017.194	3,58%	487.601	1,64%	345.916	1,21%	1.365.294	4,77%
International projects funding (FP, NATO, IAEA, etc.)	749.913	3,17%	1.377.929	4,85%	910.305	3,05%	1.575.532	5,50%	1.780.549	6,22%
Commercial contracts	1.782.322	7,53%	1.999.839	7,03%	2.449.662	8,22%	2.416.483	8,43%	1.873.087	6,54%
Donations and other funding	123.887	0,52%	264.046	0,93%	216.622	0,73%	300.392	1,05%	246.147	0,86%
TOTAL	23.671.586	100,00%	28.429.526	100%	29.819.203	100%	28.668.501	100%	28.637.807	100%

Table 1. RBI revenues from 2006-2010.

FUNDING FROM THE STATE BUDGET	2006	%	2007	%	2008	%	2009	%	2010	%
Salaries	14.194.651	68,15%	15.752.782	66,30%	17.082.656	66,63%	17.825.802	74,22%	18.243.201	76,23%
Operating costs	2.897.658	13,91%	3.052.403	12,85%	2.727.386	10,59%	1.908.463	7,95%	2.087.153	8,72%
Research projects - national	2.960.532	14,21%	3.711.388	15,62%	3.591.772	13,95%	2.659.660	11,07%	2.251.603	9,41%
Research projects - international	18.604	0,09%	25.290	0,11%	222.488	0,86%	124.391	0,52%	393.296	1,64%
International co-operation	197.193	0,95%	183.613	0,77%	160.847	0,62%	159.213	0,66%	155.848	0,65%
Construction and other investment	560.892	2,69%	1.034.174	4,35%	676.742	2,63%	915.769	3,81%	259.794	1,09%
Loan from the World Bank					1.281.309	4,98%	425.211	1,77%	540.973	2,26%
TOTAL	20.829.530	100,00%	23.759.650	100,00%	25.743.200	100,00%	24.018.509	100,00%	23.931.868	100,00%

Table 2. A breakdown of RBI revenues from the state budget from 2006-2010.

Thus, despite the increase in international project funding observed during 2010, the total RBI revenue was reduced by almost € 2 M in comparison to 2008.

Organization of international conferences

As in previous years, the RBI continued to support the organization of numerous international and domestic conferences. Many of them were organized as a part of a series of events celebrating the 60th Anniversary of the Institute. For example, a symposium on *Ivan Supek - Scientist and Humanist* was held in April at the RBI. Five plenary lectures were presented on the life and work of Ivan Supek, Croatian physicist, philosopher, writer, peace advocate, humanist and founder of the RBI. Plenary lecturers included prominent scientists and academicians, Ksenofont Ilakovac, Ivo Šlaus, Vladimir Paar, Kruno Pisk, and Vladimir Knapp.

In April the Department of Experimental Physics organized its first *Festival of Science* by young researchers. The festival showed the recent research of doctoral students in the department.

For the fourth year in a row, the RBI organized its *Open Days*. In 2010, this event took place from May 6th to 8th and attracted over 4500 visitors, not only from Zagreb, but also from all over Croatia and neighbouring Bosnia and Herzegovina. Visitors were treated to an exhibition with 16 focal points which were designed to bring the world of science closer to the general public.

The Scientists of the Institute held a series of popular lectures on current topics in various fields of science. The visitors had the opportunity to visit the exhibition "Croatian inventors through history" which showed the rich tradition of invention and patent protection in Croatia. The exhibition was organized by the State Intellectual Property Office in cooperation with RBI's spin-off company Ruder Innovations Ltd. The RBI Open House was organized as part of the activities mark-



Figure 3. A brochure from the RBI's "Open Days".

ing the 60th Anniversary of the Institute. The aim of this event was to inform the public with RBI research and to show how funds invested in science are used for the development of society, higher education and creating better living conditions for all citizens.

As part of the celebrations marking the 60th anniversary of RBI, the Center for Informatics and Computer Science and the Department of Electronics at RBI held a meeting on May, commemorating 60 Years of Electronics and Computer Science Research at RBI. Among the numerous renowned scientists from Croatia and abroad attending the event, Professor Veljko Radeka, recipient of the Harold Wheeler Award and director of the Instrumentation Division at the Brookhaven National Lab (USA) was also a participant. The meeting focused on the development of electronics and computer science at RBI over the last 60 years and many of the scientists in attendance began their careers in the area of electronics and computer science at RBI.

In cooperation with the government of the Republic of Croatia and the RBI, the *IAEA Regional Workshop on Successfully Applying for EU-funded Projects* was held in May at the RBI. The workshop brought together sixty participants from twenty countries in Europe and Central Asia.

At a gala event held in the Vatroslav Lisinski Concert Hall the 60th anniversary of RBI

was celebrated in June. Croatian president Dr. Ivo Josipovic, as well as Premier Jadranka Kosor were patrons of the event. President Josipovic in his address pointed out the work of RBI has tremendous importance for Croatia. He stated that there should be better cooperation between the educational process, science and industry. Josipovic also stated that science should not be subject to austerity measures as this undermines our future.



Figure 4. The celebration of the 60th anniversary of RBI at the Vatroslav Lisinski Concert Hall.

The third in a series of summer schools in applied molecular microbiology entitled *Microbial Metabolites: Signals to Drugs* was held in August in Dubrovnik. The Summer School is co-organized by the John Innes Centre (UK) and the RBI. The summer school is intended for scientists at the graduate level and post-doctoral fellows as well as those who plan a career in industry.

The RBI in cooperation with leading institutions in the field of nanotechnology: Finnish Centre for Nanotechnology, University of Jyväskylä and Joanneum Research in Graz organized first session of *Adriatic School on Nanoscience* - ASON-1, in September in Dubrovnik. The school brought together leading Croatian and European speakers in the fields of nanoscience as well as participants from several countries.

In September in Primošten, the RBI organized the international scientific conference *5th Central European Conference - Chemistry Towards Biology*. The conference was

attended by 124 scientists from both Croatia and abroad. This conference brings together chemists, biochemists, molecular biologists and bioinformaticists from Central European countries representing a platform for the dissemination of research results arising from collaborations during the previous two years and provides an opportunity to initiate plans for new collaborations. The most common themes at the conference were the chemistry of proteins and peptides, structural biology, bioprocesses and drug design.

The Laboratory for Ion Beam Interactions hosted the first workshop organized within the FP7 SPIRIT project valued at 7 million euros. The workshop entitled *New detector technologies for advanced materials research using ion beam analysis* was held in October at Plitvice National Park. The aim of the planned workshops was to inform a broad range of scientists on the possibilities for use of accelerator methods in scientific research in the areas of physics, chemistry, biology and medicine and thereby increase both the number of users as well as the availability of European accelerator infrastructure. The total number of participants at the Plitvice workshop was 60 scientists from 15 European countries, including a number of speakers from partner institutions within the SPIRIT project.

More details about the conferences, congresses and meetings organized by the RBI can be found in the subsequent pages of this report.

Awards and Recognition

As in previous years, the achievements of RBI scientists were also recognized through numerous awards. For example, Morana Jaganjac received prestigious *State Award for Science* in the graduate student category, for the significant scientific contribution in the study of the role of neutrophils in the growth and regression of tumours. This work has led to the application for an international patent pertaining to her work.

Young scientist Snježana Jurić received prestigious *Željko Trgovčević Award*, for research excellence in the field of molecular biology and genetics. At the 180th conference of the Hungarian Academy of Sciences, its President Professor József Palinkas awarded Karolj Skala, the RBI's head of the Centre for Informatics and Computing, with a medal for scientific research and international cooperation. In addition, the Centre for Informatics and Computing received the VIDI e-Innovation Award *Golden Tesla's Egg*.

At a meeting of the European Association for Cancer Research (EACR), Sonja Levanat from the Department of Molecular Medicine was elected to honorary membership in the EACR. As well Sonja Levanat received ca. € 70,000 of Terry Fox Run Donation. This donation would aid Sonja Levanat's work which is aimed at research and treatment of hereditary forms of breast and ovarian cancer.

Robert Vianello was awarded the *Promising Scientist Award* at the 15th international conference on Quantum Systems in Chemistry and Physics. The award was given by the Centre for Applied Quantum Mechanics in Paris for his significant contributions to the computational design of extremely strong superacids and superbases and insights into their properties.

The *Director's Prize for Most Successful RBI Scientists* have been awarded to almost 50 RBI scientists, for publication in high impact journals, successful grant applications (grants greater than ca. € 70,000), projects of special importance to RBI, successful international patent applications as well as for scientific work honoured with state awards for science.

The International Conference on Informatics and Communication Technologies, Electronics and Microelectronics - MIPRO 2010 awarded the RBI with the *MIPRO Charter* for exceptional service in the development of ICT, electronics and microelectronics.

List of all the awards and recognition given to the RBI scientists can be found in the individual Divisional reports in the subsequent sections of this report.

Education

Although the RBI is currently not able to conduct its own, independent postgraduate study program, it has developed collaborations with several universities in Croatia through a number of doctoral and specialist study programs. In addition, through basic agreements with various universities in Croatia, RBI scientists actively participate in programs of higher education in Croatia. Owing to the large number of potential mentors and qualified researchers, as well as the relatively modern research equipment, the RBI remains an attractive place for the best students from Croatian universities to pursue doctorates, which continue to provide an influx of qualified doctoral candidates. Table 3 and Figures 5 and 6 provide an overview of the level of courses and their distribution across different locations and Divisions, respectively.

Type of course	Number of courses
Undergraduate courses	76
Graduate courses	33
Ph.D. courses	181
Additional specialist courses	9
Total	299

Table 3. Overview of the courses held by RBI in 2010.

Intellectual Property

Apart from fundamental research and education, the activities of the RBI also result in various forms of intellectual creations. One important aspect of the RBI's mission is the protection of intellectual property and its commercialisation. In this context, various specific activities have been initiated and realized over the last few years. As a subsidiary, the Ruđer Bošković Institute established Rudjer Innovations Ltd., a company specializing in the commercialization of innovations and technology transfer. The intellectual property portfolio of Rudjer Innovations includes innovations protected by patents or patent applications in various fields of sci-

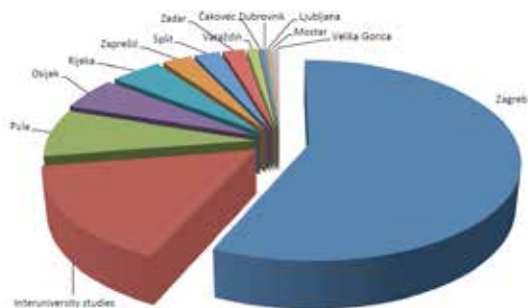


Figure 5. The distribution of the RBI courses by the location of the relevant hosting institution

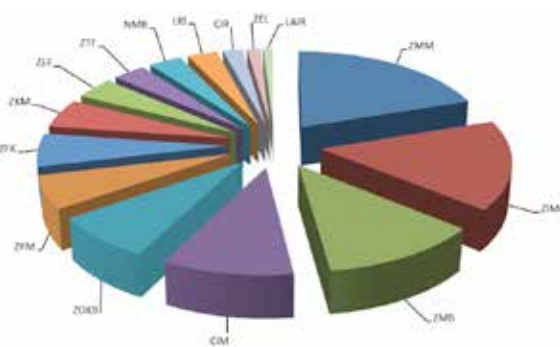


Figure 6. The distribution of the RBI courses by RBI Division

ence that have commercial potential. In 2010 RBI was granted by three patents.

The State Intellectual Property Office of the Republic of Croatia granted a patent for the innovation *NN''N''-Tris-(3-dimethylaminopropyl)-guanidine*, No. P20040341, the procedure of preparation from carbodiimide and application in reactions of the transesterification of oil, to the inventors Mirjana Maksić and Zoran Glasovac, researchers from the Laboratory for Physical-Organic Chemistry in the Division of Organic Chemistry and Biochemistry.

Similarly, the domestic Intellectual Property Office granted a patent entitled *Synthetic peptides containing unnatural adamantane relat-*

ed amino acids for use as antitumor drugs, No. P20050242), to several investigators including RBI scientists Štefica Horvat, Kata Majerski, Andreja Jakas and Jelena Veljković.

The United States Patent and Trademark Office granted a patent for the discovery of a *Mixed bacterial culture for atrazine degradation*, to a team including Dubravka Hršak, from the Department for Marine and Environmental Research at the RBI. The patent describes a new mixed bacterial culture with specific properties that quickly and completely degrades atrazine and other s-triazite pesticides over a wide concentration range and at different temperatures.

	STAFF	ARTICLES*							THESES				
Division	Research staff	Articles in CC journals	Articles in other journals and chapters in books	Articles in conference proceedings	Total articles	Books	Handbooks	Patents	Theses (written by RBI staff)		Theses (mentored by RBI staff)		
									Ph.D.	B.Sc.	Ph.D.	M.Sc.	B.Sc.
Theoretical Physics Department	24	28		1	29							2	3
Department of Experimental Physics	48	121	5	4	130		24		2	1	2		
Department of Materials Physics	28	35	1	2	38				1				4
Department of Laser and Atomic Research and Development	7	7		2	9								
Department of Electronics	11	5	3	3	11				2		1		
Department of Physics/ Chemistry	41	55	14	2	71	1			6		1		
Department of Organic Chemistry and Biochemistry	65	50	7		57			2	7			2	4
Department of Materials Chemistry	40	22	7	8	37				3				
Department of Molecular Biology	67	30	10		40				6	4		1	12
Department of Molecular Medicine	71	76	16	1	93				10		6	2	16
Department of Marine and Environmental Research	79	52	15	11	78	1		1	7	2	2	1	
Centre for Marine Research	37	12	5	8	25				1			6	1
Centre for Informatics and Computing	6	1	3	6	10								
Centre for Nuclear Magnetic Resonance	11	14	1		15	1			1		1		
Library				1	1								
TOTAL RBI	535	477	87	49	613	3	24	3	46	7	13	14	40

Table 4. Review of publications for the year 2010 (*Original scientific papers and review papers in journals/conference proceedings and chapters in books.)

DIVISIONAL ORGANIZATION

Head: Branko Guberina

The Theoretical Physics Division (ZTF) consists of the following laboratories:

- ⇒ Solid State Physics Group, Radovan Brako
- ⇒ Particle Physics and Cosmology Group, Neven Bilić
- ⇒ Theoretical and Mathematical Physics Group, Stjepan Meljanac

$$S = \frac{1}{16\pi G} \int d^4x \sqrt{-g} (R - 2\Lambda)$$

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R + g_{\mu\nu} \Lambda = 0$$

$$P_{vac} = -\frac{\Lambda}{8\pi G}$$

modified gravity theory. It was shown that the introduced modifications of gravity drastically reduce the effects of almost arbitrarily large cosmological constant of both signs that could be expected from high-energy fundamental theories (Štefančić et al., 2010).

OVERVIEW OF THE DIVISION

Research performed in the Theoretical Physics Division covers theoretical investigation of high-energy physics, including heavy-quark physics, perturbative quantum chromodynamics, gravity and cosmology, and general and mathematical physics. There is also a substantial research component in condensed matter physics, nanophysics and complex systems. The members of the Division continued to be involved in lecturing at the University of Zagreb and the University of Split and a number of students completed their B. Sc., M. Sc. and Ph. D. thesis.

TOP ACHIEVEMENTS

A large cosmological constant under control – a modified gravity story

The mechanism for the relaxation of the cosmological constant is formulated as a

Scalar Field Theory on Non-commutative Snyder Space-Time

A scalar field theory on the Snyder non-commutative spacetime was constructed. The generic construction of the coalgebraic sector underlying the Snyder geometry is derived (Meljanac et al., 2010).

Fluctuations around Periodic BPS-Density Waves in the Calogero Model

The collective field formulation of the Calogero model supports periodic density waves. We have presented a complete analysis of quadratic fluctuations around these BPS solutions. The corresponding Hamiltonian fluctuation was diagonalized in terms of bosonic creation and annihilation operators which correspond to the complete orthogonal set of Bloch-Floquet eigenstates of a related periodic Schrödinger Hamiltonian. Remark-

ably, the fluctuation spectrum is independent of the parameter which determines the density wave's amplitude (Bardek et al., 2010).

One vacuum, many possible energy densities

An analytical calculation of the probability distribution of the vacuum energy density for real and complex massless scalar fields in Minkowski space was presented. The obtained probability distributions are broad and the vacuum expectation value of the Hamiltonian density is not fully representative of the vacuum energy density (Duplančić et al., 2010).

Density functional theory with non-local correlation and the CO adsorption puzzle

The well-known CO adsorption puzzle is the incorrect predictions in ab-initio calculations of the adsorption of CO molecules into sites of different coordination on (111) surfaces of late 4d and 5d transition metals. In order to resolve the discrepancies between

experimental and density functional theory calculations, we have applied the relatively new van der Waals-density functional which includes nonlocal correlation. In all considered cases this reduces or completely solves the site preference discrepancies and improves the value of the adsorption energy (Lazić et al., 2010).

Increase of conductance in nonequilibrium gap geometry: a molecular wire story

The influence of a contact gap geometry on the transport has been investigated using density-functional theory and nonequilibrium Green's function method. The increase in the low bias conductance with the contraction of the gap is shown in line with experimental observations. However, the unusual increase of conductance is displayed with the contact separation with the lowest conductance for the equilibrium gap geometry. It is shown that all the predicted increases in the conductance arise from better band alignment between relevant frontier orbitals at nonequilibrium geometries at the expense of weaker coupling with the contacts (Crijen et al., 2010).

Massively parallel post-processing evaluation of van der Waals-density functional correlation energy

The recently developed nonlocal correlation functional vdW-DF opens the prospect of applying the Density Functional Theory calculations to soft matter and other materials in which the van der Waals interaction plays an important role, where the standard LDA and GGA functionals have not been successful. We have developed JuNoLo, a massively parallel computer code which is used in a post-DFT calculation approach, by applying the functional to the charge density calculated using any standard DFT code thus obtaining a new improved value for the total energy of the system (Lazić et al., 2010).

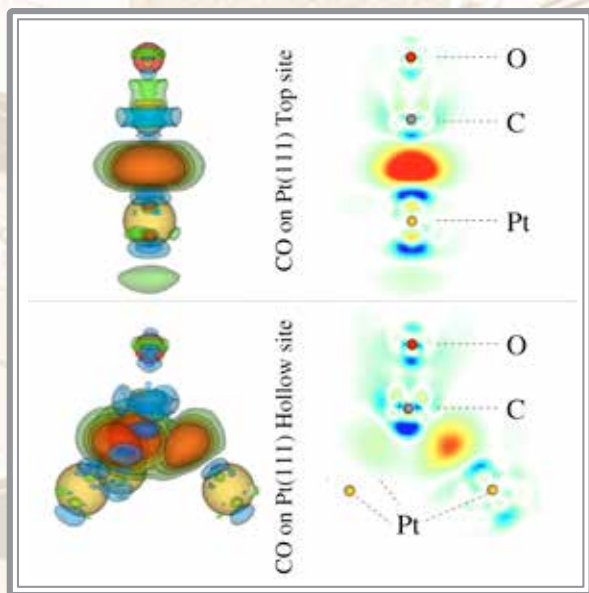


Fig. 1. Differences in correlation energy densities between Density Functional Theory calculations with the standard PBE functional and the non-local vdW-DF functional, for CO adsorbed on Pt(111) in a on-top site, upper panel, and hollow site, lower panel.

Constraints on the quantum gravity scale from kappa - Minkowski spacetime

Two versions of deformed dispersion relations (energy vs. momenta and momenta vs. energy) and the corresponding time delay up to the second-order accuracy in the quantum gravity scale (deformation parameter) are compared. A general framework describing modified dispersion relations and time delay with respect to different noncommutative κ -Minkowski spacetime realizations is proposed, within which we have shown that some of the realizations provide certain bounds on quadratic corrections and have also shown how the coefficients in the dispersion relations can be obtained through a multiparameter fit of the gamma-ray burst (GRB) data (Meljanac et al., 2010).

EDUCATION

In 2010, members of the Division served as lecturers in undergraduate and graduate courses at the Universities of Zagreb and Split. Five students completed their B.Sc. (2) or M.Sc. (3) theses.

AWARDS

Velimir Bardek, Radovan Brako, Danijel Jurman, Stjepan Meljanac, Hrvoje Nikolić, Hrvoje Štefančić and Josip Trampetić received the RBI Director's Award for Scientific Excellence and Larisa Jonke served as a member of the Steering Committee for the ESF research network Quantum Geometry and Quantum Gravity (July 2007 – December 2011).

PROJECTS

Projects supported by the Ministry of Science, Education and Sports

1. Surfaces and nanostructures: Theoretical approaches and numerical calculations, Radovan Brako
2. Electronic properties of hybrid nanostructures, Željko Crljen
3. Electromagnetic field fluctuations: the van der Waals-Casimir forces, Marin-Slobodan Tomaš
4. Fundamental interactions in elementary particle physics and cosmology, Branko Guberina
5. Noncommutative spaces in high energy physics, Josip Trampetić
6. Matrix models, duality and field theory, Larisa Jonke
7. Quantum field theory, noncommutative spaces and symmetries, Stjepan Meljanac

Research, developmental and international project

1. QCD sum rules for exclusive decays of heavy hadrons, Blaženka Melić (International Research Project promoted by the Alexander von Humboldt Foundation, with principal investigators from RBI and University of Siegen, Germany)
2. Final state interaction in non-leptonic D- and B-decays, Blaženka Melić (Croatian-French Project in the program "COGITO" - partnership Hubert Curien)
3. Modified gravity theories and the accelerated expansion of the universe, Hrvoje Štefančić (Croatian-Serbian Bilateral Project)
4. Tools and Precision Calculations for Physics Discoveries at Colliders, Josip Trampetić (collaboration to the FW 6 EU RTN Network HEPTOOLS, no. MRTN-CT-2006-035505)

SELECTED INVITED LECTURES

1. Passek-Kumerički K, GPDs from DVCS at L0 and beyond, invited talk given at the workshop

Diffraction and electromagnetic processes at LHC, Trento, Italy, January 4-8, 2010

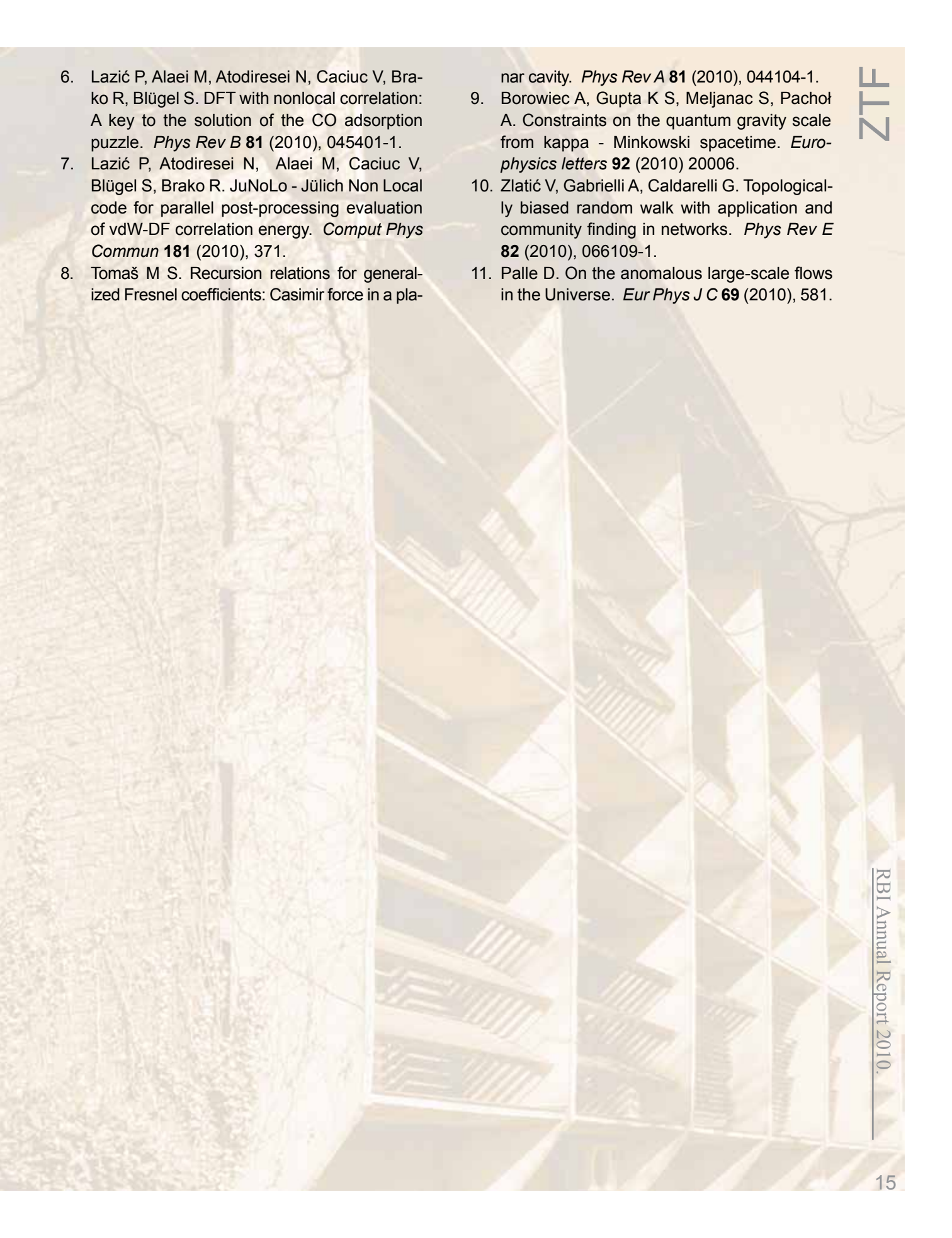
2. Bilić N, Cosmological k-essence condensation. Beyond 2010, Cape Town, South Africa, February 1-6, 2010
3. Andraši A, Energy Divergences in Coulomb Gauge QCD, Triangle Workshop on Non-Perturbative Methods in Quantum Field Theory, Heviz, Hungary, March 10-12, 2010
4. Škoda Z, Twisted nonabelian differential cohomology, Conference «Geometry at large II: Hodge and homotopy theories», University of Vienna, Vienna, Austria, May 3-7, 2010
5. Nikolić H, Making nonlocal reality compatible with relativity, Quantum 2010: Advances in Foundations of Quantum Mechanics and Quantum Information with Atoms and Photons. Torino, Italy, May 24-28, 2010
6. Melić B, Charmless two-body B-meson decays in QCD, 3rd Workshop on Theory, Phenomenology and Experiments in Heavy Flavour Physics (Capri2010), Anacapri, Island Capri, Italy, July 5-7, 2010
7. Bilić N, Cosmological condensation of the tachyon fluid, Efeitos Quanticos em Gravitacao e Cosmologia, Espirito Santo, Brasil, August 15-20, 2010
8. Nikolić H, Making Bohmian mechanics compatible with relativity and quantum field theory, 21st century directions in de Broglie-Bohm theory and beyond, Vallico Sotto, Italy, August 29 – September 3, 2010
9. Jonke L, Gauge theory on kappa-Minkowski revisited: the twist approach, Satellite Workshop on Noncommutative Field Theory and Gravity, Corfu, Greece, September 8 - 12, 2010
10. Bilić N, Cosmological condensation of the tachyon k-essence, 6th Mathematical Physics Meeting: Summer School and Conference on Modern Mathematical Physics, Belgrade, Serbia, September 14-23, 2010
11. Škoda Z, Symmetrization map, realizations and Lie algebroids, «Higher Structures in Mathematics and Physics», Erwin Schroedinger Institute for Mathematical Physics, Vienna, Austria, October 14, 2010

SELECTED ORGANIZED CONFERENCES

1. Beyond 2010, Cape Town, February 1-6, 2010 (Nevenko Bilić, member of the Organizing Committee)
2. Croatian Black Hole School, Trpanj, Pelješac, Croatia, June 21-25, 2010 (Zoran Škoda, member of the Organizing Committee)
3. 5th Austrian-Croatian-Hungarian Meeting, Summer Workshop for Theoretical Physics – „Gauge Fields, Quark Matter, and LHC“, Rab, Croatia, August 30 – September 4, 2010 (Anđelka Andraši, member of the Organizing Committee)
4. 3rd International Conference on Nuclear and Particle Physics with CEBAF at Jefferson Lab, NAPP 2010, Dubrovnik, October 3-8, 2010 (Blaženka Melić, member of the Organizing Committee)
5. Meeting of Croatian Particle and Astroparticle Physicists, Ruđer Bošković Institute, Zagreb, Croatia, October 28-29, 2010 (Goran Duplančić, member of the Organizing Committee)

SELECTED PUBLICATIONS

1. Bauer F, Sola J, Štefančić H. Dynamically avoiding fine-tuning the cosmological constant: the «Relaxed Universe». *J Cosmol Astropart P* **12** (2010), 029-1.
2. Battisti M V, Meljanac S. Scalar Field Theory on Non-commutative Snyder Space-Time. *Phys Rev D* **82** (2010), 024028.
3. Bardek V, Feinberg J, Meljanac S. Fluctuations around Periodic BPS-Density Waves in the Calogero Model. *J High Energy Phys* **8** (2010), 018.
4. Duplančić G, Glavan D, Štefančić H. Probability distribution of the vacuum energy density. *Phys Rev D* **82** (2010), 125008-1.
5. Bilić A, Crljen Ž, Gumhalter B, Gale J D, Rungger I, Sanvito S. Conductance of a phenylene-vinylene molecular wire: Contact gap and tilt angle dependence. *Phys Rev B* **81** (2010), 155101-1.

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6. Lazić P, Alaei M, Atodiresei N, Caciuc V, Brako R, Blügel S. DFT with nonlocal correlation: A key to the solution of the CO adsorption puzzle. *Phys Rev B* **81** (2010), 045401-1.
 7. Lazić P, Atodiresei N, Alaei M, Caciuc V, Blügel S, Brako R. JuNoLo - Jülich Non Local code for parallel post-processing evaluation of vdW-DF correlation energy. *Comput Phys Commun* **181** (2010), 371.
 8. Tomaš M S. Recursion relations for generalized Fresnel coefficients: Casimir force in a planar cavity. *Phys Rev A* **81** (2010), 044104-1.
 9. Borowiec A, Gupta K S, Meljanac S, Pachot A. Constraints on the quantum gravity scale from kappa - Minkowski spacetime. *Europhysics letters* **92** (2010) 20006.
 10. Zlatić V, Gabrielli A, Caldarelli G. Topologically biased random walk with application and community finding in networks. *Phys Rev E* **82** (2010), 066109-1.
 11. Palle D. On the anomalous large-scale flows in the Universe. *Eur Phys J C* **69** (2010), 581.

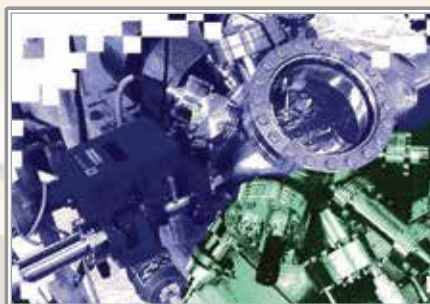


DIVISIONAL ORGANIZATION

Head: Tome Antičić

The Division of Experimental Physics (DEP) consists of the following laboratories:

- ⇒ Laboratory for hadron physics, Ivan Supek
- ⇒ Laboratory for nuclear physics, Zoran Basrak
- ⇒ Laboratory for astroparticle physics, Raul Horvat
- ⇒ Laboratory for electromagnetic and weak interactions, Milica Krčmar
- ⇒ Laboratory for ion beam interactions, Milko Jakšić
- ⇒ Laboratory for measurement of low-level activities, Bogomil Obelić
- ⇒ Laboratory for high energy physics, Krešo Kadija
- ⇒ Laboratory for nuclear analytical methods, Jasmina Obhodaš
- ⇒ Group for hadronic spectroscopy, Alfred Švarc



lated radiation applications. The division has about 65 staff, including more than 30 PhDs. They are involved in numerous experiments and experimental complexes abroad and in Croatia, and maintain a strong performance in both basic and applied physics research. The Division, due to its excellent international reputation, received a large fraction of its financing from non-MZOS sources, which was used, among others, to significantly enhance its experimental capabilities.

The main strategic objectives of DEP for the next five years are briefly:

- A significantly enlarged experimental contribution in top large international physics collaborations, in particularly involving experimental work at the DEP site, leading to a much more prominent role in these experiments.
- Strengthened partnerships at numerous levels with prominent European institutions.
- Increased experimental capabilities and capacities for experiments at the local RBI Tandem accelerator facility.
- Additional focus on local experimental capabilities, such as the Cockcroft Walton accelerator (neutron generator), or the anticoincidence germanium system experiments.

OVERVIEW OF THE DIVISION

The core activities of the Division of Experimental Physics involve experimental ion beam, nuclear, particle and astroparticle physics, interdisciplinary research including nanotechnology and detector and sensor testing and development, as well as re-

- Development of an automated underwater vehicle, which integrates several sensors for detection and identification of objects lying on the sea floor.
- Improved characterization of advanced materials and their modification.
- Improved cooperation with partners, such as the Universities of Zagreb, Split and Rijeka, Croatian industry, as well as local cultural institutions and authorities.
- Traditionally strong activities regarding development and applications of radiation based techniques in interdisciplinary research areas.
- Increased attraction for top Croatian students, as well as for current top staff.
- An even larger success in getting external funding.

TOP ACHIEVEMENTS

First data at the Large Hadron Collider (CERN)

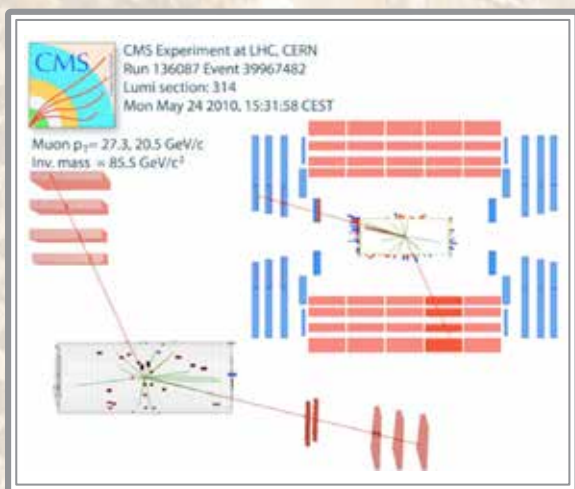


Fig. 1. First observation of a heavy Z boson decay into a pair of muons observed with the CMS experiment.

After many years of preparation, the Large Hadron Collider (LHC) has taken its first data at high energy and has therefore brought back the energy frontier in Particle Physics to Europe. Between April and November, the Compact Muon Solenoid (CMS) detector has

accumulated 36 inverse picobarns of data. The RBI group in CMS has actively participated in the data collection and has continued its contribution to the improvement of the data acquisition environment. The RBI group also played an active role in the analysis of the first data and the first published measurements, focusing on electroweak processes involving the production of the heavy W and Z bosons.

Ion beams for nanostructuring

Irradiation by swift heavy ions under the grazing incidence angle resulted in creation of chains of nanohillocks on the surface of SrTiO_3 (Karlusic et al., 2010), demonstrating the versatility of the RBI accelerator facility in materials modification research using ion beams. Furthermore, ordering of Ge nanocrystals has been induced after irradiation of thin Ge/SiO_2 multilayers by oxygen and silicon ions in collaboration with the Division of Materials Physics.

Observation of a first $\nu\tau$ candidate event in the OPERA experiment

At LNGS, the OPERA-RBI group has participated in data taking and analysis of neutrino interactions in the emulsion/lead target. The topology and kinematics of a first candidate $\nu\tau$ charged-current event satisfying the kinematical selection criteria are described. The background calculations and their cross-check are explained in detail and the significance of the event is assessed (Agafonova et al., 2010).

Search for high-energy hadronic axions

At CERN, the CAST-RBI group explored the relation between the coupling constants of pseudoscalar particles that couple to a nucleon and to two photons by using the CAST γ -ray calorimeter to look for a high-energy axion emission signal from ^7Li (0.478 MeV) and $\text{D}(p,\gamma)^3\text{He}$ (5.5 MeV) nuclear transitions (Andriamonje et al., 2010).

Holographic dark energy models

We showed that a framework underlying all holographic dark energy models is not capable of accounting for a strong jump in the entanglement entropy, measuring quantum-mechanical correlations between the cosmological horizon and its interior. (R. Horvat, 2010.)

Spin-isospin selectivity in three-nucleon forces

Nuclear force is studied via a precision measurement of the break-up reaction ${}^2H(p,pp)n$ induced by a polarized-proton beam of 190 MeV impinging on a liquid-deuterium target. The obtained vector-analyzing powers are compared with state-of-the-art Faddeev calculations including three-nucleon forces effect. Significant discrepancies between the data and theoretical predictions were observed for kinematical configurations which correspond to the ${}^2H(p,{}^2He)n$ channel (see in Fig. 2). These results are compared to the ${}^2H(p,d)n$ reaction to test the isospin sensitivity of the present three-nucleon force models. The current modeling of two and three-nucleon forces is not sufficient to de-

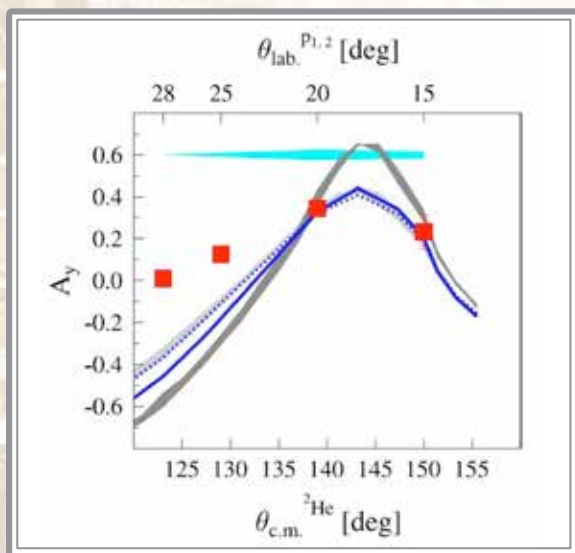


Fig. 2. The analyzing power as a function of the center of mass angle for the reaction ${}^2H(p,{}^2He)n$ induced by polarized protons of 190 MeV (square dots).

scribe consistently polarization data for both isospin states (Mardanpour et al., 2010).

Full production mode for the Crystal Ball Collaboration with MAMI-C accelerator

In 2010 the MAMI-C accelerator finally achieved 1.6 GeV with a beam current of 20 μ A. The Crystal Ball Collaboration successfully used this beam to continue with its experimental program. Highlights of this work include experiments measuring differential cross section and resonance structure for eta meson channel. The CB Collaboration has already published these measurements in the prestigious Phys. Lett. B and Phys. Rev. C journals.

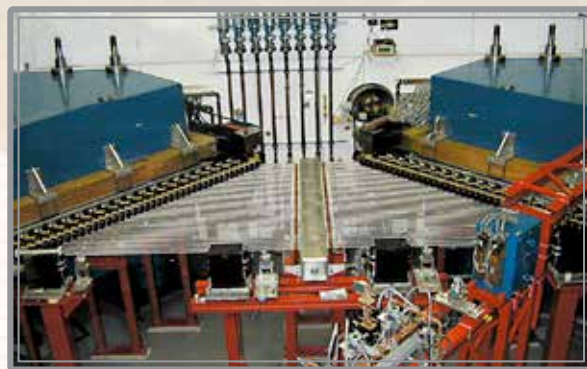


Fig. 3: New Mainz Microtron (MAMI-C) racetrack.

New Zagreb method for resonance identification confirmed

In collaboration with the Mainz group we applied the Zagreb regularization method (see Ceci et al, PR D77 116007) to investigate singularities of Dubna-Mainz-Taipei meson-exchange model amplitudes. We concluded that the RM is a reliable method of extracting the pole structure from single-channel data. In the absence of full experimental knowledge about all of the channels, this method can be sequentially applied to determine the pole structure relevant for the experimentally known channels of a multi-channel system (Tiator et al, 2010).

Zagreb amplitude resonance parameters updated

Zagreb realization of Carnegie-Melon-Berkeley amplitudes (as explained in Batinic et al, PR C51 2310) have been updated and supplemented with the pole positions (Batinic et al, 2010).

NEW EQUIPMENT

Setup for reaction products measured in coincidence

A modular array of 6 silicon strip detectors each of 50x50 mm² active area was set up, tested and applied. Telescopes consist of 20 μ m thick strip detector (SD) divided into 16 equal strips and 1000 μ m or 500 μ m thick position sensitive strip detector with perpendicularly mounted 16 strips (PSSD). Such a set-up makes possible particle identification for all reaction products from proton to oxygen (see in Fig. 4) while its granularity and large-angle coverage allows identification and detection with high efficiency of the ⁸Be exit channel through the α -particle – α -particle coincidence. The energy resolution of the detected reaction products is in the range 40 and 100 keV. This detector array has 288 outputs which are processed by usual NIM electronics and data acquisition system build

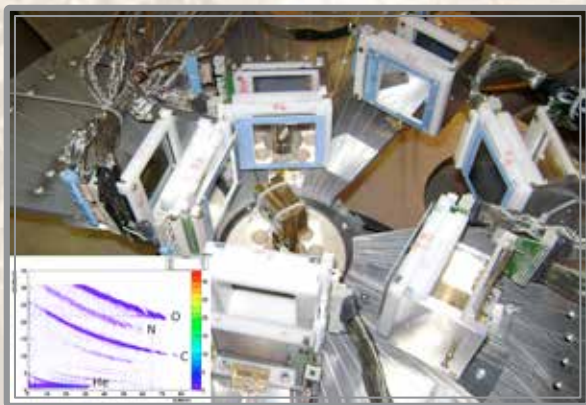


Fig. 4. The SD-PSSD telescopes mounted in the INFN-LNS Catania scattering chamber. Beam is coming from down. Inset depicts high particle-identification resolution.

on VME ADCs and MIDAS software. DAQ records both coincident events and singles scaled down for appropriate factor.

Upgraded dual irradiation beam line

The unique possibility to simultaneously irradiate materials with ion beams from both RBI accelerators, namely 1.0 MV Tandatron and 6.0 MV Tandem Van de Graaff, was made possible after installation of a new scattering chamber shown in Figure 5. This chamber has been equipped with 6 axis goniometer for sample positioning and on line monitoring of radiation damage induced by one ion beam while making analysis using another ion beam (Fig. 5).

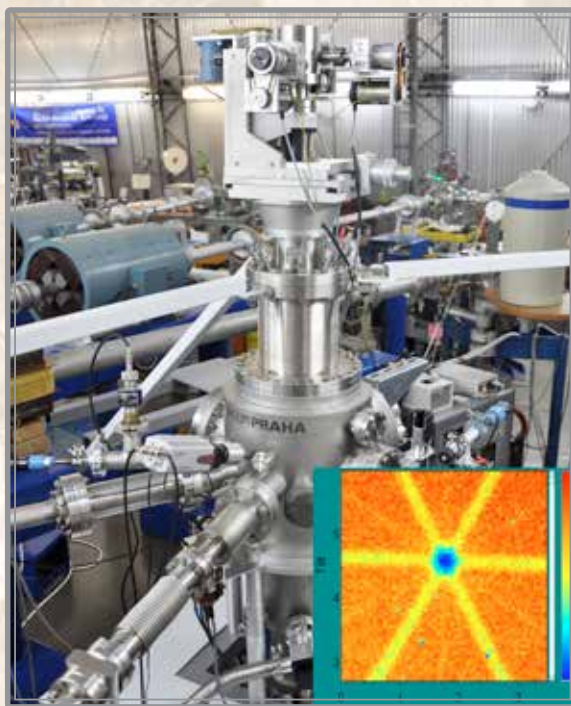


Fig 5. New dual beam irradiation chamber. 6 axis goniometer enables performance of channeling RBS. Inset at bottom right presents RBS/c imaging of silicon crystal planes.

Development of ¹⁴C AMS dating method

Graphite sample preparation (target for AMS) from micro samples for ¹⁴C dating has been further developed for different types of

material, including charcoal, bone, carbonate, DIC and DOC in water, etc. (Krajcar Bronić et al., 2010).



Fig. 6 Vacuum line for preparation of graphite for ^{14}C AMS measurement technique.

EDUCATION

Members of the Division were involved in lecturing at undergraduate and graduate courses at the Faculty of Science at the University of Zagreb, University of Rijeka, and at joint studies organized by RBI in cooperation with the Universities of Osijek and Dubrovnik. Four students completed their Ph. D. theses and one B. Sc. thesis under the leadership of division staff.

AWARDS

Raul Horvat, Neven Soić, Tome Antičić and Bogomil Obelić received the RBI Director's Award for scientific excellence in 2010. Ines Krajcar Bronić served as a member of the ICRU Report Committee on "Key data for measurement standards in the dosimetry of ionizing radiation", and Bogomil Obelić served as a member of the Expert Advisory Group (EAG) "Regional aspects of the 7th Framework Programme" of EC Research Directorate (2008-2012).

PROJECTS

Projects supported by the Ministry of Sciences, Education and Sports

1. Experimental research of the nucleus: nuclear structures and reactions, Suzana Szilner
2. Ion beam interactions and nanostructures, Milko Jakšić
3. Hadronic physics and QCD, Ivan Supek
4. Heavy-ion physics, Zoran Basrak
5. Massive neutrinos and astro-particles: from particle physics to cosmology, Ante Ljubičić
6. Experimental physics at LHC energies, Krešo Kadija
7. Experiments in quantum communication and quantum information, Mario Stipčević
8. Photon-atom interactions and correlations, Tihomir Surić
9. Natural isotopes in investigation of karst environment and dating, Bogomil Obelić
10. Development and application of nuclear analytical methods, Jasmina Obhodaš
11. Development of the methods for illicit trafficking control, Dario Matika and Davorin Sudac
12. Hadronic physics between the experiments and QCD models, Alfred Švarc
13. Test of special relativity by the Ives-Stilwell type experiment, Saša Blagus

Research, developmental and international projects

1. FP7 REGPOT project: "Particle Detectors", Tome Antičić project coordinator
2. Underwater Coastal Sea Surveyor (UNCOSS), Jasmina Obhodaš (EU FP7-SEC-2007-1, Contract No. 218148).
3. Support of Public and Industrial Research using Ion beam Technology (SPIRIT), Milko Jakšić (EU FP7 project No. 227012)
4. Network in solid waste and water treatment between Europe and Mediterranean countries (SOWAEUMED), FP7 Project, Bogomil Obelić
5. CLUustering phenomena in nuclear physics: strengthening of the Zagreb - Catania - Birmingham partnership (CLUNA), Neven Soić (FP7-REGPOT-2007-3 International Coop-

- eration - Coordination and Support action, project number 203200)
6. Hadron Physics 2, Roman Čaplar, Ivan Supek, Alfred Švarc, Ivan Supek activity leader in SPINMAP subprogram (EC FP 7 programme contract 227431).
 7. Research project Experimental nuclear physics inputs for thermonuclear runaway, principal investigator Neven Soić, part of the collaborative project Physics of compact objects: explosive nucleosynthesis and evolution, EuroGENESIS programme of the European Science Foundation
 8. Using environmental isotopes for evaluation of streamwater/groundwater interactions in selected aquifers in the Danube basin (IAEA Reg TC project RER8016, Nada Horvatinčić)
 9. Strengthening sustainability of nuclear research and development institutes in the modern science and technology environment, Stjepko Fazinić (National Coordinator, IAEA regional project RER/0/031)
 10. Isotopic composition of precipitation in Croatia and Slovenia, bilateral project Croatia – Slovenia, Ines Krajcar Bronić (2009 – 2010)
 11. Measurement of ^3H activity in natural waters with electrolytic enrichment, bilateral project Croatia – Slovenia, Jadranka Barešić (2010 – 2011)
 12. Physics of nuclei and hadrons at high energies, Roman Čaplar (International collaboration project RBI-KFKI Research Institute for Particle and Nuclear Physics, Budapest via Croatian (HAZU) and Hungarian Academy of Science)
 13. Monitoring of Marina Punat, Jasmina Obhodaš
 14. Development of frozen spin polarized target for Crystal Ball Collaboration at MAMI, Ivan Supek (University of Mainz for EU program I3HP TNA Contract)
 15. Precise Measurement of the $\Pi^+ \rightarrow e^+ n$ Branching Ratio, Ivan Supek (International Collaboration between RBI and University of Virginia, Charlottesville, USA)
 16. OPERA collaboration, Ante Ljubičić (International collaboration between RBI, CERN (Switzerland) and LNGS (Gran Sasso, Italy))
 17. CERN Axion Solar Telescope (CAST) experiment, Milica Krčmar (International collaboration between RBI and CERN (Switzerland))
 18. ALICE collaboration, Tome Antičić (International collaboration between RBI and CERN (Switzerland))
 19. NA61 collaboration, Krešo Kadija (International collaboration between RBI and CERN (Switzerland))
 20. CMS Collaboration, Krešo Kadija, Vuko Brigljević (International collaboration between RBI and CERN, Switzerland).
 21. NA49 collaboration, Tatjana Šuša (International collaboration between RBI and CERN (Switzerland))
 22. Pierre Auger Observatory, Krešo Kadija, associate membership through University of Nova Gorica, Slovenia.

SELECTED INVITED LECTURES

1. Bogdanović Radović I, Coincidence elastic scattering and TOF-ERDA – sensitive techniques for light element analysis in thin films, 13th Joint Vacuum Conference, Štrbske Pleso, Slovakia, June 20-24, 2010.
2. Bogdanović Radović I, Light elements analysis using elastic scattering coincidence technique at the Zagreb microprobe, 10th European Conference on Accelerators in Applied Research and Technology, ECAART 2010, Athens, Greece, September 13-17, 2010
3. Lakić B, Search for solar axions with the CAST experiment. «ASPERA National Day Croatia», Opatija, Croatia, May 27, 2010
4. Lakić B, Search for solar axions with the CAST experiment. «Time and Matter 2010», Budva, Montenegro, October 4-8, 2010
5. Krajcar Bronić I, Radiocarbon dating and its application to early Neolithic in Croatia, *2nd Balkan Symposium in Archaeometry - Science meets archaeology and art history*. Kultur University, Istanbul, Istanbul, Turkey, September 15-17, 2010.
6. Krajcar Bronić I, Environmental ^{14}C Activity: The Atmosphere and The Biosphere, Scientific symposium "Public health research on

- exposure to electromagnetic radiation”, Zagreb, 19 November 2010.
7. Švarc A, Poles of PWData and PWAmplitudes in Zagreb model. EBAC workshop on «Extractions and interpretations of hadron resonances and multi-meson production reactions with 12 GeV upgrade», Jlab, Newport News, USA, May 27 - 28, 2010,
 8. Basrak Z, Equation of state of asymmetric nuclear matter at supra-saturation density. CBM collaboration meeting, Darmstadt, Germany, April 12-16, 2010
 9. Szilner S, Quasi-elastic reactions: an interplay of reaction dynamics and nuclear structure. International Symposium on Quasi-fission Process in Heavy Ion Reactions, Messina, Italy, November 8-9, 2010
 10. Brigljević V, Low Pt Physics with CMS, LHC Days in Split, Split (Croatia), October 4-9, 2010.
 11. Brigljević V, CP Violation, Lectures at the Sarajevo School for High Energy Physics, Sarajevo (Bosnia and Hercegovina), May 10-12, 2010.
 12. Morović S, CMS Online Data Quality Monitoring: Real-Time Event Processing Infrastructure. International Conference on Computing in High Energy and Nuclear Physics. Academia Sinica, Taipei (Taiwan). October 18-22 2010.

SELECTED ORGANIZED CONFERENCES

1. New detector technologies for advanced materials research using ion beam analysis, FP7 project SPIRIT Workshop organized by the RBI (chaired by Milko Jakšić, program organized by Iva Bogdanović Radović, Stjepko Fazinić and Milko Jakšić), Plitvice lakes, Croatia, 24.10.-27.10.2010
2. Origin of the Elements and Nuclear History of the Universe, The first EuroGENESIS workshop, organized by the RBI Laboratory for Nuclear Physics, chaired by Neven Soić, Dubrovnik, 23- 26.11.2010. From the RBI Neven Soić, Vedrana Tokić and Lovro Prepolec participated in the organization.
3. Workshop on the first W and Z measurements with CMS at the LHC, organized by

the RBI Laboratory for High Energy Physics, RBI, November 15-19 2010.

4. IAEA Regional Workshop on “Successful Applying for EU-funded projects”, organized by the RBI (Stjepko Fazinić) in collaboration with the IAEA, Zagreb, 25-28 May 2010.
5. 14th European X-Ray Spectrometry Conference (EXRS 2010), 20-25 June 2010, Figueira da Foz, Portugal, (Stjepko Fazinić member of International Advisory Board)

SELECTED PUBLICATIONS

1. Karlušić M, Akcöltekin S, Osmani O, Monnet I, Lebius H, Jakšić M, Schleberger M. Energy threshold for the creation of nanodots on SrTiO₃ by swift heavy ions. *New J Phys* **12** (2010), 043009-1.
2. Pinto S, Rolo A, Gomes M, Ivanda M, Bogdanović-Radović I, Grenzer J, Mücklich A, Barber D, Bernstorff S, Buljan M. Formation of void lattice after annealing of Ge quantum dot lattice in alumina matrix. *Appl Phys Lett* **95** (2010), 173113.
3. Agafonova N, et al. (OPERA Collaboration-RBI: Jakovčić K, Kliček B, Ljubičić A, Stipčević M). Observation of a first vt candidate event in the OPERA experiment in the CNGS beam. *Phys Lett B* **691** (2010), 138.
4. Andriamonje S, et al. (CAST Collaboration-RBI: Jakovčić K, Krčmar M, Lakić B, Ljubičić A). Search for solar axion emission from ⁷Li and D(p,γ)³He nuclear decays with the CAST gamma-ray calorimeter. *J Cosmol Astropart P* **3** (2010), 032-1.
5. Batinić M, Ceci S, Švarc A, Zauner B. Poles of the Zagreb analysis partial-wave T matrices. *Phys Rev C* **82** (2010), 038203-1.
6. Tiator L, Kamalov S, Ceci S, Chen G Y, Drechsel D, Švarc A, Yang S N. Singularity structure of the PiN scattering amplitude in a meson-exchange model up to energies W < 2.0 GeV. *Phys Rev C* **82** (2010), 055203-1.
7. McNicoll E et al., (Crystal Ball Collaboration-RBI: Korolija M, Mekterović D, Mićanović S, Supek I, Zamboni I. Study of the gamma p -> eta p reaction with the Crystal Ball detector at

- the Mainz Microtron (MAMI-C). Phys Rev C **82** (2010), 035208.
8. Prakhov S et al. (RBI: Supek I). Measurement of K- p radiative capture to gamma Lambda and gamma Sigma0 for p(K-) between 514 and 750 MeV/c. Phys Rev C **82** (2010), 015201.
 9. Di Pietro A et al. (RBI: Zadro M). Elastic Scattering and Reaction Mechanisms of the Halo Nucleus ^{11}Be around the Coulomb Barrier. Phys Rev Lett **105** (2010) 022701.
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 11. Jiang C L et al. (PRISMA Collaboration-RBI: Szilner S). Fusion hindrance for Ca+Ca systems: Influence of neutron excess. Phys Rev C **82** (2010); 041601(R).
 12. Lopez, X et al. (FOPI Collaboration-RBI: Basrak Z, Čaplar R, Gašparić I, Kiš M, Kroljica M). Measurement of $K^*(892)^0$ and K^0 mesons in Al plus Al collisions at 1.9A GeV. Phys Rev C **81** (2010), 061902(R).
 13. Mardanpour, H et al. (BINA Collaboration-RBI: Kiš M). Spin-isospin selectivity in three-nucleon forces. Phys Lett B **687** (2010), 149.
 14. R. Horvat: Entanglement in holographic dark energy models. Phys Lett B **693** (2010), 596.
 15. Krajcar Bronić I, et al. A new graphite preparation line for AMS ^{14}C dating in the Zagreb Radiocarbon Laboratory. Nucl Instr and Meth B **268** (2010) 943.

Books

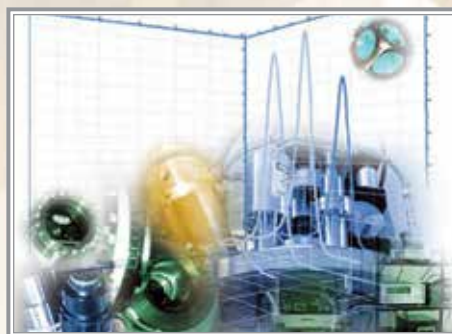
1. Obhodaš J, Valković V, Kutle A. Atlas of Sediments (Croatia's Coastal Region and Islands), *In Croatian*, Udruga Lijepa naša, Zagreb, 2010. pp 231. ISBN: 978-953-97044-3-6.

DIVISIONAL ORGANIZATION

Head: Nikola Radić

The Division of Materials Physics (ZFM) consists of the following laboratories:

- ⇒ Laboratory for Semiconductors, Branko Pivac
- ⇒ Laboratory for Thin Films, Nikola Radić
- ⇒ Laboratory for Molecular Physics, Krešimir Furić



OVERVIEW OF THE DIVISION

The primary mission of the Division of Materials Physics is the acquisition and accumulation of new knowledge through frontier research in the fundamental natural sciences - physics, chemistry and interdisciplinary research. We are focused on fundamental and applied studies of physical parameters and processes which describe and connect the microscopic, mesoscopic and macroscopic properties of condensed matter and molecules. Nanoscience and nanotechnology has been the most active direction of both fundamental scientific research and developments in technology. Fundamental research in the field of molecular and solid state physics placed special emphasis on vibrational spectroscopy in a wide range of systems, while strongly nonlinear effects in laser-matter interaction, and self-organization in condensed systems continue to be the subjects of intensive research.

TOP ACHIEVEMENTS

Ge QDs for non-volatile memories

The successful application and analysis of Deep Level Transient Spectroscopy (DLTS) in the study of Ge QDs embedded in SiO₂ deposited by magnetron sputtering. Charge trapping in Ge QDs has been demonstrated (Buljan et al., 2010a).

Self-assembling of Ge quantum dots in an alumina matrix

The structural description of a new nanomaterial consisting of self-assembled Ge quantum dots in a single, 600 nm thick (Ge+Al₂O₃)/Al₂O₃ film has been demonstrated. The observed self-assembly of the quantum dots is explained and simulated by a kinetic Monte-Carlo model (Buljan et al., 2010b).

Growth of spatially ordered nanoclusters on rippled substrates

A method for the fabrication of spatially ordered nanoclusters in amorphous matrices, where the ordering is achieved in a sin-

gle large domain has been demonstrated. Regular ordering is induced by the deposition of a multilayer on a periodically rippled substrate at an elevated substrate temperature. During the deposition, the nanoclusters self-arrange, following the morphology of the substrate (Buljan et al., 2010b, c).

Solvothermal and surfactant-free synthesis of crystalline Nb_2O_5 , Ta_2O_5 , HfO_2 , and Co-doped HfO_2 nanoparticles

A simple route to niobium, hafnium and tantalum oxide nanocrystals using a non-aqueous sol-gel route based on the solvothermal reaction of the corresponding metal chlorides with benzyl alcohol was described. This approach can easily be extended to the preparation of high quality Co-doped HfO_2 nanoparticles of uniform size and shape and with a homogenous distribution of the magnetic ions (Buha et al., 2010).

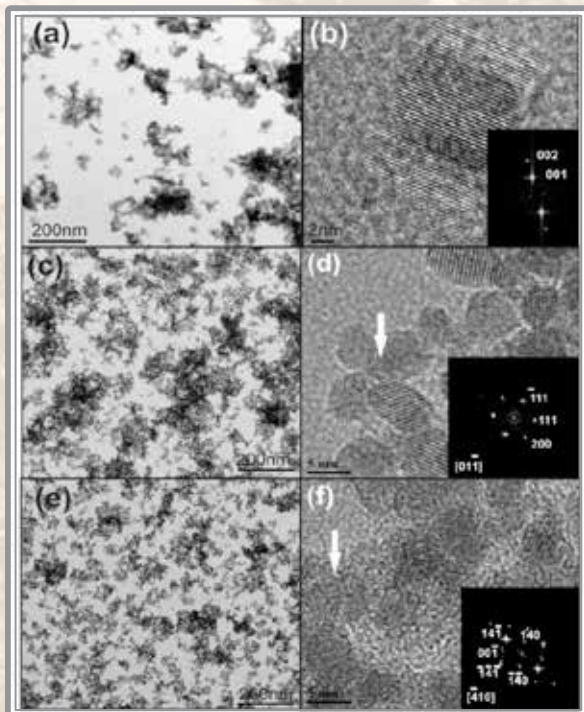


Fig. 1. TEM overview images of as prepared metal oxide nanoparticles obtained from halide precursors in benzyl alcohol: (a) Nb_2O_5 , (c) HfO_2 , (e) Ta_2O_5 . HRTEM images with the respective PS (inset) of the particle marked with an arrow of (b) niobium oxide, (d) hafnium oxide and (f) tantalum oxide.

Niobium Doped TiO_2 with Mesoporosity and Its Application for Lithium Insertion

The synthesis as well as a study of the electrochemical properties of niobium-doped TiO_2 (NTO) with mesoporosity and high surface area was described. The as-prepared samples were used as positive electrode materials for a lithium-ion battery, whose charge/discharge properties, cyclic voltammetry, and cycle performance were examined and revealed very good properties. A highly stable capacity of 160 mA h g^{-1} was found after 100 cycles (Wang et al., 2010).

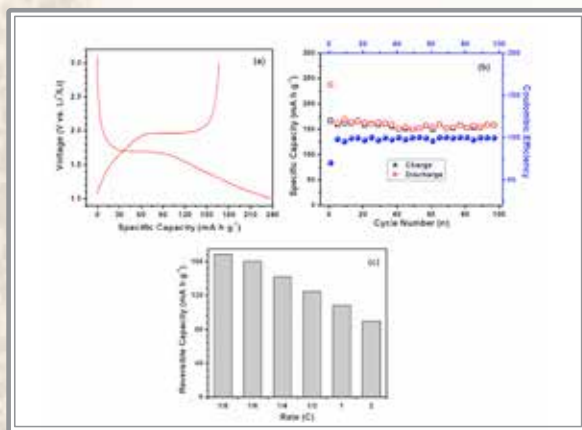


Fig. 2. The galvanostatic voltage profiles between 1 and 3.1 V for the first cycle (a), the discharge/charge capacity profile and Coulombic efficiency between 1 and 3.1 V voltage window and C/6 up to the hundredth cycle (b), and cycling and rate performance (c) of the mesoporous NTO electrode cycled at C/8, C/6, C/4, C/2, 1C, and 2C.

The Double Role of p-Toluenesulfonic Acid in the Formation of ZnO Particles with Different Morphologies

The role of p-toluenesulfonic acid (p-TSA) as a catalyst and/or morphology-directing agent for the formation of ZnO particles with different sizes (20 to 250 nm) and shapes (from bullet-like to complex, cauliflower architectures) was studied. The catalytic role of the p-TSA was pronounced when the p-TSA concentration was kept low, while an elevated acid concentration inhibits the reac-

tivity of the ZnO precursor toward the alcoholysis, presumably due to the adhesion of the p-TSA on its surface. The abundance of ZnO surface chelation with the p-TSA controls the ZnO particle growth and shape as well as the self-assembly of ZnO nanocrystals into complex architectures (Ambrožić et al., 2010).

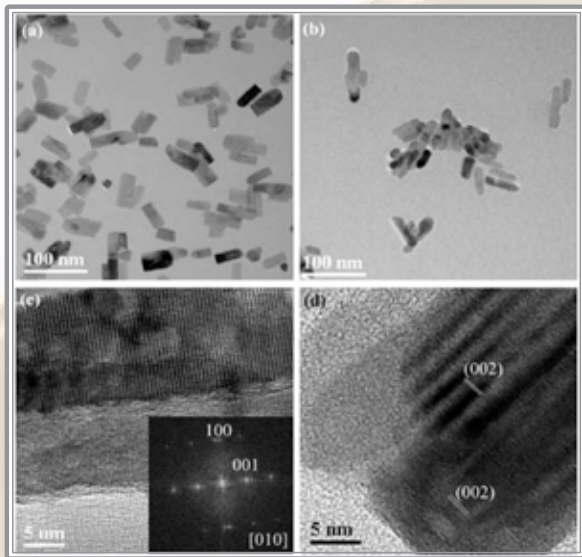


Fig. 3. (a) Overview TEM image of ZnO nanorods prepared with the assistance of p-TSA (0.02 mmol, 5 h). (b) Overview TEM image of ZnO nanorods prepared without the assistance of p-TSA. (c) HRTEM image of ZnO nanorods described in (a). The corresponding power spectrum of the nanorod displayed in the upper part of Fig. 1(c) is shown in the inset. (d) HRTEM image of the ZnO nanorods prepared without the assistance of the p-TSA.

EDUCATION

Members of the Division of Materials Physics teach 10 graduate and 4 post-graduate courses in physics and related topics at the Faculty of Sciences, **Faculty of Electrical Engineering and Computing**, Faculty of Chemical Engineering and Technology in Zagreb and elsewhere.

Research programs

1. Synergy of nanophases and nanocomposites, Aleksandra Turković
2. Basic properties of nanostructures and defects in semiconductors and dielectrics, Branko Pivac

3. Doped optoelectronic and ceramic nanomaterials, Biserka Gržeta
4. The thin film silicon alloys on the amorphous to crystalline transition, Davor Gracin
5. Thin Films of Novel Amorphous or Nanostructured Materials, Nikola Radić
6. Semiconductor materials for optoelectronics and nanotechnology, Branko Šantić
7. Physics and application of nanostructures and bulk matter, Krešimir Furić
8. Organizational processes and optical interactions in condensed molecular systems, Stjepan Lugomer

Program supported by the Ministry of Science, Education and Sports

1. Advanced materials and applications for energy conversion and storage, Branko Pivac

Research, developmental and international projects

1. Study of defects in semiconductors irradiated by fast neutrons (B. Pivac, PI) (Croatian-Slovenian bilateral project 2009-2010)
2. Influence of quantum confinement on vibrational properties in nanocrystalline silicon (D. Gracin, Croatian-Slovenian bilateral project)
3. Nanocrystalline silicon as a possible candidate for "third generation" of solar cells (D. Gracin, Croatian-Slovenian bilateral project)
4. Laser-induced surface self-organization: formation of surfaces with special properties, Stjepan Lugomer (Croatia-Hungary)
5. Atom probe tomography and electrical characterization of doping in Germanium (I. Capan, PI) (COGITO Croatian-French bilateral project 2009-2010)
6. Study of oxygen precipitation and structural defects in single crystal silicon (B. Pivac, PI) (Croatian - Chinese Scientific and Technological Cooperation)
7. Silicon nanocrystals solar cells ... Properties and characterization ((I. Capan, PI, Unity Through Knowledge Fund – Young Researchers Program; 01.10.2009 - 30.09.2011)

8. The origin of structural defects in silicate glasses and their effects upon the properties, Davor Gracin, (National Science Foundation of Croatia)

AWARDS

Dr.sc. Maja Buljan won the Annual RBI Director's Award for excellence in scientific research and publishing in highly rated scientific journals.

Dr.sc. Davor Gracin and Dr.sc. Branko Pivac, respectively, won the Annual RBI Director's Award as recipients of competitive grants (greater than 70.000 EUR).

SELECTED ORGANIZED CONFERENCES

Maja Buljan received the RBI Director's Award for scientific excellence in 2010. Davor Gracin and Branko Pivac received the RBI Director's Award as recipients of competitive grants (greater than 70.000 EUR).

SELECTED PUBLICATIONS

1. Ambrožič G, Djerdj I, Škapin S, Žigon M, Crnjak Orel Z. The Double Role of p-Toluenesulfonic Acid in the Formation of ZnO Particles with Different Morphologies. *CrystEngComm* **12** (2010) 1862.
2. Buha J; Arcon D; Niederberger M; Djerdj I. Solvothermal and surfactant-free synthesis of crystalline Nb₂O₅, Ta₂O₅, HfO₂, and Co-doped HfO₂ nanoparticles. *Phys Chem Chem Phys* **12** (2010) 15537.
3. Buljan M, Grenzer J, Holy V, Radić N, Mišić-Radić T, Levichev S, Bernstorff S, Pivac B, Capan I. Structural and charge trapping properties of two bilayer (Ge+SiO₂)/SiO₂ films deposited on rippled substrate. *Appl Phys Lett* **97** (2010a) 163117.
4. Buljan M, Pinto SRC, Rolo AG, Martin-Sanchez J, Gomes MJM, Grenzer J, Muecklich A, Bernstorff S, Holy V. Self-assembling of Ge quantum dots in an alumina matrix. *Phys Rev B* **82** (2010b) 235407.

5. Buljan M, Bogdanović Radović I, Karlušić M, Desnica U, Radić N, Skukan N, Dražić G, Ivanda M, Gamulin O, Matej Z, Valeš V, Grenzer J, Cornelius T, Metzger HT Holy V. Generation of an ordered Ge quantum dot array in an amorphous silica matrix by ion beam irradiation. *Phys Rev B* **81** (2010c) 085321.
6. Buljan M, Grenzer J, Keller A, Radić N, Valeš V, Bernstorff S, Cornelius T, Metzger HT, Holy V. Growth of spatially ordered Ge nanoclusters in an amorphous matrix on rippled substrates. *Phys Rev B* **82** (2010d) 125316.
7. Gupta SK, Desai R, Jha PK, Sahoo S, Kirin D. Titanium dioxide synthesized using titanium chloride: size effect study using Raman spectroscopy and photoluminescence. *J Raman Spect* **41** (2010) 350.
8. Kaper H, Sallard S, Djerdj I, Antonietti M, Smarsly BM. Toward a Low-Temperature Sol-Gel Synthesis of TiO₂(B) Using Mixtures of Surfactants and Ionic Liquids. *Chem Mater* **22** (2010) 3502.
9. Pinto SRC, Rolo A, Gomes MJM, Ivanda M, Bogdanović-Radović I, Grenzer J, Muecklich A, Barber DJ, Bernstorff S, Buljan M. Formation of void lattice after annealing of Ge quantum dot lattice in alumina matrix. *Appl Phys Lett* **97** (2010) 173113.
10. Stipčević M, Skenderović H, Gracin D. Characterization of a novel avalanche photodiode for single photon detection in VIS-NIR range. *Opt Express* **18** (2010) 17448.
11. Wang YD, Smarsly BM, Djerdj I. Niobium Doped TiO₂ with Mesoporosity and its application for lithium insertion. *Chem Mater* **22** (2010); 6624.
12. Zhang J, Su DS, Blume R, Schloegl R, Wang R, Yang X, Gajović A. Surface Chemistry and Catalytic Reactivity of a Nanodiamond in the Steam-Free Dehydrogenation of Ethylbenzene. *Angewandte Chem - Int Ed* **49** (2010) 8640-8644

SELECTED INVITED LECTURES

1. Buljan M, Desnica UV, Radić N, Pivac B, Dražić G, Bernstorff S, Cornelius T, Metzger H, Holy V. Production and design of regularly

- ordered quantum dot lattice in amorphous matrices. 13th Joint Vacuum Conference, Programme and Book of Abstracts, ed: Vesely, Marian; Vincze, Andrej; Vavra, Ivo. Štrbske Pleso, Slovačka, Slovak Vacuum Society, 2010, 97-97, date is missing
2. Turković A. SAXS Studies of TiO₂ Nanoparticles in Polymer Electrolytes, Second Regional Symposium on Electrochemistry, South-East Europe, Beograd, Srbija, June 6, 2010. Program & Book of Abstracts / Nikolić, Branislav ; Mišković-Stanković, Vesna, Dekanski, Aleksandar (ed.). -Beograd: Serbian Chemical Society, 2010. 15-15.
 3. Radić N. C/W nanolaminates - alternating various C & W phases. E-MRS Spring Meeting, Symposium L: "Carbon- or Nitrogen-containing Nanostructured Composite Films, Strasbourg, France, June 7-11, 2010.
 4. Desnica U. *Electricity from the Sun: A Bright Future Shines on PV*. 10th International Conference: "ECSAC 10 - Sustainable Energy: Challenges and Opportunities", Lošinj, Croatia, August, 23-27, 2010.
 5. Desnica U. Sustainable Energy: Challenges and Opportunities. 22nd Conference „Energy and Environment 2010“, Opatija, Croatia, October, 19-23, 2010.



DIVISIONAL ORGANIZATION

Head: Hrvoje Zorc

The Division of Laser and Atomic R&D consists of the following laboratories:

- ⇒ Laboratory of Optics and Thin Films, Vesna Janicki
- ⇒ Multipurpose workshops, Eduard Švegel



of multispectral/hyperspectral images; basis learning algorithms for efficient (sparse) representation of signals.

OVERVIEW OF THE DIVISION

The mission of the Division is to expand and strengthen knowledge in the field of imaging and non-imaging optics, photonics and the fundamentals of optical thin films. In addition, we are involved in activities directed to the application of these basic disciplines to the field of national security.

The Division is currently developing several strategic projects. These include modelling of thin films mixtures using effective medium theories, research on plasmonic properties of metallic nanoclusters, use of plasmonic materials in optical multilayer design, characterization and modelling of very thin metallic layers, blind and semi-blind signal processing, sparse component analysis with applications in chemometrics, use of a tensor factorization approach to blind separation of multidimensional signals with applications in blind image deconvolution and blind decomposition

TOP ACHIEVEMENTS

Optical thin films

We continue with our research on the plasmonic properties of the metal island films (MIF) and their applications. Such films show unique optical properties due to the surface plasmon resonance (SPR) of electrons in metal clusters. By varying conditions in the preparation of these films, the structural and geometrical properties of the clusters can be varied, enabling tuning of optical properties of the films. Structural and optical characterization are carried out by different techniques (AFM, GISAXS, RBS, ellipsometry), in the framework of international cooperation. Electric field assisted dissolution (EFAD) of metal clusters, involving instantaneous application of electric field and increased temperature enables structuring of such films.

The width of the SPR of metal particles increases as the particle size reduces due to

confinement effects that modify the metal dielectric function. In the limit of very low particle concentration, particle size can be directly related to the plasmon width. It is shown (1) that for noble metals the contribution of interparticle interaction to SPR width cannot be neglected even at volume concentrations of a few per cent. These results can be useful in extending nanoparticle sizing from optical extinction spectroscopy beyond the dilute limit required by classical Mie theory.

Application of EFAD to MIF, followed by thermal annealing, results in the formation of metal nanoparticles embedded in a glass matrix. The results suggest that the depth profile of metal particles might be tailored by modification of the parameters of metal film dissolution. Variation of thermal annealing parameters allows control of the nanoparticles size. Thus, the surface plasmon absorption intensity and line shape are changed, enabling tuning of the optical properties of the sample.

Three dimensional (3D) photonic microstructures are produced by the locally selective EFAD of metal clusters embedded in

dielectric multilayer stacks (Figure 1). The produced structures show a highly tailorable optical behaviour that combines the interferential effects of multilayer stacks and the SPR of non dissolved metal clusters (Figure 2). Due to its feasibility and the possibility to widely modify the optical properties of the resulting structures, the current approach represents a promising method for the production of novel components based on 3D-metallodielectric photonic structures.

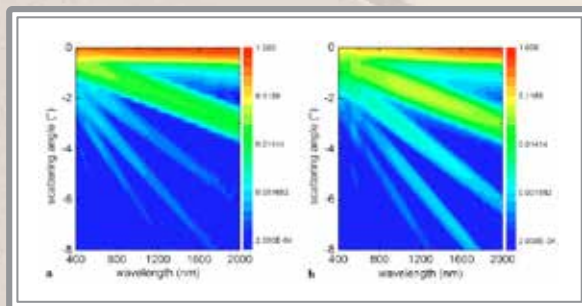


Fig. 2 Wavelength-dependence of diffraction pattern of multilayer structures produced by EFAD treatment: (a) multilayer structure BK7/(Ag/SiO₂)₅ with thickness of 7 nm of Ag and 100 nm of SiO₂ and (b) multilayer structure BK7/(X/SiO₂)₅, in which X represents a multilayer of Ag and SiO₂ films.

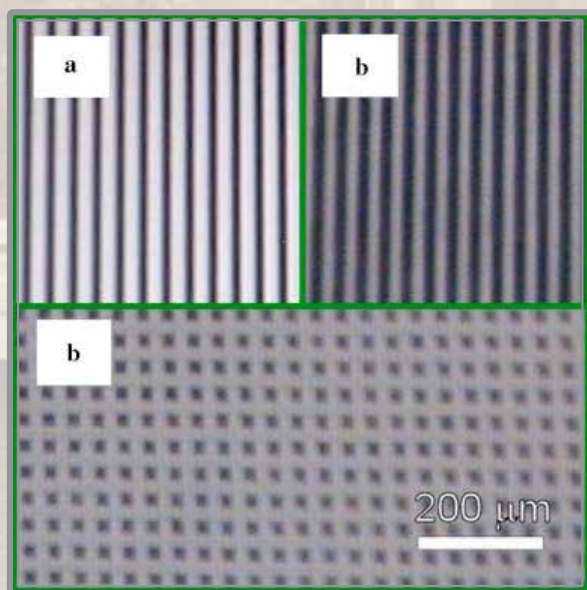


Fig. 1: Optical microscopy pictures of the grating used as electrode (a), multilayer sample after EFAD process (b) and multilayer sample after two consecutive EFAD treatments, with the electrode rotated 90° in the second treatment (c).

Signal processing

A conceptually novel sparseness-based multivariate data analysis method was developed and applied to blind separation of analytes from mixtures recorded in various types of spectroscopic and spectrometric measurements (Kopriva and Jerić, 2010). As opposed to many existing blind decomposition schemes, the present concept is capable of estimating: the number of analytes, the matrix of their concentration profiles and the analytes themselves, from available mixtures. The number of analytes can be less than, equal to or greater than the number of mixtures. The method is exemplified on a blind extraction of four analytes from three mixtures using 2D NMR spectroscopy (COSY spectra) and five analytes from two mixtures using mass spectrometry. The proposed methodology is of widespread signifi-

cance with the main application being natural products research and the field of metabolic studies, wherein mixtures represent samples isolated from biological fluids such as urine, blood, plasma, etc. Moreover, the proposed method can be applied to solve important problems in systems biology such as the reconstruction of transcription factors in gene regulating networks.

Blind image deconvolution (BID) refers to the problem of restoring the image from its blurred observation provided that point spread function (PSF) of the medium is unknown. The majority of existing BID methods rely on *a priori* information and assume that a PSF is space invariant with a known model. An image restoration method that works in a completely blind scenario is developed in: I. Kopriva, Optics Express vol. 18, pp. 17819-17833, 2010, . The method is experimentally demonstrated on single- and multiframe static and dynamic multispectral images blurred by: defocusing, atmospheric turbulence and a grating (photon sieve). This is accomplished by means of the multilinear SVD algorithm known as higher order orthogonal iteration (HOOI) method. A comparable or better performance is demonstrated in relation to the blind Richardson-Lucy algorithm which, however, requires *a priori* information about parametric model of the blur.

A novel dependent component analysis (DCA)-based approach to demarcation of basal cell carcinoma (BCC) through unsupervised decomposition of the red-green-blue (RGB) fluorescent image of the BCC is presented in: I. Kopriva *et al.*, Journal. Photochem. Photobiol. B, vol. 100, pp. 10-18, 2010. The method exhibits robustness against intensity fluctuation which is due to the scale invariance property of DCA algorithms, since they exploit spectral and spatial diversities between the BCC and the surrounding tissue. By comparative performance analysis with state-of-the-art image segmentation methods such as active contours (level set), K-means clustering, non-negative matrix factorization, ICA

and ratio imaging we experimentally demonstrate good performance of DCA-based BCC demarcation in two demanding scenarios where intensity of the fluorescent image has been varied almost two-orders of magnitude.

EDUCATION

1. Blind signal separation and independent component analysis, graduate course, Faculty of Electrical Engineering and Computing, University of Zagreb (Kopriva, Ivica).
2. Laboratory of Physical Optics, Study of Ophthalmic Optics, Polytechnic College in Velika Gorica (Lončarić, Martin).
3. Laboratory of Geometrical Optics, Study of Ophthalmic Optics, Polytechnic College in Velika Gorica (Lončarić, Martin).

AWARDS

Ivica Kopriva and Jordi Sancho-Parramon received the RBI Director's Award for scientific excellence in 2010.

Hrvoje Zorc received the RBI Director's Award as a recipient of an IPA project grant financed by the European Union.

PROJECTS

Projects supported by the Ministry of Science, Education and Sports

1. Analysis of multispectral data, Ivica Kopriva
2. Optical properties of nanostructured layers, Hrvoje Zorc

Research, developmental and international projects

1. Optical properties of metal nanoparticles embedded in dielectric multilayers, Project in collaboration with Institute of Nanostructured Materials and Photonics, Weiz, Austria, Zorc H.

2. Collaboration in development of optical systems for the company HS Produkt, Croatia
3. Collaboration with Dr. Salvador Bosch (University of Barcelona) on Mueller matrix properties of single particle scattering
4. Collaboration on algorithms for nonnegative matrix and tensor factorizations and their applications in chemometrics and multispectral image analysis with Professor Andrzej Cichocki (Laboratory for Advanced Brain Signal Processing, Brain Science Institute, RIKEN, Japan).

SELECTED INVITED LECTURES

1. I. Kopriva. Tensor Factorization Approach to Blind Separation of Multidimensional Sources, Virginia Commonwealth University, Department of Computer Science, Richmond, VA, USA, February 17, 2010.
2. I. Kopriva. Tensor Factorization Approach to Blind Separation of Multidimensional Sources, The George Washington University, School of Engineering and Applied Science, Department of Electrical and Computer Engineering, Washington D.C., USA, February 19, 2010.
3. The paper: I. Kopriva, I. Jerić (2009). Multi-component Analysis: Blind Extraction of Pure Components Mass Spectra using Sparse Component Analysis, *Journal of Mass Spectrometry*, vol. 44, issue 9, pp. 1378-1388, has been selected as one of the most novel and groundbreaking contributions in the field of chemometrics in the years 2008 and 2009 in a review article: B. Lavine, J. Workman (2010). Chemometrics, *Analytical Chemistry*, vol. 82, pp. 4699-4711.

SELECTED PUBLICATIONS

1. Sancho-Parramon J, Janicki V, Zorc H. On the dielectric function tuning of random metal-dielectric nanocomposites for metamaterial applications, *Opt Express* **18** (2010) 26915.
2. Sancho-Parramon J et. al. Optical and structural properties of silver nanoparticles in

glass matrix formed by thermal annealing of field-assisted film dissolution. *Opt Mater* **32** (2010) 510.

3. Janicki Vet. al., Three-dimensional photonic microstructures produced by electric field assisted dissolution of metal nanoclusters in multilayer stacks. *Appl Physics B - Laser Opt* **89** (2010) 93.
4. Kopriva I, Jerić I (2010). Blind separation of analytes in nuclear magnetic resonance spectroscopy and mass spectrometry: sparseness-based robust multicomponent analysis. *Anal Chem* **82** (2010) 1911.
5. Kopriva I, Peršin A, Puizina-Ivić N, L. Mirić L. Robust demarcation of basal cell carcinoma by dependent component analysis-based segmentation of multi-spectral fluorescence image. *J Photochem Photobiol B - Biol* **100** (2010) 10.
6. Kopriva I. Tensor Factorization for model-free space-variant blind deconvolution of the single- and multi-frame multi-spectral Image, *Opt Express* **18** (2010) 17819.

PEER REVIEWED CONFERENCE PAPERS

1. I. Kopriva, A. Peršin (2010). 3D tensor-based blind multi-spectral image decomposition for tumor demarcation, accepted for *SPIE Medical Imaging-Image Processing*, San Diego, CA, USA, February 13-18, 2010.
2. I. Kopriva, A. Cichocki (2010). Nonlinear Band Expansion and 3D Nonnegative Tensor Factorization for Blind Decomposition of Magnetic Resonance Image of the Brain. *Proceedings of 9th International Conference on Latent Variable Analysis and Signal Separation*, Lecture Notes Computer Science 6365, pp. 490-497, V. Vigneron (editor), September 27-30, 2010, Saint Malo, France.
3. META 10, 2nd International Conference on Metamaterials, Photonic Crystals and Plasmonics, Multilayer based interferential-plasmonic structure: metal cluster 3D grating combined with dielectric mirror 22-25 February 2010. Cairo, Egypt, V. Janicki, J. Sancho-Parramon,

4. META 10, 2nd International Conference on Metamaterials, Photonic Crystals and Plasmonics, 22-25 February 2010. Cairo, Egypt, J. Sancho-Parramon, V. Janicki, M. Lončarić, H. Zorc, P. Dubček, S. Bernstorff, Optical and structural properties of silver-gold islands films for plasmonic application,

5. OIC - Optical Interference Coatings 2010, Tucson USA, V. Janicki, J. Sancho-Parramon, H. Zorc, Gradient silver nanoparticle layers in absorbing coatings - experimental study
6. OIC - Optical Interference Coatings 2010, Tucson USA, H. Zorc, M. Lončarić, J. Sancho-Parramon, V. Janicki, Use of Gold Island Films in Design of Reflectors with High Luminosity



DIVISIONAL ORGANIZATION

Head: Tomislav Šmuc

The Division of electronics consists of two laboratories and one group:

- ⇒ Laboratory for information systems, Dragan Gamberger
- ⇒ Laboratory for stochastic signals and processes research, Branka Medved Rogina
- ⇒ Computational biology and bioinformatics group, Tomislav Šmuc



one **EU-FP7 Collaborative Project** and one COST project. During that year two PhD students finished their PhD theses and one student received a Croatian Science Foundation research grant. In 2010 we organized the celebration of 60 years of electronics and computing at the Institute with invited talks presented by former RBI prominent scientists V. Radeka, B. Souček, L. Budin and B. Jeren.

OVERVIEW OF THE DIVISION

The main topics of research in the Division of Electronics combines research in the fields of artificial intelligence (machine learning and intelligent data analysis methods, knowledge representations for information systems) with advanced measurement techniques and signal analysis. Emphasis is placed on tailored applications of these techniques in biomedicine, computational biology and bioinformatics, but also in engineering and economics, which is reflected in the multi-disciplinary character of our collaborations and publications record. Senior Division members contribute significantly to the graduate and post-graduate curricula of the University of Zagreb through a number of graduate engineering courses and PhD courses in bioinformatics and biomedicine.

In addition to long term research projects supported by the Ministry of Science, Education and Sport, in 2010 the Division obtained

TOP ACHIEVEMENTS

Knowledge technologies and computer science

e-LICO project

On June 1st, 2010 the Division of Electronics began work on the EU project e-LICO (e-Laboratory for Interdisciplinary Collaborative Research in Data Mining and Data-Intensive Sciences; FP7 STREP), leading activities in a work package on Personalization and recommendation services for digital multimedia repositories. This project represents a coupling of e-science computational infrastructure like Taverna, with open source data mining package Rapid Miner and their joint enactment via planning and meta-learning tools. Experimental demonstration of this new extension is focused in two different application domains;

one of these domains is biomedical, the other (lead by DEL members) is in the field of digital multimedia repositories and recommender systems.

Detection of genes optimized for translation using machine learning approach

Codon usage bias in prokaryotic genomes is largely a consequence of background substitution patterns in DNA, but highly expressed genes may show a preference towards codons that enable more efficient and/or accurate translation. A novel approach based on Random Forest classifier detects effects of translational selection on genes of prokaryotic organisms. In the largest genomic study to date (461 examined prokaryotic genomes); our method has shown evidence that translational selection in prokaryotes is practically universal. This approach outperforms previous distance measure-based approaches, such as the codon adaptation index. Unlike state-of-the-art results in this field, our method has shown evidence that translational selection in prokaryotes is practically universal, as depicted in Fig. 1. (Suppek et al., 2010).

Advanced signal processing techniques and measurement systems

Adapting complex procedures for real-time applications

The algorithm for approximation of multidimensional systems by self-organizing GMDH-type polynomial neural networks is adapted for modelling the calculation of complex procedures in real-time measurements. The self-organized polynomial neural networks may achieve high approximation accuracies at low complexities and are simple to implement in digital computers. The efficiency of the algorithm is demonstrated by constructing a surrogate model (Fig. 2.) of a computationally

intensive natural gas flowrate error correction procedure, which enables direct compensation of thermodynamic effects in real-time using low-computing power microcomputer (Marić and Ivek, 2010).

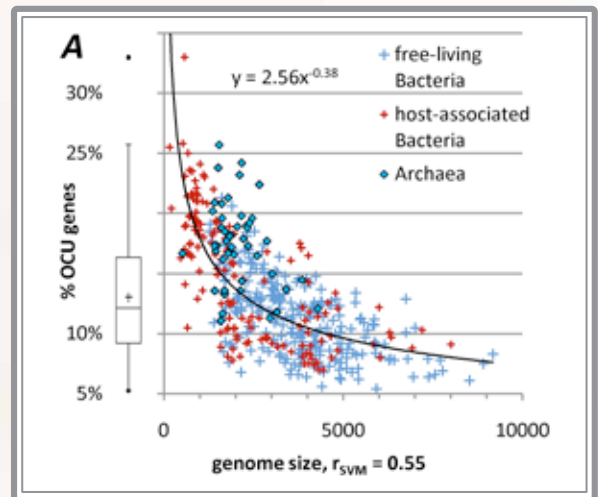


Fig. 1. Prevalence of codon usage optimized genes in prokaryotic genomes.

FPGA based embedded systems for ambient assisted living applications

In collaboration with our Hungarian partners we evaluated the potential of field programmable gate array (FPGA) devices for use in ambient assisted living (AAL) applications. One of the focuses was a video monitoring based AAL system that supervises and assists the everyday living activities of elderly people, people with disabilities, and those who are in need of rehabilitation. Such systems demand high computer power to enable event recognition and decision on action (e.g. raising alarm) to be embedded into the camera itself (smart camera). We have developed and integrated various video signal filters into an FPGA based video capture system. A search for the minimal value is performed using minimum search tree shown on figure (Fig. 3.). The tree structure is used because it allows parallelism, and also because it can be pipelined should timing constraints require it. All elements in the same column have inputs that are mutually independ-

ent and are executed in parallel. FPGAs have been found to be well suited for such video processing applications.

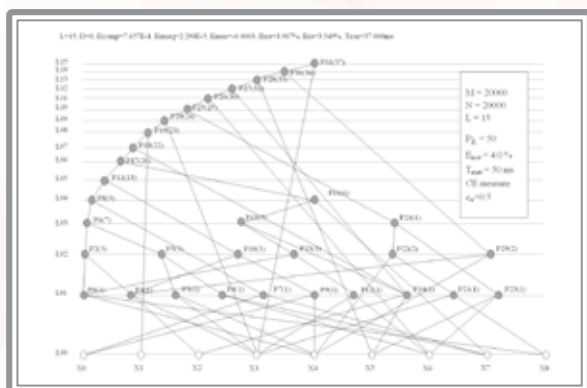


Fig. 2. Self-organized polynomial neural network for flowrate error correction.

Accelerometry based measurements in analysis of human systems motion

In the investigation of the sufficiency of using accelerometry based measurements in analysis of human systems motion we focused on mandible kinematics. The results show that accelerometry is a more than adequate method for capturing different kinematic patterns of mandible open-closing cycles using wavelet analysis of respective accelerometric data. Different positions of the head during jaw movements are clearly identified using specially designed wavelet coefficient functions. Resolution capability of the method indicates the possibility to use it for detection and quantification of different mandible pathologies that are manifested in restricted jaw kinematics. This work has resulted in a PhD thesis.

The research of human walk fractal features extraction and characterization, in collaboration with the Faculty for Kinesiology, University of Zagreb, results in introduction of a new method for fractal features detection and quantification that was established through several publications (Michieli et al., 2010). Adequacy of the method was verified on human locomotion data (stride intervals) for healthy subjects and subjects with Huntington disease (Fig. 4.)

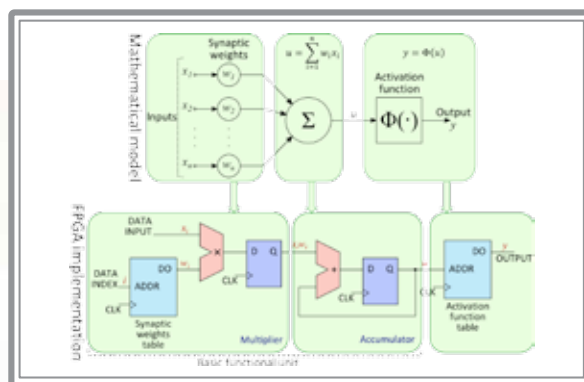


Fig. 3. Schematic of an FPGA video capture system

EDUCATION

In 2010, the members of the Division continued to be involved in lecturing undergraduate, graduate and doctoral courses in the Faculty of Electrical Engineering and Computing, the Faculty of Sciences and School of Medicine of the University of Zagreb. Two students completed their PhD theses.

Research projects supported by the Ministry of Science, Education and Sports

1. Machine Learning Algorithms and their Application, Dragan Gamberger
2. Computational Intelligence Methods in Measurement Systems, Ivan Marić
3. Real Life Data Measurement and Characterization, Branka Medved Rogina
4. Machine Learning of Predictive Models in Computational Biology, Tomislav Šmuc

Research, developmental and international projects

1. e-LICO: An e-Laboratory for Interdisciplinary Collaborative Research in Data Mining and Data-Intensive Science (**EU-FP7 Collaborative Project**), Tomislav Šmuc, Dragan Gamberger
2. Reconfigurable embedded systems based assistive applications for elderly people (Croatian-Hungarian Intergovernmental S&T Programme), Branka Medved Rogina

3. Inductive Rule Learning (Croatian-Slovenian Intergovernmental S&T Programme), Dragan Gamberger
4. The Emergence of Southern Multinationals and their Impact on Europe (COST IS0905 action), Dragan Gamberger

Research programs supported by the Ministry of Science, Education and Sports

1. Computational knowledge discovery in scientific applications, Dragan Gamberger

AWARDS

Ivan Marić, Tomislav Šmuc and Fran Supek received the RBI Director's Award for scientific excellence and international project in the field of electronics in 2010.

Matko Bošnjak and Dragan Gamberger (as a RandomGuy team) won second place at RSCTC'2010 basic track of a discovery challenge. The challenge has been organized as a part of The Seventh International Conference on Rough Sets and Current Trends in Computing, about 80 teams took part from different institutions and the task has been prediction of classes based on measured gene expression values.

ORGANIZED CONFERENCE

60 years of electronics and computing at the Institute, Zagreb, Croatia, May 31, 2010. Karolj Skala and Tomislav Šmuc

SELECTED PUBLICATIONS

1. Supek F, Škunca N, Repar J, Vlahoviček K, Šmuc T: Translational Selection Is Ubiquitous in Prokaryotes. *Plos Genetics* **6** (2010) e1001004-1.
2. Supek F, Šmuc T: On relevance of codon usage to expression of synthetic and natural genes in *Escherichia coli*. *Genetics* **185** (2010) 1129.
3. Gredičak M, Supek F, Kralj M, Majer Z, Hollosi M, Šmuc T, Mlinarić-Majerski K, Horvat Š. Computational structure-activity study directs synthesis of novel antitumor enkephalin analogs. *Amino acids* **38** (2010) 1185.
4. Marić I, Ivek I: Compensation for Joule-Thomson effect in flow rate measurements by GMDH polynomial. *Flow Meas Instrum* **21** (2010) 134.
5. Michieli I, Medved Rogina B, Ristov S: Data series embedding and scale invariant statistics. *Hum Movement Sci* **29** (2010) 449.
1. Lavrač N, Fuernkranz J, Gamberger D: Explicit Feature Construction and Manipulation for Covering Rule Learning. *Studies in Computational Intelligence*. Koronacki J (ed). Berlin, Springer-Verlag, 2010. pp. 121-146.
2. Daciuk, Jan; Piskorski, Jakub; Ristov, Strahil. NLP Dictionaries Implemented as FSAs. *Mathematics, Computing, Language, and Life: Frontiers in Mathematical Linguistics and Language Theory - Vol. 2 Scientific Applications of Language Methods*. Martín-Vide C (ed), London: World Scientific & Imperial College Press, 2010. pp. 133-204.
3. Prčela M, Gamberger D, Šmuc T, Bogunović N: Information gain of structured medical diagnostic tests: Integration of Bayesian networks and ontologies. *Proceedings of International Conference on Biomedical Engineering Systems and Technologies*. Fred A, Filipe J, Gamboa H (eds). Portugal: Institute for Systems and Technologies of Information, Control and Communication, 2010. pp 235-240.
4. Sluban B, Gamberger D, Lavrač N: Advances in class noise detection. *Proc. of 19th European Conference on Artificial Intelligence, ECAI 2010*. Coelho H, Studer R, Wooldridge M (eds). 2010. pp. 1105-1106.

DIVISIONAL ORGANIZATION

Head: Aleksandar Sablijić

- ⇒ Laboratory for Chemical Kinetics and Atmospheric Chemistry, Branka Kovač
- ⇒ Theoretical Chemistry Group, Slobodan Bosanac
- ⇒ Laboratory of Chemical and Biological Crystallography, Marija Luić
- ⇒ Laboratory for Magnetic Resonances, Boris Rakvin
- ⇒ Laboratory for Synthesis and Processes of Selfassembling of Organic Molecules, Ivan Habuš



OVERVIEW OF THE DIVISION

The mission of the Division of Physical Chemistry is the discovery, exploitation, and dissemination of fundamental knowledge in the fields of protein science, coordination chemistry, spectroscopy, and computational and theoretical chemistry, in order to emerge as an internationally recognized Center of Excellence in selected areas of molecular research.

In 2010, members of the Division published more than 50 contributions in atmospheric chemistry, chemical kinetics, structural chemistry, theoretical chemistry, modeling of physical and chemical processes, peptides and proteins research, and in other

areas of bioscience. A significant number of papers were published in the highest ranking journals such as: Proceedings of the National Academy of Sciences of the USA, Dalton Transactions, Organic Letters, Physical Chemistry Chemical Physics, Journal of Physical Chemistry A, ChemBioChem, CrystEngComm, and Journal of the American Society for Mass Spectrometry. Half of these publications resulted through domestic and international collaborations. A number of fruitful international collaborations demonstrate a strong presence of the Division in the European Research Area. Division members also contribute extensively (about 30 courses) to undergraduate and post-graduate education in Croatia. Last but not least, division members organized the 12th BRIJUNI CONFERENCE – Sustainable Sources of Energy a traditionally held international conference which included the participation of Nobel laureates. This highly regarded series of workshops has been supported by NATO and the Air Force Office of Scientific Research.

TOP ACHIEVEMENTS

Homologs of aminoacyl-tRNA synthetases: a link between ribosomal and nonribosomal peptide synthesis

Aminoacyl-tRNA synthetases (aaRSs) are ancient and evolutionarily conserved enzymes that catalyze the formation of aminoacyl-tRNAs that are used as substrates for ribosomal protein biosynthesis. Recently discovered homologues of aminoacyl-tRNA synthetases, named amino acid:[carrier protein] ligases, aminoacylate carrier proteins instead of tRNA. The enzymatic activity of aSerRS homologues is reminiscent of adenylation domains in nonribosomal peptide synthesis, and thus they represent an intriguing link between programmable ribosomal protein biosynthesis and template independent nonribosomal peptide synthesis (Močibob et al., 2010).

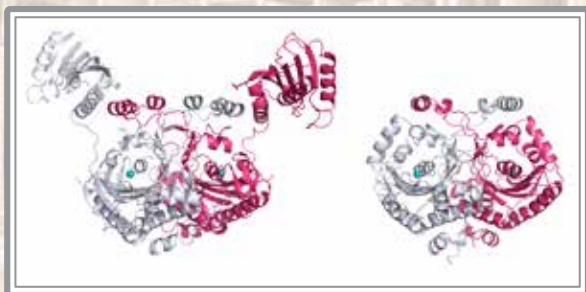


Fig. 1. Structural comparison of atypical seryl-tRNA synthetase (left) and glycyl:[carrier protein] ligase (right).

Resorcin[4]arene: A biomimetic model of the mononuclear metalloenzyme active site

The bowl-shaped resorcin[4]arene-based ligand bearing three imidazol coordination arms, represents a structural biomimetic model of the ubiquitous trihistidine coordination core in the active sites of many mononuclear metalloenzymes, was prepared through a seven-step synthetic procedure. The CH₂-O-CH₂- linkers have been designed to allow all three imidazoles to simultaneously bind

a metal ion and to favor a cis-coordination of two exchangeable external ligands. The corresponding two mononuclear Zn(II) complexes (perchlorato- and acetato-complexes) were prepared and shown to be capable of the selective guest binding and exchange at both endo and exo positions relative to the bowl-shaped cavity (Višnjevac et al., 2010).

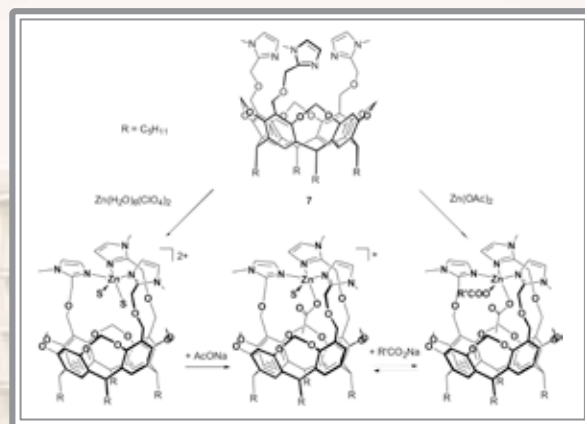


Fig. 2. Selective and reversible binding of the guest molecules at the endo- and exo-positions in the model complex.

Pd(II) emitters at ambient temperatures

The first examples of azobenzene/bipyridine palladacycles in which azobenzenes act simultaneously as monodentate C- and bidentate C,N-donors have been synthesized and fully characterized (Juribašić et al., 2010). The cleavage of one Pd-N bond in double cyclopalladated azobenzenes enables positioning of both Pd atoms onto the same side of azobenzene ligand and sig-

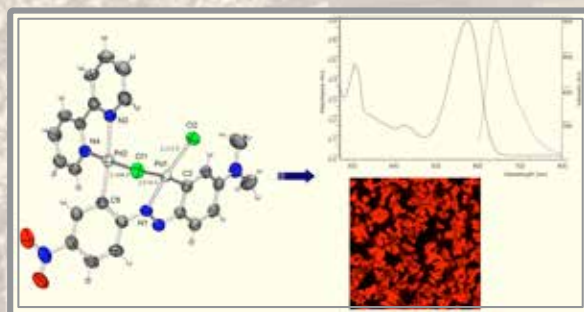


Fig 3. Azobenzene/bipyridine palladacycle as Pd(II) emitter in the solution and in the solid-state.

nificant Pd...Pd interaction and such interactions play an important role in luminescence of azobenzene/bipyridine palladacycles in both solution and solid state. These complexes are rare examples of Pd(II) emitters in solution and solid state at ambient temperatures.

Secondary structure formation in protected dipeptides

A benchmark study of the conformational preferences of small peptides: Ac-Xxx-Phe-NH₂, Xxx = Gly, Ala was performed with the local second-order Moller-Plesset method. We were able to identify the experimentally observed conformers as γ L- γ L(g-) and β -turn I(g+) in Ac-Gly-Phe-NH₂, and Ac-Ala-Phe-NH₂, and as the closely related γ L(g+)- γ L(g-) and β -turn I(a,g+) in Ac-Val-Phe-NH₂. We have shown that in Ac-Val-Phe-NH₂ the minimum energy structure corresponds to the β -strand in contrast to the experimental observation that peptides with bulky side chain have a propensity for β -turns, (Šarić et al., 2010).



Fig 4. Flexibility of the N-terminus in β L-structures. Four structures are superimposed: β L- β L(a) of Ac-Gly-Phe-NH₂ (green) and Ac-Ala-Phe-NH₂ (red) and two Ac-Val-Phe-NH₂ structures, β L(a)- β L(a) (blue) and β L(g-)- β L(a) (magenta).

Thermal and structural study of mesomorphic dodecylammonium carrageenates

Structural characteristics and thermal stability of a series of dodecylammonium carrageenates, formed by stoichiometric

complexation of cationic surfactant, dodecylammonium chloride and oppositely charged biopolymers, were investigated. IR spectral analysis confirmed the electrostatic and hydrogen bond interactions between the dodecylammonium and carrageenan species while X-ray diffraction showed an increased ordering in the complexes compared to that of the parent carrageenans. Dodecylammonium carrageenates have a layered structure, in which a polar sublayer contains layers of carrageenan chains and a nonpolar sublayer consists of conformationally disordered dodecylammonium chains electrostatically attached to the carrageenan backbone and the major factor that determines the dodecylammonium carrageenate structure is the cationic surfactant, while the carrageenans moiety plays a major role in determining thermal properties (Vinceković et al., 2010).

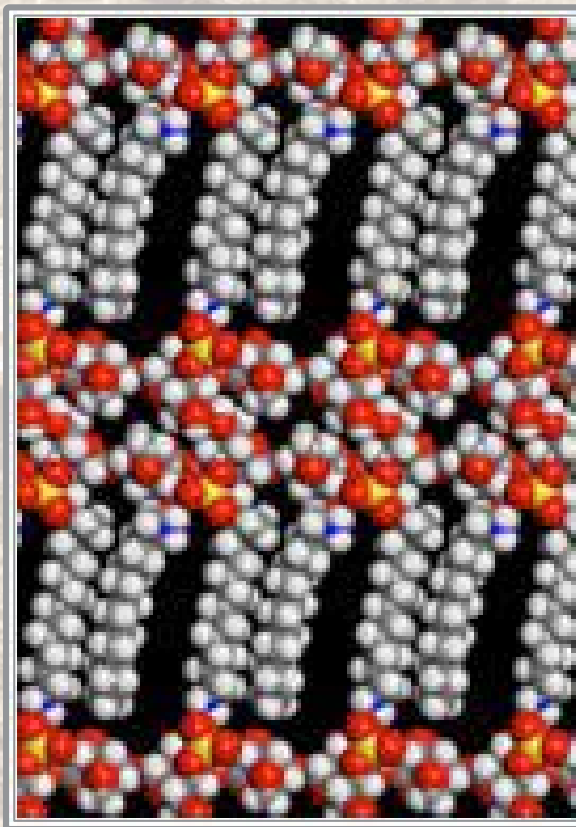


Fig 5. Model of DDAkC in the layered LC state after a short annealing dynamics simulation: carbon (gray), hydrogen (white), oxygen (red), sulphate (yellow), nitrogen (blue).

EDUCATION

Division members provided more than 30 undergraduate and graduate courses at the Universities of Zagreb, Split, Rijeka, Osijek and Dubrovnik.

AWARDS

Nives Ivić received Annual Award of "The Society of University Teachers, Scholars and Other Scientists – Zagreb" for young scientists and artists.

Nives Ivić, Marija Luić and Aleksandar Višnjevac received the RBI Director's Award for scientific excellence in 2010.

PROJECTS

Projects supported by the Ministry of Science, Education and Sport

1. Molecular structure and dynamics of systems with paramagnetic particles, Boris Rakvin
2. Surfactants, processes in solutions and at interfaces, Nada Filipović-Vinceković
3. Measurement and effect of atmospheric oxidants, Leo Klasinc
4. Advanced studies on chemical reactivity, Aleksandar Sabljčić
5. Developing methods for modelling properties of bioactive molecules and proteins, Nenad Trinajstić
6. Design, synthesis and properties of organic ligands and their metal complexes, Manda Čurić
7. Protein-ligand interactions at atomic level, Marija Luić
8. Spectroscopy, chemical properties and reactions of biologically active molecules, Branka Kovač
9. Control of atomic and molecular dynamics by shaped electromagnetic fields, Nađa Došlić
10. Computational study of bio-macromolecules and development of new algorithms, Sanja Tomić

11. Development of mathematical methods for the description of molecular structure, dynamics and reactivity, Darko Babić
12. Amino-beta-lactams-synthrons for biologically interesting compounds, Ivan Habuš

Research, developmental and international projects

1. Development of new algorithms for the analysis of protein active sites, Z. Štefanić (Bilateral project with Slovenia)
2. Theoretical Study of Enzyme Reactions, S. Tomić (Bilateral project with Slovenia)
3. Mass spectrometry -based proteomic analysis: Characterisation of horseradish esterases and snake venom proteins, and mapping of *Fusarium parasites*, I. Leščić Ašler (Bilateral project with Austria)
4. Synthesis, identification and biological activity testing of novel beta lactam cholesterol absorption inhibitors, I. Habuš (Bilateral project with Austria)

SELECTED INVITED LECTURES

1. Ljubić I (2010) Study of mechanism and kinetics of reversible hydrogen storage in titanium doped sodium aluminum hydride. «Nano and Surface Science Approaches to Production and Storage of Hydrogen», Noordwijkerhout, The Netherlands, November 14-19, 2010.
2. Tomić S (2010) Human dipeptidyl peptidase III: Insights into ligands binding. «Fourth Humboldt Conference on Computational Chemistry», Varna, Bulgaria, July 12-15, 2010.
3. Bosanac S (2010) Dirac equation and its mysteries. Florida State University, Tallahassee, Florida, USA, February 11, 2010.

SELECTED ORGANIZED CONFERENCES

1. 12th BRIJUNI CONFERENCE – Sustainable Sources of Energy, Brijuni, Croatia, August 30 – September 3, 2010.

SELECTED PUBLICATIONS

1. Močibob M, Ivić N, Bilokapić S, Maier T, Luić M, Ban N, Weygand-Đurašević I. Homologs of aminoacyl-tRNA synthetases acylate carrier proteins and provide a link between ribosomal and nonribosomal peptide synthesis. *Proc Nat Acad Sci USA* **107** (2010) 14585.
2. Višnjevac A, Gout J, Ingert N, Bistri O, Reinaud O. First Zn(II) bowl-complexes modeling the tris(histidine) metallo-site of enzymes. *Org Letters* **12** (2010) 2044.
3. Dokli I, Matanović I, Hameršak Z. Sulfur ylide promoted synthesis of N-protected aziridines: A combined experimental and computational approach. *Chem Eur J* **16** (2010) 11744.
4. Juribašić M, Čurić M, Molčanov K, Matković Čalogović D, Babić D. Unusual azobenzene/bipyridine palladacycles: Structural, dynamical, photophysical and theoretical studies. *Dalton Trans* **39** (2010) 8769.
5. Ljubić I, Clary DC. Towards understanding a mechanism for reversible hydrogen storage: theoretical study of transition metal catalysed dehydrogenation of sodium alanate. *Phys Chem Chem Phys* **12** (2010) 4012.
6. Šarić A, Hrenar T, Mališ M, Došlić N. Quantum mechanical study of secondary structure formation in protected dipeptides. *Phys Chem Chem Phys* **12** (2010) 4678.
7. Molčanov K, Kojić-Prodić B. Salts and co-crystals of chloranilic acid with organic bases: is it possible to predict a proton transfer in a crystal? *CrystEngComm* **12** (2010) 925.
8. Tobien T, Bonifačić M, Naumov S, Asmus K-D. Time-resolved study on the reactions of organic selenides with hydroxyl and oxide radicals, hydrated electrons, and H-atoms in aqueous solution, and DFT calculations of transients in comparison with sulfur analogues. *Phys Chem Chem Phys* **12** (2010) 6750.
9. Leščić Ašler I, Ivić N, Kovačić F, Schell S, Knorr J, Krauss U, Wilhelm S, Kojić-Prodić B, Jaeger K-E. Probing enzyme promiscuity of SGNH hydrolases. *ChemBioChem* **11** (2010) 2158.
10. Kazazić S, Zhang H-M, Schaub TM, Emmett MR, Hendrickson CL, Blakney GT, Marshall AG. Automated data reduction for hydrogen/deuterium exchange experiments, enabled by high-resolution Fourier transform ion cyclotron resonance mass spectrometry. *J Am Soc Mass Spectrometry* **21** (2010) 550.
11. Bertoša B, Aleksić M, Karminski-Zamola G, Tomić S. QSAR analysis of antitumor active amides and quinolones from thiophene series. *Int J Pharmaceutics* **394** (2010) 106.
12. Rožman M, Gaskell SJ. Non-covalent interactions of alkalimetal cations with singly charged tryptic peptides. *J Mass Spectrometry* **45** (2010) 1409.
13. Vinceković M, Pustak A, Liu F, Ungar G, Tušek-Božić Lj, Bujan M, Šmit I, Filipović-Vinceković N. Thermal and structural study of mesomorphic dodecylammonium carrageenates. *J Colloid Interface Sci* **341** (2010) 117.
14. Rakvin B, Maltar-Strmečki N, Kattinig D, Grampp G. ENDOR study on the dynamic properties of the first stable paramagnetic center in gamma-irradiated L-alanine crystals. *J Phys Chem A* **114** (2010) 7500.
15. Gredičak M, Matanović I, Zimmermann B, Jerić I. Bergman cyclization of acyclic amino acid derived enediynes leads to the formation of 2,3-dihydrobenzo[f]isoindoles. *J Org Chem* **75** (2010) 6219.



Division of Organic Chemistry and Biochemistry

<http://www.irb.hr/en/zokb>

ZOKB

DIVISIONAL ORGANIZATION

Head: Kata Majerski

The Division of Organic Chemistry and Biochemistry (ZOKB) consists of the following laboratories:

- ⇒ Laboratory for stereoselective catalysis and biocatalysis, Zdenko Hameršak
- ⇒ Laboratory for synthetic organic chemistry, Kata Majerski
- ⇒ Laboratory for supramolecular and nucleoside chemistry, Mladen Žinić
- ⇒ Laboratory for carbohydrate, peptide and glycopeptide chemistry, Lidija Varga-Defterdarović
- ⇒ Laboratory for cellular biochemistry, Marija Abramić
- ⇒ Laboratory for physical organic chemistry, Davor Margetić
- ⇒ Laboratory for molecular spectroscopy, Goran Baranović
- ⇒ Laboratory for study of interactions of biomacromolecules, Ivo Piantanida
- ⇒ Group for quantum organic chemistry, David Smith



istry. Over 60 contributions were published, primarily in high-ranking chemical journals. Amongst a broad range of research topics, important contributions were made in areas such as synthetic and physical organic chemistry, stereoselective synthesis, supramolecular chemistry, including gels and host-guest interactions, the interactions of small molecules with DNA/RNA, the chemistry of peptides and peptidomimetics, molecular spectroscopy; experimental and computational protein biochemistry, the structure-function relationship and catalytic mechanism of metalloproteases and quantum organic chemistry. In addition to fundamental research, 1 patent application was approved. Members of the Division provided significant contributions to higher education by participating in numerous courses at the undergraduate and post-graduate levels, as well as the supervision of 5 Diploma and 7 Ph.D theses. Based on the discoveries of OKB researchers, two spin off companies, BioZyne and Chirallica, have been established. Their respective focuses are the development of new anticancer compounds and new systems for HPLC chiral separations. The Division's staff was also active in national and international societies and bodies and served as editors or members of several editorial boards.

OVERVIEW OF THE DIVISION

In 2010, the members of the Division continued to maintain their established excellence in scientific research. The principal focus was directed towards basic research in the fields of organic and bioorganic chem-

TOP ACHIEVEMENTS

Gelation properties, self-assembly motifs and chirality effects.

In the context of an invited Feature Article, the development of chiral oxalamide gelators in the Laboratory of Supramolecular and Nucleoside Chemistry at the RBI, was described, together with numerous studies which revealed the influence of gelator stereochemistry on gelation properties and self-assembly motifs (Frkanec et al., 2010).

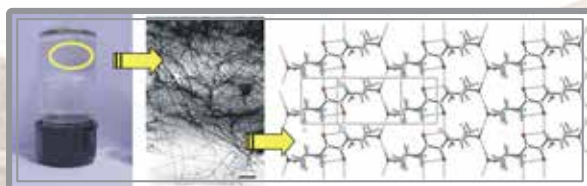


Fig. 1. Chiral bis(amino acid)oxalamides are versatile hydro- and organo-gelators due to strong intermolecular hydrogen bonding between oxalamide units. The latter induces their unidirectional self-assembly into gel fibers.

Towards an environmentally-friendly laboratory: dimensionality and reactivity in the mechanosynthesis of metal-organic compounds.

An environmentally friendly method for the synthesis of metal-organic compounds was successfully developed. For this purpose, mechanochemical reactions of cyanoguanidines with zinc and cadmium chloride were employed. (Štrukil et al., 2010).



Fig. 2. Green synthetic methods

An unusual cis selectivity

A range of *N*-Ts, *N*-SES, *N*-Boc and *N*-oNs aziridines were prepared in moderate to good yield and with high enantiomeric excess of both isomers starting from *N*-protected imines, using a oxathiane benzyl sulfonium salt. An unusual *cis* selectivity was observed in the formation of *tert*-butyl substituted aziridines and was explained using computational investigations (Dokli et al., 2010).

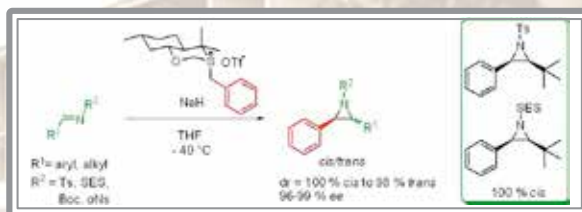


Fig. 3 Sulfur ylide promoted synthesis of *N*-protected aziridines

Advances in the development of single molecule-multipurpose sensors for simultaneous differentiation of various DNA/RNA forms

Further progress in studies of the interaction of DNA/RNA with active small organic molecules resulted in 7 new scientific publications. Among which the most comprehensive results were obtained in the article describing advances in guanidiniocarbonyl-pyrrole-aryl derivatives (Hernandez-Folgado et al., 2010).

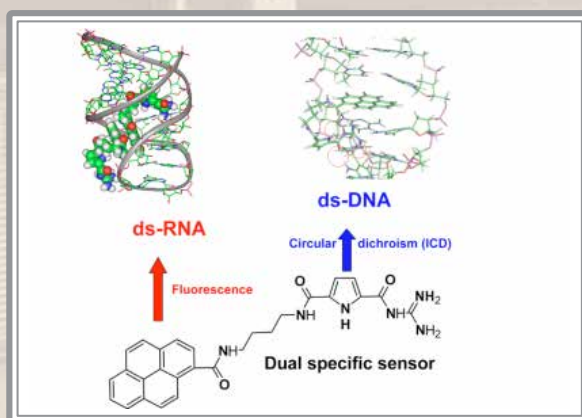


Fig. 4 A single molecule efficiently differentiates between ds-DNA and ds-RNA by two independent, sensitive spectroscopic methods

Positionally Isomeric Organic Gelators: Structure–Gelation Study, Racemic versus Enantiomeric Gelators, and Solvation Effects

The influence of positional isomerism of gelators on their self-assembly motifs and properties of gels was studied for the first time. The results revealed dramatic differences in gelling properties between positional isomers reflected in their different gelation efficiency and gelation versatility (Čaplar et al., 2010).

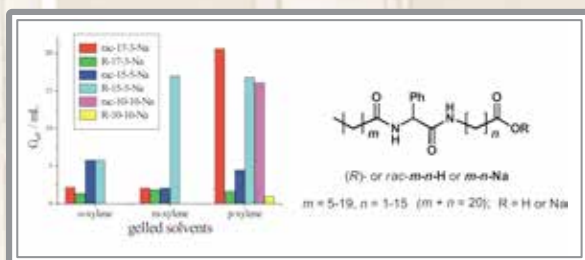


Fig. 5. Structures of positionally isomeric gelators and dramatically different gelation efficiency toward very similar isomeric xylenes.

Computational structure-activity study of enkephalin-like analogs

The capability of a Support Vector Machines QSAR model to predict the anti-proliferative ability of small peptides was evaluated by screening a virtual library of enkephalin-like analogs. The selected compounds that were synthesized showed pronounced antitumor activity compared to Met-enkephalin (Gredičak et al., 2010).

An accurate computational (QM/MM) method for use in biological systems

The mixing of quantum-mechanical (QM) and molecular-mechanical (MM) techniques has become the method of choice for the computational treatment of biological systems. By introducing a sophisticated QM treatment in this context, we arrive at a hybrid QM/MM method capable of producing chemical accuracy. In addition to testing

the method, we were able to address key aspects of the substrate mechanism of the bacterial enzyme, Pyruvate Formate-Lyase (Čondić-Jurkić et al., 2010).

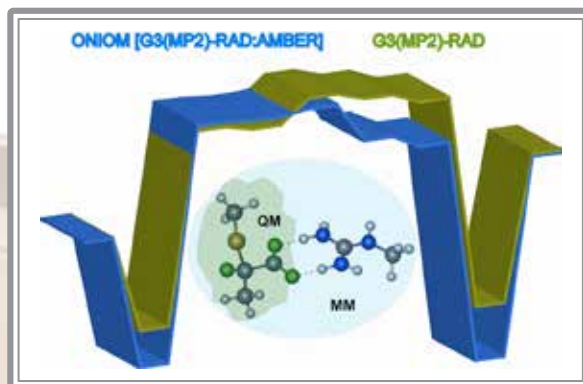


Fig. 6. Comparison of energy profiles obtained using quantum mechanical (QM) and hybrid QM/MM techniques.

Photochemical Formation of Long-Lived Adamantylidene-Quinone Methides

Hydroxymethylphenols, strategically substituted with the 2-hydroxy-2-adamantyl moiety, were synthesized and their photochemical reactivity was investigated. Introduction of the adamantyl substituent into the o-hydroxymethylphenol moiety increased the quantum yield of the associated QM formation by up to 3-fold and significantly prolonged their lifetimes (Basarić et al., 2010).

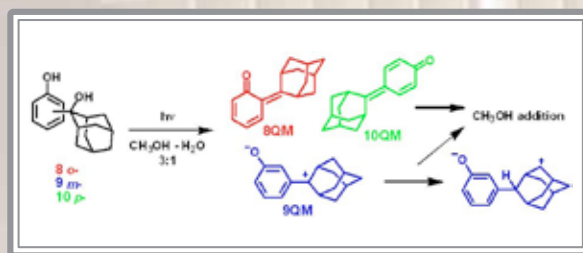


Fig. 7. Photochemical formation and chemistry of long-lived adamantylidene quinone methides.

Computational design of new superacids and the first hyperacid

Polycyclic organic compounds substituted with electron withdrawing cyano groups pro-

vide exceptionally acidic molecules, culminating with the first true hyperacid having a gas-phase deprotonation enthalpy of $\Delta H_{\text{acid}} = 242.8 \text{ kcal mol}^{-1}$ and a corresponding $\text{p}K_{\text{a}}$ value of -26.7 in dimethylsulfoxide solution. Two of the investigated unsubstituted compounds represent antiaromatic quasi-[12]annulene and aromatic quasi-[14]annulene (Vianello et al., 2010).

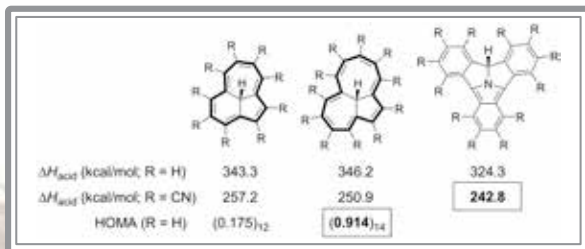


Fig. 8. Polycyclic organic molecules representing highly acidic compounds of unprecedented strength.

Enediynes-peptide conjugates

We have synthesized a series of acyclic amino acid derived enediynes and tested them under conditions relevant to the Bergman cyclization. Experimental and computational data revealed a novel, thermally induced cyclization-elimination pathway (Gredičak, et al. 2010).

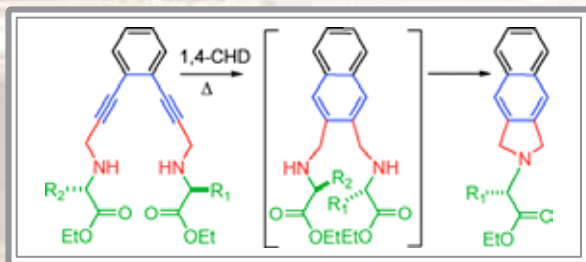


Fig. 9. Cyclization-elimination pathway of amino-acid derived enediynes.

Molecular basis for the thiol sensitivity of the M49 metallopeptidase

Metallopeptidases of the M49 family are zinc-dependent enzymes involved in protein metabolism and oxidative stress response.

To elucidate the molecular basis of their unusual susceptibility to sulfhydryl reagents, an analysis of the mutationals of all five Cys to Ser single protein variants of the M49 peptidase (dipeptidyl peptidase III), from the yeast *Saccharomyces cerevisiae*, was performed. The results revealed that only one cysteine residue, Cys639, is responsible for the fast inactivation by organomercurial compounds (Jajčanin-Jozić et al., 2010).

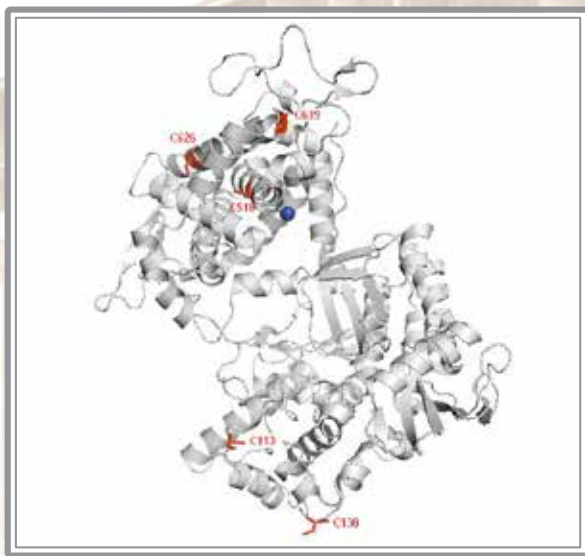


Fig. 10. Molecular basis for the thiol sensitivity of M49 metallopeptidase from yeast

NEW EQUIPMENT

An HPLC gradient semi-preparative system with diode array and fluorescent detector (Varian, USA), and a Mixer mill Retsch MM400 (Germany) were installed during 2010.



Fig. 11. Mixer mill Retsch MM400

EDUCATION

Members of the Division provided significant contributions to higher education by providing numerous courses at the undergraduate and doctoral levels at the Universities of Zagreb, Rijeka, Osijek, Split and Dubrovnik. Members of the DOCB are involved in several PhD programs, in particular, the Chemistry – PhD program at the Faculty of Science and University of Zagreb; and the Medicinal Chemistry – PhD Program at the University of Rijeka.

AWARDS

Irena Dokli, Ivanka Jerić, Mirjana Maksić, David M Smith and Vjekoslav Štrukil received the RBI Director's Award for scientific excellence in 2010.

Nikola Basarić, David M Smith and Robert Vianello received the RBI Director's Award for securing a highly funded scientific project.

Irena Dokli received the Annual award (2010) of the The Association of University Teachers and Other Scholars for enviable achievements in the fields of the natural, technical, biotechnical, humanistic and social sciences and the interdisciplinary field of art.

Robert Vianello received the Promising Scientist Prize 2010 of the Centre for the Applied Quantum Mechanics in Paris, France.

Postdoctoral fellowships / awards

Ina Nemet received the Juvenile Diabetes Research Foundation Postdoctoral Fellowship Award, "Novel Pathways of Glycation Damage in Diabetic Complications" (2008-2010).

Robert Vianello received the Personal Marie Curie Fellowship for Career Development from the European Commission under the FP7–PEOPLE–2009–IEF Call for an 18-month stay at the National Institute of Chemistry in Ljubljana, Slovenia.

PROJECTS

Research programs supported by the Ministry of Science, Education and Sport

1. New small molecules targeting macromolecules of tumor and inflammatory processes, No: 0982914, Ivo Piantanida
2. Design, synthesis and reactivity of (bio)organic molecular systems, No: 0982933, Mirjana Maksić

Research Projects supported by the Ministry of Science, Education and Sport

1. Chiral building blocks for biological active molecules. Synthesis and reactivity, Zdenko Hameršak
2. Chiral organic materials - synthetic, structural and functional research, Vladimir Vinković
3. Cage Compounds: Building Blocks for Molecular Architecture, Kata Majerski
4. Self-assembly in gels and synthesis of functional hybrid materials, Mladen Žinić
5. Synthesis of novel biologically active nucleobase and nucleotide derivatives, Biserka Žinić
6. Chemical transformations of natural compounds; Lidija Varga-Defterdarović
7. Molecular enzymology and protein interactions of hydrolases, Marija Abramić
8. 'Host-guest' interactions in polycyclic systems, Davor Margetić
9. Organic and bioorganic processes in ground and electronically excited states, Mirjana Maksić
10. Macrocyclic ligands, structures in solutions and molecular spectroscopies, Goran Baranović
11. Design, synthesis and study of interactions of small molecules with DNA, RNA and proteins, Ivo Piantanida
12. Brønsted and Lewis acids and bases in chemistry and biochemistry, Zvonimir Maksić.
13. Computational studies of protein structure and function, David Smith.

Research, developmental and international projects

1. Reinforcement of the Centre for Computational Solutions in the Life Sciences, (6th Framework Programme, EU-FP6-043749-ReCompSoLS), 2007-2010. David M. Smith.
2. Biocatalytic application of halohydrin dehalogenases for production of chiral building blocks, (UKF 3A Grant Agreement), 2009-2011. Maja Majerić Elenkov
3. Computational prediction of structure and catalytic activity of new organic superacids, (UKF 3A Grant Agreement), 2008-2010. Robert Vianello
4. Photochemistry of polycyclic molecules: From mechanistic studies to new drugs and medicinal applications (HRZZ) 2010-2013, Nikola Basarić
5. Mechanochemistry for the clean and efficient metal-catalysed synthesis of pharmaceutical targets and the study of their molecular recognition, Unity through knowledge fund, 2010-2012, Mirjana Maksić
6. Artificial Receptors for Bacillus anthracis Specific Anthrose Detection. NATO Science for Peace and Security Programme; CBP. EAP.SFP.983154. 2008-2011, Andreja Jakas and Predrag Cudic
7. Fluorescent Anion Sensors: Synthesis and Spectroscopic Characterization, Bilateral project Croatia - P.R. China, 2009 - 2011, Nikola Basarić
8. Structure – function relationship in metallo-peptidase family M49, Bilateral project Croatia – Austria, 2010-2011, Marija Abramić
9. Design and synthesis of novel aryl-guanidiniocarbonyl-pyrroles, and study of their interactions with DNA/RNA, Bilateral project Croatia-Germany (DAAD), 2009 – 2010, Ivo Piantanida
10. Acid–Base and Tautomeric Properties of Biologically Relevant Compounds in Solution, Bilateral project Croatia - Slovenia, 2009 - 2010, Robert Vianello

SELECTED INVITED LECTURES

1. Smith, David M. (Plenary) Studying Enzymatic Mechanism with QM/MM Techniques: An Application to Glycerol Dehydration «The 24th Molecular Modelling Workshop» Erlangen, Germany, February 15 – 16, 2010.
2. Smith, David M. A QM/MM Investigation of Enzymatic Diol Dehydration. «From Solid State To BioPhysics V - 'From Physics To Life Sciences'» Cavtat, Croatia, June 12 – 19, 2010.
3. Basarić, Nikola. Photochemistry of adamantyl-phthalimides: domino H-abstractions and decarboxylations. College of Chemistry and Chemical Engineering Lanzhou University, Lanzhou, P. R. China, June 21, 2010.
4. Mlinarić-Majerski, Kata. Synthesis and Ion Binding Abilities of Adamantane-annulated Ionophores. College of Chemistry and Chemical Engineering Lanzhou University, Lanzhou, P. R. China, June 21, 2010.
5. Smith, David M. Replica-Exchange Molecular Dynamics Studies on Natural and Non-Natural Opioid Peptides. «Australia-Croatia Workshop on Antimicrobial Peptides (AMP2010)» MedILS, Split, Croatia, August 9 – 14, 2010.
6. Vianello, Robert. *One Group to Rule Them All* - Polycyano Organic Compounds Are Record Holding Superacids. «XVth International Workshop on Quantum Systems in Chemistry and Physics (QSCP-XV)» University of Cambridge, England, August 31 – September 5, 2010.
7. Smith, David M. Subtle Differences with Important Consequences in Enzymatic Diol Dehydration «The 5th Central European Conference – Chemistry towards Biology» Primošten, Croatia, September 8 – 11, 2010.
8. Basarić, Nikola. Photochemistry of adamantyl derivatives of hydroxybiphenyls: ESIPT vs. photosolvolysis „Pacifichem 2010 International Chemical Congress of Pacific Basin Societies“, Honolulu, U.S.A. December 15 – 20, 2010.
9. Smith, David M. On the mechanism of biological glycerol dehydration using QM/MM techniques. «Pacifichem 2010 International Chemical Congress of Pacific Basin Societies» Honolulu, Hawaii, USA, December 15 – 20, 2010.

SELECTED ORGANIZED CONFERENCES

1. 5th Central European Conference – Chemistry towards Biology, Primošten, Croatia, 8.-11.9.2010 (organizers (from DOCB) Marija Abramić, Zvonimir Maksić, Robert Vianello)
2. The 60th anniversary of RBI, Zagreb, 09.06.2010. (organizer Mirjana Maksić)

SELECTED PUBLICATIONS

1. Sandala GM, Smith DM, Radom L. Modeling the reactions catalyzed by coenzyme B₁₂ dependent enzymes. *Acc Chem Res* **43** (2010) 642.
2. Kopriva I, Jerić I. Blind separation of analytes in nuclear magnetic resonance spectroscopy and mass spectrometry: sparseness-based robust multicomponent analysis. *Anal Chem* **82** (2010) 1911.
3. Frkanec L, Žinić M. Chiral bis(amino acid)- and bis(amino alcohol)-oxalamide gelators. Gelation properties, self-assembly motifs and chirality effects. *Chem. Comm* **46** (2010) 522.
4. Štrukil V, Fábíán L, Reid D. G., Duer M. J, Jackson G. J, Eckert-Maksić M, Friščić T. Towards an environmentally-friendly laboratory: dimensionality and reactivity in the mechanosynthesis of metal-organic compounds. *Chem Comm* **46** (2010) 9191.
5. Dokli I, Matanović I, Hameršak Z. Sulfur ylide promoted synthesis of N-protected aziridines: a combined experimental and computational approach. *Chem Eur J* **16** (2010) 11744.
6. Hernandez-Folgado L, Baretić D, Piantanida I, Marjanović M, Kralj M, Rehm T, Schmuck C. Guanidiniocarbonyl-pyrrole-aryl derivatives: structure tuning for spectrophotometric recognition of specific DNA and RNA sequences and antiproliferative activity. *Chem Eur J* **16** (2010) 3036.
7. Čaplar V, Frkanec L, Šijaković Vujičić, N, Žinić M. Positionally isomeric organic gelators: structure-gelation study, racemic versus enantiomeric gelators, and solvation effects. *Chem Eur J* **16** (2010) 3066.
8. Gredičak M, Supek F, Kralj M, Majer Z, Hollosi M, Šmuc T, Mlinarić-Majerski K, Horvat Š. Computational structure-activity study directs synthesis of novel antitumor enkephalin analogs. *Amino Acids* **38** (2010) 1185.
9. Čondić-Jurkić K, Zipse H, Smith D. M. A compound QM/MM procedure: Comparative performance on a Pyruvate Formate-Lyase model system. *J Comp Chem* **31** (2010) 1024.
10. Basarić N, Žabčić I, Mlinarić-Majerski K, Wan P. Photochemical formation and chemistry of long-lived adamantylidene-quinone methides and 2-adamantyl cations. *J Org Chem* **75** (2010) 102.
11. Vianello R, Maksić Z. Polycyano derivatives of some organic tri- and hexacyclic molecules are powerful super- and hyperacids in the gas-phase and DMSO - Computational study by DFT approach. *J Org Chem* **75** (2010) 7670.
12. Gredičak M, Matanović I, Zimmermann B, Jerić I. Bergman cyclization of acyclic amino acid-derived enediynes leads to the formation of 2,3-dihydrobenzo[f]iso indoles. *J Org Chem* **75** (2010) 6219.
13. Jajčanin-Jozić N, Deller S, Pavkov T, Macheroux P, Abramić M. Identification of the reactive cysteine residues in yeast dipeptidyl peptidase III. *Biochimie* **92** (2010) 89.
14. Eckert-Maksić M, Vazdar M, Ruckebauer M, Barbatti M, Müller T, Lischka H. Matrix-controlled photofragmentation of formamide: Dynamics simulation in argon by nonadiabatic QM/MM method. *Phys Chem Chem Phys* **12** (2010) 12719.
15. Margetić D, Ishikawa T, Kumamoto T. Exceptional superbasicity of bisguanidine proton sponges imposed by the bisecododecahedrane molecular scaffold: A computational study. *Eur J Org Chem* (2010) 6563.
16. Alešković M, Basarić N, Mlinarić-Majerski K, Molčanov K, Kojić-Prodić B. Kesharwani M. K, Ganguly B. Anion recognition through hydrogen bonding by adamantane-dipyrromethane receptors. *Tetrahedron* **66** (2010) 1689.
17. **Patent** – Maksić, Mirjana; Glasovac, Zoran. "N,N',N''-Tris-(3-dimethylaminopropyl)-guanidine, the procedure of preparation from carbodiimide and application in reactions of transesterification of oil", European patent EP 1786763, 2009 and Croatian patent HR P20040341, 2010.

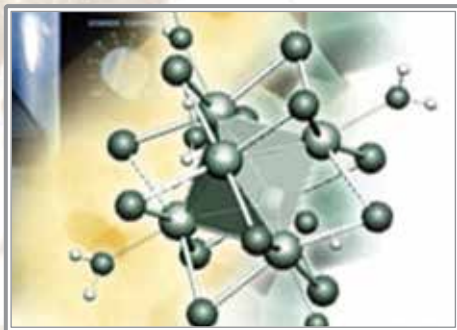


DIVISIONAL ORGANISATION

Head: Svetozar Musić

The Division of Materials Chemistry (ZKM) consists of the following laboratories:

- ⇒ Laboratory for synthesis of new materials, Boris Subotić
- ⇒ Laboratory for precipitation processes, Damir Kralj
- ⇒ Laboratory for radiation chemistry and dosimetry, Saveta Miljanić
- ⇒ Laboratory for solid state and complex compounds chemistry, Pavica Planinic
- ⇒ Laboratory for ichthyopathology – biological materials, Rozelindra Čož-Rakovac



ics and mechanisms of different precipitation systems. The radiation chemistry and dosimetry laboratory at the division is the only such existing unit in Croatia and its work covers all aspects of the physico-chemical effects of ionizing radiation and its applications. Low-dose and high-dose chemical dosimetry systems were developed and received international recognition. Our main research activities are financially sponsored by the Ministry of Science, Education and Sports.

OVERVIEW OF THE DIVISION

The Division of Materials Chemistry is a centre of excellence in materials science. Our mission is to perform high-quality research into the chemical, microstructural and physical properties of various materials, development of new synthesis methods as well as knowledge transfer to society. Our primary interests are in metal oxides, glass-ceramics, zeolites, cluster compounds, organic polymers, intermetallic compounds and metal hydrides. The division has a longstanding tradition in the investigation of the kinet-

TOP ACHIEVEMENTS

Zirconia ceramics modified by addition of copper oxide

The effect of Cu^{2+} ion incorporation on the phase composition and stability of ZrO_2 -type solid solution was clarified. The phase composition and accurate lattice parameters were determined using Rietveld and Le Bail refinements of the powder diffraction patterns while Raman spectroscopy indicated that the incorporation of Cu^{2+} ions stabilize the tetragonal ZrO_2 polymorph (Štefanić et al., 2010).

Toxicity of commercial zeolites on selected microorganisms

The inhibitory influence of commercially produced zeolite A on prokaryotic (*Acinobacter junii*) and unicellular eukaryotic (*Saccharomyces cerevisiae*) microorganisms was demonstrated. A toxic influence of zeolite A was explained by the influence of water soluble species originating from dissolution and leaching of aluminium and silicon in the form of positively charged complexes and their interaction with the predominantly electronegative surfaces of microbial cells (Hrenović et al., 2010).

Theoretical studies on magnetocaloric effect in hydrogen storage materials based on Gd-Ga intermetallic

Preliminary results were presented for the calculation of the magnetocaloric effect (MCE), in terms of the isothermal magnetic entropy changes ΔS_{mag} and the adiabatic temperature changes ΔT_{ad} , in GdGa, Gd-Ga_{1-x}Ge_x, $0 < x < 1$, and in Gd(Zn,Cu) compounds, under the magnetic field changes from 0 – 5 T. Calculations are based on the mean-field model of coupled magnetic lattices combined with the density functional theory and it is shown how they could be used in prediction of the transition ordering temperature and the MCE.

New mononuclear copper(II) oxalate complexes with 2D and 3D architectures as convenient building blocks for the synthesis of desired polynuclear species

Crystal structures of the new mononuclear complexes, $[\text{Cu}(\text{bpy})(\text{C}_2\text{O}_4)(\text{H}_2\text{O})] \cdot \text{H}_2\text{O}$ and $[\text{Cu}(\text{bpy})(\text{C}_2\text{O}_4)(\text{H}_2\text{O})] \cdot \text{H}_2\text{C}_2\text{O}_4$ (bpy = 2,2'-bipyridine), are dominated by the hydrogen-bonding (Fig. 2.) and π - π stacking interactions, giving rise to the overall 3D and 2D architectures, respectively (Androš et al., 2010). The isolated complexes have proved to be

convenient building blocks for new homo- and heteropolynuclear species. Considering the fact that mononuclear oxalate-bipyridine metal complexes are very limited in the literature, the above compounds represent a valuable contribution to the oxalate-based transition-metal chemistry (Androš et al. 2010).

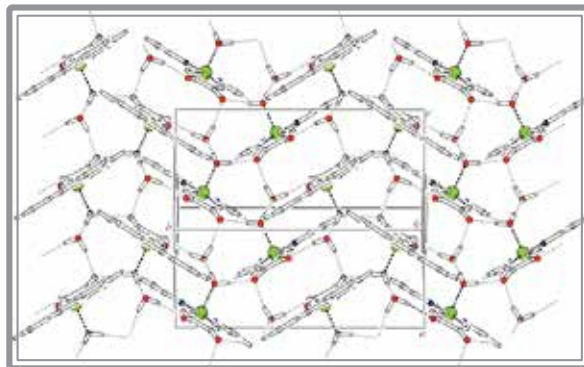


Fig. 1. Herring-bone-like hydrogen-bonding network in the bc plane of the unit cell of $[\text{Cu}(\text{bpy})(\text{C}_2\text{O}_4)(\text{H}_2\text{O})] \cdot \text{H}_2\text{O}$

Bioinorganic materials

The role of metastable precursor phases and the presence of charged synthetic macromolecules on the formation of bioinorganic composites was investigated in the precipitation system of calcium carbonates / synthetic polypeptides. The results pointed to the principal importance of kinetic, rather than thermodynamic constraints on the formation process of solid phase that is in equilibrium with solution and its physical properties (Njegić-Džakula et al, 2010).

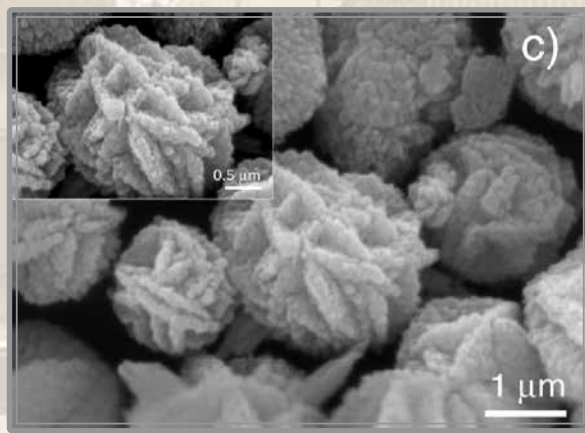


Fig. 2. Scanning electron micrographs of the calcium carbonate spontaneously precipitated in system containing poly-L-aspartic acid.

Structure-property relationships of polypropylene/polyurethane blends

Addition of thermoplastic polyurethane (TPU) to polypropylene (PP) significantly enhanced spherulite growth in polypropylene matrix during the solidification process thus affecting blend properties. A stepwise change in the morphology and mechanical properties of blends with 20 and 40 wt% of TPU indicated a matrix \rightarrow dispersed phase inversion in this concentration region (Govorčin Bajsić et al., 2010).



Fig. 3. Differential scanning calorimeter, Pyris Diamond DSC

Influence of dopants to characteristics of thermoluminescent detectors

The influence of the type and concentration of the dopants in LiF:Mg,Cu,P TL detectors was investigated. The type and concen-

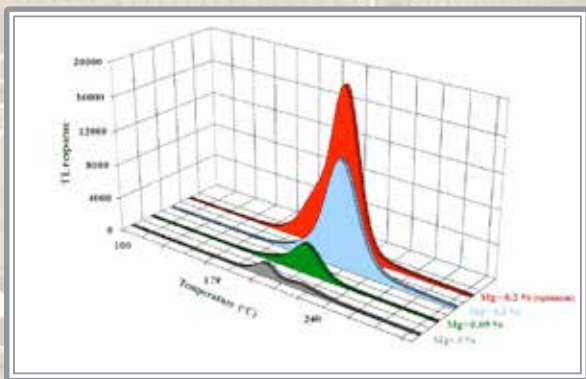


Fig. 4. Glow curves of LiF:Mg,Cu,P detectors with various Mg concentrations.

tration of the dopants influence the shape of the glow curves and sensitivity while for energy dependence is more important the presence of certain activators, namely copper (Knežević et al., 2010).

Evaluation of the micronucleus and erythrocytic nuclear abnormalities in the Balkan whip snake Hierophis gemonensis

As ectothermic analogues to fish models, reptiles were used for the first time as model organisms in genotoxicity studies. Micronucleus (MN) and Erythrocyte nuclear abnormality tests (ENA) were described and their potential application for reptile genotoxic assays evaluated (Strunjak-Perović et al. 2010).

NEW EQUIPMENT

Diferential scanning calorimeter, Pyris Diamond DSC for determination of thermal and microstructural properties, especially phase transitions of polymers, complex polymer-based systems and organic compounds. The instrument was purchased by the partial support of Ministry of Science, Education and Sports.

Pediatric Phantom, Model Number 706-D, CIRS Tissue Simulation & Phantom Technology for investigation of organ dose, whole body effective dose and verification of delivery of therapeutic radiation doses.

Digital oscilloscope (WaveSurfer 64MXs-A, LeCroy, USA).

Centrifugal evaporator

EDUCATION

In 2010, scientists and researchers from the Division contributed to the educational programs at the Universities of Zagreb, Osijek and Dubrovnik conducting 16 undergraduate and post-graduate courses.

AWARDS

Srećko Kirin: Director's Award for exceptional scientific success, Ruđer Bošković Institute (2010), for obtaining a national or international project with more than 500.000 HRK (70.000 €).

PROJECTS

Programs supported by the Ministry of Science, Education and Sports

1. New functional materials, Svetozar Musić

Projects supported by the Ministry of Science, Education and Sport

1. Synthesis and microstructure of metal oxides and oxide glasses, Svetozar Musić
2. Study of influence of aluminosilicate precursors on their transformation, Boris Subotić
3. Precipitation mechanism of inorganic biocompatible and related materials, Damir Kralj
4. Metal hydrides in clean energy systems, Želimir Blažina
5. Polynuclear metal systems – synthesis and properties, Pavica Planinić
6. Structure-property relationships of modified polymer materials, Ivan Šmit
7. Physico-chemical effects of ionizing radiation in materials, Saveta Miljanić
8. Subcellular biochemical and phylogenetic diversity of aquatic organisms, Rozelindra Čoz-Rakovac

Research, developmental and international projects

1. Metal oxides: structural and magnetic properties, Mira Ristić (Croatian-Serbian Scientific Cooperation Programme for 2009-2010).
2. Nanoparticle cell interaction: Molecular signaling events induced by synthesized new nanomaterials, Marijan Gotić (Croatian-German Scientific Cooperation Programme for 2010-2011).

3. Study of the processes of formation and growth of zeolite nuclei in the matrix of amorphous aluminosilicate gel, Josip Bronić (COGITO, Croatian-French Scientific Cooperation Programme for 2009-2010).
4. Physical-structural studies of mixed-halide metal-atom clusters building blocks, Berislav Perić (COGITO, Croatian-French Scientific Cooperation Programme for 2009-2010).
5. Organometallic and inorganic bioconjugates as potential enantioselective catalysts, Srećko Kirin (UKF project, 2009/2010).
6. Free Radicals in Chemical Biology, Branka Mihaljević (European Cooperation in the field of Scientific and Technical Research, COST CM0603, 2007-2011).
7. Enhancing Quality Control Methods and Procedures for Radiation Technology, Saveta Miljanić (IAEA Regional Technical Co-operation Project RER 8/017, 2010-2012).
8. Radiation protection dosimetry in medicine: The risk of early and late health effects from the use of radiation therapy, Saveta Miljanić (EURADOS Working Group 9, 2010-)
9. European Medical ALARA Network (EMAN), Željka Knežević (EURADOS Working Group 12 (2010-
10. Radiation synthesis and characterization of nanomaterials for health care, environmental protection and clean energy applications, Irina Pucić (IAEA Regional Technical Co-operation Project, 2010-2012)
11. Design of polymer blends and composites, Irina Pucić (Croatian-Slovenian bilateral scientific cooperation, 2010-2011)
12. The effects of high-energy radiation on polymeric systems, Irina Pucić (Croatian-Hungarian Intergovernmental S&T Cooperation, 2010-2011).
13. Using Nuclear Techniques for the Characterisation and Preservation of Cultural Heritage Artefacts in the Europe Region, Branka Katušin-Ražem (IAEA RER/8/015, 2009-2011).
14. Characterization, intercomparison and application of radiophotoluminescence (RPL) dosimetry system according to international standards and protocols, Maria Ranoga-

- jec-Komor (Scientific cooperation between Ruđer Bošković Institute and Chiyoda Technology Corporation, 2009-2010).
15. Solid state detectors in mixed radiation fields dosimetry, Saveta Miljanić (Croatian-Hungarian I Scientific and Technical Cooperation Programme for 2009-2010).
 16. Optimization of the synthesis process of zeolite A with special emphasis on the control of particulate properties (size and shape of zeolite A crystals), Boris Subotić (Bartex-Bartol and Ruđer Bošković Institute cooperation scientific research – 2nd phase).
 17. Protection of oysters production from Mali Ston by verification of its autochthony, Ivančica Strunjak-Perović (Ministry of Agriculture, Forestry and Water Management-VIP-project, 2008-2010).
 18. Breeding and selection in aquaculture: Repopulation of autochthonous brown trout in the Gacka river, Natalija Topić Popović (Ministry of Agriculture, Forestry and Water Management, 2008-2010).
 19. Breeding and selection in aquaculture: Fishery 1961, Ivančica Strunjak-Perović (Ministry of Agriculture, Forestry and Water Management, 2008-2010).

SELECTED INVITED LECTURES

1. Musić, Svetozar, ⁵⁷Fe Mössbauer spectroscopy in the investigation of the precipitation of iron oxides, 239th American Chemical Society (ACS) National Meeting, San Francisco, USA, March 21-25, 2010.
2. Miljanić, Saveta, Intercomparison of dosimeters for non-target organ dose measurements in radiotherapy – Activity of EURADOS WG 9: Radiation protection in medicine, The 6th International Workshop on Individual Monitoring of Ionizing Radiation, Oarai, Japan, November 29-30, 2010.
3. Tartaro, Ivana; Mihaljević, Branka; Ferreri, Carla; Chatgililoglu, Chrystostomos, Radiation-induced modification of lipids by thiyl radicals, EUCHEM Conference on Organic Free Radicals, Bologna, Italy, June 28- July 2, 2010.

4. Babić-Ivančić, Vesna: Precipitation of mineral constituents of urinary stones in model systems chemical composition similar to the urine, Vinča Institute of Nuclear Science, Belgrade, Serbia, December 5, 2010.

SELECTED ORGANIZED CONFERENCES

1. 3rd Croatian-Slovenian Symposium on Zeolites, Trogir, 16.-17.9.2010.

SELECTED PUBLICATIONS

1. Krehula S, Musić S. Growth of uniform lath-like Π -(Fe,Al)OOH and disc-like Π -(Fe,Al)₂O₃ nanoparticles in a highly alkaline medium. *Mater Chem Phys* **123** (2010) 67.
2. Štefanić G, Musić S, Ivanda M. Effect of Cu²⁺ ion incorporation on the phase development of ZrO₂-type solid solutions during the thermal treatment. *J Alloys Comp* **492** (2010) 536.
3. Opačak I, Ristić M, Musić S. Preparation and characterization of hollow Π -Fe₂O₃ irregular microspheres. *Mater Lett* **64** (2010) 2555.
4. Hrenović J, Željezić D, Kopjar N, Sarpola A, Bronić J, Sekovanić L: Antimicrobial activity of commercial zeolite A on *Acinetobacter junii* and *Saccharomyces cerevisiae*. *J. Hazardous Mater* **183** (2010) 655.
5. Turković A, Dubček, P, Juraić, K, Drašner A, Bernstorff S: SAXS Studies of TiO₂ Nanoparticles in Polymer Electrolytes and in Nanostructured Films. *Materials* **3** (2010) 4979.
6. Androš L, Jurić M, Planinić P, Žilić D, Rakvin B, Molčanov K: New mononuclear oxalate complexes of copper(II) with 2D and 3D architectures: Synthesis, crystal structures and spectroscopic characterization. *Polyhedron* **29** (2010) 1291.
7. Njegić-Džakula B, Falini G, Brečević Lj, Skoko Ž, Kralj D: Effects of initial supersaturation on spontaneous precipitation of calcium carbonate in the presence of charged poly-L-amino acids. *J Colloid Interface Sci* **343** (2010) 553.

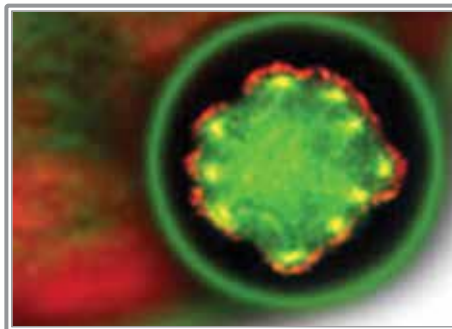
8. Vinceković M, Pustak A, Liu F, Ungar G, Tušek-Božić Lj, Bujan M, Šmit I, Filipović-Vinceković N: Thermal and Structural Study of Mesomorphic Dodecylammonium Carra-geenates. *J Colloid Interface Sci* **341** (2010) 117.
9. Knežević Ž, Ranogajec-Komor M, Miljanić S: Effect of dopants on TL characteristics of LiF:Mg, Cu, P detectors. *Radiat Measur* **45** (2010) 573.
10. Strunjak-Perović I, Lisičić D, Čož-Rakovac R, Topić Popović N, Jadan M, Benković V, Tadić Z: Evaluation of micronucleus and erythrocytic nuclear abnormalities in Balkan whip snake *Hierophis gemonensis*. *Ecotoxi-cology* **19** (2010) 1460.

DIVISIONAL ORGANISATION

Head: Igor Weber

The Division of Molecular Biology (ZMB) consists of the following laboratories:

- ⇒ Laboratory for Molecular Microbiology, Davor Zahradka
- ⇒ Laboratory for Molecular Genetics, Dušica Vujaklija
- ⇒ Laboratory of Chemical Biology, Branka Salopek Sondi
- ⇒ Laboratory of Molecular Microbiology, Davor Zahradka
- ⇒ Laboratory of Neurochemistry and Molecular Neurobiology, Branimir Jernej (until May 2010), Lipa Čičin-Šain
- ⇒ Laboratory of Molecular and Cell Biology, Ivica Rubelj
- ⇒ Laboratory for Genotoxic Agents, Maja Osmak
- ⇒ Laboratory for Structure and Function of Heterochromatin, Miroslav Plohl
- ⇒ Laboratory for Evolutionary Genetics, Đurđica Ugarković
- ⇒ Laboratory for Electron Microscopy, Hrvoje Fulgosi



fungi, cellular slime moulds, worms, molluscs, insects, plants, rodents and mammalian cells in culture. The projects in our Division broadly comprise the following fields of study: maintenance of genome integrity and regulation of genome variation (DNA replication, recombination and repair); genome organization and repetitive DNA sequences; expression of genomic information (transcription and translation); signal transduction in molecular regulation of cell division, growth, differentiation and senescence; cellular responses to toxic agents and resistance to cytostatics and antibiotics; genetic background and regulatory mechanisms of neurotransmission; regulatory mechanisms of photosynthesis; physiology, biochemistry and structural biology of plant hormones; antioxidant activity of polyphenols; dynamical processes in the cytoskeleton; and evolution of genes and genomes. The primary purpose of these research projects is a general broadening of our knowledge about biological processes at the molecular level and elucidation of the underlying principles of life, as well as the training of young scientists for professional work in the field of molecular biosciences, including biomedicine and biotechnology.

OVERVIEW OF THE DIVISION

Research in the Division of molecular biology is based on the methods of modern molecular biology, biochemistry, cell biology, genetics, biophotonics and bioinformatics. Model organisms used in these studies include viruses, bacteria, yeast and other

TOP ACHIEVEMENTS

Demosponge EST sequencing reveals a complex genetic toolkit of the simplest metazoans

Our results show that even the earliest metazoan species already have strikingly complex genomes in terms of gene content and functional repertoire, and that the rich gene repertoire existed even before the emergence of true tissues, therefore further emphasizing the importance of gene loss in shaping metazoan genomes. Our findings further indicate that sponge and human genes generally show similarity levels higher than expected from their respective positions in metazoan phylogeny, providing direct evidence for a slow rate of evolution in both basal and apical metazoan genome lineages (Harcet et al., 2010).

Taxonomic position of *Eunapius subterraneus* (Porifera, Spongillidae) inferred from molecular data - a revised classification needed?

The freshwater sponge *Eunapius subterraneus* inhabits caves in the Ogulin karst area as the only known stygobitic sponge, and an endangered karst species. Based on our phylogenetic analyses with three genetic markers, we emphasize the need for revision of the taxonomic classification of *E. subterraneus* as well as the need for a thorough re-evaluation of freshwater sponge systematics (Harcet et al., 2010).

Fidelity of DNA repair in *Deinococcus radiodurans*

We have described for the first time the conditions that impair the remarkable fidelity of DNA repair in radiation-resistant bacterium *Deinococcus radiodurans*. We have found that *recA* mutants of *D. radiodurans* frequently produce gross chromosomal rearrangements after spontaneous or gamma-radiation-induced DNA breaks. Our results show that the RecA protein, the main bacterial recombinase, is essential for the fidelity of DNA repair and, consequently, for genome stability in *D. radiodurans* (Repar et al., 2010).

Our results show that the RecA protein, the main bacterial recombinase, is essential for the fidelity of DNA repair and, consequently, for genome stability in *D. radiodurans* (Repar et al., 2010).

The relationship between cisplatin-induced reactive oxygen species, glutathione and BCL-2, and resistance to cisplatin

Apart from the induction of DNA damage, recent data have suggested that cisplatin also induces the formation of reactive oxygen species that can trigger cell death. Cell death occurs as the result of several simultaneously activated signaling pathways. The specific pathway responsible for cell death depends on the cell type and the treatment conditions. This review focuses on the relationship between glutathione and BCL-2 and their protective role in cDDP-induced reactive oxygen species formation and cDDP resistance (Brozović et al., 2010).

Downregulation of RhoB GTPase confers resistance to cisplatin in human laryngeal carcinoma cells

We have found that in human laryngeal carcinoma cells downregulation of RhoB

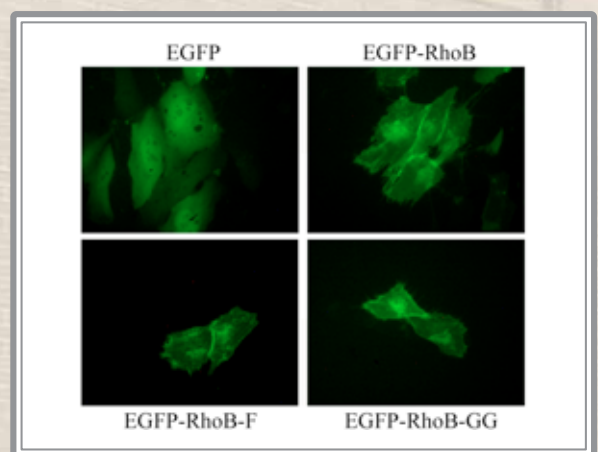


Fig. 1. Cellular localization of EGFP and EGFP-RhoB fusion proteins after transient transfection of the appropriate plasmid vectors in CA3ST cells, as viewed under the epifluorescence microscope.

confers resistance to cisplatin via decreased cellular accumulation of this drug. However, since RhoB silencing in additional tumor cell lines did not alter their sensitivity to cisplatin, we can assume that RhoB downregulation does not provide a general protective role in cell response to cisplatin. Nevertheless, gene therapy involving restoration of RhoB expression might improve the efficiency of cisplatin treatment, especially in patients with laryngeal carcinoma that acquired resistance to this chemotherapeutic drug (Čimborá-Zovko et al., 2010).

Evolution of repetitive DNAs in sibling species

By analyzing heterochromatin in the flour beetle *Tribolium audax*, we characterized two highly repetitive DNA families, which together constitute almost 60% of the whole genome. Comparison with repetitive DNAs in the sibling species *Tribolium madens* showed similarities in nucleotide sequence and length of the basic repeating units and also revealed structural and organizational parallelism in tandem and dispersed families. Differences in the nucleotide sequence and in the complexity of higher-order structures between families of the same type suggest a scenario according to which rearranged variants of the corresponding ancestral families were formed and distributed in the genomes during or after the speciation event, following the same principles independently in each descendant species (Mravinac & Plohl, 2010).

Transcriptional control of photosynthesis genes: the evolutionarily conserved regulatory mechanism in plastid genome function

Chloroplast Sensor Kinase (CSK) is a bacterial-type sensor histidine kinase found in chloroplasts – photosynthetic plastids – in eukaryotic plants and algae. Using a yeast two-hybrid screen, we demonstrate recogni-

tion and interactions between: Chloroplast Sensor Kinase, Plastid Transcription Kinase (PTK), and a bacterial-type RNA Polymerase Sigma factor-1 (SIG-1). The persistence of this mechanism in cytoplasmic organelles of photosynthetic eukaryotes is in precise agreement with the CoRR hypothesis for the function of organellar genomes: the plastid genome and its primary gene products are Co-located for Redox Regulation. Genes are retained in plastids primarily in order for their expression to be subject to this rapid and robust redox regulatory transcriptional control mechanism, while plastid genes also encode genetic system components, such as some ribosomal proteins and RNAs, that exist in order to support this primary, redox regulatory control of photosynthesis genes (Puthiaveetil et al., 2010)



Fig. 2. Postanthesis development of the Christmas rose flower (*Helleborus niger* L.) is highly mediated by plant hormones originated in the developing fruit. Plant hormones gibberellins are one of the signaling molecules identified and quantified in reproductive tissue during development.

Phylogenetic age of the transcriptome

The idea that the development of embryos mirrors evolutionary history is well known even beyond biological circles. However, due to the lack of tools that would allow explicit quantitative testing, the scientific status of this elusive concept has been unclear.

Evolutionary geneticists, Tomislav Domazet-Lošo at the Ruđer Bošković Institute in Zagreb (Croatia) and Diethard Tautz, at the Max Planck Institute of Evolutionary Biology in Plön (Germany) devised a new approach that measures the phylogenetic age of expressed genes across ontogeny and showed that the phylogeny-ontogeny correlation is real. The results were published as a cover story in the journal *Nature* (Domazet-Lošo & Tautz, 2010).

The formation of cerebrospinal fluid: nearly a hundred years of interpretations and misinterpretations

Based on our experimental results, we have abandoned the classical hypothesis of CSF secretion, circulation and absorption, and proposed a new hypothesis of CSF physiology. According to this new hypothesis, CSF is permanently produced and absorbed in the whole CSF system as a consequence of filtration and reabsorption of water volume through the capillary walls into surrounding brain tissue. The CSF exchange between the entire CSF system and surrounding tissue depends on (patho)physiological conditions that predominate within those compartments (Orešković & Klarica, 2010).

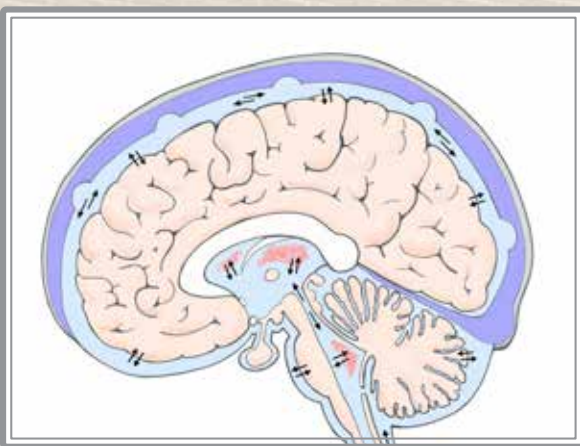


Fig. 3. A scheme of the interrelation between the cerebrospinal fluid (CSF), interstitial fluid (ISF) and cerebral blood vessels, and the exchange of water substances (black arrows) between the blood and ISF-CSF through the blood-brain barrier.

Wistar-Zagreb 5HT rats: A rodent model with constitutional upregulation / downregulation of serotonin transporter

We developed a new genetic rat model by selective breeding of animals for the extremes of peripheral serotonin (5HT) measures. Besides changes in peripheral 5HT homeostasis two sublines of this model showed dysregulation in brain serotonergic mechanisms. As such, Wistar-Zagreb 5HT rats provide an original model to address the biological and behavioral impact of altered central and peripheral 5HT homeostasis. The description of our experimental model was included as a separate chapter in the book "Experimental models in serotonin transporter research", published by Cambridge University Press (Čičin-Šain & Jernej, 2010).



Fig. 4. Testing of anxiety-like behaviour of Wistar Zagreb-5HT rat in the elevated-plus maze test.

NEW EQUIPMENT

Vertical Cabinet for cell and tissue culture CV-30/70 TELSTAR

Carl Zeiss „Primo Vert“ Microscope

Galaxy CO2 Incubator 170S (New Brunswick)

Milipore Scepter Cell Counter

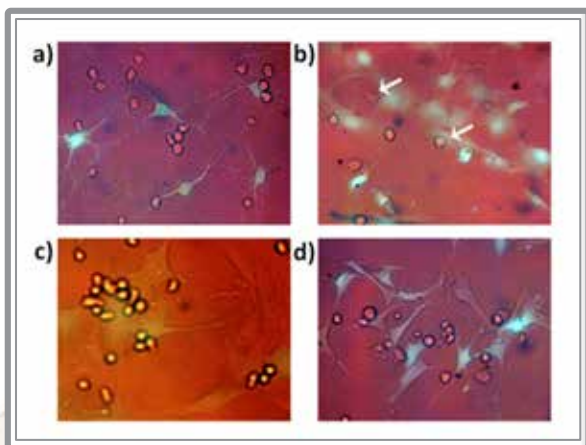


Fig. 5. Cell differentiation in cocultures with stromal cells.

RESEARCH PROGRAMS

1. Increase of adenovirus transduction efficacy and resistance to cytostatics, Andreja Ambriović Ristov
2. Serotonergic transmission: genes, proteins and behavior, Branimir Jernej
3. Molecular regulation of plant development, Branka Salopek-Sondi
4. Hydrodynamics of cerebrospinal fluid, Darko Orešković
5. Molecular mechanisms of DNA recombination and repair, Davor Zahradka
6. Fundamental molecular studies of *Streptomyces* biology, Dušica Vujaklija
7. Evolution and function of fast evolving portion of eukaryotic genome, Đurđica Ugarković
8. Genes and genomes: structures, functions and evolutions, Helena Četković
9. Regulatory mechanisms of photosynthesis and differentiation of plastids, Hrvoje Fulgosi
10. Regulation of the cytoskeleton dynamics in cell motility and cytokinesis, Igor Weber
11. Molecular mechanisms of immortalization and cellular aging, Ivica Rubelj
12. The role of recombination in DNA repair and genome evolution, Krunoslav Brčić-Kostić
13. Serotonergic mechanisms in alcoholism, Lipa Čičin-Šain
14. Cell response to cytotoxic agents and resistance development, Maja Osmak
15. Molecular interactions in lymphocyte differentiation, Mariastefania Antica

16. Transcriptional regulation in eukaryotes, Mary Sopta
17. Evolution, properties and functional interactions of satellite DNA sequences, Miroslav Plohl
18. Genetic studies of BPC-157 effect on micro-organisms, Senka Džidić

Some outstanding publications

1. Domazet-Lošo T, Tautz D. A phylogenetically based transcriptome age index mirrors ontogenetic divergence patterns. *Nature* **468** (2010) 815.
2. Orešković D, Klarica M. The formation of cerebrospinal fluid: Nearly a hundred years of interpretations and misinterpretations. *Brain Res Rev* **64** (2010) 241.
3. Mravinac B, Plohl M. Parallelism in evolution of highly repetitive DNAs in sibling species. *Mol Biol Evol* **27** (2010) 1857.
4. Harcet M, Roller M, Četković H, Perina D, Wiens M, Müller WEG, Vlahoviček K, Demosponge EST sequencing reveals a complex genetic toolkit of the simplest metazoans. *Mol Biol Evol* **27** (2010) 2747.
5. Čimborá-Zovko T, Fritz G, Mikac N, Osmak M. Downregulation of RhoB GTPase confers resistance to cisplatin in human laryngeal carcinoma cells. *Cancer Let* **295** (2010) 182.
6. Repar J, Cvjetan S, Slade D, Radman M, Zahradka D, Zahradka K. RecA protein assures fidelity of DNA repair and genome stability in *Deinococcus radiodurans*. *DNA Repair* **9** (2010) 1151.
7. Domazet-Lošo T, Tautz D. Phylostratigraphic tracking of cancer genes suggests a link to the emergence of multicellularity in metazoans. *BMC Biology* **8** (2010) 66.
8. Škrobot Vidaček N, Čukušić A, Ivanković M, Fulgosi H, Huzak M, Smith JR Rubelj I. Abrupt Telomere Shortening in normal human fibroblasts. *Exp Gerontol* **45** (2010) 235.
9. Brozović A, Ambriović-Ristov A, Osmak M. The relationship between cisplatin-induced reactive oxygen species, glutathione and BCL-2, and resistance to cisplatin. *Critical Rev Toxicol* **40** (2010) 347.

10. Plohl M, Petrović V, Luchetti A, Ricci A, Šatović E, Passamonti M, Mantovani B. Long-term conservation vs. high sequence divergence: the case of an extraordinarily old satellite DNA in bivalve mollusks. *Heredity (Edinburgh)* **104** (2010) 543.
11. Bendix L, Bendix Horn P, Birk Jensen U, Rubelj I, Kolvraa S. The load of short telomeres, estimated by a new method, Universal STELA, correlates with number of senescent cells. *Aging Cell* **8** (2010) 383.
12. Harcet, M, Bilandžija H, Bruvo Mađarić B, Četković H. Taxonomic position of *Eunapius subterraneus* (Porifera, Spongillidae) inferred from molecular data - a revised classification needed? *Mol Phylogenetics Evol* **54** (2010) 1021.
13. Piljac-Žegarac J, Valek-Žulj L, Stipčević T, Martinez S. Electrochemical determination of antioxidant capacity of fruit tea infusions. *Food Chem* **121** (2010) 820.
14. Puthiyaveetil SI, Iskander M, Jeličić B, Tomašić A, Fulgosi H, Allen JF. Transcriptional control of photosynthesis genes: the evolutionarily conserved regulatory mechanism in plastid genome function. *Genome Biol Evol* **2** (2010) 888.
15. Ayele BT, Magnus V, Mihaljević S, Prebeg T, Čož-Rakovac R, Ozga JA, Reinecke DM, Mander LN, Kamiya Y, Yamaguchi S, Salopek-Sondi B. Endogenous gibberellin profile during Christmas rose (*Helleborus niger* L.) flower and fruit development. *J Plant Growth Reg* **29** (2010) 194.

BOOK CHAPTER

Čičin-Šain L, Jernej B. Wistar-Zagreb 5HT rats: A rodent model with constitutional upregulation/downregulation of serotonin transporter. *Experimental Models in Serotonin Transporter Research*, Kalueff, Allan V.; LaPorte, Justin L. (eds.). Cambridge: Cambridge University Press (2010); 214-243.

SELECTED INVITED LECTURES

1. Vujaklija, Dušica; Bielen, Ana; Abramić, Marija; Pigac, Jasenka. The power of SGNH-lipases from *Streptomyces*, Central Europe Symposium on Industrial Microbiology and Microbial Ecology: Power of Microbes in Industry and Environment, Malinska, Krk, Croatia, September 22-25, 2010.
2. Vujaklija, Dušica. Old concepts - new insights into bacterial phosphorylation. Summer School in Applied Molecular Microbiology - "From Signals to Drug" IUC, Dubrovnik, Croatia, August 21-29, 2010.
3. Herak Bosnar, Maja; Perina, Dragutin; Bago, Ružica; Mikoč, Andreja; Harcet, Matija; Deželjin, Martina; Četković, Helena. Characterization of ancestral-type Grope I Nm23 gene/protein - structure and function is conserved from sponges to humans, «8th International Congress of the NDP kinase/Nm23/awd Family-From Basic Science to Clinical Application», Heidelberg, Germany, October 25-28, 2010.
4. Lukić-Bilela, Lada; Pleše, Bruna; Mulaomerović, Jasminko; Tulić, Una; Četković, Helena. Speleobiology and Biospeleology: Science against Blunders, «Stručni seminar o zaštiti špilja i podzemne faune» Ogulin, Croatia, January 30-31, 2010.
5. Bilandžija, Helena; Četković, Helena; Jalžić, Branko. Strictly protected species facing extinction? Dinaric cave clam (*Congerius kusceri*), «Stručni seminar o zaštiti špilja i podzemne faune» Ogulin, Croatia, January 30-31, 2010.
6. Andreja Ambriović-Ristov: Role of integrin $\Pi v \Pi 3$ in tumor drug resistance and adenovirus mediated gene delivery, 10th Congress of the Croatian Society of Biochemistry and Molecular Biology with international participation, Opatija, Croatia, September 15-18, 2010.
7. Meštrović, Nevenka; Castagnone-Sereno, Philippe; Pavlek, Martina; Car, Ana; Plohl, Miroslav. How satellite DNAs in the "library" are created? Society for Experimental Biology Annual Main Meeting 2010, Prag, Czech Republic, June 30-July 03, 2010.

8. Plohl, Miroslav. Contrasting patterns in genomic composition of satellite DNA repeats. Society for Experimental Biology Annual Main Meeting 2010, Prag, Czech Republic, June 30-July 03, 2010.
9. Fulgosi, Hrvoje; Jurić, Snježana; Tomašić Paić, Ana; Lepeduš, Hrvoje; Schleiff, Enrico. Unexpected links connecting photosynthesis with plant stress responses. 5th Slovenian symposium on plant biology, Ljubljana, Slovenia, September 06-09, 2010.
10. Weber, Igor; Faix, Jan; Filić, Vedrana; Marinović, Maja. Dual role of a Rac GTPase in the regulation of cell motility, From Solid State To Biophysics V, Cavtat, Croatia, June 12-19, 2010.
11. Ugarković, Đurđica. Transcription of satellite DNAs and genome regulation in insects. Epigenetics Europe, Dublin, Ireland, September 14-15, 2010.
12. Ugarković, Đurđica. Developmental and environmental regulation of heterochromatin transcription. COST Action TD0905 "Epigenetics-Bench to Bedside" Workshop, Brno, Czech Republic, November 22-25, 2010
2. Orešković, Darko. Annual award to RBI scientists 2010., for publishing scientific paper in high impact factor journal in the field of molecular biology
3. Hrvoje Fulgosi, Ruđer Bošković Director's General Prize
4. Miroslav Plohl: Annual IRB award (2010) for the publication of a paper with high impact factor
5. Brankica Mravinac: Annual IRB award (2010) for the publication of a paper with high impact factor

ORGANIZATION OF CONFERENCES, CONGRESSES AND MEETINGS (ALL)

1. Summer Schools in Applied Molecular Microbiology: "From Signals to Drug" IUC, Dubrovnik, Croatia, August 21-29, 2010
2. 5th Central European Conference - Chemistry towards Biology, Primošten, Croatia, September 8-11, 2010
3. Regional Biophysics Conference, Primošten, Croatia, September 15-18, 2010

AWARDS AND APPOINTMENTS (ALL)

1. Harcet, Matija; Četković, Helena: Ruđer Bošković Institute Award for the scientific publication in 2010.



Division of Molecular Medicine

<http://www.irb.hr/en/zmm>

DIVISIONAL ORGANIZATION

Head: Tatjana Marotti

The Division of Molecular Medicine (ZMM) consists of the following laboratories:

- ⇒ Laboratory for Systems Biomedicine, Mario Cindrić
- ⇒ Laboratory of Experimental Hematology, Immunology and Oncology, Jelka Gabrilovac
- ⇒ Laboratory of Epigenomics, Koraljka Gall-Trošelj
- ⇒ Laboratory of Molecular Virology and Bacteriology, Magdalena Grce
- ⇒ Laboratory of Molecular Endocrinology and Transplantation, Mirko Hadžija
- ⇒ Laboratory for Personal Medicine, Sanja Kapitanović
- ⇒ Laboratory of Experimental Therapy, Marijeta Kralj
- ⇒ Laboratory for Hereditary Cancer, Sonja Levanat
- ⇒ Laboratory for Reactive Radicals, Tatjana Marotti
- ⇒ Laboratory of Molecular Neuropsychiatry, Dorotea Mück-Šeler
- ⇒ Laboratory of Molecular Oncology, Jasminka Pavelić
- ⇒ Laboratory of Molecular Neuropharmacology, Silva Katušić Hećimović
- ⇒ Group for Translation Medicine, Oliver Vugrek
- ⇒ Laboratory for Oxidative Stress, Neven Žarković
- ⇒ Animal Core Facility, Ranko Stojković



OVERVIEW OF THE DIVISION

The mission of DMM is closely correlated with the major areas of human medicine, covering a broad spectrum reflected in the name of its laboratories. The majority of research topics have been oriented to the molecular aspects of cancer, neuroscience (neuropsychiatry, neurodegeneration, neuropharmacology), stress-related diseases and their models. Particular attention and research has been devoted to mechanisms of disease etiology through disturbed methylation of macromolecules (DNA/proteins), molecular mechanisms of disease etiopathogenesis and experimental therapy. The DMM, with its Human Tumor Bank and numerous clinical samples collected through collaborations with clinicians (e.g. in neuropsychiatry and neurodegeneration), represents an important biomedical core, dedicated to establishing and refining new strategies and methods for understanding the molecular mechanisms of disease, for improving diagnostic procedures and therapies and, of primary importance, for disease prevention.

TOP ACHIEVEMENTS

IL-2 -330 T/G polymorphism in gastroenteropancreatic neuroendocrine tumors

A single nucleotide polymorphism (SNP) in the IL-2 promoter (-330; G) was shown to be associated with both increased susceptibility to gastroenteropancreatic neuroendocrine tumors and higher IL-2 serum values, strongly indicating this polymorphism as a potential prognostic marker (Cigrovski Berković et al., 2010).

Alternative splicing of p53 and p73

A novel p53 splice variant p53 δ has been shown to be an independent prognostic marker for recurrence – free and overall survival in ovarian cancer (Hofstetter et al., 2010)

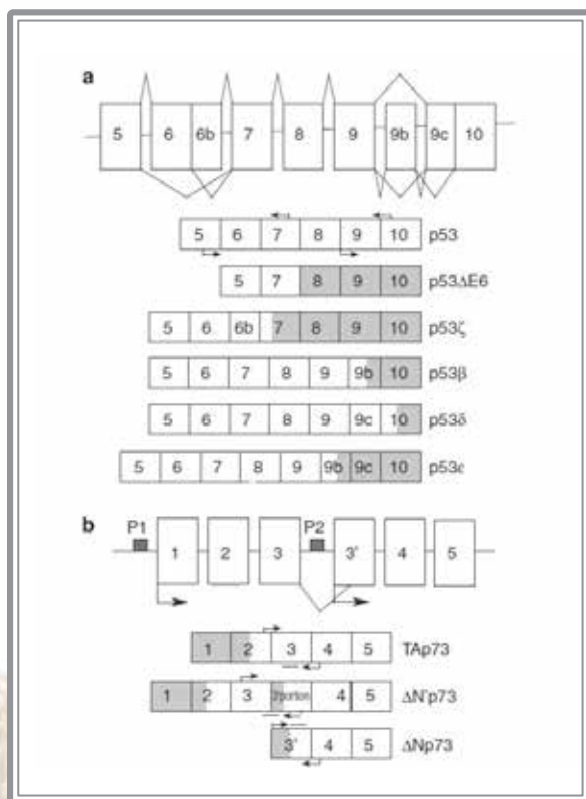


Fig. 1. The structure of the human p53 gene, comprising exons 5–10. Besides full-length p53, various p53 splice variants encoding C-terminally truncated proteins were identified. Fig. 2b. The gene architecture of the NH2 terminus of the p73 gene. Arrows illustrate the transcriptional start sides of the p73 isoforms.

The role of granulocytes in tumor growth

Granulocytes isolated from a healthy host and applied to the site of solid tumors in rats and mice reduced experimental tumor growth, extended the survival of tumor-bearing animals and, in some rats, induced tumor regression (Jaganjac et al., 2010).

Cholesterol accumulation promotes amyloidogenic processing of APP protein

The accumulation of cholesterol upon dysfunction of cholesterol transporter NPC1 was shown to lead to enhanced amyloidogenic processing of the amyloid- β precursor protein (APP) by β -secretase (BACE1), most likely due to decreased expression of APP at the cell surface (Malnar et al., 2010).

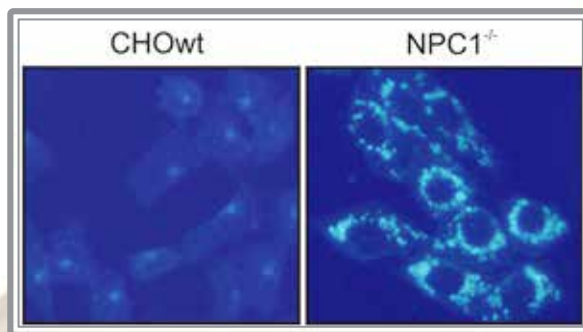


Fig. 2. NPC1-deficiency causes accumulation of free cholesterol in late endosomes/lysosomes.

A novel nano-HPLC ESI-QTOF mass spectrometry method for phospholipid analysis in cerebrospinal fluid

A method for sensitive and reliable analysis (nano-HPLC coupled to ESI-QTOF MS) of cerebrospinal fluid (CSF) has been developed through a pilot study conducted on CSF samples from Alzheimer's disease patients and age-matched healthy controls, revealing a significantly increased level of sphingomyelin in the CSF of Alzheimer's disease patients (Košíček et al., 2010).

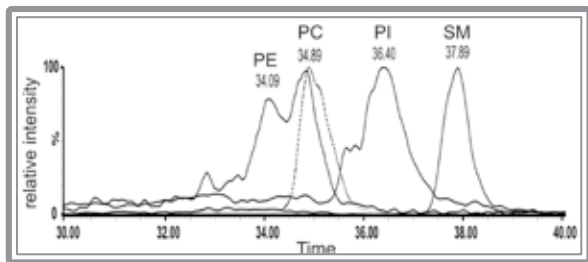


Fig. 3. Phospholipid profiling in the CSF by nano-HPLC-MS method.

NEW EQUIPMENT

1. High-Pressure Homogenizator (MSES) 20.000 EUR
2. Image Analyzer Alliance XD-79LS-26MX (MSES) 35.000 EUR

EDUCATION

DMMs researchers are very active in education at different universities, as principal teachers, organizing and actively participating in various bachelor's, master's and doctoral courses. All these collegia are listed separately.

AWARDS

Morana Jaganjac: The Croatian State Award for Science 2010 for young scientists.

Magdalena Grce: Pearl of Wisdom Award 2010. Award given by the European Cervical Cancer Association (ECCA), Brussels, Belgium, for the outstanding work on cervical cancer prevention.

Sonja Levanat: EACR Honorary membership.

The following scientists were awarded the Annual RBI Director's Award, for excellence in scientific research (Magdalena Grce, Nela Pivac, Neda Slade, Arijana Zorić), the Croatian State Award for Science 2010 for young scientists (Morana Jaganjac) and as recipient of an international project (Oliver Vugrek) in the field of molecular medicine:

PROJECTS

Research programs supported by the Ministry of Science, Education and Sport

1. Integrative genomics and proteomics in cancer research. Program leader: Krešimir Pavelić
2. Pharmacogenomics, proteomics and psychophysiology of neuropsychiatric disorders. Program leader: Dorotea Muck-Šeler

Research projects supported by the Ministry of Science, Education and Sport

1. Proteomic prostate tumor biomarker analysis, Mario Cindrić
2. Role of membrane peptidases on tumor and normal cells, Jelka Gabrilovac
3. Epigenetic and immunomodulatory changes in malignant head and neck tumours, Koraljka Gall Trošelj
4. Aberrant DNA methylation in HPV associated lesions, Magdalena Grce
5. Obtaining the structures like Langherhans islets from mouse stem cells, Mirko Hadžija
6. The role of nm23 genes in oral squamous cell carcinoma, Maja Herak Bosnar
7. Molecular genetics and pharmacogenetics of gastrointestinal tumors, Sanja Kapitanović
8. The mechanism of cholesterol action in the pathogenesis of Alzheimer's disease, Silva Katušić Hećimović
9. The role of different cell death responses to DNA-damage treatment, Marijeta Kralj
10. Signal transduction in tumors: Hh-Gli interactions and therapeutic potential, Sonja Levanat
11. Cytochrome P450 monooxygenase and tumor appearance in ageing and oxidative stress, Tatjana Marotti
12. Pharmacogenomics and proteomics of serotonergic and catecholaminergic system, Dorotea Muck-Šeler
13. Gene therapy of tumors by modulating the molecules of the immune system, Jasminka Pavelić

14. Molecular basis and treatment of psychiatric and stress related disorders, Nela Pivac
15. The role of p53/p73 network in soft tissue sarcoma, Neda Slade
16. Stress, GABA-A receptors and mechanisms of action of neurophychoactive drugs, Du-bravka Švob Štrac
17. S-Adenosylhomocysteine hydrolase (AHCY) deficiency: Molecular mechanisms of a new human disease, Oliver Vugrek
18. Lipids, free radicals and their second messen-gers in integrative oncology, Neven Žarković

Additional projects at the DMM:

1. Eye immunology, Iva Dekaris
2. Pharmacogenetics in pediatric oncology, Jasenka Stepan Giljević
3. Genetic basis in development of pituitary tu-mors, Živko Gnjiđić
4. Molecular basis of aseptic instability of hip to-tal endoprothesis, Robert Kolundžić
5. New therapeutic modalities in treatment of malignant diseases, Marko Radačić

Research development and international projects

a) Billateral Projects:

1. The analysis of intracellular localization and dynamics of A and B subunits of NDPK (Nm23-H1 and Nm23-H2), Maja Herak Bos-nar (Croatia-France)
2. Alzheimer disease – the role of cholesterol on processing and localization of APP protein fam-ily, Silva Katušić Hećimović (Croatia-Germany)
3. Improvements of adhesive properties of bio-medical materials by plasma treatment, Mo-rana Jaganjac (Croatia-Slovenia)
4. Genetic factors as indicators of suicide, Nela Pivac (Croatia-Slovenia)
5. Molecular dynamic S-adenosylhomocystein hidrolasys (SAHH) and its role in gene ex-pression, Oliver Vugrek (Croatia-Israel)
6. SAHH deficiency: Proteomic analysis of new methylation disturbance in humans, Oli-ver Vugrek (Croatia-Germany)

7. b) The Instrument for Pre-Accession Assistance - IPA

Creation of research related infrastructure for Translational Medicine and Applied Genomics, PI: Oliver Vugrek

c) FP7-REGPOT-2007-1

INTEgrating and Strengthening GENomic Re-search in South-Eastern Europe” FP7-REG-POT-2007-1 (PI: Fran Borovečki), members of the Executive Committee: Nela Pivac, Dorotea Muck-Šeler

d) BICRO

The synthesis of disulphoxy and threesulphoxy analogs for identification of peptides and pro-teins by mass spectrometry, Mario Cindrić

SELECTED INVITED LECTURES

1. Grce M: HPV vaccines and protection against cervical cancer. European perspective on HPV vaccination - Strategy and Implementa-tion, 13th Central European Vaccination Ad-visory Group Meeting, Budapest, Hungary, October 29-30, 2010
2. Herak Bosnar M: Characterization of ances-tral-type Groupe I Nm23 gene/protein - struc-ture and function is conserved from sponges to humans, «8th International Congres of the NDP kinase/Nm23/awd Family-From Basic Science to Clinical Applicationname», Hei-delberg, Germany, October 25-28, 2010.
3. Katušić Hećimović S: The link between lipids and Alzheimer's disease: a view from Nie-mann Pick type C disease, JSW Life Sci-ence company, Grambach, Austria, Novem-ber 18, 2010
4. Slade N, Zorić A, Horvat A: The effect of p53 isoforms on p73 activity in tumor cells. «1st International p53 Isoforms Meeting», Lyon, France, September 13-15, 2010.
5. Grce M: Report on the 4th Annual Summit on Cervical Cancer Prevention (the European

Parliament, Brussels, January 26-27, 2010), meeting at the Croatian Parliament on behalf of the 4th European Cervical Cancer Prevention Week, Zagreb, Croatia, January 28, 2010

6. Muck-Šeler D, Mustapić M, Nenadić-Šviglin K, Babić A, Nedić G, Nikolac M, Pivac N: Is the polymorphism in the serotonin type 1B receptor gene associated with alcohol dependence and aggressive behavior? 24th Danube Congress of Psychiatry & 12th Central European Neuropsychopharmacological Symposium, Zagreb, Croatia, May 5-8, 2010.
7. Pivac N, Kozarić-Kovačić D, Nenadić-Šviglin K, Nikolac M, Nedić G, Mustapić M, Grubišić Ilić M, Muck-Šeler D: Insomnia and serotonergic mechanisms in psychiatric disorders. 24th Danube Congress of Psychiatry & 12th Central European Neuropsychopharmacological Symposium Zagreb, Croatia, May 5-8, 2010
8. Slade N, Zorić A, Horvat A, Hofstetter G, Berger A, Concin N, Zeillinger R: The effect of p53 isoforms/splice variants on p73 activity. «10th Congress of the Croatian Society of Biochemistry and Molecular Biology», Opatija, Croatia, September 15-18, 2010.

SELECTED ORGANIZED CONFERENCES

1. First congress of Croatian Association for Cancer research HDIR-1 with international participation "From Bench to clinic", November 11, 2010 (Levanat S)
2. 5th Croatian Congress of Alzheimer's disease with international participation, Zadar, Croatia, September 22-25, 2010 (Pivac N and Muck-Šeler D)
3. 6th Croatian Congress of Pharmacology with international participation, Opatija, Croatia, September 15-18, 2010 (Pivac N and Muck-Šeler D).
4. 2nd Croatian Congress of Side Effects of Psychopharmacs with international participation, Rovinj, Croatia March 11-14, 2010 (Pivac N and Muck-Šeler D) .
5. Meeting of the Committee on Health and

Welfare, the Croatian Parliament, Zagreb, Croatia, January 28, 2010 (Grce M)

SELECTED PUBLICATIONS

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2. Hofstetter G, Berger A, Fiegl H, Slade N, Zorić A, Holzer B, Schuster E, Mobus VJ, Reimer D, Daxenbichler G, Marth C, Zeimet AG, Concin N, Zeillinger R. Alternative splicing of p53 and p73: the novel p53 splice variant p53d is an independent prognostic marker in ovarian cancer. *Oncogene* **28** (2010), 1997.
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5. Cigrovski Berković M, Jokić M, Marout J, Radošević S, Zjačić-Rotkvić V, Kapitanović S. IL-2 -330 T/G SNP and serum values – potential new tumor marker in neuroendocrine tumors of gastrointestinal tract and pancreas (GEP-NETs). *J Mol Med* **88** (2010), 423.
6. Pavišić R, Dodig I, Horvatić A, Mijić L, Sedić M, Rajić Linarić M, Gruić Sovulj I, Preočanin T, Bukvić Krajačić M, Cindrić M. Differences between reversible (self-association) and irreversible aggregation of rHuG-CSF in carbohydrate and polyol formulations. *Eur J Pharm Biopharm* **76** (2010), 357.

7. Jaganjac M, Poljak-Blaži M, Kirac I, Borović S, Schaur RJ, Žarković N. Granulocytes as effective anticancer agent in experimental solid tumor models. *Immunobiology* **215** (2010), 1015.
8. Gredičak M, Supek F, Kralj M, Majer Z, Hollosi M, Šmuc T, Mlinarić-Majerski K, Horvat Š. Computational structure-activity study directs synthesis of novel antitumor enkephalin analogs. *Amino Acids* **38** (2010), 1185.
9. Košiček M, Kirsch S, Bene R, Trkanjec Z, Titlić M, Bindila L, Peter-Katalinić J, Hećimović S. Nano-HPLC-MS analysis of phospholipids in cerebrospinal fluid of Alzheimer's disease patients—a pilot study. *Anal Bioanal Chem* **398** (2010), 2929.
10. Pinto B, Caciagli F, Ricco E, Reali D, Šarić A, Balog T, Likić S, Scarpato R. Antiestrogenic and antigenotoxic activity of bee pollen from *Cystus incanus* and *Salix alba* as evaluated by the yeast estrogen screen and the micronucleus assay in human lymphocytes. *Eur J Med Chem* **45** (2010), 4122.
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BOOK CHAPTERS:

1. Levanat S, Levačić Cvok M. Cellular and Molecular Biology of Prostate Cancer. In: Prostate cancer. Šamija M (ed). Zagreb, Medicinska naklada, 2010, pp 51-64.
2. Pivac N, Nedić G, Nikolac M, Muck-Šeler D. Genetics of suicidal behaviour. In: Coping with posttraumatic stress disorder in returning troops. Wounds of war II. NATO Science through peace and security series E: human and societal dynamics. Vol 68. Wiederhold BK (ed) IOS Press Amsterdam, 2010, pp 31-55.
3. Pivac N, Kozarić-Kovačić D, Nedić G, Nikolac M, Mustapić M, Babić A, Grubišić-Ilić M, Kovačić Z, Muck-Šeler D. Genetic markers in suicidal and non-suicidal veterans with combat-related posttraumatic stress disorder,

Chapter 4. In: Posttraumatic stress disorder (PTSD): causes, symptoms and treatment. Egan SJ (ed), Nova Science Publ, New York, 2010, pp 109-139.

4. Pivac N, Nedić G, Nikolac M, Nenadić-Šviglin K, Kozarić-Kovačić D, Mustapić M, Kovačić Z, Grubišić Ilić M, Borovečki F, Hajnšek S, Muck-Šeler D. Sleep disturbances and serotonergic markers in psychiatric disorders. In: Advances in Psychology Research. Vol 71. Columbus AM (ed). Nova Science Publ, New York, 2010, pp 1-85.
5. Muck-Šeler D, Mustapić M, Nedić G, Babić A, Mimica N, Kozarić Kovacic D, Nenadić Šviglin K, Stipčević T, Presecki P, Nikolac M, Borovečki F, Folnegović Smalc V, Kovacic Z, Pivac N. Genetic and biochemical markers of serotonergic and catecholaminergic systems in neuropsychiatric disorders. In: Advances in Genetic Research, Chapter I, Urbano KV (ed) Nova Science Publ, New York, 2010, pp 1-68.

REVIEW ARTICLES:

1. Car D, Sabol M, Musani V, Ozretić P, Levanat S. Epigenetic regulation of the Hedgehog-Gli signaling pathway in cancer. *Period Biol* **112** (2010), 419.
2. Catela Ivković T. Cyclooxygenase isoforms in tumorigenesis. *Period Biol* **112** (2010), 441.
3. Gall Trošelj K, Novak Kujundžić R. Epigenomics – A Bird's Eye Perspective on the Genome. *Period Biol* **112** (2010), 411.
4. Levanat S. Croatian Association for Cancer Research. *Period Biol* **112** (2010), 487.
5. Matijević T, Pavelić J. Toll-like receptors: cost or benefit for cancer? *Curr Pharm Design* **16** (2010), 1081.
6. Martin-Kleiner I, Gall Trošelj K. Mannose 6-phosphate/insulin-like growth factor 2 receptor in carcinogenesis. *Cancer Let* **289** (2010), 11.
7. Ozretić P, Levačić Cvok M, Musani V, Sabol M, Car D, Levanat S. In silico analysis of potential structural and functional significance of human breast cancer gene BRCA2 sequence variants found in 5' untranslated region. *Period Biol* **112** (2010), 469.

Division of Marine and Environmental Research

<http://www.irb.hr/en/zimo>

DIVISIONAL ORGANIZATION

Head: Tarzan Legović

The Division of Marine and Environmental Research (ZIMO) consists of the following laboratories:

- ⇒ Informatics and environmental modelling, Tarzan Legović
- ⇒ Satellite oceanography, Milivoj Kuzmić
- ⇒ Aquatic physical chemistry, Zlatica Kozarac
- ⇒ Physical chemistry of traces, Milivoj Lovrić
- ⇒ Colloid geochemistry, Ivan Sondi
- ⇒ Inorganic environmental geochemistry, Goran Kniewald
- ⇒ Bioelectrochemistry and surface imaging, Vesna Svetličić
- ⇒ Analytical chemistry and biogeochemistry of organic compounds, Marijan Ahel
- ⇒ Radioecology, Delko Barišić
- ⇒ Biological effects of metals, Marijana Erk
- ⇒ Molecular ecotoxicology, Tvrtko Smital
- ⇒ Aquaculture and pathology of aquatic organisms, Emin Teskeredžić



During 2010, division scientists worked on more than 50 research projects contracted by the Ministry of Science, Sport and Education and outside clients. These projects spanned a wide range of topics in marine and environmental science, ranging from satellite oceanography down to nanotechnology. Research results were published in 56 scientific papers in journals indexed by Current Contents. In addition, a number of invited lectures were held and 10 conferences were organized, four graduate schools were coordinated, 9 Ph.D, one M.Sc and two B.Sc. theses were defended, under the mentorship of Division scientists. Finally, 21 undergraduate and 70 post-graduate courses were given at universities in Croatia and abroad.

OVERVIEW OF THE DIVISION

Division contributions include fundamental and applied research of environmental systems, processes and states. Research in the Division is oriented toward an optimum environmental management for the benefit of our country and the world.

TOP ACHIEVEMENTS

Significance of data treatment in metal complexing parameters determination

Different procedures of voltammetric peak intensities determination, as well as various experimental setups were systematically tested on simulated and real experimental data in order to identify critical points in the

determination of copper complexation parameters (ligand concentration and conditional stability constant) by anodic stripping voltammetry (ASV). Peak intensities determination by fitting the whole voltammogram for subtraction of the background current is found to be the most appropriate, as it provided reliable complexation parameters (Omanović et al., 2010).

Determination of the concentration of stevioside in extracts of stevia leaves

Stevioside is one of several steviol glycosides that are extracted from the leaves of stevia (*Stevia rebaudiana* Bertoni), which is a perennial shrub of the *Asteraceae* (*Compositae*) family native to Paraguay and Brazil. Stevia glycosides are used as a general purpose sweetener and their number in the Codex Alimentarius is E-960. A maximum of square-wave voltammogram of stevioside appears at -1.3 V vs Ag/AgCl. The response is quasireversible and probably caused by electro-reduction of carboxyl or ester groups. The net peak current is linearly proportional to stevioside concentration between 1×10^{-6} mol/L and 3.5×10^{-5} mol/L (Komorsky-Lovrić et al., 2010).

Characterization of phytoplankton exudates and carbohydrates in relation to their complexation of copper, cadmium and iron.

Transparent exopolymer particles (TEP), carbohydrates, surface active substances (SAS), reduced sulfur species (RSS) and thio/amino groups in polymeric material were examined by electrochemical and complementary methods in order to investigate their contribution and influence to the complexing capacity of phytoplankton exudates for copper, cadmium or iron. This is of great significance for the transport of organic matter and particles in the oceans (Strmečki et al., 2010).

Iodine, reduced sulfur species, nutrients, lipid classes, dissolved and particulate organic matter in Rogoznica Lake a unique anoxic environment on the Adriatic coast

Iodine species, reduced sulfur species (RSS), nutrients, lipid classes, total dissolved and particulate organic matter, phytoplankton were reported for different seasons in 2004 and 2008 in a small, anoxic and eutrophicated seawater lake, Rogoznica Lake. Due to high photosynthetic activity, anoxic and sulfidic conditions were present only at the lake bottom where regeneration processes control and maintain accumulation of all of the above measured chemical species (Žić et al., 2010; Penezić et al., 2010).

Electrochemical adsorption studies of natural and synthetic organic matter (melanoidins) at the Hg electrode

Electrochemical techniques offer the possibility of direct investigation of adsorption characteristics of a complex mixture of naturally present organic solutes at the electrode-electrolyte interface. Adsorption of melanoidins, condensation products of sugars and amino acids, and their different fractions was studied at a mercury electrode by directly measuring the change of the double layer capacitance caused by the adsorption of organic molecules on the electrode surface through phase sensitive alternating current voltammetry (Čosović et al., 2010).

Mussel gills as an indicator tissue for the assessment of low-level metal contamination

The observed association of gill metallothionein levels with several biotic and abiotic factors limits its use as a biomarker of low-level metal exposure. Therefore, the use of metal concentrations in the heat-treated gill cytosol of Mediterranean mussels (*Myti-*

lus galloprovincialis) should be considered for the assessment of low-level metal contamination in coastal marine areas (Dragun et al., 2010).

Compensatory growth of gilthead sea bream

It is found that compensatory growth in gilt-head sea bream (*Sparus aurata*) compensates weight, but not length (Bavčević et al., 2010).

Maximum sustainable yield causes species extinction in ecosystems

Using simple prey-predator, food chain and food cascade ecosystem models, it is shown that in almost all cases, except harvesting top predator only, a maximum sustainable yield policy causes extinction of species. (Legović et al., 2010).

Cytosolic metal and protein levels in the gastrointestinal tissue of field-collected European chub (*Squalius cephalus*)

The study reports for the first time cytosolic metal and protein levels in the gastrointestinal tissue of field-collected European chub (*Squalius cephalus*), living in a low metal-

contaminated river section. In cytosol and heat-treated cytosol, metal levels decrease as follows: $Zn > Fe > Cu > Mn > Cd$ and are significantly higher during the spawning period. (Filipović, Marijić and Raspor, 2010).

Inducibility of metallothionein biosynthesis in zebra mussel

The specificity of metallothionein (MT) induction in *Dreissena polymorpha* was confirmed as an biological response to metal stimulation, especially by cadmium, being more closely correlated to MT than copper within the ecologically relevant concentration range. The strong induction potential of cadmium as well as an absence of MT induction following exposure to pentachlorophenol (organochlorinated pesticide) as an organic chemical contaminant are supporting evidence for usage of zebra mussel MT as a specific biomarker of Cd exposure in biomonitoring programs. (Ivanković et al., 2010).

Taxonomic and functional diversity of atrazine-degrading bacterial communities enriched from agrochemical factory soil

Atrazine-degrading bacterial communities enriched from agrochemical factory soil were characterised by analysing diversity and organization of catabolic genes. The study provided new insights into the genetic specificity and the repertoire of catabolic genes within bacterial communities originating from soils exposed to long-term contamination by s-triazine compounds (Udiković-Kolić et al., 2010).

Estimation of illicit drug abuse using sewage epidemiology

A comprehensive study of various psychoactive substances and their metabolites was performed in the wastewater treatment plant of the city of Zagreb over a period of 8 months, which allowed the estimation of drug abuse for five types of illicit drugs, including

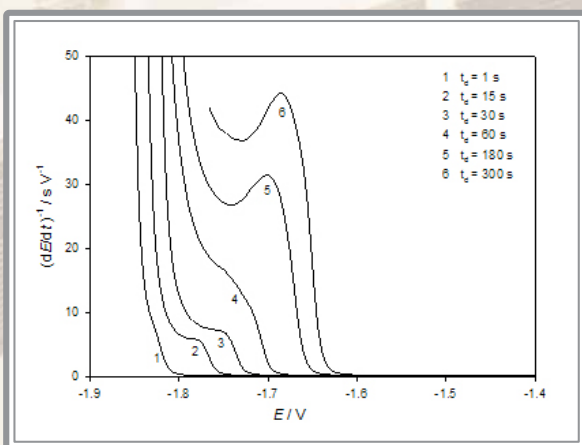


Fig. 1. Chronopotentiograms in diatom culture *Skeletonema costatum* at different deposition times (td). Recorded peak corresponds to presence of nitrogen containing polymeric organic material (N-POM) which acts as a "presodium" catalyst.

heroin, cocaine, marijuana, amphetamine and ecstasy. The results indicated that drug abuse patterns in transition countries might be different from those reported for Western Europe, in particular with respect to the comparatively increased consumption of heroin. Enhanced consumption of stimulating drugs (cocaine and ecstasy) was systematically detected during weekends (Terzić et al., 2010).

Kinetic Analysis of Isothermal Crystallization of Potassium Aluminosilicate Ceramics (Leucite and Kalsilite) from Amorphous Potassium Aluminosilicate Precursors

Kinetics of the isothermal crystallization of tetragonal modification of leucite and hexagonal modification of kalsilite from differently prepared precipitated amorphous aluminosilicate precursors were investigated at three different temperatures. Kinetic analyses of the transformation processes have shown that the crystallization of leucite occurs the same way as the crystallization of kalsilite and follows a pseudo-zero rate kinetic equation (Buljan et al., 2010).

Mathematical Model for Kinetics of Organic Particle Adhesion at an Electrified Interface

A mathematical model for the kinetics of an adhesion event based on consecutive two- and three-step processes of the first order was developed and tested. The proposed methodology enables determination of kinetic parameters of individual components of the adhesion process and the differentiation between the two- and the three-step processes (Ružić et al., 2010).

NEW EQUIPMENT

During 2010, the following larger equipment was obtained: (i) Precipitation collec-

tor NSA 181/KE, and (ii) 2x Teledyne RDI Acoustic Doppler Current Profiler (ADCP).



Fig. 2. Semi permeable membrane device used in monitoring Sava river.

EDUCATION

Division members teach at all universities in Croatia and some universities abroad. In addition, they help coordinate four Ph.D. schools: *Biophysics* with the University of Split, *Environmental Management and Oceanography* with the University of Zagreb, and *Environmental Protection and Nature Conservation* with the University J.J. Strossmayer in Osijek.



Fig. 3. Certificate of Marine Pollution Bulletin Highly Cited Author Award 2005-2009.

AWARDS

Tarzan Legović was appointed Secretary General of the International Society for Ecological Modelling, as well as becoming a member of the Committee on Biology, Ministry of Science, Education and Sports of Croatia. Irena Ciglencečki-Jušić and Marta Plavšić received the RBI Director's Award for scientific excellence in 2010, and Dušica Ivanković, Jasenka Pavičić, Marijana Erk, Vlatka Filipović Marijić, and Biserka Raspor received the Highly Cited Author Award from Elsevier (Figure 1). In June 2010, Elsevier announced its 50 top cited articles published from 2005 till 2009 in Marine Pollution Bulletin. Among the top 50 is the article entitled "Evaluation of the *Mytilus galloprovincialis* Lam. digestive gland metallothionein as a biomarker in a long-term field study: seasonal and spatial variability" (Marine Pollution Bulletin, 50, 2005: 1303-1313). The principal author is Dušica Ivanković and co-authors are Jasenka Pavičić, Marijana Erk, Vlatka Filipović Marijić, Biserka Raspor. The results presented in this article are based on multi-annual monitoring of MTs and metal levels in native populations of mussels from the central part of Eastern Adriatic coast. The study was performed within the scope of the Croatian National Monitoring Programme for the Adriatic Sea (Project "Adriatic"). Link to article: <http://dx.doi.org/10.1016/j.marpolbul.2005.04.039>. Ivan Sondi received an award for the most cited article in J. Colloid Interface Sci in 2010.

PROJECTS

Projects supported by the Ministry of Science, Education and Sports

1. Interactions of trace metal species in an aquatic environment, Ivanka Pižeta
2. Biogeochemistry of metals in sedimentary systems and soils in Croatia, Goran Kniewald.
3. Nature of organic matter, interaction with traces and surfaces in environment, Zlatica Kozarac

4. Metal-induced cellular changes in aquatic organisms, Biserka Raspor
5. Organic compounds as molecular markers of anthropogenic impact on the environment, Marijan Ahel
6. Nanoparticles in biogeochemical processes in the environment, Ivan Sondi
7. Surface force on atomic scale applied in marine science and nanotechnology, Vesna Svetličić
8. Development of nanotechnology-based sensor for bio-molecules, Croatian Science Foundation, Vesna Svetličić
9. Systematic study of the Adriatic Sea as a basis for sustainable development of the Republic Croatia, Croatian National Monitoring Programme of the Adriatic Sea.
10. Mathematical modeling of circulation and satellite sensing of boundary processes. Kuzmić, Milivoj
11. Pathology of aquatic organisms in relation to pollution and aquaculture, Emin Teskeredžić
12. Ecological modelling for sustainable management of resources, Tarzan Legović
13. Radionuclides and trace elements in environmental systems, Delko Barišić
14. Electroactive films for ecologically acceptable conversion and energy storage, Višnja Horvat-Radošević
15. Elektroanalytical research of microcrystal and traces in dissolved substances, Milivoj Lovrić
16. Information systems on environmental quality and risk, Ivica Ružić
17. Ecotoxicological significance of ABC transport proteins in aquatic organisms, Tvrtko Smital
18. Networked Economy, Zoran Skočir and Jadranka Pečar-Ilić

Research, developmental and international projects

1. Reference Laboratory for water testing laboratories in Croatia, Ministry of Regional Development, Forestry and Water Management, Water Management Directorate), Biserka Raspor, Zlatica Kozarac, Dubravka Hršak, Božena Čosović

2. Adhesion of liposomes at electrode, Croatia-Slovenia cooperation in science and technology, Nadica Ivošević DeNardis
3. Investigation of the pollution of Croatian and Slovenian Northern Adriatic coast by organotin compounds and toxic metals with different analytical techniques, Slovenian-Croatian project, Nevenka Mikac
4. Supramolecular organization of polysaccharide network in marine gels, Croatia-Slovenia cooperation in science and technology, 2010-2011, Vesna Svetličić
5. Integration of geo-chemical laboratory techniques, in situ field measurement, and hyperspectral air-borne remote sensing for environmental risk assessment, Hungarian-Croatian bilateral cooperation, S. Frančišković-Bilinski
6. On line toxicity sensors based on modification of membrane organisation, NATO science for peace and security programme, B. Gašparović and L.A. Nelson
7. Complex investigation of organic aerosols in rural, urban and marine environment, Bilateral collaboration with Air Chemistry Group of the Hungarian Academy of Sciences at University of Pannonia, Veszprém, Kozarac, Z. and Kiss, G.
8. Study of biogeochemical sulfur cycling in water column of Rogoznica Lake (Croatia) by combination of chromatographic and electrochemical techniques. Bilateral collaboration with Max-Planck-Institute for Marine Microbiology, Bremen, Germany, I. Ciglencečki-Jušić and T. Ferdelman
9. Biogeochemical processes in anoxic environment: Characterization of metal sulfide nanoparticles by electrochemical methods. Bilateral collaboration with University of Paris, IPGP, France, I. Ciglencečki-Jušić and E. Viollier
10. Biogeochemistry of sulfur, carbon, nutrients and redox sensitive elements in hypoxic/anoxic aquatic environments. Bilateral collaboration with State Key Laboratory of Marine Environmental Science, Xiamen University, China, I. Ciglencečki-Jušić and Minhan Dai
11. Development and evaluation of innovative tools to estimate the ecotoxicological impact of low dose pesticide application in agriculture on soil functional microbial biodiversity. ECOFUN-MICROBIODIV (under SEE-ERA.NET PLUS Joint Call), Ines Petrić
12. Radiochemical methods for determination of radionuclides in water samples", Croatian – Slovenian bilateral cooperation, Martina Rožmarić Mačefat
13. Nanoparticles in aqueous environment: electrochemical, nanogravimetric, STM and AFM studies, Irena Ciglencečki-Jušić
14. Hidrogeological studies of the Kupa River and its tributaries", Croatian – Austrian bilateral cooperation, Stanislav Frančišković-Bilinski
15. European network on applications of atomic force microscopy to nanomedicine and life science. COST Action TD 1002 (2010-2014), Coordinator of WG 4: Environmental Nanotoxicology and Nanoparticles Member of Core Management, Vesna Svetličić, Tea Mišić, Amela Hozić
16. Radiological monitoring in Croatia (Nuclear Power Plant Krško), Željko Grahek
17. Determination of radioactivity in the Danube River in 2010., Delko Barišić
18. The program of systematic testing and monitoring of radioactive substances in the sea – sessile indicator organisms (National Institute of Radiological and Nuclear Safety), Delko Barišić
19. Monitoring of freshwater fishery: fishing area of the Rivers Kupa, Korana, Dobra and Mrežnica", Ministry of Agriculture, Fishery and Rural Development, E. Teskeredžić

SELECTED INVITED LECTURES

1. Ciglencečki-Jušić I, Rogoznica Lake (Croatia), a unique anoxic seawater system on the Adriatic coast, Xiamen University, China, April 7-18, 2010.
2. Bura-Nakić E, Reduced sulfur and iron species in anoxic environments: Pavin Lake a meromictic crater lake as a study site, Xiamen University, China, April 7-18, 2010.
3. Mikac N, Geochemistry of marine sediments from the Eastern Adriatic Coast, Final Workshop of the project "Marine science and

coastal management in the Adriatic, western Balkan. An education and research network“, Cavtat, May 2010.

4. Ahel M, Relative contribution of polar contaminants to the toxicological profiles of the wastewater effluents of the city of Zagreb (Croatia) // SETAC Europe Annual Meeting: Science and Technology for Environmental Protection, Seville, Spain, May 23-27, 2010.
5. Ciglencečki-Jušić I, Distribution of redox-sensitive trace elements in the water column and sediments of seawater lake (Rogoznica lake, Croatia) an unique anoxic environment on the Adriatic coast, GEOTRACES Mediterranean workshop in the frame of Cost Actions ES0801 “The ocean chemistry of bioactive trace metals and paleoclimate proxies”; Nice, France, October 3-6, 2010.
6. Frka-Milosavljević S, Characterization of surface active substances in the natural sea surface microlayers of the coastal Middle Adriatic stations, GEOTRACES Mediterranean workshop in the frame of Cost Actions ES0801 “The ocean chemistry of bioactive trace metals and paleoclimate proxies”; Nice, France, October 03-06, 2010.
7. Bura-Nakić E, Voltammetric characterization of iron sulphide species in model solutions and natural samples, Max Planck Institute for Marine Microbiology, Bremen, Germany, October 10-20, 2010.
8. Omanović D, Distribution of trace metals in estuary and seawater, Université du Sud Toulon Var, Garde, France. October 13 – December 11. 2010)
9. Ahel M, Prioritization of hazardous chemical contaminants in the Sava River basin using EDA approach. „Characterization of hazardous chemical contamination-from environmental chemistry and toxicology to risk assessment“, Inter-University Center, Dubrovnik, October 23-26, 2010.
10. Klanjšček T, „From bacteria to whales: relating environment to growth and reproduction using Dynamic Energy Budget Theory“. Global Center Of Excellence (G-COE) Forum, Yokohama National University, Yokohama, Japan. December 13-20, 2010.

SELECTED ORGANIZED CONFERENCES

1. “Characterisation of hazardous chemical contamination – from environmental chemistry and toxicology to risk assessment“, Dubrovnik, 23.-26. 09.2010 (M. Ahel, Chairman)
2. 11th Reunion of the Laboratories authorised for water analysis, Biograd na moru, Croatia, November 16-19, 2010. Member of the Organizing Committee: Biserka Raspor.
3. Collaborative meeting. Charge density waves: small scales and ultrashort time. Vukovar, Croatia, 28.10.–30.10. 2010. Vesna Svetličić (collaborator)
4. IIIrd International Meeting on AFM in Life Sciences and Medicine. Red Island, Croatia, 12.05.-15.05.2010. Vesna Svetličić (chair of organizing committee), Amela Hozić Zimmermann, Tea Mišić Radić, Galja Pletikapić (local organizing committee)
5. Regional biophysics conference. Primošten, Croatia, 15.09.-18.09. 2010. Vesna Svetličić (co-organizer and member of International Advisory Board)
6. Adriatic School on Nanoscience (ASON -1). From Atomic to Macroscopic Nanostructures. Dubrovnik, Croatia, 19.09.–23.09.2010. Vesna Svetličić (programme Committee member)
7. International meeting on fishery: Prospect of Croatian fishery. Fishery and health of fish. Vukovar, Croatia, 14.4.-15.4.2010. Zlatica Teskeredžić, Emin Teskeredžić (programme Committee member)

SELECTED PUBLICATIONS

1. Omanović D, Garnier C, Louis Y, Lenoble V, Mounier S, Pižeta I. Significance of data treatment and experimental setup on the determination of copper complexing parameters by anodic stripping voltammetry. *Anal Chim Acta* **664** (2010) 136.
2. Žic V, Carić-Glunčić M, Viollier E, Ciglencečki I. Intensive sampling of iodine and nutrient speciation in naturally eutrophicated anchialine pond (Rogoznica Lake) during spring and

- summer seasons. *Estuar Coast Shelf S* **87** (2010) 265.
3. Legović T, Klanjšček J, Geček S. Maximum sustainable yield and species extinction in ecosystems. *Ecol Model* **221** (2010) 1569.
 4. Bavčević L, Klanjšček T, Karamarko V, Aničić I, Legović T. 2010 Compensatory growth in gilthead sea bream (*Sparus aurata*) compensates weight, but not length. *Aquaculture* **301** (2010) 57.
 5. Strmečki S, Plavšić M, Steigenberger S, Passow U. Characterization of phytoplankton exudates and carbohydrates in relation to their complexation of copper, cadmium and iron. *Mar Ecol - Prog Ser* 408 (2010) 33.
 6. Čosović B, Vojvodić V, Bošković N, Plavšić M, Lee C. Characterization of natural and synthetic humic substances (melanoidins) by chemical composition and adsorption measurements. *Org Geochem* **41** (2010) 200.
 7. Penezić A, Gašparović B, Burić Z, Frka S. Distribution of marine lipid classes in salty Rogoznica Lake (Croatia). *Estuar Coast Shelf S* **86** (2010) 625.
 8. Komorsky-Lovrić Š, Novak I, Novak B. Measurement of Stevioside by Square-wave Polarography. *Electroanal* **22** (2010) 2211.
 9. Dragun Z, Erk M, Ivanković D, Žaja R, Filipović Marijić V, Raspor B: Assessment of low-level metal contamination using the Mediterranean mussel gills as the indicator tissue. *Environ Sci Pollut R* **17** (2010) 977.
 10. Filipović Marijić V, Raspor B: The impact of fish spawning on metal and protein levels in gastrointestinal cytosol of indigenous European chub. *Comp Biochem Phys C* **152** (2010) 133.
 11. Ivanković D, Pavičić J, Beatović V, Sauerborn Klobučar R, Klobučar G, Igor V: Inducibility of metallothionein biosynthesis in the whole soft tissue of zebra mussels *Dreissena polymorpha* exposed to cadmium, copper and pentachlorophenol. *Environ Toxicol* **25** (2010) 198.
 12. Terzić S, Senta I, Ahel M. Illicit drugs in wastewater of the city of Zagreb (Croatia)- Estimation of drug abuse in a transition country. *Environ Pollut* **158** (2010) 2686.
 13. Udiković-Kolić N, Hršak D, Devers M, Klepac-Ceraj V, Petrić I, Martin-Laurent F. Taxonomic and functional diversity of atrazine-degrading bacterial communities enriched from agrochemical factory soil. *J App Microbiol* **109** (2010) 355.
 14. Buljan I, Kosanović C, Subotić B, Novak T, Ristić A, Gabrovšek R, Kaučič V, Mišić Radić T. Kinetic Analysis of Isothermal Crystallization of Potassium Aluminosilicate Ceramics (Leucite and Kalsilite) from Amorphous Potassium Aluminosilicate Precursors. *Cryst Growth Des* **10** (2010) 838.
 15. Ružić I, Pečar-Ilić J, Ivošević DeNardis N. Mathematical model for kinetics of organic particle adhesion at an electrified interface. *J Electroanal Chem* **642** (2010) 120.

DIVISIONAL ORGANISATION

Head: Nenad Smodlaka

The Centre for Marine Research consists of the following laboratories:

- ⇒ Laboratory for marine molecular toxicology, Renato Batel
- ⇒ Laboratory for marine ecotoxicology, Nevenka Bihari
- ⇒ Laboratory for biomineralization nanostructure and radioecology, Davorin Medaković
- ⇒ Laboratory for marine microbial ecology, Mirjana Najdek
- ⇒ Laboratory for processes in the marine ecosystem, Robert Precali
- ⇒ Laboratory for ecology and systematics of benthos, Ana Travizi



TOP ACHIEVEMENTS

Deoxyribonucleases in the cortex and endosome from marine sponge *Tethya aurantium*

The cortex, a sponge section that communicates with the environment, expresses high interindividual variability and heterogeneity of neutral DNases, while the endosome, the site of intracellular digestion, contains high acid DNase activity (Fafandel et al., 2010).

Utility of the mussel *Mytilus galloprovincialis* as an indicator of environmental conditions and pollution

Metal content in mussels as measured by ICP-AES showed a certain level of contamination in shells collected near harbours, city waste and chemical industry centers (Rončević et al., 2010). Salinity and temperature variations measured during a ten year period in the eastern Adriatic coast showed that freshwater influx is reflected in lower mussel shell carbonates indicating that bivalve shells might be used as a tracer of environmental stress (Hamer et al., 2010).

OVERVIEW OF THE DIVISION

The mission of the Center for Marine Research is the multidisciplinary study of processes in the marine environment from the subcellular to the regional scale, especially in planktonic and benthic communities of the northern Adriatic Sea. In addition to basic research, the Center is involved in monitoring of the Adriatic Sea for government purposes as well as for several international projects regarding protection of the marine environment.

Morphology and ecology of the diatom *Chaetoceros vixvisibilis* from the Adriatic Sea

The chain-forming diatom *Chaetoceros vixvisibilis* is one of the most abundant and frequent diatoms in the northeastern Adriatic Sea. This species had not been previously studied by electron microscopy. Its most characteristic feature is, however, the resting spores commonly found, which also show morphological variability, from solitary to paired, both valves convex to domed and surface smooth or with small granules, and one to four strong spines often branching dichotomically (Hernandez-Becerril et al., 2010).

Long-term changes in heterotrophic prokaryote abundance and growth characteristics in the northern Adriatic Sea

During the 1990–2008 period heterotrophic prokaryote abundance (HP) showed a substantial decrease after 2003. There were indications that changed hydrographic conditions, reduced substrate supply and quality changes might be the most responsible factors for the observed HP decrease and change in their growth characteristics (Ivančić et al., 2010a).

Phytoplankton and bacterial alkaline phosphatase activity (APA) in the northern Adriatic Sea

During late spring and summer microbial communities exploited dissolved organic phosphorus although, taking into account biomass, phytoplankton activity usually dominated over bacterial. In autumn an extra P supply from deeper waters reduced phytoplankton APA, though not bacterial APA, in upper layers. In these months bacteria degrading phytoplankton produced organic matter were P limited. In deeper waters APA was low and mainly due to the activity of free enzymes (Ivančić et al., 2010b).

New species of Syllidae from the northern Adriatic Sea

Morphological and molecular analyses of polychaetes found in the vicinity of Rovinj resulted in the description of a new genus and new species, *Erseia oligochaeta* Nygren, Sundkvist, Mikac & Pleijel, 2010, of Syllidae family for science (Mikac et al., 2010).



Fig. 1. *Erseia oligochaeta*, new genus, new species.

Distribution of limpets on intertidal seawalls

On artificial surfaces (seawalls) in Sydney Harbour (Australia), local biodiversity of grazers differs between sandstone and concrete constructions. *Patelloida latistrigata*

was the stronger competitor, with increased densities reducing survival of conspecifics and of *Siphonaria denticulata*; *S. denticulata* had not effect on survival of *P. latistrigata*. *S. denticulata* reduced amounts of macroalgae, whereas *P. latistrigata* had no such effect (Iveša et al., 2010).

Oligotrophication of the Northern Adriatic: Evidence from Chlorophyll, a Time Series

The results of the updated and quality-checked data base of field observations on chlorophyll a (Chl a) collected in the period 1970–2007 in the Northern Adriatic Sea demonstrate a global tendency towards Chl a reduction in the period of investigation, which is more marked in the eutrophic area under the influence of the Po River. The recent substantial reduction of Chl a concentrations is confirmed all over the basin ($-0.11 \text{ mg m}^{-3} \text{ year}^{-1}$) from satellite-derived information. Results are consistent with the recently evidenced decrease in concentrations of phosphate and ammonia and point to the existence of oligotrophication in the Northern Adriatic (Mozetič et al., 2010).

New records of Syllidae (Polychaeta) for the northern Adriatic Sea

Research on the family Syllidae (Polychaeta) from the Rovinj area resulted in findings of 13 species which are new records for the northern Adriatic Sea and indicate that the area is possibly undergoing long-term changes, with modifications of diversity due to the establishment of warm-water species (Nygren et al., 2010).

NEW EQUIPMENT

Cryostat

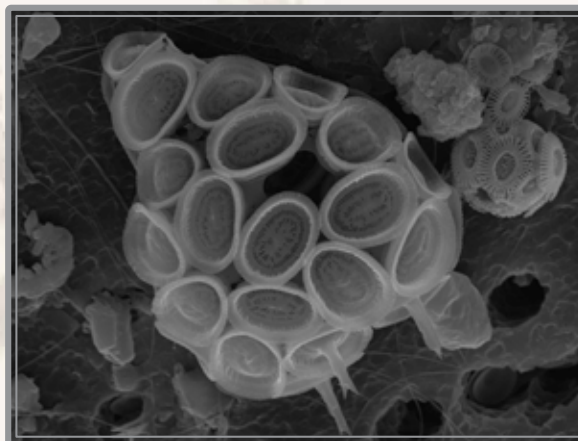


Fig. 2. *Syracosphaera pulchra*, phytoplankton species.

EDUCATION

The Center is involved in the organisation of Marine Sciences Studies (undergraduate) at the Juraj Dobrila University in Pula. The majority of courses are organized by the Center's scientists. Under- and post-graduate courses were conducted at the Universities of Zagreb, Osijek, Split, and Dubrovnik.

Research programs supported by the Ministry of Science, Education and Sport

1. Impact of pollution on programmed biosynthesis in marine invertebrates, Renato Batel
2. Ecotoxic effect of contamination on marine organisms, Nevenka Bihari
3. Biomineralization processes in marine organisms, Davorin Medaković
4. Structure and physiology of microbial communities in northern Adriatic front, Mirjana Najdek
5. Mechanisms of long-term changes in the northern Adriatic ecosystem, Robert Precali
6. Biodiversity of benthic communities in the Adriatic: natural and human impacts, Ana Travizi
7. Croatian national monitoring programme "Systematic research of the Adriatic Sea as a base for sustainable development of the Republic of Croatia" (Project "Adriatic"), Nenad Smodlaka

SOME OUTSTANDING PUBLICATIONS

1. Rončević S, Pitarević Svedružić L, Smetiško J, Medaković D. ICP-AES Analysis of Metal Content in Shell of Mussel *Mytilus galloprovincialis* from Croatian Coastal Waters. *Int J Environ Anal Chem* **90** (2010), 620.
2. Hamer B, Medaković D, Pavičić-Hamer D, Jakšić Ž, Štifanić M, Nerlović V, Travizi A, Precali R, Kanduž T. Estimation of Freshwater Influx Along Eastern Adriatic Coast as a Possible Source of Stress for Marine Organisms. *Acta Adriatica* **51** (2010), 181.
3. Mozetič P, Solidoro C, Cossarini G, Socal G, Precali R, Francé J, Bianchi F, De Vittor C, Smolaka N, Fonda Umani S. Recent Trends Towards Oligotrophication of the Northern Adriatic: Evidence from Chlorophyll a Time Series. *Estuar Coasts* **33** (2010), 362.
4. Hernández-Becerril D, Viličić D, Bosak S, Đakovac T. Morphology and ecology of the diatom *Chaetoceros vixvisibilis* (Chaetocerotales, Bacillariophyceae) from the Adriatic Sea. *J Plankton Res* **32** (2010), 1513.
5. Ivančić I, Fuks D, Radić T, Lyons DM, Šilović T, Kraus R, Precali R. Phytoplankton and Bacterial Alkaline Phosphatase Activity in the Northern Adriatic Sea. *Mar Environ Res* **69** (2010), 85.
6. Nygren A, Sundkvist T, Mikac B, Pleijel F. Two new and two poorly known autolytines (Polychaeta: Syllidae) from Madeira and the Mediterranean Sea. *Zootaxa* **2640** (2010), 35.
7. Iveša Lj, Chapman GM, Underwood A, Murphy RJ. Differential patterns of distribution of limpets on intertidal seawalls: experimental investigation of the roles of recruitment, survival and competition. *Mar Ecol- Prog Ser* **407** (2010), 55.

8. Mikac B, Musco L. Faunal and biogeographic analysis of Syllidae (Polychaeta) from Rovinj (Croatia, northern Adriatic Sea). *Sci Mar* **74** (2010), 353.

SELECTED INVITED LECTURES

1. Lyons DM. Nanobiotechnology at the Ruđer Bošković Institute, Nano-biotechnology International Workshop, Institute for Health and Consumer Protection, European Commission Joint Research Centre, Ispra, Italy, November 30–December 02, 2010.
2. Medaković D. Some ecological events in the North Adriatic Sea, TBT contamination. Fachhochschule Technikum Wien, Wien, Austria, December 18, 2010.

AWARDS AND APPOINTMENTS

Daniel M. Lyons: RBI Director's Award for Scientific Excellence for winning a competitive international or domestic project worth more than 500.000 kn.

Tina Šilović: Uncovering composition and diversity of marine picophytoplankton in northern Adriatic coastal waters (UKF, grant 2A)

ORGANIZATION OF CONFERENCES, CONGRESSES AND MEETINGS

JOINT Workshop / MC Meeting, COST Action TD0903, Understanding and manipulating enzymatic and proteomic processes in biomineralization, May 20-22, 2010, Pula, Croatia (Davorin Medaković)

ORGANISATION OF THE CENTRE

Head: Karolj Skala

The Centre for Informatics and Computing (CIC) consists of the following departments:

- ⇒ Optoelectronics and Visualisation Laboratory,
- ⇒ Department for R&D of ICST systems,
- ⇒ Department for Information systems,
- ⇒ IT Services Department



TOP ACHIEVEMENTS

Completed three EU projects

CIR successfully completed three EU FP7 projects:

1. Enabling Grids for E-science-III (EGEE-III),
2. eInfrastructure for regional eScience (SEE-GRID SCI),
3. Preparing for the construction of the Digital Research Infrastructure for the Arts and Humanities (DARIAH).

DARIAH continues as DARIA ERIC with the aim of establishing a national virtual competence centre.

Application Information Services for Distributed Computing Environments (AIS-DC)

This FP7 People Reintegration Grant has been contracted with the EC. Reintegration and establishment of a collaboration with Enis Afgan to realize two aims: (1) provide an environment and a scientific basis for his arrival to

OVERVIEW OF THE DIVISION

The Centre for Informatics and Computing is an organizational unit of the Ruđer Bošković Institute in which research projects, development programs and services for scientists are performed in the fields of optoelectronics, information technology and computing.

Mission: Scientific research, development and maintenance of the infrastructure, technology and logistics for contemporary multidisciplinary (RBI) and multi-institutional (global) scientific research, based on modern computer technologies, informatics, which have resulted in the development of eScience technologies on the basis of Science Information Communication Technology—ICST.

RBI; and (2) formulate a framework for developing and promoting a set of cloud services as an eScience computing paradigm that will facilitate long-term sustainability and growth of the scientific research infrastructure.

EDUCATION

Employees provided 5 undergraduate and 3 graduate courses at the Faculty of Electrical Engineering and Computing as well as at the Faculty of Graphic Arts at the University of Zagreb. CIR also participated in 3 doctoral studies.

AWARDS

1. Karolj Skala received the Arany Janos Medal from the Hungarian Academy of Science. Fig 1
2. CIR lab (Skala, Lipic, Gjenero, Grubisic): VIDI e-Novation Award "Golden Tesla's Egg" Fig2
3. Karolj Skala: the RBI Director's Award for successful realisation of EU FP7 projects.



Fig. 1. President of the Hungarian Academy of Science presented award to dr. Skala

PROJECTS AND PROGRAMS

Scientific program: Distributed Computing and Visualisation (2007-2012), Karolj Skala



Fig. 2. First prize VIDI eNovation Golden Tesla's Egg

Scientific project: Scientific Visualisation Methods (2007-2011), Karolj Skala

This project's associates have performed various theoretical and applied research and development, both in Croatia and abroad. The research group has experience through past project work, in signal processing, computer graphics, parallel algorithms, visual interfaces, visual peripherals, development and application of formal descriptive, prescriptive and procedural languages, experience in integration of user interfaces and interactive work in virtual and real space. Much of the research by project associates has produced a large knowledge base, theoretical as well as practical, related to the broad field of human-machine interactions and many methods of visualisation and interaction have been tested. Within the RBI Centre for Informatics and Computing, there have been several earlier related projects.

SELECTED ORGANIZED CONFERENCES

1. 33th International Convention MIPRO, CONFERENCE on GRID AND VISUALISATION SYSTEMS (GVS), Opatija, Croatia, Monday 24th - Friday 28th of May 2010, conference chair K. Skala.

SELECTED PUBLICATIONS

1. Afgan E, Bangalore P, Skala K: Application information services for distributed computing environments. *Future Gener Comp Sy* **27** (2010), 173.
2. Davidović D, Skala K, Belušić D, Telišman-Prtenjak M: Grid implementation of the weather research and forecasting model. *Earth Sci Inform* **3** (2010), 199.
3. Afgan E, Bangalore P, Skala T: Planning Job Execution of Loosely Coupled Applications. *J Supercomput* **58** (2010), 460.
4. Medved Rogina B, Škoda P, Skala K, Michieli I: Metastability testing at FPGA circuit design using propagation time characterization. *Radioelectronics & Informatics* **51** (2010), 4.



ORGANIZATION OF THE CENTRE

Head: Dejan Plavšić

The Centre consists of the following laboratories:

- ⇒ Laboratory for NMR spectroscopy and modelling, Dejan Plavšić
- ⇒ Glass Laboratory, Andrea Moguš-Milanković



OVERVIEW OF THE CENTRE

The mission of the Centre is to conduct scientific research in the field of NMR spectroscopy and provide services to scientists and researchers at the Ruđer Bošković Institute and the Universities of Zagreb, Rijeka, Split and Osijek. The Centre also provides educational and professional support to researchers from government institutions and pharmaceutical industry.

The Glass Group has been involved in several strategic projects. These include the development of novel electronic–ionic phosphate glasses and glass-ceramics for potential use in nuclear waste technology, electrochemical devices and biomedicine. Special attention has been devoted to lithium conducting glasses as candidates for solid electrolytes in lithium cells.

TOP ACHIEVEMENTS

Hepatoprotective effects of α -, β -, and γ -MSH

It was shown that α -, β -, and γ -melanocyte stimulating hormones (MSH) represent hepatoprotective substances that prevent APAP-induced liver lesions in mice. Potency and efficacy of β - and γ -MSH in this model surpass α -MSH (Blagaić et al., 2010).

Structural and electrical properties of $\text{Li}_2\text{O-ZnO-P}_2\text{O}_5$ glasses

The systematic change in the variety of properties at 20 mol % Li_2O is explained by changes in the nature of the oxygen bonds in glass network. The observed minimum in electrical conductivity at 20 mol % Li_2O is due to the structural reorganization of the glass network. With increasing Li_2O content up to 40 mol % the values of electrical conductivity increases by five orders of magnitude indicating ionic conductivity (Moguš-Milanković et al., 2010).

NEW EQUIPMENT

An Impedance Analyzer (Novocontrol Alpha A-high Performance Analyzer) has been installed in the Glass group (Fig. 1.).



Fig. 1. Impedance Analyzer (Novocontrol Alpha A-high Performance Analyzer).

EDUCATION

In 2010, the members of the Centre taught 2 undergraduate and 8 postgraduate courses at Universities of Zagreb, Split, Osijek, Dubrovnik and Rijeka. One PhD thesis has been defended by a staff member, and a second by an outside student mentored by a Centre staff member.

AWARDS

Dejan Plavšić and Dražen Vikić-Topić received the RBI Director's Award for Scientific Excellence and Luka Pavić obtained a fellowship for doctoral students from the Croatian National Science Foundation for research on Crystallization Impact on Magnetic Properties of Iron Phosphate Polaron Glasses.

PROJECTS

Projects supported by the Ministry of Science, Education and Sports

1. Modelling of molecules and materials by methods of mathematical and computational chemistry, Ante Graovac
2. Influence of structure on electrical properties of (bioactive) glasses/ceramics, Andrea Moguš-Milanković
3. NMR spectroscopy and modelling of bioactive molecules, Dejan Plavšić
4. Modelling of bioactive molecules and testing of their properties and activity, Nikola Štambuk

Research, developmental and international projects

1. New insights into charge transport in iron phosphate glasses, bilateral Croatian-German project, Andrea Moguš-Milanković
2. Investigation of electrical mobility and dielectric relaxation of bioactive glass, bilateral Croatian-Slovenian project, Andrea Moguš-Milanković
3. NMR Study of the Interactions of Angiotensin II Receptor Antagonists, bilateral Croatian-Slovenian project, Marijana Vinković

SELECTED ORGANIZED CONFERENCES AND COURSES

1. The 25th International Course & Conference MATH/CHEM/COMP 2010, Dubrovnik, Croatia, July 7-12, 2010.

SELECTED PUBLICATIONS

1. Randić M, Pisanski T, Noviĉ M, Plavšić D. Novel graph distance matrix. *J Comp Chem* **31** (2010), 1832.
2. Blagaić V, Houra K, Turĉić P, Štambuk N, Konjevoda P, Boban-Blagaić A, Kelava T, Kos M, Aralica G, Čulo F. The Influence of α -

- β -, and γ -Melanocyte Stimulating Hormone on Acetaminophen Induced Liver Lesions in Male CBA Mice. *Molecules* **15** (2010), 1232.
3. Kikaš I, Škorić I, Marinić Ž, Šindler-Kulyk M. Synthesis and Phototransformations of Novel Styryl-substituted Furobenzobicyclo [3.2.1] octadiene Derivatives. *Tetrahedron* **66** (2010), 9405.
 4. Moguš-Milanković A, Pavić L, Reis ST, Day DE, Ivanda M. Structural and electrical properties of $\text{Li}_2\text{O-ZnO-P}_2\text{O}_5$ glasses. *J Non-Cryst Solids* **356** (2010), 715.
 5. Šantić A, Kim CW, Delbert DE, Moguš-Milanković A, Electrical properties of $\text{Cr}_2\text{O}_3\text{-Fe}_2\text{O}_3\text{-P}_2\text{O}_5$ glasses. Part II. *Journal of Non-Cryst Solids* **356** (2010), 2699.
 6. Amić D, Lučić B. Reliability of bond dissociation enthalpy calculated by the PM6 method and experimental TEAC values in antiradical QSAR of flavonoids. *Bioorgan Med Chem* **18** (2010) 28.



Head of Library: Bojan Macan

OVERVIEW OF LIBRARY ACTIVITIES

Website redesign

The fast pace of development in information technology, especially the rapid growth of the Web, is transforming scholarly communication. Technological changes caused changes in the roles that researchers, funding bodies, research institutions, publishers, and libraries play in disseminating and providing access to quality-assured research outputs, in their goals and expectations, and in the services they provide and use. Researchers are investing more and more time on the Web, searching for various types of information, potential business partners, communicating with peers, and sharing their knowledge. All these changes improved and speeded up scholarly communication.

The RBI Library was the first library in Croatia which recognized the potential of the Web as a new media and launched their own website back in April 1994. This website was very popular inside the research and academic community, and had around 200.000 visits monthly. Although the library website was continuously developing, in 2010 we decided to completely reorganize and redesign it in order to improve information architecture, functionalities, visual design, and to provide new and modern services for our users.

As a content management system for the new website, the open source software Joomla was chosen. Library staff managed

the selection and testing of available software solutions, installation and setup, information architecture design, content creation and visual design, without any external support. The newly redesigned Library website was launched at the end of the year.

In 2010 the Library also moved all of its servers to a newly equipped central server room in the 1st wing.



Fig. 1: The new Library website

Open source ILS as a platform for library management

The Library continued the process of implementation of an integrated library system Koha into all spheres of library management. During 2010 the acquisition, cataloguing and

circulation of printed and e-books and theses were completely migrated to Koha. The existing library thesis records were also converted into MARC21 bibliographic metadata schema and imported into the new integrated library system.

An application for generating barcode labels was developed in the Library which enabled barcoding the printed collection of books for the purpose of faster and completely automated circulation process.

Library digital initiatives – central digital repository

The Library has finished the process of digitizing graphic and other documental materials about the Institute within the project of implementation of the RBI's Digital Repository. As a result more than 10,000 photographs are digitized and archived to the Library's Photo gallery, and visible only to RBI staff through IP range validation or AAI@Edu.Hr authentication (<http://lib.irb.hr/fotoarhiv/>). Another photo gallery was implemented to present life at the RBI to the public (<https://lib.irb.hr/foto-galerija/>). This photo gallery is administrated by the RBI's Public Relations Office and contains new, digitally born photographs. In the future the Library is planning to merge the two galleries and provide additional functionalities through detailed metadata description of photographs which will enable various search and browse functionalities. As part of the digitization project, all RBI's annual reports and all available issues of *Ruđer* magazine are also digitized and available along with a number of full text articles in the RBI's institutional repository, which will be presented to the wider public in 2012.

Collection Developement

In 2010 there were around 16,000 fee and free e-journals, and around 30 free and fee biomedical and natural sciences databases, as well as 42 biomedical e-books available to the Croatian academic community. The Li-

brary continued to provide access to all available e-journals via an in-house made search engine Pero, as well as through EZB Elektronische Zeitschriftenbibliothek. Besides national subscriptions, the Library continued to manage e-journal and e-databases subscription for RBI. In 2010 the Library subscribed to 102 e-journals and 49 printed journals (mostly in addition to e-version of journals) as institutional subscriptions, as well as one new database – Faculty of 1000.

In 2010 the Library was granted a credit card for online purchasing which ensured great savings of time and money in the process of books acquisition. During the year, a total of 314 new books were acquired. The collection of theses in 2010 included 443 volumes of Ph. D. theses and 420 volumes of M.Sc. theses.

A collection of publications written or edited by RBI researchers was organized and permanently exhibited in the library reading room in the 5th wing. For this collection in the year 2010 RBI researchers donated 24 new publications.



Fig. 2: Exhibition of publications written or edited by the RBI staff.

LIBRARY SERVICES

In 2010 the Library was focused on the development and maintenance of existing information services and projects, both for RBI users and the whole Croatian academic and research community. Some of the information services which provide and ease access to relevant scientific and other information are:

- Croatian Scientific Bibliography – CROSBİ (<http://bib.irb.hr>)
- Who's Who in Science in Croatia (<http://tkojetko.irb.hr>)
- Centre for Online Databases (<http://www.online-baze.hr>)
- CMS for web sites of Croatian academic and research libraries (<http://knjiznice.szi.hr>)
- IRB reservations (<https://rezervacije.irb.hr>)

In collaboration with the Centre for informatics and computing, the Library developed a new reservation system for lecture hall reservations and the Library continued to administer reservation of RBI auditoriums through the new application.

The significant reduction in support from the Ministry of Science, Education and Sports almost halted the continuous development of information services like CROSBİ, Centre for Online Databases, Who's Who in Science in Croatia, Croatian Scientific Portal (<http://www.znanstvenici.hr>) and repository of scientific equipment ŠESTAR (A Pair of Compasses). With great effort and a lot of voluntary work the Library provided technical support and maintenance of the majority of the popular information services with more than 20.000 visits per day. The repository of Croatian open access journals HRČAK was maintained by the University Computing Centre SRCE, and the RBI Library continued to collaborate as a part of HRČAK team.

Bibliometric analysis

The Library has continued to maintain and update the database of papers with RBI as affiliation as indexed in the Web of Science database, as well as providing bibliometric services for RBI scientists. In 2010 the Library issued 85 citation certificates for RBI employees. For this purpose citation and bibliographic databases Web of Science, Scopus, Google Scholar, SPIRES and Current Contents were used. Different bibliometric analyses for various purposes for the whole Institute were also provided.

Interlibrary loan

The inherent shortages of the RBI library collection were overcome with a well-established interlibrary loan and lending service with libraries from Croatia and abroad. Interlibrary loan services from other Croatian libraries as well as from EURASLIC/IAMSLIC libraries are mainly free of charge, while copy and loan requests from libraries abroad are charged. In 2010 the RBI library received 896 requests for document delivery by RBI staff and 96% of those requests were positively resolved. Most items were obtained through the IAMSLIC catalogue (33%), followed by SUBITO (22%). The majority of positively resolved requests were acquired free of charge (74%).

In addition, the RBI library also received 526 requests for document delivery from other Croatian libraries, and positively resolved 455 (87%) of those requests.

EDUCATION

The Library started a new series of KEKS seminars (acronym of Short Educational Library Seminars, *Kratki edukacijski knjižnični seminari* in Croatian). The seminars consist of short lectures (45 minutes) and an hour and a half or two hours workshops. The seminars are held periodically in small groups (max 10 participants) in one of the Library's



Fig. 3: Short Educational Library Seminars (KEKS)

reading rooms. Thirty five seminars were held in 2010 with 178 participants.

Library staff was also involved in undergraduate and graduate level teaching at the J. J. Strossmayer University in Osijek and the University of Zadar.

International cooperation

The Library continued its international cooperation with EURASLIC (European Association of Aquatic Sciences Libraries and Information Centres) and its parent organization IAMSILIC (European Association of Aquatic Sciences Libraries and Information Centres). Library staff had an active role in EURASLIC activities: two members in the EURASLIC board, as well as in the sub-groups ECET (European Countries in Economic Transition) group and MedSig group (The Mediterranean Special Interest Group). As part of its involvement, library staff participated in training courses held at the UNESCO/IIOC Project Office for IODE in Oostende, Belgium. The Library was also actively involved in IAMSILIC as a member of the Strategic Planning Group.

Organization of events

The Library was actively involved in the organization of RBI Open Days, held in May and participated in the programme with a presentation point „A Fistful of Books“. In this way the Library presented its activities and informed visitors about various information resources available on the Internet.

Library staff was also actively involved in organization of another important event in 2010 – the RBI 60th anniversary celebration. At the central celebration held at the Vatroslav Lisinski Concert Hall, the Library successfully presented its activities through 3 poster presentations.

During the year the Library also continued to organize the regular RBI Library Colloquia. Colloquia topics were broad and chosen to be of interest not only to librarians, but also

to RBI staff and the general public. During this year seven lectures were organized.

PROJECTS

In 2010 Library applied as a partner in the FP7 project called *2nd Generation Open Access Infrastructure for Research in Europe - OpenAIREplus* (under the Infrastructure Call 9).



Fig. 4: Library's presentation point "A Fistful of Books" at the 2010 RBI Open Days

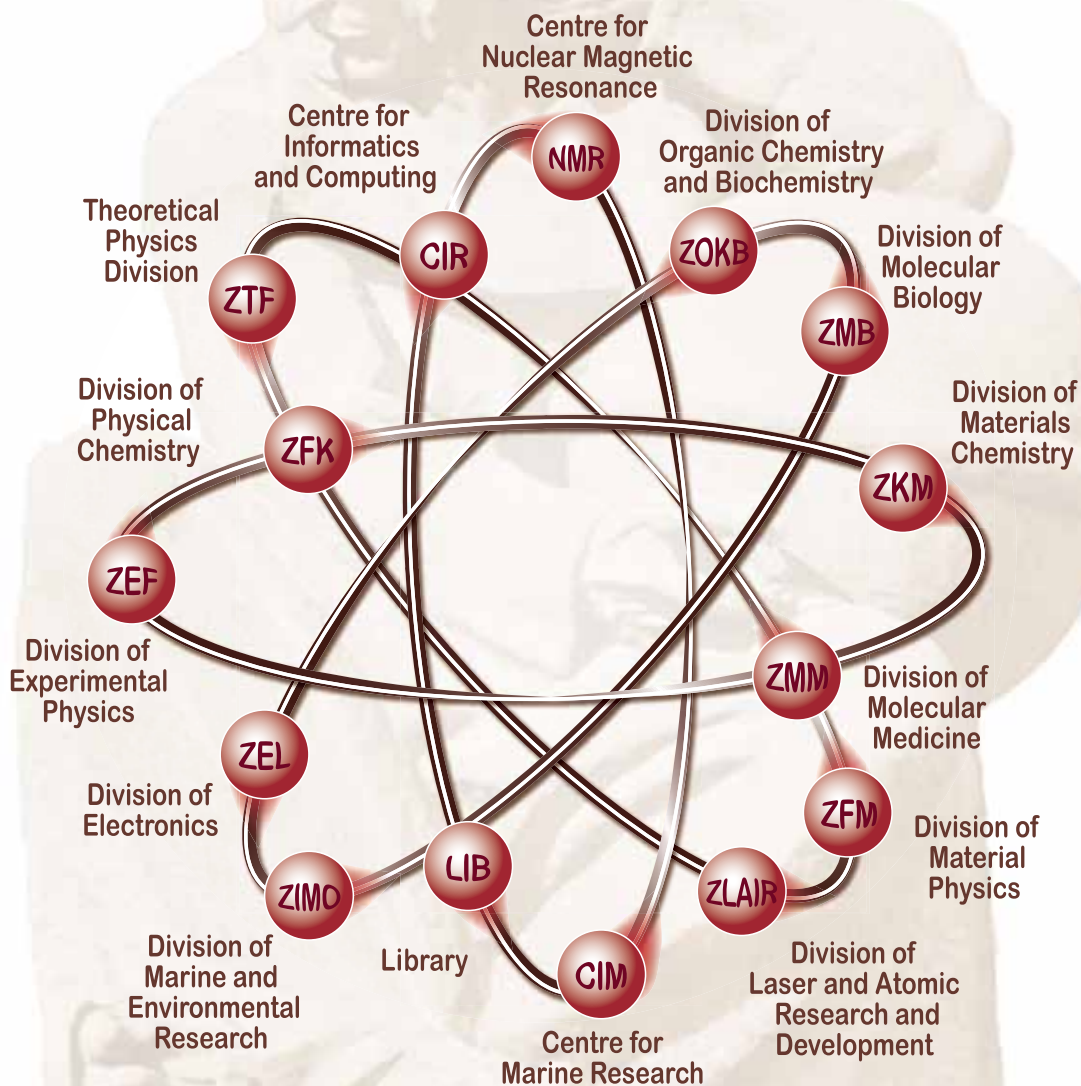
SELECTED PUBLICATIONS

1. Pažur I, Macan B: KEKS - a short educational library seminars, an example of user education at Ruđer Bošković Institute Library in Zagreb. *Vjesnik bibliotekara Hrvatske* **53** (2010), 73.
2. Stojanovski J: Metrics of scientific journalism - truths, myths and misconceptions. *Kem Ind* **59** (2010), 179.
3. Grgić M, Macan B: Impact Factor and scientific promotions. *Kem Ind* **59** (2010), 128.
4. Stojanovski J: 60 Years of the Ruđer Bošković Institute Library. *Kem Ind* **59** (2010), 608.
5. Pažur Vojvodić I: Chemistry on Facebook. *Kem Ind* **59** (2010), 80.

SELECTED LECTURE

1. Macan B, Fernandez GV. ABCD vs. Koha: open source library options. 36th IAMSILIC Annual Conference: netting knowledge: two hemispheres - one world. Mar del Plata, Argentina, October 17-21, 2010.







Ruđer Bošković Institute

The Ruđer Bošković Institute (RBI) is the largest Croatian research centre in sciences and science applications. In the multi-disciplinary environment of the Institute more than 500 academic staff and graduate students work on problems in experimental and theoretical physics, chemistry and physics of materials, organic and physical chemistry, biochemistry, molecular biology and medicine, environmental and marine research, electronics, informatics and computer science. Within Croatia, the RBI is a national institution dedicated to research, higher education and provision of support to the academic community, to state and local governments and to technology-based industry. Within the European Union, the RBI forms a part of the European Research Area. Worldwide, the RBI collaborates with many research institutions and universities upholding the same values and vision.