

Ruđer Bošković Institute

Annual report 2003



Ruđer Bošković Institute

Annual report 2003



Arial view of the RBI campus

Zagreb, 2004.

Editorial Board:

Editor: Nela Pivac

Members: Stjepko Fazinić

Stjepan Marčelja

Iva Melinščak Zlodi

Karolj Skala David Smith Neven Žarković

Technical Support:

Photographer: Josip Uhrl

Graphic Design: Faculty of Graphic Arts, University of Zagreb

Printed by: Kratis d.o.o.

Print run of 1500 copies

Web edition: www.irb.hr/annualreport

Address:

Ruđer Bošković Institute Bijenička cesta 54, P.O.Box 180 HR-10002 Zagreb, Croatia

Contact:

URL: http://www.irb.hr

e-mail: godisnjak2003@irb.hr

tel: +385 1 45 61 111 fax: +385 1 46 80 084

Copyright © 2004 by RBI ISSN 1334-854X

Contents

Introduction	
Education	5
RBI Bibliography	7
Theoretical Physics Division	11
Division of Experimental Physics	15
Division of Materials Physics	21
Division of Laser and Atomic Research and Development	25
Division of Electronics	
Division of Physical Chemistry	31
Division of Organic Chemistry and Biochemistry	35
Division of Materials Chemistry	41
Division of Molecular Biology	45
Division of Molecular Medicine	51
Division of Marine and Environmental Research	
Center for Marine Research	63
Center for Informatics and Computing	69
Center for Nuclear Magnetic Resonance	
Library	75



Introduction

Welcome to the new format of the annual report. This year, rather than providing a comprehensive report of all work at the Ruđer Bošković Institute (RBI), we wish to present selected information and examples that will illustrate the activity of the RBI in its main areas of work. The Institute strives to improve the performance in all aspects of its mission and during 2003 we made significant advances. Some of the achievements will be apparent from this report, while more details will be available shortly from the comprehensive report to be posted on the institute web pages.

In some respects, 2003 was a difficult year at the Institute. This was primarily due to the fact that, throughout Croatia, very few graduate student positions were approved by the Ministry of Science and Technology (presently the Ministry of Science, Education

and Sport). As this is ordinarily the primary source of young personnel at the Institute, progress was necessarily slowed. In an attempt to help rectify this problem, the Institute decided to use its own reserves, combined with funding received by research groups for their scientific work, to support a group of 17 graduate students. In a positive but partial corrective step, national financial support was granted to some of the students from this internally supported group, towards the end of the year.

Another step in the right direction was also made towards the end of 2003. This came in the form of around two hundred new reform positions, at the level of lecturer or research associate, made available nationally. The positions were proportionally divided between different institutions in the country so that the RBI received 18 new posts. A

competitive selection procedure, based solely on the criterion of excellence, resulted in these posts being filled with scientists ranging in age from 30 to 37. In addition, three further positions, also at the level of research associate, were approved for Croatian nationals returning from distinguished stays

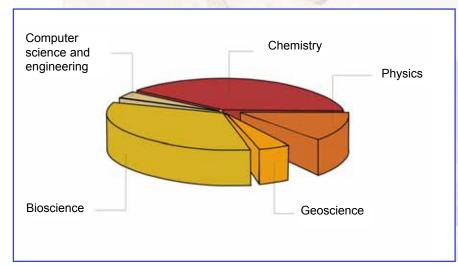


Figure 1. Composition of Researchers at the RBI

at foreign institutions. With these appointments, the scientific strength of the Institute is much improved and we are very pleased to be able to offer a warm welcome to our new colleagues as we wish them a successful career at the RBI.

OVERVIEW

The Ruđer Bošković Institute 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 in many different fields including

physics, chemistry, biology, biomedicine and marine and enviromental research (see Figures 1 and 2). 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.

ORGANIZATION OF THE INSTITUTE

Director: Stjepan Marčelja

Head of the Scientific Council: Krunoslav Pisk

Chairman of the Board of Governors: Ivo Šlaus

The organization of the Ruđer Bošković Institute is depicted in Figure 2. In an effort to improve the overall performance of the Institute, several new elements of organizational structure were introduced in 2003. These included the creation of three associate directorships (as part of Executive Management) to encompass the areas of

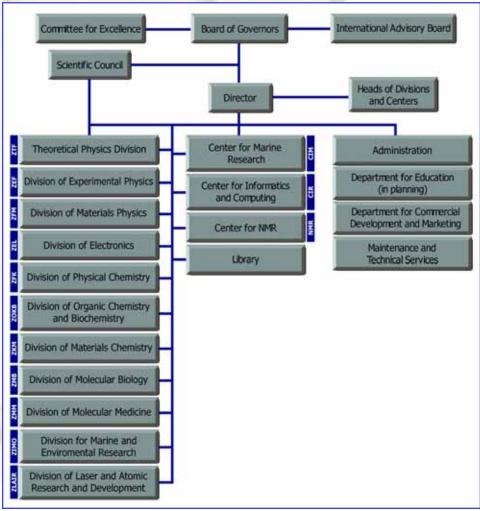


Figure 2. Organizational Structure of RBI

Science (Neven Žarković), Commercial Development (Božidar Etlinger), and Finance (Jaroslav Horvat).

ACTIVITIES

Fundamental research

Despite the somewhat difficult circumstances apparent throughout 2003, the Institute achieved many significant scientific advances. The most important achievement of the year was the discovery of two new five-quark states. Working within a large international collaboration at the CERN Super Proton Synchrotron, a small group from the RBI, consisting of Tome Antičić, Krešo Kadija, and Tatjana Šuša, analysed the data in Zagreb and identified two new heavy pentaquark baryons (see Figure 3).

Overall, 2003 saw an increase in the number of research articles published in journals cited by Current Contents. This year's total of 408 represents a 32 % improvement over the 310 such articles produced in 2002.

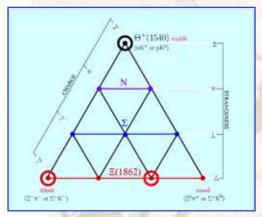


Figure 3. A hypothetical antidecuplet of pentaquark baryons. The states at the corners of the triangle are manifestly exotic and cannot be made of three quarks. Experiments now see candidates for the three circled members.

Applied Science, Technology and Business Management

For the first time ever, scientists form the Institute, lead by the Associate Director for Commercial Development, wrote the Business Plan for the period 2004-2008. This was done under the supervision of experts engaged by the Ministry of Science and Technology in the context of the World Bank restructuring program entitled *The Science and Technology Project* (STP). Several drafts (28) of the Business Plan were written and it is expected that the final version will be accepted in 2004.

The Business Plan includes a short-list of 12 applied research projects (from an original 46) selected through an evaluation process conducted by an internal committee as well as international technical experts, including the RBI's Institutional Advisor (lan Cooper) and foreign experts (Ramesh Mashelkar and Stewart Craig). During the first phase, four of these projects have been selected to be funded (with a planned support of up to \$0.5 million for equipment, consultants and services) on a pilot basis.

Contribution to higher education

Despite the fact that the RBI is primarily a research institution, our participation in educational activities during 2003 was strong. Scientists from the Institute contributed 39 courses at the undergraduate level as well as 186 postgraduate courses. In addition, 27 B.Sc., 23 M.Sc. and 28 Ph.D. theses were completed under the supervision of the Institute's academic staff. Importantly, 2003 saw the signing of an *Agreement of Collabora*-

tion between the RBI and the University of Zagreb Medical Faculty. In this context, experts from the RBI were chosen to lead the new joint field of doctoral study in *Molecular Medicine*.

Environmental research and consulting

The Institute's two environmental research divisions contribute strongly to our knowledge of the Adriatic Sea and inland waters in the region. They are also involved in nationwide programs for the monitoring of both the level of radiation and the quality of the air. The RBI, through the many international collaborations with other European countries, also contributes to the collection and dissemination of environmental information across the continent. Experts from the Institute are often contacted, by both local and national authorities, for advice on the evaluation of the environmental impact of different proposed developments.

New Instrumentation and Infrastructure

In 2003, the revived national program of major equipment purchases operated for the third consecutive year. As part of this pro-

gram, the RBI received a major grant enabling the purchase of a Confocal microscope (Leica TCS SP2 AOBS) and a CMS-18 sputtering system (Kurt J. Lesker Co, PA, USA). It is expected that both of these instruments will be used widely and contribute significantly to the expansion of research possibilities available at the Institute.

All major instrumentation at RBI is understood as a national resource and is open to all qualified users from the Republic of Croatia at the nominal running cost. The equipment use can also be leased out commercially if time is available. Indeed, several commercial users made use of this possibility with our relatively new NMR facilities and, in doing so, partially offset the operational costs.

In addition to the above purchases, the local area computer network (LAN) was overhauled in 2003. The new network consists of 5 km of fibre-optic cable stretching between 26 buildings and is controlled by 2 Layer-3 and 31 Layer-2 Cisco switches with 3100 connections. This new LAN satisfies the demanding requirements for Virtual Private Network and Grid applications.



Education

In 2003, the RBI continued with the expansion of its educational activities. The on-site education of young scientists resulted in 27 B.Sc., 23 M.Sc., and 28 Ph.D. theses. Formal teaching consisted of a total of 39 undergraduate courses and 186 postgraduate courses taught on behalf of Croatian universities.

The majority of the undergraduate courses taught by teachers from RBI (29/39) resulted from our links with the University of Zagreb (Figure 4). The Division of Molecular Biology, in collaboration with the Faculty of Science, was the most active (12 courses), followed by the Division of Physical Chemistry (9) and the Division of Marine and Envi-

ronmental Research (8) (Figure 5).

The postgraduate (doctoral) studies were also primarily conducted in collaboration with the University of Zagreb (Figure 6). Of the 160 such courses held during 2003, 109 were courses taught in collaborative programs with the Faculty of Science, University of Zagreb. The Medical School, University of Zagreb, was our second largest partner (25 courses) followed by the University of Osijek (14 courses). One course of specialized postgraduate study was taught at the Budapest University of Technology and Economics. As can be seen from Figure 7, the most active Divisions in postgraduate education were the Division of Marine and Envi-

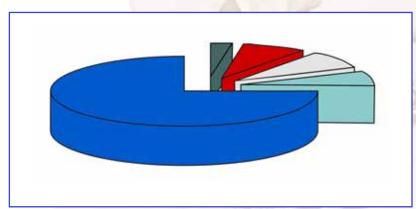




Figure 4. Distribution of the RBI held undergraduate courses by domicile University

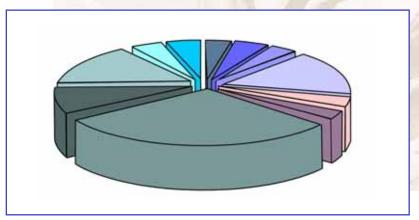
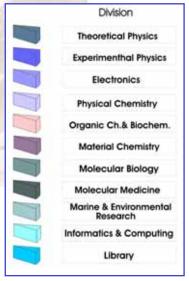


Figure 5. Distribution of the RBI held undergraduate courses by Division



ronmental Research (48 courses), the Division of Molecular Medicine (43 courses), and the Division of Molecular Biology (29 courses).

Importantly, 2003 saw the signing of an Agreement of Collaboration between the RBI and the Medical School, University of Zagreb. In this context, experts from the RBI were chosen to lead the new joint field of doctoral study in Molecular Medicine. Similarly, a Ph.D. study program in collaboration with the Faculty of Science of the University of Zagreb in the field of Environmental Management was launched during the year. These two additions brought the number of PhD programs taught in collaboration between RBI and domestic universities to 8.

The remaining programs are: Protection of Nature and Environment (in collaboration with the University of Osijek), Organic Chemistry, Biochemistry, Oceanology, Molecular and Cellular Biology, and Nuclear Physics (in collaboration with the Faculty of Science of the University of Zagreb).

The intensive level of involvement of the RBI in education led the Board of Governors to conclude that we should establish a Department of Education at the Institute. This decision saw the formal creation of such a Department (as a part of the Institute's organizational structure) but its transformation into an actual and integral part of our organization remains a task for 2004.

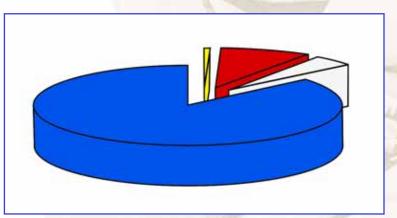


Figure 6. Distribution of the RBI held postgraduate courses by domicile University

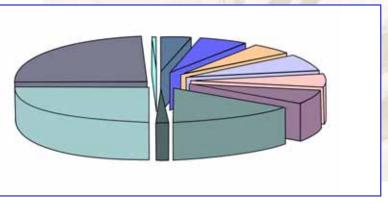


Figure 7. Distribution of the RBI held postgraduate courses by Division





RBI Bibliography

In the summer and autumn of 2002, 121 new projects from RBI received grants by the Ministry of Science & Technology. Several research groups received grants for the first time, while for others the new grants represented an increase in the research support.

Working with the benefit of new project financing, scientists from the RBI published 408 research articles in journals indexed in Current Contents (CC) in 2003. This is a 39% increase on the average productivity for the period 1996-2002 (the period of previous project grants, see Figure 8. Similar increases were also observed for articles published in other journals (33%) and books and book chapters (21%).

While the use of a simple (CC-based) publication count is not a complete criterion

for the productivity assessment of either the Institute or an individual research group, it does offer an important insight into the Institute's achievement. We expect that the significance of educational and commercial contributions, which is not reflected in the publication numbers, is apparent from the contents of the appropriate sections of this report.

Table 1 shows the number of (CC-indexed) publications produced by the subset of those fundamental research projects carried out at the RBI that, in terms of publications, were ranked among the top 10 projects in Croatia in their respective research fields. It is clear from the table that, according to this criterion, the RBI projects were among the most prominent in all fields of science during 2003. This is especially pro-

nounced in the case of chemistry, oceanology & geology and physics where 7 to 9 of the 10 to 11 most productive Croatian projects were carried out at the RBI. However. excellence in publishing papers in CC journals at the RBI was also evident for the fields of biology (5/10) and biomedicine (4/10). This latter achievement is particularly noteworthy given

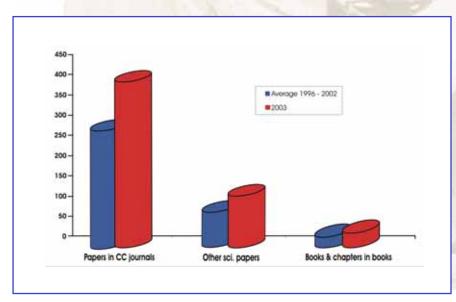


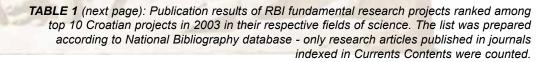
Figure 8. Publication output of the RBI since 1996

the sheer number of projects (399) funded in this field by the Ministry. In addition to the tabulated presence of projects from the RBI within the top 10 Croatian projects, it should be mentioned that according to the same criterion many other projects carried out at the RBI rank among the top 20 in their respective fields.

Although the prominence of the RBI in Croatian science was not a new factor in 2003, the large increase in CC indexed publications was, and thus deserves some brief comments. One factor contributing to this increase was certainly the significant quantity of research equipment granted by the Ministry of Science and Technology to the RBI during the last three years. This equipment enabled scientists at the Institute to participate in fields of research that were previously not accessible. In addition, 2003

was a year of promotions and re-elections for about 130 scientists at the RBI. As the criteria for these procedures were based primarily on the number of articles published in CC journals, this was quite likely a significant factor in the increased publication output.

Our experts were invited to give 85 scientific lectures in 2003, almost twice the annual average for 1996-2002 (46 lectures per year). At the same time, the number of patent applications in 2003 (6) represented a slight increase from the analogous annual average (4). This data, combined with that in Table 1, confirm the high reputation of the RBI. Concomitantly, the data can also be taken to indicate that the focus of our activities is currently oriented towards excellence in fundamental research, with less emphasis placed on commercial and applied sciences.

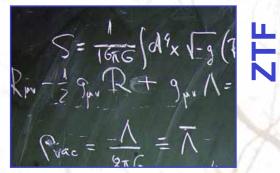


Field of Science - Number of National Projects in the Field	Project Title	Principal Investigator	Rank of the Project in the National Bibliography for 2003	Number of CC Articles Published in 2003
BIOMEDICINE	Turnour gene therapy – correction of oncosuppressor genes	Jasminka Pavelić	1-2	13
399	Gene or protein transduction and signalling	Krešimir Pavelić	3	12
	pathways in transformed cells Oxidative stress and malignant diseases	Neven Žarković	7	7
	Neuropharmacology of the serotonergic system	Dorotea Muck-Šeler	9-12	5
BIOLOGY	Dynamics and genetics of bioactive molecules	Volker Magnus	1-2	11
55	Genes and genomes of evolutionary conserved and economically important species	Vera Gamulin	4-6	6
	Regulation of recombination and recombinational repair	Mirjana Petranović	4-6	6
	Endemic and relict phytocenosis of Croatia and their mykcoflora	Andrija-Željko Lovrić	4-6	6
1	Cell response to physical, chemical and biological noxa	Maja Osmak	7-8	5
GEOLOGY & OCEANOLOGY	Nature and reactivity of organic substances in the aquatic environment	Božena Ćosović	1-4	6
52	Physical chemistry and biogeochemistry of trace metals in aquatic systems	Marko Branica	1-4	6
	Persistent organohalogenic pollutants in some costal areas of Dalmatia	Mladen Picer	1-4	6
	Programmed biosynthesis and genotoxic risk assessments	Renato Batel	5-7	5
	Mechanism of long-term changes of the Adriatic-sea ecosystem	Danilo Degobbis	5-7	5
	Geochemistry of recent and ancient sedimentary systems of the Adriatic platform	Goran Kniewald	5-7	5
	Tidal and longer-period dynamics of the northern Adriatic	Milivoj Kuzmić	8	4
	Multidisciplinary sedimentological investigations	Halka Bilinski	9-10	3
	Ecophysiological studies and stress-response in marine organisms	Čedomil Lucu	9-10	3
PHYSICS	Impact of defects and nanostructures on semiconductor properties	Branko Pivac	1	19
80	Light atomic nuclei: clusters, nuclear molecules, reactions	Đuro Miljanić	3	13
	High-energy experimental physics	Krešo Kadija	4	11
	Fundamental interactions in physics of elementary particles and in cosmology	Branko Guberina	5	10
	Heavy-ion physics	Zoran Basrak	6	9
	Nanophase films and nanocomposite solid electrolytes research	Aleksandra Turković	7-11	8
	Physics and application of nanostructures	Krešimir Furić	7-11	8
CHEMISTRY	Stereoselective synthesis and catalysis	Vitomir Šunjić	1	14
70	Reactive intermediates in ground and excited state	Mirjana Maksić	2	13
	Reactivity and reaction mechanism	Leo Klasinc	3	11
	Nuclear magnetic resonance and calculations of bioorganic molecules	Dražen Vikić-Topić	4	10
	Structure and dynamics of (bio)molecules	Biserka Kojić-Prodić	5-7	9
	Structural and biological studies of new complex compounds	Ljerka Tušek-Božić	5-7	9
	Supramolecular organization of gels, molecular recognition and catalysis	Mladen Žinić	8-10	8
	Physico-chemical effects of ionising radiation	Dušan Ražem	8-10	8



RBI annual report 2003

Theoretical Physics Division



http://thphys.irb.hr

DIVISIONAL ORGANISATION

Head: Branko Guberina

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
- Group for Linear and Nonlinear Dynamics, Mladen Martinis

OVERVIEW OF THE DIVISION

The research performed in the Division is mainly concerned with the theoretical investigation of "high-energy" physics, such as particle physics, general and mathematical physics. astroparticle physics and cosmology. In addition, there exists a healthy level of investigation into problems in condensed matter physics. A relatively new and exciting activity in the Division is the application of nonlinear dynamical analysis in biomedicine. In

2003, the members of the Division continued to be involved in lecturing at the University of Zagreb and a number of students completed their B. Sc., M. Sc. and Ph. D. theses.

TOP ACHIEVEMENTS

Quantum well states in nanometre films

The understanding of nanometre thick metal films on metal surfaces is of fundamental interest in terms of the discovery and characterization of new structural and electronic properties. The formation of discrete electronic states, so-called quantum well states is one such intriguing feature. In this respect, our ab initio numerical calculations found structural parameters of 1-5 monolayer silver films in good agreement with photoemission and STM measurements obtained by collaborating experimental groups (M. Kralj et al., Phys. Rev. B 2003, 68, 195402).

Superluminal pions found

In a recent study of the propagation of pions at finite temperature in a hadronic fluid, it was found that the velocity of massless pions differs from that of light. Importantly, one-loop calculations showed that pions in the chiral symmetry broken phase, under certain conditions, propagate faster than light (N. Bilić and H. Nikolić, *Phys. Rev. D* **2003**, *68*, 085008).

Potential for the experimental observation of noncommutativity

The Standard Model (SM) of spacetime strictly forbids certain decay modes of Z bosons. On non-commutative spacetime, however, such SM-forbidden triple gauge boson interactions are allowed. We propose that two particular decay modes, coming from the gauge sector of the Noncommutative SM, represent a potential means by which noncommutativity could be experimentally discovered (W. Behr *et al.*, *Eur. Phys. J. C* **2003**, *29*, 441).

Fate of the Universe

The renormalization group running of the cosmological constant was consistently incorporated into the standard cosmological model. Starting from the present era values for cosmological parameters, we demon-

strate how the running can easily provide a negative cosmological constant thereby changing the fate of the universe. Interestingly, the running also renders compatibility with critical string theory (B. Guberina *et al.*, *Phys. Rev. D* **2003**, 67, 083001).

Unified approach to the representations of QM on noncommutative space

We presented a unified approach to the representations of quantum mechanics on noncommutative spaces. As a demonstration of the utility of the approach we have applied it to both the two dimensional harmonic oscillator and the Landau problem (L. Jonke and S. Meljanac, *Eur. Phys. J. C* **2003**, *29*, 433).

Modeling Chronic Lymphocytic Leukaemia (CCL)

As a result of extensive modelling, we conclude that CLL occurs as a consequence of age-dependent, genetically related functional restrictions of the thymic microenvironment in supporting common lymphoid progenitor cells (B. Vitale *et al.*, *Scan. J. of Immun.* **2003**, *58*, 588).



Figure 1. Seminar room: junior researchers and Ph. D. students

SELECTED INVITED LECTURES

- B. Melić, "LCSR analysis of exclusive two-body B decays", invited plenary talk at 3rd Interna tional Workshop on B physics and CP violation (BCP3), Taipei, Taiwan, 29.9.-1.10.2003.
- K. Passek-Kumerički, "Hard exclusive processes and higherorder QCD corrections", invited talk given at the 9th Adriatic Meeting, Dubrovnik, Croatia, 4-14.9.2003.

- B. Melić, "Estimate of Charming Penguins in B ⇒ pi pi", invited talk given at International Europhysics Conference on High Energy Physics EPS, Aachen, Germany, 17-23.7.2003.
- B. Melić, "Some aspects of charmless B decays from QCD light-cone sum rules", invited plenary talk at the International conference Flavor Physics & CP Violation, FPCP 2003, Ecole Polytechnique, Paris, France, 3-6.6.2003.
- J. Trampetić, "Phenomenology of Noncommutative Gauge Theory", invited lecture at the workshop JULIUS WESS DAYS 2003, Noncommutativity: From Mathematics to Phenomenology, Bayrischzell, Germany, 2-5.5.2003.
- B. Melić, "Charming penguins in B ⇒ pi pi from QCD light-cone sum rules", invited talk, CKM Workshop, 2nd Meeting, IPPP Durham, United Kingdom, 5-9.4.2003.

INTERNATIONAL CONFERENCES ORGANIZED BY SCIENTISTS OF THE DIVISION

9th Adriatic Meeting (Central European Symposia) – Particle Physics and the Universe, Dubrovnik, Croatia, 4-14.9.2003., Chairmen: Josip Trampetić, Julius Wess.

See also: "Lecture Notes in Physics: Particle Physics in the New Millennium", Proceedings of the 8th Adriatic Meeting, J. Trampetić, J. Wess (Eds.)

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- Physics of surfaces, microstructures and strongly correlated systems, Radovan Brako
- Fundamental interactions in elementary particle physics and cosmology, Branko Guberina
- 3. Quantum field theory, noncommutative spaces, and symmetries, Stjepan Meljanac
- 4. Structure of dynamical fluctuations in nonlinear systems, Mladen Martinis

Collaborative projects

- Radovan Brako: Participation in collaborative project "Nanosciences: A way towards new technologies", MZT, December 2003. Project leader: Dr. M. Milun, Institute of Physics, Zagreb.
- Kornelija Passek-Kumerički, collaboration beetwen Ruđer Bošković Institute, Theoretical Physics Division and Institut für Theoretische Physik II, Bochum, Germany, DFG project "Higher-order QCD corrections in exclusive processes-mesons and baryons".
- M. Martinis: Research in self organization and organization of molecules in supramolecules, complexes, macromolecules, and supermolecular structures. Coordinator: N. Filipović-Vinceković, and I. Jalšenjak, Faculty of Pharmacy and Pharmaceutical Biochemistry, Zagreb.

SELECTED PUBLICATIONS

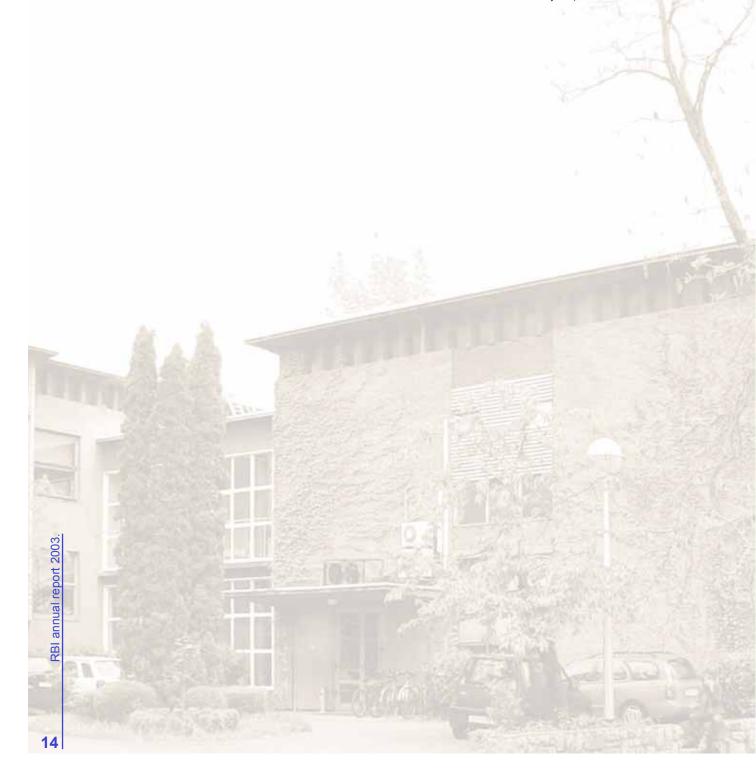
- M. Kralj, P. Pervan, M. Milun, P. Lazić, Ž. Crljen, R. Brako, J. Schneider, A. Rosenhahn, K. Wandelt, "Tetragonal silver films on V(100): Experimental and ab initio studies" *Phys. Rev. B* **2003**, *68*, 195402.
- Ž. Crljen, P. Lazić, D. Šokčević, R. Brako, "Relaxation and reconstruction on (111) surfaces of Au, Pt, and Cu" *Phys. Rev. B* **2003**, *68*, 195411.
- N. Bilić, H. Nikolić, "Superluminal pions in a hadronic fluid", *Phys. Rev. D* **2003**, *68*, 085008.
- B. Melić, D. Müller, K. Passek-Kumerički, "Next-to-next-to-leading order prediction for the photon-to-pion transition form factor" *Phys. Rev. D* **2003**, 68, 014013.
- W. Behr, N.G. Deshpande, G. Duplančić, P. Schupp, J. Trampetić, J. Wess, "The Z ⇒ γγ, gg decays in the non-commutative standard model" *Eur. Phys. J. C* **2003**, 29, 441.
- B. Guberina, R. Horvat, H. Štefančić, "Renormalization-group running of the cosmological constant and the fate of the universe" *Phys. Rev. D* **2003**, 67, 083001.

L. Jonke, S. Meljanac, "Representations of non-commutative quantum mechanics and symmetries" *Eur. Phys. J. C* **2003**, *29*, 433.

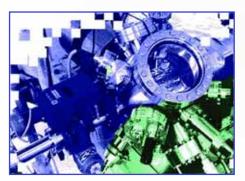
S. Meljanac, M. Mileković, A. Samsarov, "A multispecies Calogero model" *Phys Lett. B* **2003**, *573*, 202.

M. Dimitrijević, L. Jonke, L. Möller, E. Tsouchnika, J. Wess, M. Wohlgenannt, "Deformed field theory on κ -spacetime" *Eur. Phys. J. C* **2003**, *31*, 129.

B. Vitale, M. Martinis, M. Antica, B. Kušić, S. Rabatić, A. Gagro, R. Kušec, B. Jakšić, "Prolegomenon for Chronic Lymphocytic Leukaemia" *Scan. J. Immun.* **2003**, *58*, 588.



Division of **Experimental Physics**



http://www.irb.hr/str/zei

DIVISIONAL ORGANISATION

Head: Ante Ljubičić until April 16th Acting Head: Roman Čaplar from April 17th

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

- ⇒Laboratory for nuclear reactions, Đuro Miljanić
- ⇒ Laboratory for heavy-ion physics, Roman Čaplar
- ⇒Laboratory for electromagnetic and weak interactions, Ante Ljubičić
- ⇒Laboratory for ion-beam interactions, Milko Jakšić
- ⇒Laboratory for measurement of lowlevel activities, Bogomil Obelić
- ⇒Laboratory for high-energy physics, Krešo Kadija
- ⇒Group for the development and the use of analytical methods, Vladivoj Valković

OVERVIEW OF THE DIVISION IN 2003

The research goal of the Division is to obtain new basic knowledge of the structure and behaviour of matter on the subatomic level. In particular, we investigate elementary particles and their interactions, symmetries in nature, nuclear reactions, the structure of nuclei, the behaviour of nuclear matter under extreme conditions, and the interaction of charged particles with matter. We develop and use new experimental techniques for measurements and applications. We are also involved in teaching at the graduate and postgraduate levels and, as has been traditionally the case, we maintain an intense cooperation with world-leading centres in nuclear and particle physics.

TOP ACHIEVEMENTS

IRB Group Finds Evidence for More Pentaquark States in CERN Experiment

The constituent quark model of hadrons has been very successful in describing the known baryons as composites of three valence quarks. The theory of strong interactions, however, does not forbid baryons

with more than three quarks. Such states were proposed a long time ago but, until recently, no good candidates had been experimentally observed. The discovery of the exotic barions, good candidates for the isospin quartet of predicted pentaquark states, represents an important step towards the experimental confirmation of the existence of the hypothesized baryon antidecuplet (Figure 1). This discovery, made by the NA49 collaboration at CERN, was led by a group of scientists from the Institute Ruder Bošković who analysed related NA49 data accumulated over several years. The new baryon has a combination of charge and strangeness that cannot be realised with fewer than five quarks (T. Antičić et al., CERN Courier, 2003, 43, 5; C. Alt, T. Antičić et al., Phys. Rev. Lett. in press).

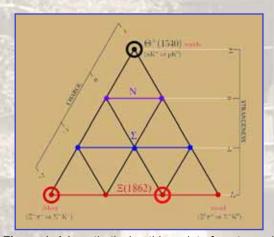


Figure 1. A hypothetical antidecuplet of pentaquark baryons. The states at the corners of the triangle are manifestly exotic and cannot be made of three quarks. Experiments now see candidates for the three circled members.

Upgrade of the IRB Accelerator Facility

The upgrade of the accelerator facility commenced in 2003 with the delivery of a

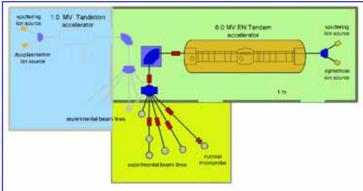


Figure 2. Layout of the ZEF accelerator facility

new 1.0 MV Tandetron accelerator, financed mainly by the joint project with the International Atomic Energy Agency (IAEA). This accelerator will be installed during 2004 in the new experimental area in the northern extension of the existing accelerator hall (Figure 2).

Nuclear Physics Measurements and Astrophysics

The α +⁸Li decay of the excited states of the ¹²B nucleus was measured for the first time and its relevance to the astrophysically important ⁸Li+ α \Rightarrow ¹¹B+n reaction was discussed (N.Soić *et al.*, *Europhys. Lett.*, **2003**, 63, 524)

The search for dark matter

Axions, which are pseudoscalars that arise in models resolving the strong CP problem in quantum chromodynamics by the Peccei-Quinn mechanism, could also explain the mystery of dark matter in the Universe. At CERN we are involved in the CAST experiment, designed to search for solar axions associated with a broad energy spectrum. Using data collected in 2003, our sci-

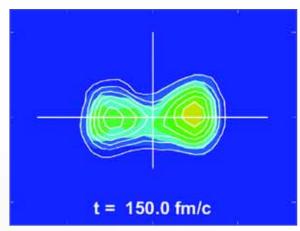


Figure 3. An example of semi-classical simulation of heavy-ion collision dynamics at an intermediate energy.

entists were able to establish a new upper bound on axion-photon coupling of 1.4x10⁻¹⁰ GeV⁻¹. This limit is approximately a factor of 4 more stringent than the best previous estimate. In addition, we proposed a novel approach to search for solar, nearmonochromatic hadronic axions, that could be created in the solar core. Finally, in an experiment performed in 2003, an upper limit of 5.5 keV on hadronic axion mass was obtained.

New experimental method

A new version of the Time Resolved Ion Beam Induced Charge (TRIBIC) technique was applied to study the temperature dependence of the shape of a transient pulse of charge, for the first time in 2003. This technique can provide information on the charge trapping mechanisms which limit the performance of such radiation detectors (Z. Medunić et al., Nucl. Instr. and Meth. B., 2003, 210, 237).

Compressed Baryonic Matter

In 2003, ZEF joined the major worldwide heavy-ion physics project, namely the international Compressed Baryonic Matter (CBM) collaboration. The goal of the collaboration is to design and build a dedicated detector in order to investigate the properties of highly compressed baryonic matter as it will be produced in ultrarelativistic nucleus-nucleus collisions at the Future International Accelerator Facility at the GSI, Darmstadt.

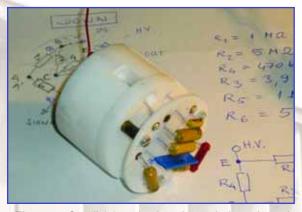


Figure 4. Small (above) microchannel plates based detector and medium size (below) nuclear microprobe experimental equipment.



Neutrons for applications

New equipment was installed in the laboratory housing the refurbished neutron gen-



Figure 5. The recently refurbished low-energy accelerator which delivers energetic neutrons via the deuteron produced in tritium fusion has become known as the neutron generator. It is used in applied research.

erator. Development and applications of nuclear instrumentation and methods for the detection and identification of hidden explosives and dangerous materials has been vigorously continued. This work, which is also devoted to the improvement of technical measures to detect and respond to illicit trafficking of nuclear and other radioactive materials, is supported by EU, NATO, and IAEA projects.

Radioactivity and ecological investigations

Ecological investigations in Dinaric Karst were continued within the 5th Framework Programme of the EU on the project entitled "Study of anthropogenic pollution after the war and the establishment of measures for the protection of Plitvice National Park and the Bihać region at the border area of Croatia and Bosnia-Herzegovina". Measurements of ²H, ³H, and ¹⁸O in precipitation of the Adriatic region were completed within the three-year long IAEA project entitled "Isotopic composition of precipitation in the Mediterranean Basin in relation to air circulation patterns and climate".

INVITED LECTURES AT INTERNATIONAL CONFERENCES

- Z. Basrak, Nuclear opacity from low to relativistic energies, 10th International Conference on Nuclear Reaction Mechanisms, Varenna, Italy,
- K. Kadija, Search for exotic baryon resonances at NA49, Penta-Quark 2003 Workshop Jefferson Lab, Newport News, USA,
- 3. D. Kekez, Role of (A2) condensate in Schwinger-Dyson approach to QCD and hadrons, 2nd International Conference on Nuclear and Particle Physics with CEBAF at Jlab, Dubrovnik, Croatia,
- 4. D. Mekterović (D. Mekterović and I. Supek for Crystal Ball Collaboration), Differential cross sections of the charge exchange reaction in a momentum region between 105 MeV/c and 180 MeV/c, ibid.
- N. Soić (N. Soić, W.N. Catford, S. Cherubini, N.M. Clarke, L. Donadille, M. Freer, B. R. Fulton, M. Lattuada, Đ. Miljanić, S. Romano, C. Spitaleri, D.L. Watson, M. Zadro), Experimental evidence for molecular structures in light nuclei, ibid.
- 6. V. Valković (D. Sudac, S. Blagus, D. Matika, R. Kollar, T. Grivičić, V. Valković), *The use of 14 MeV neutrons in explosive detection*, International Conference on Requirements and Neutralisation of Landmines and UXO, Brussels, Belgium.

CONFERENCES ORGANIZED BY SCIENTISTS OF THE DIVISION

- Second International Conference on Nuclear And Particle Physics (NAPP), Dubrovnik, Croatia (I. Supek - co-chairman)
- 5th Symposium of the Croatian Radiation Protection Association, Stubičke toplice, Croatia (B.Obelić - chairman of the Organizing Committee, I. Krajcar-Bronić - chairwoman of the Scientific Committee)
- Kick-off meeting of the EU project Study of anthropogenic pollution after the war and establishing the measures for protection of Plitvice National Park and Bihać region at the border area of Croatia and Bosnia-Herzegovina, National Park Plitvice Lakes, Croatia (B.Obelić - chairman of the Organizing Committee).

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- 1. Hadronic physics and QCD, Ivan Supek
- 2. Light atomic nuclei: clusters, nuclear molecules, reactions, Đuro Miljanić
- 3. Interactions in subatomic and medical physics, Alfred Švarc
- 4. Heavy-ion physics, Zoran Basrak
- 5. Massive neutrinos and astro-particles, Ante Ljubičić
- 6. Photon-atom interactions and correlations, Tihomir Surić
- 7. Processes of fast ion interactions with matter, Milko Jakšić
- Natural isotopes of weak activities and development of instrumentation,
 Bogomil Obelić
- 9. High-energy experimental physics, Krešo Kadija
- 10. Methods of explosive, chemical and nuclear material detection, Vladivoj Valković
- Invariant special relativity and electrodynamics, Tomislav Ivezić

Research and development projects

- Computer aided control of 1.0 MV Tandetron accelerator, Milko Jakšić (MZT, Information Technology Project)
- Secure web server with individual user passwords for access to the database, Mario Stipčević (MZT Information Technology Project)

Other projects

- Tritium and stable isotope distribution in the atmosphere at the coastal region of Croatia (Nada Horvatinčić), IAEA, Vienna, Austria,
- Nuclear Spectroscopy Techniques and Ion Beam Analysis in Environmental and Industrial Applications (Milko Jakšić and Bogomil Obelić), IAEA, Vienna, Austria,
- Quality Assurance/Quality Control of Nuclear Analytical Techniques (Bogomil Obelić), IAEA, Vienna, Austria,
- 4. Facility for testing nuclear methods for landmine and UXO detection and identification (Vladivoj Valković), IAEA, Vienna, Austria,
- 5. Study of anthropogenic pollution after the war and establishing the measures for protection of Plitvice National Park and Bihać region at the border area of Croatia and Bosnia-Herzegovina, European Commission, 5th Framework Programme, (Bogomil Obelić).
- Tritium and Stable Isotope Distribution in the Atmosphere at the Coastal Region of Croatia, IAEA, Vienna, Austria (Nada Horvatinčić),
- Determination of isotopic composition of oxygen and hydrogen in precipitation in ecological and hydrological investigations (Ines Krajcar Bronić), Croatian-Slovenian joint research project,
- 8. Monitoring of anthropogenic influence in Karst (Bogomil Obelić), Croatian-Slovenian joint research project,
- Investigation of influence of forest ecosystems of National Park Plitvice to the quality of water and lakes (Nada Horvatinčić), National Park Plitvice, Croatia,

- Control of illicit trafficking in explosives, chemical agents, and humans (Vladivoj Valković), IAEA, Vienna, Austria,
- 11. Inspection of shipping containers for undisclosed radioactive materials (Vladivoj Valković), IAEA, Vienna, Austria.

SELECTED PUBLICATIONS

- T. Antičić, K. Kadija, T. Šuša and P. Seyboth. New five-quark states found at CERN, *CERN Courier*, **Dec. 2003**, *vol. 43*, *No. 10*, p. 5.
- C. Alt, T. Antičić *et al.* Evidence for an Exotic S = -2, Q = -2 Baryon Resonance in Proton-Proton Collisions at the CERN SPS, *Phys. Rev. Lett.*, in press
- C. Alt *et al.* Directed and elliptic flow of charged pions and protons in Pb + Pb collisions at 40A and 158A GeV, *Phys. Rev. C*, **2003**, *68*, 034903

- N.Soić, S.Cherubini, M.Lattuada, D.Miljanić, S. Romano, C.Spitaleri and M.Zadro. 8 Li+ α decay of 12 B and its astrophysical implications", *Europhys. Lett.*, **2003**, *63*, 524-530.
- Z. Medunić, M. Jakšić and Ž. Pastuović. Temperature dependent TRIBIC in CZT detectors, *Nucl. Instr. and Meth. B.*, **2003**, *210*, 237-242
- A. Andronić *et al.* Directed flow in Au + Au, Xe + CsI, and Ni + Ni collisions and the nuclear equation of state, *Phys. Rev. C*, **2003**, *67*, 034907
- Z. Basrak, R. Čaplar and V. Paar (guest editors). *Fizika B,* **2003**, *12*, 1-192.
- N. Soić *et al.* Cluster structure of ¹³C probed via $^7\text{Li}(^9\text{Be},^{13}\text{C}^* \Rightarrow ^9\text{Be}^*\alpha)$ reaction, *Nucl. Phys. A,* **2003**, *728*, 12.

Division of Materials Physics



http://www.irb.hr/str/zfm

DEPARTMENT ORGANISATION

Head: Branko Pivac

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 Division of Materials Physics is focused mainly on fundamental and applied studies of physical parameters and processes that describe and connect the microscopic and macroscopic properties of condensed matter and molecules. The main goal of the ZFM is to obtain a better understanding of the fundamental characteristics of defects in simple (Si), binary (GaAs, GaN, CdS), and multinary semiconductors and their complementary oxides. Certain aspects, such as the mutual interactions of defects, their impact on the relation between microscopic

and macroscopic properties of materials, as well as nanophase and glassy material characteristics, prove particularly important. The methods of investigation include the study of amorphous thin films produced by non-thermodynamic processes (magnetron sputtering), particularly Al-W and WC, a-Si and a-Si1-xCx:H films. In addition, the study of processes in magnetron sputtering sources and plasma obtained during laser ablation of metallic and non-metallic materials, is undertaken. The ZFM is also involved in fundamental research in the field of molecular and solid state physics with special emphasis on vibrational spectroscopy. The systems under investigation vary in their origin and composition from metals, semiconductors, and ceramics on one side, to molecular crystals and biological samples on the other.

TOP ACHIEVEMENTS

Nanosciences

Nanoscience and/or nanotechnology represent the most promising direction for both modern fundamental scientific research and developments in technology. In 2003, the Croatian Nanonetwork was established, with the aim of stimulating collaboration amongst

different groups having expertise and equipment suitable for research in this field. Such a collaboration will encourage closer contacts and focus the efforts of different groups on a few selected principal directions of research. Indeed, the first results have identified several promising nucleation centers with significant future potential. The project, entitled "Nano sciences: a road to new technologies" is coordinated by M. Milun (Institute of Physics) and involves 7 institutions and 15 formal and 26 international projects. From 22 domestic projects, 4 are led by B. Pivac, N. Radić, A. Turković and D. Gracin.

The CMS-18 sputtering system

The CMS-18 sputtering system has been installed in the Laboratory for Thin Films of the Division of Materials Physics. Produced and delivered by the Kurt J. Lesker, Co. USA, the system is designed to allow the preparation of new materials in the form of thin films by magnetron sputtering of several targets under various deposition conditions. Four magnetron sputtering guns furnished with shutters, allow co- or sequential deposition of up to the same number of target materials - metals, alloys, semiconductors, or isolators. A movable substrate holder is provided with DC or RF bias capability, and the heating assembly can handle temperatures up to 800 °C. A separate assembly for LN2 cooling is also available. Besides working gas (argon), two inlets for reactive gases allow for rective deposition. Deposition process may be manually or fully computer-controlled.

New standards in measuring oxygen content in silicon

In response to an editorial invitation, that was based on their recent paper, B. Pivac *et al.* published a review article in which long standing DIN and ASTM standards for IR determination of oxygen in silicon were challenged. As this parameter is extremely important in modern semiconductor technology, this contribution is of widespread interest. In additon to the literature review component, the article presented a new method, with significantly improved accuracy, for IR determination of the interstitial oxygen in silicon (B. Pivac *et al.*, *Defect and Diffusion Forum*, **2003**, 221-223, 123).



Figure 1. The CMS-18 sputtering system



Figure 2. The 93rd Executive Council Meeting of IUVISTA, Dubrovnik

International conference

The 93rd Executive Council Meeting of IUVSTA, Dubrovnik, 19-21 September 2003 was organized by the division members N. Radić and B. Pivac.

Non thermodynamic production of quantum dots

The viability of the synthesis of a 3D ensemble of well crystallized quantum dots

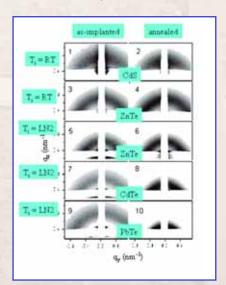


Figure 3. Non Thermodynamic production of quantum dots

(QDs) of compound semiconductors (CdS, ZnTe, CdTe and PbTe) embedded in SiO₂ substrate by ion implantation and annealing, was established.

Possible benefits of a novel method

GISAXS patterns suggest that the synthesis of nanoparticles (which may not be yet fully ordered, possibly even amorphous) occurs already during ion implantation. If, indeed, II-VI QDs are already formed during high-dose implantation, the production of high-quality QDs of II-VI compounds would be reduced to re-crystallization of already formed compounds, without requiring diffusion of the compound components. In this case, much lower annealing temperatures would be sufficient which is desirable since thermally driven, equilibrium, thermodynamic processes tend to broaden the size distribution of QDs.

Projects supported by the Ministry of Science and Technology (MZT)

- Impact of Defects and Nanostructures on 1. Semiconductor Properties. B. Pivac
- 2. Magnetron Deposition of Thin Films. N. Radić
- 3. Physics and Application of Nanostructures.
- 4. Multiphase Amorphous Silicon Alloys as Thin Films, D. Gracin
- 5. Sugar Hydratation Dynamics. V. Mohaček-Grošev
- 6. Nanophase Films and Nanocomposite Solid Electrolytes Research. A. Turković
- 7. Structure and Electrical Relaxation in Glasses and Glass-Ceramics. A. Moguš-Milanković
- Statics and Dynamics of Molecular Solids. D. Kirin
- 9. Optical Interactions and Organizational Processes in Matter. S. Lugomer
- 10. Semiconductor Materials for Optoelectronics. B. Šantić

Research and development projects

- 1. Reseach collaboration contract with the factory "Solar cells", Split (D. Gracin)
- 2. Stress in thin films (N. Radić), (Bilateral collaboration with Slovenia)
- Study of nanocomposite polymer electrolites (A. Turković), (Bilateral collaboration with Slovenia)
- Study of disordered materials, nano-optical layers (M. Ivanda), (Bilateral collaboration with Slovenia)
- Chemically durable iron phosphate glasses for vitrifying stimulated nuclear waste (A. Moguš-Milanković), (IAEA)

- B. Pivac, A. Sassella, and A. Borghesi. Recent "Advances in the Measurement of Interstitial Oxygen in Silicon by Infra-Red Spectroscopy". Defect and Diffusion Forum, 2003, 221-223, 123-131.
- I. Desnica-Franković, U. Desnica, P. Dubček, M. Buljan, S. Bernstorff, K. Helmut, B. Stritzker, "Ion beam synthesis of buried Zn-VI quantum dots in SiO₂: GISAXS studies". Journal of Applied Crystalography, 2003, 36, 439-442.
- U. Desnica, P. Dubček, I. Desnica-Franković, M. Buljan, S. Bernstorff, C.W. White, "GISAXS studies of the synthesis and growth of CdS quantum dots from constituent atoms in SiO2 matrix". Journal of Applied Crystalography, 2003, 36, 443-446.
- P. Dubček, B. Pivac, S. Bernstorff, F. Corni, R. Tonini, G. Ottaviani, "Grazing incidence smallangle X-ray scattering study of defects in deuterium implanted monocrystalline silicon". Journal of Applied Crystalography, 2003, 36, 447-449.
- V. Desnica, K. Furic, B. Hochleitner, M. Mantler, "A comparative analysis of five chrome green pigments based on different spectroscopic techniques". Spectrochimica Acta Part B. 2003, 58, 681-687.
- M. Ivanda, K. Babocsi, C. Dem, M. Schmitt, M. Montagna, W. Kiefer, "Low-wave-number Raman scattering from CdSxSe1-x quantum dots embedded in a glass matrix". Physical Reveiw B. **2003**, 67, 235329-235338.

Atomic Research and Development



http://www.irb.hr/str/lair

DIVISIONAL ORGANISATION

Head: Hrvoje Zorc

The Division of Laser and Atomic Research and Development (LAIR) consists of the following laboratories:

- ⇒ Laboratory for Optics and Thin Films, Hrvoje Zorc
- Multipurpose workshops, Eduard Švegel

OVERVIEW OF THE DIVISION

The activities of the division have been directed towards the development of new medical instrumentation, particularly in the field of photodynamic therapy using novel advanced light sources such as light emitting diode clusters. Research and development in the fields of optical design, electronics, and mechanical design, combined with a permanent interaction with the University clinic, resulted in several new devices for photodynamic therapy. Such devices are applicable to certain skin tumours, premalignant diseases and other dermatoses. In addition, clinical research has started on

several types of malignant diseases, the first results of which are very promising.

LAIR is also involved in basic research and development, as well as the small scale production of optical instruments and aiming devices for defence systems. The Division also provides user oriented educational courses for maintenance and service of the aforementioned optical devices.

TOP ACHIEVEMENTS

The major achievement in 2003 was the development of an advanced, computer controlled, apparatus for photodynamic diagnosis and therapy under the commercial name "MediLED 4 PDD & PDT" (patent pending). This comprehensive system incorporates highly efficient light sources - light emitting diode clusters and is designed for use in clinical practice.

Simultaneously, the MediLED Vio and MediLED Thera devices were produced as portable, easy to use light sources for treatment of smaller lesions (patent pending). MediLED devices were exhibited for the first time during the 5th International Symposium





Figure 1. MediLED 4, MediLED Vio and Thera

on Photodynamic Diagnosis and Therapy in Clinical Practice (Bressanone, Italy, 7-11 Oct. 2003).

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

 Photonics of image- and non-image optical systems, Hrvoje Zorc

Research and development projects

 Light sources for photodynamic therapy of tumors, Anton Peršin (HITRA-TEST)

Figure 2. Testing MediLED 4 in the laboratory

SELECTED PUBLICATIONS

Radman, I., Peršin, A., Zorc, H., Tisaj, K., Stanišić, V., Lončarić, M., Soldo Roudnicky, D., Radman, A.: First results of the use of new LED-based light sources on PDD and PDT of Mycosis Fungoides, 5th International Symposium on Photodynamic Diagnosis and Therapy in Clinical Practice / B. Kramer, H. Kostron, G. Jori (ur.), Bressanone,

2003. 31

Harvey, J.E. Bogunović, D., Krywonos, A.: Aberrations of Diffracted Wave Fields: Distortion., *Applied Optics - OT.* **2003**, *42*, 1167-1174.

Janicki, V., Zorc, H.: Determination of refractive index profile of ZrO₂ on amorphous and preevaporated substrates by reverse engineering, *Proc. SPIE*, **2003**, *5250*, 546-53.

Piegari, A., Janicki, V.:Metal/dielectric coatings for transmission filters with wide rejection bands, *Proc. SPIE*, **2003**, *5250*, 343-48.

Pavlović, M., Šantić, B., Desnica-Franković, D.I., Radić, N., Šmuc T., Desnica, U.V.: The impact of deep levels on the photocurrent transients in semi-insulating GaAs, *J. of Electronic Mater.* **2003**, *32*, 10.

Division of Electronics



http://www.irb.hr/str/zel

DIVISIONAL ORGANISATION

Head: Tomislav Šmuc

The Division of Electronics (ZEL) consists of the following laboratories:

- □ Laboratory for information systems, Dragan Gamberger
- ➡ Laboratory for stochastic signals and processes research, Ivan Michieli

OVERVIEW OF THE DIVISION

In 2003, the Division of Electronics broadened the scope of its research with applications and original contributions in the fields of bioinformatics (gene array expression data analysis, compaction and indexing DNA sequences) and time-series modelling. New international collaborations were initiated in the field of data mining, with the AI Department at the Josef Stefan Institute (AI-IJS), Slovenia, and in material behaviour modelling, with the Institute for New Materials in Saarbruecken, Germany. The laboratory for information systems organized a joint conference ECML/PKDD-2003, in Cavtat in collaboration with AI-IJS, and the CS

department KU, Leuven, Belgium. Božidar Vojnović, the former head of the Division, retired at the end of the year.

TOP ACHIEVEMENTS

Methodology for subgroup discovery

An original approach to subgroup discovery and representation was applied to problems related to the detection/classification of patients suffering from coronary heart disease. This approach has also been applied to marketing research problems, and has found use as an online data mining tool (B. Cestnik et al., Data mining and decision support, Kluwer Academic Publishers, 2003).

New areas of research

New areas of interest within ZEL include applications of machine learning methods to gene array expression analysis and compression and indexing of large DNA sequence databases. Important contributions have also been made in the areas of software engineering and modelling of chaotic signals and processes (A. Maksimović et al., J. Fluid. Struct. 2003, 17, 317. I. Michieli, B. Vojnović, J. Comp. Inf. Technol. 2003, 11, 55).

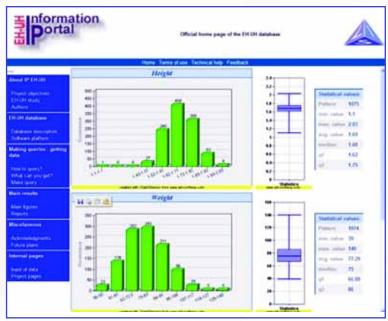


Figure 1. IP EH-UH: Information Portal of epidemiological study of Arterial Hypertension in Croatia

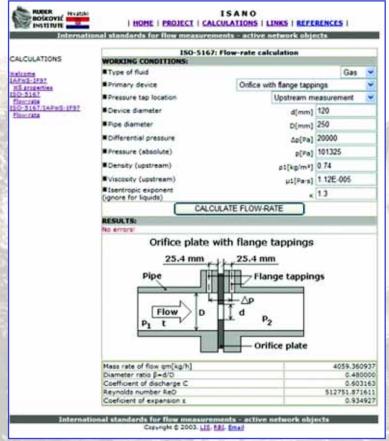


Figure 2. International Standards for the flow Measurements
- Active Network Objects

New WEB portals

Two new WEB portals, financed by the Ministry of Science and Technology (MZT) were realized within the scope of Information technology projects.

Educational activities

A new course entitled *Knowledge discovery in medical domains*, (Dragan Gamberger) is now part of the curriculum of the Ph.D. program *Biomedicine & Health Sciences*, at the Medical School of the University of Zagreb.

PROJECTS

Basic projects supported by the Ministry of Science and Technology (MZT)

- Automated Knowledge
 Discovery and Reasoning,
 Nikola Bogunović
- Analysis of Stochastic Signals,
 Time Series and Data
 Structures, Božidar Vojnović

Information technology projects supported by MZT

- International Standards for the flow measurements - Active Network Objects, Ivan Marić
- 2. Information portal for the epi demiological study of arterial hypertension in Croatia, Tomislav Šmuc

RBI annual report 2003

Research, development and collaborative projects

- Collaboration with Division for marine and environmental research on a project "Development of the new electrochemical sensor for the measurement of water pollution" (LISSP)
- 2. Intelligent Data Analysis with Al Department, Jozef Stefan Institute, Ljubljana, Slovenia

CONFERENCES

Organization of the joint conference ECML/PKDD 2003 (14th European Conference on Machine Learning and 7th European Conference on Principles and Practice of Knowledge Discovery in Databases), Cavtat, 22.-26.09.2003.

Knowledge Discovery in Databases: PKDD 2003, Lavrač, Nada; Gamberger, Dragan; Blockeel, Hendrik; Todorovski, Ljupčo (editors). Berlin: Springer, 2003, (conference proceedings)

Machine Learning: ECML 2003, Lavrač, Nada; Gamberger, Dragan; Blockeel, Hendrik; Todorovski, Ljupčo (editors), Berlin: Springer, 2003 (conference proceedings).

SELECTED PUBLICATIONS

Cestnik, B., Lavrač, N., Flach, P., Gamberger, D., Kline, M. *Data mining for decision support: Supporting marketing decisions through subgroup discovery, Data mining and decision support,* Mladenić, D., Lavrač, N., Bohanec, M., Moyle, S. (editors). Boston/Dordrecht/London: Kluwer Academic Publishers, **2003**.

Bogunović, N., Grudenić, I., Pek, E. A Synthesized Framework for Formal Verification of Computing Systems, *Journal on Systemics, Cybernetics and Informatics*. **2003**, *1*, 6-11.

Gamberger, D., Lavrač, N., Krstačić, G. Active Subgroup Mining: A Case Study in Coronary Heart Disease Risk Group Detection, *Artificial Intelligence in Medicine*. **2003**, *28*, 27-57.

Marić, I. Software objects in distributed flow measurements, *ISA Transactions*. **2003**, *42*, 497-504.

Michieli, I., Vojnović, B. Detecting Noise in Chaotic Signals through Principal Component Matrix Transformation, *Journal of Computing and Information Technology*. **2003**, *11*, 1, 55-66.

Maksimović, A., Lugomer, S., Michieli, I. Multisolitons on vortex filaments: the origin of axial tangling. *Journal of Fluids and Structures*. **2003**, *17*, 317-330.



Division of Physical Chemistry



http://www.irb.hr/str/zfk

DIVISIONAL ORGANISATION

Head: Aleksandar Sabljić

The Division of Physical Chemistry (ZFK) consists of the following laboratories:

- ➡ Laboratory for Chemical Kinetics and Atmospheric Chemistry, Dunja Srzić

- Laboratory of Chemical and Biological Crystallography, Biserka Kojić-Prodić
- ⇒ Laboratory for Magnetic Resonances, Boris Rakvin
- □ Laboratory for Analytical Chemistry, | Ivan Habuš

OVERVIEW OF THE DIVISION

In 2003, the members of ZFK contributed valuable publications on a broad range of topics such as atmospheric chemistry, structural chemistry, theoretical chemistry, the modelling of physical and chemical processes, structural and chemical analyses, and biosciences. A significant number of these

contributions were published in the highest ranking chemical journals such as the Journal of the American Chemical Society, Chemistry - A European Journal, the Journal of Physical Chemistry, the Journal of Organic Chemistry, and Biochimica et Biophysica Acta. The contribution to undergraduate and graduate education this year was extensive and the division continued to participate in the organization of highly regarded scientific conferences. In addition, the traditional international collaborations with institutions such as Harvard University, Rice University, Pacific Northwest Laboratory, Free University Berlin, and the Hebrew University of Jerusalem were maintained.

TOP ACHIEVEMENTS

Probing the properties of molecular magnets

Single molecule magnets (SMMs) are the focus of many experimental and theoretical studies. They exhibit the novel phenomenon of quantum tunnelling of the magnetization. In the context of SMMs, a single molecule may exhibit a hysteresis loop and hence has the potential to serve as the basis of memory storage at the molecular level, and possi-

bly even for quantum computation. A sensitive method, based on EPR spectroscopy, was developed to measure the magnetic field near the surfaces of the molecular magnet Mn₁₂-acetate (B. Rakvin *et al. J. Mag. Res.* **2003**, *165*, 260). This method has the potential to become an accurate, efficient and inexpensive screening tool for probing properties of highly magnetic molecules, i.e. potential molecular magnets.



Figure 1. Images of EPR probe NMP-TCNQ utilized to measure magnetic fields at the surface of nanomagnet Mn₁₂-acetate shown under magnification at 60 times

Potential new delivery system for immunostimulants

Immunostimulating compounds enhance the immune response of the host to an antigen. Such compounds are particularly useful in stimulating the immune response to weak antigens and vaccines. EPR spectroscopy was used to study the interactions of the potential immunostimulating agents, the peptidoglycan monomer and the structurally related adamantyltripeptides, with multil-

amellar liposomes. The strong interaction of adamantyltripeptides with the negatively charged liposomes makes them good candidates for use as immunostimulating agents in vivo (R. Frkanec *et al. Biochim. Biophys. Acta* **2003**, *1611*, 187).



Figure 2. Electron Paramagnetic Resonance spectrometer (FT/CW EPR) working with the pulse and continuous microwave source in a wide temperature range (4K-300K)

Designing surfactants with desirable properties

To design surfactants with specific qualities, it is imperative to understand the relationships between their structure and their supramolecular organization (into micelles, vesicles, liotropic liquid crystals). Such relationships are studied by an interdisciplinary approach involving a new generation of surfactants, namely the dissymmetric geminis. It was found that the length of the hydrophobic spacer in these molecules is a critical parameter for their structural amphotropic properties. In particular, the presence of a longer spacer was found to modify the supramolecular structure from wormlike to spherical micelles. In this way, it is possible to manipulate the arrangement of

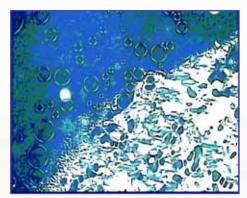


Figure 3. Transformation of dissymmetric gemini surfactants from a fan shaped texture to the giant vesicular phase

surfactants in micellar, mesomorphic and crystalline states and, consequently, to design surfactants with desirable characteristics (M. Sikirić et al. Langmuir 2003, 19, 10044).

Electronic structure of anti-HIV drug AZT revealed

The electronic structures of the anti-HIV drug AZT and the antimalarial drug artemisinine were resolved by photoelectron spectroscopy and quantum-chemical calculations (I. Novak, B. Kovač, *J. Org. Chem.* **2003**, *68*, 5777). These results will help to clarify the mechanisms of their biological activity as well as to derive improved anti-HIV and antimalarial agents.

AWARDS

 Greta Pifat-Mrzljak: Austrian Honorary Award for Science and Art, I Order

SELECTED COLLABORATIONS

- COST chemistry D-27 action "Origin of life and early evolution", Vesna Noethig-Laslo
- 2. COST D-22 Project "Protein-lipid interactions", Greta Pifat-Mrzljak

 "Ultrafast and ultracold experimental and theoretical methods and applications" Collaborative project supported by the Ministry of Science and Technology.



SELECTED INVITED LECTURES

- S. Bosanac "Charge in ultra strong electromagnetic fields" Harvard University, Cambridge, MA, U.S.A., 27 January 2003
- S. Bosanac "Dynamics in phase space" NATO Workshop "The Dynamics of Elementary Chemical Reactions" Balatonföldvár, Hungary, 8-12 June 2003
- V. Noethig-Laslo "A spin-labelling study of peptidoglycan monomer and adamantyltripeptides entrapped into liposomes" 2nd International Conference on Biomedical Spectroscopy, London, UK, 5-8 July 2003
- 4. B. Rakvin "An EPR spin probe method for measuring magnetic field at the surface of single molecule magnets Fe₈ and Mn₁₂", 8th Workshop ELECTRON MAGNETIC RESONANCE OF DISORDERED SYSTEMS, Sofia, Bulgaria, 11 November 2003

CONFERENCES ORGANIZED BY SCIENTISTS OF THE DIVISION

- 1. 18th MATH/CHEM/COMP, Dubrovnik, 23-28 June 2003
- Summer School "Supramolecular Structure and Function", Rovinj, 14-26 Sept. 2003

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- 1. Properties and behavior of atmosferic microconstituents, Tomislav Cvitaš
- 2. Surfactants, processes in solution and at interfaces, Nada Filipović-Vinceković
- Reactivity and reaction mechanism, Leo Klasinc
- 4. Investigation on chemical reactivity and ultrafast processes, Aleksandar Sabljić

- Develeopment and application of models in chemistry and bioinformatics, Nenad Trinajstić
- Structural and biological investigation of new complex compounds, Lierka Tušek-Božić
- 7. Structure and dynamics of (bio)molecules, Biserka Kojić-Prodić
- 8. Biophysics of liporotein interactions with active substances, Greta Pifat-Mrzljak
- 9. Electron spin resonance in systems with paramagnetic particles, Boris Rakvin
- Modeling of novel carbon materials, Ante Graovac
- 11. Interactions of biomembranes with amino acids and peptides, Vesna Nöthig-Laslo
- Multidisciplinary sedimentological investigations, Halka Bilinski
- 13. Matter under extreme conditions, Slobodan Bosanac
- 14. Description and behavior of quantum systems in interaction, Tomislav Živković
- 15. Custom DNA synthesis, Ivan Habuš

Other projects

- 1. Lipoprotein interactions with active substances, Greta Pifat-Mrzljak (Bilateral project with Austria)
- Prediction of Enzyme Selectivity, Regulation, and Inhibition by COMBINE Analysis,
 Tomić (Bilateral project with Germany)
- Molecular Basis for Biocatalysis by Microbial Lipases, Biserka Kojić-Prodić, (Bilateral project with Germany)
- 4. Structure and dynamics of interpenetrating polymer networks, Mladen Andreis (Bilateral project with Slovenia)
- Interaction of biomembranes with peptides, Vesna Noethig-Laslo (Bilateral project with Slovenia)
- 6. Structural investigation of natural polymers and complexes by mass spectrometry, Dunja Srzić (Bilateral project with Slovenia)

SELECTED PUBLICATIONS

- B. Rakvin, D. Žilić, J. M. North, N. S. Dalal "Probing magnetic fields on crystals of the nanomagnet Mn₁₂-acetate by electron paramagnetic resonance" *J. Mag. Res.* **2003**, *165*, 260
- B. Cage, F.A. Cotton, N.S. Dalal, E.A. Hillard, B. Rakvin, C.M. Ramsey, M.Chris, "Observation of Symmetry Lowering and Electron Localization in the Doublet-States of a Spin-Frustrated Equilateral Triangular Lattice: Cu₃(O₇C₁₆H₂₃)x1.2C₆H₁₂" *J. Am. Chem. Soc.* **2003**, *125*, 5270.
- J. Makarević, M. Jokić, Z. Raza, Z. Štefanić, B. Kojić-Prodić, M. Žinić, "Chiral Bis(Amino Alcohol) Oxalyl Amide Gelators-Gelation Properties and Supramolecular Organization. Racemate vs Pure Enantiomer Gelation". *Chemistry-A European Journal.* **2003**, 9, 5567.
- M. Kveder, A. Kriško, G. Pifat, H.J. Steinhoff, "The Study of Structural Accessibility of Free Thiol Groups in Human LDL", *Biochim. Biophys. Acta*, **2003**, *1631*, 239.
- I. Novak, B. Kovač, "Photoelectron spectra of important drug molecules: Zidovudine & Artemisinine", *J. Org. Chem.* **2003**, *68*, 5777.
- R. Frkanec, V. Noethig-Laslo, B. Vranešić, K. Mirosavljević, J. Tomašić "A spin labeling study of immunomodulating peptidoglycan monomer and adamantyltripeptides entrapped into liposomes" *Biochim. Biophys. Acta* **2003**, *1611*, 187.
- M. Sikirić, I. Šmit, Lj. Tušek-Božić, V. Tomašić, I. Pucić, I. Primožič, N. Filipović-Vinceković, "Effect of the Spacer Length on the Solid Phase Transitions of Dissymmetric Gemini Surfactants", *Langmuir* **2003**, *19*, 10044.
- M. Bonifačić, K.-D. Asmus, K.A. Gray, "On the Reaction of 2,4,5-Trichlorophenol with Hydroxyl Radicals: New Information on Transients and their Properties". *J. Phys. Chem. A*, **2003**, *107*, 1307.

Division of Organic Chemistry and Biochemistry



http://www.irb.hr/str/zokb

DIVISIONAL ORGANISATION

Head: Mladen Žinić

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

- ➡ Laboratory for synthetic organic chemistry, Kata Majerski
- ➡ Laboratory for supramolecular and nucleoside chemistry, Mladen Žinić
- Laboratory for carbohydrate, peptide and glycopeptide chemistry, Štefica Horvat
- ➡ Laboratory for cellular biochemistry, *Maja Abramić*
- ➡ Laboratory for molecular spectroscopy, Goran Baranović
- ⇔ Group for quantum organic chemistry, Zvonimir Maksić

OVERVIEW OF THE DIVISION

Research activities within the division during 2003 resulted in the publication of an impressive number of scientific papers, most of which appeared in reputed international journals. The topics of scientific investigation varied widely and included fields such as synthesis, physical organic chemistry, supramolecular chemistry, molecular spectroscopy, cellular biochemistry, and quantum organic chemistry. The members of the division actively participated in the organizing committee for the 13th European Symposium on Organic Chemistry (ESOC 13), held in Cavtat near Dubrovnik. This highly successful meeting attracted 455 participants from 40 different countries all over the world. The scientists of the division also made a significant contribution to higher education in organic chemistry by providing 9 courses, at undergraduate and postgraduate levels, and by supervising 4 M.Sc. and 5 Ph.D. theses.

TOP ACHIEVEMENTS

Supramolecular chemistry of gels

The formation of nano-fibers in organogels of bis(amino alcohol) oxalamides was



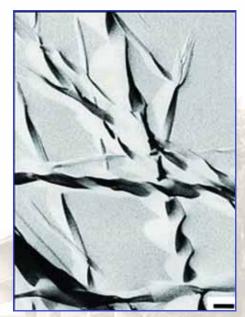


Figure 1. TEM images: gel fibres can be transcribed into silica nano-tubes (left) or twisted ribbons (right).

elucidated. The self-assembly of such molecules into fibrous aggregates was shown to result from differing strengths and directionality of aggregate forces (supramolecular vectors) in three-dimensional space (J. Makarević *et al.*, *Chem. Eur. J.* **2003**, 9, 5567). Supramolecular gels as new "smart materials" are of interest for the development of new technologies such as slow drug



delivery systems, tissue engineering, safer surface transport of dangerous liquids or fuels and the preparation of nano-dimensional inorganic materials for catalysis or electronics.

Figure 2. One molecule of an organogelator hardens up to 40.000 molecules of solvent.

Quantum organic chemistry

Studies of the correlation energy of electrons in molecules resulted in the discovery of a direct relationship between the correlation energy calculated by *ab initio* methodology and that obtained by Density Functional Theory (D. Barić, Z. B. Maksić, *J. Phys. Chem. A*, **2003**, *107*, 11577). It was shown that the energy of electronic correlation exhibits a remarkable atomic additivity which enables an accurate estimation of the correlation energy in larger molecules, for which demanding *ab initio* calculations are not feasible.

Photoprotonation studies

The protonation state of the carbonyl group of formaldehyde was shown to have important ramifications for its electronic excitation spectrum. These effects were revealed through state of the art calculations, applied to the lowest excited valence and Rydberg states (I. Antol et al. Chem.

Phys. Lett. **2003**, 374, 587), and provide an important stepping-stone on the way to a deeper understanding of photoinduced proton transfer processes in complex, biologically active molecules.

Carbohydrate and peptide chemistry

An extensive study of glycation products implicated in the pathogenesis of diabetic complications, aging, and Alzheimer's disease, revealed new facts about the stability and degradation products of the glycated peptide hormone leucine-enkephalin under physiological conditions. A new chemical transformation of the glycated peptide, leading to beta-scission of the terminal amino acid side-chain, was found to result in reactive aldehyde species that can impair cell viability (A. Jakas, Š. Horvat, *Biopolymers*, **2003**, 69, 421-431).

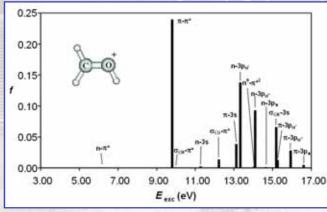


Figure 3. Calculated electronic spectrum of protonated formaldehyde.

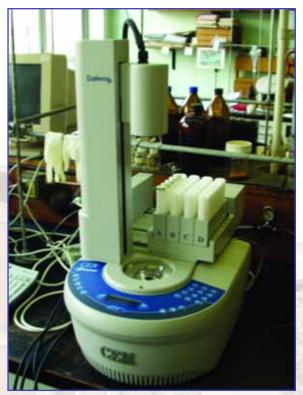


Figure 4. Apparatus for microwave assisted synthesis.

PATENT

New compounds with antitumor activity

N-1-sulfonylpyrimidine derivatives synthesized in the Laboratory for supramolecular and nucleoside chemistry showed strong *in vitro* anticancer activity against various human tumor cell lines while their cytostatic effects against normal human fibroblasts were significantly lower. European Patent (**EP 0 877 022**, **2003**; inventors: Biserka Žinić, Mladen Žinić, Irena Krizmanić,) has been granted for new sulfonylpyrimidines with antitumor activity. The compounds are promising candidates for development of new anticancer drugs.

AWARDS

Mladen Žinić was awarded the Croatian Academy of Sciences and Arts prize for scientific achievement in natural sciences -chemistry. Irena Zrinski won the annual award for young scientists from The Society of University Teach-

ers and Scientists, Zagreb, Croatia, for the most important published scientific paper (*New Journal of Chemistry* **2003**, *8*, 1270).

INVITED LECTURES

Štefica Horvat, Synthetic Glycopeptides in Exploring Sugar-Mediated Nonenzymatic Covalent Modifications of Peptides and Proteins.13th European Symposium on Organic Chemistry (Cavtat-Dubrovnik, Croatia, 10-15.09.2003.)

Kata Majerski, Carbenes in Polycyclic Systems. Generation and Fate of Carbene and Dicarbene Species, FRANK WARREN Organic Chemistry Conference, Rhodes University, Grahamstown, SA, 13-16. 04. 2003.

Kata Majerski, "Adamantane as Building Block in Construction of Crown Ethers and Cryptands: Synthesis, Structure and Properties", 2nd Central European Chemical Meeting (CECM-2) Varaždin, Croatia, 19-21. 06. 2003.

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- Stereoselective synthesis and catalysis, Vitomir Šunjić
- New optically active materials, Vladimir Vinković
- Synthesis, molecular structure and function of polycyclic molecules, Kata Majerski
- Supramolecular organization of gels, molecular recognition and catalysis, Mladen Žinić
- Design and synthesis of bioactive peptides, glycopeptides and biomarkers, Štefica Horvat
- Reactive intermediates in ground and excited state, Mirjana Eckert Maksić
- 7. Hydrolases from isolation to function, Maja Abramić
- 8. Extended π -systems and molecular spectroscopies, Goran Baranović
- 9. Proton affinity and the proton transfer reaction in chemistry, Zvonimir Maksić

International and collaborative projects

- Properties of new molecular materials, Working group within COST D26, Mirjana Eckert-Maksić
- Intrinsic Reactivity of New Molecular Materials, Working group within COST D26,
 Zvonimir Maksić
- Syntheses, structure and mechanisms of functional molecular and supramolecular systems, Collaborative project, MSES, project coordinator Mladen Žinić
- Mirjana Eckert-Maksić and Zvonimir Makasić also collaborate in 3 bilateral Croatia-Austria and Croatia-Slovenia projects.

Research and development projects

1. Potential antitumor drugs, Štefica Horvat, (MZT, HITRA, TP-B23/2001)

SELECTED PUBLICATIONS

- J. Makarević, M. Jokić, Z. Raza, Z. Stefanić, B. Kojić-Prodić, M. Žinić, Chiral Bis(amino alcohol)oxalamide Gelators–Gelation Properties and Supramolecular Organization: Racemate versus Pure Enantiomer Gelation, *Chem. Eur. J.* **2003**, 9, 5567-5580.
- D. Barić, Z. B. Maksić, Atomic Additivity of the Correlation Energy in Molecules by the DFT-B3LYP Scheme, *J. Phys. Chem. A*, **2003**, *107*, 11577.
- I. Antol, M. Eckert-Maksić, T. Mueller, M. Dallos, H. Lischka, Valence and Rydberg states of protonated formaldehyde, *Chemical Physics Letters.* **2003**, 374, 5-6; 587-593.
- A. Jakas, Š. Horvat, Study of Degradation Pathways of Amadori Compounds Obtained by Glycation of Opioid Pentapeptide and Related Smaller Fragments: Stability, reactions and Spectroscopic Properties. *Biopolymers*, **2003**, 69, 421-431.
- G. Kragol, I. Benko, J. Muharemspahić, K. Mlinarić-Majerski, A Cyclopropyl-Homoallyl Rearrangement Accompanying the Borane-

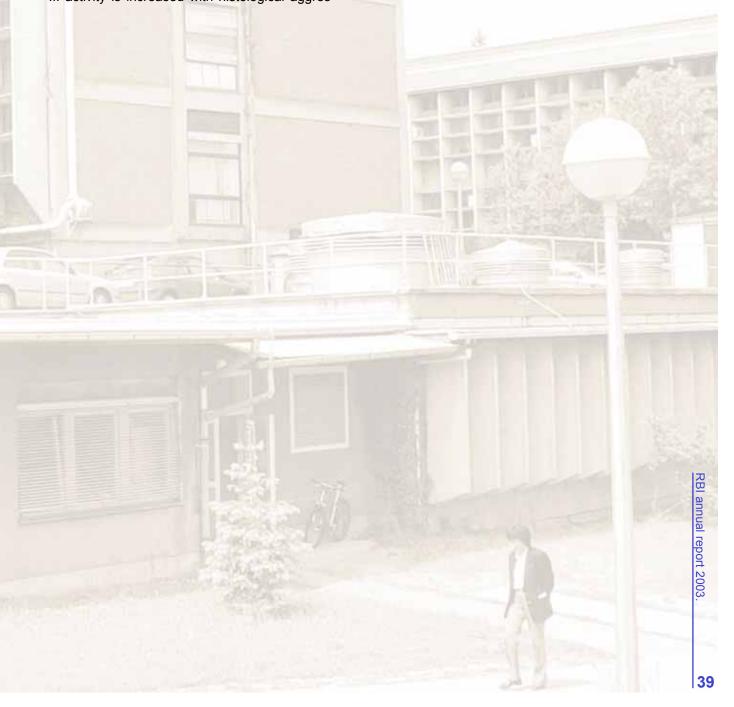
Mediated Reduction of Tosylhydrazones, *Eur. J. Org. Chem.* **2003**, 2622.

M. Majerić-Elenkov, Z. Hameršak, V. Šunjić, Kinetic Resolution of Diastereomeric Racemates of 7-Bromo-3-(1`-hydroxy-ethyl)-1-methyl-5-(2`-pyridyl)-2, 3-dihydro-1H-1, 4-benzodiazepin-2-one by Immobilized CAL-B. *Tetrahedron Asymmetry.* **2003**, 14, 2725-2730.

Š. Šimaga, D. Babić, Osmak M, Šprem M. Abramić M., Tumor cytosol dipeptidyl peptidase III activity is increased with histological aggres-

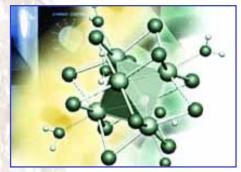
siveness of ovarian primary carcinomas, *Gynecologic Oncology*, **2003**, *91*, 194-200.

N. Biliškov, B. Zimmermann, G. Baranović,. Vibrational spectroscopy of macrocyclic oligo(phenyldi-acetylenes) – I. A theoretical and experimental study of octadehydrodibenzo[12]annulene and dodecadehydrotribenzo[18]annulene, *J. Mol. Struct.* **2003**, 661-662, 65-80.





Division of Materials Chemistry



http://www.irb.hr/str/zkm

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 solid state chemistry, Želimir Blažina
- ➡ Group for ichtiopathology biological materials, Rozelinda Čož-Rakovac

OVERVIEW OF THE DIVISION

The Division of Materials Chemistry continued to focus on obtaining a better understanding of the properties of materials such as magnetic and nonmagnetic metal oxides, oxide glass-ceramics, zeolites, cluster com-

pounds, organic polymers, intermetallic compounds, and metal hydrides. This was achieved through the application of a variety of established techniques, including the kinetics and mechanisms of precipitation, and the biochemical research of fish, shellfish and crustacean tissues, as well as through the development of new and existing theoretical and experimental methods in materials science. In addition to the 50 or so companies that used our established radiation services for sterilization, pasteurization, desinsection and/or decontamination, the division participated in numerous cooperative activities with different industries, hospitals, and state institutions.

TOP ACHIEVEMENTS

A new zeolite microstructure

Zeolites, particularly those with controllable microstructure, have the potential to be used for the storage of various organic compounds. In our laboratories one such material was synthesized by controlled heating of the NH₄-exchanged zeolite A4. This process initially resulted in an amorphous phase, which was then replaced by a mixture of

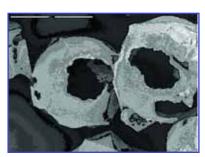


Figure 1. Mullite micro-vessels

mullite and amorphous silica (SiO_2). The treatment of this final product with alkali resulted in the extraction of the amorphous SiO_2 from the interior of each particle and formation of mullite micro-vessels (C. Kosanović, B. Subotić, *Micropor. Mesopor. Mater.*, **2003**, *2*-3, 311).

Nano-sized metal oxide particles show activity against cancer cells

Experiments with squamous carcinoma cells (SCCVII cultured in vitro) have shown, for the first time, that ultrafine iron-doped TiO₂ particles display appreciable cytotoxic effects in the presence of UV irradiation, and are otherwise relatively inert. The most pro-



Figure 2. Control of zeolite crystallization

nounced photokilling effect was observed for the Fe/Ti molar ratio of 0.136 (S. Ivanković et al. J. Sol-Gel Sci. Technol. **2003**, 27, 225).

Ultrafast redox chemistry

The second step in the biologically important reduction of hydroperoxides with iron(II) is extremely rapid and its kinetic characterization has thus far proven elusive. This year, we have succeeded to measure, by means of competition kinetics, the rate constant for the reaction of a model alkoxyl radical with iron(II) ion in methanol. The model tertbutoxyl radical was generated by applying a laser impulse at the wavelength corresponding to the absorption of the peroxide bond of dibutylperoxide. The formation of iron(III) was monitored by observing the optical absorption of the monochloroiron(III) complex on the microsecond time scale after the pulse (B. Mihaljević, D. Ražem, Radiat. Phys. Chem., 2003, 67, 269).

Orientational growth in polypropylene/talc composites

The study of the structure-property relationships of isotactic polypropylene (iPP)/talc composites is important for the design of superior plastics for industrial application. Our recent characterization of such composites has revealed that plate-like talc crystals disturbed the well-developed spherulitization of iPP matrix as well as affecting orientational growth of polypropylene lamellae. In addition, we were able to show that planeparallel separated talc crystals reduce the effects of irradiation (M. Denac *et al.*, *Polym. Degrad. Stabil.* **2003**, 82, 263).



Figure 3. Metal ion hydrolysis forced by ultrasound

A new type of materials for hydrogen storage

The crystal structure and hydrogen sorption properties of the new RENi $_{5-x}$ Al $_x$ (RE = Gd, Tb, Dy, Ho, Er and Y) alloys were investigated. In all systems the binary prototype structure of the CaCu $_5$ type is preserved up to x=2, while beyond this composition a transformation into the YCo $_3$ Ga $_2$ structure type occurs. Taking into account the hydride capacity of at least 3.5 H atoms per alloy formula unit and the suitable equilibrium pressure at ambient temperature, the systems RENi $_{4.5}$ Al $_{0.5}$ -hydrogen (RE= Tb, Y) and RENi $_4$ Al-hydrogen (RE=Gd, Tb, Y, Dy, Ho) are attractive candidates for hydrogen stor-



Figure 4. Moessbauer spectrometer for materials research

age purposes (B. Šorgić et al., J. Alloys Comp. 2003, 356/357, 501).

A new crystal structure of a molybdenum methoxo cluster

In an effort to better understand the unique nature of organometallic compounds possessing a direct metal-metal bond, two series of polymeric methoxo clusters of molybdenum and tungsten have been synthesized. In the first series, the methoxo groups act as bridges between neighbouring cluster units while the second series shows both bridging and terminal methoxo groups. The crystal structure for the monomer cluster $[Na(CH_3OH)_5]_2[Mo_6(\mu_3-Br)_8(OCH_3)_6]$ has been solved. (N. Brničević *et al.*, *Polyhedron* **2003**, *22*, 1553).

International training course

In addition to the established contribution to undergraduate and graduate education at the universities of Split and Zagreb, the division offered a specialized training course to a fellow of the International Atomic Energy Agency in the area of radiation sterilization of pharmaceuticals.

INVITED LECTURES

- F. Ranogajec, "Improvement of Polymer Stability by Radiation Grafting", International al Meeting on Radiation Processing, Chicago, September 7-12, 2003.
- F. Ranogajec, "Liquid-liquid Transition in Unsaturated Polyesters", Polymer Science and Engineering, University of Massachusetts, September 4, 2003.
- 3. F. Ranogajec, "Crosslinking and Structural Transitions in Unsaturated Polyester

- Resins", Kansas Polymer Research Center, Pittsburg State University, Kansas, September 15, 2003.
- 4. S. Musić, "Moessbauer Spectroscopy in Chemistry", Croatian Academy of Science and Arts, Zagreb, November 18, 2003.

PROJECTS

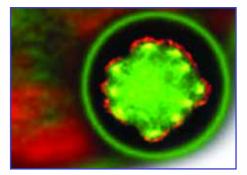
Projects supported by the Ministry of Science and Technology (MZT)

- Research of the crystallization process and use of zeolites, Boris Subotić
- Kinetics and mechanisms of solid phase precipitation from electrolyte solutions, Lierka Brečević
- 3. Synthesis and microstructure of metal oxides and oxide glasses, Svetozar Musić
- 4. Physico-chemical effects of ionizing radiations, Dušan Ražem
- Synthesis, characterization and modification of polymers by ionizing radiation, Franjo Ranogajec
- 6. Intermetallic compounds and metal hydrides, Želimir Blažina
- 7. Superconducting oxides and polynuclear metal complexes, Nevenka Brničević
- 8. Influence of dopands on the structure and properties of materials for technical applications, Biserka Gržeta
- Development of an adaptable technological procedure for the production of precipitated calcium carbonate, Damir Kralj (HITRA)
- Characterization of the aluminate cement clinker by the Rietveld method, Biserka Gržeta (HITRA).

SELECTED PUBLICATIONS

- B. Subotić, J. Bronić, "Theoretical and Practical Aspects of Zeolite Crystal Growth". S. M. Auerbach, K. A. Carrado and P. K. Dutta (Eds.), "Handbook of Zeolite Science and Technology", Marcel Dekker Inc., New York, Basel, 2003, pp. 129-203.
- C. Kosanović and B. Subotić, "Preparation of Mullite Micro-vessels by a Combined Treatment of Zeolites", *Micropor. Mesopor. Mater.*, **2003**, 2-3, 311.
- S. Ivanković, M. Gotić, M. Jurin, S. Musić "Photokilling Squamous Carcinoma Cells SCCVII with Ultrafine Particles of Selected Metal Oxides", *J. Sol-Gel Sci. Technol.* **2003**, *27*, 225.
- B. Mihaljević, D. Ražem, "Oxidation kinetics of iron(II) ion with t-butoxyl radical", *Radiat. Phys. Chem.*, **2003**, *67*, 269.
- M. Denac, V. Musil, I. Šmit, F. Ranogajec, "Effects of talc and gamma irradiation on mechanical properties and morphology of isotactic polypropylene/talc composites", *Polym. Degrad. Stabil.* **2003**, 82, 263.
- B. Šorgić, A. Drašner, Ž. Blažina, "Structural and hydrogen sorption properties of RENI_{5-x}Al_x (RE=Gd, Tb, Dy, Ho, Er and Y) alloys.", *J. Alloys Comp.* **2003**, *356/357*, 501)
- N. Brničević, I. Bašic, B. Hoxha, P. Planinić, R.E. McCarley, "Molybdenum and Tungsten Methoxo Clusters with Differently Bonded Methoxo Groups. Crystal Structure of $[Na(CH_3OH)_5]_2[Mo_6(\mu_3-Br)_8(OCH_3)_6]$ ", *Polyhedron* **2003**, *22*, 1553.

Division of Molecular Biology



http://www.irb.hr/str/zmg

DIVISIONAL ORGANISATION

Head: Đurđica Ugarković

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

- ➡ Laboratory for Molecular Genetics,
 Vera Gamulin
- ➡ Laboratory for Molecular Genetics of Eukaryotes, Miroslav Plohl
- ⇔ Gene Regulation Laboratory, Mary Sopta
- ➡ Laboratory of Experimental Cancerology, *Ivica Rubelj*
- □ Laboratory for Genotoxic Agents, Maja Osmak

OVERVIEW OF THE DIVISION

In 2003, the Division of Molecular Biology made several major discoveries in basic research areas such as bacterial recombination and translational control. The installation of a new confocal microscope will expand the scope of possible projects in many of the research groups. The division was responsible for the organization of the highly successful Methodological Courses in Biology and Medicine. In recognition for her efforts as the head of the Molecular Genetics Laboratory, Vera Gamulin was awarded the Croatian state prize for significant contributions to the development of molecular biology research in Croatia.

TOP ACHIEVEMENTS

Fidelity enhancement of RNA synthesis by small proteins

In collaboration with D. Soll's group at Yale University, I. Ahel discovered small autonomous proteins which enhance the fidelity of aminoacyl-tRNA synthesis. These editing modules could represent a link between the ancestral aminoacyl-tRNA syntheses and extant enzymes (I. Ahel et al., Proc. Natl. Acad. Sci. U. S. A., 2003, 100, 15422).

Interaction of two recombinational pathways

The first experimental proof for the possibility for enzymes derived from two independent recombinational pathways (recBCD and RecF) to functionally replace each other, under certain conditions, was obtained in the ZMB (I. Ivančić-Baće *et al.*, *Genetics*, **2003**, *163*, 485). The model which explains the interactions of these two recombinational pathways was proposed by the same authors.

New confocal microscope

The microscopy infrastructure of the Division was improved in 2003 by the installation of a Leica confocal microscope (Figure 1). It is planned to use this equipment to expand an exciting new research area introduced by Igor Weber from the Max Planck Institute in Martinsried (Figures 2, 3, 4; I. Weber, *Methods of Enzymology*, **2003**, 361, 34).

Award to Vera Gamulin

The Croatian State Award, the most prestigious scientific recognition available in



Figure 1. Confocal microscope at the Division of Molecular Biology



Figure 2. Phagocytosis of opsonized yeast particles by Dictyostelium amoebae tranfected with a protein marker for endoplasmatic reticulum fused to GFP (green).

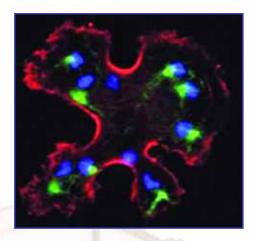
Croatia, was presented this year to Vera Gamulin, senior researcher at the Division of Molecular Biology, for research on the gene structure of marine sponges and the bacteria *Streptomyces rimosus*. She is also recognized as a pioneer of molecular biology research in Croatia for her introduction of recombinant DNA technology into the research program at the Ruđer Bošković Institute in 1982.

Biodiversity in Croatia

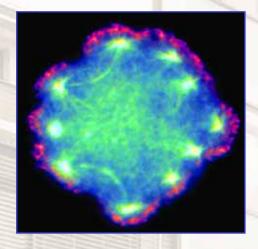
A large collaborative research project, entitled "Biodiversity in Croatia: genetic characterization of autochthonous flora and fauna and economically important species and breeds" and involving 20 research groups from different institutions in Croatia, was initiated by the ZMB. This project is coordinated by V. Gamulin and N. Tvrtković.

Novel initiative in education

To improve the education in the field of molecular biology in Croatia, the Methodological courses in Biology and Medicine were organized by the ZMB in collaboration



Figures 3 and 4. Cell division of multinuclear mutant Dictyostelium cells with deletion of a gene that codes for the motor protein myosin II. Cortical proteins of the cytoskeleton (red) and microtubuli (green and yellow) are labeled by immunofluorescence. Nuclei are labeled by DAPI (blue).



with the Divisions of Molecular Medicine, Organic Chemistry and Biochemistry, and Marine Research from the Ruđer Bošković Institute. The courses were initiated and lead by A. Ambriović-Ristov.

50 years of double helix

To mark the 50th anniversary of the discovery of the DNA double helix and the 45th anniversary of the commencement of molecular biology in Croatia, the ZMB (A. Ferle-Vidović and E. Salaj-Šmic) organized a sym-

posium on November 20-21 at the Ruđer Bošković Institute. This symposium, entitled "45 years of Molecular Biology in Croatia - 50 of Double Helix", included notable international contributions by D. Erlich, R. Lloyd, W. Mueller, M. Radman, W. Schaffner and H. Schwab.

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- 1. The role of recombination in DNA repair and genome stability, Erika Salaj-Šmic
- Regulation of recombination and recombinational repair, Mirjana Petranović
- Genes and genomes of evolutionarily conserved and economically important species, Vera Gamulin
- 4. Evolutionary dynamics of satellite DNAs, Đurđica Ugarković
- Organization of heterochromatic DNA sequences in invertebrates, Miroslav Plohl
- 6. Transcriptional regulation in eukaryotes, Mary Sopta
- 7. Molecular mechanisms of imortalization and cellular aging, Ivica Rubelj
- 8. Structure, function and regulation of plasminogen serine proteases, Branko Brdar
- Cell response to physical, chemical and biological noxa, Maja Osmak
- Molecular pathophysiology of serotonergic transmission, Branimir Jernej
- Hydrodynamics of the cerebrospinal fluid, Darko Orešković
- 12. Structure and function of plastids and cytoskeleton, Nikola Ljubešić
- 13. Dynamics and genetics of bioactive molecules, Volker Magnus
- 14. Endemic and relict phytocenoses of Croatia and their mycoflora, Andrija Željko Lovrić

Collaborative projects

- Biodiversity in Croatia: genetic characterization of autochthonous flora and fauna and economically important species and breeds, Gamulin V, Tvrtković, N collaborative project, MZT, (2003-)
- Usage of telomerase in revitalization of cells and tissues in vitro and in vivo, Rubelj I- collaborative project, MZT, (2003-)
- Plant Hormones Physiology, Biochemistry and Application, Magnus V- collaborative project, MZT, (2003-)
- Biological response to damage, Osmak M collaborative project, MZT (2003-)
- Diazenes as potential anti-cancer drugs (2001-2003), Faculty of Chemistry and Chemical Technology, University of Ljubljana, (Osmak M. and Polanc S), bilateral collaboration
- Human adenovirus type 5 retargeted on aminopeptidase (2002-2004) NATO Science Programme, Collaborative linkage Grant Nationale Veterinaire d'Alfort, France, Ambriović-Ristov A. and Eloit M.
- 7. Functional characterization of the Xtc1 protein of Saccharomyces cerevisiae, SCOPES Grant, Swiss National Science Foundation, Sopta, M. (IRB), Schaffner, W. (University of Zuerich, Institute for Molecular Biology)
- Effect of fibronilytic treatment in experimental models of rheumatoid arthritis, SCOPES
 Grant, Swiss National Science Foundation,
 Brdar, B. (IRB), Busso, N. (Centre Hospitalier Universitaire Vaudois, Lausanne)
- Serotonin and immune functions: studies on rats after pharmacological and genetic manipulations of serotonin homeostasis, Jernej, B. (IRB); Schauenstein, K (Institute for General and Experimental pathology, Karl-Franzens University, Graz) bilateral project
- Studies on serotonin transporter gene structure and expression in schizophrenia, Jernej, B.; Wildenauer, D.B (School of Medicine, University of Bonn), bilateral project

- Genetic studies on synaptic elements in healthy population and psychiatric disorders, Jernej, B. (IRB), Bondy, B. (Neurochemistry Department, Psychiatric Hospital, University of Munich) bilateral project
- Molecular enzymology and enzyme engineering of hydrolases, Vujaklija, D. (IRB), Schwab, H. (Graz University of Technology, Institute of Biotechnology) bilateral project
- Comparative study of the distribution, structure and evolution of satellite DNA sequences in the genome of root-knot nematodes in relation with their mode of reproduction, Plohl, M. (IRB), Castagnone-Sereno, P. (INRA, Antibes, France) COGITO bilateral project
- Role of RecBCD enzyme in cell viability, Salaj-Šmic, E. (IRB), Lloyd, R.G. (University of Nottingham, Institute of Genetics): Academic Links and Interchange Scheme (ALIS), British Council and MZT, Republic of Croatia

SELECTED PUBLICATIONS

Ahel, I.; Korenčić, D.; Ibba, M.; Soll, D. Transediting of mischarged tRNAs. *Proc. Natl. Acad. Sci. U. S. A.*, **2003**, *100*, 15422-15427.

Ivančić-Baće, I.; Peharec, P.; Moslavac, S.; Škrobot N.; Salaj-Šmic E.; Brčić-Kostić K. RecFOR function is required for DNA repair and recombination in a RecA loading-deficient recB mutant of *Escherichia coli. Genetics*, **2003**, *163*, 485-494.

Hranilović D, Štefulj J, Furač I, Kubat M, Balija M, Jernej B. Serotonin transporter gene promoter (5-HTTLPR) and intron 2 (VNTR) polymorphisms in suicide victims of Croatian origin. *Biological Psychiatry*, **2003**, *54*, 884-889.

Ambriović-Ristov A, Mercier S, Eloit M: Shortening adenovirus type 5 fiber shaft decreases the efficiency of post binding steps in CAR-expressing and non-expressing cells. *Virology*, **2003**, *312*, 425-433.

Bruvo B., Pons J., Ugarković Đ., Juan C., Petitpierre E., Plohl M. Evolution of low-copy number and major satellite DNA sequences coexisting in two *Pimelia* species-groups (Coleoptera). *Gene*, **2003**, *312*, 85-94.

Viguera E, Petranović M, Zahradka D, Germain K, Ehrlich DS, Michel B. Lethality of bypass polymerases in Escherichia coli cells with a defective clamp loader complex of DNA polymerase III. *Mol. Microbiol.*, **2003**, *50*, 193-204.





Division of Molecular Medicine



http://www.irb.hr/str/zmm

DIVISIONAL ORGANISATION

Head: Krešimir Pavelić

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

- ➡ Laboratory of cellular and molecular immunology, Mariastefania Antica
- ⇒ Laboratory of molecular oncology, Jasminka Pavelić
- Laboratory of experimental hematology, immunology and oncology, Jelka Gabrilovac
- Laboratory of biological response modifiers, Tatjana Marotti
- ⇒ Laboratory of immunochemistry, Biserka Pokrić
- Laboratory of molecular endocrinology and transplantation, Mirko Hadžija

- Laboratory of functional genomics, Marijeta Kralj
- ⇒ Laboratory of molecular virology and bacteriology, Magdalena Grce

OVERVIEW OF THE DIVISION

The mission of the Division of Molecular Medicine is to expand and strengthen the knowledge of the nature of disease and to develop and improve new strategies for the diagnosis, treatment and prevention of disease. These goals are realized through the evaluation of the impact of genetic factors in disease prevention, the reduction of risk factors, the development and evaluation of new drugs, the exploration of the biochemical and cellular effects of drugs on cells and living organisms, the improvement of scientific methodology, and the education of scientists and students.

The Division is currently developing several strategic projects. These range from the development of gene therapy for use against cancer to new diagnostic and research tools based on transcriptomic and proteomic approaches, as well as tissue

engineering for the purpose of therapeutic cloning. As such, the Division is emerging as a preeminent centre (centre of excellence), for research in molecular approaches to the study of disease, in south-eastern Europe.

TOP ACHIEVEMENTS

Gene therapy of cancer

Our results have contributed to a better understanding of the roles of the *p53* and *p21*^{WAF1/CIP1} genes in the regulation of the cell cycle and apoptosis. Such understanding is naturally of great importance for their future application in gene therapy. We compared the relative antitumor activities of the *p53* and *p21*^{WAF1/CIP1} genes using adenovirus-mediated gene transfer. In addition, we studied their roles in the induction of apoptosis and evaluated the possibility of using them as therapeutic genes. (M. Kralj *et al. Cancer Gene Ther.*, **2003**, *10*, 457).

New strategy for human gastric cancer therapy

A new approach, based on the blockage of the IGF family of genes, has been proposed for human gastric cancer therapy. We

discovered that the growth of gastric carcinoma cells that produce IGF 2 is regulated by autocrine IGF-2-mediated stimulation of the IGF 1 receptor. The IGF 2/IGF 1R is more pronounced in the aggressive diffuse type of cancer than the intestinal type. The autocrine circuit can be completely interrupted by using antibodies that prevent interactions between IGF 2 and one of its receptors (IGF 1R) (K. Pavelić *et al.*, *J. Pathol.*, **2003**, *201*, 430).

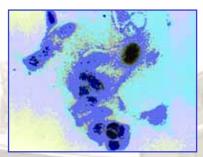
Mechanisms of antidepressant drugs

It has been shown that desipramine, an antidepressant drug that blocks the reuptake of noradrenaline, affects the rate of serotonin synthesis in the rat brain by an action that is similar to the effects of other antidepressants that selectively block the reuptake of serotonin. (N. Pivac *et al.*, *Neu*rochem Int., **2003**, 43, 611).

A powerful new technology

A powerful new technology has been implemented in the Division for global gene expression analysis (DNA microarray) for use in basic and applied research. In addition to being able to analyze a whole

genome in as little as one week, this methodology allows, after the biostatistical profiling of the relevant results, further study of specific gene clusters as well as the analysis of highly polymorphic markers. These latter two features are becoming extremely important areas of research, in their own right, in all fields of molecular medicine.



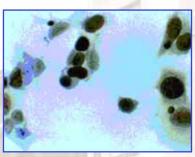


Figure 1. The expression of p53 protein in human tumor cells before (left) and after (right) the introduction of p53 gene, using adenoviral vectors.

The establishment of the Laboratory of Functional Genomics

The Laboratory of Functional Genomics was established and partially equipped in 2003. In addition to facilitating the implementation of functional genomics and proteomics methods, this laboratory is equipped to allow *in vitro* screening of potential antitumor compounds.



Figure 2. Laboratory of Functional Genomics

Megaproject Core

The establishment of "The center for integrative genomics, molecular diagnostics, and gene therapy", worth 6 000 000 HRK and led by Krešimir Pavelić and Dragan Primorac, has been recently approved.

Application to animal viruses

For the first time in Croatia, the restriction enzyme analysis of the reverse transcription/polymerase chain reaction products of viral genome segments was applied for the differentiation of field isolates of animal viruses. Infectious bursal disease virus is responsible for the outbreak of the disease resulting in a significant economical loss in chicken production during a 5-year period. The results were applied for the design of both immunoprophylactic schedules and appropriate vaccines (I. Lijkić *et al. Avian Dis.* **2003**, *47*, 59).

In vitro production of skin transplants

In vitro cultivation of human keratinocytes without feeder layer has been adopted and applied as an experimental model for the investigation of cell differentiation. The procedure for *in vitro* production of skin transplants for clinical application has been mastered.

New equipment

The Abi Prism 7000 Sequencing Detection system apparatus, for gene expression analysis (real time PCR) has been implemented for basic and applied research. The Varian Spectrophotofluorimeter Cary ECLIPSE (VARIAN) was purchased with the financial help of the Croatian Ministry of Science and Technology. This instrument is



Figure 3. The Abi Prism 310 Genetic Analyzer



Figure 4. Measurement of platelet serotonin concentration on Varian spectrophotofluorimeter

used for the measurement of fluorescence, phosphorescence and bio/chemoluminescence of various samples.

Education

Together with the Medical School at the University of Zagreb, the ZMM established a joint field of doctoral study in *Molecular Medicine*

(http://bio.mef.hr/docs/Publication.pdf) into which the Division submitted 21 new courses for the Ph.D. study program. In addition, The Division introduced the novel methodological course within the Ph.D. study program of Biomedicine and Health Sciences entitled Science management: research projects and business plans in biomedicine.

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- Molecular mechanisms in the pathogenesis of neuroendocrine tumors, Koraljka Gall-Trošelj
- 2. Molecular genetics of gastrointestinal tumors, Sanja Kapitanović
- 3. The SHH/PTCH/SMO signalling pathway in cancer and development, Sonja Levanat

- 4. Role of FHIT in neuroendocrine tumors, Šime Križanac
- 5. Insulin-like growth factor family of genes in lung cancer, Ljubomir Pavelić
- 6. New therapeutic possibilities in breast cancer, Josip Unušić
- 7. Genetic and molecular prognostic factors of cervical cancerogenesis, Magdalena Grce
- 8. Oxidative stress and malignant diseases, Neven Žarković
- Gene or protein transduction and signalling pathways in transformed cells, Krešimir Pavelić
- Cxclooxygenase-2: new target for chemoprevention and treatment of colon tumors, Radan Spaventi
- Molecular mechanisms of immunosuppression, Renata Novak
- 12. Modulation of immunological response by bioactive peptides, Biserka Pokrić
- Transcriptional control of lymphocyte development – its role in leukemogenesis, Mariastefania Antica
- 14. Tumor gene therapy correction of oncosuppressor genes, Jasminka Pavelić
- 15. Virus antitumorous action and oncolytic virus vaccine, Mislav Jurin
- 16. Embryonic cell production of pancreatic-like islets, Mirko Hadžija
- DNA chip technology in global profiling of tumors, Šime Spaventi
- 18. Nonlinear modulation of the chronic lymphatic leukemia, Branko Vitale
- 19. Regulation of ectopeptidases and opioid receptors expression, Jelka Gabrilovac
- 20. Oxidative/antioxidative status after treatment with opioids/opiates, Tatjana Marotti
- 21. Neuropharmacology of serotonergic system, Dorotea Mueck-Šeler
- Neurotransmitters in stress and regulation of GABA-A receptors in vitro, Danka Peričić
- 23. Assessing functions of the heat repeat in Huntingtin protein, Oliver Vugrek
- 24. The effects of new drugs and hyperthermia on the growth of mouse tumors and human xenografts, Marko Radačić
- 25. Specific immunotherapy and allergic diseases (Branimir Čvoriščec)
- 26. Epidemiology, diagnostics and therapy of H. pylori infection (Miroslava Katičić)

Research and development projects

- 1. Development of new analgetic, antirheumatic and antioxidative substances from pine resin, Neven Žarković (MZT, HITRA, TP-01/0098-28)
- Production of skin transplants in vitro, Milivoj Boranić (MZT, HITRA (TP-01/0098-03)
- snRNP U2 in lymphoid malignancies,
 Mariastefania Antica (International Office for Bilateral Cooperation Bonn, Germany)

Other projects

- Ecopropolis natural antioxidant, Tatjana Marotti (BICRO)
- Center for integrative genomics, molecular diagnostics, cellular and gene therapy, Krešimir Pavelić (Core)

SELECTED LECTURES

- Pavelic K: Opinion on EMBO Research Awards and about European Research Council. Member of Preparative Working party for EMBC/EMBO on the Selection of Strategic Working Party EMBC and Life Sciences in the European Research Council. The scientist's opinion. FEBS, EMBO and UNESCO. Paris 18-19 February 2003, Paris, France
- 2. Pavelic K: Nanotechnology and Molecular Medicine. The 3rd European-American School in Forensic Medicine and Mayo Clinic Course in Advanced Molecular and Cellular Medicine, 1-5 September 2003, Zagreb, Croatia
- 3. Žarković, N: Oxidative stress, lipid peroxidation and 4-hydroxynonenal in experimental neuropathology, Third International Symposium on Normal and Abnormal Development of the Human Fetal Brain, June 13-15, 2003, Zagreb, Croatia.
- Žarković N: Biomedical relevance of lipid peroxidation product 4-hydroxynonenal, 39th Congress of the Polish Biochemical Society, September 16-19, 2003, Gdansk, Poland.

CONFERENCES

- 2nd EMBO Sectoral Meeting on Molecular Medicine, 19. – 22. June, 2003. Cavtat, Croatia. Organizers: European Molecular Biology Organization and Ruđer Bošković Institute.
- 43rd International Neuropsychiatric Pula Symposium, 18-21.06. 2003, Pula, Croatia. Satellite Symposium: "Biological markers of psychiatric diseases". Organizers: Ruđer Bošković Institute and Croatian Pharmacological Society (D. Mueck-Šeler and N. Pivac).

SELECTED PUBLICATIONS

Review articles

Mueck-Šeler D. and Pivac N: Mirko Dikšić - Radiochemist and Neuroscientist. In: Herak J (ed) Distinguished Croatian Scientists in the World (Part II), Croatian-American Society, Zagreb, Croatia, 2003, pp 133-142.

Kralj M., Pavelic K., Medicine on a small scale: *EMBO Reports*, **2003**, *4*, 1008-1012.

Pavelić J., Zeljko Ž., Herak-Bosnar M., Molecular genetic aspects of prostate transition zone lesions. *Urology*, **2003**, *62*, 607-613.

Grdisa M., White M. K., Molecular and biochemical events during differentiation of HD3 chicken erythroblastic cell line, *Review. Int. J. Biochem. Cell. Biology*, **2003**, *35*, 422-431.

Žarković, N., 4-Hydroxynonenal as a bioactive marker of pathophysiological processes. *Mol. Asp. Med.*, **2003**, *24*, 281-91.

Vitale, B., Martinis, M., Antica, M., Kusic, B., Rabatic, S., Gagro, A., Kusec, R., Jaksic, B., Prolegomenon for chronic lymphocytic leukaemia [Review]. *Scand. J. Immuno.*, **2003** *58*, 588-600.

Additional publications

Pavelić K., Kolak T., Kapitanović S., Radošević S., Spaventi S., Krušlin B., Pavelić J.: Gastric cancer: the role of insulin-like growth factor 2 (IGF 2) and its receptors (IGF 1R and M6-P/IGF 2R). *J Pathol.*, **2003**, *201*, 430-438.

Kralj M., Husnjak K., Korbler T., Pavelić J.: Endogenous p21^{WAF1/CIP1} status predicts the response of human tumor cells to wild-type p53 and p21^{WAF1/CIP1} overexpression. *Cancer Gene Ther.*, **2003**, *10*, 457-467.

Pivac N., Mueck-Šeler D., Diksic M.: Effects of desipramine on regional serotonin synthesis rate in the rat brain: Acute and chronic autoradiographic studies *Neurochem Int.*, **2003**, *43*, 611-619.

Lijkić I., Biđin Z., Pokrić B.: Differentiation of infectious bursal disease viruses in Croatia. *Avian Dis.* **2003**, *47*, 59-65.

Peričić D., Swim stress inhibits 5-HT_{2A} receptor-mediated head twitch behaviour in mice. *Psychopharmacology*, **2003**, *167*, 373-379.

Erster S., Slade N., Moll U. M., Mutational analysis of p53 in human tumors: direct DNA sequencing and SSCP. *Methods Mol. Biol.*, **2003**, *234*, 219-30.

Dogan Koružnjak J., Grdiša M., Slade N., Zamola B., Pavelić K., Karminski-Zamola G., Novel derivatives of benzo[b]thieno[2,3-c]quinolones: synthesis, photochemical synthesis, and antitumor evaluation. *J Med. Chem.*, **2003**, *46*, 4516-24.

Šarić T., Muller D., Seitz H. J., Pavelić K., Non-covalent interaction of ubiquitin with insulindegrading enzyme. *Mol. Cell Endocrinol*, **2003**, *204*, 11-20.

Kowanetz K, Szymkiewicz I, Haglund K, Kowanetz M, Husnjak K, Taylor JD, Soubeyran P, Engstrom U, Ladbury J, Dikic I. Identification of a novel proline-arginine motif involved in CIN85-dependent clustering of Cbl and downregulation of EGF receptors. *J. Biol. Chem.* **2003**, *278*, 39735-39746.

Schroeter E.H., Ilagan M.X.G., Brunkan A.L., Hecimovic S., Li Y-M, Xu M., Lewos H.D., Saxena M.T., De Strooper B., Coonrod A., Tomita T., Iwatsubo T., Moore C.L., Shearman M., Goate A., Wolfe M.S., Kopan R., A presenilin dimmer at the core of the gamma-secretase enzyme: insights from parallel analysis of Notch 1 and APP proteolysis. *Proc. Nat. Acad. Sci. USA*, **2003**, *100*, 13075-13080.

Kušić, B., Dominis, M., Dzebro, S., Antica, M., Molecular insight into the diagnosis of lymphoma. *Int. J. Mol. Med.*, **2003**, *12*, 667-71.

Milošević, D., Batinić, D., Konjovoda, P., Blau., N., Štambuk, N., Nižić, Lj., Vrljičak, K., Batinić, D., Analysis of calcium, oxalate, and citrate interaction in idiopathic calcium urolithiasis in children. *J. Chem. Informat. Comp. Sci.*, **2003**, *43*, 1844-7.

Sabočanec, S., Balog, T., Šverko, V., Marotti, T., Sex-dependent antioxidant enzyme activity and lipid peroxidation in ageing mouse brain. *Free Radical Res.*, **2003**, *37*, 743-8.

Antica, M., Kusic, B., Hranilovic, D., Dietz, AB., Vuk-Pavlovic, S., Cloning the cDNA for murine U2 snRNP-A' gene and its differential expression in lymphocyte development. *Immunol. Let.*, **2003**, *82*, 217-223.

Division of Marine and Environmental Research



http://www.irb.hr/str/zimo

DIVISIONAL ORGANISATION

Head: until May 2003, Božena Ćosović, from May 2003, Tarzan Legović

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

- Group for satellite oceanography, Milivoj Kuzmić
- ➡ Group for modelling and information systems, *Ivica Ružić*
- ➡ Laboratory for aquatic physical chemistry, Božena Ćosović
- ➡ Laboratory for chemistry of trace metals, Goran Kniewald
- Laboratory for electrochemistry and surface chemistry, Marijan Vuković
- Laboratory for biogeochemistry of organic compounds, Marijan Ahel
- ⇒ Laboratory for biological effects of metals, Biserka Raspor
- Laboratory for molecular ecotoxicology, Sanja Krča

- Laboratory for aquaculture and fish pathology, Emin Teskeredžić
- ⇒ Laboratory for ecological modelling, Vera Žutić

OVERVIEW OF THE DIVISION

During 2003, researchers from the division worked on over 50 research projects contracted by the Ministry of Science and Technology, as well as outside clients. These projects spanned a wide range of topics in marine and environmental science, ranging all the way from satellite oceanography, on the large scale, down to nanotechnology, at the other extreme. Each project was designed to contribute to the overall mission of the division, which is to continue to strive for excellence in the fundamental and applied research of environmental systems, processes and states. In this way, ZIMO aims to make a significant contribution towards achieving the optimal management of the environment, for the benefit of our country and, indeed, the whole world.

TOP ACHIEVEMENTS

Electrochemistry Communications Award 2003

The Electrochemistry Communications Award 2003 for the best cited paper in the year 2000 was presented, during Electrochem 2003 in Southampton, to the authors of the publication: F. Scholz, Š. Komorsky-Lovric, M. Lovric "A new access to Gibbs energies of transfer of ions across liquid-liquid interfaces and a new method to study electrochemical processes at well-defined three-phase junctions", Electrochemistry Communications, 2000, 2, 112. The full-text of the awarded paper is freely accessible via the journal's homepage at http://www.elsevier.com./locate/elecom (see also, Electrochemistry Communications 2003, 5).

Development of the Croatian Fairway Information system

Further development of the Croatian Fairway Information system was achieved through the creation of a vectorized digital navigation map for the Croatian segment of the Danube river.

A new electrochemical method

A novel application of electrochemistry was used in the study of the surface active properties of organic matter in the Northern Adriatic Sea. This method enabled researchers, for the first time, to determine the relative acidity of organic matter in seawater and to distinguish between freshly

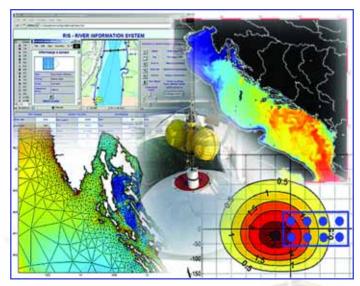


Figure 1. Above left: Software for Danube river navigation with real-time signalization of depth. Above right: Temperature as an indicator of currents from Ionean into the Adriatic sea. Below left: Filling the Adriatic map with variable-depth prisms to compute currents and dispersion from coastal sources. Center: Acoustic Doppler current profiler anchored in a way that interference from trawlers is negligible. Below right: Result of a 3-D model to estimate deposition of particles from an aquaculture.

produced biogenic organic matter and the more refractive humic substances.

Comprehensive analysis of surfactant concentrations

A comprehensive analytical approach for the trace determination of anionic and nonionic surfactants and their stable metabolic products using high-performance liquid chromatography (HPLC) and tandem mass spectrometry (MS/MS) has been developed. The methods were applied to investigate the biogeochemical behaviour of the target compounds in the highly stratified Krka estuary and indicated a significant decrease of the concentration of non-ionic surfactants, of the alkylphenol polyethoxylate type, during the last decade.

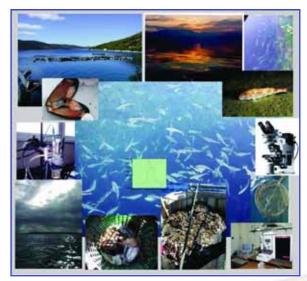


Figure 2. Effects of heavy metals on organisms

Bacteria for waste disposal

Two bacterial communities expressing Polychlorinated Biphenyl (PCB) transformation activity have been found in laboratory enrichment experiments from PCB polluted soils. In addition, substantial atrazine mineralization activities of four bacterial communities were found in enriched polluted soil and wastewater.

LABORATORY FOR PHYSICO-CHEMICAL SEPARATIONS

Figure 3. Marine lake: Investigation of its unique properties

Evidence for drug resistance in mullets

The expression of multidrug resistanceassociated proteins (MRPs) related to mRNA in the liver tissue isolated from teleost red mullet (Mullus barbatus) has been found. This novel partial cDNA sequence of red mullet represents the first MRP-related sequence reported for an aquatic teleost fish species.

Uncovering the origins of historical artefacts

An investigation of the mineralogical and chemical characteristics of the Lamboglia 2 amphorae, excavated from different underwater localities in the central Adriatic Sea was carried out. This study was used to resolve the origin of the raw materials, and consequently, to indicate the probable location of historical production facilities.

The mesocosm experiment

In the context of a bilateral cooperation with National Science Foundation (USA), ZIMO and CIM-Rovinj performed interactive and simultaneous data collection and exchange for the mesocosm experiment (http://nereus.irb.hr/lem/theexperiment, S. Geček, web-master, V. Svetličić, scientific coordinator)

Sustainable management of the Adriatic Sea

The Extension of the Croatian jurisdiction in the Adriatic Sea was approved by the Croatian Parliament on October 3, 2003. This decision, in agreement with the UN Convention on the Law of the Sea, was



Figure 4. Monitoring fish health and assessment of environmental effects

based on the proof of overfishing and the need for sustainable management presented to the Ministry of Foreign Affairs (Legović T. *Croat. Int. Rel. Rev.*, **2003**, *9*, 35).

INVITED LECTURES

- Horvat-Radošević V., Electrochemical impedance spectroscopy of some noble metal electrodes, 2003 Sofia Impedance Days, Central Laboratory of Electrochemical Power Sources, Bulgarian Academy of Sciences, Sofia, Bulgaria, 2003.
- Komorsky-Lovrić Š. Voltammetric determination of microparticles of cocaine and some local anaesthetics immobilized on the graphite electrode. 36th Heyrovsky Discussion: Electrochemistry of biological systems and their models, Trešt, Check Republic, 15. 19. June 2003.
- Legović T., Graduate Environmental Management Study. 3rd National Conference on Science, Policy and the Environment: Education for Sustainable and Secure Future. Council of Environmental Deans and Directors, Washington, USA, 1. Feb. 2003
- Legović T. Revisiting the Redfield ratio and modelling the effects of a fish culture on a marine environment, Workshop on Integrated Coastal Zone Management. Aquaplan Niva, Tromso, 2. April 2003.
- Omanović D., Pižeta I and Branica M., Pseudopolarography as a tool for characterization of natural organic matter – metal

- ions interactions, Séminaire de lancement du Groupement de Recherche « Monalisa » : 9 -10 Oct. 2003, Université de Toulon et du Var. La Garde, France
- Svetličić V., From microparticles to giant gels of northern Adriatic, 13th Balkan Biochemical Biophysical Days, Kusadasi, Turkey, 11-13. October, 2003.

ORGANIZED CONFERENCES

- 1. 8th Meeting of the Laboratories accredited for water analysis, Rovinj, March 11-14, 2003 Oceanographic Workshop (B. Raspor)
- Workshop on the Content of the Strategic Environmental Impact Assessment - Družba Adria, Ministry of Environmental Protection and Physical Planning, Zagreb, 28.04.2003 (T. Legović)
- Rovinj 2003 Experiment, Northern Adriatic Mesocosm, International Workshop, Rudjer Bošković Institute, Rovinj, 11-13 August, 2003 (Vera Žutić)
- Aquaculture, Coastal Management and Environmental Impact, Croatian - Norwegian, Workshop, Vodice, October 1 - 5, Croatia (B. Ćosović)
- Rovinj Oceanographic Workshop, Office of Naval Research International Field Office, Rovinj, 7-9 October 2003 (M. Kuzmić, H. Perkins, R. Signell)
- Biogeochemical Processes in Anoxic Marine Environments, Croatian-British Workshop, Zagreb, January, 17- 20. 2004 (I. Ciglenečki - Jušić)

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- Tidal and longer-period dynamics of the northern Adriatic, Milivoj Kuzmić
- 2. Analysis and biogeochemistry of organic compounds in the aquatic environment, Marijan Ahel
- Physical chemistry and biogeochemistry of trace metals in aquatic systems, Marko Branica

- Nature and reactivity of organic substances in marine and environment, Božena Ćosović
- 5. Electroanalytical research in liquid and solid electrolytes, Milivoj Lovrić
- 6. Models and info. systems for environmental protection and navigation management, lvica Ružić
- 7. Protection of biocoenotic balance in aquaculture receiving waters, Emin Teskeredžić
- 8. Preparation and properties of metal surfaces in the environmental protection,
 Marijan Vuković
- 9. Interfacial processes and eutrophication, Vera Žutić
- Radionuclides in environmental systems, Delko Barišić
- 11. Metals and cellular biomarkers, Biserka Raspor
- Persistent organohalogen pollutants in some coastal area of Dalmatia, Mladen Picer
- Geochemistry of recent and ancient sedimentary systems of the Adriatic platform, Goran Kniewald
- 14. Modelling aquatic ecosystems, Tarzan Legović
- 15. Microbial communities as catalysts in biotransformation processes, Dubravka Hršak
- Multixenobiotic resistance mechanism as a biomarker of environmental quality, Tvrtko Smital

Selected research and development projects

- Treatment of wastewaters using membrane techniques (HITRA), Ivan Mijatović and Marijan Ahel
- 2. Conceptual model for biological treatment of effluents from atrazine production (HITRA), Dubravka Hršak
- Development of new type of electrochemical sensor and measurement system for reactive microparticles (HITRA), Vera Žutić
- 4. Nano-systems and nano-tecnology (The role of enzymes in the formation of inorganic colloids), Croatia-Slovenia Collaboration Project (Ivan Sondi)
- 5. Reduction of environmental risks, posed by Emerging Contaminants, through advanced

- treatment of municipal and industrial wastes, EMCO (EU-FP6) (M. Ahel)
- Sava River Basin: Sustainable Use, management and Protection of Resources. EU FP6-2002-INCO-WBC-1. (B. Raspor, Coordinator of WP3)
- Environmental sono-electroanalysis: manganese speciation and determination, The Royal Society, 2003-2005. (Š. Komorsky-Lovrić and R. Compton, Oxford University).
- 8. Monitoring of Dunav water quality, Croatian Water Management, 2003 (S. Lulić)
- 9. Radiological monitoring around Krško, Nuclear Power Plant Krško, Slovenija (S. Lulić)
- Assessment of selected POPS in the atmosphere and water ecosystems from waste materials generated by warfare in the area of former Yugoslavia (APOPSBAL) (M. Picer)
- MONALISA, The role of natural organic matter in speciation of bioavailable contaminants in coastal waters, French-Croatian Cooperation, (G. Kniewald)
- Mechanism of mucilage formation in the Northern Adriatic Sea, Bilateral Cooperation project with NSF, USA, Scripps Institution of Oceanography, UCSD (V. Žutić),
- Ecosystem Approach for Sustainable Aquaculture, ECASA, EU-FP6-2003 (T. Legović)
- Croatian national monitoring programme (M. Ahel, B. Ćosović, M. Kuzmić, D. Hršak, M. Picer, B. Pivčević, B. Raspor, E. Teskeredžić, V. Žutić)

OTHER ACHIEVEMENTS

- 1. Reference laboratory (B. Ćosović, Z. Kozarac, D. Hršak, B. Raspor)
- An integrated environmental monitoring system for Croatian freshwater, estuarine and coastal marine areas. Croatian-Norwegian International project (Coordinators: Hylland, Ketil, B. Raspor, S. Britvić, B. Hackenberger, G. Klobučar)
- Digital navigational charts for the river Dunav. Ministry of Seafare and Traffic. Cooperation with the European program COMPRIS and Regional Project D4D (I. Ružić)

- Development of control system with navigational signs at the river Dunav. In cooperation with KOMTEH, Zagreb and Ministry of Seafare, Traffic and Connections (I. Ružić)
- Arrival of AFM equipment to the department. It is expected that the equipment, so far the first in Croatia, will be applied in research activities ranging from life- to material science. (V. Svetličić, V. Žutić).

SELECTED PUBLICATIONS

Legović T. (Editor), ISEM The third European Ecological Modelling Conference, *Ecological Modelling Journal*, **2003**, *170*, 170-490.

Svetličić V, Hozić A. (Editors.) Rovinj 2003 Experiment, Northern Adriatic Mesocosm: Experimental Data. Rudjer Boskovic Institute, Zagreb, **2003**, ISBN 953-6690-46-2.

Bermanec V., Furić K., Rajić M., Kniewald G., Thermal stability and vibrational spectra of the sheet borate tuzlaite, $NaCa(B_5O_8(OH)_2)x3H_2O$. *American mineralogist.* **2003**, *88*, 271-276.

Ciglenečki I., Plavšić M., Vojvodić V., Ćosović B., Pepi M., Baldi F. Mucopolysaccharide transformation by sulfide in diatom culture and natural mucilage. *Marine Ecology Progress Series*. **2003**, *263*, 17-27.

Frančišković-Bilinski S., Bilinski H., Vdović N., Balagurunathan Y., Dougherty E. R. Application of Image-based Granulometry to Siliceous and Calcareous Estuarine and Marine Sediments. *Estuarine Coastal and Shelf Science*. **2003**, *58*, 227-239.

Komorsky-Lovrić Š., Vukašinović N., Penovski R. Voltammetric determination of micro particles of some local anaesthetics and antithusics immobilised on the graphite electrode. *Electroanalysis*. **2003**, *15*, 544-547.

Lovrić M., Scholz F. Modelling cyclic voltammograms of simultaneous electron and ion transfer reactions at a conic film three-phase electrode. *Journal of Electroanalytical Chemistry.* **2003**, *540*, 89-96.

Malej, A., Mozetič, P., Turk, V., Terzić, S., Ahel, M., Cauwet, G. Changes in particulate and dissolved organic matter in nutrient-enriched enclosures from an area influenced by mucilage: the northern Adriatic Sea. *Journal of Plankton Research.* **2003**, *25*, 949-966.

Mlakar, M. Determination of trace ytterbium by cathodic stripping voltammetry. *Electroanalysis*. **2003**, *15*, 27-35.

Omanović D., Branica M. Pseudopolarography of trace metals. Part 1. The automatic ASV measurements of reversible electrode reactions. *Journal of Electroanalytical Chemistry*. **2003**, *543*, 83-92.

Pižeta I., Billon G., Fischer J-C., Wartel M. Solid microelectrodes for in situ voltammetric measurements. *Electroanalysis*. **2003**, 15, 1389-1396.

Plavšić M. Electroanalytical techniques applied for studying the interaction of organic matter and particles with metal ions in natural waters. *Analytical Letters*. **2003**, *36*, 143-157.

Smital T., Sauerborn R. and Hackenberger K.B. Inducibility of the multixenobiotic resistance mechanism (MXR) transport activity in the marine mussel *Mytilus galloprovincialis* and the freshwater mussel Dreissena polymorpha. *Aquatic Toxicol.* **2003**, *65*, 443-465.

Sondi I., Goia V.Dan, Matijević E. Preparation of Highly Concentrated Stable Dispersions of Uniform Silver Nanoparticles. *Journal of Colloid and Interface Science*. **2003**, 260, 75-81.

Tomec M., Teskeredžić Z., Teskeredžić E. Food and nutritive value of gut contents of rudd (*Scardinius erythrophtalmus L.*) from Lake Vrana, Cres Island, Croatia. *Czech Journal of Animal Science*. **2003**, *48*, 28-34.

Zelić M., Lovrić M. The influence of electrolyte concentration on the parameters of the Frumkin isotherm in the Cd²⁺ - I⁻ system. *Journal of Electroanalytical Chemistry.* **2003**, *541*, 67-76.

Center for Marine Research



http://www.irb.hr/str/cim

DEPARTMENT ORGANISATION

Head: Nenad Smodlaka

The Center for Marine Research (CIM) consists of the following laboratories:

- ⇒ Laboratory for ecology and systematics, Ana Travizi
- ➡ Laboratory for processes in the marine ecosystem, Danilo Degobbis
- Laboratory for ecophysiology and toxicology, Čedomil Lucu
- Laboratory for marine molecular toxicology, Renato Batel

OVERVIEW OF THE CENTER

Project Jadran

The Ruđer Bošković Institute (RBI), and in particular the Center for Marine Research (CIM), is responsible for coordinating the national monitoring and research aspects of the project "Jadran". In 2003 CIM enhanced the level of cooperation among various interest groups and continued to contribute to the fulfilment of Croatia's international obliga-

tions concerning environmental protection. This project potentially represents an important basis for the regional initiative, recommended by the Croatian-Italian-Slovenian trilateral commission for the protection of the Adriatic, of establishing a permanent observing system (Coordinated Adriatic Observing System - CAOS), suitable for future marine research in the Adriatic. The international projects ADRICOSM (2002-2004) and MAT (1999-2003) are closely linked with the project "Jadran".

Maritime Forecasting system

The project "ADRICOSM," an international collaboration between Italy, Croatia and Slovenia, has put in place, for the first time, a near real-time maritime forecasting system for the Adriatic Sea. The basis for this modelling and predictive forecast system has, as one of its sources, a recent high resolution oceanographic study of the north-eastern Adriatic conducted by RBI-CIM in the west Istrian coastal region (Figure 1: Circulation pattern). Previously unknown details of circulation patterns have been revealed and the subsequent establishment of a link to meteorological conditions is expected to provide a basis for a future rapid marine forecast and management system.

Mucilage events

In the framework of the project "MAT" (Mucilage phenomenon in the Adriatic and Tyrrhenian seas), numerous Italian and three Croatian research groups studied (field and laboratory work) the processes, mechanism and consequences of the mucilage events. CIM coordinated the Croatian research units and participated in the coordination activities of the entire project. A major part of the results obtained will be

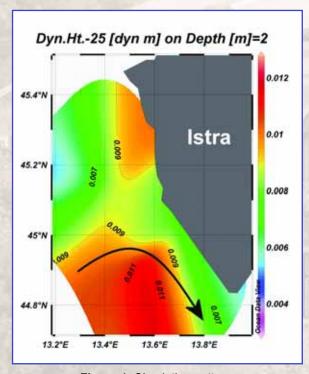


Figure 1. Circulation pattern

published in a special issue of The Science of Total Environment. The occurrence of a mucilage event in the northern Adriatic during summer 2003 (Figure 2 - mucilaginous cloud, 14 July, 20 km off the Po River delta) was monitored in real time, comparison with laboratory data was made as well studies of the consequences of the event on the ecosystem.



Figure 2. Mucilaginous cloud, 14 July, 20 km off the Po River delta

TOP ACHIEVEMENTS

Invasive seaweed effects

Caulerpa taxifolia is known to out-compete native seaweeds and seagrasses, displace invertebrate communities, and seriously reduce species abundance and diversity of benthic habitats. Formation and development of a specific epibionthic community whose appearance and existence are closely linked to the establishment and maintenance of *C. taxifolia* settlement, has been described.

New nematoda species

Free-living Nematoda species, new to science, were discovered in the northern Adriatic Sea at depths of 4-47 m and in various sediment types. In particular, two new species of the genus *Metacyatholaimus* were described as can be seen in the accompanying key.



Figure 3. Metacyathlaimus papillatus sp.nov. Male, total view

Fast genotoxicity biomonitoring

Studies of the Fast Micromethod® and its applicability for the measurement of the DNA integrity of small samples for genotoxicity assessment (biomonitoring), the effects of genotoxins on lower marine taxa or sessile invertebrates in the marine environment (e.g. sponges, mussels), and the estimation of directional changes and harmful effects in



Figure 4. Metacyatholaimus adriaticus sp. nov, Male, total view

the ecosystem, has been assessed. Investigations using flow cytometry have shown it to be a powerful technique for the determination of alterations in cell cycle characteristics in mussel hemocyte DNA (Figure 5).

Proapoptotic stress response

Studies of KRS_SD induction, its phosphorylation and proteolytical cleavage during TBT stress suggest that in sponge cells there exists a mechanism similar to that present in human cells where KRS/MST protein kinase is involved in promotion of apoptosis following oxidative stress (Figure 6).

Lobster osmoregulatory capacity

The osmoregulatory capacity of the commercially important northern Adriatic lobster Homarus gammarus was investigated. Under extreme conditions, the natural lobster population living in the northern Adriatic coastal areas can be exposed to low saline waters for short periods. For the first time under laboratory conditions, the enzyme carbonic anhydrase was found to be activated in the tissues responsible for respiration and osmoregulation, following the adaptation of lobsters to dilute seawater concentrations.

INVITED LECTURES

Čedomil Lucu: Physiological adaptive mechanisms of organisms in marine and brackish water environment. Na,K-ATPase and carbonic anhydrase. Universite degli Studi di Firenze, Dipartimento di Chimica, Consorzio per lo Svillupo dei Sistemi a Grandi Interfasi. Florence, 28 February 2003.

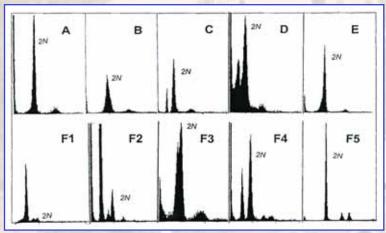


Figure 5. M. galloprovincialis DNA profiles of mussel hemocytes encountered in flow cytometric analysis: (A) normal DNA profile, normal sample 2 N peak used in statistical comparison of CV values lower then 8 %, (B) DNA profiles with CV values greater then 8 % (C) DNA profiles with aneuploid peak before 2 N peak, (D) apoptotic DNA profile, (E) asymmetric 2 N peak. F1-F5: other altered DNA profiles occurred in hemocytes of mussel natural populations.

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- Systematic research of the Adriatic Sea as a base for sustainable development of the Republic of Croatia, project "Jadran" Croatian national monitoring programme, Director Nenad Smodlaka.
- 2. Mechanism of long-term changes in the Adriatic Sea ecosystem, Danilo Degobbis
- 3. Programmed biosynthesis and genotoxic risk assessments, Renato Batel
- 4. Physiological and biochemical indicators of toxicological stress in marine biota, Bartolo Ozretić

 Ecophysiological studies and stress response in marine organisms, Čedomil Lucu

Other projects

- Mineral composition and stabile isotopes in shellfish shells as pollution indicators, Davorin Medaković (bilateral collaboration with Slovenia)
- Regional collaboration in environmental monitoring and forecasting in the northern Adriatic Sea, Nenad Smodlaka (quadrilateral collaboration with U.S.A., Italy and Slovenia)
- Adriatic Sea integrated coastal areas and river basin management system pilot proj-

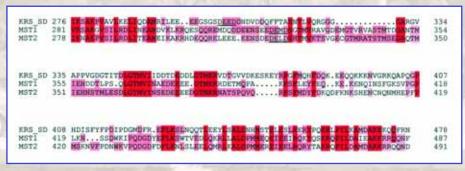


Figure 6. Alignment of C-terminal regions of sponge and human MST homologues (MST-1/KRS-2, accession number Q13043, MST-2/KRS-1, accession number Q13188). Caspase-3 recognition sites are underlined.

- ect (ADRICOSM), Nenad Smodlaka (quadrilateral collaboration with Italy, France and Slovenia)
- Progetto di monitoraggio e studio delle mucillagini nell'Adriatico e nel Tirreno (MAT), Danilo Degobbis (bilateral collaboration with Italy)
- Molekulare Biotechnologie und Wirkstoffe mariner Schwaemme sowie Schwammassoziierter Mikroorganismen (Biotec-Marin), Project: Schwaemme aus Rovinj (Kroatien) – Extractbereitstellung und Marikultur, Renato Batel (bilateral collaboration with Germany)
- 6. Biosensor methods for the assessment of the effects pollution, Renato Batel (bilateral collaboration with Germany)
- Mechanism of mucilage formation in the northern Adriatic Sea: A component of CREICO (Cooperative research on ecological interactions in the coastal ocean, NSF), Vera Žutić (quadrilateral collaboration with U.S.A., Italy and Slovenia)

SELECTED PUBLICATIONS

Bihari, N., Mičić, M., Batel, R., Zahn, R.K. Flow cytometric detection of DNA cell cycle alterations in hemocytes of mussels (*Mytilus galloprovincialis*) off the Adriatic coast, *Croatia. Aquat. Toxicol.* **2003**, *64*, 121-129.

Fafanđel, M., Müller, W.E.G., Batel, R. Molecular response to TBT stress in marine sponge *Suberites domuncula*: proteolytical cleavage and phosphorylation of KRS_SD protein kinase. *J. Exper. Mar. Biol. Ecol.* **2003**, 297, 239-252.

Jakšić, Ž., Batel, R DNA integrity determination in marine invertebrates by Fast Micromethod®. *Aquat. Toxicol.* **2003**, *65*, 361-376.

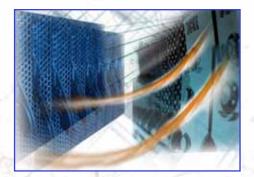
Lucu, Č., Towle, D. Na,K-ATPase in gills of aquatic crustacea. *Comp. Biochem. Physiol.*, **2003**, *135*, 195-214.

Lučić, D., Njire, J., Morović, M., Precali, R., Fuks, D., Bolotin, J. 2003. Microzooplankton in the open waters of the northern Adriatic Sea from 1990 to 1993: the importance of copepod nauplii densities. *Helgol. Mar. Res.*, **2003**, *57*, 73-81.

Pavičić-Hamer, D., Devescovi, M., Lucu, Č. Activation of carbonic anhydrase in tissues of the lobster *Homarus gammarus* by dilute seawater exposure. *J. Exp. Mar. Biol. Ecol.*, **2003**, 287, 79-92.



Center for Informatics and Computing



http://www.irb.hr/cir

ORGANISATION OF THE CENTER

Head: Karolj Skala

The Center for Informatics and Computing (CIR) consists of the following sections:

- ➡ The optoelectronics and hypermedia laboratory, Karolj Skala
- Information and Computer Technology research and development, Zorislav Šojat
- ⇒ Information systems, Neven Kmetić
- Service and maintenance, Ratko Mileta

OVERVIEW OF THE DEPARTMENT

In 2003, CIR focused on applied scientific and technological research as well as Information and Computer Technology (ICT) advancement. The center was heavily involved in software implementation and development as well as the advancement of computer usage in scientific work (e-Science technology). Further development was carried out in the areas of detection theory, modern network technology and

distributed computing, cluster computing, and GRID systems.

The CIR played an important role in the development and maintenance of the Institute's computational infrastructure. In particular, services such as server park for information services, numerical cluster computation, printing, plotting, e-mail and internet access were provided. The Institute's local area network and associated equipment, which connects computers throughout the whole Institute, was also under the auspices of CIR, Figure 2.

TOP ACHIEVEMENTS

Development of new technologies and equipment

New design, implementation and testing of the new hybrid fiber optical cable for monomodal and multimodal optical signal transmissions which is now in production in ELKA d.d.

Research and development of the free space laser communication equipment for metropolian area networks was undertaken and the successes presented (E. Wendling, K. Skala, 26th International MIPRO Convention), Figure 3.

SIR

Infrastructure improvements

CIR planned and implemented the campus gigabit Ethernet optical and wireless computer network. The existing distributed



Figure 1. Young CIR staff, mean age 32

computing infrastructure was also improved and the enhancements in cluster computing were constantly provided.

New software

CIR designed the software for the Web Content Management Systems as well as for pilot wireless LAN applications, both on land and at sea (K. Skala et al., Retrospective of distributed media server technology, Intelligent Media Communications, Kluwer Ltd. 2003, 317. D. Kolarić et al., Proceedings ELMAR, 2003, 345).

Project initiatives

CIR started the CRO GRID national project initiative and completed the negotiations for the European project SEE-GRID as part

of the Sixth Framework Program. The goal of this project is to combine with other European countries, in the context of pan-European and worldwide Grid initiatives, in order to establish e-Science technologies.

CONFERENCES AND SPORTING EVENTS

CIR organized the annual conference *Hypermedia and Grid Systems* within the International Convention MIPRO in Opatija. The traditional yearly gathering of scientist sailors from the University and Institutes at the *University sailing regatta* was also staged by CIR in Zadar, Adriatic coast.

PROJECTS

Supported by Ministry of Science and Technology (MZT) and European Union (EU) Coordinator of the projects: Karolj Skala

Scientific project in Applied Science

1. Stohastic Source Detection and distributed information processing (2002-2005).

Technological projects

- 1. Free space laser optical communications,
- 2. CRO GRID Infrastructure,
- 3. CRO GRID Applications, STRIP,
- 4. Campus Local Area computer network project and realization.

Information technology project

Remote monitoring and control of Cluster computers.

International projects

- COST-276 "Information and Knowledge Management for Integrated Media Communication".
- Joint project with the Institute for Software Science from the University of Vienna, Austria: "Development of New Grid Technologies for Advanced Scientific and Engineering Application".

- 3. Grid Enabled Infrastructure Development, SEE GRID, EU F6, con. no. 002356
- Joint project with the Faculty of Education, University of Maribor, Maribor, Slovenia: "Visual Interface Development using Multimedia technologies and Intelligent Agents".

COLLABORATION WITH OTHER INSTITUTIONS

- Institute for Software Science of the University of Vienna, Austria
- Long-term contract for collaboration in the field of GRID technology, Ericsson - Nikola Tesla, Zagreb
- Collaboration agreement for the transfer of GRID computing technology, HEP, Zagreb
- 4. Collaboration contract for fiber-optic network development, ELKA, Zagreb
- 5. Memorandum of joint ICT development, SRCE, Zagreb



Figure 2. Local area network active equipment



Figure 3. Free space optical communication link developed in CIR in cooperation with LAIR (project HITRA)

SELECTED PUBLICATIONS

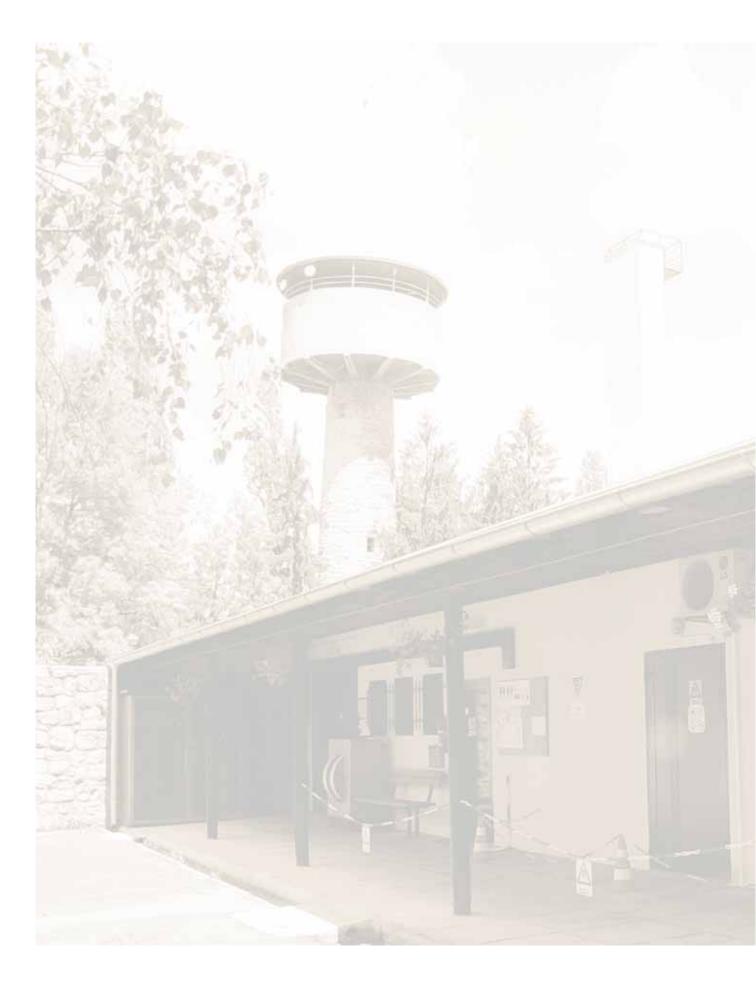
Skala, K., Zelenika, H., Nikolić, I. *Retrospective* of distributed media server technology, Intelligent Media Communications, editor Mohamed Najim, Kluwer Ltd., London, **2003**, 317-330.

Wendling, E., Skala, K. Free Space Optical Link Towards Remote Cluster, 26th International Convention MIPRO, Hypermedia and Grid Systems Conference Proceedings HGS, **2003**, 173-177.

Kolarić, D., Dubravić, A., Skala, K. Determination of the Space characteristics of the Flame in Video Signal, Proceedings ELMAR 2003, **2003**, 345-349.

Žiha, K., Stanković, T., Pavković, N., Skala, K. *Handling Engineering Design Experience*, Proceedings of 25th Int. conf. Information Technology Interfaces, ITI, **2003**, 287-291.

Skala, K. *Optoelektronički sustavi*, University text book, ISBN 953-6564-07-6, **2003**.



Center for Nuclear Magnetic Resonance



http://www.irb.hr/nmr

Head of center: Dražen Vikić-Topić

OVERVIEW OF THE CENTER

The International Opening of the NMR center, the first and only academic NMR facility in Croatia, took place in October 2003. Since this time, extensive services have been provided for scientists and researchers from the Ruđer Bošković Institute, from the Universities of Zagreb, Rijeka, Split and Osijek, as well as governmental and industrial institutions. Research work at the NMR center includes bioorganic and pharmaceutical chemistry as well as theoretical calculations of structure and spectral parameters. Investigations of small peptides, gels and isotope effects are also in progress. The center was also involved in undergraduate and graduate studies of the Universities of Zagreb and Osijek. The center's equipment includes 300 and 600 MHz NMR spectrometers manufactured by Bruker Avance.

TOP ACHIEVEMENTS

Small active peptide fragments

Investigations of small peptide fragments which are able to mimic, and even

supercede, the activity of the whole peptide from which they are derived, were undertaken in the center in 2003. A detailed understanding of this phenomenon requires the determination of subtle sense-antisense interactions between short peptide fragments with five to thirteen amino acids. Furthermore, it is neccesary to perform such analysis both in solution, via NMR spectroscopy, and in the gas phase, via mass spectrometry (N. Štambuk *et al.*, to be published).

PROJECTS

Cooordinator of the projects: Dražen Vikić-Topić

Domestic and international projects

- Nuclear Magnetic Resonance and Calculations of Bioorganic Molecules
- 2. Multi-Dimensional NMR Spectroscopy of Biomolecules, Austrian-Croatian project

Technological projects

 Plant Terpenes and Lignin as Natural Substrates for Biosythesis of Anticancer and Industrial Intermediates, EUREKA project.

Information technology projects

 Web Server with Individual Approach to Data Base and Separated Local Network with Applications for Providing Services to NMR

Contract with industry

 Collaboration Contract with BELUPO d. d. Pharmaceutical Industry, 2003-2004

International collaborations

- Institute of Chemistry, Johannes Kepler University, Linz, Austria
- 2. National Institute of Chemistry, Hajdrihova 19, Ljubljana, Slovenia
- 3. Faculty of Science, Masaryk University, Brno, The Czech Republic
- Mayo Clinic and Foundation, Rochester, MN, USA

ORGANIZATION OF INTERNATIONAL CONFERENCES AND COURSES

- Opening of the NMR Center and FT EPR Facility at Ruder Bošković Institute and The Second International DU NMR Conference, Zagreb, October 20-22, 2003
- 2. The 2nd Central European Chemical Meeting, Varaždin, June 19-21, 2003
- Summer School on Biomolecular Structure and Dynamics - Advances in NMR and Computational Methods, Otočec, Slovenia, June 22-29, 2003
- 4. The 18th Dubrovnik International Course & Conference on the Interfaces among Mathematics, Chemistry and Computer Sciences, Dubrovnik (IUC), July 23-28, 2003
- The Fourth International Dubrovnik NMR Course and Conference, DU NMR 2003, Dubrovnik (IUC), June 28-July 1, 2003



Figure 1. The NMR operators room with a view on 300 MHz NMR magnet

SELECTED PUBLICATIONS

Ž. Marinić, M. Ćurić, D. Vikić-Topić and Lj. Tušek-Božić: Assignment of ¹H and ¹³C NMR Data for Diethyl 2- and 8-Quinolylmethylphosphonates and their Palladium(II) Dihalide Complexes. *Magn. Reson. Chem.* **2003**, *41*, 969-973.

A. Višnjevac, B. Kojić-Prodić, M. Vinković, K. Mlinarić-Majerski: Dispiro [Adamantane 2,2-1,3,6,9,11,14-Hexathiacyclohexadecane-10,2-Aadamantane]. *Acta Cryst.* C., **2003**, *59*, 314-316.



Figure 2. The staff of NMR center with a 600 MHz NMR magnet

Library



http://library.irb.hr

Head of Library: Jadranka Stojanovski

OVERVIEW OF LIBRARY ACTIVITIES

As the largest scientific library in the field of natural sciences in Croatia, the holdings of the Institute's library cover the fields of physics, mathematics, electrical engineering, chemistry, biology, medicine, environmental, and marine sciences.

The Library's book collection amounts to some 33000 volumes, 500 of which were newly acquired in 2003. The total number of available journal volumes is nearly 40000. As electronic access to information and journal articles increased significantly in 2003, the journal acquisition model was rather complex. It consisted of:

- 96 printed and electronic journals funded by the RBI
- 251 printed journals funded by Ministry of Science and Technology (MZT)
- 7530 electronic journals funded by MZT via consortia agreements with major scientific publishers
- 6715 electronic journals provided through cooperation with University Library of Regensburg and their collaborative project Elektronische Zeitschriftenbibliothek EZB.

The access to the relevant bibliographic and full-text databases was provided through the center for online databases (http://baze.irb.hr), maintained by the RBI Library for the academic and research community in Croatia. Databases such as Current Contents, Medline, Inspec, PsycInfo, El Village, Web of Science (WoS) and others are accessible on a regular basis.

The RBI Library has a well established interlibrary loan service with Croatian and foreign libraries. Last year it fulfilled approximately 700 requests for documents made by RBI members, and over 1200 requests from other libraries. To help our users, and other libraries, to obtain printed and electronic documents faster and more easily, we developed a system (SEND) for managing loans through a web interface.

In addition, the library's extremely popular web portal, with more than 2500 web pages, received over 1400 visits per day and was regularly maintained throughout the year.



Figure 1. CROSBI Interface

TOP ACHIEVEMENTS

Croatian Scientific Bibliography (CROSBI)

The new version of CROSBI (http://bib.irb.hr), which collects and publicly releases data about scientific papers resulting from research projects financed by the MZT, was released in 2003. CROSBI has now evolved into a comprehensive bibliography and collection, with over 100000 records covering all scientific publications in Croatia.

The EJOL project

EJOL (http://ejol.irb.hr) is the newest product of the RBI Library. The main goal of this project is to provide access to electronic journals through a single interface. Upon its creation, the database enabled access to the full text of more than 7000 journals, and is currently enjoying a rapid expansion.

The SEND project

SEND (http://send.irb.hr) is the electronic document ordering system for interlibrary

loans. Fully developed inside the library, the system was designed to facilitate document ordering by users, to improve the management and processing of requests, and to provide comprehensive statistical reports.

SELECTED LECTURES

- 1 Konjević, S. Croatian Scholarly Journals on the Web // EURASLIC 10 "Smooth Sailing: Crossing the Boundaries in Aquatic Sciences Information Management". Kiel, Germany, 7-9 May 2003
- Melinščak Zlodi, I.; Melinščak M. OAl@AKM // Archives, Libraries, Museums 2003. Rovinj, Croatia, 24-26 November 2003



Figure 2. EJOL Homepage

- Pažur, I. Electronic Journals Catch them if you Can // Croatian Academic and Special Libraries Conference "Don't shoot the librarian - how others see us" Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia, 8-9 November 2003
- Stojanovski, J. Croatian Academic and Special Library Web Sites: an Analysis of Content // Libraries in the Digital Age LIDA 2003. Dubrovnik, Mljet, Croatia, 26-30 May 2003.

The Croatian academic and special libraries conference of 2003 entitles "Don't shoot the librarian - how others see us?" was organized by the Institute's library at the faculty of engineering and computing, Zagreb University, Zagreb, from 8 - 9 November 2003.

PROJECTS

Projects supported by the Ministry of Science and Technology (MZT)

- Croatian Scientific Bibliography CROSBI (Jadranka Stojanovski)
- Croatian Scientific Information System Natural Sciences (Jadranka Stojanovski)
- 3. Online Databases Center (Jadranka Stojanovski)
- 4. Who is Who in Science in Croatia (Jadranka Stojanovski)
- 5. EJOL Electronic Journals Online Library (Ivana Pažur and Sofija Konjević)

SELECTED PUBLICATIONS

Konjević, S. Hrvatski znanstveni časopisi na Internetu, *Vjesnik bibliotekara Hrvatske*, 46, (2003) 3-4, 111-118.

Melinščak Zlodi, I. Elektronički arhivi – revolucija u pristupu znanstvenim informacijama? 6. seminar Arhivi, knjižnice, muzeji : mogućnosti suradnje u okruženju globalne informacijske infrastrukture: zbornik radova, Katić T.(ur.). Zagreb: Hrvatsko knjižničarsko društvo, **2003**.

Pažur, I. Digitalni izvori znanja i njihovo korištenje - primjer knjižnice Instituta Ruđer Bošković Specijalne knjižnice - izvori i korištenje znanja, Jokić, M. (ur.). Zagreb: Hrvatsko knjižničarsko društvo, **2003**, 32-41

Pažur, I.; Konjević, S. Kemičari instituta Ruđer Bošković i elektronički časopisi. *Kemija u industriji.* **2003**, *52*, 123-125.

Stojanovski, J. CROSBI - A Tool for Monitoring Scientific Productivity TERENA Networking Conference and CARNet User's Conference 2003 Conference Proceedings.



Figure 3. RBI Library and its users

Bilješke:





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 and computer science and electronics. 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.