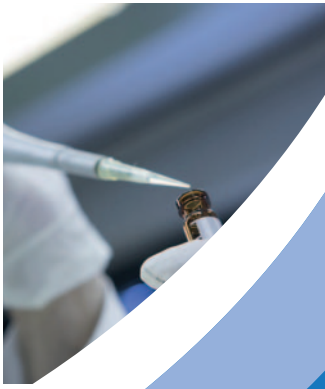





ELTE Faculty of Science
INSTITUTE OF CHEMISTRY

Education and research at the Institute of Chemistry of Eötvös Loránd University

INTRODUCTION

Established in 1635 the Eötvös Loránd University (ELTE) is both the oldest and the leading Hungarian university for science research and teaching. As director of the university's Institute of Chemistry, and on behalf of all my colleagues, I welcome everybody interested in the Institute's courses. ELTE's status as the leading university in Hungary is based on the excellence of its staff and outstanding achievements of its students. In the Institute of Chemistry you will acquire the skills and knowledge to pursue a successful career in chemistry in, for example, research, industry, public services and education. Further you will do this in the vibrant and modern environment established by our professors and their support staff.

Success as a student requires serious study, commitment and application. We make no secret of this and believe it is the only way the next generation will acquire the creativity and innovative thinking needed to tackle issues and problems being faced now and in the future. My colleagues are passionate about their work and the importance of passing their knowledge on to future generations. Their relationships with thousands of professionals working for hundreds of educational and research organisations in Hungary and around the world ensure that the Institute of Chemistry is an excellent place to begin your career in chemistry. I speak for all my colleagues when I wish success to all those who study here.

Szalai István

István Szalai

CHEMISTRY IN THE FACULTY OF SCIENCE

The Institute of Chemistry is.part of the Faculty of Science of ELTE. The Faculty is the largest among the science faculties in our country and covers all scientific disciplines at the highest level. It is located in two new buildings on the bank of the Danube in our beautiful capital of Budapest. About 5000-6000 students and approximately 400 PhD students participate in our education and training each year.

Almost all educators in the Institute of Chemistry have a PhD. They include about thirty full professors and twenty associate professors. Seven of our colleagues are members of the Hungarian Academy of Sciences (MTA). The list of our colleagues, their contact details, publication lists and awards gained may be found on our website together with other useful information about the Institute.

EDUCATION

The Institute of Chemistry consists of five departments

- **Department of Analytical Chemistry**
- **Department of Inorganic Chemistry**
- **Department of Organic Chemistry**
- **Department of Physical Chemistry**
- **Savaria Chemistry Department**

Our Institute is responsible for teaching the chemistry content of several qualifications. For example: BSc in chemistry, biology, geology, environmental sciences or physics; MSc in chemistry, biology, environmental sciences, materials science, geology, pharmacy and chemistry education. Students may take some of their BSc and MSc Chemistry courses in English. The Institute of Chemistry has several well-equipped and modern teaching laboratories. The content of courses is influenced by regular consultations of the representatives of the chemical and pharmaceutical industry and economy.

CHEMISTRY BSc

Students with completed secondary school education in Hungary, or having received the equivalent of General Certificate of Education (UK) or high school diploma (US), including the pre-university program in countries where that exists, can apply for this program. Our BSc explores the world of atoms and molecules, unravel the principles which govern the chemical reactions occurring between them, and devise ways to create entirely new compounds and materials. The program aims to provide rigorous education in fundamental areas of chemical knowledge and chemical experimentation. It is sufficiently flexible to provide an excellent preparation for careers in many different areas of chemistry.

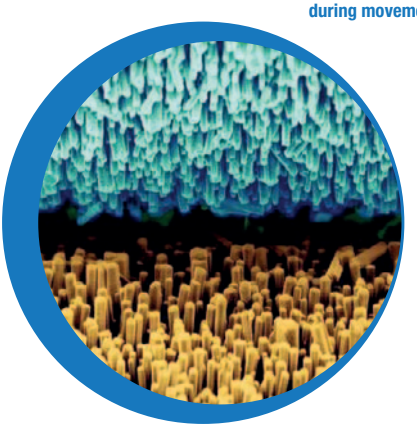
The program is designed to provide an education both for students planning to go on to graduate study, and for those intending to immediately pursue professional careers in chemistry or an allied field in which sound knowledge of chemistry is important. Chemistry graduates have much scope to use their knowledge within a range of research sectors, including roles within chemical engineering, chemical and related industries, healthcare and more. One can work e.g. at a pharmaceutical company, developing and testing new drugs; at a university, combining research with teaching; or at a public-sector research centre dedicated to interdisciplinary research on the environment, agriculture, chemical diagnostics or analysis of relevant data (e.g. meteorological data or chemical analysis of soil, water etc.).

Laboratory practice in the Institute of Chemistry

CHEMISTRY MSc

The Chemistry MSc is intended to provide a training with a flexible choice of courses, where students with different entry skills are able to acquire knowledge in all fields of chemistry, a general experience in laboratory work, an advanced knowledge at least in one of the disciplines of chemistry, and the skill of developing and applying ideas within a research project. The MSc training is accessible with degrees in BSc in chemistry, chemistry related engineering and materials science BSc-s and all other science BSc-s. Moreover the entry is possible with any BSc qualification, where the sum of science credits is at least 40, whereof 20 credits belong to chemistry. Students with less than 50 credits of chemistry have to choose, and ones with less than 80 credits of chemistry are suggested to choose courses from the bridging module. The MSc program provides a flexible choice of courses.

Microscopic picture of a textile that can generate electricity during movement



Academic specializations can be obtained as well:
a) Analytical Chemist
b) Material Researcher Chemist
c) Material Structure Researcher Chemist
d) Pharmaceutical Chemist
e) Preparative Chemist
Students who complete a specialization module also receive a written statement on the specialization. Our MSc degree qualifies students to find a job in the wide range of the chemical and pharmaceutical industry. Among others they can apply for jobs such as analytical, synthetic, pharmaceutical, food, environmental, computational chemist, moreover, materials science researcher and production manager. The MSc program helps students to be admitted to PhD school as well.

MATERIALS SCIENCE MSc

The Materials Science MSc is an interdisciplinary program aimed at providing a rigorous education in materials science and the fundamental physics and chemistry that underlie this discipline. The courses offer an overview of the types of materials, their chemical and physical structures and properties. The program is based on lectures, seminars and practical laboratories in advanced materials including metals, ceramics, polymers, biomaterials and composites, as well as physical phenomena. The compulsory basic courses provide the solid framework of the program; the semi-optional and special lecture courses give the basics of the specification and their wide choice results in the flexibility of the program.

MSc laboratory practice

PHARMACISTS' EDUCATION

There has been an educational cooperation for decades between the Faculty of Science of ELTE and the Faculty of Pharmacy of Semmelweis University in high-level training of pharmaceutical students in chemistry and botany at graduate and postgraduate level. The Institute of Chemistry teaches the majority of the basic chemistry subjects (general and inorganic chemistry, qualitative and quantitative analytical chemistry, physical and colloid chemistry) in three languages: Hungarian, English and German. A great number of pharmacist candidates participate in extra-curricular research programs and many PhD students complete their research at ELTE.

The pharmacists' training is built on the close cooperation of the ELTE and the Semmelweis University

MASTER OF EDUCATION, MEd

The university's aim is to train people committed to teaching chemistry and want to share their enthusiasm with future generations, show them the beauty of chemistry and how civilization could not exist and develop without chemistry. The lack of chemistry teachers in Hungarian schools ensures graduated students will find teaching places that are intellectually and financially rewarding.

Chemistry teacher trainees

TRAININGS OF THE SAVARIA UNIVERSITY CENTRE

Certain trainings of ELTE are available also at the Savaria University Campus in Szombathely (West Hungary). The chemistry department of this campus coordinates the education of both chemistry and science teachers, and provides chemistry courses for non-chemistry major students.

The main building of the campus in Szombathely

ELTE HEVESY GYÖRGY PhD SCHOOL OF CHEMISTRY

The topics covered by the Chemistry PhD program include practically the whole spectrum of chemistry, i.e., inorganic, physical, analytical, environmental and theoretical chemistry, moreover, organic and biochemistry, electrochemistry, structural chemistry, and polymer chemistry. The program is research oriented; the students start to work on their chosen topic in the respective laboratory under the guidance of a project leader. Students must take selected courses. By the end of the 8-semester-long program the PhD students obtain results which are published (or accepted for publication) at leading international journals. At least two such papers are necessary to obtain the PhD degree. The students report about their research progress at yearly conferences organized by the School. The Advisory Board of the Hevesy György PhD School of Chemistry consists of internationally renowned experts of their fields. The research advisors collaborate with several research institutes and universities both in and outside of Hungary, and regularly have visitors from abroad doing research or giving courses.

Consultation with the PhD supervisor

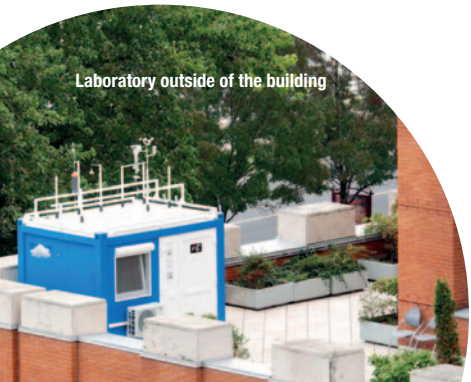
Research laboratories

The ELTE is a research university and its Institute of Chemistry is one of the most significant centres of the chemical research in Hungary. It has a well-established professional relationship with all chemical research institutes of Hungary and more than 400 research organizations abroad. It also has close contacts with the companies of the Hungarian chemical and pharmaceutical industry and participates in industrial research and development. Colleagues working for the Institute of Chemistry publish 150-200 articles per year and receive about 5000 citations. Several patents have also been gained. Researchers working for the Institute receive significant financial support from Hungarian and foreign resources. This includes European Union funding and commercial funding as well.

BUDAPEST PLATFORM FOR AEROSOL RESEARCH AND TRAINING

(led by Prof. Imre Salma)

The Platform is a research facility to serve and advance the research of atmospheric aerosols through complex surface based and satellite born measurements, as well as to promote the training of students at master or PhD levels and young researchers. The scientific interests cover all aspects of tropospheric aerosol research, implications on climate, human health, and built environment, especially studies on urban-type aerosol. Students can participate in investigating and solving real research issues.



Laboratory outside of the building

LABORATORY OF ELECTRO-CHEMISTRY AND ELECTROANALYTICAL CHEMISTRY

(led by Prof. György Inzelt)

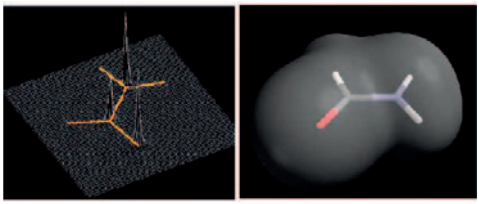
The Laboratory has great traditions in fundamental as well as in applied research in the field of electrochemistry. Some of the research topics we work on: electrochemically active surface layers, redox and electronically conducting polymers, polynuclear complexes, synthesis, characterization (mechanism and kinetics of charge transport, equilibria) and application (electrocatalysis, electrochromic displays, gas, potentiometric and amperometric sensors); environmental electrochemistry (monitoring, extraction and decomposition of pollutants); electrochemical materials science, corrosion, anodic dissolution, passivation, composite materials, electroless alloy deposits; electrochemical oscillations; molecular electrochemistry, electrochemical transformations of organic compounds; solid phase electrochemistry, electroanalysis of microcrystals and microdroplets.

LABORATORY OF THEORETICAL CHEMISTRY

(led by Ágnes Szabados PhD)

The research fields of the Laboratory are quantum chemical method development and applications to chemical and physical problems. Many of the recent methodological results concern the so-called multireference based approaches. Members of the Laboratory are particularly interested in computations on the spectroscopic properties of molecules and nanosystems as well as ab initio modelling of molecular dynamics. Talented students with a solid background in theoretical chemistry are welcome to assist in our research. Master's and PhD theses are regularly supervised by members of the Laboratory.

The HYGO-2 vehicle working by fuel cell



The electrondensity of the formamide molecule

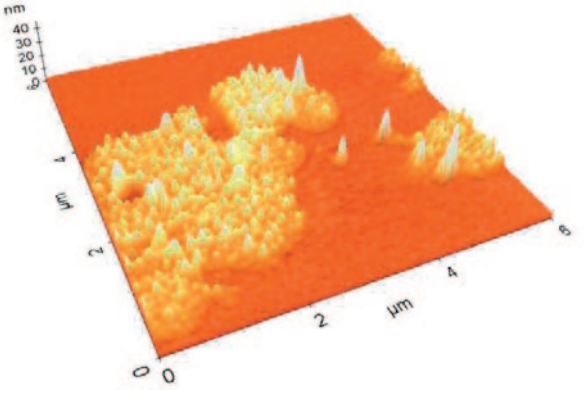
Working with gas chromatograph

JOINT RESEARCH AND TRAINING LABORATORY ON SEPARATION SCIENCE
(led by Zsuzsanna Eke PhD)

The Laboratory is an example of cooperation between academic and industrial sectors. This partnership facilitates the use of modern chromatographic techniques. Gas and liquid chromatography coupled to mass spectrometry are powerful tools in answering analytical questions in numerous fields. These techniques are used in food production and control, environment protection, pharma industry, etc. We are focusing on analytical methods for identification of fuel pollutions; determination of polycyclic aromatic hydrocarbons (PAH) in environmental and food samples; and migration of varioius compounds from food contact materials. We welcome graduate and undergraduate students to join our research work.

LABORATORY OF INTERFACES AND NANOSTRUCTURES
(led by Prof. Éva Kiss)

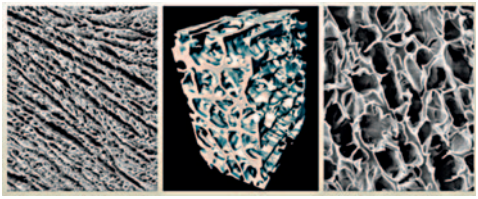
Research subjects of the Laboratory: Polyelectrolyte/surfactant interaction in bulk and at interfaces. Preparation and characterization of hierarchical soft nanoparticles, responsive polymeric nanosystems. Molecularly ordered Langmuir and Langmuir-Blodgett layers. Interaction of drugs, drug-peptide conjugates and colloidal drug carriers with model lipid systems. Biorelated systems, surface and interfacial properties of polymeric nanoparticles and microgels. Development of biodegradable polymeric nanoparticles for drug delivery with tuneable surface properties to improve the cellular uptake and of low cytotoxicity. Preparation and characterization of



Atomic force microscope image of the surface of a lipid layer destroyed by antibacterial material

complex inorganic nanoparticles. The Laboratory offers access to equipment necessary for the characterization of nanomaterials: dynamic and static light scattering, electrophoretic mobility measurement, computer controlled drop profile analyser, L- and LB-technique, scanning probe microscopy (AFM, STM), quartz crystal microbalance, reflectometry, fluorescence and UV-Vis absorbance spectroscopy, surface area determination.

SOL-GEL LABORATORY
(led by Katalin Sinkó PhD)



Al_2O_3 systems with ultraporous structure for the insulation of planes and spaceships

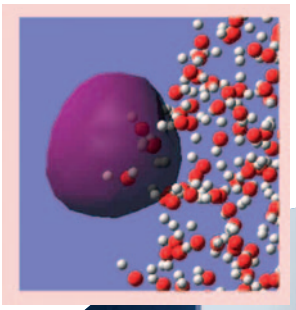
Objectives of research in Sol-gel Laboratory: Replacement of traditional melting process by a technique of low energy consumption: at aluminum oxide hydroxide; calcium silicate; aluminum silicate systems. Preparation and structure investigation of silicate systems, which cannot be produced by melting process, such as special composition of calcium and aluminum silicate systems. Synthesis of nano-, meso-, and hierarchical porous materials presented by ultra-light cryo- and aerogels with controlled porosity. Synthesis and structure investigation of materials with tailored structures – from various porous systems, through spinnable composition to dense monoliths. Produce of multicomponent, complex systems: extra hard nanocomposites and organic–inorganic hybrid materials. Preparation of nanoparticles with controlled size.

LABORATORY OF ENVIRONMENTAL CHEMISTRY AND BIOANALYTICS
(led by Prof. Gyula Záray)

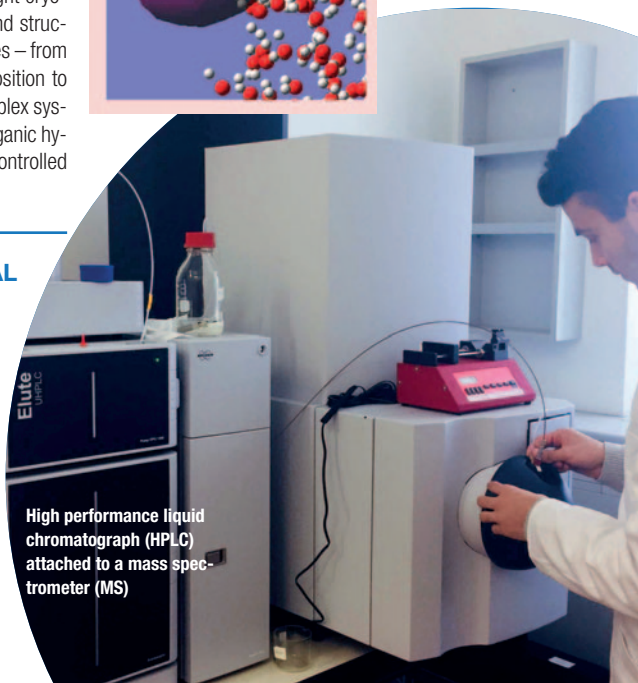
The activities of the Laboratory are focused on the identification and quantitative determination of inorganic and organic pollutants as well as on the development of technologies aiming at their removal from diverse environmental matrices. The negative effects on water ecological systems exerted by pharmaceutical residues discharged into wastewater contaminating the surface water systems and bioaccumulation of heavy metals are also studied. Sensitive atomic spectrometric (ICP-MS with different sampling introduction methods such as nebulization and laser ablation for liquid and solid samples, respectively; X-ray fluorescence), separation (GC, HPLC) and hyphenated (GC-MS/MS, LC-MS/MS) techniques are applied.

LABORATORY OF CHEMICAL INFORMATICS
(led by Prof. László Túri)

The Laboratory focuses on chemical problems that are connected by the intensive application of computational methods. The studied systems cover a wide range in size, complexity and function from isolated gas phase molecules, molecular clusters, simple solvent models and crystalline structures to large, biologically relevant molecules. The methods of the investigations include various level computer simulation techniques. The group members are experts of chemical structure calculations, chemical dynamics, chemical informatics, chemical statistics and chemometrics. The laboratory has contributed to such large and widely-used international software packages, as Gaussian or GROMACS.



The quantum calculations model of hydrated electron



High performance liquid chromatograph (HPLC) attached to a mass spectrometer (MS)

LABORATORY OF NUCLEAR CHEMISTRY
(led by Prof. Zoltán Homonnay)

The Laboratory is engaged in development and application of two nuclear methods applied in structural chemistry. Mössbauer Spectroscopy is based on specific absorption of gamma rays by nuclei. This absorption is sensitive to the chemical environment of the nucleus. Oxidation state, spin state and detailed electronic structure of atoms can be investigated. Mostly iron and tin containing substances can be studied. Positron annihilation spectroscopy is based on electron-positron annihilation. When positron interacts with electron, annihilation will take place, resulting in the formation of gamma photons. Measuring the life time of the positrons will provide information about lattice vacancies, paramagnetic impurities, spatial structure of polymers etc. Applications in pharmaceutical research became quite popular recently.

Measurement in the nuclear chemistry laboratory

LABORATORY OF MOLECULAR SPECTROSCOPY AND MTA-ELTE LABORATORY ASTROCHEMISTRY "MOMENTUM" RESEARCH GROUP
(led by György Tarczay PhD)

In the Laboratory conventional (IR, Raman, UV-Vis) and state-of-the-art (Vibrational Circular Dichroism: VCD, Raman Optical Activity: ROA) molecular spectroscopic, as well as special, home-developed matrix isolation and jet-cooled laser

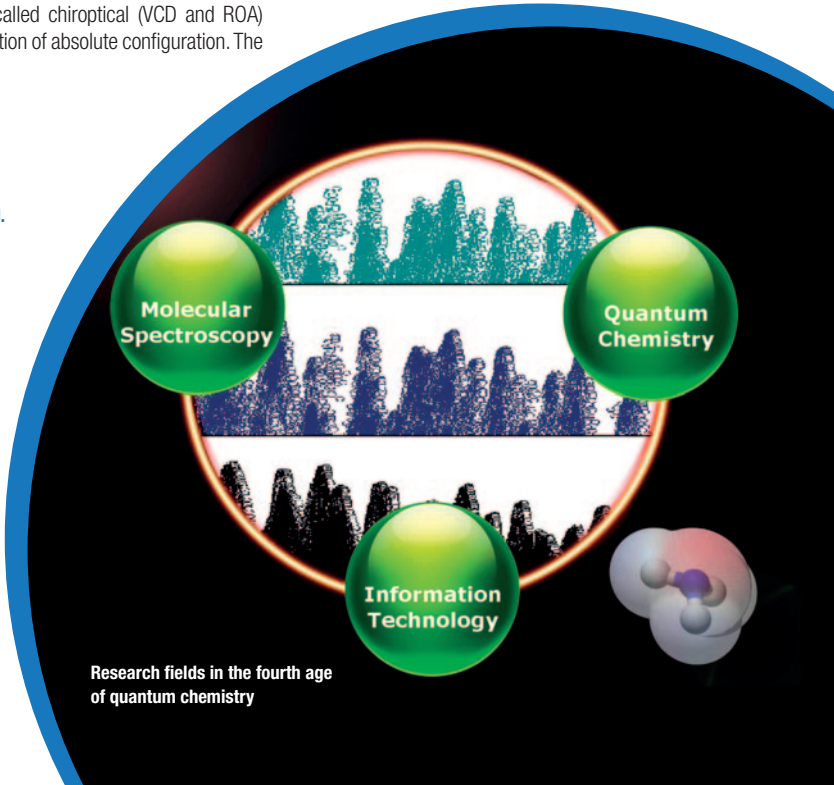
Work in the laser laboratory

most sophisticated method used in these experiments is the so-called matrix isolation method. In this technique the biomolecules are prepared in an almost non-interacting environment (e.g. in frozen argon) at low-temperature, typically at 10 K. Most of our experimental studies are supported by extensive computational chemistry (quantum chemistry and molecular dynamics) simulations. A special 4 K cryogenic setup is under construction. This setup will be suitable for investigation of the radiation chemistry and spectroscopy of astrophysical analogue ices, and molecular physics phenomena in para-hydrogen quantum host.

LABORATORY OF MOLECULAR STRUCTURE AND DYNAMICS AND THE MTA-ELTE COMPLEX CHEMICAL SYSTEMS RESEARCH GROUP

(led by Prof. Attila G. Császár)

The Laboratory and the associated Research Group are known for performing leading-edge basic research in the fields of theoretical and computational chemistry, quantum chemistry, spectroscopic setups are used for the investigation of biomolecules, reactive atmospheric and astrochemical species, and molecular physics phenomena. Using these methods the conformations and the conformational dynamics of small biomolecules are explored, the effect of hydration or complex formation on the structure is investigated. We also use and develop the so-called chiroptical (VCD and ROA) methods for the determination of absolute configuration. The



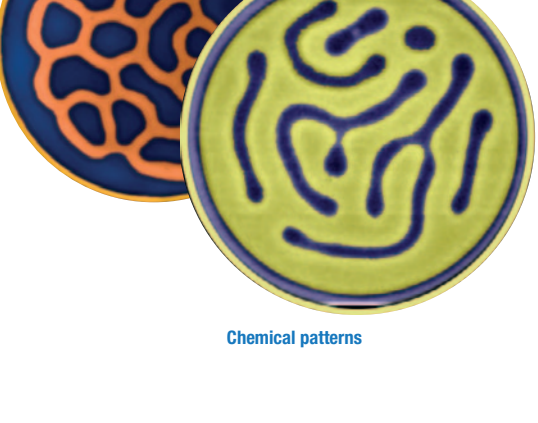
Research fields in the fourth age of quantum chemistry

Spectroscopic networks and the MTA-ELTE Complex Chemical Systems Research Group on the front cover of J. Phys. Chem. A

computational molecular spectroscopy, first-principles thermochemistry, structural biochemistry, as well as reaction kinetics and dynamics. Utilization and extension of algorithms from interdisciplinary areas, such as mathematical statistics, informatics, information technology, and elevation of existing knowledge to new heights by bridging several of these areas are the everyday activities of the Group. We have been developing generally applicable techniques, with special emphasis on related high-level computer codes, which help to understand our natural environment (e.g., combustion systems, star formation, and atmospheres of exoplanets), as well as to protect the quality of life as we know it (e.g., via an improved scientific understanding of the greenhouse effect on earth). Establishment of modern, active chemical databases and improvement of existing (spectroscopic) databases (like HITRAN) is another important activity of the Group.

NONLINEAR CHEMICAL DYNAMICS LABORATORY
(led by Prof. Miklós Orbán)

Our research interest involves studies on two subfields of the nonlinear chemical dynamics: oscillatory chemical reactions and spontaneous pattern formation. We have succeeded in producing many types of chemical oscillators (e.g. uncatalysed bromate systems, chlorite oscillators, the family of manganese-chemistry based group, copper-catalysed oscillators, one- and two-substrate pH oscillators, etc.) and patterns (e.g. travelling chemical waves, Turing structures etc.). Recent projects are to refine the design methods and to utilize them on producing new and more complex periodic systems (e.g. induced oscillations in complex equilibria, Turing structure in a gel reactor using pH oscillators).



Chemical patterns

CHEMICAL KINETICS LABORATORY
(led by Prof. Tamás Turányi)

The Laboratory deals with topics such as chemical transformations in the troposphere, biochemical reactions in living cells, and some processes of the chemical industry. We have published new reaction mechanisms for the characterization of the combustion of hydrogen, syngas, methanol and ethanol. Our current research topics are the combustion of methane and butanol, and the transformations of nitrogen oxides during combustion. We have elaborated a series of new computational and mathematical tools for the processing of experimental data, determination of chemical kinetic parameters and the analysis and reduction of detailed reaction mechanisms.

Combustion of the mixture of methanol and oxygen. The time difference between the two photographs is 0.017 second

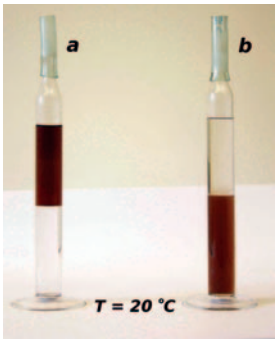
LABORATORY OF STRUCTURAL CHEMISTRY AND BIOLOGY AND MTA-ELTE PROTEIN MODELLING RESEARCH GROUP
(led by Prof. András Perczel)

Our Research Group is dedicated to understand both structure and function of polypeptides and proteins, with special emphasis on the target molecules and processes of the human physiology. We study and further optimize drugs currently used to treat type II Diabetes and Cancer. In addition, the molecular causes of some hereditary kidney diseases, the machinery of the human immune-system and the pathological protein-aggregation processes of Alzheimer-disease are in our focus. To understand the molecular details of these processes and interactions involved, we have to explore the structure of these molecules at atomic details. For this end, we attempt to crystallize proteins and use X-ray diffraction techniques for their structure determination. Furthermore, we study the interaction of these macromolecules in solution by NMR techniques and CD-spectroscopy. We use a large array of experimental results to build up models and pictures of enzymes and proteins, the architecture and reaction affinity of which is challenged by calculations.

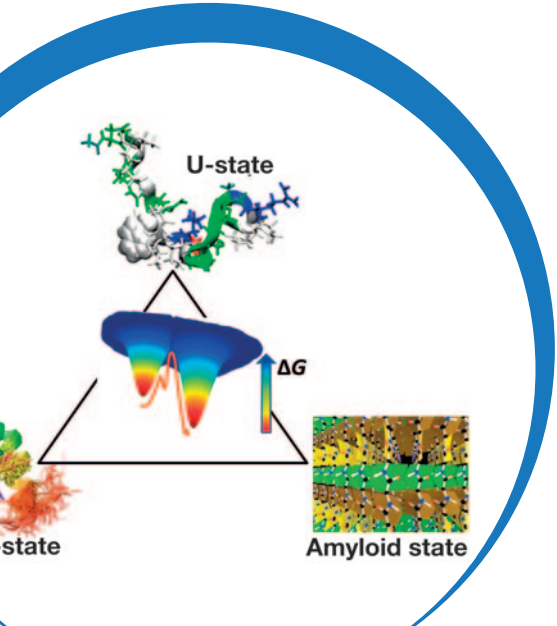
The conformation states of a protein

LABORATORY OF ORGANIC FLUOROCOMPOUNDS
(led by Prof. József Rábai)

The purpose of the Laboratory is to develop innovative procedures for the synthesis of organic fluorine compounds. The main challenge is to introduce safe, practical and environmentally benign methods for their synthesis. Our basic approach for the design and performance such reactions calls for the understanding the correlation between molecular structures and macroscopic properties of compounds involved in the reaction systems. The application of this new paradigm based on molecular engineering, which allows the fine tuning of phasephilicity of the educts and the products, and consequently rendering them to gather separately into orthogonal phases.

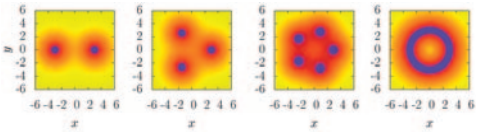


Two-phase fluorous systems coloured by organophilic (a) and fluorophilic (b) gold nanoparticles



MOLECULAR QUANTUM DYNAMICS RESEARCH GROUP
(led by Edit Mátyus PhD)

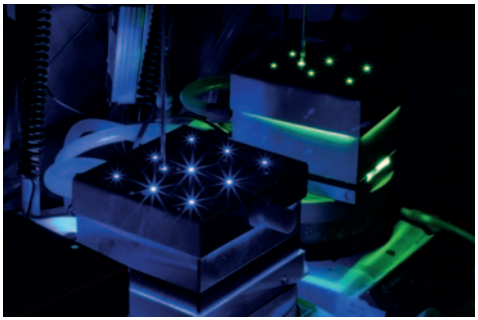
The research activities of our Research Group are devoted to methodological developments and computation of quantum dynamical properties of molecular systems. Recent work includes the spectroscopic study of van der Waals complexes, that contributes to the spectroscopic validation and improvement of intermolecular interaction models and to the exploration of unusual molecular quantum dynamical features such as tunnelling. Further efforts are oriented towards metrology and testing fundamental physical theories with molecular precision measurements and computations. The definition of molecular structure without the Born-Oppenheimer approximation is also on our agenda.



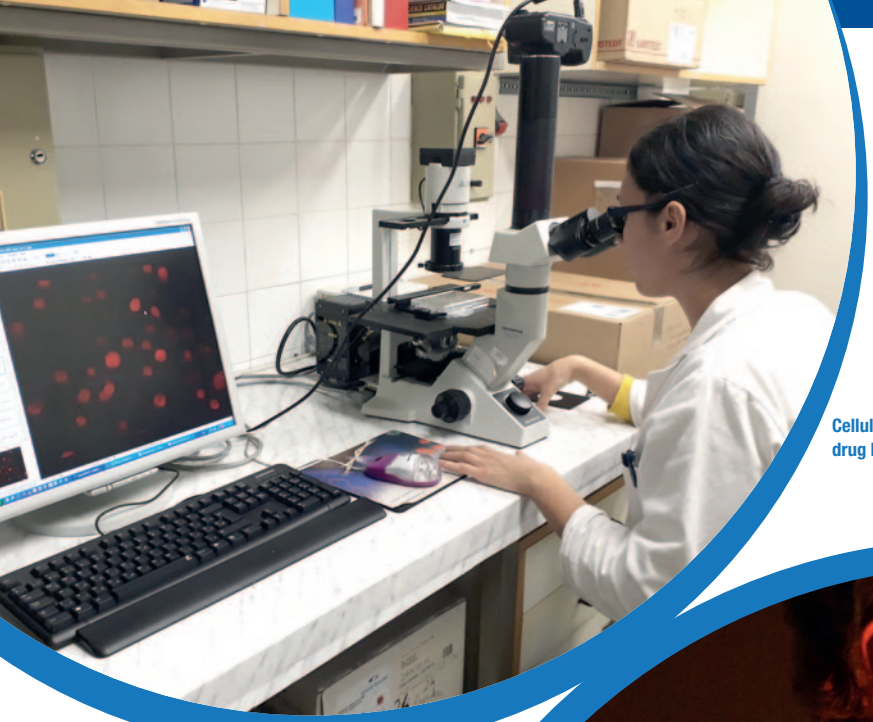
Tunneling phenomenon and large-amplitude motion

LABORATORY OF CATALYSIS AND ORGANIC SYNTHESIS
(led by Zoltán Novák PhD)

The Laboratory focusses on the research, development and application of novel transition metal (Pd, Cu, Fe, Au, Ir, Ru, Rh, Co, Ni) catalysed transformations for the construction and functionalization of aromatic and heteroaromatic systems. The goal of our research is the development of methodologies which can be applied in the synthesis of pharmaceutically active compounds. These studies generally carried out in collaboration of research institutes of medicinal chemistry. Amongst the transition-metal catalysed reactions we study the cross coupling and C-H activation reactions, and the visible light induced photocatalytic transformations.



The lights of the laboratory



Cellular uptake study of anticancer drug by microscopy

RESEARCH GROUP OF PEPTIDE CHEMISTRY
(led by Prof. Gábor Mező)

Our research focuses on the synthesis of peptide based drug delivery systems and diagnostics, and their structural and functional characterization. The goal is the development and study of peptides, polypeptides and their conjugates for the treatment of cancers and bacterial infections. The Research Group has projects for development of peptide carriers that deliver specifically anticancer drugs into cancer cells without affecting healthy tissues. In this way the cancer patients might be saved from toxic side effects. Our research work needs organic and peptide syntheses, various analytical approaches (e.g. HPLC, MS) and in vitro biological studies on different cancer cell lines.

MTA-ELTE RESEARCH GROUP ON INQUIRY-BASED CHEMISTRY EDUCATION

(led by Luca Szalay PhD)

Our Research Group is funded by the Content Pedagogy Research Program of the Hungarian Academy of Sciences (MTA). The goal is to investigate how inquiry-based chemistry education might be introduced in Hungary. The longitudinal study takes four school years. Over 900 students are involved, all were 12-13-year-old in the beginning of the study. Each year they spend six lessons carrying out practical activities using worksheets provided. The impact of the intervention on the students' experimental design skills, subject content knowledge and attitude toward chemistry is measured by structured tests.

7th grade
students making an experiment

Spectacular chemistry lectures for primary
and secondary school students

STIPENDIUM HUNGARICUM SCHOLARSHIP PROGRAMME

The core mission of the Stipendium Hungaricum Scholarship Programme is to increase the number of foreign students in Hungary and to encourage Hungarian higher education institutions to attract top foreign students. Students can apply for study programmes at bachelor, master and PhD level, and preparatory courses as well. Apart from the tuition-free education, the Programme provides monthly stipend, medical insurance and housing allowance for the scholarship holders.

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INVESTING IN YOUR FUTURE