

ACHIEVEMENTS IN SCIENCE 2016 • LATVIA

THEORETICAL SCIENCE

Modelling and synthesis of flexible magnetic filaments

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Flexible magnetic filaments in an external magnetic field behave like micro-organisms, and may be used for creation of micro-swimmers, micro-mixers, nanorobots and similar devices. Theoretical models of flexible magnetic strings, numerical algorithms for their behaviour simulation and their synthesis protocols are the parts of the research. In 2016 the findings have been published in prominent scientific journals.

Studies of asteroids, small planets of the Solar system

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A set of 72 publications represents results of multiannual research of the small planets of the Solar system, as performed in the Baldone Observatory. 48 new asteroids of the Solar system are discovered and orbits of 826 asteroids are specified through determination of astrometric positions of 3511 small bodies. Theory of orbit's evolution forecasting for the Centauri type asteroids has been complemented.

Pharmacological effects and pharmacokinetic properties of *meldonium*

LAS academician Maija Dambrova, Dr.pharm. Marina Makrečka-Kūka, Dr.pharm. Reinis Vilšķērsts, Dr.pharm. Elīna Makarova, Dr.pharm. Jānis Kūka, LAS corresponding member Edgars Liepiņš

Latvian Institute of Organic Synthesis

The activity of *meldonium* depends on the lowered concentrations of L-carnitine and its metabolites, acylcarnitines and trimethylamine-N-oxide, and the following adaptive changes in the cellular energy metabolism pathways. These molecular mechanisms of action secure activity of *meldonium* in the treatment of cardiovascular diseases, atherosclerosis and diabetes complications. Pharmacologically decreased levels of acylcarnitines and trimethylamine-N-oxide contribute to the preserved mitochondrial function and protect cardiac and other tissues against ischemia and metabolic stress. The active transport of *meldonium* in tissues is ensured by the organic cation transporter 2, OCTN2.

A concluding stage of the research into Latvian folklore dedicated to studies of the form and content of more than 4 000 Latvian sun-songs

Monograph "The Threefold Sun. The Mythological Sun" (Rīga: Pētergailis, 2016, 488 pp.) by Vaira Vīķe-Freiberga

The present volume, „The Mythological Sun” represents the last in a pentalogy of commentaries about the corpus of over 4000 Latvian folksongs (*dainas*) containing the word “sun”, the texts of which are available digitally, as well as in printed form (Vīķe-Freiberga & Freibergs, 1988). A separate collection of Latvian „Sun-song Melodies”, along with their original texts and English translations, has also been published (Vīķe-Freiberga, 2005).

The texts of the Latvian sun-songs were originally classified as aspects of „The Threefold Sun” and the subsequent volumes of commentaries have followed the same conceptual principles. First was „The Cosmological Sun” (Vīķe-Freiberga, 1997), linked to pre-Christian conceptions of heaven and earth, this world and the next, death and life. The second, the physical sun, with around 2500 texts relating to it, was in turn subdivided into three conceptual categories: „The Chronological Sun” (1999) about the sun as heavenly time-piece, the meteorological „Warm Sun” (2002) about good and bad weather and the „Luminous sun” in its visual aspect of light and brightness (2011).

The present volume about “The Mythological Sun” refers to approximately 40% of the original Sun-song corpus, with 1567 separately numbered texts, but takes into consideration additional variants and subvariants of the same (originally not digitized) from the original collection of Barons and Visendorfs (1895-1915). Since some mythological texts may have as many as 60 or even 100 versions, this considerably enlarged the material to be analysed (but not necessarily quoted). As in the previous four volumes, song texts are regrouped for analysis according to their main thematic content, then according to clusters dealing with more specific motifs. Within each subsection, songs are organized according to surface features of the text, such as repeated keywords, formulaic half-lines, lines, line couplets or even longer text modules that reappear as such in different contexts. The texts are discussed with respect to their semantic content, linguistic and logical structure and poetic effect, using ethnographic and historical references where necessary for their better understanding and, where pertinent, referring to interpretations offered by earlier authors.

An important contribution to the history of architecture in Latvia – a treatise on the architecture of Riga in the 17th century

Monograph “Architecture and Urban Planning of Riga in the 2nd Half of the 17th Century” (Riga: Institute of Art History of the Latvian Academy of Art; Art History Research Support Foundation, 2016, 447 pp.) by Anna Ancāne

The innovative importance of *Dr.art.* Anna Ancāne’s work lies in her addressing the 17th century architecture of Riga – a part of heritage that has long been left outside the focus of art-historical interests. Her book can be considered as the first comprehensive publication about the urban development in Riga in the period when the medieval town was transformed into a modern Baroque city. Having explored a wealth of sources, the author gives a detailed analysis of transformations of the fortification system and urban planning, innovations in the architecture of religious and public buildings, typology of residential houses, their architectural structure, finish and *décor*. Furthermore Anna Ancāne has explored and reconstructed international routes of influence establishing the position of Riga in the context of European architecture in that time.

Analytic and topical research-based overview of the crucial period in Latvia’s cultural progress from the First World War till the loss of national independence (1915–1940)

The volume “Art History of Latvia V: Period of Classical Modernism and Traditionalism. 1915–1940” (Riga: Institute of Art History of the Latvian Academy of Art; Art History Research Support Foundation, 2016, 694 pp.), ed. by Dr.habil.art. Eduards Kļaviņš, with contributions by the editor, Dr.art. Stella Pelše, Mg.art. Anita Vanaga, Dr.art.h.c. Valdis Villerušs, Dr.art. Katrīna Teivāne-Korpa, Mg.art. Ilze Martinsone, Mg.art. Rūta Rinka and Mg.art. Marta Šuste

The book has separate Latvian and English editions, for the first time covering all forms and spheres of visual arts in a comprehensive, in-depth and topical research-based overview of the crucial period in Latvia’s cultural progress from the First World War till the loss of national independence to the aggression of totalitarian empires. In the previous general art histories of Latvia, some of the arts (photography, design) have not been considered at all; some other ones (artistic life, book art, stage design, etc.) were revealed inadequately because of ideological barriers or lack of research.

The preceding volume IV of the “Art History of Latvia” – “Period of Neo-Romantic Modernism. 1890–1915” (ed. by Eduards Kļaviņš) was listed as a Latvian Achievement in Science 2014 and has received positive reviews in international scholarly journals (*Centropa*, *Kunstchronik*, *Kunsttiteaduslikke Uurimus*). The full programme of the publication will comprise seven volumes about the whole span of time from the prehistory to our days. The institute is working on materials for volumes I and III.

The most comprehensive scientific monograph on fruit growing over the period of 50 years

Monograph "Fruit Growing" LV Latvia State Institute of Fruit-Growing, Latvia University of Agriculture, 2015, 544 pp.) by Dr.biol. Laila Ikase (editor-in-chief), Dr.biol. Sarmīte Strautiņa, Dr.agr. Māra Skrīvele, Mg.agr. Inese Drudze, Dr.agr. Daina Feldmane, Dr.agr. Edgars Rubauskis, and 24 more authors

Fruit growing is a developing branch of agriculture in Latvia with significant increase recently. It has been over 50 years since a comprehensive text book in fruit growing has been published in Latvia, including both theory and practice. This book attempts to fill in this significant gap. It is a collective work of the most experiences fruit scientists and practitioners in Latvia. The book opens with a historical review of fruit science in Latvia, further it gives a deeper insight in fruit plant biology and biochemistry, their vegetative development, flower and fruit development processes. It analyses the influence of environment on plants and practical solutions to reduce plant stress. A special chapter is devoted to fruit plant winter hardiness. The origin and biology of temperate fruit crop species, including rare and novel crops with commercial potential is described, as well as fruit breeding methods, fruit breeding programmes and achievements in Latvia and worldwide. Based on research and practical experience in Latvia and other countries, the book deals with modern and traditional fruit propagation methods, orchard establishment, fruit and berry growing and storage technologies.

APPLIED SCIENCE

Technologies for semantic analysis of natural language

LAS corresponding member Guntis Bārzdriņš, Mg. Didzis Goško, Mg. Pēteris Paikens, Dr.sc.comp. Normunds Grūzītis

An accurate, rapid and practically functional computerised semantic (i.e. the relationship between the characters/symbols and what they represent) analysis technology is designed. An innovative machine learning method and the world's best tool for English semantic parsing is developed. The technology is adapted also for Latvian language and introduced by the news agency LETA in automatic media monitoring.

The three dimensional structures of ssRNA phages AP205 and MS2 established

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Latvian Biomedical Research and Study Centre in cooperation with France National Centre of Research, Leiden University and Madrid National Centre of Biotechnology*

In collaboration with the colleagues from the Netherlands, France and Spain, researchers from Latvian Biomedical Research and Study Center (BMC) have established the three-dimensional structure of bacteriophage AP205 virus-like particles (VLPs) and contributed to asymmetric structure of phage MS2 virion. The structure of AP205 VLPs was established by combining three different methods in three European countries – protein x-ray crystallography (BMC), cryo-EM (Netherlands) and solid state NMR (France, including guest researcher Kristaps Jaudzems from Latvian Institute of Organic Synthesis). As a result, it was established that during evolution the structure of AP205 capsid has become very different from that of related phages, since a part of N-terminal sequence has been shifted to C-terminus. As a result, both terminal ends of coat protein are exposed on the surface of VLPs, which is an important factor in construction of VLP-derived vaccines. Bacteriophage MS2 now is the first virus in the world with established three-dimensional asymmetric structure at medium (7.5Å) resolution, which includes coat protein and genome. The investigation is of fundamental importance, since for the first time there is undisputable argument that virus genome can have a strictly defined three-dimensional structure.

Novel leads for antimalarial drug development

Mg. Dace Rasiņa (LIOS), Mg. Mārtiņš Otikovs (LIOS), Mg. Jānis Leitāns (BMC), Dr. Rosario Recacha (LIOS), Dr.chem. Oleksandr V. Borysov (LIOS), Mg. Iveta Kaņepe-Lapsa (LIOS), Dr.chem. Ilona Domračeva (LIOS), Mg. Teodors Panteļejevs (LIOS), LAS academician Kaspars Tārs (BMC), Dr.chem. Kristaps Jaudzems (LIOS), LAS corresponding member Aigars Jirgensons (LIOS)

Latvian Institute of Organic Synthesis (LIOS) in cooperation with Latvian Biomedical Research and Study Centre (BMC) and Francis Crick Institute (UK)

Novel class of non-peptidic malaria plasmeprin inhibitors has been discovered. Representatives of this class show high potency and selectivity in enzymatic tests as well as promising growth inhibition of *Plasmodium falciparum* in cell-based assays. These properties render them as perspective leads for the anti-malarial drug development. The investigation involves screening of fragment library by NMR, protein crystallography, molecular modelling, biochemical assays and modern organic synthesis as a collaborative effort of experts of various research fields.

A new conception of complex recycling process of birch bark into a high added value production

Dr.sc.ing. Jānis Zandersons, Dr.sc.ing. Jānis Rižikovs, Dr.sc.ing. Aigars Pāže, Mg.chem. Kristīne Meile, Dr.sc.ing. Ausma Tardenaka, Mg.chem. Baiba Spince, Bc. Ance Pļavniece

Latvian State Institute of Wood Chemistry (LSIWC)

The applied research on complete recyclability opportunities of birch trees' bark into biologically active compounds and polymer raw materials has been accomplished. As a result, a novel birch bark chemical processing method has been developed and patented as well as its processing equipment. The method ensures extraction of high purity *betulin* in a single technological stage. Owing to the obtained results the studies of industrial production and commercialisation process of the extractive matter of birch bark suitable for cosmetic production were launched in co-operation with JSC "Latvijas Finieris". The results were used in development and patenting a new free of formaldehyde emission mode of fabrication of chipboard panels made of the residue left after the birch bark extraction.

DIPLOMA OF THE PRESIDENT OF THE LATVIAN ACADEMY OF SCIENCES

Theoretical Science

Discovery and investigation of pressure-induced insulator to metal phase transition in tin tungstate

LAS academician Alexei Kuzmin, Dr.phys. Andris Anspoks, Dr.phys. Aleksandr Kalinko, Dr.phys. Janis Timoshenko, Dr.phys. Robert Kalendarev

Institute of Solid State Physics, University of Latvia

Pressure-induced insulator to metal phase transition in orthorhombic tin tungstate (α -SnWO₄) has been theoretically predicted and experimentally investigated. The conditions of collapse of the tungstate band gap in the pressure range of 5-7 GPa have been established. The origin of the phase transition has been explained using theoretical modelling from the first principles.

A novel study into 20th century Latvian, Estonian and Lithuanian drama.

Monograph „20th Century Baltic Drama: Postcolonial Narratives, Decolonial Options” (Bielefeld: Aisthesis Verlag, 2016, 238 pp., University of Latvia, Institute of Literature, Folklore and Art) by Benedikts Kalnačs.

The path of Estonian, Latvian and Lithuanian societies has to a great extent been determined by historical processes of occupation, colonization and foreign settlement. This remains a terrain insufficiently explored by literary scholars. In this book 20th century drama in Baltic countries provides a matrix which helps to take these issues into account. Principal literary texts are discussed within their specific political, social and aesthetic contexts relevant for all

three cultures from the perspective of postcolonial studies. The main question posed by the book is whether Baltic cultures might be looked upon as agencies of Europe's internal others and in what ways Baltic identity has been determined by responses to these threats and challenges.

Applied Science

Study of bio-hydrogen production from the organic production waste materials and storage in metalhydrides for further exploitation

Dr.biol. Ilze Dimanta, Mg.biol. Sintija Valucka, engineer Laimonis Jēkabsons, Dr.chem. Ilva Nakurte, Dr.phys. Jānis Kleperis, Dr.biol. Vizma Nikolajeva, LAS academician Indriķis Muižnieks

Institute of Solid State Physics and Faculty of Biology, University of Latvia

The research demonstrated hydrogen production *via* fermentation with pure bacterial cultures, extracted from Latvia's soil and waters. Economically available organic waste materials were used as substrates: crude glycerol (waste of bio-fuel production) and lactose as a waste of dairy production. Innovation for the bio-produced hydrogen storage is the use of selectively absorbing metal alloys.

Application of sulphur dioxide in the synthesis of high-value products

LAS academician Māris Turks (RTU), Mg. Jevgeņija Lugiņina (RTU), Dr.chem. Irina Novosjolova (RTU), Bc. Krista Suta (RTU), Mg. Daniels Posevins (RTU), Mg. Agnese Stikute (RTU), Bc. Dace Cīrule (RTU), Mg. Jevgeņija Uzuleņa (RTU), Dr.chem. Dmitrijs Stepanovs (LIOS)

Riga Technical University (RTU) Institute of Technology of Organic Chemistry

New methods for the use of sulphur dioxide in organic synthesis were developed. The reagents obtained *via* fixation of SO₂ are useful for the gas chromatographic analysis of non-volatile substances and also in the synthesis of biologically active substances. Additionally, it was discovered that liquid sulphur dioxide can be used as an easily recyclable solvent for accomplishment of various organic synthesis processes. The developed methodologies can be applied in the synthesis of pharmaceutically active substances.

New material and technology for solar energy collectors

Dr.habil.sc.ing. Gundars Mežinskis (RTU), Dr.sc.ing. Laimons Bīdermanis (RTU), Dr.sc.ing. Ilona Pavlovska (RTU), Dr.sc.ing. Andris Cimmers (RTU), Dr.sc.ing. Jānis Liepiņš (RTU), Dr.sc.ing. Kaspars Mālnieks (RTU), Dr.phys. Jevgēnijs Gabrusenoks (University of Latvia Institute of Solid State Physics)

Riga Technical University (RTU) Institute of Silicate Materials

Tubular material for high-power solar collector (HPSC) must be able to withstand continuous high temperatures, without changing their microstructure and losing its initial thermodynamic characteristics. The scientists of the Institute of Silicate Materials, RTU, in collaboration with a specialist of the Institute of Solid State Physics of University of Latvia developed a technology that allows to obtain HPSC solar energy receiving material capable to withstand 600°C for at least 250 days. This material is based on stainless steel tubular material coated with a glass-ceramic enamel containing pigments which provide black colour to the enamel. Not only specific supplements added to the enamel but also the additional sol-gel nano-coating applied to the enamel ensures the heat treatment process of the enamel and the long-term high-temperature stability.

Innovative approach to hull-less spring cereals and triticale use from human health perspective

Dr.sc.ing. Evita Straumīte, Dr.sc.ing. Dace Kļava, Dr.sc.ing. Tatjana Ķince, Dr.agr. Ieviņa Stūrīte, Dr.agr. Arta Kronberga, Dr.med. Laila Meija

Latvia University of Agriculture (LLU), Faculty of Food Technology, LLU Institute of Agricultural Resources and Economics (AREI), NIBIO (Norway), Riga Stradins University (RSU)

Latvia University of Agriculture (LLU) Faculty of Food Technology, LLU Institute of Agricultural Resources and Economics (AREI), NIBIO (Norway), Riga Stradins University (RSU) have conducted a study about hull-less barley, oats and triticale growing possibilities in Latvia and Norway, developed technology for germinated flakes production by preserving biologically active compounds, additionally clinical studies were carried out about influence of germinated flakes on human health. The overall aim of the project is to increase a knowledge on impact of triticale and hull-less spring cereal species on human health potential.