

***THEORETICAL SCIENCE***

**An unusual DNA form with an unusual packaging and genome maintenance function has been discovered in human cells**

*Dr. boil.* Kristīne Salmaņa, LAS academician *Dr.habil.med.* Jekaterina Ērenpreisa, *Dr.biol.* Tāļivaldis Freivalds, *Dr.biol.* Turs Selga, *Mg.* Germanis Sorokins, Jēkabs Krīģerts (graduate student).

Latvian Biomedical Research and Study Centre, University of Latvia, Riga Technical University

Through the use of cytophysical and cytochemical methods, a A-DNA with an unusual manner of supra-nucleosomal packaging was discovered in human cell nuclei. Up until now, this form of DNA has only been observed in viruses and dry yeast. With its unique structure and manner of packaging, this small (5%) fraction of DNA usually serves to maintain the spatial organization of chromosomes in the cell nucleus. By virtue of its unusual structure, it can help uphold genome integrity by serving as a DNA “vehicle” (comparable to railway wagons) during the routine process of “cleansing” the genetic material from “waste” of damaged DNA. The A-form of DNA, alongside the canonical B-form, was identified for the first time by Rosalind Franklin and her student Mr. Gosling, using X-ray structural analysis. These findings were then subsequently published in the same 1953 issue of *Nature* as Watson and Crick’s article on the DNA double helix. B-DNA was observed to undergo a reversible shift to the A-DNA form in conditions of reduced humidity.

**The collective monograph by an international team of scholars, philosophers and theologians, linguists, pedagogical historians offers the first interdisciplinary study of the great 18th century Baltic German enlightener *Gotthard Friedrich Stender***

The collective monograph “Gotthard Friedrich Stender (1714-1796) and the Enlightenment in the Baltics in European contexts”. Compiling editor LAS full member *Dr.philol.* Māra Grudule. Riga: UL ILFA, 2018.

University of Latvia, Institute of Literature, Folklore and Art

The collective monograph “*Gotthard Friedrich Stender (1714-1796) and the Enlightenment in the Baltics in European contexts*” (ed. M.Grudule, R., 2018) offers the first interdisciplinary study of the personality and work of the outstanding enlightener, theologian and literarian G.F.Stender. The collective monograph opens up a new, broader perspective on Stender’s activities in the German-speaking European space: a newly-revealed polemics of J.G.Herder and G.F.Stender, a first-time analysis of Stender’s prose and poetry in the context of

**the German fable's history, a first-time discussion of the links between G.F.Stender and the French enlightener de Bray; G.F.Stender's linguistic efforts in the context of German linguistic history, etc.. The collection also gives an insight into the Baltic Enlightenment processes - introduces the feminine discourse of Enlightenment, the views of G. F. Stender's contemporary G.Hamann, the connections of the Baltic and Nuremberg in the field of art, the traditions of domestic music-making, etc. It also focuses on the comparative aspect: G.Stender and Enlightenment in Lithuanian Culture, G.Stender and Georgian Enlightenment. The collective monograph includes studies in German, Latvian and English, all of which are accompanied by a comprehensive summary in German, English and Latvian, giving an opportunity to get acquainted with the content of the monograph to a wide range of European readers.**

**An overview of musical life during the decade after the WWII (1944-1953) and against the backdrop of political and social tensions in the Latvian Soviet Socialist Republic**

Arnolds Laimonis Klotiņš. The Music in Post-War Stalinism: The Musical Life and Progress in Latvia during (Mūzika pēckara staļinismā: Latvijas mūzikas dzīve un jaunrade). 1944–1953. LU LFMI, 2018.

University of Latvia, Institute of Literature, Folklore and Art

**For the first time since regaining independence, there is an overview of musical life during the decade after the WWII (1944-1953) and against the backdrop of political and social tensions in the Latvian Soviet Socialist Republic. The work of composers and performers was dictated by the ideology of the time, when between the artists and the government there was a pendulum of compliance and rebellion – the peculiar relationship of unceasing and simultaneous conflict and co-existence, which was to last for decades and still ensured the survival and progress of art, including that of music. The damage to Latvian music made by ideological constraints, as well as artistic achievements, are evaluated here scientifically.**

**The monograph provides data on the place and importance of the heritage of the art Nouveau architecture of the early 20<sup>th</sup> century in the contemporary built up environment of Latvia**

Jānis Krastiņš. Jūgendstila arhitektūra Latvijā = Art Nouveau Architecture in Latvia. Rīga: Madris, 2018. 304 pp. In Latvian and English.

**The book provides for the first time data on the place and importance of the heritage of the Art Nouveau architecture of the early 20th century in the contemporary built up environment of Latvia. The internationally well-known Art Nouveau in Rīga is analysed in the context of the contribution of individual architects. The legacy of the Art Nouveau of Liepāja is commensurate with a number of recognized European Art Nouveau centers. The Art Nouveau**

architecture in Ventspils, Jelgava and Cēsis is analysed in details. High quality examples of Art Nouveau in Daugavpils, Kuldīga, Talsi, Bauska, Smiltene and other places are analysed as well. A separate chapter is devoted to the unique heritage of Art Nouveau in Jūrmala. The architecture of Art Nouveau manor houses, hunting palaces and other buildings in rural environment is also reflected. The annexes to the book provide glossary of architectural terms, as well as registers of the buildings and persons mentioned in the text.

### Research and tools for developing the smart economy and society in Latvia

Monograph “Beyond a Century. The Smart Latvia” (“Simtam pāri. Viedā Latvija”), 2018, 416 pp. Editor-in-chief LAS academician Baiba Rivža, scientific editor *Dr.oec.* Elita Jermolajeva, managing editor Ausma Mukāne.

The monograph “Beyond a Century. The Smart Latvia” produced within the national research programme EKOSOC-LV, 416 pages in length, represents a summary of 10 research projects of EKOSOC-LV (2014–2018) regarding new approaches to the formation of a knowledge society (economic, spatial – rural and regional –, public and legal aspects) that includes a number of conclusions on and recommendations for necessary change at the current situation, which has been complexly examined, and instruments for achieving the change, including the municipality smart development index, debates at the Saeima, guidelines for ecosystem sustainability, a model for employee financial participation in the enterprise equity and a methodology for social innovation development. It is supplemented with expert opinions, examples of best practices regarding smart processes and scenarios for development in order not to be a country of a cheap workforce. The monograph gives general insight, which is important because of available fragmented relevant information, and could be used in decision making, studies and research.

## APPLIED SCIENCE

### Novel energy efficient method for preparation of long afterglow phosphors on metals

*Mg.phys.* Ivita Bite, *Mg.phys.* Guna Krieķe, *Mg.phys.* Aleksejs Zolotarjovs, *Mg.phys.* Katrīna Laganovska, *Bc.phys.* Krišjānis Auziņš, *Virgīnija Vītola*, *Dr.phys.* Krišjānis Šmits, *Dr.habil.phys.* Larisa Grigorjeva, *Dr.habil.phys.* Donats Millers, LAS academician *Dr.habil.phys.* Linards Skuja

University of Latvia, Institute of Solid State Physics (ISSP UL)

Novel method for preparation of strontium aluminate coatings with phosphorescent properties has been developed. Strontium aluminates are the most popular phosphorescent materials with long afterglow up to several hours at room temperature. Despite the great potential for commercialization and large number of scientific studies, including contribution from ISSP UL, the synthesis methods of these materials are mostly inefficient and are not

environmentally friendly. The novel method utilizes plasma electrochemical oxidation. It is energy efficient and environmentally friendly and in addition, the phosphorescent coating on metal can be prepared in single step process. The developed method has been successfully used to prepare  $\text{SrAl}_2\text{O}_4: \text{Eu}^{2+}, \text{Dy}^{3+}$  long afterglow coating on commercial industrial grade aluminium AL6082. Novelty of the research – such coating has been prepared for the first time and the possible processes during the formation of the coating in plasma electrochemical oxidation have been described. The practical applications of the developed method include the preparation of energy efficient safety and road signs, adverts and others. The researchers of ISSP UL were the first to utilize the plasma electrochemical oxidation for preparation of coatings for optical applications. The research is developed in collaboration with company from Latvia Elgo Tech. This research is supported by ERDF Project No.1.1.1.1/16/A/182.

### Neural Machine Translation System for Small Languages

*Dr.sc.comp.* Mārcis Pinnis, *Mg.sc.comp.* Rihards Krišlauks, *Mg.sc.comp.* Matīss Rikters, *B.sc.comp.* Roberts Rozis, *Dr.sc.comp.* Raivis Skadiņš, *Mg.sc.comp.* Valters Šics, *B.mgt.* Artūrs Vasiļjevs, *Dr.sc.comp.* Andrejs Vasiļevskis, LAS corresponding member *Dr.habil.sc.comp.* Juris Borzovs and *Dr.sc.comp.* Jānis Zuters.

Company “Tilde”, University of Latvia

Researchers from the company “Tilde” and the University of Latvia have developed a new machine translation technology, which is based on deep neural network machine learning methods and is especially suited for translation into Latvian and other smaller languages. The solution that was developed in the research project has won for two years in a row (in 2017 and 2018) in an international competition, which is organised annually within the scope of the Conference on Machine Translation (WMT). This shows the abilities of researchers from Latvia to outmatch technologies created by world-leading researchers and companies, such as Google and Microsoft. The solution is used in practical applications that are available to the Latvian society (translate.tilde.com), in the language technology platform of the public administration Hugo.lv, and enables translation in the translation solution of the Council of the European Union translate2018.eu, which was used in the presidencies of Estonia, Bulgaria and Austria.

### The new concept nanogenerators for mechanical to electrical energy conversion

*Dr.sc.ing.* Andris Šutka, *Dr.sc.ing.* Kaspars Mālnieks, *Dr.phys.* Artis Linarts, *Mg.sc.ing.* Linards Lapčinskis, *Dr.phys.* Juris Blūms, *Mg.sc.ing.* Ilgvars Gorņevs, *Mg.sc.ing.* Vilnis Jurķāns, *Mg.sc.ing.* Astrīda Bērziņa, LAS academician *Dr.habil.phys.* Māris Knite.

Riga Technical University, Faculty of Materials Science and Applied Chemistry, Laboratory of Technology of Functional Materials, Institute of Technical Physics

The triboelectric nanogenerator (TENG) approach has been introduced into the field of mechanical energy harvesting over the past 5 years. TENG devices are constructed from cheap flexible polymer materials and has high potential for charging portative devices, maintain sensor nodes and networks, as well as provide clean alternative to batteries. A typical TENG device is made from electrodes, covered with layers of triboelectrically active polymer materials. Friction between contact points during oscillatory motion of triboactive surfaces results in contact electrification to produce electrostatic induction and current flow between the electrodes, thus converting mechanical energy into the electricity. We have developed the new concept triboelectric-like nanogenerators where triboelectric contacting surfaces has been replaced by inversely polarised soft ferroelectric materials. This nanogenerator concept allow to observe significantly higher performance.

### **Plant virus-based universal vaccine technology for the treatment of chronic diseases**

*Dr.biol.* Ina Balķe, *Mg.biol.* Gunta Reseviĉa, Vilija Zeltiņa, LAS corresponding member *Dr.biol.* Andris Zeltiņš.

Latvian Biomedical Research and Study Centre

In collaboration with Swiss colleagues from the Universities of Bern and Zurich and British colleagues from Oxford and Dundee Universities, researchers from Plant Virology Group of the Latvian Biomedical Research and Study Centre have cloned Cucumber mosaic virus envelope protein gene from infected lily plants, inserted into its structure a fragment of the tetanus vaccine and have developed a universal vaccine platform. Using this technological platform experimental vaccines for treatment of several chronic diseases have been developed such as psoriasis, atopic dermatitis and insect-induced allergies, as well as for the prevention of Alzheimer's disease. The efficacy of created experimental vaccines is shown in animal models. Several of these vaccines have reached the technology transfer phase and are being introduced into production as well tested in veterinary trials. The research done has important theoretical and practical significance showing unknown to date aspects of therapeutic vaccination and ensuring the generation of effective vaccines against allergies and autoimmune diseases that can replace monoclonal antibodies therapies.

### **Role of peripheral innervation in wound healing**

*Dr.pharm.* Vadims Parfejevs, Prof. Una Riekstiņa, Prof. Lukas Sommer (University of Zurich).

University of Latvia, Faculty of Medicine

**Wound healing is a complicated process that aims at restoring initial structure and functions of the skin. So far not much is known about the involvement of dermal innervation in wound healing. This study demonstrates that after injury myelin sheath-forming Schwann cells detach from nerve fibres in the skin and migrate towards the wound bed to foster wound closure. Based on the changes in gene expression, we see that after injury Schwann cells acquire certain stem cell features. These activated cells can secrete proteins that change wound environment and modify the involvement of other cells (e.g. fibroblasts) in skin repair process. These findings pave the way for other studies on nerve-derived cell cross-talk with other cell types and their role in repair process of the skin and other organs.**

### **Sea buckthorn extracts developed for use in veterinary practice and farms for the improvement of animal healthcare**

LAS corresponding member *Dr.sc.ing.* Dalija Segliņa, *Dr.sc.ing.* Pawel Gornas, *Dr.sc.ing.* Vitālijs Radenkovs; *Dr.med.vet.* Laima Liepa, *Dr.med.vet.* Ilmārs Dūrītis, *Dr.med.vet.* Inga Pigiņka-Vjačeslavova, *Mg.med.vet.* Evita Zolnere.

Latvia University of Life Sciences and Technologies, Faculty of Veterinary Medicine, Institute of Horticulture

**Sea buckthorn extracts for use in the improvement of animal health were developed based on scientific studies. By-products of the sea buckthorn cultivation and processing (shoots with leaves, pomace) contain biologically active compounds, the developed extracts positively affect the immunity of newborn calves, the growth of animals and future productivity. The results of clinical trials are contributing to the production of new, natural feed additives with the potential to reduce the use of antibiotics that is important for organic farms.**

### **The original technology for the synthesis of nanoporous carbonaceous material from wood and its processing residues using thermochemical activation**

*Dr.habil.chem.* Gaļina Dobeļe, *Mg.* Aleksandrs Volperts, LAS full member *Dr.ing.* Aivars Žūriņš, *Mg.* Lilija Jašina, *Mg.* Ance Pļavniece, *Ing.* Dmitrijs Djačkovs.

Latvian State Institute of Wood Chemistry

**The original technology for the synthesis of nanoporous carbonaceous material from wood and its processing residues using thermochemical activation is developed. Process includes biomass carbonization, activation with alkali and demineralization and leads to the formation of polyaromatic structure with specific pore area up to 3000 m<sup>2</sup> /g. The relationships between porous activated carbon porous structure and its electrochemical properties were established, activation conditions were optimized and their influence on the carbonaceous material structure and functional composition was studied. Activated carbon properties and its application for environment protection, for supercapacitor**

electrodes for energy accumulation, with capacitance higher than 20% comparing to commercial carbonaceous products, as well as for oxygen reduction in fuel cells, comparable to the commercial 20% PT/C catalyst, are demonstrated.

## DIPLOMA OF THE PRESIDENT OF THE LATVIAN ACADEMY OF SCIENCES

**“Nonregular nanosystems – Theory and Applications”, Series: Lecture Notes in Nanoscale Science and Technology, 2018, Vol.26, Springer 412**

*Dr.habil.phys.* Yuri Shunin (1951-2018), PhD Stefano Bellucci (National Institute for Nuclear Physics, Frascati National Laboratory), PhD Alytis Gruodis (Vilnius University, Department of General Physics and Spectroscopy), *Dr.paed.* Tamara Lobanova-Shunina (Riga Technical University, Institute of Aeronautics, Faculty of Mechanical Engineering, Transport and Aeronautics).

The book *Nonregular Nanosystems – Theory and Applications* was published in the encyclopaedic edition – *Lecture Notes in Nanoscale Science and Technology*, volume 26, by Springer at the beginning of 2018. The book presents an original systemic view of nanophenomena in terms of disordered condensed media. This book covers multiple aspects of nonregular nanosystems arising from the fundamental properties of disordered nanosized media, from electronic structure, surface nanophysics, and allotropic forms of carbon such as graphene and fullerenes including defect characterization, to spintronics and 3D device principles. *Nonregular Nanosystems* will be of interest to students and specialists in various fields of nanotechnology and nanoscience, experts on surface nanophysics and nanochemistry, to educational professionals as well as managers dealing with marketing of nanoproducts and consumer behaviour research.

### **The unique skin cancer (melanoma) diagnostics service**

*Dr.phys.* Aleksejs Ļihačovs, *Dr.phys.* Ilze Ļihačova, *Dr.phys.* Ilona Kuzmina, *Dr.med.* Aleksandrs Derjabo, *Mg.sc.* Marta Laņģe, *BSc.med.phys.* Emīlija Vija Ploriņa, *Mg.sc.phys.* Ilze Ošiņa, *Dr.phys.* Vanesa Lukinsone, LAS academician *Dr.phys.* Jānis Spīgulis, *Dr.phys.* Mindaugas Tamošiūnas, *Dr.phys.* Rita Veilande, *Mg.sc.phys.* Mārtiņš Osis, *BSc.phys.* Gatis Tunēns, *Dr.sc.ing.* Dmitrijs Bļizņuks, *Dr.sc.ing.* Katrina Boločko, *Dr.sc.ing.* Pāvels Osipovs, *Dr.sc.ing.* Mihails Kovaļovs, *Mg.sc.* Jurijs Jonass, *Mg.sc.* Gundars Miežītis, *Mg.sc.* Andrejs Kalniņš.

University of Latvia, Institute of Atomic Physics and Spectroscopy, Riga Technical University, Faculty of Computer Science and Information Technology

**In cooperation with Riga Technical University the unique skin cancer (melanoma) diagnostics service has been developed and currently tested at the**

**general practitioner practice. Diagnostics underlies collecting images of diffuse reflectance and skin autofluorescence. The developed device uses a specific illumination of LEDs with peak emission at 405 nm, 526nm, 663nm and 964nm corresponding to the specific properties of skin chromophores and fluorophores. The developed device is intended mainly for general practitioners to perform patients full-body examination in order to detect skin cancer at early stage. The device is connected to the remote cloud service where images of the suspicious skin lesions are processed and become available to the specialist via the Internet. Diagnostics system has been clinically tested in the Latvian Oncology Center, demonstrating high diagnostics accuracy by detecting all skin cancer – melanoma cases from inspected 1000 different skin lesions.**

### **An original approach for transforming the architecture of artificial neural network into Field-programmable gate array**

LAS academician Modris Greitāns, *Dr. Kaspars Ozols, Mg.sc.ing.* Rihards Novickis, *Mg.sc.ing.* Daniels Jānis Justs.

Institute of Electronics and Computer Science

**Nowadays artificial neurons networks (ANN) are used in all areas of life – transport, production, medicine, etc. Computation of algorithms transfers from classical computers to embedded systems, including Field-programmable gate array (FPGA), thereby reducing the size, weight and energy consumption of devices. For real-time processes it is vital to ensure high refresh rate of data. Complexity of architecture of the systems increases, which makes it difficult to implement them in practice. The proposed approach transform ANN architecture into FPGA structures taking into account efficient use of resources. The approach is approbated within Horizon 2020 project 3CCar, demonstrating the four-wheel drive control of an electric car using 17 sensor data at the entrance.**

### **The Genetic Prehistory of the Baltic Sea Region**

The Genetic Prehistory of the Baltic Sea Region. Nature Communications, Vol. 9, 2018, Article number 442. DOI: 10.1038/s41467-018-02825-9.

Alissa Mitnik, Chuan-Chao Wang, Saskia Pfrenge, Mantas Daubaras, LAS full member Gunita Zariņa, Fredrik Hallgren, Raili Allmäe, Valery Khartanovich, Vyacheslav Moiseyev, Mari Törv, Anja Furtwängler, Aida Andrades Valtueña, Michal Feldman, Christos Economou, Markku Oinonen, LAS corresponding member Andrejs Vasks, Elena Balanovska, David Reich, Rimantas Jankauskas, Wolfgang Haak, Stephan Schiffels, Johannes Krause.

University of Latvia, Institute of Latvian History

**The study for the first time in the history of ancient population DNA research summarizes DNA analysis results of anthropological material from 25**



archaeological sites in territories of Lithuania, Latvia, Estonia, Sweden, Karelia and Archangelsk region. A general notion of ancient people migration in this region for the period of 7500 to 200 years BC is formed. The results obtained suggest of the Western hunter-gatherer presence to the East of the Baltic sea in the Mesolithic, which persisted throughout Early and Middle Neolithic without gene flow from the Central European farming population. Arriving of steppe pastoralists in this region during Late Neolithic introduced a major shift in economy which is being associated with expansion of the Corded Ware culture in the Northern Europe. In the context of Latvia, that means 1) arrival of farming from the South East, not from the South West as was believed before; 2) arrival of the Baltic tribes is connected to Late Neolithic, not earlier than around 2900 BC.

### **Analytical survey of sanatoriums built and arranged in the Republic of Latvia during the inter-war period of 1918-1940**

Karīna Horsta. Sanatorium Architecture in Latvia: 1918–1940. Riga: Institute of Art History of the Latvian Academy of Art; Art History Research Support Foundation, 2018. 256 pp., 274 images. ISBN 978-9934-8721-2-9. In Latvian with an English summary.

**This study is an analytical survey of sanatoriums built and arranged in the Republic of Latvia during the inter-war period, broadening the view on the healthcare architecture at that time. In Latvia's history of sanatorium architecture that began in the 1870s and lasted till the 1980s, the 1920s–30s saw the peak of the sanatorium construction type as a well-considered, stylistically consistent architectural object, organically blending in with the landscape and surrounding buildings. Leading architects of the time, like Ernests Štālbergs, Kārlis Bikše and Aleksandrs Klinklāvs, have greatly contributed to the development of Latvia's sanatorium architecture. Because of the specific requirements for sanatoriums, the researched objects are mostly located outside Riga – in rural areas and former resorts throughout Latvia. The book results from the author's Master's Thesis, defended at the Art History Department of the Latvian Academy of Art in 2016.**