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1. Fig mosaic virus was sequenced in Russia for the first time

Press Service of the National Research Center "Kurchatov Institute"
March 22, 2021

Фото: С. Чирков

Specialists of the Kurchatov Genomic Center as part of a research group for the first time studied in detail the causative agent of fig mosaic disease. The results of the work were published in the journal Plant Disease.

The mosaic virus got its name because the plants affected by it acquire the characteristic color of leaves, stems or fruits. It is common in the regions where fig trees are cultivated, including Russia, and can affect up to a third of the plantings on average.

Samples were taken in the Nikitsky Botanical Garden (Yalta).Scientists selected 59 fig trees with characteristic mosaic symptoms, isolated RNA from their leaves, sequenced, and then bioinformatically analyzed the viral material.

“The capabilities of whole genome sequencing, which the Kurchatov Institute possesses, allow carrying out genetic research at a new level. With the help of these technologies, we obtain comprehensive information about the structure of the genomes of the studied biological objects. The sequencing results allowed us to evaluate how the viruses of fig mosaic disease are arranged, how they differ from each other, how they can spread, ”explained Sergey Rastorguev, head of the bioinformatics laboratory of the Kurchatov Genome Center.

During the study, experts identified five types of fig mosaic virus. Comparison of the obtained data with international databases of genetic information made it possible to establish that the Crimean samples of the virus in nucleotide sequence more than 90% coincide with those already known. At the same time, some samples have similarities with Italian counterparts, others with Japanese ones. This indicates a complex and nonlinear evolution of this group of pathogens.

The results of the study expand knowledge about the geographical origin and routes of spread of the causative agent of fig mosaic disease, as well as about its genetic characteristics.
The work was also attended by specialists from the Moscow State University. Lomonosov and Nikitsky Botanical Garden.

2. By the end of the 21st century, trees in the north and in the mountains may become insensitive to climate change

FRC KSC SB RAS, March 22, 2021

Global warming over the past decades has intensified tree growth in most northern and upper forest habitats around the world. An international team of scientists predicted that by the beginning of the next century, provided the temperature continues to rise, the relationship between temperature change and the rate of annual growth of wood in such conditions will practically disappear. This means that the ability of trees to absorb CO2 will not increase in proportion to the increase in temperature.

Tree rings on tree cut

Over the past 100 years, global air temperatures have increased by 0.8 degrees Celsius. Global warming is projected to continue throughout the 21st century. This warming, coupled with an increase in atmospheric carbon dioxide, has accelerated tree growth in conditions where, until recently, it was limited by temperature variability. However, there is no certainty that the growth rate of the trees will continue to increase.

An international team of scientists, which included a researcher from the Krasnoyarsk Scientific Center of the SB RAS, analyzed the trends in tree growth in the 20th century and made a forecast of the impact of climate change on forest development up to the beginning of the 22nd century. The models showed that in the future, the dependence of tree growth on temperature changes will weaken, and low temperatures will no longer limit tree growth in northern latitudes.

"The growth of trees in the north at the present time, first of all, depends on the variability of summer temperature. Under these conditions, the slightest positive changes in it, especially at the beginning of summer, lead to the fact that the growth of trees accelerates. Within certain limits, there is an almost direct relationship between summer temperature and growth. However, at temperatures above a certain threshold, a tree enters the comfort zone, "explained one of the authors of the article, Doctor of Biological Sciences, leading researcher at the V.N.Sukachev SB RAS and Siberian Federal University **Alexander Kirdyanov.**

To solve a large-scale task, researchers collected data for the northern and upper forest boundaries for thirteen key forest regions of the world, including ecosystems in the tropical, temperate continental, Mediterranean, boreal and subarctic zones. The main source of information was wood cores - cylindrical wood samples with a diameter of about five millimeters used to estimate the age of trees and the rate of radial growth. To calculate climatic changes and compare them with the growth in trees, scientists used statistical data on the average monthly temperature and the amount of precipitation for 1901-2004.

Based on the data obtained, the scientists tested how the relationship between temperature and tree growth will change under moderate (0.9–2.6 ° C) and intense (1.4–4.8 ° C) warming scenarios by the end of the 21st century. Simulation of the radial growth of trees predicted a decrease in the dependence of the growth rate of trees on temperature. As soon as the summer temperature becomes comfortable for the trees, the further increase in temperature ceases to affect the formation of tree rings to the same extent. Hence, the ability to absorb CO2 from the atmosphere in trees will not increase in proportion to an increase in temperature.

“After analyzing the data for half a century (from 1950 to 2004), we showed that trees at the northern and upper border of the forest on four continents increased their growth rate. A particular acceleration has been noted since the 1980s.These changes coincide with the onset of rapid warming. However, the forecast for the same areas at the end of XXI century showed a

weakening of the relationship between changes in climatic parameters and growth in trees. We interpreted this process as a loss of sensitivity to changes in summer temperature, which will be especially noticeable in boreal forests. As the relationship between temperature and growth disappears, local conditions or competition between plants will become decisive factors. How trees will adapt to further warming is of great importance for the fate of forests in northern ecosystems," said **Alexander Kirdyanov**.

Scientists believe that the lack of dependence of growth on temperature can affect ecosystem processes in mountainous and polar regions. In particular, this will lead to the expansion of the distribution areas of trees and their colonization of mountain and tundra territories. Such changes will also affect carbon stocks, nutrient and water cycling in the mountains and in the north.

3. Bridging the gap between quantum simulators and quantum computers

March 22, 2021

The Skoltech researcher succeeded in bringing the prospects of quantum computing closer by making a discovery that proves the universal nature of their variational model. With this discovery, it becomes possible to use quantum simulators for general-purpose computing.
A quantum simulator must have the same properties as the quantum system for which it is intended to study. If the first quantum simulators were created for a specific task without the possibility of programming and tuning and simulated only one or several systems, then modern quantum simulators provide for the ability to change the settings and implement wider functionality.

Unlike a quantum simulator, the much talked about quantum computer is a fully programmable quantum system. While building a fully programmable quantum processor remains a daunting task, partially programmable noisy quantum processors capable of executing short quantum programs are already being used in leading laboratories around the world. In terms of their capabilities, such quantum processors have already come close to the more familiar quantum simulators.

Despite the fact that today's prototypes of quantum processors are still little controllable and have a high level of noise, they have undoubted advantages, which has been clearly demonstrated by Google and Chinese scientists. The superiority of quantum computing lies in the fact that quantum processors are able to solve individual problems much faster than the world's best supercomputers.

However, the superiority of quantum computing was achieved only with limited programmability: tuning a certain short quantum program or circuit is possible only if subsequent simplified quantum measurements are performed. The question that now worries researchers around the world: to what extent can such a simplified approach be developed in relation to applications that, in addition to quantum superiority, will also have real, practical advantages?

"When will a quantum simulator turn into a quantum computer? Quantum processors from Google and other companies are often said to be "somewhere between a specialized quantum simulator and a programmable quantum computer." Google and other developers took a special variational approach, which consisted of tuning a quantum circuit to minimize the cost function computed by classical methods. As it turns out, this approach is a universal model of quantum computing, which means that a quantum simulator needs only some additional

control settings to execute general quantum algorithms, ”says Jacob Biamonte, head of the Laboratory for Quantum Information Processing, Skoltech Associate Professor.

According to the publishers of Physical Review A., Biamonte proved "that the modern variational approach to quantum algorithms allows us to create a universal model of quantum computing." The publishers also claim that "this approach narrows the gap between the resources required for general purpose quantum computing and modern quantum processors."

“This research helped bridge the gap between a programmable quantum simulator and a universal quantum computer. The variational approach will allow realizing full-fledged quantum algorithms on modern quantum devices, ”adds Jacob Biamonte.

4. Anti-corrosion detergent

Source: pnzgu.ru, March 22, 2021

At the Penza State University, scientists have developed a new method of applying galvanic coatings with an indium-lead alloy with a surfactant - a detergent.

The method includes electrode-position of an alloy from an electrolyte, which contains: lead acetate, indium nitrate, sodium acetate, acetic acid and additionally, as a surfactant organic substance, a detergent "Drop VOX superactive oxygen".The deposition is carried out using inert anodes, forming uniform fine-crystalline coatings with an indium-lead alloy with an indium content of 12 to 86%.

As a result, uniform, well-adhered to the base coating with an indium-lead alloy with an indium content of 12 to 86%, with a sufficiently high current efficiency are obtained.
The invention can be used to apply protective corrosion-resistant coatings that have good solder-ability and anti-friction properties.

The opening was reported at the Department of Chemistry of the Faculty of Industrial Technologies, Power Engineering and Transport of the Polytechnic Institute of PSU: "The coating has sufficiently high corrosion, anti-friction and electrical properties, as well as a low melting point."
The use of the VOX Super Active Oxygen Drop detergent does not create additional difficulties in the disposal of waste water and spent electrolyte.

5. Physicists of Moscow State University have developed a new method for detecting thyroid tumors

Source: Moscow State Univ, March 22, 2021

Employees of the Moscow State University scientific school "Photonic and Quantum Technologies. Digital Medicine" have developed methods of terahertz (THz) pulsed spectroscopy in the time domain using machine learning methods for detecting thyroid tumors. The work was published in the journal Biomed.Opt.Express

Terahertz (THz) spectroscopy has repeatedly confirmed its sensitivity to many metabolites in human tissues, which makes it possible to use it for the diagnosis of various diseases, including cancer and diabetes. However, the sensitivity of THz methods is limited, and therefore the task of increasing it is urgent. The use of meta-materials in the THz range allows one to cope with some limitations and expand the field of application of THz spectroscopy in the fields of biology and medicine.

Employees of the Physics Faculty of Moscow State University studied the blood plasma of patients in liquid and lyophilized form. The THz spectra of the absorption coefficient and refractive index for liquid plasma are reliably separated only for healthy people and patients with thyroid diseases, while for dry plasma there is a separation also within the group of patients with diseases.Thus, THz spectroscopy of lyophilized plasma allows the separation of patients with benign and malignant thyroid tumors. This division is confirmed by the correlation of THz absorption spectra with the concentration of glucose and tumor markers in the plasma of patients, as well as by the results of machine learning.

It has been proven that THz TDS can be sensitive to changes in blood composition depending on the degree of malignancy of the thyroid nodules. The use of machine learning methods makes it possible to increase the degree of differentiation, which gives hope that THz spectroscopy will be used in medical and biological practice on a par with other known methods.

6. Development of the NTI Central Committee based on Skoltech will reduce the risk of heart attacks and strokes in hazardous jobs

Source: Skoltech, March 23, 2021

Skoltech-based specialists from the NTI Competence Center have learned how to use data from standard wearable heart rate monitors to reduce the error in blood pressure measurements. The developed algorithms based on machine learning technologies and deep neural networks will in the future be used in compact devices for continuous monitoring of the health of employees at hazardous jobs and people from various risk groups.

The rise in blood pressure is often imperceptible to humans. However, this deviation from the norm dramatically increases the likelihood of developing heart disease. For the timely diagnosis of problems associated with changes in pressure (hypertension or hypotension), the doctor needs data from regular observations. Sudden pressure surges, both up and down, not only pose a threat to the health of a particular person, but can also pose a danger to other people if loss of consciousness, heart attack or stroke occurs, for example, in a bus driver, pilot or train driver.

The usual way to measure blood pressure - with a cuff that is placed on the arm - is simple, but not mobile enough. It is difficult to imagine a taxi driver or crane operator, every now and then distracted by such a procedure. At the same time, another indicator of the work of the heart - the pulse - has long been sufficiently accurate to measure with a heart rate monitor, which is a small wearable device. A light emitting diode installed in it directs a beam of light to the wrist, which is reflected and received by a photo-resistor (light-sensitive sensor). Part of the light transmitted through the skin is absorbed by the

blood, which flows through the artery, and part is reflected back and enters the photoresistor. This method of measuring the pulse, photoplethysmography, is based on the fact that the volume of blood in an artery depends on the current phase of the pulse,

Photoplethysmography has long been suggested to be used to measure pressure, but the achieved measurement accuracy was not sufficient from the point of view of doctors. Only in recent years, with the development of compact sensor technologies and with an increase in the speed of digital signal processing, it has become possible to offer the medical community a tonometer in a wearable form factor (as evidenced by the abundant compact tonometers and pressure measuring smart watches that are abundantly appearing on the shelves).

During the research, a team of scientists from the Skoltech-based NTI Competence Center under the leadership of Professor Dmitry Dylov realized how, using artificial intelligence, it is possible to use photoplethysmography data as much as possible to reduce the error in measuring blood pressure in wearable devices.

The research was carried out with the financial support of NTI.“I am very glad that under the auspices of NTI a number of completely new breakthrough projects are being born, including in the field of artificial intelligence in medicine. Among them are the development of the team of Professor Dylov, as well as the successfully completed project "CoBrain-Analytics" of NTI, whose flagship developments, as you know, formed the basis of the emerging ecosystem for the development of artificial intelligence in healthcare in Russia, which is coordinated by SberMedII ", - comments Alexander Kuleshov, academician RAS and rector of Skoltech.

As Dmitry Dylov explains, the device on the wrist measures not the pulse itself, but the entire pulse wave, including all its shape bends, time delays and even those abstract signs that are inaccessible to the human eye, but are "visible" to artificial intelligence neural networks. “This waveform contains a lot of useful information that classical signal processing methods were previously unable to capture. As a result, blood pressure readings can be calculated and displayed with an accuracy that surpasses that of other compact blood pressure monitors, ”says the scientist.

To train the neural networks, the researchers used both sensor readings from their laboratory and extensive data from publicly available sources. “Also, within the framework of the agreement with Skoltech, indirectly useful data - electrocardiogram - is shared with us by the national cardio center, for which we are very grateful to them,” Dylov notes.

At the moment, the team has developed a set of algorithms, having done a tremendous job of comparing existing approaches for analyzing photoplethysmogram data, which made it possible to understand their limitations and, accordingly, see a "niche" for inventions. “At this stage, we are engaged in setting and adapting algorithms for different data sets and devices. We also created a working prototype of a wearable tonometer for laboratory testing and testing the interaction of software and hardware solutions, ”says the chief engineer of the project Yevgeny Borisov.

“Our benchmark is maximum compatibility with devices and software environments. In general, only those algorithms that are initially aimed at universality can withstand competition in the market. Anyone who already uses a smart-watch will understand everything without further explanation by seeing the pressure readings on the screen. The settings themselves may vary. For example, measurements will be made at some frequency or on demand, and the results can be stored on the device, transmitted to a doctor or to the control center of a medical

institution. But all these are the nuances of digital platforms and standards, of which such devices become a part, ”adds Dylov.
He notes that already today scientific articles are being published in which the functional pulsation of blood on the skin of patients can be restored from the analytics of simple video filming.“So far, in terms of measurement accuracy, these technologies are far from perfect, but the interest of investors is undeniable, which will inevitably lead to the stimulation of the development of“ remote sensing ”algorithms and to the appearance of corresponding products in the future,” Dylov concludes.

7. Scientists have collected new reference mosquito genomes to fight malaria

ITMO University Press Service, March 23, 2021

A team of researchers from Virginia Polytechnic Institute, George Washington University and ITMO University have presented new data to study the behavior and physiology of two species of malaria mosquito. The information will accelerate the search for regions of the genome responsible for communication with the causative agent of malaria, as well as regions associated with the habit of biting humans. The work of scientists is published in the journal GigaScience.

Anopheles mosquitoes include 400 species of insects, and 30 of them are considered the main vectors. Malaria is caused by the parasite Plasmodium, which mosquitoes transmit to humans when bitten. To combat the disease, it is important to understand how the differences in the feeding behavior of mosquito-carriers and their safer "relatives" are formed at the genetic level. The knowledge gained can help find ways to influence the “diet” of specific species so that malaria mosquitoes either stop feeding on human blood or no longer carry parasites. If earlier scientists had a reference genome of only one species of Anopheles gambiae, now they have at their disposal two more species of African malaria mosquito: Anopheles coluzzii and Anopheles arabiensis.

Many short stretches of DNA are assembled into several long sequences. This process is called genome assembly. The best assemblies for a particular species are called reference assemblies. In fact, these are "averaged" genomes of an organism, with the help of which they find the differences of some individuals or populations from each other.

“Assembling the genome of a mosquito is a medium-level task. On the one hand, it has a fairly large genome: about 300 million characters, only ten times less than that of a human. On the other hand, mosquitoes have only three pairs of chromosomes, not 23 as in humans. Since little genetic material is obtained from one mosquito, we used material from the entire colony, that is, the DNA of many individuals enters the sequencer at once. As a result, we see all the individual differences of individual mosquitoes that need to be leveled in order to assemble a reference genome, ”explains

Anton Zamyatin, an employee of the Research and Education Center for Genomic Diversity at ITMO University.

The research began in 2018. Genome isolation and sequencing were performed at Virginia Polytechnic University. There, scientists keep, for experimental purposes, entire colonies of insects, divided by species. After that, ITMO University specialists started assembling the genome. ITMO scientists are planning new projects related to assembling reference genomes of other types of malaria mosquitoes.

8. MSU scientists to create single-photon light sources on a chip

MSU Press Service, March 23, 2021

Scientists from the Center for Quantum Technologies of the Physics Faculty of Moscow State University are working on the creation of single-photon emitters. At the moment, the research phase of the work is being completed, and by the end of the year, prototypes of the devices will be released. In the future, such emitters will help make optical circuits used in quantum computers and quantum cryptography systems more compact and more economical to manufacture. In addition, the emitter solves the important problem of equipment import substitution.
Single-photon light sources (single-photon emitters) are sources that emit light in the form of individual photons.They are one of the key elements in many problems in the field of quantum informatics, including quantum computing and quantum cryptography.Such devices are nanodiamonds with color centers deposited on the surface of a photonic crystal that supports the propagation of surface electromagnetic waves called Bloch surface waves (BSW).Nanodiamonds are coated with a polymer layer, and then waveguide structures are created in the region of nanodiamonds with a single color center using the method of two-photon laser lithography.In this way,“The key difference of this development from other single-photon emitters is the use of Bloch surface waves.This is a type of electromagnetic waves that propagate along the surface of a photonic crystal - a structure consisting of periodically alternating layers of dielectric materials, ”said Andrey Fedyanin , head of the nanophotonics sector of the Center for Quantum Technologies of Moscow State University, Doctor of Physical and Mathematical Sciences, Professor of the Russian Academy of Sciences, Vice-Rector of Moscow State University.At the moment, BPWs are being actively investigated for use in integrated optical circuits due to their unique characteristics. For example, the dispersion law of the BPW is determined by the parameters of the photonic crystal (materials and layer thicknesses), and it is possible to achieve the existence of the BPW in any given region of the spectrum. In addition, the use of exclusively dielectric materials leads to a long propagation length of the BPW in the visible range of radiation, which is especially important for the integration of single-photon sources emitting in this range.

“ The main advantage of solid-state single-photon sources based on nanodiamonds being developed at the Moscow State University's CCT is their integration with wave guide structures. Thus, single photons emitted by a source can immediately enter integrated-optical circuits for quantum computing without the need for bulk optical elements. This significantly improves the convenience of working with single-photon sources, ” notes Kirill Safrono, a researcher at the Moscow State University's CCT .-It is also important to note the more convenient and cost-effective manufacture of such devices, which provides the use of inexpensive technology of two-photon laser lithography. Thanks to it, it is possible to create complex compact integrated-optical structures in a single lithography cycle without

increasing the cost of the final device. In addition, potentially single-photon sources based on nano-diamonds can be replaced by any other nano-scale solid-state sources without significantly changing the procedure for their integration into wave-guides. "

The task of creating a single-photon source integrated on a chip is part of a larger-scale project to control Bloch surface waves using dielectric structures on the surface of a one-dimensional photonic crystal, which is being implemented by a group of scientists from the nanophotonics sector of the Center for Quantum Technologies under the leadership of Professor A.A. Fedyanin. This project is aimed at solving the fundamental problem of developing new methods for controlling the generation and propagation of Bloch surface electromagnetic waves at the one-dimensional photonic crystal - dielectric interface. The solution of this problem is necessary for the development of the fundamental foundations of a new all-dielectric integrated optics platform based on Bloch surface waves.
In addition to solid-state single-photon sources, which are being developed at the Center for Quantum Technologies, there are other options. In particular, the development of sources based on colloidal crystals, from a superconducting qubit, based on semiconductor nano-structures is underway.

9. Life-related molecules of a carbon ring have been discovered in space for the first time

Source: Scientific Russia news, March 23, 2021

For the first time, complex carbon-containing molecules have been discovered in space that may help explain the origin of life,*sciencenews.org* **writes, citing Science.**

These molecules, called polycyclic aromatic hydrocarbons or PAHs, are composed of several linked hexagonal carbon rings with hydrogen atoms at their edges. Astronomers have suspected for decades that these molecules are abundant in space, but none of them have been directly detected before.

Simpler molecules with one carbon ring have been observed before. But "we are now delighted to see that we can detect these larger PAHs for the first time in space," says astro-chemist Brett McGuire of the Massachusetts Institute of Technology.

Studying these and similar molecules could help scientists understand how the chemical precursors of life could have appeared in space. “Carbon is a fundamental part of chemical reactions, especially reactions that lead to vital molecules,” says McGuire. "This is our window to their huge reservoir."

Since the 1980s, astronomers have observed mysterious infrared light emanating from points in our galaxy and elsewhere. Many suspected that the glow was from PAHs, but were unable to identify a specific source. Signals from several different PAHs overlap too much to distinguish between them - it's like mixing voices in a choir.

Instead of looking for one voice in infrared signals, McGuire and his colleagues turned to radio waves when different PAHs sing different songs. The team trained the powerful Green Bank Telescope in West Virginia on TMC-1, a dark cloud about 430 light years from Earth, near the constellation Taurus.
McGuire previously discovered that the cloud contains benzonitrile, a molecule composed of a single carbon ring. So he thought it was a good place to look for more complex molecules.

The team discovered 1- and 2-cyanonaphthalene, two-ring molecules with 10 carbon atoms, eight hydrogen atoms and a nitrogen atom.The concentration is rather vague, McGuire said: "If you fill the inside of your average compact car with [gas] TMC-1, you have less than 10 molecules of every PAH we find."

But this was much more than the team expected. The cloud contains 100,000 to 1 million times more PAHs than theoretical models predict.“This is crazy, this is too weird,” says McGuire.

PAHs are believed to be formed in space in two ways: from the ashes of dead stars or through direct chemical reactions in interstellar space. Since TMC-1 is just beginning to form stars, McGuire expected any PAHs it contained would be formed from direct chemical reactions in space.But this scenario cannot explain all of the PAH molecules the team found. Star Ash explains too much too. This means that something is probably missing from astrochemists' theories of how PAHs might form in space.
"We're working here in uncharted territory," he says, "which is very interesting."

Identifying PAHs in space is "a big deal," says astrochemist Alessandra Ricca of the SETI Institute in Mountain View, California, who was not involved in the new study. The work “is the first to show that these PAH molecules actually exist in space,” she says."It used to be just a hypothesis."

Ricky's team is working on a database of PAH infrared signals that can be found by the James Webb Space Telescope, which is scheduled to launch in October.“All of this will be very useful for researching carbon in the universe,” she says.

10. Energy of black holes

Source: KFU, March 23, 2021

Kazan Federal University scientists have discovered 20 supermassive black holes located 8-12 billion light-years from Earth.

Employees of the Department of Astronomy and Space Geodesy of the Institute of Physics of Kazan Federal University have recorded twenty new quasars. The discovery was made through optical identification of space objects, which are detected by the orbiting X-ray observatory "Spektr-RG". The research results of the first group of 9 objects are published in the Russian edition of Letters to Astronomical Journal. The English translation of the article is also available on the Springer website. Experts

continue to study the second group, which includes 12 distant quasars.

On July 13, 2019, the Spektr-RG spacecraft was launched at the L2 Lagrange point (its distance is about 1.5 million kilometers from the Earth). An observatory was created with the participation of Germany within the framework of the Federal Space Program of Russia by order of the Russian Academy of Sciences. It is equipped with two unique X-ray mirror telescopes: the Russian ART-XC and the German eROSITA. The latter works on the principle of oblique incidence X-ray optics. The project is being implemented by the Space Research Institute of the Russian Academy of Sciences in cooperation with Roscosmos and the German Space Agency under the leadership of RAS Academician, Honorary Professor of Kazan University Rashid Sunyaev. The goal of the project is to build the world's most accurate map of the Universe in the X-ray wavelength range.

According to the first author of the publication, Professor of the Department of Astronomy and Space Geodesy, Corresponding Member of the Academy of Sciences of the Republic of Tatarstan Ilfan Bikmaev, the map of the Universe was built at the IKI RAS as a result of two scans of the celestial sphere (there will be eight in total). It includes about a million X-ray sources. This is almost two times more than was discovered during the entire existence of X-ray astronomy by all the satellites of the world.

“Three quarters of these sources are quasars and galaxies with active nuclei (these are supermassive black holes with masses of 10-100 million solar masses). The remaining 250 thousand sources include galaxy clusters, close binary systems in our Galaxy, stars close to the Sun with magnetic and chromospheric activity, says Ilfan Fyaritovich... - Unfortunately, it is impossible to establish the astrophysical nature of the newly discovered sources and classify them only from X-ray observations of the Spektr-RG satellite. To solve the problem of optical identification and classification of sources, both electronic archives of optical and infrared telescopes of the world posted on the Internet are involved, as well as operating ground-based optical telescopes. The staff of the IKI RAS created a computer program SRGz, which works with large databases (Big Data) according to the principle of a neural network. It makes it possible to select from a million SRH X-ray sources a hundred necessary, most interesting objects - candidates for distant quasars. However, the reliability of their real belonging to quasars must be checked using ground-based optical telescopes. In these studies, the KFU RTT-150 telescope installed in the mountains of Turkey is involved. On it we performed (for the first time in the history of Kazan astronomy) spectroscopic observations of twenty distant quasars at redshifts z = 2.5-4.5 (distances of 10-12 billion light years), discovered in the X-ray range by the Spektr-RG orbital observatory in 2020. It is gratifying to note that young researchers from KFU are taking part in this study: Eldar Irtuganov, Evgenia Nikolaeva, Alexander Sklyanov, Maxim Glushkov ".

Quasars are supermassive black holes. Their mass reaches 1 billion solar masses at the centers of young galaxies in the early Universe. They have a high rate of accretion (an increase in the mass of a celestial body by the gravitational attraction of matter, usually gas, onto it from the surrounding space) and therefore emit an enormous amount of energy. Because of which they are found at cosmological distances of 8-12 billion light years.

According to the astronomer, the lines of hydrogen Lyman-alpha (1216 Angstrom), carbon C IV (1549 Angstrom) and other chemical elements are detected in the optical spectra of quasars, which were obtained on

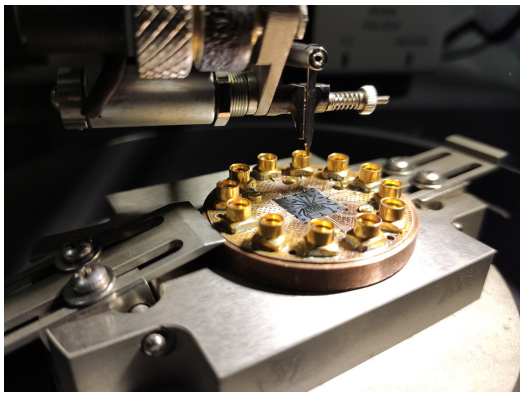
RTT-150. They are formed in the ultraviolet range, while being recorded in the optical range of the spectrum. This is due to the physical Doppler effect and the expansion of the Universe at high speeds at high redshifts.

“Close quasars at low redshifts (z = 1–2) were previously detected in large numbers (40,000–50,000) by mass photometric and spectroscopic observations at various survey telescopes around the world. However, the number of the most distant quasars at redshifts z = 3-5 turns out to be much smaller (100-1000). The reason may be due to both the selectivity of observations (distant quasars are weak sources in the sky, and they are difficult to detect), and physical reasons - there were few of them in the early stages of the evolution of the Universe, ”the professor explained.He also emphasized that the Spektr-RG observatory has the potential to detect quasar candidates at large distances. This is achieved due to the high X-ray sensitivity of the equipment.

“We have long dreamed that someday, being in Kazan, at a distance of 2.5 thousand kilometers from the RTT-150 telescope, we will be able to carry out observations on it remotely. In April 2020, the dream came true - remote observation consoles were organized in the building of the department. Of course, this was partly due to the restrictions on international travel in 2020, but despite these restrictions, we were able to continue observing the RTT-150 in the KFU time quota. Twenty distant quasars became the first objects that were discovered by us during remote observations from Kazan, from Kazan Federal University , ”Ilfan Bikmaev said in conclusion.

11. Physicists at MIPT brought the creation of a quantum computer closer to Russia

April 1, 2021 MIPT Press Service



For the first time in Russia, a quantum integrated circuit based on five superconducting qubits has been created in the laboratory of artificial quantum systems at the Moscow Institute of Physics and Technology. It is an important step towards the development of full-scale general purpose quantum processors and simulators. This unique and fully controllable multi-qubit quantum circuit can be considered a prototype of a quantum processor, of which there are very few in the world.

The new device can already be used in quantum machine learning - a field of science at the intersection of quantum physics and data processing. Quantum systems can speed up computations and reduce the number of parameters in a neural network. Thanks to this, quantum neural networks become more expressive and allow you to describe the problem with fewer parameters. The system will also help in the study of approaches to the creation of quantum simulators that serve to

controlled imitation of the behavior of natural systems that defy classical calculations.
The world's leading scientific centers are working on the creation of a universal quantum computer capable of solving any algorithmic problem. However, it is more likely that it is quantum simulators for machine learning that will allow the technology to be commercialized in the very near future and will bring the moment of emergence of universal devices closer.

The integrated circuit was developed in the laboratory of artificial quantum systems of the Moscow Institute of Physics and Technology and manufactured on the technological basis of the Center for Collective Use of the Moscow Phystech. The first measurements showed that all circuit elements operate with expected parameters. At the moment, MIPT has a unique opportunity to independently develop, manufacture and test quantum devices.

Alexei Bolgar, one of the developers of the circuit, a researcher at the Laboratory of Artificial Quantum Systems at the Moscow Institute of Physics and Technology, commented: “After receiving the first Russian qubit in 2015 within the walls of our laboratory, we learned a lot. All these years, the employees of the MIPT Center for Collective Use and the laboratory have been working on improving the technology for fabricating superconducting quantum structures with various architectures. As a result we now have technology that is already robust enough to create multi-qubit computing devices. The integrated quantum circuit we have created, in contrast to the prototypes previously developed in Russia, allows you to fully control the state of all five qubits. Such integrated circuits are needed to create a universal quantum computer based on superconducting qubits. This is a great technological success. "

The current achievement was made possible by several key facts. Firstly, the staff of the Center for Collective Use of the university and the technologists of the laboratory managed to significantly improve the control of the geometric and electrical parameters of the tunnel contacts. These contacts are the "heart" of superconducting qubits; the performance of the entire quantum circuit depends on the quality and reproducibility of their manufacture.

Secondly, the technology of manufacturing microwave resonators was debugged, the Q-factor of which in the single-photon mode is hundreds of thousands. Such high-Q resonators are an integral part of a quantum integrated circuit - they are located on a chip near qubits and serve to read out their quantum state.

The third important milestone in the development of the technology was the debugging of the process of manufacturing hinged bridges - the so-called air bridges, which allow suppressing parasitic resonant modes and thereby increasing the Q-factor of structures.
Finally, the fourth and perhaps the most important component of success is the experience accumulated by the staff of the MIPT Technology Center and the Laboratory of Artificial Quantum Systems in recent years. A well-coordinated team of talented and enthusiastic researchers has been formed here. And it, by the way, continues to grow, because the system of training students at MIPT allows talented people to carry out research work directly in scientific laboratories.

Alexey Bolgar adds: “Our current results indicate that the technological and measurement capabilities of the Center for Collective Use and our laboratory allow us to work out and perform all the steps necessary to create elements of quantum processors, from technological drawings to an integrated quantum circuit on a chip and its measurements. However, further development of work on the creation of

controllable elements of a quantum computer and the computer itself will require the modernization of the “clean zone” of the CCU and additional equipping of the laboratory with modern research equipment ”.

12. Russian and German scientists have proposed a method for energy efficient oil production

Perm Polytechnic Press Service , April 2, 2021

On April 4, Russia and some other CIS countries celebrate the day of the geologist. It is considered a professional holiday by specialists who are associated with the search and extraction of minerals. Scientists of the Perm Polytechnic University and their colleagues from the Cologne University of Applied Sciences (Germany) are developing a software package that will help to make the most rational use of natural resources in oil and gas production. The development has no analogues in Russia and in the world.

The researchers plan to implement the software package using funds allocated by the government of the Perm Territory in 2020.The support amounted to 9 million rubles and will last 3 years.The development became possible thanks to a unique project of international research groups (MIGs), which has been operating in the Perm Territory since 2011 and has no analogues in Russia.

Scientists create a software package in cooperation with the Perm scientific and educational center of the world level "Rational Subsoil Use".

We are developing a kind of "digital twin" of water flows of an oil field, which will allow more rational use of natural resources, minimize or prevent pollution of the geological environment. Due to “smart” water use, enterprises will also be able to reduce energy consumption without reducing oil production,” says **Larisa Rudakova, the project** manager from the Russian side, Doctor of Technical Sciences, Professor, Head of the Environmental Protection Department of the Perm Polytechnic University.

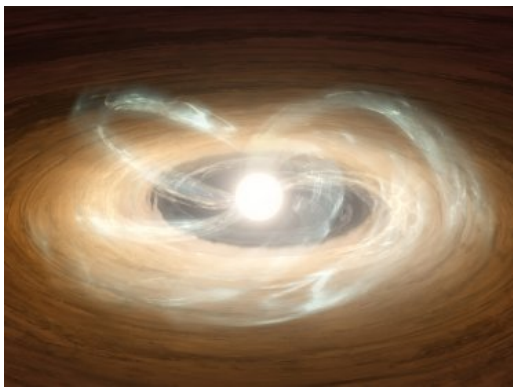
The software package will allow you to control the process of artificial water flooding of oil reservoirs, which is used to increase the production of "black gold".The technology will ensure the most efficient field development.

- Together with colleagues from the Cologne University of Applied Sciences under the guidance of Professor Frank Rögener, we take into account the world's leading practices for handling water flows in oil production areas.The software package will be created on the basis of unique predictive analysis algorithms. This will make it possible to accurately calculate the change in the reservoir properties of wells, evaluate the effectiveness of their development and determine how injection and production wells affect each other, - the scientist notes.

Unlike analogs, the complex will allow assessing the technical condition of the equipment. For example, the system will be able to predict the corrosion process in time and determine the resource of pipelines. Enterprises will be able to integrate development into their databases.
The software package will be useful for oil and gas companies, scientists say. Algorithms and models can be used in other industries, as well as for rational water consumption in the housing and utilities sector.

13. New Sun

Source: SFU, April 15, 2021



Scientists at the Southern Federal University studied the luminosity flares of young protostars, which, according to some sources, occurred in the early stages of the formation of the Sun.

The study of the formation processes of stars and planets is one of the leading areas of modern astrophysics. Observations of foci of star formation in the vicinity of the Sun using ground-based and space telescopes, supplemented by highly efficient numerical simulations on modern supercomputers, contributed to a quantum leap in understanding the processes of star formation and planet formation. But despite this, there is a class of young protostars, whose behavior, according to experts, is difficult to fit into classical theories. They are called fuors after the first discovered FU object in the constellation Orion.

Fuors are distinguished by spontaneous and unpredictable flashes of luminosity lasting tens and even hundreds of years, during which the amount of emitted energy can increase hundreds of times.

“Had such a flash on the Sun now, it would undoubtedly lead to catastrophic consequences for all life on Earth. However, in the early stages of star formation, the outbursts of fuors can be of fundamental importance for chemical synthesis and the formation of primary blocks of protoplanets in the protoplanetary disk surrounding the star , ”said **Vardan Elbakyan,** senior researcher at the Scientific Research Institute of Physics of the Southern Federal University.

Experts note that some data in primary meteorites may indicate the existence of such flashes of luminosity in the early stages of the formation of the Protosun.

14. The first climatic REC is created in Russia

Source: minobrnauki.gov.ru, April 15, 2021

A scientific and educational center (REC) will appear in Russia, which will specialize in the study of climate and carbon footprint. The website of the Ministry of Education and Science informs about it.

The rector of the Siberian Federal University Maxim Rumyantsev spoke about the scientific and educational center at the Krasnoyarsk Economic Forum.According to Maxim Rumyantsev, the activities of the climate REC will be focused on three key areas:

- scientific substantiation of the carbon sequestration capabilities of forests and soil;
- development and implementation of available technologies to reduce the carbon footprint of industrial and energy enterprises;
- creation of a network of carbon polygons.

To build a reliable and internationally recognized system for monitoring greenhouse gas emissions, the Ministry of Science and Higher Education of the Russian Federation has launched a pilot project to create test sites for

the development and testing of technologies for monitoring carbon balance.

“The strategy of scientific and technological development of the Russian Federation is aimed at transforming science and technology and ensuring the country's ability to effectively respond to major challenges. Therefore, issues related to the study of climate change and the assessment of the consequences of climate change on the socio-economic activities of a person, region, country, are a priority, ”said the head of the Russian Ministry of Education Valery Falkov.
The work on the new REC is of a systemic nature: the Governor of the Krasnoyarsk Territory, Alexander Uss, signed a corresponding order on the establishment of the Center. Currently, the list of participants has been formed and the ideology of work has been determined in accordance with the priorities of technological development of industrial partners.

15. A new way to protect liver cells

Source: Russian Medical Journal, April 15, 2021

Russian scientists have proven the ability of Siberian fir terpenes to restore and protect liver cells

The trunk and roots of Siberian fir contain natural terpenes. They have the strongest hepatoprotective properties and are able to protect and restore liver cells after such adverse effects as alcohol intoxication, malnutrition, viral infections, drug and chemotherapy. This is the conclusion reached by Russian scientists from the Institute of Organic Chemistry named after A.E. Arbuzov of the Kazan Scientific Center of the Russian Academy of Sciences and the research and production company "Initium-Pharm", studying the properties of terpenes for more than 30 years.

Terpenes are a broad class of secondary metabolites found in a variety of herbs, flowers, trees, fruit and vegetable crops.

“Plants secrete protective substances - terpenes, which keep cells in a stable state even under adverse stress conditions. Terpen is actually a stress hormone of a plant cell, - says the candidate of medical sciences, an employee of the research and production company "Initium-Pharm" **Ludmila Lacerus** , - At the same time, a plant cell has a similar structure to an animal cell. And what protects the plant cell cannot but affect human cells. That is why we used this idea for our scientific developments. "

In the process of incorporation into the human body, terpenes are either intermediate or initial links in the synthesis of cholesterol, squalene, sex hormones, steroid hormones, enzymes, that is, all substances necessary for healthy life. Such terpenes have been used for the prevention and treatment of various diseases for many thousands of years, but scientists are only now learning about the hepatoprotective properties of terpenes.

Scientists have studied the terpenes found in conifers, namely in the roots and trunk of Siberian fir. After all, conifers are very stable plant creatures, long-livers, some of them live for 4 thousand years. Thanks to terpenes that

protect cells from adverse effects, conifers do not shed their foliage in 60 degrees frost and 40 degrees heat.

In order to prove the hepatoprotective properties of terpenes, scientists conducted an experiment during which rats were injected with ethanol diluted with water and terpene-containing drugs for a month. As a result, it was found that under the influence of terpenes in alcoholic rats, the biochemical parameters of the blood normalize, the severity of damage to the liver cells decreases, and the mass coefficient of the liver decreases. The research results are published in the April issue of Clinical Guidelines and Algorithms.

“Alcoholic liver damage is just one model of adverse effects. Our studies show promising use of terpenes to protect the liver from any toxic effects, for example because of irregularities in the diet, chemotherapy, long-term use of drugs, virus exposure " , - said Lyudmila Latserus.

According to her, terpenes, showing high pharmacological activity, do not have unwanted side effects on the entire body and do not create pharmacological burden.

“Of course, as with any natural compound, an allergic reaction to terpenes is possible, we cannot rule out this. But terpenes are not such a foreign compound. We have all been in coniferous forests, we all like the coniferous smell, we know how good it is to breathe in a coniferous forest, and we even think how good it would be to put it in a test tube. So what we breathe in the coniferous forest is now available in a test tube, ”explains the researcher.

Doctor of Medical Sciences, Professor of the Department of Gastroentorology and Scientific Secretary of the Academic Council of the Central State Medical Academy of the Administrative Department of the President of the Russian Federation **Igor Zverkov** noted that the properties of terpenes discovered by Russian scientists will not go unnoticed by the medical community.

“Terpenes are a class of compounds that doctors and humans know very little about. Vitamins are heard, flavonoids are also heard, and the fact that we need terpenes for our body to function normally, we do not fully understand. I think that in the future the use of terpenes in preventive medicine would be for us as commonplace as the use of complex vitamins in',- says **Igor Zverkov.**

16. Rare earth metal will help compress gas

Source: South Ural Panorama, April 15, 2021

For storage and transportation of gas, it is converted into a liquid state - so it takes up 600 times less volume. The gas liquefies under the influence of ultra-low temperatures. The technology of magnetic cooling works according to this principle, the meaning of which is the ability of materials to change temperature under the influence of a magnetic field.

Chelyabinsk scientists have found that solid solutions of the rare earth metal dysprosium

make it possible to "tune" the required temperatures of the magnetic phase transition. Great opportunities in this regard are opened by a solid solution of dysprosium with yttrium.

Dmitry Bataev, head of the SUSU functional materials laboratory, says that the "behavior" of solid solutions of these metals is very unusual. If, with the addition of yttrium, an external magnetic field is applied to a substance, it acquires spontaneous magnetization. And it sharply enhances the "refrigerating" properties of such a material.

Dysprosium and its solid solutions attract researchers by their magnetic properties and the ability to set the temperature of the magnetic phase transition. Scientists will continue to study the beneficial properties of the rare earth element, creating compounds with different temperature ranges.

17. Biotechnologists have found a way to extract rare metals from smartphone screens

Source: Perm Polytechnic University, April 15, 2021.

On April 15, many countries around the world celebrate the Day of Environmental Knowledge. By 2020, 53.6 million tonnes of e-waste have accumulated worldwide, including non-working electrical devices and smartphones. A young researcher from the Perm Polytechnic Institute has developed a method for extracting rare and expensive metals from monitors and screens, which has no analogues in the world. The group of scientists presented the first results of the research in the E3S Web of Conferences magazine.

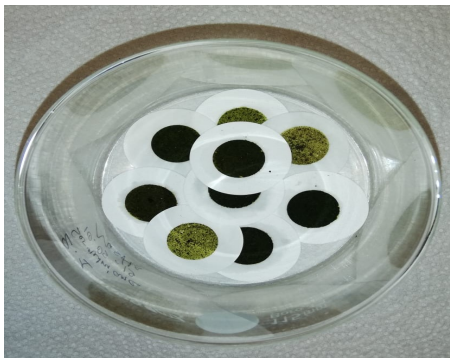
According to bio-technologists, around 53.6 million tons of e-waste have been generated worldwide by 2020. Their number is growing every year, and in 10 years this figure may reach 74.7 million. For example, 1.6 million tons of electronic waste appears in Russia every year.

Mobile phone screens

Today, the average lifespan of mobile phones and computers is shrinking to about 2 and 6 years.The devices then become waste that cannot be recycled. As a result, they pollute the environment. Therefore, we have proposed a method that will allow rare and expensive metals to be returned to the production cycle, ”says **Anastasia Chugainova** , a postgraduate student of the Environmental Protection Department of the Faculty of Chemical Technology, Industrial Ecology and Biotechnology of the Perm Polytechnic University **.**

E-waste contains many rare and expensive metals such as indium, gold, cerium and erbium. In addition, they contain other beneficial elements: aluminum, arsenic, boron, barium, calcium, chromium, copper, iron, potassium, magnesium, molybdenum, sodium, nickel, lead, tin, antimony, strontium and zinc. In particular, the screens are coated with indium and tin to obtain a touchscreen. Most smartphones are equipped with a display made from a mixture of aluminum oxide and silicon dioxide. It is

additionally hardened with potassium ions to increase strength. Rarer elements are being used to color the display and resist UV radiation, the researchers said.



Microscopic algae Chlorella Sorokiniana

Rare metals are now mined from natural sources, but these reserves will last for 20 years. Their content in the source is from 0.001% to 0.1%. Extraction produces more than 90% of additional impurities. By recycling electronics, you can get more useful material and reduce the hazard class of waste. Isolation of a specific metal from the entire stream will allow it to be returned to the production cycle, and not buried at MSW landfills, as is happening now.

- We leach metals into a solution that needs to be brought to the required pH level. Microscopic algae Chlorella Vulgaris, Chlorella Sorokiniana, Chlorella Spirulina, and Scenedesmus sp. absorb them from screens and monitors. Then we burn the algae, and the metals remain in the ash residue. We are now "training" algae to "selectively" extract rare metals. Our group has already determined the necessary conditions for the processing of screens and the extraction of metals, explains the biotechnologist.

According to biotechnologists, the development may be of interest to consumers of rare metals - manufacturers of electronic equipment and enterprises of the machine-building and metallurgical industries. In addition, the technology can be applied at plants for the extraction and production of rare metals and at landfills for municipal solid waste.

18. Kuzbass scientists have developed a new method of treating cardiovascular diseases

Source: ANO Scientific and Educational Center Kuzbass, April 13, 2021

Scientists from the Research Institute of Complex Issues of Cardiovascular Diseases (a member of the Kuzbass REC) for the first time in the world proved the influence of disturbances in the regulation of the mineral balance of blood on the development of cardiovascular diseases. Fundamental studies of this problem have been carried out at the institution since 2013.

The discovery was made by scientific groups led by Anton Kutikhin, head of the laboratory for fundamental aspects of atherosclerosis, and Olga Gruzdeva, head of the homeostasis research laboratory. The study showed that an increase in blood free calcium levels as a result of a decrease in the concentration of the calcium-binding protein albumin is an important risk factor for the development of coronary heart disease and ischemic stroke. As a result, an excessive amount of calcium-protein complexes is formed in the blood of such patients.

“Nature intended that the formation of these mineral-protein complexes protects against a life-threatening condition - calcification of internal organs (including blood vessels). But at the same time, evolution did not have time to debug this mechanism - a violation of the mineral balance during a long life of a person can lead to the development of atherosclerosis. Thus, we are faced with the task of successfully

correcting the design of nature, ”said Anton Kutikhin.

Now scientists are conducting preclinical tests on genetically modified mice, which are prone to atherosclerosis from birth. They entered the Kuzbass in cooperation with the University of Heidelberg (Germany). On animals, chemical compounds are tested that dissolve calcium-protein complexes in the blood and, in parallel, remove excess calcium ions released from them. The researchers hope that this will prove the potential effectiveness of Kuzbass therapies for patients with cardiovascular diseases around the world. Preclinical trials will be completed in the second half of 2022.

19. Scientists have developed a sensor to monitor the level of "stress hormone"

Source: Skoltech, April 13, 2021

Skoltech researchers have developed a prototype of a fluorescent sensor to continuously monitor the concentration of cortisol in the human body in real time. This development can be used to control various pathological conditions. An article describing the results of the study was published in the journal Talanta .

Cortisol, also known as the "stress hormone", is a steroid hormone that plays an important role in regulating glucose levels, blood pressure, and many physiological processes in the human body, including inflammation. A decrease or increase in cortisol levels can be a sign of various diseases, however, there are still no sufficiently accurate and reliable methods to continuously monitor cortisol levels in vivo . Existing laboratory methods, in particular, enzyme-linked immunosorbent assay (ELISA), provide the necessary reliability of the result, but require preliminary preparation of samples, which does not allow their use in real time.

“First, monitoring analyte levels in vivo is challenging in and of itself. Second, the cortisol molecule is relatively small. Finally, taking blood samples is a stressful procedure both in animals (mice or rats) and in humans, and under stress, the concentration of cortisol rises, and the test result turns out to be unreliable. The goal of the research is to develop an implantable sensor for controlling cortisol directly in the bloodstream, ”says Vladimir Drachev, one of the authors of the article, professor at Skoltech and the University of North Texas (USA).

Vladimir Drachev and his colleagues at the Skoltech Center for Design, Manufacturing Technologies and Materials (CDMM) have created a prototype immunosensor using gold nanoparticles to control cortisol levels. Free cortisol in the sample displaces fluorescently labeled cortisol / bovine serum albumin (BSA) complexes that bind to monoclonal antibodies to cortisol and are deposited on gold nanoislands on the sensor. The concentration of cortisol in a sample can be measured by the level of fluorescence.

The research is being carried out in collaboration with a group of Skoltech biologists led by Yuri Kotelevtsev.

The researchers conducted in vitro tests , showing that the new sensor is capable of recording the minimum level of cortisol - 0.02 μg per milliliter, which corresponds to the normal level of the hormone in human blood plasma. Reversibility of the response to cortisol has also been demonstrated in in vitro tests . The researchers hope that based on the proposed method, it will be possible to create an implantable sensor for continuous monitoring of the concentration of cortisol in the blood in real time. It is assumed that the implantable sensor will be in the form of an optical fiber, at the end

of which there is a capillary cell with a semipermeable membrane placed in a thin needle connected to a portable spectrometer via an optical fiber.

“We need to develop an implantable sensor with a semi-permeable membrane that separates small molecules such as cortisol from proteins and other components of the biological fluid (blood, saliva, interstitial fluid). Similar devices for measuring glucose already exist. To create an implantable sensor, a number of complex problems still have to be solved, ”notes Vladimir Drachev.

20. Ural physicists will print magnets on a 3D printer

Source: Ural Federal University, April 13, 2021

The movable planetary chevron gear is a non-separable system that can only be obtained by 3D printing. Detail after post-processing

“The movable planetary chevron gear is a non-separable system that can only be obtained by 3D printing, Part after post-processing”

Physicists of the Ural Federal University (UrFU, Yekaterinburg) will 3D print unique magnets, magnetic systems, soft magnetic elements. Samples printed on this printer can be useful in almost any field - from medicine to space. For example, they can be used to create robotic assistant surgeons in cleaning arteries and veins or when placing stents. According to Aleksey Volegov, associate professor of the Department of Magnetism and Magnetic Nanomaterials of the UrFU, now scientists are deciding which magnets will start printing first.

“Or magnets based on samarium and cobalt compounds. They can be used in submarines, space stations, ships, that is, where there are very strong temperature drops and special requirements are imposed on magnets in terms of stability of properties. Or simple ones, based on an alloy of neodymium, iron and boron, which work at normal temperatures. Such magnets are used in smartphones, hard drives, and automotive engine sensors. For example, such magnets are installed in the latest generation Tesla electric motors, ”says Aleksey Volegov.

Scientists will create small magnets. Their requests were met by the only model of a German printer on the world market. There are few printers in the world that can print from metal powders and have open print settings. These printers are primarily used in research and development organizations.

“Our model is probably the only one in the world that meets our goals. The printer makes it possible to obtain samples from metal powders using selective laser fusion and selective laser sintering technologies. In the first case, the powder particles are completely remelted, in the second, they are slightly submelted at the Third boundaries.

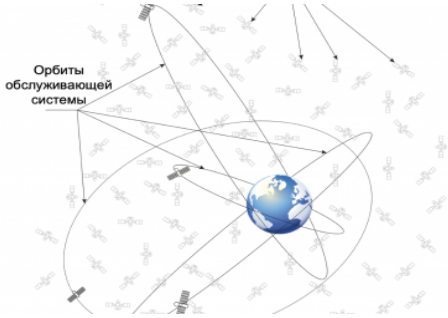
There are about 20 published scientific papers in the world today, the authors of which have tried to print magnets. And work on selective laser fusion in general can be counted on the fingers of one hand, ”explains Volegov.

At this stage of the work, printed samples require post-processing (now scientists magnetize parts after printing). In order for the printer to immediately print magnets with specific properties, it is necessary to teach it to work with specific powders and print the required samples. According to Aleksey Volegov, such works can take from six months to several years.

Scientists were the first to print three small parts as test samples to test the accuracy of the printer (geometric shapes, adherence to dimensions, angles).The first was sent to Germany to adjust equipment (for a fraction of a percent in specific areas). The second is the planetary chevron gear, a non-separable system that can only be obtained by 3D printing. The third detail is the lower levels of the tower with a spiral staircase and railings.

21. Right on target - the RUDN University algorithm more accurately estimates the flight path to the satellites

Source: RUDN, April 13, 2021



1200 spacecraft revolve around the Earth in different orbits. Their service life is limited by wear and tear of onboard equipment and fuel consumption. It is expensive to launch spacecraft for servicing satellites - such schemes are justified if the satellite has no analogues and is of high value, for example, the Hubble telescope.

A team of RUDN University scientists has found a solution for servicing low-orbit constellations, which consist of dozens of satellites. The algorithm minimizes fuel consumption through optimal maneuvering. Its use on board the service module will make it possible to quickly and accurately estimate the flight trajectory to the satellites in a limited time, taking into account the fuel supply on board the module.

“One of the primary tasks in the creation of advanced space systems, along with the technical implementation and solution of legal issues, is the choice of the orbital construction of the system, the calculation of flight trajectories ... analysis of its functioning according to various optimization criteria. Our algorithm is also applicable to assessing dangerous encounters with other satellites and space debris objects , ”said **Vladimir Razumny,** associate professor of the Department of Mechanics and Mechatronics at the RUDN University of Engineering **.**

22. Russia's hydrogen future begins in Chernogolovka

Source: Scientific Russia, April 13, 2021

On December 12, 2015, the leading countries of the world adopted an agreement under the UN Framework Convention on Climate Change, regulating measures to reduce the carbon dioxide content in the atmosphere. In December 2020, on the eve of the fifth anniversary of the landmark Paris Agreement, UN Secretary-General Antonio Guterres published an article urging the international community to achieve a complete decarbonization of the global economy by 2050, introduce a carbon tax and strengthen adaptation to the effects of climate change.

The International Energy Agency estimates that the share of renewables in the global electricity supply will grow from 27% in 2019 to 60% in 2030.

The International Energy Agency estimates that the share of renewables in the global electricity supply will grow from 27% in 2019 to 60% in 2030.

The Paris Agreement spawned the carbon neutral movement. Decarbonization is increasingly being discussed by governments and the scientific community. Scientists believe that in order to combat global warming and atmospheric pollution, it is necessary to reduce the production of coal, oil and gas by an average of 6% per year. The plans changed after the clash of humanity with the new coronavirus infection, which dealt a severe blow to the economies of all countries of the world. To stabilize the consequences, many countries are planning, on the contrary, to increase the production of fossil fuels by a few more percent. While governments are looking for a way out of the crisis, scientists and engineers are creating unique installations that will not only be in demand in the future, but, in theory, will solve the problem of greenhouse gas emissions.

The ideas of using hydrogen for energy purposes have been expressed for a long time, and interest in them has been manifested more than once. And if in the 1970s they hoped for the development of hydrogen energy in connection with the oil crises, today - in connection with the growing concern about climate change.The problem of a global scale stimulated a surge in research and development (with an emphasis on transport), but it did not come to a serious practical implementation of hydrogen technologies. The situation began to change rapidly when the leading countries of the world began the path to sustainable development and to the implementation of the concept of a carbon-free energy future. That is why they began to pin great hopes on hydrogen.

Meanwhile, hydrogen will not solve all our problems at once. According to the head of the Competence Center of the National Technology Initiative "New and Mobile Sources of Energy" **Yuri Dobrovolsky** , hydrogen is not the best fuel for energy, but it can be used in a different capacity - an energy storage device using renewable energy sources. For example - solar and wind."The production cycle of renewable energy sources is always intermittent. Therefore, the surplus must be accumulated somewhere, and this can be done by obtaining hydrogen using electrolysis of water. While the existing technologies are quite expensive, but nevertheless the obtained hydrogen can be stored indefinitely, but within the framework" green "energy to use as fuel for transport. We are actively working on this today ."

Electrolyzer for hydrogen production

The NTI Competence Center, created on the basis of the Institute for Problems of Chemical Physics in Chernogolovka, works in several areas of hydrogen energy at once, including the creation of specialized installations for producing hydrogen from water using electricity. So, quite recently, the first autonomous hydrogen filling station in Russia appeared in the city of science. It must be said that the station was built by colleagues of scientists from Germany according to the Russian technical assignment. At the same time, initially it used expensive balloon hydrogen, but now the situation is changing. Thanks to many years of research by Polikom employees, it was possible to create an electrolysis generator of ultrapure hydrogen, which reduces the cost of the process of producing hydrogen fuel for the transport of the future.

Yevgeny Volkov, head of the Polikom company, a partner of the NTI Central Committee, comments:

“We have created the first domestic hydrogen generator with a capacity of up to 6 cubic meters of hydrogen per hour, based on alkali-free electrolysis. The plant generates hydrogen from water using electricity. It can be used in various industries, for example, for cooling electric generators in power plants, in the semiconductor and food industries. , metallurgy, and, of course, in the field of hydrogen energy.

We have been developing this equipment for five years. Very soon we will move on to serial production of units for ultrapure hydrogen production.

Our plant differs from the older alkaline electrolysers. We do not use alkaline electrolyte. Instead of alkali, a proton exchange membrane is used. Moreover, the only liquid in the system is ultrapure (deionized) water. It is obtained from ordinary tap water by reverse osmosis, a universal purification technology. Avoiding the use of alkali has a number of important advantages. First of all, this allows you to completely avoid corrosion of the system components. Moreover, our hydrogen generator is very easy to maintain. Unlike alkali solution, if necessary, water is simply drained into the sewer, and any part can be easily replaced.

During the operation of the installation, water enters the electrolysis module, where, under the action of an electric current, it decomposes into hydrogen and oxygen. Oxygen is a by-product for us, so it is released into the atmosphere. And hydrogen goes through a two-stage stage of purification from water vapors, and at the exit we get ultrapure hydrogen.

When we start serial production, we will be able to produce about 60 units per year. "

Tests of refueling with an electrolysis module will take place on different types of transport - drones, hydrogen buses, trucks and cars, including on an unmanned transport platform, for which a hydrogen fuel cell has also been created at the Competence Center.

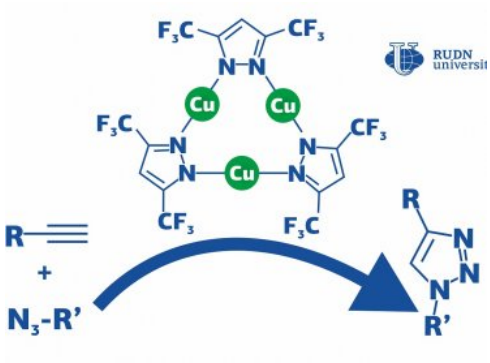
"When it comes to transport - an airplane, car, train, it is necessary to create refueling systems, preferably cheap, otherwise the idea will not get applied. We are trying to get hydrogen with the help of an electrolysis unit. True, there is no talk of its exceptional ecological purity so far. since we still get electricity from the outlet. Now our goal is to create a plant for industry, where you can get cheap hydrogen in different ways, depending on the raw materials, "- said Yuri Dobrovolsky.

Hydrogen infrastructure for our country is a significant element of the national program for the development of hydrogen energy in Russia. The specialists from Chernogolovka are planning to transfer the municipal services and transport of the city to hydrogen. It is from here that the "hydrogen" path of development will

begin. “I am convinced that we have chosen the right direction. When I just started working on hydrogen energy 40 years ago, I faced misunderstanding and mistrust in this area ,” says **Boris Tarasov** , head of the laboratory of materials for hydrogen energy storage at the Institute of Problems of Chemical Physics, Russian Academy of Sciences Chernogolovka. -"And today the state policy in this area has already been developed. I am sure that at present, within the framework of the state-supported program, scientific youth will apply all their skill and enthusiasm for the rapid, purposeful and productive development of hydrogen energy.

23. Bio active substances are synthesized using copper

Source: RUDN, April 16, 2021



The RUDN University chemist used a copper complex as a catalyst for the click reaction of azide-alkyne addition "CuACC", which produces triazoles - biologically active substances with antibacterial, neuroleptic, antispasmodic activity - for example, fluconazole and itraconazole. Click-reactions is a general name for reactions in which simple molecules-modules “click” among themselves and, like a constructor, are assembled into a large complex molecule.

Typically, copper-based catalysts are used for this. They speed up the process, but additional conditions are required - for example, heating or additional chemical reagents. This increases the cost of production. The RUDN University chemist suggested using a copper complex. The catalyst increased the reaction rate several times and allowed it to be carried out at room temperature and without the use of bases and solvents. In this case, the efficiency of the reaction turned out to be almost one hundred percent, without by-products.

“Today, various copper catalysts are used for CuAAC, but in many cases, harsh conditions are required (high temperatures, additional reagents, etc.). Although the mechanism of this reaction is well known and studied, there is still debate about what exactly the mechanism of action of catalysts is based on , ”said **Vladimir Larionov, an** employee of the Department of Inorganic Chemistry of the Peoples' Friendship University of Russia, PhD in Chemistry.

The compound studied by chemists contains three copper ions. They are connected by "bundles" ligands - complex organic ions. Chemists have used it as a catalyst in the CuACC reaction at room temperature and atmosphere. Chemists tried to use dichloromethane, toluene and other reagents as a solvent. However, even without a solvent, the copper complex gave the desired product in 4 hours - without a catalyst it did not proceed at all.

24. Bioactive implant coatings have been obtained that are resistant to most bacterial strains

Source: NUST MISIS, April 16, 2021

Young scientists from NUST MISIS presented multilayer antibacterial coatings with a prolonged effect and a universal spectrum of action. The coating is based on modified titanium oxide and several antiseptic component.The coatings can be used in modern implantology as a protective layer for the prevention of concomitant complications - inflammation or implant rejection The results of the work were published in the international scientific journal Applied Surface Science.

Antibacterial coatings are currently being actively researched, as the search for alternatives to traditional antibiotics is growing.They can be applied to implants, thereby preventing inflammation caused by nosocomial infections.

Nevertheless, the creation of antibacterial, but at the same time biocompatible and bioactive surfaces is a problem that the scientific community has been solving for many years, and the "dream materials" have not been developed.

Young scientists from the NUST MISIS Laboratory of Inorganic Nanomaterials have created an innovative multilayer coating that synthesizes the protective properties of nanoparticles, biopolymers, anticoagulants and antibioticThe antibiotic and silver nanoparticles provide an antibacterial effect, while heparin prevents bacterial cells from sticking to the tissue surface, which reduces the amount of antibacterial agent required.

“The method of obtaining a multilayer coating is a combination of several technologies: first, using magnetron sputtering, a thin bioactive nanostructured coating of the TiCaPCON composition was obtained, then silver particles were introduced into the coating by ion implantation, then a biopolymer layer was applied, which in the preparation plays the role of a carrier for bactericidal molecules of heparin and gentamicin "said the author of the work, a researcher at the laboratory" Inorganic nanomaterials "NUST" MISiS "Elizaveta Permyakova.

The chemical composition of the resulting coating layers was carefully studied by the developers using infrared and X-ray photoelectron spectroscop.It was found that the incorporation of therapeutic components occurs throughout the entire thickness of the plasma-applied polymer layer.

Together with colleagues from the State Scientific Center for Applied Microbiology and Biotechnology, the scientists studied the effect of each type of antibacterial component (silver ions, gentamicin and heparin) on the antibacterial activity and biocompatibility of the obtained coatings.

According to the results of in vitro studies, the coatings showed cellular compatibility and

demonstrated excellent (up to 99%) bactericidal efficacy against the antibiotic resistant E. coli bacterial strain.

25. An affordable technology for the production of dietary supplements with antimicrobial and antitumor action has been proposed.

Source: kantiana.ru, April 16, 2021

Researchers at the Institute of Living Systems have determined the qualitative composition of the biologically active substances of the medicinal plant Rhodiola rosea, the IKBFU website reports. I. Kant . For this, scientists have grown in vitro (in a test tube) individual groups of cells of this plant and have found valuable substances that are promising from the point of view of industrial and technological production (ecdysteroids and flavonoids).

“Nowadays, many people prefer natural biologically active additives to synthetic drugs,” said Evgeny Chupakhin, associate professor of IzhS. - The future lies in the biotechnological production of callus, suspension cells and cells of root cultures in vitro. This technology makes it possible to increase the biosynthetic activity of substances by regulating physical, chemical, nutritional and genetic parameters. These are real phytochemical factories for the mass production of phytopreparations ”.

According to the expert, Rhodiola rosea extracts studied in the laboratory are readily available and effective - with fewer side effects compared to modern drugs in the treatment of various diseases. Biologically active substances of this plant can become the basis for the production of pharmaceuticals and dietary supplements of antitumor, antimicrobial and antioxidant action. There are also plans to use cell cultures to create genetically modified plants in agriculture.

The results of scientific work are published in the authoritative journal "Biomolecules". The study involved Stanislav Sukhikh, Evgeny Chupakhin and Olga Babich, employees of the Institute of Living Systems, as well as colleagues from Kemerovo State University and Kuzbass State Agrarian Academy.

26. Geophysicists of St. Petersburg State University have developed an algorithm to improve the reliability of the study of the earth's interior

Source: St. petersburg State Univ, April 19, 2021

Geophysicists of St. Petersburg State University have developed an algorithm for the joint interpretation of two methods of earth sounding, which can significantly improve the accuracy of engineering surveys. The research results are published in the Journal of Environmental and Engineering Geophysics.

An important stage prior to construction or mining is the study of the geological structure of the study area. At the same time, the role of geophysical research in this process is quite high, since it is geophysics that allows one to obtain not point information about geological horizons, such as, for example, a well, but in

volume. Under relatively simple conditions, standard geophysical methods can successfully solve this problem. However, if the geological structure is complex, for example, there are thin layers of sand and clay, serious inaccuracies can be obtained using classical DC geoelectrics.

One of the most common methods in electrical engineering is the electrotomography method. It is based on the study of a direct current field on the earth's surface or in boreholes and allows geologists to "see" different rocks, because they all have different electrical resistivity. Electro-tomography can also give significant errors in determining the thickness of the geological layer, overestimating the indicators by several times.

“Inaccurate data on soil properties can lead, for example, to incorrect pile foundations and other problems during construction. When it comes to the extraction of construction sand, there is a high probability of receiving distorted information about its reserves in the field. We never know exactly what is underground, and if we approach the solution of this problem formally, errors are very likely, ”notes the first author of the study, research engineer at the Institute of Earth Sciences of St. Petersburg State University, Ph.D. in physics and mathematics Arseny Shlykov.

At the same time, electrotomography is not the only method that allows specialists to look deep into the depths of the earth's interior. Geophysicists of St. Petersburg State University, together with colleagues from the Institute of Geophysics and Meteorology at the University of Cologne (Germany) and the Indian Institute of Technology in Kharagpur, are developing a relatively new method of radio-magnetotelluric (RMT) soundings. It is based on measurements of the electromagnetic fields of radio stations and is designed to study relatively shallow depths from 1 to 30 meters. Modification of RMT with a controlled source (RMT-K), in addition to the ability to work in remote regions, allows you to look even deeper - up to 100-150 meters underground.

“If you use both methods in one area, where there are complex horizons, they can give completely different results, because they are based on the use of electromagnetic fields of different structures. However, when used together, they complement each other, and the joint interpretation of such data will increase the accuracy of the information obtained. That is why an algorithm was needed to do this work immediately, ”says Arseniy Shlykov.

The field experiment was carried out at the MSU training ground located in the village of Aleksandrovka in the Kaluga region. An international team of geophysicists compared the results of both methods, interpreted separately and jointly. As a result, the data obtained using the new algorithm turned out to be the closest to that shown by the drilling results.

“The algorithm we have created is another small step towards improving the accuracy of geophysical surveys of the earth. The existing version works within the framework of a one-dimensional horizontally layered vertically anisotropic earth model. The one-dimensional models are the simplest and represent the earth like a layer cake with horizontal layers. The properties of rocks in such models change only in one direction – down. Hence the name – one-dimensional. Of course, in reality, the geological section is much more complicated, says Arseny Shlykov. - We will continue to develop our algorithm for 2D and 3D models of the geological environment. Two-dimensional models take into account, in addition to the vertical measurement of rock properties, also horizontal ones in one direction. Three-dimensional models are the most complex, but close to reality.

27. Skoltech scientists have found a new mechanism for regulating gene expression

Source: Skoltech, April 19, 2021

A group of scientists from Russia studied the role of double-stranded RNA fragments in the process of its maturation. It was shown that the interaction between distant regions of RNA can regulate the maturation of information RNA molecules. The results of the study are published in the journal Nature communications.

In the school curriculum, it is usually said that DNA has a double-stranded structure, and RNA is single-stranded, but this is not entirely true. Scientists are aware of many examples where RNA forms a double-stranded secondary structure that plays an important role in the functioning of these molecules. Secondary structures of RNA are involved in the regulation of genes. Double-stranded regions in RNA adapt molecules for specific functions, and the loss of such structures leads to serious diseases. A double chain can form between the complementary sections, opposite A should be the letter Y, and opposite C the letter G, otherwise the chains will not "stick" to each other. Most of these adhesion sites are located close to each other, but the role of mutually complementary sites separated by large distances is

A group of scientists from the Skoltech Center for Life Sciences under the leadership of Skoltech Professor Dmitry Pervushin, in collaboration with domestic and foreign laboratories, using molecular biological and bioinformatics methods, analyzed the structure and role of complementary RNA regions that are distant from each other, capable of forming secondary structures. It turned out that such secondary structures play an important role in the splicing process. Splicing is the process of maturation of information RNA molecules, when in the process of transcription (reading information from DNA) non-coding regions are cut from the resulting RNA, and the coding regions are stitched together. Scientists have shown the possibility of regulation of splicing by secondary structures of RNA, which makes a significant contribution to the regulation of genes.

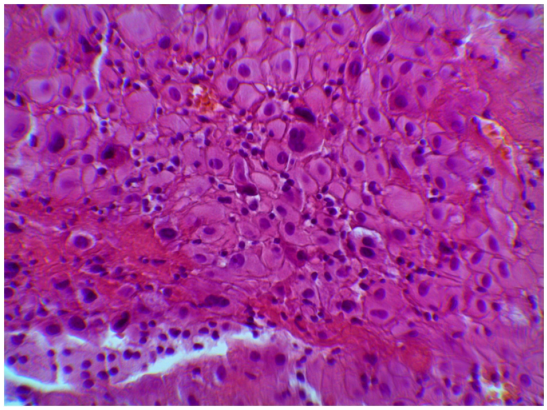
“This publication is the result of many years of work by our scientific group in the direction of studying the secondary structure of RNA and its role in the regulation of gene expression. We have published a large computationally obtained catalog of potentially important RNA structures, but experimental work in this direction is just beginning, ”Professor Dmitry Pervushin comments on the study.

28. The device of scientists of the Perm Polytechnic will be able to automatically detect oncopathology

Source: Perm Polytechnic Univ, April 19, 2021

Scientists from the Perm Polytechnic Institute have created a project of a device for automatic histological analysis. The development will make it possible to promptly identify cellular pathologies, including oncopathology, in

humans and animals. In the future, the actions that are now being performed by several technicians, the apparatus will be able to produce faster and cheaper. Researchers conducted a series of experiments that showed an accuracy of disease recognition of up to 92%.

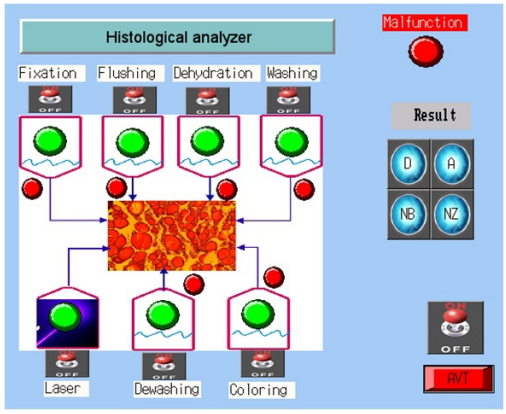


Decidual cells of the bovine placenta with large hyperchromic nuclei and vacuolated cytoplasm (400 times magnification)

In addition to scientists from the Perm Polytechnic University, developers from the Perm State Aviation Technical University and the Perm Institute of the Federal Penitentiary Service of Russia took part in the project. The scientific group published the results of the work in the collection IOP Conference Series: Earth and Environmental Science and Journal of Physics: Conference Series.

- Structural changes in cell tissues detected by histological analysis give an accurate picture of a person's disease. Now this process is quite lengthy, several specialists are involved in the work, who carry out research manually. The goal of our development is to automate the procedure of histological analysis to accelerate the recognition of diseases. The decision support module will be able to eliminate the human factor as much as possible and increase the accuracy of the analyzes. In addition, our device will help reduce the burden on medical personnel, - says Professor of the Department of Information Technologies and Automated Systems of the Perm Polytechnic University, Doctor of Technical Sciences, Associate Professor **Sergei Kostarev** .

According to scientists, morphostructural changes in cells have a tree-like structure, which makes it possible to automatically determine indicators of pathologies. The research process begins with loading material samples into the apparatus, preparing a histological specimen and scanning them. Then specially developed computer algorithms process the resulting image. The device uses neural networks to "decode" it, finding indicators of tissue destruction that characterize various pathological processes.



Project of the screen of the instrument of the operator-histologist

To develop an automated system, scientists proposed using the theory of finite automata, in particular the Mealy automaton. They presented calculations for the pathology of structural changes in tissues and the coding of the necessary indicators. The researchers developed the method of automated diagnosis based on the analysis of pathology indicators. Scientists also conducted simulation modeling to determine these indicators. They programmed the device

under design using the CX-One for the Omron PLC.

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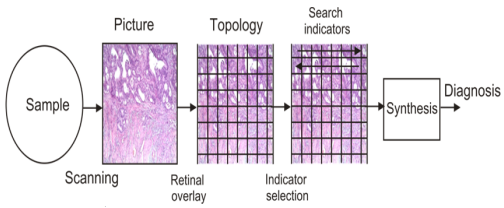


Building and training a neural network

We conducted a series of experiments on the recognition of cellular pathologies, the results of which were evaluated by a laboratory assistant-histologist. In the process, we used a system of histological guiding - a Leica histological processor, a rotary microtome ThermoScientific HM 325 and other equipment. The results showed that the device will be able to achieve fairly high accuracy rates - from 82% to 92%. In the future, our device will make it possible to identify various types of pathologies: from dystrophy to oncological diseases, ”explains **Sergey Kostarev** .

29. Accuracy at the level

Source: Ministry of Education and Science
April 19, 2021

Scientists from the St. Petersburg State Electrotechnical University "LETI" named after V.I. Ulyanov (Lenin) created a device for more accurate determination of blood sugar levels.

The proposed technology is based on optical principles. It will make the procedure for measuring blood glucose concentration non-traumatic and more accurate.

According to statistics from the World Health Organization, 422 million people have diabetes. And according to the organization's forecasts, diabetes will become the seventh leading cause of death worldwide by 2030.

One of the developers of the new device, Roman Lee, notes that the use of such devices is often accompanied by injuries and an increased risk of wound infection.

Scientists have solved not only this problem, but have also been able to make blood glucose measurements more accurate. A non-invasive, optical-based glucometer will help with this. The development is unique and has no analogues.

The development was supported by the Ministry of Science and Higher Education of the Russian Federation within the framework of the federal target program "Research and Development in Priority Areas of Development of the Scientific and Technological Complex of Russia for 2014-2020".

30. The secret properties of strontium titanate

Source: Ministry of Education and Science
April 19, 2021

Scientists from the Institute of Physics of the Kazan Federal University (KFU) have discovered new qualities of strontium titanate. This will help improve modern devices .

A team of scientists, which included specialists from KFU and employees from the Physico-Technical Institute named after AF Ioffe conducted a study to study titanate crystals of various shapes using electron para-magnetic resonance. As a result, they found that the shape

of the strontium titanate (SrTiO3) sample determines its internal symmetry.

At room temperature, SrTiO3 is a crystal with high cubic symmetry. The lattice of strontium titanate, like bricks, is made up of unit cells. Each of them is a regular cube. But in thin, tenths of a millimeter thick, plates and columns, the symmetry decreases to a structure that was not observed in SrTiO3 earlier, each unit cell turns from a cube into a parallelepiped.

Such results are of scientific and practical importance. Often it is not the amount of distortion that matters, but its presence. Lowering the symmetry opens up the possibility of realizing phenomena that are forbidden in a cubic structure.

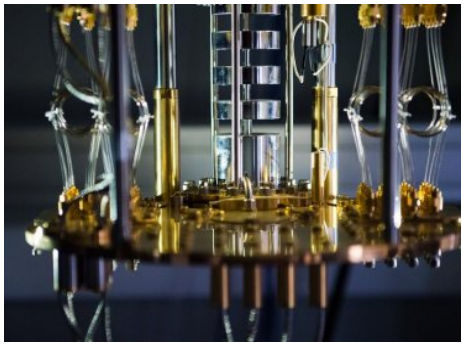
By controlling the amount of distortion of the structure of the substrates, it is possible to develop on their basis new electronic devices, miniature sensors and sensors, for example: processors in computers and gadgets, monitors and smartphone screens, high-capacity batteries, information storage devices.

31. Scientists have proven the possibility of interaction between photons

Source: NUST MISIS, April 19, 2021

Scientists from NUST MISIS as part of an international group of researchers have proven the possibility of effective interaction between microwave photons. During the experiment, the researchers created the conditions for their interaction through superconducting qubits. He showed the possibility of transferring quantum information from one chip to another in the form of microwave photons. The work, published in npj Quantum Materials , could be a step towards solving the problem of quantum memory and bring the creation of commercial quantum devices closer.

In existing computing devices, information is transmitted by electrons. Scientists believe that if we replace them with photons - quanta of light and encode them with quantum information, then data can be transmitted literally at the speed of light. But in order to use this information, the photons must be made to somehow interact with each other and change their state as a result of such interaction. It is quite difficult to do this, so quantum computers using photons operate on probabilistic principles, which makes them not completely universal.



A group of scientists from NUST MISIS, the Russian Quantum Center, the A.F. Ioffe and the Karlsruhe Institute of Technology demonstrated for the first time the possibility of efficient interaction between photons using a chain of superconducting qubits - quantum analogs of bits in computer memory, in a wave-guide. In their work, the researchers used photons, which are quanta of an electromagnetic field with a frequency of about several gigahertz and a wavelength of several centimeters.

“The use of superconducting qubits, which are, in fact, man-made atoms, is explained by the fact that this type of object is characterized by a very strong interaction with light. Ordinary atoms are much smaller than wavelength. The interaction of ordinary light with a natural atom

is rather weak. Superconducting qubits can be assembled by hand, and their dimensions are fractions of a millimeter, which makes it possible to significantly increase the dipole moment and polarizability of these objects. Thus, there is a strong interaction between the electromagnetic field and local electromagnetic excitation inside the qubit. That is, in fact, there is a strong interaction between light and matter, which is difficult to achieve in natural atoms, "explains one of the authors of the study. Head of the Superconducting Meta-materials Laboratory, NUST MISIS, and Group Leader at the Russian Quantum Center, Professor, Doctor of Physics and Mathematics. Sci. Alexey Ustinov.

Today, superconducting qubits are the most popular and promising type of qubits. On their basis, quantum computing devices are most often developed. In this case, computers operating on superconducting qubits must be cooled to ultra-low temperatures - less than 50 millikelvin. The most powerful superconducting quantum computers currently in existence have fewer than a hundred qubits. In this case, the power of the device grows exponentially with the number of qubits. The maximum number of qubits, in turn, is limited by the size of cryostats - special "coolers" in which qubits are cooled to operating temperatures. Respectively, To solve this problem, scientists used a waveguide - a guiding channel in which a light wave can propagate.

“We have actually implemented a one-dimensional space. Ordinary atoms are in three-dimensional space, so the direction of radiation cannot be predicted, it is radiated in all directions. When we place a superconducting qubit in a waveguide, which is a one-dimensional channel of light propagation, then the light can go either to the right or to the left. Due to the interaction with the qubits, the photons that propagate in this channel begin to effectively interact with each other, and the interaction of photons mediated through the qubits arises. They exchange quantum information in a very specific way. Thus, we can actually change the quantum states of photons that propagate in such a one-dimensional space, ”emphasizes Aleksey Ustinov.

In the course of the experiment, it was demonstrated that due to the interaction with the array of qubits, a frequency interval arises in the photon spectrum in which the waveguide becomes opaque. That is, photons in this frequency range are simply reflected back due to interference between different qubits, since they cannot be absorbed. This is evidence that the effective interaction between photons described in the study does exist.

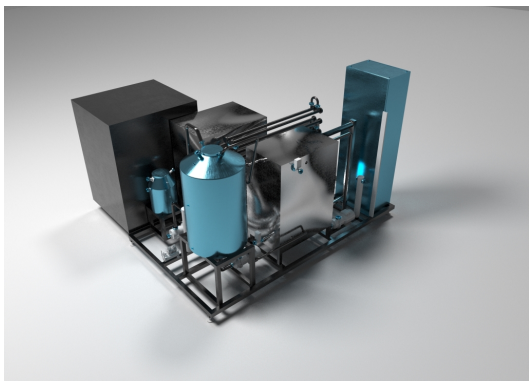
According to the authors of the study, the results of the work may form the basis for larger-scale experiments with a large number of qubits, which will bring the creation of commercial quantum computing devices closer.

32. Russian scientists invented to pasteurize milk using microwave radiation

Source: Scientific Russia, April 19, 2021

Employees of the Engineering Center for Instrumentation, Radio and Microelectronics of the Southern Federal University (Taganrog), within the framework of a project supported in a competitive selection by Decree of the Government of the Russian Federation No. 218, are developing a complex in which milk pasteurization takes place under the influence of microwave waves.

The industrial partner of this project is Taganrog Scientific Research Institute of Communications JSC, which is a part of KRET (Concern Radioelectronic Technologies).



3D-model of a pasteurization complex developed at the Engineering Center of the SfedU.

The new complex effectively destroys pathogenic microorganisms, while maintaining the taste and beneficial properties of milk. This method of pasteurization is especially in demand for the supply of milk to distant regions of the country, for example, the Arctic, as well as for the production of high-quality cheeses in our country.

In classic pasteurization methods, a milk flow or a large container is disinfected using different types of heating elements. Innovative methods use different types of radiation to heat milk, such as ultraviolet or microwave waves.

It is the microwave radiation that is used by engineers from Taganrog. The complex for innovative microwave pasteurization assumes heating milk to 65 ° C and the following short-term jump to 75 ° C in 0.15 seconds. After the temperature jump, a sharp cooling occurs immediately. Under such conditions, milk sugar (lactose) is not destroyed, and minerals (for example, calcium), vitamins and valuable enzymes retain their properties.The innovation consists in the use of new programmed pasteurization modes that allow you to optimize the required temperature conditions and prevent uneven, too long or strong heating.

All pasteurization methods are dangerous by overheating or overexposing milk during the process - this is what engineers try to avoid.

“Even in a conventional microwave, you can simply heat milk and kill bacteria. But in this case, either overheating or incorrect milk aging occurs. It is the selection of special control modes for the duration and power of heating that provides the desired temperature profile for milk pasteurization. The overall temperature does not rise above 75 ° C, and then only for a split second, ”said Andrey Kovalev, head of the Engineering Center of the Southern Federal University.

In the new installation, pasteurization takes place as follows: milk, preheated, enters through glass tubes into a microwave chamber with a magnetron, which irradiates the flow to provide an instant temperature jump. At this moment, pasteurization takes place. Then the milk flow is rapidly cooled. Microwave radiation is carried out in a sealed metal chamber, and therefore it does not enter the surrounding space and does not in any way affect the organisms of people near the installation (for example, the operator of the complex).

The method of microwave pasteurization is relevant for processing milk, from which cheese will then be made.For its production, lactobacilli and other beneficial microorganisms contained in milk are important. UHT milk is not used to make cheese, whether in production or even at home.

In the Arctic, in the absence of farms, it is necessary to deliver good quality products “from the mainland”. Classical pasteurization does not give such results - pathogenic microorganisms may not be completely destroyed, and then the milk will deteriorate on the way.

Changes in organoleptic properties should be minimal - this is ideal pasteurization: the absence of pathogens while maintaining the taste and benefits of natural milk. The properties of milk pasteurized using the microwave are superior to those of milk pasteurized using the classical method.
Whether the installation will be implemented everywhere, if the properties of milk are superior to conventional pasteurization, depends on economic reasons, including its more expensive cost. This will affect the final product price.

“The installation is under development, we are completing the design documentation and proceeding to the production of the model. By the end of 2021, we plan to make the first prototype,” concluded Andrey Kovalev.

33. Launch of the first Soviet orbital station "Salyut"

Source: Scientific Russia, April 19, 2021

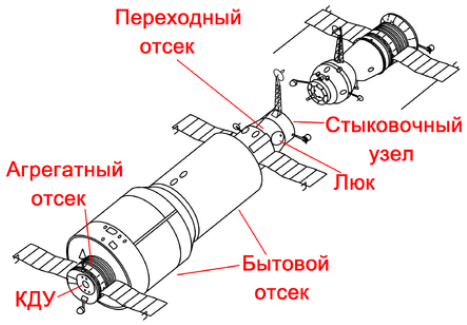
60 years ago, a significant event took place for the Soviet Union and all mankind - the first manned flight into space. Yuri Alekseevich Gagarin made a revolution around the Earth on the Vostok-1 spacecraft. And exactly 50 years ago, on April 19, 1971, the Soviet Salyut station was launched into orbit by the Proton-K launch vehicle. The space station was created under the Long-Term Orbital Station program of civil manned stations. According to the Mission Control Center, Salyut-1 stayed in space for 175 days, after which it was removed from orbit and entered the dense layers of the atmosphere. Then the unburnt debris of the station was recorded in the waters of the Pacific Ocean.

The working compartment is the central place of the spacecraft in the form of a cylinder with a diameter of 2.9 meters and a length of 3.5 meters. This part is connected to a special conical stand - its dimensions are 4.15 meters in diameter and 2.7 meters in length. A frame structure is fixed inside the body, which connects the units and assemblies. Also, the working compartment had free space, which was intended for the space crew.

The transfer compartment - 2 meters in diameter, 3 meters long with a docking station, is connected to the working compartment, where a sealed hatch is located for transferring to the Soyuz transport spacecraft. A hatch is also located on the side surface of the transition compartment, which serves to penetrate into the station during construction work on Earth. And from the outer part of the transition compartment there are two fixed solar panels (in another way they are also called "wings").In the transition compartment itself there are also scientific instruments for conducting research.

The aggregate compartment is used to accommodate a corrective propulsion system (KDU), which contains fuel tanks, attitude control engines with their own fuel tanks. It is known that the corrective propulsion system and the attitude control engines were taken from the Soyuz spacecraft. But in comparison with it, the volume of the fuel tanks of the orbital station is doubled. On the aggregate compartment, as well as on the transitional one, "wings" are installed.

Other stations of the Salyut series were designed according to the same scheme. These devices were equipped with a variety of instruments with which they could conduct research in extraterrestrial space, as well as astronomical observations, and observations of the atmosphere and the Earth's surface.



The structure of the orbital station "Salyut"

The space station provided tremendous opportunities, and it was a real breakthrough. It had a lot in common with an artificial Earth satellite. There was only one difference: a crew was present at the orbital station, which periodically changed with the help of manned transport ships. The same ships delivered fuel and materials for the functioning of the systems, spare parts for the modernization and repair of the station, food supplies, hygiene items and letters for the crew members on board the orbital station. materials for new scientific research, etc. Upon completion of the flight, the transport ships returned with a change of crew and the results of the research carried out.

34. Media Reports on SARS-Cov2 and Vaccines in Russia

i) Fontanka Online Gazette – Reason for Mutations

"Promising mutants will remain and" go into the world "" - how the treatment of coronavirus provokes its mutation How and why the coronavirus is changing, said Anch Baranova, professor at the School of Systems Biology at George Mason University. The mutation, in particular, is caused by treatment, she said. “The infectivity of the virus has increased, and this is striking. However, the increase in infectivity in itself does not mean that the disease has become more dangerous, - Baranova told RIA Novosti in an interview published on December 23. "Scientists, however, noticed another important thing - signs that this strain arose as a result of evolution within a single host." That is, the virus was in one person for a long time and evolved in it. The virus can stay in the body for a long time, for example, during immunosuppression, when the immune system is suppressed. Drug immunosuppressive therapy is performed with organ transplantation or HIV. “The use of such therapy is correct, but it creates conditions for the virus to stay in the body longer. A person tolerates the disease more easily, but it takes more time for the body to clear the virus, ”says Baranova. SARS-CoV-2 under the influence of treatment evolves faster than in natural conditions. “For example, we use coalescent plasma, which contains a large number of specific antibodies. They kill the virus. In the body of a person who has been ill for a long time and seriously, there is often more than one species of the SARS-CoV-2 virus. Plasma will remove those viruses that bind to antibodies and leave the rest. A directed evolution of the virus will take place, ”the biologist explained. Substances that disrupt the work of viral polymerase can play a special role. “For example, Favipiravir, known in Russia as Areplivir, Coronavir, etc., or Remsedevir, which is used in England, contributes to the production of“ spoiled ”mutated variants of the virus. For the most part, they are not viable sickles, and some may turn out to be promising material for viral evolution. Then we add the convalescent serum, we will knock out the standard intact viruses, and the promising mutants will remain and “go into the world,” says Baranova.

ii) Russia is stepping up production of vaccines and medical equipment

The FORT company (Natsimbio holding of the Rostech State Corporation) is stepping up production of the innovative Ultrix Quadri vaccine of the latest generation against four current influenza virus strains. The product complies with the World Health Organisation's recommendations on inactivated vaccines, and is produced using a full-cycle technology meeting international GMP standards

According to the company, 10 million doses of the Ultrix Quadri vaccine were produced in 2020. As of 2021 the supplies will be scaled up both in the domestic and international markets. An almost twofold increase in the production of medical equipment (in particular for combating COVID-19) was achieved in 2020 by the POZIS company (Technodinamika holding of the Rostech State Corporation). First of all, it is medical refrigeration equipment, pharmaceutical refrigerators and freezers (to store blood, plasma, vaccines, etc.). All equipment meets the stringent "cold chain" requirements ensuring that medical substances are stored in a stable temperature environment in line with GMP standards. The production of disinfecting equipment over the past year increased 8.5 times, including bactericidal irradiator re-circulators, the demand for which is steadily growing.

iii) Russia's Chumakov Center proves efficacy of polio vaccine against Covid-19

Russia's Chumakov Federal Scientific Center for Research and Development of Immune and Biological Products of the Russian Academy of Sciences has proved the efficacy of its polio vaccine against the novel coronavirus, the Center's director, Aidar Ishmukhametov, said on Wednesday.

"We inoculated volunteers with a live polio vaccine and observed a dramatic slump in [coronavirus] incidence in this group. We have proved that," he said in an interview with the Vesti daily news roundup on the Rossiya-1 television channel.

"So far, we have left aside this matter [the efficacy of a polio vaccination as an anti-Covid measure as, so to say, an emergency option," he added. According to Ishmukhametov, the study involved more than 600 people in the city of Kirov.

The Chumakov Federal Scientific Center for Research and Development of Immune and Biological Products was created on the basis of the Institute of Poliomyelitis and Virus Encephalitis of the USSR Academy of Medical Sciences. Academician of the USSR Academy of Medical Sciences Mikhail Chumakov was the Institute's founder and first director (until 1972). Today the Chumakov Center is a leading world research organization in the sphere of medical virology.

The Center has also developed its own dead whole-virion vaccine against the novel coronavirus infection (CovviVac). Whole-virion vaccines are based either on artificially weakened viruses incapable of causing a disease or killed (inactivated) viruses. The CoviVac vaccine was registered with the Russian health ministry on February 19.

iv) Interactive platform for remote rehabilitation of patients with various complications after COVID-19

COVID REHAB cloud platform is a service for conducting online group classes for patients with complications after COVID-19 disease.The platform was created by the team of TelePat LLC in conjunction with the National Medical Research Center for Rehabilitation and

Balneology of the Ministry of Health of the Russian Federation (NMRC RB).

The platform is based on temporary guidelines developed by NMRC RB. The purpose of rehabilitation is to recover quickly and minimize the risk of complications at the outpatient stage of treatment after discharge from the hospital and to prevent repeated unplanned hospitalizations. The platform's quick launch is due to successful joint experience in remote rehabilitation of cancer patients on the OncoRehab cloud platform (https://oncorehab.online).

Patients who have had COVID-19 with moderate and severe course, often get complications like cough, shortness of breath with little physical activity, hypo- or atrophy of the muscles, functional and psychological problems, digestive system disorders and others. Online classes conducted by unique specialists on the COVID REHAB platform will help increase the effectiveness of the recovery period during self-isolation, as well as provide access to rehabilitation for patients living in remote areas or unable to undergo full-time rehabilitation.

The COVID REHAB platform allows the doctor, having remotely analyzed medical documents, to identify the patient in one of the rehabilitation groups of patients, united by common problems. Further, professional instructors-rehabilitologists remotely carry out group programs of physiotherapy exercises, group and individual psychotherapeutic sessions, art- and occupational therapy sessions to correct neurological and mental disorders.

Making a daily questionnaire, doctors conduct individual control of adherence to treatment, the effectiveness and safety of classes in the process of rehabilitation. It also allows to remotely observe the dynamics or record complications that arise in the post-hospital period.

The platform technically allows to conduct online not only individual and group classes, but also distance schools of patient mutual assistance (up to 100 people at a time), enabling online communication between a high-class expert doctor conducting a patient school from a medical organization and patients who are not having the opportunity to come to full-time patient schools, but wishing to ask an expert a question about their condition online.

Online classes for patients are conducted strictly by filling out test questionnaires under the supervision of a doctor and include:

- performing breathing exercises and aerobic exercises;
- strength training of varying intensity;
- training of drainage breathing equipment: in patients with increased sputum formation;
- neuropsychological training: counseling, psychological support and cognitive training;
- video lectures with recommendations on nutrition, restoration of intestinal microflora and non-drug methods of recovery after COVID-19.

v) Developer: Kovivac is effective against all Covid-19 mutations

The Kovivac vaccine against the corona virus is effective against all strains of infection, the head of the Chumakov Center, Aydar Ishmukhametov, stated. The scientist recalled that Kovivac is a "whole-virion" vaccine - it is made of a coronavirus that has been inactivated, TASS reports. Ishmukhametov stressed that Kovivac effectively protects against all known mutations. Ishmukhametov has no doubt that, should new strains of the virus emerge, scientists will definitely develop a new vaccine. Kovivak was approved in Russia at the end of February. It became available for domestic use at the end of March. **The maximum selling price is 4,330 rubles for ten ampoules.**

The specialists of the Chumakov Center highly appreciated the level of antibodies that appear as a result of vaccination. In the fall, scientists are going to apply to WHO for retraining. It is planned to produce at least10 million doses by the end of the year.

vi) Russia ready to support patent protection lift from COVID-19 vaccines in the world — Putin

President Putin noted that Russia is the only country in the world that transfers technology for the production of its vaccines to other countries

Russia is ready to support the idea of removing patent protection from coronavirus vaccines so that they can be used around the world, said Russian President Vladimir Putin at a meeting via video link with Deputy Prime Minister Tatyana Golikova on Thursday.

President Putin called the ideas voiced in Europe to "remove patent protection altogether" from COVID-19 vaccines as noteworthy, stressing that this falls in line with WTO rules for these measures during emergencies. President Putin instructed Golikova, together with her colleagues, to work out this issue. "Of course, Russia would support this approach, bearing in mind that in modern conditions, we should think not about how to extract maximum profit, but about ensuring the safety of people," said he, adding, that "safety can only be ensured if vaccines are used in the vast majority of countries in the world."

President Putin stressed that in this case, in the broadest sense of the word, general immunity will be developed. "This applies to everyone, including our country," he said.

President Putin noted that Russia is the only country in the world that transfers technology for the production of its vaccines to other countries. "This practice is already being implemented, it is already in progress, in some countries the production of our vaccine has already been organized with the transfer of technology," Putin emphasized.

Russian President Vladimir Putin has made assurances that authorities will continue to monitor the coronavirus spread situation in popular destinations for Russian tourists.

"With expert help, we will thoroughly monitor with our colleagues the situation that is actually unfolding in these countries and make appropriate decisions for our tourists," the head of state said during a video conference with Deputy Prime Minister Tatyana Golikova on Thursday.

"We are interested in people being able to move about freely and to have a proper vacation," the president emphasized.

At the same time, the Russian leader noted that the issue of limiting transport links with other countries due to the spread of the coronavirus infection is not political. "Concerning our partners abroad, we constantly talk about this at all levels. The issue, of course, does not lie in the political sphere, this is exclusively the issue related to medical restrictions," the head of state said.

"We understand that in many countries where the tourism sector is very important for the economy in general, this situation is extremely dangerous, especially when the season begins," the Russian president said.