The Second School of Young Scientists "Monitoring of Natural and Technogenic Systems

16-18 November, 2020
Perm, Russia

Second announcement

The Perm Federal Research Center of the Ural Branch of the Russian Academy of Sciences announces the Second School of Young Scientists "Monitoring of Natural and Technogenic Systems", which will be held in Perm on November 16 - 18, 2020. The School is organized with financial support of the Russian Science Foundation within the framework of the project No. 19-77-30008.

The program of the School, which includes lectures by leading Russian and foreign specialists, is posted on the home page of the conference website https://www.icmm.ru/nauka/konferentsii and in the appendix to this information letter. The program is still subject to alterations and amendments.

Conference application

Registration of participants is indispensable and is available online on the website until November 10, 2020.

There is no registration fee for participants.

Conference venue

The school is hosted by the PFRC UB RAS at the address: Academician Korolev st., 3 The organizers will arrange accommodation for school participants in city hotels, information of which can be found at the address http://hotel.perm.ru/. The online city map is available on the website http://perm.2gis.ru/

Information on the distant participation will be sent to registered participants at a later date.

Important dates:

November 10, 2020 - third announcement containing the program of the School;

until November 10, 2020 - registration of School participants.

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Keynote speakers of
the Second School of Young Scientists "Monitoring of Natural and Technogenic Systems",
16-18 November, 2020
Perm, Russia

Getman Alexsander Fedorovich

Professor, Doctor of Engineering Science, Laureate of the USSR Council of Ministers prize in the field of science and technology. Author of about 300 scientific papers, including 35 inventions, more than 10 normative documents in the field of safety of nuclear power stations (NPS) and 9 monographs.

System conception of strength and examples of its application in nuclear power engineering

The system conception of strength (SCS) is based on the methodology of a system approach to the problems of strength and safety and makes it possible to raise the strength reliability to a principally new level.

The effectiveness of this approach has been repeatedly supported by the results of solving particular problems of exploiting nuclear power plants and other equipment.

The widespread application of SCS to modern technology, in our opinion, is of nation-wide importance, since it will significantly (by orders of magnitude) increase the level of strength reliability, and hence the level of the corresponding technical safety.

Malovichko Aleksey Alexandrovich

Doctor of Engineering Science, Corresponding Member of the Russian Academy of Sciences, Scientific Director of the Federal Research Center "United Geophysical Service of the Russian Academy of Sciences", a leading specialist in the field of monitoring seismic processes at different scales. Honored Scientist of the Russian Federation, member of the Bureau of the Earth Sciences Division of the Russian Academy of Sciences, Chairman of the Scientific Council of the Russian Academy of Sciences on Problems of Applied Geophysics; member of the Russian Expert Council for Earthquake Forecasting, member of the Russian section of the Coordination Committee as part of the implementation of the Agreement between the Government of the Russian Federation and the Preparatory Commission for the Comprehensive Nuclear Test-Ban- Treaty Organization (CNTBT).

Multi-scale seismological monitoring of natural and technogenic seismic processes on the territory of the Russian Federation

The paper is concerned with the formation and development of a multilevel system for seismological observations within the territory of the Russian Federation. The structure, state and trends of its evolution are described. The emphasis is placed on the main trends in the development of instrumental seismology and newly formulated problems, the solution of which has become possible due to the implementation of more advanced instrumental observations (with a wide frequency band and a large dynamic range). A number of examples are given to demonstrate the effective use of broadband digital seismological data for studying the characteristic features of the depth section of seismically active regions and forecasting the geodynamics of local objects using the results of monitoring the natural and technogenic seismic activity at different scales.

Babeshko Vladimir Andreevich

Full Member of the Russian Academy of Sciences, Doctor of Physical and Mathematical Sciences, Professor, Head of the Department of Mathematical Modeling of the Kuban State University, Head of the Department of Mathematics and Mechanics at the Southern Scientific Center of the Russian Academy of Sciences, Laureate of the State Prize of the Russian Federation. Representative of the Kuban State University in the Association of Institutes of Seismology of the USA. He was awarded two gold medals of the EU Scientific and Industrial Chamber .

Mechanical and mathematical modeling of some natural and technogenic processes

The block element method as a new high-precision tool for mathematical modeling designed in Russia. The block element method as a mathematical apparatus, which is based on the higher mathematics. Application of the block element method in earth sciences. Discovery of a new previously unknown type of earthquakes, which are called "starting" and can be forecasted. Identification of new tsunami precursors. Explanation of the reasons why tsunami does not occur during some strong sea earthquakes and the possibility of tsunami formation even at weak earthquakes.

Application of the block element method to study the phenomenon of "subduction" - a shift of marine lithospheric plates beneath the continental ones. Application of the block element method to the problem of strength of underground structures containing systems of parallel tunnels. Application of the block element method to the problem of strength of fractured bodies. Detection of new types of previously undescribed cracks complementary to the Griffiths cracks. On the additional mechanism of material fracture. The block element method in some problems of climatology.

Rigmant Mikhail Borisovich

Candidate of Physical and Mathematical Sciences, Senior Research Scientist in the Laboratory of Magnetic Structural Analysis at Yekaterinburg Institute of Metal Physics of the Ural Branch of the Russian Academy of Sciences. Research interests: development of new methods and devices for controlling the phase composition, structure and magnetic properties of products made from austenitic steels and alloys. Main results: acquisition of patent of the Russian Federation, development and manufacture of devices of the "Ferritometers" series, which make it possible to determine the phase composition and properties of structures of complex configuration in local control zones. Author of the monograph "The Role of Russian Science in the Development of the Domestic Submarine Fleet", which won the competition of the Association of Russian Book Publishers (ASKI 2009) in the nomination "Best Publication in Natural Sciences, Technology and Medicine".

Modern methods and devices for non-destructive testing of phase composition, magnetic and electrical properties of products made from austenitic steels and alloys

Steels and alloys of the austenitic and austenitic-ferritic class employed in modern industry constitute a considerable fraction of all materials used. Most of these materials have high heat-resisting properties, corrosion resistance, high plastic properties and mechanical strength. Magnetically, most of these materials exhibit paramagnetic properties, which are important for many objects, which should meet strict requirements for magnetic environment. The required level of operation properties is ensured by maintaining the specified content of the phase composition, first of all, the ferrite phase (α-phase). Furthermore, the use of products under the action of external stresses causing deformation can give rise to phenomena associated with another phase - deformation-induced martensite (α'-phase), which increases the tendency of the material to cracking. Non-destructive (instrumental) control of the content of both the ferrite component and martensite phase in finished products made of austenitic steels is a challenging task. For many products made of austenitic steels, one of the important characteristics is the prescribed "low magnetic" state of the material, in which the relative magnetic permeability μ does not exceed $\mu \leq 1.10$. Devices for local monitoring of this condition are not produced in Russia.

The paper presents modern methods and devices for non-destructive testing, which make it possible to measure the phase composition and specified properties, both during the production and operation of finished products.

Antonovskaya Galina Nikolaevna

Doctor of Engineering Sciences, Head of the Laboratory of Seismology at the Federal Research Center of Integrated Study of the Arctic (Arkhangelsk). Research interests: seismic monitoring of the Western Arctic sector of the Russian Federation, geodynamics of platform territories, inspection of engineering facilities and development of seismic methods for their monitoring. Author and co-author of over 120 scientific papers, 3 monographs and 3 patents.

Monitoring of natural and technigenic hazards, including the Far North conditions, by seismic methods

In connection with the estimated growth rate of industrial development of the Arctic region and, first of all, the development of mining, processing and transportation industries, one of the urgent trends in the studies in this area are preventive works aimed at ensuring the safety of operation of the relevant industrial facilities. It is known that natural processes, including earthquakes, landslides, earth falls, exaration, etc. account for 12% of the main causes of accidents. Weak events and their secondary effects occurring within the location of the facilities lead to emergency situations. The possibility of similar negative processes in the Arctic territories, which remains underexplored in terms of seismology, should not be ruled out.

The revival and installation of new seismic stations have created favorable conditions for the registration and location of low-magnitude earthquakes in some areas of the Eurasian Arctic. Scientists have the opportunity to assess the effects of current weak seismicity and use these data for subsequent geological-tectonic and geodynamic forecasting. Moreover, the use of modern seismological equipment and passive seismic methods opens up new perspectives for studying the seismic conditions in the regions of locating critical infrastructures, which is very important in a changing climate.

The lecture will address the following problems:

- seismic monitoring of the Western sector of the Russian Arctic;
- the capabilities of seismic equipment for monitoring the sub-grade support of railway lines in the regions with complicated soil conditions;
- seismic methods of investigation of anthropogenic objects of various applications.

Melnik Oleg Eduardovich

Corresponding Member of the Russian Academy of Sciences, Head of the Laboratory of General Hydromechanics in the Research Institute of Mechanics at Moscow State University named after M.V. Lomonosov. Laureate of Lomonosov award (2008) for the series of works "Application of methods of hydromechanics and petrology to the study of mechanisms of magma rise and volcanic eruptions." Research interests: hydromechanics, mechanics of multiphase media, dynamics of volcanic eruptions.

Mathematical problems of volcanic eruption monitoring

A volcanic eruption is a complex physicochemical natural process, the study of which is associated with certain difficulties caused by the impossibility of direct observation of the processes occurring in the volcano-magmatic system. In this regard, the understanding of the mechanisms of volcanic eruptions, and the evaluation of parameters and hazards of particular volcanoes is impossible without the development of mathematical models allowing the appropriate interpretation of the field observation data. The report will survey the existing methods for monitoring volcanoes, data obtained during eruptions and mathematical models describing various aspects of volcanic activity.

The interpretation of field observation data is based on solving the inverse problems. The specific feature of natural process monitoring is insufficient knowledge of the physical properties of magma and enclosing strata, as well as the need to take into account the interaction between different parts of the system. For example, the interaction of magma flowing through the volcano conduit with the geothermal system contributes significantly to deformation of the volcano structure, and the nucleation of gas bubbles leads to long-period volcanic earthquakes. Therefore, without a comprehensive simulation of physical processes it is impossible to obtain an adequate interpretation of the data obtained during monitoring the volcanic activity.

Mikhailov Valentin Olegovich

Chief research scientist of the Laboratory for Integrated Geodynamic Interpretation of Terrestrial and Satellite Data of the Department of Mathematical Geophysics and Geoinformatics at the Institute of Physics of the Earth named after O. Yu. Schmidt RAS. Corresponding Member of the Russian Academy of Sciences, Doctor of Physical and Mathematical Sciences, Professor. Specialist in the fields of geophysics, geodynamics, numerical modeling, application of satellite technologies in earth sciences. Author of more than 120 scientific works, including 3 monographs and 1 patent.

Application of satellite technologies for solving problems of geophysics and geodynamics

Modern satellite technologies provide ample opportunity for high accuracy registration of the displacements of the earth's surface and man-made objects. In our country , data from global navigation satellite systems GPS and GLONASS have become common use. This, however, does not apply to the methods of radar satellite interferometry, which are still used less frequently.

By processing two satellite images taken with the use of synthetic aperture radars (SAR interferometry, SAR), it is possible to determine the displacements of the earth's surface, which occurred during the time interval between repeated surveys. This makes it possible to study active geodynamic processes, including those associated with volcanism, earthquakes, to monitor landslide processes, displacements of technogenic objects, subsidence in the areas of ore mining and oil and gas pole development, etc.

At present, methods for analyzing a series of radar images - technologies of stable reflectors - are rapidly evolving. These technologies make it possible to record the displacements of individual sites, which steadily reflect the radar signals from satellites, and to determine the displacements at the level of the first millimeters per year.

The attendees will have the opportunity to get acquainted with currently operating satellite systems, specific features of radar surveying at different wavelengths, processing technologies, software packages, methods of joint interpretation of different terrestrial and satellite data and some results of SAR interferometry obtained at the IPE RAS over the past 15 years.

Pradere Christophe

Institut de Mécanique et d'Ingénierie de Bordeaux France, I2M-département TREFLE - transfert fluide énergétique Directeur de Recherche

Multispectral infrared as a tool for heat and mass transfer studies

In the first part, the study of Non Destructive Testing and Evaluation on multiscale heterogeneous solid materials will be presented in order to demonstrate the ultra-capacity of these tools to offer an understanding and characterization of materials

Then, in second part, the previous method has been extended to the study of multispectral heat and mass transfer in microfluidic systems. In fact, the recent development of the Fast Infrared Imaging Spectroscopic Technique (FIIST) allows simultaneous acquisition of temperature and concentration fields, using a non-intrusive method and also Thermal Imaging Velocimetry (TIV). In this work, the exothermic acid-base reaction between sodium hydroxide and hydrochloric acid is performed in a co-flow microfluidic chip of high aspect ratio. This configuration makes it possible to obtain laminar flows where the mixture of the species is then only due to a radial diffusion process and advection. Mass diffusion cone makes out since water transmittance is increased in presence of the ion pair of Na^+ and Cl^-. Both heat and mass diffusivities are estimated from the logarithmic parabolas method, originally developed for thermal transfer but applied here also in the mass transfer case since the diffusion transport equation which is similar in both cases.

Finally, in a last part, the beginning of thermospectroscopic tomography will be presented with imaging system that is able to measure transient temperature phenomena taking place inside a bulk by 3D tomography. This novel technique combines the power of multispectral waves and the high sensitivity of infrared imaging. The tomography reconstruction is achieved by the 3D motion of the sample at several angular positions followed by inverse Radon transform processing to retrieve the 3D transient temperatures. The aim of this novel volumetric imaging technique is to locate defects within the whole target body as well as to measure the temperature in the whole volume of the target. This new-fashioned thermal tomography will open research perspectives in the non-invasive monitoring techniques for volume inspection and in-situ properties estimations.

Matvienko Yuriy Grigorievich

Doctor of Engineering Sciences, Professor, Head of the Department of Strength, Longevity and Safety of Machines at the Institute of Mechanical Engineering named after A.A. Blagonravov of RAS. Honored Scientist of the Russian Federation. Head of the Base Department of Rocket Engineering at the Moscow Regional Technological University. As a professor and scientific expert, he was repeatedly invited to universities and research institutes in England, France, Japan, Italy, South Korea, Slovenia and Thailand. Research interests: strength, fracture mechanics, endurance, life time and safety of machines and structures in a severely damaged state under extreme physical and mechanical impacts and corrosive environments

Longevity control in models and criteria of modern fracture mechanics

At the present stage of development of science, prevention of failure and maintenance of safety of complex technical systems is largely determined by the adaptation of the main conceptions of the modern control theory to the formulation and solution of longevity problems. The analysis of damage and fracture kinetics of technical systems at the model or physical level should be considered as one of the main issues of the control theory as applied to the problems of safety, endurance and lifetime of structures.

The general formulation and solution of fundamental system and applied problems of safety and hazards of mechanical engineering objects are based on the analysis of their direct quantitative relation with the formulation of problems of fracture and lifetime control. In this respect, the crack resistance, longevity and reliability can be considered as the integral parts of such analysis.

The paper presents motivation and validation of the development of numerical and experimental approaches to the analysis of the longevity and safety of machines and structures, including a comprehensive analysis of strength, lifetime, endurance and safety; multiparameter models and criteria for nonlinear fracture mechanics at different scales and structural levels; methods for experimental determination of fracture mechanics characteristics for non-standard samples and elements of full-scale structures; monitoring and diagnostics of damage and fracture, location of crack-like defects; physical, mathematical and simulation modeling; engineering and technological aspects of modern two-parameter fracture mechanics.

Lomakin Evgeny Viktorovich

Head of the Department of Plasticity Theory at the Faculty of Mechanics and Mathematics, (Department of Mechanics) of Moscow State University named after M.V. Lomonosov, corresponding member of RAS, specialist in the field of mechanics of deformable media, fracture mechanics and mechanics of composite materials. Member of the Bureau of the Solid Mechanics Research Council of the Russian Academy of Sciences, member of the Expert Council of the Higher Attestation Commission of the Ministry of Education and Science of Russia on Mathematics and Mechanics, member of the Expert Council of the Russian Foundation for Basic Research, member of dissertation committees at Moscow State University named after M.V. Lomonosov and the Institute of Mechanical Engineering of RAS

Modeling of nonlinear deformation and damage in composite materials

The paper presents several models for describing the dependence of hardening characteristics and strength of composite materials on damage and strain rate. The results of experimental studies of composite material responses to deformation in a wide range of strain rates are analyzed and some patterns of their behavior are determined. The nonlinear characteristics of the material under static deformation and high speed hardening under dynamic loading of the material are taken into account using the fracture criterion, which includes the dependence of fracture characteristics on damage, as well as the rate of damage evolution. Based on the dependence of the stiffness characteristics on the damage parameters, the ordinary differential equations can be formulated for conditions of proportional loading at different rates of deformation.

A method for the experimental determination of material parameters is proposed. Some patterns of material behavior under conditions of complex non-monotonic loading and unloading of composite materials are analyzed.

This work was supported by the Russian Science Foundation grant #. 20-11-20230.

Thierry PALIN-LUC

Thierry Palin-Luc is Deputy Director of the Institute of Mechanics and Mechanical Engineering (I2M) in Bordeaux (France), a joint research unit with Bordeaux University, CNRS, Arts et Metiers Institute of Technology and Bordeaux Polytechnic Institute. He is working on high cycle multiaxial fatigue of metals since 1993 and on the development of fatigue strenght criteria and fatigue life calculation methods for variable amplitude loadings. For helping engineers to solve the difficult task of the transferability of data from the lab to real components he has proposed several non local high cycle fatigue models and concentrated his researches on both the effect of the manufacturing process on the fatigue strength of metals and on the gigacycle fatigue. Indeed, since 2007, he is working on the fatigue of metals in very high cycle fatigue regime.

Fatigue strength of metals and fatigue life calculation for long and very long life: what is known and what are the challenges

In service, most of the mechanical components or structures are submitted to cylic loading. To avoid failure of such systems, engineers have to design them against fatigue crack initiation (and then propagation). For short lifetimes (in low cycle fatigue, LCF) regime, up to ~10^5 cycles) macroscopic plasticity is responsible of crack initiation. For longer lifes (i.e. in high cycle fatigue, HCF) up to approximatively 10^7 cycles, the key role of microplasticity at the grain scale is now well established. Very promissing results have been obtained in literature with polycristal plasticity and critical plane based or energy based approaches. In the two previous regimes (LCF and HCF) cracks initiate at stress concentrators and at the surface of metals with a scenario where persistent slip bands are the precusors of crack. But for very long life, named gigacycle regime (that is beyond 10^8 cycles) when very low cyclic load level is applied (the stress amplitude could be ~0.3 times the material yield stress) fatigue crack initiation occurs in the core of the material whereas it is at the surface for higher load levels (in LCF and / or HCF). In gigacycle fatigue, non-metallic inclusions are often crack initiation triggers, but internal crack initiation occurs also without any inclusion (in titanium alloy for example). Consequently the mechanism of crack initiation is not so clear. There is no model able to explain why crack initiation shifts from the surface to the core of the material when the cyclic load level is decreased. Some ways for future researches are proposed to progress in the understanding of this open question.