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# 'THE THIRD POLYAKHOV LECTURES' INTERNATIONAL CONFERENCE ON MECHANICS† (4–6 February 2003, St Petersburg)

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'The Third Polyakhov Lectures' International Scientific Conference on Mechanics, devoted to the memory of Professor N. N. Polyakhov, was held on 4–6 February 2003. The conference was organized by the Russian Ministry of Education, the Russian Foundation for Basic Research, St Petersburg State University, the Institute of Mechanical Engineering Problems of the Russian Academy of Sciences, The Scientists' Club of the Russian Academy of Sciences, the A. N. Krylov St Petersburg Central Scientific Research Institute, and the St Petersburg Division of the Academy of Non-Linear Sciences. The conference was chaired by N. F. Morozov, the cochairs were G. A. Leonov and M. P. Yushkov, and the Scientific Secretary was I. A. Pasynkova.

At the conference, 178 papers were presented by 233 authors from Russia, Armenia, Belarus, Georgia, the Ukraine, China (PRC and Taiwan), France, Germany, Romania and the United States. Work by the Moscow and St Petersburg schools of mechanics were widely represented. A considerable number of papers were given by young scientists and postgraduates.

The subject field of the conference covered the main areas of modern mechanics. The scientific programme included commissioned papers (plenary session) and work in sections: theoretical and applied mechanics, the mechanics of space flight, fluid mechanics, the mechanics of deformable bodies, and the history of mechanics.

At the plenary session, the following papers were presented: N. F. Morozov, S. A. Zegzhda, and B. N. Semenov on 'Application of Lagrange's equations to problems of fracture mechanics'; S. A. Zegzhada, Sh. Kh. Soltakhanov and M. P. Yushkov on 'The main results of the Polyakhov School of Analytical Mechanics'; A. V. Karapetyan on 'Stability and bifurcation of the steady motions of non-holonomic systems'; V. V. Beletskii on 'Yegorov, Lidov, Yershov, and flights to the moon'; K. F. Chernykh on 'Non-linear problems of the theory of elasticity (theory and applications)'; Yu. V. Lapin on 'Modelling of near-wall turbulence: achievements and problems'.

We will give a brief indication of the results presented in the sections.

## SECTION 'THEORETICAL AND APPLIED MECHANICS'

*1. Analytical mechanics*

It was demonstrated that almost all periodic motions of a second-order autonomous reversible system are "retained" under the action of reversible periodic disturbances. A study was made of the regular precessions of a gyrostat with a stationary point, Lagrange–Euler equations were used in the dynamics of submersible apparatus, and elementary gyroscope theory was applied to the study of the precession of the earth. An approach was described to the derivation of the equations of motion of both holonomic and non-holonomic systems with constraints of any order, the equations were applied to problems of mechanotronics, and steady motions, stability, stabilisation, and other problems of non-holonomic mechanics were considered.

*2. Vibrations and the stability of mechanical systems*

The vibrations of a piecewise-linear oscillator were studied; the stability and bifurcation of the steady motions of a body filled with liquid were investigated; the synchronization of dynamic objects with internal degrees of freedom was described; the periodic motions of an aseismic foundation with elastic arresters were analysed; an analytical and numerical description was given of the non-linear vibrations of an unbalanced rotor with radial clearance; the vibrations of a single-circuit electromagnetic pendulum in a variable magnetic field were analysed; the stability of the motion of dynamical systems of polynomial structure and regular processions in axisymmetric fields was investigated.

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*3. Dynamics in specific problems*
An analysis was made of the operation of a centrifuge under the action of impulses, different anti-aircraft missiles, a disc with anisotropic friction, a ship under the action of external vibrations, and an automobile, taking into account the possibility of drift. The results of the modelling of self-balancing devices for rigid rotors, rotors in an associated medium, an electromechanical system with a large number of generators and motors, etc. were presented.

## SECTION 'DYNAMICS OF SPACE FLIGHT'

The kinematics and dynamics of the controllable and uncontrollable orbital motion of celestial bodies were studied. Analytical and numerical methods were developed for solving many-body problems. The libration points in the problem (including photogravitation) of three bodies and their surroundings were studied. Questions of using triangular points as the reference base for an interplanetary solar stereoscopic observatory, and collinear points for locating an "umbrella" against solar radiation and protection of the earth from overheating, were examined. An investigation was made of the dynamics of rotational motion about the centre of masses of artificial satellites of the earth in an elliptical orbit under the action of factors of different physical kinds (gravitation, the atmosphere, a magnetic field, light pressure, etc.), and their ties (tether systems).

Improved methods were proposed for solving applied problems of the dynamics of spacecraft. New principles of space flight and for controlling the orientation of spacecraft were developed.

## SECTION 'FLUID MECHANICS'

*1. The kinetic theory of liquid and gas*
Problems of the fractal modelling of a rough surface were examined. Several papers were presented on non-equilibrium processes (including a non-Newtonian model of blood and a model of a lung).

*2. Hydroaeromechanics and gas dynamics*
The shock wave structure in the first roll of an overexpanded jet was analysed. Problems of calculating the aerodynamic characteristics of aircraft in a rarefied gas and the saltation of particles at the surface were considered, and transient processes in supersonic flows were examined. Some basic problems of hydroelasticity, hydrodynamics, and gas dynamics were discussed. Specific problems (the use of numerical methods to design propellers and turbine grids, mixing layer, etc.) were examined. Experience in using different software packages was assessed.

## SECTION 'MECHANICS OF DEFORMABLE SOLIDS'

*1. Fraction mechanics*
The dynamics of crack propagation was examined, and new results were presented on the delamination of composite materials and the fracture of materials (including materials with shape memory) under the action of high-velocity loads.

*2. Theory of shells and plates*
Papers were devoted to the development of asymptotic methods for solving problems of the theory of vibrations and the stability of thin shells and plates. In particular, the stability of laminated shells and of shells reinforced with strands, and also the vibrations of reinforced and matched shells, was investigated.

*3. The non-linear theory of elasticity and models of media with a complex internal structure*
Solutions of some topical problems of mechanics were obtained using the moment theory of elasticity. New mathematical models were proposed for nanostructural objects and media with a relaxing internal structure.

*4. Biomechanics*
Mechanical models were developed for describing the emergence and development of glaucoma, and also a model of the strain of the crystalline lens capsule of the eye. The stress-strain state of a heart valve under external actions was modelled. A mathematical model was proposed for describing the vibrations of the middle ear membrane.

*5. Technical applications*

A number of urgent technical problems were solved. In collaboration with scientists of Hannover University (Germany), the behaviour of containers with spent nuclear fuel when they fall onto a concrete slab was investigated. An effective method was developed for determining the effect of the rigidities of the rotor supports of gas turbine motors on their critical rotational speeds. The loads leading to a loss of the bearing capacity of the shells of underwater hardware components were determined.

## SECTION 'HISTORY OF MECHANICS'

The history of the St Petersburg scientific schools of mechanics in the nineteenth and twentieth centuries (on the 300th anniversary of St Petersburg), their scientific ties with the Paris Academy of Sciences, and the contribution of the Scientific Research Institute of mathematics and the Theoretical Mechanics Faculty of St Petersburg University to the development of mechanics in the twentieth century were described.

New developments in the history and philosophy of mechanics were given. The history of problems of free fall, of the motion of bodies, and of the Poincaré homoclinic pattern was discussed.

The scientific legacy of Leonardo da Vinci (on his 550th anniversary), Girolamo Cardano (on his 500th anniversary), and M. V. Ostrogradskii (on his 200th anniversary), and also the scientific activity of professors of St Petersburg University A. A. Grib and Ye. A. Ugryumov, was analysed.

The conference was organized with the support of the Russian Foundation for Basic Research (03-01-10011).

It was decided to hold 'The Fourth Polyakhov Lectures' in February 2006, to coincide with the 100th anniversary of the birth of N. N. Polyakhov.

*Translated by* P.S.C.