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# A REVIEW OF THE THIRD INTERNATIONAL SYMPOSIUM ON CLASSICAL AND CELESTIAL MECHANICS - VELIKIE LUKI 1998

*UDC: 531*

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**Abstract.** *The article provides for basic scientific-professional information about the organizer and the program of The Third International Symposium on Classical and Celestial Mechanics - Velikie Luki, August 23-28, 1998, Russia, as well as about its participants. It also presents a review of the given Plenary Sessions and Minisimposiums and the given short lectures during the Symposium, as well as a survey of the directions of future research in the field of Classical and Celestial Mechanics.*

## 1. INTRODUCTION

The Third International Symposium on Classical and Celestial Mechanics was held in the period August 23-28, 1998, in the Campus "Solnechniy" , Sapuhlinki, Velikie Luki, Russia. It was organized by the Computing Center of the Russian Academy of Science, Academy of Cosmonautics of Russia, Moscow State University M. V. Lomonosov, Moscow State Aviation Institute, Moscow State Academy of Instrument Making and Computer Science and State Agriculture Academy at Velikie Luki and sponsored by Russian Foundation of the Fundamental Research as well as by Holding Company ELVO-Velikie Luki. It is the most competent scientific symposium in the field of classical and celestial mechanics offering the highest and cognitive potentials in the field of mechanics.

Chairman of the Scientific Committee was academician RAN *V. V. Rumyantsev* (Russia). Members of the Scientific Committee were following professors: V. V. Baletskii, A. V. Karapetyan, V. V. Kozlov, P. S. Krasil'nikov, P. D. Panagiotopoulos, M. Pascal, G. V. Plotnikova, C. Simo, H. Troger, V. N. THai, D. P. Chevallier, and other.

This specialized international Symposium gathered a number of active and most

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competent researchers and scientists in the field from all over the world ( Russia, Greece, Belgium, France, USA, Italy, Spain, Austria, Germany, Hungary, Yugoslavia).

**Scientific Program: Plenary Lectures**

Eleven Plenary Lectures A were given with duration of 45 minutes each and twelve Invited Lectures B on minisimposium on a joint session of two section were given with duration of 30 minutes each as well as a 86 short lectures on minisymposiums C, D in a scope of Classical Mechanics and Celestial Mechanics sections, followed by discussions and active response of the participants resulting in the exchange of relevant scientific information, agreements and initiatives for joint research projects.

Two minisymposium were organized on a joint sessions of two sections: Methods of Classical and Celestial Mechanics and Selected Direction in Classical and Celestial Mechanics. Inside the Classical Mechanics section were organized the following minisymposiums: Analytical Mechanics, Theory of Stability and Bifurcations, Regular and Chaotic Dynamics, Dynamics of Rigid and Deformable Body. Inside the Celestial Mechanics section were organized following minisymposiums: The Problems of Three and N Bodies, Investigations on Dynamics of Solar System Planets, Motion under Solar Light Pressure, Dynamics of Rotational Motion of Celestial Bodies.

Symposium was organized in Memory of Professor V.G.Demina.

The Opening Ceremony was Ceremony followed by chairman of Scientific Committee, academician RAN *V. V. Rumyantsev*.

The Program of the Conference continued by following Plenary Lectures:

**V. A. Proshkin, Ya. V. Tatarinoff (Russia)**: *On creative Heritage of Vladimir Grigor'evich Demin*. In the communication the main results of many-sided creative activity of V. G. Demin both in field of science and in ones of its organization, and popularization, investigations in history and methodology, teaching methods in mechanics are highlighted.

**E. A. Grebenikov, L. V. Demina (Russia):** *Life and Work of Vladimir Grigor'evich Demin*.

**M. Pascal (France):** *A pseudo Rigid Model for the Dynamical Simulation of Flexible Mechanisms*. The aim of this work is to show that it is possible to use any existing rigid body codes for the dynamical simulation of elastic multibody systems provided that these codes are based on variational methods like Lagrange's equations or direct application of d'Alambert's principle. A first attempt for this possibility was made for planar interconnected flexible beams. In the present work three dimensional interconnected flexible bodies are considered and the method used to identify the approximated model of the flexible multibody system with a fictitious rigid multybody system is rather different from other idea used in known literature. Several applications are made using the symbolic dynamical code.

**V.V. Beletskii (Russia):** *On Evolution of Rotational Motions of Celestial Bodies with Tidal and Aerodynamic Dissipation*. Since Beletskii's works evolution of rotational motion of a celestial body under tidal dissipation has been studied by the method of averaging over fast rotations. The motion evolution revealed by this method leads to the region of the phase space where fast variables become slow and the method of averaging may not be formally applied. However, it is this region where the most interesting dynamical effects occur. Thus, there is a necessity of confirmation of the results by other

method.

In the present work such corroboration is given by exact integration of the equations of evolution for a celestial body with the spherical ellipsoid of inertia in a Keplerian circular orbit of its center of mass. There are new dynamical effects of the second order, not found out by the method of averaging.

The similar research is also carried out for a problem of aerodynamic dissipation, considered before by the method of averaging.

**A. D. Bruno (Russia):** *Power Geometry and Asymptotic Solutions to an ODE System*. On the basis of the geometry of the power exponents there were developed universal algorithms of local and asymptotical analysis of solutions to systems of equations (algebraic, ordinary differential and partial differential). The efficiency of these algorithms was demonstrated on several complicated problems from Robotics, Celestial Mechanics and Hydrodynamics.

**V. V. Rumyantsev (Russia):** *On General Equations of Analytical Dynamics*. The lecture presents an introduction in the theory of the generalized Poincare's and Chetayev's equations based on a closed system of infinitesimal operators. These equations include both the motion's equations in independent and dependent, holonomic and nonholonomic coordinates for holonomic mechanical systems with finite number of degree of freedom. In this sense the generalized Poincaré-Chetayev's equations are the general equations of analytical dynamics. Some examples are considered.

**D. G. Saari (USA):** *Tractable Newtonian n-body Problems*. Understanding the *n*-body problem is crucial for our appreciation of problems from mathematical astronomy, manned missions, etc.. Yet, the complexity of the problem has frustrated attempts to obtain other than limited insight about the possible solutions. In this talk, a new reduction for the system is described. The advantage of this reduction is that it simplifies the analysis for a large class of *n*-body problems - they now become tractable. Moreover, the approach provides a program for the analysis for related systems.

**V. V. Kozlov (Russia):** *Field of Directions Freezing Condition, Small Denominators, and Chaotization of Steady Flows of Viscous Liquid*. The relation between classical Helmholtz theorem on vortex in ideal fluid and the known problem of small denominators is discussed.

**W. Poth, M. Schagerl, A. Steindl and H. Troger (Austria)**: *Efficient Numerical Calculation of Large Amplitude Motions of Tethered Satellite Systems*. Three-dimensional large amplitude motions of a system of two satellites modeled as rigid bodies connected by a continuous tether, modeled as a massive flexible viscoelastic extensible string, on a circular orbital motion around the Earth are studied. A fully nonlinear geometrically exact description both of the motion of the end bodies and of the displacement of the tether is given.

The main object of this paper is to compare two different descriptions of the deformation of the tether of a tethered satellite system.

**A. P. Markeyev (Russia):** *On stability and Nonlinear Oscillations of Hamiltonian System in Case of Two Zero Roots*.

**J. Wittenburg (Germany) and L. Lilov (Bulgaria)**: *Decomposition of a Finite Rotation into Three Consecutive Rotations about Fixed Axes*. The angular orientation of a rigid body with a fixed point can be described as the result of a finite rotation with unit vector along rotation axis and with rotation angle. It can also be represented by three parameters. For any three- parametric representation there exist critical cases in which the

parameters are partially indeterminate. Subject of the present paper is the following unusual three-parametric representation. Given are the unit vectors along the axes of three consecutive rotations. All three vectors are fixed in the same reference space in which finite rotation is given. They are not co-planar and, in general, non-orthogonal. In the present paper rotations are described by dyads and quaternions. Necessary and sufficient conditions are given for the existence of real solutions.

## 2. THE CHOICE OF THE MINISYMPOSIUM PLENARY LECTURES OF THE PROGRAM

### B1. Methods of Classical and Celestial Mechanics

**V. A. Vujičić (Yugoslavia):** *A Non-Standard Interpretation of Newton's and Lagrange Mechanics*. In several papers and monographs some important modification of classical analytical dynamics have been done. These modifications were necessary, as it was shown that the theorem concerned with the energy exchange cannot be proved by Lagrange differential equations of second kind or Hamiltonian canonical ones of motion. It has been also shown that principles of mechanics are not invariant regarding the transformation of parameter equations or time-dependent constraints. Some important modifications are presented in the comparison.

**A. V. Karapetyan (Russia):** *On the Influence of Dissipative Forces to Form and Stability of Steady Motion of Mechanical Systems*. The influence of dissipative forces with total dissipation and constant forces to form and stability motions of mechanical systems with cyclic coordinates is investigate.

**Yu. A. Sadov (Russia):** *On Structure of Motions in Multyfrequency System with Fast Phases*. The motion separation methodology for systems with small parameters is developed. System-generation processes are discussed and specific features of evolution in hierarchical structure of subsystems are described. It is pointed out that some crises in such evolution can arise caused by interaction between subsystems of different ranges.

**V. N. Tkhai (Russia):** *Periodic Rotational Motions of the Mechanical Systems*. The lecture proposes the results of the systematic development of the theory of the periodic rotational motions. A number of mechanical applications are also considered.

### B2. Selected Directions in Classical and Celestial Mechanics

**Yu. G. Borisovich (Russia):** *Asymptotic Decomposition of Periodic Solutions of Singular-Perturbed Evolution Systems with Distributed Parameters*. In this paper the classical Yu. L. Daletski-S.G. Krein method is developed for periodic solutions of singular-perturbed evolution systems with distributed parameters and nonbounded operators. The main result is the theorem for abstract differential operator.

**Yu. F. Golubev (Russia):** *Estimation of Parametric Resonance Domains for Linear Systems with Periodic Coefficients*. This lecture develops a method to study and control parametric resonance in systems which are governed by linear differential equations of the second order with periodic coefficients. This method allows to find a monodromy matrix as a result of comparison of elementary phase flux tranfornations. The method is based on piecewise constant approximation of coefficients of the equations. A criterion for parametric resonance is found which is taking into account multiplicity of roots of the characteristic equation of monodromy and action of a dissipative forces as well.

Complete study of parametric resonance is presented for Holl's equation and for equation with dissipative term in a special case of periodic two-step piecewise constant coefficients.

**K. (Stevanović) Hedrih (Yugoslavia):** *Vectorial Method of the Kinetic Parameters Analysis of the Rotor with Two Rotation Axes and Nonlinear Dynamics in the Field of the Turbulent Damping*. By examples of the rotor system which rotate about two axes with section build the vectorial method of the kinetic parameters analysis of the rotors with many axes. The mass moment vectors for the pole and the axis, as well as the kinematic vectors rotators are using for the analysis of the system kinetic parameters. Expressions for the corresponding linear momentum and angular momentum, as well as their derivatives in time are derived. By these expressions vectorial equations of the rotor system dynamics are derived, as well as the expression for the kinetic pressures on the rotor system bearings.

By vectorial equations we composed two scalar differential equations of the heavy rotor system nonlinear dynamic in the field with turbulent dumping. For the case when one rotation about axis is controlled by constant angular velocity the nonlinear dynamics of the rotation about other axis in the field with turbulent dumping is studied. Nonlinear rotor system dynamics in the field with turbulent damping are presented by phase portrait in the phase plane, with trigger of the singularities, as well as with homoclinic orbits and homoclinic points of the nonstable type saddle. The portrait of the constant energy in the phase plane is presented. For the case rotor system dynamics under the action of the perturbed couple the sensitive dependence in the vicinity of the equilibrium nonstable position which corresponds to homoclinic point of the type nonstable saddle, the possibility of the chaotic character behavior is pointed out, as well as properties of Poincare maps.

**D. P. Chevallier (France):** *Curvature and Dynamics of an Affinely Deformable Body*. The cofiguration space of an affinely deformable body is described by a manifold endowed with two structures. First is a principal homogeneous space with a linear isomorphism. Second, the action of the subgroup defines a principal fiber bundle, with natural projection of the configuration space onto "shape space". The kinetic energy defines a D-invariant Riemannian structure which may be defined by a family of bilinear forms.

**A. A. Burov and G. V. Plotnikova (Russia):** *On Motion of Systems with Unilateral Constraints*. The first problem to study is the motion of a material point entering in contact with a half-plane being an inhomogeneous elastic medium. The second problem is the motion of a material point entering in contact with an elastic medium filling a half plane. This point has an initial velocity directed orthogonally to the half plane and inside of the medium it is submitted to the action of Coulomb's forces of dry friction. One studies the dynamics of motion of this point inside the medium as function of the initial velocity of impact. In particular, conditions of arrest inside of a half plane are fined.

In the third part it is study the dynamics of motion of material point entering in impact with an elastic medium boarded by a parabola.

Authors made discussing applicability of considered models of a justification the theory of systems with unilateral constraints.

**P. S. Krasil'nikov (Russia):** *Fast Non-Resonance Rotations of the Satellite in Three-Body Problem with Account of Magnetic Field*. Resonance fast rotations of the satellite in restricted three-body problem with account of magnetic field (created by one of the main

bodies) are considered. The magnetic field is simulated by oblique dipole. The following assumptions are made: the kinetic energy of satellite is greater than it's potential energy, the ellipsoid of moments of inertia is arbitrary one. The average equations of motions are investigated.

**V. A. Sarychev (Russia):** *Equilibrium Orientations of a Pendulum in an Artificial Satellite*. Author investigates an attitude motion of a satellite-pendulum system in a circular orbit under the influence of gravitational torque. It was supposed that the pendulum is attached to a fixed point of the satellite by a spherical hinge. Here we present an analysis of all equilibria of the satellite pendulum system. Main directions of the study are following: Nonlinear equations of the attitude motion; Equilibrium orientations; Single's special case; Blitzer's special case; General case; Stationary rotations of the pendulum in the satellite body; Equilibria of a double pendulum; Stability of equilibria.

**A. S. Shmyrov (Russia):** *Planet Few Bodies Problem Stable Trajectories*. The relation between stability of planet few bodies problem trajectories and optimality in a sense of variational principles of mechanics is considered.

## 3. CONCLUDING REMARKS

The participation on such a scientific Symposium offers an outstanding experience and scientific satisfaction, providing grounds for the comparison of one's own scientific results with the results of other researchers and their evaluation which, is always an inspiration for new scientific projects. The attitudes of the colleagues shared on such occasions are also a unique scientific inspiration; on the other hand, new ideas ease and smooth the way for keeping up with the latest achievements in the field - Classical and Celestial Mechanics.

The organizers of *The Third International Symposium on Classical and Celestial Mechanics - Velikie Luki, August 23-28, 1998, Russia*, were presented following publications: *The Third International Symposium on Classical and Celestial Mechanics - Velikie Luki, August 23-28, 1998, Russia, Program and Register of Participants*, Computing Center of the Russian Academy of Science, pp.40. and *The Third International Symposium on Classical and Celestial Mechanics - Velikie Luki, August 23-28, 1998, Russia, Abstracts*, Computing Center of the Russian Academy of Science, pp. 188.

The international Symposium brought together experts from across the world in area of Classical and Celestial Mechanics. It advanced the theoretical underpinnings of this important scientific area.

## REFERENCES

1. *The Third International Symposium on Classical and Celestial Mechanics - Velikie Luki, August 23-28, 1998, Russia, Program and Register of Participants*, Computing Center of the Russian Academy of Science, pp.40.
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# VALENTIN VITALYEVICH RUMYANTSEV

## Academician of Russian Academy of Science
## Academician of Serbian Academy of Science and Arts

***Chairman of the Scientific Committee***
***of the Third International Symposium on Classical and Celestial Mechanics***
***Velikie Luki 1998, Russia***

Professor Valentin Vitalyevich Rumyantsev, Ph. D a famous scientist and educationist, is wellknown in Russia as well as in the world. Professor V. V. Rumyantsev carried into foundamental contribution to development of stability theory of motion, rigid body dynamics as well as to analytical mechanics. Having big scientific erudition and authority, Valentin Vitalyevich Rumyantsev took a stand as one of leaders who develop in all world scientific directions, based on the Lyapunov's as well as on the Chetaev's results. Professor Valentin Vitalyevich Rumyantsev founded and developed stability theory by variable parts, stability theory of body motion with poles, containing fluid, as well as other results having principles with theoretical and applied significance. His papers and articles have clearity and strict resutlts with analytical contributions with thin mechanical intuition. Numerous scientific results of V.V. Rumyantsev are enclosed in monography and university books of mechanics as a classical knowledge.

Valentin Vitalyevich Rumyantsev was born in village N. Skatovka Saratov's Region, on July 19, 1921. After graduation at the Saratov University in 1945, he entered postgraduate studies and research at the Institute of Mechanics Academy of Sciences of the Soviet Union, under the guidance of scientist Nikolay Guryevich Chetaev. Meeting with the scientist Chetaev had a major scientific as well philosopfical influence on V.V. Rumyantsev in forming his scientific, ideological and personality ideals as a scientist-Mechanicst. He obtained candidate degree (1948) as well as Ph. D degree (1953) at the same Institute of mechanics. Ph. D dissertation was in the field of stability of rigid body motions with fulid. After Chetaev's died in 1959, V. V. Rumyantsev become his worthy heir in the field of mechanics. He was the head of the department for analytical mechanics, as well as of a scientific seminar on analytical mechanics, and he also supervised the work of postgraduate students and scientific reserch. Begining from 1965 V. V. Rumyantsev worked at Computing Center of RAS as a head of the Laboratory of stability theory and Mechanical System Control. In 1970. he became a corresponding

member of Academy of Sciences of Soviet Union. Now he is a member of the Russian Academy of Science, as well as of the Serbian Academy of Science and Arts.

V. V. Rumyantsev is author of monographies: "*On the Stability of Stationary Motions if the Satellite*" (in Russian, 1967) and "*Dynamics and Stability of Rigid Bodies*" (1972).

He is Editor-in-Chief of "*Applied Mathematics and Mechanics*", Moscow, a member of the Editorial Boards of the journal "*Mechanics*". He is a member of National Committee of Theoretical and Applied Mechanics. Hi was vice-president of Scientific board of Academy of Sciences of Sovet Union in field of General Mechanics.

More then forthy candidate disertations and Ph. D dissertation were defended under the supervision of V. V. Rumyantsev in the field of stability theory.

He is generally acknowledged as one of the pioneers and founders of modern classical mechanics undertakings in world. His major research activities include: the.stability with respect to a part of the variable, dynamic and stability of rigid body as well as filled with fluid, variational principles of mechanics, general equations analytical dynamics..

He also made great contribution to the application of scientific knowledge, such as in the articles: Stability of motion of solid bodies with liquid-filled cavities by Lyapunov's methods; Nonlinear methods in the theory of stability motion of solids with liquid-filled cavities; On stability of statinary motion of the Gyrostat-satellite; On the influence of gyroscopic and dissipative forces on the stability of steady-state motion, ect.

V. V. Rumyantsev is a professor of the faculty of mechanics-mathematics Moscow State University - named Lomonosov. He founded series of new general and special courses, seminars and symposium in the field of mechanics and theory of motion stability.

V. V. Rumyantsev was a member of numerous scientific committees of international scientific conferences, congreses and symposiums

For the resultts of his scientific work he received the following awards: in 1958 avard named Chaplyigin of Academy of Scince of Soviet Union for result in field of rigid body dynamics; in 1980 State award for papers series in field of dynamics of rigid body with polos, and filled with fluid.


Participants
of the Third International Symposium on Classical and Celestial Mechanics
Velikie Luki 1998, Russia

# PRIKAZ TREĆEG INTERNACIONALNOG SIMPOZIJUMA KLASIČNE I NEBESKE MEHANIKE - VELIKI LUKI 1998

**Katica (Stevanović) Hedrih**

*Članak daje bazne naučnostručne informacije o organizatoru i programu Trećeg internacionalnog simpozijuma iz klasične i nebeske mehanike koji je održan od 23 do 28 avgusta 1998. godine u Rusiji, Velikim Lukima. Dat je prikaz plenarnih predavanja, kao i predavanja održanih na plenarnim zasedanjima svih sekcija.*

*Pod nazivom Valentin Vitaljevič Rumjancev data je kratka naučna biografija predsednika Internacionalnog naučnog komiteta Simpozijuma klasične i nebeske mehanike i inostranog člana SANU.*