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THE XXXV INTERNATIONAL SUMMER SCHOOL "ADVANCED PROBLEMS IN MECHANICS"

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The XXXV International Summer School "Advanced Problems in Mechanics" (APM 2007) was held from 20 to 28 June, 2007 in St. Petersburg, Russia

The Conference is organized by the Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences (IPME RAS) under the patronage of the Russian Academy of Sciences (RAS). The main purpose of the meeting is to gather specialists from different branches of mechanics to provide a platform for cross-fertilisation of ideas.

This conference was devoted to the 20th anniversary of the Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences (IPME RAS). The institute was founded in 1986 by Vladimir P. Bulatov as a branch of Moscow Institute of Mechanical Engineering. In 25 june 1991 IPME became an independent institute, which nowadays became a St. Petersburg centre of research in area of theoretical and applied mechanics. The institute includes 26 laboratories carrying out investigations in various areas of mechanics and physics. The list of problems under investigation is not limited to questions of mechanical engineering, but includes practically all advanced problems in mechanics, which is reflected in the name of the conference. The main attention is given to problems on the boundary between mechanics and other research areas, which stimulates the investigation in such domains as micro- and nanomechanics, material science, physics of solid states, molecular physics, astrophysics and many others. The Institute has strong links with research organisations and universities in many countries. The conference "Advanced Problems in Mechanics" helps us to maintain the existing contacts and to establish new ones between foreign and Russian scientists.

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The topics of the conference

- solids and structures
- phase transitions
- nanostructures and thin films
- wave motion
- nonlinear dynamics, chaos and vibration
- dynamics of rigid bodies and multibody dynamics
- fluid and gas
- computational mechanics
- mechanical and civil engineering applications
- molecular and particle dynamics
- aerospace mechanics

More then three hundred participants attended APM 2007; the participants come from 25 countries: Ukraine (10), Germany (9), United Kingdom (8), Italy (5), Latvia (5), USA (3), Spain (3), Netherland (3), France (3), Japan (2), etc.

The 18 plenary lectures are presented at the conference:

1. **A. K. Belyaev.** 20 years of the Institute of Problems in Mechanical Engineering. Past, Present and Future.
2. **H. Irschik.** Generation of transient desired displacement fields in force loaded solids and structures by smart actuation.
3. **V. A. Babeshko, O. M. Babeshko, O. V. Evdokimova.** Materials of complex block structure.
4. **E. V. Lomakin, B. N. Fedulov.** Plastic limit state of dilatant solids under conditions of plane strain.

5. **H. Altenbach, K. Naumenko, B. Renner**. On the orientation of a rigid particle in a polymer suspension.
6. **D. A. Indeitsev, V. N. Naumov, B. A. Semenov.** Dynamical effects in the material of complex structure.
7. **I. G. Goryacheva.** Effect of imperfect elasticity in sliding/rolling contact.
8. **A. Cherkaev.** Optimal multiphase structures and bounds for their effective properties.
9. **V. N. Kukudzhanov.** Coupled models of elastoplasticity and damage and their integration.
10. **M. Wiercigroch, M. Keber, C. Mazzilli, C. Sanchez.** Application of Nonlinear Normal Modes to Vibration of Vertical Offshore Risers.
11. **H. L. Duan, J. Wang, B. L. Karihaloo**. Nano-mechanics or how to extend continuum mechanics to nano-scale.
12. **A. Movchan, G. Mishuris, A. Piccolroaz. Weight** functions and singular perturbation problems for interfacial cracks in three dimensions.
13. **S. A. Nazarov.** Elastic waves dampers.
14. **A. Barrero, I. G. Loscertales**. Mico and nanoparticles vна electro-capillary flows.
15. **A. Ramos, A. Castellanos.** Electrohydrodynamic and Magnetohydrodynamic Integrated Micropumps.
16. **I. I. Blekhman, D. A. Indejtsev.** On "internal pendulum" in an oscillatory system with inertia excitation.
17. **M. A. Guzev.** Exactly solved model of molecular dynamics.
18. **E. L. Aero.** Some effects of cardinal rearrangements of crystalline structure under catastrophic deformations in the frame of nonlinear micromechanics.

Participants of the APM 2007

Special symposia-sessions

1. Molecular dynamics of nanostructures, physical and mechanical applications. A. M. Krivtsov, M. A. Mazo.
2. Mechanics of Materials with Internal Instabilities. A. B. Freidin, L. Truskinovsky.
3. Dynamic interaction of flexible structures with solids and fluids. A. V. Metrikine.
4. Nonlinear Dynamics of Enginering Systems. M. Wiercigroch, E. Pavlovskaya.

5. Theory and Applications, Measures of the Dynamical Integrity. K. S. Hedrih.
6. Nonlinear Waves in Mechanical Systems. A. V. Porubov, V. I. Erofeev.
7. Vibrational Mechanics and Synchronization. I. I. Blekhman.
8. Mobile Particulate Systems. A. Castellanos.
9. Rare Dynamical Phenomena in Mechanics. Theory and Applications. M. V. Zakrzhevsky

This year a special "young participants section" was held for students and PhD students in the frame of the Summer School-Conference "Advanced Problems in Mechanics (APM) 2007". Participants born in 1980 or later, were invited to make their presentations at this section. The main goal of the "young participants section" is to provide the exchange of experience and scientific communication between young researchers from various cities and countries, and the possibility to meet the scientists from the leading scientific schools of the world.

Participants of the "youth section" at the APM 2007

IPME presentation

Laboratory Discrete Models in Mechanics. Head of laboratory Prof. Anton M. Krivtsov.

Modeling of thermomechanical behavior of solids at different scale levels using particles. (A.M. Krivtsov)

The investigation of thermomechanical effects in particulate systems is presented. Such phenomena as big deformation, fracture, internal friction and heat conductivity in strictly conservative systems are analyzed and discussed. The systems under consideration are the collections of particles connected by interaction potentials, moving according classical mechanical equations of motion. The application of such systems for the modeling of thermomechanical behavior of solids at different scale levels is described and discussed.

Molecular dynamics modelling of high speed spallation and penetration processes. (Igor E. Berinskiy)

This work is dedicated to the investigation of a high speed interaction of elastic bodies. Molecular Dynamics (MD) method is used. In the first part of the work an impact interaction

of two 2D elastic plates is considered. At the initial time one of the plates has high speed (impactor) and the speed of the second one is equal to zero (target). The comparison of the MD investigation with finite element analysis is done. The second part of the work is dedicated to the high-speed penetration of the deformable impactor to the deformable target. 2D and 3D problems are considered. The dependence of the penetration depth on the initial velocity of the impactor is obtained. Qualitative comparison of the obtained results with the results of real experiments and finite element computations ([1], [2]) is made. The investigation shows good applicability of the MD simulation to the problems of high-speed interaction of solids. [1]. V. M. Fomin, A. I. Gulidov, G. A. Sapozhnikov. High-speed interaction of solids. Novosibirsk, Russia. Publishing of Siberian branch of RAS. 1999.-600p. [2]. P. A. Gorelchenko. Finite element investigation of high-speed penetration of cylindrical projectile into finite deformable plate. XXXV week of science in SPbSTU: Proceedings of All-Russia students and PhD-students conference. Vol. IV. SPb, Russia: Publishing of Polytechnical University, 2007.

Microscopic derivation of Gruneisen parameter.
(Vitaliy A. Kuzkin)

This paper is devoted to the analytical derivation of Gruneisen function. Gruneisen function is the key thermodynamical parameter in the study of systems at high pressures and temperatures. Usually Gruneisen parameter is deriving in terms of the so called cold curve (volume-pressure dependence at zero temperature). New approach for Gruneisen function based on molecular dynamics was considered. According to this approach, microscopic analogies of pressure, volume and temperature was suggested. Then it was shown that expanding into series by microscopic analogue of temperature and neglecting terms of second order leads to Mie-Gruneisen equation of state and direct form of Gruneisen function. Also it was shown that Mie-Gruneisen equation can not give the desired accuracy in case of high tensile deformations. The modified form of Mie-Gruneisen equation of state correct until the failure was obtained.

Determination elastic properties of structures with complex crystal lattice(diamond). Scale effect in elastic properties.
(Olga S. Loboda)

The paper considers the discrete nanocrystal model with complex crystal lattice. There are no close-packed lattices, which typical for some of the metals and for elements with covalent bonds, for example diamond, graphite. Traditionally for description this kind of lattices used many-particle interaction potentials. However the form of these potentials is extremely difficult. The alternative approach considers rotatory degree of freedom and allows the moment contribution in interatomic interaction. The particles interacted using forces and moments. In this paper the characteristics of interatomic bonds are determinated for crystals with diamond structure (carbon, silicon, germanium). It is shown, that the relation of bending stiffness covalent bonds of carbon atoms to longitudinal equal 0.5 (in diamond crystals). Hence, bending stiffness is comparable with longitudinal and it is necessary to take into account on calculation covalent crystals. For crystals silicon and germanium this relation equal 0.34. The strength of covalent bonds decrease with the rise interatomic space in sequence C-Si-Ge. Also, in this paper the nanocrystals with different number of atomic layers is considered and scale effect in elastic properties of nanostructures from number of atomic layers is investigated. The results of the work show that the sizes of nanocrystal bring additional anisotropy to its elastic properties. We can see that additional anisotropy cased by the crystal size is imposed upon anisotropy coupled with the type of crystal lattice. The elasticity properties of nanocrystal substantially depend on the number of atom layers N in all 3 directions. When the number of layers grows up they all are tending to their values, corresponding to the infinite crystal.

Participants of the APM -
Minisyposia "Theory and Applications, Measures of the Dynamical Integrity"

The Organizing Committee would like to tender thanks to Professor Katica Hedrih for her minisymposium "Theory and Applications, Measures of the Dynamical Integrity" at the APM 2007.

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