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Recent Researches in Applied Mechanics

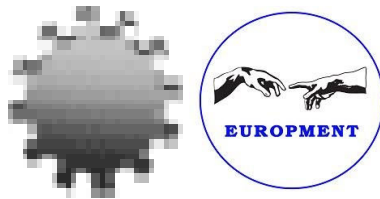
**Proceedings of the 3rd International Conference
on Theoretical and Applied Mechanics (TAM '12)
Proceedings of the 3rd International Conference
on Fluid Mechanics and Heat and Mass Transfer (FLUIDS-HEAT '12)**

Vouliagmeni Beach, Athens, Greece, March 7-9, 2012

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Plenary Lecture 1

Instability of Cracked and Porous Media by Statics and Small Vibrations



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Abstract: The book introduces strain problems for high-contrast microinhomogeneous media featuring a very high (many orders of magnitude) difference in physical-mechanical properties between the matrix and the closing. These are oil, gas or water reservoir, coals and other fractured rocks. The classical continuum hypothesis is unsuitable for these media, since the classical continuum implies that close points should have close values of all physical properties (stresses, strains, temperatures etc). Rejecting the continuum hypothesis means either setting the boundary conditions at the whole internal pore surface or constructing a new continuum with initially specified collective geometrical properties of pores and fractures. The integral geometry describes these collective properties. This geometry substantially affects the physics of elementary strain process so that the equilibrium and motion equations differ radically from the classic ones. These equations describe, besides the regular effects, very slow waves, catastrophe dynamics and the intermediate states between statics and dynamics.

Brief Biography of the Speaker:

I was born in 1939 in Leningrad (Sankt-Petersburg). In 1961 graduated Leningrad University in special engineer-geophysics. In 1971 I have got degree candidate of physics and mathematics in special "Theory of elasticity and plasticity". In 1986 I have got degree as senior research worker. In 1987 I have got State Praise Winner of USSR for papers in the field of multi-wave seismic. In 1989 I have got a degree of doctor of physics and mathematics in special geophysics. In 1999 I have got degree as professor of Novosibirsk University. I am a participant of 11 International conferences in geophysics and meso mechanics. During 1998-2000 I was a visiting professor in Brazil (Petrobras Company, Unibersity of state Para). During 1996-1997 I was a member of expert Council of Fund of fundamental researches of Russia.

Plenary Lecture 2

Gauge theory of flows of an ideal fluid



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Abstract: Fluid mechanics is a field theory in Newtonian mechanics, i.e. a field theory of mass flows of Galilean symmetry. In the gauge theory of theoretical physics, a guiding principle is that laws of physics should be expressed in a form that is independent of any particular coordinate system. Variational formulations of fluid flows are reviewed first from the point of view of gauge theory, and then a new variational formulation is proposed, which leads to a new representation of compressible rotational flows of an ideal fluid. This improves the classical solution of Clebsch (1859). There is a fundamental question how a rotational component of fluid flow can be formulated in the variational framework of an ideal compressible fluid. Present Lagrangian for the action principle consists of main terms of total kinetic energy and internal energy (with negative sign), together with three additional terms yielding the equations of continuity, entropy and the third term which provides rotational component of velocity field. The last term leads to an explicit expression of non-vanishing helicity. Thus, a new expression of velocity field $\mathbf{v}(\mathbf{x}, \mathbf{t})$ is given in terms of vector potentials of frozen field, i.e. the potentials are convected by the fluid flow under effect of stretching, while the potentials of Clebsch solution are just convected without stretching effect. It is verified that the system of new expressions in fact satisfies the Euler's equation of motion. Associated with two symmetries (translation and space-rotation), there are two gauge fields \mathbf{E} and \mathbf{H} , which do not exist in the system of discrete masses. One can show that those are analogous to the electric field and magnetic field in the electromagnetism, and fluid Maxwell equations can be formulated for \mathbf{E} and \mathbf{H} . Sound wave within the fluid is analogous to the electromagnetic wave, in the sense that phase speeds of both waves are independent of wave lengths, i.e. non-dispersive.

$$[\mathbf{E} \equiv (\mathbf{v} \cdot \nabla) \mathbf{v} , \mathbf{H} \equiv \nabla \times \mathbf{v}]$$

Brief Biography of the Speaker:

Tsutomu Kambe graduated from the University of Tokyo (Physics Department) in 1962, and started his career of research from 1966 in fluid mechanics from physical point of view. He stayed in Cambridge (England) as a postdoc scholar of British Council and worked with Professor Sir James Lighthill and Professor George Batchelor on vortex motion, animal locomotion and aerodynamic sound. He studied sound generation by vortex motions both theoretically and experimentally at the Kyushu University (Japan). In 1983, this study succeeded in the first experimental detection of sound waves generated by collision of vortex rings, which were consistent with theoretical prediction. In 1984, he became Associate Professor at the Department of Physics, University of Tokyo, and Full Professor there in 1995. His research interests now focus on gauge theoretic formulation of fluid flows, which is the study of fluid mechanics on the basis of theoretical physics. This resulted in formulation of Fluid Maxwell Equations (2010) and a new variational formulation of fluid flows of an ideal fluid (2007, 2008). He is author of about 100 papers published in international journals and conference proceedings. He published two textbooks, Elementary Fluid Mechanics (2007) and Geometrical Theory of Dynamical Systems and Fluid Flows (2004, 2010), in addition to Japanese publications of four textbooks and about fifty papers. He is Former Professor of physics and retired from the University of Tokyo. He is Honorary Member of the Japan Society of Fluid Mechanics, Former member of IUTAM Bureau, and Visiting Professor at the Chern Institute of Mathematics (Tianjin, China).

Plenary Lecture 3

Different mixtures of diesel-vegetable oils as fuel



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Abstract: Biofuels are the fuels that are being produced from biomass. Furthermore, biofuel is defined as solid, liquid or gas fuel derived from relatively recently dead biological material. They can replace conventional fuels, completely or partially, in the internal combustion engines. Some of the consequences of crude oil dependence are the increasing price of crude oil, the important changes in oil market, the finite of reserves as well as the environmental pollution. Therefore, there is a big need to produce appropriate fuels, which will have minimal environmental and social degradation. This led to the revaluation of the importance of the rural and forestall factor as a renewable resources supplier. This work examines the behavior of a four-stroke Diesel engine when mixtures of diesel-vegetables oils (sunflower oil, olive seed oil, cotton oil) are used as fuel. For those mixtures the gas emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen monoxide (NO) and smoke emissions are being examined.

Brief Biography of the Speaker:

Dr. Charalampos Arapatsakos is a Greek citizen, who has been born in Athens. He has studied Mechanical of Engineering. He is a Ph.D. Assoc. Professor in the University of Thrace in Greece. At the present he is a member of Technical Chamber of Greece, member of Electrical and Mechanical Engineering Association and member of Combustion Institute of Greece too. Dr C. Arapatsakos has participated in many research programs about biofuels, gas emissions and antipollution technology. His research domains are mainly on biofuels and their use in internal combustion engines, the power variation from the use of biofuels, the gas emissions and mechanical damages.

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