Pergamon
www.elsevier.com/locate/jappmathmech
PII: S0021-8928(00)00074-5
J. Appl. Maths Mechs, Vol. 64, No. 4, pp. 493–495, 2000

0021-8928/00/$—see front matter

ROBERT ISKANDEROVICH NIGMATULIN (ON THE OCCASION OF HIS 60TH BIRTHDAY)†

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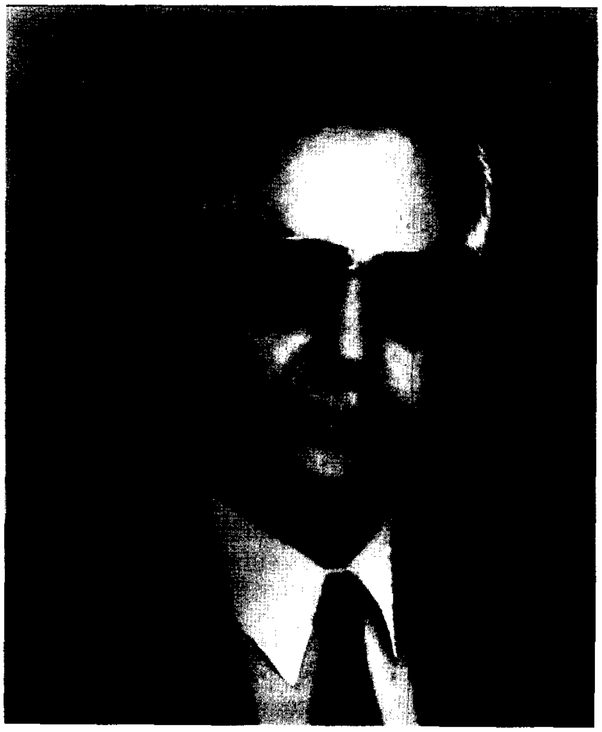

On the 17 June 2000, Academician Robert Iskanderovich Nigmatulin, a prominent scientist scholar in the field of mechanics and applied mathematics, celebrated his 60th the birthday.

Robert Nigmatulin was born in Moscow. In 1963 he graduated from the Faculty of Power Engineering of the N. E. Bauman Moscow Technical High School, and in 1965 from the Mechanics and Mathematics Faculty of the M. V. Lomonosov Moscow State University (MGU). In 1967 he obtained his Candidate's degree, and in 1971 his Doctor's degree. From 1963 to 1986 he worked at the MGU Institute of Mechanics, where he followed the path from junior research fellow to Head of Laboratory and Professor of the MGU Mechanics and Mathematics Faculty. In 1986, when the Tyumen Scientific Centre of Siberian Division of the USSR Academy of Sciences was being set up, he was invited there and, together with his former students, he organized the Faculty of Mechanics of Multiphase Systems at the Tyumen State University and the Institute of Mechanics of Multiphase Systems of the Siberian Section of the Russian Academy of Sciences. In 1987, he was elected a corresponding member of the USSR Academy of Sciences, and in 1991 a full member of the Russian Academy of Sciences. In 1993 he was sent to Ufa, where he headed the Ufa Scientific Centre of the Russian Academy of Sciences and the Bashkortostan Academy of Sciences. In 1995 he became a member of the Presidential Council of Bashkortostan. In 1996 he was elected a deputy of the State Council of Bashkortostan and a member of the Bashkortostan Government. In 1999 he was elected a deputy of the Russian State Duma. He is a winner of the USSR State Prize (1983), the USSR Lenin Comsomol Prize (1973) and First Prize of the Siberian Section of the USSR Academy of Sciences Basic Research Competition (1990). He was

†*Prikl. Mat. Mekh.* Vol. 64, No. 4, pp. 515–517, 2000.

also awarded the Gold Medal of the USSR Exhibition of National Economic Achievements (1989) and the Makeyev Gold Medal of the Russian Federation of Astronautics (1996).

He is a leading research scientist in the area of mechanics and is the founder of a scientific school specializing in the mechanics of multiphase systems that has received world-wide recognition and where 16 doctors and 38 candidates of science have been trained. He is a member of national committees on theoretical and applied mechanics and on heat and mass transfer, of an International committee on multiphase flows and of the editorial board of a number of Russian and foreign journals.

He has published over 200 scientific papers, books and inventions, among which there are eight monographs and textbooks. His monographs are reference books for specialists and workers in the area of the mechanics and thermophysics of heterogeneous media. A two-volume monograph *Dynamics of Multiphase Media* has been published in the USA.

His work has contributed considerably to the solution of such basic problems as the mathematical modelling of the dynamics of multiphase media, the hydrodynamics and gas dynamics of vapour– and gas–liquid systems, combustion, detonation and explosion in dispersed media; the seepage of multiphase fluids, and the dynamics of elastoplastic media with physicochemical transformations.

Under his guidance, urgent research and development has been carried out on problems of the safety of power engineering and production systems, new methods for oil and gas production, methods of increasing the oil yield of deposits, and methods of increasing the efficiency of production processes in power engineering, oil refining, chemical engineering and blasting.

He proposed an original general formulation of the problem of the motion of heterogeneous media, methods for describing intraphase and interphase processes, based both on methods of averaging microequations and on phenomenological methods, and a method for constructing closed systems of equations of the dynamics and thermodynamics of different types of heterogenous medium. Here it proved possible to distinguish an important class of motion of mixtures containing a gas phase, when a uniform pressure is produced in the latter, which can change with time. This type of motion is called homobaric, for which it is possible to simplify the system of equations of the dynamics of the mixture and to obtain solutions of the corresponding boundary-value problems by analytical or simple numerical methods.

Effects of a non-monophase nature are clearest in the case of wave propagation. With colleagues, he established the laws of propagation of various types of wave (compression, rarefaction, combustion and detonation waves) in two-phase systems of different structure and found a number of new effects. The existence of shock waves of a continuous monotonic and oscillatory structure was demonstrated in which effects of the transient structure of the wave play an important role. The decisive part played by interphase heat and mass exchange in shock-wave propagation in bubbling media was discovered. The mechanism of abnormal intensification or accumulation of shock waves in boiling liquids was established. The existence of different types of detonation wave in combustible aerosuspensions was predicted theoretically, and the conditions under which they occur were indicated. A number of problems were formulated concerning the escape of vapour–liquid mixtures and boiling liquids from volumes under high pressure, and effective methods for solving them were proposed. Conditions for the critical escape of a vapour–liquid mixture were formulated.

Research carried out under his guidance established the mechanism of the coking of tubular kilns for the heating of hydrocarbon feedstock, which is related not only to the kinetics of chemical reactions but also to the hydrodynamics of gas–liquid flow. As a result, measures were proposed for preventing this effect.

He developed the theory of high-speed deformation of solids undergoing allotropic transformations, the formation and motion of dislocations and the hardening of metals under explosive loads. He was the first to formulate and solve the problem of the high-speed collision of elastoplastic bodies undergoing phase transitions, when a multiwave pattern of motion arises. Here, a number of effects were predicted, which were subsequently confirmed by experiment. As a result of thorough investigation, the decisive part played by phase transitions during abnormal explosive hardening of low-carbon steel was demonstrated, equations describing superplasticity were obtained and a theoretical and experimental method was proposed for determining the kinetics of dislocation processes by solving inverse problems.

In recent years, he has been working on the problem of controlling the bursting of gas bubbles in a liquid with the aim of producing ultrahigh temperatures in the gas. This may have wide applications. The effect of the luminescence of gas bubbles in an acoustic field has been termed sonoluminescence. By virtue of the emergence of high temperatures in the bubbles, the acoustic field may initiate certain chemical reactions that are impossible under other conditions (sonochemistry). However, most impressive of all is the fact that, at ultrahigh temperatures, a thermonuclear reaction may begin in the bubbles. Deuterium bubbles in heavy water under ultrahigh compressions can release thermonuclear energy (a "bubble thermonucleus"). However, normal ultrasound is inadequate for this. The main idea behind the new approach he proposed is to coordinate the process of change in pressure in the liquid with forced vibrations of the bubbles, and the use of non-linear resonance under the non-periodic action of an external pressure field of moderate amplitude, which he has called the 'basketball mode'. To implement this idea, the problem of spherically symmetrical vibrations of a gas bubble in a compressible liquid was formulated and solved. On the basis of the analytical solution obtained, an effective computer code was developed for the mathematical modelling of the bursting of a bubble taking into account different dissipative mechanisms such as viscosity, heat conduction, radiation, ionization, wave processes around and within the bubble, and heat and mass transfer between the bubble and the surrounding liquid at ultrahigh compressions of the bubble.

Academician Nigmatulin combines the talents of a scientist and teacher, a prominent organizer of science, and remarkable personal qualities. He possesses a huge capacity for work, and is always captivated, and captivating to those around him, by new scientific problems. He, Nigmatulin, is a model of the true scientist for his students, colleagues and young scientists.

His students, disciples, and colleagues, the Editorial Board and the editorial staff of *Applied Mathematics and Mechanics* warmly congratulate him on his 60th birthday, and wish him good health, long life and further outstanding achievements.

Translated by P.S.C.