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Personalia

60th birthday of Mykhailo Tokarchuk

The development of nonequilibrium statistical theory in Ukraine during the last several decades is indubitably associated with the name of Professor Mykhailo Tokarchuk, a prominent scientist who celebrates these days his 60th anniversary.

Mykhailo Tokarchuk was born on November 3, 1956 in the town of Broshniv of Ivano-Frankivsk region. After finishing secondary school education, in 1975 he entered the Physics Department of Ivan Franko Lviv State University. Having graduated from the University in 1980, he started his scientific work as an engineer of the Lviv Division of Statistical Physics at the Institute for Theoretical Physics (ITP) of the Academy of Sciences of Ukraine. Early studies of Mykhailo Tokarchuk were devoted to the elaboration of statistical theory of ionic-molecular systems in collaboration with Ihor Yukhnovskii and Myroslav Holovko. As a result, an improved method for the calculation of the group coefficients for the binary distribution functions of the ion-dipolar systems was proposed. The results obtained were used successfully for the study of the rotational diffusion coefficients of aqueous electrolyte solutions such as NaCl and LiCl.

Following suggestion of I.R. Yukhnovskii, in 1984 M.V. Tokarchuk got acquainted with an outstanding representative of Moscow school of statistical physics Dmitry N. Zubarev (at Steklov Mathematical Institute). Evidently, this event launched a new fruitful period in M.V. Tokarchuk's scientific activities. Under supervision of D.N. Zubarev he continued his studies in the theory of solutions and developed a kinetic approach to the theoretical description of ionic-molecular systems. Among other fields of his interest at that time there were the derivation of kinetic equations for dense fluids based on the nonequilibrium statistical operator (NSO) method and some problems related to turbulence in liquids. High professionalism and best human features of D.N. Zubarev left an ineffaceable mark upon all further scientific career of Mykhailo Tokarchuk.

His first scientific publications deal with the study of nonequilibrium processes in ionic melts and electrolyte solutions. Making use of the NSO method, he developed (together with D.N. Zubarev) a statistical theory of hydrodynamics state of ionic liquids. Within this theory, he was able to obtain, in particular, the spectra of mass and charge fluctuations in NaCl. His attempt to construct generalized hydrodynamics of ionic-molecular systems was also a success. All these results were included in Mykhailo

Tokarchuk's Ph.D. dissertation entitled "Investigation of kinetic transport coefficients in ionic-dipole systems" defended by him under D.N. Zubarev's supervision in 1986.

Later on, M.V. Tokarchuk focused his attention on the consideration of inverse osmosis processes of transport of ions and molecules of electrolyte solutions through membranes structures (in collaboration with M.F. Holovko and I.J. Kurylyak), as well as on the problem of a self-consistent description of kinetics and hydrodynamics in condensed matter (together with D.N. Zubarev and V.G. Morozov). The kinetic theory of dense gases and liquids was also developed in collaboration with I.P. Omelyan who defended the Ph.D. thesis under M.V. Tokarchuk's supervision in 1990. In the same year, the Lviv Division of the ITP was transformed into the Institute for Condensed Matter Physics (ICMP) of the National Academy of Sciences of Ukraine, and Mykhailo Tokarchuk headed the Laboratory of Nonequilibrium Processes in Gases and Plasma of the Institute. In 1994 he defended the Doctor of Sciences thesis entitled "Consistent description of kinetics and hydrodynamics for systems of interacting particles in the NSO method".

In 1996 Mykhailo Tokarchuk organized and headed the Department for Theory of Nonequilibrium Processes of the ICMP. In such a way, a whole new area of investigations at the Institute was officially launched. Since then, the list of problems considered by M.V. Tokarchuk has significantly extended. It covers various aspects of nonequilibrium statistical mechanics for many classical and quantum systems. In 2000 he was awarded by the highest academic rank of Professor in theoretical physics. Three years later, Mykhailo Tokarchuk together with Yuri Rudavskii and Ihor Mryglod became a laureate of S.I. Pekar's Award of the National Academy of Sciences of Ukraine for the series of papers "Theory of dynamic properties and phase transitions in liquid magnets".

A substantial progress in the development of nonequilibrium theory in condensed matter physics was achieved by M.V. Tokarchuk (in common papers with D.N. Zubarev, V.G. Morozov, and I.P. Omelyan during 1987–1993) by proposing a concept of self-consistent description of kinetic and hydrodynamic processes in dense gases and liquids based on the NSO method. This allowed one to derive from the first principles the kinetic equations of the revised Enskog and Enskog-Landau theories for the systems of neutral and charged hard spheres. The normal solutions to these equations were also obtained without using any phenomenological assumptions. Moreover, there was performed (together with I.P. Omelyan) a generalization of the kinetic theory on the case of multi-step functions and the H-theorem was proved. In further investigations, these results were adapted to dense one-component plasma (with A.E. Kobryn) and even up to now they are successfully applied to many real systems and extended to dense mixtures (with Y.A. Humenyuk).

In the succeeding years, M.V. Tokarchuk (together with I.M. Mryglod and I.P. Omelyan, 1994–1995) improved the method of generalized collective modes for simple liquids. As a consequence, the time correlation functions and generalized transport coefficients of the Lennard-Jones model were originally calculated without using adjustable parameters. His development of the generalized hydrodynamics of polar liquids in an external electric field (with I.P. Omelyan and R.I. Zhelem, 1996–1997) can be considered as a significant contribution to the theory of nonequilibrium processes. By applying this approach to the TIP4P model of water there were obtained the hydrodynamic, kinetic, and polar modes in a wide range of wavevectors, taking into account spatial distribution of charges within a molecule. The wavevector- and frequency-dependent dielectric function was also evaluated with an excellent agreement with computer simulation data. For semiquantum liquids (together with V.V. Ignatyuk and I.M. Mryglod, 1997–2001), the collective excitation spectrum was investigated based on the thermoviscous model. A partial contribution of every collective mode to the dynamic structure factor was established. The relationship of these investigations with neutron scattering experiment and with previous theories was discussed. The key results were obtained by M.V. Tokarchuk (together with I.M. Mryglod and Yu.K. Rudavskii, 1998–2002) for liquid magnets. Here, the analytical expressions for partial dynamical structures factors were derived for the first time. They generalize the well-known Landau-Plachek formula for simple liquids to the case of multicomponent mixtures. Some new effects and phenomena were also predicted. There was proven the existence of a strong dynamical interaction between liquid and spin subsystems which leads to the fact that dynamical properties of magnetic liquids appreciably differ from those inherent in simple fluids and in solid magnets.

During the period of 1993–2008, due to I.R. Yukhnovskii's initiative Mykhailo Tokarchuk together with his numerous colleagues took part in solving complex problems for minimizing the negative effect of the catastrophe at Chornobyl nuclear power plant. In particular, among many others he considered

the following issues: radionuclides migration in soils and water; interaction of aqueous solutions of radionuclides with fuel-containing masses inside the “Shelter” installation; elaboration of new technologies for the refinement of “block waters” by carbonate-containing clays modified by ferrocyanides of copper and iron. In view of the achievements in this direction in 2006 he was awarded a Diploma of the Parliament of Ukraine for a distinguished contribution to the elimination of the consequences of the Chornobyl disaster, development of Ukrainian science, and high professionalism.

A series of important results have been obtained by M.V. Tokarchuk for the recent years. In particular, from 2008 to 2014 he has developed (together with B.B. Markiv and I.P. Omelyan) a kinetic theory for a description of relaxation processes from a strongly nonequilibrium state to a state of molecular hydrodynamics. As a consequence, the corresponding characteristic time intervals of such processes were established for the first time. In order to accomplish this, the generalized nonmarkovian equations were introduced, and it was realized that the collision integral is of a Fokker-Planck-like form. In 2011–2013, the concept of a self-consistent formalism of kinetics and hydrodynamics was extended by M.V. Tokarchuk (with P.A. Hlushak) to quantum Bose systems, with taking into account nonlinear fluctuations. There was obtained the kinetic equation for one-particle distribution function and generalized Fokker-Planck equation for nonequilibrium distribution of hydrodynamic variables. The structure function for the description of processes of quantum turbulence was calculated as well. The generalization of the NSO method to the case of Renyi statistics was also proposed and further developed during 2011–2016 (together with B.B. Markiv, R.M. Tokarchuk, and P.P. Kostrobij). Using this statistics, a theoretical approach for a consistent description of reaction-diffusion processes in “gas-adsorbate-metal” systems was proposed.

Nowadays, the main efforts of M.V. Tokarchuk are directed (together with I.R. Yukhnovskii and P.A. Hlushak) to the application of the method of collective variables to the theory of nonequilibrium processes. As a result, the modified hierarchy of kinetic equations of BBGKY-like type was derived. This made it possibile to calculate in higher (than Gaussian) approximations both the structure function and hydrodynamic velocities of collective variables.

Mykhailo Tokarchuk is known not only as a prominent physicist-theoretist, organizer and popularizer of science but also as a talented teacher. Many staff members of the ICMP still remember his first lectures on statistical mechanics of nonequilibrium processes he read as far back as in 1990s. His recommendations, pieces of advice, and encouragement have helped many students and young researchers to choose promising trends in their own scientific investigations. Six researchers received their Ph.D. degrees under his supervision, while one of them became a Habilitated Doctor of Sciences. Also, one doctoral dissertation was successfully defended under his guidance. Since 2001 M.V. Tokarchuk has carried out educational and scientific work at the Applied Mathematics Chair of Lviv Polytechnic National University and has instructed graduate and postgraduate students. During years 2005–2006 he was head of the State Examining Board at the Physics Department of Ivan Franko National University in Lviv.

M.V. Tokarchuk is the author of over 320 scientific works, two monographs and educational manuals.

Mykhailo Tokarchuk is a member of the Scientific and Specialized Councils at the ICMP. He is also a member of the Editorial Board of the “Condensed Matter Physics” journal. M. Tokarchuk initiated several special issues of this journal related to various fields of condensed matter physics and nonequilibrium statistical mechanics, which were highly acknowledged by the international physics community.

In 2016 Mykailo Tokarchuk became Head of the Department of Soft Matter Theory, newly created on the basis of unification of the Department for Theory of Solutions and the Department for Theory of Nonequilibrium Processes.

Friends, colleagues, coworkers cordially congratulate Mykhailo Tokarchuk with his 60th jubilee and wish him and his family to stay in good health, to be full of energy and enthusiasm, outline new creative plans for further scientific discoveries.