

In memoriam

**VLADAN ĐORĐEVIĆ**  
**1938–2022**

Professor Vladan Dordević, a full member of the Serbian Academy of Sciences and Arts (SASA), passed away on October 15<sup>th</sup>, 2022. We consider ourselves lucky to have known him and been friends with him. He was more than a sincere friend, an older brother, always prepared to give us advice and help whenever needed. Due to his humanity and comprehensive education, he was highly respected, especially in scientific circles. We would like to present some information from the biography of academician Vladan Đorđević.



Vladan Đorđević, a mechanical engineer, university professor, and academician, was born in Kruševac on October 7<sup>th</sup>, 1938. He graduated from the Faculty of Mechanical Engineering, University of Belgrade, at the Hydropower Department. He completed his Master's studies at the Faculty of Science at the Mechanics Department. In 1966, he defended his doctoral dissertation entitled *Laminar Boundary Layer on Thin Rotating Bodies*, in this department. Since 1971, he was an assistant professor at the Faculty of Mechanical Engineering in Belgrade, where he received all teaching qualifications and was elected full professor in 1981. He spent the academic 1968–1969 on the post-doctoral specialization at the Albert-Ludwigs University in Freiburg (Germany) as a Humboldt scholarship holder, and the academic 1975–1976 as a Fulbright scholarship holder at the University of Southern California in Los Angeles (USA). At this university, at the Department of Aviation and Mechanical Engineering, he spent two and a half years as a visiting professor, from 1985–1988. In addition to his research work, he taught two courses in the doctoral studies program. At the Faculty of Mechanical Engineering in Belgrade, he was vice-dean for education (1989–1991) and the head of the Fluid Mechanics Department (1988–2000). In the Yugoslav (now Serbian) Society for Mechanics, he was the secretary general (1977–1981) and president (1993–1997). He was a member of the Society for Applied Mathematics and Mechanics (GAMM). He was the head of the Department of Mechanics at the Mathematical Institute of SASA (2000–2006). He was also a member of the editorial boards of *Theoretical and Applied*

*Mechanics*, *Facta Universitatis*, and *FME Transactions* (chief editor 2000–2004). He was a member of the editorial board of the Serbian Encyclopedia (vice president, 2006–2008). For years, he was a correspondent of the reference journal *Mathematical Reviews* for fluid mechanics. He was elected a corresponding member of SASA in 1985 and a full member in 1997. He was also a member of the *Academy of Engineering Sciences of Serbia* (AESS, since 2002) and the *Serbian Academy of Non-linear Sciences* (SANS). At SASA, he managed the work of the Committee for the *Study of the Life and Work of Scientists in Serbia and Scientists of Serbian Origin* (since 2002). Also, he was the editor-in-chief of the *Life and Work of Serbian Scientists* edition, published by this Committee. In the Mathematical Institute of SASA, he managed the work of the Committee for non-periodical editions of the Mathematical Institute.

Vladan Đorđević's scientific activity relates to theoretical and applied fluid mechanics. He worked in the following areas: boundary layer theory, theory of the flow of inhomogeneous and/or rotating fluids, theory of wave movements of fluids, theory of hydrodynamic stability, biomechanics of fluids, theory of the flow of rarefied gases in micro-channels, etc. (a) In the theory of the boundary layer, he provided a method for calculating the fluid flow in the boundary layer on thin rotating bodies, where the thickness of the boundary layer is of the same order of measurement as the radius of the cross-section of the body. He also provided a method for calculating the temperature field on these bodies. (b) Flows of inhomogeneous and/or rotating fluids fall broadly into the so-called geophysical fluid mechanics. Vladan Đorđević studied the propagation of small disturbances in such environments and came to results that show that the propagation of these disturbances differs qualitatively depending on whether the frequency of the source of disturbance is greater or less than twice the angular speed of rotation of the entire system, if it is a rotating fluid, that is, from the so-called Brant-Woeissla frequencies, if it is an inhomogeneous liquid. (c) Within the wave motion of fluids, Vladan Đorđević dealt with non-linear problems of motion of dispersion waves, where nonlinearity and dispersion are effects of the same order of magnitude. On that occasion, waves of constant form, so-called solitary waves – solitons can be created. Particular emphasis in these works is placed on studying the transformation of these waves when moving over an uneven bottom, whereby under certain conditions, a characteristic phenomenon known as soliton fission at the "threshold" can occur. The works also dealt with the problems of the influence of surface tension on the propagation of these waves in extremely thin liquid layers, the so-called liquid films, as well as the problem of the dissipation of these waves. Special attention is paid to the problems of the so-called slow modulations of capillary-gravity waves on the free surface of the liquid. Given that these problems are usually described either by the classic Korteweg-de Vries equation or by the non-linear Schrödinger equation, or by one of their numerous modifications, Vladan Đorđević's papers also made certain contributions to the mathematical theory of these equations. (g) The hydrodynamic stability theory deals with one of fluid mechanics' most important fundamental problems - the transition from a laminar flow regime to a turbulent one. Within this theory, Vladan Đorđević dealt with non-linear stability problems, so-called free shear layers, considering the fluid's viscosity. Both incompressible and compressible flows are included. The so-called subcritical unstable and supercritical stable flow regimes are delimited. Landau-type non-linear equations were derived, which describe these regimes, and problems of deterministic chaos were also encountered on that occasion. (d) Dealing with some problems of fluid biomechanics, Vladan Đorđević worked on the hydrodynamics of the vestibular system in humans. He modeled the fluid flow in the semicircular channels of the system and the mechanical behavior of the dome, performed experiments on himself and created the possibility of predicting human orientation in extreme conditions, which can be of practical importance

in pilot training. He also worked on fluid flows in elastic vessels, bearing in mind blood flow in human blood vessels. For the first time, he treated this problem as a problem of strong interaction between fluid and elastic structures. The problem of fluid flow and the problem of elasticity of the structure are mathematically connected so that they cannot be treated independently of each other. The obtained results match the experiments remarkably well. Finally, Vladan Đorđević was involved in modeling the rheological behavior of the human cell. For the first time, he used the mathematical apparatus of fractional derivatives for this purpose and obtained remarkable compatibility with the experiments carried out at Harvard University in the USA in a wide frequency range of five order of magnitudes. (f) Recently, Vladan Đorđević was dealing with the problems of the flow of rarefied gases in micro-channels - channels of micrometer scale, which are found in the so-called MEMS (micro-electro-mechanical systems) technologies. For the first time, he modeled the boundary condition of gas slippage on the channel wall using the spatial fractional derivative. He thus obtained excellent compatibility with numerous experiments in the literature, including the so-called Knudsen minimum, which occurs at moderately high values of the Knudsen number. In addition, Vladan Đorđević published individual papers in the field of magnetohydrodynamics, turbulent fluid flows, and the theory of partial differential equations of mathematical physics with fractional derivations. Here are bibliographic data on several of Vladan Đorđević's selected papers:

1. V. D. Đorđević, L. G. Redekopp, *On two-dimensional packets of capillary-gravity waves*, J. Fluid Mechanics **79**(4) (1977), 703–714.
2. V. D. Đorđević, L. G. Redekopp, *The fission and disintegration of internal solitary waves moving over two-dimensional topography*, J. Physical Oceanography **8**(6) (1978), 1016–1024.
3. V. D. Đorđević, L. G. Redekopp, *Non-linear stability of subsonic mixing layers with symmetric temperature variations*, Proc. Roy. Soc., London A, Mathematical and Physical Sciences **426** (1989), 287–330.
4. V. D. Đorđević, J. Jaric, B. Fabry, J. J. Fredberg, D. Stamenović, *Fractional derivatives embody essential features of cell rheological behavior*, Annals of Biomedical Engineering **31**(6) (2003), 692–699.
5. V. D. Đorđević, T. M. Atanacković, *Similarity solutions to nonlinear heat conduction and Burgers/Korteweg-de Vries fractional equations*, J. Computational and Applied Mathematics **222**(2) (2008), 701–714.

In his professional work, Vladan Đorđević collaborated with the Military Technical Institute in Belgrade. He worked on developing one semi-automatic and one automatic chemical detector for detecting nerve agents. He managed the work of the following projects funded by the Ministry of Science and Technology of Serbia (each lasting five years): *Current problems of fluid flow in energy*, *Research of fundamental processes in thermal energy*, and *Analytical and numerical methods of fluid mechanics*.

For the results achieved in his scientific and research work, he was awarded in 2007 the award *Prof. Dr. Vojislav K. Stojanović* by the Association of University Professors and Scientists of Serbia, in 2015 with the *Vidovdan Charter* of the City of Kruševac and in 2017, the Academic Ljubomir Klerić Charter for Lifetime Achievement by the Department of Mining, Geological and System Sciences, AINS.

If we want to describe Vladan Đorđević briefly, we could say: strong and consistent. His every word was thought out and credible. He spoke softly and slowly. He was aware that even in difficult situations, the truth depends on the facts, not on the volume of the voice. Everything was in order and harmony with Vladan, from his thoughts to his presentation. He was benevolent, lively, and above all, humane. He was there for everyone

but never discussed his problems and difficulties. We do not know a more dignified and respectable man than Vladan Đorđević. We admired Vladan for his sophistication and intellectualism. Sometimes, we consulted with Vladan, and he was always honest and critical. We are grateful to him for that. But most of all, we are thankful to him for our friendship, which has grown since we first met. We consider ourselves lucky: we had a genuine and sincere friend.

**Jovo Jarić**  
**Teodor Atanacković**