Đorđe Mušicki
1921–2018

Đorđe Mušicki was born on November 4, 1921 in Pančevo (Kingdom of Serbs, Croats and Slovenes). He passed away on November 16, 2018 in Belgrade, Serbia.

He was the only son of Divna, born Matejić (1888–1946), and Dimitrije Mita Mušicki (1868–1935), lawyer, representative of Serbs in the Hungarian Parliament in Pest until 1914, and a member of the State Council (Supreme Court) of the Kingdom of Serbs, Croats and Slovenes (1921–1928).

He attended elementary and high school in Belgrade, and then enrolled in the Department of Physics of the then Faculty of Philosophy in Belgrade in 1940. During the war, 1941–1945, the teaching at Belgrade University was suspended, so he formally continued his education only in November 1945. He graduated in Physics in September 1947. In March 1948, he was appointed as teaching assistant at the newly formed Faculty of Natural Sciences and Mathematics in Belgrade. From April 1951 to June 1952 he worked at the Institute for Nuclear Sciences in Vinča, and then returned to his previous position of assistant. His doctoral dissertation titled "Applying Pfaff's Methods to Some Problems of Theoretical Physics" was defended at the Faculty of Natural Sciences and Mathematics in Belgrade in January 1956. The dissertation,done under the guidance of Prof. Dr. Tatomir Anđelić, was related to the extension of the results of Dr. Anton Bilimović in the field of analytical mechanics to some problems of theoretical physics.

During the 1956/1957 school year Professor Mušicki was on specialization studies in Paris at Le Collège de France, where he was working with Professor Roger Nataf on some problems in the field of nuclear physics, particularly on shell models of the nucleus. He spent the 1964/1965 school year at the Institute of Theoretical Physics of Bern University with Professor André Mercier, and at Le Collège de France in Paris working with Professor André Lichnerowicz on some problems of classical field theory.

Professor Mušicki spent his entire working life at the Faculty of Natural Sciences and Mathematics, where he progressed from teaching assistant to full professor. In 1954 he

created the course in Theoretical Physics, which was the first complete course in theoretical physics in Yugoslavia and, as such, provided the original impetus for the school of theoretical physics at the University of Belgrade. From 1966 to 1977, he was head of the Department of Physics at the Faculty of Natural Sciences and Mathematics. After the reorganization of the faculty, he was head of the Department of Theoretical Physics within the Department of Physical and Meteorological Sciences. He was also Chairman of the Commission for Teaching and Textbooks of the Faculty of Natural Sciences and Mathematics for many years.

Professor Mušicki was an extraordinary teacher, who cared very much about his students and their academic and other achievements. He held lectures on theoretical physics (mechanics and electrodynamics), theoretical mechanics, classical theoretical physics (statistical physics and electrodynamics), mathematical physics (vector and tensile calculus), and analytical mechanics with field theory. He also held several specialist courses in theoretical physics at postgraduate studies in the Department of Physics and the Department of Physical Chemistry, and he taught classical theoretical physics at the Faculty of Philosophy in Novi Sad and the Faculty of Natural Sciences and Mathematics in Kragujevac.

Professor Mušicki published his lectures first in the form of authorized lecture notes in three volumes, and later in the form of university textbooks. They were the first textbooks of theoretical physics in the Serbian language. These books were published under the common title "Introduction to Theoretical Physics" and were divided into "Theoretical Mechanics", "Statistical Physics" and "Electrodynamics with the theory of relativity". They had several updated, revised and extended editions, and have stayed relevant and highly sought after to the present day. He also coauthored with B. Milić the book titled "Mathematical foundation of theoretical physics, with the collection of problems and solutions".

In his scientific work, Professor Mušicki was doing research mostly in analytical mechanics and classical field theory. He published over seventy scientific papers in reviewed journals. His work has been cited and referenced by many physicists working in these areas in the country and abroad. Although he retired in 1987, he continued with the scientific work until his death. After retiring, he published about 20 scientific papers. The most important scientific work and results can be broadly divided into several groups:

Pfaff–Bilimović principle of mechanics: Professor Mušicki generalized this principle in the field theory (Publ. Inst. Math., Nouv. Sér. **2**(16) (1962), 5–20) and for the canonical formalism with higher order derivatives with the corresponding Lagrange and Hamilton equations derived (Theor. Appl. Mech. **5** (1979), 105–144). He also contributed papers on the application of the Pfaffian principle to quantum mechanics and theoretical physics.

Contributions to *Canonical transformations* in the classical field theory include formulations based on the functional calculus of V. Volterra (C. R. Acad. Sci., Paris **260** (1965), 6280–6283 and Publ. Inst. Math., Nouv. Sér. **7**(21) (1967), 5–24); a covariant formulation of canonical transformations with a proof that it can be done only using hyperplanes in Minkowski space, leading to some results different from corresponding results in the classical field theory, e.g. Hamilton–Jacobi equation and Poisson brackets (C. R. Acad. Sci., Paris **260** (1965), 6517–6520 and Publ. Inst. Math., Nouv. Sér. **8**(22) (1968), 8–22).

His work on *Generalized mechanics* covered canonical formalism with the derivatives of higher order and specifically the canonical formalism with the derivatives of higher order in field theory (Publ. Inst. Math., Nouv. Sér. **23**(37) (1978), 141–153 and J. Phys. A, Math. Theor. **11**(1) (1978), 39–53). Also a small monography on Degenerate systems

in generalized mechanics was published by Mathematical Institute of SASA, spec. ed., **15**, 1–28, 1992.

Professor Mušicki published ten papers related to the *extended Lagrangian formalism* since 1992 mostly in search of a better explanation of the integral of energy presented in the works of V. Vujačić on modifications of mechanics of rheonomous systems. In the process he provided a number of scientific contributions: a parametric formulation of the mechanics of rheonomic systems (Theor. Appl. Mech. **18** (1992), 103–117); conservation laws and Noether's theorem in a parametric formulation of mechanics (Theor. Appl. Mech. **19** (1993), 87–97); generalization of a new parametric formulation of mechanics for systems with variable mass (Eur. J. Mech., A, Solids **19**(6) (2000), 1059–1076); an extended Lagrangian formalism and the corresponding energy relations (Eur. J. Mech., A, Solids **23**(6) (2004), 975–991); an extended Lagrangian formalism and the main general principles of mechanics (Eur. J. Mech., A, Solids **24**(2) (2005), 227–242); a contribution to the theory of the extended Lagrangian formalism for rheonomic systems (Theor. Appl. Mech. **36**(1) (2009), 47–83); an extended Lagrangian formalism for rheonomic systems with variable mass (Theor. Appl. Mech. **44**(1) (2017), 115–132).

He also provided valuable generalizations of *Noether's theorem* for non-conservative systems (Eur. J. Mech., A, Solids **13**(4) (1994), 533–539) and of direct and inverse Noether's theorem in generalized mechanics (Theor. Appl. Mech. **21** (1995), 91–104); for systems with variable mass (Theor. Appl. Mech. **23** (1997), 129–150), for non-conservative systems in quasi-coordinates (Theor. Appl. Mech. **43**(1) (2016), 1–17), and for continuous mechanical systems (Acta Mech. **228**(3) (2017), 901–917).

Scientific research of non-conservative systems inspired by works of B. Vujanović and Đ. Đukić has resulted in a series of results on *pseudo-conservative systems* (Acta Mech. **223**(10) (2012), 2117–2133). Similarly, research on *degenerate systems* resulted in papers on canonical formalism for degenerate systems and canonical transformations of degenerate systems (co-authored with D. Đokić Ristanović, Publ. Inst. Math., Nouv. Sér. **10**(24) (1970), 38–50 and 25–37). He also published some additional results on properties of canonical transformations for degenerate systems (Fizika **114**(3) (1982), 167–176). The research on *non-holonomic systems* was published in a scientific paper on energy integrals for the systems with non-holonomic constraints of arbitrary form and origin in collaboration with D. Zeković (Acta Mech. **227**(2) (2016), 467–493). Research results on the general energy change law for *systems with variable mass* were also published (Eur. J. Mech., A, Solids **18**(4) (1999), 719–730). Professor Mušicki was also doing research and contributing scientific results in the areas of *homogeneous formalism*, *electrodynamics*, *shell models of the nucleus* and *axiomatic physics*.

The *history of physics* was an especially dear topic to Professor Mušicki, which he was exploring and writing about and contributing to numerous jubilee occasions and publications at the Serbian Academy of Sciences and Arts and the University of Belgrade. He wrote about the development of physics and the beginnings of theoretical physics in Serbia. He put together the biography and bibliography of Vjačeslav Žardecki, whom he considered as a pioneer of theoretical physics in Serbia. He explored the history of development of some major ideas in physics, such as a general law of mutual effect for central forces (Phlogiston **16** (2008), 7–43), then the development of the law on energy conservation in classical mechanics with the presentation of the original works of the main founders of this law and with a special reference to contributions of our investigators to this issue (in Posebna Izd., Mat. Inst., Beograd, Matematički Vidici **8** (2011), 1–61). He also wrote about the development of the concept of mechanics and the first formulation of the law of energy conservation, with the presentation of the original work of D. Bernoulli,

(Phlogiston **23** (2015), 45–66), and about the development and meaning of the concept of variation in theoretical mechanics (Phlogiston **26** (2018), 215–244).

In closing, the mathematical talent, a deep understanding of physics and the intellectual power of Professor Mušicki were exceptional. These characteristics combined with his energy, curiosity, outstanding memory, and genuine interest in people made him a successful scientist, an extraordinary teacher, interesting interlocutor, and a very pleasant person with broad interests in science, literature, politics, history, sports etc. The lives he touched were enriched too with the conveyed knowledge, with advice, anecdote, or idea, and, above all, with attention. He was proud of his family – wife Umilna, astronomer and mathematician (died in 2008) and daughters Vesna (PhD in mathematics) and Biljana (PhD in molecular biology). For us, colleagues and students, who had the privilege to know him personally, enjoying his wits and warm personality, this is a big loss, and we will always remember him with respect and appreciation.

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