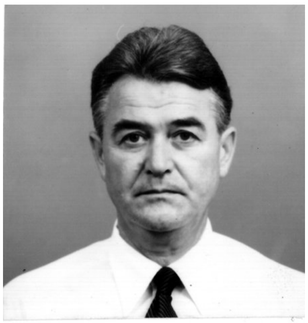
Editorial

Božidar D. Vujanović: A biographical note

(1930 - 2014)



Professor Dr Božidar Vujanović, a member of the Serbian Academy of Sciences and Arts and, for many decades, a member of the Editorial Board of our journal "Theoretical and Applied Mechanics", passed away at the age of 83 on March 11, 2014 in Novi Sad, Serbia.[1]

Božidar D. Vujanović was born in the city of Smederevo (Serbia) in 1930. After finishing the elementary school, music school and Gymnasium in Smederevo, he graduated at the Department of Mechanics at the University of Belgrade 1956., and his doctorate was conferred to him at the same University at 1963. The title of the doctorate is: *The Geometrization of Motion and Disturbances of Nonconservative Dynamical Systems* from the area of mechanics. He was appointed as an Assistent of Mechanics at the Mechanical Engineering Faculty, the University of Belgrade, the position he held from 1957 to 1963. Since then he has held positions at the Department of Theoretical and Applied Mechanics, Faculty of Technical Sciences, University of Novi Sad, where he retired as a Full Professor in 1995. He held visiting positions at: Department of Theoretical and Applied Mechanics, University of Kentucky, Lexington, USA (1967-9); - Institute of Electronics and Information Sciences, University of Tsukuba, Japan (1977-8); and, Institute of Engineering and Material Sciences, Vanderbilt University in Nashville, Tennessee, USA (1984). Among his numerous scientific interests prominent were theoretical and applied mechanics, variational principles

[1]Main body of this text is based on the report of the Serbian Academy of Sciences and Arts which is available at the link www.sanu.ac.rs/Biblioteka/Biblioteka.aspx. On this link a complete list of papers of prof. Božidar Vujanović may be obtained.

and their applications to conservative and nonconservative dynamical systems, heat conduction theory, optimal control theory, and, nonlinear oscillations with dissipative elements.

In 1990 he was elected as a Corresponding Member of the Academy of Sciences and Arts of Vojvodina in Novi Sad, and after the fusion of this Institution with the Serbian Academy of Sciences and Arts in Belgrade he has been adopted as a Member of the same rank. In 2000 he was to the full membership of the Serbian Academy of Sciences and Arts in Belgrade. In 2009 he was elected as a Foreign Member of the Academy of Sciences in Turin, Italy (Accademia delle Scienze di Torino, Classe di Scienze Fisiche, Matematiche e Naturali). Professor Vujanović scientific and academic activities have been recognized by a numerous awards, including:

- The October's Prize of the City of Novi Sad for Science, 1970,

- The University of Novi Sad "Golden Memorial Award" 1996,

- The Golden Placard of the Faculty of Technical Sciences 1990, for the distinguished contribution to the field of Mechanics,

- the Golden Placard of the Society of the University Professors of Serbia, 1996.

- He was commissioned A "Kentucky Colonel" from the Governor of the State Kentucky W.G. Wilkinson, 1990.

- The Silver Placard "Antico Segillio della Cita di Torino" 1984.

For more than forty years he served as a Reviewer of the Journals: Zentralblatt für Mathematik und ihre Grenzgebiete (Berlin, Germany) and Mathematical Reviews (Ann Arbor, USA). From 1986-2000 he was the President of the Yugoslav Society of the Theoretical and Applied Mechanics (two mandates). He was the Member of the American Mathematical Society, The Tensor Society (Japan), as well as the American Scientific Society "Sigma Ksi".

A Brief Description of the Scientific Works

The scientific activity of Professor Vujanović was concentrated to the several areas of Analytical Mechanics:

Geometrization of motion of nonconservative dynamical systems;

Variational Principles of Mechanics for Irreversible dynamical systems with the finite and infinite degrees of freedom;

Generalization of the Hamilton-Jacobi theory and its applications to nonconservative systems;

Variational description of the heat transfer theory through the solids including the change of phase;

Study of the conservation laws of the conservative and nonconservative dynamical systems with the finite number of the degrees of freedom etc.

His major contributions can be divided into following three groups:

1. He devoted many years to the study of conservation laws for conservative and nonconservative dynamical systems (linear and non-linear) with finite number of degrees of freedom. Conservation laws play a very important role in physics and engineering from both theoretical and practical standpoint. They can considerably simplify the integration of the differential equations of motion, and they provide insight into the physical mechanisms governing a dynamical system. Probably the best-known and most popular modern method for finding conservation laws is based on invariant properties of the Hamilton action integral with respect to infinitesimal transformations of the generalized coordinates. This traditional approach is based on the celebrated Emmy Noether's theorem. Since Noether's theorem does not offer any suggestions as to how to find the infinitesimal transformations that leave the Hamilton action integral unchanged, professor Vujanović studied the question of finding infinitesimal transformations that will yield conservation laws. The solution of this problem leads to a system of first-order partial differential equations which he named the generalized Killing's equations. In its original form, Noether's theorem is applicable only to the Lagrangian-type dynamical systems. To generalize the theory to the non-conservative dynamical systems, Vujanovic studied the transformation properties of the D'Alambert differential variational principle, applicable to both - conservative (Lagrangian) and nonconservative dynamical systems, and succeeded to enlarge the finding of conservation laws to nonconservative systems. In addition, the further study showed that as the starting point for finding conservation laws can also be based on Gauss and Jourdain differential variational principles.

2. The next part of his research was devoted to the variational principles suitable for the study of irreversible phenomena whose physical manifestations are described by means of partial differential equations and appropriate initial and boundary conditions. The effort to find an appropriate variational principle suitable for a nonconservative physical field is entirely pragmatic. In fact, the merit and efficiency of each variational formulation is tested for the possibility of obtaining information about the behavior of the physical systems when applying the direct methods of variational calculus. For most important processes of irreversible physics, the exact Lagrangian function of the problem in the sense of classical mechanics does not exist. For example, the transient parabolic differential equation of heat conduction in solids, even in the linear one-dimensional case, does not have any classical Lagrangian function. Thus in order to give irreversible phenomena some variational characteristics, especially in the sense of Hamilton's variational principle, Vujanović has been compelled to modify some of the basic rules of the classical variational calculus, whose structure has an exclusively potential character. The main characteristic of this new variational approach is based upon the "Variational principle with a vanishing parameter". The essence of this approach is that the Hamilton principle generates more complex field than the relevant differential equations of the physical process. Thus obtained differential equations contain a parameter that approaches zero after the finishing the process of variation. This method yields the correct differential equations of the process. It is important to note that in the heat transfer theory, the vanishing parameter has a clear physical interpretation related to the finite velocity of propagation of the thermal disturbance and based upon the Cattaneo hyperbolic heat conduction theory. From this point of view, the principle with a vanishing pa-rameter represents a transition from the generalized (hyperbolic) heat transfer theory to the classical (parabolic) heat transfer mechanism of the Fourier type, which has an infinite velocity for the propagation of the thermal signal. The variational principle with a vanishing parameter is employed as a starting point for obtaining approximate solutions in two physical areas that have a remarkable nonconservative nature: linear and nonlinear transient heat transfer in solids and the theory of laminar boundary layer of the fluid flow. It should be noted that the variational principle with a vanishing parameter is profoundly different than the variational formulations of Glansdorff-Prigogine, Bateman and Biot. Another variational approach introduced by Vujanović is called the "variational principle with noncommutative rules of variations". In this variational principle the variation of velocity and the velocity of variation-are distinct, which not the case in the classical variational calculus. These new rules represent the measure of nonconservativity of a dynamical system and are equally applied to the dynamical systems with a finite and infinite number of degrees of freedom. It is also shown that the applications of the Gauss differential variational principle can be useful in obtaining the approximate solutions of various irreversible processes by applying the direct methods of variational calculus.

3. The Hamilton-Jacobi method can be advantageously used in many practical situations as an exact method for solving the canonical differential equations of motion. Based upon this method, a variety of approximate solutions to nonlinear problems can be constructed, of particular importance being those for which an exact, complete solution of the Hamilton-Jacobi nonlinear partial differential equation is not available. However, the method of Hamilton and Jacobi can be employed only with those dynamical systems described by the Langrangian or

Hamiltonian function, and purely nonconservative (non-Hamiltonian) systems remain outside of the areas treated by this method. Vujanović introduced a field method suitable for finding the motion of conservative or purely nonconservative dynamical systems, which is conceptually different than the method of Hamilton and Jacobi. The basic assumption in this field method is that one of the state variables (a generalized coordinate or generalized momentum) figuring in the dynamical system can be interpreted as a field dependent on time and the state variables of the dynamical system. The resulting field equation, which Vujanović calls the basic equation, is a single quasi-linear partial differential equation of the first order. If one is able to find a complete solution of this equation, the motion of the dynamical system can be obtained without any additional integration. It is to be noted that this field method can be used in solving conservative (Hamiltonian) dynamical systems (for which the Hamilton-Jacobi method can be also applied). An important advantage of this field method is that one has to solve the quasi-linear partial differential equation which is much more manageable than to find a complete solution of the nonlinear Hamilton-Jacobi equation. Since one of the dynamical variables is interpreted as the basic field, the corresponding field equation is more intimately connected with the dynamical problem in question than the Hamilton principal function, which is not by itself a constituent of the dynamical problem. The field method has been successfully employed to linear and nonlinear boundary value problems, as well as to the study of nonlinear vibration theory as means for finding approximate solutions.

Invited Lectures

The scientific results of professor Vujanović have attracted the interest of many universities, scientific institutions, and he has been invited to present his scientific results to, among others:

Carnegie-Mellon University, Pittsburg, 1968.

Department of Physics, Czechoslovak Academy of Sciences, Prague, 1971.

Kings College, London 1972.

Department of Mechanics, Technical University Budapest, 1975.

L'Instituto di Fisica Matematica "J.L.Lagrange" Universita degli Studi di Torino, 1977.

Dipartimento di Matematica e Informatica "Ulisse Dini", Universita degli Studi Firenze, 1977.

Department of Mathematics and Physics, Tokyo University, 1978.

Department of Theoretical and Applied Mechanics, University of Kyoto, Japan 1978.

Summer School of Theoretical and Applied mechanics, Hiroshima, Japan 1978.

Summer school of Mechanics, Institute of electronics and information sciences, Tsukuba University, Japan 1978.

"Colloquia on Mechanics" Department of Theoretical and Applied Mechanics, University of Kentucky, Lexington, KY, USA 1984.

Department of Mechanical and Material Engineering, Vanderbilt University, Nashville, TN, USA 1984.

Faculdad de Ciencias Fisicas, Departmento de Fisica Teorica, Universidad Complutense de Madrid, 1988.

Instead of Conclusion

When we talk about our dearest deceased, we always search for their best characteristics. Sometimes this is not easy to do. But in the case of Professor Božidar D. Vujanović this is easy, because he was a noble gentleman whose presence ennobled others around him. When he arrived in Novi Sad, very few people in the department of mechanics were involved in true scientific work, but when he retired he left behind a strong and internationally recognized school of mechanics. His colleagues in this school owe him as their teacher and friend so much. His work and contributions to our journal "Theoretical and Applied Mechanics" were precious. All of us in the Serbian Society of Mechanics, and all others who had a privilege to know him and share with him his warm personality and wisdom, will dearly miss him, but will always remember him with admiration and respect. God rest his soul.

Kragujevac, March, 2014 Milan Mićunović, Editor