

## In memoriam Iliya I. Blekhman

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On 3<sup>rd</sup> February 2021 Professor Dr. Iliya Izrailevich Blekhman (born on 29<sup>th</sup> November 1928 in Kharkov), head of the Laboratory of Vibration Mechanics at the Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences (St.Petersburg, Russia), an internationally highly esteemed outstanding scientist in the field of the theory of nonlinear oscillations, the dynamics of machines and vibration technology and a good and loyal friend of the Institute of Mechanics at Otto von Guericke University Magdeburg, passed away in St. Petersburg.

In 1951, he completed his studies in St. Petersburg at the chair of the renowned representative of mechanics Anatoly Isakovich Lurie. The name of Iliya I. Blekhman is closely associated with the Mekhanobr Tekhnika Corporation, where he completed practical training as a part of his studies as early as 1949. There he was later head of the department for fundamental research. From 1996 he also headed the Laboratory of Vibrational Mechanics, which belongs to the Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences. Under his leadership, many new vibration machines were developed and put into practice.

He created and developed a number of new scientific directions within the framework of applied mechanics, especially the theories of non-linear vibrations, vibration processes and vibration machines. He can be called the originator of the now established disciplines of vibrational mechanics and vibrorheology. He recognised early the surprising extent to which vibrations can change the properties of systems - up to and including paradoxical phenomena.

Together with G.Zh. Dzhanlidze, he developed a theory of vibration displacement (Blekhman and Dzhanlidze, 1964). With the collaboration of his colleagues from the Mekhanobr Tekhnika Corporation, he discovered the fundamental and practically significant phenomena of self-synchronisation of unbalanced rotors, the phenomenon of gravity-gas lifting flow (fountain), and the vibrational injection of the gas into fluid, for each of which he developed the theory and calculation methods. Together with K.A. Lurie, he successfully worked on the development of fundamentally new materials - so-called dynamic materials and composites. In the sense of generalising fundamental laws of mechanics, he extended the classical stability theorem of Lagrange-Dirichlet to an extremal criterion of the stability of the synchronous rotation of weakly connected bodies, he described a class of essentially non-conservative mechanical systems, which develop a "potentiality on the average" under the effect of vibrations, and he generalised the classical principle of Laval's self-centring for non-linear systems with many rotors.

Characteristic for Prof. Blekhman's work was always the combination of the highest theoretical level with the technical practice, which was advanced to the point of readiness for use and production. In connection with this, he and his co-workers developed many simplified calculation methods that were directly useful for practical engineers, of which the method of direct separation of motions is mentioned here as representative.

In 1971, he published the almost encyclopedic monograph *Synchronisation of Dynamic Systems* (Blekhman, 1971), which contains almost 900 pages. Professor Blekhman himself repeatedly pointed out that synchronisation as a physical phenomenon is characteristic not only for mechanical objects, but also for electrical, chemical, biological and even social ones. Due to the synchronisation of rhythms of the human body, he also initiated a subject-specific research in medicine. Although the phenomena mentioned so far belong to the "macro-world", I.I. Blekhman also contributed to the recent discussion of corresponding phenomena in the "micro-world". At the same time, he named the unsolved problems and requested the scientific community to solve them. Iliya I. Blekhman is the author of more than 10 monographs, some of which have been translated into English and German, more than 300 scientific publications, and more than 50 patents with licences in the USA, Japan, Bulgaria and Iran. A significant part of



Fig. 1: I.I. Blekhman (1928-2021)

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his results was published not only in the scientific literature, but also in reference books and textbooks. Thus, in addition to many lectures and reports, he made a significant contribution to the well-known 6-volume encyclopedic work *Vibrations in Technics* (Chelomey, 1978-1981). His contributions to the theory of synchronization were summarized in English in Blekhman (1988). Of the monographs, special mention should be made of the extensive late works *Vibrational Mechanics/Nonlinear Dynamic Effects, General Approach, Applications* (Blekhman, 2000), *Theory of Vibrational Processes and Systems/Vibrational Mechanics and Vibration Engineering* (Blekhman, 2013) and *Vibrational Mechanics and Vibrorheology/Theory and Applications* (Blekhman, 2018). Antiquarian copies of English editions of his works are now available only at high prices.

His burning interest in the puzzles of nature and technology was followed by his intense study of scientific methodology and the foundations and paradoxes of applied mathematics and mechanics. Evidence of this is a joint book with A.D. Myškis and Ja.G. Panovko in 1976, which was published in German in 1984 under the title *Angewandte Mathematik. Gegenstand, Logik, Besonderheiten* (Blekhman et al., 1984). He was a personality with a high level of education and a wide intellectual horizon, so that every conversation with him was enriching, also those about general philosophical questions.

I.I. Blekhman was the recipient of a number of high-ranking national and international awards and a member of several high-ranking academies and scientific committees including those of international conferences at home and abroad. He has given guest lectures in the USA, the UK, Brazil, Germany, Italy, Poland, Denmark and the Netherlands. Thus it is almost superfluous to emphasise his friendly connection with a large number of colleagues and personalities at home and abroad.

At today's Institute of Mechanics at the Otto von Guericke University Magdeburg, a doctoral thesis on the subject of the self-synchronisation of unbalanced rotors, based on publications by Blekhman, his colleagues and collaborators, was successfully defended as early as 1966. In it, Lutz Sperling, among others, introduced for the first time the harmonic influence coefficients for a simpler calculation of the existence and stability conditions of the synchronous motions, which, in the case of a linear support system, reduced this to an ordinary vibration problem for linear systems, which was demonstrated in various applications. This result was later explicitly acknowledged in Blekhman's publications. The first written contacts took place in 1967, a first personal meeting in 1973. The connection was resumed and intensified with mutual visits from 1997 onwards, e.g. through the joint participation in summer schools in St. Petersburg/Repino from 1998 onwards. In 1999, Professor Blekhman could be won as a reviewer in the doctoral procedure of Falk Merten. In 2000, Iliya I. Blekhman was honoured with the Humboldt Award in Germany, which was associated with three months of work each at the Chair of Machine Dynamics/Vibration Theory of Professor Hans Dresig in Chemnitz and the Chair of Vibration Theory and Technical Dynamics of Professor Lutz Sperling in Magdeburg as well as further follow-up visits (see Sperling, 2001). Among many other activities of the guest, the stay in Magdeburg in March 2000 was also used for a workshop at the Institut für Fertigteiletechnik und Fertigungsbau Weimar i. V., our industrial research partner. As a result of joint research on synchronisation phenomena for objects with internal degrees of freedom, five joint publications were produced (see e.g. Blekhman and Sperling, 2004). Otherwise, the corresponding scientific researches in Magdeburg concentrated on the further development of the theory of self-synchronisation of unbalanced rotors for the active practical engineers, including new cases of application, and on the fundamentals of automatic balancing by means of self-synchronisation, which was pursued at the chair until very recently. As a result of Professor Blekhman's mediation, Dr. Boris Ryzhik, formerly of St. Peterburg, was able to take up a fruitful scientific activity at the chair for several years at the beginning of 2001.

With the death of Professor Iliya I. Blekhman, an extremely rich and productive research life has come to an end. In gratitude, his memory is honoured.

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