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PERSONALIA

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In memory of Mikhail Borisovich Voloshin

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On March 20, 2020, the outstanding theoretical physicist Mikhail Borisovich Voloshin passed away unexpectedly in the 67th year of life.

Voloshin was born on May 14, 1953 in Romania, where his father worked at that time. He went to the first specialized physical class of the famous 57th Moscow school, which he graduated from in 1970, and then entered, without exams, the Faculty of General and Applied Physics of the Moscow Institute of Physics and Technology (MIPT) as a winner of the International Physics Olympiad.

Already in his student days, Voloshin's leadership among physicists of his generation became clearly pronounced. He studied at the department of elementary particle physics, whose head was Karen Avetovich Ter-Martirosyan. The institute associated with the department was the Institute for Theoretical and Experimental Physics (ITEP). When a third-year student, Voloshin passed the theoretical minimum exams on quantum mechanics and quantum electrodynamics under Ter-Martirosyan and on General Relativity (GR) under Igor' Yur'evich Kobzarev.

Voloshin's academic advisor was Lev Borisovich Okun', who considered Voloshin his favorite student. The first paper by Voloshin, co-authored with Kobzarev and Okun', was devoted to the decay of a false vacuum. The results obtained there have been included in textbooks and are topical even now: the Higgs boson mass is such that our vacuum is at the stability boundary. The paper was published in the journal *Yadernaya fizika* (*Nuclear Physics*) (Vol. 20, p. 1229) in 1974.

In about ten years, in a series of studies written by Voloshin together with K G Selivanov, he examined the processes of induced false vacuum decay with heavy-particle masses or colliding particle energies as inducing factors. It was revealed that the induced processes cannot be described by the perturbation theory on the background of a Euclidean solution, and the possibility of the disappearance of exponential suppression on the sphaleron energy scale was analyzed. This pioneering work opened new fields of research.

In the autumn of 1974, the "November revolution" broke out: the groups of Ting in Brookhaven and Richter in Stanford discovered the J/Ψ meson almost simultaneously. Voloshin and collaborators immediately joined the development of quarkonium theory; later, Voloshin without a doubt became the most prominent expert on heavy quark physics in the world. He made a fundamental contribution to the sum rule, the physics of hadrons containing heavy quarks, the basic elements of QCD, and the quark model. Based on the QCD sum rules, he predicted the η_c-meson mass that differed greatly from the experimental values available at the time. The uncertainty of that prediction was estimated, showing that the experimental value could not be valid. This prediction was confirmed by subsequent experiments. Together with M A Shifman, Voloshin found an elegant way to evaluate the matrix element of the Kobayashi–Maskawa matrix V_{cb} from exclusive semilepton B-meson decays. This method was used to seek manifestations of the new physics.

Mikhail Borisovich Voloshin
(14.05.1953 – 20.03.2020)

Having graduated from MIPT in 1976, Voloshin began working at ITEP, and a year later defended his candidate thesis. Several years later, he defended his doctoral thesis devoted to the Υ-meson theory.

Voloshin had a very wide spectrum of interests, not limited to heavy quark physics. He discovered the 'custodial symmetry' of the electroweak theory relating the masses of W and Z bosons. Voloshin, along with Okun' and M I Vysotskii, proposed to measure time variations of neutrino fluxes associated with solar cycles as a method to discover the neutrino magnetic moment. These measurements have been carried out to date.

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Translated by M V Tsaplina

Research fellow at the Theoretical Department of CERN, John Ellis (left) and Mikhail Voloshin at the XV Moscow International Physics School at ITEP (40th ITEP Winter Physics School). Village of Snegiri, Moscow region, February 2012. (Photo by I Dolgova.)

In 1979, long before the discovery of the Higgs boson, Voloshin, A I Vainshtein, V I Zakharov, and Shifman proved low-energy theorems for the interaction of Higgs bosons with photons. This result became classical.

From time to time, Voloshin would ask himself rash questions and seek quantitative answers to them. For example, together with Okun', he studied the possibility of electric charge nonconservation with a massless photon, looked at the possibility of violation of the electric neutrality of atoms in Grand Unified theories, and analyzed the possibility of the existence of lepton photons. Each study contained a brilliant nontrivial insight.

He developed a new direction in quantum field theory, which is now known as the threshold multiparticle production. Many other beautiful physical problems were also solved. For example, he considered solitons in two-dimensional supersymmetric theories in which the central-charge anomaly was discovered.

Voloshin liked to surprise an interlocutor with an unexpected general physical problem, of which he had plenty on hand. The problems were simple and elegant — the more joyous it was to learn how they are solved.

From 1990, Voloshin worked at the W Fine Theoretical Physics Institute of the University of Minnesota. There, he delivered lectures on high-energy physics. The students regarded Voloshin's lectures as exemplary. On his invitation, many Russian theoreticians worked in Minneapolis with him, and he in turn was a regular lecturer at the ITEP Physics School, where he delivered a record number of lectures over 40 years.

Exotic tetra- and pentaquark states extremely popular in recent years were among his numerous interests. Both of the most reasonable scenarios — molecular and hadrocharmonium — were first proposed in his work. A paper on the possible existence of molecular charmonium was published by him and Okun' long ago in 1977. He believed that it was not yet time to give preference to any scenario and that experiment should suggest the choice. For that reason, he decided to concentrate on the processes of pentaquark production and on new experiments to study their properties. It was he who put forward the idea to observe them at the Jefferson Laboratory (JLab), and such experiments are already under way.

Physics was the science of nature for him; he worked a great deal with experimenters, who became his co-authors.

Together with Ter-Martirosyan, he published the monograph *Theory of gauge interactions of elementary particles* in 1984.

Voloshin was always a benevolent, friendly, and hospitable person. Anybody could address him with any problem, either personal or scientific. He took it very much to heart. He enthusiastically met the discussion of an interesting scientific problem and often made exceedingly important comments, owing to which he might be included as a co-author, but he often refused to agree. He had a keen critical mind and quickly felt pitfalls, shortcomings, or contradictions of problems under discussion and criticized them without regard for the rank or title of his interlocutors.

It was a great pleasure to work with him, so how sad that he is no longer with us.

The USSR Academy of Sciences awarded Voloshin the 1983 Physics Prize and Medal for the series of studies "The properties of heavy quark systems outside the perturbation theory of quantum chromodynamics." In 1997, he was elected an honorary fellow of the American Physical Society. In 2001, the American Physical Society decorated him and the American physicists Mark Wise and Nathan Isgur with the Sakurai Prize "For the construction of the heavy quark mass expansion and the discovery of the heavy quark symmetry in quantum chromodynamics, which led to a quantitative theory of the decays of c and b flavored hadrons." Voloshin was a 2004 Humboldt Prize winner.

Voloshin worked and taught actively till the last days of his life; he is the author of more than 250 original scientific works.

His demise is an irretrievable loss for his colleagues and friends all over the world.

A E Bondar', A I Vainshtein, M I Vysotsky,
A S Gorskii, M V Danilov, A D Dolgov,
A Yu Morozov, V A Novikov, V Yu Petrov,
V A Rubakov, M A Shifman, M I Eides