PERSONALIA

In memory of Dmitrii Aleksandrovich Varshalovich

The outstanding Russian theoretical physicist, full member of the Russian Academy of Sciences (RAS), Dmitrii Aleksandrovich Varshalovich, well known for his studies in the field of quantum theory, radiation theory, physics of interstellar matter, quasar physics and cosmology, passed away on April 21 at the age of 86.

Varshalovich was born in 1934 in Leningrad into the family of a prominent entomologist, Aleksandr Aleksandrovich Varshalovich, and a biologist, Vera Yakovlevna Skurikhina. In 1941, when a child, he was evacuated from Leningrad, where he returned with his mother in 1944. In 1952, he finished school with a gold medal and entered the physical faculty of Leningrad State University. He graduated from the University in 1957 as a specialist in nuclear spectroscopy and joined the laboratory of nuclear isomerism of the Leningrad Physical-Technical Institute (LPTI, now Ioffe PTI).

Within several years, he carried out a series of studies in nuclear isomerism and nuclear spectroscopy, collaborating with L I Rusinov and L K Peker. Those same years, together with I V Kurcharov and Rusinov, he wrote a book on nuclear isomerism. The book was unfortunately not published because of the untimely death of Kurcharov and Rusinov in 1960. In 1961, Varshalovich was transferred to the Department of Theoretical Physics at LPTI, where he continued working in nuclear spectroscopy and interferential methods of studying gamma-ray emission of nuclei and at the same time became engaged in astrophysics. In 1963, he joined the Sector of theoretical research in astrophysics (now the Sector of theoretical astrophysics) just then founded on the initiative of the LPTI director B P Konstantinov (the first head of the Sector was A Z Dolginov). Varshalovich worked in this Sector for all of his life. In December of 1966, he defended his candidate (PhD) thesis "Dynamic orientation of atoms in the cosmic medium." The paper appeared to be so significant that the official opponents Ya B Zel'dovich and I S Shklovskii, as well as Ya A Smorodinskii, who took part in the work of the committee, suggested that Varshalovich be given the degree of Doctor of Science in physics and mathematics. The chair of the dissertation committee, Konstantinov, and the members of the committee unanimously supported the suggestion (the decision of the committee was approved by the Higher Attestation Commission in May of 1968). From 1986 to 2010, Varshalovich was head of the Sector of theoretical astrophysics and managed to maintain the activity and operability of the Sector even in the period of deep crisis in the 1990s.

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Dmitrii Aleksandrovich Varshalovich (14.08.1934–21.04.2020)

Varshalovich had profound fundamental knowledge, great keenness and competence, scientific intuition, and the ability to put forward and implement original ideas. He made an invaluable contribution to the development of a number of areas in astrophysics.

In the 1960s–1970s, he published a series of studies for the first time exploring the dynamic alignment of atomic and molecular spins in a rarefied cosmic medium caused by resonance scattering of anisotropic radiation fluxes. The effect proved to be important for the investigation of the physical parameters and chemical composition of interstellar gas clouds, the shells of stars, nebulae, comets, and other objects. At the same time, in the early 1960s, Varshalovich proposed the hypothesis (published in 1966) that maser pumping mechanisms in quantum transitions in hydrogen atoms can be realized in thermodynamically nonequilibrium interstellar gas clouds. The discovery in 1965 by radio astronomers of interstellar masers on transitions between rotational levels of OH molecules piqued his interest in cosmic masers.

In the 1970s–1980s, Varshalovich organized extensive theoretical studies of cosmic masers with the involvement of many scientists. In the 1970s, a major series of studies was completed in collaboration with V V Burdyuzha and later with W Kegel and S Chandra. The conditions for the occurrence of cosmic masers, their energetics, pumping mechanisms, and polarization effects were investigated in detail, new maser lines were predicted, and probing methods for maser radiation sources were proposed.

Over the same period of the 1970s–1980s, Varshalovich supervised interstellar molecule spectroscopy studies aimed at investigating the kinetics of molecular states in a strongly nonequilibrium interstellar gas. A large series of now classic studies on this subject was carried out in collaboration with V K Khersonskii. Experiments on laboratory modeling of physico-chemical processes in the interstellar medium were performed on the initiative of Varshalovich. They showed the important role played by interstellar dust particles in the formation of organic molecules in space.

From the late 1970s, Varshalovich initiated an immensely successful series of studies in guasar physics and cosmology. Together with Khersonskii, he developed theoretical methods to detect nonequilibrium pregalactic gas in the early Universe after hydrogen recombination with a preview of the future measurements of singularities in the background radiation spectrum in the radio and IR bands. At the same time, he initiated precision spectral studies of distant interstellar and intergalactic gas clouds transluminated by the radiation of quasars that existed in the early Universe 10 to 12 billion years ago. In the course of these studies, discovered for the first time were cosmologically distant clouds containing H₂ molecules (together with S A Levshakov, 1979) and HD molecules (together with A V Ivanchik, 2001). This provided unique information on the substance composition and physical characteristics of the early Universe. In particular, the abundance of primary deuterium and the mean baryonic density in the Universe were independently estimated. The quasar spectrum analysis also allowed obtaining constraints on potential variations of fundamental physical constants in the course of the evolution of the Universe. Together with A V Orlov and Ivanchik, Varshalovich modeled the synthesis of primary chemical elements in the early Universe, which allowed obtaining constraints on the parameters of cosmological models. Together with E E Kholupenko and Ivanchik, he modeled recombination of primordial hydrogen-helium plasma; these results are used in the analysis of the observable anisotropy of background radiation. Investigations of matter in the early Universe are currently being continued by the team of scientists put together by Varshalovich.

Varshalovich also participated in many other studies devoted to different aspects of physics and astrophysics. His deep knowledge of the basic principles of spectroscopy found application in work (implemented in collaboration with colleagues from the Space Research Institute, Russian Academy of Sciences: E M Churazov, R A Syunyaev, S Yu Sazonov, and others) on the analysis of the annihilation radiation spectra from the galactic center measured by the international gamma-ray astrophysics laboratory INTEGRAL. As a result, the parameters of the interstellar medium in the range of positronium annihilation were determined.

The monograph *Quantum theory of angular momentum* written by Varshalovich together with A N Moskalev and Khersonskii and first published in 1974 was broadly recog-

nized throughout the world. The first volume of the new twovolume book *Quantum theory of angular momentum and its applications* (written together with Khersonskii, E V Orlenko, and Moskalev) was published in 2018 and the second volume (written with Khersonskii and Orlenko) appeared in 2019. This fundamental encyclopedic work will long remain a handbook for scientists of different specialties.

Varshalovich was the author of over 230 research papers and several reviews and monographs. The recognition of his scientific merits was his election in 1994 as a corresponding member and in 2000 a full member of the Russian Academy of Sciences. Varshalovich was an RF State Prize laureate in the field of science and technology (2008), the Fock Prize (2001), the Belopol'skii Prize (1990), and prizes of MAIK NAUKA publishers (1997, 2007). He was awarded the medal of "Merit to the Motherland" of the 2nd degree (1999) and the Order of Friendship (2010).

Varshalovich was a member of the International Astronomical Union (from 1976) and a member of the editorial board of the journal *Pis'ma v Astronomicheskii Zhurnal* (*Astronomy Letters*) (from 1994). For many years, he was a member of the Academic Council at the Ioffe PTI and sat on academic councils of a number of research and educational institutions.

For more than 40 years, Varshalovich was engaged in teaching. From 1979, he was professor at the department of Space Research at the Leningrad Polytechnical Institute (now Peter the Great SPbPU) and from 2003 to 2018 was head of this department. His lectures on classical and quantum electrodynamics, dimensional theory, nuclear physics, interstellar-matter physics, and other areas educated generations of physicists; he helped many of his students to start their career in science. He actively promulgated science, delivering popular lectures to various audiences until the last years of his life.

Varshalovich was an outstanding erudite in what concerns exact sciences and at the same time was deeply interested in biology, medicine, history, literature, and politics. As a schoolboy, he played the violin and was inspired by classical music through all of his life.

All his life, Varshalovich was nothing but modest, friendly, lively, and well-disposed man inspired by new ideas and ready to discuss any topic with colleagues of any age or status. In these discussions, he always insistently advocated his own point of view. He stoically bore periods of serious illness; he almost never asked for help and rarely resorted to help when offered, while he himself always helped his friends and colleagues. His personal qualities and talent as a scientist deservedly won the sincere love and respect of very many colleagues. The memory of him will live in his work and in the hearts of his friends, colleagues, and students.

E B Aleksandrov, A M Bykov, A G Zabrodskii, A V Ivanchik, A D Kaminker, A A Kaplyanskii, S A Levshakov, N N Rozanov, R A Suris, R A Syunyaev, V K Khersonskii, D G Yakovlev