Professor Boris A. Mamyrin—American Society for Mass Spectrometry Award for a distinguished contribution to mass spectrometry

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Boris Mamyrin is a prominent Russian scientist, well known in the field of mass spectrometry and its fundamental applications. He has published about 320 papers, two books and 35 patents. He is an elected member of the Russian Academy of Sciences and Russian Academy of Natural Sciences. He supervised 15 PhD projects and three of his pupils have received DSc degrees.

Mamyrin was born in 1919 in Lipetsk, Russia. Both his parents were doctors of medicine. His early dream was to follow in his parents' footsteps, but first of all he wanted to be well educated in physics. His Master's degree was obtained just before World War II, from the Physical Mechanical Department of the Leningrad Polytechnic Institute. However, World War II destroyed his plans and he could not afford medical education. Throughout the war he served in the army, being demobilized from military service after a three-year delay: the army did not like to lose so able a servant with a university diploma.

Mamyrin then entered the Leningrad Physical Technical Research Institute (PTI). He had previously received a brilliant education. The Department from which he graduated with his Master's degree was a prototype for several Russian university schools, combining a deep scientific and a technical education (in particular, this was used as a model for the Moscow Physical Technical Institute). Its organizer and head was academician Abram Ioffe, who was simultaneously Director of the Research Institute, to which he invited Boris. In fact, it was Ioffe's influence that, in 1948, had extracted Boris from the Army. In spite of six years post-university interruption, Boris' talent and workaholism in the Institute allowed him to refresh his knowledge of physics and to obtain his PhD within a year of entering PTI.


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At the PTI, Mamyrin had the good fortune to join the group headed by the famous mass spectrometrists, Vladimir Dukelsky and Nikolay Ionov. The latter was a scientist with whom Boris carried out his first investigations of time-of-flight (TOF) and magnetic resonance mass spectrometers. The group combined, as we say, “brains and hands”. (The author of this introduction remembers with pleasure how Ionov taught him to make a spiral stainless shield for the Nier-type sector glass mass spectrometer which had recently been assembled at our Moscow Institute of Chemical Physics). Both features are characteristic of Boris, who rapidly became a dedicated and productive team member. He concentrated on the mass spectrometers mentioned before, in which separation of ions and their mass measurement are based mainly on time and frequency and not on geometrical ion optical principles. Maybe his skill in radio techniques acquired while in the Polytechnic Institute and army contributed to his choice of research area.

The first TOF mass spectrometer with real analytical characteristics was created by Mamyrin in the early 1950s. Several of these instruments, having perfect technical specifications (for that time), were built entirely in the institute workshops, with a publication in 1953 in the *Soviet Journal of Technical Physics*. One of the instruments demonstrated at the famous nine-month long World Exhibition in Brussels in 1958 was the only TOF mass spectrometer shown there. (It should be added that Boris was not allowed to go to Brussels by "the authorities" and the instrument was shown by someone who had not participated in its development).

Boris' main scientific goal at that time was to study physical processes and phenomena that required mass spectrometry with very high resolution, accuracy and sensitivity. Consequently, he moved on to the creation of magnetic resonance mass spectrometers. An instrument described in the Proceedings of the Academy of Sciences of the USSR in 1969 had a resolution of 350,000, with absolute sensitivity of several thousand atoms in a sample and, of special interest for the author's research, the ability to measure isotopic ratios of up to 10^{-11}. Later, similar instruments became available commercially from the Plant of Scientific Instrumentation of the Academy of Sciences of USSR. The desire to achieve significantly better resolution for TOF mass spectrometers by some "non-magnet" means necessitated a thorough investigation of all the possible factors limiting the resolution of what we now describe as "linear" TOFs. Mamyrin's conclusion was that the resolution was degraded mainly by the energy spread of ions originating within the ion source zone. His prescription was as simple as it was elegant: to reflect the ion packet by an electrostatic mirror after first passing through the drift tube, thus allowing more energetic and less energetic ions to arrive at the detector simultaneously. High resolution was also achieved due to second-order focusing on the basis of energy and vertical/horizontal angles of ion take-off from the source.

The reflectron is now the accepted standard for TOF mass spectrometry, being employed by all commercial manufacturers world-wide. It is not necessary to describe this part of its author's biography in a professional journal. Currently, the widest application of the reflectron is in the area of bioorganic analysis, so Boris' childhood dream to work for medicine has come true, though indirectly. The reflectron received the Soviet Inventor's Certificate in 1967, was published in *Sov. Phys. JETP* in 1973 and obtained UK (1977), French (1978) and Germany (1980) patents. I had the honor to be an official opponent at the defense of Mamyrin's DSc thesis in 1966, which already contained a chapter on the reflectron.

Mamyrin's direct and very deep applications of the magnetic-sector mass spectrometers of the two types are associated with the measurement of the fundamental physical constants and the $^3He/^4He$ ratio for geophysical and geochemical goals, the discovery of helium and anomalously high ^3He content in the Earth's mantel, whereby, he discovered an important correlation between the ratio $^3He/^4He$ and heat fluxes in the Earth's crust for the continents ("helium isotope thermometer"). He was also involved in the automation of gas analysis by TOF in the converter steel process, a brave journey for a fundamental physicist! He also measured, most precisely, the ratio of the magnetic moment of the proton to the nuclear magneton that increased the accuracy of physical fundamental constants. Recent works allowed the measurement of the decay half-life of tritium molecules with high precision. For the first time the decay half-time of tritium atoms and bare tritium nuclei was obtained.

Our hearty congratulations go out to Boris, together with our best wishes for continuing success in his research efforts.