PERSONALIA

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In memory of Boris Aleksandrovich Mamyrin

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Professor Boris Aleksandrovich Mamyrin, Corresponding Member of the Russian Academy of Sciences, Doctor of Physicomathematical Sciences, died on March 5, 2007 after a long severe illness.

B A Mamyrin was born on May 25, 1919 in the town of Lipetsk. Having graduated from a secondary school in Saratov, he enrolled in 1937 in the Physics and Mechanics Department of Leningrad Polytechnical Institute (LPI). As an LPI freshman and sophomore, Mamyrin took part in oscilloscope development work. In 1939, third-year student Mamyrin volunteered for military service in the war against Finland, immediately displaying his passion for all things technical — he was in a unit that saved Red Army soldiers from frostbite using high-frequency irradiation. During Great Patriotic war Boris Aleksandrovich was on active duty in the army and in the Communications Academy.

In 1948, Soviet Army captain Mamyrin was invited by Academician A F Ioffe to the Physico-Technical Institute (FTI, or Fiztekh); he was demobilized and started as senior research worker in Yu A Dunaev's laboratory, which worked on isotope separation for the Atomic Project. In 1949, Mamyrin wrote, submitted, and successfully defended his thesis "Modulating circuits for uranium-isotope-separation facilities by high-frequency method" for Candidate of Technical Sciences.

As any work on isotope separation and enrichment requires knowledge of the composition of the compounds involved, mass spectrometry analysis was started at Fiztekh and Mamyrin began to work in this field in the laboratory headed by V M Dukel'sky, together with more experienced experimenters who were already well known: N I Ionov, N V Fedorenko, and E Ya Zandberg. Boris Aleksandrovich's talent for seeing the general behind a particularity, of approaching any problem from contrasting standpoints, of regarding any device or instrument as an object for making improvements, of identifying weak spots and suggesting novel solutions manifested itself here in full measure. One of the main principles of Mamyrin's work was that any research effort should be extended to its logical end: the implementation of the result of research as a practical device or as an industrially produced item, or the development of an instrument with improved parameters or of a completely novel device, or obtaining a numerical value of a quantity measured. Mamyrin and his co-workers along with colleagues from other institutions developed with equal relish high-vacuum metal seals allowing numerous close – open cycles, ion sources, modulators, phase shifters, broad-band amplifiers, stroboscopic devices for weak signal extraction, electrometric amplifiers, open-input dynode multipliers (in collaboration with M R Ainbund, G S Vildgrube, and N V Dunaevskaya), vacuum leak-valves, and many other elements or devices that are still used by experimenters. Many of Mamyrin's publications deal with developing methods for measuring certain physical quantities: extremely low pulse voltages and currents, the characteristics of gas discharge, plasma parameters at high discharge current densities, small inhomogeneities of magnetic induction in high-intensity fields, etc.

Boris Aleksandrovich Mamyrin
(25.05.1919 – 05.03.2007)

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In 1966, Boris Aleksandrovich Mamyrin presented and brilliantly defended a thesis "Studies of ion separation by time-of-flight technique" for Doctorate of Physicomathematical Sciences. In the mid-1970s, he received a Professorship certificate. In 1981, Mamyrin organized at the A F Ioffe FTI the first mass spectrometry laboratory in the USSR Academy of Sciences with the task of developing new mass-spectrometric techniques for utilization in fundamental and applications-oriented research.

Mamyrin's main contribution to science was made in the field of dynamic mass spectrometry and its applications. In contrast to static mass spectrometers in which ions with different mass-to-charge ratios are separated in constant electric and magnetic fields, ions in dynamic spectrometers are exposed to alternating (high-frequency) electric fields, which provides certain advantages in comparison with static devices. Of the ten existing types of various mass spectrometers, two (the magnetic resonance mass spectrometer (MRMS) and time-of-flight mass reflectron) were proposed and developed at the A F Ioffe FTI of the USSR Academy of Sciences. MRMS development and design began in the 1950s, with B A Mamyrin playing one of the main roles in this process. The first publication informing about the creation of this instrument appeared in 1953, authored by N I Ionov, B A Mamyrin, and V B Fiks. Important contributions to the theory of MRMS, to understanding how it operates, and to achieving high analytical characteristics of the instrument itself and of its many applications were made by the staff of Mamyrin's laboratory — A A Frantsuzov, B N Shustrov, G S Anufriev, S A Alekseenko, N N Aruev, and others. At the moment there are only six MRMS instruments in the world and all of them are at the FTI. Owing to their extremely high analytical characteristics, these instruments were used in isotope composition studies of helium and other inert gases. It is common knowledge that the isotope ^4He is a product of decay of transuranium elements, while the isotope ^3He is either a product of the synthesis of light deuterium nuclei or a product of the β-decay of tritium. Consequently, the ratio of isotopic contents $^3He/^4He$ can provide information on the processes that occur in nature: in the mantle and crust of the Earth, on the Moon, in the Sun, in the solar wind, in anthropogenic materials, and in iron – magnesium nodules on the sea and ocean floor.

In his work on helium isotopes in natural and anthropogenic subjects, Mamyrin obtained fundamental results and three among them were certified as discoveries. The discovery of the anomalously high content of ^3He and primordial ^3He in the Earth's mantle was the subject of Mamyrin's Discovery No. 253 (1982, with G S Anufriev, L V Khabarin, I N Tolstikhin et al.). Mamyrin's Discovery No. 68 (with V I Kononov, B G Polyak et al.) which established a global connection between the isotope ratio $^3He/^4He$ and thermal fluxes through continental crusts received the discovery certificate in 1990. The study of helium penetration into solids when these undergo deformation revealed the effect of dynamic dislocation diffusion, which was registered in 1997 as Discovery No. 50 (authored by B A Mamyrin, O V Klyavin, L V Khabarin, and Yu M Chernov). Work on helium isotopy is currently in progress.

Measurements of fundamental physical constants (FPCs) became another application of the MRMS. This is a consequence of the principle that is basic for cyclotron devices. Indeed, the MRMS makes it possible to measure with great precision the cyclotron frequency of ions and find the proton cyclotron frequency. In turn, the ratio of the proton's spin precession frequency to the proton cyclotron frequency gives the proton magnetic moment in nuclear magnetons. Mamyrin headed the project and took active part in the work on determining μ_p/μ_N: in the 1960s together with A A Frantsuzov, and in the 1970s with N N Aruev and S A Alekseenko. The value of μ_p/μ_N was measured in this last work with a world-record accuracy (relative error 0.43 ppm). This value was included without corrections into the official table of recommended adjusted values of fundamental physical constants from 1973 until 1986, which to a large extent dictated the values of many electromagnetic physical constants. Further progress in measuring FPCs required an essential increase in the resolving power of the MRMS, so Mamyrin initiated the required effort. A pilot MRMS system achieved a resolution of about 350,000 at half-height of the mass line, which made it possible to resolve for the first time the mass doublet $^3H^+ - {}^3He^+$. At the moment, an instrument with a projected resolving power of about 10^6 is being built for measuring atomic masses and FPCs. After this work was recognized by the world scientific community, B A Mamyrin was elected to the Task Group on Fundamental Physical Constants in the international CODATA (Committee on Data for Science and Technology) and remained a member until the last days of his life.

Another important application of the MRMS stems from its extremely high absolute sensitivity ($\sim 3 \times 10^4$ atoms of ^3He in the volume of the analyzer) and large dynamic range ($\sim 10^{11}$). The need arose in mid-1970s to have a better value for the half-life of tritium, the heaviest of hydrogen's isotopes. All relevant techniques available by that time were absolute, that is, required absolute measurements of the amount of mother element — tritium — or the daughter element ^3He, or the amount of energy released in the β-decay of tritium. Mamyrin and his co-workers N N Aruev, Yu A Akulov, L V Khabarin, and B S Yudenich developed an original technique for determining the tritium half-life $T_{1/2}$, based on relative measurements of the ratio $^3He/^4He$. An essential advantage of this method in comparison with earlier developments was that the time of exposure of a sample containing a mixture of tritium and ^4He was only 1 – 2 years, while exposure time in all other studies required ten years or more. Mamyrin and his co-workers carried out pioneer experiments on measuring the half-lives of the tritium nucleus, tritium atom, and tritium molecule. Confirmation of the results of these experiments will be very important for clarifying the influence of orbital electrons on tritium half-life, for determining the lifetime of free neutron, and for measuring the ratio of the axial-vector and vector constants of the weak interaction.

The work of Boris Aleksandrovich Mamyrin and his colleagues (V I Karataev, D V Shmikk, and V A Zagulin) that was published in 1973 gained the highest recognition by the scientific community; it presented the nonmagnetic time-of-flight mass spectrometer that became known the world over as the Mamyrin mass reflectron. This instrument possesses high resolving power and sensitivity, short response time, and an unlimited mass range. Owing to their unique analytical characteristics mass reflectrons are very widely used in various fields of science (organic chemistry, biology, ecology, proteomics, pharmacology, etc.) and technology for monitoring fast technological processes. Nowadays, mass reflectrons are manufactured by practically all instrumentation-designing companies in all countries. In our country, the large series of FTIAN-3, FTIAN-4, FTIAN-5, and MX-5302 were industrially produced. Industrial production of a large number of mass reflectrons and the unstoppable initiative of B A Mamyrin and V M Tuchkevich made it possible to equip most metallurgical plants in Russia and other republics of the USSR with systems of continuous monitoring of converter production of steel, copper, and nickel, and also blast furnace processes and the vacuum remelting of steel. For his work on organizing industrial production and promoting large-scale use of mass reflectrons in metallurgy, B A Mamyrin was awarded the Order of Labor Red Banner and won the 1982 Academician B P Konstantinov Prize of the Presidium of the USSR Academy of Sciences. In 2000, the American Society of

Mass Spectrometry (ASMS) gave Boris Aleksandrovich Mamyrin its medal for his "distinguished contribution in mass spectrometry." Work on the use of mass reflectrons for the monitoring and control of technological processes in the metallurgical, oil, and gas industries is being continued by Boris Aleksandrovich's disciples.

B A Mamyrin paid much attention to training new generations of researchers. From 1948 to 1971 he read a course of radiophysics that he prepared for students of the Leningrad Polytechnical Institute. Under his supervision, 20 Candidate and three DSc theses were submitted and successfully defended.

B A Mamyrin carried a considerable load of science management. He was a member of the Learned Councils of the A F Ioffe FTI and D I Mendeleev VNIIM, a member of the editorial boards of *Zhurnal Tekhnicheskoi Fiziki* and *Pis'ma v ZhTF*, and a member of the mass-spectrometric commission. He was also a member of the Council on Scientific Instrumentation Design and Council on Metrology of the RAS Presidium, chaired the National Task Group on Fundamental Physical Constants, and represented our country in the International CODATA Task Group on Fundamental Physical Constants.

In his years of research, Boris Aleksandrovich Mamyrin published two monographs (co-authored by I N Tolstikhin) and 350 papers, and obtained four patents and nearly 35 Inventor's Certificates. In 1994, he was elected Corresponding Member of the Russian Academy of Sciences in the Physical Sciences Division.

It is said that if a person is talented, they are talented in everything. Boris Aleksandrovich had numerous talents, was able to look at any problem in a wider context, and invariably enjoyed the process of seeking its solution. He loved beauty in everything, be it a scientific theory, an operatic aria, or a cast-iron piece from Kasli. Boris Aleksandrovich enjoyed great respect not only as a well-known scientist but equally as a man whose company was pleasant and interesting. This was facilitated by his benevolence, good sense of humor, ability to listen, and willingness to understand his interlocutor, and his readiness to give practical help. Disciples and colleagues of Boris Aleksandrovich Mamyrin will always remember this wonderful man.

E B Aleksandrov, Zh I Alferov, G S Anufriev,
N N Aruev, D A Varshalovich, A G Zabrodsky,
A A Kaplyansky, V I Karataev,
E P Mazets, M P Petrov