Sergei Vladimirovich Lebedev (Obituary)

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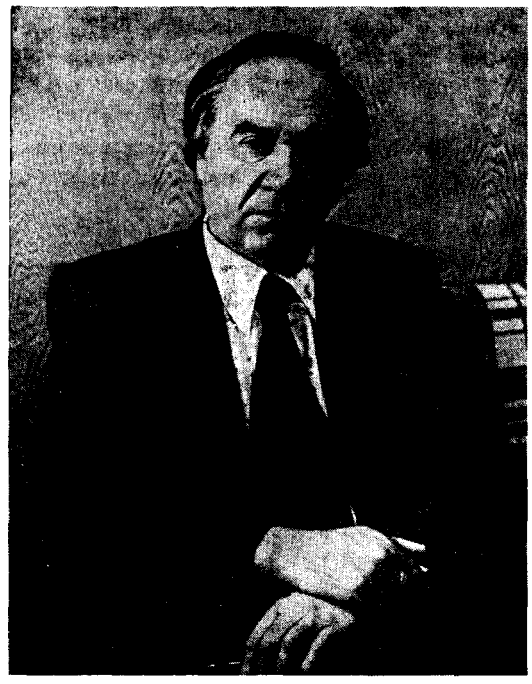
The talented experimental physicist and Doctor of Physical and Mathematical Sciences Sergeĭ Vladimirovich Lebedev died on April 2, 1990. S. V. Lebedev is well known primarily for his fundamental papers on the investigation of metals at high temperatures and of the electrical explosion of conductors. He was the first one to suggest using pulsed heating by high density current for the experimental study of physical phenomena and the properties of a metal in the solid and liquid states, and also of the disappearance of metallic conductivity. He obtained the clearest and most significant results in this field, and the efficient method for investigating metals which he created is extensively used in the Soviet Union and abroad.

S. V. Lebedev was born on March 14, 1913 in Moscow, into the family of the biology professor Vladimir Nikolaevich Lebedev, the founder of scientific cinematography in Russia, and a close friend and colleague of the outstanding biologist N. K. Kol'tsov. S. V. Lebedev entered the Physics Department of Moscow State University in 1932, from which he graduated with distinction in 1938 with specialization in the "Theory of Vibrations." On the initiative of L. I. Mandel'shtam, S. V. Lebedev was retained as a graduate student in the vibrations laboratory of the Institute of Physics at Moscow State University with S. E. Khaĭkin. Here he carried out his first work on the physics of metals. In particular, S. V. Lebedev, together with S. E. Khaĭkin, detected the interesting phenomenon of the anomalous thermal electron emission from a metal, which arises during its rapid heating by a high density electric current ($\sim 10^6$ A/cm^2). These anomalies appear as an unusually large amount of electron emission from a metal in the solid state near its melting point, and also as having a nonequilibrium nature: after a sharp cutoff of the heating current, the emission current drops sharply to its usual equilibrium value after a time of $\sim 10^{-4}$ sec, during which one may neglect the cooling of the emitter.

S. V. Lebedev was at the front from the start of the war, but in 1943 he was assigned to a laboratory founded by A. F. Ioffe in the Scientific Research Institute for the Electrical Industry to develop an invention. Here he was actively occupied with an investigation of thermal effects and of electrical erosion of electrodes during heavy-current discharges between them. Here it was shown by S. V. Lebedev that the local release of Joule heat and the electrical explosion of small sections of electrode surface layer serve as the main causes of erosion.

In 1946 S. V. Lebedev was directed into Laboratory No. 2 of the Academy of Sciences of the USSR (now the I. V. Kurchatov Institute of Atomic Energy) in I. K. Kikoin's section to take part in work on separation of isotopes. For 20 years his further activity was continuously connected with the Physics Institute, Academy of Sciences of the USSR, to which he was invited in 1947 by M. A. Leontovich in the vibrations laboratory to conduct research on the physics of metals. Also in this period (1948–1965) he actively taught



SERGEI VLADIMIROVICH LEBEDEV
(1913–1990)

on the faculty of general physics at Moscow Physicotechnical Institute. Many graduates of the Physiocotechnical Institute remember with great warmth S. V. Lebedev as a highly qualified teacher and an exceptionally benevolent person. A long series of papers was written by S. V. Lebedev at the Physics Institute, Academy of Sciences of the USSR on the investigation of the electron emission and electrical conductivity of metals, and also on the explanation of the physical mechanism for the electrical explosion of conductors during rapid ($\lesssim 10^{-5}$ sec) pulsed heating by high density current ($\sim 10^6$ to 10^7 A/cm^2). It was established that values of the anomalous emission current near the melting points of metals is larger by two orders of magnitude than the usual tabulated values that are determined by the well-known Richardson-Dushman equation. For example, this leads for tungsten to a violation of the Langmuir law on the limitation of the anode current in a vacuum diode by the negative space charge, which is explained by the significant increase of the electron concentration near the surface of the emitter and by the departure of the electron gas from an ideal state. Besides, it was shown that the disappearance of metallic conductivity occurs as a result of the separation of liquid metal by the fluctuating surfaces of microscopic discontinuities for regions with sizes close to the electron mean free path in con-

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densed metal, while the explosion products are a sol with particle sizes from 100 Å to 1 000 Å. The results of these papers written by S. V. Lebedev in the 1950s and 1960s became widely known and the keys to further research on metals by the electric explosion method. A number of interesting investigations on the vacuum spark and other pulsed sources of short-wavelength radiation that are used to excite the spectra of multiply charged ions were also carried out by S. V. Lebedev from 1957 through 1967 in the spectroscopy laboratory of the Physics Institute, Academy of Sciences of the USSR. These papers exerted a significant influence on the explanation of the mechanism responsible for the origin of soft x-ray radiation in a spark discharge plasma.

S. V. Lebedev was invited by A. E. Sheĭndlin in 1967 to the Institute of High Temperatures, Academy of Sciences of the USSR, where he worked until very recently. He created new original procedures which enabled one to conduct extensive research on many thermal and electrical properties of refractory metals at high temperatures. In particular, the electrical resistance and specific heat in the solid and liquid states, the heats of fusion, and also the enthalpy and thermal expansion in the liquid state were measured for the first time for a number of metals and alloys. These data (which are necessary for creating a theory of melting and of the liquid state) had not been obtained successfully earlier by other methods. The nonequilibrium phenomenon of the anomalous specific heat for refractory metals (W, Ta, Mo, and Nb) near the melting point, which is closely connected with anomalous electron emission, has been detected. Thse anomalies were explained by the nonequilibrium concentration of point defects in a metal which arises during its rapid heating at a rate $\sim 10^9$ K/sec. A new approach to investigating the electrical explosion of conductors for the purpose of creating large energy densities in a metal was formulated by S. V. Lebedev with his colleagues at the start of the 1980s. Rapid heating was carried out in thick-walled insulating capillary tubes, which guaranteed the occurrence of high pulsed pressures in the metal itself. This enabled one for the first time to measure the conductivity of liquid metals and graphite both at high temperatures and simultaneously at high pressures ($P \sim 10$ kbar to 50 kbar). The main results of investigating metals during rapid heating by an electric current have been discussed in a review by S. V. Lebedev and A. I. Savvatimskiĭ [Usp. Fiz. Nauk **144**, 215 (1984); Sov. Phys. Usp. **27**, 749 (1984)].

A talented scientist unselfishly devoted to science, S. V. Lebedev has left a memory of himself not only as that of a bright experimental physicist, but also as that of a genuine intellectual, of a deeply decent man who was not subservient to opportunism. Colleagues and people who knew S. V. Lebedev well valued highly his modesty, his exacting nature towards himself combined with tolerance and humanity with regard to others. His openness, fine sense of humor, and originality brought joy to all who worked with him or simply came in contact with him.

Translated by Frederick R. West