

## Yakov Borisovich Zel'dovich (Obituary)

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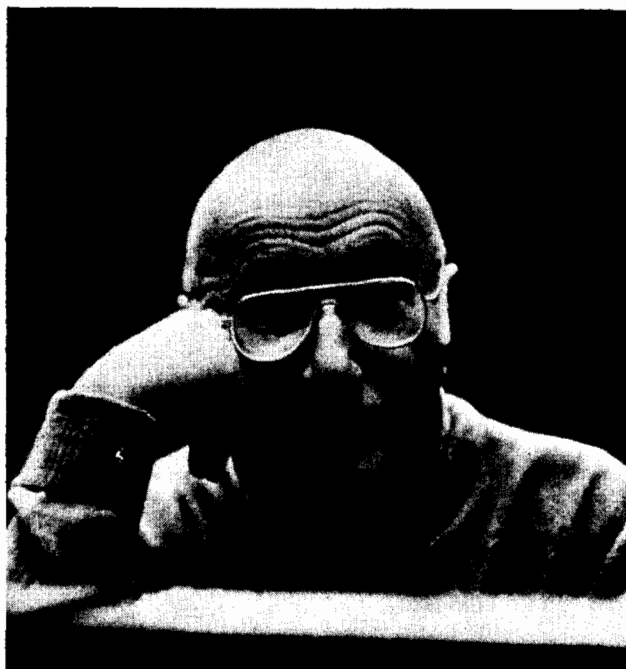
Academician Yakov Borisovich Zel'dovich, one of the greatest physicists of our time, passed away suddenly on December 2, 1987.

Ya. B. Zel'dovich was born on March 8, 1914 in Minsk. He studied at the Leningrad Physicotechnical Institute and the Institute of Chemical Physics. A scientist of the broadest range, Ya. B. Zel'dovich made enormous contributions to the development of modern theories of combustion and detonation, the physics of explosions and shock waves, nuclear and particle physics, theories of gravitation and cosmology, high-energy astrophysics and x-ray astronomy. His contribution to the defense capabilities of our country was invaluable. The central importance of the gunpowder combustion research carried out by his group for the legendary "Katyusha" rocket launchers is well known. He was among the first to be enlisted by I. V. Kurchatov to take part in designing the first Soviet atomic reactor. He participated in the development of atomic weapons. His experience, knowledge, and scientific talents proved incalculably important to our country.

The first investigations of Yakov Borisovich, including experimental ones, concerned the processes of adsorption and catalysis. He studied the effect of surface inhomogeneities on adsorption. His ideas and accomplishments live on to this day and he remains an acknowledged authority in the field. Thus, in 1938, he pointed out the possibility of adsorption affecting the structure of the adsorbent. The importance of this concept can be fully appreciated today, when similar ideas are appearing in many areas, including molecular biology.

In the first half of the 1930s N. N. Semenov enlisted Yakov Borisovich in a large collective research project on the oxidation of nitrogen during combustion. In a logical fashion Zel'dovich then turned to the general theory of combustion, detonation and shock waves, in which field he obtained seminal results. As we cannot provide a detailed list of his accomplishments,<sup>1)</sup> it suffices to say that he created the modern theory of combustion and explosion. His scientific collective grew into a large and multifaceted school.

Yakov Borisovich was characteristically quick to adopt a new field. Soon after the discovery of fission in uranium (1939) he and Yu. B. Khariton developed the theory of a chain reaction in such a process. In a series of articles they reached fundamental conclusions, both negative (a chain reaction is impossible in natural uranium, nor is a self-sustaining reaction possible in a homogenous "natural uranium + light water" system) and positive: the elucidation of the role of delayed neutrons, uranium enrichment with light isotopes, evaluation of the critical mass, the neutron multiplica-



YAKOV BORISOVICH  
ZEL'DOVICH  
(1914–1987)

tion criterion in systems with slowed neutrons. For his work on cold neutron storage (1956) Ya. B. Zel'dovich was awarded the I. V. Kurchatov medal of the Praesidium of the USSR Academy of Sciences.

In the 1950s Ya. B. Zel'dovich embarked on elementary particle research. In 1952 he formulated the baryon number conservation law as applied to the then recently discovered strange particles. In 1953 he formulated the lepton number conservation law. His studies of  $\beta$ -decay occupy an important place in his work: of particular significance were his calculations of pion  $\beta$ -decay and his related, profound notion of weak vector current conservation. This idea serves as an integral component of the modern theory of electroweak interactions. As early as the 1950's Zel'dovich advanced the striking concept of isotopic lepton spin and proposed experiments to discover parity violations in atoms.

Ya. B. Zel'dovich devoted the last twenty five years of his life to cosmology and relativistic astrophysics.

The arrival of Yakov Borisovich in astrophysics coincided with the second revolution in astronomy. He was one

of the leading theorists who planned and actively participated in this revolution. He stood at the wellspring of a new scientific field—relativistic astrophysics. He studied accretion processes on black holes and neutron stars, predicted the possibility of creation of black holes of low mass, carried out detailed investigations into the properties of relativistic stars. He devoted much attention to the problem of the creation of magnetic fields in astronomical objects, to dynamo theory. After the discovery of cosmic background radiation Ya. B. Zel'dovich was among the first to appreciate its utility as a means of studying the history of the Universe. He analyzed problems of anisotropy and radial fluctuations of the background radiation, nuclear synthesis of elements in the hot Universe, background neutrinos, quarks and monopoles. He solved the problem of hydrogen recombination in the Universe, calculated distortions in the background radiation spectrum due to decay of unstable particles, matter—antimatter annihilation, and dissipation of potential and eddy motion. Ya. B. Zel'dovich predicted that the radiant temperature of background radiation would be smaller in directions of galactic clusters containing hot intergalactic gases. This effect has been observed experimentally and its detailed study is included in the programs of the world's largest radiotelescopes.

The main problem on which Ya. B. Zel'dovich worked for the last twenty five years of his life was the origin of large-scale structure in the Universe. He investigated the reasons behind the amazing variety of galaxies, galactic clusters and superclusters. His main accomplishment in this field, the "pancake theory", has achieved world-wide acceptance. He was also fascinated by the problem of the birth of the Universe as a whole.

He authored twenty excellent, seminal books in many areas of physics and astrophysics. The importance of his research in the world-wide scientific development has been universally acknowledged. Many of his studies have attained the status of classics; his monographs have become textbooks for generations of younger scientists. Scientific schools founded by Ya. B. Zel'dovich are active in the Institute of Chemical Physics, Institute of Applied Mathematics, Institute of Space Research, Institute of Physics Problems of the USSR Academy of Sciences, State Astronomy Institute at Moscow State University, and many industrial institutes.

Ya. B. Zel'dovich was thrice named a Hero of Socialist

Labor. He was a laureate of the Lenin and State Prizes of the USSR. He was elected to membership in the London Royal Society, National Academy of Sciences of the United States, Hungarian Academy of Sciences, "Leopoldina" Academy (East Germany), International Academy of Astronautics and a number of other academies. He was awarded honorary degrees by many famous universities and received the Catherine Bruce gold medal, with the citation reading "for a life devoted to astronomy and great contributions to that science".

Ya. B. Zel'dovich was one of the first two recipients of the Dirac prize awarded for outstanding contributions to theoretical physics. His accomplishments were also honored by a gold medal from the Royal Astronomical Society of Great Britain.

His great talent and personal charm permitted Yakov Borisovich to found a number of world-class scientific schools in the most promising branches of chemical and nuclear physics, particle physics, astrophysics and cosmology. He helped hundreds of young people to find their place in science, generously sharing his knowledge, experience, and ideas. People turned to him for help in difficult situations. For instance, many of us remember how he would don his "medals" to approach the authorities in order to obtain a Moscow residence permit for a promising young scientist. He often succeeded in seemingly hopeless endeavors. Conferences and seminars took on a unique ambience with his participation. Science meant everything to him; his capacity for creative work was astounding. And yet in many ways he remained a very simple and charming man. His many friends, colleagues and students will remember him, above all, as a kind, understanding and cheerful person.

Yakov Borisovich did not die resting on the laurels of his enormous scientific contributions, but rather in the midst of strenuous research. He loved science passionately and toiled until his last days without respite.

<sup>1)</sup>A complete list of Ya. B. Zel'dovich's works is available in a two-volume collection of his selected works published in 1984 by "Nauka": vol. 1—"Chemical Physics and Thermodynamics", vol. 2—"Particles, Nuclei, and the Universe". Selected works of Ya. B. Zel'dovich are to be published in English by Princeton University Press in 1989.

Translated by A. Zaslavsky