

Professor M. L. Lidov: Per Aspera ad Astra (to the 100th Anniversary)

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Abstract. The year 2026 marks the 100th anniversary of the birth of Professor Mikhail Lvovich Lidov, an outstanding mechanician. M. L. Lidov made a great contribution to the success of many projects that are the pride of Russian cosmonautics: obtaining the first images of the far side of the Moon, the first lunar landing, the first artificial satellite of the Moon, and the first broadcasting satellites that covered the entire territory of the USSR. One of the fundamental effects of celestial mechanics—the von Zeipel–Lidov–Kozai effect—is named after him. My talk outlines the main milestones in Lidov’s scientific career and provides a brief overview of his research.

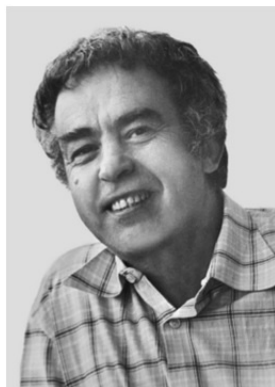


FIGURE 1. Mikhail Lvovich Lidov (04.10.1926 — 30.12.1993)

Introduction

Mikhail Lvovich Lidov was an leading Soviet scientist in the fields of celestial mechanics, space flight mechanics, and the study of the planets of the Solar System.

He was awarded the Lenin Prize and received numerous other state awards. He was equally at home in abstract theory and in practical engineering.

M. L. Lidov belongs to the generation of outstanding scientists and engineers whose talent made possible the emergence and rapid development of the space era. In the year of the centenary of his birth, it is worth recalling the main stages of his life and noting his unique scientific achievements, many of which remain relevant in modern celestial mechanics.

Early Years

Mikhail Lvovich Lidov was born on October 4, 1926, in Cherkassy. His childhood and youth fell on a dramatic period in Soviet history. His father, Lev Iosifovich Lidov, was convicted in the 1930s on charges of counter-revolutionary activity, spent time in camps and exile, and was fully rehabilitated in 1955. In 1940, Lidov's elder sister Vera was also arrested and convicted.

In 1944, Mikhail Lvovich began military service as an aircraft armament mechanic. After the war, while still in service, he completed his secondary education and in 1949 entered the Faculty of Mechanics and Mathematics of Moscow State University. After his demobilization in 1951, he continued his studies as a full-time student at the same faculty.

Lidov's first scientific investigations were carried out under the supervision of Academician L. I. Sedov. In 1954, his paper on gas motion taking into account Newtonian gravitation was published in the *Doklady of the Academy of Sciences of the USSR*. In the same year, he graduated with honours from Moscow University in Mechanics.

Because his father had been convicted of counter-revolutionary activity, the young graduate could not find a job for almost a year. In 1955, he was employed by the Interdepartmental Commission for Interplanetary Communications. In December 1957, with the support of V. A. Egorov and D. E. Okhotsimsky, M. L. Lidov joined the Department of Applied Mathematics (OPM — the Russian abbreviation for *Otdelenie Prikladnoi Matematiki*) of the Steklov Mathematical Institute of the Academy of Sciences of the USSR, later reorganized as the Institute of Applied Mathematics.

Scientific Achievements

One of Lidov's first studies at the Division of Applied Mathematics concerned the atmospheric drag experienced by the earliest artificial Earth satellites. From observations he determined the density of the upper atmosphere and identified regularities in its variation, including the relationship between the intensity of orbital decay and the migration of the orbital perigee between the daytime and nighttime sectors of the Earth's atmosphere.

An important stage of his activity was his participation in the preparation of the flight of the spacecraft Luna-3. Lidov and his colleagues from OPM needed to find a trajectory that would allow photographing the far side of the Moon and ensure the transmission of images to Earth using ground stations in the USSR. They proposed a trajectory for Luna-3 that involved a gravity assist at the Moon, which ensured the spacecraft's return to the radio visibility zone from the Soviet Union.

In October 1959, Luna-3 transmitted the first images of the far side of the Moon to Earth. For his contribution to the success of this mission, M. L. Lidov received the Lenin Prize in 1960.

In 1961, Lidov published his fundamental work on the evolution of planetary satellite orbits under gravitational perturbations from external bodies. It showed that the attraction of a distant celestial body can cause coupled periodic changes in the eccentricity of the orbit and its orientation in space. Under certain conditions, the eccentricity can increase so significantly that the satellite approaches the surface of the central body or collides with it.

As an illustration, M. L. Lidov considered the motion of a hypothetical "polar Moon", whose orbital plane is perpendicular to the plane of the Earth's motion around the Sun. His approximate formulas predicted the collision of such a satellite with the Earth after 52 revolutions. Subsequent numerical integration of the equations of motion gave a collision after 55 revolutions, confirming the high accuracy of the analytical result.

Similar regularities were investigated at the beginning of the 20th century by the Swedish astronomer Hugo von Zeipel, and in 1962 by the Japanese scientist Yoshida Kozai. Currently, the corresponding phenomenon is commonly called the von Zeipel–Lidov–Kozai effect. Its manifestations are found in a wide range of problems: from the motion of artificial and natural satellites of planets to the dynamics of stellar systems and the evolution of compact astrophysical objects.

Another major area of Lidov's research was the theory of guaranteed estimation. In 1964, his pioneering paper appeared, in which he studied the problem of determining the parameters of a system without using probabilistic assumptions about measurement errors. It was assumed only that the absolute values of the errors did not exceed specified bounds. Lidov showed that finding a guaranteed estimate, valid for all admissible error realizations, could be reduced to a linear programming problem.

M. L. Lidov also developed methods for estimating motion in the presence of unmodeled accelerations. Such problems were interpreted as differential games, in which the estimation algorithm opposes the most unfavorable admissible perturbation. The theoretical results were developed into computational algorithms and applied to specific problems of spacecraft navigation and control.

A significant part of Lidov's research in the 1970s–1980s concerned the dynamics of telecommunication satellites. Together with A. A. Soloviev, he established important regularities in the orbital evolution of Molniya satellites, which provided television broadcasting to Siberia and the Far East.

Together with M. A. Vashkovyak and A. P. Markeev, M. L. Lidov studied the motion of spacecraft in the vicinity of the unstable libration points of the Earth–Moon system. The possibility of placing a relay satellite in such a region to provide communication with a lander on the far side of the Moon was considered. The practical effectiveness of such a scheme was confirmed decades later.

In the last years of his life, Lidov worked on a scheme for a fly-by of several asteroids during a single mission, analyzed the use of the Moon’s gravitational field to insert a spacecraft into a halo orbit in the Sun–Earth system, and studied quasi-satellite orbits.

Conclusion

Lidov’s scientific achievements received high recognition. In addition to the Lenin Prize, he was awarded the Order of the Red Banner of Labour. His PhD dissertation, prepared in 1964, was recognized as a work deserving the degree of Doctor of Physical and Mathematical Sciences.

The scientific legacy of Lidov combines fundamental studies in celestial mechanics with the solution of specific problems arising in space missions. His methods for investigating orbital evolution, guaranteed estimation, and trajectory correction retain both scientific and practical significance. His name is preserved in the von Zeipel-Lidov-Kozai effect and was also assigned to asteroid (4236) Lidov.

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