Chaplygin, Sergei Alekseevich | Encyclopedia.com

(*b*. Ranenburg [now Chaplygin], Russia, 5 April 1869; *d*. Moscow, U. S. S.R., 8 October 1942),

mechanics, engineering, mathematics.

Chaplygin was born into the family of a shop assistant. His father, Aleksei Timofeevich Chaplygin, died suddenly of cholera in 1871, when his son was two. In 1886 Chaplygin graduated from the Voronezh Gymnasium and immediately enrolled at Moscow University, from which he graduated with a brilliant record in 1890; at the request of N. E. Zhukovsky he was retained there to prepare for a teaching career. He became an assistant professor at Moscow University in 1894. From 1896 until 1906 he taught mechanics at Moscow Technical College and from 1901 was professor of mechanics al Moscow Women's College, which he headed from 1905 until 1918.

Chaplygin's first scientific papers, which were written under Zhukovsky's influence, were devoted to hydromechanics. In 1893 he wrote a long article, "O nekotorykh sluchayakh dvizhenia tverdogo tela v zhidkosti" ("On Certain Cases of Movement of a Solid Body in a Liquid"), which was awarded the Brashman Prize. In 1897 there appeared a second article with the same title; this was his master's dissertation. In these papers Chaplygin gave a geometric interpretation of those cases of the movement of a body in a liquid that had earlier been studied from a purely analytic standpoint by the German scientists Clebsch and Kirchhoff, as well as by the Russian scientist Steklov. In this regard Zhukovsky has written that Chaplygin "demonstrated in his two excellent papers what strength the cleverly conceived geometrical methods of investigation can possess."

Even at the beginning of his scientific career Chaplygin devoted much attention to the development of the general methods of classical mechanics. A whole series of his papers, which appeared at the turn of the century, has among its topics the problem of a body's motion in the presence of nonintegrable relationships and the motion of a solid body around a fixed point. In the article of 1897, "O dvizhenii tverdogo tela vrashchenia na gorizontalnoy ploskosti" ("On the Motion of a Solid Body of Revolution in a Horizontal Plane"), general equations for the motion of nonholonomic systems were first obtained; these equations are a generalization of the Lagrangian equation. The Petersburg Academy of Sciences awarded Chaplygin a gold medal in 1899 for his investigations of the movement of a solid body.

Among Chaplygin's papers a special place is occupied by his investigation of the mechanics of liquids and gases. Even in the 1890's he had shown a great interest in the study of jet streams. At that time jet flow theory was the basis for study of the laws of motion of bodies in a fluid. In 1899 Chaplygin, using Zhukovsky's investigations as a base, solved somewhat differently the problem of a stream of incompressible fluid passing around a plate ("K voprosu o struyakh v neszhimaemoy zhidkosti" ["To the Problem of Currents in an Incompressible Fluid"]). The problem of gas passing around bodies was especially interesting to him.

In the nineteenth century Russian scientists as well as others had published a number of papers on the theory of a high-speed stream of gas. For example, in 1839 St. Venant had investigated the phenomenon of the escape of gas through an opening at a great rate of flow. In 1858 N. V. Maievsky established the influence of the compressibility of air on the resistance to the motion of a shell for a flight velocity close to the speed of sound.

In 1902 Chaplygin published his famous paper "O gazovykh struyakh" ("On Gas Streams"), in which he developed a method permitting the solution, in many cases, of the problem of the noncontinuous flow of a compressible gas. With this paper he opened the field of high-velocity aeromechanics. The method devised by Chaplygin made it possible to solve the problem of the flow of a gas stream if, under the limiting conditions, the solution to the corresponding problem of an incompressible liquid is known. The equations derived by Chaplygin for the motion of a compressible fluid are valid for the case in which the velocity of the current never exceeds the speed of sound. He applied this theory to the solution of two problems concerning the stream flow of a compressible fluid: escape from a vessel and flow around a plate that is perpendicular to the direction of flow at infinity.

Chaplygin found precise solutions to the problems he examined; they are still the only instances of precise solutions to problems in gas dynamics. He compared the results of his theoretical investigations on the escape of a gas and on the flow around a plate with experimental data and obtained qualitative confirmation of his theory.

Chaplygin also developed a method of approximation for the solution of problems in gas dynamics that was noteworthy for its simplicity; however, it is possible to apply this method only when the velocity of the gas flow does not exceed approximately half the speed of sound.

"O gazovykh struyakh" was Chaplygin's doctoral dissertation. At the time it did not receive wide recognition, partly because at the velocities then obtaining in aviation there was no need to consider the influence of the compressibility of air; on the other hand, in artillery great interest was centered on investigations at velocities greater than the speed of sound.

The significance of this paper for solving problems in aviation came to light at the beginning of the 1930's when it became necessary to create a new science about the motion of bodies at velocities equal to and greater than the speed of sound, and for the flow patterns past them. The bases of this new science, gas dynamics, had been laid down by Chaplygin, who thus was more than thirty years ahead of the necessary technology.

In 1910 Chaplygin began his important investigations into the theory of the wing. That February he reported to the Moscow Mathematical Society on the aerodynamic forces acting on an airplane wing. He stated the results of these investigations in his paper "O davlenii plosko-parallelnogo potoka na pregrazhdayushchie tela (k teorii aeropaana)" ("On the Pressure Exerted by a Plane-parallel Stream on an Impeding Body [Toward a Theory of the Airplane]"), which was published that same year. The postulate concerning the determination of the rate of circulation around a wing was first precisely stated in this paper. This postulate—the so-called Chaplygin-Zhukovsky postulate—gives a complete solution to the problem of the forces exerted by a stream on a body passing through it. This article includes the fundamentals of plane aerodynamics, particularly Chaplygin's celebrated formulas for calculating the pressures exerted by the stream of a fluid on an impeding body. These formulas were applied by Chaplygin to the calculation of the stream pressure on various wing profiles for which he gives the construction.

In "O davlenii plosko-parallelnogo…" Chaplygin obtained a number of other remarkable results. He was the first to study thoroughly the question of the longitudinal moment acting on a wing, considering this question an essential element of the theory of the wing. On the basis of a study of the general formula for the moment of the lifting force he established a simple relationship between the longitudinal moment and the angle of attack; this relationship was not obtained experimentally until several years later and subsequently proved to be one of the fundamental aerodynamic characteristics of a wing.

After the October Revolution, Chaplygin immediately sided with the Soviet government and, with Zhukovsky, actively participated in the organization (1918) of the Central Aerohydrodynamic Institute; after the death of his friend and teacher, Chaplygin became the director of this prominent scientific center. In 1924 he was elected a corresponding member, and in 1929 a full member, of the Academy of Sciences of the U. S. S.R. In 1929 the title Honored Scientist of the R. S. F.S.R. was conferred on him. His scientific, technological, and organizational services were recognized in 1941, when he was awarded the title Hero of Socialist Labor.

Chaplygin's subsequent scientific papers were devoted to the development of aerohydrodynamics. His fundamental investigations of wing cross sections, wing profiles, a wing's irregular motion, and the theory of structural framework had great significance for the development of aerodynamics throughout the world.

Chaplygin's works also enriched mathematics: his studies of methods of approximation for solving differential equations are achievements of mathematical thought.

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