Sergey Alexeyevich Chaplygin

This issue of *Theoretical and Applied Mechanics* is devoted to the 150^{th} anniversary of the birth of the distinguished scientist, Sergey Alexeyevich Chaplygin (April 5, 1869, Ranenburg – October 8, 1942, Novosibirsk).

We briefly review the biography of the preeminent mathematician, mechanist and mechanical engineer, and an outstanding administrator of research, technological production, and higher education. One can find more details in [1–6].

Chaplygin's father, Aleksei Timofeevich died when the future scientist was only two years of age. The family lived afterwards in very poor conditions. Sergey Alexeyevich's mother Anna Petrovna remarried and they moved to Voronezh. Because of his extraordinary academic potential, the tuitions for Chaplygin's education were waived. In order to improve his mother's financial situation, Chaplygin started tutoring at the age of 14. He graduated from the Gymnasium in 1886 with a gold medal and started studies of mathematics at the Moscow University in the same year. In the first two years he was focused on mathematics only, but under the influence of Nikolai Egorovich Zhukovsky, he shifted towards mechanics. After graduation in 1890, he continued to work with Zhukovsky on the mechanics of liquids and gases. In 1893 Chaplygin published "*On certain cases of the motion of a solid body in a fluid*". In 1897 he submitted his Magisterium of Science thesis under the same title as his 1893 paper. Zhukovsky indicated that Chaplygin "*demonstrated in his two excellent papers what strength the cleverly conceived geometrical methods of investigation can possess*".

Chaplygin lectured from 1894 at the Moscow University as an assistant professor, being promoted to professor in 1903. From 1901 he was also professor of mechanics at Moscow Women's College. He was the director of the Advanced Course for Women from 1905 to 1918 when the Advanced Course became the Second Moscow State University. He was rector of this university for one year 1918–19 until the two universities were merged into a unified Moscow University.

Along with his work on fluid and gas dynamics, Chaplygin worked on two fundamental problems of theoretical mechanics: the motion of a rigid body subjected to nonholonomic constraints and the study of the motion of a heavy body about a fixed point. Chaplygin's paper "*On the motion of a heavy body of revolution in a horizontal plane*" from 1897 inaugurated the general equation of motion of a nonholonomic system. In the same year he published the paper "*On a certain possible generalization of the theorem of areas with an application to the problem of rolling balls*". Chaplygin was awarded the Gold Medal of the St Petersburg Academy of Sciences in 1899 "*... for his studies of the theory of the motion of a body in a fluid and the motion of bodies with nonintegrable constraints*".

In 1902 Chaplygin presented "*A new particular solution to the problem of motion of a rigid body in a fluid*". In the same year, Chaplygin published a seminal work "*On gas streams*". It was his doctoral dissertation. It paved the way for aeromechanics of high velocities and was pioneering and appeared several decades ahead of the technological development. It reached the level needed to benefit from these deep theoretical results of

Chaplygin only in the 1930's. Keldysh said: "*... it gave a method of studying jet flows of a gas at any subsonic speed. At that time the investigation of gas flows at speeds near the speed of sound had no practical application in aviation. Three decades later, however, Chaplygin's dissertation served as a starting point for many studies by aerodynamics specialists and provided the basis for the solution to problems of subsonic flows*".

In 1910 he studied the theory of the aeroplane wing and published the paper "*On the pressure exerted by a plane-parallel flow on an obstructing body*". Khristianovich described: "*The most notable feature of this study is the statement that if the wing profile has a rounded leading edge and a sharp trailing edge then as it moves uniformly in a fluid, a circulatory flow is established with continuously shedding flow at the sharp trailing edge. In this case a lift proportional to the angle of attack develops. The Chaplygin–Zhukovsky postulate solves the problem of the forces exerted by a stream on a body passing through it. The formulated fundamentals of plane aerodynamics included Chaplygin's formulas for the pressures exerted by the stream of a fluid on an impeding body and applied by Chaplygin in his constructions of various wing profiles*".

In 1911 together with a significant group of professors Chaplygin resigned in protest against the action that was being taken against the university and its professors. The Moscow Mathematical Society, with Zhukovsky as the president, kept together the mathematicians after they had left the university. Chaplygin presented results on mechanics and approximate methods for solving differential equations in the Society.

Chaplygin's 1914 paper "*Theory of cascaded airfoils*" founded the theory of circulation round cascades, used in the design of various hydraulic devices.

In 1919 Chaplygin established his fundamental method of solving differential equations approximatively: "*Foundations of a new method for approximative integration of differential equations*".

Zhukovsky, assisted by Chaplygin, planned an aeronautical research center in Moscow, which was opened in 1918 as the Central Aerohydrodynamic Institute (TsAGI). Upon the death of Zhukovsky in 1921, Chaplygin became Chairman of the Board, then Executive Director of the Institute from 1928 to 1931, after that becoming Head of the scientific work of the Institute.

Chaplygin received many awards and recognitions: he was elected a corresponding member of the Russian Academy of Sciences in 1924. He was awarded the Zhukovsky Prize in 1925. Then, he was elected a full member of the USSR Academy of Sciences (former Russian) in 1929. In the same year he was also awarded the title Honored Scientist. He received two Orders of Lenin, two Orders of the Red Banner of Labour, and was the first scientist awarded the title Hero of Socialist Labour in 1941.

In the fall of 1941, after the attack of Germany on the Soviet Union, the Central Aerohydrodynamic Institute was evacuated from Moscow. Chaplygin was in charge of the Novosibirsk branch of the Institute and promptly built a wind tunnel and research laboratories. Chaplygin died from a brain hemorrhage in October 1942.

Posthumously, in 1942 the USSR Academy of Sciences established the S. A. Chaplygin Prize "*for the best original work in theoretical research in the field of mechanics*". Since 1995, *the Russian Academy of Sciences* has awarded *the Chaplygin Gold Medal every five years, for the exceptional results in theoretical mechanics.* Chaplygin's native town, Ranenburg, was renamed after him in 1948. Among the scientific notions named after Chaplygin, let us mention: Chaplygin gas, Chaplygin's equation, Chaplygin sleigh, Goryachev–Chaplygin's top, Chaplygin method of solving differential equations.

This volume of TAM provides six scientific papers presenting a contemporary view on fields of mechanics which emerged within the rich scientific legacy of S. A. Chaplygin.

References

1. *Академик С. А. Чаплыгин*, Ред.-сост. Г. С. Бюшгенс, М.: Наука, 2010, 286 с, ISBN 978-5-02-036972-6.
2. В. В. Голубев, *Сергей Алексеевич Чаплыгин*, М., 1947, С. 14. Переиздание: В. В. Голубев *Чаплыгин*, М., 2002, С. 11, ISBN 5-93972-152-4.
3. Гумилевский Л. И. Чаплыгин. — М.: Молодая гвардия, 1969, 272 с.
4. М. В. Келдыш, *Сергей Алексеевич Чаплыгин*, 1969.
5. *Сергей Алексеевич Чаплыгин*. 1869–1942. *Биографический очерк*, серия "Замечательные учёные Московского университета", 1951.
6. J. J. O'Connor, E. F. Robertson, *Sergei Alekseevich Chaplygin*, MacTutor History of Mathematics archive, University of St Andrews, Scotland.

Editor-in-Chief
Vladimir Dragović