Friedmann, Aleksandr Aleksandrovich | Encyclopedia.com

(*b*. St. Petersburg, Russia, 29 June 1888; *d*. Leningrad, U. S. S. R., 16 September 1925)

mathematics, physics, mechanics.

Friedmann was born into a musical family—his father, Aleksandr Friedmann, being a composer and his mother, Ludmila Vojáčka, the daughter of the Czech computer Hynek Vojáček.

In 1906 Friedmann graduated from the Gymnasium with the gold medal and immediately enrolled in the mathematics section of the department of physics and mathematics of St. Petersburg University. While still a student, he wrote a number of unpublished scientific papers, one of which, "Issledovanie neopredelennykh uravneny vtoroy stepeni" ("An Investigation of Second-degree Indeterminate Equations," 1909), was awarded a gold medal by the department. After graduation from the university in 1910, Friedmann was retained in the department to prepare for the teaching profession.

At the beginning of 1913, Friedmann began work at the aerological observatory located in Pavlovsk, near St. Petersburg. There he immersed himself in a study of the means of observing the atmosphere. In addition to synoptic and dynamic meteorology, he familiarized himself with the theory of the earth's magnetism and quickly became a prominent specialist in meteorology and related fields.

The year 1914 was marked for Friedmann by two important events: he passed the examinations for the degree of master of pure and applied mathematics at St. Petersburg University and he published in the *Geofizichesky sbornik* an important paper, "O raspredelenii temperatury vozdukha s vysotoyu" ("On the Relationship of Air Temperature to Altitude"). In this paper he examined theoretically the question of the existence of an upper temperature inversion point in the stratosphere.

In the fall of 1914, Friedmann volunteered for service in an aviation detachment, in which he worked, first on the northern front and later on other fronts, to organize aerologic and aeronavigational services. While at the front, Friedmann often participated in military flights as an aircraft observer. In the summer of 1917 he was appointed a section chief in Russia's first factory for the manufacture of measuring instruments used in aviation; he later became director of the factory. Friedmann had to relinquish this post because of the onset of heart disease. From 1918 until 1920, he was professor in the department of theoretical mechanics of Perm University.

In 1920 he returned to Petrograd and worked at the main physics observatory of the Academy of Sciences, first as head of the mathematical department and later, shortly before his death, as director of the observatory.

Friedmann's creative thought penetrated into every area of his knowledge and illuminated it with the brilliance of his disciplined mind and creative imagination. His scientific activity was concentrated in the areas of theoretical meteorology and hydromechanics. Here were manifested his mathematical talent and his unwavering striving for, and ability to attain, the concrete, practical application of solutions to theoretical problems.

Friedmann was one of the founders of dynamic meteorology. To him belong fundamental works in such areas as the theory of atmospheric vortices and vertical air fluxes. He also studied the problems of applying to aeronautics the theory of physical processes that occur in the atmosphere.

Friedmann's most important work in hydromechanics is *Opyt gidromekhaniki szhimaemov zhidkoti* (1922). In this work he gave the fullest theory of vortical motion in a fluid and examined—and in a number of cases solved—the important problem of the possible motions of a compressible fluid under the influence of given forces.

Friedmann made a valuable contribution to Einstein's general theory of relativity. As always, his interest was not limited simply to familiarizing himself with this new field of science but led to his own remarkable investigations. Friedmann's work on the theory of relativity dealt with one of its most difficult questions, the cosmological problem. In his paper "Über die Krümmung des Raumes" (1922), he outlined the fundamental ideas of his cosmology: the supposition concerning the homogeneity of the distribution of matter in space and the consequent homogence of "world" time for which, at any moment in time, the metrics of space will be identical at all points and in all directions. This theory is especially important because it leads

to a sufficiently correct explanation of the fundamental phenomenon known as the "red shift." This solution of the Einstein field equations, obtained from the above propositions, is the model for any homogeneous and isotropic cosmological theory. It is interesting to note that Einstein thought that the cosmological solution to the equations of a field had to be static and had to lead to a closed model of the universe. Friedmann discarded both conditions and arrived at an independent solution. Einstein welcomed Friedmann's results because they showed the dispensability of the ad hoc cosmological term Einstein had been forced to introduce into the basic field equation of general relativity. Friedmann's interest in the theory of relativity was by no means a passing fancy. In the last years of his life, together with V. K. Frederiks, he began work on a multivolume text on modern physics. The first book, *The World as Space and Time, is devoted* to the theory of relativity, knowledge of which Friedmann considered one of the cornerstones of an education in physics.

In addition to his scientific work, Friedmann for several years taught courses in higher mathematics and theoretical mechanics at various colleges in Petrograd (the Polytechnical Institute, the Institute of Ways and Means of Communication, and the Military Naval Academy). He found time to create new and original courses, brilliant in their form and exceedingly varied in their content, which covered approximation and solution of numerical equations, differential geometry and tensor analysis, hydromechanics, applied aerodynamics, and theoretical mechanics. Friedmann's unique course in theoretical mechanics combined mathematical precision and logical continuity with original procedural and physical trends. He is rightfully considered a distinguished representative of a renowned pleiad of Russian students of mechanics to which also belonged such leading figures as Zhukovsky, Chaplygin, Krylov, and Kochin.

Friedmann died of typhoid fever at the age of thirty-seven. In 1931, he was posthumously awarded the Lenin Prize for his outstanding scientific work.

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