

Soviet revolutions

Harold Zirin

Alexander A. Friedmann: The Man Who Made the Universe Expand. By E. A. Tropp, V. Ya. Frenkel and A. D. Chernin. Cambridge University Press: 1993. Pp. 267. £30, \$49.95.

ALTHOUGH 'Friedmannian models' are widely used in cosmology, few people have any idea of the remarkable discoverer of these equations. Alexander Friedmann (1888–1925), the originator of the expanding Universe, was a balloonist, a highly decorated military aviator, an outstanding meteorologist and mathematician, and an administrator of some repute. This biography presents a fascinating picture of an active intellect and a turbulent life. Written for his centenary near the end of the Soviet era, the account is still somewhat Soviet, with the translation by Alexander Dron and Michael Burov following the original faithfully, for better or worse. But the story of this remarkable man is absorbing.

Friedmann came from a family of musicians. His grandfather converted from Judaism to the Russian Orthodox Church under the rigours of military service around 1830. His mother left his father when our hero was 12 months old, and as a result was sentenced to a life of celibacy by the church authorities. His father obtained a divorce in 1897 to marry a ballerina, and Friedmann was brought up by his grandfather. (These scandals are omitted from this book but noted in *A. A. Friedmann: Centenary Volume* edited by M. A. Markov, V. A. Berezin and U. F. Mukhanov (World Scientific, 1988).)

As a student at a gymnasium in St Petersburg, Friedmann excelled. The authors follow his education in exhaustive detail, even with examples of the complex matriculation mathematics problems he had to solve. He entered the University of St Petersburg as a student of academician V. A. Steklov. Despite the turmoil in the aftermath of the 1905 revolution, the 19-year-old Friedmann pursued the study of Bernoulli numbers, prime numbers, congruences and the theory of elementary functions.

Friedmann graduated in 1910 with a gold medal for a study of "second-degree indeterminate equations". He became a close friend of the Dutch physicist Paul Ehrenfest, who, with his Russian wife, then lived in St Petersburg. In 1913, Friedmann joined the aerological observatory in Pavlovsk, part of the Main Physical (later Geophysical) Observatory. This was the beginning of his long career in dynamic meteorology. Although the authors laud him as a representative of

'Soviet science', these achievements predated the Revolution; he was clearly a product of the old regime. Another annoying feature of the book, possibly due to the collaboration of three authors, is a tendency to lurch from one place or activity to another without explanation; in 1913 (p. 63) Friedmann suddenly turns up in Leipzig studying with V. F. K. Bjerknes without any explanation of how he got there.

Friedmann spent most of the First World War in military aviation, especially fighting the Austrians on the Galician front. His role was to make aerological observations, carry out reconnaissance and develop a practical theory of bomb trajectories, which he claims to have introduced successfully by bombing the arsenal of the fortress of Przemyśl. Steklov wrote to tell him that he should quit flying and concentrate on calculations, but he was eager to test his theories. The meteorologist H. Ficker, who fought on the Austrian side, recorded that the bomb dropped by Friedmann was the only Russian one to hit its target in Przemyśl. Friedmann was awarded the George Cross, the highest Russian military decoration. Despatched to Kiev as a teacher of meteorology to aviators, he there produced *A Synopsis of Lectures on Aeronautics*, a short book intended for use in training pilots. He then supervised the construction of a plant for manufacturing aviation instruments in Moscow.

The description of his adventures in the Russian Revolution and subsequent Civil War is confusing, perhaps deliberately so. Friedmann took part in the establishment of a new university in Perm, far to the east of Moscow. The city passed back and forth between the Bolsheviks and the Whites; the supporters of each side withdrew and re-entered accordingly. Friedmann was sympathetic to the Bolsheviks, but returned without trouble to Perm before Kolchak left. It is hard to understand what happened.

After the Revolution, Friedmann returned to the Main Geophysical Observatory and wrote his dissertation on *The Hydrodynamics of a Compressible Fluid*. This important work had great influence on dynamic meteorology in the Soviet Union. Abruptly, we find him occupied with the new world of relativity, with a semipopular book and the first volume of a serious text. His most famous contribution was the paper "On the curvature of space" published in the *Zeitschrift für Physik* in 1922, which was at that time one of the main forums for relativity papers. Here he derived an exact solution for \dot{R} , the time derivative of the radius of curvature of the Universe. He showed that the Einstein and de Sitter worlds were particular static cases, and if R varied, it must increase. Friedmann demonstrated that R depended on density, so for a critical

density, a closed Universe exists; and he estimated that for a mass of 5×10^{21} Suns and $\Lambda = 0$ (the famous Einstein "cosmological constant") the age of the Universe is 10^{10} years, not a bad estimate for 1922! Einstein soon objected to the concept of a nonstationary world, writing in the journal that the solution did not satisfy the field equations. Friedmann immediately responded with a letter and sent documents to Berlin with Yu. A. Krutkov, who met Einstein in Leiden and convinced him; Einstein withdrew his criticism in *Zeitschrift für Physik* in May 1923. The retraction won Friedmann instant fame in the Soviet Union as "the man who had proved Einstein wrong".

The fame of the Friedmann equation was established by its rediscovery by A. G. E. Lemaitre and the discovery of Hubble's law. Friedmann became the director of the Main Geophysical Institute and devoted himself to teaching and reorganizing meteorology in the Soviet Union. He also set the national height record with a balloon ascent to 7,400 metres. In 1923, he followed family tradition by abandoning his first wife for a younger woman. This proved his undoing, for the new couple had a religious marriage ceremony in 1925 in the Crimea; on his way back he caught typhoid fever and his illustrious career ended at the age of 37.

This book is full of interesting information, but it is disjointed. We never get to know Friedmann, who remains an icon. The authors present a lot of detail on relativity, but little on the problems of Communism, although it is pointed out that none of those who followed Friedmann in relativity survived the purges of 1937 (except his student G. Gamow, who fled from the Soviet Union). But the book ends on a triumphant note, with the resurgence of Friedmann's field in the Soviet Union, under the leadership of Ya. B. Zeldovich. □

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