

Biographical Encyclopedia of Astronomers

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Kaluza, Theodor Franz Eduard

Born Ratibor (Racibórz, Poland), 9 November 1885

Died Göttingen, (Germany), 19 January 1954

German mathematician Theodor Kaluza, together with Oskar Klein, gave his name to the Kaluza-Klein theories of physics in which spacetime has five dimensions rather than the four of Albert Einstein's equations of general relativity. Kaluza studied at Königsberg (now Kaliningrad, Russia), receiving a doctorate in 1910 for a thesis on a mathematical topic called Tschirnhaus transformations. He remained at Königsberg as a *Privatdozent* (lecturer) for nearly 20 years (a very long period in this low-level position) until, at the urging of Einstein, the University of Kiel appointed him to a minor professorship. Kaluza finally became a full professor at the University of Göttingen in 1935, dying very shortly before he would have retired

The idea for which Kaluza was remembered appeared in a 1919 letter to Einstein, in which he suggested writing the field equations of general relativity in five dimensions. The new equations contained within them Einstein's original four-dimensional theory plus a new piece that turned out to be exactly James Maxwell's theory of light (electromagnetism). The fifth dimension was in the shape of a cylinder, assumed by Kaluza to be of macroscopic size. Two years later, Einstein submitted the paper for publication. It was widely thought to be too mathematical to have any connection with the real world. In 1926, Klein heard of Kaluza's work from Wolfgang Pauli and, while describing it as a shipwreck, really made only one major change. The cylindrical fifth dimension was curled up into a ball the size of the Planck length, 10^{-33} cm, making it undetectable. But this meant that it did not violate any experiments. The outcome of this work was a new branch of field theory known as the Kaluza-Klein theory. The Kaluza-Klein theory held some interest in theoretical physics for a few years, but by the 1930s the theory was dead, at least temporarily. A renaissance occurred in the early 1980s when many physicists realized the power of multidimensional analysis. What they did was extend the Kaluza-Klein theory to N dimensions, allowing them to add symmetry to hyperspace. When these N dimensions were curled up like the fifth dimension in the Kaluza-Klein theory, the celebrated Yang-Mills field of the Standard Model of particle physics popped out of the equations! This marked the beginning of the very active fields of superstring theory and supergravity. Thus, Kaluza's legacy lives on today in these theories as well as in the Kaluza-Klein theory itself. A version with $N = 11$ became quite popular near the turn of the century. The lowest-mass Kaluza-Klein particle is a possible dark matter candidate.

Ian T. Durham

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