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(*b*. Lugau, near Chermnitz [now Karl-Marx-Stadt], Germany, 26 December 1861; *d*. Giessen, Germany, 29 September 1941)

mathematics.

The son of a Lutheran pastor, Engel attended the Gymnasium at Greiz from 1872 to 1879, studied mathematics in Leipzig and Berlin from 1879 to 1883, and received his doctorate in Leipzig in 1883 under Adolph Mayer. In 1884 and 1885 he studied with Sophus Lie in Christiania (now Oslo). In 1885 Engel qualified as a lecturer in pure mathematics at Leipzig and became an assistant professor there in 1889 and an associate professor in 1899. In 1904 he succeeded his friend Eduard Study as full professor at Greifswald, and in 1913 he went in the same capacity to Giessen, where, after his retirement in 1931, he continued to work until his death.

Although Engel was himself an important and productive mathematician he has found his place in the history of mathematics mainly because he was the closest student and the indispensable assistant of a greater figure: Sophus Lie, after N. H. Abel the greatest Norwegian mathematician. Lie was not capable of giving to the ideas that flowed inexhaustibly from his geometrical intuition the overall coherence and precise analytical form they needed in order to become accessible to the mathematical world. It was no less a mathematician than Felix Klein who recognized that the twenty-two-year-old Engel was the right man to assist Lie and who sent him to Christiania.

Shortly after Engel's return to Leipzig in 1886, Lie succeeded Klein there, and the fruitful collaboration was continued. The result was the *Theorie der Transformationsgruppen*, which appeared from 1888 to 1893 in three volumes "prepared by S. Lie with the cooperation of F. Engel."

Engel performed two further services for the great man long after the latter's death in 1899. In 1932 there appeared Engel's lectures *Die Liesche Theorie der partiellen Differentialgleichungen: Erster Ordnung*, prepared for publication by Karl Faber. For Lie the transformation groups had only been an important aid in handling differential equations; however, he never succeeded in composing a work on his theory of these differential equations. In Faber the seventy-year-old Engel had found the right person to help him in completing this work of his teacher.

Between 1922 and 1937, Engel published six volumes and prepared the seventh of the seven-volume edition of Lie's collected papers, an exceptional service to mathematics in particular and scholarship in general. Lie's peculiar nature made it necessary for his works to be elucidated by one who knew them intimately, and thus Engel's *Anmerkungen* ("Annotations") competed in scope with the text itself. The seventh volume finally appeared in 1960.

Engel's numerous independent works also are concerned primarily with topics in the fields of continuous groups and of partial differential equations: contact transformations (in his dissertation, before his meeting with Lie), Pfaffian equations, Lie's element sets and higher differential quotients, and many others. Lie's ideas were also applied to the n-body problem in mechanics (the ten general integrals).

Engel also edited the collected works of Hermann Grassmann, thus bringing posthumous fame to this great mathematician. In addition, with his friend P. Stäckel, Engel investigated the history of [non-Euclidean geometry](#); along with this study he translated the essential works of N. I. Lobachevsky from Russian into German, their first appearance in a Western language.

Engel was a member of the Saxon, Russian, Norwegian, and Prussian academies. He received the Lobachevsky Gold Medal and the Norwegian Order of St. Olaf and was an honorary doctor of the University of Oslo. In 1899 he married Lina Ibbeken, the daughter of a Lutheran pastor. Their only child died very young.

BIBLIOGRAPHY

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H. Boerner