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(*b*. Hamburg, Germany, 19 August 1739; *d*. Halle, Germany, 4 August 1812)

mathematics, physics.

Klügel was the first son of a businessman and received a solid mathematical education at the Hamburg Gymnasium Academicum, which he attended after completing the local Johanneum. In 1760 he entered the University of Göttingen to study theology; but he soon came under the influence of A. G. Kaestner, who interested him in mathematics and induced him to devote himself exclusively to that science. At Kaestner's suggestion Klügel took as the subject of his thesis, which he defended on 20 August 1763 (*Conatuum praecipuorum theoriam parallelarum demonstrandi recensio*), a critical analysis of the experiments made thus far to prove the parallel postulate. His criticism of the errors provided a new incentive to investigate this problem. (For instance, Lambert, one of the outstanding forerunners of non-Euclidean geometry, expressly referred to Klügel, who is also cited by most later critics of the problem of parallel lines.)

After five years at Göttingen, Klügel went in 1765 to Hannover, where he edited the scientific contributions to the *Intelligenzblatt*; two years later he was appointed professor of mathematics at Helmstedt. His extensive work in mathematics and physics began then and increased after his transfer to the chair of mathematics and physics at the University of Halle. His work included papers, textbooks, and handbooks on various branches of mathematics.

Despite the generally encyclopedic character of his works, in some respects Klügel put forward new ideas. His most important contribution was in trigonometry. His *Analytische Trigonometrie* analytically unified the hitherto separate trigonometric formulas and introduced the concept of trigonometric function, which in a coherent manner defines the relations of the sides in a right triangle. He showed that the theorems on the sum ofthe sines and cosines already "contain all the theorems on the composition of angles" and extended the validity of six basic formulas for a right spherical triangle. Not even Euler, who returned to the problem of extending Euclid's trigonometry nine years after Klügel, was able to achieve Klügel's results in certain respects. Klügel's trigonometry was very modern for its time and was exceptional among the contemporary textbooks. Other work in advance of its time concerned stereographic projection, where the properties of this transformation of a spherical surface onto a plane were geometrically derived and the ideas were also applied to spherical trigonometry and gnomonics.

In 1795 in the small publication *über die Lehre von den entgegengesetzten Grössen* Klügel dealt with questions of formal algebra and tried to define formal algebraic laws. His most popular and useful work was his mathematical dictionary. *Mathematisches Wörterbuch oder ErKlärung der Begriffe, Lehrsätze, Aufgaben und Methoden der Mathematik*, to which three volumes by Mollweide and Grunert were added in 1823-1836l; it was used throughout much of the nineteenth century.

While at Halle, Klügel was elected member of the Berlin Academy on 27 January 1803. In 1808 he became seriously ill, and he died four year later.

BIBLIOGRAPHY

I. Original Works. A complete list of Klügel's works can be found in *Hamburger Schriftstellerlexikon* (see below). They include *Conatuum praecipuorum theoriam parallelarum demonstrandi recensio …* (Göttingen, 1763); *Analytische Trigonometrie* (Brunswick, 1770); *Von den besten Einrichtung der Feuerspritzen* (Berlin, 1774); *Geschichte und gegenwärtiger Zustand der Optik mach der Englischen Priestleys bearbeitet* (Leipzig, 1776); *Analytische Dioptrik*, 2 vols. (Leipzig, 1778); *Enzyklopädie oder zusammenhängender Vortrag der gemeinnützigsten Kenntnisse*, 3 pts. (Berlin-Strettin, 1782-1784, 2nd ed. in 7 pts., 1792-1817); "Über die Lehre von den entgegengesetzten Grössen", in Hindenburg's *Archiv der reinen und angewandten Mathematik*, **3** (1795); and *Mathematisches Wörterbuch oder Erklärung der Begriffe, Lehrsätze, Aufgaben und Methoden der Mathematik*, **3** vols. (Leipzig, 1803-1808).

II. Secondary Literature. On Klügel or his work, see M. Cantor, *Vorlesungen über Geschichte der Mathematik*, IV (Leipzig, 1908), especially pp. 27, 88, 389, 406, 412ff., 424ff., 616, which evaluates Klügel's mathematical work; *Lexikon der hamburgischen Schriftsteller …* IV (Hamburg, 1858), 65-73, which includes a complete list of Klügel's writings; and A. H. Niemeyer, obituary, in *Hallisches patriotisches Wochenblatt* (5 September 1812), 561-569.

Jaroslav Folta