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(*b.* Sorau, Germany [now Zary, Poland], 29 January 1810; *d.* Berlin, Germany, 14 May 1893)

*mathematics.*

After the early death in 1813 of Kumer's father, the physician Carl Gotthelf Kummer, Ernst and his older brother Karl were brought up by their mother the former Friederike Sophie Rothe. Following private instruction Kummer entered the Gymnasium in Sorau in 1819 and the University of Halle in 1828. He soon gave up his original study, Protestant theology, under the influence of the mathematics professor Heinrich Ferdinand Scherk and applied himself to mathematics, which he considered a kind of "prparatory science" for philosophy. (Kummer maintained a strong bent for philosophy through his life.) In 1831 he received a prize for his essay on the question posed by Scherk: "De consinuum et sinuum potestatibus secundum cosinus et sinus arcuium multiplicium evolvendis."

In the same year Kummer passed the examination for Gymnasium teaching and on 10 September 1831 was granted a doctorate fro his prize essay. After a year of probation at the Gymnasium in Sorau he taught from 1832 until 1842 at the Gymnasium in Liegnitz (now Legnica, Poland), mainly mathematics and physics. His students during this period included [Leopold Kronecker](#) and Ferdinand Joachimsthal, both of whom became interested in mathematics through Kummer's encouragement and stimulation, Kummer inspired his students to carry out independent scientific work, and his outstanding teaching talent soon became apparent. Later, together with his research work, it established the basis of his fame His Period of Gymnasium teaching coincided with his creative period in function theory, which began with the above-mentioned prize work. Its most important fruit was the paper on the hypergeometric series.<sup>1</sup> While doing his military service Kummer sent this paper to Jacobi. This led to his scientific connection with the latter and with Dirichlet, as well as to a corresponding membership through Dirichlet's proposal, in the Berlin Academy of Sciences in 1839. After Kummer has thus earned a name for himself in the mathematical world, Jacobi sought to obtain a university professorship for him, in which endeavor he was supported by [Alexander von Humboldt](#).

In 1840 Kummer married Otilie Mendessohn, cousin of Dirichlet's wife. On the recommendation of Dirichlet and Jacobi, he was appointed full professor the University of Breslau (now Wrocław, Poland) in 1842. In this position, which he held until 1855, he further developed his teaching abilities and was responsible for all mathematical lectures, beginning with the elementary introduction. During this period an honorary doctorate was bestowed on Ferdinand Gotthold Eisenstein; it had been by Jacobi (probably on Humboldt's suggestion) and was carried out by Kummer despite considerable opposition. The second period of Kummer's research began about the time of his move to Breslau; it was dominated especially by [number theory](#) and lasted approximately especially by [number theory](#) and lasted approximately twenty years. Not long after the death of his first wife in 1848, Kummer married Bertha Cauer.

When Dirichlet left Berlin in 1855 to succeed Gauss at Göttingen, he proposed Kummer as first choice for his Berlin professorship and Kummer was appointed. Kumer arranged for his former student Joachimsthal to become his successor at Breslau and hindered the chances of success for Weierstrass' application for the Breslau position, for he wanted the latter to be at the University of Berlin. This plan succeeded; Weierstrass was called to Berlin in 1856 as assistant professor. When Kronecker, with whom Kummer carried on an exchange of scientific view, also moved to Berlin in 1855, that city began to experience a new flowering of mathematics.

In 1861 Germany's first seminar in pure mathematics was established at Berlin on the recommendation of Kummer and Weierstrass; it soon attracted gifted young mathematicians from throughout the world, including many graduate students. It is permissible to suppose that in founding the seminar Kummer was guided by his experiences in Halle as a student in Scherk's Mathematischer Verein. Kummer's Berlin lectures, always carefully prepared, covered [analytic geometry](#), mechanics, the theory of surfaces, and number theory. The clarity and vividness of his presentation brought him great numbers of students—as many as 250 were counted at his lectures. While Weierstrass and Kronecker offered the most recent results of their research in their lectures, Kummer in his restricted himself, after instituting the seminar, to laying firm foundations. In the seminar, on the other hand, he discussed his own research in order to encourage the participant to undertake independent investigations.

Kummer succeeded Dirichlet as mathematics teacher at the Kriegsschule. What would have been for most a heavy burden was pleasure for Kummer, who has a marked inclination to every form of teaching activity. He did not withdraw from this additional post until 1874. From 1863 to 1878 he was perpetual secretary of the physics—mathematics section of the Berlin Academy, of which—on Dirichlet's recommendation—he had been a full member since 1855. He was also dean (1857–1858 and 1865–1866) and rector (1868–1869) of the University of Berlin. Kummer did not require leisure for creative achievements but was able to regenerate his powers through additional work.

In his third period, devoted to geometry. Kummer applied himself with unbroken productivity to ray systems and also considered ballistic problems. He retired at his own request in 1883 and was succeeded by Lazarus Fuchs, who had received his doctorate under him in 1858. Kummer spent the last years of his life in quiet retirement; his second wife and nine children survived him.

Kummer was first *Gutachter* for thirty—nine dissertations at Berlin. Of his doctoral students seventeen later became university teachers, several of them famous mathematicians: Paly du Bois—Reymondn, Paul Gordan, Paul Bachamam, H. A. Schwarz (his son—in—law), Georg Canto, and Arthur schoenfiles Kummer was also second *Gutacheter* for thirty dissertations at Berlin. In addition he was first referee when Alfred Clebsch, E. B. Christoffel, and L. Fuchs qualified for lectureships; and he acted as second referee at four other qualifying examinations. Kummer's popularity as a professor was based not only on the clarity of his lectures but on his charm and sense of humor as well. Moreover, he was concerned for the well—being of his students and willingly aided them when material difficulties arose; hence their devotion sometimes approached enthusiasm.

On Kummer's nomination Kronecker became a member of the Berlin Academy and Louis Poinso, George Salmon, and Ludwig von Sedel became corresponding members. He himself became a correspondent of the Paris Academy of Sciences in 1860 and a foreign associate in 1868. This Academy has already awarded him its Grand prix des Sciences Mathématiques in 1857 for his "Theories der idealen Primfaktoren." Of his memberships in scientific societies, that in the [Royal Society](#) as foreign member (1863) should be mentioned.

Kummer's official records reflect his characteristic strict objectivity, hardheaded straightforwardness, and conservative attitude. This is seen in keeping that during the revolutionary events of 1848, in which almost every important German mathematician except Gauss took an active role, Kummer was in the right wing of the movement, while Jacobi, for example belonged to the professional left. Kummer advocated a constitutional monarchy, not a republic. When on the other hand, Jacobi, with his penchant for slight overstatement, declared that the glory of science consists in its having no use, Kummer agreed. He too considered the goal of mathematical research as the enrichment of knowledge without regard to applications; he believed that mathematics could attain the highest development only if it were pursued as an end in itself, independent of the external reality of nature. It is in this context that his rejection of multidimensional geometries should be mentioned.

Kummer's greatness and his limits lay in a certain self—restraint, manifested—among other ways—in his never publishing a textbook, but only articles and lectures. Weierstrass was led to state that, to some extent in his arithmetical period and more fully later Kummer no longer concerned himself with

.. what was happening in mathematics. If you say to him, Euclidean geometry is based on an unproved axiom, he grants you this; but proceeding from this insight, the question now is phrased: How then does geometry look without this axiom? That goes against his nature; the efforts directed towards this question and the consequent general considerations, which free themselves from the empirically given or the presupposed are to him idle speculations or simply a monstrosity.<sup>2</sup>

To be sure, the time at which this criticism was made must be considered; after Kummer, Kronecker, and Weierstrass had worked for twenty years in friendly, harmonious agreement and close scientific contact, an estrangement between Weierstrass and Kronecker took place in the mid—1870's which led to an almost complete break. Kummer's continuing friendship with Kronecker was not without its repercussions on Weierstrass' attitude towards Kummer. If, therefore Weierstrass' evaluation of Kummer is to be taken with a grain of salt, it is nevertheless essentially correct.

Kummer's sudden decision to retire was another example of his inflexible principles. On 23 February 1882 he surprised the faculty by declaring that he had noticed a weakening of his memory and of the requisite ability to develop his thought freely in logical, coherent, and abstract arguments. On these grounds he requested retirement. No one else had detected such impairments, but Kummer could not be dissuaded and compelled the faculty to arrange for a successor.

Gauss and Dirichlet exerted the most lasting influence on Kummer. Each of Kummer's three creative periods began with paper directly concerning Gauss, and his reverence of Dirichlet was movingly expressed in a commemorative speech on 5 July 1860 to the Berlin Academy.<sup>3</sup> Although he never attended a lecture by Dirichlet, he considered the latter to have been his real teacher. Kummer in turn had the strongest influence on Kronecker, who thanked him in a letter of 9 September 1881 for "my mathematical, indeed altogether the most essential portion of my intellectual life."

Today, Kummer's name is associated primarily with three achievements, one from each of his creative periods. From the function—theory period date his investigations, surpassing those of Gauss, of hypergeometric series, in which, in particular, he was the first to compute the substitutions of the monodromic groups of these series. The arithmetical period witnessed the introduction of "ideal numbers" in an attempt to demonstrate through multiplicative treatment the so—called great theorem of Fermat. After Dirichlet had pointed out to Kummer that the unambiguous prime factorization into number fields did not seem to have general validity, and after he had convinced himself of this fact between 1845 and 1847 he formulated his theory of ideal prime factors.<sup>4</sup> It permitted unambiguous decomposition into generally number fields and with its help Kummer was able to demonstrate Fermat's theorem in a number of cases.<sup>5</sup> It is again characteristic that Kummer elaborated his theory only to the extent required by those problems which interested him—the proof of Fermat's theorem and of the general law of reciprocity. Kummer's works were developed in the investigations of Richard Dedekind and Kronecker, thus contributing significantly to the arithmetization of mathematics.

The third result dates from Kummer's geometric period, in which he devoted himself principally to the theory of general ray systems, following [Sir William Rowan Hamilton](#) but treating them purely algebraically: the discovery of the fourth—order surface, named for Kummer, with sixteen isolated conical double points and sixteen singular tangent planes.<sup>6</sup> The number of other concepts connected with Kummer's name indicates that he was one of the creative pioneers of nineteenth—century mathematics.

## NOTES

1. "Über die bypergeometrische Reihe ...." In *Journal für die reine und angewandte Mathematick*, **15** (1836), 39–83, 127–172.
2. Göa Mittagè—Leffler, "Une page de la vie de Weierstrass," in *Comptes rendus du 2<sup>e</sup> Congrès international de mathématiciens* (Paris, 1902), pp. 131–153, see pp. 148–149, letter to Sonya Kovalevskysy, 27 Aug. 1883.
3. "Gedächtnisrede auf G.P.L. Dirichlet," in *Abhandlungen der K. Preussischen Akademie der Wissenschaften* (1860), 1–36.
4. See "über die Zerlegung der aus Wurzeln der Einheit gebildeten complexen zahlen in ihre Primfactoren," in *Journal für die reine und angewandte MatheMatik*, **35** (1847), 327–367.
5. "Beweis des Fermatschen Satzes der Unmöglichkeit von  $x^\lambda - y^\lambda = z^\lambda$  für eine unendliche Anzahl Primzahlen  $\lambda$ ;" in *Monatsberichete der K. Prussischen Akademie der Wissenschaften* (1847), 132–141, 305–319.
6. "Über die Flächen vierten Grades, auf welchen Schaaren von Kegelschnitten liegen," *ibid.* (1863), 324–338; "Über die Flächen Vierten Grades mit sechzehn singulären Punkten" *ibid.* (1864), 246–260;" "Über die strahlensysteme, dern Brennfächen Flächen vierten Grades mits sechzehn singularären punkten sind," *ibid.*, 495–499.

## BIBLIOGRAPHY

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MS materials is in the archives of the Deutsche Akademie der Wissenschaften zu Berlin (D.D.R.) and Humboldt University, Berlin (D.D.R.), and in the Deutsches Zentralarchiv, Merseburg (D.D.R.).

II. Secondary Literature. For a bibliography of secondary literature, see Poggendorff, VIIa Suppl., 343–344. See also the following, listed chronologically: O. N.H., "Eduard Kummer," in *Münchener allameine zeitung*, no. 139 (20 May 1893); Emil Lampe, "Nachruf für Ernst Eduard Kummer.;" in *Jahresbericht der Deutschen Mathmaëtiker—vereinigung*, **3** (1894), 13–21; Leo Koenigsberger, [Carl Gustav Jacob Jacobi](#) (Leipzig, 1904); Whilhelm *Jacobi* (Leipzig, 1907); Kurt Hensel, *Festschrift zur Feier des 100. Geburtstages Eduard Kummers* (Leipzig—Berlin, 1910), 1–37; Wilhelm Lorey, *Des Studium der Mathematik an den deutschen Universitäten seit Anfang des 19. Jahrhunderts* (leipzig—Berlin, 1916), Leo Koenigsberger, *MeinLeban* (Heidelberg, 1919), 21, 24, 27, 28, 31, 31, 53, 114; [Felix Klein](#), *Volesungern über die Entwicklung der Mathematik, im 19. Jahrhundert*, I (Berlin, 1926), 167, 172, 199, 269, 282 321–322; Kurt—R. Biermann, "Zur Geschichte der Ehrenpromotion Gotthold Eisenstenis," in *Forschungen und Fortschritte*, **32** (1958), 332–335; Kurt—R. Biermann, "Über die Förderung detscher Mathematicker durch [Alexander von Humboldt](#)," in *Alexander von Humboldt. Gedenkschrift zur, 100. Wiederkehr seine Todestages* (Berlin, 1959), pp. 83–159; "J.P.G. Lejeune Dirichlet," in *Abhandlungen der Deutschen Akademie der Wissenschaftern zu Berlin*, Kl. für Math., phys. und Tech. (1959), no. 2; "Vorschläge zyr Wahl von Mathematikern in die Berliner Akademie," *ibid.* (1960), no "Die Mathematik und ihre Dozenten an der Berliner Universitaät 1810–1920" (Berlin, 1966), MS; and Hans Wussing, *Die Genesis des abstraketen Gruppenbegriffes* (Berlin, 1969).

Information on kummer is also contained in Weierstrass' letters and in the secondary literature on him and on Leopold Kronecker.

Kurt-R. Biermann

