encyclopedia.com

Ruffini, Paolo | Encyclopedia.com

Complete Dictionary of Scientific Biography COPYRIGHT 2008 Charles Scribner's Sons
12-17 minutes

(*b*. Valentano, Italy, 22 September 1765; *d*. Modena, Italy, 10 May 1822), *mathematics, medicine, philosophy*.

Ruffini was the son of Basilio Ruffini, a physician, and Maria Francesca Ippoliti. While he was in his teens, his family moved to Modena, where he spent the rest of his life. At the University of Modena he studied medicine, philosophy, literature, and mathematics, including geometry under Luigi Fantini and infinitesimal calculus under Paolo Cassiani. When Cassiani was appointed councillor of the Este domains, Ruffini, while still a student, was entrusted with his course on the foundations of analysis for the academic year 1787–1788. Ruffini obtained his degree in philosophy and medicine on 9 June 1788 and, soon afterward, that in mathematics. On 15 October 1788 he was appointed professor of the foundations of analysis, and in 1791 he replaced Fantini, who had been obliged by blindness to give up teaching, as professor of the elements of mathematics. Also in 1791 Ruffini was licensed by the Collegiate Medical Court of Modena to practice medicine. His exceptional versatility was reflected in his simultaneous activity as physician and researcher and teacher in mathematics—especially at a time when scientific specialization predominated.

Following the occupation of Modena by Napoleon’s troops in 1796, Ruffini was appointed, against his wishes, representative from the department of Panaro to the Junior Council of the Cisalpine Republic. Relieved of these duties, he resumed his scientific activity at the beginning of 1798. His subsequent refusal, on religious grounds, to swear an oath of allegiance to the republic resulted in his exclusion from teaching and from holding any public office. Ruffini accepted the experience calmly, continuing to practice medicine and to pursue mathematical research. It was during this period that he published the mathematical theorem known as the Abel-Ruffini theorem: a general algebraic equation of higher than the fourth degree cannot be solved by means of radical-rational operations.

A preliminary demonstration of this result appeared in *Teoria generale delle equazioni* (1799). Discussions with mathematicians such as Malfatti, Gregorio Fontana. and Pietro Paoli led to publication of the theorem in refined form in *Riflessioni intorno alla soluzione delle equazioni algebriche generali* (1813). Ruffini’s results were received with extreme reserve and suspicion by almost every leading mathematician. Only Cauchy accorded them full credence, writing to Ruffini in 1821: “Your memoir on the general resolution of equations is a work that has always seemed to me worthy of the attention of mathematicians and one that, in my opinion, demonstrates completely the impossibility of solving algebraically equations of higher than the fourth degree.” Following its independent demonstration by Abel in 1824, the theorem eventually took its place in the general theory of the Solubility of algebraic equations that Galois constructed on the basis of the theory of permutation groups.

Ruffini’s methods began with the relations that Lagrange had discovered between solutions of third- and fourth-degree equations and permutations of three and four elements: and Ruffini’s development of this starting point contributed effectively to the transition from classical to abstract algebra and to the theory of permutation groups. This theory is distinguished from classical algebra by its greater generality: it operates not with numbers or figures, as in traditional mathematics, but with indefinite entities, on which logical operations are performed.

Ruffini also developed the basic rule, named for him, for determining the quotient and remainder that result from the division of a polynomial in the variable x by a binomial of the form $x - a$. He treated the problem of determining the roots of any algebraic equation with a preestablished approximation by means of infinite algorisms (continuous fractions, development in series).

Ruffini was a staunch advocate of rigor in infinitesimal processes, a requirement that had assumed special importance toward the turn of the nineteenth century. Despite the success obtained following the algorismic systematization of calculus by Newton and Leibniz, there was an increasing awareness of the uncertainty of the foundations of infinitesimal analysis and of the lack of rigor of demonstrations in this field. A critical detail of the issue concerned the use of divergent and indeterminate series. As president of the Societá Italiana dei Quaranta, Ruffini refused to approve two papers by Giuliano Frullani, presented by Paoli, because they used series of which the convergence had not been demonstrated. Although Frullani cited Euler and Laplace as having remained unconcerned about convergence in treating similar problems, Ruffini remained firm in his own demand for rigor. His position was supported by Cauchy in his *Analyse algébrique* (1821) and by Abel in a letter to Holmboe in 1826.

The application of Ruffini’s mathematical outlook to philosophical questions is reflected in *Della immaterialità dell’anima* (1806), in which he enunciated the “theorem” that a being endowed with the faculty of knowledge is necessarily immaterial. His extremely detailed argument is developed by showing irresolvable differences between the properties of material beings and of beings endowed with the faculty of knowledge—such as the human soul. In another philosophical work, *Riflessioni critiche sopra il saggio filosofico intorno alla probabilità del signor Conte Laplace* (1821), Ruffini attempted to refute certain theses in Laplace's *Essai philosophique sur les probabilités* (1812) that he considered contrary to religion and morality. He began by rejecting the conception of Laplace's intelligence, which was inspired by the hypothesis of a rigid universal determinism. Ruffini argued from the basis of man's direct psychological experience of the exercise of his free will, which effects a change not only in states of consciousness but also in the physical world. Citing Jakob Bernoulli's theorem on probability and frequency, Ruffini developed a criticism of the applicability of the urn model to problems concerning the probability of natural events and attempted to determine to what extent the analogy between the two types of considerations holds true. In contrast with Laplace, who attempted to apply his calculus indiscriminately to moral actions, Ruffini observed that since the faculties of the soul are not magnitudes, they cannot be measured quantitatively.

The mathematician and physician converged in Ruffini to consider the probability that a living organism is formed by chance. He examined probability in relation to the truthfulness of evidence, showing that Laplace's solution applied to a different problem than that under consideration and that it represented a faulty application of Bayes's theorem. Ruffini thus anticipated the thinking of certain modern writers on the calculus of probability (see G. Castelnuovo, *Calcolo della probabilità*, **I** [Bologna, 1947], 150).

With the fall of Napoleon and the return of the Este family to Modena, Ruffini was appointed rector of the restored university in 1814. The contemporary political climate rendered his rectorship especially difficult, despite his enthusiasm, discretion, and honesty. He also held the chairs of applied mathematics and practical medicine until his death, but poor health forced him to relinquish the chair of clinical medicine in 1819.

Ruffini's patients included the destitute, as well as the duchess, of Modena. While tending to the victims of the typhus epidemic of 1817–1818 he contracted a serious form of the disease. In "Memoria del tifo contagioso" (1820), written after his recovery, he dealt with the symptoms and treatment of typhus on the basis of his own experience. Despite advice that he moderate his activities, he resumed his scientific and medical work. His strength gradually ebbed; and in April 1822, after a visit to one of his patients, he was struck by a raging fever, which obliged him to give up his activities. This last illness (chronic pericarditis) led to his death.

He was almost completely forgotten after his death, because of political and ideological reasons as well as the difficulty of interpreting his writings. His research bore precious fruit, however, largely through the work of Cauchy.

BIBLIOGRAPHY

I. Original Works. Ruffini's writings include *Teoria generale delle equazioni in cui si dimostra impossibile lasoluzione algebrica delle equazioni generali di grado superiore al quarto*, 2 vols. (Bologna. 1799): "Della soluzione delle equazioni algebriche determinate particolari di grado superiore al quarto," in *Memorie di matematica e di fisica della Società italiana delle scienze*, **9** (1802), 444–526: "Riflessioni intorno alla rettificazione, ed alla quadratura del circolo," *ibid*., 527–557; "Della insolubilità delle equazioni algebriche generali di grado superiore al quarto." *ibid*., **10,** pt. 2 (1803), 410–470: *Sopra la determinazione delle radici delle equazioni numeriche di qualunque grado* (Modena, 1804); "Risposta … ai dubbi propostigli dal socio Gianfrancesco Malfatti sopra la insolubilità delle equazioni di grado superiore al quarto." in *Memorie di matematica c di fisica della Società italiana delle scienze*, **12** , pt. 1 (1805), 213–267: "Rillessioni… intorno al metodo proposto dal consocio Gianfrancesco Malfatti per la soluzione delle equazioni di quinto grado." *ibid*., 321–336: *Della immaterialità dcll'anima* (Modena. 1806): and "Della insolubilità delle equazioni algebriche generali di grado superiore al quarto qualunque metodo si adoperi algebrico esso siasi o trascendente," in *Memorie dell'Istituto nazionale italiano*, Classe di fisica e di matematica, **1** , pt. 2 (1806), 433–450.

Subsequent works are "Alcune proprietà generali delle funzioni," *in Memorie di matematica e di fisica della Socictà italiana delle scienze*, **13** . pt. 1 (1807), 292–335: *Algebra e sua appendice*, 2 vols. (Modena, 1807–1808): "Di un nuovo metodo generale di estrarre le radici numeriche," in *Memorie di matematica e di fisica della Società italiana delle scienze*, **16** , pt. 1 (1813), 373–429; *Riflessioni intorno alla soluzione delle equazioni algebriche generali* (Modena, 1813); "Memoria del tifo contagioso." in *Memorie della Società italiana delle scienze*, Phys. sec., **18** . pt. 1 (1820). 350–381; "Intorno al metodo generale proposto dal Signor Hoêne Wronscki onde risolvere le equazioni di tutti i gradi," *ibid*., Math. sec., **18.** fasc. 1 (1820), 56–68: and "Opuscolo **I** e **II** della classificazione delle curve algebriche a semplice curvatura." *ibid*., 69–142, 269–396.

See also *Riflessioni critiche sopra il saggio filosofico intorno alla probabilità del signor Conte Laplace* (Modena, 1821); "Elogio di Berengario da Carpi," in *Fasti letterari della città di Modena e Reggio*. **III** (Modena, 1824); "Alcune proprietà delle radici dell'unità." in *Memorie dell'***I.R.** *Istituto del regno lombardo-veneto*, **3** (1824), 67–84: "Riflessioni intorno alla eccitabilità, all'eccitamento, agli stimoli, ai controstimoli, alle potenze irritative, alle diatesi si iperşteniche cheiposteniche," in *Memorie della R. Accademia di scienze, lettere ed arti in Modena*, **1** (1833), 1–55: "Osservazioni intorno al moto dei razzi alle Congreve," *ibid*., 56–78; "Intorno alla definizione della vita assegnata da Brown," *ibid*., 319–333; and *Opere matematiche*, E. Bortolotti. ed., 3 vols. (Rome. 1953–1954).

MSS. letters, and documents relating to Ruffini are in the Academy of Science, Letters, and Arts of Modena.

II. Secondary Literature. See the following, listed chronologically: A. Lombardi, *Notizie sulla vita e sugli scritti del prof. Paolo Ruffini* (Modena. 1824): H. Burkhardt, "Die Anfänge der Gruppentheorie and Paolo Ruffini," in *Zeitschrift für Mathematik and Physik*, **37** (1892), supp.,119–159: and "Paolo Ruffini e i primordi della teoria dei gruppi," in *Annali di matematica*. 2nd ser., 22 (1894). 175–212: E. Bortolotti, "Influenza dell'opera matematica di Paolo Ruffini sullo svolgimento delle teorie algebriche," in *Annuario della R. Università di Modena*(1902–1903). 21–77: "Un teorema di Paolo Ruffini sulla teoria delle sostituzioni," in *Rendiconti dell' Accademia dei Lincei*, ser. 5a. **22** (1913). 1st sem., pp. 679–683: and "I primordi della teoria generale dei gruppi di operazioni e la dimostrazione data da Paolo Rufflni della impossibilità di risolvere con funzioni trascendenti esatte le equazioni generali di grado superiore al quarto." in *Memorie della R. Accademia di scienzc, lettere ed arti in Modena*, ser. 3a, **12** (1913). 179195: G. Barbensi. *Paolo Ruffini nel suo tempo* (Modena. 1955). with complete bibliography of Ruffini's writings: G. Varoli. "Su un'opera pressochè sconosciuta di Paolo Rufftni," in *Statistica* (Bologna) (July-Sept. 1957), 421–442: and E. Carruccio, "Paolo Ruffni matematico e pensatore." in *Memorie della R. Accademia di scienze, lettere ed arti in Modena*, 6th ser., 8 (1966), liii–lxix.

Ettore Carruccio