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(*b*. Épernon, France, 15 November 1793; *d*. Paris, France, 18 December 1880),

synthetic geometry, history of mathematics.

Chasles was born into an upper-middle-class Catholic family, settled in the region of Chartres. He was given the name Floréal, but it was changed to Michel by court order, 22 November 1809. His father, Charles-Henri, was a lumber merchant and contractor who became president of the *chambre de commerce* of Chartres. Chasles received his early education at the Lycée Impérial and entered the École Polytechnique in 1812. In 1814 he was mobilized and took part in the defense of Paris. After the war he returned to the École Polytechnique and was accepted into the engineering corps, but he gave up the appointment in favor of a poor fellow student. After spending some time at home, he obeyed his father's wishes and entered a stock brokerage firm in Paris. However, he was not successful and retired to his native region, where he devoted himself to historical and mathematical studies. His first major work, the *Aperçuhistorique*, published in 1837, established his reputation both as a geometer and a historian of mathematics. In 1841 he accepted a position at the École Polytechnique, where he taught geodesy, astronomy, and applied mechanics until 1851. In 1846 a chair of higher geometry was created for him at the Sorbonne, and he remained there until his death.

Chasles was elected a corresponding member of the Academy of Sciences in 1839 and a full member in 1851. His international reputation is attested to by the following partial list of his affiliations: member of the Royal Society of London; honorary member of the Royal Academy of Ireland; foreign associate of the royal academies of Brussels, Copenhagen, Naples, and Stockholm; correspondent of the Imperial Academy of Sciences at St. Petersburg; and foreign associate of the National Academy of the United States. In 1865 Chasles was awarded the Copley Medal by the Royal Society of London for his original researches in pure geometry.

Chasles published highly original work until his very last years. He never married, and his few interests outside of his research, teaching, and the Academy, which he served on many commissions, seem to have been in charitable organizations.

Chasles's work was marked by its unity of purpose and method. The purpose was to show not only that geometry, by which he meant synthetic geometry, had methods as powerful and fertile for the discovery and démonstration of mathematical truths as those of algebraic analysis, but that these methods had an important advantage, in that they showed more clearly the origin and connections of these truths. The methods were those introduced by Lazare Carnot, Gaspard Monge, and Victor Poncelet and included a systematic use of sensed magnitudes, imaginary elements, the principle of duality, and transformations of figures.

The *Aperçu historique* was inspired by the question posed by the Royal Academy of Brussels in 1829: a philosophical examination of the different methods in modern geometry, particularly the method of reciprocal polars. Charles submitted a memoir on the principles of duality and homography. He argued that the principle of duality, like that of homography, is based on the general theory of transformations of figures, particularly transformations in which the cross ratio is preserved, of which the reciprocal polar transformation is an example. The work was crowned in 1830, and the Academy ordered it published. Chasles requested permission to expand the historical introduction and to add a series of mathematical and historical notes, giving the result of recent researches. His books and almost all of his many memoirs are elaborations of points originally discussed in these notes. One of his weaknesses—that he did not know German—is apparent here too, and as will be seen below, many of the results claimed as new had been wholly or partly anticipated. It was this expanded work which was published.

Chasles wrote two textbooks for his course at the Sorbonne. The first of these, the *Traité de géométrie supérieure* (1852), is based on the elementary theories of the cross ratio, homographic ranges and pencils, and involution, all of which were originally defined and discussed in the *Aperçu historique;* the cross ratio in note 9, involution in note 10. In the case of the cross ratio, which Chasles called the anharmonic ratio, he was anticipated by August Moebius, in his *Bary centrische Calcul* (1827). However, it was Chasles who developed the theory and showed its scope and power. This book, Chasles felt, showed that the use of sensed magnitudes and imaginary elements gives to geometry the freedom and power of analysis.

The second text, the *Traité sur des sections coniques* (1865), applied these methods to the study of the conic sections. This was a subject in which Chasles was interested throughout his life, and he incorporated many results of his own into the book. For example, he discussed the consequences of the projective characterization of a conic as the locus of points of intersection of corresponding lines in two homographic pencils with no invariant line, or dually as the envelope of lines joining corresponding

points of two homographic ranges with no invariant point. Chasles had originally given this in notes 15 and 16 of the *Aperçu historique*, but here also he must share credit with a mathematician writing in German, the Swiss geometer Jacob Steiner.

The book also contains many of Chasles's results in what came to be called enumerative geometry. This subject concerns itself with the problem of determining how many figures of a certain type satisfy certain algebraic or geometric conditions. Chasles considered first the question of systems of conics satisfying four conditions and five conditions (1864). He developed the theory of characteristics and of geometric substitution. The characteristics of a system of conics were defined as the number of conics passing through an arbitrary point and as the number of conics tangent to a given line. Chasles expressed many properties of his system in formulas involving these two numbers and then generalized his results by substituting polynomials in the characteristics for the original values. There are many difficulties in this type of approach, and although Chasles generalized his results to more general curves and to surfaces, and the subject was developed by Hermann Schubert and Hieronymus Zeuthen, it is considered as lacking in any sound foundation.

Chasles did noteworthy work in analysis as well. In particular, his work on the attraction of ellipsoids led him to the introduction and use of level surfaces of partial differential equations in three variables (1837). He also studied the general theory of attraction (1845), and though many of the results in this paper had been anticipated by George Green and Carl Gauss, it remains worthy of study.

Chasles wrote two historical works elaborating points in the *Aperçu historique* (notes 12 and 3 respectively) which had given rise to controversy. The *histoire d'arithmétique* (1843) argued for a Pythagorean rather than a Hindu origin for our numeral system. Chasles based his claim on the description of a certain type of abacus, which he found in the writings of Boethius and Gerbert. The second work was a reconstruction of the lost book of *Prisms* of Euclid (1860). Chasles felt that the porisms were essentially the equations of curves and that many of the results utilized the concept of the cross ratio. Neither of these works is accepted by contemporary scholars.

In 1867 Chasles was requested by the minister of public education to prepare a *Rapport sur le progrès de la géométrie* (1870). Although the work of foreign geometers is treated in less detail than that of the French, the *Rapport* is still a very valuable source for the history of geometry from 1800 to 1866 and for chasles's own work in particular.

Chasles was a collector of autographs and manuscripts, and this interest allied with his credulity to cause him serious embarrassment. From 1861 to 1869 he was the victim of one of the most clever and prolific of literary forgers, Denis Vrain-Lucas. Chasles bought thousands of manuscripts, including a correspondence between Isaac Newton, Blaise Pascal, and Robert Boyle which established that Pascal had anticipated Newton in the discovery of the law of universal gravitation. Chasles presented these letters to the Academy in 1867 and took an active part in the furor that ensued (1867–1869), vigorously defending the genuineness of the letters. In 1869 Vrain-Lucas was brought to trial and convicted. Chasles was forced to testify and had to admit to having purchased letters allegedly written by Galileo, Cleopatra, and Lazarus, all in French.

But this misadventure should not be allowed to obscure his many positive contributions. He saw clearly the basic concepts and their ramifications in what is now known as projective geometry, and his texts were influential in the teaching of that subject in Germany and Great Britain as well as in France. Finally, with all its faults, the *Aperçu historique* remains a classic example of a good history of mathematics written by a mathematician.

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The Traité de géométrie supérieure (Paris, 1852), reprinted in 1880, was freely translated into German under the title *Die Grundlehren der neueren Geometrie. Erster Theil: Die Theorie des anharmonischen Verhältnisses, der homographischen Theilung and der Involution, and deren Anwendung auf die geradlinigen and Kreis-Figuren*, C. H. Schnuse, trans. (Brunswic, 1856). Principal parts of the work also appear in Benjamin Witzchel, *Grundlinien der neueren Geometric mit besonderer Berücksichtigung der metrischen Verhältnisse an Systemen von Punkten in einer Geraden and einer Ebene* (Leipzig, 1858), and in Richard Townsend, *Chapters on the Modern Geometry*, vol, II (Dublin, 1865). The second part of the *Traité des sections coniques faisant suite au taité de géométie supérieure* (first part, Paris, 1865) never appeared.

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