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(*b*. Loons-le-Saulnier, France, 17 April 1798; *d*. Châlons-sur-Marne, France, 22 March 1840)

geometry, mechanics.

Étienne Bobillier was the second son of Ignace Bobillier, a merchant, who died when Étienne was seven years old. He and his brother Marie André were raised by their mother, a wallpaper merchant. Étienne attended the local secondary school and seemed inclined toward literary studies, in which he won awards. Until he was sixteen, he showed no interest in mathematics, but then his brother, a student at the *lycée* of Besançon, was accepted by the École Polytechnique. Étienne resolved to follow this example and, shutting himself up with the books left behind by his brother and aided from time to time by advice from him, he completed the course in special mathematics. He then presented himself for the competitive entrance examination in 1817. The examiner, well known for his severity, put Étienne first on his list. He was admitted to the École Polytechnique as fourth in rank.

Bobillier finished his first year eighth out of sixtyfour students. Because of financial needs, he took a leave of absence from the École Polytechnique in October 1818, in order to became an instructor in mathematics at the École des Arts et Métiers at Châlons. The young instructor soon showed a remarkable gift for teaching; exhibiting a rapid judgment, lively mind, lucid language, and strength of Character that impressed, captivated, and subdued his students [1]. He taught trigonometry, statics, analytic geometry, descriptive geometry, practical mechanics, physics, and chemistry.

In 1829 Bobillier, who saw no future where he was, applied for a university post and, upon Poisson’s recommendation, he became professor of special mathematics at the Collège Royal of Amiens. The minister of commerce, however, who had authority over all Écoles des Arts et Métiers, named him director of studies at the École of Angers. He took up his post there on 1 January 1830. After the July Revolution, civil war broke out again in the west and Bobillier, a volunteer in the National Guard of Angers, fought in a rather hard month-long campaign against the Chouans.

In 1832 his post as director of studies was abolished, and Bobillier returned to Châlons as instructor-in-chief in mathematics. By 1834 he was full professor, a rank he retained until his death. He also held a professorship of special mathematics at the municipal high school. Bobillier was named Chevalier at the legion of Honor in 1839.

In 1836 he became seriously ill; but the following year he married. In spite of a recurring illness, Bobillier refused to interrupt his work, even though he finally was confined to bed. Imprudently, he resumed his teaching and other activities too soon—a decision that hastened his death in 1840.

Bobillier became known to the scientific world particularly through his contributions to the *Annales de Gergonne*.[2] The first, in August 1826, was a modest solution of certain problems posed to the readers by the editor. In April 1830 he went on to demonstrate the principle of virtual velocities for machines in equilibrium. He also contributed to Quetelet’s *corresp;ondance mathématique et physique*,[3] to the *Mémoires de l’Académie de Caen*,[4] and to a few provincial journals [5]—probably a total of some forty writings. He also edited for his students a book of elementary algebra and a complete course in geometry. His corses in mechanics and physics were written out in autograph. [6]

At the time of his death, Bobillier was working on a dissertation concerning the geomatric laws of motion [7] that he meant to present as a report before the Académie des Sciences. Some of the passages in his course in geometry are probably an early outline for this.

Because of his isolation in the provinces, Bobillier had few direct contacts with the scientific world of his time. His premature departure from the École Polytechnique prevented him from forming the lasting friendships that are one of the principal hallmarks of that famous school.

He knew Poncelet, however, through correspondence and a close relationship that began in 1828–1829. [8] Unfortunately, their correspondence seems to have been lost. Bobillier never met J. D. Gergonne, the editor of the *Annales*, nor Adolphe Quetelet and Michel Chasles. In spite of the coincidence of their statements and interests, and of the fact that questions of priority arose between them, they do not seem to have corresponded directly. In fact, in the notice that Chasles wrote on Bobillier, he made a serious error as to the date of his death. [9]

There is even more reason to think that Bobillier had neither contact nor correspondence with Jakob Steiner and Julius Plücker, his emulators on the staff of the *Annales*. It should be noted that Gergonne often edited the articles of his collaborators to suit himself, which makes it difficult to judge them definitively.

Loyal to Gaspard Monge's ideas, Bobillier treated geometric problems in a way akin to both analytic geometry and projective geometry. He first set up a problem in the form of an equation in a particular case, simple enough so that the analytic geometry of his time could deal with it. Then, through a transformation by reciprocal polars, he obtained the dual. In this respect he was a disciple of Gergonne.

Such a method was hardly suitable for treating metric proportion. In 1824 Poncelet presented to the Académie des Sciences a report in which he solved the difficulty by taking the sphere as the quadric of reference. [10] Since his report had not been published, he then, at Gergonne's insistence, gave a somewhat at sybilline sketch of it in the *Annales*. [11] Upon reading this. Chattel and Bobillier rediscovered Poncelet's method; and Bobillier was first to publish it. [12]

In his course in geometry Bobillier was the very first to use transformation by reciprocal polars relative to a circle in order to provide an elementary study of conic sections. For a more sophisticated point of view of the same field, his following proposition may be cited: The polar circles of a fixed point of a conic section, relative to all the triangles inscribed in the curve, meet at the same point.[13]

Bobillier is best known, however, for his studies of successive polars of curves or algebraic surfaces, and for his abridged notation. He stated, following Monge, that the tangents drawn from a point to a plane curve of order m have their points of contact on a curve of order $m-1$, which he called the polar of the point. He made analogous statements concerning space.

In a series of studies [14] Bobillier showed that the polars of collinear points have $(m-1)^2$ points in common. The polars of a point relative to a linear pencil (an expression that came into use after his time) of curves of order m form a pencil of order (m–1). If the point describes a straight line, the $(m-1)^2$ points at the base of this pencil describe a curve of order 2(m–1).

In considering the successive polars of the same points that are of order (m–1), (m–2)… 1, one is led to the following theorem: The polar of order n of a point P is the locus of all points whose polars of order (m–n) pass through P. Plücker agreed with Bobillier in stating this theorem, which he had mentioned to Gergonne without any proof.

In May 1828 there appeared in the *Annales* Bobillier's essay on a new mode of research on the properties of space. [15] The method of research that he expounded was, he stated, susceptible to various applications, which he hoped to publish in successive issues.

With A a linear function of two coordinates and a a constant, $A= 0$ is the equation of a straight line. $ABC = 0$ is the equation of the extensions of the sides of a triangle, known as the equation of the traingle; and $aBC + bCA + cAB = 0$ is the general equation of a conic section circumscribed about the triangle. Its tangents at the vertices are $bC + cB = 0$; $cA + aC = 0$; $aB + bA = 0$. In fact, the straight line $bC + cB = 0$ meets the conic only at the point $B = 0$, $C = 0$. The triangle circumscribed about the conic, the points of contact being the vertices of the first triangle, has for its "equation" (bC + cB) (cA + aC) "equation" $(bC + cB)(cA + aC)(aB + bA)= 0$. The straight line passing through the three points of intersection of the tangents with the corresponding sides of the original triangle is $bcA + caB + abC = 0$. The lines of junction of the corresponding vertices of the two triangles—$cB - bC = 0$; $aC - cA = 0$; $bA - aB = 0$—are concurrent. It is then a trivial matter to show that this point and this line are pole and polar of each other in relation to the conic section in question.

Bobillier showed by a similar and clever process that, in space, if a tetrahedron is inscribed in a quadric, then another tetrahedron can be circumscribed about the same quadric so that the points of contact of its faces are the vertices of the original tetrahedron. The oppositely placed faces of the two tetrahedrons cut each other in four lines, and their oppositely placed vertices are joined by four other lines. The straight lines of each group belong to the same quadric.

Aware of the value of his method, Bobillier applied it in the 1 June 1828 number of the *Annales* to some elementary geometric propositions. [16] In particular, he obtained from it the known proposition concerning the chords common to a circle and a conic section, and the theorems of Pascal and C. J. Brianchon. The efficacy of the method may be judged by these simple examples.

In statics, in which Bobillier was particularly concerned with catenaries, his report "De l'equilibre de la chaînette sur une surface courbe" [17] should be mentioned. This problem was taken over by F. Minding in 1835, by C. Gudermann in 1834 and 1846, by P. Appell in 1885, and by A. G. Greenhill in 1897. In spite of a few minor errors in computation, the work remains most elegant.

Bobillier's demonstration of the principle of virtual velocities [18] consisted in substituting "for any ordinary machine, whose character can be changed in an infinite number of ways, the winch, whose conditions of equilibrium are so well known and that, at least for the infinitely small deviation that we can estimate in its equilibrium, remains, exactly the same." His method is extremely clever.

In kinematics there seem to be no known traces of the work Bobillier was doing toward the end of his life, although the passages in his book on geometry that treat this subject are still extant. [19] Two theorems and one problem are particularly in evidence: All movement of a triangle on a plane can be produced by rolling a certain line over another fixed line, the triangle being invariably linked to the first line. If a triangle, *abc*, moves in such a fashion that the sides *ab* and *ac* constantly touch two circles, the envelope of the third side is also a circle; and the centers of the three envelopes determine a new circle that includes all the instantaneous centers of rotation. Bobillier then went on to pose the problem of how to determine the corresponding center of curvature in the path of the third vertex, *c*, when given the centers of curvature at points *a* and *b* of the paths described by vertices *a* and *b* of triangle *abc*. The construction he gave of this center is known as the Bobillier construction.

NOTES

1. Obituary, in Almanach du départment de la Marne (1841), pp. 316–320.

2. In vols. **17–20.**

3. Vol. **4** (1828).

4. “De la courbe nommée chaînette,” 1831.

5. E.G., *Recueil des travaux de la Société d'agriculture, commerce, sciences et arts de la Marne* (1826); material Correspondance mathématique et physique, **4** (1828): “De la courbe nommée chaînette,” in Mémoires de l'Académie de Caen (1831): “Note sur le principe de Roberval” (1834).

6. From the obituary of 1841.

7. From the obituary. However, Bobillier notes this memoir in the 10th ed. of the *Géométrie*, p. 208.

8. Poncelet, *Applications d'analyse et de geométrié*, II, 486. Poncelet calls Bobillier “an intelligent and singularly active mind.”

9. *Rapport sur les progrés de la géométrie*, pp. 65–68. “We owe remarkable researches to Bobillier, a distinguished geometer who gave hopes of great achievements for mathematical sciences, from which he was snatched in 1832 at the age of thirty-five.”

10. See, e.g., *Applications*, p. 529.

11. Vol. **17** , pp. 265–272; see also vol. **18** , pp. 125–149.

12. *Annales*, **18** , pp. 185–202, “Démonstration de divers théorèmes de géométrie.” “In writing the above article we have used only the contents of M. Poncelet's letter” (the letter in vol. **17**). On p. 269 of vol. **18** . Chasles said: “It was only yesterday evening that your number of January 1828 reached me. I have read M. Bobillier's report with considerable eagerness…but I must say that the special case in which a sphere is taken…has come to me only through the reading of the analysis in the report” (report by Poncelet, vol. **17** , p. 265).

13. “Memoire sur I'hyperbole équilatère.”

14. *Annales*, vol. **18** , pp. 89, 157, 253; vol. **19** , pp. 106, 138, 302.

15. Vol. **18** , pp. 321–339.

16. “Philosophie mathématique. Démonstration nouvelle de quelques propriétés des lignes du second ordre.”

17. *Annales*, vol. **20** , pp. 153–175.

18. *Ibid*., pp. 285–288.

19. *Cours de géomertrie*, 10th ed., pp. 204–208.

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I. Original Works. Among Bobillier's writings are "Notes sur les puits a bascule," in *Recueil des travaux de la société d'agriculture, commerce, sciences et arts de la Marne* (1826): material in *Correspondance mathematique et physique*, **4** (1828): "De la courbe nommée chaînette," in *Memoires de I'Academie de Caen* (1831); "Note sur le principe de Roberval," in *Recueil des travaux*… (1834); *Cours de géométrie* (10th ed., Paris, 1850); and *Principes d'algébre* (6th ed., Paris, 1865).

Many of his articles were published in the *Annales de mathématiques pures et appliquées:* "Démonstration de divers théorèmes de géométrie," **18** , 185–202; "En rédigeant l'article qu'on vient de lire…." *ibid*., 89, 159, 253, and **19** , 106, 138, 302; an article on new methods of research on the properties of space, **18** , 321–339; "Philosophie mathematique. Démonstration nouvelle de quelques proprietes des lignes du second ordre," *ibid*., 349–359; "De l'equilibre de la chainette sur une surface courbe," **20** , 153–175; and an article on the principle of virtual velocity, *ibid*., 285–288.

II. Secondary Literature. Works providing more information on Bobillier and his accomplishments are Michel Chasles, *Rapport sur les progres de la géométrie* (Paris, 1870), pp. 65–68, excellent from a mathematical standpoint: J. L. Collidge, *A History of Geometrical Methods* (Oxford, 1940; New York, 1963), p. 143, which perpetuates Chasles's error on the date of Bobillier's death; and Poncelet's *Applications d'analyse et de geometrie* (Paris, 1864), II, 486, 529; and an article on the sphere as the quadric of reference, in *Annales de mathématiques pures et appliquées*, **17** , 265–272, and **18** , 125–149. There is an obituary of Bobillier in *Almanach du département de la Marne* (1841), 316–320.

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