Duhamel, Jean-Marie-Constant | Encyclopedia.com

(*b* St. Malo, France, 5 February 1797; *d*. Paris, France, 29 April 1872)

mathematics, physics.

Duhamel's scientific contributions were minor but numerous and pertinent; his teaching and involvement in academic administration were probably the primary sources of his influence. Today his name is best remembered for Duhamel's principle in partial differential equations;[1] Duhamel obtained this theorem in the context of his work on the mathematical theory of heat. Using the techniques of mathematical physics he also studied topics of acoustics. In his interests and approaches Duhamel was clearly in the tradition of the French *géomètres*.

Duhamel entered the École Polytechnique in Paris in 1814, after studying at the lycée of Rennes. The political events of 1816, which caused a reorganization of the school, obliged him to return to Rennes, where he studied law. He then taught in Paris at the Institution Massin and the Collège Louis-le-Grand (probably mathematics and physics) and founded a preparatory school, later known as the École Sainte-Barbe. The subject of his first memoir, presented in 1828,[2] indicates that by this time he was quite involved in current problems of mathematical physics.

Except for one year, Duhamel taught continuously at the École Polytechnique from 1830 to 1869. He was first given provisional charge of the analysis course, replacing Coriolis. He was made assistant lecturer in geodesy in 1831, entrance examiner in 1835, professor of analysis and mechanics in 1836, permanent examiner in 1840, and director of studies in 1844. The commission of 1850 demanded his removal because he resisted a program for change, but he returned as professor of analysis in 1851, replacing Liouville. Duhamel also taught at the École Normale Supérieure and at the Sorbonne. He was known as a good teacher, and students commented especially on his ability to clarify the concept of the infinitesimal, a topic also emphasized in his text.[3] Duhamel's most famous student was his nephew by marriage, J. L. F. Bertrand.

Duhamel's earliest research dealt with the mathematical theory of heat and was based on the work of Fourier and Poisson. It was the subject of the theses, accepted in 1834,[4] that he submitted to the Faculty of Sciences. His first memoir treated heat propagation in solids of nonisotropic conductivity, and the laws that he obtained were later verified experimentally by Henri de Sénarmont.[5] In 1833 Duhamel published a solution for the temperature distribution in a solid with variable boundary temperature. He was considering the situations in which the surface radiates into a medium and in which the temperature of the medium changes according to a known law. His object was to reduce these cases to those of a surface at constant temperature. His method, based on the principle of superposition, generalized a solution by Fourier and substituted, in place of the original temperature function, the sum of a constant temperature term and an integral term (an integral of the rate of change of the temperature function).[6] This method generalizes to Duhamel's principle.

In acoustics Duhamel studied the vibrations of strings, the vibrations of air in cylindrical and conical pipes, and harmonic overtones. For an experimental check on his analysis of a weighted string Duhamel used a novel method whereby a pointer attached to the string leaves a track on a moving plane. His study of the excitation of vibration by the violin bow, based on Poisson's *Mécanique*, used the expression for friction force that had been experimentally determined by Coulomb and Morin. Duhamel was intrigued by harmonic overtones and suggested, independently of Ohm,[7] that one perceives a complex sound as the group of simultaneous sounds into which its vibrations can be decomposed.[8]

NOTES

1. For example, R. Courant and D. Hilbert *Methods of Mathematical Physics*, II (New York, 1966), 202–204.

2. Published in 1832.

3. Commenting on the disagreement among mathematicians over definitions of the differential, Duhamel pointed out in an introductory note to the second edition of his *Cours d'analyse* (Paris, 1847) that he had changed his own approach. Instead of considering the differential as an infinitely small addition to the variable, as he had done in the first edition, he was now considering differentials as quantities whose ratios in the limit are the same as the ratios of the variables.

4.*Théorie mathématique de la chaleur* (Paris, 1834) and *De l'influence du double mouvement des planètes sur les températures de leur différent points* (Paris, 1834).

5. "Sur la conductibilité des corps cristallisés pour la chaleur," in *Annales de chimie*, **21** (1847), 457–476; "Second mémoire sur la conductibilité des corps cristallisés pour la chaleur," in *Comptes rendus hebdomadaires des séances de l'Académie des sciences*, **25** (1847), 459–461, 707–710; *Annales de chimie*, **22** (1848), 179–211.

6. For a modern discussion of Duhamel's principle and its use in solving heat problems, see H. S. Carslaw and J. C. Jaeger, *Conduction of Heat in Solids*, 2nd ed. (Oxford, 1959), 30–32.

7. G. S. Ohm, "Ueber die Definition des Tons, nebst daran geknüpfter Theorie der Sirene und ähnlicher tonbildender Vorrichtungen," in *Annalen der Phvsik*, **59** (1843), 513–566.

8.*Comptes rendus*, **27** (1848), 463.

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I. Original Works. A partial listing of Duhamel's textbooks includes *Cours d'analyse*, 2 vols. (Paris, 1840–1841; 2nd ed., 1847); *Corns de mécanique*, 2 vols. (Paris, 1845–1846; 2nd ed., 1853–1854); *Élements de cateul infinitésimal*, 2 vols. (Paris, 1856; 2nd ed., 1860 –1861); *Des méthodes dans les sciences de raisonnement*, **3** vols. (Paris,1865 –1873).

His articles include "Sur les équations générales de la propagation de la chaleur dans les corps solides dont la conductibilité n'est pas la même dans torn les sens," in *Journal de l'École polytechnique*, **13** (1832), *cahier* 21, 356 –399; "Sur la méthode générale relative au mouvement de la chaleur dans les corps solides plongés dans des milieux dont la température varie avec le temps," *in Journal de l'École polytechnique*, **14** (1833), *cahier* 22, 20–77; "De l'action de l'archet sur les cordes," in *Comptes rendus hebdomadaires des séances de l' Academie des sciences*, **9** (1839), 567 –569; **10** (1840), 855 –861; *Mémoires présentiés par divers savants à l'Académie des sciences*, **8** (1843) 131 –162; "Mémoire sur les vibrations des gaz dans les tuyaux de diverses formes," in *Comptes rendus hebdomadaires des séances de l'Académie des sciences*, **8** (1839), 542–543; *Journal de mathématiques pures et appliquées*, **14** (1849), 49–110; "Sur les vibrations d'une corde flexible chargée d'un ou de plusieurs curseurs," in *Journal de l'École polytechnique*, **17** (1843), *cahier*, 29, 1 –36; "Sur la résonnance multiple des corps," in *Comptes rendus hebdomadaires des séances de l'Académie des sciences*, **27** (1848), 457–463; and "Sur la propagation de [1]a chaleur dans les cristaux," in *Journal de l'École polytechnique*, **19** (1848), cahier 32, 155–188.

For an extended list of Duhamel's papers, see the *Royal Society Catalogue of Scientific Papers, 1800–1863, II (1868), 376–377; and 1864–1873*, VII (1877), 569.

II. Secondary Literature. Not much material is available on Duhamel. For short accounts, see Louis Figuier , *L'année scientifique et industrielle (1872)*, XVI (Paris, 1873), 537–540; M. Maximilien Marie, *Histoire des sciences mathématiques et physiques*, XII (Paris, 1888), 220–224; and E. Sarrau, "Duhamel," in *Eeole polytechnique, livre du centenaire 1794–1894*, I (Paris, 1894–1897), 126–130.

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