Joseph Fourier

Joseph Fourier

Jean Baptiste Joseph Fourier

Born	March 21, 1768 Auxerre, Yonne, France
Died	May 16, 1830 Paris, France
Residence	France
Nationality	French
Field	Mathematician, physicist, and historian
Institution	École Normale École Polytechnique
Alma mater	École Normale
Academic advisor	Joseph Lagrange
Notable students	Gustav Dirichlet Giovanni Plana Claude-Louis Navier
Known for	Fourier transform
Religion	Roman Catholic

Jean Baptiste Joseph Fourier (March 21, 1768 - May 16, 1830) was a French mathematician and physicist who is best known for initiating the investigation of Fourier series and their application to problems of heat flow. The Fourier transform is also named in his honor.

Life

Fourier was born at Auxerre in the Yonne département of France, the son of a tailor. He was orphaned at age eight. Fourier was recommended to the Bishop of Auxerre, and through this introduction, he was educated by the Benvenistes of the Convent of St. Mark. The commissions in the scientific corps of the army were reserved for those of good birth, and being thus ineligible, he accepted a military lectureship on mathematics. He took a prominent part in his own district in promoting the French Revolution, and was rewarded by an appointment in 1795 in the *École Normale Supérieure*, and subsequently by a chair at the *École Polytechnique*.

Fourier went with Napoleon on his Eastern expedition in 1798, and was made governor of Lower Egypt. Cut off from France by the English fleet, he organized the workshops on which the French army had to rely for their munitions of war. He also contributed several mathematical papers to the Egyptian Institute which Napoleon founded at Cairo, with a view of weakening English influence in the East. After the British victories and the capitulation of the French under General Menou in 1801, Fourier returned to France, and was made prefect of Isère, and it was while there that he made his experiments on the propagation of heat.

Fourier moved to England in 1816. In 1822 he published his *Théorie analytique de la chaleur*, in which he bases his reasoning on Newton's law of cooling, namely, that the flow of heat between two adjacent molecules is proportional to the extremely small difference of their temperatures. In this work he claims that any function of a variable, whether continuous or discontinuous, can be expanded in a series of sines of multiples of the variable. Though this result is not correct, Fourier's observation that some discontinuous functions are the sum of infinite series was a breakthrough. The question of determining when a function is the sum of its Fourier series has been fundamental for centuries. Joseph Louis Lagrange had given particular cases of this (false) theorem, and had implied that the method was general, but he had not pursued the subject. Johann Dirichlet was the first to give a satisfactory demonstration of it with some restrictive conditions. A more subtle, but equally fundamental, contribution is the concept of dimensional homogeneity in equations; i.e. an equation can only be formally correct if the dimensions match on either side of the equality.

Fourier died in Paris in 1830.

Fourier left an unfinished work on determinate equations which was edited by Claude-Louis Navier and published in 1831. This work contains much original matter — in particular, there is a demonstration of Fourier's theorem on the position of the roots of an algebraic equation. Joseph Louis Lagrange had shown how the roots of an algebraic equation might be separated by means of another equation whose roots were the squares of the differences of the roots of the original equation. François Budan, in 1807 and 1811, had enunciated the theorem generally known by the name of Fourier, but the demonstration was not altogether satisfactory. Fourier's proof is the same as that usually

given in textbooks on the theory of equations. The final solution of the problem was given in 1829 by Jacques Charles François Sturm.

Other work

Fourier is also credited with the discovery in his essay in 1827 that gases in the atmosphere might increase the surface temperature of the Earth. This was the effect that would later be called the greenhouse effect. He established the concept of planetary energy balance - that planets obtain energy from a number of sources that cause temperature increase. Planets also lose energy by infrared radiation (that Fourier called *"chaleur obscure"* or "dark heat") with the rate increasing with temperature. A balance is reached between heat gain and heat loss; the atmosphere shifts the balance toward the higher temperatures by slowing the heat loss. Although Fourier understood that rate of infrared radiation increases with temperature, the Stefan-Boltzmann law which gives the exact form of this dependency (a fourth-power law) was discovered fifty years later.

Fourier recognized that Earth primarily gets energy from Solar radiation, to which the atmosphere is transparent, and that geothermal heat doesn't contribute much to the energy balance. However, he mistakenly believed that there is a significant contribution of radiation from interplanetary space.

Fourier referred to an experiment by M. de Saussure, who exposed a black box to sunlight. When a thin sheet of glass is put on top of the box, the temperature inside of the box increases. Infrared radiation was discovered by William Herschel twenty five years later.