Siméon Denis Poisson

Quick Info

Born
21 June 1781
Pithiviers, France

Died
25 April 1840
Sceaux (near Paris), France

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Summary
Siméon-Denis Poisson worked on definite integrals and Fourier series. This was the foundation of later work in this area by Dirichlet and Riemann.

Biography

Siméon-Denis Poisson's parents were not from the nobility and, although it was becoming increasingly difficult to distinguish between the nobility and the bourgeoisie in France in the years prior to the Revolution, nevertheless the French class system still had a major influence on his early years. The main reason for this was that the army was one of the few occupations where the nobility enjoyed significant institutional privileges and Poisson's father had been a soldier. Certainly Poisson's father was discriminated against by the nobility in the upper ranks of the army and this made a large impression on him. After retiring from active service he was appointed to a lowly administrative post which he held at the time that his son Siméon-Denis was born. There is no doubt that Siméon-Denis's family put a great deal of energy into helping him have a good start in life.

Siméon-Denis was not the first of his parents children but several of his older brothers and sisters had failed to survive. Indeed his health was also very fragile as a child and he was fortunate to pull through. This may have been because his mother, fearing that her young child would die, entrusted him to the care of a nurse to bring him through the critical period. His father had a large influence on his young son, devoting time to teach him to read and write.

Siméon-Denis was eight years old when the Parisian insurrection of 14 July 1789 heralded the start of the French Revolution. As might be expected of someone who had suffered discrimination at the hands of the nobility, Poisson senior was enthusiastic about the political turn of events. One immediate consequence for his support of the Revolution was the fact that he became president of the district of Pithiviers which is in central France, about 80 km south of Paris. From this position he was able to influence the future career of his son.

Poisson's father decided that the medical profession would provide a secure future for his son. An uncle of Poisson's was a surgeon in Fontainebleau and Poisson was sent there to become an apprentice surgeon. However, Poisson found that he was ill suited to be a surgeon. Firstly he lacked coordination to quite a large degree which meant that he completely failed to master the delicate movements required. Secondly it was quickly evident that, although he was a talented child, he had no interest in the medical profession. Poisson returned home from Fontainebleau having essentially failed to make the grade in his apprenticeship and his father had to think again to find a career for him.

Times were changing quite quickly in France which was by this time a republic. No longer were certain professions controlled by the nobility as they had been and there had been moves towards making education available to everyone. In 1796 Poisson was sent back to Fontainebleau by his father, this time to enrol in the École Centrale there. On the one hand he had shown a great lack of manual dexterity, but he now showed that he had great talents for learning, especially mathematics. His teachers at the École Centrale were extremely impressed and encouraged him to sit the entrance examinations for the École Polytechnique in Paris. He sat these examinations and proved his teachers right, for although he had far less formal education than most of the young men taking the examinations he achieved the top place.

Few people can have achieved academic success as quickly as Poisson did. When he began to study mathematics in 1798 at the École Polytechnique he was therefore in a strong position to cope with the rigours of a hard course, yet overcome the deficiencies of his early education. There were certainly problems for him to overcome for he had little experience of the social or academic environment into which he was suddenly thrust. It was therefore to his credit that he was able to undertake his academic studies with great enthusiasm and diligence, yet find time to enjoy the theatre and other social activities in Paris. His only weakness was the lack of coordination which had made a career as a surgeon impossible. This was still a drawback to him in some respects for drawing mathematical diagrams was quite beyond him.

His teachers Laplace and Lagrange quickly saw his mathematical talents. They were to become friends for life with their extremely able young student and they gave him strong support in a variety of ways. A memoir on finite differences, written when Poisson was 18, attracted the attention of Legendre. However, Poisson found that descriptive geometry, an important topic at the École Polytechnique because of Monge, was impossible for him to succeed with because of his inability to draw diagrams. This would have been an insurmountable problem had he been going into public service, but those aiming at a career in pure science could be excused the drawing requirements, and Poisson was not held back. In his final year of study he wrote a paper on the theory of equations and Bézout's theorem, and this was of such quality that he was allowed to graduate in 1800 without taking the final examination. He proceeded immediately to the position of répétiteur in the École Polytechnique, mainly on the strong recommendation of Laplace. It was quite unusual for anyone to gain their first appointment in Paris, most of the top mathematicians having to serve in the provinces before returning to Paris.

Poisson was named deputy professor at the École Polytechnique in 1802, a position he held until 1806 when he was appointed to the professorship at the École Polytechnique which Fourier had vacated when he had been sent by Napoleon to Grenoble. In fact Poisson had little time for politics for rather his whole energies were directed to support mathematics, science, education and the École Polytechnique. When the students at the École had been about to publish an attack on Napoleon's ideas for the Grand Empire in 1804, Poisson had managed to stop them, not because he supported Napoleon's views but rather because he saw that the students would damage the École Polytechnique by their actions. Poisson's motives were not understood by Napoleon's administration, however, and they saw Poisson as a supporter which did his career no harm at all.

During this period Poisson studied problems relating to ordinary differential equations and partial differential equations. In particular he studied applications to a number of physical problems such as the pendulum in a resisting medium and the theory of sound. His studies were purely theoretical, however, for as we mentioned above, he was extremely clumsy with his hands [19]:-

> *Poisson ... was content to remain totally unfamiliar with the vicissitudes of experimental research. It is quite unlikely that he ever attempted an experimental measurement, nor did he try his hand at drafting experimental designs.*

His first attempt to be elected to the Institute was in 1806 when he was backed by Laplace, Lagrange, Lacroix, Legendre and Biot for a place in the Mathematics Section. Bossut was 76 years old at the time and, had he died, Poisson would have gained a place. However Bossut lived for another seven years so there was no route into the mathematics section for Poisson. He did, however, gain further prestigious posts. In addition to his professorship at the École Polytechnique, in 1808 Poisson became an astronomer at Bureau des Longitudes. In 1809 he added another appointment, namely that of the chair of mechanics in the newly opened Faculté des Sciences.

In 1808 and 1809 Poisson published three important papers with the Academy of Sciences. In the first *Sur les inégalités des moyens mouvements des planètes* Ⓣ he looked at the mathematical problems which Laplace and Lagrange had raised about perturbations of the planets. His approach to these problems was to use series expansions to derive approximate solutions. This was typical of the type of problem which he found interesting. Libri wrote [1]:-

> *... he especially liked unresolved questions that had been treated by others or areas in which there was still work to be done.*

In 1809 he published two papers, the first *Sur le mouvement de rotation de la terre* Ⓣ and the second, *Sur la variation des constantes arbitraires dans les questions de mécanique* Ⓣ was a direct consequence of developments in Lagrange's method of variation of arbitrary constants which had been inspired by Poisson's 1808 paper. In addition he published a new edition of Clairaut's *Théorie de la figure de la terre* Ⓣ in 1808. The work had been first published by Clairaut in 1743 and it confirmed the Newton-Huygens belief that the Earth was flattened at the poles. In 1811 Poisson published his two volume treatise *Traité de mécanique* Ⓣ which was an exceptionally clear treatment based on his course notes at the École Polytechnique.

Malus was known to have a terminal illness by 1811 and his death would leave a vacancy in the physics section of the Institute. The mathematicians, aiming to have Poisson fill that vacancy when it occurred, set the topic for the Grand Prix on electricity so as to maximise Poisson's chances. The topic for the prize was as follows (see for example [20]):-

> *To determine by calculation and to confirm by experiment the manner in which electricity is distributed at the surface of electrical bodies considered either in isolation or in the presence of each other - for example at the surface of two electrified spheres in the presence of each other. In order to simplify the problem, the Class asks only for an examination of cases where the electricity spread on each surface remains always of the same kind.*

Poisson had made considerable progress with the problem before Malus died on 24 February 1812. Poisson submitted the first part of his solution to the Academy on 9 March entitled *Sur la distribution de l'électricité à la surface des corps conducteurs* Ⓣ. As the mathematicians had intended, this was the deciding factor in Poisson being elected to the physics section of the Institute to replace Malus. It also marked a move away from experimental research towards theoretical research in what was considered to constitute physics, and in this the Institute was following the lead given by Laplace.

Poisson continued to add various responsibilities to his already busy life. In 1815 he became examiner for the École Militaire and in the following year he became an examiner for the final examinations at the École Polytechnique.

It is remarkable how much work Poisson put in; to his research, to his teaching and to playing an ever increasingly important role in the organisation of mathematics in France. When he married Nancy de Bardi in 1817 he found that family life put yet another pressure on him yet somehow he survived the pressures continuing to take on further duties. His research contributions covered a wide range of applied mathematics topics. Although he devised no innovative new theories, he made major contributions to further developing the theories of others often being the first to exhibit their real significance. We mention now just a few of the topics he studied after his election to the Academy.

In 1813 Poisson studied the potential in the interior of attracting masses, producing results which would find application in electrostatics. He produced major work on electricity and magnetism, followed by work on elastic surfaces. Papers followed on the velocity of sound in gasses, on the propagation of heat, and on elastic vibrations. In 1815 he published a work on heat which annoyed Fourier who wrote:-

> *Poisson has too much talent to apply it to the work of others. To use it to discover what is already known is to waste it ...*

Fourier went on to make valid objections to Poisson's arguments which he corrected in later memoirs of 1820 and 1821.

In 1823 Poisson published on heat, producing results which influenced Sadi Carnot. Much of Poisson's work was motivated by results of Laplace, in particular his work on the relative velocity of sound and his work on attractive forces. This latter work was not only influenced by Laplace's work but also by the earlier contributions of Ivory. Poisson's work on attractive forces was itself a major influence on Green's major paper of 1828 although Poisson never seems to have discovered that Green was inspired by his formulations.

In *Recherches sur la probabilité des jugements en matière criminelle et matière civile* Ⓣ, an important work on probability published in 1837, the Poisson distribution first appears. The Poisson distribution describes the probability that a random event will occur in a time or space interval under the conditions that the probability of the event occurring is very small, but the number of trials is very large so that the event actually occurs a few times. He also introduced the expression "law of large numbers". Although we now rate this work as of great importance, it found little favour at the time, the exception being in Russia where Chebyshev developed his ideas.

It is interesting that Poisson did not exhibit the chauvinistic attitude of many scientists of his day. Lagrange and Laplace recognised Fermat as the inventor of the differential and integral calculus; he was French after all, while neither Leibniz nor Newton were! Poisson, however, wrote in 1831:-

> *This [differential and integral] calculus consists in a collection of rules ... rather than in the use of infinitely small quantities ... and in this regard its creation does not predate Leibniz, the author of the algorithm and of the notation that has generally prevailed.*

He published between 300 and 400 mathematical works in all. Despite this exceptionally large output, he worked on one topic at a time. Libri writes

[1]:-

> *Poisson never wished to occupy himself with two things at the same time; when, in the course of his labours, a research project crossed his mind that did not form any immediate connection with what he was doing at the time, he contented himself with writing a few words in his little wallet. The persons to whom he used to communicate his scientific ideas know that as soon as he had finished one memoir, he passed without interruption to another subject, and that he customarily selected from his wallet the questions with which he should occupy himself. To foresee beforehand in this manner the problems that offer some chance of success, and to be able to wait before applying oneself to them, is to show proof of a mind both penetrating and methodical.*

Poisson's name is attached to a wide variety of ideas, for example:- Poisson's integral, Poisson's equation in potential theory, Poisson brackets in differential equations, Poisson's ratio in elasticity, and Poisson's constant in electricity. However, he was not highly regarded by other French mathematicians either during his lifetime or after his death. His reputation was guaranteed by the esteem that he was held in by foreign mathematicians who seemed more able than his own colleagues to recognise the importance of his ideas. Poisson himself was completely dedicated to mathematics. Arago reported that Poisson frequently said:-

> *Life is good for only two things, discovering mathematics and teaching mathematics.*

Quotations by Siméon-Denis Poisson
Other Mathematicians born in France
A Poster of Siméon-Denis Poisson

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