

Henri Poincaré

[Jules] **Henri Poincaré** (April 29, 1854 – July 17, 1912) was one of France's most important theoretical scientists and one of its greatest geniuses. He published 500 papers and more than 30 books. In *Men of Mathematics*, Eric Temple Bell dubbed Poincaré “the Last Universalist.” He made far-reaching contributions to both pure and applied mathematics in almost all their branches. He contributed so much to the central concepts of “analysis situs” that many considered him the originator of algebraic topology. Poincaré was a pioneer in hyperbolic geometry and is considered the originator of analytic functions of several complex variables. His inventive qualitative methods in the study of differential equations enabled him to transform celestial mechanics. His generalization of the *three-body problem* prefigured a subject of considerable current interest, dynamical systems and chaos. In mathematical physics, he earned credit as a co-discoverer, with Albert Einstein and Hendrik Lorentz, of the special theory of relativity.



The famous “Poincaré conjecture” states that “every simply connected closed 3-manifold is homeomorphic to the 3-sphere,” that is, topologically they are identical. It remained unsolved for 99 years but in April 2003, Russian mathematician Grigori Perelman of the Steklov Institute of Mathematics of the Russian Academy of Sciences in St. Petersburg announced a proof of the Thurston Geometrization conjecture (named after William Thurston, who first proposed it in the late 1970s), of which the “Poincaré conjecture” is a special case. Perelman worked alone for eight years developing his techniques and proof, which if it stands the scrutiny of the mathematical world, will make him eligible for a Clay Mathematics Institute one million dollar prize.

Henri Poincaré's father was a Professor of Medicine at the University of Nancy, and his cousin Raymond Poincaré was prime minister of France several times and president of the French Republic during WWI. In 1862 Henri attended the Lycée in Nancy, which has since been renamed in his honor. He was considered a top student in all subjects, but was described by his mathematics teacher as a "monster of mathematics." He entered the École Polytechnique in 1873 and later studied at the École des Mines, from which he received his doctorate in mathematics in 1879 for a dissertation on differential equations under the supervision of Charles Hermite. Poincaré immediately accepted a position at the University of Caen, where his lecturing was considered disorganized. Two years later he was appointed to a chair in the Faculty of Science in Paris. In 1886 he was nominated for the chair of mathematical physics and probability at the Sorbonne. Hermite's intervention secured the position for him as well as getting him appointed to a chair at the École Polytechnique.

Poincaré suffered throughout his life from severe health problems. As a child he was nearsighted, had poor muscular control and was seriously ill for a time with a bout of diphtheria. Fortunately he had a remarkable memory and a rare ability to visualize, a valuable talent when, as a student attending lectures, his eyesight was so poor that he could not see what the instructors were writing on the blackboard. Poincaré kept very precise working hours. He did mathematical research four hours a day, from 10 a.m. to noon and then again from 5 p.m. to 7 p.m. One of his lectures, which he gave to l'Institut Général Psychologique in Paris in 1908, entitled *Mathematical Invention* is a fascinating examination of his own thought processes.

Poincaré's writings were not the result of careful planning. He merely began, often without a firm understanding of where his ideas would lead him. If he found the beginning part of his creation easy, he continued until he came to satisfactory conclusions. If the beginning did not go well, he would abandon

the attempt. Despite his tremendous influence on the mathematics of his time, he never founded his own school of thought because he did not have doctoral students. Nonetheless, he achieved the highest honors for his contributions. Poincaré was the only member of the *Académie des Sciences* to be elected to every one of the five sections of the Academy, namely geometry, mechanics, physics, geography, and navigation.

In 1908, Poincaré was elected to membership of the literary section of the *Académie Française* for the literary quality of his popular essays on probability theory. Philosophers know him for his forceful development of the doctrine of conventionalism, which maintains that there is an objective criterion, independent of the scientist's will, according to which it is possible to judge the soundness of the scientific theory, namely the accuracy of its predictions. Thus the principles of science are not set by an arbitrary convention. However, according to Poincaré, every scientific law can be analyzed into two parts, a *principle*, that is, a conventional truth, and an *empirical law*, that is, one that can be demonstrated by experiment. In his analysis on classic mechanics in *Science and Hypothesis*, he wrote:

“Are the laws of acceleration and composition of forces nothing but arbitrary conventions? Conventions, yes; arbitrary, no; they would seem arbitrary if we forgot the experiences which guided the founders of science to their adoption and which are although imperfect, sufficient to justify them. Sometimes it is useful to turn our attention to the experimental origin of these conventions.”

Poincaré suffered from a distressing prostate illness during the last four years of his life. Surgeons operated on him and for a time it was believed that he had been cured, but in the spring of 1912, he fell ill again and underwent a second operation. Even though the operation was successful he died a week later from an embolism. Only a short time before, perhaps with premonitions of his death, he wrote to the editor of a mathematical journal with the unusual request that an unfinished memoir of his be

accepted. He claimed it was a rather important piece of work and he wasn't sure he would have time to finish it. He was correct in this. Shortly after the publication of Poincaré's unfinished memoir, American mathematician George David Birkhoff experienced the first great highlight of his distinguished mathematical career when he proved Poincaré's so-called "last geometric theorem."

Quotation of the Day: "A scientist worthy of the name, above all a mathematician, experiences in his work the same impression as an artist; his pleasure is as great and of the same nature." – Henri Poincaré