André Weil

André Weil (May 6, 1906 – August 6, 1998) was one of the most brilliant and influential mathematicians of the 20th century. He made notable advances in the areas of algebra, number theory, algebraic geometry, differential geometry, topology, Lie groups and Lie algebras, analysis, and history of mathematics. A substantial part of his research was motivated by his efforts to prove the Riemann hypothesis regarding the zeros of the zeta function. He discovered a profound connection between topology and number theory, and formulated the so-called Shimura-Taniyama-Weil conjecture on elliptic curves. The conjecture was used by Andrew Wiles as a link in the proof of Fermat's Last Theorem. In 1994, Weil received Japan's Kyoto Prize, awarded for what he called the Weil Conjectures. The conjectures, formulated in 1948, articulated his grand vision of how arithmetic and geometry should be linked. Alexandre Grothendieck and Pierre Deligne later proved the conjectures, which have provided the principles for modern algebraic geometry and laid the foundation for the elements of coding theory as an aid to the transmission of computer data.

Weil was born in Paris, the son of Jewish parents. He was a child prodigy as was his younger sister, Simone. He early exhibited precocious mathematical and philological interests. He thought of making a career of philosophy, but after shining on an examination in the subject without having done the required reading, he changed his mind. He reasoned that a field in which "one could do so well while barely knowing what one was talking about was hardly worthy of respect." Most of his mathematical education was acquired at the École Normale Superieure in Paris, which he entered at the age of sixteen. It was while at the École Normale that Weil was introduced to the *Bhagavad-Gita*, an epic Indian poem, which became the foundation of his personal philosophy.

During 1925-26, Weil spent six months in Rome with Vito Volterra and Francesco Severi, becoming familiar with the algebraic geometry of Italian mathematicians. He spent part of the next year in Germany on a fellowship at Göttingen, studying the number theory of German mathematicians. Weil received his D.Sc. in 1928 from the University of Paris for solving a problem concerning elliptic curves that had been proposed by Henri Poincaré. Weil spent the year 1928-29 doing his compulsory military service and left as a lieutenant in the reserves. He taught mathematics at the Aligarh Muslim University in India (1930 to 1932), at the University of Marseille (1932-33), followed by an appointment with the University of Strasbourg (1933 to 1939).

Weil was convinced that with the exception of Jacques Hadamard and Élie Cartan, his professors in Paris were out of touch with recent developments in mathematics. In the 1930's, together with Henri Cartan, Weil co-founded a group of young French mathematicians from the École Normale, working under the name "Nicolas Bourbaki." The group was dedicated to the production of a collective work, providing up-to-date foundations for the whole of modern mathematical science. Its founding members included Henri Cartan, Claude Chevalley, and Jean Dieudonné. After World War II, other mathematicians were invited to join the group, including Samuel Eilenberg, an exception to the unwritten rule of restricting Bourbaki to Frenchmen. Eilenberg was known to his friends of his youth as S^2P^2, for Smart Sammy the Polish Prodigy. The Bourbaki group produced volume after volume in the series *Elements of Mathematics*, in an attempt to synthesize the content of one mathematical subject after another.

According to Cartan, by the end of the seventies, Bourbaki's method was understood, and many textbooks were being written in its style. In 1983 Bourbaki published the last of its 40 volumes: *IX*

Spectral Theory. Cartan said by that time “Bourbaki was a dinosaur, the head too far away from the tail.” In an article on Nicolas Bourbaki, Émilie Richer concluded by saying, “Now after almost twenty years without a significant publication is it safe to say the dinosaur has become extinct? But since Nicolas Bourbaki never in fact existed, and was nothing but a clever teaching and research ploy, could he ever be said to be extinct?” International Bourbaki seminars are held three times a year, hosting over 200 mathematicians who listen to presentations on topics chosen by Bourbaki.

There are many legends surrounding the choice of the pseudonym “Nicolas Bourbaki” for a collection of French mathematicians. It is said that the inspiration came from an army officer of the Franco-Prussian war, General Charles Dennis Sauter Bourbaki, who, at the age of 46, declined the offer to become king of Greece. Weil’s wife added the given name “Nicolas” for reasons no one remembers. The founding members and those who followed (which number between ten and twenty at a time, with a mandatory retirement age of fifty), so enjoyed their joke that they have given Bourbaki a personality and a history. It is said that Bourbaki was born in the (mythical) country of Poldavia. Weil’s official Institute for Advanced Studies’ biography omitted mention of his many awards and honors, listing him only as a “Member, Poldavian Academy of Sciences.” Bourbaki is said to reside in Nancy, France, which is fitting since several of the mathematicians who have worked under his name were associated with the University of Nancy. When Nicolas Bourbaki was listed as author of “The Architecture of Mathematics” in *The American Mathematical Monthly* (1950), his home institution was given as the “University of Nancago” (Nancy plus Chicago) for at that time Weil was on the faculty of the University of Chicago. Jean Dieudonné, Bourbaki’s chief scribe from the beginning, once explained how the group‘s cooperative volumes get written. Once a subject is identified, one member is assigned to write a draft, which is then presented at a group meeting where it is criticized mercilessly. The draft is then discarded and another member is recruited to write a new draft, completely from scratch,

mindful of the errors and mistakes of his predecessor. This process is continued until a draft is unanimously deemed worthy of publication. Each member has veto power, and a veto means the project is abandoned.

During WWII, Weil was a conscientious objector and fled to neutral Finland once war was declared. After the Russian invasion of Finland in 1939, Weil was arrested on the apparently spurious charge of being a Russian spy. The day before he was scheduled to be executed, the chief of police happened to mention to Finnish mathematician Rolf Nevanlinna that "tomorrow we are executing a spy who says he knows you." Nevanlinna intervened and Weil was deported instead to Sweden, thus sparing his life. Sweden sent him back to France in 1940, where he was arrested, convicted of failure to report for duty, and sentenced to five years in prison. While in jail for six months at Rouen, he proved the Riemann hypothesis for curves over finite fields. As the French military was being crushed on the battlefields by the Germans, Weil feared for his life, partly because of his Jewish background and partly because his sister, the renowned philosophical writer and mystic Simone Weil, was a leading figure in the French Resistance movement. She died in 1943 from voluntary starvation in an attempt to identify with her compatriots suffering in Nazi occupied France. Deciding the army to be the lesser of two evils Andre Weil gained his release from prison on the condition that he agreed to join a combat unit.

After the Franco-German armistice, Weil's regiment was evacuated to England, where the troops had the choice of joining de Gaulle's army or to be deported from England. Weil's military unit was delayed in reaching the rendezvous point for the voyage back to unoccupied France and was left behind. He was in London during the Luftwaffe's daily bombing raids. In 1941, he returned to France and was reunited with his wife and young son. Using a card he fabricated while in England, he managed to get himself discharged, but he feared he might be required to serve the remainder of his

suspended sentence. Somehow he was able to arrange for visas to the United States for himself and family. He briefly found work at Princeton, then Haverford College, followed by Swarthmore and Lehigh. During the years 1945-1947, he was on the faculty of São Paulo University in Brazil. On returning to the United States, he joined the faculty of the University of Chicago, remaining there until 1958, finally settling at the Institute for Advanced Studies at Princeton where he remained until his retirement in 1976. Weil was still active as professor emeritus at the Institute until a few years before his death. Among his most famous books are *Foundations of Algebraic Geometry* (1946) and *Elliptic Functions According to Eisenstein and Kronecker* (1976). After his wife Eveline died in 1986, he wrote an outstanding autobiography, *The Apprenticeship of a Mathematician* (1992).

Quotation of the Day: "Rigor is to the mathematician what morality is to man. It does not consist in proving everything, but in maintaining a sharp distinction between what is assumed and what is proved, and in endeavoring to assume as little as possible at every stage." – André Weil