Adolf Hurwitz

German mathematician **Adolf Hurwitz** (March 26, 1859 – November 18, 1919) was enamored of the deductive method of exposition, both in his writing and lectures. He was among the first prominent mathematicians to recognize uses for Georg Cantor's new theory of sets, indicating important applications of the theory of transfinite numbers to analysis. Hurwitz had the distinction of being a strong influence in the mathematical development of David Hilbert and Herman Minkowski, as well as exerting a decisive impact on Einstein. Hurwitz was born at Hildesheim, Hanover where he attended the Gymnasium. His mathematics teacher Hermann Schubert developed enumerative geometry in *Kalkül der abzählenden Geometrie* (1879).

A problem dating to the time of Apollonius deals with determining the number of curves or surfaces, which touch or cut other curves or surfaces subject to certain conditions. The study was revitalized when Schubert generalized and algebraized the theory into a study of the number of objects, such as tangent points, common to sets of geometrical objects. Enumerative geometry didn't thrive until the 1930s, when a new phase of research in topology and abstract algebra subsumed enumerative geometry under algebraic geometry. Enumerative geometry is that part of algebraic geometry that considers problems that have a finite number of solutions. It has been used to solve mathematical problems such as calibrating robotic systems and obtaining very subtle estimates of the complexity of the aspect graph, an object representation in computer vision. Before graduating, Hurwitz collaborated on a paper in the field with his teacher.

A little before his eighteenth birthday, Hurwitz attended the lectures of Felix Klein at the Munich Technical Institute and learned of the ideas of Riemann, who had died only a short time earlier. A year later, Hurwitz was at Berlin to attend seminars of Kummer, Weierstrass and Kronecker. Hurwitz considered himself to be a student of Klein, and after three semesters at Berlin, he returned to Munich and then followed Klein to Leipzig. Hurwitz's 1881 Ph.D. thesis, supervised by Klein, was on elliptic modular functions. These are functions that are automorphic with respect to the modular group or a subgroup of the modular group (consisting of transformations of the form $w = (az + b)/(cz + d)$, with $ad - bc = 1$, with a, b, c, and d real integers), and which is single-valued and analytic in the upper half of the complex plane except at the poles.

For two years Hurwitz was a Göttingen *Privatdozent*, before accepting an invitation from Carl Lindemann to fill a chair at Königsberg. By this time, Hurwitz had established a record of publishing important papers, marking him as a first class mathematician. Among his students at Königsberg were Hilbert and Minkowski. During long walks, Hurwitz became the younger men's guide as they explored almost ever corner of the known mathematical world. It is said they extended their discussions to include philosophy and women. In 1892, when Georg Frobenius left his chair at the Eidgenössiche Polytenikum in Zurich, Hurwitz took the vacant position and remained there for the rest of his life. He also married the daughter of one of the institution's medical professors. Throughout his life Hurwitz suffered from poor health, being afflicted with severe migraine headaches, and twice-contracting typhoid fever. In 1905, he had one kidney removed and the remaining one did not function properly. His health problems were the likely reason that he was not called to a professorship in his homeland. At the time, a chair in a Swiss university was considered a stepping-stone to one in Germany.

Klein, who influenced most of Hurwitz's papers, described his student as an "aphoristician." An

aphorism is a short concise statement or principle expressing a wise or clever observation of a general truth. Hurwitz's papers were like aphorisms, in that he gave surprisingly simple solutions to weighty problems, presented in what appeared to be the only way possible. He wrote on a variety of subjects including abstract groups, complex function theory, Fourier series, continued fractions, approximate representations of irrational numbers, the theory of ideals, quaternions, theory of invariants, and the solution of Diophantine equations.

Quotation of the Day: "A Ph.D. dissertation is a paper of the professor written under aggravating circumstances." – Adolf Hurwitz