Princeton University

Honors Faculty Members
Receiving Emeritus Status

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colleagues in the departments of those honored.

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Simon Bernard Kochen

Simon (Si) Bernard Kochen is a major figure in mathematics, whose startling contributions in areas of mathematical logic, model theory, number theory, and quantum mechanics are well known to mathematicians, and of an interest to many who are not professional mathematicians.

Si was born in Antwerp, Belgium. Fleeing from the Nazis, his family was saved due to the selfless bravery of a Norwegian ship captain, who took them from Calais to England. Si grew up in England and attended grammar school there, before emigrating to Canada. He earned his bachelor's and master's degrees at McGill University, then came as a graduate student to Princeton, where he earned his Ph.D. in 1959 for a thesis in mathematical logic directed by Alonzo Church. He then joined the faculty at Cornell University, rising to professor by 1965, but returned to Princeton in 1967 as a professor of mathematics, where he has remained until retiring this year. During his years at Cornell and Princeton he was a Guggenheim Fellow at the E.T.H. in Zurich in 1962–1963, a member of the Institute for Advanced Study in 1966–1967 and 1978–1979, and Scientific Research Council Fellow at the University of Oxford in 1973–1974. At Princeton he held the Henry Burchard Fine Research Professorship in Mathematics in 1994–1995 and in 2001. He served as chair of the mathematics department from 1990 to 1993; after that and until his retirement this year he continued to serve the department as departmental representative and associate chair with general responsibility for the undergraduate academic program in mathematics. He was extraordinarily effective in this role, significantly increasing the number of mathematics majors and the quality of undergraduate teaching in the department.

Si is widely known for three very important and striking results in mathematics, applying techniques of mathematical logic to problems in a variety of fields with results to which he has left his name as a lasting memorial. The first of these is the Ax-Kochen Theorem, a famous result for which he and James Ax in 1967 shared the Frank Nelson Cole Prize in Number Theory, a prize awarded every five years by the American Mathematical Society. This result was developed in a distinguished series of papers applying p-adic techniques and model theory to problems of Diophantine number theory. Emil Artin had conjectured that for any integer d and for all primes p, every homogeneous polynomial of degree d over the p-adic numbers in at least $d^2 + 1$ variables has a nontrivial zero. What Ax and Kochen proved, by extraordinary model-theoretic methods, is that the Artin conjecture is true for all but a finite number of primes; later a counterexample to the full conjecture was found by Guy Terjanian. Si's subsequent work in that area led to what are now known as the Kochen ring and the Kochen operator in number theory.

The second result also dates from 1967, when Si and Ernst Specker proved the Kochen-Specker Theorem in quantum mechanics, a result that imposes constraints on the permissible types of hidden variable theories that attempt to explain some of the peculiarities and indeterminacy of quantum mechanics through deterministic models involving hidden states. This theorem demonstrates a contradiction between basic assumptions of hidden variable theories and the predictions of quantum theory. It was a major contribution to the longstanding history of debates about quantum mechanics, going back to Einstein's doubts about that most puzzling of the theories of physics. The prediction of quantum mechanics on which the Kochen-Specker Theorem was based has been confirmed by a recent experiment.

The third result, a strengthening of the Kochen-Specker Theorem that has aroused even more widespread interest among both mathematicians and non-mathematicians, is the more recent work by Si and John Conway on the Free Will Theorem. That theorem amounts roughly to the assertion that if human experimenters have a certain amount of free will then so do elementary particles. The notion of free will is the same for both humans and particles: their actions are not predetermined functions of the past. As might have been expected, this result has aroused a great deal of interest, and a great many debates, about what it really means.

It rests on three rather basic and generally agreed upon axioms. Given these axioms, it follows that if physicists are free to make choices about what measurements to take in experiments in physics then the results of the measurements cannot be determined by anything previous to the experiments. In that sense it quite strongly implies that there are no hidden variables possible in quantum mechanics.