

Nathan Rosen (1909 - 1995)



Nathan Rosen, 1909--1995

Nathan Rosen died in his sleep on 18 December 1995. He had been active in research until his last day, regularly publishing papers in Physics journals (his last two articles have yet to appear). He had taught his General Relativity course until 1991.

Nathan Rosen was born in Brooklyn, N.Y., in 1909, and was educated at M.I.T. (Sc.B., Electromechanical Engineering, 1929, Sc.M., Physics, 1931, Sc.D., Physics, 1932). As a student, he wrote several remarkable papers. One of them, entitled "The Neutron" [1], discussed the hypothetical properties of a composite system, consisting of a proton and a negative particle, tightly bound to it and described by the Klein-Gordon equation. Had the pion been known at that time, this would have given an almost correct prediction of the neutron properties, one year before its experimental discovery by Chadwick. Unfortunately, the only known negative particle was the electron, and that theoretical "neutron" never materialized.

Another article, this one of lasting value, was the first reliable calculation of the structure of the hydrogen molecule [2]. In that work, Rosen used "entangled" wave-functions, which could not be written as products of separate wave-functions for the two electrons in the molecule. None of the electrons had a definite quantum state, only the *pair* had a pure state. These entangled functions were to play a crucial role in Rosen's work with Einstein a few years later.

In 1934--36, Nathan Rosen was the assistant of Albert Einstein at the Institute for Advanced Study in Princeton, where they co-authored several articles. These were among the most important of Einstein's contributions to science during the second half of his life. One of these article involved entangles wave-functions, with which Rosen was so familiar. He pointed out to Einstein some of their bizzare properties, and after further collaboration with Boris Podolsky, the celebrated Einstein-Podolsky-Rosen paradox was born [3]. The implications of this paper have been discussed ever

since, first as a philosophical problem, more recently in relation to their potential technical applications for secure communication (quantum cryptography).

Another seminal work, later dubbed the "Einstein-Rosen bridge" [4], was a precursor of the general relativistic wormhole. From that time on, Rosen's main interest was the theory of gravitation. In 1936-38, he briefly worked in the Soviet Union, as many other young physicists at that time (he was a Professor of Physics at the University of Kiev). He then returned to the United States. From 1941-1952, he taught at the University of North Carolina.

In 1953, Nathan Rosen permanently moved to Israel. He joined the Technion, and played a pivotal role in the transformation of this small technical college into a major scientific and technological institution. He was, at various times, Dean of Graduate School, Dean of the Faculty of Science, Head of the Physics Department and Head of the Department of Nuclear Engineering. In 1969-71, he was the Dean of Engineering at the University of the Negev in Beer-Sheva (now Ben-Gurion University), while the latter was being set up. In 1977, he was awarded the title "Distinguished Professor" at the Technion.

Nathan Rosen was one of the founders of the Israel Academy of Sciences and Humanities, of the Physical Society of Israel (of which he was president in 1955-57), and of the International Society for General Relativity and Gravitation (its president, 1974-77).

Those who had the privilege of knowing Nathan personally will always remember his kindness, modesty, integrity, and his keen sense of humor. He will be sorely missed by all his friends.

Nathan Rosen was Asher's PhD supervisor, his mentor and admired model. When Nathan died, he was buried in the old part of the Haifa cemetery, in the last row, near the fence (in Jewish tradition, being buried near the fence is considered a humiliation). The professors of the Physics department were very angry, and Jacques Goldberg said that "we should all ask to be buried here, this is a place of honor". So Asher and Aviva went to the cemetery authorities and bought the place next to Nathan's grave, and Asher was buried next to his beloved teacher.

The above is Asher's obituary of Nathan, from Foundations of Physics. Asher read a Hebrew translation of this obituary at the Technion Senate meeting on December 24, 1995. The last paragraph was quoted by Yosi Avron in his obituary of Asher at the Technion Senate meeting on January 16, 2005.

Nathan Rosen most significant publications

[1] R. M. Langer and N. Rosen, "The neutron", *Phys. Rev.* **37** 1579, (1931).

[2] N. Rosen, "Normal state of the hydrogen molecule", *Phys. Rev.* **38** 2099 (1931).

[3] A. Einstein, B. Podolsky, and N. Rosen, "Can quantum-mechanical description of physical reality be considered complete?", *Phys. Rev.* **47** 777 (1935).

[4] A. Einstein and N. Rosen, "The particle problem in the general theory of relativity", *Phys. Rev.* **48** 73 (1935).