NATHAN ROSEN: 1909–1995

Nathan Rosen was born in Brooklyn, New York, at the end of the first decade of the twentieth century; he deceased in Haifa on 18 December 1995, just four years short of the turn of the century.

His life elapsed in an epoch of profound revolutionary changes in our understanding of the laws of nature, in a time when totally new physical theories made their appearance. The framework of new theories, called the physics of the twentieth century, was presented by several founding fathers during the first quarter of the century. It was further worked out and developed by brilliant young physicists, some of whom themselves became leaders and giants in the course of time. Nathan Rosen belongs to this pleiad of giants. His outstanding scientific activity, his creativity, his vitality, as well his typical kindly gentlemanly manner made him a paragon and a source of inspiration for generations of young scholars.

Ever since Nathan Rosen and his family made Aliya to Israel in 1953, he was deeply involved in the organization and guidance of institutions of higher education and physical research in this country. At the Technion he was, at various times, Dean of the Graduate School, Dean of the Faculty of Science, and Dean of the Department of Physics. Responding to a request of David Ben-Gurion, the first prime minister of Israel, Nathan Rosen held the post of Dean of the Faculty of Engineering at the University of Negev (now the Ben-Gurion University) in Beer-Sheva, while this institution was being set up, during 1969–1971. He was also one of the founders of the Israel Academy of Sciences and Humanities, founder (and president in 1955–1957) of the Physical Society of Israel, and one of the founders of the International Society for General Relativity and Gravitation (and its president in 1974–1977). In 1977 Nathan Rosen became Distinguished Professor at the Technion.

The scientific activity of Nathan Rosen began with several remarkable works written by the young student. In one of those earlier papers [R.M. Langer and N. Rosen, “The neutron,” Phys. Rev. 37, 1579 (1931)], a system consisting of a proton and a negative particle was considered. That system was described by the Klein-Gordon equation and, with the present pion, one could obtain a realistic description of the neutron discovered by James Chadwick in 1932.

In 1934–1936 Nathan Rosen worked as Albert Einstein’s assistant at the Institute of Advanced Studies in Princeton. Rosen was deeply impressed by the personality of this great scientist and
humanist. The fruitful cooperation during the Princeton period be-
got several fundamental works, which had a remarkable influence on
physical conceptions in the following decades. From one [A. Einstein,
B. Podolsky, and N. Rosen, "Can quantum-mechanical description of
physical reality be considered complete?" *Phys. Rev.* 47, 777 (1935)]
the celebrated Einstein-Podolsky-Rosen paradox arose. In another
paper [A. Einstein, and N. Rosen, "The particle problem in the gen-
finds the basic concepts of the "Einstein-Rosen bridge," a precur-
sor of the present general-relativistic wormholes. In a third work
[A. Einstein, and N. Rosen, "On gravitational waves," *J. Franklin
Inst.* 223, 43 (1937)], for the first time, a deep, basic discussion of
that phenomenon was presented and an exact solution for cylindri-
cal gravitational waves was obtained. In this paper, the well-known
Einstein-Rosen metric was derived.

From that time on, Rosen's main scientific interest was the
theory of general relativity, alternative theories of gravitation, unified
theories of gravitation and electromagnetism, cosmology, and related
problems.

The writer of the present tribute had the great privilege to
meet Nathan Rosen in 1971, to be his D.Sc. student, and to coopera-
ate closely with him up to December 1995.

In the period 1969–1979, Rosen and his cooperators constructed
and developed several alternative theories of gravitation. Among
them the very interesting non-covariant theory of gravitation (in
1969–1972). This theory was based on the equivalence principle, but
it was not covariant. In the three crucial tests, the non-covariant
theory led to the same results as the general theory of relativity.

Later, in the period 1972–1979, Rosen's bimetric theory of
gravitation was constructed. This beautiful alternative theory is
based on the presence of two metrics, the background metric and a
physical one (the later defines the gravitational field). The action
of Rosen's theory differs from that of Einstein's general theory of
relativity, but the bimetric theory of gravitation satisfies both the
equivalence principle and the covariance principle. In Rosen's theory,
the field equations have a simple structure, and there are no black
holes. It is also possible to obtain a non-singular cosmological model
of the universe. The conclusions of this theory agree with those of
general relativity up to the accuracy corresponding to observations
made up to now. Rosen's bimetric theory has many adherents in
astrophysical centers all over the world.

Nathan was fascinated by Einstein's general theory of rela-
tivity, by its intrinsic coordination, integrity, completeness, and ele-
gance. 1 The desire for keeping the beautiful structure of Einstein's
theory, on the one hand, and the wish for removing black hole sin-

1 "Apropos "elegance," once I told Nathan about Boltzmann's