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Obituary[1]

JOAQUIN M. LUTTINGER

On 6 April, the noted theoretical physicist Joaquin M. (Quin) Luttinger died suddenly in New York City at the age of 73 of complications arising from cancer of the bone marrow. He had been in good spirits until just a few days earlier. Luttinger's major work, done mainly in the period 1945–1970, has left its imprint on physics and continues to have a strong influence on current developments.

Having earned a BSc in 1944 and PhD in 1947—both in physics at MIT—Luttinger took advantage of a Swiss-American exchange fellowship to become the first American postdoc in Wolfgang Pauli's group at the Swiss Federal Institute of Technology in Zurich after World War II. There, he demonstrated his brilliance in contributions, made partly with Res Jost, to the just-developed renormalized quantum electrodynamics. Especially noteworthy is his 1948 calculation of the anomalous magnetic moment of the electron, carried out independently of and approximately simultaneously with the calculation by Julian Schwinger.

In his early work—as a National Research Council Fellow (1948–1949), Jewell fellow at the Institute for Advanced Study (1949–1950) and physics professor at the University of Wisconsin (1950–1953)—Luttinger pursued interests that were eclectic, ranging from his thesis work on antiferromagnetism to studies of pion physics. In 1953, he joined the physics department at the University of Michigan. Four years later, he moved to the University of Pennsylvania (1958–60), before settling at Columbia University in 1960. He held visiting positions at the Ecole Normale Supérieure in Paris (1957–1958) and at Rockefeller University (1967–1968 and 1975–1976).

Beginning in 1953, Luttinger spent more than a dozen summers at Bell Telephone Laboratories. There, he began a long and fruitful collaboration

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with Walter Kohn, another summer visitor. He also had strong interactions with resident theorists such as Conyers Herring, Melvin Lax and Philip Anderson, with other, less regular visitors such as Philippe Nozières and John Ward and with resident experimentalists. The early successes of the Kohn–Luttinger visits played a major role in Bell Labs' decision to form and support its theory department.

His research between 1953 and 1965 produced a long string of epoch-making papers. Partly in collaboration with Kohn, Luttinger developed the effective mass theory of electrons and holes in semiconductors and applied it to shallow impurity states and to optical and magnetic effects. Since then, effective mass theory has become an integral part of the thinking about charge carriers in semiconductors.

Also with Kohn, Luttinger carried out the quantum derivation of the Boltzmann transport equation, which made possible the study of higher-order quantum effects such as the ferromagnetic Hall effect.

Luttinger, partly with Kohn, Nozières and Ward, contributed critically to the many-body theory of interacting three-dimensional electrons, including the derivation of the Landau theory of interacting Fermi liquids to all orders in perturbation theory and the de Haas-Van Alphen effect for interacting electrons. Especially noteworthy was what became known later as the Luttinger theorem, which states that the volume enclosed by the Fermi surface of interacting electrons in an external potential is unaffected by the interaction and is completely and simply determined by the number of electrons. This exact theorem is a cornerstone of the theory of strongly interacting electron systems.

In 1963, Luttinger published an exact solution for interacting one-dimensional fermions. (His model was related to an earlier, approximate model devised by Sin-Itiro Tomonaga.)

One-dimensional Fermi systems, now called Luttinger liquids, differ in essential ways from three-dimensional Fermi liquids. The physics of Luttinger liquids is relevant to one-dimensional conductors and to edge currents in the quantum Hall effect, and has been proposed as relevant to two-dimensional interacting electrons, such as those involved in high-temperature superconductors.

In yet other work, undertaken partly with Kohn, Luttinger demonstrated superfluidity and superconductivity in three-dimensional Fermi systems with purely repulsive interactions. Accordingly, the ground state of such a system was not like that of the Landau–Fermi liquid theory, but had an instability that destroyed the sharp Fermi surface.

Luttinger and Kohn also introduced the concept of anomalous diagrams, which lead to Fermi surface rearrangements.

This period of Luttinger's greatest productivity coincided with what one might call the classic period of many-body theory, in which the presently accepted canon was constructed. Luttinger not only was one of the giant figures of that period but also laid some of the foundations for present-day revisions of that canon.

As a teacher at Columbia, Luttinger received student evaluations that were the envy of his colleagues. Despite a strong aversion to public duties, he was persuaded to serve as chairman of the department from 1977 to 1980. In discussing appointments and promotions, he was always the hardest person to satisfy. If Luttinger approved, his colleagues knew they had made a good choice.

In spite of two decades spent in exile elsewhere, Luttinger was really at home only in New York City, the place of his birth. He was raised in a brownstone on Washington Square and lived nearby in the 1960's.

Luttinger was widely read in English, French and German, had a fine ear for classical music and, in the 1960's and 1970's, experimented with abstract plastic arts. He was a delightful conversationalist with a sense of fun, including a touch of irony, and was the life of every party. Luttinger had a natural love of and affinity for children, both his own and those of his relatives and friends.

Luttinger's work was marked by mathematical power and originality; he had an exceptional ability to formulate theories in appropriate and beautiful mathematical structures. His scientific papers stand out for their clarity and literary quality. With his death, the world of physics, especially condensed matter theory, has lost an original and influential voice that helped to shape the discourse in the second part of this century and will be heard far into the future.

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