

Preface

In theoretical physics, history can be largely unfair. In times when there are urgent problems to be solved, it quickly creates a number of “great scientists” and immortalizes them, crowned with glory, in its books. This was certainly the case during the first decades of the 20th century. There were experimental puzzles crying to be solved and in a relatively short time the remarkable fields of special relativity and quantum mechanics were born. Many were those who went to history as great scientists, by contributing to different aspects of this revolution. Without hints from nature, it is very difficult for a theoretical physicist to “show the whole world” how great he/she is, even if he/she were the smartest and most creative scientist of his/her time. Creating a new wave, without experimental hints, is a tremendous challenge. The best (and only?) example is the creation of general relativity, where Albert Einstein “single-footedly” climbed up all the way to the top of the ladder of fame by single-handedly proposing his theory of general relativity. But he could *afford* it, as he was already at the top due to his other contributions which had been prompted by experimental observations. One may wonder what would have happened if Einstein had *only* postulated his theory of general relativity and nothing else. Had the scientific community noticed it and cared enough about it to send expeditions to Brazil and Africa to check his “speculations”?

Källén sometimes expressed his regret for having been born “too late”, as he put it. He had come to Lund University in 1948 as a full-fledged 22 year old electrical engineer who wished to re-orient himself toward theoretical physics. In no time at all he had acquired an incredible amount of knowledge, as it is testified by his very first paper published already in 1949. Indeed, Källén was born in 1926, while the founding fathers of quantum electrodynamics, with whom he compared himself, had been around years before he appeared on the scene. They had almost done it all! Years later, his four years older collaborator, from Princeton University, Arthur S. Wightman said about him:

“At that time I was trying to puzzle out the grammar of the language of quantum field theory, and here was KÄLLÉN writing poetry in the language.”

Here below is a more extended version of Wightman's description³ of Källén:

"Gunnar Källén's death in an airplane accident, October 13 at Hannover, Germany, is a great personal loss to his many friends all over the world, a loss to research and education in Scandinavia, in which he played an important role, and a loss to theoretical physics where his contributions are well known. Gunnar Källén was a proud continuer of the tradition in quantum field theory established by Wolfgang Pauli⁴. His papers on quantum electrodynamics in the period 1950–1954 carried the non-perturbative approach to quantum electrodynamics forward to a point beyond which very little essential progress has been made up to the present day. I still remember the impact of the *Helvetica Physica* paper of 1953. At the time I was trying to puzzle out the grammar of the language of quantum field theory, and here was KÄLLÉN already writing poetry in the language!

In 1960's Källén spent an increasing fraction of his time on the phenomenology of elementary particles. A by-product of this was his book "*Elementary Particle Physics*". A typical remark about the book was: "That is the book on elementary particles the experimentalists really find helpful". Those of us who knew him expected that.

Källén's unflinching adherence to what he thought was essential and true in theoretical physics was combined with personal cheerfulness and friendliness."

As a second year graduate student from Lund University, Källén was sent to Zürich to attend Pauli's lectures in the 1949 summer session at ETH (Swiss Federal Institute of Technology, a prestigious institute for higher education and research in Zürich). This event staked out Källén's research path for years to come. It was also the beginning of a most fruitful interaction between Källén and Pauli, for almost a decade until Pauli's death in 1958. They were mutually attracted to each other. Perhaps Pauli saw in Källén an image of himself as a young man. Källén found Pauli's approach to physics, his strong opinions, his wit and sharp tongue quite similar to his own. They enjoyed each other's company.

³ Wightman's entire article is published in *Communications in Mathematical Physics*, Volume 11, Number 3 (1968–1969) pages 181–182. See also Chap. 64 and 78.

⁴ Wolfgang Pauli will be introduced in Chap. 3.

Källén's scientific work can largely be grouped into four main categories, namely:

- (1) **Quantum electrodynamics and renormalization**, without using perturbation theory: It was in this area that the young Källén demonstrated his legendary ability to grasp difficult issues quickly as well as his mathematical power and originality. His work placed him in Julian Schwinger's "Hall of Fame of Quantum Electrodynamics". In the literature, his name appears in the Källén-Yang-Feldman formalism, Källén-Lehmann representation and Källén-Sabry potentials. He would have been pleased to see that his "potentials" are used even now, after more than half a century, within a *broad* spectrum of applications whenever precision is required, such as in quantum chromodynamics, Z-decays, atomic transitions, and exotic atoms.
- (2) **The Lee Model**: The joint Källén-Pauli 1955 paper on the mathematical structure of T. D. Lee's model of a renormalizable field theory added richly to the understanding of a certain class of field theories. The Nobel Laureate **T. D. Lee**, (together with R. Friedberg) has written a special article for this book to honor Källén's memory. Why Källén was at all interested in the Lee Model is described in a chapter in this book by another Nobel Laureate, **Steven Weinberg**, who also gives his views on the future of quantum field theory. Weinberg considers himself as one of Källén's "disciples".
- (3) **The n -point functions**: Källén devoted several years to the study of these functions, which are the vacuum expectation value of the product of n scalar fields. He was hoping that this novel approach would help him resolve the issue of whether quantum field theory (specially quantum electrodynamics) is a consistent theory. This was a topic close to his heart, as he expressed it himself. The challenging mathematical beauty and complexity of the n -point functions appealed to him. Källén loved to solve difficult problems. Pauli disapproved of Källén's involvement in this field of research and warned him that he was wasting his time. Källén disagreed but a few years later he got very disappointed that this line of research did not lead to progress in *physics* that he had anticipated.
- (4) **Radiative corrections in weak interactions**. After having written his book "Elementary Particle Physics", published in 1964, Källén started doing research in this field and for a few years worked on radiative corrections to neutron beta decay. In this volume, **Alberto Sirlin**, a pioneer and expert in this field, gives a status report and discusses Källén's work.

In addition to his scientific heritage, Källén left behind a substantial number of "**disciples**", many of whom became university professors.

The purpose of this book is to present Källén, who was one of the shining stars on the physics sky of 1950's and 1960's. The reader is invited to get to know his unusual personality and become acquainted with some aspects of the history of our science in those days, as related by him and those who corresponded with him. In addition, a selection of his most important and not easily accessible papers is included, for the specialists to enjoy. If the reader is interested in any of his other papers he/she is invited to contact me (CJ) as I have a complete collection.

Portrait of Gunnar Källén

A Physics Shooting Star and Poet of Early Quantum
Field Theory

Jarlskog, C. (Ed.)

2014, XXVIII, 631 p. 180 illus., Hardcover

ISBN: 978-3-319-00626-0