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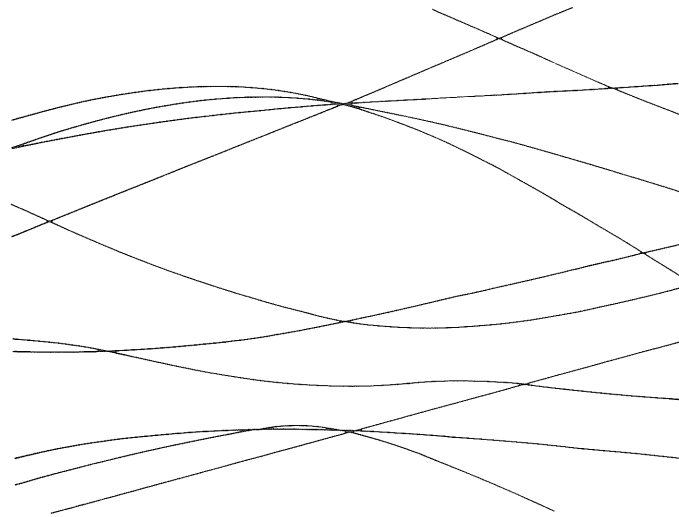
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NUCLEAR PHYSICS

SVEN GÖSTA NILSSON

1927-1979





(ii)

SVEN GÖSTA NILSSON
1927-1979

Sven Gösta Nilsson was a leading figure in the nuclear physics community. His many profound contributions have had a decisive impact on the development of the field. With his warm and enthusiastic personality and his broad insight, he gave inspiration to many colleagues and created at the Technical University of Lund one of the most active centers of theoretical nuclear physics*.

Our group in Copenhagen had the special good fortune to be able to benefit from an intimate scientific collaboration with Sven Gösta Nilsson that extended through his entire scientific career. This collaboration began in 1952 when Sven Gösta came to Copenhagen as a young student starting his work in nuclear physics. He was quickly attracted by the inspiring personality of Tommy Lauritsen who, as a visiting professor at the Institute for Theoretical Physics (later the Niels Bohr Institute), was carrying out elegant experiments on resonance scattering in the $d + {}^4\text{He}$ system. Sven Gösta was able to contribute a theoretical analysis of the measured angular distribution that made possible a determination of the spin and parity of the first excited state of ${}^6\text{Li}$. Tommy was very enthusiastic about the collaboration and thus Sven Gösta appeared to be on the threshold of a promising career as a theorist of light nuclei. These systems held great attraction because of the simplicities associated with the relatively small number of constituents.

However, at this same time, the experimental study of the spectra of heavy nuclei were presenting challenging problems. In particular, the discovery of rotational spectra revealed the occurrence of a large class of nuclei whose shapes deviated essentially from spherical symmetry. Sven Gösta chose to take up these problems of the heavy nuclei, and he attacked the basic issue of analyzing the orbits and spectra of single-particle motion in nuclei with strongly deformed shapes. The problem involved solving the one-body Schrödinger equation in a non-separable potential; a crucial point was the selection of an appropriate form for the potential that could be readily solved on the rather primitive electronic computers then coming into use, and which at the same time was sufficiently flexible to reproduce the evidence on the level spectra of spherical nuclei. Sven Gösta's analysis of this

* A memorial article, which also describes Sven Gösta Nilsson's childhood and university studies, has been written by Professor Torsten Gustafson, who was his teacher at a decisive stage of his development. Copies of this article can be obtained by writing to The Department of Mathematical Physics at the University of Lund, Box 725, S-220 07 Lund.

problem was to become a classic work in nuclear structure, reflecting his style in its exhaustive working out of the problems, its broad view, and clarity of presentation. Contemporary workers continue to return to this work for insight and valuable information.

Sven Gösta's work opened the way for major progress in the understanding of nuclear spectra. It quickly became possible to establish a detailed correspondence between the calculated spectra and the sequence of lowest states as observed in odd- A rare-earth nuclei. After this first foothold had been gained, there followed more than a decade of extensive effort involving both experimental and theoretical developments, which led to a vast growth of knowledge concerning single-particle motion in nuclei. Among the landmarks on this frontier were the extension of the classification to new regions of the periodic table (actinides, s-d and p shell nuclei), selection rules, effects of higher moments in the nuclear shape, identification of polarization effects in nuclear moments and transitions, and extensive testing of the single-particle wave functions in one-particle transfer and alpha decay. The successful application of the deformed potential in the analysis of the spectra of light nuclei led to the recognition of the connection between the many-body shell-model calculations and the Nilsson wave functions. The firm basis for understanding single-particle motion in deformed nuclei also opened the way to significant developments illuminating the microscopic origins of collective properties such as equilibrium shapes, pair correlations, rotations and vibrations. In these developments, which involved contributions from a large part of the nuclear physics community, Sven Gösta played a major role both through his own central contributions as well as through his extensive personal contacts.

The spirit of this period is well captured by Viki Weisskopf's summary talk at the Kingston conference in 1960: "Another . . . impressive indication of the validity of the independent-particle is the immense success of the Nilsson scheme, We know the famous level scheme and the popularity of his paper – I am sure this is the one paper which one finds on the desk of every nuclear physicist – . . .".

In 1963, Sven Gösta Nilsson took up a professorship at the Technical University at Lund and began building up the institute that he was to lead so successfully and to imbue with such a spirit of common participation in a tremendously exciting adventure. His enthusiasm, personal generosity, and outstanding qualities as a teacher attracted a large number of highly gifted and dedicated students, whom he was able to bring into the frontiers of research.

Sven Gösta's group has taken up over the years a wealth of different problems that have been in the foreground of developments in nuclear physics. A major program has involved the study of the effect of single-particle motion on nuclei with very large deformations with a view to illuminate the fission process as well as to study the possibility of metastable nuclei with exotic shapes. This work was in part inspired by the dramatic experimental discovery of the "fission isomers", revealing major shell structure effects in the region of the fission saddle point. The

reflecting his style in its clarity of presentation. His insight and valuable

the understanding of the detailed correspondence between experimental states as observed in nature. Gained, there followed experimental and theoretical work concerning single-particle motion where the extension of the s-d and p shell model, identification of the shape, identification and extensive testing of the model and alpha decay. The analysis of the spectra of the many-body shell-model provides a basis for understanding the origin of significant developments in nuclear properties such as fission. In these developments nuclear physics concentrated contributions

summary talk at the occasion of the validity of the Nilsson scheme,
"Sven – I am sure this is a physicist – . . .".

Technical University of Denmark and so successfully and tremendously exciting and inspiring qualities as a teacher and students, whom he

of different problems in nuclear physics. A major problem is the motion on nuclei in the fission process as well as in fusion. This work was in the area of "fission isomers", and the study of the saddle point. The

investigations contributed significantly to the understanding of this phenomenon and also cast light on many other features of the fission process, including the long-standing problem of the origin of the asymmetry observed in the mass distribution of fission fragments.

A second major theme in the work has been the study of stability of nuclei with charge and mass number considerably beyond the presently known species. The expected shell structure effects for masses of about $A \sim 300$ opens the possibility of an "island" of stability (surrounded by the "sea" of very short-lived spontaneously fissioning species), and this prospect has exerted a profound fascination for both the theoretical and experimental community. Sven Gösta's group has played a leading role in the exploration of this field, attacking the problems in the broadest possible manner, including investigations of all the different decay modes as well as of the reactions which might lead to the formation of these elusive species. The possibility of formation of these elements in astrophysical processes has been a special chapter. Extensive experimental efforts in laboratories all over the world have not as yet succeeded in producing traces of the envisaged "superheavy elements", but the basic issue of major new shell structure effects in this region remains unsettled and continues to pose a major challenge.

In the past five years, a new dimension has been added to nuclear studies through the possibility of producing systems with very large values of the angular momentum. Again, the Lund group has been among the pioneers on the new frontier. Indeed, a basic element in this development has been the extension of Sven Gösta's classic work to single-particle motion in rapidly rotating potentials. Among the important results of the work in Lund have been predictions concerning changes of the nuclear shape produced by rotation and the possibility of new types of isomerism.

The above account reflects only a part of Sven Gösta's impact on the development. He travelled extensively and had highly developed personal contacts with almost all the centers contributing to nuclear physics. He shared his broad experience, knowledge, and common sense with an appreciative community both at his own institution, in the Nordic countries and throughout the world. His refined sense of humor, generosity, and the kindness of his personal relations gave special quality to the contacts with him.

At the time of his death, Sven Gösta's group was engaged in far-reaching investigations on all the major problems mentioned above, and the nuclear physics community feels a deep sense of loss in no longer having his inspiring participation in the continuing discussion. The vital group of his colleagues and students represent a legacy whom we all must wish success in their efforts to continue in the spirit that he established.

Aage Bohr Ben R. Mottelson

CURRICULUM VITAE

Sven Gösta Nilsson: born, Kristianstad, Sweden, January 14, 1927; married to Ingrid M. (Peterson), June 10, 1954; children: Bengt O. and David G.; B.Sc., Occidental College, Los Angeles, California, 1949; M.Sc., Royal Institute of Technology, Stockholm, 1950; Ph.L. and Ph.D. University of Lund, Sweden, 1954 and 1955. Teaching Assistant, Royal Institute of Technology, Stockholm, 1949–50, 1951–52; Assistant, University of Lund, 1950–51, 1952–55; Docent (Assistant Professor), University of Lund, 1955–63; Professor, mathematical physics, Lund Institute of Technology, Sweden 1963–; Guest researcher, Institute of Theoretical Physics (“Niels Bohr Institute”), Copenhagen, 1953–55, partly as a CERN theoretical study group fellow; Guest Professor, Nordita, Copenhagen, 1959, 1960, 1962–63; Member research staff Lawrence Berkeley Laboratory, 1956–57, 1960–61, 1967–68, 1972–73; Consultant, Los Alamos Scientific Laboratory, 1973; Scientific Associate, CERN, Geneva, 1977–78; Member of Swedish and Danish Academies of Science.

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