

Foreword

After being postponed for two years due to the pandemic, the 16th Edition of the Varenna Conference Series on Nuclear Reaction Mechanisms (NRM) was finally held once again at Villa Monastero on June 11-16, 2023 (<https://indico.cern.ch/e/Varenna2023>), pursuing a strong tradition built under Prof. Ettore Gadioli's enthusiastic guidance.

With about 70 participants from across the world, the scientific programme accommodated over 60 oral contributions, reporting recent advances on nuclear structure, nuclear potentials and form factors, nuclear reaction theory and measurements, as well as filling specific sessions dedicated to nuclear fission, particle transport and interaction codes, and medical radioisotopes.

We are truly indebted to Prof. Dr. Horst Lenske for his friendly availability to join the event, where his scientific legacy was celebrated, as summarized in the following pages.

We gratefully acknowledge the indispensable support of Los Alamos National Laboratory, the European Organization for Nuclear Research, CEA Paris-Saclay, and the International Center Piero Caldirola.

For the first time, the proceedings volume is published in EPJ Web of Conferences, which we thank for the editorial support, while expressing our gratitude to all the authors and the colleagues who contributed to the peer review effort.

See you in Varenna in 2026.

Francesco Cerutti
Toshihiko Kawano
Francesc Salvat Pujol
Patrick Talou

Dedication

*We are delighted to dedicate this 16th NRM edition to **Prof. Dr. Horst Lenske**, whose inspiring and long-lasting participation has extensively enriched the Varenna Conference series.*



Biography of Horst Lenske

Horst Lenske was born on March 6, 1950, in Bad Godesberg, now part of the City of Bonn, Germany. After graduating from high school and completing his military service, he studied physics at the University of Bonn, obtaining his Diplom in 1976. As a doctoral student at the University of Bonn and in the group of Amand Fässler at Forschungszentrum (FZ) (at that time KFA) Jülich, he investigated isospin symmetry violations in nuclear reactions. In July 1979 he was promoted to Dr. rer. nat. at the University of Bonn, based on his dissertation on "Isospin Violation in Deuteron-Induced Reactions".

From 1979 to 1981 Horst Lenske stayed as a Postdoc at the University of Texas at Austin, working with Taro Tamura on the theory of nuclear pre-equilibrium reactions, known as the TUL theory. In 1981 he returned to Germany to work at the Ludwig-Maximilian University in Munich, where he completed his habilitation in 1987 and held the position of Assistant Professor from 1989 to 1992. In close collaboration with Hermann Wolter, he developed a microscopic theory of pre-equilibrium and direct nuclear reactions. As major results, the first fully microscopic, quantal descriptions of heavy ion pre-equilibrium and charge exchange reactions were achieved, hitherto treated primarily by means of classical or semi-classical approaches.

In fall 1992 Horst Lenske moved to Justus-Liebig University Gießen, being in charge of a chair in theoretical physics, initially as an Extraordinary (apl.) Professor and, from 2006 onwards, as an Endowed GSI Professor. After retirement in 2015, he was awarded a research professorship until 2016.

Horst Lenske is still attached to the Gießen Institut für Theoretische Physik by ongoing research grants and to GSI Darmstadt as council member of NUSTAR and theory advisor for PANDA. From 1995 on, he was involved in the preparation of the FAIR project as convener for nuclear theory. From 2003 to 2010, he was member and chairman of the advisory committee for hadron and nuclear physics at the German Federal Ministry for Education and Research. He is a referee for funding agencies in Germany and other EU countries, the European Commission, and outside Europe. Among his duties, peer reviewing is still an important and exciting activity.

At the Gießen Institut für Theoretische Physik, Horst Lenske set up and led a large and highly motivated research group of doctoral students and postdocs. Their research projects addressed a broad spectrum of topics, including nuclear structure and reaction theory for stable and exotic halo nuclei, astrophysical studies, Dirac-Brueckner and relativistic mean-

field theory for nuclei and hypernuclei, and strangeness and charm meson production in reactions on nucleons and nuclei. He supervised more than 20 PhD dissertations. Since 2015, he is a member of the NUMEN collaboration, investigating heavy ion double charge exchange reactions as probes for nuclear matrix elements of double beta decay. His work is documented in many original research papers, and summarized in several review articles:

- Density dependent relativistic field theory, Lect. Notes Phys. **641** (2004) 147;
- Baryons and baryon resonances in nuclear matter, Prog. Part. Nucl. Phys. **98**, 119 (2018);
- Hyperons and Resonances in Nuclear Matter, Lect. Notes Phys. **948**, 161(2018);
- Dissolution of shell structures and the polarizability of dripline nuclei, Eur. Phys J. A **55**, 238 (2019);
- Heavy ion charge exchange reactions as probes for nuclear beta-decay, Prog. Part. Nucl. Phys. **109**, 103716 (2019);
- Theory and applications of nuclear direct reactions, Int. J. Mod. Phys. E **30**, 10, 2130010 (2021);
- Self-consistent methods for structure and production of heavy and superheavy nuclei, Eur. Phys. J. A **57**, 3, 89 (2021);
- Shedding light on nuclear aspects of neutrinoless double beta decay by heavy-ion double charge exchange reactions", Prog. Part. Nucl. Phys. **128**, 103999 (2023);

Life besides physics: Rowing; for years spending holidays on bike tours with his wife, exploring France, the Alps, the coastal regions of the North Sea and the Baltic Sea; long walks and hikes; hosting dinner parties for and with friends, including the preparation and cooking of meals.

His motto:

"A physics problem a day keeps the doctor away."

Laudation of Horst Lenske

Nadia Tsoneva, Francesco Cappuzzello, and Hermann Wolter

Dear Horst,

We all three feel very honored and happy to contribute to celebration of the dedication to you of the 16th Varenna Conference on Nuclear Reaction Mechanisms, which we think is an outstanding and well deserved honor, which is not easily bestowed on a scientist. Each of us has her/his own personal recollections and highlights of the work and life with you from different stages of your remarkable scientific carrier. Thus in the following each of us, in chronological order of first contact with you, has written a brief text - too brief to express everything that comes to mind when recalling all the times and scientific adventures with you.

Hermann: When I think back of my times with Horst Lenske, I realize that there have been particularly strong overlaps of us in space, time and scientific interests, which mean a lot to me. We first met in Jülich in 1975 where he started work on his PhD with Amand Faessler, with whom I had also done my PhD in Münster in the 60's. As a postdoc he went to Austin, Texas, to work with Taro Tamura and Takeshi Udagawa, where I had also been in the 70's for my own postdoc working with the same professors. With his return in the beginning of the 80's he came to Munich and joined our group. There we worked closely together, he wrote a remarkable habilitation thesis, and finally moved to the University of Giessen in the beginning of the 90's to become a professor himself. If it had not been for science-political reasons, he might have been a leader in an important research institution in Germany.

I consider it a big fortune of myself that he joined my group in Munich. He came not only as a young rising researcher, but brought with him new research fields, which he developed with large international acclaim. One was the theory of statistical direct reactions. The then popular approach was the theory by Feshbach, Kerman and Koonin - you hardly can think of more important people in nuclear physics at that time - the FKK theory of pre-equilibrium reactions, which however made drastic assumptions in multi-step processes. Horst together with Udagawa and Tamura developed in Texas a much better-founded approach, which separated cleverly the incoherent statistical structure effects from the coherent multi-step dynamics. As the multi-step direct reaction (MSDR) theory he developed and applied this approach in Munich and it became a standard in the field, and I was happy to be part of this. It also led to close contacts with applications in nuclear data with Giovanni Reffo and Mike Hermann. A special feature of this approach was the development and use

of microscopically derived average strength functions, which were later used in many fields, as Nadia will mention, but also in the work on charge-exchange reactions with Francesco.

A second field that he initiated in Munich together with our student Christian Fuchs, was a density dependent relativistic mean field (RMF) theory. At that time, it had been realized by Walecka and others that the use of relativistic dynamics led to a much deeper understanding of nuclear structure physics. In the original form, however, it had difficulties to describe nuclear matter away from saturation density and a number of ad-hoc solutions, like non-linear meson interactions were employed. It was really Horst who found a very elegant way to solve the problem by density-dependent meson-nucleon couplings, and who also justified this approach from microscopic relativistic Brueckner theory. This approach is now the standard in RMF, and our first paper on this is his most cited work.

In Munich also started his interest in charge-exchange reactions, where we studied the competition of direct and two-step mechanisms to (single) charge-exchange and applied it extensively together with Gerhard Bohlen in Berlin, as he generally puts great emphasis on collaborating with experimentalists and there are many who value this very much. As we see also at this meeting, charge-exchange reactions, particularly double charge-exchange, today are touching very fundamental questions, as is shown by Francesco in the NUMEN project, where Horst plays a major part.

He works very efficiently. When in Munich, he still had his home in Bonn, where his wife Hilde had a highly influential position as a publisher. He left by train on Friday noon and returned on Monday afternoon, and one could have said that this was a convenient arrangement. But completely wrong, Horst once said that he worked best on the train, and, in fact, on Monday he came with new ideas and calculations – though he had also turned off physics for the weekends with Hilde. He once remarked, that with all the traveling on train, he essentially owned a wagon of the Deutsche Bahn.

In all this Horst had a very good feeling for important developments in nuclear physics, and an excellent knowledge and the intellectual capabilities, to make important contributions to several fields. He not only talks about these but makes hard calculations and produces new and interesting results. Thus, he became well known in a wide nuclear physics community, organizing workshops and conferences, giving invited talks and lectures in many conferences and places, participating in and advising many collaborations, serving in important roles in committees in Germany and of funding agencies world-wide, and, last not least, educating many young physicists. It is fair to say that Horst has and is giving a big service to the nuclear physics community. He has his own characteristic style. In conferences important people usually sit in the front rows of the audience, to show their importance, but not so Horst. But the discussions really become interesting and exciting when Horst gets up in the back and makes his deep comments.

But as motivated and creative he is in physics, physics is not everything for him. His interests range wide from politics, literature, to travel and other cultures, and we all know that he likes the good life with friends and good eating. In all this he and Hilde supported each other in many respects, and I am very happy that also Hilde is here today, since she deserves part of the honor. I am happy that Horst and Hilde became very good friends of my wife Barbara and me, and we look forward for good times to come.

Francesco: It is a great pleasure for me to be close to you while you are being honoured by the dedication of the XVI edition of the Varenna Conference on Nuclear Reaction Mechanisms. Indeed, as a theoretician, you have given an invaluable thesaurus of ideas, theories, data analyses tools among other to the scientific community, often fostering a much deeper understanding of nuclear structure and reaction phenomenology.

In your long career you have being moved around an exceptionally broad space of research items in the fields of nuclear physics, hadron physics and nuclear astrophysics. Courageously you have not looked for a comfort zone, where you could have taken profit of an initial acquired knowledge to build a limited research portfolio. Instead, you have faced several hot topics of the evolving research fields, although I think this has required many more efforts and a pronounced open-minded approach.

I know you since a long time, precisely from 1998, when as a young Ph.D. student of the Catania University I spent a couple of weeks at the Giessen University, to collaborate with you for our charge exchange reaction project. At that time, I was shocked by your rare ability to go through nuclear structure and reactions methodologies, by your deepness in finding the key aspects of the most complex scientific problems and propose clever approximate schemes not to forget your skills in developing highly performing computer codes. I learnt in two weeks more than I did in the previous years, and I am very proud of the several articles that would have stemmed later from that seminal work. In the following years it became mandatory for our research group to send our best students to Giessen, in order to learn directly from you and get important upgrade of our research activity as nuclear experimentalists. Part of these findings were recently recalled in some review articles that I was honoured to share with you.

At that time, I quickly realized that, you were working in parallel in a number of quite different projects, embracing nuclear spectroscopy of light and heavy nuclei, quasi-elastic and dissipative reaction mechanisms driven by mean field as well as by nucleon-nucleon interactions and even by short range nucleonic correlations, hadron physics, hyper-nuclei, resonance theory and so on. In most of these projects you have got excellent results, as witnessed by the quality of the resulting scientific production.

I remember that, when in 2015 we started in Catania our ambitious new project of double charge exchange reactions, looking for useful links with neutrino-less double beta decays, one of the basic issues was the lack of any theory for such class of nuclear reactions. That was a key aspect which could have easily weakened the project. I was hoping that you could be with us in such a challenging enterprise, realizing that maybe it would have been the only realistic way to face the problem. Thus, when you accepted, I was extremely happy and relieved to collaborate with you again. Since then, a full microscopic quantum reaction theory has been developed from scratch, which accounts for a complete set of relevant nuclear, nucleon and sub-nucleon degrees of freedom. Several articles have already been published, describing different aspects of the problem, together with a recent review article on double charge exchange, witnessing the value of the achieved results. To my knowledge, the fact that such a wide and deep development is so much fostered by a single scientist is maybe a unique case in the history of nuclear reaction theory.

But I cannot here ignore another key element of your personality. As evident as the figure of an outstanding scientist, briefly and only partially depicted above, there is the figure of a genuine gentleman, which I do not need here to further develop, since it is clear to everybody who has the fortune to know you.

Once more, I am happy and proud to celebrate your valuable recognition from the distinct panel of advisors of the Varenna Conference on Nuclear Reaction Mechanisms and I hope you many of these in the future.

Nadia: It is a great pleasure and honor for me to know H. Lenske personally and to be one of his collaborators for many years. In 2001, shortly after completing my PhD thesis at the Institute for Nuclear Research and Nuclear Energy in Sofia, I met Horst Lenske at the Gießen Institut für Theoretische Physik, where he worked as an Extraordinary (apl.) Professor. At the time, I was just starting my scientific career and was looking for a postdoctoral position in the field of nuclear theory. Horst Lenske invited me for a talk and then offered me a postdoctoral position in his group. During our discussion he impressed me with his erudition and scientific enthusiasm, his extensive knowledge of relativistic field theory, nuclear matter, nuclear structure and reaction theory, and his curiosity to explore new and challenging areas of physics at the limits of the existence of matter. But not only. I should mention here that the situation was very delicate for me and my husband at that time, as we had a young daughter, and I was very worried about whether I would be able to balance my motherly duties with academic work. Horst Lenske's full support and understanding of my personal situation was important for my decision to work with him.

As a young researcher and also later as an experienced researcher, I spent a lot of time with Horst Lenske working in the field of nuclear structure theory, where we developed one of the most advanced and precise theoretical methods for the theoretical study and prediction of pygmy resonances and other excitations in stable and exotic nuclei. Our nuclear structure theory is currently widely used in the description and theoretical interpretation of nuclear structure data by leading experimental laboratories and institutions worldwide, as well as for astrophysical applications. And our scientific cooperation has existed for more than 20 years. During this time we have published more than 30 scientific papers and conference proceedings. Currently we work on a new project which is devoted to the study of second-order processes in nuclei, namely the double-gamma and double charge-exchange reactions, looking for useful connections with neutrinoless double-beta decays, which is fundamental to the understanding of weak processes in nuclei.

From 2006 onwards until his retirement in 2015, Horst Lenske worked as a GSI Endowed Professor at the Gießen Institut für Theoretische Physik and he established and led a large and highly motivated working group of more than 10 PhD students and postdoctoral fellows. The projects touch on a wide range of topics, including nuclear structure and reaction theory for stable and exotic halo nuclei, astrophysical studies, Dirac–Brückner theory and relativistic mean field theory for nuclei and hypernuclei, and meson production for strangeness and charm meson production in reactions on the nucleon and on nuclei. Over 20 dissertations were supervised. I must say that during all this time he was a leader, a teacher and a good and reliable friend for us.

Dear Horst, once again, I am pleased and proud to celebrate your valuable recognition by the esteemed Advisory Panel of the Varenna 2023 on Nuclear Reaction Mechanisms conference, and I am confident that you have much more to give to the physics community in the future.

All: We wish you a bright future. When looking at your publication record, e.g., in INSPIRE, it reaches an all-time high at the time around and after your formal retirement. Thus, there is good hope that you will continue to make important contributions to our fields, and that we can look forward to your continued help, advice, and encouragement for our work, as well as to your cherished friendship. We also wish that you will continue your enjoyment of life together with Hilde.

*Yours, with best wishes,
Nadia, Francesco, and Hermann*