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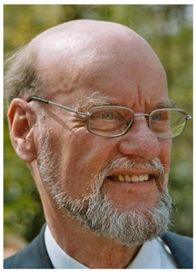
In Memoriam J.M.J. “Hans” van Leeuwen (1932–2024)



J.M.J. “Hans” van Leeuwen died on December 3, 2024; he is survived by his spouse Alice and their four children Hugo, Marc, Monica and David. Hans was a prominent internationally recognized scholar who has made major contributions to statistical physics over more than six decades. As Professor Emeritus at the Leiden University in The Netherlands, he continued to be professionally active till a few months before his death.

Hans, born on August 5, 1932, in Heerhugowaard, The Netherlands, grew up in a family with a strong emphasis on education as his father was principal of the local elementary school. He would later transmit this atmosphere of emphasizing education to his own children, all of whom obtained a PhD in the sciences. Hans entered the University of Amsterdam in 1951, where after completing his undergraduate education, he started pursuing PhD research directed by Jan de Boer. The Institute for Theoretical Physics, with de Boer as an inspiring director and with Eddie Cohen as an enthusiastic lector, was an excellent place to study statistical physics for students like Hans van Leeuwen, Hans Groeneveld, Frans Kruseman Aretz, Matthieu Ernst, and for Anneke Levelt and one of the authors (JVS) from the adjacent Van der Waals Laboratory.

The PhD research of Hans van Leeuwen, entitled “Diagram Techniques in Statistical Mechanics” was a scholarly study of evaluating molecular correlation functions in the so-called hypernetted-chain approximation which he developed. It led to five publications in the Proceedings of the Koninklijke Akademie van Wetenschappen, and two important articles with de Boer and Groeneveld in Physica. In addition, he published with Cohen two papers on the phase separation in a Bose-Fermi gas mixture explaining incomplete phase separation in ^{3}He-^{4}He mixtures which would become important for helium-dilution refrigerators. Hans was also a collaborator with other colleagues of the Institute evaluating properties of gaseous para- and ortho-hydrogen and their mixtures at low temperatures and addressing how to deal with intermolecular potentials that include a hard-core interaction. This is truly an extraordinary record by any measure for a graduate student.

After his graduation from the University of Amsterdam in 1962, Hans became a Scientific Collaborator at the newly established Department of Physics of the Catholic University in Nijmegen. For an academic position in The Netherlands, it was desirable to get research experience in the US. Hans was able to get a postdoc position at Cornell University in 1963/1964 with Ben Widom and subsequently a postdoc position at the National Bureau of Standards in 1964/1965 with Mel Green. At that time Widom had just discovered his famous particle-insertion method for calculating the chemical potential which would become very important in molecular computer simulations. Hans immediately grasped the importance of this discovery and rederived and extended it to partially coupled systems. In addition, Hans and Sidney Yip, who at that time was also at Cornell University, published a detailed derivation of kinetic equations for the interpretation of slow neutron scattering.

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In Nijmegen Hans was initially involved with colleagues studying electrical conductivity of solids. Having become familiar in the US with problems encountered with the density expansion of gases, he and Ab Weyland made a detailed study of the non-analytic density dependence of the diffusion coefficients of a two-dimensional and a three-dimensional Lorentz gas. In 1967 Hans got a leave of absence to return to the US, first as Visiting Associate Professor at the Rockefeller University and then as Associate Professor at Temple University. At the Rockefeller University Hans continued his work on incomplete phase separation in Fermi-Bose mixtures with Cohen. At Temple University Hans first continued to work on ^{3}He-^{4}He mixtures and then started his attention on spin systems as models for phase transitions in ferromagnets.

In 1969 Hans was appointed as full professor at the Technical University in Delft as successor of Ralph Kronig. Hans established a research program of international stature In Delft, Hans first continued his research on correlation functions including a detailed study of the so-called long-time tails of the correlation functions in collaboration with Matthieu Ernst and Eivind Hauge.

Most influential was Hans' contribution to the development of the renormalization theory for critical phenomena, or Wilson theory as it was known at the time. In 1971 Ken Wilson proposed, on the basis of earlier ideas of Leo Kadanoff, a computational scheme to investigate the transformation of critical and near-critical systems under a change of spatial scale. The scheme was based on the integration of small wavelength fluctuations. As the scheme became exact at some upper critical dimension, and could be performed for arbitrary dimension d, this led to an expansion in powers of (4-d), known as the epsilon-expansion. This approach also underpinned the concept of universality, the notion that critical exponents and a number of other quantities, depend only on the spatial dimension and on the symmetry relevant for the phase transition.

The essential contribution of Hans, in collaboration with Theodorus Niemeijer, was to construct calculational schemes in terms of local variables in real space, which became known as real-space renormalization. Their approach became enormously popular and attracted many researchers to the study of critical behavior, and to the study of real-space renormalization theory.

Eventually Niemeijer and Van Leeuwen were invited to write a chapter for the famous series of books on Phase Transitions and Critical Phenomena, edited by Domb and Green, which became a standard reference for applications of renormalization theory. Their approach was most successful in two dimensions. In the same period many experimental studies investigated the behavior of monolayers of atoms adsorbed on the surface of a crystal, observing phase transitions in effectively two-dimensional systems. This resulted in a fruitful exchange between theoretical and experimental studies. A particular focus of these studies was on the application of universality. The real-space renormalization theory as developed by Niemeijer and Van Leeuwen contributed significantly to the acceptance of this notion of universality. With these contributions Hans established himself as one of the truly prominent scholars in statistical physics.

A subject that caught Hans' interest was the possibility to set up an exact renormalization scheme. Together with Henk Hilhorst and Michael Schick he succeeded. They constructed an exact renormalization transformation for the Ising model on a triangular lattice with spatially varying interactions. Attempts to generalize this to other models, remained unsuccessful, but the result itself was elegant, conceptually important and appreciated by many researchers in the field. As a consequence, this work received much more attention than citations.

Another subject that had Hans' warm interest was the study of the liquid-vapor interface affected by gravity. With Jan Sikkenk and one of the authors (JVS) he produced detailed studies of the effect of gravity on the critical behavior of fluids, showing that under the influence of gravity the correlation length remains finite in all directions even at the critical point. A series of articles on the liquid-vapor interface concluded with a beautiful paper of Hans addressing the question whether the interface experiences a Van der Waals loop.

In 1986, Hans moved from Delft to the Institute-Lorentz of the physics department in Leiden. The new research environment, with a stronger focus on fundamental physics than at the Technical University Delft, and with its celebrated Kamerlingh Onnes low-temperature laboratory and the 'Colloquium Ehrenfestii' – the Wednesday evening colloquium started by Ehrenfest – stimulated Hans to branch into new directions and explore new problems. In 1994, during a stay in Leuven, his insight into Ginzburg-Landau theory for superconductors and that of Joseph Indekeu into wetting were combined to predict that type-I superconductors provide an ideal test case for experimental observation of wetting phase transitions. In addition, he became interested in quantum lattice problems: with one of his students, he developed a fixed node method for quantum lattice simulations, which could be proved to yield a strict upper bound for the ground-state energy, with another he explored the density-matrix renormalization method for quantum problems like the Hubbard model.

After his retirement, Hans continued to be active and pick up new problems, such as polymer dynamics and reptation. He always addressed fundamental problems in physics with elegance and precision, but at the same time did not shy away from resolving long-standing controversies from daily life, like the question whether dominoes fall faster when placed closer together or whether skating is still possible when it is very cold. This latter topic betrays Hans's love for ice skating, something he not only enjoyed doing with his children and grandchildren but also with students and colleagues.

Hans was averse to pomp and power games, steadfastly adhering to his principles and views, including his criticism that money and grant applications play too dominant a role in the current scientific system. He was highly approachable for young researchers: especially during the development of renormalization theory, an entire generation of younger statistical physicists was influenced and inspired by their interactions with him at critical points in their careers. This is especially true for two of us, BN and WvS. But Hans continued to have a stimulating influence on young researchers throughout his career: many PhD students, postdocs and visitors at the institute in Leiden profited from his versatility, sharpness and rigor, and the fact that he had time while he did not care about hierarchy or differences in standing.

In Hans van Leeuwen, we lose not only a colleague but also a wonderful teacher, a guiding figure, mentor, and friend.

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