BIOGRAPHY OF LEON VAN HOVE(1924 - 1990)

born Feb. 10, 1924, Brussels, Belgium.
died Sep. 2, 1990.

Leon Charles Prudent Van Hove (Brussels, 1924 - 2 September 1990), was a Belgian physicist and mathematician. He developed a scientific career from mathematics, over solid state physics, elementary particle and nuclear physics to cosmology. He studied mathematics at the *Universite Libre* of Brussels. In 1946 he received his Ph.D. on a thesis about a topic in the calculus of variations. It was followed by a series of articles about the calculus of variations, about mathematical problems of differential equations, and about transformation groups.

He started his work in the domain of theoretical physics from the statistical mechanics. He studied the behaviour of the statistical system in the limit in which the volume of the system becomes infinitely large. This was called the "*thermodynamic limit*". The "*thermodynamic limit*" or infinite-volume limit give results which are independent of which ensemble you employ and independent of size of the box and the boundary conditions at its edge. And in the grand ensemble it is only in this limit that phase transitions, in the form of mathematically sharp discontinuities, can appear. Thus the thermodynamic limit provides a *clean* mathematical problem from which certain complications have been removed.
LEON VAN HOVE published two papers on this subject (in French):
L. Van Hove, *Physica* 15 (1949) pp.951-961;
L. Van Hove, *Physica* 16 (1950) pp.137-143;
The importance of "*thermodynamic limit*" or infinite-volume limit was first mentioned by N. N. Bogoliubov in his seminal monograph *"Problems of Dynamical Theory in Statistical Physics"* in 1946. Later on, in 1949, N. N. Bogoliubov published (with B. I. Khatset) a short article on this subject: "On some mathematical problems of the theory of statistical equilibrium". *Doklady Academy of Sci., USSR*, 66 N 3 (1949) pp.321-324.
The proof of Van Hove contained some mathematical shortcomings and was improved by M. E. Fisher and D. Ruelle:
M. E. Fisher and D. Ruelle, *Journal of Mathematical Physics* 7 (1966) 260;
D. Ruelle, *Ann.Phys.* 25 (1963) 209;
D. Ruelle, *Rev.Mod. Phys.* 36 (1964) 580;

The complete mathematical treatment of the thermodynamic limit problem was given by N. N. Bogoliubov and collaborators in 1969:
N. N. Bogolyubov, D. Ya. Petrina and B. I. Khatset,
Mathematical description of the equilibrium state of classical systems on the basis of the canonical ensemble formalism.
***Theoretical and Mathematical Physics*, 1, N2 (1969) 251-274.**
See also:
N. S. Gonchar and A. B. Rudyk. Oscillation of the radial distribution function. Journal of Statistical Physics, Volume 68, Numbers 5-6, 1065-1087, (1992); DOI: 10.1007/BF01048885.

From 1949 to 1954 LEON VAN HOVE worked at the Princeton Institute for Advanced Study by virtue of his meeting with Robert Oppenheimer. Later he worked at the Brookhaven National Laboratory.At Princeton LEON VAN HOVE met G. Placzek, who was working on the theory of neutron scattering. He started to work in this field and published a few important papers on the subject. Three of them are:
G. Placzek and L. Van Hove, Crystal Dynamics and Inelastic Scattering of Neutrons,
***Phys. Rev.* 93 (1954) 1207;**
L. Van Hove, Correlations in Space and Time and Born Approximation Scattering in Systems of Interacting Particles,
***Phys. Rev.* 95 (1954) 249;**
This paper is cited about 2000 times.
L. Van Hove, Time-Dependent Correlations between Spins and Neutron Scattering in Ferromagnetic Crystals,
***Phys. Rev.* 95 (1954) 1374;**
It has ever since served as the foundation of the entire field.

Microscopic descriptions of condensed matter dynamical behavior use the notion of correlations over space and time
(see: B.J. Berne, Time-Dependent Properties of Condensed Media).
Correlations over space and time in the density fluctuations of a fluid are responsible for the scattering of light when light passes through the fluid. Light scattering from gases in equilibrium was originally studied by Rayleigh and later by Einstein, who derived a formula for the intensity of the light scattering. The dynamical properties of a system of interacting particles are all contained in the response of the system to external perturbations. The basic quantities are then the dynamical susceptibilities, which in the general case describe the response of the system to external perturbations that vary in both space and time. For simple liquids the two basic susceptibilities describe the motion of single particles and their relative motions. The fluctuating properties are conveniently described in terms of time-dependent correlation functions formed from the basic dynamical variables, e.g. the particle number density. The fluctuation-dissipation theorem, shows that the susceptibilities can be expressed in terms of the fluctuating properties of the system in equilibrium.
The relation between the cross-sections for scattering of slow neutrons by an assembly of nuclei and space-time correlation functions for the motion of the

scattering system has been given by Van Hove. The concept of time-dependent correlations has been used widely in connection with particle scattering by solids and fluids. A fundamental formula for the differential scattering cross section of a slow neutron in the Born approximation was deduced by Van Hove. He derived a compact formula, and related the differential scattering cross section to a space-time pair correlation function.
As was shown by Van Hove in his seminal paper, the Born approximation scattering cross section can be expressed in terms of the four-dimensional Fourier transform of a pair distribution function depending on a space vector and a time variable. The formula obtained by Van Hove provided a convenient method of analyzing the properties of slow neutron scattering by systems of particles, of light scattering by media, etc.
The advantage of using the Van Hove formula for analysis of scattering data is its compact form and intuitively clear physical meaning (see: W. Marshall and S. W. Lovesey, *Theory of Thermal Neutron Scattering*. (Oxford University Press, Oxford, 1971).
Although there have have been many light and neutron scattering investigations of complex statistical systems during last decades, it is true to say that until recently the properties and implications of the particle scattering by the nonequilibrium statistical medium were not yet understood fully. There was not a fully satisfactory theoretical formalism of the interpretation of the light or thermal neutron scattering experiments for a system in the nonequilibrium state.
The solution to this problem was formulated by A.L. Kuzemsky in 1970-1971 (unpublished) and published at the paper:
A.L. Kuzemsky
Generalized Van Hove Formula for Scattering of Neutrons by the Nonequilibrium Statistical Medium.
International Journal af Modern Physics (2012) V.B 26, No. 13, p.1250092 (34 pages).
The theory of scattering of particles (e.g., neutrons) by statistical medium was recast for the nonequilibrium statistical medium. The correlation scattering function of the relevant variables give rise to a very compact and entirely general expression for the scattering cross-section of interest. The formula obtained by Van Hove provides a convenient method of analyzing the properties of slow neutron and light scattering by systems of particles such as gas, liquid or solid in the equilibrium state. In this paper the theory of scattering of particles by many-body system was reformulated and generalized for the case of nonequilibrium statistical medium. A new method of quantum-statistical derivation for the space and time Fourier transforms of the Van Hove correlation function was formulated. Thus in place of the usual Van Hove scattering function, a generalized one was deduced and the result was shown to be of greater potential utility than those previously given in the literature. This expression gives a natural extension of the familiar Van Hove formula for scattering of slow neutrons for the case in which the system under consideration is in a nonequilibrium state. The feasibility of light- and neutron-scattering experiments to investigate the appropriate problems in real physical systems was discussed briefly.

Since 1954 LEON VAN HOVE was a professor and Director of the Theoretical

Physics Institute at the University of Utrecht in the Netherlands. In 1958, he was awarded the Francqui Prize on Exact Sciences. He studied the irreversible processes in many-particle systems and investigated the derivation of the *master equation* by special perturbation technique.

He also known for his work on Van Hove Singularity. A Van Hove singularity is a kink in the density of states (DOS) of a solid. The wavevectors at which Van Hove singularities occur are often referred to as critical points of the Brillouin zone. (The critical point found in phase diagrams is a completely separate phenomenon.) The most common application of the Van Hove singularity concept comes in the analysis of optical absorption spectra. The occurrence of such singularities was first analyzed by Van Hove in 1953 for the case of phonon densities of states.
L. Van Hove, "The Occurrence of Singularities in the Elastic Frequency Distribution of a Crystal,"
***Phys. Rev.* 89, 1189–1193 (1953).**

In 1961, he received an invitation to become Leader of the Theory Division at the CERN in Geneva, where he would spend three decades. After coming to CERN in 1961, he brought his experience in statistical physics to bear on multiparticle production. He emphasised the importance of non-resonant particle production, and the role of longitudinal phase space. He also took an active interest in quark-gluon plasma dynamics, particularly in the nonperturbative transition from the plasma to conventional hadrons, and maintained this interest until his death. In all his work in particle physics, he stressed the importance of phenomenology in the quest for new understanding.
Van Hove was leader of the CERN theoretical physics division from 1961 to 1970, playing a key role in its formation and orientation. He was subsequently chairman of the Max Planck Institute for Physics and Astrophysics in Munich from 1971 to 1974. In 1976 he became research director general of CERN and provided, together with Sir John Adams, the visionary leadership that brought the laboratory to the forefront of high energy physics. He saw clearly the physics opportunities provided by the SPS proton-antiproton collider project and took a strong personal interest in its approval, execution and subsequent success.
He also laid essential groundwork for the approval of LEP and its experimental programme. His vital contribution to the development of this laboratory still bears fruit today.
He continued to offer scientific leadership in the decade after stepping down from the director generalship of CERN, chairing the scientific policy committee of ESA while a dynamic new phase of its activity was being planned, and helping to establish the joint ESO/CERN symposia on astronomy, cosmology and fundamental physics. Indeed, the interface between particle physics and cosmology was one of his active research interests during his last few years, and provided the subject of his last scientific paper.
Van Hove was a man of great culture, with a wide field of interest in art and literature as well as the sciences. He was a true European, speaking French, Flemish, German and English fluently, and with a university career spanning several countries. He was a man of great honesty, who expressed his opinions

clearly and abhorred trivialities. He never favoured his own personal interest, and was always devoted to the cause of science. His detachment and objectivity, even close to the end, were almost Olympian, but he had a keen awareness of the needs of others. His humanity found expression in the defence of those weaker than himself, and even his readiness to act the dinosaur in a CERN theory division Christmas party play.

There are a few places where the biography of LEON VAN HOVE can be found.

Wikipedia electronic Encyclopedia(http://en.wikipedia.org/) , an article LEON VAN HOVE.

N. G. van Kampen, Leon Charles Prudent Van Hove, in: *Royal Dutch Academy of Arts and Sciences. Obituaries*, 1992.

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