KONINKLIJKE NEDERLANDSE AKADEMIE VAN WETENSCHAPPEN

BIJZONDERE BIJEENKOMST
DER AFDELING NATUURKUNDE

op zaterdag 17 december 1966, des namiddags te 3.30 uur,

voor de plechtige uitreiking van de *Lorentz-medaille* aan
FREEMAN J. DYSON,
verbonden aan het Institute for Advanced Study te Princeton

Voorzitter: P. J. GAILLARD
Secretaris: Mw. C. H. MACGILLAVRY

De voorzitter opent deze bijzondere zitting.

Buiten een aantal leden der Akademie, zijn verschillende autoriteiten en verdere genodigden aanwezig, die door de voorzitter worden welkom geheten.

Daarna verleent de voorzitter het woord aan de heer R. KRONIG, die de redenen uiteen zal zetten, welke ertoe geleid hebben de Lorentz-medaille aan de heer DYSON toe te kennen en die, namens de Akademie de medaille aan de heer DYSON zal uitreiken.

De heer KRONIG richt zich met de volgende woorden tot de begiftigde:

Mr. Dyson,

A committee appointed by our Academy has selected you as recipient of the Lorentz-medal and has charged me with addressing you on this festive occasion. My task is on the one hand to commemorate before the present assembly the person and work of the great Dutch scientist whose name and image is borne by the medal, and on the other hand to motivate the choice of the committee. I shall try to perform both duties by not only giving a brief survey of your achievements as a physicist, but also by relating some of these to problems with which already Lorentz has been confronted.

The first publications bearing your name which I was able to discover and which date back to 1943 have a purely mathematical content. They deal respectively with the theory of continued fractions and with combinatory analysis and are already symptomatic for the strong mathematical interest and potency that also characterise your research in theoretical physics. For indeed, only a few years later your full attention is switched over to physical theory, and right away to some of its most fundamental aspects.

The field of classical phenomenological electrodynamics, in which the electric charge is treated as a continuous fluid, underwent its development during the last century in the hands of Ampère, Ørsted, Faraday, Henry, Maxwell and Lorentz. In particular, Lorentz was concerned with the generalisation of Maxwell's equations to the case of moving media, the propagation of light in such media and the ponderomotive forces to which they are subject. His efforts in this field led him to the Lorentz-transformation that paved the way to Einstein's theory of relativity. But in addition Lorentz was the first who tried in a general way to bring together electrodynamics and the atomistic view of matter and charge. His theory of electrons was the outcome, a fact of which the term "Lorentz-force" for the action of an outside field on an electron still reminds us.

In spite of its great success this theory encountered serious difficulties when the reaction was investigated which an electron suffers from its own field. A series development of this force begins with a term proportional to the acceleration, and hence of an inertial character, that varies inversely as the radius of the spherical charge distribution assumed for the electron. It is followed by a term proportional to the first time derivative of the acceleration, corresponding to radiation damping and independent of the electronic structure, together with terms proportional to higher time derivatives, going to zero with the electronic radius and negligible for all practical purposes. The theory is thus subject to the dilemma that for a point electron it diverges while for an electron of finite extent it is called upon to explain the stability of the charge distribution, an impossibility on a purely electrodynamic basis.

With the coming of quantum mechanics in 1925 the task of introducing quantum concepts consistently into the theory of the electromagnetic field arose. It was attacked by a number of physicists, notably by Heisenberg and Pauli. Unfortunately the difficulties, already encountered in the classical electron theory, showed up also in the quantum version. They seemed to prevent the solution of such problems as the calculation of the level shift which the coupling to the radiation field produces in atomic systems. Following some early suggestions of Kramers and Bethe, Tomonaga in 1947 applied the method, now known as charge and mass renormalisation, for eliminating the divergent terms when computing observable effects. His work was soon followed and further systematized by the investigations of Schwinger, Feynman and yourself. In particular you were able to prove that the approach of Feynman is mathematically equivalent with that of Tomonaga and Schwinger, although at first sight it looks rather different. While the other authors just mentioned had in fact confined their attention to first order perturbations by the radiation field, you were able to demonstrate that also in the higher orders mass and charge renormalisation is possible and eliminates the divergent parts effectively. You contributed essentially to the technique by working with the so-called intermediate representation of the quantumtheoretical operators in question and by making extensive use of the concept of the scattering matrix, previously introduced by Heisenberg. The elaboration of the renormalisation procedure into a consistent and managable instrument is in large part your merit.

Like the work of most of the great masters the investigations of Lorentz demonstrate an astounding versatility. There is hardly a branch of physics which he has not enriched by his efforts. His researches in fluid dynamics led him in later life to his basic studies of the influence which the closing of the Zuider Zee would have on the tidal levels and currents along our coast, and formed a necessary preparation of this great engineering feat. His elucidation of the general foundations of electrodynamics has already been alluded to. But also in the discussion of specific problems he achieved great progress. I need only refer to his interpretation of the Zeeman effect, of the breadth of spectral lines, of dielectric polarization and magnetisation with their Lorentz-Lorenz correction, of the dispersion of light by matter and of electric conduction in solids. Statistical mechanics played an important part in many of these problems and enjoyed the attention of Lorentz throughout his scientific career.

Looking now at your own work, other than your contributions to quantum electrodynamics, I find a parallel breadth of interest. It was natural that you tried, as many others, to exploit the newly acquired insight into quantum electrodynamics for a meson theory of nuclear interactions. That the large values of the coupling constant have made such efforts illusory, at least in a quantitative sense, might be called a fault of nature. During the last ten years you have devoted much ingenuity to problems connected with the theory of the solid state.

Thus you studied the dynamics of a linear chain of point masses, bound to each other by elastic forces and vibrating in a longitudinal direction. But while hitherto the discussion had essentially been confined to the case of equal masses and equal elastic binding, you considered a probability distribution of the masses and of the binding constants. For this general case you showed how the frequencies of the normal vibrations are distributed in the frequency scale. As shown by Schmidt, your results are not only of importance for the mechanics of this particular system, but are also applicable to the quantum mechanics of electrons in a one-dimensional potential built up of delta-functions. In a model invented 35 years ago by Penney and myself these delta-functions were assumed of equal strength, with equal spacing, thus forming a periodic potential. The eigenvalue problem of the disordered linear chain, treated by you, is mathematically equivalent to the problem of the electronic levels in a potential formed by delta-functions with a probability distribution of strength and spacing.

About the same time you developed a theory of magnetic resonance for the conduction electrons in metals. Here the diffusion of the electrons into and out of the skin layer of the metal is decisive and, as you could show, determines the shape and intensity of the resonance line.

Two of your publications are concerned with the problem of spin waves in a cubic lattice with exchange coupling between the spins. In the treatment of this subject little progress had been made since Bloch first introduced the concept of spin waves and Bethe elaborated the idea for the one-dimensional case. Among your interesting results may be mentioned a determination of the cross-section for the scattering of two spin waves by each other and an exact expression for the free energy of the system. With the latter a solid basis became available for the thermodynamics of the Heisenberg ferromagnet. Several results of other investigators could thereby be shown to be at fault.

An interesting research carried out by you deals with the properties of a gas, the molecules of which obey the Bose statistics and interact as hard spheres. Here you could give rigorous lower and upper bounds for the energy of the ground state. A little excursion took you into an idealized atmosphere, the stability of which you subjected to examination.

During the last few years themes with a strong mathematical bias from the realm of statistics appear to have fascinated you. A statistical theory of the energy levels of complex systems, to which your research on the linear disordered chain may be regarded as the first stepping-stone, forms the content of a series of publications. In one of these a model based on the concepts of Brownian motion is used for making deductions about the eigenvalues of a random matrix. At a time when phenomena of disorder such as dislocations or point defects in crystal structures, the transition from the solid to the liquid phase or the influence of the doping with impurities on the electronic levels in semi-conductors occupy the attention of many experimenters, it calls for our gratitude when the mathematical equipment for discussing the relevant systems is extended and strengthened.

Mr. Dyson! I do not hesitate to say that both the depth and the breadth of your scientific outlook are in line with those shown by the previous recipients of the Lorentz-medal. I take great pleasure, on behalf of our Academy and of its selection committee, in requesting you to come forward and accept this token of our scientific appreciation.

De voorzitter wenst de heer Dyson namens de Akademie geluk met de hem toegekende onderscheiding en stelt hem in de gelegenheid enkele woorden tot de aanwezigen te richten.

De heer Dyson spreekt de vergadering als volgt toe:

Mrs. De Haas–Lorentz, Mr. President, Ladies and Gentlemen:

First of all, I must say thank you to Professor Kronig for the amiably exaggerated picture he has given you of my contributions to science. Second, I would like to thank all of you who are members of the Academy, for your astonishing decision to award me the Lorentz Medal. Third, I take this opportunity to thank all my friends in Holland for the hospitality which I have enjoyed this week and in the past. One of my oldest friends who is here to-day wrote a letter welcoming me to "our little cold, wet, but cozy country." I think it is true in general, and certainly in this case, that the places with the worst climates have the best people. So I say thank you now to all those whom I have no chance to thank individually.

Luckily I am supposed to make only a short speech. I want to express just a few personal thoughts which are suggested by the name of Lorentz. Lorentz was of course not the first great scientist that the Netherlands produced, but he stands in the eyes of the would as the ideal of what a Dutch scientist should be. Inside the Netherlands he has left a tradition which deeply affected those who followed him. The character of his influence is expressed most eloquently in the writings of Ehrenfest, and Einstein's correspondence also bears witness to it. Though my knowledge of Lorentz is entirely second- or third-hand, I have a vivid impression of a man who was great not only scientifically but also politically. By politically I mean that he contributed more than anybody else of his time to the functioning of science as an international activity. He took the trouble to speak many languages well, he presided at the early historic Solvay meetings, and he worked hard as unofficial administrator of international science.

In my country, things are rather different. Or, I should say, in both my countries, since I started life English and became American. In England our scientific folk-hero is Isaac Newton. Our traditional view of a great scientist is that he ought to be as eccentric as possible, secretive, solitary, suspicious of his colleagues and especially of continental Europeans, and with a crazy devotion to alchemy or apocalyptic religion. Well, this Newtonian tradition in English science is now dead, thanks to Rutherford who was also a good friend of Lorentz. At the most, the Newtonian tradition only survives in one or two of our more ancient universities.

In America the place of science in society is dominated by yet a third tradition, that of Benjamin Franklin. Franklin is even more of a folk-hero than Newton and Lorentz. Toward the end of his life he devoted his talent and his reputation completely to the service of his country, became a full-time political leader and perhaps won the War of Independence by his diplomacy in Paris. So in America there is a door wide open to any scientist who wants to follow Franklin and take part in the operations of government. I myself enjoy this aspect of American life. I spent one year designing a nuclear space-ship which the government decided not to build, and I spent four months at the Disarmament Agency giving advice about political problems of arms control negotiations. Many of my scientist friends are involved in advising the government at a much higher level, and many take an active role in political life outside the government.

Now the question immediately arises and has been often asked, what right scientists have to give advice and formulate policy, when the central issues are mainly political rather than technical. The general public mostly believes that scientists are listened to because they know how to build hydrogen bombs. If that were our only credential, our advice would not be worth much. But one can see from the example of Franklin that technical knowledge is not the main contribution of a scientist to public affairs. Franklin was valuable to the American republic, not because he knew how to build a lightning-conductor, but because he had the unchallengeably solid reputation and the wide personal contacts that result from a lifetime of international scientific activity. Scientists now are valuable in arms control negotiations, not because we understand the insides of a bomb, but because we know personally many of the men on the other side of the table, and because we know better than the diplomats what it feels like to operate a genuinely international enterprise.

I am making a large claim for the scientific community. I am claiming that we have the right and duty in all countries to take a lead, to persuade our peoples that policies of narrow nationalism and ideological autarky are as futile in politics as they are in science. The force of our persuasion must rest on the fact that we can display a creative alternative to nationalism, a working model of an international community, in our own professional lives. This is why I consider Lorentz to have been not only a great scientist but a great politician. He was one of the chief sustainers of the international community of science, which may in the end be the best hope for teaching mankind to live together in peace.

De voorzitter zegt de heer Dyson dank en spreekt zijn erkentelijkheid uit jegens de leden van de commissie en jegens de heer Kronig voor de door hen in het belang van de Akademie verrichte werkzaamheid. Hierna sluit de voorzitter de vergadering.

De aanwezigen begeven zich hierna naar de koffiekamer waar zij in de gelegenheid worden gesteld de heer Dyson te complimenteren.