Reminiscences

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When asking for an autobiography of a kind Prof. Ewald wisely added a few directives for its contents.

'*What made you a chemist?*' No doubt the excellent training in chemistry I received at the secondary school, where the understanding was emphasized and not the learning by heart. In the beginning of this century, before the theory of Bohr and the data of the X-ray analysis, and before the recent astounding development of chemistry, the subject matter treated at the time offered hardly any high lights. But the well planned way in which it was built up, and how, with the aid of balance and logic, one arrived at the atomic composition of matter—this deeply impressed us. And now that we have witnessed the spectacular growth of X-ray analysis and the no less amazing progress in the determination of chemical conformation by entirely different means, our admiration for the direct optical Fourier method can only increase that for its surprisingly complicated older partner.

At the time of my final examination at the secondary school one had to take a tough supplementary examination in Latin and Greek in the Netherlands for the admission to the study of the natural sciences at the University, and this took another year or two! Not until 1917 was there a change. Nevertheless it is with pleasure that I recall this time, since it provided the scarce chance of leaving me ample time for music.

'*Does the physicist or the chemist prevail in you?*' I studied chemistry in Amsterdam, which study in so far as it concerned the chemical part gave me but little satisfaction owing to a lot of elementary analytical chemistry in the first few years—this state of affairs is still often found here—and later on much phase theory, a continuation of the famous work of Bakhuis Roozeboom. Only lately has far more choice been provided at the Netherlands Universities of drawing up one's own programme of study (especially after the B.A. examination). Fortunately physics made up for a good many failing expectations. As a second-

year student I prepared my first publication, together with the professor of experimental physics, Dr. Sissingh, a man of unparalleled enthusiasm in lecturing, whose memory I cherish most gratefully. I always remember these months with pleasure. One day when measuring the angles of a nearly equilateral glass prism with the goniometer, on reflecting from a lateral face more than one image appeared. The assistant was called in—it was a horribly cold day—and he pronounced: it must be the cold! Solving even such a childish little problem—the light beam is reflected directly but also leaves after circulating the prism—will fascinate the beginning student. I mention this occurence to bear witness to experimental work in the first years of study of a more romantic nature than usual, a subject that of late has come up for discussion now and than in *J. Chem. Education.*

The First World War I spent in military service; it gave me the opportunity—it was shortly after my B.A. examination—to study quietly thermodynamics and statistical mechanics. My later liking for teaching these subjects dates from that time. I even made the attempt —though without success—to invite attention for the 2nd Law of Thermodynamics already at the secondary school, as it moves head and heart more strongly than many other topics learned.

As a physico-chemist I have later always felt somewhat envious of theoretical physicists. In this volume I should like to make particular mention of how much I admired Ewald's classic articles on light propagation in crystals when I was re-reading them recently. I also remember vividly a lecture on this subject delivered by him in 1924 in Leiden.

'*What made you a crystallographer?*' The excitement aroused by Bragg's NaCl model at the chemical laboratory in Amsterdam. I arrived there to continue my studies having been demobilized. My tutor Smits was against the model: 'In the representation of the solid substance given by the Bragg model the considerations are perfectly ignored which have led to the firm conviction that the atoms in the molecule are bound by forces which are characterized by their localized nature and by their definite number.... so that any representation which leaves out of account these circumstances so exceedingly important from a chemical point of view, must be erroneous.'

The happy consequence which this view brought about was that the decision was taken to start X-ray investigation in Amsterdam; in this endeavour A. Karssen, the friend I lost too early, joined me. For a couple of months we studied at the Laboratory of the Veterinary College at Utrecht, where Keesom and Kolkmeyer had started this

research shortly before. The latter was to remain my fatherly friend all his life. Our first investigation was concerned with the crystal structure of $NaClO_3$. I well remember Keesom's virtuosity in motivating these investigations for the Ministry of Agriculture—the Veterinary College came under its competence.—In our publication one reads: 'For biological science every deepening of our insight into the nature of the chemical bindings of the element carbon, so important for the organic world, will be of great value.... sodium carbonate and sodium-hydrocarbonate first came into consideration because of their importance for animal life. Considering, however, that we could expect to meet with great difficulties in these investigations.... we first investigated some substances with analogous(!) structure. We chose sodium-chlorate and sodium-carbonate.'

The apparatus was made up from an old induction coil and a self-constructed tube on a Gaede pump. One of the most important occupations when experimenting was fanning away again and again the spark discharge which jumped between a disk and point when the tube became too hard. In toy-shops we hunted for the little balls for our atom models. At that time the 'playing' with these models tickled everybody to laughter. Instead of the *International Tables* there were only the space-group tables of Niggli and, a few years later, those of Wyckoff. Then Wyckoff was a help and a name to me, afterwards he became a warm-hearted friend.

For our doctor's degree Karssen and I had determined the crystal structures of LiH and $NaClO_3$, and we drew lots who was to take which for a doctorate thesis. The investigation of LiH was a first, bold attempt—on the ground of Bohr's orbitals—to localize the valency electrons. Shortly afterwards we spent a brief but extremely instructive period at the laboratory of Sir Lawrence Bragg in Manchester. This allows me to count Sir Lawrence Bragg among my personal tutors, a priviledge not all crystallographers enjoy, even though we all learnt from him. Dr. James had the daily supervision—I recall his saying: 'Don't think too highly of our physics', a pronouncement that is surely easily disproved by his Volume II of *The Crystalline State.*

I retain a painful memory of a visit Sir William Bragg paid to the Amsterdam laboratory. So persistent were they in pouring out the hackneyed arguments against the results of the X-ray analysis that Sir William in despair, raised his arms to heaven. I need not mention that in later years Sir Lawrence's lectures at our Universities were the summits of röntgenographical life. Some ten years ago we were

predicted that the solution of the structure of haemoglobin 'was just around the corner'. Many were in doubt. We now know: wrongly so.

In Amsterdam I became lecturer in crystallography and thermodynamics. And there I passed through a time of struggle for the raison d'être of X-ray analysis in crystallography. A large geological institute was being built and crystallography was to get a floor. The professor in geology had the overall directorship. But he first wanted us to make a study-tour through Germany to ascertain whether X-ray analysis was of real importance for mineralogy (ten years after Bragg's silicate structure and Goldschmidt's Geochemische Verteilungsgesetze!). When this had been convincingly demonstrated to him the intended report of our findings was not drawn up. Shortly afterwards I was informed that chemists were not permitted to work in the new institute so as to prevent it from becoming top heavy. Of course I did not give up my pupils, though this set-back resulted in my being without any official subsidy for some years. Of this fight mainly two points remained with me: I had the support of my friend Nieuwenkamp, then my assistant, now my colleague in petrography in Utrecht, who never lost his sense of humor. And furthermore, the interest of the physicists, who did see the importance of X-ray analysis. They made the training in elementary crystallography obligatory for students of physics; this was in contravention of our official examination statutes which still require crystallography for chemists but not for—solid state!—physicists. This Amsterdam regulation is still being continued there, and there alone, also under my excellent successor Caroline MacGillavry.

In 1939 I changed over—at first not without heartache—from crystallography in Amsterdam to physical chemistry at Utrecht, as successor of Prof. Ernst Cohen, well known for his investigations into allotropy. During the war Cohen, being a Jew, was killed, though it was he who, after the First World War, had been the great advocate for admitting the Germans again into the international organizations.

My teaching task—physical chemistry, excepting only electrochemistry and colloid chemistry—was a heavy one, but it always pleased me provided I was not too troubled by imperfections in such an extensive teaching job. I once told a Swedish colleague that I lectured ten hours, he answered: I give five. A little later it appeared that with him it meant five hours yearly, whereas mine were given weekly! By dividing and doubling chairs this has much improved the last few years and at present my job is shared by my colleague Peerdeman. Another pleasant change was that my Röntgen department was

separated from the physico-chemical laboratory ten years ago, and put up—odourless—in a gentleman's house. Students call this the Crystal Palace. Living as I do in my laboratory I could observe a co-worker—Dr. van Bommel—who for some years slept from say 4 a.m. till 10 a.m. and for the rest measured and calculated. This tenseness, when eagerly awaiting results so directly and strikingly visible, is quite characteristic for the Röntgenanalyst. Exciting also was our first record with anomalous scattering, which required a continuously watched exposure of some hundreds of hours. It had to be successful in view of an intended journey, and was daily threatened with failure because of the improvised Zr-tube and the freakishness of a pump that had been hurriedly put back into use. Twenty-four hours before the time of departure half of the Weissenberg (deflection 0/180°) was developed and revealed nothing, the next day the further exposed other half (0/−180°) showed the effect looked for.

Often one forgets—or one is anxiously silent—about that which lies uppermost in our heart: Very much I owe to my co-workers, to their friendship too. A close friendship with Paul Rosbaud dates from the German version of my X-ray textbook; his flying visits are a delight to me and my family.

With the publications of the Union I had for many years a pleasant contact as co-editor of *Structure Reports* and here—beside the lot of work—I especially think of Wilson's occasional, welcome appearance in Utrecht when on his way to his publisher. My most remarkable recollection from my time as President of the Union was—beside that of the cheerful meeting in Paris—the reversal of financial distress into prosperity by increasing the subscription price of *Acta*. I worried about this daring solution. Fortunately my worries were lived down.

In a public lecture given in 1925 at Leiden Dr. van der Veen ended, after describing Von Laue's, and the Braggs' discoveries: 'There we have the jousting ground, where the natural sciences may compete and where chemistry and physics unite.' This jousting ground has indeed shown exciting and unexpectedly grand victories, where these pioneers did not confine themselves to formulating the rules of the game, but themselves remained the first players.

Personal background behind it all. I admire Mozart, crystals (let him who visits Paris take delight in Professor Wyart's wealth of beautiful crystals) and cats. My wife was amongst my student audience in Amsterdam; after having lost sight of her for five years, I asked her to marry me.