

Harald Bohr

Professor and Head of Department

By HANS TORNEHAVE

This is an attempt to tell about Harald Bohr as we knew him, “we” meaning students and junior teachers. I was his student 1935–1940 and a junior teacher at the institute till after his death in 1951.

The nineteenthundred and thirties were the peak of Harald Bohr’s career. The almost periodic functions had made him known all over the mathematical world. The original papers appeared in 1924–26 and the monograph in *Ergebnisse* in 1932. He had been a professor at the Technical University since 1914, but was called to our university in 1930. He got his new mathematical institute in 1934 at the 450th anniversary of the university. It was a grant from the Carlsberg Foundation, and it was built as a new wing of his brother’s Institute for Theoretical Physics, which is now called the Niels Bohr Institute.

Before he started in his new position at the university, Harald Bohr went on a tour to U.S.A., where he visited Stanford University and the Institute for Advanced Study. He was a member of the Royal Danish Academy of Sciences and Letters from 1918, and he was the chairman of our Mathematical Society from 1935.

According to Harald Bohr the textbook in mathematical analysis known as “Bohr and Mollerup” was inspired by Jordan’s *Cours d’Analyse*, but also Hardy: *A Course of Pure Mathematics* has had some influence. Johannes Mollerup has probably been somewhat underestimated and most of the details in the text-book have certainly been the result of discussions between the authors. However, Bohr wrote very much like he talked, and we who knew him hear the echo of his voice when we read his book. Hence, we think that Bohr is responsible for the formulation, but we also know that he was extremely willing to accept good ideas proposed by others.

Bohr did not give elementary lectures at the university. The students attended the lectures for engineering students on mathematical analysis, theoretical mechanics and physics, while they shared the chemistry lectures with the students of medicine. The students had separate elementary lectures only in geometry and astronomy.

In 1933 Bohr tried just once to lecture over his textbook for the mathematics students. The lecture went on until the fall term in 1935. Bohr was somewhat more sedate than in his younger days. He had given up the habit of keeping the sponge on the floor, kicking it ceilingwards and catching it neatly, when he had to erase something. He had been a top soccer player, expert dribbler and very popular. He continued playing even as a professor at a time when tailcoat and tophat were standard equipment at the university. In the thirties it was a lot more informal, although most students wore a suit and a tie at the lectures.

Bohr talked very fast and with a flat “a” reminiscent of Copenhagen dialect. He used the blackboard in a systematic way starting upper left and finishing lower right, writing in long horizontal lines. He supplied the lecture with many cross references while moving rapidly back and forth and underlining this and that on the blackboard in different colors. He did not spend much time on straightforward proofs, but where a trick was needed he demonstrated how the obvious method failed, and he also motivated the kind of trick to be used. He used many words in the text-book, but still more in his lectures.

For his advanced lectures Bohr always prepared a complete manuscript written by hand in a solid bound volume with ruled pages. If he had an interested assistant, he discussed the text with him, and suggestions from the assistant were quite often tried out in the manuscript and in the lecture. Nevertheless it happened quite often that Bohr improvised something, and his improvisations were the best parts of his lectures. He lectured regularly on number theory and on complex analysis, but the content of these lectures varied considerably. He arranged it usually so that his assistant could continue the lecture in a subsequent term and talk about his own particular interests.

Mathematicians of to-day would find Bohr’s lectures rather old-fashioned, but one must remember the current state of mathematics at that time. The shift from combinatorial to algebraic topology had just started and Hilbert space and spectral theory were known, but hardly in the abstract form. General topology was also known, but it had not a quite definite form. Measure theory had not yet become abstract, and convexity theory was mostly finite dimensional.

Bohr was very open for new ideas and he enjoyed the abstract points of view, but he did not lecture on these modern subjects although he quite often treated very modern subjects in brief talks, e.g. in our mathematical society. We had also lectures by Bohr’s friends, former pupils, young assistants etc. on such modern subjects, but before I start on this I must tell a little about the life at the institute.

The former institute building looks small to-day, but it was really quite ample. About 20 students per year started in the compulsory combination of mathematics, physics, chemistry and astronomy and about half of them specialized in mathematics. The other professors in mathematics were N. E. Nørlund and J. Hjelmslev, but Nørlund was also the director of the Geodetic Institute and only part time professor. He gave two lectures a week, sometimes on geodesy. Hjelmslev was really a genius and he contributed much to the understanding of the interactions of the axioms of geometry. His lectures were brilliant and convincing, but he did not really care about minor details, and many students found it hard to follow him. His assistant David Fog interpreted Hjelmslev’s text quite well, and he was very popular with the students. Nørlund’s assistant G. Rasch was well liked by the students who attended his exercises on differential equations, but he was dismissed some time in the thirties. He was son of a missionary and he became a preacher of statistics himself and did a lot to improve the statistical work in medicine and biology, and in the end he became a professor.

Most students of mathematics specialized with Bohr. His assistant J. Pál was also the mathematics teacher of the chemical engineering students. He was probably the first Jewish mathematician helped by Harald Bohr. He was Hungarian, and Bohr found him in Göttingen, where he seemed more or less lost. He was interested in real and complex analysis, topology, convexity, formal algebra and projective geometry. He did not look like a Jew, and very few persons knew that he came from a Jewish family, and he did not really like Jews in general. He was religious, and he called himself a Catholic. He had very strict views on morality and on teaching, and he insisted that students should learn only what they were able to learn well. He was very helpful to several students including myself, but he could be very disagreeable to some students. His exercises in connection with Bohr's elementary lectures were considered a trial by most of the students.

It was unfortunate that there was too little contact between Bohr's students and the students who specialized with Hjelmslev or Nørlund, but it was fortunate that Bohr was the center of much debate and activity. Many teachers of the technical university participated in seminars arranged by Bohr and they lectured occasionally at the university. Among them were A. F. Andersen, Richard Petersen, Johannes Møllerup (who died in 1937), Kaj Rander Buch, Vilhelm Jørgensen, Svend Lauritzen. Most of all Børge Jessen, who stayed with us from 1941, and Svend Bundgaard, who was with us much of the time. Erik Sparre Andersen, Erling Følner and some more joined us towards the end of the thirties. A few high school teachers were also regular guests.

There were also mathematicians whom Bohr had helped to get away from Hitler's Germany. Most of them stayed in Denmark only for a short time, but Werner and Käthe Fenchel came for good, and Otto Neugebauer was here for many years. He started our tradition of history of science. Olaf Schmidt and Asger Aaboe were his pupils.

The physicists had even more guests and there was fraternization between the two populations. Hevesy did chemistry and biology and talked Hungarian with Pál. Frisch and Meitner told us about their discoveries. The brothers Bohr talked much with each other, but always quite in private. It was very obvious that they were great friends. Occasionally, we also exchanged some small talk with Niels Bohr, but seldom with both brothers simultaneously.

An important event was the big lecture series in 1936/37 on almost periodic functions. Jessen lectured and Bohr was the most eager commentator. Most of the mathematicians mentioned above were in the audience and also some students. The lecture included the generalizations to Abelian groups and the theory of analytic almost periodic functions, but not the generalizations to Lebesgue-integrable functions. These were investigated very thoroughly shortly afterwards by Bohr and Følner in a large joint paper and in Følner's thesis. Følner and Jessen collected a nearly complete bibliography of almost periodic functions, and it was during this work that Følner found Bogoliubov's second proof of the approximation theorem.

It has been said that everybody in Hilbert's Göttingen discussed everything with everybody else, while nobody in Poincaré's Paris discussed anything with anybody else,

and Bohr was as much influenced by Göttingen as Nørlund by Paris. Bohr was much attached to Landau, and he quoted occasionally some of Landau's deprecating remarks about Hilbert, but he really also admired Hilbert very much. It was probably one of the greatest disappointments in Bohr's life that nobody succeeded in finding a place for Landau outside Germany.

Hardy was another friend of Harald Bohr and had a lot of influence on him. Hardy was the typical diner at high table in college, who liked the learned discussions and enjoyed taking a standpoint and defending it, even in matters he knew little about. He was the genuine English combination of the extremely refined with the quite informal, and he was very outspoken. Bohr has told that Hardy called his English atrocious and that Hardy had to teach him that it was important to say "he did not come" rather than "he does not came". Hardy was obviously a clever teacher, and Bohr's English grew much better. His German was very efficient, but he spoke it with the flat Copenhagen "a".

It is easy to understand that Bohr and Hardy fascinated each other. Both liked taking standpoints on everything, but Bohr did it experimentally and his standpoints were to be changed eventually. Hardy enjoyed defending his standpoints as a kind of sport. Bohr and Hardy paid visits to each other and Hardy liked the Danish landscape with the red cows drawing circles in the pastures.

Our mathematical society had more frequent meetings in those days; there was no competition with advanced colloquia. We had a good many foreign guests. It is true that it was not very wealthy, but even a small grant went a long way. So, we were quite well informed about new mathematical events. For instance we had Landau's assistant Heilbronn giving a brief series of lectures on Vinogradov's proof of the weak Goldbach conjecture.

Bohr understood and accepted new ideas quite readily, as e.g. the theory of distributions when he heard Laurent Schwartz lecture on them shortly after the war. In his teaching, however, he stuck to the classical subjects, which he knew extremely well, but he encouraged the junior teachers to lecture on these modern subjects. Sv. Bundgaard lectured in abstract algebra and on Lebesgue integration theory. Occasionally a teacher from the technical university gave a course. Jessen has already been mentioned, but also Jakob Nielsen gave a course on his own subject, surface topology.

Theoretical logic was viewed by Bohr with some suspicion, and most of the other mathematicians at the institute agreed with him. Kronecker's strict point of view was generally respected, but Bohr and everybody else were as unwilling as Hilbert to abandon Cantor's paradise, and nobody was able to manage without Zermelo's result. In the teaching Landau's *Grundlagen der Analysis* was more or less chosen as a basis.

As a matter of fact the professor of philosophy Jørgen Jørgensen was a preacher of formal logic. He read an introductory course in philosophy. It was compulsory for all university students, but they could choose between three very different teachers. Jørgen

Jørgensen experimented with polyvalent logic, and he was also once invited to give a special course at the institute. One student specialized in logic, and Bohr was not very happy about it, but the student passed with nice marks. The attitude to logic changed while Jessen was head of department, and Gutmann Madsen started lecturing on it.

Bohr enjoyed talking informally with us when we were engaged in idle discussion in the lunch room at the institute, and when we were discussing whatever it might be, he quite often added some very surprising remarks. He was very observant and had a keen sense for all kinds of absurdities in the real world, and occasionally he enjoyed talking nonsense. I remember once, when the news of the discovery of the rabbits' "chewing pellets" first reached us, that one student stated that hares and rabbits were really ruminants, and, of course, he met intense opposition, but then Bohr appeared and he supported the student because, he said, he knew that these animals could not be imported in Sweden, and he thought that was because of the mouth and hoof disease, which attacked only ruminants. Then he went on telling that he once caught the mouth and hoof disease himself and it was really quite disagreeable.

Ulla Bohr has told a story from Bohr's visit in U.S.A. shortly after the crash in 1929. When they first visited a private home over there, Bohr went to the bathroom and got so much absorbed in studying the gadgets that the company became nervous and came looking for him. He was interested not only in things, however, but also in people and he had a deep understanding of relations between people.

Quite often Bohr celebrated the end of a term of lectures by inviting the participants and perhaps also some of his colleagues to a dinner in his home, and afterwards he might read something to us, and quite often something with overtones of absurdity. He has read to us from *Babbitt* by Sinclair Lewis and from *Winnie the Pooh* in the Danish translation "Peter Plys", and he made very similar comments on the two texts. Babbitt was the American who lived through the boom and the crash and who said and did just what everybody else said and did and understood nothing of what happened, and the ways of Winnie the Pooh were much the same, although his crash was less definite.

After the war Bohr became the Provost of Regensen, our closest equivalent of Trinity College. It is governed by three persons with mock clerical titles, the provost, the vice provost and the bell ringer, who is the students' representative. The provost lived in Regensen, where he had an old-fashioned, but comfortable apartment, and it was an attractive setting for his parties.

He also owned a fine old fisherman's cottage with leaded window-panes and a thatched roof. It is situated on a low cliff about half a mile south of Fynshav on the island Als. In those days the ferry harbour was at Mommarmark some 6 miles farther south and Fynshav was very peaceful. It was also on the edge of a very small village with a few farms and some small houses. Bohr invited his foreign and Danish friends to stay with him at Fynshav, and he found living quarters for them in the village. I visited him there a few times during the war, when he had no foreign guests, but it was charming to

discover that the villagers knew Landau, Hardy, Weyl, Bochner and many other famous mathematicians.

We learned in Fynshav that Bohr was a nasty player of croquet and boccia, and on a rainy day the relatives of his mother, the Adler's, were even more nasty players of parlour games like writing lists of as many famous persons as possible with their last name starting with E. Occasionally, the blackboard was carried outside on the gravel and somebody gave a lecture. Some of Jacob Nielsen's results were presented there first. He had a house about half a mile northwest of Fynshav and the two families paid many visits to each other, Jacob Nielsen often travelling in his kayak.

Bohr's health was not quite satisfactory. On Als we saw how he spread sesam seeds on his oatmeal in the mornings, and during the terms he might take a little time off for recreation at Aldershvile by Bagsværd Lake, and we might have to go there to discuss some problem with him. Nevertheless he was always quite cheerful, although he was nervous now and then about the success of some effort to get somebody away from Germany.

We remember Harald Bohr as extremely mild mannered, but it would be very wrong to consider this as a symptom of weakness, and he could be incredibly stubborn when he fought for a cause that he felt was just. Once, when he had to judge a doctor's thesis, which was barely acceptable, he did accept it, but at its defence he told the doctor in no uncertain terms that it was just barely acceptable, and he did it in such a way that also the doctor was convinced.

As told above, Bohr enjoyed many kinds of absurdities, but he really hated the absurdities used by the German nazis as excuses for the worst atrocities. He also felt that the German jews should be helped indiscriminately, since they were persecuted indiscriminately. This led to his disagreement with Pál, who did not like jews indiscriminately, and Pál left the institute. Actually there were many jews among Pál's best friends, and the real background for the break was the strict religious-moralistic point of view of Pál, who wanted everybody to follow the straight path regardless of the kind of provocations they met with.

Harald Bohr died, and the message of death reached us at the institute a dreary winter morning immediately before we should start a day of examinations, which went off rather badly. But Bohr had been the kind of leader who left a healthy institute, which lived on and thrived. He would have enjoyed being with us to-day.

Matematisk Institut
Universitetsparken 5
DK-2100 København Ø
Denmark