

“I shall always follow your progress with warm interest”: Niels Bohr as seen from a Swedish perspective until 1930

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Abstract

Niels Bohr made several crucial contributions to the development of physics in the 20th century, not only through his scientific publications but also through establishing an important environment for international collaboration at the institute at Blegdamsvej. This paper investigates Bohr’s activities from a Swedish perspective. Besides all his other important activities Bohr took an active interest throughout his career in the local promotion of the physical sciences. Bohr as seen from a Swedish perspective might then not only satisfy the local historical interest in the matter, but also add elements to the understanding of Bohr’s work by taking the Scandinavian connection into consideration.

Key words: Niels Bohr; Oskar Klein; Carl Wilhelm Oseen; atomic theory; reception of atomic theory; Scandinavian collaboration.

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1. The reception of Bohr's work in Sweden

Late in August 1911, the Second Scandinavian Congress of Mathematicians was held in Copenhagen. That is where Niels Bohr and Carl Wilhelm Oseen met for the first time. Bohr had previously sent his doctoral dissertation to Oseen, who was a professor of mechanics and mathematical physics at Uppsala University. The Swede had appreciated the dissertation so much that he chose to devote his seminars during the autumn term in Uppsala to the electron theory of metals – the topic of Bohr's dissertation.¹ In a letter after the congress, he wrote to Niels Bohr: "For me it is one of the highlights of the congress that I got to know both of you [Niels and Harald Bohr]. I believe this is a matter of importance to my whole life. I have learned a lot from you and have even more to learn. I shall always follow your progress with warm interest."²

After the congress in August 1911, Bohr had worked with J.J. Thomson in Cambridge as a postdoctoral researcher and moved the following year to work with Ernest Rutherford in Manchester. In the summer of 1912 he returned to Copenhagen and married Margrethe Nørlund, also becoming an assistant lecturer that autumn and teaching at the College of Advanced Technology (Polytekniske Lærestalt). In February 1913, Bohr took the opportunity to visit Oseen, who was ill with tuberculosis and staying at a sanatorium, while he and Margrethe were in Sweden to attend the inaugural lecture of Margrethe's brother, N.E. Nørlund, as a professor at Lund University. Oseen greatly appreciated the visit, since it had been a long time since he had met any colleague, and he had the chance to discuss physics with Bohr.³ During this visit, it is possible that they discussed Bohr's ideas about how a new atomic model could conceivably explain the characteristic line spectra of various elements, but a letter to Hevesy from this period mentions nothing

1. UUA, Fakulteternas arkiv 4. Filosofiska fakultetens arkiv, Matematisk-naturvetenskapliga sektionens dagböcker, F1b:9.

2. Oseen to Bohr, 3 September 1911, NBA in BSC. Bohr was on his way to England. Bohr to Oseen, 6 September 1911, CWOA, E1:1. Also in Bohr (1972), I, p. 126.

3. Oseen to Bohr, 10 February 1913, NBA, BSC. Also in Bohr (1987), p. 755 f. Cf. Kragh (2012), pp. 45-50.

about any such ideas. Otherwise at precisely this time, Bohr became interested in Balmer's formula for line spectra, which in the spring of 1913 led him to create a theory based on an atomic model in which electrons moved in definite, discrete orbits around the nucleus of an atom and in which electrons that shifted from one orbit to another emitted (or absorbed) energy equivalent to the lines in the hydrogen spectrum. This theory was published in three parts – "On the constitution of atoms and molecules" – during the summer of 1913. Bohr described this new work to Oseen in a letter in July.⁴ Oseen was critical of the quantum hypothesis, but at the same time anxious not to be dismissive. And as Bohr's atomic model was published, some of his criticisms faded. When Bohr had sent the second part to Oseen in October, Oseen replied with a letter in which he expressed his admiration for the Dane's latest work.

What I would like to tell you first is that, although I already knew the direction of your thinking as well as some of its results, I was still surprised at one point by the beauty of your result. This was the connection between h and the Balmer-Rydberg constant. As far as one can see, on this point you have gone beyond the region of hypotheses and into that of truth itself. Higher no theorist can reach, and I congratulate you with all my heart.⁵

Oseen himself now tried to reconcile the development of Bohr's atomic model with the established theories of electromagnetism of James Clerk Maxwell and Hendrik Lorentz. This required extensive revisions of the previous theories. Oseen therefore wondered: What would replace Maxwell's equations?

There were attempts to arrange an academic appointment for Bohr in Copenhagen. Niels Bohr himself believed that there was some opposition to him among the university faculty. He thus

4. Bohr to Oseen, undated but July 1913, BSC. Cf. Oseen's reply, 20 July 1913, BSC. In August that year, he sent a reprint of the first part. Bohr to Oseen, 11 August 1913, BSC. Bohr (1913), reproduced in Bohr (1981), pp. 161-185; cf. also pp. 103-134.

5. Oseen to Bohr, 11 November 1913, BSC. Bohr (1981), p. 552. See also Bohr to Oseen, 17 October 1913, CWOA, E1:1, also in BSC.

turned to his two allies Rutherford and Oseen in the hope that they could help him.⁶ The Swede wrote a very positive statement, and he believed that Bohr might be having difficulties with the faculty because not so many members could actually understand what Bohr had achieved.⁷ A few weeks later, Bohr was able to inform him that his situation looked promising. Oseen's and Rutherford's statements on his behalf had been very useful. A "teaching position" in theoretical physics would be established, he believed.⁸

Oseen's Swedish colleagues viewed Oseen as critical of quantum physics, but Bohr's atomic model was new and promising and thus avoided his criticism. "I do not know any physicists now living who have discovered more beautiful things than those that appear to me to be the facts and unassailable results of your theory," Oseen wrote to Bohr. He also thought that a "radical overhaul" of existing knowledge of physics would be needed before Bohr's ideas made their breakthrough.⁹

Just before Christmas 1915, Bohr wrote from Rutherford's laboratory in Manchester and thanked Oseen for his paper on Bohr's atomic model and Maxwell's equations. In his paper, Oseen maintained that any attempt to combine Bohr's atomic model with Lorentz's electron theory was unfeasible without creating internal contradictions. Yet his paper should not be perceived as a polemic against Bohr's theory, he insisted, but as a *logical clean-up job*. He could not go along with theories based on contradictory assumptions.¹⁰ Bohr took the Swede's criticism in stride and said he had come to similar conclusions, but from other vantage points.

I do not know what your point of view of the quantum theory really is; but to me it seems that its experimental reality can hardly be doubted, this is perhaps most evident from Bjerrum's beautiful theory, and E. v. Bahr's papers almost seem to offer direct proof of the

6. Bohr to Oseen, 10 March 1914, CWOA, E1:1.

7. Oseen to Bohr, 12 March 1914; Bohr to Oseen, 18 March 1914, BSC.

8. Bohr to Oseen, 8 April 1914, CWOA, E1:1.

9. Oseen to Bohr, 9 October 1914, BSC.

10. Oseen (1915). Oseen developed his criticism further in Oseen (1916a) and in Oseen (1916b). In Oseen (1916c) he also focuses on similar issues.

quantum laws, or at least the impossibility of treating the rotation of the molecules with anything resembling ordinary mechanics.¹¹

Oseen was thus positive towards Bohr's theory, which in his opinion provided new hope for atomic physics.¹² The two continued their exchange of letters early in 1916. In mid-March the Dane wrote that he agreed with Oseen that logical criticism of the quantum theory was needed, but that he probably had a more optimistic view of its potential than the Swede had.¹³ In turn, Oseen replied and congratulated Bohr because it appeared that the Dane would now finally get a professorship in Copenhagen, also praising him for "the brilliant way in which your theory has shown its fruitfulness."¹⁴

Another phase started in the winter of 1917, when Niels Bohr's young Dutch assistant Hendrik A. Kramers was traveling in Sweden.¹⁵ From Stockholm he wrote to Bohr and explained that he would be giving a lecture at the Stockholm Physical Society. There he intended to say "something about the use of quantum theory in spectral lines," a topic on which Bohr had lectured during the preceding term.¹⁶

Kramers did not have time to cover everything he had intended in his lecture – he had wanted to raise just about every theoretical aspect of the then-prevailing atomic physics, "but that wasn't too

11. Bohr to Oseen, 20 December 1915, BSC. Bohr (1981), pp. 564 ff. Cf. Bahr (1914). Eva von Bahr was a Swedish experimental physicist from Uppsala who knew Oseen very well, but who was working in Berlin at that time.

12. Oseen to Bohr, 3 March 1916, BSC. Also, but with various incorrect transcriptions, in Bohr (1981), pp. 568 f.

13. Bohr to Oseen, 17 March 1916, draft, BSC. Also in Bohr (1981), pp. 571 ff.

14. Oseen to Bohr, 27 March 1916, BSC.

15. Kramers was only 22 years old when he set out to introduce Bohr's theories to Swedish physicists. He had received a thorough education in theoretical physics at Leiden from Ehrenfest and Lorentz before ending up working with Bohr in Copenhagen. See Dresden (1987), p. 35 and p. 101.

16. Kramers to Bohr, 2 March 1917, BSC 4.2. J. L. Heilbron and L. Rosenfeld, interview with Oskar Klein, February 25, 1963. OHI – O. Klein 3(6). Cf. Oseen's and Benedick's exchange of letters in BKB & CWOA, E1:1. Kramers to Bohr, 5 and 6 March 1917, BSC 4.2.

bad; because I had, nevertheless, told enough that wasn't understood." In the discussion after his lecture, several audience members had been critical, questioning the equation $h\nu = E_1 - E_2$, which is fundamental to Bohr's theory; they maintained that an electron would need an "information bureau" to be able to calculate the frequency that would be emitted. The formula was only a formula and said nothing about the actual mechanism.¹⁷ Bohr had recommended Kramers that he should study the Swede's papers, and Kramers did so to the best of his ability. Kramers also had time to visit the Nobel Institute in Stockholm, where he was shown an X-ray machine, and where he met "a Dr. Klein, who is an assistant in Arrhenius's laboratory". This was the first time that Oskar Klein and Kramers met. At their very first meeting the Dutchman introduced Klein to Bohr's theories, and they would continue along this path.¹⁸

Kramers was stimulated by his meeting with Oseen, and the Dutchman therefore returned to Uppsala a week later. On March 22, 1917 he wrote to Bohr and announced that he now intended to stay in Uppsala for two weeks. He had continued his discussions with Oseen on the latter's attempts to modify the Maxwell-Lorentz theory to fit in with the new atomic models, but there were great difficulties associated with this. Kramers had also attended a seminar.¹⁹

One can say that Kramers in this way acted as a diplomat on behalf of Bohr's atomic physics during his visit to Sweden, both by visiting Bohr's old ally Oseen and by trying to win over new supporters for Bohr's atomic theories by lecturing.

2. Klein and a "fruitful mysticism"

Oskar Klein's original plan that year had been to travel to Göttingen to work on his dissertation on electrolytes with Peter Debye and

17. Kramers to Bohr, 12 March 1917, BSC 4.2. Bohr (1976), p. 10 and pp. 652 f. Cf. Robertson (1979), pp. 51 f.

18. Kramers to Bohr, 17 March 1917, BSC 4.2. Kramers especially mentions Oseen (1915).

19. Kramers to Bohr, 22 March 1917, BSC 4.2.

then continue on to Einstein, but since Bohr and Kramers were located along the way, he decided to visit them in Copenhagen firstly. His meeting with Kramers had even persuaded him to consider a long stay with Bohr.²⁰

After having asked Kramers for his advice and after having applied for a scholarship, Klein approached Bohr directly, asking him first if Bohr would consider receiving him. Klein explained that he was interested in “quantum theory matters” and would like to work on a problem related to this. Bohr replied that he was “highly welcome” to Copenhagen.²¹ Klein was eager to emphasize his interest in Bohr’s research specialty, but it was probably not only the prospects of quantum theory that tempted him. It was very much Bohr’s way of working that attracted him.²² Bohr responded that he was interested in Klein’s paper related to his own work on quantum theory and sent him the first part of “On the quantum theory of line spectra”, which would provide the basis for the discussion of quantum theory over the next few years.²³ Klein also received instructions on what he should read up on.²⁴

Klein traveled to Copenhagen, and during the summer of 1918, Bohr introduced him to his problems and working methods. Kramers was still in Copenhagen as Bohr’s assistant, and when Bohr himself was not guiding Klein in quantum theory, Kramers did so.²⁵ Klein worked all summer and learned a lot from Kramers and Bohr. “It is enormously fun to see how much of the old mechanics will be useful thanks to quantum theory. Theorems that not even the astronomers have had any use for will now be beneficial.”²⁶

After his summer in Copenhagen was over and Klein had returned to Stockholm without getting to Göttingen, he wrote – this

20. Of course Copenhagen in neutral Denmark had distinct advantages over destinations in warfaring countries. OHI - O. Klein 1(6).

21. OHI - O. Klein 2(6). Klein to Bohr, 27 March 1918, BSC 4. Bohr to Klein, 5 April 1918, OKP.

22. Klein to Bohr, 8 April 1918, BSC 4.

23. Bohr to Klein, 29 April 1918, OKP. Klein (1973), p. 160.

24. Klein to Bohr, 2 May 1918, BSC 4.

25. Klein to Arrhenius, 21 May 1918, SAA, E1:13.

26. Klein to Arrhenius, 28 June 1918, SAA, E1:13.

time in Danish – and thanked Bohr for the pleasant and instructive stay. He also declared that “all the physicists here would be pleased if you came and spoke about quantum theory.”²⁷

In the autumn Klein wanted to focus on his interest in Bohr’s own research specialty. “Until now I have not looked much at quantum theory this autumn; there is so much of the old physics that I know little about. But this winter I would like to get into atomic model issues in earnest.” He would have the chance to do this, but not with Bohr’s help. Bohr became ill, and Kramers then took the opportunity to visit Stockholm. Klein was very pleased about this visit and informed Bohr that they would travel north to the Dalarna province to “go cross-country skiing, and he [Kramers] will teach me quantum theory.”²⁸ The two young men went skiing, discussing quantum theory and Klein’s electrolytes.²⁹ From Dalarna, Kramers also took the opportunity to contact Oseen in Uppsala, informing him that he and Klein hoped they could visit the professor in Uppsala on their way back. It was thus Kramers who introduced Klein to Oseen.³⁰

A few days later, Kramers wrote to Bohr and told him about the lecture. Several Uppsala physicists had attended. “They were very interested in seeing something about the latest progress in the spectrum line field, and I believe they lost some of the skepticism about quantum theory that prevails in Uppsala.” Oseen had been cautious in his judgment, almost hesitant, and “thought that it was all mysterious, yet he cannot deny that all the reasoning is sound and that it is a fruitful mysticism.” Kramers had also spoken in Stockholm, but there his audience had less potential to understand the problems, although they were interested.³¹ In other words, he con-

27. Klein to Bohr, 27 September 1918, BSC 4; Benedicks to Bohr, 27 September 1918, BSC 1.

28. Klein to Bohr, 29 November and 28 December 1918, BSC 4.

29. Kramers to Bohr, 28 December and 30 December 1918, BSC 4.2. Cf. Klein’s statement that Fredholm was trying to monitor developments in theoretical physics and that he was giving lectures on quantum theory and the theory of relativity. OHI – O. Klein 3(6).

30. Kramers to Oseen, 8 January 1919, OFA, AXXIV:2.

31. Kramers to Bohr, 27 January 1919, BSC 4.2. Cf. Robertson (1979), pp. 51 f. The original is “Mystik” that could be translated into either *mystery* or *mysticism*.



Figure 1. Sommerfeld, Bohr and Siegbahn on the first step of the stairs at the atomic physicists' conference at Lund University 1919. Klein could possibly be no. 4 from the left. Source: Niels Bohr Archives.

tinued to advocate for Bohr's quantum physics among Swedish physicists when given the opportunity.

During the winter 1919 Klein told Bohr that the Swedish physicists would be very pleased "if you came to Sweden and talked about quantum theory. Kramers's visit has also done a lot of good in providing Swedish physicists with more understanding of quantum theory."³² Kramers had been the advance man, but unsurprisingly they wanted to hear Bohr himself.

Oseen too was eager to introduce Bohr's theories to a wider audience in Sweden and did so at a summer course for upper secondary school teachers in Uppsala in 1919 about "Atomic concepts in physics today". The contents of these popular science lectures had in part been the topics of his lectures and seminar work during the previous academic year.³³ The contents of the summer course were

32. Klein to Bohr, 7 February 1919, BSC 4.

33. UUA, Fakulteternas arkiv 4. Filosofiska fakultetens arkiv, Matematisk-naturvetenskapliga sektionens dagböcker, F1b:12-13.

published, generating extensive interest among Swedish physicists in the new discoveries.³⁴

It was finally time for Bohr himself to present his ideas in Sweden. In mid-September 1919 both Bohr and Arnold Sommerfeld lectured at an “atomic physicists’ conference” organized by Manne Siegbahn in Lund.³⁵ Sommerfeld talked about the anomalous Zeeman effect and Bohr more generally about atomic physics and radiation. Klein, who had arrived in Copenhagen early that summer, accompanied Bohr as his assistant. He thought that it was very interesting to hear both Bohr and Sommerfeld lecture.³⁶ Sommerfeld tried to modify Bohr’s atomic model of 1913 by calculating the electron orbits in the Bohr atomic relativistically. But Sommerfeld was not alone in developing Bohr’s theory; in his lecture “On atomic physics and the problem of radiation”, the Dane himself presented the current form of his atomic model, in a lecture that Klein had helped him to write.³⁷

A few years later, Klein published a two-part paper about the “Bohr Atomic Theory”, 40 and 50 pages in length, respectively in two of the first volumes of the newly established yearbook of the Swedish Society of Physicists, *Kosmos*.³⁸ Working with these texts was demanding and required a lot of Klein’s time and energy.

So if it was not Bohr himself, it was Kramers or Klein who propagated the latest findings from Copenhagen in Sweden. In other words, it was not enough merely to publish the results; at least equally important was Klein’s and Kramers’s repeated cultivation of Swedish physicists through conversations, lectures and articles.

34. Oseen (1919).

35. See Newspaper *Sydsvenska Dagbladet Snällposten*, 8 and 11 September 1919. A group portrait of the attendees can be found in Hulthén (1951), p. 6.

36. OHI - O. Klein 3(6). Klein (1964), pp. 77 f.

37. ”Lund 10-9-1919”, Niels Bohr manuscripts, NBA, NB MSS 8.3. Several different drafts and manuscripts for the lecture have been preserved, in both Bohr’s and Klein’s handwriting.

38. Klein (1922) and Klein (1923).

3. The Nobel Prize and quantum mechanics

Oskar Klein also accompanied Bohr to Göttingen in June 1922 as his assistant.³⁹ Bohr had been invited there to hold the “Wolfskehl Lectures”. This was the occasion when Bohr met Werner Heisenberg for the first time. The lectures were later referred to by Wolfgang Pauli and Heisenberg as the “Bohr Festspiele”. Bohr was especially impressed by the young Heisenberg, who dared to raise objections against Kramers’s theory of dispersion, which Bohr had presented. Oseen was also there, and the three Scandinavians stayed at the same inn on the outskirts of Göttingen.⁴⁰

Bohr’s atomic theory, which he presented in Göttingen, was still mechanically based; the year before, he had successfully explained the periodic system using his atomic model. Late in August the same year, Bohr, Kramers and Klein traveled to Uppsala to attend the Second Nordic Physics Conference. There Bohr presented the main address, speaking “On the Explanation of the Periodic System”. In Uppsala, he had occasion to meet Oseen.⁴¹ It was thus an important occasion for justifying the central role of theoretical atomic physics to his Nordic physicist colleagues. It was viewed as something of a “summit meeting” between Oseen and Bohr.⁴²

Oseen had been elected to the Royal Swedish Academy of Sciences in 1921, and the following year he was elected to its Nobel Committee for Physics.⁴³ After arriving home from his trip to Germany in the summer of 1922, Oseen sat down to write special evaluation reports about two of that year’s Nobel Prize candidates: Albert Einstein and Niels Bohr.⁴⁴ The Nobel Committee produces

39. Bohr to Klein, 3 July 1922, OKP. Klein (1959), pp. 9 f.

40. Bohr (1977), pp. 23 ff. and 341-419. OHI - O. Klein 2(6). Klein (1964), p. 80. Cf. Cassidy (1992), pp. 127-130 and Eckert (1993), pp. 90-93. Hermann, (1977), p. 28 and pp. 54 f.

41. Cf. Fysikermötet (1922). OHI - O. Klein 3(6). Bohr (1977), p. 25 and pp. 421-424.

42. Cf. von Bahr-Bergius to Klara Oseen, 31 August 1922, OFA AXXV.

43. Minutes 6 December 1922, §17 and 22 November §12, KVAP.

44. A good overall account of the twists and turns related to Einstein’s Nobel Prize is provided in Elzinga (2006). An excellent study of Bohr’s Nobel Prize is to be found in Aaserud (2001).

Figure 2. The Bohr Festspleie in Göttingen in June 1922 From Left: Oseen, Bohr, Franck and Klein, seated Born. Note Oseen's admiring glance at Bohr. Source: NBA.



such special reports on the candidates of greatest interest each year. Svante Arrhenius had previously investigated Bohr's work but had noted that it "must be stated that the assumptions on which Bohr's atomic model are based run counter to the laws of physics, which we have not yet been able to dispense with."⁴⁵ As a newly elected member of the Nobel Committee, Oseen had thus received this sensitive assignment. For a long time, Einstein's candidacy had been a difficult matter for the cautious Committee, and one of the five members of the Committee, Allvar Gullstrand, was even a sworn opponent of Einstein. This member had declared that it was a "matter of faith" whether to believe in Einstein's theory of relativity or not. Oseen, however, was positive towards the theories of relativity, but understood that it would be nearly impossible to award a prize

45. Arrhenius, "Short overview over Einstein's theory concerning the photoelectric effect" ('Kort översikt över Einsteins teori angående den fotoelektriska effekten'), 14 August 1921; Granqvist et al. to the Royal Swedish Academy of Sciences, 22 September 1920, KVANP.



Figure 3. Oseen at the desk where he wrote his successful special reports on Einstein and Bohr in the summer of 1922. Source: CWOA.

to Einstein for them. But the many nominations of Einstein were a growing problem. His solution was to nominate Einstein himself for the Prize based on law of the photoelectric effect. No one else had ever nominated Einstein on the basis of this theory alone. Due to the interpretation of Nobel's will, it needed to be a clear contribution or discovery in order to be awarded the prize. It was thus important for Oseen to emphasise that the photoelectric effect was an unquestionable *law* of physics, which had been proven through numerous experiments. In addition, this theory was related to Bohr's atomic model, which he was also assigned to investigate. Oseen wrote his two reports on Einstein and Bohr during the same summer week. Another aspect was that in 1922, there were two Nobel Prizes in Physics to award, both the 1922 prize and the 1921 one that had been postponed. This suited Oseen perfectly, since Bohr and Einstein were intimately related in his recommendations and, put simply, one can view Oseen's reports on Bohr and Einstein as a *single* package.

The law of the photoelectric effect had been experimentally proven, Oseen maintained, and one of the most important proofs of this law came from Bohr's atomic theory. "Einstein's hypothesis and Bohr's objectively identical frequency conditions are currently one of the most certain hypotheses found in physics." Einstein had qualified in other areas, but his most important achievement was his "theory of the quantum emission and absorption of light." And the most important argument was: "Nearly all confirmations of Bohr's atomic theory are likewise confirmations of Einstein's thesis."⁴⁶ If Bohr were to be awarded a Nobel Prize, it would be necessary to award one first to Einstein, whose discovery occurred earlier in time and was also a prerequisite for Bohr's theory, he argued.

Atomic physics was a fruitful field, and it offered the best opportunities for theorists and experimentalists to work together. Confirmations of Bohr's theory had come from a number of experiments, including Siegbahn's mapping of the X-ray spectrum in Lund. Oseen was careful to point this out; this was the closest possible approximation of his ideal of how physics research should be pursued. Close cooperation between experimentalists and theorists was necessary, he maintained, in order to prevent degeneration by one kind of physics or the other being pursued too one-sidedly. He ended his report by citing this particular aspect.

Both with regard to its already confirmed findings and with regard to the powerful stimulus that this theory has given to both experimental and theoretical physics, Bohr's atomic theory seems to me fully worthy of a Nobel Prize.⁴⁷

In late August 1922, the Second Nordic Physics Conference was held in Uppsala.⁴⁸ The conference was hosted by the chairman of the Physics Department, but Oseen came to be regarded as the cen-

46. Oseen, "Einstein's law for the photoelectric effect" ('Einsteins lag för den fotoelektriska effekten'), 13 August 1922, 12 pp. KVANP.

47. Oseen, "The Bohr Atomic Theory" ('Den Bohrska atomteorien'), 9 August 1922, 34 pp. KVANP.

48. Fysikermötet (1922).

tral figure at the conference. The main address was given by Niels Bohr, “On the Explanation of the Periodic System”.⁴⁹ After the conference, Oseen received many compliments from those who had attended.⁵⁰ Eva von Bahr-Bergius, who had been an associate professor of experimental physics working with Knut Ångström (and who was a close friend of Lise Meitner since her period in Berlin), was teaching at the time at Brunnsvik Folkhögskola but had traveled south to Uppsala for the physics conference. She was undoubtedly not in the centre of the physics world at this adult education institution, and after the conference she wrote to Oseen’s wife that “To me it was a real experience to be part of this little circle who gathered around two personalities like Bohr and Vilhelm.”⁵¹ Oseen himself in turn thanked Bohr, writing “that what you gave us during our little dinner made it unforgettable for the participants.”⁵² The Uppsala conference thus represented one more step towards confirming atomic physics as central to physics – both theoretically and experimentally.

Oseen’s two Nobel reports were well-received, and on 9 November 1922 it was announced that Einstein was awarded the reserved 1921 Physics Prize and Niels Bohr the 1922 Prize.⁵³ Eva von Bahr-Bergius, was also pleased with this result and wrote to Oseen:

More than one month ago – when the names of the Nobel laureates were announced – I was determined to write to you. I felt a need to thank you for being there and taking care of the Nobel Prizes, so that physicists will not embarrass themselves in the same way as the Swedish Academy [has]. Because your influence on these matters is very great, I understand very well. I would very much wish that some day

49. Oseen, draft, “2:a skand. Fysikerkongr.” OFA, BIV:1.

50. See, for example, Bohr to Oseen, 30 August 1922; Lindman to Oseen, 16 September 1922; Holtsmark to Oseen, 13 March 1923, OFA AXXIV:1-2; and von Bahr-Bergius to Klara Oseen, 31 August 1922, OFA, AXXV.

51. von Bahr-Bergius to Klara Oseen, 31 August 1922, OFA, AXXV.

52. Oseen to Bohr, 31 August 1922, BSC. We do not know what Bohr talked about at the dinner, but one could suspect that he talked about his visions for the development of atomic physics. Cf. Bohr’s comment in footnote 57.

53. See Elzinga (2006), cf. also with Friedman (1981), p. 795, Friedman (1990), pp. 198f, Friedman (1989), pp. 66 ff.

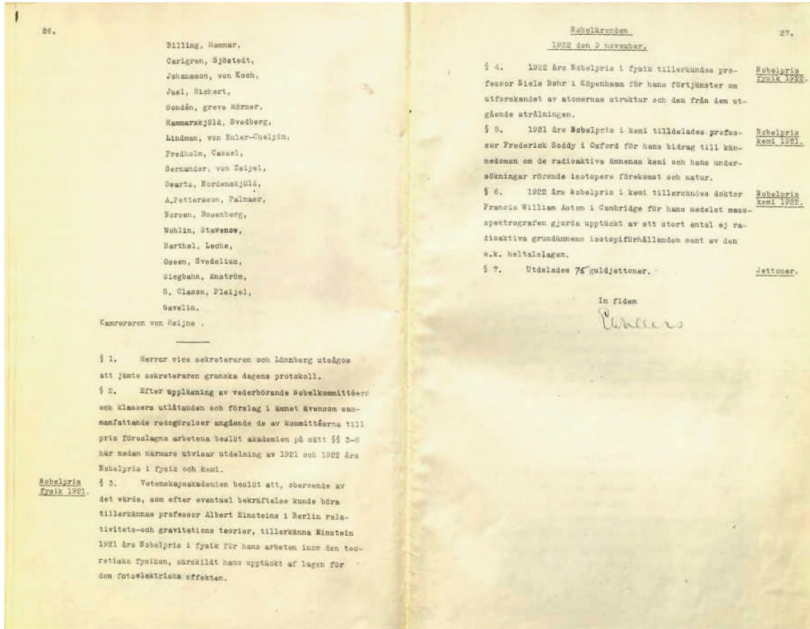


Figure 4. The Nobel Prize decisions in Physics in 1922. Source: KVANP.

you alone would be in charge of awarding the Nobel Prize, but I am afraid that you write such learned things that – at least here in Sweden – there is no one who can judge them.

I assume that there was a controversy about Einstein’s name. His opponents, who succeeded in excluding the theory of relativity from the prize statement, have thereby simply ensured that in the future he will receive the prize one more time.⁵⁴

Bohr himself was pleased at his prize, since he hoped that it would lead to better working conditions. In addition, he expressed great satisfaction that Einstein had also received the prize, since his own work was based on the latter’s theory⁵⁵

54. von Bahr-Bergius to Oseen, 16 December 1922, OFA AXXIV:1. Bahr-Bergius’ wish that Oseen should be solely in charge is ambiguous in the Swedish original; the phrase could also mean that she wished for Oseen to be awarded the prize, but the given translation conveys the most probable interpretation. The ambiguity might of course even have been intended.

55. Bohr to Oseen, 14 November 1922, OFA AXXIV:1.

The task of refining Bohr's atomic theory continued but was not fully resolved. Early in 1925, Oseen expressed despair about the future prospects of theoretical physics, partly due to the problems in quantum theory. But during the second half of 1925, the situation began to change. This was communicated to Oseen by his student Ivar Waller, who had received an eight-month scholarship to spend time with Niels Bohr in Copenhagen and learn about atomic theory. Waller wrote home to Oseen:

There seem to be plenty of problems, and it feels alluring to come to grips with one of them soon. Here [in Copenhagen] a lot of attention is being paid to the progress made in atomic theory through Heisenberg's latest work in *Z.f.Phys.* Born and Jordan have mathematically developed this new form of quantum theory. Their work will soon be published in *Z.f.Phys.* Pauli is said to have successfully dealt with the hydrogen atom in crossed electrical and magnetic fields according to this new method.⁵⁶

In a long oft-quoted letter to Oseen from January 1926, Niels Bohr himself summarised the recent rapid developments in theoretical atomic physics. For a long time, things had looked gloomy, but now "we again see brighter days ahead". What was promising for the future were Kramers' and especially Heisenberg's new ideas about quantum mechanics, which have "been shaped into such a wonderful theory by Born". In addition, at the celebration of the 50th anniversary of Lorentz' doctorate in Leiden earlier that year, Bohr had learned about Goudsmit's and Uhlenbeck's electron spin hypothesis – that an electron spins around its own axis and thereby achieved a magnetic moment. At first he had been skeptical, but was now unreservedly enthusiastic about the spin hypothesis. "In fact, all the difficulties which in the last few years have accumulated in the analysis of the fine structure of spectra, the Zeeman effect and related phenomena, seem to disappear completely." And the problems that perchance were not immediately solved would, through more careful quantum mechanical investigations, soon be in full agreement

56. Waller to Oseen, 28 November 1925, CWOA suppl.

with the correspondence principle. The new theory made it possible to eliminate unnecessary portions of the old theory and, in itself, provided a new basis for atomic physics. "Altogether, the development in this field gives ample material to reflect on the fate to which human conceptions of nature are subjected." Bohr wondered whether it had been fortunate or not that his own theory, with its mechanical approach to the atom's electrons in Kepler orbits, had been so successful in predicting the spectral lines of hydrogen. It had gradually turned out that this road was impassable, but meanwhile precisely this approach had led to an interest in the problems, which in turn had led to quantum mechanics. Bohr was "again at least as optimistic as when we were together in Göttingen about the possibility of attaining with simple means at least a qualitative understanding of the entire question of atomic structure."⁵⁷

Oseen became very excited about this letter, and he read aloud from it at his seminar. One of his students wondered how on earth Bohr had time to write such long, detailed letters to all his friends. Actually Bohr didn't, but it is worth noting that Bohr was eager to inform Oseen in particular that a number of central problems in quantum physics had now been solved. Explaining things thoroughly to his old, critical friend was important, and this says a lot about their scientific relationship. Bohr the pioneer wanted the approval of his critic Oseen.

However, Oseen was less enthusiastic about the new quantum physics than he had been about Bohr's first atomic model a decade earlier. But via Bohr, he was still in close contact with developments in quantum mechanics. Although he showed a positive attitude toward the new physics when asked to present it to the general public, he was more critical toward the new variants of quantum physics at his seminars, in Nobel reports and in contacts with other physicists.

57. Bohr to Oseen, 29 January 1926, CWOA suppl., also in BSC. Bohr (1984), pp. 405-408, Cf. also Erik Rüdinger and Klaus Stolzenburg, "Introduction", Bohr (1984), pp. 219-240.

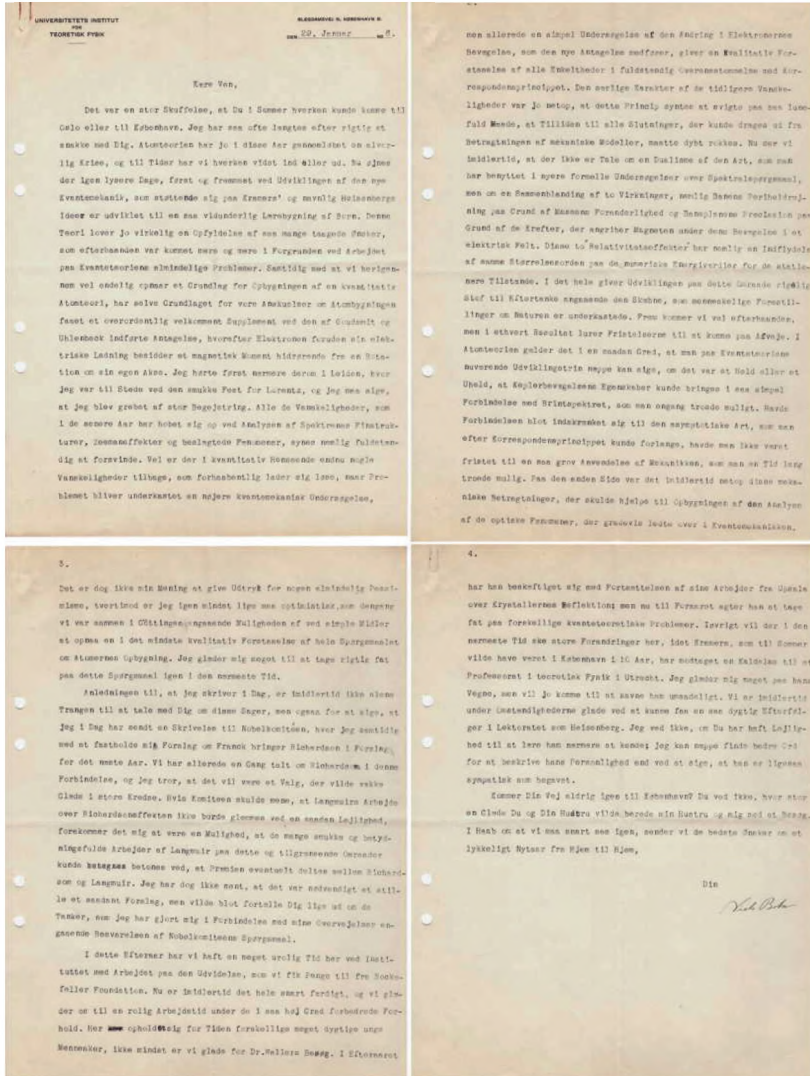


Figure 5. Bohr’s long letter about the development of the new quantum mechanics, January 1926. Source: CWOA.

4. Niels Bohr on the Nobel Committee

Another illustration of what a central role Bohr played in Sweden is that he was proposed in 1929 to become member of the Nobel Committee in Physics.⁵⁸ The background was that the term of office of an older member of the Committee, Vilhelm Carlheim-Gyllensköld, would expire in 1929. Oseen and Siegbahn thus wrote to the Academy of Sciences that because of his old age, he should not be re-elected. They also maintained that this was particularly unfortunate since there was no other Swedish physicist who could take his place, especially because there was no one in the “already narrow circle of persons who could be considered in this selection process.”⁵⁹ In a postscript, they stated that they had assumed that members should come from Stockholm or Uppsala for practical reasons, but that it had been pointed out to them that a member of the Nobel Committee did not even have to be Swedish. If the Academy took advantage of this opportunity, there would be no problem at all in “recruiting a fully competent person, who moreover possesses exactly the qualifications that must be given the highest priority, considering the investigative work for which the Committee is responsible: a familiarity with the new theoretical physics.”⁶⁰ Their proposal was sent to the Nobel Committees in Physics and Chemistry for comment.⁶¹ This led to forceful objections that questioned several of Oseen’s and Siegbahn’s arguments.⁶² Oseen and Siegbahn tried to manoeuvre the issue along. By moving one Committee member from a position with a certain term of office, they created a one-year vacant position on the Committee. Oseen then proposed that Niels Bohr,

58. Cf. Aaserud (2001), pp. 299 f., Friedman (1981), p. 796, and Friedman (2001), pp. 168 f.

59. Oseen and Siegbahn to the Academy of Sciences, 6 October 1929. KVANP 1929 II 51.

60. Oseen and Siegbahn to the Academy of Sciences, 15 October 1929. KVANP 1929 II 50.

61. Minutes §8 KVANP 9 October 1929, 21. Class minutes, 16 November 1929, II 43-44.

62. Pettersson to Class 3 & 4, 12 November 1929. KVANP 1929 II 47-49 and §5 KVANP, 27 November 1929, 31.

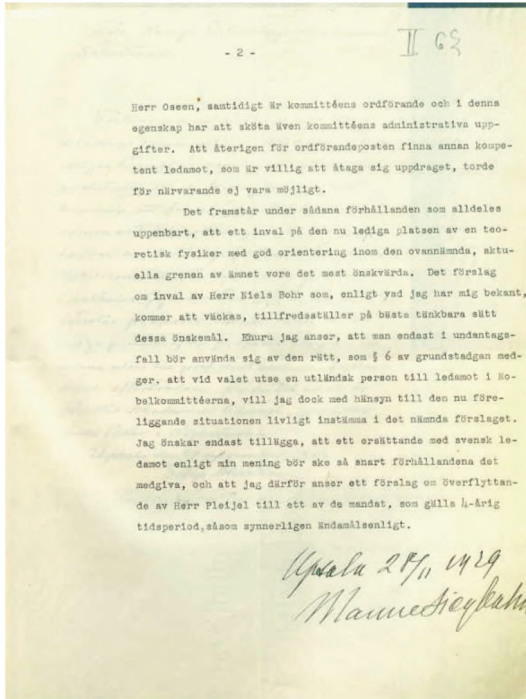


Figure 6. Siegbahn's letter in which he recommended Bohr being elected to the Nobel Committee.
Source: KVANP

who was a foreign member of the Academy of Sciences, should be elected. However, there was a competing faction of the Class for Physics that instead proposed Carlheim-Gyllensköld. Oseen's proposal nevertheless received a majority of votes (5-3).⁶³ Manne Siegbahn did not attend the meeting, but he had sent in a recommendation of Bohr, writing that since the Committee had to investigate so many Nobel Prize nominations concerning theoretical atomic physics, Niels Bohr possessed the extra expertise it needed.

This would of course lead to extra (travel) expenses, but what was most painful was that the Committee could not find any worthy Swedish physicist.⁶⁴ Oseen's and Siegbahn's attempt to modernise the Nobel Committee did not succeed this time around however. Carlheim-Gyllensköld was allowed to stay for another several years

63. Class minutes, 30 November 1929, II 59-60.

64. Siegbahn to Class 3, 28 November 11 1929, KVANP 1929, II 61-62. Cf. Aaserud (2001), p. 300.

on the Committee, once the issue was decided by the Academy. Niels Bohr was not elected, but the episode shows what an extraordinary position he held among Swedish physicists.

5. Epilogue

Bohr continued to play a major role for Swedish physics and for Swedish physicists. Several of Oseen's students, for example Ivar Waller and Hilding Faxén, spent several periods at his Institute for Theoretical Physics. However, it took some time before Swedish physicist Torsten Gustafsson spent substantial time at the Institute. He visited as early as the mid-1920s and ventured the question to Kramers about the future prospects of quantum physics, but at the time Kramers was preoccupied with the difficulties of quantum physics and dissuaded the young Swede, who instead chose another topic for his dissertation. Gustafsson nevertheless returned. He began to visit the Institute on Blegdamsvej starting in 1936, after which he had extensive contact with Bohr. During the war years when Denmark was under German occupation, Bohr was able to visit Sweden on a few occasions, but as the situation worsened, this became impossible. Finally Bohr and his family fled across the Öresund to Sweden in the autumn of 1943. Bohr spent a few days in Stockholm at Klein's home before being flown to Britain. Once Bohr was able to return to Denmark after the war, people in Sweden were interested in both his opinions about the Swedish atomic energy programme and his political opinions in general. Torsten Gustafsson arranged some meetings between the Swedish prime minister, Tage Erlander, and Bohr with this in view. When the theoretical division of CERN later moved from Copenhagen to Geneva, there was a Nordic initiative to start a Nordic Institute for Theoretical Physics (Nordita) associated with Niels Bohr's institute. Bohr and Gustafsson were members there and were able to maintain the existing Nordic contacts – a cooperative effort that continues even today, though Nordita has since moved to Stockholm.

6. Conclusion

This text investigated Bohr's activities from a Swedish perspective. It thus has the traditional form of a reception study.⁶⁵ But we have also seen how this was not only a process going in just one direction. Already at the Second Scandinavian Congress of Mathematicians in Copenhagen in 1911, Oseen and Bohr met and recognized their common ambition to strengthen physics in their respective small countries. Oseen supported Bohr in obtaining a professorship and Bohr later on helped Oseen's students. Oseen midwived Bohr's Nobel Prize and Bohr was interested in Oseen's critique. Bohr's reputation grew in Sweden and his standing eventually even led to him being suggested to become a member of the physics Nobel committee. The Scandinavian element continued and got even more pronounced after World War II through for instance discussions of the peaceful uses of nuclear energy with the Swedish Prime Minister Erlander and the establishment of Nordita.

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ARCHIVAL SOURCES

- OHI Archives of the History of Quantum Physics, Oral History Interview.
- SAA Svante Arrhenius Archives, Center for History of Science, Royal Swedish Academy of Sciences.
- BKB Benedick's Archives, National Library, Stockholm.
- BSC Bohr Scientific Correspondence, Niels Bohr Archive.
- OKP Oskar Klein Papers, Niels Bohr Archive.
- KVAP Minutes of the Royal Swedish Academy of Sciences.
- KVANP Nobel Archives of the Royal Swedish Academy of Sciences.
- CWOA Carl Wilhelm Oseen Archives, Royal Swedish Academy of Sciences.
- OFA Oseen Family Archives, The Regional State Archives, Lund.
- UUA Uppsala University Archives.

65. Cf. Pallo (2015), this volume.

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