CHAPTER 1.1

Love and physics: Margrethe Nørlund and Niels Bohr's scientific creativity, 1910–1913

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Abstract

Previously unavailable correspondence between Niels Bohr and his fiancée (and later wife) Margrethe Nørlund during Niels Bohr's stay in England from September 1911 through July 1912 indicates that Bohr's immense creativity behind the formulation of his atomic model in 1913 was to a great extent inspired by the strong emotional relationship between the two. Their correspondence about mutual interests in literature, philosophy and religion, as well as Bohr's situation and research, documents not only Bohr's broad interests, but also his singular need to share his ideas with others, and in particular his fiancée, in order to get on with his life and work. The correspondence brings new understanding to the origins of Bohr's atomic model and presages the role that Margrethe was going to play throughout Bohr's life.

Key words: Niels Bohr; Margrethe Nørlund; Harald Bohr; correspondence; Bohr atomic model; scientific creativity; literature; spouses.

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This contribution is based on my article in the book *Love, Literature, and the Quantum Atom: Niels Bohr's 1913 Trilogy Revisited* co-authored with J.L. Heilbron.[1] The book was made possible by the Bohr family kindly giving me permission to study the early correspondence between Niels Bohr and his fiancée and later wife Margrethe Nørlund. The family wished that I should write something on the basis of these letters for the 100th anniversary of the Bohr atom, for which the rich correspondence between the two while Bohr was in England from September 1911 through July 1912 was particularly important. During the process of writing an article on the basis of these letters, Heilbron—who in 1969 had published a seminal article with Thomas S. Kuhn on the origins of the Bohr atom[2]—took an interest in the work, and we agreed, with the permission of the Bohr family, that he should write a revised interpretation of how Bohr arrived at his revolutionary model on the basis of the letters quoted in a draft of my article.[3] Oxford University Press then agreed to publish our two articles, along with the original 1913 "Trilogy" in which Bohr first presented his quantum atom, as a 1913 celebratory volume, which is the book referred to.

In the article in the book, and more briefly here, I concentrate on the nature of the Niels-Margrethe relationship and its importance for Bohr and his creativity generally speaking. In addition to the correspondence between Bohr and his fiancée, my article in the book by Heilbron and me includes previously unpublished letters between Bohr and members of his family, which shed further important light on his personal and scientific development.

Niels Bohr was born in Copenhagen on 7 October 1885 as the second child of Christian and Ellen Bohr (née Adler). His father was a physiologist at the University of Copenhagen, where he advanced to professor in 1886. He was twice nominated for the Nobel Prize for Physiology and Medicine. As was common at the

1. Aaserud and Heilbron (2013).

2. Heilbron and Kuhn (1969).

3. Heilbron's conclusions were summarized in the plenary lecture for the 1913 centenary conference, reprinted at the beginning of this volume.

time, he and his family lived on the premises of his laboratory, where the young Niels showed an early interest in scientific work. Christian Bohr also had broad philosophical, literary and political interests, which his son was introduced to early in life. He died in 1911 at the early age of 55, only months before his son defended his doctoral degree. The father was a veritable role model for the son.

Niels Bohr's mother was the daughter of a prominent banker. She too was a strong support in Niels's life, as was her unmarried sister, Hanna, one of the first two women in Denmark to take a physics degree at the university. Hanna Adler was also a pioneer in introducing co-education in Denmark, establishing a school of her own in Copenhagen, where the young Bohr occasionally substituted as a teacher. She followed his career closely, advising him during his first stay in England about the English educational system and encouraging him to stay on good terms with their shared physics professor, Christian Christiansen, in order to maintain good relations with physics at the University of Copenhagen.

Margrethe Nørlund entered Niels Bohr's life in 1909 through her older brother, Niels Erik Nørlund, a fellow student of Bohr at the university. Margrethe and Niels Erik's father was a pharmacist in the provincial town of Slagelse, some 60 miles south-west of Copenhagen. Niels and Margrethe were engaged in August 1910. It appears from Margrethe's later letters that she was secretly in love with Niels for some time before he became aware of it. When Margrethe was about to move to Copenhagen shortly after the engagement, it was Niels who bombarded Margrethe with letters, showing his strong feelings for her. In one of several letters dated 20 August 1910, Niels reacted to a photograph of Margrethe that he had just received in the mail from her parents:

> I cannot say that I was happy for it. Do you think that I will have anybody between you and me, and do you think that I care the least about knowing what an abominable and silly photographer thinks that you look like. ... Had it only been one of your mother's own pictures. ... Luckily, I have a picture inside me of you yourself that is not so easily disturbed (to be quite sure of this, however, I have put the

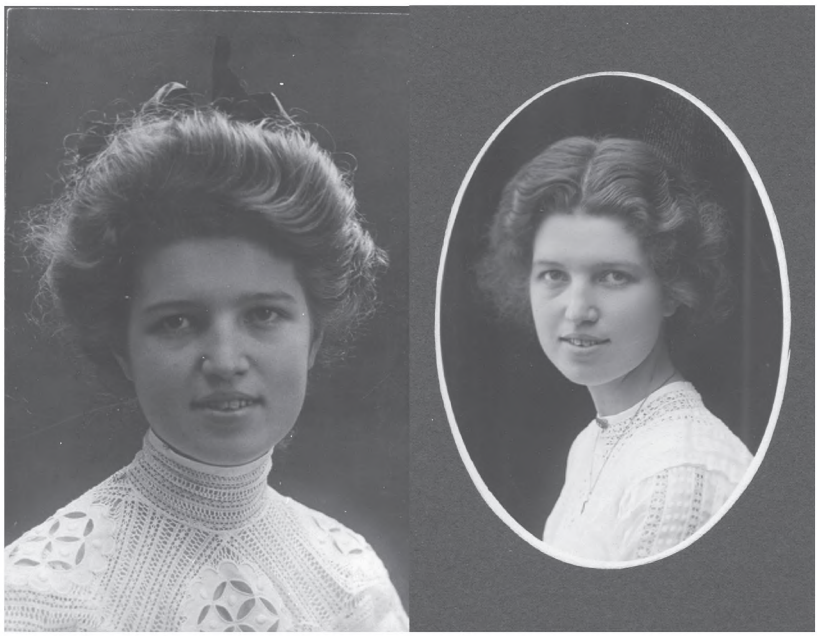

Figure 1. It may have been one of these photos of Margrethe that Niels disliked.

> disgusting picture in the bottom of a drawer and decided not to look at it before you come here).[4]

In the fall of 1909 Margrethe had enrolled at the notable Zahle's School for Female Specialist Teachers (*Zahles Faglærerindeskole*) in Copenhagen, which the pioneering educationalist Natalie Zahle had established in 1905. However, being of poor health in her youth, not long after the engagement she was admitted to the hospital of the renowned physician Knud Faber, who was a friend of the Bohr family. While Niels was away from Copenhagen in order to write his doctoral dissertation in physics in peace and quiet, his mother, Ellen, visited Margrethe at the hospital regularly, reading Dickens

4. This letter, and other family correspondence quoted in this article, are reproduced both in the original Danish and in English translation in Aaserud and Heilbron (2013).

aloud to her. In December 1910 Margrethe was depressed, being uncertain as to whether or not to pursue her own career. Obviously, she had expressed her concern to her prospective mother-in-law, for on 10 December Ellen Bohr wrote a letter to her, which reads in part:

> I think that the task that you have chosen, to tie your life to such a rare nature as Niels, is the best evidence of your own rare nature, and if you could make his life, and thus your own, so rich and happy as you can with your loving, mild and gentle character, then this purpose is a sacred and great purpose, just as serious and just as good as if you devoted your strength to studies or other activities that could give you what in your foolish little mind you think that you are lacking, the ability to talk about all kinds of things.

To Ellen Bohr the choice was obvious, as in fact it also was to Margrethe's mother, Sophie, as evidenced by the correspondence between mother and daughter.

Margrethe was soon out of the hospital, yet did not continue her studies at Zahle's; the last mention of Margrethe in the school records is dated July 1910. Instead, she concentrated on assisting Niels in completing his doctoral dissertation on the electron theory of metals, which he defended at the University of Copenhagen in May 1911. He dedicated the dissertation to his deceased father. Niels's wish to continue his studies at the University of Cambridge was no doubt informed by his father's close ties to British science in addition to a desire to study with Professor Joseph John Thomson, who had discovered the electron a little more than a decade earlier. Bohr's wish was realized when he succeeded in obtaining support from the Carlsberg Foundation for studies abroad. He left for Cambridge in September, leaving Margrethe behind in the expectation that they would marry and move together upon his return.

Niels was particularly close to his mathematician brother Harald, who, although being nearly two years younger, had completed his doctoral studies before Niels. Niels and Harald shared concerns with regard to both personal and scientific matters. Like their mother, Harald was strongly supportive of the affiliation with Margrethe. The relationship between Niels and Harald is neatly encapsulated

in Harald's birthday greeting to Niels dated 4 October 1911 and the photograph enclosed, which Harald described as follows:

> I think it symbolizes a certain aspect of our relationship with one another. My impudence and your being a little embarrassed on my behalf, but also—as it was I who said it, and as we always have been a little fond of each other—then you think nevertheless in all your niceness that it was nevertheless quite amusing to have such an impudent little brother.

Like his mother and Aunt Hanna, Harald wrote supportive letters to Niels during his first experience alone in a foreign country.

Niels found another kind of comfort, as well as a means to improve his English, in reading his mother's favourite author, Dickens, in the original English language. More specifically, he read *David Copperfield*, sharing the experience with his fiancée. In his correspondence with Margrethe he also showed his own literary flair, particularly up to Christmas 1911, as expressed in this combination of reality and fantasy dated 21 December 1911 about the two of them flying to the northern lands:

> And then we fly above the great ocean. But we do not fly the shortest route, for it is Christmas Eve and we fly higher toward the north, where Christmas resides. See. See, the great house alight in the middle of the snow. See the spruces quite covered by snow in fantastic forms, and see the stars that shine and glitter in the frosty night, and see the moon that lights it all up more sharply and garishly than the clearest sunshine. See, see, for that a human being has never seen who has not been far up north. Let us just look into the great house. See the beamed hall with the mighty fire and the huge Christmas tree, and all the happy people. See, there is the little boy and his aunt and his cousin and the little boy has grown up and talks about philosophy with an old gentleman. But we do not enter. And still, that Christmas Night, when he went to bed, his courage roared so wildly, so wildly, for he thinks that he too could think, and images rolled up before him. My little one, can you care for him, see his silly wild presumption, what came out of it. My own little darling, if you will care for him, he will try to find meaning in his wild courage; if with all your

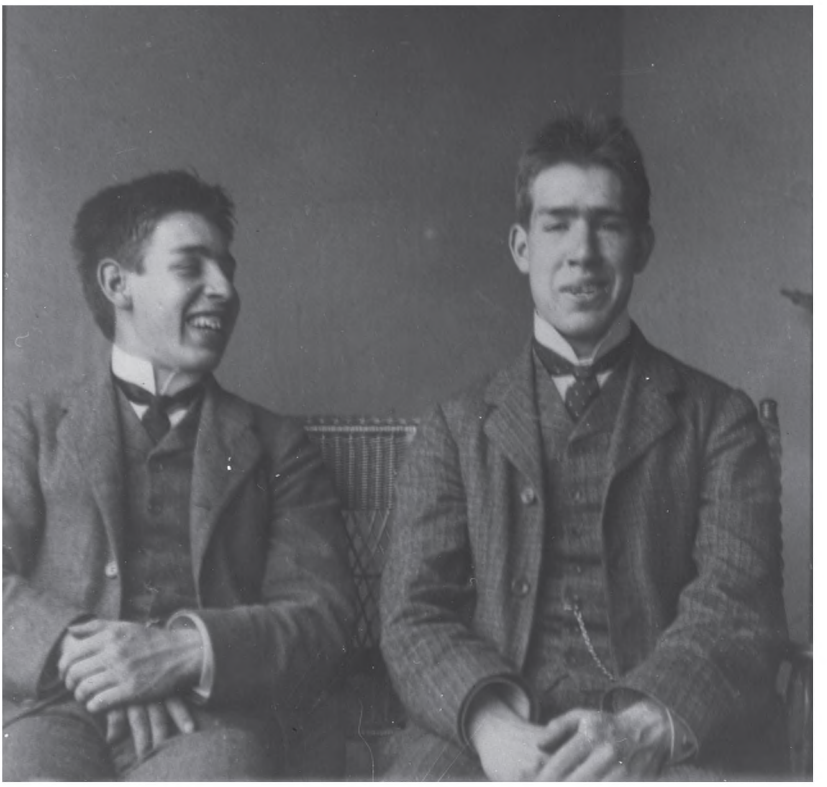

Figure 2. Photograph, taken c. 1902, given to Niels Bohr on his 26th birthday by his brother Harald.

> infinite love you will pay the debt for his poor soul, he will try out whether he too can get something out of it.

Margrethe's independent interest in literature is shown by her suggesting that Niels read a particular book by the British author, Thomas Carlyle, *On Heroes and Hero Worship and the Heroic in History*, first published in 1841.[5] Niels was enthralled by Carlyle's dealing with Nordic mythology, yet in a letter to Margrethe of 15 January 1912 expressed reservations:

5. Carlyle (1841).

> You ask what I meant by what I wrote about Carlyle—I was sorry about what I wrote for, as I said, I was not quite sure whether it was right or just my own reaction; but one of the next few days I will get the book again and read it through and write to you again. —By comparing it with a sermon I just mean that one does not demand of a sermon that everything in it should be true, in the same way as of a great work of literature. There exist so many different truths, they will of course always be more or less dependent on the sympathies of the author. With a sermon the main purpose is to show your sympathies and make others enthusiastic about them; and that can of course be just as important as trying to create something which one calls greater—that is, more universally human—and the truth of which will be of a somewhat different kind, coming closer to the so-called scientific truths, which are again of a somewhat different kind. This is so stupidly and so badly put, but we will talk about it sometime in greater detail, for it is something that I feel very strongly about; I can almost call it my religion, that I think that everything that is of any value is true (or, perhaps more precisely, real). It is so difficult to explain what I mean by this; I mean, among other things, that when a work of art is good, then it refers to something specific that one can see, or even, if this is not possible, to something one can hope to see. It is perhaps even more difficult to understand that this is something other than a triviality, and perhaps it is too; but I think that I draw from it consequences that not everyone agrees with. But it is all something you must help me with, if you can care about my silly thoughts, even though they should not be right. But for now you must promise me not to pay attention to this silly scribbling. If you will not promise me not to try to find the meaning in it that perhaps is not there, then you must promise me to burn it immediately.

Thus, Bohr's reading of Carlyle provoked him to express his philosophical views, which are most likely similar to those that he presented to the Cambridge mathematicians Godfrey Harold Hardy and John Edensor Collingwood at a private dinner on 9 December the year before. The letter also showed his great need for discussing and checking his thoughts with Margrethe.

In a letter from Cambridge of 15 February 1912, Bohr again showed his appreciation of literature, this time by expressing his love for Margrethe with a quotation from the beginning of the Nor-

wegian author Henrik Ibsen's drama *Brand*, where Einar expresses his love for Agnes:[6]

> No, I shall gather you up with such care,
> and lock you away as heart's treasure;
> there you can play your whole life long
> the game that you've learnt gives most pleasure!

Niels went on to repeat his gratitude for Margrethe's willingness to "pay all the debt for me that my poor little soul may incur." This debt most likely referred to what Niels felt that he owed not least to his family, who supported him so strongly. While not evoking God and Christianity, he may have been inspired to this way of thinking by the literature he read. Thus, Ibsen's drama just quoted contains the following dialogue between the clergyman Brand (who by this time had captured Agnes from Einar) and his dying mother:

> Brand: ... the soul once winged for aspiration
> you've wing-clipped into worldliness.
> *That* is your debt. What shall you do
> when God requires His own of you?
> Mother (abashed): What shall I do? What then?
> Brand: Don't fret
> your son takes on himself your debt.

Margrethe not only gave Niels an outlet for his literary side and his felt need for repentance; he also approached her with regard to more practical matters relating to his work and career in physics.

> ... yesterday I would have asked you whether, if my plans are realized as at the moment I think best, you might want to be like a mother to my students, for otherwise I would never have the strength myself to try to be a little bit of a father to them. I am sitting thinking of Father, of everything that he has been to so many, many. Will you help me; just to dare think of his example.

6. Ibsen (1865).

Figure 3. Niels visiting Margrethe in Denmark, Easter 1912.]

Three days later Margrethe responded without hesitation:

> ... there are no limits at all to how much I wish that I could be allowed to try to be a mother to your students, and how we will think about your father together.

Clearly, Christian Bohr was a role model for both. As we now know, Niels's wish and Margrethe's promise that she would mother his students were more than fulfilled.

In early November 1911 Niels visited James Lorrain Smith, a physiologist and close colleague of his father, in Manchester. Lorrain Smith introduced Niels to Ernest Rutherford, professor of experimental physics at the University of Manchester. There is no record of what Niels Bohr and Ernest Rutherford discussed on this occasion, but the meeting was the beginning of a relationship that would last until Rutherford's premature death in 1937. The meeting

augured the major breakthrough in Bohr's career. On 15 March 1912 Niels started to work in Rutherford's laboratory, after two terms in Cambridge during which his scientific development, and in particular his contact with Thomson, had been less than hoped for. However, although Rutherford had proposed the nuclear atom the year before on the basis of experiments, in Manchester Niels continued pursuing his original interest in the electron theory of metals while learning experimental techniques in radioactivity research.

This was still the case when Niels visited Denmark for Easter. While there, he canceled his membership in the Danish State Church. He was confirmed in his decision when he visited relatives in Edinburgh a couple of weeks later. His relatives took him to a sermon in St Giles Cathedral, where the Minister spoke about the Titanic disaster, which had taken place on the night between 14 and 15 April. The Minister spoke of the disaster as predetermined by God, to which viewpoint Niels responded in a letter to Margrethe dated 23 April, after he had returned to Manchester:

> It is scarcely poorer and everything is scarcely less, just because one understands that human beings cannot know whether such answers [as the predetermination of the Titanic disaster] are true or not, or, more correctly, that they do not know, and can in the nature of the matter not know what it would mean if they were true or not. (And talking about priests, then it may be convenient to recall that it is usually only the less gifted who think that they can explain anything at all by the pious misunderstandings they call religion, but the sharper ones, as you certainly know, tend to emphasize as the most important [aspect of] religion that there are more things in the world than people can understand, only they tend to forget to say that human beings can understand that this is the way it had to be).

In the same letter Niels reported the great impression that the cathedral itself had made on him. He was amazed by

> ... what a mighty impression of strength and power such a pillar [in the cathedral] can give. Is it possible that human beings can do such a thing. They can when their mind is moved deeply by something that is great. There are things in the world which are greater than human

> beings can understand; but that makes the world no poorer for a human being to live in; it sets the blood boiling ever so wildly, when suddenly one senses, senses that it can be sensed.

In a letter written to Margrethe shortly after his arrival in Cambridge, he had made a similar observation regarding the King's College Chapel:

> (My little one, it is wonderful that people can make something so great that other people think that they become so small by looking at it) ... it is always the towers of King's College Chapel that rule here.

These statements of every human being's independence to think for himself or herself and to achieve great things stand in remarkable contrast to Niels's own often-stated need for Margrethe to pay his debts. It is tempting to conclude that in this case Bohr lived by his own dictum that there are several kinds of truth.

As has been long established by students of Niels Bohr's early work, it was not until the second half of June 1912 that Bohr turned from his original theoretical interest in the electron theory of metals to an understanding of the nuclear atom, for which work he would eventually gain world acclaim and which has been celebrated at the 100th anniversary in 2013 with, among many other things, the conference on which the present publication is based. Before he left Manchester for Copenhagen at the end of July 1912 Bohr had been able to discuss his new ideas with Rutherford, but it took another year of thinking and incorporating experimental results until the first instalment of the Trilogy, which contains his revolutionary model of the hydrogen atom, was published.

In the meantime, Niels and Margrethe were married in Slagelse on 1 August 2012. Niels was so impatient about continuing his work that he insisted on a morning wedding, so that the couple could leave for their honeymoon that very evening. In the end, the honeymoon was not going to take place in Norway as originally planned, but in Scotland by way of Cambridge and Manchester where Niels showed Margrethe the places he had corresponded so enthusiastically about and where Rutherford helped him complete a publica-

tion. In early April 1913, he visited Rutherford again, this time to discuss the first instalment of the Trilogy, which Rutherford had insisted be shortened before publication. Niels stubbornly insisted that everything should be kept as it was, and as is well known, Rutherford gave in. After speaking with Rutherford, Niels wrote to Margrethe:

> I have spoken so pleasantly with Rutherford, and I look forward so much to coming home and to really get going and try to get the other parts done quickly. Shall we really try? My dearest little one. Rutherford should only know that it is you who have to do it all.

In conclusion, the letters between Niels Bohr and Margrethe Nørlund, up to the publication of the Trilogy, and in particular the intensive correspondence during Bohr's stay in England, bring forth previously unexplored traits of Bohr's personality and thinking. The couple's shared interest in literature, as well as Niels's own flair for literary allusions and writing, exhibit a broadness of interest that cannot be separated from his scientific work. In particular, his early philosophical viewpoint concerning different categories of truth, which J.L. Heilbron argues was crucial for Bohr's argument behind the atomic model,[7] was closely connected with his literary interest as well as his religious views. Most of all, the correspondence testifies to Bohr's need for constant attention to his thinking by the people closest to him, whether or not they were engaged in his own field of work. As such, Bohr's last statement quoted above from the letter about Rutherford should be taken quite seriously, even though Margrethe's background in physics was limited to say the least. Margrethe's choice not to pursue a career on her own, but to devote her life entirely to Niels, was essential to his early scientific creativity. A close study of their continued relationship can be expected to show that Margrethe's role in this regard did not abate during the rest of their lives.

It is not often that such private correspondence of scientists is available, and even more rare that it is used for scholarly purposes.

7. Aaserud and Heilbron (2013), p. 175.

If the case of Bohr is in any way representative, such material can be expected to illuminate the career of other scientists as well and indeed open up for a reinterpretation of scientific creativity and the scientific process.

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