

Niels Bohr's Philosophical Background

Hans Halvorson

April 22, 2025

Princeton University

Introduction

- I am not (really) a historian of science.
- My job description is “philosopher”, but I think it means “hopelessly interdisciplinary”.
- My intended audience today is not *fagfilosoffer*. It is primarily people who, like me, (a) care about the “meaning” of physics, and (b) are confused about the current moment in the history of physics.

The current moment in physics



1. Students of physics cannot *tilegne* quantum mechanics
 - “Shut up and calculate”
 - “Bohr solved the foundational crisis in physics”
 - “Philosophy is dead”
2. Students of physics defect to philosophy

My attempt to get unconfused

- Bring to bear all the tools of understanding we have: mathematical, conceptual, historical
- Earlier career: I focused on mathematical clarification
- More recently: I have focused on understanding Bohr's thought — which led me to language, culture, and the history of (Danish) philosophy
 - Why Bohr and not just the history of quantum physics generally?

Philosophy as *Livsanskuelse*

Bohr's philosophy

“No man who is called a philosopher really understands what one means by the complementary description. . . . They did not see that it was an objective description, and that it was the only possible objective description.” (Interview with T. Kuhn, Nov 17, 1962)

“The notion of complementarity does not imply any renunciation of detailed analysis limiting the scope of our enquiry, but simply stresses the character of objective description, independent of subjective judgment, in any field of experience where unambiguous communication essentially involves regard to the circumstances in which evidence is obtained. In logical respect, such a situation is well known from discussions about psychological and social problems where many words have been used in a complementary manner since the very origin of language.” (Bohr, 1961a, p. 1105)

“Far from indicating a departure from our position as detached observers, the notion of complementarity represents the logical expression for our situation as regards objective description in this field of experience, which has demanded a renewed revision of the foundation for the unambiguous use of our elementary concepts.”
(Bohr, 1955, p. 54)

“By the lesson regarding our position as observers of nature, which the development of physical science in the present century has given us, a new background has, however, been created just for the use of such words as objectivity and subjectivity. From a logical standpoint, we can by an objective description only understand a communication of experience to others by means of a language which does not admit ambiguity as regards the perception of such communications.” (Bohr, 1953, p. 386)

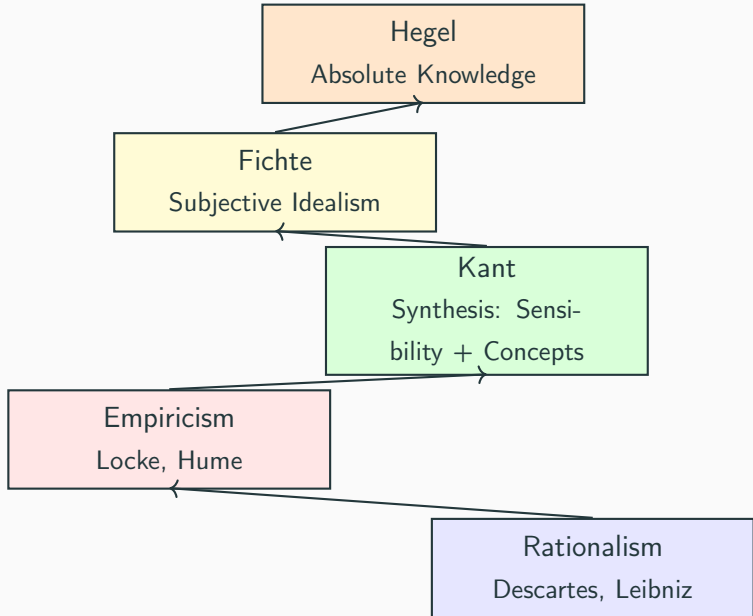
“...volition and causation are equally indispensable elements in the relationship between subject and object, which is the most central problem of epistemology”

“Samtidig drejer det sig på begge områder om idealisationer, hvis naturlige begrænsning kan gøres til genstand for undersøgelse og som betinger hinanden i den forstand, at viljesfølelse og årsagskrav er lige uundværlige elementer i forholdet mellem subjekt og objekt, som er erkendelsesproblemets kerne.” (Bohr, 1929, p. 82)

“The complementary way in which words like contemplation and volition are used has especially to be taken into account when turning to the problem of the freedom of the will, discussed by philosophers through the ages.” (Bohr, 1961b, p. 66)

The Philosophical Context

Dialectical Progression to Absolute Knowledge



The Subject-Object Problem: From Kant to Hegel

- **Kant:** Introduced the distinction between the knowing subject and the object of experience. The object is constituted through the subject's forms of intuition and categories.
- **Fichte:** Radicalized Kant — all objectivity arises from the self-positing activity of the *I*. The object is a projection of the subject's own limitation.
- **Hegel:** Resolved the opposition of subject and object through dialectic. The Absolute is the self-unfolding unity of subject and object in Spirit (*Geist*).

“It is thus ‘the absolute method of knowing,’ a spiritual excitation that is the immanent development of the concept. When the concept is fully revealed, the recipient of that revelation (i.e., Hegel) has overcome the split between subject and object. The history of philosophy is complete and the absolute is present within human time. Being and thinking are the same.” (Rosen, 2019, p. 35)

“Hegelian philosophy culminates in the thesis that the outer is the inner and the inner is the outer.”

Concluding Unscientific Postscript

“So we return to the two paths of reflection, and have not forgotten that it is an existing spirit that poses the question, quite simply a human being. Nor can we forget that his existing is just what will stop him going both ways at once, while his anxious question will prevent him from frivolously and fantastically becoming subject-object. Which of these two paths, then, is the path of truth for an existing spirit? For only the fantastic I-I is finished with both paths all at once, or proceeds methodically down both paths simultaneously, a gait so inhuman for an existing human that I do not risk recommending it.” (Postscript, Hannay translation, p 162)

Complementarity between reflection (overvejelse) and decision (afgørelse)

“Once subjectivity is taken away, and passion from subjectivity, and infinite interest from passion, there is absolutely no decision [afgørelse] at all, on this problem or any other. All decision, all essential decision, lies in subjectivity. At no point does an observer (and that is what objective subjectivity is) have any infinite need of a decision, and at no point sees it.” (Postscript, p 29)

Danish philosophy

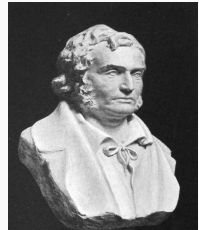
Philosophical Background to Niels Bohr



Ludvig Holberg



Frederik Sibbern



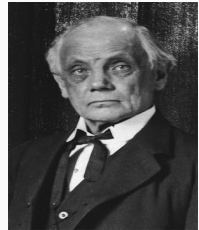
Poul Møller



Søren Kierkegaard



Rasmus Nielsen



Harald Høffding

Ludvig Holberg: Tone Setter for Danish Philosophy



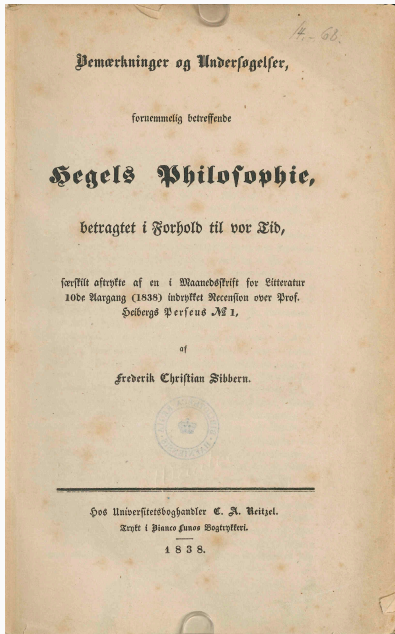
Ludvig Holberg (1684–1754)

Playwright, historian,
philosopher

- Advocated for clarity, reason, and practical civic values.
- Blended satire and empiricism to challenge intellectual pretension.
- Strongly opposed scholasticism — especially abstract metaphysics and theological hairsplitting.
- Promoted a philosophy grounded in common sense and historical learning.
- Set the tone for a distinctly Danish style of thought: moderate, worldly, ironic.

“Danish thinking has been most interested in psychological and ethical questions, and it has usually been critical of the practice of system-building.” (Høffding, 1909, p. 2)

Sibbern on Hegel



“Nor do I need bring to mind the amusing story about the licentiate in *The Adventures of a Danish Student*, which I related at my talk in Pasadena to elucidate the complementary use of terminology in psychology. The point here is, of course, that even though every unambiguous communication requires distinction between a subject and an object, the subject implied in a given situation can wholly or partially be included in the objective content of a communication about another situation.”

NB to Delbrück, July 25, 1959

Sibbern and Møller: Resistance to Hegelianism



Frederik Sibbern
(1785–1872)



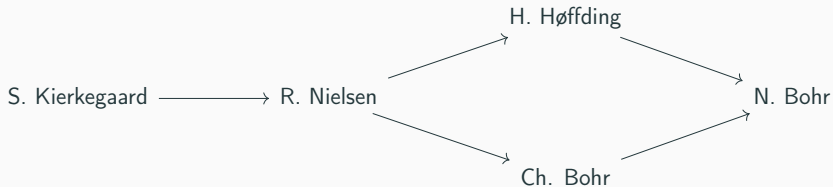
Poul Møller
(1794–1838)

- Both Sibbern and Møller engaged critically with Hegel's philosophy — especially its abstract systematization and speculative ambitions.
- Sibbern emphasized lived experience, emotional life, and psychological observation over metaphysical constructs.
- Møller responded with irony and literary sensibility, expressing skepticism toward philosophical totality.
- Their opposition set the stage for Kierkegaard's more radical critique of Hegelianism — but in a tone that remained characteristically Danish: modest, ironic, and anti-systematic.

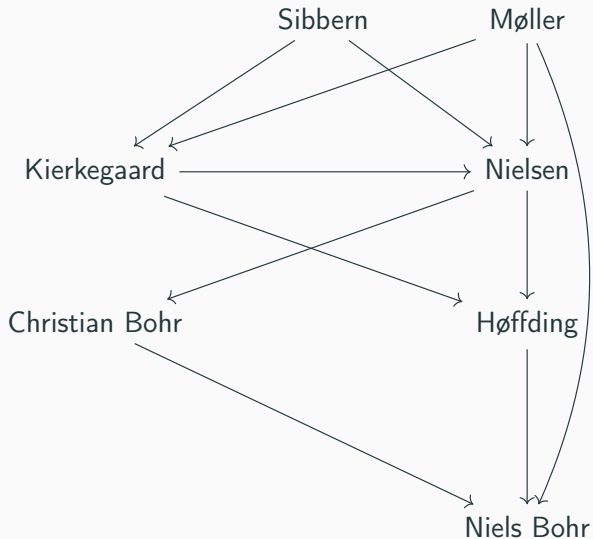
The missing link?

Hypothesis

Rasmus Nielsen transformed the qualitative epistemological and psychological ideas of Sibbern, Møller, Kierkegaard, etc. into something that was scientifically useful for Bohr.



Preparing the ground for Bohr



Rasmus Nielsen: The forgotten philosopher

“At first it was Rasmus Nielsen, whose enthusiastic references to Kierkegaard and whose rousing eloquence had the greatest influence on me.” (Høffding, 1909)

“No one who studies the life of the mind in nineteenth-century Denmark, will be able to skip over [Nielsen’s] great philosophical writings, and everyone who got to hear his lectures at the university will remember him as a great awakener and a rare personality.” (Brandes, 1889)

Nielsen against Hegel: No Absolute Knowledge

“Vi kunne derfor hverken i Naturen eller i Historien og lige-saalidt i Religionen selv vente at komme til absolut Viden, da det netop er denne Verdens ejendommelige Charakter, at alle Livets Elementer i den adsplittes i løsrevne Brudstykker.”

(Nielsen, 1842)

- Hegel: Reality and knowledge form a unified totality.
- Nielsen: The world disaggregates into “løse Brudstykker” — no absolute synthesis is possible.
- **Bohr**: Echoes this view with his idea that physical phenomena must be described from mutually incompatible perspectives.

“As my recent writings show, it has been my goal, for a number of years, to clarify and demonstrate the relationship between philosophy and the separate sciences as comprehensively as possible. The future of philosophy depends in an essential way on a thorough understanding and accurate determination of this relationship.” (Nielsen, 1864, p. 18)

G. J. P. Bolland.

13. 4. 61

Forelæsninger

over

„Philosophisk Propædæntik“

fra

Universitetsaaret 1860—61,

af

N. Nielsen.

II.

Philosophien og de særskilte Videnskaber.

Almindeligt	30
A. Philosophiens Forhold til Mathematiken: Uendelighedsproblemet	39
a) Uendelighedsbegrebet	40
b) Uendelighedsproblemet	45
α) Begreb og Problem	46
β) Mathematisk Opfattelse	47
γ) Filosofisk Opfattelse	48
c) Det Uendeliges Analyse	50
α) Grænser	53
β) Overgange	56
γ) Articulationer	65
B. Philosophiens Forhold til Chemien: Forandringsproblemet	81
a) Chemien som særegen Videnskab	82
α) Chemiens Oprindelse	83
αα) Mystisk Speculation: Oldtid og Middelalder	84
ββ) Gamlen efter Methode: kvalitativ Analyse	87
γγ) Methodens Fastsettelse: kvantitativ Analyse	90
β) Chemiske Kræfter	92
αα) Slægtstaber	93
ββ) Betingelser	96

	Side
b) Forandringsproblemet i Chemien	121
a) Atom og Equivalent	124
β) Atomconstitution og Krystallform	130
γ) Atom og Substans	135
c) Forandringsproblemet i Philosophien	143
a) Atomet som Discretionspunkt	145
β) Atomet som Functionspunkt	151
γ) Atomet som det substantielle Moment	160
Resultat	167
C. Philosophiens Forhold til Physiologien: Livs=	
problemet	177
a) Livets Væsen	200
a) Organismen	208
β) Den organiske Type	236
γ) Det organiske Formaal	261
b) Livets Trin	286
a) Plantelivet	291
aa) Grundformer	292
ββ) Metamorphoser	304
γγ) Individuationer	313
β) Dyrelivet	328
aa) Dyr og Plante	329
ββ) Dyr og Dyrerækker	362
γγ) Dyreriget	386
γ) Menneskelivet	399
aa) Dyret og Mennesket	399

Nielsen and Høffding: Objectivity Without Absolutes

- **Rasmus Nielsen:** Proposed a **law of objectivization**:
There is no object without a corresponding objectification
— *and no objectification without an objectifying subject.*

Reality is not given independently, but always mediated by the activity of a subject.

- **Harald Høffding:** Extended Nielsen's insight. Claimed that:
There is no final or absolute objectifying subject.

Subjectivity itself is historically and psychologically conditioned — there is no Archimedean point. Objectivity emerges from an evolving network of perspectives.

“No object without a corresponding objectification; it is an a priori law that underwrites all empiricism, a basic law that in science is, if possible, even more unshakable than Newton’s law of gravity. From this it can be seen, that a critical boundary, a boundary line, on whose one side we have the objectivizing subjectivity, while the object is standing on the other side, is confused and meaningless.”
(Nielsen, 1880, p. 41)

Rasmus Nielsen: The Law of Objectification

Central Thesis: There is no object without an objectifying subject.

- Nielsen's *law of objectification* (*Objectiveringsloven*) states that only what is objectified becomes an object.
- The subject plays an active, constitutive role in experience: objectivity is not merely *given* but *formed*.
- **Implication for Bohr:** The epistemological conditions for describing phenomena may already embed subject-object relations, anticipating Bohr's focus on measurement contexts.

"All objective relation is grounded in subjective reflection; this is a law of objectification, as strict as any natural law."

“...all search for an ultimate subject is at variance with the aim of objective description which demands the contraposition of subject and object.” (Bohr, 1961b)

“Nielsen believed that, to describe the interrelation between the subjective and the objective, an infinite analysis was needed, since every subject presupposes an object, and every object in turn a subject.” (Høffding, 1909, p. 189)

Mechanism vs. Teleology

Nielsen's Dialectic: Nature is governed both by mechanism (*Andethed*) and teleology (*Selvhed*).

- Nielsen critiques both reductionist mechanism *and* vitalist teleology.
- He affirms that physical processes obey mechanistic laws *but* life reflects inner purpose.
- Nature's intelligibility, for Nielsen, requires both explanatory frames.
- **Connection to Bohr:** Bohr's complementarity likewise resists reduction—physics must account for wave and particle, description and limitation.

"The law of otherness is the law of matter; the law of selfhood is the law of life."

Freedom and Necessity

A Fundamental Tension: Nielsen roots the contrast between scientific and ethical domains in a deeper metaphysical duality.

- Physical necessity arises from the law of *Andethed* — the logic of things governed by external relations.
- Freedom is grounded in *Selvhed* — the inner form of the self.
- **No sharp boundary:** The duality pervades all of reality, not just human action.
- **Relevance for Bohr:** Suggests a metaphysical precedent for Bohr's openness to indeterminacy and contextual constraint.

“The struggle between freedom and necessity begins with life itself.”

“Just as form and content are abstractions, since in every act of cognition we have a combination of them, so it is with subject and object.”

“Ligesom Emne og Form ere Abstraktioner, da vi i enhver Erkendelsesakt have en Forbindelse af dem, saaledes forholder det sig ogsaa med Subjekt og Objekt.” (Høffding, 1910, p. 297)

“We could make our own subject an object for us, just as when we study it psychologically, e.g. to find out the forms by which it works in its cognition. These forms, which are systematized in the study of the categories of cognition, must be taken as facts. They are made subjects when reflection is applied to them. Every cognition takes place from a certain point of view, which it can be meaningful to ascertain [konstatere]. We then objectify the subject.” (Høffding, 1910)

“When we consider something as an object, we must indicate the nature of the subject in relation to which it exists. And when we consider something as a subject, we must partly seek the objective context that determines its nature and thereby the contents and forms that are at its disposal, and on the other hand we need to note that by this investigation we ourselves make that subject into an object (if it is ourselves, then for ourselves in a somewhat different state, at any rate at a different moment, than before). We never have a pure subject (S), but always an objectively determined or yet an objectified subject (S_o). And we never have a pure object (O), but always a subjectivized object (O_s). S and O are mere abstractions. What we have before us is always S_o and O_s .”
(Høffding, 1910, p. 298)

“The act of becoming self-conscious, of making one’s I (one’s conditions, one’s work, one’s circumstances) into an object for itself, can always be repeated. The I that becomes self-conscious can itself become the object of a new act of self-consciousness, and so on. Such a series ($S_1 \prec S_2 \prec S_3 \prec S_4 \dots$) has already been mentioned above in connection with the possibility of an epistemological investigation into epistemology.” (Høffding, 1917, p. 36)

“Den Akt at blive sig selv bevidst, gøre sit Jeg (sine Tilstande, sit Arbejde, sine Kaar) til Genstand for sig, kan formelt stadig gentages. Det Jeg, der bliver sig selv bevidst, kan selv blive Genstand for en ny Selvbevidsthedsakt, og saaledes fremdeles. En saadan Række ($S_1\{S_2\{S_3\{S_4....\}$) er allerede omtalt ovenfor i Anledning af Muligheden af en erkendelsesteoretisk Prøvelse af Erkendelsesteorien.” (Høffding, 1917, p. 36)





Conclusion







Summary





- Bohr faced scientific challenges of great complexity and delicacy.
 - Stability of matter
 - The quantum of action
 - Heisenberg and Schrödinger
 - Objective description
- Bohr was fortunately equipped with a dynamic *livssyn* that allowed him to take satisfaction in meeting challenges without final resolution.

- Bonus: Significant figures (especially Sibbern and Nielsen) have been neglected
- Challenges:
 - Bohr is both Danish and international
 - Bohr is both scientist and humanist

References

-  Bohr, Niels (1929). “**Atomteori og naturbeskrivelse**”. In: *Beretning om det 18. skandinaviske Naturforskermode i København 26.-31. August 1929*. Copenhagen: Frederiksberg Bogtrykkeri, pp. 71–83.
-  — (1953). “**Physical science and the study of religions**”. In: *Studia Orientalia Ioanni Pedersen Septuagenario A.D. VII id. Nov. Anno MCMLIII*. Ejnar Munksgaard, pp. 385–390.
-  — (1955). “**The unity of knowledge**”. In: ed. by ed. L. Leary. Doubleday & Co., pp. 47–62.
-  — (1961a). “**The Rutherford Memorial Lecture 1958**”. In: *Proceedings of the Physical Society* 78.6, p. 1083.

-  Bohr, Niels (1961b). “The unity of human knowledge”. In: *Revue de la Fondation Europeenne de la Culture*, pp. 63–66.
-  Brandes, Georg (1889). *Essays. Danske Personligheder*. Gyldendal.
-  Høffding, Harald (1909). *Danske filosoffer*. Vol. 108. Gyldendal.
-  — (1910). *Den menneskelige tanke: dens former og dens opgaver*. Gyldendal.
-  — (1917). *Totalitet som kategori: en erkendelsesteoretisk undersøgelse*. AF Høst & søn.
-  Koch, Carl Henrik (2016). *Den danske idealisme: 1800-1880*. Lindhardt og Ringhof.

-  Nielsen, Rasmus (1842). “Den speculative Methodes Anvendelse paa den hellige Historie”. PhD thesis. Københavns Universitet.
-  — (1862). *Forelæsninger over Philosophisk Propædeutik fra Universitetsaaret 1860–61*. Gyldendal.
-  — (1864). *Grundideernes Logik*. Gyldendal.
-  — (1880). *Almindelig Videnskabslære i Grundtræk*. Gyldendal.
-  Rosen, Stanley (2019). *The Idea of Hegel’s ‘Science of Logic’*. University of Chicago Press.