The Mind that Created the Bohr Atom

Séminaire Poincaré,
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Today's Program
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Christian Bohr at his desk, perhaps about to hear, and smile at,
his son’s confession

of loss of faith

Margrethe and Niels in their engagement photograph

Jenny Adler (née Raphael) and her daughters Emma, Hanna and Ellen (later Bohr), by Julius Exner, 1868

Georg Brandes as he would have appeared when lecturing on the Jewish spirit in Danish culture in 1912

Progress Report

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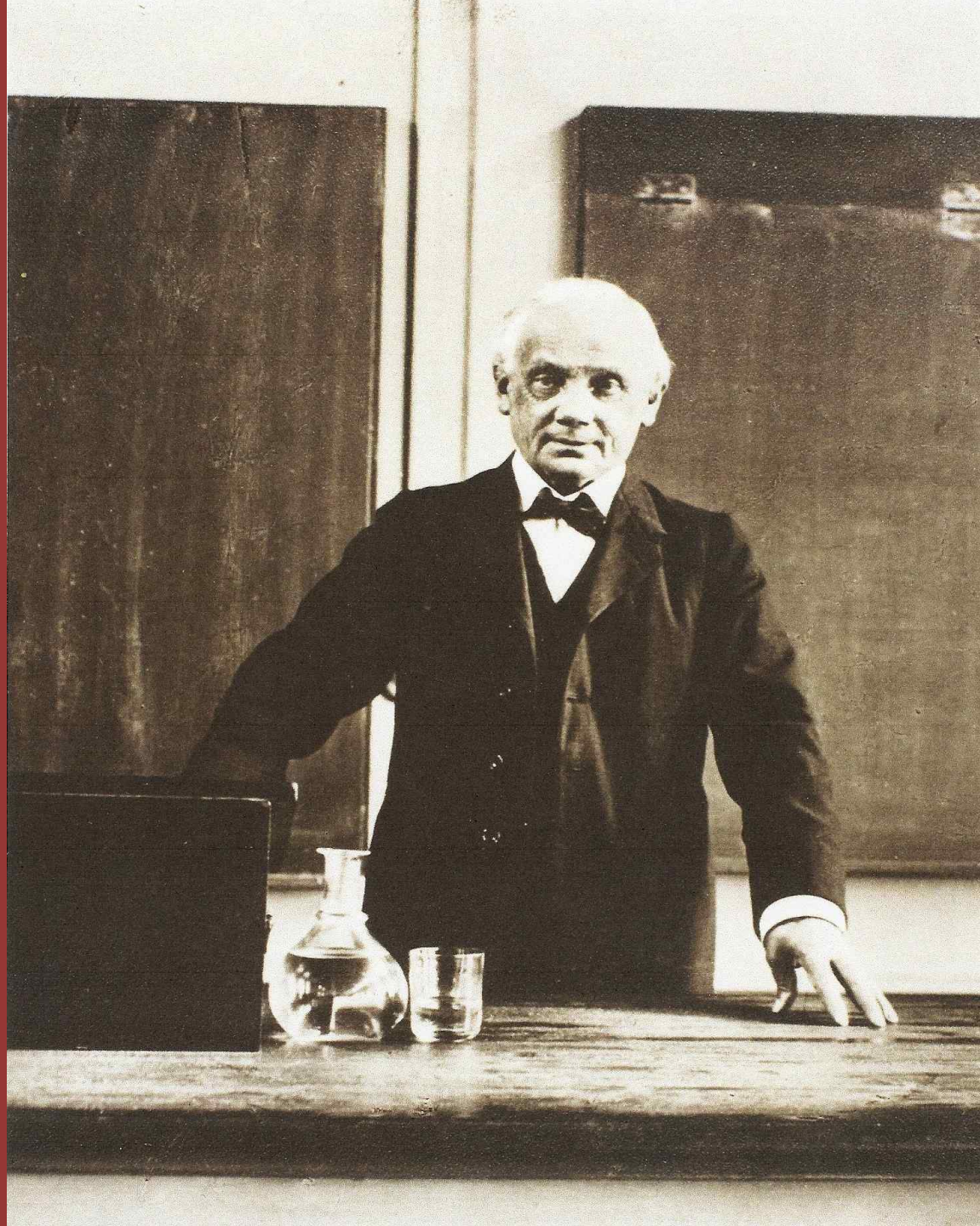
Bohr’s genial professor of philosophy at the University of Copenhagen, Harald Høffding, “a good pluralist and irrationalist.”



The parsonage where Bohr walked alone

Søren Kierkegaard walking alone while in his aesthetic stage

More Progress

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The Analogy to Planck

Planck's opaque rule of radiation is

$$E = h\nu,$$

where ν is the frequency of a "quantum" of radiant energy E and h is "Planck's constant."

Bohr's opaque rule of the ground state is

$$T = K\nu,$$

where T is the kinetic energy of an electron after it has radiated away an energy T while falling into an orbit of frequency ω, and K is a multiple or submultiple of h.

Niels and Margrethe resting from building up the periodic table

Bohr's basic quantum condition

To obtain the Balmer formula,

$$\nu n = R(1/22 - 1/n2),$$

from the generalization of his ground-state rule,

$$Tn = Kn\omega n,$$

while conforming to Planck's radiation rule,

$$En = h\nu n,$$

Bohr had to make

$$Tn = nh\omega n/2.$$

Consequently he arrived at the manifest absurdity,

$$\nu n = \omega 2 - n\omega n/2$$

for the frequency of the nth Balmer line.

Justification of the Planck Analogy

To obtain the ½ in the basic quantum condition

$$\nu n = n\omega n/2,$$

Bohr made the frequency νn of the emitted energy equal to the average of the orbital frequencies before and after capture,

$$\nu n = \tfrac{1}{2}(\omega\infty + \omega n) = \tfrac{1}{2}(0 + \omega n) = \omega n/2.$$

To secure the multiplier n in the basic condition,

$$\nu n = n\omega n/2,$$

he supposed that either the electron emitted n quanta each of frequency $\omega n/2$, or one quantum of frequency $n\omega n/2$. The second possibility voided the argument by which he had obtained the ½ that secured the first.

Almost Done

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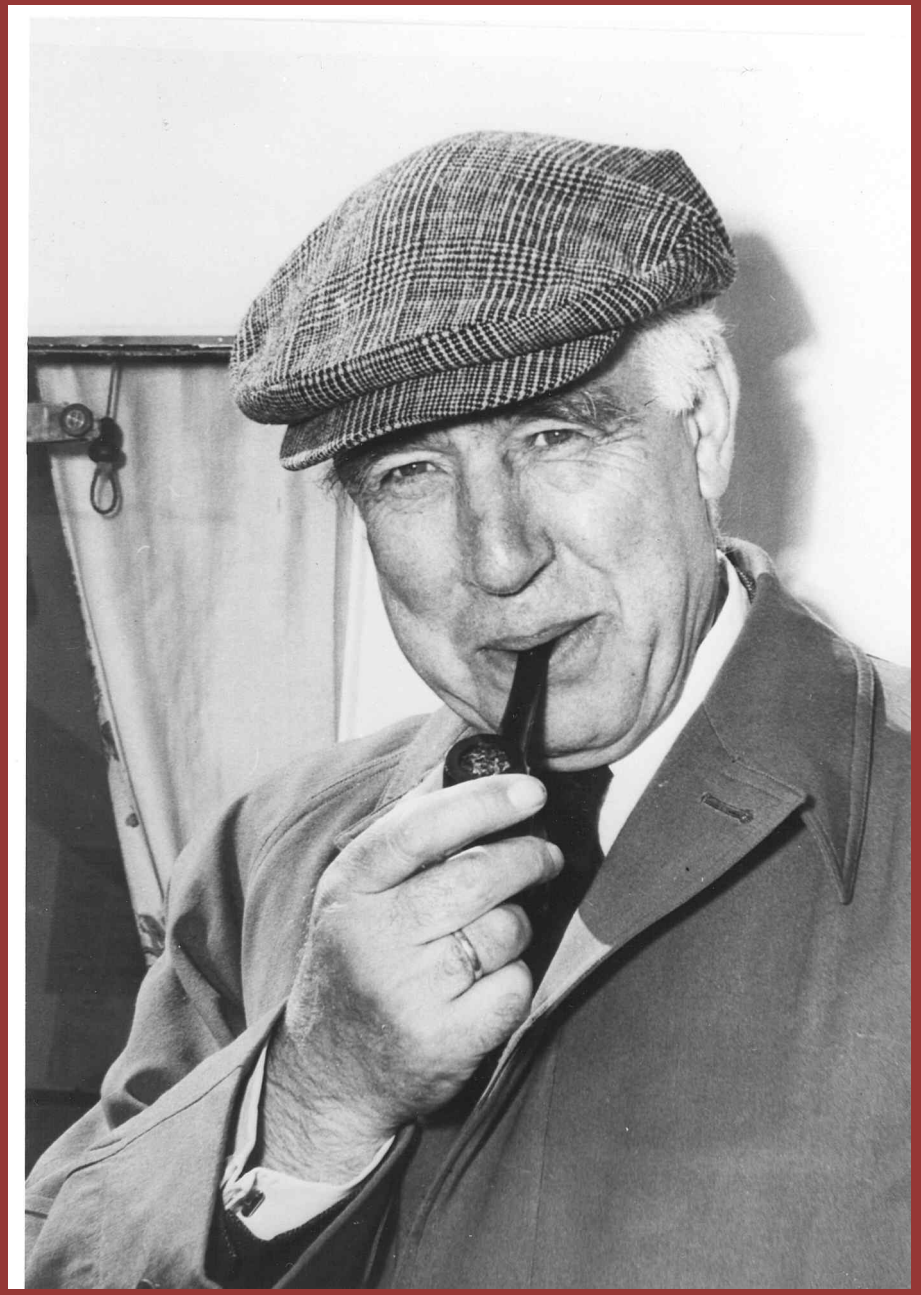
Old Bohr a few years before he declared that most of the paper that inaugurated the quantum theory of the atom was nonsense. Was he joking?



1954

Young Bohr at his father's desk, thinking about who knows what. Was he joking?

Contraries are Complements

Bohr’s expression of the basis of his philosophy of complementarity, minted from the general ideas he had from Høffding after passage through the refinery of quantum mechanics. This image depicts his baronial shield in the Danish Order of the Elephant.