

# Constructing the Myth of the Copenhagen Interpretation

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# The Standard View

By the end of 1927 the Copenhagen interpretation had established itself as the dominant interpretation of quantum mechanics. Central to that interpretation were the ideas of Bohr, the main outlines of which were presented at the Centennial Conference in Como in September 1927 and the Fifth Solvay Conference in Brussels in October that same year. At the latter conference Einstein first voiced his doubts about the newly emerging orthodoxy.

D. Murdoch, 'The Bohr-Einstein Dispute', 1994.

# Historiographical Problem

## What is the 'Copenhagen interpretation'?

The first thing that must be realized if such attempts are to succeed is that there is no point in looking for *the* Copenhagen interpretation as a unified and consistent logical structure.

E. Scheibe, *The Logical Analysis of Quantum Mechanics*, 1973.

The Copenhagen interpretation is in fact a compilation of various philosophical strands, given a public presentation that often hid shifting disagreements between its main architects

M. Beller, *Quantum Dialogue*, 1999.

# Constructing the Orthodox Narrative

While the *theory of quantum mechanics* is a product of the 1920s, the *Copenhagen interpretation*, contrary to the standard view, is a construction of the 1950s and 1960s. The idea of a unitary interpretation only emerges in the context of

- the challenge of Soviet Marxist critique of quantum mechanics
- Heisenberg's announcement of the unified 'Copenhagen interpretation' in 1955 and the private philosophical disagreements of the 'Copenhagen school'
- Wigner's papers on the measurement problem in the early 1960s.

# Niels Bohr and the Philosophical Interpretations of Quantum Mechanics

- Internal disagreement among the orthodox camp – Bohr, Heisenberg, Born, Dirac, Wigner ~ 1927
- Different philosophical interpretations of Bohr from the 1930s
  - positivist (Jordan and Franck),
  - neo-Kantian (Heisenberg and Weizsäcker)
  - Marxist (Rosenfeld)
- Bohr's spokesmen as “clarifiers”, e.g. Franck and Fock

# Soviet Marxism and the Critique of Quantum Mechanics

The rise of a Soviet Marxist critique of quantum mechanics in the 1950s

“In the early 1950s the almost unchallenged monocacy of the Copenhagen school in the philosophy of quantum mechanics began to be disputed in the West... The extent to which this process was fomented and supported by social-cultural movements and political factors such as the growing interest in Marxist ideology in the West deserves to be investigated.”

M. Jammer, *The Philosophy of Quantum Mechanics*, 1974.

# The Soviet Marxist Critique

- Žhdanov's 1947 speech and the ideological campaign against the 'Copenhagen school'
- The Leninist Method
  - λ The hidden agenda of modern positivism - science in the service of "subjective idealism". Positivism is irrational and leads to religiosity
  - λ Authors holding different views from different eras are lumped together
  - λ Positivists in reality hold views different from that which they proclaim
- The polarisation of the debate over quantum mechanics into two philosophical positions – materialism and idealism
- The Soviet Marxist critique became influential in France in the 1950s, and among certain writers elsewhere in the West

# The 'Subjective Idealism' of the Copenhagen School

“Among the different idealistic trends in contemporary physics, the so-called Copenhagen school is the most reactionary. The present article is devoted to the unmasking of idealistic and agnostic speculations of this school on the basic problems of quantum mechanics”.

D. Blokhintsev, 'Kritik der philosophischen Anschauungen der sogenannten Kopenhagener Schule in der Physik', 1953.

“It is precisely this school of positivism which is the basis of the physical conceptions of the Copenhagen school: *the principle of complementarity is directly the fruit of the idealistic positivist theory of knowledge*”.

D. Blokhintsev, 'Critique de la conception idéaliste de la théorie quantique', 1952

# The Invention of the 'Copenhagen Interpretation'

The months which followed Schrödinger's visit [in September 1926] were a time of the most intensive work in Copenhagen, from which there finally emerged what is called the "Copenhagen interpretation of quantum theory"... Since the Solvay conference of 1927, the "Copenhagen interpretation" has been fairly generally accepted, and has formed the basis of all practical applications of quantum theory.

W. Heisenberg, 'The Development of the Interpretation of Quantum Theory', 1955.

# A Question of Philosophy

“What was born in Copenhagen in 1927 was not only an unambiguous prescription for the interpretation of experiments, but also a language in which one spoke about Nature on the atomic scale, and in so far a part of philosophy”

W. Heisenberg, 1955.

“[The controversy surrounding quantum mechanics] is not so much an internal matter of physics, as one of its relation to philosophy and human knowledge in general”.

M. Born, 1953.

“I deliberately put the discussion on the philosophical ground, because it seems to me that the root of the evil is there rather than in physics”.

L. Rosenfeld to Pauli, 20 March 1952.

# Dissent among the Copenhageners

With regard to the epistemological problems just mentioned, Heisenberg's exposition naturally follows the line of argument which he has himself so decisively contributed to establish, and which he calls, in homage to Niels Bohr's great leadership, the "Copenhagen interpretation"... But the account he gives of the "Copenhagen" ideas is unfortunately not so good as it ought to be; and certainly not one of the physicists now working in Copenhagen would subscribe to the general philosophical attitude underlying this account. Altogether it would be better to discard such an ambiguous expression as "Copenhagen interpretation", were it only because it falsely suggests that there could be other possible interpretations of quantum theory.

L. Rosenfeld, 'Heisenberg, Physics And Philosophy, 1960.

# Private Disagreements in the 1950s

- Rosenfeld's criticism of Heisenberg's 'idealism' (1950s)
- Born and Pauli were critical of Rosenfeld's 'Marxist' interpretation of complementarity (1954-5)
- Pauli and Bohr disagreed over the "detached observer" (1955)
- Weizsäcker and Bohr on complementarity (1955-6)

# The Role of the Conscious Observer

“The Copenhagen, or ‘orthodox’, solution [to the measurement problem] is typically understood as having proposed that something non-physical — namely, the mind or consciousness — must ‘reduce’ the superposition to give what we observe”.

S. French, ‘A Phenomenological Solution to the Measurement Problem?’, 2002.

Where does this view come from?

# The Measurement Problem

But the role of the conscious observer in quantum mechanics was never discussed in the 20s and 30s by Bohr, Heisenberg, Pauli, Dirac, Jordan - In fact it was categorically rejected!

“[A]bove all we must become more precise about what we understand in this context as an “observation”. Naturally the physical behaviour of the electron cannot depend on whether a *human consciousness* registers something from it or not. Rather it depends on the measuring instrument with which the electron physically interacts, so that the electron exercises an effect on the measuring instrument, which reveals something about the state (e.g. position or momentum) that the particle is in... [We must] completely avoid, and ultimately dispel the – naturally completely erroneous – impression, that *the human being* and its consciousness plays a role in the dependence of microphysical events on single acts of ‘observation’”

P. Jordan, *Das Bild der modernen Physik*, 1947.

# The Conscious Observer

“Measurement is achieved only when the position of the pointer has been observed... There is an essential role played by the consciousness of the observer

F. London & E. Bauer, *La Théorie de l'Observation en Mécanique Quantique*, 1939.

“The separation of the world into an ‘objective outside reality’ and ‘us’, the self-conscious onlookers, can no longer be maintained... the *observer* appears as a necessary part of the whole structure, and in his full capacity as a conscious being”.

W. Heitler, ‘The Departure from Classical Thought in Modern Physics’, 1949.

Through the creation of quantum mechanics, the concept of consciousness came to the fore again: it was not possible to formulate the laws of quantum mechanics in a fully consistent way without reference to the consciousness.

E. Wigner, ‘Remarks on the Mind-Body Question’, 1961.

# Wigner's Version of the Orthodoxy

[I]t is useful to review the standard view of the late “Twenties”, and this will be the first task of this article. The standard view is an outgrowth of Heisenberg’s paper in which the uncertainty relation was first formulated. The far-reaching implications of the consequences of Heisenberg’s ideas were first fully appreciated, I believe, by von Neumann, but many other arrived independently at conclusions similar to his. There is a very nice little book, by London and Bauer, which summarizes quite completely what I call the orthodox view.

E. Wigner, ‘The Measurement Problem’, 1963.

# The Subjectivist Reading of the Copenhagen Interpretation

We must “exorcize the ghost called ‘consciousness’ or ‘the observer’ from quantum mechanics” which appears in “the Copenhagen interpretation.”

K. Popper, ‘Quantum Mechanics without the Observer’, 1968.

“The Copenhagen doctrine is logically inconsistent, and this blemish derives from its adopting a subjectivist philosophy... Bohr, Heisenberg, Born, Dirac, Pauli and von Neumann ... by smuggling the observer into QM render the latter psychophysical rather than purely physical”.

M. Bunge, *Philosophy of Physics*, 1973.

“I have the impression, perhaps mistaken, that that your father at one time thought that for the making of an observation it only took in the end an irreversible account of amplification; but that later on he changed his position to something closer to the idea that no observation is an observation unless it enters the consciousness. However, I am not able to find anything to document this supposed change of view, and my understanding of the history may be quite wrong”.

J. Wheeler to A. Bohr, 25 February 1977.

# Conclusions

- λ No single view is *the* Copenhagen interpretation
- λ Disagreements among the key protagonists rarely acknowledged in public. Semantic plasticity of terms used - e.g. wave-particle duality, complementarity, completeness.
- λ The revisionist histories of Heisenberg and Wigner obscure the diversity of views
- λ The Soviet-marxist critique was crucial in the translation of the debate over quantum mechanics into two distinct philosophical positions.