BOOKS: PHYSICS

Bohr the Innovator? Or Bohr the Intimidator?

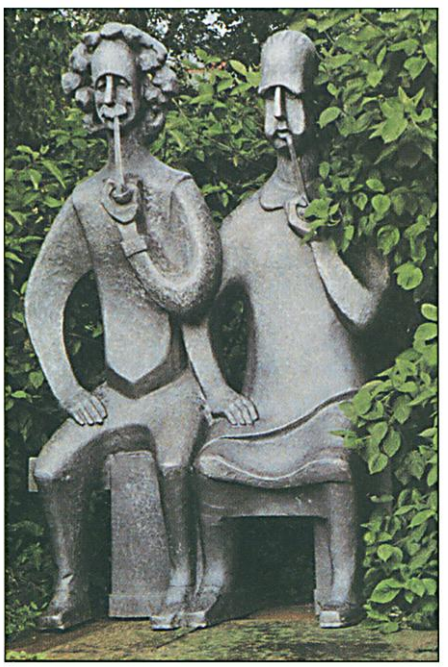
Daniel Greenberger

In *Quantum Dialog*, Mara Beller presents a revisionist history of the development of quantum theory and its philosophy. The author, a professor of the history and philosophy of science at the Hebrew University of Jerusalem, focuses on the controversies of the late 1920s. Her approach, which she calls "dialogical," consists of a comprehensive analysis of the participants' conversations, letters, lectures, and other writings to produce a complete context within which to contemplate the sources of their ideas, their progress, and their motivations. The technique leaves much room for the contributions of minor players and the arguments of dissenters. As the author is intensely aware, these can be buried in the rewriting of history that invariably takes place as a successful theory comes first to be accepted, then presented as an irresistible standard, and finally is made to seem inevitable. Beller makes a good case for how the steamroller of orthodoxy came to take over the development of quantum theory. But while she makes her point in many ways, she unfortunately also demonstrates the serious weaknesses in the technique, wherein one's own convictions can lead one to make much too much out of very little evidence. Ultimately the argument bogs down in her thoroughly unconvincing attacks on the intellectual integrity of figures such as Bohr and Heisenberg.

Quantum Dialog
The Making of a Revolution
by Mara Beller
University of Chicago Press, Chicago, 1999. 381 pp. $35, £24.50. ISBN 0-226-04181-6.

The first half of the book shows how Heisenberg, Bohr, Born, and their collaborators slowly developed the Copenhagen interpretation of quantum theory, partly in response to challenges from Schrödinger, Einstein, and others. This was primarily a process of trying to splice together a consistent explanation—using various thought experiments, with the gradual inclusion of the uncertainty principle, complementarity, and Bohr's insistence of the importance of classical measuring devices—while refuting the objections that were constantly being raised against the theory. Beller sees as the end product of this process an inconsistent melange of ideas, where others see a totally consistent theory.

In the second half of the book, the author makes a case for a gradual shift in the rhetoric of defending and explaining the theory. The arguments that showed the consistency of the standard interpretation were, through a process of grand overreaching, slowly replaced by an account that claimed to show the inevitability of this interpretation. Beller believes that its acceptance was no simple success story, but was due primarily to intimidation and abuse of authority by Bohr and his collaborators.



Lost in uncertain thoughts. Einstein and Bohr in B. C. Lemport's aluminum sculpture from a Moscow park.

Now there are many accounts in the literature that show that Bohr's charisma and single-minded determination could, at times, prove rather daunting, and so her arguments to this effect seem to make sense up to a point. But she goes way overboard and implies a conscious attempt by Bohr and Heisenberg to browbeat the opposition into accepting an interpretation that they knew could not be defended. She uses words, like "deceptive," that imply a deliberate intellectual dishonesty on their part. It is hard to deny the strength of her conviction in quotes like "There was neither belief nor commitment on Heisenberg's part—only a selective and opportunistic use of Bohrian doctrine in those circumstances where Heisenberg's aim was to argue against the opposition...This is a characteristic example of a powerful social strategy of legitimation disguised as an abstract theoretical argument." But the evidence just doesn't support such a negative spin on the situation.

Beller attributes the acceptance of the Copenhagen interpretation by most physicists, in no small part, to hero worship. She believes that "One cannot overestimate the impact of the authority figure in the evaluation and acceptance of ideas. Bohr's unprecedented authority not only promoted the widespread, uncritical acceptance of the Copenhagen philosophy but obtained a favorable reception for his dubious and poorly developed ideas outside of his area of competence." She gives many quotes to indicate his acceptance as a "father figure," both professional and personal, to the younger physicists about him. She claims "it became almost obligatory, when writing about Bohr, to refer to the 'subtlety' of his thinking." She then points out that he was exceptionally hard to understand and essentially accuses everyone who praised the depth of his thought of having been intimidated into accepting obscurity as profundity. When she quotes "Pais *graciously* remarks that 'Bohr's strength lay in his formidable intuition and insight rather than in erudition'" (my italics), she cannot believe that he really means it.

Although even Bohr's intellectual opponents (Bohm and Hiley) call him subtle, she remarks that they too felt the pressure of intimidation. She seems to feel that everyone but her has been cowed by this—even Einstein and Schrödinger. The tremendous displays of warmth and affection for Bohr shown by the students at his institute, and even their parodying of him, Beller takes as further evidence of "hero worship and the associated suppression of criticism." She quotes an anecdote by Feynman to the effect that when the young Feynman met Bohr at Los Alamos and (not knowing who he was) criticized him, Bohr suggested that the next time they discussed ideas they should do so privately, so as to avoid all the big shots who always said "yes, yes Dr. Bohr." She offers this to show how intimidated physicists were by Bohr but seems unaware that the anecdote also has a contrary interpretation—one suggesting both Bohr's great sensitivity and how the enormous affection everyone had for him might have been earned.

By the way, the issue here is not whether physicists are hero worshipers. My own experience convinces me that they certainly

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are. The real issue is whether Bohr would deliberately and dishonestly use his authority to intimidate others into accepting a position that he did not believe to be true.

Beller takes great pains to show that Bohr was not at home with difficult mathematics, and she uses this to imply that he was actually, deep down, sort of a bumbler. She even calls him "a tragic figure," who should not have been taken so seriously by so many great physicists. But truly great insights in physics rarely come primarily from mathematical sophistication, and I find her arguments somewhat irrelevant to the issue of how much respect Bohr is due. Einstein, who never accepted Bohr's interpretation of quantum theory, called Bohr's insights "the highest form of musicality in the sphere of thought." (This quote is not from Beller's book, but it is hard for me to see intimidation at work here.)

As a parallel case, I remember when I found out that Irving Berlin could not read a note of music. Rather than convince me that his songs were no longer worth listening to, this made me appreciate all the more what a phenomenal natural genius he must have been. My reaction to Bohr's mathematical deficiencies is similar.

Also, many of Beller's other arguments against Bohr depend on accepting her reading of very weak evidence. There is just no smoking gun here. When one reads everything someone has written over several decades, it is easy to find shifting opinions, contradictions, and confusing remarks. This does not necessarily make a case for intellectual dishonesty. Nor does trying to use different strategies of argument, geared to different types of audiences, prove that one is disingenuous. I think Beller is guilty of trying to force the worst possible conclusions out of very slight and ambiguous evidence. The problem is that she has not approached her subject with a very open mind. One can begin to see her bias in comments such as "One interesting attempt to find some stability, objectivity, and cohesion, despite the impressive impact of social studies of science that deny those characteristics to science, is..." This jaundiced look at science in general leads to such opinions as "finality is an ideological, not a conceptual, position, and this is perhaps the reason scientific controversy often looks more like a political campaign, with one side discrediting and caricaturing the other, than an open-minded dialogue about fundamentals."

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So what is one to make of *Quantum Dialog*? The author makes a good case for the contention that arguments about the consistency of the Copenhagen interpretation came to support the incorrect conclusion that it was the only possible interpretation. How could this happen? I think this is a fascinating question, well worth a book. But I also think that it is a serious mistake to look for villains. That makes the process much simpler and less significant than it was. The problem becomes much more interesting and important when one sees the process unfolding and asks how could so many people, all looking for the truth, have convinced themselves that one viable interpretation was actually unique and unassailable.

It is easy to construct a much more conventional and, to my mind, plausible scenario as to how this occurred, one without conspiracy theories. Furthermore, scientists like to believe that the scientific enterprise is a self-correcting one. And although there is nothing inevitable in the process, in the case of quantum theory, one can see the corrections slowly taking place. The original Copenhagen interpretation had a tremendous formal mathematical beauty, and Von Neumann had "proven" that a hidden variable interpretation was not viable. So it is easy to see how most physicists accepted this and considered the matter closed.

Only in the 1950s did Bohm invent his alternate model, which led John Bell to disprove Von Neumann's result. (Beller mentions a previous argument against Von Neumann's proof by a student of Heisenberg, but because she doesn't give any details, one cannot evaluate its merit.) Bell then also proved his own famous theorem, which showed that one can experimentally test certain types of realistic interpretations. This not only led to a series of still-ongoing experiments to test aspects of various interpretations, but it also increased interest in the possibility of other interpretations. Since then, Bohm's interpretation and several others as well have slowly been winning converts. Many philosophers have become interested in the new models. In general, the situation is now much more favorable for the acceptance of new models than it was in the past, although none have yet caught on among working physicists, mostly because there are no new experimental situations that have needed to be explained by them. But in this history, one can see the gradual development of an open-mindedness in the field.

Scientists unfortunately do jump on bandwagons and make flawed judgments, and this does slow the process of choosing between theories. But in this case the process does seem to be slowly correcting itself. There is no necessity for seeing dark forces at work here or for impugning the character of the scientists. Making Heisenberg and Bohr into villains doesn't ring true and doesn't solve the interesting problems involved. (Of course, Beller is fully aware of everything I have said above, but she would certainly not agree with me. To the extent that one denies objectivity to science, "self-correcting" becomes a meaningless concept, and one is forced to find more sinister explanations based on the foibles of individuals.)

EXHIBITIONS: ART AND ASTRONOMY

Views of the Final Frontier

Jay M. Pasachoff

From the 19th-century movement known as Romanticism through the early 20th-century Avant-garde and now into the 21st century, artists' perceptions of the cosmos have continued to evolve. The plurality of worlds foreseen by Giordano Bruno (the 400th anniversary of whose death was marked this February) found its way into the Russia of the 1920s. One result of this trajectory is a strange room created by Ilia Kabakov in the 1980s, with walls covered in Cyrillic posters from the Soviet era and with pages of typewritten text describing a purported escape from the Soviet Union to outer space from an in-house rocket explosion. The room is one feature of the exhibition *Cosmos* and its accompanying book, both of which present a fusion of science, art, politics, and humanistic thought. The utopias in space imagined by Russian writers after their revolution are discussed in one of the book's essays.

Cosmos
From Romanticism to the Avant-Garde
Jean Clair, chief curator, and Pierre Théberge, director

At the Montreal Museum of Fine Arts, 17 June to17 October 1999; Centre de Cultura Contemporània de Barcelona, 24 November 1999 to 27 February 2000; Palazzo Grassi, Venice, 25 March to 23 July 2000.

Cosmos
From Romanticism to the Avant-Garde
Jean Clair, Ed.

Published for the Montreal Museum of Fine Arts by Prestel, New York, 1999. 396 pp. $75, £45. ISBN 2-89192-231-X.

The exhibition is a remarkable amalgam of paintings, photographs, books, sculptures, and other artifacts. I saw it in Barcelona, where the contents differed somewhat from the original presentation at the Montreal Mu-

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