

MARXISM AND QUANTUM CONTROVERSY: RESPONDING TO MAX

JAMMER'S QUESTION¹

OLIVAL FREIRE JR.²

Introduction

I shall use the term “quantum controversy” as shorthand for the controversy over the interpretation of the formalism of quantum mechanics. Max Jammer wrote that the manner in which opposition to the Copenhagen interpretation of quantum mechanics “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 just as diligently as the influence of the ‘Weimar culture’ on early quantum theory has recently been studied.”³ My main point in this short paper is that there is now historical evidence to answer definitively Jammer’s question.

Additionally, criticizing Copenhagen interpretation, Soviet and Western Marxist physicists played their role in breaking the “monocracy of Copenhagen school”, using Jammer’s words, which reigned among physicists in the 1950s. Since breaking that

¹ Paper to be presented at the conference **Intelligentsia: Russian and Soviet Science on the World Stage, 1860-1960**, University of Georgia, Athens GA, on 29-31 October 2004. I am thankful to CNPq (Grant 303967/2002-1). I also thank to Michel Paty for inviting me to the “table ronde” *Interactions entre sciences, politiques et institutions au sortir de la 2^e guerre mondiale*, held at Equipe REHSEIS, Paris, February 2004, where I could discuss a first version of this paper; Joan Bromberg, and Shawn Mullet for their comments on a first version of this paper.

² Dibner Institute for the History of Science and Technology, MIT – E56-100, 38 Memorial Dr, Cambridge, MA 02139. On leave of absence from Physics Institute – UFBA – Salvador, BA, 40210-340, Brazil. E-mail: freirejr@ufba.br

³ M. Jammer, *The Philosophy of Quantum Mechanics - The Interpretations of Quantum Mechanics in Historical Perspective*, New York: John Wiley & Sons, 1974, p. 251.

monocracy was an indispensable condition for creating a field of research dedicated to the foundations of quantum mechanics, we can conclude that Marxist criticisms played a positive role in the birth of this contemporary scientific field. This conclusion stands no matter how the Marxist camp, in the USSR and in the West, developed that criticism, in the 1950s.

Jammer's question can interest historians of Marxism, of Soviet science, and historians of science in general. Historians of Marxism tend to see in this Soviet case a minor example of the "Zhdanovshchina" campaign, but it deserves close inspection since it is a case in which the relationship between science and ideology seems to exhibit richer features than we usually admit. To historians of science, the fact that interest in the research on the foundations of quantum physics has continuously increased, arriving in the 1990s at the possibility of turning philosophical debates into technological applications, makes Jammer's question still more meaningful.

Literature

Even before Jammer's appeal, Loren Graham had studied the interactions between Marxism and quantum controversy in the USSR in a comprehensive manner.⁴ He recognized that Soviet criticisms were akin to the Western ones, such as those elaborated by Einstein and others. He was able to identify the two parties in dispute in the USSR, the first one, dominant, being that of the criticisms of complementarity for its idealistic flavor. Of the second one, that of the supporters of complementarity, he commented on the singularity of V.A. Fock's ideas, an attempt to combine complementarity with

⁴ L. Graham. *Science and Philosophy in the Soviet Union*, New York: Knopf, 1972.

dialectical materialism. He emphasized that it rests an open question for the philosophy and history of physics to weigh the real influence of Fock on some of Bohr's last texts.⁵ However, in Graham's account criticisms of complementarity seem to have been mere reflections of the ideological context of the time, and he does not discuss the influence that these criticisms might have had on the mainstream of science. Andrew Cross studied the influence of that ideological context on the Western Marxist physicists, especially on the idea they preached of the existence of a crisis in physics at the time. Cross has the merit of not restricting his study to national boundaries. Nevertheless, he did not analyze the scientific content of these criticisms, and for that reason he could not grasp the relationship between these criticisms and the lasting controversy over the foundations of quantum physics. In particular, he did not see that some of these criticisms kept their interest among physicists even after the ideological context he studied.⁶ Kremontsov, while reviewing and summarizing the literature about Russian science in the Twentieth century, remarked that "in the last years of Stalin's rule the Soviet science system was completed by a cascade of campaigns in almost all disciplines", but he did not single the quantum case out for its singularity.⁷ So, it seems to me that the history of science has not faced Jammer's question, and it remains worth studying.

⁵ "More work on this issue is in process, but it already seems rather clear that some transition did occur in Bohr's thought, a transition away from emphasis on the interaction of the measuring instrument and the micro-object as the key to quantum mechanics, away from a renunciation of causality, and toward a greater recognition of the physical reality of the microbodies of quantum mechanics. And it is entirely possible that the conversations with Fock were an important cause for Bohr's shifts, although proving this causation would be quite difficult." Loren R. Graham - *Science in Russia and the Soviet Union - A Short History*, New York: Cambridge University Press, 1993, p.116. See also Loren Graham - The Soviet Reaction to Bohr's Quantum Mechanics, in H. Feshbach, T. Matsui, and A. Oleson (eds), *Niels Bohr: Physics and the World - Proceedings of the Niels Bohr Centennial Symposium*, Harwood Academic Publishers, 1988, 305- 317.

⁶ A. Cross. "The Crisis in Physics: Dialectical Materialism and Quantum Theory", *Social Studies of Science*, 21(4), 735-59, 1991. See also O. Freire Jr., "Response To Cross - Comment On 'The Crisis In Physics'", *Social Studies of Science*, 22(4), 739-42, 1992.

⁷ Kremontsov, N. "Russian Science in the Twentieth Century", in Krige, J. & Pestre, D. (eds) - *Companion to Science in the Twentieth Century*, London: Routledge, 1997, 777-794

Soviet and Marxist criticisms of complementarity

The main spokesman of Soviet criticisms of complementarity was the physicist Blokhintsev. To him, quantum mechanics was a statistical theory, in the sense that it deals adequately with a large number of quantum systems or, in an inverse way, it is not an adequate theory for singular quantum systems. Blokhintsev shared with other critics a revulsion for the emphasis put by complementarity supporters on the role of observation in quantum mechanics. To the Soviet critics, the inclusion of observation conditions into the quantum phenomena, as maintained by Niels Bohr, was a kind of idealism and an inclination towards what they considered to be bourgeois trends in the philosophy of science.⁸ Except for its ideological flavor, that criticism was similar to those kept in the West by physicists and philosophers such as Einstein, Popper, and de Broglie. Soviet criticisms were not limited to Soviet boundaries. The network of cultural and political organizations linked to the Western Communist parties took in its charge the task of spreading that criticism everywhere. So, many times these criticisms circulated in the West in vehicles not specialized in physics. This way, Soviet texts on quantum mechanics and other issues laden with ideology were translated and published in several countries by the initiative of cultural associations and journals related to Marxists. In some cases, cultural and political associations took the initiative of circulating among physicists the Soviet criticisms. In France, for instance, papers by Soviet physicists and philosophers were published by “Les éditions de la nouvelle critique”, a publisher related to the French

⁸ “Cependant, l'école de Copenhague relègue au second plan le fait que la mécanique quantique n'est pas applicable qu'à des ensembles statistiques et se concentre sur l'analyse de la relation mutuelle entre le phénomène individuel et l'appareil. [...] Ainsi, le caractère statistique des phénomènes quantiques est dû à la liaison mutuelle entre les phénomènes microscopiques et macroscopiques. [...] C'est pourquoi la fonction d'onde n'est pas la caractéristique de la particule microscopique 'en soi', mais la caractéristique de son appartenance à tel ensemble. [...] C'est pourquoi la mécanique quantique étudie les propriétés du phénomène microscopique individuel par l'intermédiaire de l'étude des lois statistiques d'un groupe de tels phénomènes.” D. I. Blokhinzev - Critique de la conception idéaliste de la théorie quantique, in *Questions Scientifiques – Physique, tome 1*, Paris: Les éditions de la nouvelle critique, 1952, pp.95-129, translated by François Lurçat.

Communist Party. As another example, Pauline Yates, Secretary of the Science Section of “The society for cultural relations between the peoples of the British Commonwealth and the U.S.S.R.”, translated into English a paper by Ya.I. Frenkel, “which foreshadows the development of a non-statistical theory of microphenomena and final elimination of indeterminacy,” and tried to publish it in *Nature*. She gave up her goal because of opposition from Rosenfeld, but reproduced it as a stenciled translation for the members of that society.⁹

However, the main criticism of complementarity in the 1950s did not come from the USSR, but from a young American physicist, David Bohm, from Princeton University, with close ideological links to Marxism. His causal interpretation was a direct challenge to complementarity since it replicated the standard results of non relativist quantum mechanics but it got them with a model embedded in a quite different philosophical framework.¹⁰ Even if Bohm’s philosophical views, strong causality and realism, were central values shared by physicists with different ideological trends, like Einstein and Blokhintsev, Bohm’s causal interpretation did not get support from them. In fact, the causal interpretation had a poor reception among physicists at the time. However, it gathered a small but active group of physicists, mainly in France under the leadership of Louis de Broglie, the Nobel Prize, and Jean-Pierre Vigier, a young Marxist. In spite of the ideological neutrality of de Broglie, adhesion to causal interpretation in France was favored by the strong presence of the Communist Party among the young French

⁹ See letters from P. Yates to L. Rosenfeld, 02.07.1952 & 02.19.1952. Rosenfeld Papers.

¹⁰ D. Bohm, “A Suggested Interpretation of the Quantum Theory in Terms of “Hidden” Variables, I and II” - *Physical Review*, 85(2), 166-179 & 180-193, 1952.

intellectuals.¹¹ Besides, in France, there was a resonance between the defense of the causal interpretation and the criticisms of the complementarity's idealistic flavor. Causal interpretation was presented by Vigier as the materialist dialectical point of view on quantum mechanics. The French case is the best locus to see how Soviet criticisms of complementarity were used to support the causal interpretation.¹² The same resonance does not seem have existed in the Soviet Union or, at least, it was lesser than that wished by David Bohm.¹³

As a consequence either of the seduction of the causal interpretation or the ideological appeal of Soviet criticisms, one can identify plenty of critics of complementarity influenced by that context. Besides Vigier, Bohm, Blokhintsev, we can enroll Terletskii, Bunge, Janossy among the quantum dissenters related, to a certain degree, to Marxism.

At the end of the 1950s the ideological cultural tension raised by the “Zhdanovshchina” campaign began to fade. Marxist philosophical engagements continued to play a role in the quantum controversy but they were less influential than they had been in the 1950s. The influence of positions such as of Bohm and Blokintsev, however, increased with time. Two brief remarks could give us an idea of this kind of influence. First, the reach of the causal interpretation stands beyond the debates of the 1950s and its poor reception among the physicists of the time. Historically, it opened the doors to John Bell's inequalities, formulated in the middle of the 1960s, which gave a great impetus to the

¹¹ Evry Schatzman suggested that, in the early fifties, about a quarter of the students at the Ecole Normale were Communists. Evry Schatzman, interviewed by Spencer Weart, on August 21, 1979, to the “Sources for History of Modern Astrophysics”, Center for History of Physics – American Institute of Physics.

¹² O. Freire Jr., “Quantum Controversy and Marxism”, *Historia Scientiarum*, 7, 137-152, 1997; & *David Bohm e a controvérsia dos quanta*, Campinas: Centro de Lógica Epistemologia e História da Ciência, 1999.

¹³ Letter from D. Bohm to M. Phillips, 03.18.1955. Bohm Papers, University of London.

research on the foundations of quantum theory. Besides, physicists like Bohm and Vigier actively worked on foundations of quantum mechanics until their last days, even if they had further disagreements about the content of their positions. David Bohm, indeed, in the 1990s, was largely recognized for his contributions to that field of research. Second, it became common among physicists when speaking about the so-called “statistical interpretation” of the quantum theory, which has remained as one of the alternative interpretations to the complementarity one, to include among its ancestors Einstein, Slater, Popper and the Soviet physicist Blokhintsev.¹⁴

So far, we have already evidence to say that “factors, such as the growing interest in Marxist ideology in the West,” fomented and supported the opposition to the Copenhagen interpretation of quantum mechanics. There was, however, an interesting by-product of that context. It stirred up the disputes among Marxists, from one side, and that dispute moved some of the founder fathers of quantum mechanics to include ideological considerations in the debate; and all those events amplified the controversy on the interpretation of quantum mechanics.

The many Marxisms and the quantum controversy

The 1950s not only saw the criticisms of complementarity by Marxists but also a dispute among Marxists, since there were, indeed, a number of Marxist physicists who defended complementarity and even its compatibility with dialectical materialism. This trend had two major spokesmen: Léon Rosenfeld in the West, and Vladimir Fock in the USSR.

¹⁴ See D. Home & M. A. B. Whitaker. “Ensemble Interpretations of Quantum Mechanics – A Modern Perspective” *Physics Reports* 210(4), 223-317, 1992.

The role played by Fock in the USSR was well studied by Graham and for that reason I will not deal with it. I just want to point out that, in the second half of the 1950s, he played a double role, philosophical and diplomatic. It was the time of the dissolution of the “Zhdanovshchina” campaign, after Stalin’s death. He not only went to Copenhagen to discuss philosophical issues with Bohr but also invited him and organized the first visit of the Danish physicist to USSR, after the war.

In contrast to Fock’s case, Rosenfeld’s activities have not been comprehensively scrutinized from a historical point of view yet.¹⁵ Rosenfeld had been Bohr’s former assistant since the 1930s, and a physicist very sensitive to epistemological matters. He had been engaged in Marxist philosophy since the thirties, but Rosenfeld’s Marxism was closer to Western Marxism than it was to Soviet Marxism, to use the terms introduced by Perry Anderson in order to make sense of Marxist trends in the 20th century.¹⁶ Hence, Rosenfeld was both orthodox in quantum mechanics as heterodox in Marxism. Intending to preserve what seemed to him to be a dialectical feature of complementarity, Rosenfeld criticized the Soviet and Marxist physicists who were themselves critics of complementarity.¹⁷ In the 1950s, Rosenfeld used both political and scientific personal links to fight against the Soviet critics of complementarity and the causal interpretation supporters. Among the people with whom he exchanged letters defending complementarity against its Marxist critics we may find scientists, philosophers,

¹⁵ Anja Skaar Jacobsen, from Roskilde University, develops now the project “Complementarity and Marxism: Epistemology, historiography, and ideology in twentieth century physics elucidated by the case of Léon Rosenfeld.”

¹⁶ P. Anderson, *Considerations on Western Marxism*. London: Verso, 1979.

¹⁷ L. Rosenfeld, « L’évidence de la complémentarité », in André George (ed), *Louis de Broglie - Physicien et Penseur*, Paris: Editions Albin Michel, 1953, pp. 43-65.

historians, and social activists, such as Frédéric Joliot-Curie, David Bohm, Evry Schatzmann, E. Burhop, V. A. Fock, Hans Freistadt, Adolf Grunbaum, Lancelot Law Whyte, Robert Haveman, Robert Cohen, J.L. Destouches, John D. Bernal, Benjamin Farrington, Abraham Pais, Koefed, Guido Beck, Gerard Vassails, Pauline Yates, and Nature's editors.¹⁸

Disputes among Marxists about the philosophical status of complementarity were not restricted to the discussions having Fock and Rosenfeld as protagonists on the side of complementarity. For example, during David Bohm's exile in Brazil, while prosecuted by McCarthyism, he met Mario Schönberg as a colleague at the same Physics Department of the University of São Paulo. Being both Jews and Communists, they had their mutual solidarity reinforced, but they did not agree about one issue, the philosophy of quantum mechanics. Schönberg was close to Rosenfeld's views, and suggested to Bohm the study of Hegel in order to get a broader understanding of causality since Lenin had recommended that Communists should read the German philosopher.¹⁹ Bohm took the suggestion seriously, and some of that influence could be found in Bohm's later reflections on causality, first expressed in his "Causality and Chance in Modern Physics."²⁰

A fair debate among Marxists, such as that between Bohm and Schenberg, was not the rule of the time. In general, those who were aligned with the criticism of

¹⁸ All of those letters are at *Rosenfeld Papers*, Niels Bohr Archive, Copenhagen. I am indebted to Felicity Pors for his assistance while consulting them. To the discussions between Rosenfeld and Joliot-Curie, see M. Pinault, *Frédéric Joliot-Curie* Paris: Editions Odile Jacob, 2000, p. 508.

¹⁹ F. David Peat. *Infinite Potential - The Life and Times of David Bohm*, Addison-Wesley Pub.Co, 1996.

²⁰ D. Bohm. *Causality and Chance in Modern Physics*, Princeton: Van Nostrand, 1957.

complementarity, which was the dominant position in the Marxist field, reproduced the dogmatic practice in cultural and philosophical issues so common in the Western Communist parties and in the USSR. So, in the many publications and debates organized at that time, papers by Marxist defenders of complementarity were not published. The French Marxist milieu went as far as to make up the intellectual heritage of one of its predecessors – physicist Paul Langevin – in order to present Langevin’s ideas as compatible with the dominant criticism of complementarity.²¹

Returning to Rosenfeld, let me speak about the other by-product of this whole affair that contributed to heated discussions, this time among some of the founder fathers of quantum mechanics. In fact, Rosenfeld faced opposition not only from the Marxists aligned with the criticism of complementarity but, for a different reason, also from physicists and supporters of complementarity, such as Werner Heisenberg, Max Born, and Wolfgang Pauli. They did not accept Rosenfeld’s mixture of Marxism with complementarity. With Heisenberg, Rosenfeld kept a lasting debate, until 1970, criticizing his leaning towards idealism.²² With Born and Pauli, he kept a private struggle. As part of the debate, Max Born wrote and sent to him a 10-page typed text in which he argued that dialectical materialism could not appeal for achievements of contemporary science to be corroborated.²³ Eventually, Born abandoned the idea of publishing the text once he saw the beginning of a détente between West and East in the late 1950s. Wolfgang Pauli used his famous ironic and bitter correspondence style to hit Rosenfeld.

²¹ O. Freire Jr. “L’interprétation de la mécanique quantique selon Paul Langevin.” *La Pensée*, 292, 117-134, 1993; & “La physique quantique et l’humanisation de la science.” *Epistémologiques*, 2 (1-2), 111-126, 2002.

²² See L. Rosenfeld, “Heisenberg, physics and philosophy.” *Nature*, Vol. 186, June 11, 1960, pp. 830-1; and “Berkeley redivivus,” *Nature*, Vol. 228, October 31, 1970, p. 479..

²³ O. Freire Jr. “ Science, Philosophy and Politics in the Fifties - On the Max Born's unpublished paper entitled 'Dialectical Materialism and Modern Physics'”. *Historia Scientiarum*, 10(3), 248-254, 2001

When editing a volume in honor of Bohr, he wrote to Heisenberg, managing to prevent Rosenfeld from adorning his paper with banalities on Materialism, and labeled Rosenfeld “ $\sqrt{\text{Bohr} \times \text{Trotsky}}$.”²⁴

Conclusion

Let me finish with three conclusions. The first one, already mentioned, is that we have enough historical evidence to answer Jammer’s question. Marxists, in the West, and Soviet critics, fomented and supported the opposition to the Copenhagen interpretation. They were not the only factors, and not even the main ones, but they contributed to the increasing opposition. This stands not only for their direct criticisms but also for an indirect and unintentional effect, that is, the disputes among Marxists and the reaction of some of the founder fathers that heated the quantum controversy.

My second conclusion derives from the fact that quantum controversy, which has opposed, on philosophical grounds, such giants of the 20th century physics as Niels Bohr and Albert Einstein, melded science, philosophy and ideology in different degrees, according to the people, time and places involved.²⁵ Therefore, Marxism’s influence on that story was as legitimate as were other philosophical views.²⁶ That is why my second

²⁴ Letter from Pauli to Heisenberg, 13 May, 1954. The same expression can be found in a letter to Rosenfeld, 28 September, 1954. The letters are in *Wolfgang Pauli – Scientific Correspondence*, Vol.IV, Part II (1953-1954), ed. by Karl von Meyenn, Springer-Verlag, 1999.

²⁵ O. Freire Jr. “A Story Without An Ending: The Quantum Physics Controversy 1950-1970.” *Science & Education*, 12(5-6), 573-586, 2003

²⁶ As early as 1966, Paul Feyerabend arrived at a similar conclusion. His argument, however, is grounded on a philosophical analysis of Bohr’s thought while the mine is based on a historical analysis of the quantum case. See P. Feyerabend, “Dialectical Materialism and the Quantum Theory.” *Slavic Review*, XXV, 414-17, 1966.

conclusion is that, unlike Joravsky's conclusion when studying the Lysenko affair,²⁷ one cannot establish in the quantum case a sharp distinction between science and ideology. Would it be by chance that the quantum controversy left indelible traces in the Soviet and Russian cultures, like that beautiful sculpture [see next page] of Bohr and Einstein in a Russian park?

Finally, focusing on the Marxist branch of the quantum controversy should not lead us to overestimate its role but, by the same token, should not lead us to underestimate its due recognition. Since we consider that, in fact, it was necessary to break Copenhagen monocracy as a condition to create a field of research dedicated to the foundations of quantum mechanics, in which complementarity is considered one, even the main, but not the only possible interpretation of quantum mechanics, the role played by Marxist criticisms needs reevaluation. The French physicist Alain Aspect – a leader in this field –, wrote recently that “questioning the ‘orthodox’ views, including the famous Copenhagen interpretation, might lead to an improved understanding of the quantum mechanics formalism, even though that formalism remained impeccably accurate.” The improved understanding, according to Aspect, concerned the quantum description of the “entangled states,” and “single objects,” both two derived directly, the first, and indirectly, the second, from John Bell's works in the middle of the 1960s.²⁸ So, for its contribution to that quest, Marxism played a favorable role in the development of such a field of scientific research.

²⁷ D. Joravsky - *The Lysenko Affair*, Chicago: The University of Chicago Press, 1970, p.1.-17.

²⁸ A. Aspect, Introduction, in J.S. Bell, *Speakable and Unspeakable in Quantum Mechanics*, 2nd edition, Cambridge University Press, Cambridge, 2004, pp. xvii-xxxix.

