LETTERS

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Cassidy's assumptions. Heisenberg was relieved that fate had kept him from being involved in bomb construction. He never claimed moral superiority, but he regretted reproaches of moral culpability that were occasionally directed at him because he had remained in Germany.

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The discussion about *Copenhagen* misses a very important point. Werner Heisenberg's visit to Niels Bohr occurred during a generally forgotten half-year window of time between the German invasion of the Soviet Union and the Japanese attack on Pearl Harbor.

The German blitzkrieg into the Soviet Union left an impression, certainly held by Heisenberg, that the Germans would win the war quickly and that the world would conduct business as usual with the victors who had destroyed the evil Communist empire.

An objective evaluation of America in 1941 and of what has been learned about the German uranium project supports a very different version of the visit from those presented in the play. We heard this version from Niels Bohr when he came to the Weizmann Institute around 1960.

Heisenberg and his colleagues had been completely surprised by the news that an atom bomb had been dropped on Hiroshima. Germany had no serious atom bomb program; the Germans never believed that it was possible. To cover their embarrassment at having missed this possibility, Heisenberg and friends invented the story that they had opposed the bomb project for moral reasons. Bohr was furious at this outright lie, and told Amos de Shalit that Heisenberg's message in 1941 was "You know that we are going to win this war and we will be building a new high-tech Europe based on the discoveries in quantum physics and nuclear energy. Why don't you join us?" One can imagine Bohr's feelings about being asked to participate in the building of Adolf Hitler's "thousand-year Reich" and Heisenberg's insensitivity to such feelings. The possibility of an atomic bomb was probably not even discussed, being considered irrelevant at the time.

Several years ago I checked the story with my friend Abraham "Bram" Pais whose description of this visit in his biography of Bohr was suspiciously vague. Bram would neither confirm nor deny my story. He said that Bohr had been very angry at Heisenberg and had written him an angry letter. Bram had seen this letter, but was not at liberty to reveal its contents because the Bohr family insisted on its being kept confidential.

Most discussions of a possible German atomic bomb project overlook the role played in the US Manhattan Project by an enormous military–industrial complex that did not exist in wartime Germany. That the German project was not in that league is clearly indicated by the memoirs of Nikolaus Riehl, the industrial physicist who directed the German plant producing reactor-grade uranium, was grabbed by the Russians immediately after their entry into Berlin, and was kept for 10 years doing a similar job for the Russians. Riehl had to wait many months to obtain the copper needed to produce a transformer for his uranium production at a time when the large American industrial nuclear plant at Hanford, Washington, was processing tons of reactor-grade uranium to make the plutonium that was used in the bomb dropped on Nagasaki. The Germans did not even have the uranium to make a reactor, let alone a mammoth plant like Hanford.

Perhaps historians will soon put the essentially nonexistent German bomb project in its proper place and give a more realistic picture of the Bohr–Heisenberg meeting in 1941.

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David C. Cassidy states that "there is no evidence in any other sources . . . that moral issues regarding nuclear fission research were of particular concern for Heisenberg—nor for many other physicists, for that matter."

This statement gives the false impression that the physicists who were working on the US Manhattan Project had no concern for the moral issues related to their research. I was a physicist working at Argonne National Laboratory during 1943 and 1944. I know from experience that a majority of physicists there were very concerned about the moral issues related to the development and use of the atomic bomb.

There were many informal discussions among the physicists at Argonne concerning these issues. Most of the discussions ended with the conclusion: We must be first! Few of us had access to information about how far along the Germans were in their nuclear research. However, we knew that if the Germans were to develop the bomb first, the results would be disastrous for the free world.

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CASSIDY REPLIES: One of the most difficult and debated episodes in recent physics history concerns the involvement of German scientists in nuclear-fission research during World War II. The difficulty stems from the traumatic events, from the characteristic ambiguity of circumstances and behavior in that period, and from the realization that some admired participants were as imperfect as the rest of us.

The play *Copenhagen* succeeded in part by making a virtue of ambiguity. By magnifying the mystery of what Werner Heisenberg told or tried to tell Niels Bohr during his visit to Copenhagen, the play explores many possibilities. A primary purpose of my paper was to defuse much of the mystery in the play by briefly outlining the historical context. As Harry J. Lipkin notes, that visit occurred during a "window of time" in which the prospect of a German victory seemed quite real. I was not arguing, as Klaus Gottstein suggests, that Heisenberg was there to convince Bohr that a German victory was inevitable, but rather "that the seemingly inevitable German victory would not be so bad for Europe after all" when compared with a Soviet victory.

At the time of Heisenberg's visit, the German army was indeed still in control of fission research. After the army withdrew almost entirely in early 1942 and Albert Speer assumed administrative authority, the project never fully recovered. I don't find any slackening of Heisenberg's fission research before 1942, and Gottstein seems to agree. But I did not equate "fission research" with "construction of a nuclear bomb," as Gottstein suggests. All of the work until war's end was directed toward reactor construction, a goal the Germans did not achieve. However, echoing Heisenberg's vague reference from his letter of 1 October