

LETTERS

Heisenberg's Message to Bohr: Who Knows?

I read with great interest in the July 2000 issue of *PHYSICS TODAY* the articles by David C. Cassidy (page 28) and Hans A. Bethe (page 34) on Werner Heisenberg and the German uranium project and by Gerald Holton (page 38) on Heisenberg and Albert Einstein, as well as letters by Gustav Born and Alvin M. Weinberg (page 74). I have also read Michael Frayn's play *Copenhagen*, regarding the 1941 meeting between Niels Bohr and Heisenberg.

I discussed that visit with Heisenberg himself, and also asked Carl Friedrich von Weizsäcker about it. Weizsäcker had accompanied Heisenberg to Copenhagen, and talked with him immediately after he returned in despair. Heisenberg was my director at the Max Planck Institute for Physics from 1950 to 1971. I was associated with Weizsäcker from 1974 to 1980 at his Starnberg institute. In early 2000, at a colloquium in honor of Weizsäcker's 88th birthday, I asked him again about the Heisenberg-Bohr visit.

Heisenberg was worried that a nuclear bomb might be built and used, and wanted Bohr's opinion about whether the small international community of nuclear scientists could agree not to work on the bomb. But he did not get his message across.

Heisenberg told me that he used very involved language with Bohr so that, if necessary, he could have given the Gestapo a harmless interpretation. The reactor project was a military secret, and telling a foreigner about it was treason, punishable by death. Unfortunately, Bohr understood only that Heisenberg worked on fission and knew in principle how a nuclear fission bomb could be made, and that, somehow, he wanted to get Bohr involved. Bohr ended the conversation.

In 1980, Edward Teller and I discussed the misunderstanding. Teller

said that Bohr had been shocked and dismayed about the Nazis, was himself in personal danger, and apparently did not listen carefully enough. Bohr had spent his life teaching complementarity and the necessity of using imperfect language to express the truth, so Teller would assign blame primarily to Bohr for the misunderstanding.

However, by a well-meant but insensitive remark Heisenberg may have contributed to the confusion. He knew that one official at the German legation in Copenhagen was a trustworthy anti-Nazi. He seems to have suggested that Bohr contact this person if he should ever have difficulties with German authorities in Denmark. Bohr may have misunderstood the comment as a suggestion that he collaborate with the Germans. This interpretation is supported by a report that Bohr gave to the Russian physicist Evgenii Feinberg after the war.

Cassidy is wrong when he suggests that Heisenberg went to Copenhagen to convince Bohr that German victory was inevitable. That he wanted Bohr to use his influence to prevent Allied scientists from "building a bomb that could be used against Germany" may be partially true. The full truth is probably that Heisenberg wanted to talk with his friend about avoiding altogether the construction of nuclear bombs. Bohr was isolated in occupied Denmark, so Heisenberg cannot have hoped to learn anything from him about Allied operations.

Cassidy's comment that Heisenberg could have turned for counsel to Max Planck and Max von Laue is beside the point. Both Planck and von Laue were respected older colleagues who had also chosen to stay in Germany. But neither worked on fission, and neither had as close a relationship with Heisenberg as Bohr had.

True, Heisenberg and Weizsäcker thought that German domination of Europe would be a lesser evil than Soviet domination. Auschwitz was not yet known, but Stalin's purges, prison camps, and massacres were. Nevertheless, Heisenberg did not consider it his task to express this

opinion. He was closely watched by Nazi authorities when traveling, and statements doubting Germany's superiority and final victory would be subject to severe punishment. After surprising initial German victories, Heisenberg may have doubted his earlier convictions that Germany would lose the war. His hope, and that of other non-Nazi Germans, was that, after victory, the German army would remove the Nazi system.

Heisenberg made several trips during the war, but most of these were not at his own initiative. In most cases he was asked by German authorities to accept invitations to give lectures. After earlier accusations that he represented "Jewish physics," these official invitations brought him and modern physics a level of esteem.

It is unfair to say that Heisenberg's determination to stay in Germany "arose not only from his personal attachment to the German nation and culture, but also from his misguided belief that if he personally could survive in Germany . . . then so, too, would decent German science." Like Planck and von Laue, he felt responsible for the students who represented the future of German science. He did not want to desert them.

Highly misleading is Cassidy's statement that "Heisenberg returned home intent on continuing fission research. He had already resigned himself to the march of events. . . ." Heisenberg did return to fission research. But he believed that construction of a nuclear bomb by war's end was impossible. Of course, it cannot be said that he refrained from bomb construction for moral reasons; the moral question simply did not arise, because a bomb did not seem feasible.

Cassidy gives the impression that Heisenberg's "bomb work" was thwarted by lack of support from the German army. In fact, such decisions were in the hands of the munitions and armaments minister, Albert Speer, who offered support for the reactor project.

The resolution of the "mystery" of Heisenberg's trip to Copenhagen, as described here, is different from

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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

1941, I did refer to a “march of events” (my words) that he apparently perceived as leading toward nuclear weaponry. I don’t see where I referred in this article to “Heisenberg’s ‘bomb work.’”

I also tried to show how, in hindsight, Heisenberg, as well as many other prominent Germans, had been used by the Third Reich for its own purposes. Obtaining such lessons is among the tasks and benefits of history. I explored this topic in my biography.¹ With encouragement from Max Planck, Heisenberg came to believe, long before the outbreak of war, that he personally must survive in Germany so that his students and decent German science could survive.

The war began nearly 7 years into the 12-year reign of the Third Reich. We cannot fully understand behavior during the war without first examining attitudes and responses established during the pre-war years. Some authors have reached what I find to be untenable conclusions because they neglected to consider the preconditions. Gottstein disagrees with my understanding of Heisenberg’s rationale, but we would have to work through the earlier years to determine exactly where we disagree.

My suggestion that Heisenberg might have consulted with Planck and Max von Laue also refers to the earlier years, specifically 1933 through 1936, when the three men frequently discussed how best to respond to the Nazi assault on physics and on academe in general.

I agree with many of Gottstein’s other comments, in particular, that Heisenberg’s invited travels “brought him and modern physics a level of esteem” in Germany, which is why he accepted the invitations.

Lipkin’s report of Bohr’s reaction to the visit and to Heisenberg’s subsequent remarks on the lack of progress in fission research may find support in Bohr’s unpublished letter to Heisenberg regarding Robert Jungk’s book.² However, as Gerald Holton reported, the Bohr family has sealed this letter until 2012.

References

1. D. C. Cassidy, *Uncertainty: the Life and Science of Werner Heisenberg*, Freeman, New York (1992).
2. R. Jungk, *Brighter than a Thousand Suns: A Personal History of the Atomic Scientists*, Harcourt, Brace & Co., New York (1958).

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Haigerloch Cave Survived the War

The figure caption “Dismantling the Last German Atomic Pile” (PHYSICS TODAY, July 2000, page 35), contains two incorrect statements.

The dismantling of the pile occurred not after the war, but in April 1945, a few weeks before the war ended in Europe.

The cave was not blown up by the American soldiers. The laboratory was dismantled and the utilities disconnected, but the cave as such was not destroyed. According to the recollections of older residents in Haigerloch, the destruction was avoided by a local priest, who persuaded the Americans to refrain from the destruction because an explosion would have also destroyed a medieval church and castle on the cliff above the cave. Incidentally, Heisenberg occasionally played Bach on the organ of that church.

Today, there is a small museum in the cave, with original and reconstructed artifacts. Visitors are most impressed by how unbelievably small and primitive the



historic laboratory was, compared to the gigantic and elaborate technology of the Manhattan Project. It looks more like a Tinkertoy™ arrangement than something on the forefront of technology at the time; however, if completed, the Haigerloch laboratory would have led to huge sources of energy and the power for enormous devastation!

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[Editor’s note: We contacted Michael Thorwart of the Atomkeller Museum at Haigerloch. He and Egidius Fechter, director of the museum, provided the following detailed information on the dismantling of the German nuclear lab and the fate of the cave that housed it.]

THORWART AND FECHTER COMMENT:
The French army arrived in Haigerloch on Sunday, 22 April 1945, but took no notice of the underground nuclear lab. The war in Germany officially ended on 8 May 1945.

American–British ALSOS forces arrived on Monday, 23 April 1945, with the lab as their target, and soon dismantled it. According to our archive, the photograph in PHYSICS TODAY showing the dismantling was taken by Samuel Goudsmith, the scientific head of ALSOS, on 24 April 1945. So, this was very near—but before—the official end of the war.

German scientists had removed the uranium cubes and the heavy water from the lab and hidden them before ALSOS arrived. They left only the inner and outer vessels and the graphite block that separated them.

Colonel Boris Pash of ALSOS initially planned to destroy the entire



FIGURE 1 (above). Reconstructed model reactor in the original hole, Atomkeller Museum, Haigerloch, Germany.
FIGURE 2 (left). Damaged outer reactor vessel, on display at the museum.

cave. However, local priest Monsignore Marquard Gulde convinced him that the beautiful baroque church on top of the cave would also be destroyed. After ALSOS forces had found and confiscated the heavy water, the uranium, and the inner vessel, Pash agreed to spare the church, possibly because he realized that the lab was too small for any future German nuclear experiments. He ordered a very limited explosion that destroyed the remaining outer vessel within the cave.

The Atomkeller Museum is underground and the original structure is completely preserved—even the hole for the reactor vessel, which now contains a model of the original reactor, as shown in figure 1. Aside from the damaged outer vessel, shown in