

A Closer Look at Heisenberg's Uncertainty:

Physics for Warfare or Warfare for Physics?

The German nuclear weapons program began in 1939, and was turned over to the Reich Research Council in 1942 after it was determined that nuclear fission would not contribute significantly to the war effort. Nuclear research in Germany continued until 1945, when the effort disbanded with the fall of Berlin. During this time, the German nuclear program made much research progress on fission and its application to reactors and explosives. However, no concrete plans to build a nuclear bomb were ever formed, largely due to the constrictions in resources with Germany's wartime economy in 1942. The role and responsibility of German physicists and their nuclear weapons research during World War II is a complicated topic to discuss. Their knowledge on and attitudes towards nuclear physics for the application of an explosive have been documented with conflicting views and reconstructed with bias in the post-war effort to place emphasis on certain interpretations. Even the most genuine observations on the physicists from their detention at Farm Hall and other seemingly private interactions they had are biased by the ever-looming suspicions that they were being bugged, either by the Allies or by the Nazi government. Because of the extensive breadth and complexity of the subject, this paper will only focus on Werner Heisenberg, who was the unofficial scientific leader in the nuclear program under the Third Reich. This paper will assert that Heisenberg walked a fine line, trying to put physics in a place of power

without putting himself in danger. Over the course of the war, Heisenberg tried to keep physics attractive to German officials and secure resources for their research efforts. However, after the war, Heisenberg became more concerned with his own safety and the well-being of the German physics community, maintaining that physics remained apolitical and presenting himself as a desirable scientist to work with.

In the first years of the research program, it seems especially clear that Heisenberg tried to use warfare for physics without giving physics to warfare by producing a bomb that would effectively turn over the power advantage from physicists to the government. Having won the Nobel Prize just as the National Socialist Party came into power in Germany in 1933, Heisenberg had some sense of security as a leading scientist as the period of *Deutsche Physik* began to take over.¹ By 1939, when asked to produce a secret, comprehensive theoretical report to Army Ordnance, Heisenberg “immediately immersed himself”.² Within three months, he submitted “The possibility of the technical acquisition of energy from uranium fission”, a detailed report confirming the possibility of a controlled fission reactor and a devastating bomb. According to David Cassidy, the report “immediately made him the leading German expert on nuclear fission, and it served as a basic guide for the German project throughout the war.”³ However, despite the title, the paper

¹ David Cassidy, “Werner Heisenberg (1901-1976),” *American Institute of Physics*, Last modified 2015, <https://www.aip.org/history/heisenberg/p01.htm>.

² David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 421.

³ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 421.

focused mainly on reactor applications. Nevertheless, if Heisenberg's initial attitude was one of eagerness, it quickly died down.

In February the next year, Heisenberg submitted the second part of his report. This document expressed less optimism on the potential success for a nuclear reactor, stressed the technical difficulties and industrial resources needed for further hope of acquiring energy from uranium fission, and made no mention of the explosive possibility.⁴ There are many nuances in Heisenberg's complete report. Firstly, his title implies the possibility for an explosive, but his paper spoke only of reactor applications. Secondly, whatever promises he raised for the successful application of fission, he quickly scaled back with the skepticism of the second addition to the report. What was he trying to achieve here? Historians continue to debate. Was he trying to gain the attention of the Nazi government to show them how physics could serve warfare while actually using warfare to serve physics? If so, he seems to have achieved just that. Perhaps with his skepticism in the second part of the report, Heisenberg was trying to steer himself away from the moral dilemma of building a destructive weapon. However, he also effectively shielded the research from the pressures the government would put on the team to build a bomb by claiming that it would be much too difficult to be done during the war. Yet he still asserted the attractiveness of the explosive possibility, claiming in the first part of his report that "the explosive power [...] exceeds that of the strongest explosives by

⁴ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 423.

several powers if ten.”⁵ Of course, the government could not refuse putting in some effort towards that possibility for the future, thus securing some resources and power to continue research.

With the German army’s successful exploits by April 1941, the Germans had all the uranium, heavy water, and cyclotrons they would need.⁶ Now the simple desire to do science for science’s sake was no longer simple. Physics became enmeshed in politics. The resources needed to further the nuclear program were obtained, but only through the invasion and exploitation of neighboring countries. To push science to the practical ends then became possible, but through these means, to continue the research objective then became a moral question.

Later that year, in September, Heisenberg met with Bohr through a propaganda conference hosted by the Germans in Copenhagen. As Heisenberg prepared for the trip, he carried a “vague hope”⁷ that has made their meeting a subject of discussion as to what Heisenberg’s motivations were. Going into the meeting with confidence in a German victory and with recent affirmation that the possibility of a nuclear explosive could be realized, he was weighed down with moral questions that some claim he wanted Bohr to help answer.⁸ Believing that Germany would not have the time nor energy and resources to exhaust in order to embark on the industrial endeavor needed to achieve the bomb, he still feared that

⁵ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 422.

⁶ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 429.

⁷ Thomas Powers, *Heisenberg’s War: The Secret History of the German Bomb* (Boston: Little, Brown, 1993), 118.

⁸ Thomas Powers, *Heisenberg’s War: The Secret History of the German Bomb* (Boston: Little, Brown, 1993), 117.

the Allies might make headway in the same attempt. He hoped that he could convey to Bohr that the Germans would not be able to build a bomb, and that Bohr could pass on the message to his American and British correspondents.⁹ Through this, some claim he tried to start an international boycott of sorts in which physicists would band together in mutual agreement to not build an invention that could destroy the world. Here, then, he also seems to have tried to promote the power of physics and physicists by urging Bohr to convey to the Allies that the Germans couldn't build a bomb, also hoping, as a German patriot, to protect his country from its destructive powers. Even though there is a lot of controversy over their meeting, as even Bohr expressed (in an unsent letter to Heisenberg) that he got a very "different impression of what happened during this visit than the one you expressed in Jungk's book,"¹⁰ it is at least clear from a drafted letter written by his wife that he "understood [there] was important information which he was obliged to try to bring to the attention of the English."¹¹ However, because Heisenberg felt he was in superior position with the confidence in a German victory, he spoke insensitively towards the Danes and angered Bohr. He left in despair, believing that Bohr was so shocked by his mention of what nuclear physics could create and that Bohr did not get his message to pass on the information. However, in his attempt to signal that Germany could not build the bomb, he also gave away the most critical of secret

⁹ Thomas Powers, *Heisenberg's War: The Secret History of the German Bomb* (Boston: Little, Brown, 1993), 122.

¹⁰ Neil Bohr, Incomplete draft of letter from Bohr to Heisenberg, dated March 26, 1962, Last updated February 2002, <http://nba.nbi.dk/papers/docs/d11ctra.htm>.

¹¹ Margrethe Bohr, Draft document, undated, Last updated February 2002, <http://nba.nbi.dk/papers/docs/d11ctra.htm>.

government information: the existence of the German nuclear weapons research program.¹²

But was Heisenberg really so concerned with the heavy questions of what his research could mean for the world? Perhaps not as much as many would like to think. “While working intensely on fission research in two cities, Heisenberg seemed satisfied with his personal life. ‘If one can keep life in one’s small circle in order,’ he told his mother, ‘one must be content.’”¹³ It seems he felt the same towards the nuclear program and Nazi regime. Though he was never a member of the Nazi party, he never actively resisted them either. For instance, when Germany invaded Poland in 1941, Heisenberg was ordered to bar Edwin Gora, a Polish student of German descent, from the institute in Warsaw. Heisenberg did so without resistance, but “quietly took Gora under his wing, gave him private lessons in his home, and eventually enabled him to pass his doctoral examination under Hund in 1942.”¹⁴ In another instance, when Heisenberg spoke with the scientific publisher Paul Rosbaud, he asserted that the Nazi party leaders have “the advantage of giving you money if the plan which you have to develop is large enough.” In the hypothetical situation that a scientist needed a new large observatory, one of the leading Nazis could see to it that he got it. When Rosbaud responded angrily that it would no doubt be run by a Nazi, Heisenberg responded blandly, “but what of it? –good people

¹² Thomas Powers, *Heisenberg's War: The Secret History of the German Bomb* (Boston: Little, Brown, 1993), 124-127.

¹³ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 430.

¹⁴ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 431.

could still work there.”¹⁵ Evidently, Heisenberg was less concerned by the politics of the situation and more with the science and aspect of daily life. Given his complacency in daily life then, in terms of answering the moral questions, he seems to do what he can to help out and not resist. Indeed, can we blame him? As two former members of British wartime nuclear research, Sir Rudolf Peierls and Sir Nevill Mott remarked, “it is reasonable to assume that [Heisenberg] wanted Germany to win the war. He disapproved of many facets of the Nazi regime, but he was a patriot... Most citizens of countries at war participate in the war effort when called upon, and the few who do not require exceptional courage and exceptional strength of conviction.”¹⁶ With regards to the nuclear weapons research program then, his attitude was similarly complacent and self-centered. He wanted to continue doing science, and so he did. Even though much of the resources were obtained through Germany’s exploitation of neighboring countries, the “circumstance seemed to both no one,”¹⁷ including Heisenberg. He and his family continued to live a more or less unperturbed life, and he seemed content to continue doing science. He apparently didn’t want to build a bomb, and luckily, he didn’t have to. Conscientiously, he was not in a position to promise the government, who needed quick results because of the constraints of the wartime economy, to go through with

¹⁵ Thomas Powers, *Heisenberg’s War: The Secret History of the German Bomb* (Boston: Little, Brown, 1993), 111.

¹⁶ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 424.

¹⁷ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 429.

a full out program to build a bomb. At the time, he wasn't even sure how much uranium and heavy water they would need, only that it was theoretically possible.¹⁸

In 1945, under British and American Operation Alsos and Operation Epsilon, Heisenberg and nine other nuclear scientists were picked up and incarcerated in Farm Hall in England. While detained there, the Americans dropped the atomic bomb on Japan. Upon hearing the news, Heisenberg was incredulous at first.¹⁹ When it became clear that the news was in fact true, he struggled with his pride as a physicist and morals as a human: did the German program under his scientific leadership not succeed because they didn't want to build a bomb or because they weren't keen enough to realize the means to do it? While Heisenberg did give a fairly accurate estimation of how the American bomb worked, he also missed some key points such as the possible use of plutonium and how much uranium was needed to make the bomb ignite the critical chain reaction.²⁰ In the end, the Germans claimed they didn't build a bomb because they were focusing on making a reactor. With the majoring of German physicists, Heisenberg claimed that physics remained apolitical under the Third Reich.²¹

When released, Heisenberg tried to keep a positive outlook on his scientific career. He wanted to portray himself as an attractive nuclear scientist to work with.

After all, as part of the German program, he made many strides in theoretical

¹⁸ David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (San Francisco: W. H. Freeman, 1992), 425.

¹⁹ Farm Hall Transcripts, edited by Charles Frank (Berkeley: University of California Press, 1993), 70-71.

²⁰ Farm Hall Transcripts, edited by Charles Frank (Berkeley: University of California Press, 1993), 70-91.

²¹ Mark Walker, *Nazi Science: Myth, Truth, and the German Atomic Bomb*, (New York: Plenum, 1995), 202.

nuclear research that he hoped the Allies would be interested in. "Perhaps German physics will be able to collaborate as part of a great Western group," Heisenberg remarked hopefully during his detention at Farm Hall.²² Indeed, after being released, "Heisenberg, who had never joined a National Socialist organization and in postwar Germany enjoyed the status of a 'victim of the Nazis,' had a great deal of influence as the author of 'whitewash certificates' written testimonials designed to help an individual pass unscathed through the process of denazification."²³ He even helped the National Socialist physicist Pascual Jordan receive an university appointment.²⁴ However, he also used his influence to condemn Johannes Stark, a Nobel Prize-winning physicist who rallied against Jewish physicists in Germany.²⁵

In the decades following the war, there was the popular belief that Heisenberg had tried to save the world from the atomic bomb by meeting with Bohr. However, as Cathryn Carson notes in her thesis, Heisenberg never publicly confirmed nor denied this. He merely continued to insist that the moral question of building a bomb was taken out of the physicists' hands by the circumstances of the war; Germany's wartime economy was not capable of investing in a full-out nuclear explosive program, which at that time, was estimated to need more resources and money than was actually needed (as the Allies realized in their effort to build the bomb). It seems Heisenberg was largely able to carry on with his life, walking the

²² Farm Hall Transcripts, edited by Charles Frank (Berkeley: University of California Press, 1993), 88.

²³ Mark Walker, *Nazi Science: Myth, Truth, and the German Atomic Bomb*, (New York: Plenum, 1995), 203.

²⁴ Mark Walker, *Nazi Science: Myth, Truth, and the German Atomic Bomb*, (New York: Plenum, 1995), 202-203.

²⁵ Mark Walker, *Nazi Science: Myth, Truth, and the German Atomic Bomb*, (New York: Plenum, 1995), 203.

same fine line. He never fully put himself under Nazi rule, yet still advanced physics and his own scientific career. He relieved his conscience by helping a person out here and there during and after the war, yet never ever put up the active resistance that his actions suggest he internally felt.

In some ways, Heisenberg was not so different from his colleagues. Kurt Diebner, one of the physicists detained at Farm Hall, claims to have joined the Nazi party only because he knew that if Germany had won, only party members would be given good jobs. He had previously seen how the Nazis could control the academic bureaucracy when in 1933 his affiliation as a Freemason in opposition to National Socialism delayed his promotion to civil servant.²⁶ Heisenberg was able to smartly steer his own path without enmeshing it too much in politics. Just as Lise Meitner accused of Hahn, Heisenberg also “worked for Nazi Germany [...] and never even tried to put up a passive resistance either. Certainly, to buy off [his] consciences [he] helped a person in distress here and there but have allowed millions of innocent people to be slaughtered without making the least protest.”²⁷ Like Gerlach, he also seemed to believe that peace could be achieved if Germany again dominated science, irrespective of the war.²⁸ After all, Heisenberg was still a German patriot who stayed in Germany to keep German physics alive, despite not agreeing with the Nazi regime and believing as Weizsacker said that “it might have been a much greater tragedy

²⁶ Mark Walker, *Nazi Science: Myth, Truth, and the German Atomic Bomb*, (New York: Plenum, 1995), 212-213.

²⁷ Selections from *Physics and National Socialism: An Anthology of Primary Sources*, edited by Klaus and Ann Hentschel (Boston: Birkhauser, 1996), 333.

²⁸ Mark Walker, *Nazi Science: Myth, Truth, and the German Atomic Bomb*, (New York: Plenum, 1995), 230.

for the world if Germany had had the uranium bomb.”²⁹ Of course, the big moral questions of the physicists’ role in the war through their nuclear research still remain, and this paper does not attempt to address it, but rather only acknowledge that the scientists did what many others would have, as Peierls and Mott noted, it would have taken a lot of courage to oppose the existing regime. And even so, as Mark Walker questions, “how could a researcher’s work during the Third Reich be criticized, when the Soviets or Americans wanted these same scientists and engineers to continue their work in the Soviet Union or the United States?”³⁰

Heisenberg remains a character to be studied. In this paper, the view that he seemed to try to promote the power of physics while still maintaining his safety, including his safety from troubling moral dilemmas, has been expressed. Like many others would have done, after the war, Heisenberg maintained that physics remained apolitical during the war and worked to preserve the well-being of his fellow physicists and his own scientific career. Indeed, he succeeded and moved on to conduct research in elementary particle physics and was active in West German science policy.³¹

²⁹ Farm Hall Transcripts, edited by Charles Frank (Berkeley: University of California Press, 1993), 78.

³⁰ Mark Walker, *Nazi Science: Myth, Truth, and the German Atomic Bomb*, (New York: Plenum, 1995), 206.

³¹ David Cassidy, “Werner Heisenberg (1901-1976),” *American Institute of Physics*, Last modified 2015, <https://www.aip.org/history/heisenberg/p01.htm>.

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