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**“An Explosive of Quite Unimaginable Force”:
Did Werner Heisenberg Obstruct German Atomic Bomb Research?**

In late February 1942, the German nuclear physicist Werner Heisenberg declared to a group of Nazi party officials that the splitting of uranium atoms could produce “an explosive of quite unimaginable force.” Heisenberg’s ten-minute lecture, entitled “The Theoretical Foundations for Energy Acquisition from Uranium Fission,” was one of seven non-technical lectures at a conference held to inform Nazi military research and industrial decision-makers on the application of atomic physics to weapons and energy production. This short program of lectures featuring many of Germany’s most prominent nuclear physicists was organized by Bernhard Rust of the Reich Research Council shortly after he assumed control of Germany’s nuclear research program early in 1942. After his memorable description of an atomic bomb, Heisenberg went on to note that obtaining sufficient fissionable material for such a bomb would be “very difficult.” This combination of an alluring description for his Nazi listeners and a qualifier to dampen their enthusiasm captures the ambiguity that is so often seen in Heisenberg’s actions regarding nuclear research during World War II. Heisenberg’s wartime conduct is therefore subject to multiple interpretations by historians attempting to discern his true stance on the provision of an atomic bomb to Nazi Germany.¹

Heisenberg and his fellow German nuclear physicists cannot ultimately be held responsible for the failure of Nazi Germany to produce an atomic bomb. There are larger political and military explanations for why Hitler never had an atomic bomb at his disposal. Germany’s early war strategy of “lightning” war depended on the rapid occupation of enemy territory. Until late 1941, the brisk pace of the war created a prevailing view in Germany that it

would soon end in a victory for Hitler. The anticipated lengthy research process required to develop an atomic bomb made it a low funding priority early in the war.ⁱⁱ

After more than two years of a successful lightning war, the German army faced its first major obstacles in the forms of the Russian army and winter in December 1941. This caused the Nazi government to begin an evaluative process of reassessing its military priorities and how the Germany economy could best be made to support them. As for military weapons development, priority went to arms that could be developed sooner rather than later. Typical of this approach was Hitler's 1942 decree that no weapons projects were to be funded that could not have arms ready for field use within six weeks of their start date. Physicists engaged in nuclear research did not ultimately receive the substantial funding that would have been necessary to make a serious attempt at building an atomic bomb before the war's end. A major subject of this paper will be the interpretation of Heisenberg's apparent attempts to gain Nazi support for nuclear research during this transitional stage in the war.ⁱⁱⁱ

Werner Heisenberg was arguably the most prominent physicist in German nuclear research during the war. His early wartime research at Leipzig focused on the theory of chain reactions in uranium. In April 1942, Heisenberg was appointed to the position of director at the Kaiser Wilhelm Institute for Physics, from which nuclear research throughout the nation was directed. His significance as a Nobel prize winner and an important member of the pre-war international physics community, his friendships with many physicists who eventually worked on the Allies' Manhattan Project, and his postwar explanations of his nuclear research in Nazi Germany have all made Heisenberg a popular subject for historians.^{iv}

Heisenberg was never a member of the Nazi party. Even his critics would concede that he never supported Nazi political and social ideals. For example, Mark Walker considers him an

apolitical scientist who did not sufficiently consider the ethical aspects of his research. The subject of the debate is whether Heisenberg conscientiously worked to produce an atomic bomb for the Nazis. Heisenberg variously claimed that he either never had a choice to make or not make the bomb, or that his and his colleagues' moral scruples in opposition to it resulted in the failure of the Nazis to produce a bomb.^v

As Heisenberg saw it, he had three possible responses to the outbreak of war in 1939. First, he could emigrate to the United States. In fact, Heisenberg seriously considered a teaching position at Columbia University in 1938. However, in the end, he was too devoted to the well-being of Germany, particularly modern German science.^{vi} Second, he could actively oppose the Nazi regime. Third, he could "pretend to collaborate." Heisenberg considered the latter two options in a letter to Robert Jungk.

Under a dictatorship active resistance can only be practiced by those who pretend to collaborate with the regime. Anyone speaking out openly against the system thereby indubitably deprives himself of any chance of active resistance. For if he only utters his criticism from time to time in a politically harmless way, his political influence can easily be blocked... If, on the other hand, he really tries to start a political movement, among his students for instance, he will naturally finish up a few days later in a concentration camp. Even if he is put to death his martyrdom will in practice never be known, since it will be forbidden to mention his name... I have always... been very much ashamed when I think of the people, some of them friends of my own, who sacrificed their lives on July 20 and thereby put up a really serious resistance to the regime. But even their example shows that effective resistance can only come from those who pretend to collaborate.^{vii}

According to Heisenberg's postwar recollections, he chose to pretend or fake his collaboration with the Nazis. If this is an accurate characterization of his decision, then his choice had major consequences for the historical interpretation of his actions, as will be shown below.

To pretend collaboration with the Nazis was a dangerous game to play. He had to act in such a way that not only Nazi officials would believe, but also any of his physicist colleagues who supported the Nazis, that he supported their causes. What deeply cherished personal values

would have caused Heisenberg to make this sacrifice? Preservation of the modern scientific enterprise in Germany was a preeminent value of Heisenberg's.

Heisenberg had good reasons for believing that war and Nazi ideology could threaten the progress of modern German science. In 1936 and 1937, Heisenberg was personally attacked by Philipp Lenard, a leader of a German nationalistic science movement known as *deutsche Physik*, as a "white Jew." His scientific accomplishments were an "aberration of the Jewish mind." Proponents of *deutsche Physik* responded to the numerous discoveries by Jewish physicists, Albert Einstein and his theory of relativity being the most notable, during the early 20th century. They argued that the discoveries of ethnic German physicists were superior or had greater truth-value than their Jewish counterparts. Their opponents, including Heisenberg, responded that scientific propositions could not be evaluated on the basis of the ethnicities of their progenitors. Despite Heisenberg's reputation as the leading theoretical physicist in 1930s Germany, *deutsche Physik* had sufficient political strength to block Heisenberg's succession to the teaching post of his mentor Arnold Sommerfeld at the University of Munich upon the retirement of the latter. Heisenberg naturally perceived *deutsche Physik* as a major threat to the practice of modern physics in Germany so long as the Nazis were in power.^{viii}

Heisenberg aimed to "put the war in the service of science" by pursuing nuclear research for Germany.^{ix} Nuclear research held out the hope for Nazis of an atomic bomb and massive energy production. But at that time nuclear research was also a scientific pursuit on the cutting edge of physics. One basic way to help German science during the war was to keep the scientists from being killed or injured during military service. Heisenberg sought exemptions from military service for several hundred young scientists that he needed for nuclear research after becoming director of the Kaiser Wilhelm Institute for Physics in 1942.^x

Heisenberg's stance versus the Nazis and his desire to preserve German science through wartime nuclear research unfortunately generated conflicting claims. Could he conduct nuclear research for the Nazis without building an atomic bomb for them to use? Heisenberg thought that the circumstances of bomb research were favorable to his reconciliation of the two conflicting ends. Heisenberg recalled after the war that he discussed this complex issue with his close friend Carl Friedrich von Weizsacker. Heisenberg told his friend, "If the technical exploitation of atomic energy is still a very, very long way off, then it can do no harm to work in what you call the 'uranium club.'" At the time, he argued that the technical barriers to the creation of an atomic bomb were so great that the weapon could not be built before the war's end. Participating in the Nazi-led nuclear research effort also meant that he could ensure that the bomb would stay under the control of physicists, the assumption being that physicists were on a higher ethical plane than the Nazis. "Again, if atomic technology is, so to speak, knocking at the gate, then it is far better to have some influence over developments than leave it all to others or to pure chance."^{xi}

In Heisenberg's autobiography *Physics and Beyond*, he recalled a conversation he had with von Weizsacker early in the war about how to do nuclear research without giving Hitler an atomic bomb. They discussed the strategic limitation of nuclear research to subject areas that could not produce a bomb. "I believe that we can work with a clear conscience—even in our relations with the officials—on chain reactions in this type of [natural] uranium pile and can leave the business of getting uranium 235 to others." It is ironic that Heisenberg's Leipzig research team eventually specialized not only in chain reaction theory but also isotope separation. It seems naïve in retrospect to believe first that such a strategic approach could be consistently adhered to by the entire group of German nuclear physicists—a necessity if a bomb

would be prevented—and, second, that such a scheme could be kept secret from Nazi authorities.^{xii}

The strategy for developing atomic bomb technology but keeping it out of Nazi hands entailed several levels of risk for Heisenberg. Nuclear research in the 1930s and 1940s was a field with intensely self-driven scientists who were always eager for the recognition that came with major discoveries. The satisfaction provided by such discoveries of having acquired new knowledge of reality should not be discounted. This ambitious nature could easily blunt the ethical sensibilities of many scientists. But it was not exclusive to German scientists. Richard Rhodes captures this milieu of scientific ambition well when relating Edward Teller and Hans Bethe's early conceptualization of the hydrogen bomb for the Allies. "It was new, important and spectacular and they were men with a compulsion to know." Was Heisenberg's assessment correct that his group of German physicists were of a sufficiently uniform approach to keep an atomic bomb out of Nazi hands? The German science publisher Paul Rosbaud answered in the negative. Observing a group of nuclear physicists who expressed relief in knowing in mid-1942 that the Nazis had finally abandoned the hope of building a bomb in time for the war, he countered, "Nonsense! If you knew how to build it, you'd present it to your Fuhrer on a silver platter."^{xiii}

Heisenberg was far from immune to the same weakness as his fellow physicists. Two people who knew him well, his wife Elisabeth and his friend von Weizsacker, applied the German word "*ehrgeiz*", usually translated as "greed for honor," to Heisenberg. Von Weizsacker described him as "competitive, fair, [with] uncontrollable ambition for achievement." When Heisenberg's wife used *ehrgeiz* to describe him, she hastened to qualify this by adding that his ambition for achievement was more prominent than his desire for recognition. Heisenberg's most

frequent justification for engaging in nuclear research during the war was that due to Germany's wartime economy and military strategy, an atomic bomb could never have been produced before the war's end. But given the universal ambition in the German physics community, this was certainly a risky supposition. While confined by the British at Farm Hall in 1945, Heisenberg, Otto Hahn, and other leading German nuclear physicists became aware for the first time of the Allies' atomic bomb after the Hiroshima bombing. Hahn responded to the news with a taunt: "If the Americans have a uranium bomb then you're all second-raters. Poor old Heisenberg."^{xiv}

Following the war, Heisenberg typically denied that he had any significant impact on whether a German atomic bomb was built or not. He was never compelled to make a decision on making a bomb or not simply because Germany was not prepared in terms of either its military strategy or industrial capacity for the sustained effort necessary to create a bomb. In a conversation with his wife in 1942, he reportedly observed, "We are lucky that things are as they are, and that these facts spare us from having to make a real decision. It is being made for us, and for this we are grateful." Heisenberg implied at other times that he more actively resisted the production of a bomb. Jungk describes Heisenberg as being much more actively involved in preventing the production of a bomb by, for example, attempting to create an international alliance of scientists against atomic bomb production and by pursuing the directorship of the Kaiser Wilhelm Institute for Physics. Heisenberg read proofs of *Brighter Than A Thousand Suns* and corresponded with Jungk afterward, but never attempted to correct Jungk's portrayal of an active conspiracy against the bomb as untrue.^{xv}

Historians have not always been charitable in their judgment of Heisenberg's participation in Germany's nuclear research program. Arnold Kramish argues that Heisenberg was acting in the role of a Nazi spy gathering intelligence on Allies' nuclear research during his

September 1941 visit with Niels Bohr in Copenhagen, despite relying only on circumstantial evidence that von Weizsacker was interested in the progress of Allied research around that time. Any voluntary interaction by Heisenberg with the Nazis is often interpreted by historians to be collaborative and is held against him.^{xvi}

One can gather from Heisenberg's own post-war writings outlined above the standard of Nazi resistance that he wished to be measured against. He "pretend[ed] to collaborate" with the Nazis in order to achieve two higher goods: a) The preservation of modern German science during the war. b) The prevention of an atomic bomb from being built in Nazi Germany.

Heisenberg sought two higher goods through his participation in Germany's wartime nuclear research.	
a)	The preservation of modern German science during the war.
b)	The prevention of an atomic bomb from being built in Nazi Germany.

If this is thought to be a reasonable and ethical response to Nazi rule, then there are two interpretive assumptions for the historian to adhere to: 1) One can expect to find evidence of a mix of pro-Nazi and anti-Nazi actions in Heisenberg's record. Heisenberg believed that he needed to take what he considered inconsequential actions in support of the Nazis in order to establish his loyalty and generate credibility for actions that the Nazis thought to be questionable. 2) One should not expect to find gratuitous pro-Nazi actions in Heisenberg's record. There should not be actions that seem to have no strategic value for the ultimate achievement of the higher goods in view. It should, however, be recognized that gratuitous pro-Nazi actions are sometimes difficult to definitively identify.

Not only did the two higher goods conflict with Nazi ideals, they also at times conflicted with each other. Higher good a) conflicted less with Nazi ideals as the war progressed and Nazi officials began to see the military benefits of allowing modern scientists to develop new weapons. But higher good b) progressively conflicted with higher good a) in proportion to the degree that the Nazis increasingly accepted a). In other words, Nazis began to accept the legitimacy of modern science as they recognized its possible products, such as the atomic bomb. But as Nazis perceived the growing reality of an atomic bomb's creation, opponents of an atomic bomb for Hitler were forced to curtail their advocacy of modern science—at least within earshot of the Nazis.^{xvii}

Interpretive Assumptions: If Heisenberg “pretend[ed] to collaborate” with the Nazis, then the historian should expect to find the following features in his wartime research record:	
1)	A mix of pro-Nazi and anti-Nazi actions.
2)	A lack of gratuitous pro-Nazi actions with no strategic value.

Another interpretive point of Heisenberg's wartime actions concerns the evidence used to evaluate them. Sources contemporary to the events in question are clearly beneficial in being “closer” to the event itself. However, because of the totalitarian nature of Nazi Germany, evidence of anti-Nazi action by Germans is often difficult to come by. The truth behind a given document or memory of a conversation may be hidden behind a façade meant to hide it from Nazi authorities. Heisenberg noted that “communication became increasingly difficult—only the most intimate of friends dared to speak their minds to one another, otherwise, you resorted to the kind of language that hid far more than it revealed.” Fortunately, evidence in the form of post-war testimony or memory of wartime events was provided free of the fear of Nazi

recriminations. However, one façade is traded for another as witnesses or actors to wartime events are now free to alter the narrative for selfish purposes if they wish. There are at least three reasons why Heisenberg in particular would be tempted to selfishly adjust a narrative of wartime events he was featured in. First, he may have been ashamed of his actions in the Nazi's nuclear research program; perhaps his ethical judgments of Hitler and the Nazis shifted following the war and his postwar beliefs condemned his war actions. Second, his wish to continue professionally in nuclear research on energy production following the war may have compelled him to minimize his role in wartime atomic bomb research; the Allies occupying West Germany certainly did not wish to risk the chance of ex-Nazi physicists developing an atomic bomb. Third, Heisenberg may have been too professionally proud to admit that he had failed or even appeared to fail at building a bomb.^{xviii}

The remainder of this paper will be an application of this charitable standard of conduct to a selected set of Heisenberg's major decisions and public acts that occurred during a pivotal period for both the German nuclear research program and the larger Nazi war effort, late September 1941 to June 1942. The following events in Heisenberg's wartime experience will be examined:

- 1) A September 1941 conversation with Niels Bohr in Copenhagen, Denmark.
- 2) A February 1942 lecture for Nazi officials on the applications of fission chain reactions to military purposes.
- 3) A June 1942 lecture for Nazi officials on how an atomic bomb could be built.
- 4) Heisenberg's July 1942 appointment to the directorship at the Kaiser Wilhelm Institute for Physics in Berlin.

I will argue that although Heisenberg's record regarding these events is mixed and not susceptible to a definitive conclusion, there are significant indications that he was able to sustain modern German physics during the war and that he sought to prevent Hitler from acquiring an atomic bomb.

In September 1941, the astounding success of Hitler's lightning war tactics was on full display as Germany occupied increasingly more of Europe. This was a time when Germans' self-confidence in their war effort ran high and Germany seemed unstoppable. By December 1941, circumstances for the German army had drastically changed as it met the obstacles of the Russian army and a severe winter. From this time, Nazi officials began a period of self-examination in which they assessed how the resources of the nation were being used to support the war effort. The wealth of the nation was brought to bear more closely on the German war effort. Walker writes that, "although German authorities and most Germans still expected to win, any hope of a quick victory was gone, and it now appeared that the war might drag on for a few years." Heisenberg probably embarked from his train in Copenhagen in September 1941 with the expectation of an impending Germany victory.^{xix}

Heisenberg's Visit With Niels Bohr in Copenhagen, Denmark

In September 1941, Heisenberg and von Weizsacker traveled to Copenhagen to lecture at an astrophysics conference hosted by the German Cultural Institute. They had arranged the trip through the influence of von Weizsacker's father, a Reich Foreign Office official, for the purpose of speaking with the Danish physicist Niels Bohr. German physicist Fritz Houtermans had recently discovered that using a nuclear reactor, U-238 could be made to absorb a neutron and eventually decay into plutonium, another fissionable material that could be used for an atomic bomb. This was thought by Heisenberg to be an easier and faster route to acquiring fissionable

bomb material than the separation of uranium isotopes. Houtermans' discovery caused Heisenberg to later reflect that, "It was from September 1941 that we saw an open road ahead of us, leading to the atomic bomb." Now that development of a German atomic bomb had taken a major step toward becoming a reality, Heisenberg and von Weizsacker, speaking after the war, related how they began discussing the ethical implications of their research at this time. They wanted to discuss these issues with Bohr, their former teacher and close friend during prewar years.^{xx}

Despite their longstanding friendship, Bohr was suspicious of his former students' visit for several reasons. Bohr had not seen either of them since before the German occupation of Denmark in April 1940, raising his suspicions that the two German physicists had secrets they were hiding, possibly about German nuclear research. Heisenberg and von Weizsacker demonstrated a lack of empathy for Bohr's circumstances as a half-Jewish physicist in a German occupied country. They callously expressed their disappointment that Bohr boycotted the conference at the German Cultural Institute, a disseminator of German propaganda to the occupied nation. In a lunch conversation at Bohr's Institute of Theoretical Physics, Heisenberg defended the German invasion of Poland and called war a "biological necessity."^{xxi}

Heisenberg's visit to Copenhagen is well-known and often examined by historians looking for insight into his perspective on the German atomic bomb program. Bohr's and Heisenberg's communication with one another was impaired by their cautious awareness of Nazi surveillance. Heisenberg later reflected, "Being aware that Bohr was under the surveillance of the German political authorities... and that his assertions about me would probably be reported to Germany, I tried to conduct this talk in such a way as to preclude putting my life into

immediate danger.” Heisenberg claimed afterward that this cautiousness caused them to misunderstand each other.^{xxii}

Another factor in their poor communication was the effect of a year’s scientific isolation and secrecy during a period of such prolific discoveries in nuclear physics. Bohr did not yet believe that an atomic bomb could be successfully made. Bohr probably misunderstood Heisenberg’s drawing of a reactor due to an independent path of nuclear inquiry that German physicists traveled while isolated from international developments. The physicist Hans Bethe believed that Bohr and Heisenberg “talked straight past each other” due to their differing awareness of recent discoveries.^{xxiii}

The content of their conversation has been the subject of intense debate by historians. Heisenberg without question shocked Bohr with the news that Germany had a research program to develop an atomic bomb. Heisenberg expressed his ethical concerns about the research, wondering if “one has the moral right to work on the practical exploitation of atomic energy.” Bohr missed Heisenberg’s meaning and responded with resignation that physicists could be expected to work for their own governments during wartime. According to Heisenberg, Bohr was so surprised at the prospect of Hitler acquiring an atomic bomb that he was unable to attend to other concerns Heisenberg wished to communicate to him.^{xxiv}

After telling Bohr of his research in Germany, Heisenberg shared with Bohr his assessment that Germany could never surmount the substantial technical and industrial obstacles to building an atomic bomb during the war. Heisenberg further intimated that it might be “possible for all physicists to agree among themselves that one should not even attempt work on atomic bombs.” This was an ironic proposition given Heisenberg’s efforts to advance German science despite the war. An international boycott on bomb research would place limits on

Heisenberg's personal and nationalistic ambition. If Heisenberg's recollection of this proposition was accurate, then it would have entailed a significant personal sacrifice. Mark Walker and David C. Cassidy express skepticism that Heisenberg ever proposed a boycott on bomb research in this conversation. Walker argues that Heisenberg's post-war recollection was a product of "the shock of Hiroshima and the threat of the looming Cold War." He writes that it is difficult to believe that Heisenberg would have sought such a boycott at a time when the German army had had such unmitigated success and was expected to win the war. Moreover, why would Heisenberg seek a boycott when he did not judge either side to be capable of summoning the resources and technical effort to create a bomb before the war's end anyway? Cassidy adds that there is no evidence up to the date of the conversation that Heisenberg was ever concerned about the ethical implications of his research. Finally, in an unsent letter addressed to Heisenberg after the war, Bohr's memories of the conversation are clear: Heisenberg told him that the war would be decided with atomic weapons, and Bohr did "not sense even the slightest hint that you and your friends were making efforts in another direction."^{xxv}

While Bohr's memory was clear, the correct historical interpretation of this conversation is less than clear. There is no evidence to suggest Heisenberg's ethical introspection prior to his conversation with Bohr. But is it reasonable for one to expect evidence of this type? To have written down or orally communicated such concerns could have made Heisenberg vulnerable to Nazi authorities. Furthermore, Heisenberg took a great risk in visiting Bohr and telling him about Germany's secret bomb research. His meeting with the citizen of an occupied country to reveal the existence of a secret Nazi program meant that Heisenberg's life was endangered—not only by Nazi surveillance, but also American and British intelligence officers. If Heisenberg's recollections are believed, then his conversation with Bohr supported higher good b) outlined

above. Additionally, the historian's prior anticipation of a mix of pro-Nazi and anti-Nazi (interpretive assumption 1) above) is also realized. Heisenberg traveled to Copenhagen on the Nazi business of lecturing at the German Cultural Institute, but was actually attempting to build an international boycott on bomb research. The mixed evidence for this event prevents the historian from arriving at a strong conclusion about Heisenberg's conscientious work to achieve higher good b). One must look elsewhere for more conclusive evidence.^{xxvi}

"The Theoretical Foundations for Energy Acquisition from Uranium Fission"

Heisenberg delivered a lecture to Nazi officials on the generation of energy from uranium fission on February 26, 1942. (This paper began with a brief description of his lecture.) The lecture was given at a time when the nuclear research program had recently lost its funding by the Army Ordnance Office. The German Physical Society, with which Heisenberg was associated, had therefore begun a campaign to lobby the government for increased funding for physics research. Cassidy argues that its goal was to "make warfare serve physics by demonstrating how physics could serve warfare." Much of the ten-minute lecture was oriented toward a basic, non-technical description of uranium fission and how it could be used in power production as opposed to building a bomb. However, Heisenberg made two remarkable points that surely caught the officials' attention. First, he tantalizingly described a bomb based on uranium fission as having "quite unimaginable force." Second, after noting the difficulty of separating a sufficient amount of U-235 isotope from natural uranium for the attainment of a bomb's critical mass, he proceeded to describe the much easier process of acquiring the fissionable bomb-material of plutonium from decaying U-238. Heisenberg finished the lecture by effectively issuing a challenge to his listeners: "The Americans seem to be pursuing this line of research with particular urgency." All of these features of the lecture appear to have been

calculated to generate support for nuclear research, including that for an atomic bomb. In fact, Heisenberg achieved his apparent objective. Wolfgang Finkelburg, vice-president of the German Physical Society, thanked Heisenberg two months later for his role in the February conference, which he credited for an uptick in inquiries from Nazi officials on the military applications of physics.^{xxvii}

Not all historians agree with this assessment of his lecture. Thomas Powers argues that Heisenberg's lecture was confusing, vague, and deliberately intended to confuse his science-illiterate listeners. For example, Powers contends that he intentionally obscured the distinction between fast and slow fission. David Irving on the other hand calls the lecture "a masterpiece of clear exposition, and even now it is hard to fault." Indeed it is hard to attribute obscurity to a lecture in which Heisenberg explained the concept of fission chain reaction using a simple analogy to the increases and decreases in a human population, accompanied by a diagram.^{xxviii}

A successful defense of Heisenberg's continued focus on higher good b) depends on two anticipatory points he must have kept in mind. First, this lecture must be interpreted as Heisenberg demonstrating to Nazi officials that he was loyal to the government and working hard to create an atomic bomb. Second, due to the limited wartime resources of Germany and the major industrial and technical requirements for an atomic bomb, "we were happily able to give the authorities an absolutely honest account of the latest development, and yet feel certain that no serious attempt to construct atom bombs would be made in Germany." Assuming the truth of these two points, then Heisenberg played a dangerously high-stakes game. The game was not made any safer by his use of the memorable and astonishing description of the bomb as a "quite unimaginable force" or by virtually daring the Nazis to beat Allied forces to the creation of an atomic bomb. Cassidy contends that Heisenberg was "willing to flirt with the catastrophic

consequences of atomic research for the sake of what he believed would be beneficial to himself and to German science.” While his persuasive tactics were effective in promoting higher good a), they did so at the expense of higher good b) and violated interpretive assumption 2).^{xxix}

A Pineapple-Sized Bomb

On June 4, 1942, Heisenberg delivered another lecture to Nazi officials and industrial leaders on the topic of how an atomic bomb could be built. It was well-attended by top decision-makers, including Albert Speer, who Hitler had charged with mobilizing the German economy for the support of the military effort. The timing of the lecture was essential for the future funding of German nuclear research. The Reich Research Council, which administered the nuclear research project, was about to be subjected to the funding priorities of Hermann Goring’s Four-Year Plan. Speer’s assessment of Heisenberg’s lecture and those of other physicists speaking at the Kaiser Wilhelm Society-hosted conference determined the funding priority level that would be assigned to the project. Heisenberg’s topic came as a surprise to many attendees, most of whom did not know that a bomb of such immense explosiveness was possible. Heisenberg claimed afterward that he intentionally did not mention plutonium as one type of bomb material “because we wanted to keep this thing as small as possible.” However, historian Paul Lawrence Rose counters that Heisenberg did in fact propose the use of plutonium during the lecture and afterwards as well. During the discussion period, Heisenberg used yet another memorable and stirring phrase to describe the bomb to his audience. He was asked, “How big must a bomb be in order to reduce a large city like London to ruins?” Powers explains that Heisenberg “cupped his hands in midair around an imaginary bomb core, and said, ‘About as big as a pineapple.’” Irving notes that this description caused “uneasy excitement” among the attendees. Rose argues that Heisenberg’s pineapple-sized bomb must have been a plutonium

bomb due to his documented misunderstanding of uranium's critical mass at that time, which he thought to be several tons in weight.^{xxx}

Speer and Heisenberg had a significant conversation after the conference about the funding of nuclear research. During the lecture, Heisenberg had complained about the drafting of young physicists into the military and the difficulty of obtaining raw materials for research during the war. Speer asked him afterward what else he needed to build an atomic bomb for Germany. Heisenberg's list included greater access to raw materials for research, a cyclotron, an underground bunker laboratory, and more young scientists exempted from military service. He also asked for a budget increase from 75,000 to 350,000 marks, a sum that Speer still considered "ridiculously tiny." Overall, Speer reflected after the war that Heisenberg's answer to his funding inquiries was "by no means encouraging" as, despite granting all requests, he was still told not to "count on anything for three or four years." He consequently assumed that atomic bomb "development was very much at its beginning."^{xxxi}

It is unclear why Heisenberg requested so little funding for the German nuclear research project at a time when Speer was prepared to grant him much more. He explained after the war that he would not have had the "moral courage" to request the industrial employment of 120,000 people on the project at such a critical moment in the war. Rose suggests that Heisenberg believed that the project had not reached the point scientifically at which he would know how to employ an industrial force on the scale being used by the Allies' Manhattan Project. In case of failure to produce a bomb before the end of the war, he did not want to be held by the Nazis to that standard. His funding requests were simply based on his more immediate objective of building a "critical reactor." Perhaps the best explanation for Heisenberg's decision was given by his wife, Elisabeth: "He did nothing to try and convince the responsible people in the

government to seriously attempt to build the bomb. No doubt, if he had wanted to achieve this he could have.”^{xxxii}

The record of Heisenberg’s June 1942 lecture is mixed. His unfortunate description of a pineapple-sized bomb capable of destroying the city of London clearly violates interpretive assumption 2). Even if true, it was a sensational image that Heisenberg could have excised from his exposition, yet still made his point. However, this drawback is outweighed by Heisenberg’s decision to ask for very little funding from Speer and by leading him to believe that an atomic bomb could not be made before the war’s end. This was a decision that adversely affected higher good a), while possibly constituting as big a factor as any in the achievement of higher good b).

Appointment to Director at the Kaiser Wilhelm Institute for Physics

Heisenberg assumed the position of director at the Kaiser Wilhelm Institute for Physics on July 1, 1942. This Institute was the focal point of nuclear research in Germany from 1942 onward. The Institute’s director was the highest position a physicist could hold in Germany but was also highly politicized. He could not have been appointed without an excellent reputation in support of the Nazi regime. Heinrich Himmler played a critical role in the appointment as he fulfilled a promise he had made to Heisenberg following the Munich professorship debacle. Heisenberg was criticized after the war for, according to his wife, “having assumed such an important position in the Nazi regime at such a late date.” Critics understood his acceptance as an endorsement of Nazi policy and argued that if Heisenberg had taken a moral stance against Hitler, then other German physicists might have been inspired to resist as well.^{xxxiii}

Heisenberg had at least two good reasons for accepting the position. First, as the Institute’s director, he would have control and leadership of the entire German nuclear research program. Aside from the prestige, Jungk notes that Heisenberg “feared at that time that other less

scrupulous physicists might in different circumstances make the attempt to construct atom bombs for Hitler.” This reason, if it is an accurate portrayal of Heisenberg’s motivations, satisfies interpretive assumption 1). Accepting the directorship was an excellent example of how Heisenberg could take an outwardly pro-Nazi action for the anti-Nazi reason of gaining higher good b). Second, Heisenberg’s acceptance of the director position constituted a definitive victory over the *deutsche Physik* movement. In this way, he could ensure the ongoing preservation of modern German physicists and the institutions they worked in during the war. This was an unusual instance in which he could take a major step toward the achievement *both* of his higher goods without violating any of the interpretive assumptions for wartime propriety.^{xxxiv}

Conclusion

Despite his leadership of Germany’s nuclear research program during World War II, Heisenberg’s actions either for or against the building of an atomic bomb are not a definitive factor in explaining why Hitler never acquired an atomic bomb. The isolation of Germany’s physicists and the paucity of resources available to them compared to the large host of physicists and industrial strength brought to bear on the problem by the Allies help to explain why Germany never had an atomic bomb. Even with the focus and resources of the Allies, they still did not have a bomb ready for use until the closing phase of the Pacific war.

Yet Heisenberg is a fascinating figure for historians to study because he was a Nobel prize-winning nuclear physicist who was fully a member of the prewar international scientific community, but decided to stay in Germany during the war despite being opposed to Hitler and the Nazis. He arguably stayed in Germany and pretended to collaborate with the Nazis in order to realize two higher goods: preservation of modern German scientists and scientific institutions, and the prevention of an atomic bomb from being built. Heisenberg ran the risk during his lectures of promoting atomic bomb possibilities *too* much—he risked actually getting what he

asked for. He heightened the risk with his vivid descriptions of the bomb. But the lectures were also highly effective in protecting German physicists and their research—i.e., higher good a).

The evidence in his record is not unambiguous concerning Heisenberg's efforts toward higher good b). The two lectures analyzed in this paper were counterproductive to his apparent effort to prevent a German bomb. But he took two major steps to demonstrate his commitment to preventing a bomb's construction in Germany: his decision to request little funding for nuclear research at a time when larger amounts were surely available to him, and his acceptance of the directorship at the Kaiser Wilhelm Institute for Physics. The four events examined in this paper are, of course, not the whole story of Heisenberg's wartime experience regarding nuclear research; there is an immense amount of additional evidence that has been exhaustively evaluated particularly well by historians such as David C. Cassidy and Thomas Powers. But his funding request and Institute directorship were major actions of Heisenberg's at a critical moment in the war for both Germany as a whole and for its nuclear research program. Overall, Heisenberg was able to effectively achieve both of his higher goods through his approach of "pretend[ing] to collaborate" with the Nazis.

ⁱ David Irving, *The German Atomic Bomb: The History of Nuclear Research in Nazi Germany* (New York: Simon & Schuster, 1967), pp. 106-108. Irving has received publicity for his belief that the Holocaust, or attempted genocide of the Jewish people, by the Nazis never happened. This fact clearly counts against him in an assessment of his historical judgement in general. However, in the case of this book, I have not found any grounds for questioning the facts he reports. Moreover, his book is unique for the personal access he had to Heisenberg during his research. David C. Cassidy, *Beyond Uncertainty: Heisenberg, Quantum Physics, and the Bomb* (New York: Bellevue Literary Press, 2009), p. 322; Paul Lawrence Rose, *Heisenberg and the Nazi Atomic Bomb Project: A Study in German Culture* (Berkeley: University of California Press, 1998), p. 175.

ⁱⁱ Irving, *German*, pp. 76-78.

ⁱⁱⁱ Robert Jungk, *Brighter Than A Thousand Suns: A Personal History of the Atomic Scientists*, Translated by James Cleugh (New York: Harcourt Brace Jovanovich, 1958), p. 165; Werner Heisenberg, Review of *Virus-Haus*, by David Irving, Translated by Margaret Seckel, *Bulletin of the Atomic Scientists*. 24, no. 6 (June 1968): 34-35. There are varying accounts of how long an armaments project had to produce a usable weapon beginning in 1942. The six-week requirement stated above is cited by Jungk. Heisenberg writes of a 1942 order that a weapons project could take no longer than six *months*.

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- ^{iv} Mark Walker, *German National Socialism and the Quest for Nuclear Power* (Cambridge: Cambridge University Press, 1989), pp. 19-21, 51-53, 73-80.
- ^v Mark Walker, *Nazi Science: Myth, Truth, and the German Atomic Bomb* (New York: Plenum, 1995), pp. 243-247, 266; Werner Heisenberg, *Physics and Beyond: Encounters and Conversations*, Translated by Arnold J. Pomerans (New York: Harper & Row, 1971), p. 180.
- ^{vi} Cassidy, *Beyond*, p. 275.
- ^{vii} Heisenberg, *Physics*, p. 91.
- ^{viii} Thomas Powers, *Heisenberg's War: The Secret History of the German Bomb* (Boston: Little, Brown and Co., 1993), p. 41; David C. Cassidy, "New Light on Copenhagen and the German Nuclear Project", *Physics in Perspective*. 4 (2002): 447-455; Jungk, *Brighter*, p. 74.
- ^{ix} Quoted in Powers, *Heisenberg's War*, p. 100.
- ^x *Ibid*, p. 151.
- ^{xi} Heisenberg, *Physics*, p. 173; Powers, *Heisenberg's War*, p. 117.
- ^{xii} Heisenberg, *Physics*, p. 174. In Heisenberg's recollection and paraphrase of this conversation, it is not always clear which man is speaking at any given time. But Heisenberg indicates that von Weizsacker were of the same opinion at this time on the conduct of nuclear research during the war. Mark Walker outlines the research specialties of each nuclear research laboratory in Germany in Walker, *German*, p. 52-53.
- ^{xiii} Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon & Schuster, 2012), p. 417; Rose, *Heisenberg*, p. 183.
- ^{xiv} Elisabeth Heisenberg, *Inner Exile: Recollections of a Life with Werner Heisenberg*, Translated by S. Cappellair and C. Morris (Boston: Birkhauser, 1984), pp. 83-86; Arnold Kramish, *The Griffin* (Boston: Houghton Mifflin, 1986), p. 117; Hahn is quoted in Leslie M. Groves, *Now It Can Be Told: The Story of the Manhattan Project*. (New York: Da Capo, 1983), p. 333.
- ^{xv} Heisenberg, *Inner*, p. 76; Powers, *Heisenberg's War*, pp. 132-133; Heisenberg, Review of *Virus-Haus*, 35; Heisenberg, *Physics*, p. 180; Jungk, *Brighter*, p. 91; Walker, *Nazi*, p. 255.
- ^{xvi} Kramish, *The Griffin*, pp. 118-121.
- ^{xvii} Heisenberg, *Inner*, p. 72.
- ^{xviii} Heisenberg, *Physics*, p. 165.
- ^{xix} Walker, *German*, p. 47; Walker, *Nazi*, p. 248.
- ^{xx} Quoted in Cassidy, *Beyond*, pp. 310-312; Powers, *Heisenberg's War*, p. 112; Rhodes, *Making*, p. 383.
- ^{xxi} Aage Bohr, "The War Years and the Prospects Raised by the Atomic Weapons", In *Niels Bohr: His Life and Work as Seen by his Friends and Colleagues*, edited by S. Rozental, 191-214 (Amsterdam: North Holland Publishing Company, 1967), p. 193; Walker, *German*, p. 224; Powers, *Heisenberg's War*, pp. 122-123.
- ^{xxii} Rhodes, *Making*, 384.
- ^{xxiii} Powers, *Heisenberg's War*, pp. 98, 124; Heisenberg, *Physics*, p. 180; Bethe quoted in James Glanz, "New twist on physicist's role in Nazi bomb." *New York Times* 7 Feb. 2002: A1. *The New York Times*. Web. 14 Sept. 2013.
- ^{xxiv} Heisenberg quoted in Cassidy, *Beyond*, p. 313; Powers, *Heisenberg's War*, pp. 124-125; Heisenberg, *Physics*, p. 182. Bohr's response displays his reasonable assumption that because Heisenberg decided not to leave Germany before the war, then he wanted to support the Nazi governments with his nuclear research.

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- ^{xxv} Heisenberg, *Physics*, p. 182; Powers, *Heisenberg's War*, p. 124; Walker, *Nazi*, p. 238; Cassidy, *Beyond*, p. 314; Niels Bohr, "Release of Documents Relating to 1941 Bohr-Heisenberg Meeting." Niels Bohr Archive. <http://www.nba.nbi.dk/release.html> (accessed September 23, 2013): Document 7 Translation.
- ^{xxvi} Heisenberg, *Inner*, p. 80; Powers, *Heisenberg's War*, p. 127; Walker, *German*, p. 226.
- ^{xxvii} Irving, *German*, pp. 106-108; Cassidy, *Beyond*, p. 323; Heisenberg quoted in Rhodes, *Making*, p. 403.
- ^{xxviii} Powers, *Heisenberg's War*, p. 139; Irving, *German*, p. 108. One of the best descriptions of Heisenberg's analogy comparing fission to a human population, accompanied by the diagram, appears in Walker, *German*, p. 57.
- ^{xxix} Heisenberg, *Physics*, p. 180; Cassidy, *Beyond*, p. 323.
- ^{xxx} Cassidy, *Beyond*, p. 331; Irving, *German*, p. 120; Heisenberg quoted in Powers, *Heisenberg's War*, pp. 147-148; Irving, *German*, p. 120; Rose, *Heisenberg*, pp. 176-179.
- ^{xxxi} Powers, *Heisenberg's War*, pp. 148-151; Rose, *Heisenberg*, p. 182; Cassidy, *Beyond*, p. 331.
- ^{xxxii} Irving, *German*, pp. 121-122; Rose, *Heisenberg*, p. 182; Heisenberg, *Physics*, p. 151; Heisenberg, *Inner*, p. 74.
- ^{xxxiii} Cassidy, *Beyond*, p. 333; Heisenberg, *Inner*, p. 83; Jungk, *Brighter*, pp. 90-91.
- ^{xxxiv} Jungk, *Brighter*, p. 91; Cassidy, *Beyond*, p. 329; Walker, *German*, p. 79.

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