HEISENBERG, GOUDSMIT AND THE GERMAN ATOMIC BOMB

Contrary to accounts based on Heisenberg's claims, the German fission research effort in World War II was indeed a nuclear weapons program, and contrary to Goudsmit's interpretations, the German team knew what it was doing.

Mark Walker

The question of whether German scientists would have been willing to make atomic bombs for Adolf Hitler has excited persistent interest. Just why this is so is a topic I have explored elsewhere.[1] Here, I contend that the roots of the controversy about the role of the German scientists are to be found mainly in the period immediately after the war, not in the war itself.

When I set out several years ago to write a doctoral dissertation on Germany's wartime nuclear program, I found that the secondary literature was confusing, contradictory and largely undocumented. Almost all the literature turned out to derive either from a polemic interpretation of the German war work set forth by Samuel Goudsmit or from an apologetic interpretation proffered by Werner Heisenberg. In particular, the well-known book by Robert Jungk, *Brighter than a Thousand Suns* (Harcourt, Brace, New York, 1958), did much to amplify Heisenberg's claim that the German scientists had conspired to deny Hitler a bomb. While this conspiracy theory was rebutted in David Irving's *German Atomic Bomb* (Simon and Schuster, New York, 1968), Irving perpetuated Heisenberg's false claim that an erroneous calculation by Walter Bothe had seriously retarded the German effort. Irving's book has influenced books on related but broader topics, and even when such books have met high scholarly standards, they have tended to follow in the footsteps of the previous secondary literature.[2]

This article focuses on the illuminating and troubling dialogue that took place after the war between two colleagues and former friends, Goudsmit and Heisenberg—the debate that did so much to shape subsequent literature.

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Goudsmit, who had discovered electron spin with George Uhlenbeck (see PHYSICS TODAY, December, page 34) and who for many years was editor in chief of The American Physical Society, was one of the most influential physicists in America after World War II. But he is perhaps best known outside of the physics community for his work in scientific intelligence. During the last few years of the war, Goudsmit served in Europe as a reserve officer and the ranking scientific member of the Alsos Mission, an extraordinary intelligence-gathering unit of the American nuclear weapons project. Goudsmit and his colleagues hunted down the German scientists who had been involved in applied nuclear fission and isotope separation research, in the process seizing scientific reports and materials, destroying experimental apparatus and arresting physicists and chemists. Goudsmit's heroic account of his adventures was presented in his book *Alsos* in 1947 (Tomash, Los Angeles; second edition, American Institute of Physics, 1988).

In many respects, by the time Goudsmit received his discharge from the army, he was an embittered man. His mother and father had died at Auschwitz. The loss of his parents and the horrific legacy of National Socialist Germany were blows that he would feel keenly the rest of his life. Understandably, Goudsmit no longer was completely objective when it came to Germany, German science or German scientists. Immediately after the war, he advocated a sink-or-swim policy for German science. But he eventually came to soften and qualify his stance toward German science, and he did so partly as a result of his emotional public and private debate with Heisenberg.

Heisenberg, already a world-famous physicist when the war began, was an ambitious man and a German patriot who, after being badly bruised in the 1930s by attacks by the physicist Johannes Stark, an early supporter of Hitler, had had to solicit the assistance of the SS to defend his position. After the war Heisenberg was eager to be recognized as a leader of Germany's physics community.[3] In his exchanges with Goudsmit, he sought to portray

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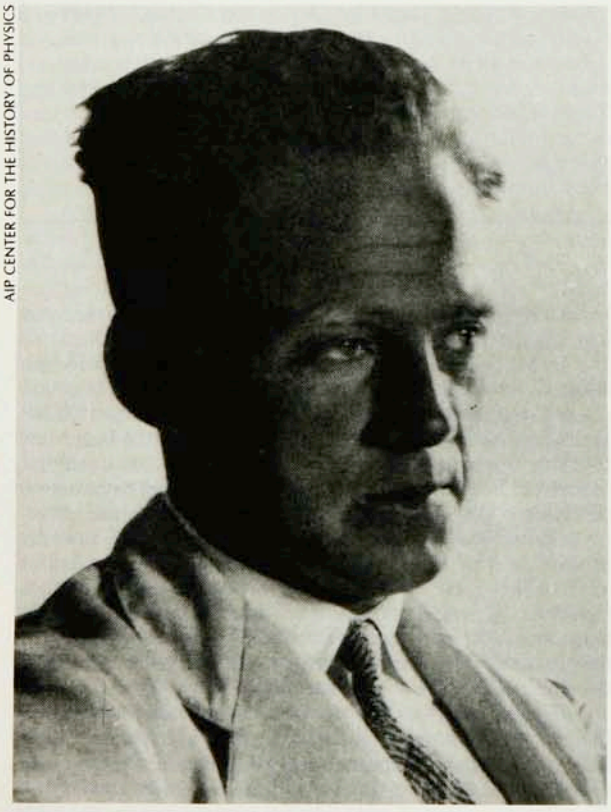
Samuel Goudsmit (left), a member of a military intelligence force during the war and a leader of the physics community in postwar America, clung tenaciously to the mistaken idea that the Germans thought an atomic bomb would consist of a nuclear reactor in which thermal neutron reactions went out of control.



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Werner Heisenberg, an ardent German nationalist but not a National Socialist, sought to dissociate himself and other leading physicists in postwar Germany from Nazi science by portraying physics administrators in the Third Reich as incompetent.

his wartime responsibilities as greater than they actually were without incurring the moral onus of having tried to build a superbomb for Hitler. At the same time, he tried to dissociate himself and most German physicists from the wartime leaders of German fission research by insinuating, without coming right out and saying so, that the administrators had been contaminated with Nazism, so that they would be lumped together with the proponents of *deutsche Physik*—the antirelativistic, supposedly more Germanic theories expounded by physicists like Philipp Lenard and Stark (see the article by Fritz Stern in PHYSICS TODAY, February 1986, page 40).

A common attribute of Heisenberg's apologetic account and Goudsmit's polemic was, ironically, a distinct exaggeration of Heisenberg's importance. Heisenberg appeared as though he had controlled and dominated the entire German nuclear fission project. This oversimplified version of the project's history sat easily with a stereotype that was and is widely held by scientists: the view that scientific progress results mainly from a few "great" scientists having profound ideas.

Another commonality between Goudsmit and Heisenberg, also deeply based in scientific stereotype, had to do with scientific objectivity and the politicization of science. Goudsmit and Heisenberg tended to classify project scientists as objective and apolitical, even though they plainly were doing their work in furtherance of well-defined and well-understood political objectives. Both men tended to classify the physicists administering the project, equally inappropriately, as political hacks.

The wartime project

In April 1939, a few months after the discovery of fission, the German physicist Wilhelm Hanle delivered a lecture on possible applications of nuclear energy making use of a uranium–graphite pile. Georg Joos, a colleague at Göttingen, transmitted a report on Hanle's lecture to the Ministry of Education, which in turn passed it on to Abraham Esau, who was in charge of physics at Ger-

The German Decision for Heavy Water

The initial German experiments on carbon as a moderator in nuclear reactors were done by Paul Harteck in Hamburg, who used dry ice, and Walther Bothe in Heidelberg, who used graphite. Bothe concluded on the basis of experiments with graphite he had obtained from Siemens that a uranium machine meeting the requirements of Heisenberg's theoretical model would not work because graphite would absorb too many thermal neutrons. Subsequent experiments by Wilhelm Hanle showed, however, that Bothe's conclusion was erroneous: Hanle showed that even the very pure Siemens graphite contained boron and cadmium, strong absorbers of thermal neutrons, and that these impurities had been lost to the air when Bothe reduced the graphite to ash. Hanle reported his results to Army Ordnance, which took them fully into account in opting for heavy water as a reactor moderator.

Heisenberg already had demonstrated that a uranium machine relying on graphite would require much more uranium and much more moderator than a machine relying on heavy water. The cost of producing large quantities of graphite that was free of cadmium and boron seemed prohibitively high to Army Ordnance. Supplies of heavy water could be much more readily assured, and several

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Walther Bothe, winner with Max Born of the 1954 Nobel Prize in Physics, was a leading experimental physicist on the German fission research project.

German scientists already were highly expert in dealing with heavy water. It was a German physical chemist, Karl-Friedrich Bonhoeffer, who persuaded Norsk Hydro, a Norwegian company, to begin commercial production of heavy water after American researchers discovered in 1932 that heavy water could be separated from light water by means of electrolysis. Karl Wirtz, an assistant to Bonhoeffer, had done a lot of work with heavy water, and so had Harteck and Klaus Clusius, a physical chemist in Munich who was a key figure in Germany's uranium isotope separation effort. In August 1940, Robert Döpel demonstrated experimentally in Leipzig that heavy water would make an excellent moderator.

By this time Germany had occupied Norway, and it was soon decided that the quickest, most efficient and cheapest means of assuring a large heavy-water supply would be to boost Norwegian production. Norsk Hydro was ordered to increase its annual production rate from 20 liters to 1 metric ton. In 1941 Norsk Hydro was ordered to install a novel catalytic conversion technology designed by Harteck and his assistant Hans Suess.

It was recognized all along that ordinary water might also be a satisfactory moderator but would require the use of enriched uranium. But an isotope separation technique developed by Clusius and Gerhard Dickel ran into unforeseen problems, and centrifuge technology could not be brought to fruition within a meaningful time. Thus the Germans came to focus on developing a reactor fueled by natural uranium and moderated by heavy water.

many's Reich Research Council.

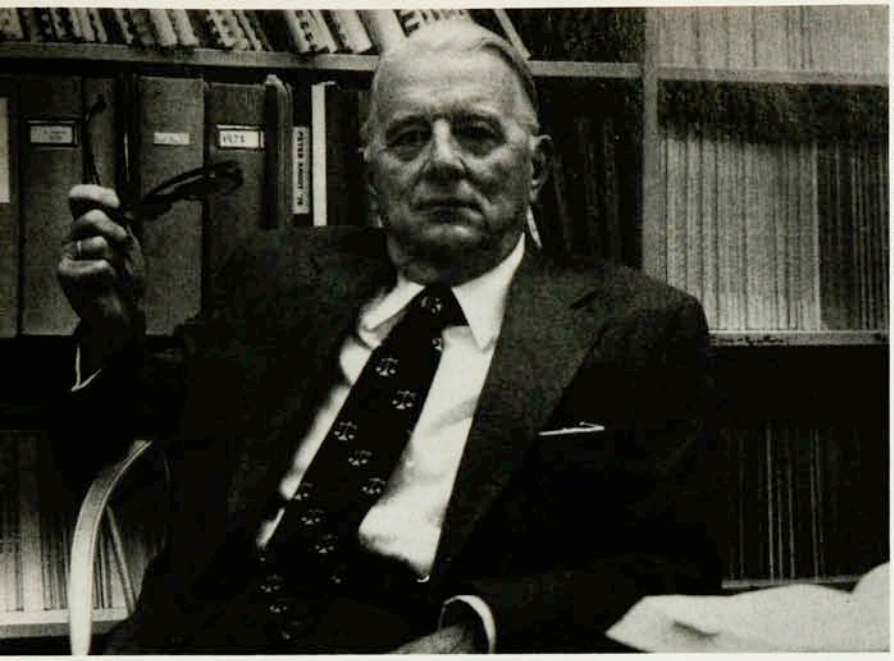
Meanwhile, Nikolaus Riehl, a former student of Otto Hahn and Lise Meitner who was working as an industrial physicist at the Auer Company in Berlin, brought nuclear fission to the attention of the Army Ordnance Office. Independently of Hanle and Riehl, the Hamburg physical chemists Paul Harteck and Wilhelm Groth wrote to the Army drawing attention to the possibility of making nuclear explosives. Their communication was reviewed at Army Ordnance, probably by Erich Schumann, the head of research, and Kurt Diebner, the resident expert on nuclear physics. Esau and Diebner were PhD physicists, and Schumann was qualified to teach physics at the university level.

Two uranium workshops, in April and September 1939 led to the convening of two conferences, in September and October of that year, dedicated among other things to the feasibility of using nuclear energy and to the theory of chain reactions. As a result of the conferences it was decided by the Army Ordnance Office to distribute work on nuclear fission among several institutes, rather than concentrate it at the Kaiser Wilhelm Institute at Berlin–Dahlem. Important assignments were given to the University of Hamburg (Harteck), Leipzig (Robert Döpel, Heisenberg), the Army Research Center at Gottow (Diebner), the Kaiser Wilhelm Institute for Medical Research in Heidelberg (Bothe) and the Kaiser Wilhelm Institute for Physics (Fritz Bopp, Diebner, Carl-Friedrich von Weizsäcker, Karl Wirtz).

In the fall of 1939 the Dutch physicist Peter Debye was asked to take German citizenship as a condition of his managing military research as director of the Kaiser Wilhelm Institute of Physics. When he declined and left to take a position at Cornell, Diebner took over the institute. In July 1942, after the institute was returned to the Kaiser Wilhelm Society, Heisenberg was made director. Esau was the senior official in charge of nuclear physics at the Reich Research Council from November 1942 to December 1943, when he was replaced by Walther Gerlach. Throughout the war Gerlach, Bothe, Heisenberg, Harteck, Hahn and Klaus Clusius—all scientists of the first rank—were involved in the scientific work and the administration of the German fission project.

The first phase of the project was devoted to establishing the feasibility of building a "uranium machine," that is, a prototype of a reactor capable of producing energy and explosive material for nuclear weapons. This was accomplished by the end of 1941, almost exactly in parallel with work in the United States and Great Britain. At this juncture the project was evaluated, just when Germany's fortunes in the war were changing dramatically as a result of Germany's failure to subdue Britain, the first Russian counterattacks and Pearl Harbor.

A 150-page report to Army Ordnance, prepared



RENSSELAER POLYTECHNIC INSTITUTE

Paul Harteck, a physicist at the University of Hamburg, was perhaps the most dynamic and effective member of the German nuclear fission project. Exploiting excellent connections with German industry, he made important contributions to work on moderators, uranium enrichment and reactor design.

probably by Diebner and younger project scientists, strongly recommended an industrial-level effort to build a working reactor and to produce fissionable materials, despite the admittedly rather distant prospects for actual construction of a bomb. In light of Germany's urgent military situation, competing demands on resources, and scarcity of certain critical materials—notably materials suitable for use as reactor moderators—Army Ordnance decided against industrialization of the project. This was the final verdict, which never was reassessed.

The project was transferred to the Kaiser Wilhelm Society, in keeping with its designation as basic research (albeit *kriegswichtig*—important to the war), but then was shifted back again to the Reich Research Council. By now the council was part of the sprawling jurisdiction of Reichsmarschall Hermann Göring, the Air Force chief, but Albert Speer, the head of armaments and later war production, also took an interest in the fission project. While bureaucratic battles associated with the project's loose organization occasioned some unhappiness among project scientists, the disaffection appeared to have everything to do with personal rivalries and wounded vanity and nothing to do with the fundamental objectives of the project, which were well understood and accepted on all sides.

Goudsmit attacks

During the course of 1946, Goudsmit published several popular articles on physics under Nazism.[5] These essays had both a pedagogical function and a political aim: to illustrate the debilitating effect of fascism on science, and to argue against tight military control of postwar American research. Although Goudsmit presented his account as authoritative, he grossly misrepresented the German scientific achievement. Goudsmit's initial distortion of the record was unintentional, the result of sloppy research, but once he had staked out positions, he refused to recant. Among other erroneous statements, Goudsmit claimed that the Germans conceived of an atomic bomb as a nuclear reactor gone out of control and that the Germans did not seriously consider using plutonium for atomic bombs.

Heisenberg and his close friend and younger colleague von Weizsäcker, who often spoke with one voice, had tried to publish an account of the German nuclear fission research as soon as the imprisoned German scientists had been released from confinement in England and returned to Germany, but they were stopped by the British occupation officials. But the following year Heisenberg received permission to proceed with publication of an article on the German fission project, which appeared in *Die Naturwissenschaften* in November 1946.[5] Heisenberg composed a preliminary draft—which fortunately has survived—and sent copies to selected colleagues for criticism. By this time Heisenberg had seen a copy of the "Smyth report" and thus knew a considerable amount about the successful American nuclear weapons project.

When Heisenberg's article is compared with sources documenting the history of the German nuclear fission project, several important discrepancies emerge. First of all, Heisenberg slighted the project scientists and administrators connected to Army Ordnance and those who held other high positions in the Third Reich's science policy bureaucracy—particularly Diebner, Esau and Schumann. For example, Heisenberg gave Gerlach, Esau's successor as head of the German nuclear fission effort, credit for several of Esau's innovations and accomplishments.

Scientists like Esau and Schumann were in many respects an embarrassment to the rest of their colleagues in postwar Germany, for they had held highly visible positions under National Socialism. Even after the end of the war and the revelations about German atrocities, these professionally respectable, if not world-class, physicists often admitted their wartime support of Nazi Germany unrepentantly. In other words, they represented exactly that from which Heisenberg and others were trying to distance themselves.

Graphite and plutonium questions

The second discrepancy that stands out in Heisenberg's draft article of 1946, and one that surprised and annoyed Bothe, was Heisenberg's assertion that Bothe's measure-

ment of the diffusion length of neutrons in carbon had been a mistake that had hindered the further progress of the entire nuclear fission project. Bothe protested, and Heisenberg accepted the rewording that his Heidelberg colleague suggested. Nevertheless, this theme, "if only we had tried graphite . . . ," continued to circulate within Heisenberg's circle and beyond. Eventually Bothe became a scapegoat—the scientist who had made "the mistake" that had kept the Germans from achieving a chain reaction.

The reasonable and justifiable decision for heavy water and against carbon as a moderator was made on economic grounds by those responsible at Army Ordnance, in full knowledge of the potential of carbon as a moderator (see the box on page 54). Why then did Heisenberg claim otherwise? By the time he wrote his draft article, of course, he had studied the Smyth report, and he had noted that the Americans—in contrast to the Germans—had used graphite for their nuclear piles. The facts that the Americans had used graphite and succeeded, whereas the Germans had not and failed, were used to reach the dubious conclusion that the Germans would have succeeded, or certainly would have gone much further, if only Bothe had not made his "error" and they had chosen graphite as their moderator.

A third discrepancy in Heisenberg's printed article—but not in his draft!—concerned von Weizsäcker's theoretical discovery of the explosive properties of plutonium. In the draft article, Heisenberg mentions von Weizsäcker's discovery that an operating nuclear reactor produces uranium-239, whose transuranic daughter products have the same properties as uranium-235. Heisenberg thus wrote in the draft that an energy-producing nuclear reactor could be used to produce materials for nuclear explosives.

Apparently one of Heisenberg's colleagues thought that this passage was too explicit, for the published version was much more circumspect. Instead of stating flatly that nuclear explosives can be produced using materials from an operating nuclear reactor, the sentence now allowed that von Weizsäcker's work made it more probable that an energy-producing nuclear reactor could manufacture fissionable materials, but immediately added that the "practical execution" of this process had not been discussed at the time. The form the final version took could be taken to imply that this lack of discussion was intentional.

A fourth important discrepancy was Heisenberg's description of how the Germans came to conclude that nuclear weapons could not influence the further course of the war. Here Heisenberg grossly misrepresented one important aspect of this question by attributing falsely the decision not to shift the research up to the industrial level of production to a meeting of a small group of Kaiser Wilhelm Society scientists with Speer in June 1942. Heisenberg implied that it was Speer who decided that the scientists should focus on the design and construction of a "peaceful" nuclear reactor rather than on military applications.

In fact, the decision to leave the research at the laboratory scale was made by Army Ordnance alone, more than half a year before the meeting with Speer. But apparently Heisenberg preferred to attribute this crucial judgment to a meeting in which he personally played a considerable role rather than to Army Ordnance. This was consistent with his apparent strategy of implying that project scientists had actively refrained from working on a bomb project for Hitler and of dissociating himself and other project scientists from Army Ordnance, whose scientists and science policy makers were discredited in the postwar era.

The alleged conspiracy

In the second-to-last paragraph of the published version of his 1946 article, Heisenberg presented an excellent summary of why the Germans had not attempted the production of nuclear weapons on an industrial scale: Until 1942, the Germans anticipated an early end to the war and were uninterested in weapons that could not be used in the immediate future; after 1942, it was evident that a bomb could not be built before the war was over, and Germany's steadily deteriorating military situation hampered any further progress.

Had Heisenberg left it at that, his ultimate conclusion about Germany's fission effort would have been unimpeachable. But both the draft version and the published version ended with a paragraph implying that the German scientists—especially the circle around Heisenberg—had held themselves back from producing nuclear weapons for the Nazi state because of moral scruples. Indeed this passive resistance was supposed to have stopped the German production of such weapons. In the published article, Heisenberg wrote that the German physicists had striven from the very beginning to keep the control of the project in their hands, and that they had used the influence they had as experts to steer the research away from the manufacture of nuclear weapons.

Of course it is possible that some of the German scientists who worked on nuclear energy and weapons, including Heisenberg, neither intended nor desired that German nuclear weapons be created and used. But Heisenberg's claim that the scientists willfully hindered the creation of nuclear weapons for Hitler's government is not supported by the documentary evidence, and it is intrinsically implausible. Why should they have feared and tried to prevent that which they knew could not and would not be done before the end of the war?

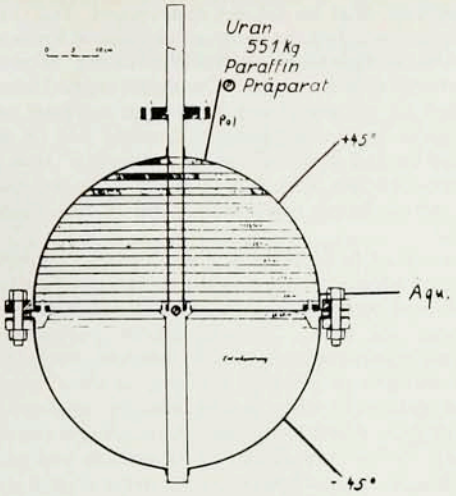
Goudsmit's second offensive

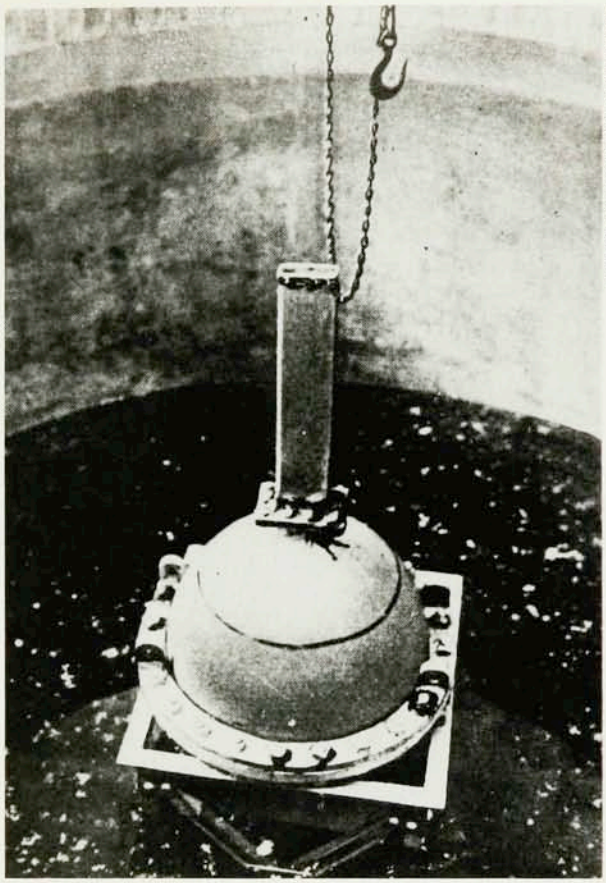
Goudsmit was angered after reading a translation of Heisenberg's article in the British journal *Nature*. According to Goudsmit, Heisenberg's account had all the earmarks of being meant for consumption in Germany: It was meant to appeal to national sentiment that German science was good and pure and could not fail.

In Goudsmit's opinion (which was poorly based in fact), Heisenberg had not owned up to the failures of the German nuclear fission project; indeed he had told a "tale of success." But what really enraged Goudsmit was Heisenberg's attempt to seduce the casual reader into believing that the German scientists had made a "deliberate decision" to refrain from making nuclear weapons. Goudsmit argued, correctly, that the Germans themselves had thought that they were progressing satisfactorily in that direction.

Heisenberg's article was probably one reason why Goudsmit decided to take his case to a broader audience and so wrote the popular book *Alsos* in 1947. In order that *Alsos* not go unnoticed, Goudsmit arranged for it to be previewed in *Life* magazine on 20 October 1947.

Alsos posed and purported to answer a question that was of keen interest to Goudsmit and of great topical importance at a time when the organization of big science was at issue in the United States: Why did German science fail where the Americans and British succeeded? Goudsmit's answer was that science under fascism was not, and probably could never be, the equal of science in a





BROOKHAVEN NATIONAL LABORATORY

Alternating horizontal layers of uranium powder and paraffin (diagram, above) were characteristic of the early German reactor experiments. Heisenberg's insistence on completing this kind of experiment late in the war, when other scientists such as Karl-Heinz Höcker and Kurt Diebner of Army Ordnance wanted to proceed rapidly with construction of reactors consisting of uranium lattices suspended in heavy water, may have held back German progress toward a self-sustaining nuclear reaction. The spherical design of the early German reactors (right) apparently fortified Goudsmit in his misconception that the reactors themselves were intended to be bombs. In his book *Alsos* he reproduced drawings of such reactors and labeled them "Germany's atom bomb."

democracy. In Goudsmit's opinion, the "totalitarian climate" of Nazi Germany led to complacency, politics in science and hero worship, all of which adversely affected the German research.

Goudsmit's account of the Alsos Mission and the German nuclear fission research program was basically the same as that set out in his earlier articles. Heisenberg was portrayed as a tragic figure, an extreme nationalist led astray by the Nazis and made to appear foolish by the revelations of Hiroshima. But Goudsmit was concerned with issues larger than the German nuclear energy and weapons project. Using Gestapo records that he himself considered suspect, Goudsmit unfairly dismissed Schumann and other National Socialist science policy administrators as incompetent Nazis and drew an arbitrary line of demarcation between the "good scientists"—good in both the professional and moral senses—and the "Nazi scientists." Thus Goudsmit did exactly what Heisenberg had done, although his motives were quite different.

Goudsmit's concluding chapter sharply criticized what he saw as American complacency about its scientific and military superiority over the Soviet Union, and he attacked those who wanted to continue wartime restrictions on nuclear science in the United States. He used the example of Heisenberg to argue that isolation, secrecy and governmental control ruin science.

Heisenberg–Goudsmit correspondence

The publication of *Alsos* touched off a fascinating correspondence between Goudsmit and Heisenberg. The exchange brought out a central issue in postwar psychology—the issue of whether the past should simply be buried, so that one could move on unencumbered, or whether it needed to be addressed and worked through.

Without having read *Alsos*—indeed there is no record that he ever read it—Heisenberg wrote to Goudsmit in the fall of 1947 and enclosed a copy of his article from *Die Naturwissenschaften*. Using polite language, Heisenberg remarked that he had seen several of Goudsmit's articles and had gotten the impression that Goudsmit was unaware both of the details of the German fission effort and the psychological situation in Germany during the war.

After reminding Goudsmit that he had misled Heisenberg in the spring of 1945 (when Goudsmit still was subject to the secrecy requirements of the Manhattan Project) by telling him that the Americans were not working on nuclear weapons, Heisenberg went on to describe the wartime situation in Germany in a manner difficult to reconcile with his conduct during the war. On one hand, he wrote, it was clear to the scientists what "heinous consequences" the victory of Nazism in Europe would have, but on the other hand, in view of the hatred toward Germans with which the war had saturated Europe, they could hardly look forward to the country's utter defeat. The situation, Heisenberg argued, led them to assume a more "passive and humble manner."

After some delay, Goudsmit finally replied to Heisenberg on 1 December 1947 by criticizing Heisenberg's justification of this "passive and humble manner." Goudsmit had been deeply disappointed to learn of Heisenberg's attempts at a compromise with the Nazis, he said. What surprised him most was that Heisenberg did not see that such a compromise was impossible. Attempts to convince the Nazis of the soundness of relativity and quantum theory—an effort Heisenberg emphasized in his opening

letter—seemed to Goudsmit so out of place.

How, Goudsmit asked, could Heisenberg have hoped to be successful, or have thought that these were important issues? In Goudsmit's opinion, not the period under Hitler but the present was the right time for the "more humble manner" Heisenberg described.

Heisenberg replied in early 1948, and this time his tone was colder and less polite. First of all, he made it clear that the question he now considered most important was whether the Germans had known how an atomic bomb would have worked. He then went on to refute Goudsmit's claims on this score by showing that the Germans had understood both fast-neutron chain reactions and the potential of plutonium. Letting a little sarcasm leak into his tone, Heisenberg remarked that obviously Goudsmit had accidentally overlooked the reports that would have given him the correct picture. Only after they had agreed on the "facts" of the German scientific achievement would Heisenberg be willing to discuss the political motives behind the work.

However, Heisenberg wanted to comment on a few points raised by Goudsmit's letter. First of all, he pointed out that he had always believed that German science had suffered under Nazism, especially because of the expulsion of many capable scholars from Germany and the advancement of nonsensical theories such as *deutsche Physik*. Moreover, Heisenberg had made critical comments about *deutsche Physik* in public at a time when such action had been dangerous. Also, it never would have occurred to Heisenberg to think that the German physicists were any different from their Allied counterparts. But how could Goudsmit continue to overlook the fact that the German physicists also found themselves in a different psychological situation from their colleagues in England and America?

Heisenberg also commented on what Goudsmit had described as compromises with Nazism by denying that he had been so naive as to believe that there was much chance of winning over SS leader Heinrich Himmler, and he bluntly stated that he would have "criminally" neglected his duty if he had not, at least in his small circle, tried to shatter the "delusion" of the dictatorship. In particular, Heisenberg had never had the slightest sympathy for the people who withdrew from all responsibility during the Third Reich but then in a safe dinner conversation would tell someone that National Socialism would ruin Germany and Europe, just wait and see.

At the end of his letter, Heisenberg turned to the present situation in Germany and his views on dealing with the past. It was difficult, he wrote, to win the hearts and minds of people through the force of arms, especially because of the "indescribable misery" in Germany. What the Germans needed was not a hateful settling of accounts with the past, but instead a quiet reconstruction of a life worthy of a human being. In any case, Heisenberg assured Goudsmit that he could be certain that the German physicists would gladly participate in any effort that would contribute to a "better world understanding."

Intervention by van der Waerden

At this point the Dutch mathematician Bartel L. van der Waerden, a friend of Heisenberg, former countryman of Goudsmit and a very perceptive observer, briefly entered the debate. Van der Waerden had spent the war years at the University of Leipzig, where for many years he was Heisenberg's colleague. After the war he went to teach at Johns Hopkins, where he read *Alsos* in March 1948 and experienced the American debate over the book firsthand.

Subsequently he wrote both Goudsmit and Heisenberg. Van der Waerden told Goudsmit that there was one point in *Alsos* that he did not understand. Did Goudsmit mean, he asked, that the German physicists, knowing who Hitler was, had planned "the horrible crime" of putting an atomic bomb into his hands? Goudsmit replied (obscurely) that such an act would not have been a crime; rather it would have been something that could not be stopped. (Perhaps he had in mind the "inevitability" that the US weapons scientists often talked about, once the feasibility of an atomic bomb was established in the Manhattan Project.)

According to Goudsmit, the Germans thought that making an atomic bomb was much more difficult than it actually was, and thus the question of conscience was not so urgent for them. This argument pervaded all of Goudsmit's publications on the German nuclear fission project and was an attempt to reconcile the evidence that he had gathered with his profoundly ahistorical and noncontextual preconceptions of how science and technology work. In his view, since the Americans had succeeded in building an atomic bomb, the Germans should somehow have known that it was feasible. Since the German scientists and authorities had decided that this task was *not* feasible, Goudsmit concluded that this decision must have been a mistake, and searched until he thought he had found the German error in the concept of a nuclear pile as a bomb—an error they never made.

(In November 1944 the Alsos Mission heard from a secondhand source that Hahn's institute had estimated the minimum mass of an atomic bomb at eight tons. In hindsight it is evident that the source was confusing the mass of a reactor with the mass of a bomb, but Goudsmit attributed the confusion to the whole project; a subsequent misreading of a letter by Gerlach fortified Goudsmit in his conviction that the Germans thought the reactor itself would be the bomb.)

Van der Waerden wrote Heisenberg immediately after his conversation with Goudsmit, noting that documents in Goudsmit's office verified Heisenberg's claims about what the Germans had known about plutonium and nuclear weapons, but adding that in his opinion questions such as the "complacency" of the German physicists or what Heisenberg and other scientists had understood or overlooked were insignificant.

The two Dutch-born scientists also had discussed the "question of guilt," van der Waerden told Heisenberg. In the end they still disagreed over the psychological question—what Heisenberg's group would have done if they had made greater progress—but agreed someone should not be condemned for what he might have done if the situation had been different.

Although van der Waerden was defending Heisenberg, he was also critical of his friend and former colleague. In a second letter, sent the very next day to Germany, van der Waerden asked for more information. Heisenberg had informed high-ranking German authorities about the potential of nuclear explosives during the war; had he also considered the question of responsibility at that time? Had Heisenberg's statements touting the military potential of the project been a mere ruse to get money for physics?

As Heisenberg's "lawyer" (van der Waerden's term), van der Waerden said he had enough evidence to defend him, but as Heisenberg's friend he also wanted to believe that under any circumstances Heisenberg's decency would have been stronger than the combination of his nationalism and ambition.

Van der Waerden made one last attempt to reconcile Goudsmit and Heisenberg before he returned to Holland. Naturally Heisenberg was right to claim, van der Waerden argued in his second letter, that his efforts on behalf of

Von Laue and Morrison on the Arming of 'Himmler and Auschwitz'

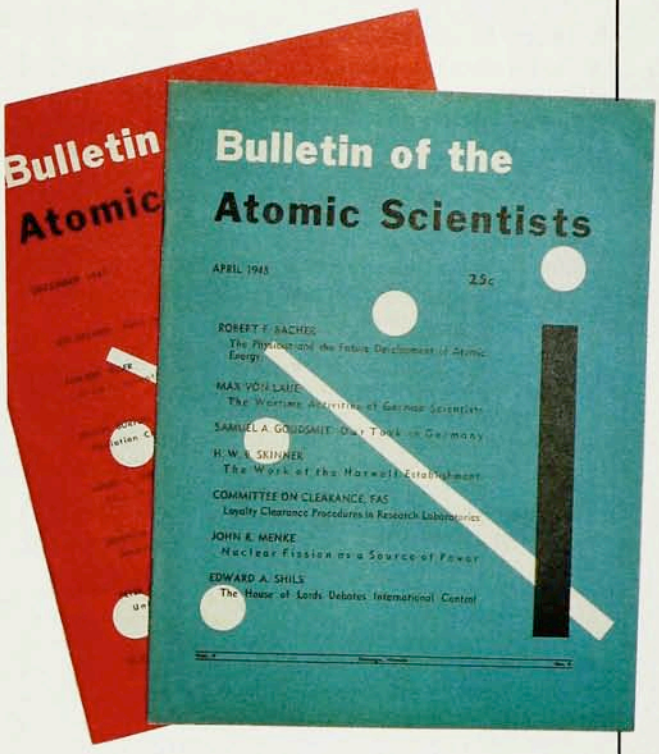
Goudsmit's book *Alsos* touched off an emotional debate in the *Bulletin of the Atomic Scientists*. Philip Morrison, a Manhattan Project scientist who had also been involved with scientific intelligence, reviewed the book and attacked Heisenberg's suggestion that the Germans had not wanted to create nuclear weapons. Like their counterparts in America and Britain, Morrison stated, the German scientists had worked for the military as best as their circumstances allowed. The difference, which Morrison found unforgivable, was that they worked for the "cause of Himmler and Auschwitz," for the burners of books and the takers of hostages.

With justification, Morrison and others in America believed that the Germans were implying that German scientists had been morally superior to their American and emigré counterparts because they had not built a bomb—and because in particular, they had not built bombs that were actually used to destroy cities.

Morrison's attack provoked a response from Max von Laue, perhaps the only German physicist residing in Germany who still commanded respect in America at that time. Von Laue was a more outspoken critic of National Socialism than Heisenberg or von Weizsäcker, but as acting director of the Kaiser Wilhelm Institute for Physics, he had helped oversee the work on applied nuclear fission and was aware of its military potential. Von Laue's reply to Morrison was published in German in *Physikalische Blätter*, so that many German readers saw only his forceful comments and not the original critiques by Goudsmit and Morrison.

Von Laue attacked Morrison for the "monstrous suggestion" that German scientists as a body had worked for Himmler and for Auschwitz. He recognized that Goudsmit had lost many of his closest relatives in concentration camps and what unutterable pain the mere word "Auschwitz" must evoke in the Jewish physicist. But von Laue then went on to draw the conclusion that neither Goudsmit nor his reviewer Morrison was capable of an unbiased judgment.

Just because a few German scientists had managed to avoid being drawn into the maelstrom, von Laue wrote, this did not mean that all could have. Von Laue argued that whereas open refusal to participate in war work would have led to catastrophic personal consequences, a fictitious compliance often allowed German physicists to shield younger researchers from the war. Sometimes, von Laue continued, the physicists protected "political suspects" from concentration camps by assigning them work labeled "of military importance." Von Laue asked ironically whether such scientists and internal refugees should be labeled "armorers of Himmler and Auschwitz." Von Laue said that articles such as Morrison's merely kept "alive hate."



Regretting that he had to take issue with von Laue's "moving statement," Morrison pointed out in the same issue that he had accused the German scientists of working not for Himmler, but for Himmler's cause, the victory of Nazi Germany.

For Morrison, Goudsmit and many people who had been in or had fled from countries dominated or threatened by Germany, working for a German victory in World War II was seen—after the fact—as equivalent to working for the cause of Himmler and Auschwitz. But, during the Third Reich few Germans had distinguished clearly between the known military and political goals of the National Socialist government and those of Germany or the German people. Once the full extent of Nazi crimes was revealed and undeniable, Germans such as von Laue and Heisenberg advanced a retrospective argument implying that efforts toward a German victory and for the good of the German people had been separable from allegiance or service rendered to Nazism.

German physics represented a significant success. But on the other hand, van der Waerden could understand the negative reaction of Goudsmit and others toward those same efforts. This negative reaction was admittedly illogical. But emotionally it was comprehensible. Could Heisenberg associate with the SS and leading National Socialists, even exert influence over them, van der Waerden asked, without compromising himself? Van der Waerden believed that he could, but could understand if others did not feel that way.

In a letter written on 28 April 1948, Heisenberg replied to van der Waerden by addressing the moral question once again. When he knew near the end of 1941 that a nuclear reactor would work and that nuclear weapons probably could be built, Heisenberg explained, he had been "shocked" by the thought of such weapons in the hands of some ruler, and not only Hitler. In any case, Heisenberg flatly stated, he would have considered it a crime to make atomic bombs for Hitler. But Heisenberg also considered it unfortunate that these weapons were given to other rulers and were used by them. During the past few years, Heisenberg said, he had learned something that his friends in the West did not want to understand: During times like those in Germany during the war,

hardly anyone can avoid committing crimes or supporting them by doing nothing. Heisenberg hastened to add that he did not mean he would have been prepared to commit any sort of crime for Hitler.

A failure to communicate

Goudsmit wrote Heisenberg in late September of 1948 and admitted that he had been wrong about certain details, but now he grasped mistakenly at another perceived German deficiency by claiming that the Germans had not understood that an atomic bomb would rely on a fast-neutron chain reaction. However, Goudsmit's main aim in this letter was again to stress how science had suffered under Nazism and how political interference ruins science. As Goudsmit himself realized, the contents of this letter differed little from the previous one he had sent Heisenberg.

After spending several letters discussing the moral aspects of the German nuclear fission project, only to have Goudsmit stubbornly continue to make false statements about Germany's scientific achievements, Heisenberg dealt almost exclusively with the question of scientific competence in replying to Goudsmit's latest missive. The German physicist noted with pleasure Goudsmit's grudging partial admission of error. Now that Goudsmit had agreed that the Germans had known about plutonium, Heisenberg wanted him to make this admission public, in the *Bulletin of the Atomic Scientists*.

But Heisenberg did more than gloat over Goudsmit's discomfiture. Naturally, he wrote, he agreed that a totalitarian system greatly damages science, but in *Alsos* this conclusion was based on false arguments, which Heisenberg found very unfortunate.

Goudsmit found Heisenberg's answer "impertinent" in turn and could not understand why the recognition of the value of Heisenberg's scientific work meant so much to his German colleague. Heisenberg may well have been asking himself why Goudsmit could not recognize the admittedly modest German achievement.

Before Goudsmit could write his German colleague or publish anything in the *Bulletin*, Heisenberg took his case directly to the American people by means of an interview published in *The New York Times*. He devoted most of the interview to refuting Goudsmit's claims about the German scientific work, but he also addressed the moral question carefully: Because of their sense of decency, most of the leading German scientists had disliked the totalitarian system, he claimed; yet as patriots, when called upon to work for the government, they could not refuse.

Goudsmit responded in a letter to the *Times* by admitting that his portrayal in *Alsos* was an oversimplification, but he still insisted stubbornly that the Germans had had only a very vague notion of how an atomic bomb works.

On 11 February 1949 Goudsmit wrote Heisenberg again, advancing the same arguments, and in an exasperated tone asked whether further correspondence made any sense. Heisenberg responded with his most curt letter yet, stating bluntly that he would have preferred no public discussion of the German nuclear energy and weapons research, that through his articles and book Goudsmit repeatedly had spread false information about the German work, that it was time that a correct description of the German research was presented in the newspapers for a change, and that he was disappointed that Goudsmit did not recognize Heisenberg's right to take his case to the public as Goudsmit had done so often. It is clear that in the end Goudsmit's unfair criticism of Heisenberg's scientific abilities and achievement exasperated and embittered the German physicist. The damage done to his reputation as a physicist may have come to bother him more than the criticism he received for serving the Nazism. The debate between Goudsmit and Heisenberg left outsiders with the impression that Heisenberg was morally insensitive or even obtuse, but that impression is not altogether warranted. Private wartime correspondence shows that Heisenberg was indeed troubled by his compromises with National Socialism. He also was troubled by the fate of individuals. In 1943, at the request of a Dutch physicist, Heisenberg wrote a letter to authorities on behalf of Goudsmit's parents, who were about to be sent to a concentration camp. Even for a person in Heisenberg's position, this was a very dangerous move at that time. Yet throughout the long and painful correspondence with Goudsmit after the war, Heisenberg never mentioned his intervention on behalf of Goudsmit's parents.

Last letters and visit

In the course of their protracted debate, both Goudsmit and Heisenberg had come very close to losing their tempers, and they now realized that it was pointless to continue. Goudsmit wrote one last letter in which he repeated his litany of arguments, told Heisenberg that he would not bring up the matter again, and expressed the hope that they could continue to correspond about physics. Heisenberg replied immediately and thanked him for his letter, which this time Heisenberg had been very happy to receive. Goudsmit could be certain, Heisenberg promised, that he would not stir up the controversies of the past few years again, and especially not in public. Exactly like Goudsmit, Heisenberg said, he believed that it was more interesting to discuss physics than the unpleasant past.

Both men worked very hard the rest of their lives to restore international cooperation in science. Despite the loss of his parents, Goudsmit went out of his way to assist German scientists. In the same issue of the *Bulletin of the Atomic Scientists* that contained a debate between Philip Morrison and Max von Laue on the German scientists' role during the war (see the box on page 59), Goudsmit contributed an essay that showed he had changed his mind about the sink-or-swim policy he once had advocated for German science. Entitled "Our Task in Germany," Goudsmit's article once again called for international scientific cooperation, and this time he extended his hand to Germans as well. Goudsmit expressed the belief that American scientists should morally support those German colleagues who were worthy of confidence, and he added that there were many of them. Americans did not have to agree with all of their opinions but should make allowances for the disturbing circumstances under which these Germans had lived and were still living. Americans had to communicate with them, Goudsmit maintained, as in the days before Hitler. It was as if Goudsmit had been converted by the disturbing forces that he had helped to unleash.

In 1950 Heisenberg visited Goudsmit at Brookhaven National Laboratory in Long Island, New York, and they discussed only physics.

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