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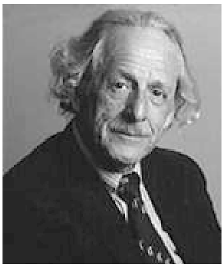

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EUGENE GARFIELD
INSTITUTE FOR SCIENTIFIC INFORMATION®
3501 MARKET ST. PHILADELPHIA, PA 19104

Cassidy's Heisenberg: Part 2. Developing Quantum Mechanics and the Uncertainty Principle; SS Interrogations and the Controversy Over Building an A-Bomb

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In Part 1 of David C. Cassidy's biography of Werner Heisenberg,[1] the controversial Nobel laureate who gave the world the uncertainty principle and ran Nazi Germany's nuclear program, we touched on various aspects of his youth—his family, his schooling, and his involvement in the Hitler youth movement.

In Part 2, we give the reader a glimpse of his scientific endeavors—the journey into quantum mechanics, the development of the uncertainty principle, his relationships with Niels Bohr and Albert Einstein, the Gestapo's investigation into his loyalty, and, finally, the controversy surrounding his position on building an atomic bomb. It is a fascinating story.

REFERENCE

1. **Cassidy D C.** *Uncertainty: the life and science of Werner Heisenberg.* New York: Freeman, 1991. 669 p.

Uncertainty: The Life and Science of Werner Heisenberg [Part 2]

by
David C. Cassidy

ABSTRACT

Heisenberg's breakthrough "matrix mechanics"; activities at Niels Bohr's Copenhagen institute; development of the uncertainty principle; an important meeting with Einstein; Hitler's rise to power; Heisenberg's loyalty is questioned; investigation by the SS; Heisenberg's role in the frustrated German effort to produce an atomic bomb.

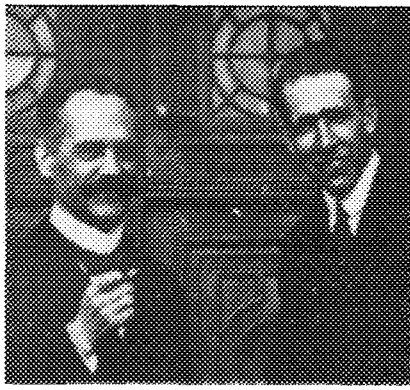
Quantum Multiplying

In the September 1925 issue of the *Zeitschrift für Physik*, [Werner] Heisenberg published a 15-page article with the harmless-sounding title, "On a quantum-theoretical reinterpretation of kinematic and mechanical relations." But the aim was ambitious—no less than "to establish a basis for theoretical quantum mechanics, founded exclusively on relationships between quantities which, in principle, are observable." It dealt with observed frequencies and intensities of emitted and absorbed light, and, in so doing, it enabled a momentous breakthrough in physics, assuring Heisenberg's place in modern science. Heisenberg's paper laid the foundation of a new theoretical "matrix mechanics," one form of the long-sought quantum mechanics—a new physics of the atom and its interactions that replaced the classical mechanics of Newton and Maxwell. Heisenberg, Born, and their colleagues brought the new physics to fruition during the months following Werner's initial breakthrough. Werner's breakthrough precipitated the culmination of the quantum revolution of the first decades of this century, a revolution that reached its conclusion two years later.

Heisenberg's path to matrix quantum mechanics was neither direct nor his alone. In the introduction to his paper, Heisenberg acknowledged those who had set the stage: "One can regard the [Bohr] frequency condition and the dispersion theory of Kramers, together with its extensions in recent papers, as the most important first steps toward quantum-theoretical mechanics." He cited in particular Born's 1924 discretizing rule for differentials and the Kramers-Heisenberg dispersion theory of early 1925. To these important first steps, one must add Pauli's relativistic destruction of Werner's core model in 1925, the Copenhagen sharpening of the correspondence principle, the demise of the Bohr-Kramers-Slater theory, and Heisenberg's revival of core-model physics in reciprocal dualities.

One must also acknowledge the hothouse "atmosphere of quantum theory" that pervaded Bohr's Copenhagen institute. There, Bohr and his young exotics—Heisenberg, Pauli, and Kramers—struggled intensively and exhaustingly, with each other and with each other's idiosyncratic approaches, to cultivate their achievements.

Bohr's Institute for Theoretical Physics, like its inhabitants, rode the tail of a shooting star in 1924 and 1925. During the last years of World War I, in which Denmark remained neutral, Bohr, professor of theoretical physics at the University of Copenhagen since 1916, convinced the Danish authorities and the Carlsberg Brewery foundation to give him a three-story institute in place of his one-room office. The sons of a famous Copenhagen university professor, Niels Bohr and his brother Harald, a mathematics professor, easily moved within the higher circles of Copenhagen social and cultural life. Like most of the young physicists and mathematicians who would come to work and study with the Bohrs, culture and breeding made an unspoken communality of interest and outlook—communality expressed in such joint endeavors as musical evenings, horseback riding, hiking tours, and frequent trips to the local movie house to view the latest silent films.



Courtesy David C. Cassidy

Arnold Sommerfeld and Niels Bohr, circa 1920

In 1921, Bohr inaugurated his new building in the nearly rural outskirts of town. The institutional-looking rectangular building, with its grey-stucco facade, pitched red-tiled roof, and gabled third-floor windows, stood behind a wire fence only a few yards from the sidewalk at Blegdamsvej 15. Within a few years, flowers had sprouted by the front gate to beckon visitors, and collegiate ivy had grown to cover the entire first floor of the outer walls, reaching almost to the large letters embedded in the wall above the entryway: "Universitetets Institut for Teoretisk Fysik 1921...."

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Heisenberg's fabrication of quantum mechanics may be reduced to three steps. First, he reinterpreted the equations of classical space-time kinematics as nonclassical formulas in quantum mechanics by making use of the observable properties of radiation emitted by virtual atomic oscillators. Then he raised the positivist criterion of observability of all quantities to a basic postulate of the theory. Finally, he "killed off" the mechanical orbits, replacing them with what became matrix elements....

Certain of Uncertainty

On March 22, 1927, Werner Heisenberg submitted a paper to the *Zeitschrift für Physik* entitled "On the perceptual content of quantum theoretical kinematics and mechanics." The 27-page paper, forwarded from Copenhagen, contained Heisenberg's most famous and far-ranging achievement in physics—his formulation of the uncertainty, or indeterminacy, principle in quantum mechanics. Together with Bohr's complementarity principle, enunciated later that year, and Born's statistical interpretation of Schrödinger's wave function, Heisenberg's uncertainty principle formed a fundamental component of the so-called Copenhagen interpretation of quantum mechanics—an explication of the uses and limitations of the mathematical apparatus of quantum mechanics that fundamentally altered our understanding of nature and our relation to it....

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Just two weeks after he submitted his paper enunciating the uncertainty principle, Heisenberg published the first of his many nontechnical summaries of the nature and significance of his work for nonphysicists. In his insightful summary, published in a German periodical, Heisenberg suggested that the content of a physical theory may be easily recognized not by its mathematical formulation but by the new concepts to which it gives rise. Until the turn of the century, Newtonian mechanics and Maxwellian electrodynamics had been seen as the foundations of all of physics. These theories involved the concepts of force, mass, absolute space and time, continuous processes, causality, and an objective reality existing more or less independently of the observer. Relativity theory changed our notions of space and time and showed that under certain conditions—that is, high speeds and large expanses of space and time—Newtonian mechanics had to be replaced by a new relativistic mechanics....

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Previously one could always describe the motion of an electron by noting its position and velocity at any given moment. Now,

Werner Heisenberg

Courtesy of David C. Cassidy

Heisenberg argued in his essay, such concepts are meaningful only when they are referred to or defined by the actual experimental operations used to measure them. The physicist cannot know any more than what he or she can actually measure. Here a puzzle arises. If one seeks to measure the exact position of an electron, he explained, one could use a microscope of very high resolving power, which would require the illumination of the electron with light of very short wavelengths. But the shorter the wavelength, the greater the energy of the light quantum (or the greater the pressure of the light wave) hitting the electron—thus the greater the recoil velocity of the electron. Because of this, Heisenberg noted, there seems to be a reciprocal relationship between the imprecisions, or uncertainties, with which one can simultaneously measure the velocity and the position of an electron at any given instant: "The more precisely we determine the position, the more imprecise is the determination of velocity in this instant, and vice versa." And this reciprocal relationship between uncertainties in measurement also holds for other conjugate pairs of variables, such as energy and time. This, in a few words, is Heisenberg's uncertainty principle....

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Heisenberg's intellectual route to uncertainty lay through the work of his closest colleagues—Born, Jordan, Pauli, Dirac, and Bohr. As each struggled during the last months of 1926 with interpretations of the mathematical formalism, each informed Schrödinger of his opposition to Schrödinger's assertions that a theory involving continuous waves alone would suffice to account for phenomena that seemed to demand discontinuities, quantum jumps, and spinning particles. To Heisenberg and his colleagues, the particle side of the wave-particle duality seemed paramount. Pauli and Jordan even tried to throw the weight of majority opinion against Schrödinger. Wrote Pauli: "But I am convinced now as before (together with many other physicists) that the quantum phenomena cannot be encompassed with the conceptual resources of the continuum physics alone." A continuum theory could not encompass phenomena that seemed to require jumping, rotating, orbiting balls of charged matter—electrons....

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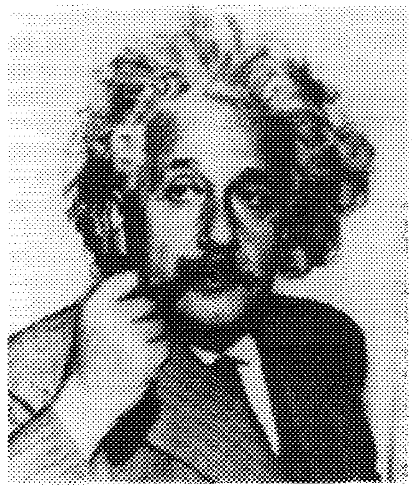
In May 1926, Heisenberg had lectured on matrix mechanics before the Berlin physics colloquium on April 28, 1926. Following the lecture and a long discussion with the many skeptics in the audience, an intrigued (though skeptical) Einstein invited young Werner to accompany him on the walk home to his apartment. Werner gladly accepted, and during the half-hour walk along the tree-lined streets of Berlin to his apartment in Haberlandstrasse, Einstein got to know the brilliant young man a little better. Werner had first met the great physicist two years earlier in Göttingen. But it had been only a brief encounter and had concentrated on Einstein's objections to the Bohr-Kramers-Slater theory. This time Werner was a principal author of a revolutionary, yet baffling, new mechanics, and the two had exchanged several letters on the subject during the previous months. Einstein, then 47 years old, wanted first to know more about Werner's background, education, and research; Werner, half Einstein's age, wanted Einstein's opinion on whether or not he should refuse the Leipzig job offer in favor of working with Bohr. Einstein urged the young man to work with Bohr.

When the two men finally arrived at Einstein's elegantly furnished apartment—with its heavy oak Biedermaier furniture, glass-enclosed breakfront, overstuffed leather sofas, and built-in bookcases containing the complete works of Goethe, Schiller, and Humboldt—the conversation turned to the issue at hand: quantum mechanics. In a sense the conversation reflected Einstein's own role in quantum physics. From the very beginning of the quantum revolution at the turn of the century, Einstein had been a principal player but never a principal contributor to an encompassing quantum theory. His work, more than that of any other physicist, had indicated the very existence of quanta of energy and the necessity for radical revisions of physics to encompass them. He had argued the hypothesis of light quanta; he had presented a theory of specific heats of crystals in which the atoms appeared to oscillate like balls on springs but with only certain discrete amounts, or quanta, or energy; he was the first to introduce the radical notion of probability into quantum physics by suggesting that individual quantum jumps between stationary states could not be treated exactly but only in terms of probability amplitudes. Quantum oscillators and probability amplitudes formed the basis of virtual oscillators and a fundamental component of the Born-Heisenberg-Jordan formulation of matrix quantum mechanics.

Einstein did not like it. He preferred instead the approach that led to wave mechanics. He shared with Schrödinger the conviction that the quantum had to be understood in traditional terms, not merely accepted or assumed. Thus, while Heisenberg, Bohr, and others struggled to obtain a new atomic theory that would somehow consistently encompass quanta, jumps, and discontinuities, Einstein's research and each of his fundamental papers provided a new and cogent argument for the appearance of energy quanta in nature. But the argument was always heuristic—nature behaved under certain circumstances only as if energy quanta really existed. The existence was only "for the hour," until energy quanta could be properly understood, more or less, on existing principles. Schrödinger's approach,



Courtesy of the Institute for Advanced Study

Albert Einstein

based on the continuous wave nature of matter, which Einstein had encouraged, coincided with his own aims and seemed to hold promise of an understanding of quantum phenomena without relying on quanta, discontinuity, problematic particles, or unvisualizability. Just two days before Heisenberg's visit, Einstein wrote Schrödinger that he was convinced that Schrödinger's work represented " a decisive step forward,...just as I am convinced that the Heisenberg-Born approach is off the track."

Heisenberg's much later recollection of the meeting focused on Einstein's objections to the empirical and positivistic elements of the Heisenberg-Born approach. Heisenberg, Born, and Jordan assumed the existence of electrons inside the atom but made no attempt to describe their actual orbital motions. Instead, Heisenberg had built his multiplication rule on equations that, he argued, involved only quantities that could be observed in the laboratory—primarily frequencies and intensities of emitted radiation—and, in his enthusiasm, he had elevated this approach to a prescription for the formulation of any cogent theory.

"But you don't seriously believe," Einstein objected, "that none but observable magnitudes must go into a physical theory?" Heisenberg attempted to raise Einstein's formulation of the special theory of relativity in his defense. Einstein had excluded such notions as absolute space and time because they could not be observed, and he had used an operational definition of the simultaneity of two events.

Muttering that a "good trick should not be tried twice," Heisenberg recollected Einstein called such empirical reasoning nonsense. "In reality the very opposite happens," he declared. "It is the theory that decides what we can observe." Confronted ten months later with the unified formalism of the Dirac-Jordan transformation theory, but without a satisfactory interpretation of its symbols, Heisenberg recalled suddenly remembering Einstein's statement just before writing his uncertainty paper, thus probably just after reading Jordan's paper. Operational definitions of fundamental concepts subject to quantum mechanics and the uncertainty relations quickly followed. The theory did indeed decide what could or could not be observed or remembered....

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Einstein and his followers, to the end of their lives, insisted upon various versions of the EPR [electron/particle relationship] argument. In his response to the contributors to a volume in honor of his seventieth birthday in 1949, Einstein reiterated the argument nearly word for word in asserting the incompleteness of quantum mechanics. He expressed his general views as follows: "Above all...the reader should be convinced that I fully recognize the very important progress that the statistical quantum theory has brought to theoretical physics.... This theory and the (testable) relations, which are contained in it, are, within the natural limits of the indeterminacy relation, *complete*.... What does not satisfy me in that theory, from the standpoint of principle, is its attitude towards that which appears to me to be the programmatic aim of all physics: the complete description of any (individual) real situation (as it supposedly exists irrespective of any act of observation or substantiation)...."

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Pauli's worries notwithstanding, the physics community, especially the American community, never wavered in its preference for Copenhagen. Although Einstein spent the rest of his life in the United States, his objections never persuaded many of his American colleagues. The majority had already pledged their allegiance to Copenhagen by 1935. This came about not only because the Copenhagen interpretation always seemed to work when needed (regardless of philosophical disputes), while its opponents offered no viable alternative, but also because Americans were already receptive to the proselytizing influence of European quantum mechanicians during the late 1920s and early 1930s. American physics had come of age by the 1920s, and American physicists were eager to participate in new fields of research....

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A New Regime

At the end of January 1933, Germany's president, Field Marshal Paul von Hindenburg, appointed Adolf Hitler, then chairman of the influential National Socialist German Workers Party, German chancellor and head of a new cabinet in Berlin. Many Germans were relieved. A cabinet crisis was finally resolved, and with nationalist conservatives in control. The *Leipziger Naueste Nachrichten*, a conservative Leipzig newspaper not allied with the Nazis (as the National Socialists were disparagingly called), extolled the event: "The first day of the Hitler cabinet has closed in the brightest glitter. The day was dominated by a feeling of widespread joy at the unification on the [political] right.... It cannot be better expressed than in Hitler's own words at his first cabinet meeting: 'Faith and trust shall not be disappointed!' "

From the moment Hitler gained control of the chancellery, he and his party held the "nation of poets and thinkers" in an ever-tightening grip. Within a day, the Reichstag was dissolved; within a month, the constitution was suspended. By the summer, thousands of Jews and political opponents had lost their jobs, and many were leaving the country. The first concentration camps—intended to concentrate opponents, criminals, and others in a common prison—were already in operation. Political efforts to halt the National Socialist takeover were thwarted by the imposition of one-party rule. A year later, by the end of August 1934, Hitler had created for himself the position of national Führer; Germany's first democracy had been stamped out by a Nazi dictatorship.

The frightening rapidity and seeming ease with which Hitler and his henchman seized the German state resulted from a combination of unique demonical genius and the particular susceptibility of the populace to demagoguery. Although politically the National Socialists gained their greatest support from the unemployed and the economically threatened lower middle class, most observers agree that they could not have taken over so rapidly and completely after January 1933 had they not received the crucial support of the army and the initial acquiescence of the upper middle class—civil servants, bureaucrats, industrialists, professors....

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On a visiting professorship to the United States when Hitler came to power, Einstein made known his decision not to return to Germany and declared in an interview: "As long as I have any choice in the matter, I shall live only in a country where civil liberty, tolerance, and equality before the law prevail.... These conditions do not exist in Germany at the present time. Men, among them leading artists, who have made a particularly great contribution to the cause of international understanding are being persecuted there...."

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Like...other nationalist oriented non-Jewish German academics, Heisenberg was at first appalled at the crudity of the new leaders and the "excesses" of their new regime, but he greatly sympathized with the long-term national revival promised by the National Socialists. "Much that is good is now also being tried," he wrote as late as October 1933, "and one should recognize good intentions...."

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At the beginning of the 1933-1934 winter semester, Heisenberg learned that he would receive the prestigious Max Planck Medal, and on November 9 he received the exciting news that he had been awarded the 1932 Nobel prize for physics. At the same time, Heisenberg refused to participate in a highly publicized national rally held on November 11 in Leipzig under the auspices of the National Socialist Teachers League. The rally, a widely publicized "demonstration of German scholarship," supported the nation's withdrawal from the League of Nations, to be decided ostensibly by a referendum and an election on November 12. Heisenberg informed the rally organizer, physicist Johannes Stark, that he would not attend.

Numerous teachers and students, four university rectors, and six professors did attend, among them the noted philosopher Martin Heidegger (also a rector). A vindictive Stark informed Leipzig students of Heisenberg's refusal to join the "acknowledgment by professors to Adolf Hitler." Students, delighted by Heisenberg's prestigious prizes but angered by his failure openly to support the cause, were thrown into confusion. "How vehemently the debates swirled about you in those days," one lecture student recalled, "when at the beginning of the winter semester 1933 your refusal to participate in the election rally resulted in a small scandal in the institute! And how much support for you among the students finally outweighed everything else!..."

Late in 1935, as Heisenberg's attention turned again to cosmic-ray showers and high-energy physics, Stark's attention turned to the control of REM [Reich Education Ministry] appointment policy and to Heisenberg in particular. The Munich faculty had begun to seek a successor for Stark's old nemesis, Arnold Sommerfeld, and Sommerfeld made no secret of his top choice for the position—Werner Heisenberg....

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In the fall of 1937, after the SS onslaught had delayed Heisenberg's appointment once again, the Munich Teachers League began proposing its own candidates to succeed Sommerfeld, all of whom Sommerfeld and colleagues rejected as unqualified. Most had little training in theoretical physics, and none could be considered suitable as a successor to the great Sommerfeld. The danger that one of these individuals rather than Heisenberg would nevertheless occupy Sommerfeld's chair vastly increased after a conference of university rectors in December 1937. At that meeting Wacker, apparently seeking closer ties with Hess's organizations, agreed to consider "political reliability" a specific criterion for faculty appointments. He further agreed that Hess, with the willing assistance of his Teachers League, should politically evaluate candidates for professorships. The implication was clear. Heisenberg would never succeed Sommerfeld unless the Nazi students and teachers could be convinced of his "reliability," and that was impossible without SS "exoneration."

Heisenberg himself chose not to discuss the investigation in any of his memoirs—he did not even discuss it with his wife at the time. Moreover, the SS records of the investigation were apparently lost in the war—SS functionaries burned as many documents as they could get their hands on in the last days of the Third Reich. Other sources indicate that Himmler's investigators apparently focused on two areas: Heisenberg's ideological standpoint in scientific matters and his personal and political orientations. The SS—hardly an objective agency bent on exonerating those falsely accused of traitorous actions—employed its already infamous methods to discover the "truth." Heisenberg had to endure long and exhausting interrogations; spies were planted in his classroom and throughout the institute; the Gestapo bugged his home. The SS also used another tactic it had perfected: bringing an even more serious charge against the victim, who would then be all too eager to "confess" to the lesser, original charge in order to escape the greater danger.

The more serious charge brought in this case indicates that Heisenberg was indeed in grave personal danger. Hints regarding the charge are found only in letters surrounding the investigation. The accusation is spelled out in one such letter in November 1937 regarding the article in *Das Schwarze Korps*: "Not everything, however, is in the article; for example Heisenberg is not clean with respect to 175; he indeed married quickly but only to cover this up." The reference is to section 175 of the old Weimar criminal code, in effect to this day, making male homosexuality a crime. If convicted of this crime in 1937, the offender landed immediately in a concentration camp.

The imputation requires careful handling. First, it is an accusation made by a dedicated SS functionary engaged in a campaign of character assassination. Such a source is hardly reliable or objective. Second, the SS often used the charge of homosexuality to extract confessions to lesser crimes. Third, it is true that Heisenberg did prefer the company of younger men, and one or two in particular. The investigation, however, which no doubt involved interrogations of some of these younger companions, apparently yielded no evidence of homosexuality; if it had, that evidence would certainly have been used against him. Moreover, if the SS functionary did think he had such evidence, it may have concerned the Wyneken affair in the Bavarian Neupfadfinder, which had caused a considerable scandal in the early 1920s. Apparently it had not involved Heisenberg's group. Heisenberg did marry rather precipitously for various reasons, but there is no indication that concealing homosexuality was one of them.

The agony that such accusations must have caused Heisenberg is evident in his annual assessment of his life. In a long letter to his mother in November 1937, he expressed his feelings more openly than usual: "I wish for the coming year a clearing away finally of these horrible things, for, as unwillingly as I admit it, such a struggle poisons one's entire thoughts, and the hate for these fundamentally sick individuals who torment one eats into one's soul." A week later, as he looked forward to his first Christmas with his new wife, he had entirely withdrawn into quiet family pleasures: "In this we realize once again how important living together with decent people is." Nevertheless, the accusations and investigations of 1937-1938 had a lasting effect on Heisenberg.

Heisenberg's correspondence in that period indicates several difficult trips to Berlin to further his case. At least one of these was for an official interrogation in the notorious basement chambers of the SS headquarters at Prinz-Albert-Strasse 8. A cynical sign reading "Breathe deeply and calmly" hung on the bare cement wall as a constant reminder to the victim of his or her predicament. Of the three known SS investigators assigned to Heisenberg, one worked with the Sipo (Sittenpolizei), or morals police, and all three had some training in physics. Heisenberg had even participated in the oral examinations of one of them for his Leipzig doctorate in physics! Convinced by Heisenberg himself, his diplomatic Berlin supporters, and their own conscientious investigation, all three turned into strong and valuable supporters thereafter....

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If no actual attempt was made to construct an atom bomb in Germany (regardless of whether a reactor was or was not intended as the first step in that direction), a strong difference of opinion emerged between German and American scientists as to why the attempt was not made. The loudest and most divisive debate occurred between Heisenberg and the former Alsos science head Samuel A. Goudsmit, then professor of physics at Northwestern University. Goudsmit offered his highly influential views in a series of articles and in a monograph, widely read among American scientists, entitled *Alsos*. Their debate raged through the pages of the *New York Times* and in an exchange of long and fascinating letters.

In many ways Goudsmit was bitterly disillusioned concerning Germany, German science, and one German scientist in particular, Werner Heisenberg. Moreover, the broader concerns that he and his colleagues faced regarding science in the United States were quite different from those the Germans were facing. As the cold war deepened, the paramount issues for American scientists were those of secrecy, administration, and the relationship between science and the military. Goudsmit expressly intended his account of the failed German project—

"failed" apparently because it did not produce an atomic bomb—as a case study of what can go wrong, an example of "how incompetent control (which is not restricted to totalitarian countries) can kill scientific progress in a short time." If Heisenberg was arguing the competence and success of the German scientists in preserving their science and their scruples under Hitler, Goudsmit was arguing just the opposite—each, in part, for his own contemporary audience. And indeed each audience has tended ever since to subscribe to the respective views Goudsmit and Heisenberg offered.

According to Goudsmit, a variety of factors caused the death of science in Nazi Germany. Nazi racial doctrine removed essential personnel from the laboratory and the classroom and weakened the scientists' adherence to fundamental scientific theories. The organization of German science and its support systems was disastrous in its lack of coherence and cooperation. The scientists themselves, who had grown accustomed to leading the world in modern science, became convinced that their superiority was absolute and therefore grew complacent: if they could not make an explosive uranium-235 bomb, neither could the Allies. And finally, said Goudsmit, the German scientists indulged in an excess of hero worship, such as that practiced by "the smug Heisenberg clique," that overlooked less heroic but more practical-minded technicians such as Diebner or the self-made Manfred von Ardenne.

The German researchers had concentrated on a reactor because they believed that, uncontrolled, it would eventually explode. But even then, they believed that the Allies were far behind them. In Goudsmit's opinion, the Germans had completely missed both fast-neutron fission and the plutonium alternative. If they had seen them, they, like the American scientists, would have pressured their government for more support. Thinking themselves far ahead, wrote Goudsmit, in actuality German scientists had only the vaguest notions of how a uranium bomb or even a reactor actually works, as shown by the lack of control rods in their experiments. They were obviously far behind the Allies in such technical efforts as isotope separation and moderator testing and production.

Heisenberg vehemently objected to Goudsmit's account on nearly every score. In long exchanges with Goudsmit, in letters to and interviews with the *New York Times*, and through C.F. von Weizsacker and B.L. van der Waerden, then in the United States, Heisenberg vigorously maintained the advanced state of German war research. Possibly through his American uncle Karl, still living in New York, Heisenberg gained the backing of Waldemar Kaempffert, the German-American science editor of the *New York Times*. In an interview by Kaempffert, in response to Goudsmit's *Alsos*, Heisenberg, speaking "with an objectivity that is convincing," insisted that the destruction of German industry and unresolved technical problems forced the German scientists to give up "the idea of devising an atomic bomb and to concentrate on the development of atomic power for industry." Three days after the interview appeared, Goudsmit wrote a letter to the *Times* taking issue with Heisenberg's account. "Heisenberg stresses the lack of industrial resources during the second half of the war. The book, 'Alsos,' points at the lack of vision of the German scientists." Kaempffert angrily replied that "liars do not win the Nobel prize"—a remark that prompted Goudsmit's publisher to inquire of Einstein whether in fact Nobel laureates do lie.

Erratum

In the introduction to Steven Goodman's article "Have You Ever Meta-Analysis You Didn't Like?" (*Current Contents*, 28 October 1991, p. 8), two of the names in reference 13 were misspelled. The correct reference is: **Dickersin K., Higgins K., Meinert C L.** Identification of meta-analyses—the need for standard terminology. *Contr. Clin. Trial.* 11:52-66, 1990.