

Windows into the lives of the men who developed quantum physics

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Jones, Sheilla: The quantum ten: a story of passion, tragedy, ambition and science. Oxford University Press, Oxford, 2008, xii + 323 pp, US \$24.95 HB

Farmelo, Graham: The strangest man: the hidden life of Paul Dirac, quantum genius. Faber and Faber, London, 2009, x + 539 pp, £22.50 HB

Cassidy, David C.: Beyond uncertainty: Heisenberg, quantum physics, and the bomb. Bellevue Literary Press, New York, 2009, 480, £27.00 HB

Will readers 80 years from now be interested in the lives and times of the scientists winning today's Nobel Prizes and Fields Medal? I ask this rhetorical question because over 80 years have passed since the scientists who developed quantum physics did their work, and still we are interested in reading about not only their work but also their colorful, sometimes tragic, lives, as well as the politically volatile times in which many of them actively participated. As the three books under consideration here attest, even at a time when book publishing is retrenching, one highly regarded academic press, one distinguished press associated with T. S. Eliot (a Nobel laureate poet who may well have rubbed shoulders at the Institute for Advanced Study with some of the quantum scientists), and a fledgling literary press with the mission of publishing "books at the intersection of the arts and sciences," have all devoted their resources to biographical works focused on the group of scientists whose theoretical work has led to the development of lasers, medical imaging, and transistors, among other things.

All three biographers have done extensive research in the kinds of primary documents that deepen our understanding of their subjects. Sheilla Jones's collective biography of the eponymous group that the jacket blurb calls "the ten key figures who wrestled with the mysteries of the new science of the quantum"

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provides an excellent introduction for readers who have little previous background information about the exciting story of the development of quantum physics. Jones's *Quantum Ten* are, in the order in which she introduces them in a two-page spread preceding Chapter One, Albert Einstein, Niels Bohr, Paul Ehrenfest, Max Born, Erwin Schrödinger, Wolfgang Pauli, Louis de Broglie, Werner Heisenberg, Paul Dirac, and Pascual Jordan. Just as a playwright often lists some telling detail about each of the *dramatis personae*, Jones shapes our responses to the scientists even before we begin reading the book itself, using such characterizations as “An enthusiastic womanizer who was constantly getting distracted from his innovative work in science by the pleasures of the flesh” (Schrödinger) and “A moody young man with a fondness for nightclubs and wine who would sink into a depression when he failed to live up to the exalted standards he set for himself in his work” (Pauli).

Aside from the fact that it focuses on ten scientists rather than one, it differs from the other two books in another, more significant, way. Jones—who, as we also learn from the blurb, is “an award-winning Canadian journalist and former CBC news editor with an advanced degree in theoretical physics”—challenges a point Farmelo makes toward the end of *The Strangest Man*: “Most young physicists... are concerned not with the internal logic of quantum mechanics but with using the theory as a way of getting quick and reliable results” (429). Jones, by contrast, asserting that “leading physicists have been saying for years that nobody understands quantum physics” (15), devotes her book to the very “re-examination of how quantum physics was created,” in the hopes that doing so “can shed some small light on why, after 80 years, physicists are still having so much trouble reconciling the classical and quantum worlds” (16). Her book, then, is a challenge to what she calls “the entrenched resistance in the discipline to looking that old quantum elephant in the eye. If the reason that the very smart and talented people working in physics cannot reconcile quantum physics with relativity is that quantum physics is somehow flawed or mistaken, it’s time to open it up to discussion again. If it’s relativity that’s the problem, well, that’s another story” (292)—and not the one she’s chosen to focus on here.

Jones has an inkling that the problem with quantum physics can be traced to the Fifth Solvay Conference of 1927, attended by all but one of her Quantum Ten, where there was what she calls a “showdown” among several interpretations of quantum physics: “de Broglie’s classical pilot wave theory, which sought to integrate wave-particle duality via pilot waves; Schrödinger’s semi-classical wave mechanics; ... Heisenberg and Born’s non-classical, probabilistic quantum mechanics (a blend of wave and matrix mechanics)” (255), along with Bohr’s complementarity theory—the principle that both wave and particle behavior must be considered for an understanding of atoms, which, following the Solvay Conference, was expanded into the “Copenhagen interpretation,” to encompass the principle of uncertainty as well. According to Jones, after World War Two, “a scientific mythology emerged,” according to which not only had “the version of quantum physics promoted by those working with Niels Bohr in Copenhagen... won the day at the 1927 Solvay Conference and been declared the winner,” but also that “all the issues and questions” about quantum physics “had been settled at that time,”

obviating the need “to revisit the creation of quantum physics” (14–15). This book is Jones’s attempt to revisit that creation herself.

The task Jones thus takes on leads to another obvious difference between her book and the other two biographies. While Farmelo and Cassidy trace the lives of their subjects chronologically from birth to death, Jones focuses on a period that begins with what she sees as the roots of the quantum revolution in the work of Helmholtz, Boltzmann, and Planck, to the years immediately following the 1927 Solvay Conference.

Jones never really convinces me that the papering-over of the confrontation at that conference underlies whatever may still ail quantum physics, but I nonetheless learned quite a lot from her story about its various participants, and most especially about Ehrenfest. Jones says that Ehrenfest’s life “did, very much, mirror the development of quantum physics. He had been with Boltzmann, who started it all with his imaginary ‘chunking’ of energy, and worked with both Planck’s and Einstein’s ideas on quantization” (286–287). As author of young-adult biographies of both Bohr and Einstein, I had been aware of the role that Ehrenfest played in their interactions but knew little else about him. Even though Ehrenfest’s actual contributions to quantum physics are not on a par with those of the others, he did play a significant role in the history of its development about which I was glad to learn more from Jones’s extensive coverage, though saddened to learn of the psychological troubles that plagued him. My horizons thus broadened, I was able to appreciate all the more Farmelo’s additional insights about Ehrenfest, and was especially moved to read about Dirac’s sense of guilt that he might have done something to keep Ehrenfest from committing suicide. I hope someday to visit the colloquium room in Leiden to see the wall installed there from the Ehrenfest bedroom, covered with signatures of the many scientist guests and spouses who enjoyed the home hospitality of Paul and Tatyana.

Aspects of Jones’s narrative that raise my hackles are related to my own biographical efforts. I am much more of a Bohr fan than is Jones, who blames Bohr for whatever the shortcomings of quantum physics may be. While she grudgingly concedes that “He’d earned his Nobel Prize” and that his “institute was a place of great intellectual stimulation and simple fun,” with Bohr taking good care of “the people around him” (278), she obviously disapproves of the adulation his disciples heaped on him: “Bohr was not superhuman, yet his pronouncements on quantum theory were judged so subtle or so deep that even the world’s leading physicists were not smart enough to fathom what he was saying.... Bohr might well have been speaking gibberish, but who dared say so? Before long, physicists could not even question the shortcomings of quantum physics. Challenging quantum physics became conflated with doubting the great Bohr, and anyone who dared to criticize quantum physics quickly brought the wrath of the Bohr disciples upon his or her head” (279).

Jones also makes a small error in her biographical coverage of Bohr. She says that “the pretty blonde Margrethe,” whom Bohr married in 1912, was “the sister of one of Harald’s [Bohr’s mathematician brother’s] friends” (73). In fact, Niels and Harald together participated at university in an informal student discussion group with another pair of brothers, the Nørlunds, who were Margrethe’s brothers.

At least Bohr is a major player in her tale, but why does Jones have to pick on Marie Curie, whose biography I have also written? Even though Curie participated in the 1927 Solvay Conference, I see no reason for Jones to bring up the affair between Curie and Paul Langevin that created a scandal following the first Solvay Conference in 1911, or why it's important to know that "The scandal spawned at least five duels in defence of Curie's honour," especially since Jones admits that "Sixteen years later, the grand passions of that affair had long since cooled" (23). Nor do I understand why it's necessary for Jones to quote Einstein's comment about Curie's lack of sex appeal (23), especially since it's not unlikely that Einstein said "she is not attractive enough to become dangerous to anyone" in order to keep his wife from becoming jealous when Einstein interacted professionally with Curie.

To my mind, Jones's book shares a flaw with Farmelo's: each introduces every chapter with an epigram, most of which seem pretty pointless. Perhaps because I found so many of the epigrams distracting and irrelevant, the several that strike me as apt and illuminating stand out in my memory. Of these, the most striking is one with which Farmelo opens his book, from John Stuart Mill's *On Liberty* (1869): "[T]he amount of eccentricity in a society has generally been proportional to the amount of genius, mental vigour, and moral courage which it contained. That so few now dare to be eccentric, marks the chief danger of the time." While Dirac clearly needed no marching orders from Mill or anyone else to give him the courage to be eccentric, we do know that in his final undergraduate year at the University of Bristol, attempting to understand "step by step, how Einstein had developed his ideas" on the general theory of relativity (39), Dirac was inspired by a series of lectures by Professor of Philosophy Charles Broad to read Mill's *A System of Logic*, "which the young Einstein had studied some 15 years before" (43). As Farmelo notes, Mill's 1843 scientific agenda, which Dirac recalled reading "all through," would have introduced him to "the important idea that the disparate scientific observations and theories he had learned about had an underlying unity" (44). Farmelo later connects what he calls Dirac's "top-down approach" of thought to this search for underlying unity. In developing his chef-d'oeuvre, for example, his relativistic equation for the electron, "Rather than tinker with existing equations, he took the top-down approach, trying to identify the most general principles of the theory he was seeking, before going onto express his ideas mathematically" (141).

In Farmelo's final chapter, "Legacy," he broadens the connection through John Stuart Mill to Einstein, asserting that "Dirac was a great scientist, one of the few who deserves a place just below Einstein in the pantheon of modern scientists," assuming that the criterion of scientific greatness is a scientist's success in revealing "more than a typical share of nature's secrets" (428). Like Einstein, too, another measure of Dirac's scientific greatness is what Farmelo calls posthumous productivity: "many of the concepts he introduced"—including the Dirac equation, relativistic quantum field theory, the existence of antimatter, and a quantum theory of magnetic monopoles—"are still being developed, still instrumental in modern thinking" (430). He points to the possibility that the Dirac equation, "once seen as mathematical hieroglyphics with no relevance to everyday life," may become "the theoretical basis of a multi-billion dollar industry" if the branch of spintronics—spin-based electronics—enables engineers to produce spin-based transistors (429),

and suggests that Dirac's work on isotope separation may eventually be used in the nuclear industry.

The Strangest Man is a long book, but it is engrossing from beginning to end. The title of the book is elucidated in Chapter Eight, where Farmelo—harkening back to Mill's passionate endorsement of eccentricity—notes amusingly that “even by the standards of theoretical physicists [Dirac] was profoundly eccentric” (107). Max Delbrück is quoted as describing the experience of entering a seminar at the University of Göttingen—one of the main centers of quantum physics: “you could well imagine that you were in a madhouse” (125). The mecca of quantum studies, however, was probably Bohr's Institute of Theoretical Physics in Copenhagen, and it was Bohr who, according to Farmelo, most enjoyed entertaining his visitors with stories about Dirac's eccentricities. “Four years before he died, he told a colleague that, of all the people who had visited his institute, Dirac was ‘the strangest man’” (120). (Of course, as Jones reminds us, Bohr's colleagues also relished recounting instances of that great man's eccentricities. She quotes, for example, from a letter Ehrenfest sent his students George Uhlenbeck and Samuel Goudsmit, describing Bohr's obsessive-bordering-on-mad behavior during the 1927 Solvay Conference, when Bohr thought nothing of awakening Ehrenfest in the middle of the night for help with the thought experiments with which Einstein had challenged him during the day: “Every night at 1 a.m.... Bohr came into my room just to say ONE SINGLE WORD to me, until 3 a.m.”) Nor was Bohr the only one to call Dirac “strange”; even Dirac's close friend Anna Kapitza, on learning of his marriage, writes to the new Mrs. Dirac, “I hope you will be very happy with that strange man, but he is a wonderful creature and we all love him very much” (286).

Farmelo withholds some interesting insights from us until the penultimate chapter, “On Dirac's Brain and Persona.” There we learn that Farmelo—now Senior Research Fellow at the Science Museum in London and an adjunct professor of physics at Northeastern University in Boston—was inspired to become a theoretical physicist as a teenager, when he was introduced to Dirac in an unusual way: “I first heard his name on a suburban doorstep, when I was hawking subscriptions for a weekly raffle in aid of the Liberal Party.... When I was closing a sale on a spring evening in 1968, my new customer—a distracted, oddly engaging man by the name of John Bendall—mentioned perfunctorily that he was a theoretical physicist. We became friends, and, during several Sunday-morning chats in his front room, I realised that he was a Dirac fanatic: Bendall would find an excuse to introduce his hero's name in every conversation lasting longer than a few minutes.... Minutes after I first browsed through [Bendall's] copy [of Dirac's *The Principles of Quantum Mechanics*], I knew I too wanted to be a theoretical physicist” (420).

The major revelation of Chapter Thirty, however, is Farmelo's hesitant diagnosis of autism to account for Dirac's strangeness. It would be an understatement to call the Dirac to whom Farmelo has introduced us in his first 29 chapters a man of few words; perhaps my favorite Dirac story among those Farmelo offers is his colleagues' coinage in about 1925 of “a new unit for the smallest imaginable number of words that someone with the power of speech could utter in company—an average of one word an hour, ‘a Dirac’” (89). Although Dirac himself later in life

suggested to a select few that his vexed relationship with his educator father explained his withdrawn nature, Farmelo concludes otherwise: “Much more likely, it seems to me, is that the relationship between Paul and [his father] was doomed by nature rather than nurture: the young Dirac was born to be a child of few words and was pitifully unable to empathise with others, including his closest family” (427). Acknowledging that “one should be extremely careful about making this diagnosis” and that “it is not easy to psychoanalyse someone who is dead” (421), he notes that the characteristics associated with autism—“reticence, passivity, aloofness, literal-mindedness, rigid patterns of activity, physical ineptitude, self-centredness and, above all, a narrow range of interests and a marked inability to empathise with other human beings”—all characterize Dirac’s adult behavior, and that these are the characteristics “at the root of the humour in almost all the tales about Dirac physicists have been telling each other for decades: almost all of these ‘Dirac stories’ might also be called ‘autism stories’” (422). Farmelo notes that brain-imaging techniques demonstrate that “the regions linked with the process of ‘reading other people’s minds’ in the brains of people with autism are noticeably less active than in most other people” (423). He fails, however, to note an irony pointed out elsewhere: the PET scans that can show these brain tissue irregularities are a medical application of the antimatter that Dirac was first to predict (F. Close, “Paul Dirac: a physicist of few words,” *Nature*, vol. 459, 21 May 2009, p. 327).

At the risk of resembling Dirac, who when asked what he thought of Dostoevsky’s *Crime and Punishment*, called it “nice,” but noted that “In one of the chapters the author makes a mistake: he describes the sun as rising twice on the same day” (339), I nonetheless was troubled by a few minor errors in Farmelo’s book: (1) I think his description of Einstein’s war effort in Chapter Twenty-two is at least misleading. Farmelo asserts that “Roosevelt invited Einstein to join a committee of government advisers but he brusquely declined and sat out the war at the Institute for Advanced Study in Princeton, where word spread that the Nazis were indeed working on a bomb” (307). The picture painted by Einstein biographer Denis Brian in his 1995 *Einstein: A Life* is rather different. According to Brian, World War II transformed Einstein “from a crusading pacifist into an eager war worker.” Although Einstein made no appearances at any government-organized conferences, he became a consultant in June 1943 to the US Navy’s Bureau of Ordnance, telling a friend, “So long as the war lasts, I do not want to work on anything else.” (2) Farmelo also makes a couple of minor errors regarding Oppenheimer and his wife. The former became director of the Institute for Advanced Study not in 1946, as Farmelo says (342), but in 1947. The latter did not become an alcoholic only in the aftermath of her husband’s security clearance hearings in spring 1954, as Farmelo asserts (352), but rather showed signs of alcoholism over a decade earlier. Jennet Conant, for example, in her 2005 *109 East Palace: Robert Oppenheimer and the Secret City of Los Alamos* notes that “Everyone drank at Los Alamos, but Kitty drank with an abandon that was disturbing to watch and which clearly destined her for the alcoholism that took hold as the war came to a close.” (3) Farmelo is inconsistent in attributing a religious affiliation to Dirac’s brother-in-law, Joe Teszler, a Budapest friend of Dirac’s wife Mancí (née Margit Wigner). When we first meet Joe, we learn that he was “a

Roman Catholic”—“an essential requirement for Betty” (286). A few pages later, however, Farmelo places the couple in occupied Holland, where, “Joe, like all the other Jews, lost much of his freedom” (308). While we can assume that Joe was a convert, Farmelo might have clarified that. (4) Somerset Maugham’s 1915 masterpiece is not *On Human Bondage* (315), but rather *Of Human Bondage*—a book loaned to Mancini by Jim Crowther, the Marxist science reporter of the *Manchester Guardian* and a great “favourite” of Mancini’s, to “help her improve her English and her understanding of British foibles.”

Preparing to shift attention to Cassidy’s biography of Heisenberg, we may note that the discoverer of the uncertainty principle pops up quite frequently in Farmelo’s coverage of Dirac’s life. Although, as Farmelo notes, the two men, though close in age, were “very different” (82), their collegial relationship prompted each to act on the other’s behalf during and after World War II. Worried about his sister’s safety in wartime Holland, Dirac asked Heisenberg—who chose to remain in Hitler’s Germany—to intervene, leading Heisenberg to “[attest] to the occupying Nazis that she was not Jewish” (325). When, in summer 1945, the British sequestered at Farm Hall several German scientists suspected of having worked on nuclear projects for the Nazis, Dirac, though living only fifteen miles away in Cambridge, had no awareness of the interment of Heisenberg or any of the others. When the two men met for the first time after the war, Dirac “accepted Heisenberg’s explanation of his wartime conduct at face value and believed Heisenberg had behaved reasonably in an extremely difficult situation,” whereas Mancini, like many others, thought Dirac was taken in and called Heisenberg “That Naaaaazi” (340). Even during the war, Dirac not only supported Heisenberg for foreign membership of the Royal Society but also asked German-Jewish emigré Max Born to support him as well. Among the contrasts between Dirac and Heisenberg to which Farmelo points is Dirac’s devotion to mathematical beauty, which Heisenberg downplayed in favor of agreement with experiment. Farmelo discusses a 1965 debate on the topic between the two, filmed for BBC2’s science series *Horizon*, in which “Dirac took up the cudgels for aestheticism, forcing Heisenberg onto the defensive.” Dirac prevailed, Farmelo suggests, because Heisenberg “had been weakened by years of postwar humiliation” (377–378). Despite Dirac’s victory in debate, the producer of the film noticed that “away from the *mêlée*, Dirac followed Heisenberg like a butler” (377). A couple of years later, Heisenberg asked Dirac for comments on his new theory of particle physics. Dirac gave it “the thumbs down... because its basic equation had ‘insufficient mathematical beauty’” (380). It is interesting to read, too, that while Dirac in his seventies no longer kept up to date with the latest physics journals, Heisenberg “kept an open mind about new theoretical developments until liver cancer took his life in February 1976” (400).

I am a great admirer of Cassidy, Professor of Natural Sciences at Hofstra University and author, among other books, of *J. Robert Oppenheimer and the American Century*, which I have also reviewed for *Metascience* (N. Pasachoff, “The Many Facets of J. Robert Oppenheimer,” *Metascience* 15, 2006, pp. 251–263). *Beyond Uncertainty*, the book under consideration here, is a new, expanded version of Cassidy’s 1991 *Uncertainty: The Life and Science of Werner Heisenberg*, winner of the American Institute of Physics Science Writing Award and the History of

Science Society Pfizer Award. Cassidy, an inveterate scholar and researcher, was not satisfied to rest on his laurels. As the Foreword informs us, what led to the revision of an already highly acclaimed book was the release over the years since its publication of important material, including “captured German war documents in formerly Soviet archives,” along with documents from the former East Germany and other countries in the FSU “relating to Nazi science policy and antiscientific propaganda”; Heisenberg’s letters to family members, published by the Heisenbergs in 2003; drafts released in 2002 by the Niels Bohr Archive in Copenhagen of unsent letters from Bohr to Heisenberg, beginning in 1957, reflecting unfavorably on Heisenberg’s visit to Bohr in German-occupied Copenhagen in 1941; and recently declassified transcripts of the secretly recorded conversations among the German nuclear scientists interned at Farm Hall, which, among other things, shed light on “the formation of a postwar rationale for their work” on behalf of Germany during the war (8). Cassidy believed that incorporating this new material could result in a more comprehensive biography that would appeal to a general audience, including those lacking grounding in quantum physics or even in the history of the period. He has met this goal with great success.

Cassidy also succeeds in the following goal outlined in the Foreword: “to provide today’s readers with an appreciation of how difficult it was for a ‘mere scientist’ to respond to a regime for which he... [was] completely unprepared” (10). Knowing today how different the Nazis were from anything that came before them, it is easy to harshly assess the German academics for doing nothing. But Cassidy reminds us that “the new regime had come to power... under the guise of legality,” and that “professors did not recognize the utter contempt in which Hitler and his cronies held intellectuals and the law” (211), nor could they predict at the outset “the incarnate evil of the death camps” (218) or “the evil nightmare that the Nazi dictatorship became” (210). Cassidy provides enough information about Heisenberg’s upbringing in a Bavarian academician’s home during a politically turbulent period in German history to make it possible for us to empathize with Heisenberg’s decision to remain in Nazi Germany without necessarily accepting that he had no other choice. We are able to “comprendre tout,” so to speak, without feeling we must “pardonner tout.” Cassidy’s book is no whitewash.

Among the themes Cassidy develops is the German intelligentsia’s tradition of avoiding the dirty world of politics “as antithetical and detrimental to scholarly objectivity” (204). The impetus to steer clear of political involvement only deepened during the economic crisis and political instability enveloping Germany following World War I. Heisenberg’s own retreat from politics, Cassidy explains, is a variant of this general academic distaste. While Heisenberg considered himself a social democrat and did not reject democratic politics out of hand, “he came to view his physics—along with nature and music—as belonging to a higher plane of existence and truth that somehow transcended the ephemeral, dirty world of politics” (64). Cassidy also points out, however, that holding politics at arm’s length meant that non-Jewish German academics also avoided overtly opposing Nazi anti-Semitism. For those scientists who did oppose the anti-Einstein campaign, which began in the decade before the Nazis officially came to power, the rationale was not that the attack was immoral but rather that Einstein’s

international fame made such an attack unpatriotic, by tarnishing the “foreign image of German physics” (79).

Cassidy demonstrates how deeply Heisenberg, and his fellow Nobel laureates Max Planck and Max von Laue, were implicated in the Nazi system, however little they may have approved of it. When in spring 1933 the Nazis took the first steps to make academia *judenrein*, the three deplored the emigration of their non-Jewish colleagues, including Schrödinger, because of the damage such actions would wreak on German physics; the newly vacant academic slots would surely be filled “by unworthy individuals” (211), causing “a new deep wound” to their profession (214). These brilliant physicists seem never to have considered “that the preservation of decent science under the Nazi regime would support the arguments that National Socialism was not so bad after all and that it was not fundamentally incompatible with the ideals of scientific inquiry” (215–216).

Heisenberg’s attempt to keep his beautiful work separate from the ugly world outside was destined to fail, however. Despite Heisenberg’s acceptance of the requirement that all professors begin public lectures with the Hitler salute and sign official correspondence “Heil Hitler,” he became soon enough the target of those who spearheaded the anti-Einstein campaign, who labeled him the “spirit of Einstein’s spirit” (247) and a “white Jew.” When Heisenberg realized that he would be denied the academic appointments he sought, first as Born’s successor in Göttingen and then as Sommefeld’s in Munich, he did what he felt he must to clear his name. I was astonished to learn how, in his attempt to rehabilitate himself, Heisenberg solicited the assistance of none other than Heinrich Himmler—the head of the entire Nazi police force, including the Gestapo, and one of the most feared men in Europe. Heisenberg’s maternal grandfather and Himmler’s father had been fellow members of a hiking club for rectors of Bavarian gymnasia (high schools). Himmler arranged for the SS to investigate Heisenberg’s life. In July 1938, following an 8 months’ ordeal, Himmler sent an official letter to Heisenberg’s home. In a postscript, he advised Heisenberg that if he wished to continue teaching relativity, he should separate the work from its author. From then on, Heisenberg was careful to use only the title of Einstein’s paper “The Electrodynamics of Moving Bodies” when discussing relativity theory.

Himmler did not, however, use his power to see that Heisenberg—who was not a party member—received the academic appointment he sought in Munich, which indeed went to a mediocre scientist in autumn 1939. In February 1943 Heisenberg was appointed to the directorship of the Kaiser Wilhelm Institute for Physics, coupled with a non-teaching appointment at the University of Berlin, but his decision to remain in Germany was hardly “tantamount to the survival of decent physics” there, as he had hoped it would be (280). The “spirit of Einstein” attack seems to have left Heisenberg so insecure about his own reputation and that of his field that “no amount of recognition accorded him or his physics could ever... reassure him that their status had not somehow declined once again” (336). This insecurity may explain his eagerness to undertake one of the government’s wartime nuclear projects. As Cassidy puts it, although Heisenberg’s “primary interests and expertise lay elsewhere,” he “saw this project mainly as a means to personal and professional ends” (375). Cassidy also suggests that the real reason for Heisenberg’s

1941 visit to Bohr—the subject of Michael Frayn’s much admired play “Copenhagen”—was not to seek ethical advice or to “stave off an Allied crash program in nuclear fission research” (314) or “to assure himself that Bohr and his institute were unmolested by the German occupation” (316), but rather to participate in a German propaganda event as a means “to prove his reliability to regime officials” (316).

While Himmler may not have pulled every available string on behalf of Heisenberg, Himmler as well as other high-ranking officials who helped clear Heisenberg’s name following the “white Jew” attack, may—albeit out of self-interest—have shielded him from interrogation following the abortive plot to assassinate Hitler. I hadn’t known of Heisenberg’s membership in the Wednesday Society, an elite Berlin men’s club that served as “a breeding ground for the... conspirators of the failed coup d’état of July 20, 1944” (344). Eight days before the attempt on Hitler’s life, Heisenberg hosted the society’s final meeting, and though many of the society’s members were executed or encouraged to commit suicide, Heisenberg was not even called in for questioning, perhaps because of the intervention of his former backers, who feared that their support of such a man might call their own “judgment, and loyalty ... into question” (336).

Of the many other things I learned from this nuanced biography, perhaps the most poignant relates the greatest satisfaction of Heisenberg’s last years to his 1920s relationship with Bohr—a relationship he never could mend following his wartime conduct and postwar self-exonerations. In 1952 Heisenberg became president of the Alexander von Humboldt Foundation, whose mandate was to bring foreign postdocs to West Germany, to broaden the young researchers personally and to renew their countries’ interactions with German science. “As a one-time foreign postdoctoral student in Denmark, Heisenberg knew the value of work abroad and came to cherish the Humboldt Foundation presidency above all the many offices he held” (395).

To return to the rhetorical question with which this review began, I cannot predict what books, if any, the descendants of *Metascience* readers will be poring over in 80 years. What I can say, however, is that it is worthwhile for today’s *Metascience* readers to spend some time with each of the three books discussed above.