His fame and reputation, however, have been dogged by controversy and paradox. The same Haber–Bosch process could be used to make high explosives, enabling Germany to prolong the trench warfare of the First World War despite a Royal Naval blockade of mineral nitrogen.

Haber's reputation has been further besmirched by his involvement in poison-gas warfare. On the afternoon of 22 April 1915, Haber and a troop of gas scientists opened the valves of nearly 6,000 cylinders containing chlorine gas in liquid form. A blanket of thick green-yellow gas swept into the Allied trenches, killing some 5,000 Allied troops (a figure that would be revised downwards by Germany after the war) and injuring 10,000 more. The Germans gained only one mile on the Ypres front as a result. Haber was disappointed: he had hoped to unleash a weapon of mass destruction so powerful that it would bring the war to an abrupt end, and he blamed his generals for restricting its use.

These actions earned Haber the reputation of a war criminal, forcing him into hiding for a period after the war. But there was worse. It was Haber who oversaw the research that created the insecticide Zyklon B, which, a decade after this death, would be used in the Nazi gas chambers on his own relatives.

There has long been a need for a book in English on the life of Fritz Haber, and Daniel Charles is the ideal biographer. His previous book, *Lords of the Harvest*, explored biotechnology and the global food supply, an essential dimension of the Haber story.

In *Between Genius and Genocide*, Charles takes in the huge range of Haber's scientific, technological and patriotic interests, including his quest for cheap gold to beat the postwar reparations burden. A typical Haber scheme, hare-brained from one perspective and yet eminently practicable from another, was his attempt in the 1920s to harvest gold from the sea. The Swedish chemist Svante Arrhenius had found tiny amounts of gold in sea water and calculated that every ton of the ocean contained 6 milligrams of the precious metal. After extensive experiments and many trips on the oceans of the world, Haber discovered that Arrhenius was wildly out: sea water contains only 0.01 milligrams of gold per ton.

Nor does Charles neglect the turmoil of Haber's private life, including his marriages. The tale of the suicide of Haber's first wife, Clara — an event that has prompted various contradictory accounts — is a model of scrupulous biography. Clara, one of the first women to get a PhD in Germany, had married Haber in the hope of sharing in his life in science. But it seems she was increasingly isolated by his preoccupation with work, and during the First World War deplored his use of poison gas. After returning from Ypres, Haber threw a party and Clara found him in an "embarrassing situation" with the woman who was to become his second wife. After he had fallen asleep, she took his service revolver and killed herself.

But Charles's principal focus is Haber as a faustian embodiment of science and technology in the twentieth century. For Charles, Haber's fatal flaw is his willingness "to serve any master who could further his passion for knowledge and progress. He was not an evil man." Charles draws the chilling conclusion that the moral choices that Haber confronted during his life "were not so different from those that we face today".

Charles might have gone further to reflect that underlying Haber's flaws is the proposition, widely accepted and promoted by those involved in the public understanding of science today, that science is morally neutral. The Janus-faced nature of the Haber–Bosch recipe seems to support the contention. In Germany, moreover, scientists traditionally worked under the auspices of a civil service that was both apolitical and value free. Yet it was precisely this neutrality that provided an alibi for the German scientific community when Jewish researchers were expelled after the Nazis came to power. Haber was forced out of the Kaiser Wilhelm Institute, which he helped to found in Berlin, despite Max Planck's attempt to argue his case with Hitler. "A Jew is a Jew," Hitler shouted.

The Institute for Physical Chemistry in Berlin now bears Haber's name, but this is still controversial. As the historian Fritz Stern comments in his elegant essay on Haber and Einstein: "The memory lives on — dimly in distorted controversy." Charles's admirable biography will elucidate the controversy and shed fresh light on Haber's memory. ■

John Cornwell is director of the Science and Human Dimension Project, Jesus College, Cambridge, UK, and is the author of *Hitler's Scientists*.

Short cut to space-time

A Briefer History of Time
by Stephen Hawking with Leonard Mlodinow
Bantam Books: 2005. 176 pp. $25

Jim Al-Khalili

The phenomenal success of Stephen Hawking's *A Brief History of Time* demands that the arrival of this new edition be treated as a major publishing event. So let me begin with a few facts. First, *A Briefer History of Time* is not a new book, but rather an updated and reworked edition of the original. Second, it is certainly briefer, at three-quarters the length of the original. Third, the simple black-and-white diagrams of the first book have been replaced by stylish colour images, ranging from the amusing (Hawking and co-author Leonard Mlodinow strapped into their time machine) to the misleading (space-times, of expanding universes and wormholes, embedded within space-time).

So what is the motivation for *A Briefer History of Time*? I will leave aside any cynical accusation of opportunistic marketing because I believe the authors have made an honest attempt here to rectify what they perceive as a problem with the original: that millions of readers with no scientific background did not get beyond the first chapter before their brains blew up. To remedy this, that first chapter has been chopped into three bite-sized

and hopefully, one imagines, more digestible ones. On the whole I like this, but it does seem a bit of a cheat if readers get through the same amount of material before giving up, only now boasting of having seen off three chapters instead of one.

The new book is certainly easier going. The old third chapter ("The expanding Universe") of 11 in the original is now the seventh chapter of 12, highlighting the additional weighting given to introductory material. The three middle chapters ("Black holes", "Black holes ain't so black" and "The origin and fate of the Universe"), which together made up a total of 70 pages in the original, are now lumped into one chapter just 18 pages long. Elsewhere, every attempt has been made to clarify those passages deemed to be hard going. Finally, out goes the chapter on the arrows of time, the diagrams of light cones and event horizons, and discussions of chaotic boundary conditions, and in comes a new crowd-pleasing chapter on time machines.

I find myself unconvinced by this valiant effort, however. Clearly, the incredible success of *A Brief History of Time* was due to a combination of timing, marketing and the persona of the author. It can never be repeated. But what is often overlooked is that its major, paradoxical attraction was its charming incomprehensibility to the non-physicist — the idea that anyone could take a peak inside one of the greatest minds in science. This is lost in the new book. For millions of people around the world, *A Brief History of Time* would have been the only science book they have ever read or attempted to read. But with the briefer version, I feel the baby has been thrown out with the bathwater. It is just another run-of-the-mill popular science book on modern physics. The topics that it claims to treat more carefully have been covered better elsewhere. In any case, many of the topics left in and flagged as more introductory are just as baffling, abstract and abstruse to non-scientists as those left out. Just because quantum mechanics and the special theory of relativity are not at the cutting edge of current thinking doesn't mean they are any less counter-intuitive. The two-slit experiment and the notion of the relativity of simultaneity could have been explained better, especially as the latter receives just a single paragraph.

Fresh material, based on advances made over the past two decades, has been included, such as the concept of 'dark energy' and advances in string theory. I am also pleased to see that the discussion of the anthropic principle is retained. This is a hot topic of discussion at the moment in connection with multiverse theories. However, I found it a little surprising that the idea is still treated rather cautiously here.

I have no doubt that *A Briefer History of Time* will soon be on the shelves of every high-street bookstore around the world. This is surely to be welcomed: any book that can reach a wide audience and get across the excitement of science has to be a good thing. And with Hawking enjoying an iconic status not seen in a scientist since Einstein, his role as an ambassador for science should not be underestimated. ■

Jim Al-Khalili is professor of the public engagement of science in the Department of Physics, University of Surrey, Guildford, Surrey GU27XH, UK. He is the author of *Black Holes, Wormholes and Time Machines*.

Science in society

Victory and Vexation in Science: Einstein, Bohr, Heisenberg and Others
by Gerald Holton
Harvard University Press: 2005. 244 pp.
$35, £22.95

Daniel J. Kevles

In *Victory and Vexation in Science*, Gerald Holton, a physicist and historian of science at Harvard University, provides a series of illuminating historical and biographical essays on science and scientists in the twentieth century. This thought-provoking book mixes reminiscence with scholarly reflection, drawing on Holton's deep knowledge of scientists and their intellectual, religious and social engagements.

The 14 essays range over a variety of topics and are organized into two sections: 'Scientists' and 'Science in context'. The first part covers, in addition to the icons in the book's subtitle, the physicists Enrico Fermi, Percy Bridgman and Isidor Isaac Rabi, and the psychologist B. F. Skinner. The subjects in the second section include innovation in science and art, policy for basic science, postmodernism and science, and women in science. The subjects are disparate, but several arresting topics appear and reappear in the volume.

Among them is the religious impulse that Holton finds behind the science of Einstein and Rabi. As a youth, Einstein was deeply religious in some profound non-sectarian sense, even though he was raised in an irreligious household. After the age of 12, when he began encountering science, his religious inclination was transformed into a strongly felt quest to comprehend the physical world. This drive, Holton says, constituted a flight from "personal, everyday life, with all its dreary disappointments, and escape into the world of objective perception and thought". Indeed Einstein once remarked that the tenacious pursuit of a difficult scientific problem demanded "a state of feeling similar to that of a religious person or a lover".

Einstein ultimately embraced a transcendent spiritualism, free of anthropomorphic and what he considered primitive elements. His views irritated the theologian Paul Tillich and angered clerics such as a Roman Catholic cardinal in Boston, who found intimations of atheism in Einstein's theories of space-time. Queried on the point, Einstein declared that he believed in "Spinoza's God, Who concerns Himself in the lawful harmony of the world, not in a God Who concerns Himself with the fate and the doings of mankind".

Unlike Einstein, Rabi was raised as an orthodox Jew, but while he separated from orthodoxy, Holton notes that deep down he remained "God-struck throughout his life". Like Einstein, Rabi saw science as a means of transcendence beyond the visceral concerns of the human species. He once recalled that physics filled him with awe and put him in touch with a sense of original causes. "Whenever one of my students came to me with a scientific project, I asked only one question, 'Will it bring you nearer to God?'."

The role that intuition plays in science is