

next two chapters, containing well-known information about stars and cosmology, seem unrelated to the book's central topics. To be clear, the presentation in those chapters is accurate, but given the presumed background of the intended audience, it could just as easily have been omitted. Chapter 4, devoted to black holes, is potentially more interesting and more pertinent to dark matter, but its tune is off. It contains some obvious shortcomings; for example, primordial black holes are not discussed as candidates for baryonic dark matter and are mentioned only briefly later in the text.

The core of *Dark Matter, Neutrinos, and Our Solar System* starts with chapter 5, a historical overview of particle physics. The technical content is at an intermediate level, in contrast to some difficult and less pertinent subjects, like Penrose diagrams presented in the earlier chapters. Nonetheless, the introduction in chapter 5 is undoubtedly useful, though perhaps it could have been expanded to better prepare the reader for what is to come.

Chapters 6, 7, and 8 represent the book at its best. In 280 pages they discuss the main issues behind the question of what dark matter actually is and,

in particular, the role of neutrinos. Those chapters could be used for a graduate-level introduction to the subject and for physicists wishing to start their own studies. Chapter 8 deals with the timely and important issue of the supersymmetric particles known as WIMPs (weakly interacting massive particles)—including some discussion of how they might be detected. That chapter concludes the book's explorations of the main particle solutions to the dark matter puzzle.

To fully understand dark matter and neutrinos, the interested reader will need to seek additional material to supplement Prakash's presentation. I cannot refrain from imagining an alternative plan for chapters 1 to 5 that would boost the material presented in chapters 6 to 8. But these observations do not diminish the merits of the book. The ninth and final chapter is a discussion that, although fascinating, again seems off-topic, at least on first reading. It is hard to imagine how Saturn's rings or Mars rovers relate to dark matter. In my opinion, this solar system fraction of the book would be more appropriate as a separate text.

I also could not help but notice how the author transmitted her passion for

the general enterprise of science; many of its historical and human aspects were scattered throughout the book. In particular, her mathematical background shows intermittently, in a sort of *contra-punto* to the physical and phenomenological subjects. Many readers will appreciate that passion, as I did, in this exuberant book.

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Robert Oppenheimer A Life Inside the Center

Ray Monk
Doubleday, 2012. \$37.50 (825 pp.).
ISBN 978-0-385-50407-2

The cover of the May 1948 inaugural issue of *PHYSICS TODAY* featured a photo of J. Robert Oppenheimer's porkpie hat resting on a cyclotron. In *Robert Oppenheimer: A Life Inside the Center*, Ray Monk writes that this important physicist was "so famous that he did not actually need to be pictured in order to be represented." Despite that fame, Oppenheimer has remained enigmatic, even though about a dozen books since 2002

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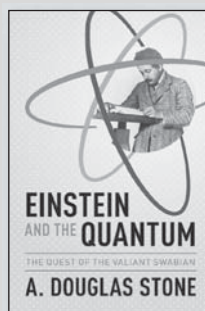
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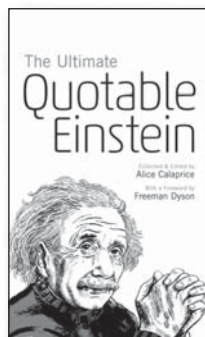


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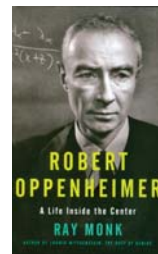
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books

have attempted to explain him. The preeminent work is Kai Bird and Martin Sherwin's *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (Knopf, 2005; reviewed in PHYSICS TODAY, November 2005, page 51).



Thanks to those books, the outline of Oppenheimer's story is well known: He overcame an awkward and lonely childhood and rose to the top of American physics. During the Great Depression, his political awakening brought him into Communist circles. As World War II began, Oppenheimer transformed into the determined and respected scientific leader of the Manhattan Project, the tremendously successful program to build the world's first atomic bombs. After the war he served as a high-ranking government adviser, but because of his earlier dalliances with Communist causes, he fell victim to the Red Scare. After he was stripped of his security clearance in 1954, the humiliation Oppenheimer felt persisted for the rest of his life.

Robert Oppenheimer is suitably complex, and Monk does an excellent job making sense of Oppenheimer's beguiling decisions, such as his insistence in overstaying his welcome as a science adviser during the McCarthy era. But Monk is at pains to set his biography apart. So he presents "Oppenheimer's life as it was shaped and driven by his desire to understand physics," and he downplays the broader political, social, and cultural context in favor of "Oppenheimer *himself*, his extraordinary intellectual powers, his emotional and psychological complexity and his curious mixture of strengths and weaknesses in dealing with other people."

Science dominates the book. Monk covers Oppenheimer's floundering attempts at experimental physics as a graduate student; his proximity, while in Europe, to the 1920s quantum revolution and the transportation of that knowledge to the US; and the birth of big science and quantum electrodynamics (QED) in the 1940s and 1950s. Although Oppenheimer probed the existence of subatomic particles, his greater contribution was in playing a "midwifery role" in the development of QED by encouraging Julian Schwinger and Richard Feynman to elaborate on the theory.

Monk details the many students of Oppenheimer's who went on to shape

the discipline of physics; the book even includes the footnotes from their articles in which they thanked their old mentor. Monk, a professor of philosophy, excels in discussing Oppenheimer's science and in explaining why he succeeded and why he more than once narrowly missed a tremendous breakthrough.

But *Robert Oppenheimer* suffers when it looks beyond science. Monk, like other biographers, places tremendous importance on Oppenheimer's inability to acknowledge his Jewish heritage. He quotes I. I. Rabi, who famously said that Oppenheimer "never got to be an integrated personality" and "lived a charade" because he spurned his Jewishness and separated himself from the cohesion of the Jewish community. But it seems unconvincing—indeed unfair—to suggest that Oppenheimer, who suffered from depression since his youth, could have overcome crippling and complex mental health problems simply by embracing Judaism.

The book's final chapter noticeably lacks the dogged thoughtfulness of the previous ones. Here Monk piles on lengthy block quotes from almost everything Oppenheimer said or wrote during the last years of his life, with no real payoff for the reader. He even dissects at length the origins of the title of a talk Oppenheimer gave called "The Added Cubit." In addition, Monk misidentifies the well-known chemist George Kistiakowsky as a physicist.

Robert Oppenheimer should appeal greatly to those interested in the physics of the pre- and postwar eras. But as a definitive biography, this book supplements rather than supplants *American Prometheus*. Even after reading Monk's book, it remains an open question whether understanding Oppenheimer's science is essential to understanding him as a person. In emphasizing Oppenheimer the scientist, Monk has obscured Oppenheimer the man. For example, Monk says precious little about Oppenheimer's adult relationships. His children make just a token appearance, and his wife, Kitty, and lover, Jean Tatlock, merit little discussion. Most surprisingly, Ruth Tolman is barely mentioned and never identified as another of Oppenheimer's lovers and as his emotional confidant. In a book this big about someone so opaque, surely there was room for more of the man.

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