American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer FREE

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The Rise and Fall of a Chameleonic Physicist

American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer

Kai Bird and Martin J. Sherwin
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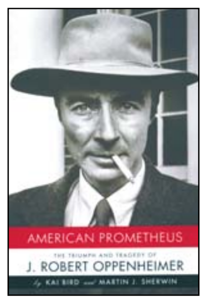
Reviewed by John S. Rigden

J. Robert Oppenheimer is not on the list of great physicists. Given his uncommon intellectual acuity, his absence prompts the question, "Why?" Oppenheimer was a complex individual; however, the contrast between the triumphant and the tragic Oppenheimers is so sharp it begs one to ask, "How could it be?"

Many books and articles have been written about Oppenheimer. Among them, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* by Kai Bird and Martin Sherwin is the most complete I have read, and I recommend it enthusiastically. With telling and interesting details, the authors open Oppenheimer's fascinating and troubling life to the reader. The book is well written and almost free of serious errors. (The authors repeat, on page 57, one error that plagues the history of physics: It was Albert Einstein, not Max Planck, who proposed the light quantum.) As you read *American Prometheus*, the intellectual tension between the triumph and the tragedy is almost palpable. Thus reading this worthy book is a gripping experience: It stimulates the mind and stirs the emotions.

Oppenheimer began his professional life as the theory of quantum mechanics reached its completion. It was a time when, as Edward Condon said (page 63), "Great ideas were coming out so fast. . . ." Oppenheimer mastered quantum mechanics quickly. Yet the great idea that might have secured his place among great physicists eluded him. Or did he elude the great idea?

Oppenheimer's brilliance allowed him to range widely over physics. Max Born, his thesis adviser, said of him (page 74), "He is doubtless very gifted but completely without mental discipline." Oppenheimer's practice was to jump from problem to problem, to start something and move on before he completed it, and to help other people with their problems. As mentioned on page 215 of my book, *Rabi: Scientist and Citizen* (Harvard U. Press, 2000), this behavior is consistent with Frank Oppenheimer's description of his brother: "What my brother did, and was terribly interested in, is a kind of teaching and talking with other people, getting them to get their ideas straight. So that part of his scatteredness was reacting to the ideas around him." Oppenheimer's work habits gave him breadth rather than depth.



His eagerness to help other people with their physics made him an excellent thesis adviser, and his students worshiped him. He and they divided their time between Berkeley and Caltech during the 1930s, and together they built a school of theoretical physics that helped bring the US into the front ranks of world physics.

The 1930s changed Oppenheimer. From a well-to-do family and educated in a private school, he had never known financial need. During the 1930s, he became aware of other worlds. He "saw what the Depression was doing" to his students (page 114). He began regularly reading the newspaper, and the Spanish Civil War became an issue for him. He was friends with active members of the Communist Party and attended meetings where leftist concerns were aired. Later, those political activities would lead to his downfall.

In the early 1940s, the chameleonic Oppenheimer changed again. World War II had begun; the implications of nuclear fission were quietly being discussed by leading physicists, and Oppenheimer wanted in on the discussions. He became a patriot. With his colleague Ernest Lawrence vouching for him, he attended a meeting in October 1941, during which questions about a nuclear bomb were discussed by James Conant, Arthur Compton, Lawrence, and others. Oppenheimer's calculations of the amount of uranium-235 needed for a useful weapon were included in the final report of the meeting and immediately demonstrated his near-instantaneous grasp of any problem. He "could often understand an entire problem after he heard a single sentence," said Hans Bethe (page 182). In a stroke of genius, General Leslie R. Groves selected Oppenheimer to lead the Manhattan Project.

A new age began in August 1945. Physicists spawned the nuclear age, and only they knew the secrets of the atomic nucleus. Oppenheimer was their undisputed leader. In mid-1947, he moved from California to New Jersey, where he became director of the Institute for Advanced Study in Princeton and was easily accessible to Washington, DC. Oppenheimer changed again, becoming a power player and loving it. His brilliance, as always, was impressive, but his propensity to use it to humiliate people made lasting enemies in high places.

Oppenheimer's triumph was laudatory; his tragedy disgraceful. With his lightning-fast mind, he commanded the prima donnas at Los Alamos with such decisiveness that he earned their respect and awe. "He brought out the best in all of us," said Bethe (page 218); Robert Wilson went further (page 218): "In his presence, I became more intelligent, more vocal, more intense, more prescient, more poetic myself." Oppenheimer could be tough, however—almost cruel. "He could cut you cold and humiliate you right down to the ground," said Seth Neddermeyer (page 280). Brilliant, undisputed leader, tough.

Meanwhile, Oppenheimer turned to mush in the face of the officious Lilliputians who were secretly determined to destroy him. In 1943, as his fame and glory were growing, he lost control of his senses and lied to the functionary, Boris Pash, who was interrogating him. Later in October 1945, Oppenheimer behaved so pitifully in President Harry S Truman's office (page 332) that Truman later called him a "cry-baby scientist." Still

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later, in 1954, Oppenheimer totally disintegrated as Roger Robb, with prosecutorial vengeance, questioned him. At one point (page 507), Oppenheimer stupidly responded to Robb with the words, "because I was an idiot." Weak-minded, feeble, pitiful.

For the US, there were also triumph and tragedy. The Los Alamos physicists were given a free hand. President Franklin D. Roosevelt and Groves established an environment with no bureaucratic distractions, in which physicists could single-mindedly pursue a scientific and technical goal. Later, the US revealed its ugly side. Officials at the highest levels behaved wretchedly. With passions sweeping reason aside, FBI Director J. Edgar Hoover, Chairman Lewis Strauss of the Atomic Energy Commission, and, sadly, many others actively set out to destroy Oppenheimer. Several, including President Dwight D. Eisenhower, capitulated as they watched passively. In the tragic affair, national leaders broke the law, lied routinely, and, in exercising their powers, stacked the deck so that the 1954 hearings would achieve their objective: the destruction of Oppenheimer. After the hearings, Oppenheimer lived out his days in Princeton, a shadow of his former self.

Oppenheimer deserved his triumph and his tragedy. And the US deserved its triumph and its tragedy.

Quantum Field Theory of Many-Body Systems: From the Origin of Sound to an Origin of Light and Electrons

Xiao-Gang Wen
Oxford U. Press, New York, 2004. $99.50 (505 pp.).
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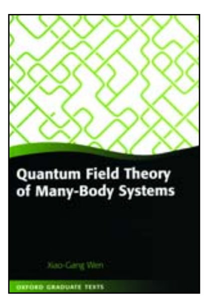

During the past two decades, a quiet but persistent paradigm shift in the quantum theory of solids has been steadily brewing. The field is currently in flux, and the uncertainty as to how it will shake down is palpable. In the old school, band theory—together with Lev Landau's Fermi-liquid theory, which subsumes electron interactions into effective parameters—readily accounts for the basic difference among simple metals, insulators, and semiconductors. In metals, residual interactions that drive instabilities toward, for example, superconductivity or magnetism can be treated with Landau's theory of phase transitions. The central message in Xiao-Gang Wen's remarkably original new book, *Quantum Field Theory of Many-Body Systems: From the Origin of Sound to an Origin of Light and Electrons*, is that an exciting and rich world lies beyond Landau's theories. Belying its familiar main title, the book takes its readers on an exotic tour to the outer reaches of modern many-body theory and seeks to distill the essential ingredients of a possible new paradigm.

Perhaps by necessity within a book this ambitious, the experimental physics fueling the theoretical exploration is largely absent. But such an absence ought not to be taken as dismissal of the pressing—even urgent—need for new ways to understand strongly interacting, many-electron systems. In fact, the experimental picture is quite clear: Many crystalline solids, in which the electrons at the Fermi energy come from partially filled atomic *d* or *f* shells, are nonconformist "bad actors." They stubbornly refuse to fit into the standard framework of band and Landau theory. High-temperature superconductors are the best-studied example but appear to be only the tip of the iceberg of such complex crystalline solids. Constructing a new framework, however, has been exceedingly challenging, with experts disagreeing on even its rough outline.

Wen has arguably been one of the most creative theorists seeking to supplant the existing foundations of solid-state theory. His creative approach finds its roots in the fractional quantum Hall effect, a phenomenon discovered in the early 1980s. When electrons are confined to two dimensions, cooled to cryogenic temperatures, and subjected to intense magnetic fields, they can condense into a novel quantum-liquid state. Like ordinary liquids, these fractional quantum Hall fluids are featureless. But hidden within, the electrons are undergoing a remarkably intricate sequence of dance patterns: They swirl around one another in a dizzying yet coherent fashion. Wen recognized that these dance patterns could be fruitfully characterized in terms of a special kind of hidden order, which he christened "topological order." If confined to the surface of a torus (surely a *gedanken* experiment!), the ground state of the quantum Hall fluid is multiply degenerate: The ground states are locally indistinguishable and differ only in the nature of the nonlocal entanglement between electrons encircling the whole system. Such topologically ordered fluids generically support particle-like excitations that carry fractional quantum numbers: charge $e/3$ for the celebrated Laughlin quasiparticles.

Before venturing into such exotica, one finds that the early chapters of Wen's book are, by and large, devoted to standard topics: the path-integral formulation of quantum mechanics, weakly interacting boson systems, and weakly interacting fermion systems, with the latter including Landau's two pillars. But the author's unique perspective is amply evident on almost every page. For example, Wen offers a new hydrodynamic approach to the Fermi liquid, and the Berry phase plays a rather central role throughout. Those early chapters could serve as a textbook to augment a standard graduate course in many-body theory.

In chapter 6, lattice gauge theory is demystified. Gauge symmetry is rightfully exposed as not being a symmetry at all but rather just a theoretical construct employing a many-to-one labeling of quantum states. That chapter serves as a point of departure from standard theory, with the latter part of the book devoted to Wen's vision of an emerging new paradigm. Central to his vision is the notion of topological order and a more subtle, and apparently less well-defined, concept of quantum order. Exotic spin-liquid quantum states, which arise in toy models of quantum magnetism, are concrete examples. Despite their aesthetic appeal, the relevance of these exciting new theoretical developments to the experimental puzzles presented by complex, strongly correlated electronic crystals is currently unclear—although it would seem that the potential relevance is quite significant.

Throughout the book, Wen's prose is informal yet strikingly clear and incisive. The message is buoyant and optimistic. Each section has a highlighted bullet or two encapsulating a key snippet of philosophy. Problems are scattered throughout. One minor stylistic quibble: Quantum field theories vacillate between 1+2 and 2+1 spacetime dimensions—perhaps a case of quantum dyslexia.

In the final chapter, Wen turns his attention to particle physics. He argues that it should be possible to obtain the standard model of particle physics—nonabelian gauge interactions, the photon, and Dirac fermions—starting