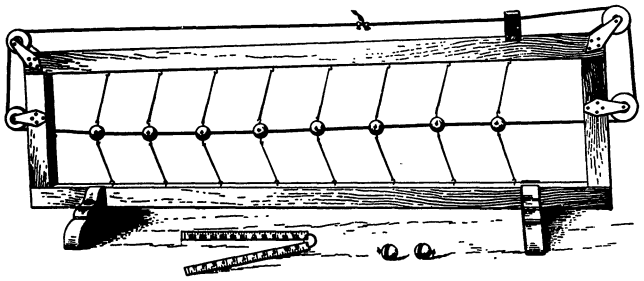
the four now called "Maxwell's equations." It was he, before Gibbs, who developed vector analysis. He invented the crucial idea of the inductive loading of cables and contributed significantly to the theory of duplex telegraphy (the beginning of communications theory). His mathematical methods have been much praised, though two of the best-known—the operator calculus and the "Heaviside step function" (from which came Dirac's delta function)—are not strictly his. The step function appears in Maxwell's *Treatise*, and the operator calculus was developed by D. F. Gregory and others at Cambridge in the 1830s.



Oliver Lodge's string-and-button model of an electric circuit, devised in the 1870s to illustrate Maxwell's theory of electric conduction and dielectric polarization. "The string runs through slots in the buttons, which are attached by rubber bands to the wooden frame. By tightening or loosening the screws holding the buttons to the string, the model can be made to represent either a dielectric or a conducting circuit." [From *The Maxwellians*]

Maxwell founded the Cavendish Laboratory at Cambridge, and most of his British followers were Cambridge men. Hunt's trio were not. Heaviside had no university connection; Lodge gained an external degree (that is, one based on part-time study) at London University and went on to become a professor at Liverpool; FitzGerald lived all his life in Ireland. Hunt argues persuasively that this outsidedness drew them together, though FitzGerald was anything but a social or academic outsider. He was from one of the high Irish Protestant families with connections to Trinity College, Dublin, in its greatest days. His father had been a professor there before becoming a bishop in the Church of Ireland. His uncle, George Johnstone Stoney, also a Trinity man, was a physicist of distinction who deserves remembrance as a pioneer in molecular physics, theoretical spectroscopy, and electron theory. (He invented the word *electron*.) It was from this privileged background that FitzGerald, himself a professor at Trinity College from the age of 30, came to play his special role.

FitzGerald is now remembered for his "contraction" hypothesis to explain the null result of the Michelson-Morley experiment. In reality he did much more. He pioneered the electromagnetic theory of metallic reflection, introduced "retarded potentials" into Maxwell's theory, and derived in 1883 the fundamental equation of radio according to which the radiated power from an oscillating electric charge is proportional to the fourth power of its frequency. Still the contraction hypothesis was his most brilliant idea. The problem is well known. If, as Fresnel had supposed, the earth moves through a fixed ether, then the round-trip travel time for light as measured in an interferometer moving with the earth should be greater for along-track than for cross-track signals. In 1887 Michelson and Morley conclusively demonstrated that the two times are the same. The obvious explanation was that the ether is "convected" (that is, dragged along with the earth) as Stokes had hypothesized for other reasons in 1849; and that was what Michelson thought he had proved. FitzGerald advanced the much more daring idea that the interferometer contracts along the direction of motion by an amount that exactly compensates for the expected delay.

Most physicists hear of this, dismissively, as an ad hoc guess to be contrasted with Einstein's profound kinematical deduction of the relativistic contraction in 1905. In fact, as Hunt demonstrates in one of his most rewarding sections, it followed a fascinating exchange between Heaviside, FitzGerald, and Lodge, at which Heaviside during his first meeting with FitzGerald (8 February 1889) explained a recent result of his, to the effect that the equipotentials around a moving electric charge assume an elliptical shape proportional to $\sqrt{1 - v^2/c^2}$. FitzGerald argued that matter is held together by electric forces and undergoes the same contraction. *Science* should take pride in being the journal in which FitzGerald chose to publish this result, in a letter dated 2 May 1889. So careless was FitzGerald of his jewels, however, that he never bothered to find out whether the letter had appeared (as it did; *Science* **13**, 390 [17 May 1889]).

FitzGerald died at 50 in 1901. With his death the inspiration went out of the little group of friends. Heaviside's reclusiveness got the better of him; Lodge, who lived on to 1940, contributed to the development of radio but achieved most fame as a scientific popularizer and advocate of spiritualism. The personal dynamics of physicists as of other people is mysterious. Sometimes the full power of the individual human spirit is only apparent after it has been removed. That is one of the unexpected lessons of *The Maxwellians*.

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Complexities of Feynman

Genius. The Life and Science of Richard Feynman. JAMES GLEICK. Pantheon, New York, 1992. x, 533 pp., illus., + plates.

Richard Feynman, the subject of this extraordinary, complex, but very readable book, was, of course, not just the joker and self-created legend of *Surely You're Joking, Mr. Feynman!*, nor was the celebrated incident of the Challenger Commission, described in its sequel, *What Do You Care What Other People Think?*, more than a footnote to his real career. Feynman was undoubtedly one of the great geniuses of modern physics, one of the finest among an extraordinary generation who built, on the basic framework of quantum theory and relativity, the accurate, detailed, wide-ranging, and beautiful edifice that is modern physics. His personal aura was such that, as Gleick relates, his mere presence changed the sound level in an auditorium or caused a visible stir in a student cafeteria. And for all his determined pose as a "natural man" with the unmistakable accents of Far Rockaway in his voice, Feynman was one of the greatest expositors of the methodology and of the beauty of science.

In Gleick's account we follow Feynman from Far Rockaway, M.I.T., and Princeton to his extraordinary two years of leading the computational group that made the crucial calculations for the atomic bombs (calculations that, incidentally, were unprecedented in method and scope). Feynman's wartime boss, Hans Bethe, then persuaded him to come to Cornell, where after a brief sterile period of decompression he solved the difficulties of quantum electrodynamics in a burst of renewed energy, using a revolutionary methodology that remains at the core of all of quantum physics (which is of course all of physics, in a sense). Then to Caltech, via an episode in Brazil that included a stretch in a samba band, and to a long career of further research that alone would have been distinguished enough to win him the Nobel Prize—say, for his quantized vortices in liquid helium, or for the theory of the weak interactions, for which Murray Gell-Mann and he invented the crucial apparatus of current algebra.

Vignettes: Calling for Callers

At this time, our country looms large on the world horizon as an example of the popular faith in the underlying principles of the republic . . . .

In making us a homogeneous people . . . . the telephone has played its part as the situation has required. That it should have been planned for its present usefulness is as wonderful as that the vision of the forefathers should have beheld the nation as it is today.

The transmitter of the telephone is the result of years of study and experimentation by telephone engineers. It is of delicate adjustment and its fullest efficiency can only be obtained through proper use.

The lips should not be more than an inch from the transmitter, and the voice should be clear, not loud.

Speak distinctly into the mouthpiece. This will mean your satisfaction and that of the person with whom you are talking.

A telephone on the farm is the greatest obstacle to rural thieves. A telephone can head off the theft of your chickens, hogs, harness and gasoline—and warn folks down the road of the crooked peddler and the vicious tramp . . . . You need your telephone to give your family and property protection they deserve.

Lines from early telephone advertisements reproduced in Claude S. Fischer's *America Calling: A Social History of the Telephone to 1940* (University of California Press)

Gleick resists the temptation to simplify his main character. Was he admirable for his unswerving honesty and refusal to sanction any kind of bombast or irrational cant—even refusing to say the Kaddish over his father's grave—or reprehensible for his attitude toward women and his rejection of conventional aesthetics? admirable for his eagerness to talk to undergraduates and his democratic associations with samba bands, bar girls, and the Esalen Institute, or reprehensible for his behavior toward the many colleagues whom he almost deliberately insulted or intimidated and for his refusal to take on the social responsibilities—refereeing, hiring, memberships, recommendations, and all that—of his profession? We are left free to decide for ourselves.

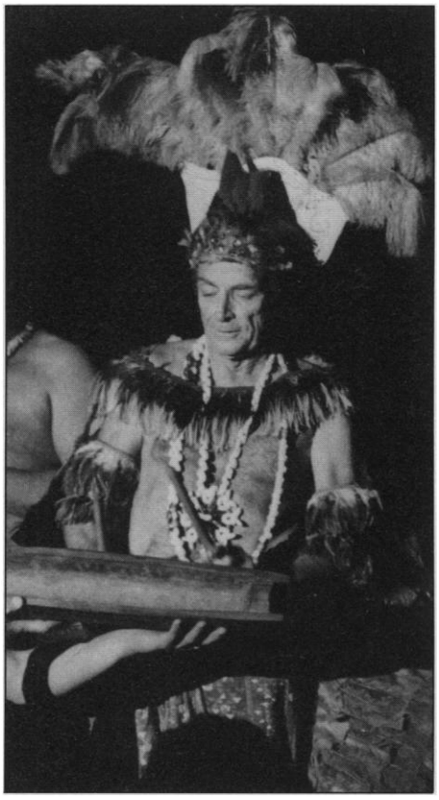
Feynman's relationships with women are, also, left deliberately ambiguous. He had two touching love affairs and successful marriages, the first with his boyhood sweetheart, who was dying of tuberculosis as he labored his 16-hour days at Los Alamos, and the second with the wife of his last three decades, who started as his au pair, imported by legal legerdemain, but whom he came to praise loudly and publicly as "a great English lady." In between were a disastrous marriage, in itself almost an expression of contempt for women, and a succession of predatory affairs with women who sometimes bitterly reproached him, not to mention the bar girls. Yet, in the notes to the book it is revealed that one of these women friends was, much later, instrumental in his being chosen for the Challenger Commission. On the whole, Feynman gets by on the Henry Higgins defense: male or female, obscure or influential, he treated everyone with equal rudeness.

Richard Feynman at Los Alamos. "I opened the safes which contained behind them the entire secret of the atomic bomb . . . ." [From *Genius*; Los Alamos Scientific Library, courtesy AIP Niels Bohr Library]

Gleick sets his hero off against capsule sketches of three other extraordinary men: Julian Schwinger, Freeman Dyson, and Murray Gell-Mann. The competitor in Feynman's greatest work was Schwinger, a mathematical juggernaut, suave and elegant, "speaking in full paragraphs," a prodigy recognized by Rabi at age 14, while Feynman seemed rough, crude, and inelegant. Schwinger was the same age as Feynman, and his background seemed so close to what Feynman's mother felt she might have been able to provide for him had the family's fortunes not declined that she kept track of their relative progress throughout her life. Ironically, though Schwinger disdained low-energy physics, his methods (when combined with Dyson's and Feynman's) and his students found, in the end, their greatest influence there. Already in 1956, when most of theoretical physics met at the Seattle international congress at which Feynman gave his famous talk on superfluidity and superconductivity, Schwinger seemed to be dropping away from the leading edge. Feynman, by contrast, to his great credit, disavowed the arrogant snobbishness of the particle theorists, paralleling Lev Landau in his eclecticism and excelling in his feel for experimental details and for engineering.

The one of the three who is most clearly also a genius is Gell-Mann, an equally complex and difficult character who, like the later Feynman, seemed to have "created himself as a mask and then become indistinguishable from it." Their relationship is one of the fascinating points of the book; a long-term association with another genius on the level of equality must have been very difficult to maintain on either side. Gleick resists the temptation in describing the physics to oversell Feynman's wonder-working and gives Gell-Mann, as well as Dyson (and also Lars Onsager in the theory of superfluidity), some measure of appreciation.

The core theme of the book, as proclaimed in the title and as emphasized by the inclusion of these alternative models, is the nature of genius in general and of Feynman's in particular. Extensive quotations from other writers on the subject as well as from Feynman himself end with Feynman's cryptic remark, "no one is that much smarter." This, to me, implies something Feynman kept emphasizing: that the key to his achievements was not anything "magical" but the right attitude, the focus on nature's reality, the focus on asking the right questions, the willingness to try (and to discard) unconventional answers, the sensitive ear for phoniness, self-deception, bombast, and conventional but unproven assumptions. Somehow a mind utterly devoid of all the standard



Feynman "playing a chieftain in a student production of *South Pacific*." [From *Genius*; Gweneth Feynman]

distractions is rare enough—if it has adequate quickness—to be called "genius" and to produce results as if by magic. It seems to me that it may have been because of this knowledge of his own finiteness that Feynman could not bear to see minds as good as his own hobbled by unnecessary nonsense, and this in turn led to some of his rudest outbursts.

The review of this book in the *New York Times*, which seemed to treat this as a popular physics book, on the model of Hawking's *A Brief History of Time*, was wide of the mark. This is not intended to be a book to learn physics from, though in fact Feynman's work lends itself well to verbal description rather than to a cursory mathematical one. On the whole the book is not scientifically inaccurate; it gives the nonspecialist a good overview of the essentials and even gives some credit to others, as I remarked above; at worst, it glamorizes some of Feynman's minor works a bit. It deserves to be a best-seller as a good, well-written biography of one of the century's outstanding geniuses, not as coffee-table science.

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A Pandemic Reconstrued

AIDS and Accusation. Haiti and the Geography of Blame. PAUL FARMER. University of California Press, Berkeley, 1992. xiv, 339 pp. $35. Comparative Studies of Health Systems and Medical Care, vol. 33.

It is perhaps a historical accident that the AIDS pandemic has coincided with major theoretical shifts in the humanities and social sciences. These shifts have led to the emergence of a critical perspective that questions accepted paradigms and subjects them to a searing critique, deconstructing meanings and reducing "scientific facts" to mere cultural representations. Whether through accident or not, the accepted medical and social "truths" about AIDS have been subjected to critical reappraisal and revision perhaps more quickly and with more intensity than has been the case for any other disease in human history.

At the center of these attacks has been a concern with the role of cultural stereotypes and victim-blaming in the discourse on AIDS. Assumptions about the role of homosexuals, Africans, prostitutes, and Haitians in the AIDS pandemic have all been subjected to scrutiny by anthropologists, historians, and literary critics. Few of these studies have explored their subject with as much sensitivity, breadth of vision, or attention to the multiple layers of meaning that surround the occurrence of AIDS as Paul Farmer's beautifully written study of AIDS in Haiti.

This book is not simply another critique of victim-blaming. It is rather an attempt to place the history of AIDS in Haiti, and Haiti in AIDS, in a wider historical context. Farmer argues that this context has shaped both the epidemiology of AIDS in Haiti and the meanings given to AIDS by Haitian villagers, Haitian-Americans who have been labeled as AIDS transmitters, U.S. health officials who have constructed these ascriptions, and U.S. popular opinion.

Farmer demonstrates that accepted medical facts about the role of Haitians in the spread of HIV/AIDS emerged from a mix of cultural misunderstanding and sloppy epidemiological research, supported by a long history of popular misconceptions about Haiti, Haitians, "voodoo," "zombies," and "blood magic." These misconceptions stretch back to the period of Haitian independence, when the world's first black republic was viewed by its neighbors as a regional and international pariah. Drawing on more recent epidemiological research, Farmer shows how, contrary to what U.S. health officials and the popular media assumed, AIDS began in Haiti in much the same way in which it emerged in the United States, hitting homosexual communities and recipients of blood transfusions first. Only later, as Haiti sank into economic despair and both men and women were forced to sell their bodies for cash, did AIDS enter the heterosexual population and Haiti acquire what the World Health Organization has termed Type II AIDS.

Farmer also shows how Haiti's declining economic fortunes, which have served as a catalyst for the spread of AIDS, were directly related to U.S. political and economic policies, reaching back to the early 19th century. The diplomatic isolation of Haiti following the revolution, the use of gunboat diplomacy to extort large sums of money from Haiti's dwindling treasury, the U.S. occupation of Haiti from 1915 to 1934, and the subsequent penetration of the Haitian economy by large-scale agricultural interests, which accelerated the impoverization of much of the island's population, all contributed to the island's economic woes. Finally, in the 1980s, as if to add insult to injury, early assumptions about the role of Haitians in the spread of HIV/AIDS, legitimated by the U.S. Centers for Disease Control and Food and Drug Administration, dried up a once-lucrative tourist industry. Farmer traces this long list of insults and shocks that the United States has inflicted on the political and economic body of Haiti. At the same time, he explores the consequences of these assaults for individual Haitians who have succumbed to HIV/AIDS.

Embedded in Farmer's contextualization of the relationship between AIDS and Haiti are the lives of the people of Do Kay. Do Kay is a small village of once-prosperous farmers who lost their land to the waters that backed up behind a dam that was constructed to provide electricity for the people of far-away Port-au-Prince. Farmer begins and ends his study in Do Kay, tracing the arrival of AIDS, the responses of the people of the village to this new disease, and their efforts to give meaning to its occurrence. Farmer's sensitive exploration of the lives and deaths of the people of Do Kay give his study a distinctly human face and an emotional edge that moves the study and the reader beyond the cynical gaze of post-modernism and political economy. The book is at the same time fiercely personal and coldly objective. The result is both moving and illuminating.

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