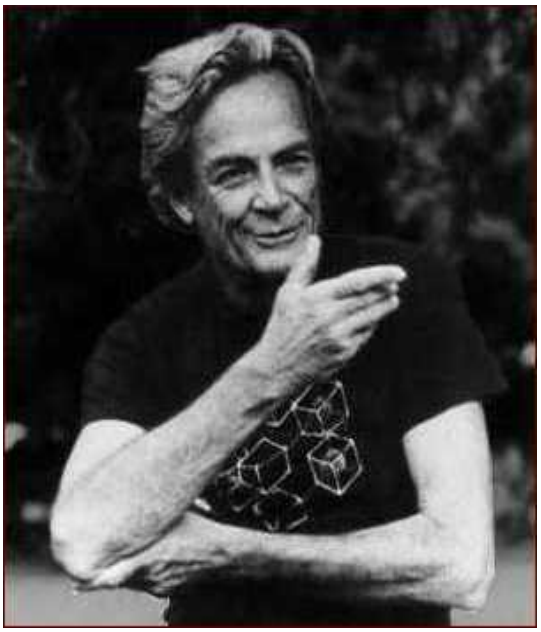
Richard Phillips Feynman



Acclaimed by his contemporaries as "the most brilliant, iconoclastic, and influential of the post war generation of theoretical physicists" and "the most original mind of his generation," Nobel Prize winner **Richard Phillips Feynman** (May 11, 1918 – February 15, 1988) was widely known for his insatiable curiosity, gentle wit, brilliant mind and playful temperament. He worked in quantum electrodynamics (QED) and introduced important new techniques for studying the electromagnetic interactions between subatomic particles. One of his many labor-saving inventions is the *Feynman diagram,* a graphical method of representing the interactions of elementary particles. A Feynman diagram consists of two axes, one representing space, the other representing time. Straight lines represent electrons and wavy lines represent photons. The exchange of particles is described by the junction of three lines, or a vertex. His research tied together all the varied phenomena at work in light, radio, electricity, and magnetism, resulting in an alteration in the way scientists understood the nature of waves and particles. Feynman was a best-selling author, a legendary and outrageous teacher, and a musician. Extremely informal, Feynman didn't like ceremony or pomposity, and he was celebrated for his irreverent approach to physics.

Feynman was born in Far Rockaway, New York, the descendent of Russian and Polish immigrants who moved to the United States in the latter part of the 19th century. He was raised in a loving Jewish household, although his family did not practice Judaism as a religion. His father, a maker of uniforms, demonstrated basic principles of physics to his son, emphasizing the importance of logical observation. At the age of 10 Feynman began to buy old radios to use in his "personal laboratory," and by 12 he was repairing radios for his neighbors. Rather than learning trigonometry from a book, he reinvented all the formulas. By age 15 he had mastered differential and integral calculus. In 1936 Feynman attended the Massachusetts Institute of Technology and took every physics course offered. His interests in subatomic physics set him on a lifelong quest to clarify the mathematics of the subatomic world. After graduation from MIT, he went to Princeton and was awarded his doctorate in 1942. His dissertation, supervised by John A. Wheeler, was a new approach to quantum mechanics using the

principle of subatomic particles. He replaced the wave model of electromagnetics of James Clerk Maxwell with a model based on particle interactions mapped into space-time. He dealt with advanced waves, that is, the theory of electromagnetic waves that travel “backwards” in time.

After finishing his Ph.D., Feynman married his longtime sweetheart Arline Greenbaum, although she was suffering from fatal tuberculosis of the lymphatic system. In 1942 Feynman was appointed to the staff of the atomic bomb project installation at Los Alamos, New Mexico. Though only 24, he was named a group leader in the theoretical division. His job was to estimate how much uranium was necessary to achieve critical mass. He devised procedures to protect the staff at Los Alamos from radiation poisoning. As serious as the project was and despite the grave illness of his wife, Feynman found time to be mischievous, causing consternation for his superiors and colleagues. He figured out how to pick the locks on filing cabinets and safes that contained classified information. Without removing anything, he would leave them open with taunting notes inside, letting officials know that their security system had been breached. He also enjoyed sneaking out a hole in the fence and going around to the front of the compound to surprise the guards.

In 1945 Arlene died. Feynman never got over his grief of losing her. He later wed Mary Louise Bell, a marriage that ended in divorce. In 1960, he married for the third time to Gweneth Howarth, with whom he had a son and a daughter. After the war Feynman became a professor of theoretical physics at Cornell University, followed in 1951 by a similar appointment at the California Institute of Technology, where he remained the rest of his life. Feynman successfully developed the rules that all quantum field theories must obey, and in the process, discovered how to renormalize the theory of quantum electrodynamics. For this work, in 1965 he was awarded the Nobel Prize for Physics (which he called “a pain in the neck”), shared jointly with Julian S. Schwinger and Sin-itiro Tomonaga, who had made independent contributions in the same area of research.

Feynman played a vital role as a member of the presidential commission investigating the 1986 Challenger Space Shuttle disaster. Frustrated by the evasiveness of witnesses’ answers and slow bureaucratic procedures, he conducted an impromptu experiment before a nationally televised audience that proved the key to the investigation. He demonstrated with stunning simplicity the physics of the disaster. He dunked a piece of the rocket booster’s rubber O-ring gasket into a cup of ice water and quickly showed that it lost all resiliency at low temperatures allowing the rocket exhaust to burn a hole in the rocket. On

February 15, 1988 his decade long battle with abdominal cancer ended, two weeks after he taught his last class at Caltech. His last words, when he briefly came out of his final coma, were, "This dying is boring." Feynman's death may have been from a relatively rare form of cancer and somehow related to his exposure to radiation in atomic bomb tests. While watching "Trinity," the first atomic bomb test, in 1945, Feynman decided no one knew if the explosion would be bright enough to damage the eye, so he watched it directly through the windshield of his truck. Many of his colleagues at Los Alamos also died of cancer.

Feynman's sister Joan said of her brother: "He has become a fable – and a fable for good, I think." Indeed he has, but the fable has more to do with his personality than the contributions he has made to physics. Perhaps more important than changing the face of physics with a series of lectures he gave at Caltech from 1961 to 1962 is the fact that Feynman inspired legions of students. To them he seemed an incredibly exciting and atypical professor, one his friend David Goodstein described as "an impossible combination of a truly great theoretical physicist and a person you might meet in a bar somewhere and get to be friends with without ever knowing he was both."

Among his many books are: *QED – The Strange Theory of Light and Matter* (1985), in which Feynman clearly explains the arcane workings of quantum electrodynamics, and his popular three volume lecture series *The Feynman Lectures on Physics* (1963-65). In his books and his lectures, Feynman provided many very quotable observations. It seems appropriate to present a few at this time.

"I think that I can safely say that nobody understands quantum mechanics."

"Science is the belief in the ignorance of experts."

"The first principle is that you must not fool yourself –

and you are the easiest person to fool."

"Physics is like sex. Sure it may give some practical results, but that's not why we do it."

There are so many stories that reveal just what a fascinating fellow Feynman was, but there's only room for one here. He was asked to be a member of a California textbook selection committee, charged with evaluating textbooks for use in California schools. Believing this was a good thing to do, he agreed. He had no idea how many books there were and how

lucrative it was to publishers to have their text on the approved list. He was surprised when the book depository called and wanted to know where he wanted the 300 pounds of books delivered. He was offered an assistant to help him, but declined; insisting if he was to make recommendations he should read all the books himself. During the weeks that followed he received many calls from publishers wanting to take him out to lunch, to dinner, whatever he wanted. He declined the invitations because he knew the teachers who would actually use the books would not be similarly wined and dined.

At one point, he arrived in San Francisco the evening before a committee meeting. As he was about to leave his hotel, two men stopped him, addressed him by name, and asked if they could help him in any way. He explained he was just on his way out to "get into a bit of trouble." They responded, "Maybe we can help you with that too." He declined, but later felt he should have allowed it to play out some more just to see how far they would go. During a meeting he was asked by other committee members what he had thought of a particular book. He said, he couldn't say, as he never received it. Then a book depository employee explained that the publisher had missed the deadline and substituted a book with blank pages instead. The publisher had included a note in the book explaining that the real book would be ready in time to be used and hoped it could still be considered. What astonished Feynman was that several committee members had this book on their recommended lists of texts to appear on the approved list. Unbelievable? Not if you know academia.

Quotation of the Day: "To those who do not know mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty, of nature … If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks in."– Richard Feynman