

Foreword

Douglas R. Hofstadter
Distinguished College of Arts and Sciences Professor
Indiana University, Bloomington

I'm sad that I met Frederick Reines on only two occasions, but so grateful for the powerful and indelible impression that he left on me. Every time I remember him or hear about him, I feel a sense of admiration and an irrepressible urge to smile. He was, as they say in Yiddish, a real *mensch* — a deep, generous, and always reliable soul.

Fred Reines was one of the twentieth century's true pioneers in physics. He had great visions and great ambitions, and yet he was astonishingly modest. His most significant achievement was probably his "sighting" of the extraordinarily elusive neutrino in the mid-1950s, carried out with his friend Clyde Cowan. This particle had been hypothesized in 1930 by the Austrian theorist Wolfgang Pauli, who was so ashamed of his idea that he didn't dare write an article about it, or even present it in a talk. Instead, he typed a humorous letter to be read aloud by a friend at a conference, in which he semi-seriously suggested a new particle that, if it existed, could save the sacrosanct laws of conservation of energy and momentum, both of which seemed to be violated by radioactive decays — but Pauli also apologized for his brashness in making such a wild hypothesis (a "desperate remedy", as he called it). Four years later, two famous theorists — Hans Bethe and Rudolf Peierls — wrote an article in which they stated that the neutrino, should it by chance exist (which was far from clear), would "obviously" never be detected by human beings.

This kind of throwing-down of the gauntlet was irresistible to Fred Reines, and in the late 1940s and early 1950s, he began formulating possible strategies to "see" the "unseeable" neutrino (if indeed it existed!). His first brainstorm involved exploding a nuclear bomb, with an underground detector only 50 meters (!) from the explosion point. (Some wag suggested that a graduate student should be placed right next to the detector, in order to babysit it. The suggestion was politely vetoed.) Reines and his colleague Cowan worked on this idea for a couple of years, but eventually they were talked out of it, deciding that it would make more sense to use a nuclear reactor as a potential neutrino source, even though it was far less intense a source. At the time, the reality of neutrinos was still far from certain, so Reines and Cowan light-heartedly dubbed their experiment "Project Poltergeist" (a poltergeist being an invisible spirit that rumbles around making strange noises), and they gave their detector the name "Herr Auge" ("Mr. Eye", in German).

The story of how Reines and Cowan finally did indeed "see" the neutrino (that is, "see" it through a highly recognizable kind of "signature" written in the language of photons) is admirably told in this loving biography by Fred's younger cousin Leonard Cole, who as a boy was inspired by his affectionate cousin to explore science and to savor its beauty and depth. Cole went on to become first a dentist, then a political scientist, and then a world expert on bioterrorism. But he never forgot the influence of his beloved older cousin, and later in life he decided that Fred Reines deserved a biography. This excellent decision was followed up by years of very intense work and travel. Cole visited many laboratories in the United States and Europe, and talked with dozens of colleagues, students, and family members whose vivid recollections of Fred Reines pepper this book in a very lively fashion.

What is impressive to me is how deeply Leonard Cole has internalized not only the physics itself but also the history of twentieth-century physics, both of which he relates in a crystal-clear manner to lay readers. He takes his cue from Fred Reines himself, whose *modus operandi*, as a communicator in his humbly-named course for non-physics majors “Rainbows and Things”, was to use the simplest possible means of expression, bypassing mathematics and in its place using vivid images, colorful analogies, clear demonstrations with ordinary objects (candles, paper clips, pieces of string), and even singing and whistling, as well as reciting poems.

Speaking of singing and whistling, Fred Reines was a deeply musical soul, and it was with enormous gusto and panache that he performed songs and arias from such diverse sources as Gershwin, Bach, Handel, and Gilbert and Sullivan. He also loved acting, and played the role of “Drummond” (alias Clarence Darrow) in the famous drama about the Scopes “monkey trial”, *Inherit the Wind*. But Reines’ greatest love was the pursuit of the neutrino, which, after a while, became the pursuit of different *types* of neutrinos, and of neutrinos emanating from different *sources*, such as the sun, a supernova, or the Big Bang.

In 1962 it was discovered that there were at least two different types of neutrino, not just one, as had been originally believed, and Reines was fascinated. However, in 1988, when this later discovery was rewarded by a Nobel Prize while the discovery of the *first* type of neutrino had gone totally unrecognized, Reines was shocked and hurt. He was never one to clamor for glory, but he felt that something was deeply wrong when the *second* neutrino had been recognized by a Nobel Prize, but not the *first* one. An amazing anecdote is told in Chapter 15 of this book about a lecture at the great laboratory of CERN in Geneva in which this crazy irony was brilliantly pinpointed by the speaker. Fred was sitting in the audience right next to Leon Lederman, one of the Nobel winners for the *second* neutrino, and the speaker said... But I will not give it away. It is just too delicious for words.

Luckily, the Nobel Committee had the wisdom, at long last, to recognize the greatness of the classic Reines–Cowan experiment, and they awarded Fred Reines a Nobel Prize for Physics in 1995, but by that time, sadly, his co-discoverer Clyde Cowan had been dead for over twenty years. Such are the unfortunate twists and turns of fate. By now, many Nobel Prizes have in fact been given for discoveries related to various facets of the neutrino (or rather, the *neutrinos*, since now there are believed to be three types, plus three *antineutrinos*, as well), and the more that has been learned about these “poltergeists”, the more bizarre they seem. The lore and lure of neutrinos constitutes such an enticing and rich saga that anyone interested in ideas at all should take some time to read about it.

I am so impressed and gratified that Fred Reines’ younger and ever-loyal cousin Leonard had the inspiration to take up his pen and to write this wonderful book telling all about these mysterious particles, and recounting the life of one of the great scientists of our era and one of the finest human beings I have ever had the honor to meet.

September 2020
Bloomington, Indiana

