A Forceful Life[1]

Thomas Hager, Force of Nature: The Life of Linus Pauling Simon & Schuster 1995,

Istvan Hargittai

Thomas Hager first met Linus Pauling in 1984 at a presentation on vitamin C by the then 83-year-old scientist. Both men arrived early and found themselves alone in the seminar room. Pauling introduced himself and, wasting no time, proceeded to deliver an enthusiastic "minilecture on the chemical binding properties of tin." Hager's description of this encounter reminded me of my own meeting with Pauling, only a couple of years before Hager's, at the University of Oslo. Pauling lectured a packed auditorium about structural chemistry. He was deriving complicated expressions without using so much as a scrap of paper, marching back and forth in front of the long blackboard, which he covered with formulas. He kept his enthusiastic Norwegian audience in awe and only gradually did it dawn on me that the sophisticated derivations were superfluous to an understanding of the subject matter. During the luncheon after the talk, he stayed fresher and more alert than any of us.

Hager faced a daunting task in trying to document the energy and diversity that marked Pauling's long scientific career (spanning almost 70 years until his death in 1994). To the public, Pauling is probably best known for his championing of the health benefits of vitamin C. In scientific circles, however, he is most renowned as the principal architect of structural chemistry, the fundamental science of the spatial arrangements of atoms in molecules and crystals and the interactions that bond substances.

This work, crowned by his book *The Nature of the Chemical Bond* (first published in 1939), earned him the 1954 Nobel Prize for Chemistry. Although Pauling possessed only a tiny fraction of what we know today about structural chemistry, his observations have withstood the test of time. His achievements have also demonstrated that a method of collecting information and arriving at a discovery may have as lasting an impact on the development of science as a discovery itself.

Hager, a science journalist, describes Pauling's science well—not a simple task, considering its breadth. He explains complicated concepts easily yet correctly and fixes ideas in the reader's mind with succinct descriptions. For example, the ability of hydrogen to bond simultaneously to two atoms instead of the usual one-a structural feature of vital importance to chemistry-becomes "hydrogen bigamy." Just as Hager uses human terms in explaining science, he also speaks about the "chemical bond" between Pauling and a fellow scientist.

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[1] Scientific American1996, July, 101–103.

The author has exercised much restraint in condensing Pauling's exceptionally productive and inspiring life into a manageable book. Those aspects of the scientist's work that are left out of *Force of Nature* might suffice as life achievements for lesser researchers. For example, Pauling and his graduate student assistant, Lawrence O. Brockway (whose name is misspelled in the book) used gas-phase electron diffraction to determine the structure of volatile molecules during the early 1930s; they introduced a technique called Fourier transformation with which the distances between atoms can be determined directly. This approach is now applied daily in electron diffraction laboratories.

Hager also omits Pauling's role in the development of Corey-Pauling-Koltun (CPK) space-filling models, Tinkertoy-like objects whose relative sizes and connection points are based on those of actual atoms and molecules. They facilitate hands-on testing of proposed molecular structures and are still in widespread use. They were instrumental in launching the theory of host-guest chemistry, which earned Donald J. Cram a Nobel Prize in 1987, and have aided in many a chemist's education.

Force of Nature presents Pauling not only as a great scientist but also as an exceptional human being. Hager reaches back to Pauling's ancestors from Germany and Ireland, tracing his childhood in Oregon and his youthful travels to his happy and productive decades at the California Institute of Technology. (Hager also tells the love story of Pauling and Ava Helen Miller. We learn about their dogged pursuit of their goals; a pursuit they sometimes engaged in at the expense of their four children.)

Pauling played a major role in making Caltech a world center of scientific research. Yet the institute attempted to ease him out in the 1950s, when his leftist political activism began to embarrass its mostly conservative administration. His resistance to the actions of the House Un-American Activities Committee, the Federal Bureau of Investigation and the Passport Office of the State Department showed him to be a true champion of the spirit of American independent thinking. Even so, Pauling eventually felt compelled to choose between conspicuous political resistance and research opportunities, so he scaled down his political activism. There are lessons in this chapter of Pauling's story that remain important today.

Hager's book gives great emphasis to the other arena of Pauling's political work: his fight against nuclear weapons testing, for which he received the 1962 Nobel Peace Prize. In these activities he appears to have been somewhat one-sided, trying to pressure the U.S. (and Great Britain) more than the Soviet Union. Pauling explained that it was more natural for him to criticize his own country's government than that of the U.S.S.R. He apparently was fooled by Soviet propaganda and did not see the Soviet Union for what it was.

It is ironic, then, that just as Pauling was facing political problems at home, he was declared a public enemy by the Soviet chemistry establishment. Some mediocre but influential professors considered his resonance theory to be ideological heresy and managed to terrorize the entire Soviet chemistry community into reviling it. Pauling thought Soviet chemists merely needed more time to appreciate his theory. In fact, generations of talented young Russians considered theoretical chemistry hazardous and continued to shy away from it long after the resonance theory had become a nonissue.

At times, Hager appears to succumb to the temptation to make his subject larger than life. Something of this bias may be seen when Hager details Pauling's unsuccessful attempts to help the son of a German crystallographer escape Nazi Germany. The relatively large weight given to this one episode—and the lack of similar ones—suggests that Pauling's aid to victims of German National Socialism was limited. This early stance is in pointed contrast to his work on behalf of Japanese-Americans interned in the U.S. during World War II and his later dedication to other causes involving the persecuted and oppressed.

Hager does not flinch, however, from recounting some of Pauling's personal and professional relationships that became very close, only to break apart, sometimes ending in lawsuits. Pauling's attitude toward the mathematician Dorothy Wrinch and her original (albeit probably erroneous) protein model, for instance, appears anything but magnanimous.

Another such story, which Hager does not mention, involves Pauling's unbending hostility toward quasicrystals after their discovery in 1984 by Dan Shechtman. Quasicrystals are regular but non-periodic structures that scientists once considered to be a physical impossibility; the evidence for their existence necessitated a change in the very definition of what a crystal is. Pauling never did believe in quasicrystals, and his immense influence may have hindered the broadening of crystallographic concepts. Despite the 627 pages of text and more than 50 pages of notes, it is inevitable that *Force of Nature* omits chunks of Pauling's life. Nevertheless, Pauling comes alive on the page—forceful, creative and unyielding. Hager has produced a book worthy of its subject.

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