Linus Pauling's Molecular Models and the Stories that they Tell

By Chris Petersen

Senior Faculty Research Assistant
Special Collections and Archives Research Center
Oregon State University Libraries and Press

The Ava Helen and Linus Pauling Papers are one of the largest collections of personal papers in the world. The collection was first pledged to Oregon State University – Pauling's alma mater – in 1986, and over the course of twenty years the papers were assembled from at least five different locations; processed, arranged and described; and ultimately housed under one roof for the first time. The finding aid for the collection is six volumes in length, and the boxes holding papers themselves, if set down on the ground in a straight line, would span a distance of eight-tenths of a mile.

In addition to the types of materials that one might expect to find in an archival collection – manuscripts, letters, photographs and newspaper clippings, for example – the Pauling Papers hold an assemblage of much more eclectic items. Included among these would certainly be Pauling's beard clippings from the 1930s, as well as a karate gi (presented upon his receipt of an honorary black belt in the early 1980s), and a beautiful collection of minerals given to Pauling as a gift by Robert Oppenheimer in the early 1930s.

Likewise included in the papers are dozens of molecular models and an even larger set of model parts. Pauling was certainly not the first scientist to use molecular models as a component of his scientific process, but he did much to popularize their use. The oldest models in the collection are rudimentary, made out of paper, and date back to the 1920s. Pauling's eldest son, Linus Jr., who is now ninety-one years old, has memories of seeing these models sitting around the house while he was a young child.

Over the course of time, Pauling's model-building became more advanced and, as he graduates from material type to material type, one is able to witness the evolution of his scientific interests. And so it is that we are now able to examine early ball-and-stick models that were almost certainly machined at Caltech in the 1930s, and that were used by Pauling to progress the thinking on crystal structures that informed his seminal work, *The Nature of the Chemical Bond*, published in 1939. Present as well are models made out of aluminum ingots, again likely created in house, and applied to Pauling's vast program of proteins work that spanned much of the 1940s and 1950s.

Pauling's most well-known model is the alpha helix, a fundamental building block of many proteins that he first conceptualized in 1948, while lying sick in bed with a cold. The story goes that Pauling grew tired of passing the time by reading detective stories, so he decided instead to think about the structure of proteins for a while. As such, he pulled out a pen and a few pieces of paper, and starting drawing bond lengths and angles that had been observed through x-ray crystallographic study in the laboratory. After less than an hour of twisting and folding, he had come across a successful model that made a major impact on the history of twentieth century science.

Unfortunately, that original piece of paper no longer exists. But the Pauling Papers do hold four different models of the structure, including a very large one that used to live in the Pauling family's backyard. Today, an art piece based upon the structure stands in front of Pauling's boyhood home in southeast Portland, which now houses an institute devoted to conversation on contemporary issues in science, engineering and public policy. Pauling's alpha helix also served as inspiration for what is inarguably the most famous scientific model of the twentieth century: James Watson and Francis Crick's double helical structure of DNA. As Crick later wrote in his memoir, the duo debt owed a great debt to Pauling as "helices were in the air" during the frenzied period of the young researchers' own molecular modeling.

With his Caltech colleague Robert Corey and, later, a Berkeley researcher named Walter Koltun, Pauling helped to create a type of space-filling model that, in the years that followed, was used in laboratories worldwide. Called CPK Models (for Corey, Pauling, and Koltun) these three-dimensional model kits were widely adopted and provided enormous assistance to a new generation of researchers, many of them not blessed with the machining capacity available to Pauling during his early years at the California Institute of Technology.

Pauling was a tremendously charismatic lecturer and he often used models as demonstration aids in the classroom. One of the more intriguing of these is a plastic blue spiral that, upon closer inspection, consists of a school of fish swirling upward. Pauling used this specific item to demonstrate the concept of chirality to Caltech undergraduates.

Likewise, as a researcher, Pauling was always looking to three-dimensional resources as a tool for furthering his scientific ideas. In the mid-1960s, he began investigating the structure of atomic nuclei, and he identified a need for a very quick and simple model-building process to prompt his thinking forward. He ultimately settled upon a novel method involving marbles and balloons. As he later described in a typescript, Pauling would fill a balloon with water, then insert a quantity of marbles that might correspond with the nuclear structure he was examining. From there, it was a simple task to prick the balloon, drain it of water, and tie its end. *Voila*, instant model!

Over the years, numerous researchers have examined Pauling's models as a component of their own scholarly endeavors, and plenty more artists and photographers have used the models as forms of inspiration, often (as with this book) documenting them as works of art in their own right. In 2008, my department engaged in a program of model-building ourselves, enlisting two undergraduates from OSU's College of Science to replicate several of Pauling's early crystal structures in three-dimensional form. Relying upon the information relayed in reprints of Pauling's scientific papers, and armed with materials purchased from the local craft store, these talented students breathed new life into a dozen molecules that Pauling had "solved" using x-rays, mathematical formulas and, yes, molecular models of his own construction. In this, OSU added its voice to a visual conversation that will soon be one-hundred years old.