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William D. Phillips – Autobiography



I was born on 5 November 1948 in Wilkes-Barre, Pennsylvania, just across the river from the town of Kingston, where my parents lived with my one and a half year old sister, Maxine. My parents had come to this small Pennsylvania town from places and backgrounds that were far apart and yet quite similar.

My mother, Mary Catherine Savino (later, Savine), was born in the southern Italian village of Ripacandida in 1913. Among her earliest memories are riding into her grandfather's vineyards in a horse-drawn cart. Her father emigrated to the US and brought the family to Altoona, Pennsylvania in 1920. Her new American schoolmates teased her for her inability to speak English and taunted her as a "Wop" for her Italian heritage. She resolved to excel, and so she did, graduating near the top of her class from Altoona High School.

My father, William (Bill) Cornelius Phillips, was born in Juniata, a community on the edge of Altoona, in 1907. His father was a carpenter and his mother operated a boarding house to augment the family income. His grandfather was a barrel-maker, who would demonstrate the quality of his product by jumping onto the finished barrel in front of the customer. Dad could trace his heritage to ancestors from Wales who fought in the American Revolution.

My father and mother were each the first in their families to go to college, each attending [Juniata College](#), a small school in Huntingdon, Pennsylvania, founded and strongly influenced by the pacifist Church of the Brethren. My father and mother graduated from Juniata in 1930 and 1936, respectively, but never met until a Juniata professor who knew them both suggested to my father that he might call a young Juniata alumna and ask her out. This Italian Catholic young woman and this Welsh-American Methodist young man met, fell in love, got married, earned Masters degrees and became professional social workers in the hard coal country of Pennsylvania.

I grew up surrounded by family and friends, church and school, and physical and mental activity. I clearly remember the value my parents placed on reading and education. My parents read to us and encouraged us to read. As soon as I could read for myself, walking across town to the library became a regular activity. Almost as far back as I can remember, I was interested in science. I assembled a collection of bottles of household substances as my "chemistry set" and examined almost anything I could find with the microscope my parents gave me. Although they had no particular knowledge or special interest in

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science, they supported mine. Science was only one of the passions of my childhood, along with fishing, baseball, bike riding and tree climbing. But as time went on, Erector sets, microscopes, and chemistry sets captured more of my attention than baseball bats, fishing rods, and football helmets. In 1956, my family moved from Kingston to Butler, near Pittsburgh. I remember that during that time I decided that science was going to be my life work, and sometime during the late 1950s, I came to appreciate, in a very incomplete and naive way, the simplicity and beauty of physics.

My brother Tom was born in 1957 - a concrete confirmation, my sister and I believed, of the power of prayer. We had been praying for a sibling, unaware that our parents could decide, and had decided, that two children were enough. Apparently our prayers were effective. The result was a thrill and a blessing for all of us. Another blessing was my being placed into an experimental "accelerated" class. There, dedicated and concerned teachers taught us things that were not part of the ordinary elementary school curriculum, like French and advanced mathematics. When my family moved to Camp Hill, near Harrisburg, in 1959, interested teachers continued to provide me with advanced instruction, and when I entered the 7th grade of Camp Hill High School in 1960, it was in another accelerated program.

During this time, I had a laboratory in the basement of our family home. Ignorant and heedless of the dangers of asbestos, electricity, and ultraviolet light, I spent many hours experimenting with fire, explosives, rockets and carbon arcs. But life was not all science. I ran for the track team and played for the tennis team at school. During the summer, I spent all day either on the tennis courts or in the community swimming pool, and considered the advantages of life as a tennis bum.

While my parents were not directly involved in my scientific interests, they tolerated my experiments, even when the circuit breakers all tripped because of my overloads. They were always encouraging, and there was never any lack of intellectual stimulation. Dinner table conversations included discussions of politics, history, sociology, and current events. We children were heard and respected, but we had to compete for the privilege of expressing our opinions. In these discussions our parents transmitted important values about respect for other people, for their cultures, their ethnic backgrounds, their faith and beliefs, even when very different from our own. We learned concern for others who were less fortunate than we were. These values were supported and strengthened by a maturing religious faith.

In high school, I enjoyed and profited from well-taught science and math classes, but in retrospect, I can see that the classes that emphasized language and writing skills were just as important for the development of my scientific career as were science and math. I certainly feel that my high school involvement in debating competitions helped me later to give better scientific talks, that the classes in writing style helped me to write better papers, and the study of French greatly enhanced the tremendously fruitful collaboration I was to have with Claude Cohen-Tannoudji's research group.

The summer after my junior year in high school, I worked at the [University of Delaware](#) doing sputtering experiments. It was a great experience and I learned an important truth from Jim Comas, the graduate student who supervised me. "An

experimental physicist," he told me, "is someone who gets paid for working at his hobby."

Another important part of my high school experience was meeting Jane Van Wynen. Her family had moved from Maine when we were in ninth grade, but we largely ignored each other until our senior year when, during a school trip to the New York World's Fair during its closing days in 1965, I became suddenly aware of her considerable charms. She was not so immediately convinced that I had any charms of interest to her, but my natural tenacity paid off, and we started dating.

In the fall of 1966 I started my studies at Juniata College, as my mother and father, my Aunt Betty, and my sister had before me, and as my younger brother, Tom would later. Juniata had a foreign language requirement, which could be satisfied by studying two years of a language or by passing a test. I passed the test in French, whereupon the chairman of the French department, who knew my sister, a French major in her senior year, suggested that I enroll in an advanced French literature class. Being a naive freshman, I did. The professor lectured in French, we read classic French literature and wrote our exams in French - not what I was used to in high school! I got a "C" on my first test and realized that college was not going to be as easy as high school. I finished the course with an "A", and learned an important lesson: I would have to work hard at Juniata.

Physics with calculus was a challenge as well, but a true joy. Ray Pfrogner, who taught that first course, revealed a beauty and a unity in physics and mathematics that, until then, I had lacked the tools to appreciate. Some evenings he invited us students to showings of films of [Richard Feynman's](#) classic public lectures on "The Character of Physical Law." These events included popcorn that Pfrogner popped himself. Feynman's breezy yet incisive style on occasional evenings and Pfrogner's clear expositions every other morning fueled my passion for physics.

My passion for Jane was also increasing during this time, fueled by daily letters, weekly phone calls and infrequent visits to her school, [Penn State University](#). It is a passion that has matured and deepened but remained undiminished over the years. Our separation during our college years meant that I did not have a highly active social life, leaving lots of time for physics.

During my first year at Juniata, Wilfred Norris, the Physics Department chairman, invited me to start on the laboratory course normally taken by third-year students - a series of classic physics experiments, which I did under his supervision. Later, I started doing serious research under Norris's direction, rebuilding an X-band electron spin resonance (ESR) spectrometer and trying to resolve discrepancies in the literature about ESR linewidths.

In my senior year I spent a semester doing ESR at [Argonne National Laboratories](#), working with Juan McMillan and Ted Halpern. There, I experienced full-time research, performed by a team of professionals who would discuss what the important problems were, decide what to do, how to do it, and then go into the lab and do it. I loved it!

Back at Juniata for my final semester, I was applying to graduate schools. First on my list was [Princeton](#) - because I had heard its graduate program was superb and because a visitor to

Juniata had told me that a physics student from my school would never be accepted to Princeton! I was accepted, but a visit to Princeton left me unconvinced that I wanted to go there. From the lobby of the Princeton physics building, I called Dan Kleppner at the [Massachusetts Institute of Technology \(MIT\)](#).

Dan had seen my application to MIT, including my experience in magnetic resonance, and had invited me to visit his group and consider working on a hydrogen maser experiment. So I visited MIT (and [Harvard](#) for good measure); I was struck by the pleasant camaraderie, and the friendly yet electric atmosphere that Dan had created in his group. That emotional reaction, and Jane's desire to return to New England, more than any purely scientific considerations, made me decide to go to MIT. I never regretted that decision, or any of the other decisions I made afterwards based on considerations of the heart.

During a hectic several weeks in 1970, Jane and I graduated from our respective colleges, married, honeymooned and moved to Boston. At MIT I started working with Fred Walther on the high-field hydrogen maser, another X-band magnetic resonance spectrometer. I learned how to do electronics, machining, plumbing and vacuum - all skills I have found essential in experimental research. I also learned from Dan, and from the others in his group, a way of thinking about physics intuitively, and a way of inquiring about a problem that has shaped the way I approach physics to this day. The style of open and lively discussion of physics problems that I found in Dan's group is one that I have tried to emulate in my own group at [NIST](#). I also try to follow the principle Dan taught by example: that one can do physics at the frontiers, competing with the best in the world, and do it with openness, humanity and cooperation.

For my thesis research I measured the magnetic moment of the proton in H_2O . Through this project I met others in the community of precision measurements and fundamental constants - in particular, Barry Taylor and Ed Williams at the National Bureau of Standards. By the time I completed that measurement (which is, at least for the moment, still the best of its kind), tunable dye lasers had become commercially available and had found their way into our lab. I decided that I should learn more about these new toys and, with Dan's encouragement, embarked on an experiment to study the collisions of laser-excited atoms. I finally wrote up both experiments for my thesis and defended it in 1976.

I accepted a Chaim Weizmann fellowship to work on projects of my own choosing at MIT for another two years. During that time, I continued to work on collisions with Dave Pritchard and Jim Kinsey; I also started work on Bose-Einstein condensation (BEC) in spin-polarized hydrogen with Dan and Tom Greytak. We were filled with optimism in the early days of that experiment, but today, 22 years later, BEC of hydrogen is still "just around the corner." Nevertheless, the innovations achieved by that group, long after I left, along with the developments in laser cooling recognized by this year's Nobel Prize, were crucial in showing the way to the eventual success of BEC in alkali vapors.

At the party celebrating my thesis in 1976, Dan Kleppner said it was fortunate that I had done the second experiment, using lasers, because otherwise I would probably have ended up going to the National Bureau of Standards (NBS). In 1978 I accepted a position at NBS (later renamed the National Institute

of Standards and Technology-NIST) in Barry Taylor's division, working with Ed Williams and Tom Olsen on precision measurements of the proton gyromagnetic ratio and of the Absolute Ampere. These were exciting projects, but my experience with lasers and atomic physics had also earned me the opportunity to devote part of my time to exploring ways of improving measurement capabilities using those tools. I used that opportunity to pursue laser cooling, and the story of how that went is told in the accompanying Nobel Lecture.

In 1979, shortly after Jane and I moved to Gaithersburg, we joined Fairhaven United Methodist Church. We had not been regular church-goers during our years at MIT, but Ed and Jean Williams invited us to Fairhaven and there we found a congregation whose ethnic and racial diversity offered an irresistible richness of worship experience. Later that year, our first daughter, Catherine, now known as Caitlin, was born. In 1981 Christine was born. Our children have been an unending source of blessing, adventure and challenge. Their arrival, at a time when both Jane and I were trying to establish ourselves in new jobs, required a delicate balancing of work, home, and church life. Somehow, our faith and our youthful energy got us through that period.

At NBS, with some borrowed equipment and some extra money that Barry Taylor, in his inimitable fashion, obtained from somewhere, I got started with laser cooling. Support from the Office of Naval Research allowed Hal Metcalf to spend time at NBS in those early days. I had worked with Hal a little at MIT, and I knew that his unbounded enthusiasm and his effervescent creativity were priceless qualities. My collaborating with Hal on laser cooling was the first and one of the most important among many valuable interactions with colleagues who came to NIST, or whom I met elsewhere. I have mentioned many of these in my Lecture, and I want to emphasize again how much they have contributed to the development of laser cooling, and particularly, how important the senior group members, Kris Helmerson, Paul Lett, Steve Rolston, and Chris Westbrook, have been. I also want to recall the words of Bengt Nagel in his formal remarks to Steve Chu, Claude Cohen-Tannoudji and myself on 10 December 1997 in Stockholm. He said that we were being recognized as leaders and representatives of our groups. The three of us feel very strongly that this Prize honors all of those wonderful colleagues who contributed so much to the development of laser cooling.

Since the announcement of the award of the 1997 Nobel Prize in Physics, I have been honored to receive greetings and congratulations from colleagues and friends all over the world, as well as from many people whom I did not know. One such greeting came, not to me but to my children, from Susan Hench Bowis. She had read newspaper accounts of the announcement and recalled to my teenage daughters that she had been 17 when in 1950 her father, [Philip Hench](#), had been awarded the Nobel Prize in Physiology or Medicine. He had been far from home at the time of the announcement, as I had been, and, like Caitlin, Susan Hench had been away at school. Transatlantic telephone calls were not common in those days, and so when she eventually made contact and congratulated her father, it was by cable. He cabled back to her, "Prouder of you, my darling, than of any prize." Surely the Nobel Prize is the highest award a scientist could hope to receive, and I have received it with a sense of awe that I am in the company of those who have received it before. But no prize can compare in importance to the family and friends I count as my greatest treasures.

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