FROM ELEMENTS OF RADIO TO ELEMENTARY PARTICLE PHYSICS

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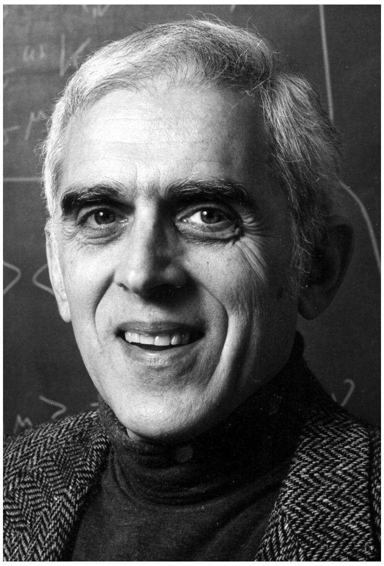

I was born in 1939 in New York City to Irving and Ruth Relis Adler. My father was a mathematics teacher and my mother had also majored in mathematics in college. I was directed towards science by my parents from an early age. When I was two years old my father built me a gadget box from pieces of hardware, and around the same time my mother made me a home-made version of the "Pat the Bunny" book, each page containing a different tactile or manual operation for me to perform. When I was older my father built me electrical toys such as telegraphs, a "burglar alarm" that rang a bell when a door was opened, and a miniature traffic light. We also engaged in nature activities, collecting snakes and butterflies. When I was eight I participated in a young people's astronomy course at the Museum of Natural History in New York, and my fascination with the fossils I saw at this museum led me to think briefly of being a paleontologist, but this interest soon waned.

My actual career path began in sixth grade of elementary school, when a classmate started to talk to me about his interest in radio; I visited him at home and saw his equipment and tools. This introduction developed into a serious interest in electricity, radio, and electronics while I was still in elementary school. I built various electrical devices, such as electric motors with rotor laminations cut from tin cans and permanent magnet stators taken from old radio loudspeakers. (I still have one of these on my bookcase at the Institute for Advanced Study). With encouragement from my father I read Marcus and Marcus's classic World War II text "Elements of Radio"; my father made a point of letting me be the family radio expert, while he was the consultant on the few bits of algebra in the text. Also at my father's suggestion, I started to canvass the neighborhood door to door, pulling a small wagon and asking for old radios, appliances, and television sets people were planning to throw away. I stripped the parts out of these, and used them to build radios, amplifiers, and even an oscilloscope using a salvaged 7-inch television tube. I also learned enough Morse code to get my Technician Class amateur radio license, and built a small rig using a war surplus aircraft receiver and a home-built transmitter. However, amateur radio activity did not interest me nearly as much as building electronic equipment, which I continued through various science projects in high school.

Given this exposure to electronics, it would have been natural for me to pursue a career in electrical engineering, but towards the beginning of my high school years I got a first glimpse of the fascinating world of high energy physics research. For two summers my family had vacationed in a state park near Ithaca, NY, and Phillip Morrison, an old friend of my father's, gave us a tour of the physics laboratories at Cornell, where Robert Wilson had built a succession of particle accelerators. I liked the ambience of these laboratories, and was impressed with the fact that if I pursued physics as a career I would learn and use electronics, but not necessarily the other way around. By my junior year in high school, I had decided on experimental physics as a career.

My first physics research laboratory experience came at the end of my senior year in high school, when I attended a two-week course in X-ray diffraction techniques for industrial engineers given at Brooklyn Polytechnic Institute by Isadore Fankuchen, who would every now and then include a bright high school student in his class. I was able to do all the theoretical and laboratory work, and learned many things, such as crystal lattice structure and Fourier transforms, that are standard physicist's tools. Almost immediately afterwards, I went to a summer job at Bell Labs in Manhattan, along with eight other science-oriented high school graduates. Many of them had already learned calculus, and so I decided to teach myself calculus that summer.

My father gave me his old calculus text, along with the sage advice to do every *third* problem—because I had to do problems to learn the material, but there was not time (and it would be too boring) to try to do all of them. So I spent my commuting time, and spare time at work, doing calculus problems. As a result, when I entered Harvard in the fall I was able to place directly into Advanced Calculus, which had a major impact in how fast I was able to proceed with my physics education.

I entered college intending to be an experimentalist, but my friendships with various classmates, among them Daniel Quillen (later a Fields medalist) got me interested in mathematics. I found that I was very good at the theoretical aspects of my classes, but although competent in the laboratory, I lacked the touch of the gifted experimentalist. So, by the middle of my freshman year, I had decided to shift my sights from experimental to theoretical physics. Along with Fred Goldhaber, who was to be my first year roommate in graduate school at Princeton, I took essentially the whole graduate course curriculum at Harvard during my junior and senior years. Memorable teachers at Harvard included Ed Purcell, Frank Pipkin, Paul Martin, and Julian Schwinger. As a result of my Harvard preparation, at Princeton I was able to take my General Exams at the end of the first year, and then to start thesis research with Sam Treiman at the beginning of my second year.

Treiman suggested that I look for calculations to do in the newly emerging area of accelerator neutrino experiments, and this was the beginning of my career in high energy physics. A major part of my thesis work was a calculation of pion production from nucleons (protons or neutrons) by a neutrino beam. Although this was a long and tedious project, it gave me a detailed introduction to the "vector" and "axial-vector" currents through which neutrinos interact with nucleons. This knowledge growing out of my thesis project was the foundation for my most significant scientific contributions during the period 1964 through 1972, which all involved in some way or another the discovery of further results connected with vector and axial-vector currents. These included various low energy theorems for pion emission derived from the hypothesis of a "partially conserved" axial vector current, various sum rules including the Adler-Weisberger sum rule for the axial vector coupling to nucleons and a sum rule for deep inelastic high energy neutrino scattering cross sections, as well as the co-discovery (along with Bell and Jackiw) of the "anomalous" divergence properties of the axial-vector current. The theoretical analysis of anomalies led to a deeper understanding of neutral pion decay into gamma rays, provided one of the first pieces of evidence for the fact that each quark comes in three varieties (now called "colors"), and has had a multitude of other consequences for theoretical physics over the last thirty-five years.

During the years since 1972, I have worked on a variety of other topics in theoretical high energy physics, including neutral current phenomenology, strong field electromagnetic processes (such as photon splitting near pulsars), and acceleration methods for Monte Carlo simulation algorithms. Throughout the last twenty years I have devoted about half of my research time to studying embeddings of standard quantum mechanics in larger mathematical frameworks. One aspect of this work involved a detailed study of a quantum mechanics in which quaternions replace the usual complex numbers. Another, more recent aspect, has involved the study a possible "pre-quantum" mechanics based on properties of the trace of a matrix, from which quantum theory can emerge as a form of thermodynamics. I have written books describing both of these studies. For the next few years, I plan to return to my original area of particle phenomenology, in the context of supersymmetric models for further unifying the elementary particles and the forces acting on them.