September 6, 1995

Of those here tonight, I am the first to have encountered Lonnie professionally. It happened as follows: In 1962 Professor Harvey Brooks, of Harvard, called me in Dearborn, Michigan. He said he had a graduate student who wanted to pursue a thesis on a subject that would interest me. "Would you take him?"

A month later Lonnie arrived at the Ford Scientific Laboratory. His field of research was a very popular and important one: the unexpected electronic and thermal properties of noble metals (such as copper, silver, or gold) when alloyed with small amounts of magnetic elements (such as chromium, manganese, iron, cobalt, or nickel). Lex Gerritsen, at Purdue, was an important player in this arena. Incomprehensible phenomena occurred in specific heat, resistivity, magnetic susceptibility, thermal conductivity, magnetoresistivity, and thermoelectric power.

The last of these was the focus of Lonnie's endeavor. The giant thermoelectric power had been discovered thirty years before, in 1932, by Keesom, Borelius, and Linde. (This was not Piet Keesom, of Purdue, but rather Piet's father.) The observed thermoelectric effects were a thousand times larger than theory allows or, for that matter, larger than what is observed in pure metals. No one had found a physical explanation. The opening paragraph of Lonnie's dissertation portrays the dilemma:

> "The modern theory of metals begins in 1928 with Sommerfeld's simple model of a box of noninteracting fermions. In the light of later developments, the remarkable success of so simple a picture is better understood, but no less wonderful. The value of this simple box model, as a starting point for improved calculations, as a conceptual framework for the organization of ideas, as a numerical tool for the estimation of errors, persists even to the point that observational deviations from its predictions by factors of order different from unity are called anomalous, or giant, or some such term signifying surprise."

The title of Lonnie's thesis was, "Some Effects of Static Spin Density Waves on Electrical Transport." The motivation for such a study arose from the experimental work of Jim Zimmerman at the Ford Scientific Laboratory. He had discovered extraordinary specific heat anomalies in dilute magnetic alloys; and these could be explained quantitatively by a spin-density-wave, which is created by its interaction with the spins of the magnetic impurities. (Incidentally, it was Jim Zimmerman who with Arnold Silver, also at Ford, invented the SQUID and coined that acronym.) Lonnie found that inelastic scattering of conduction electrons by the transition-element spins did indeed lead to a thermoelectric power a thousand times larger than normal. Needless to say, the theory remained incomplete because the number and size of the spin density waves, together with their orientation, polarization, and domain structure were unknown. The concluding paragraph of Lonnie's thesis was:

> "We have not answered the riddle of dilute alloys; our theory is too simple. We have, nonetheless, established that in the search for understanding of these systems, the possibility of the existence of spin density waves is worthy of serious consideration."

Thirty years later, just a few years ago, Sam Werner (from the University of Missouri) finally proved the existence of spin density waves in dilute magnetic alloys by using polarized-beam neutron diffraction to study the appearance of weak magnetic satellites. Of interest is the fact that Sam and Lonnie overlapped at Ford as graduate students. Sam's thesis on the dynamical diffraction of neutrons from perfect silicon crystals (both experiment and theory) was supervised by Tony Arrott (who will be presenting the October 19 Physics colloquium). Lonnie appreciated, of course, that Sam's discoveries conveyed perpetual significance to his doctoral research.

It is interesting that the interval between discovery of the giant thermoelectric effect and the demonstration that spin density waves really occur was sixty years. Lonnie's illumination of the subject was a brief, but brilliant burst of light halfway inbetween. There is now a super-giant thermoelectric

effect in the superconductor indium, which is too large by one hundred thousand. I hope that for Catalina Marinescu, who is to solve that enigma, a similar feat of heroic patience need not be required.

Lonnie defended his thesis at Harvard in February, 1964. During the following years I encountered Lonnie occasionally at physics meetings. Only after I arrived here at Purdue (six years after Lonnie) did our close relationship grow and become, for me, one of the treasures of my life.

Lonnie's scientific interests were very broad. Even in physics, he embraced topics from the foundations of quantum theory to the structure and motion of DNA. I used him as a sounding board to try out new ideas and, sometimes, I served in that role for him. When opinions clashed, it never mattered who prevailed, as long as there emerged a glimmer of truth.

Lonnie became the most articulate and skilled writer I have ever known personally. His creative forms of expression made reading his essays a literary joy. On this account I took advantage of him by providing him opportunity to read my own efforts. Invariably they came back all marked in red, and, as a consequence, much improved.

Most of all Lonnie was a friend. With him I could open my heart, whether my concerns were immanent or transcendent. For now, I must learn to invoke the many happy memories I own, and to surmise the counsels he would likely provide.

William F Buckley, Jr.
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During the recent holiday I found and read "Nearer, My God." I appreciated the glimpse you gave into a corner of the heart that most forever conceal.

The chapter excerpted from Valtorta has prompted me to show you the enclosed (unpublished) essay of Van Zandt. Unfortunately, Van Zandt succumbed to brain cancer in July, 1995. He was my closest friend and colleague for twenty years. You had a brief contact when you published his note on atmospheric CO2 in the NR, 10/5/92.

I believe that Valtorta's work led to Van Zandt's request for baptism in 1995. He told me that all hesitations he had acquired from the Gospel accounts were clarified.

Yours sincerely,

Albert Overhauser