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MARCEL J.E. GOLAY (1902-1989)

With the sudden death, shortly before what would have been his 87th birthday on May 3, l989, of Marcel J.E. Golay, the field of information theory lost one of its earliest and most original contributors.

Golay was not cast in the same mold as most information theorists. He reasoned physically rather than mathematically, using mathematics more as a language to express his brilliant insights than as a means for establishing their validity. This trait became very apparent to me in l979 when I was asked by the Editor of IT-Transactions to mediate a dispute that had arisen between Golay and the referees of his paper, "The Merit Factor of Long Low Autocorrelation Binary Sequences" (IEEE Trans. Info. Th., vol. IT-28, pp. 543-549, May l982). In reviewing the file on this paper, I soon concluded that the referees were right about the details (e.g., that some of Golay's assertions were mathematically contradictory), but Golay was right about the essentials. Just as a skillful physicist will invoke the wave theory of light for some purposes but will switch to the particle theory of light for others, so would Golay employ some mathematical hypothesis about a sequence for some purposes but switch to a formally incompatible hypothesis about the same sequence for others. The paper in dispute concerned the quality of the autocorrelation function of very long $\pm$ 1 - valued sequences as measured by the ratio of the central term to the sum of the squares of the off-peak terms, the "Golay merit factor" that he introduced in "Sieves for Low Autocorrelation Binary Sequences", IEEE Trans. Info. Th., vol. IT-23, pp. 43-51, Jan. 1977, and that is now widely used. Golay always regarded the length 13 Barker Sequence, whose merit factor is 14.08... as a singularity of nature whose goodness would never again be attained. His 1982 paper explains why he believes that the best very long sequences will have a merit factor of precisely 12.32... . I would not want to bet on the contrary. This editorial assignment gave me my first direct contact with Golay, albeit telephonic. I could scarcely believe that the youthful and energetic voice on the other end of the line belonged to a man whom I knew to be 75 years old.

Golay was born in Neuchâtel, a lovely town that lies on a lake of the same name in the French-speaking part of Switzerland. He studied electrical engineering at the German-language Swiss Federal Institute of Technoloy (or "ETH" to use its German initials) in Zürich because the present French-language counterpart (the "EPF") did not then exist. After receiving his ETH diploma in 1924, Golay joined the Bell Laboratories. Four years later, he began doctoral studies in physics at the University of Chicago where he received the Ph.D. degree in 1931. Golay then joined the U.S. Army Signal Corps Laboratories in Fort Monmouth, New Jersey, where he remained for almost 25 years and rose to the position of Chief Scientist in the Materials Division. The citation for the Harry Diamond Memorial Award of the IRE presented to Golay in 1951 reads: "for his many contributions in the over-all Signal Corps research and development program and particularly for his accomplishments leading toward a reduction in the infrared-radio gap". Among these "many contributions" was Golay's formulation and publication in 1951 of the complementary code sequences that are still used worldwide in the Loran C precision navigation system. Golay served a two-year stint in Academe, becoming the first holder of the Chair of the Science of

Analogies at the Technological University of Eindhoven in The Netherlands in 1961, a chair whose title appears to have been tailored to Golay's mode of reasoning. In 1963, Golay became a Senior Research Scientist with the Perkin-Elmer company, a post he held until his death. At Perkin-Elmer, he invented the "Golay cell" for infrared detection, which I am told is as famous among physicists as are the "Golay perfect codes" among communications engineers. Golay was a prolific inventor who held more than 50 patents on his conceptions.

My first face-to-face meeting with Golay came in 1982 when he presented a colloquium talk at the ETH about his research on sequences. Golay had many years before moved his residence back to his native Switzerland, in a small village near Lausanne, and I had issued him an invitation to speak at the ETH shortly after my move there in late 1980. Golay told me on his arrival in Zürich that this was his first visit to his alma mater in 58 years. That evening he joined my wife, Lis, and me for dinner, together with Peter Hilton, a mathematician who was then visiting at the ETH and who, as a very young man, had been part of the code-breaking group with Alan Turing at Bletchley Park. Both Lis and I remember vividly the stimulating conversation and reminiscences of that evening. One anecdote that Golay told concerned his discovery of the famous (23,12) code. It seems that Golay had formulated 5 necessary conditions that a perfect code must satisfy when he chanced upon the (23,12) code. Although the code satisfied only 4 of the 5 "necessary conditions" for perfectness, Golay was so convinced that it was perfect that he wrote and submitted his now-celebrated paper on perfect codes. It wasn't until some weeks later that he located the error that he had made in checking the fifth "necessary condition" and verified that the code was indeed perfect.

Golay's one-page paper, "Notes on Digital Coding" (Proc. IRE, vol. 37, p. 657, 1949) is surely the most remarkable paper on coding theory ever written. Not only did it present the two perfect "Golay codes", the (n = 23, k = 12, d = 7) binary code and the (n = 11, k = 6, d = 5) ternary code, but it also gave the non-binary generalization of the perfect binary Hamming codes and the first publication of a parity-check matrix. Golay told me once that the only prior work on coding to which he was then privy was the two-paragraph description of the (7,4) Hamming code that appears in Shannon's 1948 paper. Golay's paper also contains the expression of his belief that all perfect codes had now been found, which twenty years of research by many first-rate mathematicians finally confirmed. Not only Golay found it difficult to provide the mathematical justification for the truths he so clearly saw.

Golay contributed regularly to the advance of information theory over a span of 40 years; his last paper thereon is still in the editorial process and will be published posthumously. He enjoyed robust physical and mental health up to the day of his death. He had been scheduled to give another colloquium talk at the ETH a few weeks later and to serve as an examiner for the final doctoral exam of one of my students, Jürg Ruprecht. Golay's life and death will be an inspiration for all of us who love information theory and strive after its perfection.

James L. Massey