

Award, the Comstock Prize, and the National Medal of Science. For his role in giving us the *HST*, he abundantly deserved NASA's Exceptional Achievement Award, which was, sadly, awarded posthumously.

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Richard Henry Dalitz

What Richard Henry Dalitz, who died in Oxford, England, on 13 January 2006 following a stroke, modestly called phase space diagrams, every other particle physicist knows as Dalitz plots. From such plots, together with Dalitz pairs and CDD poles (named after Leonardo Castillejo, Dalitz, and Freeman Dyson), Dick's name will forever be a byword in high-energy particle physics. (Although famous in physics, the name Dalitz is a rare one. One of Dick's lifelong passions outside science was researching the history of his name, which led him to become an expert historian on the Wendish—also called Sorbian—people, pre-German settlers of Brandenburg who speak a Slavic language.)

Dick was born in Dimboola, Australia, on 28 February 1925. After earning bachelor's degrees in mathematics and physics at the University of Melbourne, he moved to the University of Cambridge in 1946 and in 1950 completed his PhD on "zero-zero transitions in nuclei." In such transitions, emission of a real photon is forbidden by angular-momentum conservation, but the transitions do allow for a longitudinally polarized virtual photon that converts into an electron-positron pair. It was this early insight of Dick's that would later



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bear fruit with the concept of Dalitz pairs—a form of internal conversion in $\pi^0 \rightarrow 2\gamma$ decay in which one of the emitted photons becomes an e^+e^- pair.

While working on his PhD thesis, Dick spent a year working alongside Cecil Powell's cosmic ray group at Bristol University and became interested in the strange particles that were beginning to be found in cosmic rays and at particle accelerators. Those particles included the first hypernucleus, in which one of the nucleons is replaced by a strange baryon, and it inspired a lifelong interest in hypernuclei. The observations also included two kinds of mesons, named θ and τ (today known to be the same K^+ meson), with the same masses and lifetimes but distinguished by their decays: θ into two pions and τ into three pions. In 1953, by then a lecturer at Birmingham University, Dick analyzed the τ decay into three pions and in so doing introduced the Dalitz plot, a kinematic two-dimensional diagram that reveals quantum properties

of unstable particles. The plot showed that the τ had even spin and odd parity, which is different from the θ .

The " θ - τ puzzle"—how could two mesons have the same masses and lifetimes and yet have different quantum numbers?—persisted for two years. Dick mused to colleagues that perhaps the law of parity had to be abandoned, although all the evidence at the time appeared to say otherwise. The breakthrough came from T. D. Lee and C. N. Yang, who realized in 1956 that the assumption of conserved parity in weak interactions had not been tested, and it was the weak force that was at work in the θ - τ decays.

Dick spent much of the next 10 years in the US, notably as a professor of physics in the Enrico Fermi Institute for Nuclear Studies at the University of Chicago. He spent a sabbatical year at the University of California, Berkeley, where with a hydrogen bubble chamber Luis Alvarez's team discovered the strange baryon resonance $\Sigma(1385)$ in $K^-p \rightarrow \Lambda\pi^+\pi^-$ and displayed the three final-state particles on a prominently acknowledged Dalitz plot. Dalitz plots led to the discovery of other baryon and meson resonances, which in turn led to the idea that a more fundamental level of reality existed in what Murray Gell-Mann called quarks in 1964. It was initially unclear whether these fractionally charged quarks were just a mathematical convenience for operations in $SU(3)$ flavor symmetry or were real particles. It was around this time, in 1963, that Dick returned to Britain and joined Rudolf Peierls at the University of Oxford as a Royal Society Research Professor.

Dick took the idea of physical quarks seriously and in 1965 proposed that they were the basic blocks of baryons and mesons, which could be excited into different energy states according to the established rules of nonrelativistic quantum mechanics and nuclear

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physics. To explain the pattern of the baryon $SU(3)$ octet and decuplet representations required assuming what became known as a symmetric quark model, in defiance of the established antisymmetry for fermions. Over the following decades, many other resonances were discovered for both baryons and mesons, in many cases by application of Dalitz plots. During that time, the nonrelativistic quark model, with later incorporation of color $SU(3)$ effects from quantum chromodynamics, became established as an orderly description of what had formerly been a menagerie of particles.

For Dick, quarks were real, but as his student in 1968, I found that being asked to believe in fractionally charged particles that no one had seen and that few outside Oxford took seriously could be demoralizing. When their reality began to emerge in deep inelastic scattering data around that time and Richard Feynman developed his parton model, Dick seemed hesitant to push the new area forward. With quarks as with the θ - τ analysis earlier and the eponymous Dalitz plot, he had helped pave the way in different manners for Nobel Prizes, but he never made the final step himself.

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Valentine Louis Telegdi

On 8 April 2006, Valentine Louis Telegdi died in Pasadena, California, of complications following surgery for an aortic aneurysm. With his passing the physics community lost one of its most original and distinguished members. Val's contributions to our understanding of weak and electromagnetic interactions are seminal. Beyond those contributions, though, what made Val unique was the depth of his understanding of the theoretical fine points of the physics, which in his fundamental particle-physics experiments led him to beautiful and far from obvious ways of testing an idea. A Telegdi experiment was always marked as much by the conceptual cleverness of its design as by the importance of its results.

Val was born on 11 January 1922 in Budapest, Hungary. After wandering all over Europe, the Telegdis ended up in Italy. From there they sought wartime shelter in Switzerland but did not find it until 1943, when in the wake of the German army's defeat at Stalingrad, the Swiss reoriented the tilt of their much-

vaunted neutrality. Ending up in Lausanne, Val attended the legendary lectures in which Ernst Stueckelberg discussed his causal propagator and those remarkable diagrams that were also independently discovered and put to marvelous and universal use by Richard Feynman after World War II.

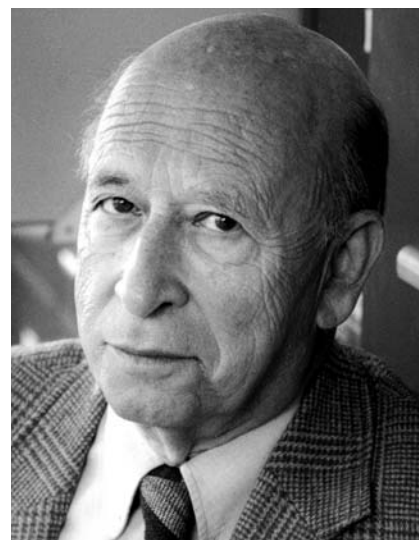
In 1946 Val moved to ETH Zürich for graduate study in Paul Scherrer's group. His observation of so-called three-pronged stars, corresponding to the reaction $\gamma + C \rightarrow \alpha + \alpha + \alpha$, deeply impressed Scherrer. Though offered a position at the University of Bristol by C. F. Powell, Val chose to go to the University of Chicago, where he caught the tail end of the Fermi years.

In line with his broad interests in physics, Val, together with one of us (Gell-Mann) who was a guest in Val's Chicago lab at the time, published a paper on charge independence in nuclear reactions involving photons, relating to the work on isospin selection rules by Luigi Radicati.

The 1956 parity revolution put Val on the map as a major player in particle physics. The University of Chicago experiment by Val and Jerome Friedman on parity violation in the $\pi \rightarrow \mu \rightarrow e$ chain is one of the three independent and almost simultaneous experiments that vindicated the bold idea of T. D. Lee and C. N. Yang that parity conservation is violated in weak interactions. A lot of acrimony was connected with the time-ordering of those three independent and brilliant experiments. The Columbia University-National Bureau of Standards collaboration led by Chien-Shiung Wu and the Columbia team of Richard Garwin, Leon Lederman, and Marcel Weinrich were the first to publish. An editorial decision was made to publish the Telegdi-Friedman letter in the next issue of the journal in question instead of the issue containing the Columbia letters. At the time of the parity experiment, there was close scientific contact between Val and one of us (Oehme), who discovered that charge-conjugation symmetry must also be violated in the experiments.

The field was now moving fast, and once the so-called V-A theory of the weak interactions had been proposed, it became essential to accurately measure the ratio of the Gamow-Teller and Fermi matrix elements in neutron beta decay. A classic experiment by a University of Chicago-Argonne National Laboratory collaboration led by Val found the value 1.25 for this ratio.

A fundamental CERN experiment led by Val and Garwin in 1959-60 meas-



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ured the muon's anomalous magnetic moment and provided one of the most stringent tests of quantum electrodynamics. Val Telegdi, Valya Bargmann, and Louis Michel constructed the elegant, and in this context very useful, relativistic theory of the precession of the spin of a charged particle moving in a homogeneous electromagnetic field. In the latest version of this muonic " $g-2$ " experiment, parts-per-million accuracy has been reached.

Among Val's other important experiments were ones on K_S regeneration, muonium, and the helicity of the muon neutrino. He also worked on muonic atoms, a field in which Wu, Val's erstwhile competitor, was also active. That shared research interest further fanned the flames of an outright Telegdi-Wu feud, which was fought with etiquette that would have passed muster at the courts of both the Hapsburg and the Qing emperors, and yet was as harshly antagonistic as feuds between great scientists can get.

In 1976 Val left the University of Chicago, where he had been the Enrico Fermi Distinguished Service Professor of Physics, for a professorship at ETH Zürich. Val was elected to the CERN Scientific Policy Committee and soon became its chairman. In that capacity he was instrumental in starting a collaboration between CERN and Russia. Over the past two decades, he spent much time first at Caltech and then at the University of California, San Diego.

For his major contributions to standard-model physics, Val was elected to the national academies of the US, Sweden, Hungary, and Russia; to the Royal Society in London; and to the Accademia dei Lincei in Rome. In 1991 he shared the