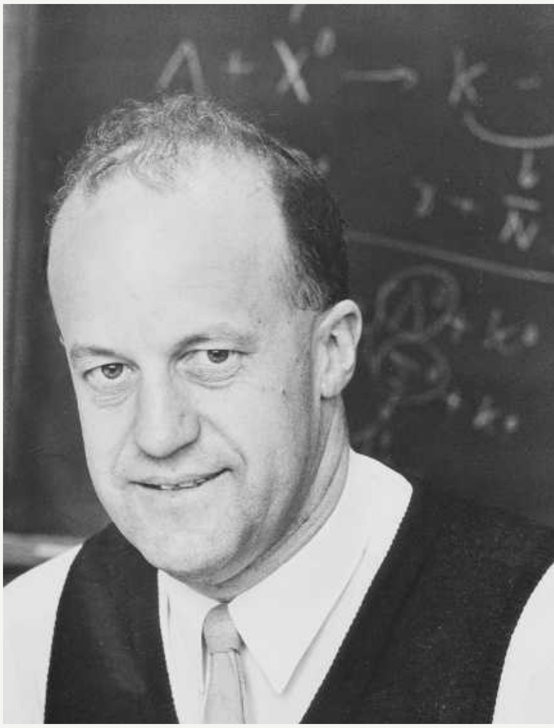
OBITUARY

Richard Dalitz (1925–2006)

Particle physicist and creator of the Dalitz plot.



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Richard Henry Dalitz was a giant in the field of particle physics. A theorist who always endeavoured to work close to experiment, his contributions over 60 years shed vital light on the nature of the fundamental forces and the constituents of matter.

Born in the small wheat-belt town of Dimboola, northwest of Melbourne, Australia, Dalitz gained degrees in both mathematics and physics at the University of Melbourne. Awarded a travelling scholarship, he moved in 1946 with his wife Valda to England, to study for a PhD under Nicholas Kemmer at Trinity College, Cambridge. There he benefited from the teaching of Paul Dirac, whose lecture course on quantum mechanics he attended twice. After two years, he ran short of funds and, with a small child to support, moved to a one-year post as assistant to Nevill Mott at the University of Bristol. In retrospect, Dalitz considered this year at Bristol vital to his subsequent research: there he first learned from the group of Cecil Powell about elementary particle physics and the 'strange' particles (so named because they left unusual tracks in the emulsions used to detect them) produced in cosmic-ray collisions. He started to think particularly about the nature of one of these, the 'tau meson', or K^+, as it is now known.

Dalitz was invited by Rudolf Peierls to the University of Birmingham in 1949, where his encounters with Freeman Dyson proved most useful for his mastery of the quantum-electrodynamical methods that Richard Feynman was then developing to describe electromagnetic interactions. After completing his thesis, which was on transitions between spin states in the oxygen nucleus, Dalitz was finally able to concentrate on particle physics and study of the tau.

The result was two seminal contributions that bear his name: the study of the decay of the neutral pion (one of the lightest mesons, a class of particles now identified as quark–antiquark pairings) to a photon and an electron–positron, or 'Dalitz', pair; and the development of the 'Dalitz plot'. This plot presents the kinematic variables of the three-body final state of a reaction in two dimensions. This allowed so-called resonances — transient states that flag their existence through their decay to final-state particles of definite total energy — to be readily visible.

Dalitz was interested in the difference between the tau and another strange particle, the theta, which seemed to be the tau's identical twin except for the fact that it decayed into two pions, whereas the tau decayed into three. Using his plot, he was able to establish that the tau, like the theta, has zero spin, so that the two particles could not be identical if parity holds. (Parity is the idea that reactions proceed the same way when all spatial coordinates are reversed.) Indeed, this 'tau–theta' puzzle was the first indication that parity did not hold for interactions involving the weak nuclear force. The subsequent realization by T. D. Lee and C. N. Yang that this could indeed be the case won them the 1957 Nobel Prize in Physics.

After brief periods at Cornell University in Ithaca, New York, and back at Birmingham, in 1956 Dalitz accepted a professorship at the Enrico Fermi Institute in Chicago. Working with Riccardo Levi-Setti, he developed what became a lifetime interest, often pursued in collaboration with Avraham Gal, in the recently discovered hypernuclei, in which a strange particle takes the place of a proton or neutron.

In 1963, Dalitz was persuaded by Peierls to return to Britain and join him at the University of Oxford as a Royal Society research professor and, from 1964, a fellow of All Souls College. At Oxford, Dalitz continued his work on the resonant states that were being discovered in ever-larger numbers — often through the use of Dalitz plots. These states could be grouped according to their mass, spin and parity into families of eight and ten. Murray Gell-Mann dubbed this the 'eightfold way', and proposed that the pattern could be explained if the resonances were combinations of fundamental building-blocks of fractional electric charge — quarks, as he named them.

At the time, most physicists considered quarks as merely a mathematical tool. Boldly, Dalitz pursued the possibility that they might be real dynamical objects, and, in a remarkable paper presented in Tokyo in 1965, showed how different combinations of three tightly bound 'up' and 'down' quarks explained many properties of the proton and neutron. He further proposed that the quark model could describe not only these ground states, but also the multitude of higher-energy resonant states.

At Oxford, Dalitz established a flourishing research programme to study the quark model, and attracted many senior physicists and students to it. Their work, and work worldwide, has shown that all particles found then and since fit well with quark-model predictions. This encompasses the original strange particles, whose unusual properties are now attributed to the presence of at least one 'strange' quark in their make-up that hampers their decay, as well as states that contain the heavier quarks 'charm' and 'bottom'.

The quark model was the foundation of quantum chromodynamics (QCD), the comprehensive theory of the strong nuclear force that depicts quarks as being held together by the exchange of gluons — analogues of the photons of the electromagnetic force — which are coupled to a new 'colour' charge. Dalitz first heard of colour in a talk by Gell-Mann and recognized that it resolved some profound problems associated with the quark model. The success of this model once colour was included set the scene for the subsequent development of QCD. Dalitz's interest in the quark model continued all his working life. In 1992, with Gary Goldstein, he developed a method still in use today, to determine the detailed properties of the 'top' quark, the last of the six types of quark to be found.

A fellow of the Royal Society and recipient of many honours, among them the Hughes Medal and Royal Medal of the Royal Society, 'Dick' Dalitz never lost his appetite for physics. He remained an active member of the theoretical-physics department at Oxford after his retirement in 1990, always keen to encourage students to share in his passion for physics. He died on 13 January 2006, and is survived by his wife, son and three daughters.

Graham Ross
Graham Ross is in the Rudolf Peierls Centre for Theoretical Physics, University of Oxford, 1 Keble Road, Oxford OX1 3NP, UK.
e-mail: g.ross@physics.ox.ac.uk