obituaries

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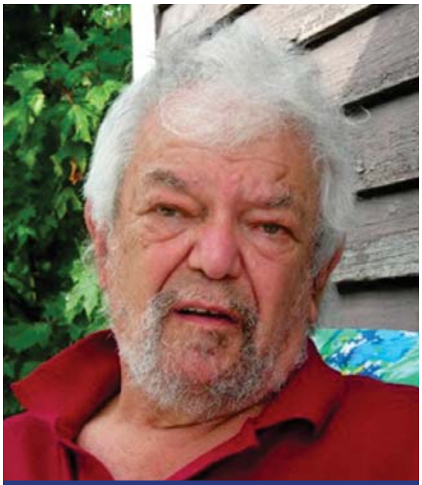
Robert Brout

Our present understanding of the world in physical terms bears the mark of Robert Brout's contribution to physics. Evoking his legacy, I revive intense memories of our lifelong friendship and of our collaborations.

Born in New York City on 14 June 1928, Robert obtained his PhD in physics at Columbia University in 1953. He was a professor at Cornell University when I went there in 1959 to work with him as a research associate. Our first meeting was unexpectedly warm. He picked me up at the airport and took me for a drink, which lasted nearly the whole night. When we parted we knew that we would become friends. Two years later, when I was scheduled to return to Belgium, our collaboration in statistical physics and our friendship had indeed become deeply rooted. Robert resigned from Cornell and joined me in Belgium with his wife Martine and his children. He became a professor at the Université Libre de Bruxelles, acquired Belgian citizenship, and eventually codirected the theoretical physics group with me.

Motivated by Yoichiro Nambu's beautiful 1960 paper analyzing superconductivity in field theoretic terms and by our previous analysis of spontaneously broken symmetry in phase transitions, we applied SBS considerations to the massless Yang–Mills gauge fields associated with any symmetry group. Those gauge fields transmit long-range interactions. We found that while gauge fields pertaining to unbroken subgroups remain massless, the other gauge bosons acquire mass, transmuting the corresponding long-range forces into short-range ones. The SBS mechanism thus unifies in this way long- and short-range forces, and the full gauge invariance of the theory is maintained in the asymmetric phase. That discovery was published in *Physical Review Letters* in 1964 and was followed a few weeks later by an independent paper from Peter Higgs on the same subject. A further 1964 contribution was made by Gerald Guralnik, Carl Hagen, and Tom Kibble.



Robert Brout

The 1964 paper by Robert and me predates all other papers on the SBS mechanism and is the most detailed one. To realize SBS, we introduced scalar fields in representations of a symmetry group and coupled them to the corresponding gauge fields. We then computed the masses of all gauge bosons in the self-consistent quantum vacuum. We also considered an alternative simple model of dynamical SBS, in which the scalar SBS fields are traded for a fermion condensate from broken chiral symmetry; that idea anticipated later works that used detailed Technicolor or extended Technicolor models. The paper also naturally led us in 1966 to suggest the renormalizability of the theory.

The generality of our results is largely attributable to the use of quantum field theory, which at the time was largely ignored in elementary-particle physics. Its use in deriving the mechanism was no accident. Driven by his unusual faculty to translate abstract concepts into tangible intuitive images, Robert always conspicuously disregarded academic knowledge and favored entering any subject from scratch. For him, the fact that he was no expert on particle physics was an advantage: He could easily free himself from fashionable trends in the quest for a consistent theory of short-range fundamental forces.

The SBS mechanism is one of the most important discoveries in theoretical physics since the 1960s. It became the cornerstone of the electroweak theory, initiated the modern view of unified laws of nature, and was essential in motivating the construction of the Large Hadron Collider. The LHC should elucidate the precise realization of the SBS mechanism. The mechanism itself should be considered as established: All precision computations in particle physics rely deeply on it. What is not known is its detailed realization: Are there one or many SBS scalar bosons, or is the self-consistent vacuum generated dynamically? All those possibilities appear in our 1964 paper. But the theoretical significance of the paper goes even further: The paper assessed field theory as a favored tool to investigate fundamental interaction, thereby anticipating a change in the whole approach to elementary-particle physics.

The SBS work was honored with prestigious prizes: the High Energy and Particle Physics Prize of the European Physical Society in 1997 and the Wolf Prize in 2004, both with Higgs and me, and the J. J. Sakurai Prize of the American Physical Society in 2010 with Hagen, Higgs, Guralnik, Kibble, and me.

From the new approach initiated by his basic 1956 paper on irreversibility and from his early work on the statistical theory of phase transitions, to his later studies in field theory, elementary-particle physics, lattice gauge theory, general relativity, black hole physics, and cosmology, Robert made invaluable contributions to diverse domains of theoretical physics. They display his unique way of escaping the conventional track. To wit, his pioneering work in cosmology, which eventually involved our entire group, introduced the idea of inflation and related it to the emergence of the universe itself out of a quantum fluctuation, a scenario that might well turn out to be correct.

Robert taught at different Belgian universities in Brussels, Leuven, and Louvain-la-Neuve and was pivotal in developing and bringing together physicists from different schools. He

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Rosalyn S. Yalow
19 July 1921 – 30 May 2011
Willard S. Boyle
19 August 1924 – 7 May 2011
John Richard Hardy
9 January 1935 – 5 May 2011
Frank Edward Moss
1934 – 4 January 2011
Richard E. Watson
30 September 1931 – 13 September 2010

formed a new generation of physicists to whom he transmitted his particular approach to knowledge.

After becoming emeritus in 1993, he kept a constant interest in cosmological problems and continued working at the Université Libre de Bruxelles and at both the Perimeter Institute for Theoretical Physics and the University of Waterloo in Canada, where he frequently visited. Some two years ago he fell terminally ill. During that ordeal he was helped day and night by his loving wife Kathy, whom he had married after the loss of Martine; he passed away close to her in their home in Brussels on 3 May 2011.

François Englert
Université Libre de Bruxelles
Brussels, Belgium

Jay Gregory Dash

Jay Gregory Dash

With the passing of Jay Gregory Dash on 28 November 2010, the scientific community lost an innovator in the study of low-dimensional matter. His work had a profound influence on disciplines ranging from superfluidity to phase transitions and on the role that dimensionality plays in them.

Greg was born in Brooklyn, New York, in 1923 and obtained his BS in physics from City College in 1944. After serving in the US Navy during World War II, he entered graduate school at Columbia University. Under Henry Boorse and Mark Zemansky, he earned his PhD in physics in 1951 for studies on the flow of helium films, in the normal and superfluid states, on insulators, metals, ferromagnets, and superconductors. Throughout his career, Greg maintained his interest in superfluidity and thin films, which were an ideal fit for the research being conducted in the low-temperature group that he joined in 1951 at Los Alamos National Laboratory. There he studied superfluid hydrodynamics and was involved in one of the first direct measurements of the heat of mixing of liquid ^{3}He and ^{4}He at low temperatures.

His helium research led to a Guggenheim fellowship, which he spent at the University of Cambridge in 1957–58. On his return to New Mexico, Greg and Fred Reines founded the Los Alamos Philosophical Society. At its meetings Greg learned of the new area opened up by Rudolf Mössbauer's discovery of recoilless resonance absorption of gamma rays. Greg and his colleagues were the first to confirm the Mössbauer effect, and Greg refined the technique to great advantage as a probe of many basic physical processes. After visiting Seattle in 1960, he chose to move to the University of Washington instead of accepting an invitation from Reines to join him at Case Western Reserve University.

During the following two decades, Greg sought to understand what happens to the phase behavior of matter when the dimensionality is reduced. That basic question can be traced to the work of Felix Bloch, who showed that a planar, two-dimensional magnet could have no spontaneous magnetization because it would be destroyed by spin waves, and the work of Rudolf Peierls, who similarly demonstrated that a 2D solid could have no long-range positional order, since that order would be destroyed by phonons. Greg hoped to realize systems confined to two dimensions by adsorbing gases, such as helium, on smooth surfaces. The principal difficulty lay in obtaining a surface that was sufficiently smooth. Greg's student Michael Bretz eventually used a substrate of exfoliated graphite and obtained a helium heat capacity signal that approached Boltzmann's constant at high temperature, the long-desired signal of a 2D ideal gas.

Greg's next period of discovery included observing and interpreting the differences in the behavior of ^{3}He and ^{4}He due to their different statistics and an intriguing $\sqrt{3} \times \sqrt{3}$ order–disorder transition shown to be in the universality class of the three-state Potts model.

By 1970 Peierls was drawn back into questions of 2D physics and went to Seattle, where he and Greg collaborated and traveled together between two and three dimensions. With more than a decade of research, Greg formed the