

principle of microscopic reversibility.

In 1948, he published a famous paper with Dik Polder on the influence of retardation on the London-van der Waals forces. What is now known as the Casimir force has been convincingly demonstrated only recently. In 1996, Steve Lamoreaux at Los Alamos National Laboratories measured the force and found it to be in agreement with the Casimir-Polder theory.

When he and Polder wrote their paper, Casimir was already one of the labs' three research directors. In 1957, he was appointed a member of Philips Co's management board. He was in charge of all research activities of Philips worldwide, and contributed to their expansion. Even then, Casimir continued to be scientifically active. An interesting example is his work with Chris Bouwkamp on the representation of the field of spatially distributed electrical currents into a series of multipole fields. This work formed the basis for extensive work on antennas with arbitrary current distributions.

In this period he also laid the foundation for what came to be known as the science-technology spiral. Technology uses science with a time delay of, say, 10 years; science in turn is driven by new developments in technology; and both progress together. For example, radio lamps made it possible for new aspects of atomic and nuclear physics to be researched. The resulting science-technology spiral is largely responsible for the great technology progress of the previous century. A much more comprehensive description of Casimir's views (and an excellent book) can be found in his autobiography *Haphazard Reality—Half a Century of Science* (Harper & Row, 1983).

The Philips labs had been isolated from the rest of the world during World War II. Consequently, catching up in science and technology was paramount. With that aim, Casimir strongly cultivated contacts with colleagues from other scientific centers and industry all over the world. In this effort, he drew on his impressive fluency in several languages and his deep conviction that "research is essentially an international activity, and that repetition and duplication are useless!"

Within the company, Casimir did not put many restricting boundary conditions on suggestions for programs of work, provided they were potentially of interest to Philips and not merely, as he put it, "advanced

classroom experiments." He was able to stimulate people by knowledgeable hints for progress in widely diverging fields, avoiding short-term interference with their affairs. Casimir's abundant knowledge of science (and arts!) together with his extraordinary capacity for dissecting the most intricate problems, often by the use of amusing metaphors, made conversation with him on the bottlenecks in scientific progress not only entertaining but also effective. He contributed substantially to an atmosphere at the Philips research facility that was fertile and productive. After his retirement from Philips in 1972, he continued to foment research by coming into the laboratory in Eindhoven and asking young people "What is new in physics and what can we learn from it?" As a young physicist at Philips, I was greatly stimulated by such conversations.

Casimir was active on the Dutch and European physics and industry scenes. He was involved in the founding of the European Physical Society in 1968, and after his retirement from the Philips board of management in 1972, he became president of that society. He was also one of the founders and the first chairman of the European Industrial Research Management Association (EIRMA).

Casimir loved strenuous walking in mountainous areas, eating good food, and playing the violin. With his extraordinary memory, he recited by heart poems to his children, and used poems in his lectures. He loved a good chat with people from almost any discipline, particularly the arts or literature. He visibly and deeply loved his wife and five children, and they formed a fine family.

Casimir was awarded many prizes and honors. Most recent was the American Physical Society's George E. Pake Prize for outstanding scientific and industrial research leadership. With the death of Henk Casimir, we have lost one of the most gifted scientists and industrial research leaders of the century.

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David George Crighton

David George Crighton, one of the most influential, inspiring, and popular figures in fluid mechanics,

died of cancer in Cambridge, England, on 12 April. He was head of the department of applied mathematics and theoretical physics (DAMTP) at the University of Cambridge for nine years and master of Jesus College, Cambridge for three years.

Crighton was born on 15 November 1942 in Llandudno, North Wales, to which his parents had been evacuated in World War II to avoid German bombing. Christened David (but not Lloyd!) George, and claiming no Welsh ancestry, he captained his school at rugby and won a mathematics scholarship to Cambridge. He graduated as a top student in 1964.

In his first position, as a lecturer at Woolwich Polytechnic, Crighton taught mathematics to mature students in night school, where, he claimed, he mastered the elements of crowd control. But, having reached the top of that career path by the age of 24, he switched his sights to research. In 1967, he joined my group in the mathematics department of Imperial College as a research assistant.

With characteristic boldness, Crighton wanted to study the origin of turbulence. As his adviser, however, I was determined not to allow my obviously talented student to waste time on such an intractable subject, and I argued that the effects of turbulence formed a more suitable topic. He agreed, and worked instead on the effect of bubbles on the noise of underwater turbulence. His first paper demonstrated, with a hint of disappointment, that compressible homogeneous turbulence has no terrestrial scale application. His second widely quoted paper predicted that bubbles do indeed have a startling effect on the noise of underwater turbulence. He earned his PhD in 1969.

Two specific problems formed the context of Crighton's work: quieting the Concorde's excessively noisy take-off and limiting the underwater sound by which submarines could be detected. In tackling both problems, he mounted the most vibrant attack on the aeronautical noise problem and its underwater counterpart. He was superb at finding new techniques of analysis with which to model novel sound sources and, by correlating his results with experiment, he made an enormous contribution to the subject. His use of singular perturbation and matched asymptotic expansions laid solid foundations for wave analysis, and naval interests, both in the UK and the US, consulted him a great deal. For example, he helped British admiralty experts reduce the sound of

vibrating structures, a complicated matter in which naval vessels act as a sort of acoustic baffle. Much to Crighton's amusement, the experts were known collectively as the "Baffle Panel."

Imperial College's aeroacoustic research program moved to Cambridge in 1972, and Crighton moved with it—but only briefly. He was immediately appointed to succeed Thomas George Cowling as professor of applied mathematics at the University of Leeds, where he threw his energy into raising academic standards and staff morale. He brought about a veritable transformation of that department. He knew how to attract funds and how to motivate his team. He wrote with great clarity and authority and lectured extensively, earning international acclaim. He collaborated effectively and made friends easily—friendships that lasted.

Crighton enormously admired George Batchelor, who founded DAMTP and was the founding editor of the *Journal of Fluid Mechanics*. In 1986, Crighton became a professor at DAMTP and later succeeded Batchelor as editor of the journal. Though he survived Batchelor by less than a month, he held the department's and journal's reins long enough for both to surge forward under his leadership. He brought the same inspiration to Cambridge that had transformed Leeds. He chaired mathematics committees of the UK's funding councils, founded and chaired their nonlinear systems initiative, and also chaired the NATO nonlinear science panel. Crighton was president of the European Mechanics Society and served as president of the Institute of Mathematics and its applications in succession to James Lighthill, a close friend, whose obituary he wrote for *PHYSICS TODAY* a year ago (March 1999, page 104). Lighthill had pioneered the subject of aeroacoustics, but Crighton was probably the more versatile in using the theory to model definite physical problems precisely. Crighton wrote some 120 scientific papers around this subject and was notable for the way he brought into Western use techniques pioneered in the Soviet Union.

Elected a fellow of the Royal Society in 1993, he served as editor of the society's proceedings and on many other editorial boards. Devoted to the education of mathematicians at all levels, he was the inspiration behind a mathematics exhibition that toured the schools of Britain to raise mathematical awareness. When he died, he was president-elect of the London



DAVID GEORGE CRIGHTON

Mathematical Society. He had been welcomed into the White House by President Clinton, and, although he died before learning of it, he would have received an honor this year from the queen of England.

Crighton was passionately devoted to the music of Richard Wagner, and would travel many miles to operatic productions—even several times to the same opera. He wrote for *Wagner News*, and, shortly before his death, had conducted the Jesus College orchestra in an exhausting Wagnerian performance that gave him and his audience great pleasure.

He served as master of Jesus College so effectively and with such humanity that everyone in the college loved him. He will be missed dreadfully. All my memories of him are pleasant ones. I'm glad his surname began with *C*, making him, not me, the leading author of *Modern Methods in Analytical Acoustics* (Springer-Verlag, 1992). Produced initially to help the British admiralty's work on underwater noise, the book was the basis of many lecturing tours, which were always fun—a most appropriate concluding word.

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Michael Marinov

Michael Marinov, the theorist who, with Felix Berezin, introduced the classical description of spin by anticommuting Grassmann variables, died of cancer on 17 January in Haifa, Israel.

Born on 4 July 1939 in Moscow, Marinov studied at Moscow University and received his PhD in 1966 from the Institute of Theoretical and Experimental Physics (ITEP). His PhD study was devoted to spinning particles—the subject various aspects of which he continued to investigate throughout his life. During his 14 years at ITEP, Marinov went through all the stages of an academic career, from junior to senior researcher.

Marinov achieved worldwide recognition in the area of quantum field theory and related problems in mathematical physics. He had a deep understanding of the path integral method and used it extensively in his studies. Most theorists in the 1970s viewed this approach as rather symbolic compared to the operator method. Marinov analyzed the relation of the method to canonical quantization in his review on path integrals published in *Physics Reports* in 1980.

With the path integral method, the transition from classical to quantum physics can be understood as integration over paths near classical trajectories. A uniform treatment of bosons and fermions in the path integrals is another advantage of this method, which is based on the representation of fermions through anticommuting Grassmann variables. Berezin was largely responsible for advancing the calculus, including integration, on these variables. In 1975, Berezin and Marinov introduced a novel extension of that concept—namely, a classical description of spin by Grassmann variables. This idea sounds strange for spin- $1/2$ particles: We are used to viewing their spin properties as quantum phenomena. For Marinov, however, the introduction of classical spin trajectories was quite logical within the framework of path integration over anticommuting variables. This logic now is well-recognized and accepted.

Marinov also used path integrals fruitfully in the challenging area of quantization on manifolds with non-trivial geometry. In this complicated problem, which he started to tackle in 1979 with Mikhail Terentev, Marinov focused on manifolds associated with Lie groups. He continued to work on this problem until the end of his life. In his last years, he studied path integrals with application to quantum tunneling and multidimensional semiclassical approximation.

The year 1979 was a turning point in Marinov's life. In pursuit of his lifelong dream of living in Israel, Marinov applied for exit visas from the