by CNES, to enlist cooperation between French and Soviet scientists on several space projects in astronomy and the exploration of Venus. As a consultant to CNES, he worked on the *Ariane* launcher's engines. At the same time, as chairman of a joint working group charged with coordinating the technology programs of the European Space Agency and of CNES, Pellat successfully managed to increase the overall efficiency of European technological developments. One area in which Pellat was keenly interested was the development of nuclear propulsion and energy for interplanetary travel.

In his capacity as chairman of the consultative committee for fusion for EURATOM (1999–2003), Pellat played a decisive role in resuscitating ITER. Originally, ITER was a joint project among Europe, the US, Russia, and Japan. In 1998, in view of escalating costs, the US withdrew from the project (see PHYSICS TODAY, March 2000, page 65). Pellat was among those who helped reduce the scope of the project by downsizing the power to only 400 MW of power for 500 seconds, at about half of the original cost. Scaling down the cost of the ITER project was key in getting the US to rejoin ITER and in getting China and South Korea to sign on. Pellat's death is certainly a severe drawback at a time when site selection for ITER is under way. Pellat preferred Cadarache in southern France. He would have loved to have conducted the negotiations until a final decision had been reached.

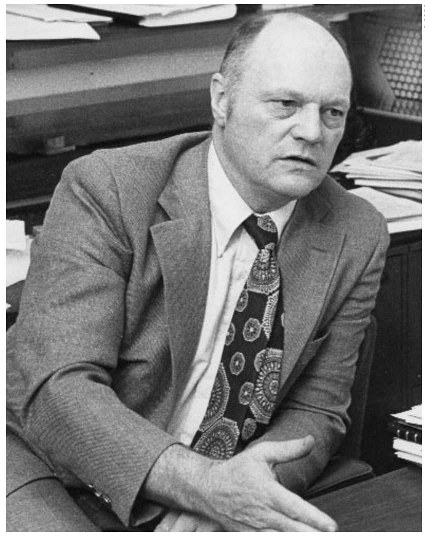
In all his domains of research, Pellat was eager to train young scientists, many of whom are now leaders in their disciplines. He taught at the École Polytechnique, in several French universities, and at UCLA. He was an adviser to the government of France under several administrations and chaired scientific committees for numerous agencies. He was president of CNRS (1989–92); president of CNES (1992–95); and high commissioner of CEA from 1998 until his death. In 2000, he, Jean-Michel Charpin, and Benjamin Dessus, published an important report on the evolution of the electrical power supply system and on the role of nuclear power in France. Beginning in September 2001 until his death, Pellat was in charge of nuclear safety and radioprotection for all defense-related activities and facilities.

Pellat's contributions to science garnered him the silver medal of CNRS in 1972. He was elected as a corresponding member in the physics section of the French Academy of Sciences in 1982 and was named Officer of the Légion d'Honneur in 2000.

Pellat was a generous, internationally oriented, and open-minded man without prejudices. He was unusually frank and did not hesitate to express dissenting opinions when called for. His unexpectedly shortened life shocked the scientific community worldwide.

Roger-Maurice Bonnet
International Space Science Institute
Bern, Switzerland
Guy Laval
Jean-François Luciani
École Polytechnique
Palaiseau, France

Norman Carl Rasmussen


MIT

Norman Carl Rasmussen

Norman Carl Rasmussen, a pioneer of probabilistic risk assessment for nuclear power plants, died on 18 July 2003 in Concord, Massachusetts, of complications from Parkinson's disease.

Born in Harrisburg, Pennsylvania, on 12 November 1927, Norm served in the US Navy from 1945 to 1946. He graduated from Gettysburg College in 1950 with a BA in physics, entered graduate school in the department of physics at MIT, and earned his PhD there in 1956. His doctoral research was in the field of low-energy nuclear physics.

Norm remained at MIT as an instructor in physics until 1958, when he was appointed assistant professor in the newly formed MIT department of nuclear engineering. He was promoted to full professor in 1965, served as head of the department from 1975 to 1981, and was named McAfee Professor of Nuclear Engineering in 1983.

His early research was in the field of radiation detection, including activation analysis, low-level counting techniques, and gamma-ray spectroscopy. He carried out extensive work on the development of lithium-drifted germanium gamma-ray detectors and their application to problems of gamma-ray spectroscopy.

During the period 1972 to 1975, Norm served the US Atomic Energy Commission and the US Nuclear Regulatory Commission (NRC) as director of a study to evaluate the risks from nuclear power plant accidents. The final, multivolume report resulting from that study was issued in 1975 and is now known as the Reactor Safety Study, WASH-1400, or the Rasmussen Report. The report was a pioneering effort in which probabilistic methods were used for the first time to quantify the level of risk to the public from nuclear power plants. It identified the most likely accident sequences, and thus provided a very useful knowledge base to the nuclear industry and regulators for risk management.

After President Dwight D. Eisenhower delivered his "Atoms for Peace" speech at the United Nations in 1953, the development of nuclear power reactors started in earnest. The prevailing thinking at the time was that accident frequencies could not be evaluated, yet the plants should be designed and regulated so that these frequencies would be very low; the predominant belief was that the accident consequences would be catastrophic. The regulatory system, based on those beliefs, evolved over a number of years. Its cornerstone was the concept of defense in depth, which is defined in a 1999 white paper by the NRC as the "safety philosophy that employs successive compensatory measures to prevent accidents or mitigate damage if a malfunction, accident, or naturally caused event occurs at a nuclear facility." The most severe design-basis accident was considered to be the hypothetical double-ended guillotine break of the largest pipe in the plant (large loss-of-coolant accident).

The Rasmussen Report changed the prevailing thinking in fundamental ways. Taking a systems approach to reactor safety, the report identified accident sequences that were previously unknown, pointed out the significance of human error, and identified the small loss-of-coolant accident as a significant contributor to risk. It also showed that the frequency of severe core damage was not as low as previously believed—the best estimate was about five core damage events every 100 000 reactor years, with an upper bound of three events per 10 000 reactor years. In addition, it was determined that the accident consequences were significantly smaller than previously believed.

Opponents of nuclear power attacked the report vigorously. Norm did a remarkable job defending its methods and results. He gave several hundred lectures around the world and media interviews and press conferences. The significance of the report's methods and findings was soon recognized. In 1982, President Ronald Reagan appointed Norm as a member of the National Science Board, on which he served for six years. He received the US Department of Energy's highest scientific award, the Enrico Fermi Award, in 1985.

The methods of the Rasmussen Report have stood the test of time. Probabilistic risk assessment is now recognized as a discipline and is used internationally for nuclear power plants and other major technological facilities. The report has allowed the NRC to issue quantitative health objectives and to pioneer the development of risk-informed regulations, with the goals of maintaining safety, increasing public confidence in the regulatory system, and removing the unnecessary regulatory burden that results from excessive application of defense in depth.

Norm was an avid skier and a dedicated birdwatcher. He was extremely quick witted, with a marvelous sense of humor. According to Kent Hansen of MIT, who knew Norm since his graduate student days, Norm was once testifying before the US Senate about the Reactor Safety Study. Senator John Pastore of Rhode Island was chairing the session. The quorum bell rang; the senator interrupted Norm to say that the senators would have to leave in a few minutes and asked Norm how much longer he needed. Norm replied, "Senator, that depends on how smart you are." The staffers and members of the NRC were aghast. Pastore roared with laughter and said perhaps they'd better adjourn now and save some time for Norm for another appearance.

Norm was a major figure in the field of reactor safety. Those of us who knew him consider ourselves fortunate to have worked with him, enjoyed his wit and great sense of humor, and benefited from his wisdom.

George E. Apostolakis
Massachusetts Institute of Technology
Cambridge

Michael Dudley Sturge

Michael Dudley Sturge

Michael Dudley Sturge, best known for his contributions to solid-state spectroscopy, died of leukemia on 13 July 2003 in Castleton, England.

Born on 25 May 1931 in Bristol, England, Michael obtained his BA in engineering and physics (1952) and his PhD in physics (1957) at Cambridge University, where he worked on superconductors under Brian Pippard. After two years at Philips Labs outside London, Michael moved to the Royal Radar Establishment in Malvern, where he published, in *Physical Review*, his paper on the spectroscopy of gallium arsenide. That work included GaAs band structure parameters (most timely for the GaAs laser, invented in the same year) and the first observation of Wannier–Mott excitons in a III–V semiconductor. The paper became a citation classic and brought him international recognition.

In 1961, Michael joined Bell Labs in Murray Hill, New Jersey. During his more than 20 years as a member of the technical staff, he grew into one of the leading experts on the optical properties of semiconductors and commanded a tremendous level of respect within that highly skilled community. His expertise, intense level of scientific curiosity, and personal and scientific integrity attracted many young scientists to Bell Labs, and he became a cherished mentor to many of them.

In 1984, Michael joined Bell Communication Research in Murray Hill, an R&D firm that had split from Bell Labs. Two years later, he became a professor of physics at Dartmouth College.

Michael first worked on the spectroscopy of transition-metal ions in crystals, basic solid-state laser materials. By combining optical and electron paramagnetic resonance spectroscopies, he identified the role of the dynamic Jahn–Teller effect in ion-level splitting and the collective Jahn–Teller effect in phase transitions of rare-earth perovskites.

In the mid-1970s, Michael returned to the fundamental optical properties of semiconductors. He studied the excited states of excitons bound to isoelectronic nitrogen pairs in bulk gallium phosphide and classified them using the model of a tightly trapped electron and a hole orbiting the pair. When the interest of the semiconductor community turned to quantum wells and superlattices, he studied transport and cyclotron resonance in two-dimensional electron systems and participated in the discovery of minigaps in metal-oxide-semiconductor field effects and in the initial experiments on modulation-doped superlattices.

In the early 1980s, Michael made important contributions to the spectroscopy of disordered semiconductor systems. By combining experiments of luminescence, resonant Rayleigh scattering, hole burning, and transient grating spectroscopy, he found clear evidence for a mobility gap in the spectrum of excitons in quantum wells. He also discovered a new type of exciton in short-period superlattices, which is indirect in both real and reciprocal spaces, and electric-field controlled switching between the direct and indirect band structures.

Michael's last work was on trions, complexes of a hole and two electrons similar to H^- ions. He discovered a puzzling abrupt changeover in the magnetoluminescence from free-particle to bound-particle behavior when the lower electron Landau level becomes just filled. That observation proved that a "hidden symmetry," known for strong magnetic fields, surprisingly manifests itself in moderate-to-weak fields.

Michael always set the highest standards for his work. He perceived science in its unity and applied that approach when composing, with one of us (Rashba), the volume *Excitons* (North-Holland, 1982), which included reviews of excitons. As the general editor of the *Journal of Luminescence* from 1985 to 1990, Michael expanded its scope to embrace modern research areas. At Dartmouth, he brought the same standards to his