Obituary

Per Bak (1947–2002)

With Per Bak's death on 16 October 2002, Denmark lost one of its most prominent scientists. Per Bak was known worldwide for his contributions to the physics of complex systems and was one of the world's most cited physicists. His premature death at the age of 54 leaves a deep void at the Niels Bohr Institute, where his lively nature and rich stream of ideas never failed to engage the people around him.

Bak studied at the Technical University of Denmark and obtained his PhD from the Risø National Laboratory in 1974. Soon after, he moved to the Brookhaven National Laboratory in New York. His long association with Brookhaven was interrupted by stays at the University of Copenhagen and at the Nordic Institute of Theoretical Physics in Copenhagen. From the start, Bak showed himself to be a creative and productive scientist, concentrating in these early years on critical phenomena and phase transitions in metals and other materials. His 1976 work on the structure of synthetic one-dimensional conductors is a fine example of the elegance of his scientific methods and was for several years one of the most cited publications in solid-state physics.

In 1979 Bak was employed as a lecturer at the University of Copenhagen's Ørsted Laboratory and turned his attention to chaos and fractal theory. As usual, Bak was several steps ahead of everyone else, and his ability to combine different areas of physics enabled him to lead this developing field into uncharted territory. His skill at generating original scientific ideas gave him the opportunity to travel to conferences and universities around the world. Although he had a great talent for guiding students, he was not totally committed to curricular teaching. Rather, he would prefer to find thought-provoking projects for his students and spent days discussing them. In 1982, Bak received a doctor of science degree for his thesis on modulated and chaotic phases — another classic, highly cited paper.

But sometimes he felt that Denmark was too small to satisfy his restless nature, and in 1983 Bak returned to a permanent position at Brookhaven. This was the start of another productive period, in which he turned his attention to what is now called the physics of complex systems. In 1987, with Chao Tang and Kurt Wiesenfeld, he published what he and many colleagues considered to be his most important contribution to science: the theory of self-organized criticality (SOC). For years Bak had pondered the many examples of fractal structures found in nature — from clouds and earthquakes to the distribution of galaxies in the Universe — and his theory of SOC underpins the observed self-similar structure of such systems. Once again, he had demonstrated his particular ability to piece together observations and theoretical knowledge to make a great leap forward.

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Pioneer in the physics of complex systems, and discoverer of self-organized criticality

The theory of self-organized criticality spread, like the forest fires it describes, through the scientific community, and his ideas were adopted around the world. As with any of Bak's proposed theories, there were sceptics as well as adherents, but the latter were far more numerous. Bak enjoyed the often heated debate and participated enthusiastically in discussions at conferences and by e-mail. He never went with the flow but threw himself with tremendous energy against it. For those around him, this attitude brought opportunities to participate in exciting discussions, with fresh ideas always seeming to ferment just below the surface.

Bak's lively temper was legendary. Woe betide that seminar speaker who had misunderstood a central idea or happened to find himself at cross-purposes to it. Bak's objections were always delivered with a touch of humour and were mostly well founded.

Over the past 15 years, the theory of SOC has become an established part of many scientific disciplines, and remains one of the most cited works in theoretical physics. Bak was delighted that his theory could be applied to virtually every branch of science and that it stands as one of the most successful interdisciplinary contributions to science in recent decades. He collaborated and published with economists, geologists, biologists, physicians, mathematicians and many others. The theory of SOC was also the theme of his popular book *How Nature Works* (Copernicus, 1996), which has been translated into several languages.

Bak was a frequent guest speaker at international conferences on statistical physics and the physics of complex systems. His lecturing style was always relaxed, even when he was putting forward the often controversial ideas from his latest research. He was interested in the big picture. Although details did not concern him, they were often the source of questions from his audience, and his elegant brush-offs were a source of great amusement for his listeners. A lecture by Bak was never boring, and conference organizers all over the world knew it.

In 1996, Bak was called home to take up a professorship in theoretical physics at the Niels Bohr Institute in Copenhagen. He greatly appreciated this recognition, and valued the unique atmosphere at the institute. But he watched with growing concern as the institute was reduced by innumerable budget cuts. He viewed the hierarchical management and control mechanisms of politicians and bureaucrats with open contempt, and was convinced that heavy-handed management of science would strangle free-thinking research, replacing it with 'programmes' of little originality and no lasting value. The rare but genuinely revolutionary advances would succumb, he feared, to a steady stream of uninteresting technical progress.

Over the past few years, Bak believed that Denmark's reputation in fundamental research was in serious decline, in spite of his own considerable efforts to further it. Indeed, the recognition of truly free scientific research as a central element in any healthy society would be the most fitting memorial to Per Bak's own life and work.

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