# James Cronin

## (1931–2016)

Particle physicist who helped to explain the dominance of matter in the Universe.

For decades, physicists have puzzled over why the Universe contains more matter than antimatter — essentially, how it is that we are here. It was expected that particles of matter and antimatter would mutually destruct.

A major step towards the answer came from an experiment in which James (Jim) Cronin and Val Fitch, along with two other colleagues, showed that an elementary particle, called a neutral kaon, decayed in an unexpected manner. For their discovery, Cronin and Fitch received the Nobel Prize in Physics in 1980.

Cronin, who died after a fall on 25 August, was born in Chicago in 1931. He grew up in Dallas, Texas, and attended the city's Southern Methodist University, where his father was a classics professor. In 1951, he pursued a PhD at the University of Chicago in Illinois, on the spin and parity of the nuclear states of carbon. Subsequently, he moved to Brookhaven National Laboratory in Upton, New York, and later to a faculty position at Princeton University in New Jersey. In 1971, he returned to Chicago — largely because of the university's proximity to the Fermi National Accelerator Laboratory (Fermilab).

In 1964, the team of four at Brookhaven found that the long-lived neutral kaon decayed unexpectedly into two pions. This observation is known as charge–parity (CP) violation, and because of it we can begin to understand why there is more matter than antimatter in the Universe. The CP violation experiment had at its heart spark chambers — a technique that allowed the decays to be studied in unprecedented detail.

Cronin's expertise with this technique was pivotal to the design of another Brookhaven experiment, in which it was shown that the neutrino associated with muon decay was different from that associated with beta decay — and for which the discoverers were awarded the 1988 physics Nobel prize. However, Jim's modesty was such that he would never claim credit for his role in this achievement.

In 1977, the director of Fermilab appointed Cronin as head of the Colliding Beams Division. Cronin resigned after only a few months, realizing that he would never be happy with the responsibilities of academic or scientific administration. He returned to making seminal discoveries in particle physics, which included, in 1982, measuring the lifetime of a subatomic particle called

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the neutral pion at CERN, the European particle-physics laboratory near Geneva, Switzerland.

By the mid-1980s, however, a golden age of particle physics had ended. For Cronin — who liked to do things with his own hands and take a leading role — experiments being done by teams of hundreds held little appeal. So he shifted his attention elsewhere.

In 1985, with a small team, he designed and constructed an experiment to study the cosmic-ray showers expected to result from the high-energy γ-rays emitted by certain stellar systems. The showers are cascades of ionized particles and electromagnetic radiation that are produced when a cosmic ray enters the atmosphere. In terms of the number of detectors it involved (more than 1,000), the scale of the project was vast by conventional standards. Indeed, Cronin's leadership and vision gave new respectability to a field for which many particle physicists had little regard.

With typical thoroughness, Cronin visited several cosmic-ray institutions to discuss his plans and seek advice. One of these was Haverah Park in the United Kingdom, near the University of Leeds, where I had a professorship. Our strong friendship, helped by a mutual respect for malt whisky, grew from his Leeds visit — as did the creation of the Pierre Auger Observatory in Argentina, which at 3,000 $km^2$ is the largest cosmic-ray detector ever built.

Designed to detect cosmic rays of multi-joule energies, the Pierre Auger Observatory is operated by 430 scientists from 16 countries. Having the project evaluated, sourcing initial financial support and getting people from all over the world to collaborate would have been impossible without Cronin's formidable drive and status.

At the time, the United States was not a member of UNESCO (the United Nations Educational, Scientific and Cultural Organization), which aims to promote international collaboration, including through scientific initiatives. Cronin still managed to extract US$100,000 to enable scientists from developing countries, such as Bolivia and Vietnam, to work on a design study at Fermilab. Ultimately, an evaluation of the project by a panel of experts invited by Cronin helped us to raise $50 million, an unprecedented sum for cosmic-ray work. Cronin even formed a remarkable relationship with the then-president of Argentina, Carlos Menem, whose government contributed 11 million pesos (roughly $11 million at the time of the donation) towards the project.

The Pierre Auger Observatory has greatly enhanced the profile of fundamental physics in Argentina, Brazil, Mexico and Vietnam. Vietnam is no longer a member, but a thriving astrophysics community has evolved there. The James Cronin School, a high school in the small town of Malargüe in Argentina, which hosts the Pierre Auger Observatory, was financed by Cronin and private donors.

Neither Jim nor I (both averse to working in vast teams) had expected the Auger collaboration to become so large. But Jim thrived in his role as a leader of the project. He stimulated the ambitions of many young scientists and conducted his own analyses of the data using FORTRAN, an early programming language, and an ancient graphics package hosted on a Chicago computer.

I think of Jim as a 'vector' — a quantity having magnitude and direction. Jim's magnitude as a scientist is unquestioned. Without his strong sense of direction, coupled with his persuasive skills, the Pierre Auger Observatory and many other projects would never have succeeded. He was an outstanding experimentalist physicist and an exceptionally gracious, modest and generous man. He will be sorely missed. ■

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