

RETROSPECTIVE

Stephen Hawking (1942–2018)

The world's best-known scientist richly deserved his fame

By John Preskill

Stephen William Hawking died on 14 March (Albert Einstein's birthday) at the age of 76 after decades of battling the incurable disease amyotrophic lateral sclerosis (ALS). His early scientific work transformed our understanding of general relativity, Einstein's theory of gravitation. Later in life, Stephen became an immensely successful popularizer of science; his courage and high spirits in the face of his disability inspired millions. Stephen Hawking's achievements as a scientist, communicator, and public figure were commensurate with his great fame.

Stephen was born in Oxford on 8 January 1942 (which, as he enjoyed pointing out, was the 300th anniversary of Galileo's death) and entered the University of Oxford in 1959. Although his mathematical aptitude was quickly recognized, Stephen was not a diligent student, and his performance was lackluster. Nonetheless, he graduated in 1962 with a bachelor's degree in natural sciences. Soon after beginning doctoral studies at the University of Cambridge, where he joined the research group of physicist Dennis Sciama, Stephen was diagnosed with ALS. Although terminal, the disease progressed more slowly than anticipated, and with Sciama's encouragement, Stephen focused on research with newfound determination, completing his Ph.D. in 1965. He remained at Cambridge for the rest of his career, confounding expectations by surviving for 55 years after his initial diagnosis. From 1979 until 2009, Stephen was the Lucasian Professor of Mathematics at Cambridge, following in the footsteps of Isaac Newton, Paul Dirac, and other scientific luminaries. He remained scientifically active until his death.

Stephen's scientific career divides naturally into two phases, which could be called his classical gravity phase and his quantum gravity phase. During his classical phase, one of his early achievements was proving that time had a beginning—that the laws of physics as we now understand them must have broken

down very early in the history of the universe, at the Big Bang. Stephen also greatly advanced our understanding of black holes, where gravitational forces are so strong that time comes to an end; in particular, he discovered and elucidated a deep analogy between classical black holes and thermodynamics.

Stephen's pivot from classical to quantum gravity was precipitated by his greatest scientific achievement, which shook the world of physics in 1974. According to Einstein's theory, nothing, including light, can escape from inside a black hole, which explains why it's black. But Stephen found that black holes



are not really completely black. Instead, due to the subtle consequences of quantum physics, they emit what we now call Hawking radiation. He computed the temperature of a radiating black hole, and derived a beautiful formula for its entropy, validating and refining an earlier conjecture by theoretical physicist Jacob Bekenstein (which Stephen had hoped to refute). A major milestone in the history of science, the theory of Hawking radiation established a profound connection among gravitation, quantum physics, and information science, which still guides the ongoing search for a more complete theory of quantum gravity. Stephen's subsequent research focused on that quest, emphasizing the role of quantum physics in the origin and early history of the universe.

Although his scientific accomplishments alone would suffice to ensure an enduring

legacy, Stephen Hawking also became one of the world's most successful science communicators. Stephen firmly believed that the quest for a complete theory of the universe should be accessible to everyone, at least in broad principle, not just to a few specialists. That conviction drove him to write *A Brief History of Time*. Whereas other scientists have tried to write books for lay readers, Stephen earned tenure on the *New York Times* best seller list, thanks in part to that ingenious title. The book sold more than 10 million copies and was translated into dozens of languages. Its extraordinary success led to more books, including a series for children, which Stephen coauthored with his daughter Lucy.

Stephen achieved scientific greatness despite a severe physical disability, while displaying a zest for life and buoyant sense of humor that seemed miraculous under the circumstances. People rooted for Stephen, and he appreciated having millions of fans.

I first got to know Stephen at a 1982 workshop in Cambridge, but we became closer after he began making regular visits to the California Institute of Technology in 1991. Stephen was fun to be with; we could always make each other laugh, and he enjoyed being treated irreverently. In the middle of a scientific discussion, I could interject, "And what makes you so sure of that, Mr. Know-It-All?" knowing that Stephen would respond with his eyes twinkling: "Wanna bet?"

With our friend Kip Thorne, we made some of those bets "official," and we were all taken aback by how much attention they received. Stephen conceded our most famous bet (regarding whether black holes destroy information) in 2004, before an audience in Dublin of 700 scientists and at least 50 reporters from print and electronic media. To pay his debt, he presented me with *Total Baseball: The Ultimate Baseball Encyclopedia*. You can't buy one of those in Ireland, so Stephen's assistant had arranged to have it shipped overnight. Not knowing what else to do, I held the book over my head as though I had just won the Wimbledon final, while what seemed like a million flashbulbs popped to record the moment.

We made bets for fun, but physicists passionately care about the scientific issues in question, founded on some of Stephen's most far-reaching contributions. Combining extraordinary depth of thought with an irrepressible sense of play—that's what I'll remember best about Stephen Hawking. ■

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