By SARAH ACHENBACH

Beyond Expectations

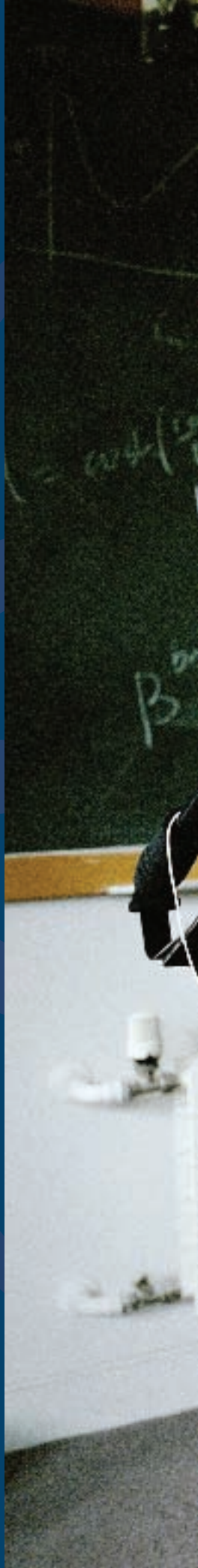
PHYSICALLY PARALYZED FOR MOST OF HIS ADULT LIFE, SCIENTIST STEPHEN HAWKING CONTINUES TO EXPLORE THE MYSTERIES OF THE UNIVERSE

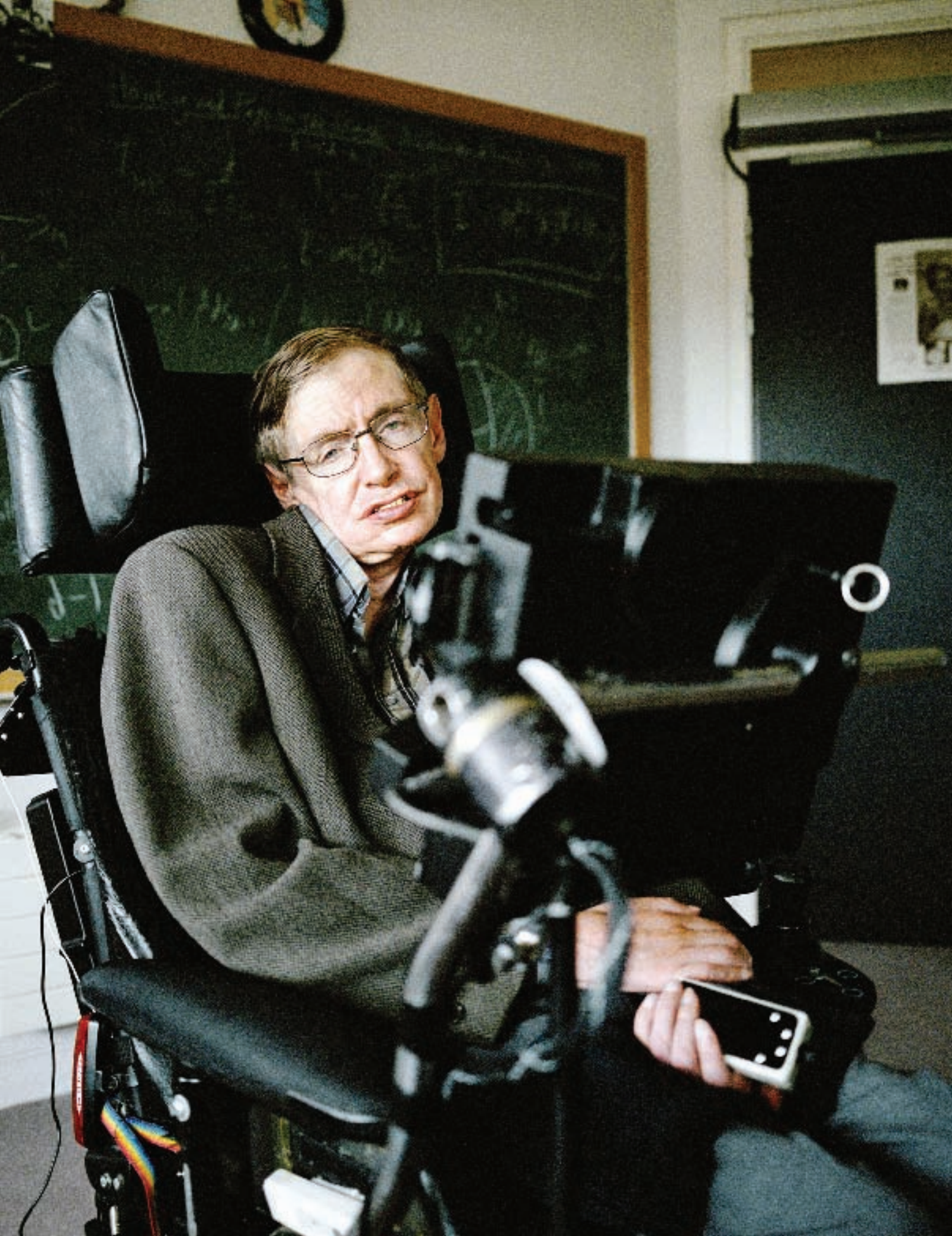
The prognosis was grim: 21-year-old Stephen Hawking likely had only a few years to live. The young man was just coming into his own as a scientist, working on a Ph.D. in cosmology, the study of the universe's origin, structure and development, at Cambridge University.

"The doctors told me to go back to Cambridge and carry on with the research I had just started in general relativity and cosmology. But I was not making much progress, because I didn't have much mathematical background. And anyway, I might not live long enough to finish my Ph.D. I felt somewhat of a tragic character," Hawking writes.

Instead of surrendering to what is now known to be amyotrophic lateral sclerosis or ALS (also known in the United States as Lou Gehrig's disease), Hawking discovered with great surprise that the prospect of imminent death brought out a joy for life. His research began to progress, and he became engaged to his first wife, the former Jane Wilde, whom he had started dating about the time of his diagnosis. "That engagement changed my life," he says. "It gave me something to live for."

And live he did.





Now arguably the most famous cosmologist in the world, Hawking's dazzling intellect has secured his place as one of history's most important scientists. The Lucasian Professor of Mathematics at Cambridge University since 1979, he holds the same post that Sir Isaac Newton once held. The recipient of numerous honorary degrees, medals and prizes, including the Companion of the Order of the British Empire in 1982 and the Companion of Honour in 1989, Hawking is a Fellow of The Royal Society and a member of the U.S. National Academy of Sciences.

His boundless curiosity and the very limited boundaries of his physical self have made him an internationally known and respected figure well beyond scientific circles. His popular books—*A Brief History of Time* (Bantam, 1988), which spent a record four years on the *London Sunday Times*' best-seller list, *Black Holes and Baby Universes and Other Essays* (Bantam, 1993) and *The Universe in a Nutshell* (Bantam, 2001)—have helped stargazers everywhere better understand the universe.

In *A Brief History of Time*, he writes, "However, if we discover a complete theory, it should in time be understandable by everyone, not just by a few scientists. Then we shall all, philosophers, scientists and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason—for then we should know the mind of God."

AT A LOOSE END

In a coincidence bordering on prescience, Hawking was born on Jan. 8, 1942, exactly 300 years after the death of Galileo. His parents, Frank and Isobel, raised him in Oxford, England—a safer place during World War II than their London home—and when the young Hawking was 8, his family moved to St. Albans, a small town north of London. At the St. Albans School, Stephen was a good, but not outstanding, student who immersed himself in books. Enrolling in his father's alma mater, University College, Oxford, Hawking intended to study mathematics, although his father, a research biologist, preferred he study medicine. Since mathematics was not offered at University College, he chose physics, earning a degree in natural science. It was during his time at Oxford that the young man started to blossom.

His physics tutor, Robert Berman, later said in *The New York Times Magazine*, "It was only necessary for him to know that something could be done, and he could do it without looking to see how other people did it. ... He didn't have very many books, and he didn't take notes. Of course, his mind was completely different from all of his contemporaries."

It was just as his world was opening up intellectually that his physical abilities were beginning to deteriorate. Never particularly graceful or athletically inclined, he was getting more and more clumsy. In his third year at Oxford, he had fallen a few times for no apparent reason. At his father's urging, Hawking went to his family doctor, who in turn referred the young scientist to a specialist.

Just after his 21st birthday, Hawking entered the hospital for a two-week battery of tests. The results ruled out multiple sclerosis, but no specific diagnosis was offered at the time. Instead, Hawking recalls that the doctors gave him vitamins and the news that they expected his incurable, terminal condition to get much worse rather quickly. "Not knowing what was going to happen to me, or how rapidly the disease would progress, I was at a loose end," he writes.

His engagement to Jane provided the impetus to keep going: Hawking needed to find a job if he were to provide for a family. (He and Jane were married for 30 years before they divorced. They have three children, Robert, Lucy and Tim, and two grandchildren. Hawking is divorced from his second wife and former nurse, Elaine Mason.) While at Cambridge,

A growing black hole, called a quasar, can be seen at the center of a faraway galaxy in this artist's concept, opposite page. Hawking's early research explored the creation and extreme conditions of black holes. Hawking experiences zero gravity during a flight over the Atlantic Ocean. "It was amazing ... I could have gone on and on," Hawking, then 65, said after riding on the modified jet.

IMAGE COURTESY OF NASA.

he applied for and received a research fellowship in theoretical physics at Gonville and Caius College, Cambridge.

As his disability worsened and he was confined to a wheelchair, his scientific reputation blossomed. "This meant that people were prepared to offer me a sequence of positions in which I only had to do research, without having to lecture," writes Hawking.

The disease was causing his speech to slur. Hawking could communicate, but only those who knew him well could understand him clearly. His papers were dictated to a secretary and any lectures he gave were through an interpreter. A tracheotomy operation following a bout of pneumonia in 1985 left him unable to speak at all. Now, Hawking had to painstakingly point at letters on a card to communicate with his family, nurses and colleagues.

Walt Woltosz, a California-based computer programmer, came to the rescue with Equalizer, a program that allows Hawking to select his words from menus on a screen by pressing a switch, which can be operated by head or eye movement. With his wheelchair fitted with a laptop, Equalizer and a speech synthesizer made by Speech Plus that varies intonation, Hawking is able to speak or write about 15 words a minute through an infrared sensor mounted on a headpiece that detects motion in his cheek. "The only trouble is that it gives me an American accent," he quips.

MYSTERIES OF THE UNIVERSE

Hawking's early research focused on using Einstein's Theory of Relativity to explore the creation and extreme conditions of black holes. Coupling for the first time General Relativity (gravity) with Quantum Mechanics (the physical laws that govern atoms), Hawking and his Ph.D. adviser Roger Penrose proved the radical theory that black holes aren't completely black, but rather that they emit radiation. As massive stars shrink, they become black holes radiating substance into space, ending in an explosion and an eventual, inevitable disappearance.

Now referred to as Hawking Radiation, this theory combines the concept of "space-time singularities"—events during which the laws of physics appear to collapse—the thermodynamics of black holes, and highly complex mathematics. Hawking's research is one of the most significant contributions to the Grand Unified Theory through which physicists use a single equation to explain all physical matter in the universe.

This revolutionary research led Hawking and Penrose to equally radical discoveries about the Big Bang Theory implying that the laws of science entirely determined the cosmos' creation and will predict its end. On his Web site, Hawking elaborates in a lecture titled "The Beginning of Time": "…The universe has not existed forever. Rather, the universe, and time itself, had a beginning in the Big Bang, about 15 billion years ago. This is probably the most remarkable discovery of modern cosmology."

Hawking and Penrose predicted that time begins and ends within a black hole or "singularity," at which point Einstein's Theory of Relativity breaks down—and can no longer be used to predict what might emerge from the singularity. The universe, he theorizes, has no edge or boundary, but exists in a unique state of constant transition with one universe changing into another. Hawking's current research focuses on the new idea of imaginary time (measuring time in imaginary numbers), further defining space and time's intricacies and infinities.

His life's research and writings have greatly broadened modern knowledge of how the universe is expanding, how galaxies developed and the role black holes played in their creation—and will play in their extinction. Through it all, Hawking has never stopped dreaming about traveling through the very galaxy he's spent a lifetime quantifying.

On April 26, 2007, he took a short flight—and a small step toward that goal—aboard the Zero Gravity Corp.'s modified Boeing 727 jet that simulates the experience of weightlessness. During the flight from NASA's Kennedy Space Center in Florida, Hawking went weightless for about 25 seconds at a time—about four minutes total—during the jet's eight parabolic dives from 32,000 feet to 24,000 feet. Hawking hopes to be part of Virgin Galactic's suborbital space tours, which the company plans to begin in 2009.

"I think the human race doesn't have a future if it doesn't go into space," Hawking told the BBC News Web site prior to his flight. "I also want to show," he said in an e-mail interview with *The New York Times*, "that people need not be limited by physical handicaps as long as they are not disabled in spirit."

Hawking has helped to explain the mysteries of the universe to millions. But it is his perseverance in the face of daunting physical limitations that teaches the real lesson of life. "My expectations were reduced to zero when I was 21," he says. "Everything since then has been a bonus."