Monsignor Georges Lemaître & Albert Einstein, 1933

In the winter of 1998, two separate teams of astronomers in Berkeley, California, made a similar, startling discovery. They were both observing supernovae – exploding stars visible over great distances – to see how fast the universe is expanding. In accordance with prevailing scientific wisdom, the astronomers expected to find the rate of expansion to be decreasing, Instead they found it to be increasing – a discovery which has since "shaken astronomy to its core" (*Astronomy*, October 1999). This discovery would have come as no surprise to Georges Lemaitre (1894-1966), a Belgian mathematician and Catholic priest who developed the theory of the Big Bang. Lemaitre described the beginning of the universe as a burst of fireworks, comparing galaxies to the burning embers spreading out in a growing sphere from the center of the burst. He believed this burst of fireworks was the beginning of time, taking place on "a day without yesterday."

After decades of struggle, other scientists came to accept the Big Bang as fact. But while most scientists – including the mathematician Stephen Hawking -- predicted that gravity would eventually slow down the expansion of the universe and make the universe fall back toward its center, Lemaitre believed that the universe would keep expanding. He argued that the Big Bang was a unique event, while other scientists believed that the universe would shrink to the point of another Big Bang, and so on. The observations made in Berkeley supported Lemaitre's contention that the Big Bang was in fact "a day without yesterday."

When Georges Lemaitre was born in Charleroi, Belgium, most scientists thought that the universe was infinite in age and constant in its general appearance. The work of Isaac Newton and James C. Maxwell suggested an eternal universe. When Albert Einstein first published his theory of relativity in 1916, it seemed to confirm that the universe had gone on forever, stable and unchanging.

Lemaitre began his own scientific career at the College of Engineering in Louvain in 1913. He was forced to leave after a year, however, to serve in the Belgian artillery during World War I. When the war was over, he entered Maison Saint Rombaut, a seminary of the Archdiocese of Malines, where, in

his leisure time, he read mathematics and science. After his ordination in 1923, Lemaitre studied math and science at Cambridge University, where one of his professors, Arthur Eddington, was the director of the observatory,

For his research at Cambridge, Lemaitre reviewed the general theory of relativity. As with Einstein's calculations ten years earlier, Lemaitre's calculations showed that the universe had to be either shrinking or expanding. But while Einstein imagined an unknown force – a cosmological constant – which kept the world stable, Lemaitre decided that the universe was expanding. He came to this conclusion after observing the reddish glow, known as a red shift, surrounding objects outside of our galaxy. If interpreted as a Doppler effect, this shift in color meant that the galaxies were moving away from us. Lemaitre published his calculations and his reasoning in *Annales de la Societe scientifique de Bruxelles* in 1927. Few people took notice. That same year he talked with Einstein in Brussels, but the latter, unimpressed, said, "Your calculations are correct, but your grasp of physics is abominable."

It was Einstein's own grasp of physics, however, that soon came under fire. In 1929 Edwin Hubble's systematic observations of other galaxies confirmed the red shift. In England the Royal Astronomical Society gathered to consider this seeming contradiction between visual observation and the theory of relativity. Sir Arthur Eddington volunteered to work out a solution. When Lemaitre read of these proceedings, he sent Eddington a copy of his 1927 paper. The British astronomer realized that Lemaitre had bridged the gap between observation and theory. At Eddington's suggestion, the Royal Astronomical Society published an English translation of Lemaitre's paper in its *Monthly Notices* of March 1931.

In January 1933, both Lemaitre and Einstein traveled to California for a series of seminars. After the Belgian detailed his theory, Einstein stood up, applauded, and said, "This is the most beautiful and satisfactory explanation of creation to which I have ever listened."

Most scientists who read Lemaitre's paper accepted that the universe was expanding, at least in the present era, but they resisted the implication that the universe had a beginning. They were used to the idea that time had gone on forever. It seemed illogical that infinite millions of years had passed before the universe came into existence. Eddington himself wrote in the English journal *Nature* that the notion of a beginning of the world was "repugnant."

The Belgian priest responded to Eddington with a letter published in *Nature* on May 9, 1931. Lemaitre suggested that the world had a definite beginning in which all its matter and energy were concentrated at one point:

If the world has begun with a single quantum, the notions of space and time would altogether fail to have any meaning at the beginning; they would only begin to have a sensible meaning when the original quantum had been divided into a sufficient number of quanta. If this suggestion is correct, the beginning of the world happened a little before the beginning of space and time.

In January 1933, both Lemaitre and Einstein traveled to California for a series of seminars. After the Belgian detailed his theory, Einstein stood up, applauded, and said, "This is the most beautiful and satisfactory explanation of creation to which I have ever listened." Duncan Aikman covered these seminars for the *New York Times Magazine*. An article about Lemaitre appeared on February 19, 1933, and featured a large photo of Einstein and Lemaitre standing side by side. The caption read,

"They have a profound respect and admiration for each other."
For his work, Lemaitre was inducted as a member of the Royal Academy of Belgium. An international commission awarded him the Francqui Prize. The archbishop of Malines, Cardinal Josef Van Roey, made Lemaitre a canon of the cathedral in 1935. The next year Pope Pius XI inducted Lemaitre into the Pontifical Academy of Science.
Despite this high praise, there were some problems with Lemaitre's theory. For one, Lemaitre's calculated rate of expansion did not work out. If the universe was expanding at a steady rate, the time it had taken to cover its radius was too short to allow for the formation of the stars and planets. Lemaitre solved this problem by expropriating Einstein's cosmological constant. Where Einstein had used it in an attempt to keep the universe at a steady size, Lemaitre used it to speed up the expansion of the universe over time.
Einstein did not take kindly to Lemaitre's use of the cosmological constant. He regarded the constant as the worst mistake of his career, and he was upset by Lemaitre's use of his super-galactic fudge factor.
After Arthur Eddington died in 1944, Cambridge University became a center of opposition to Lemaitre's theory of the Big Bang. In fact, it was Fred Hoyle, an astronomer at Cambridge, who sarcastically coined the term "Big Bang." Hoyle and others favored an approach to the history of the universe known as the "Steady State" in which hydrogen atoms were continuously created and gradually coalesced into gas clouds, which then formed stars.
But in 1964 there was a significant breakthrough that confirmed some of Lemaitre's theories. Workers at Bell Laboratories in New Jersey were tinkering with a radio telescope when they discovered a frustrating kind of microwave interference. It was equally strong whether they pointed their telescope at the center of the galaxy or in the opposite direction. What was more, it always had the same wavelength and it always conveyed the same source temperature. This accidental discovery required the passage of several months for its importance to sink in. Eventually, it won Arno Penzias the Nobel Prize in physics. This microwave interference came to be recognized as cosmic background radiation, a remnant of the Big Bang. Lemaitre received the good news while recovering from a heart attack in the Hospital Saint Pierre at the University of Louvain. He died in Louvain in 1966, at the age of seventy-one.
After his death, a consensus built in favor of Lemaitre's burst of fireworks. But doubts did persist: Did this event really happen on a day without yesterday? Perhaps gravity could provide an alternative explanation. Some theorized that gravity would slow down the expansion of the universe and make it fall back toward its center, where there would be a Big Crunch and another Big Bang. The Big Bang, therefore, was not a unique event which marked the beginning of time but only part of an infinite sequence of Big Bangs and Big Crunches.
When word of the 1998 Berkeley discovery that the universe is expanding at an increasing rate first reached Stephen Hawking, he said it was too preliminary to be taken seriously. Later, he changed his mind. "I have now had more time to consider the observations, and they look quite good," he told *Astronomy* magazine (October 1999). "This led me to reconsider my theoretical prejudices."
Hawking was actually being modest. In the face of the scientific turmoil caused by the supernovae results, he has adapted very quickly. But the phrase "theoretical prejudices" makes one think of the attitudes that hampered scientists seventy years ago. It took a mathematician who also happened to be a Catholic priest to look at the evidence with an open mind and create a model that worked.
Is there a paradox in this situation? Lemaitre did not think so. Duncan Aikman of the *New York Times* spotlighted Lemaitre's view in 1933: "'There is no conflict between religion and science,' Lemaitre has been telling audiences over and over again in this country ....His view is interesting and important not

because he is a Catholic priest, not because he is one of the leading mathematical physicists of our time, but because he is both."

ACKNOWLEDGEMENT
Midbon, Mark. "'A Day Without Yesterday': Georges Lemaitre & the Big Bang." *Commonweal* (March 24, 2000): 18-19.
Published with permission of *Commonweal*.
THE AUTHOR
Mark Midbon is a senior programmer/analyst at the University of Wisconsin.