

constitute the circumstantial evidence of the existence of God.”

Born in Tarnow, Poland, in 1936, Heller and his family fled to Russia to escape the advancing Nazis in 1939, returning to Poland only in 1949. Ordained aged 23, he studied physics and mathematics at Lublin University and theology at Krakow. He earned his PhD with a thesis in relativistic cosmology in 1966. Obtaining a passport in 1977, he began a series of visits to foreign universities for research, including Louvain, Leicester and Oxford. In 1986, he began research at the Vatican Observatory in Castel Gandolfo, where he has worked with George Coyne, the observatory’s director emeritus, astrophysicist and theologian William Stoeger, and many others.

Heller’s current work is in geometry and “groupoid theory” in mathematics, continuing his life’s work on the problem of the origin of the universe. He plans to dedicate the Templeton Prize money to help create a Copernicus Centre in conjunction with Jagiellonian University and the Pontifical Academy of Theology in Krakow to further research and education in science and theology as an academic discipline.

The 2008 Templeton Prize will be officially awarded to Heller by the Duke of Edinburgh, at Buckingham Palace on Wednesday, 7 May.

■ John Cornwell is director of the Science and Human Dimension Project at Jesus College, Cambridge.

JOHN FARRELL

The original Big Bang man

For much of modern history, scientists followed the old theories that the cosmos was eternal and unchanging. It took a Catholic priest to devise an expanding model of the universe – a model which transformed our understanding of cosmology

For the critics of religion, science is all too frequently seen as a means with which to knock faith. Cynics and sceptics often strive to portray science and belief as incompatible, as if faith means irrational thinking that gets in the way of scientific research. Inevitably, they point to Galileo and his treatment at the hands of the Church as the most telling example of faith misunderstanding science.

Yet the greatest advance in physics and cosmology is due to the work of a remarkable priest and scientist – a man whose name few Christians even recognise. For it was Mgr Georges Lemaître who laid the scientific ground that led to the Big Bang theory.

Misunderstandings have surrounded Georges Lemaître ever since he died in June 1966. Most recently, the writer Dan Brown, for example, described him in his potboiler *Angels and Demons* as the “monk” who wanted to “prove” the existence of God and that he did so by formulating his theory in 1927. Then there are others who claim the Belgian scientist was a Jesuit who concocted the Big Bang, and that it was probably because – being a cleric – he was religiously motivated to find a “moment of Creation” in cosmology.

In fact, the main achievement of Lemaître was that he convinced Einstein and his generation of scientists, including Sir Arthur Stanley Eddington and Willem de Sitter, that the universe was – and had to be – dynamic. It could not be the static never-ending continuum that Isaac Newton had supposed. Basing his work on Einstein’s field equations, Lemaître demonstrated that the universe could have a limited radius that could change over time. But no one wanted seriously to consider this back in the 1920s.

Lemaître was born in 1894, the eldest son of a lawyer, in the town of Charleroi. A bright student with a gift for mathematics, Lemaître felt an early calling to the priesthood. But his formal education was interrupted by the First World War, during which he served in the Belgian army. After the end of hostilities, Lemaître entered the seminary (he would become a diocesan priest, not a Jesuit), and it

was there that his archbishop as well as some of his teachers pointed him to the work of Einstein, whose equations implied that the universe could not be static, but was expanding or contracting. He did, however, suggest that there was something that held the universe still. The general theory of relativity made headlines, with Eddington’s famous trip to photograph the sun during an eclipse in order to demonstrate the bending of starlight, and Lemaître gave it his full attention. He shortly after wrote a paper that won a scholarship allowing him to study in Cambridge with Eddington himself in 1923.

During this period Lemaître rediscovered the work of Alexander Friedman, the Russian mathematician who first used Einstein’s equations in 1922 to model universes that expanded. Einstein disputed Friedman’s models, and the Russian died young in 1925 before anyone could take further notice of his work. But Lemaître picked up the thread, as it were, publishing his own papers; he went further than Friedman, grounding his model of Einstein’s universe with astronomical data that he acquired first-hand.

After working with Eddington at Cambridge, Lemaître went to study with the American astronomer Harlow Shapley at Harvard while completing a second PhD at Massachusetts Institute of Technology. He met the astronomer Vesto Slipher in Arizona and the taciturn Edwin Hubble in California, in order to put together enough data to predict that the universe should be expanding. He outlined his thesis in a 1927 paper that he published in Belgium and mailed to Eddington.

Specifically, he argued that Einstein’s static model and Willem de Sitter’s “empty” model were just two extremes of a dynamic expanding model of the universe. He even derived what we now call Hubble’s Law (that the red shifts of distant galaxies were proportional to their distances from us), two years before Hubble did. Lemaître’s work was ignored at first, even by Eddington, until Hubble published his findings of red shifts in 1929. It wasn’t until Eddington and Einstein were puzzling over the implication of these findings that Lemaître

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jogged his old mentor's memory and Eddington quickly translated his 1927 paper, somewhat sheepishly realising Lemaître had been ahead of the game.

Lemaître's initial proposal of the universe's expansion had nothing to do with the Big Bang per se. By 1931, however, he had drawn up new variations based on Einstein's equations and realised that his original model could not exist indefinitely into the past. It had to have a cosmic beginning; it must have originated with a primeval atom of energy. This he initially called *Latom primitif*, a sort of super-dense cosmic sphere that disintegrated at the beginning of time and initiated the expansion of the universe. Later George Gamow and his team refined it into the more familiar Big Bang theory of today. But the idea of a cosmic beginning struck most of his colleagues, agnostics and believers alike, as just too provocative. Eddington, who was a devout Quaker, found the idea repugnant. To his credit, Einstein, who also thought the idea smacked too much of "the Creation", nevertheless could not resist its theoretical potential and he recommended to Lemaître that he explore the possible singularities that might lurk at the extremes of such an expansion model.

On the face of it, there was no overtly religious reasoning behind his theory. Still, Lemaître had to fight the impression that many of his colleagues had that there was ultimately a religious inspiration. This was brought to a head in 1951, when Pope Pius XII, in a famous enthusiastic address, all but affirmed his own opinion that the Big Bang represented the moment of Creation.

This was too much for the normally easy-going Lemaître, who was a leading member of the Pontifical Academy of Sciences. Pius XII's enthusiasm caused him embarrassment with many scientific colleagues, and he met the Pope to express his uneasiness with drawing too obvious a parallel between scientific theory and the Book of Genesis. The Pope did not disagree. But in a sense, Lemaître felt the damage had been done, and from this point to the end of his life, he published no further research on the Big Bang.

Fred Hoyle, the main proponent of the alternative steady-state theory, once greeted Lemaître at a conference with "Here comes the Big Bang man!" In spite of Hoyle's well-documented anticlericalism and dislike for the Big Bang theory, he and Lemaître actually got along well together, and had respect for each other's work.

This was not the last of Lemaître's comic misadventures with the Pontifical Academy of Sciences (of which he was the president by 1960). In 1962, Pope John XXIII asked him to be on a commission to study the issue of birth control, and Lemaître was bemused to the point of telling the commission's head that he thought it dangerous for a scientist to wander outside his speciality. Not that anything came of his role, for he died in June 1966 before the second commission had made any recommendation to Pope Paul VI.

By then, Penzias and Wilson's discovery of the cosmic microwave background radiation convinced most astronomers that Lemaître



had been right about the Big Bang. Since then he has turned out to have been prescient on other issues as well. A lifelong proponent of Einstein's cosmological constant, which he believed could accelerate the expansion rate, he would have been delighted by the discovery in the late 1990s that new measurement standards strongly suggest the expansion rate is indeed accelerating.

None of this is to suggest that theology did not inspire Lemaître in his work. It clearly did – but not in the way most legends about him suggest. Lemaître was different from Einstein and the others of his generation who, when they first began exploring the possibilities sug-

gested by relativity, couldn't help thinking of the universe in Newtonian terms. Lemaître had no such preconceptions. He had not been educated as a physicist but as a mathematician. And as science historian Jean Eisenstaedt remarked, he felt free to tear the old universe apart and rebuild it from scratch based on Einstein's work alone. He was able to approach Einstein's equations with more intellectual freedom, to "play", as it were, with the extremes that the field equations suggested. "As a priest he probably felt a closeness to God that may have given him a feeling of freedom in front of Creation," Eisenstaedt has written. "Lemaître aimed at combining the global and the local: is there a question more suitable for a priest?"

For all of his work modelling the cosmos, however, Lemaître's sense of God was closer to earth. Nobel laureate Paul M. Dirac recalls: "When I was talking with Lemaître about this subject and feeling stimulated by the grandeur of the picture that he has given us, I told him that I thought cosmology was the branch of science that lies closest to religion. However, Lemaître did not agree with me. After thinking it over he suggested psychology as lying closest to religion."

Spoken like a good parish priest, which he remained until the end.

■ John Farrell is the author of *The Day Without Yesterday: Lemaître, Einstein and the birth of modern cosmology* (Thunder's Mouth Press).



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