



# In the Beginning Was the Bang—a Big One

By Robert Jastrow



*Robert Jastrow, an astrophysicist, was director of NASA's Goddard Institute for Space Studies at the time this editorial was published in the Los Angeles Time Opinion section on June 25, 1978*

When an astronomer writes about God, his colleagues assume he is either over the hill or going honkers. In my case they would be mistaken; I am an agnostic in religious matters. However, I am fascinated by some strange developments going on in astronomy partly because of their religious implications and partly because of the peculiar reactions they have provoked from my colleagues.

The strange developments are rooted in the growing evidence that the universe had, in some sense, a beginning – that it began at a certain moment in time. Further, that beginning occurred under circumstances that seem to make it impossible – not just now, but ever – to find out what force or forces brought the world into being at that moment. It raises the question of whether the creative agent was one of the familiar forces of physics, or was it, as the Bible says, "Thine all powerful hand that creates the world out of formless matter"? (1)

This question, more interesting than any other, is one that can never be answered. We can never tell whether the hand of God was at work in the moment of creation – for a careful study of the stars has proved, as well as anything can be proved in science, that the universe came into being approximately 20 billion years ago in a cataclysmic explosion. In the searing heat of that first moment, all the evidence needed for a scientific study of the cause of the great explosion was melted down and destroyed

This is the crux of the new story of Genesis. Familiarly known for years as the "big bang" theory, it has shared the limelight with other theories, especially the "steady-state" cosmology, which holds that the universe had no beginning and is eternal. But adverse evidence has led to the abandonment of the steady state theory by nearly everyone, leaving the "big bang" as the only adequate explanation of the facts.

The general scientific outline that points to the big bang theory is well known. We have been aware for 50 years that we live in an expanding universe, in which all the galaxies around us are moving away from us and one another at enormous speeds. The universe is blowing up before our eyes, as if in the aftermath of a gigantic explosion. If we retrace the motions of the outward moving galaxies backward in time, we find that they all come together, so to speak, roughly 20 billion years ago. At that time, all the matter in the universe was packed into a dense mass, at temperatures of many trillions of degrees. The dazzling brilliance of the radiation in this dense, hot universe must have been beyond description. The picture suggests the explosion of a cosmic hydrogen bomb at an instant which marked the birth of the universe. The exact moment is unknown. But the important point is that it occurred at one sharply defined instant.

Now we see how the astronomical evidence supports the biblical view of the origin of the world the word used in the Bible to describe the universe. The details differ, but the essential elements in the astronomical and biblical accounts of Genesis are the same: A chain of events leading to man which commenced suddenly, at a definite moment in time, in a flash of light and energy.

Some scientists are unhappy with the idea that the world began in this way. Until recently, many of them preferred the steady state theory. But the latest evidence makes it almost certain that the big bang really did occur billions of years ago. In 1965, Arno Penzias and Robert Wilson of the Bell Telephone Laboratories discovered that the earth is bathed in a faint glow of radiation coming from every direction in the heavens. Their measurements showed that the earth itself could not be the origin of this radiation, nor could the radiation come from the direction of the moon, the sun or any other particular object in the sky. The entire universe seemed to be the source.

The two physicists were puzzled by their discovery. Their research was not part of an investigation into the origin of the universe, and they did not realize that they had stumbled upon a key to one of the great cosmic mysteries. But scientists who believed in the big bang theory had long asserted that the universe must have resembled a white hot fireball in the first moments after that great explosion. Gradually, as the universe expanded and cooled, the fireball would have become less brilliant, but its radiation would never have disappeared entirely. It was the diffuse glow of this ancient radiation, dating back to the birth of the universe, that Penzias and Wilson had apparently discovered.

No explanation other than the big bang has been found for the fireball radiation. The clincher, which has convinced almost the last doubting Thomas, is that the radiation discovered by Penzias and Wilson has exactly the pattern of wavelengths expected for the light and heat produced by so great an explosion. Supporters of the steady-state theory have tried desperately to find an alternative explanation, but without success.

Theologians generally are delighted with the proof that the universe had a beginning. But astronomers were curiously upset by it. Their reactions provide an interesting demonstration of the response of the scientific mind, supposedly a very objective mind, when evidence uncovered by science itself leads to a conflict with the articles of faith in their profession. It turns out that scientists behave the same way the rest of us do when our beliefs are in conflict with the evidence. We become irritated; we pretend the conflict does not exist; or, we paper it over with meaningless phrases.

This scientific reaction first began back in 1913, when Vesto Melvin Slipher – looking for something else, needless to say – happened to discover that about a dozen galaxies in the earth's vicinity are speeding away from us at rates up to about 1 million miles an hour. Slipher's discovery was the first hint that the universe is expanding. He reported his extraordinary finding at a meeting of the American Astronomical Society at Evanston, Ill., in 1914. John Miller, who had been Slipher's professor, was present at the meeting. In 1937, Miller described the scene to John Hall, who was director of Lowell Observatory in Flagstaff, Ariz., where Slipher made his discovery. Recently, Hall passed the account on to me. Slipher presented the paper with great modesty, but his slides clearly revealed the telltale red shift that indicated the enormously rapid motion of these galaxies. Then, said Miller, "Some thing happened, which I have never seen before or since at a scientific meeting. Everyone stood up and cheered."

Although the assembled astronomers did not know exactly what Slipher's discovery meant, they had a gut feeling that this discovery must be of great importance.

Meanwhile, on the other side of the Atlantic – where by now it was 1917 and wartime – Albert Einstein published his equations of general relativity. At once, Willem de Sitter, a Dutch astronomer, used Einstein's equations to predict an exploding universe in which the galaxies moved rapidly away from one another – just what Slipher had

already observed. However, because of the interruption of communications by the war, de Sitter probably did not know about Slipher's observations at that time.

Einstein himself had failed to notice that his theory predicted an expanding universe. Later, he missed the same conclusion again, when a Russian mathematician, Alexander Friedmann, unearthed a schoolboy error in Einstein's algebra. In effect, the great physicist had divided by zero at one point in his relativity calculations – not a valid procedure in mathematics. When Friedmann corrected the mistake, the new solution popped up.

Einstein was disturbed by the notion of a universe that blows up, because it implied that the world had a beginning. In a letter to de Sitter, he wrote, "This circumstance of an expanding universe is irritating," and in another letter, "To admit such possibilities seems senseless to me."

It was curiously emotional language for a discussion of some mathematical formulas. I suppose that the idea of a beginning in time annoyed Einstein because of its theological implications. He had well-defined feelings about God, but not as the Creator or the Prime Mover. When a rabbi sent him a telegram during his visit to New York in 1921 asking, "Do you believe in God?" Einstein replied, "I believe in Spinoza's God, who reveals Himself in the orderly harmony of what exists . . ."

During the early 1920s, Edwin Hubble and Milton Humason began to follow up on Slipher's work. At first they used the 60 inch telescope on Mount Wilson; later they attacked the problem with the 100 inch telescope, then the world's largest. By measuring the speeds and distances of many galaxies too faint to be seen by Slipher with his smaller instrument, Hubble and Humason confirmed Slipher's discovery; all the galaxies they could see were moving away from us at high speeds. Some were retreating at the extraordinary speed of 100 million miles an hour.

Then, in 1929, Hubble came upon the amazing relationship known as Hubble's Law: The farther away a galaxy is, the faster it moves. The same law was predicted by Einstein's Theory of Relativity, and the agreement made a tremendous impression on astronomers.

Suddenly, both theory and observation pointed to an expanding universe and a beginning in time. Still, Einstein resisted the new developments, holding onto his idea of a static, unchanging universe until 1930, when he traveled halfway around the world from Berlin to Pasadena to visit Hubble. He studied Hubble's plates, looked through his telescope, and finally announced himself convinced.

Around 1930, the model of the expanding universe became widely known. Hubble had just published his famous law on the expansion of the universe, and concurrently a great deal of discussion arose about the fact that the second law of thermodynamics, applied to the cosmos, indicates that the universe is running down like a clock. If so, there must have been a time when it was fully wound up. When that was, and who or what had done the winding, were questions that particularly bemused theologians, physicists and astronomers in the 1920s and 1930s.

A few scientists bit the bullet and dared to ask, "What came before the beginning?"

Others were even bolder asking, "Who was the Prime Mover?" The British theorist Edward Milne wrote a mathematical treatise on relativity that concluded, "As to the first cause of the universe, in the context of expansion, that is left for the reader to insert, but our picture is incomplete without Him."

But: the views of most physicists and astronomers were closer to that of St. Augustine, who, when asked what God was doing before He created the materials of heaven and earth, replied, "He was creating hell for people who asked questions like that." In fact, some prominent scientists began to feel that same irritation over the expanding universe that Einstein had expressed earlier. Sir Arthur Eddington, the most distinguished British astronomer of his day, wrote in 1931, "I have no axe to grind in this discussion, but the notion of a beginning is repugnant to me . . . The expanding universe is preposterous . . . incredible . . . It leaves me cold."

More recently, Philip Morrison of MIT said a few years ago in a BBC film on cosmology, "I find it hard to accept the big bang theory; I would like to reject it."

There is a strange ring of feeling and emotion in these reactions. Such judgments are expected to come from the brain, whereas these come from the heart. Why?

I think part of the answer is that scientists cannot bear the thought of a natural phenomenon which cannot be explained, even with the use of unlimited time and money. There is a kind of religion in science; a faith that there is order and harmony in the universe, and that every event can be explained as the product of some previous event.

Einstein wrote, "The scientist is possessed by the sense of universal causation." This conviction is violated by the discovery that the world had a beginning under conditions in which the known laws of physics are not valid, and that it was a product of forces or circumstances we cannot discover. When that happens, the scientist has lost control. If he really examined the implications, he would be traumatized. As usual when the mind is faced with trauma, it reacts by ignoring the implications – in science this is called "refusing to speculate" – or by trivializing the origin of the world by calling it the big bang, as if the universe merely a firecracker.

Consider the enormity of the problem: Science has proved that the universe exploded into being at a certain moment. It asks, what cause produced this effect? Who or what put the matter and energy into the universe? Was the universe created out of nothing, or was it gathered together out of pre-existing materials? And science cannot answer these questions.

This is an exceedingly strange development, unexpected by all but the theologians. They have always accepted the word of the Bible: In the beginning God created heaven and earth. To which St. Augustine added, "Who can understand this mystery or explain it to others?" But scientists did not expect to find evidence for an abrupt beginning because they have had, until recently, such extraordinary success in tracing cause and effect backward in time.

Now they would like to pursue that inquiry farther back in time, but the barrier to progress seems insurmountable. It is not a matter of another year, another decade of work, another measurement, or another theory. At this moment, it seems as though science will never be able to raise the curtain on the mystery of creation.

For the scientist who has lived by his faith in the power of reason, the story ends like a bad dream. He has scaled the mountains of ignorance; he is about to conquer the highest peak; as he pulls himself over the final rock, he is greeted by a band of theologians who have been sitting there for centuries.

- (1) *This is an incorrect statement. The bible actually teaches "creatio ex nihilo" – creation out of nothing. Genesis 1:1 "In the beginning God created the heavens and the earth." The use of "heaven and earth" in this context is a "merism" – a figure of speech in which a pair of related objects is named, which comprises a totality including the pair and everything between the pair. (See *Creation out of Nothing* by Paul Copan and William Lane Craig, Apollos/Baker Academic, 2004 for a comprehensive treatment of this subject from a biblical, philosophical and scientific standpoint.)*



**Robert Jastrow** is Director and Chairman of the Board of Trustees of the Mount Wilson Institute, which manages Mount Wilson Observatory in California on behalf of the Carnegie Institution of Washington. Dr. Jastrow is a member of the NASA Alumni Association.

Dr. Jastrow received his A.B., A.M. and Ph.D. degrees in theoretical physics from Columbia University. He joined NASA when it was formed in 1958 and was a prominent figure in the American space program from its inception. Dr. Jastrow was the first chairman of NASA's Lunar Exploration Committee, which established the scientific goals for the exploration of the moon during the Apollo lunar landings. In 1961, Dr. Jastrow set up NASA's Goddard Institute for Space Studies, a U.S. Government laboratory charged with carrying out research in astronomy and planetary science. He served as director of the Goddard Institute until his retirement from NASA in 1981.

In recognition of his work in NASA, Dr. Jastrow has received the NASA Medal for Exceptional Scientific Achievement and the Arthur S. Fleming Award for Outstanding Service in the U.S. Government. He has also received the Columbia University Medal of Excellence, the Columbia Graduate Facilities Award to Distinguished Alumni and Doctor of Science degree (honorary) from Manhattan College.

Dr. Jastrow has hosted more than 100 CBS-TV network programs on space science. He was the special guest of NBC-TV with Wernher von Braun for the Apollo-Soyuz flights, and he was the featured guest of the TODAY show on the 10th anniversary of the landing on the moon. Dr. Jastrow's articles on astronomy and space have appeared in *The New York Times*, *Reader's Digest*, *Foreign Affairs*, *Commentary*, *Atlantic Monthly*, and *Scientific American*. Writings include: *Astronomy: Fundamentals And Frontiers* (Wiley, 1972); *God And The Astronomers* (Norton, 1978); *The Enchanted Loom* (Touchstone, 1983)

In 1981, Dr. Jastrow left NASA to join the faculty of Dartmouth College as Professor of Earth Sciences. He resigned from Dartmouth in 1992 to take up duties as manager of Mount Wilson Observatory.