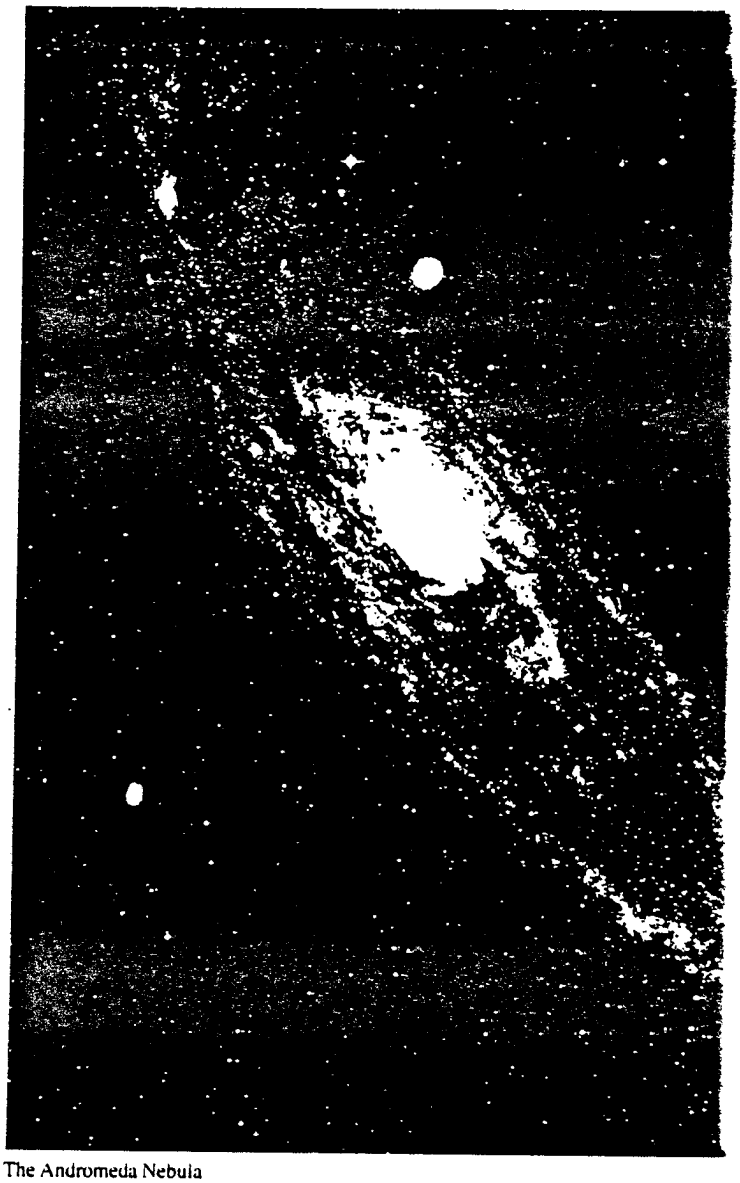
Science and the Creation

Robert Jastrow



The Andromeda Nebula

I should like to say at the start that I am an agnostic in religious matters. I am fascinated, however, by some recent developments in astronomy — partly because of their religious implications and partly because of the peculiar reactions of my colleagues. In a nutshell, the astronomers, studying the universe through their telescopes, have been forced to the conclusion that the world had a beginning. Scientists have always felt more comfortable with the idea of a universe that has existed forever because their thinking is permeated with the idea of cause and effect: they believe that every event that takes place in the world can be explained in a rational way as the consequence of some previous event. If there is a religion in science, this statement can be regarded as its main article of faith. But the latest astronomical results indicate that at some point in the past the chain of cause and effect terminates abruptly. An important event occurred — the origin of the world — for which there is no known cause or explanation within the realm of science.

The story of the scientific attempt to reconstruct the creation of the Universe began in 1912 at the observatory in Flagstaff, Arizona. The director of the observatory, an American named Percival Lowell, asked his main assistant, Vesto Melvin Slipher, to focus the observatory's twenty-four-inch telescope (a good instrument for the time, but very small today) on a pin-wheel shaped spiral of gas known as the Andromeda nebula. We now know the nebula to be an island universe located about two million light years away (a light year is six trillion miles) with hundreds of billions of stars and planets like our own, but no one knew about this in 1912. Spiral galaxies like the Andromeda nebula were thought by many astronomers to be little wisps of rotating gas located quite near the sun in our own galaxy. Only a few prescient individuals believed that they were island universes.

Lowell thought that the Andromeda nebula was a solar system in the process of being formed. He was also a great believer in life on other worlds. He believed that there was life on Mars and was an avid supporter of Schiaparelli, who had reported canals on the red planet. Lowell had written one or two books on the subject of life on other worlds; and he thought that if he could show planets being formed elsewhere, it would help to give credence to the view that planets, and therefore life, were common in the universe. So he asked Slipher to study the Andromeda nebula and see if he could detect a subtle change in the color of the light from this nebula that would betray its rapid rotation.

Slipher did just that but found no evidence of the rotation. Actually, a number of years later he did find evidence of rotation, but what he found in his initial study was a uniform shift in the color of the light emanating from this nebula. To experienced scientists this indicated something called the Doppler Shift: the change in color was caused by a rapid motion of this nebula through the heavens relative to the sun and the earth. In fact, the nebula was moving across the sky at a speed relative to us of about a million miles an hour, which was staggering. Slipher did not know what this meant, but he saw that he was on to something important. So he took spectra, that is, he measured the colors of the light emitted from fourteen other spiral nebulae like Andromeda near our solar system. These nebulae were the only ones within range of his modest sized instrument. To his amazement Slipher found that all of these spiral nebulae were moving into the heavens at fantastic speeds, in some cases ranging up to

Robert Jastrow *is Professor of Astronomy and Geology at Columbia University; Professor of Astronomy at Dartmouth College; and Director of the Goddard Institute for Space Studies, NASA.*

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millions of miles an hour. Furthermore, most of the nebulae were moving away from the earth, and that was the biggest shock of all. It would perhaps have been possible to understand these galaxies or nebulae moving around in space like bees buzzing in a hive, but, if that were so, half of them on any given moment should be moving towards us and half should be moving away. So it was impossible to understand why they should all, or nearly all, be moving away from us.

Because he did not interpret the evidence correctly, Slipher did not know that he had stumbled on the first evidence for the expanding universe. Slipher thought that the observed motion was merely an apparent motion caused by the fact that our sun was moving through space at a rapid rate. He misinterpreted his own results; nonetheless, as had happened many times in the history of thought and science, in discovering this motion Slipher joined a select group of men who, by accident or design, have uncovered some element of the great plan that has unfolded since the beginning of time down to the appearance of man.

The next person to enter this story is Albert Einstein, but he was incommunicado in wartime Germany (World War I) and did not know about Slipher's results. I will come to him in a moment, for he is the key character in the story. The next person directly involved was Edwin Powell Hubble, an American and a man of many talents — champion boxer (went three rounds with Carpentier), lawyer, Rhodes scholar. He did not enjoy any of these pursuits and finally decided to give up everything for astronomy, which he cared about. Hubble went to graduate school at the University of Chicago in 1914 and eventually became America's greatest astronomer.

In August, 1914, just when the war was getting hot across the Atlantic, Hubble was in the audience at an historic meeting of American astronomers in Evanston, Illinois. With most of the astronomers in America gathered together (at that time about fifty people), Slipher presented a paper in which he reported that all the spiral nebulae within reach of his telescope were speeding away from the earth as if they were repelled from us by some force — an amazing result. The astronomers present did not know what the evidence meant any more than Slipher did, but they had a feeling that something of epochal importance was in the making so they stood up and cheered — the first and only time that has happened at a meeting of the American Astronomical Society.

Later Hubble said that Slipher's work made a tremendous impression on him, and it was apparently through the coincidence of being present at this momentous gathering of astronomers that Hubble first got started on his life's work. What Hubble did, of course, was to pick up where Slipher left off and to extend the results deeper into space using the mammoth instruments in California, including a 60-inch, a 100-inch, and finally a 200-inch telescope. He confirmed that not only were a handful of galaxies in our neighborhood speeding away from the earth, but that all the galaxies within the view of the largest instruments available to man were receding from the earth — the most distant at speeds of six hundred million miles an hour (not too far from the speed of light, roughly a billion miles an hour). In that enterprise he enlisted another person, who is not so well-known, named Milton Humason. Humason measured the color of the light from these galaxies, which allowed them to calculate the speeds. Hubble then measured the distances and discovered the famous law known as Hubble's Law, which says that every galaxy moves away from us at a speed proportional to its present distance. So if one galaxy is ten million light years away and another is twenty million light years away, the second one will be receding from us at twice the speed of the first.

This is the law of uniform motion. Everything in the universe that expands uniformly behaves this way. This goes for a loaf of raisin bread that you set in the oven and allow to rise. As the loaf swells, every raisin will move away from its neighbor at a speed that is proportional to its distance from the other raisin. If the loaf rises three inches per hour, two raisins at opposite ends of the loaf will move apart three inches in an hour. That is Hubble's Law.

If you were to double the size of a lecture hall, two individuals seated 3 feet apart in adjacent chairs would move to 6 feet apart. If you double the size in one minute, then they would move apart 3 feet in one minute. But two individuals on opposite sides of the hall, say 80 feet away, would move to separation of 160 feet in one minute, so their speed of separation is far greater than that of the near neighbors. They are moving apart at the rate of 80 feet per minute. That is Hubble's Law.

When put in this way, the law becomes trivial. It is only a way of saying that the expansion is uniform. If it were any other way and the lecture hall expanded other than according to Hubble's Law, then all the chairs would pile up in one corner or another. Likewise, if the galaxies moved apart in any way other than according to Hubble's Law, the galaxies would pile up in one part of the universe or another. This is the law of uniform expansion.

Together with Einstein, Hubble deserves the title "Architect of the Universe." When Hubble's Law was in hand, certain ideas began to gel in the minds of astronomers because the law of uniform expansion had been predicted for the entire universe by a Dutch astronomer named William de Sitter. De Sitter had discovered that uniform expansion was a consequence of Einstein's equations of relativity. Einstein himself had not made that discovery. He found the equations of relativity in 1915 and published them in 1916 after working on them since 1907. For some reason he did not notice that in those equations was a solution which predicted the expansion. De Sitter found that solution.

It is interesting to note that now the first signs of irritation begin to appear in the scientific community. When de Sitter pointed out to Einstein that an expanding universe was a feature in the solutions to his equations of relativity and also that it expanded in accordance with Hubble's Law, which was now coming to be known to astronomers, Einstein wrote to him saying: "I have no quarrel with your mathematics in that proof, but this circumstance [of an expanding universe] irritates me." What a funny word to use for a mathematical result. In another letter, he writes concerning the notion of an expanding universe that "to admit such possibilities seems senseless." Why should the movement of the galaxies away from us and one another be labeled nonsensical by a theoretical physicist? Why the emotional content of these words? The answer is to be found in another part of the first letter when Einstein points out to de Sitter that if all the galaxies are moving away from one another, there would be what Einstein called a "singularity in time." In other words, the universe would have had a beginning.

The thought that entered Einstein's mind instantly when he saw de Sitter's result was something like this. Let us retrace the movements of the outward-moving galaxies backward in time like a movie strip run in reverse: the galaxies come closer and closer together as time goes on in reverse and into the past; the galaxies meet, then overlap and mingle; as the atoms come together, it gets very dense and very hot, and finally the entire universe is infinitely compressed and infinitely hot. That moment must mark the beginning of the universe. It is a singularity in time or what we call today the big bang. Why did Einstein object to the idea of a beginning? I suppose, and I think it is plausible, that he did not believe in God the Creator. A beginning presupposes an agent that set in motion the events which we call the explosion of the universe; that was anathema to Einstein. He believed in Spinoza's God, who created order and harmony in the universe and is revealed in equations like Einstein's relativity equation, but he did not believe in a personal God or God the Creator.

As all of this developed, there was a correspondence between de Sitter and Einstein, who was vacationing in Lucerne. When Hubble announced his law of the expansion of the universe, Einstein traveled halfway around the world from Berlin to Pasadena to look at Hubble's plates before he was convinced that the universe really was expanding. He just did not believe it up to that time, so much did he dislike that idea. But after Einstein looked through the telescope and looked at the plates, he announced to the press that he now accepted the fact that the universe was expanding.

At this point, there was a congruence of forces. Hubble, Slipher, and Humason were on the American side of the Atlantic with Hubble's Law, and in Europe de Sitter had found proof that the relativity theory predicted an expanding universe in accordance with Hubble's Law, a finding now admitted by Einstein. The correspondence of theory and observation made a profound impression on astronomers, particularly on some astronomers in Britain, such as Arthur Eddington. Eddington was the only man who could immediately understand Einstein's mathematics, and de Sitter had sent him his early papers; so Eddington was well-equipped to realize and to propagate his views on the importance of this development. On both sides of the Atlantic a few isolated men (actually, on the American side no one understood the importance of this except Hubble) saw that the universe really did seem to be blowing up, as if we were witnessing in these galaxies the fading cinders, to borrow from Lamaitre, of a vanished world, the dully glowing remnant of a cosmic explosion that had occurred sometime in the past. What that meant no one knew, but more signs of irritation began to crop up in the scientific community about the theological implications of the fact that there was a beginning.

Somewhat out of order I would like to skip forward from this period (about 1925–30) to the present in order to tell you about the results that have convinced astronomers that the world really did blow up a long time ago and that everything we see in the universe today is the product of this first explosion. In 1965, two fellows named Arno Penzias and Robert Wilson, who were — needless to say — looking for something else, found a faint hiss in their radio receivers at an experimental set up at the Bell Telephone Laboratories. The hiss seemed to come from everywhere in the sky; it was a kind of cosmic radio static with no discernible source. They thought at first it might be a defect in their equipment. Then they thought perhaps some pigeons they discovered roosting in the apex of the horn antenna had caused the static. So they cleaned out the pigeons, but the hiss persisted. Then a friend told them about a prediction made by Dicke, and earlier by Gamow, Alpher, and Herman, that if the world really began in an explosion, there should be present today a fading remnant of the fireball that filled the universe at the time of the explosion. In fact, this remnant should have just the properties of the faint radio static that Penzias and Wilson had found: it should come at the earth uniformly from every direction, and it should have very long wave lengths because it is much weakened by the passage of billions of years. Penzias and Wilson realized, and everyone agreed, that they had stumbled upon the remnant of the birth of the universe.

With this discovery, which has been confirmed by many details since that time, everyone (except Fred Hoyle, I should say) now agrees that the universe really did have its birth in an explosive moment in the past. We can even figure out approximately when this happened. From the present separation of the galaxies and the rate at which they are receding, we can calculate when it was that they were all together, that is, the birth of the universe, which turns out to be twenty billion years ago, give or take two billion years. It does not matter exactly when it happened, only that it happened suddenly, sharply, and abruptly at a certain time in a very biblical sense.

Now I skip back to the 1930's and to Britain. There was not yet clear proof that the universe had been born in an explosion (as a matter of fact, at that time Penzias and Wilson had not yet been born); but the expanding universe as an observation was widely accepted, and there were some other indications that the world had a beginning. The physicists had calculated from the second law of thermodynamics, called the law of increasing entropy, that everything in the world was winding down and decaying; the universe was unwinding like a watch. If the universe is a watch that is winding down, the question arises when it was wound up and who or what wound it up. There was an inference from the second law of thermodynamics that there was a beginning. Furthermore, there was a third set of results: the fact that the stars manufacture heavy elements out of hydrogen in their interiors. There must have been a time when the universe had no stars and only hydrogen. That again implies an evolution of the universe and a beginning. So from three completely independent lines of inquiry came the same result: that the world had a beginning.

If you examine the conditions under which the world began, you will see that we are deprived today, tomorrow, and very likely forever of finding out what forces created this explosive moment of birth. The world had a beginning, but we cannot find out what caused that beginning. That was a distressing result for the scientist because, as Einstein once said, "The physicist is possessed of a sense of infinite causation." He believes in cause and effect as his religion in the same way that others have their religious faiths. In the scientist's view, every phenomenon in the world is an effect, which has a cause that he, given enough time and money, can reconstruct and fit into a

framework of natural rather than supernatural forces. He has, in fact, succeeded in carrying out an extraordinary program which expands and adds many details to the first pages of Genesis about how man came to be on earth. He has traced the steps back from man to the lower animals and then across the threshold of life into a time when the earth did not exist. He goes farther and farther back through the corridors of time to when the galaxy did not exist, and he is near success when suddenly the chain of cause and effect runs out. He comes to a blank wall where the big bang occurred. The cosmic explosion, the birth of the universe, is an effect for which he cannot find the cause. Some might say that if he cannot find it today, he will find it tomorrow; and we will read about it in the *New York Times* when Walter Sullivan gets around to it. This, however, is one finding in science that seems likely never to succumb to scientific investigation because in the first moments of the universe's existence the temperature and the pressure were infinitely high, which means that all relics of a pre-creation universe that might have given us a clue to some natural forces that conspired to bring about the explosive moment we call the big bang are gone. All of the evidence the scientist could examine to explain this cosmic holocaust has been melted down and destroyed in the fiery heat of that first moment itself. That is why it seems to me and a few other people that this is a blank wall, a curtain covering the mystery of creation never to be raised by human minds, at least in the forseeable future.

This brings us to a very interesting pass. The world has come into being as a product of forces that are today, and very likely forever, outside the reach of scientific inquiry. These forces do not fit into the present body of natural forces — gravity, electricity, nuclear forces — and, being outside the realm of nature as the scientists understand it, they must, therefore, properly be termed supernatural. In this statement cosmologist and astronomer finally come face to face with the theologian, who has always thought that what one might call a supernatural force, a creative force, has been responsible for the origin of this world. This is the circumstance we are in today. I would like to tell you something about the reactions of my friends to it.

Many people, including myself, find this circumstance very interesting, and, for a reason I will explain, we are rather optimistic. In fact, we are buoyed up by this finding. In contrast, during the 1930's, Eddington, when talking about the idea of the expanding universe, the fact that the universe is running down, and the consequent hypothesis of a beginning, said: "I have no axe to grind . . . " That is how he started, and then he ground his axe, saying: "The notion of a beginning is repugnant to me . . . the expanding Universe is preposterous . . . incredible . . . it leaves me cold." And he went on a bit longer in this vein. As I already mentioned, Einstein said that the thought of a beginning was irritating.

In more recent times, Phillip Morrison of M.I.T. said in a BBC program a few years ago: "I find it hard to accept the Big Bang theory; I would like to reject it." What a value-laden, emotional, and subjective statement. Why does he want to reject it? It is as good as any other theory. It fits the facts and it agrees with Einstein's predictions. Allen Sandage, who inherited Hubble's mantle and extended the reach of the law of uniform motion way out to the edge of the universe with the 200-inch telescope of Mt. Palomar, has suggested that the expansion of the universe "is such a strange conclusion . . . it cannot really be true." What a statement of religious faith and a purely subjective coloring of the facts because they do not suit you. This is Galileo and the Inquisition with the sides reversed.

More recently, James Peebles, a first-rate theoretical cosmologist at Princeton who has contributed much to our understanding of the properties of the cosmic fireball radiation, said in a "Nova" film: "What the Universe was like at day minus one, before the big bang, one has no idea. The equations refuse to tell us, I refuse to speculate." Why does he refuse to speculate? Is not this the most interesting question of all? And is it not extraordinary that science, through its own findings, should lead us to contemplate it. Again, I think so, but my colleagues have been strangely resistant.

In conclusion, I will attempt to suggest why many scientists resist the idea that the universe had a beginnning. It is not because of a biased anticlericism per se, but rather because science has its own religion. That religion is founded on faith in natural law and in cause and effect. When the scientist comes up against a situation in which a fact defies his religious faith, the belief in natural law, then the scientist (a human being like the rest of us and not the objective person he has represented himself to be) reacts as we all do when the mind is faced with trauma. We ignore the fact; we paper it over with meaningless phrases; or we trivialize the situation by calling this explosion the big bang, as if the universe were a cosmic firecracker. Science has created a circumstance in which it has succeeded in posing, on its own terms, questions not answerable within the domain of science.

I have some idiosyncratic views about the possibility of answers to those questions. My views are based on the fact that the astronomical findings not only indicate that the universe had a beginning; they strongly suggest *when* that beginning occurred. In fact, they indicate that the universe came into being twenty billion years ago. This is the age of the world according to science.

Twenty billion years is a very long time. The earth has been in existence only 4.5 billion years. There has been life on the earth for at least 3.5 billion years, and man has existed for about a quarter of a million years. This means that most of the stars and planets outside our solar system are older than we are by billions of years — a fact that we can only state as a result of the Slipher-Hubble-Einstein findings. Indeed, most of them are on the average about ten billion years older, twice as old as the earth and its solar system. If life is common in the cosmos, which is possible, then most of that life has advanced billions of years beyond us in evolution. And what does a billion years mean in evolution? A hundred years means nothing; that is only a few generations. A thousand years is not much more. A million years is the time it takes a new species to develop. What does a billion years mean? A billion years ago the fossil records show that the highest form of life on the earth was the worm. So, if there are intelligent entities in space, out there, they are as far beyond us as we are beyond the worm. They may know the answer to the cosmic mysteries. They may know the meaning of the big bang.