Seeds of Discovery – 1970

Narrator: You don't remember this miracle but it happened, to you. You were born into chaos; those first days were a blur. But then by the power of your mind you resolved that chaos into a universe, a small universe at first but a supreme act of learning. From then on you became a learning machine, acquiring knowledge at a rate that you would never match again.

I'm Jim Franciscus. No one of us has been untouched by our advances in space, and I don't mean only the spectaculars, impressive as they've been. Join me as we look into some of the space explorations that so excite us and have such promise for improving man's environment that we dare not ignore them. For it is in the quest for such knowledge that science is bringing us closer to an understanding of who and where we are and, like that baby in the crib, helps us resolve our world, our universe. We who make our way in more mundane pursuits, enjoy the results, applaud the discoveries, and then take the benefits of science for granted. But seldom do we think about the discipline each scientist faces. What we believe to be true today will be adequate for most of us; not, however, for the scientist. He is driven, quite simply, because he knows there is more to know, and this knowledge when tested and proved will, as it always has, be used to improve the quality of our lives.

Four hundred years ago the lords and ladies, their jesters, their knights, and the peasants, believed the solar system looked like this: the Earth in the center, the Sun out there, going around us. One of the men thinking about this was a Polish doctor, Nicolaus Copernicus. He found an answer that his mind couldn't resist: the Sun is really at the center; the Earth goes around the Sun. But the establishment wasn't easily moved. It was easier for them to move Copernicus and his Earth with him. But then came Johannes Kepler, a German. He believed Copernicus but thought he'd satisfy the powers that be as long as the new universe moved in perfect circles. But then Kepler saw the truth. His mathematics insisted the circles needed stretching: the orbits were elliptical. From Italy came Galileo. Hitting upon Kepler's notes he came up with a telescope and he saw the stars, myriads where others before him had seen only thousands. And he saw that the planet Venus has phases, like the Moon, which proved it must be orbiting the Sun. And the moons of Jupiter – if a planet could have satellites, why not the Sun? Finally an Englishman, Isaac Newton, discovered why the Earth and the planets move about the Sun. It is the gravitational pull of the Sun which keeps them from flying off into space. Newton told them:

Isaac Newton: The solar system is a great clockworks. If you understand the laws of nature you can make or do most anything.

Man: Really?

Narrator: The human race saw, became a great learning machine, and made progress never before possible.

Well I'm not sure you can credit Newton for everything you've just seen. However the practical results from what appear to be a purely scientific discovery are often unpredictable. A good example that looks contemporary despite its origin in the 1800s is Michael Faraday's statement defending his research before an English Parliamentary group.

Michael Faraday: Gentleman, I do not know what this electricity can be used for, but I predict that one day you will tax it.

Narrator: Give a man knowledge, then step back and see what happens to him. It a— well it seems to free him, and that's what's put us in space today. Until recently almost everything we knew about space was learned through this tiny window, the visible light window. All the rest of the secrets of the universe were hidden behind windows of invisible radiations: low frequency radio waves, infrared, ultraviolets, and others. Signals from the universe, energy that would unlock so many secrets, were blocked out by our own atmosphere. And a pretty good thing too since part of the radiation generated by this invisible energy is harmful to us. But as for seeing behind these windows, the Earth's atmosphere makes it impossible even with the largest, most sensitive telescopes.

There is one solution: go higher and higher, taking our telescopes with us, beyond the atmosphere to outer space. Out here what was invisible down below is still invisible to our eyes, but here we can measure it. And by measuring the radiation – infrared, ultraviolet, X-ray, gamma ray, cosmic ray – we can tell the distance of the stars, the energy they are pumping into space, how the atmosphere of other planets is different from our own, the temperature of gases in interstellar space, the strength of magnetic fields, the speed of particles and galaxies. The measurements become numbers, and the numbers are rained down on Earth. And out of the numbers grow pictures: the Earth and its sister planets, the ultraviolet Sun, the X-ray Sun, radio sounds from space, and the word that there are more than a hundred billion stars out there besides the Sun. And with each spacecraft, each measurement, we are bringing the universe into sharper and sharper focus, resolving it, seeing it grow brighter and ever clearer in our minds.

In a universe of billions of stars, there are billions of mysteries. What is the origin, age, and evolution of the universe, the destiny of the stars and galaxies? We have reached the unique moment in history where man has developed the tools to take scientific measurements that that may unlock some of these mysteries. Our satellites will help us crack the secrets of our solar system, unlock the doors in the universe, and enable us to learn more about our own planet Earth. With this knowledge we may be able to improve life and avoid disaster. Without this knowledge, we may be able to do neither.

In the few years we have jumped into space, our image of the Earth's environment has utterly changed. We've found for example that instead of being simply surrounded by a magnetic field that faded out endlessly in space, we are actually encased in a vast space suit, the magnetosphere. And that this magnetosphere ends at about 40,000 miles, ends because there's a great wind out there. A wind, mind you, where there is no air, no molecules that you feel pushing against your face when you stand in a breeze. This airless jet stream is the solar wind, and to stand in it unprotected would be like holding radioactive material in your bare hands. You saw our astronauts on the Moon unfurl a window shade of metal foil, which they later brought home with them. Man was catching, literally, bits and pieces of the Sun, fallout from the Sun's nuclear hell. And that is what the solar wind is, fallout from the thermonuclear reaction in the Sun.

We wanted that sample because we live in a cavity in that wind, and we want to know how it is affecting us when there is a storm on the Sun, changing our weather and blacking out our international radio communications completely. And we want to know what effect that solar wind has on life; how dependent are we on that magnetosphere? If another planet didn't have this protection, would it still have life as we know it? Or something else we cannot even imagine? There may be only one way to know: go to the other planets.

The inner planets – Mercury, Venus, Earth, and Mars – are relatively small, solid bodies like the Earth. Investigating them is our immediate goal. In 1973, the Earth, Venus, and Mercury will be lined up, so that we can try a new way to go further in space. We'll launch our Mariner to Venus, and then use the gravity of that planet like a roller coaster to give more speed and fling it into space toward Mercury, the first time we have ever been able to explore that planet. Venus is a paradox. It rotates the wrong way, for example, the opposite of all the other planets; or perhaps we are all out of step except for our lady in space, Venus. Why? Well we really don't know, but if we find out it may tell us more about how the solar system was put in motion and all the other planets moving counterclockwise. Venus is the brightest planet, but no one has ever seen it. We have seen the thick reflecting clouds that hide it, but not the planet itself. These clouds heat the planet. Any water on the surface of Venus would immediately boil off into the heavy atmosphere, more like super-heated steam than water.

Why bother? To satisfy scientists' curiosity? No. No, to know our own atmosphere better, we have to know all atmospheres. We have to ask, how did the Venus atmosphere get that way? Is it possible we are headed that way? Are we mass producing enough pollution, enough smog, that might trigger the change, upset the balance, change the beneficial effects of our atmosphere, only to mire ourselves in a malignant envelope that alters our climate drastically, that in the end might extinguish human life entirely. On the other hand, might it be possible for us to reverse conditions on Venus, perhaps with vegetation or chemicals, so that the oxygen locked in the carbon dioxide of the clouds is released, so that the planet cools, rain falls, and it becomes more like Earth? Is it possible that we might seed this bit of matter in space so that some future generation from Earth can become pioneers in a distant new world? Why not?

On Mercury, the nearest planet to the Sun, there is probably no hope like that. If this planet ever had an atmosphere it was blown into space long ago by the pressure of radiation from the Sun. Here we may be seeing for the first time a completely desolate planet with no protection from the solar wind. Looking at Mercury we can ask, is this the way the Earth would be without a magnetosphere or an atmosphere, lashed by the full force of the solar wind without hope of life?

And what about Mars? Well this is the planet where we hope to find life, or which will help us understand the life process. In 1965 Mariner 4 got our first close-up photographs of Mars. Four years later Mariners 6 and 7 returned for a more detailed look. They sent back fascinating pictures of the rugged surface and the polar ice caps. When you watched this on TV, did you really feel that the spacecraft sending back the pictures was actually 60 million miles away? Can you imagine 60 million miles?

The next step will be to orbit Mars. This unmanned flight is scheduled for March in 1971. Then we'll colonize it with machines. Our *Mayflowers* and our Pilgrim fathers on Mars will be Viking, Orbiters and Landers. On the way down the Landers will measure the thin atmosphere, while overhead the Orbiters make related measurements. Then, for at least 90 days, our mechanical astronauts will take pictures, analyze the soil, sniff the strange air of Mars, feel for moisture.

Thus we will obtain information about Mars from the ground up to the limits of its atmosphere. Perhaps the greatest interest will be in the Landers' search for signs of life. We're pretty certain now that there's no man-like life there, but we were not always men. We were once just cells; before that we were perhaps just molecules of protein. And we still want to know if there's that kind of life, or if sometime in the past life did exist on Mars and what could've happened to it. All of this will lead up to the ultimate exploration by man himself on Mars.

The outer planets, on the other hand, are entirely different from the inner planets. On Jupiter, Saturn, Uranus, and Neptune, there may be no place to land, stand, or walk. They're all several times the size of Earth, but they may not have a solid surface to land on. About the fifth one, Pluto, we don't know enough to call it either solid or gaseous. Our spacecraft will leave the Earth for Jupiter in 1972. It will be a 400 million mile journey and it will take almost two years. Jupiter is the largest of all planets, 11 times the diameter of Earth and over 300 times as massive, but a quarter of the density. We will want to know what causes the color changes in the bands of clouds, what causes the mysterious red spot that drifts around the planet. And we'll want to know if before the Earth became what it is, it was perhaps first like this, a mass of gas and dust and vapor, a condensing part of a nebula out of which the Sun was also forming, the proto-planet caught by the mother star's gravity, turning eternally in orbit, condensing into stone, into rock, destined to develop life, and then perhaps to become in the end like Mercury, an airless rock baking in the Sun.

To go to the planets beyond Jupiter will be a journey, an odyssey of years. To do so our spacecraft will have to have an operating life far surpassing any we have planned before. Moreover, these planets are so far away we shall have to take advantage of special conditions to reach them. In the period 1976 to 1980, they will be in an unusual alignment that will enable us to go to all of them. And this alignment won't happen again for over 179 years. The last time the planets approached anything like this grouping was when Thomas Jefferson was president of the United States, and you'll remember it was he who sent Lewis and Clark to explore the West to resolve the image of our country.

On our first grand tour we'll launch a spacecraft toward Jupiter, then using the rollercoaster maneuver we tried out on the Venus-Mercury flight, we'll send the spacecraft to Saturn, use the rollercoaster again and the spacecraft will go on to find Pluto. It will be a seven-year voyage. In the second grand tour the spacecraft will go to Jupiter as before, then Uranus, on to Neptune, nearly three billion miles from Earth. After nearly eight years, the spacecraft, which will be sending back its rain of data, will then escape the solar system and become the first object created by man to adventure into the galactic space of the Milky Way, a message to a hundred billion stars that we are here, somewhere in the universe.

How can we use the knowledge we will gain of the solar system for the betterment of our life on Earth? Our spacecraft are already being used to observe the Earth, to count the Earth's resources, provide better communications, better navigation, and to study the Earth's atmosphere. We live in this atmosphere, we breathe atmosphere, we see atmosphere, the sky is blue only because the atmosphere scatters the Sun's light. It is here that the interaction between the Sun and its solar wind and Earth, between oceans and land, between the Earth and its own atmosphere, is acted out. This is where the hurricanes, the typhoons, tornadoes, tidal waves move across the stage. It is in that thin layer that the very fabric of life is both nurtured and attacked by nature. Can we do something about weather? Has our study of other planetary atmospheres given us any clues to the weather here on Earth?

We think so, and in the next few years, the world is going to see the largest, most widespread scientific experiments ever attempted. It will be known as the Global Atmospheric Research Program, GARP. This will be a cooperative effort of the scientific societies and academies of almost the entire world. Everything that we know, everything that we can learn, will eventually be drawn together to create a model, a mathematical description of the atmosphere. When this is done, and with continuing observations, we hope to have the ability to forecast the weather accurately up to two weeks in advance. Think of the vacations saved, the picnic sandwiches, the rain check you wished you never got, the hairdo that was so special and had to look just right. More important perhaps than all the things you've just seen, we may be able to tell food producers everywhere in the world how much moisture they can expect, when to plant, how big their harvest is going to be, and where to distribute the food where it is apt to be most needed.

Today we look to spacecraft to help solve these problems. In ancient times man looked to the stars, and isn't that how astronomy began in the first place? We live under the influence of a star, our Sun. Yet for two centuries after the invention of the telescope, we almost ignored the Sun; it was, perhaps, too close to be interesting. Today our Orbiting Solar Observatories are making up the lost time. Soon we plan to put a telescope into orbit around the Earth, with its instruments pointed at the Sun and an astronaut to adjust it, recover the photographs from time to time. We will call this the Apollo Telescope Mount.

The Sun, as we now appreciate, is a most unique laboratory. By measurements and logic we are deducing its life history and the life history of countless other stars. We believe that it was once a much larger, far cooler ball of glowing red gas; cooler because the nuclear reactions that make stars hot were just beginning. Its own gravity pulled it inward, decreasing its size, increasing its heat, moving it into the main sequence of a star's life. It became the yellow-orange Sun that rises in the morning over the life it has nurtured. As it grows older it will probably grow hotter, larger again. Then a great flash of light in the sky and nova, it may collapse, and pass its age as a cool white dwarf, its story all but ended, perhaps.

But from what we learn on the Sun, we can instruct our other satellites what to measure among the other stars. Our Orbiting Astronomical Observatories, turning their eyes to see what is invisible from Earth. Or our Radio Astronomy Explorers, spinning out arms longer than the Empire State building is tall, reaching out for radio waves that come from stars, the planets, the Earth itself. They will find mysteries, some that we shall solve, some that will lead to other mysteries.

For example, the Crab Nebula. Until a century ago, astronomers with simple telescopes saw this as a blur, then resolved its image further with modern telescopes, and now see in greater detail by space observations. In its center is a small blue star, a faint hot star, one whose history we believe has all but ended; yet from that point of light comes energy at a rate 50,000 times greater than the Sun's. It is a pulsar, and it pumps an unbelievable burst of energy into the heavens 30 times every second. What does it mean to us? Well if we can measure it, describe it mathematically, understand its laws, then perhaps someday we might be able to duplicate this newly discovered energy source, as we did with the nuclear reaction astronomers found on the Sun, and perhaps even tax it.

Who will we meet as we travel in and out of the byways and boulevards of space billions and trillions of miles in length and breadth? Is there a chance that we will find planets where there are beings, like us or unlike us, but perhaps alike in their deep curiosity about where they are, where they came from, and who shares the universe with them. Many of us think so, because even in our own galaxy with its billions of stars, there should be millions of planets on which life could have evolved. For we are like the child in the crib, its eyes open, resolving its first mystery.

Well there it is, the great adventure of the universe, which it took man more than 6,000 years simply to define. And at last we are ready to go there, ready for the next great leap in learning that the human race makes to meet the challenges of the moment.