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# Extraterrestrial Life in the Universe

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## Summary

The possibility that life exists elsewhere in the universe, even in our own planetary system, has intrigued scientists, philosophers, and theologians for centuries. The spaceflight programs of NASA have provided much new information about our planetary neighbors and have put to rest some speculations about the existence of life on those planets or their satellites. However, there are still undetermined questions about the possibility of some form of life existing in the far distant past in our planetary system. Beyond our planetary system, the astronomical quest for scientific clues about life continues, largely via the radio telescope. Thus far there is no conclusive evidence. Can it be that the Earth contains the only form of life in this vast universe? In this report, some of the recent findings about our planetary neighbors are reviewed and the question about life elsewhere in the universe is addressed.

## Introduction

From the dawn of recorded history, the human race has wondered about its place in the universe. Today we ask the same old questions that our ancestors have asked for thousands of years. Who am I? Why am I here? Am I unique to the universe? The only thing that has changed about these questions is that through science we know more about ourselves, other animal life, and the physical universe all around us. The stories that explain our existence and the beginnings of the world or the universe have taken on more grandeur than the early oral myths passed along from generation to generation by the patriarchs of early civilizations. Today's stories or myths have been embellished by the wealth of the new knowledge we are accumulating at an ever-increasing rate. Our concepts of the universe and the creative process within the cosmic system outshine the most grandiose fantasies of old.

Those prominences, or flares, on our Sun (shown in fig. 1) have been studied by NASA in the Hi-Max program, and can be the source of severe communications disruption. Our Sun is just one sun in a galaxy of a thousand billion suns, or stars. Most of these stars are much larger and more energetic than ours. However, measured in any energy scale, our Sun delivers energy at a rate beyond comprehension. In one ten-millionth of a second, it delivers an energy amount equivalent to all the nuclear bombs made in the world! Our galaxy, known

affectionately as the "Milky Way," is only one of one hundred billion galaxies that populate the universe. The enormity of the universe causes us to wonder about the prospects of other planetary systems revolving about a sun with life on one of its planets. On this subject we can only speculate because our instruments are not yet sensitive enough to detect planetary systems revolving about even the closest stars.

The advanced state of our knowledge causes us to ponder more fervently about our existence in the universe. Can it be that we are unique? Is it possible that we humans represent the only advanced form of life in the whole creation? Perhaps the question suggested by the astronomer Sebastian Von Hoerner (ref. 1) is more appropriate: "Where is everybody?" in such a universe.

Meanwhile, the dawn of space exploration has been allowing us to inspect at close range the planets, and their moons, of our splendid planetary system. As NASA approached this venture, the age long sought to check out old speculations about some forms of life on the nearby planets of Mars and Venus. Are the markings our telescopes revealed on Mars creature-made canals? What sorts of atmospheres and temperatures are present on Venus? Does water exist on our Moon?

Let us review some of the principal findings of our recent planetary exploration. What have we learned about our planetary neighbors? Do they show signs of life existing now or before?

## Unmanned Missions

The unmanned missions to the planets began in the early 1960's. The spacecraft for these missions contained some form of onboard electric power, sensors and specialized instruments, data processing equipment, communication transmission, and trajectory control. The first of these (shown in fig. 2) were called "Mariners." They were employed in the investigations of the near planets Mercury, Venus, and Mars. Larger and more complex craft, called "Pioneers" (shown in fig. 3), were developed to explore the more distant planets and to send probes into the atmosphere of Venus. Figure 4 is a photo of the "Viking" spacecraft which was designed and built for the investigation of Mars. Prior to the Moon landings, "Surveyor" spacecraft (fig. 5) were sent to the Moon's surface to obtain more reliable information concerning the condition of the surface. Some of the most remarkable achievements of the space program have been the missions to the outer planets

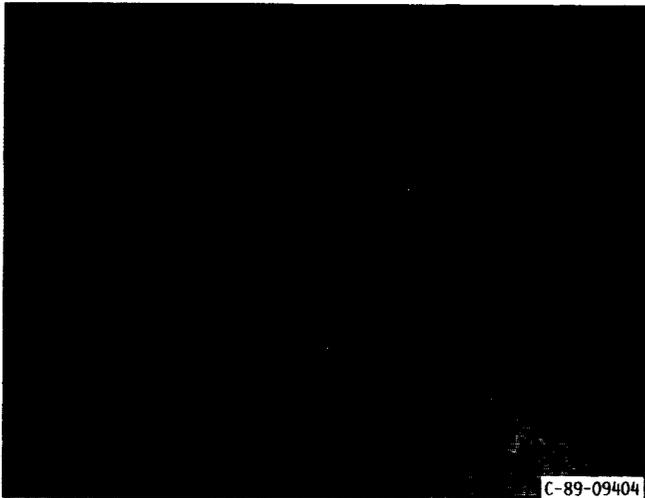


Figure 1.—Prominences of Sun.



Figure 4.—Viking spacecraft.

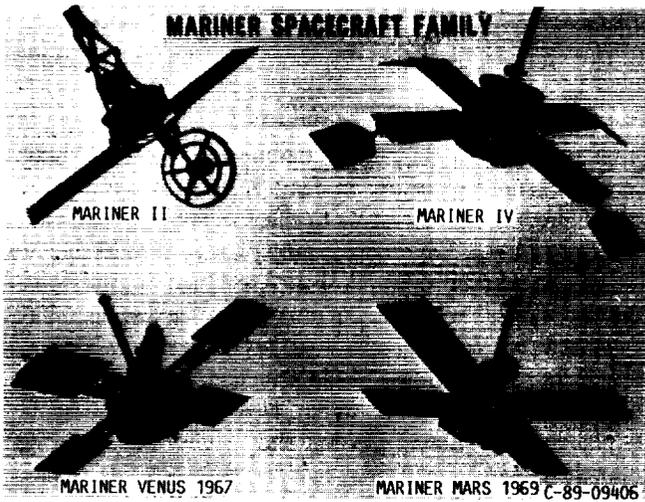


Figure 2.—Mariner spacecraft.



Figure 5.—Surveyor spacecraft.



Figure 3.—Pioneer spacecraft (orbiter).



Figure 6.—Voyager spacecraft.

using the "Voyager" spacecraft shown in figure 6. Two of them were launched by Lewis launch crews in 1977 on Titan-Centaur Boosters.

## Earth's Moon

Our Moon (fig. 7) has been the object of both scientific and romantic inquiry for centuries. Landing a man on the Moon became a national goal for the 1960's. The Apollo project became the best known and most watched technical venture of all history (fig. 8). As a result of man's exploration, we have a wealth of information about the Moon. It is best described as a gigantic fossil whose continuing study is revealing much about our Earth and the entire solar system. We know that there has been no significant volcanic activity for at least three billion years, yet the geological surface is much like Earth's. In contrast to Earth, there is absolutely no water in either a free or combined state. The origin of the Moon remains a big question. There are no signs of any form of life, past or present.

## Mercury

For discussion purposes we begin our description of the planetary explorations with the Mariner mission to Mercury, the planet nearest the Sun. Figure 9 is a general view of that planet and figure 10 is a closeup. Mercury resembles our Moon and is also devoid of any atmosphere. It takes 59 Earth days to make one rotation, and the surface temperature fluctuates between 950 °F on the Sun side to -350 °F on the dark side of the planet.

## Venus

The planet Venus has often been referred to as Earth's twin. It is about the same size, shows evidences of an atmosphere, and is covered by clouds (fig. 11). Even in recent times it was looked upon as a possible place for some form of life to exist. However, these speculations have proven to be without foundation. Venus is starkly different from Earth.

In the early 1960's both the Soviet Union and the United States began spacecraft explorations of Venus. At first they were flyby missions with the Soviet "Venera" and United States "Mariner" space probes. The Soviet Union's first successful scientific landing was in October 1967. In 1974, our Mariner 10 obtained the first pictures of Venus made from a spacecraft using ultraviolet imaging.

The most significant scientific mission to Venus took place in 1978 when NASA launched two spacecraft in a coordinated observation of the planet. Pioneer I (as depicted in fig. 12), was designed to orbit the planet for at least one year and gather radar images of the topology. Pioneer II (fig. 13) was a multiprobe vehicle that separated into five atmospheric entry

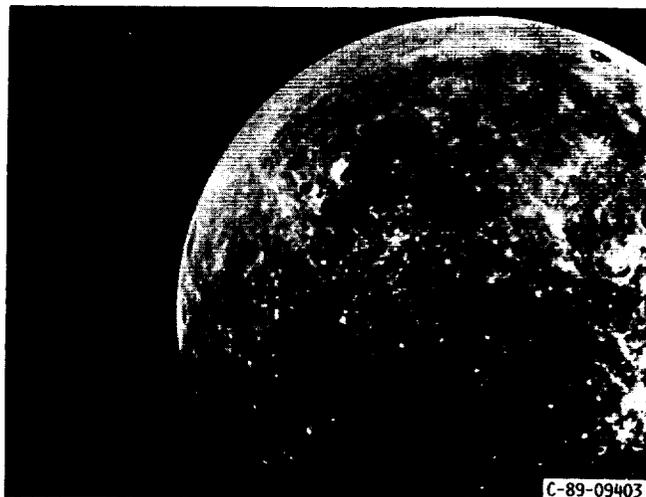


Figure 7.—Earth's Moon.



Figure 8.—Astronaut on Moon.

craft which entered Venus' atmosphere at different points on the day and night sides of the planet. The Pioneer mission of six observing spacecraft was highly successful. In fact, Pioneer I has been sending back images of that planet's surface for more than 10 years.

The space missions to Venus have revealed that Venus is a very hot (850 °F) planet with a dense atmosphere of CO<sub>2</sub>. Its cloud cover is approximately 10 miles thick. The surface

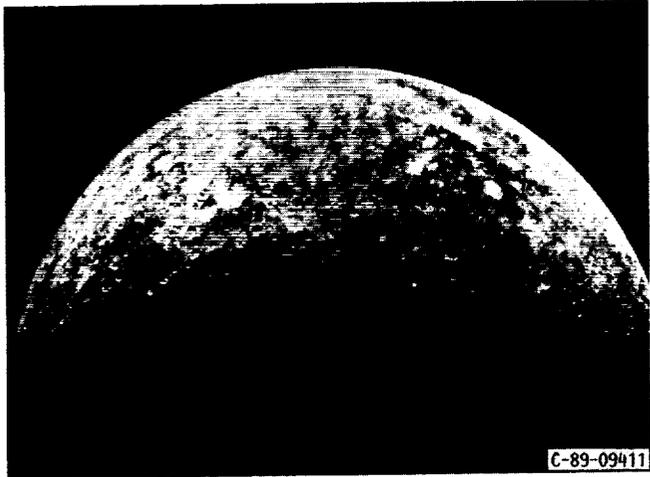


Figure 9.—Planet Mercury.



Figure 12.—Pioneer orbiting Venus.

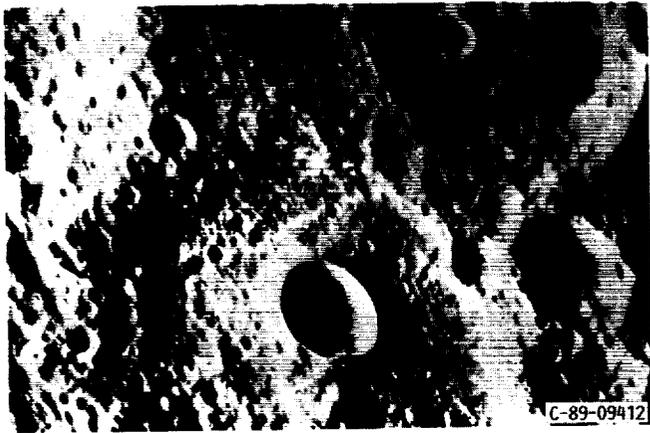


Figure 10.—Planet Mercury (closeup).

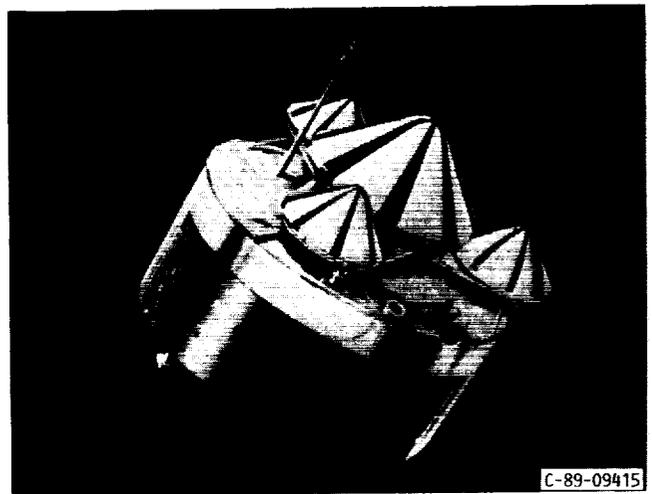


Figure 13.—Pioneer multiprobe entry craft.



Figure 11.—Planet Venus.



Figure 14.—Mars Canyon—Valles Marineris.

of the planet is completely hidden by the clouds. Radar images of the surface reveal that it has a plateau twice as large as anything on Earth. A mountain on this plateau is higher than Mt. Everest, and it has volcanic chains that rival the size of the Hawaiian Islands.

Carried into Earth orbit in the spring of 1989 on board the space shuttle "Atlantis" was the newest Venus space probe, "Magellan," which will carry out the most extensive investigation of any of the planetary missions to date. Through the use of a special high-resolution radar, it will map over 90 percent of the planet's surface in great detail. The primary goal of the mission is to learn more about the geological history of Venus. The greenhouse effect of its CO<sub>2</sub> atmosphere is of great interest because of our own planet's problems with that phenomenon.

## Mars

Our closest planetary neighbor, farther out from the Sun, is Mars. Telescopic observations of that planet revealed canallike images over much of the surface. Some have even speculated that these were not natural—but creature-made. The term "Martian" was coined in case such creatures did exist.

As part of the Bicentennial Celebration in 1976, we sent two vehicles to Mars. Each vehicle comprised an orbiter and a lander. The orbiters systematically photographed the surface and the overall weather conditions, while the landers observed the physical changes at their respective sites and made meteorological measurements. These Viking spacecraft have enabled the entire surface of Mars to be photographed. The seasonal changes of the planet have been documented. One of the Viking orbiters came within 20 miles of one of the Martian moons while photographing it. We now know a great deal about this planet.

One of the things we have learned is that the canals, or channels, are not creature-made—they are natural. Figure 14 is an image of a canyon that is 3000 miles long and 4 miles deep. There are other channels that appear to have been cut by torrents of water; several of them are estimated to be 10,000 times greater than the volumetric flow of the Amazon River. The terrain suggests that at one time there were great rivers and oceans on Mars. However, no liquid water exists on Mars now. Life may have existed on this planet, but there is no conclusive proof of its existence today. In an interesting but controversial book by Richard C. Hoagland (ref. 2), the author proposes that some of the NASA pictures suggest that an ancient civilization may have existed there.

The atmosphere of Mars is mostly carbon dioxide, but it also includes oxygen and water vapor. The atmospheric pressure is so low (one percent of Earth's) that blood would boil and water cannot exist in liquid form. It is a cold place, with equatorial temperatures falling to 150 °F below zero at night.

The soil is rich in iron, giving the planet its characteristic red hue. One of its volcanic mountains is three times as high



Figure 15.—Planet Jupiter.



Figure 16.—Planet Saturn.

as Mt. Everest, and its base is approximately 325 miles in diameter.

## Jupiter, Saturn, Uranus, and Neptune

The two largest planets in the solar system are out beyond Mars—in fact, far beyond Mars. These are Jupiter and Saturn. Beautiful images of these planets are shown in figures 15 and 16, respectively. No one expects to find any forms of plant or animal life on them similar to that on Earth. These planets are of interest because of their immensity, and they are thought to harbor clues about the beginnings of our planetary system. Their composition is largely hydrogen, so they bear some similarity to stars.

The NASA space probes to these planets have made much news during their lifetimes. Two identical Voyager spacecraft were launched about a month apart in 1977 on a long journey

to approach these planets at relatively close range so that pictures could be made and other data taken. These spacecraft have passed by both planets and sent back remarkable closeup images of each.

The thousands of images that these TV cameras have transmitted to Earth will keep scientists busy for many years. Dramatic closeup images of the "red eye" of Jupiter were made as illustrated in figure 17.

In less than one week, more information was learned about Saturn from Voyager 1 than was known from centuries of astronomical observations. Among the new findings were: Saturn has something like 1000 rings—not 6 as the Earth telescopes had discerned. Figure 18 is the ring structure as seen by Voyager. Some of the rings are truly eccentric and even appear to be braided. There seems to be a spokelike structure in some regions on the rings.

A total inventory of 17 moons has been observed in orbits around Saturn. One of the largest moons in the solar system, Titan, was found to have a cloudy nitrogen atmosphere—not methane, as assumed by scientists. The surface of Titan was found to be a cold  $-300^{\circ}\text{F}$ —too cold to support life. The other principal moons observed showed craters and volcanoes on their surfaces. Two new moons were discovered almost embedded in the edge of the ring structure. Voyager 1, its Saturn mission complete, left the solar system in 1981 and will wander through interstellar space forever.

During the last week of August 1981, Voyager 2 had its rendezvous with Saturn and passed closer to the planet than did Voyager 1. The thousands of images transmitted have provided the basis of additional information about Saturn, its moons, and its rings. It sped away from Saturn to encounter the planet Uranus in 1986. Uranus has its axis of rotation in the plane of its orbit. It is too distant to be studied in any detail from Earthbound observations. Voyager 2's 1986 images of Uranus, its moons, and its rings provided long-awaited astronomical data. Distant and closeup images of this planet are shown in figures 19 and 20.

In late August 1989, Voyager 2 made its historic final encounter with our solar system when it passed within 3044 miles of Neptune and observed its largest moon, Triton. Remarkably, the spacecraft missed its target trajectory by only 3 miles altitude and 21 miles lateral displacement as it sped by the planet. A huge atmospheric dark spot, the size of Earth, was observed to be rotating around the planet every 18.3 hours. A smaller spot, lower in latitude, was rotating at an even faster rate. A strong magnetic field, tilted at  $50^{\circ}$  to the rotational axis of the planet, was discovered. Voyager 2 also discovered six new satellites, making a total of eight satellites around Neptune. Three rings similar to those of Saturn were identified as girding the planet.

Although the encounter with Neptune was engrossing, more excitement seemed to be generated when Voyager passed over Triton. This moon is large enough to have its own atmosphere. Much of its surface had the textured appearance of a canteloupe. On closer scrutiny, the surface condition suggested volcanic activity at cryogenic temperatures, with methane ice being



Figure 17.—Red eye of Jupiter.

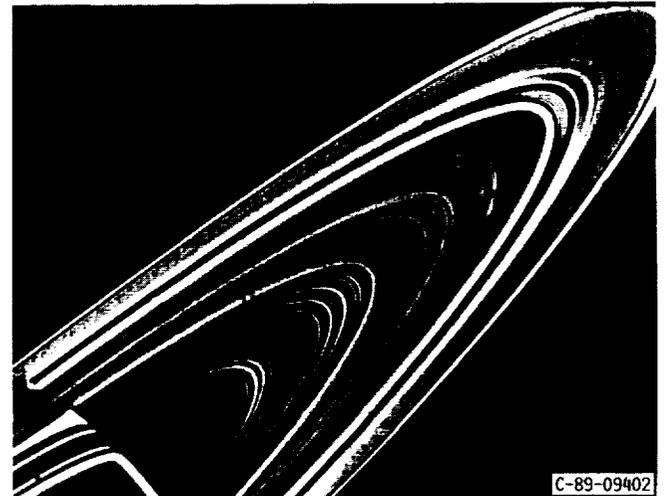


Figure 18.—Rings of Saturn.

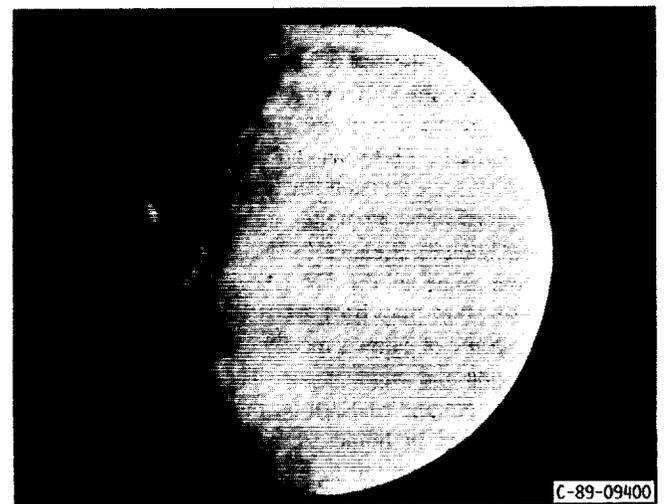


Figure 19.—Planet Uranus.



Figure 20.—Closeup of Uranus.

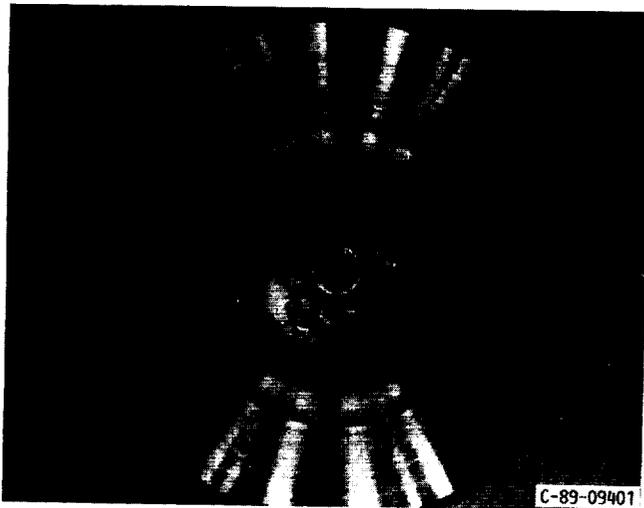


Figure 21.—Permanent recording on Voyager.

blown out by liquid nitrogen geysers. The temperature of Triton was  $-400^{\circ}\text{F}$ , the coldest temperature of any body observed in the entire planetary system. The diameter of this moon was determined to be 1690 miles and it rotated in the opposite direction to that of Neptune. Voyager 2 now joins its twin spacecraft as it leaves the planetary system destined for a cosmic journey into the galaxy.

Because both Voyagers are destined to meander in interstellar space, it seemed appropriate to equip the spacecraft with some kind of identification that would tell something about the senders. On the chance that some creature might intercept one of the Voyagers, a permanent phonograph and the equipment to play the phonograph are on board. A photo of the phonograph record is shown in figure 21. This was Carl Sagan's idea. Pictures in computerized analog form, music, and voice recordings are included. The pictures include a variety of people, animals, birds, our planet cities, automobiles, etc.—a total of over 100 images. Admittedly, the prospect of another civilization intercepting either of these spacecraft is very slight, but there is always that possibility.

## Speculation on Extraterrestrial Life

It has been proven rather conclusively that the Earth contains the only form of animal life in our planetary system at the present time. Mars may have supported life at some earlier time. The uniqueness of our existence in this system should remind us of our fragility and our utter dependence on a one-planet habitat. Although nothing comparable to our planet seems to co-exist within a distance of a few billion miles, we cannot say that life does not exist in other solar systems in stellar space. Perhaps the enhanced versatility and capability of the Hubble telescope to be launched in 1990 will aid in finding other planets orbiting around suns in the cosmic structure of the universe. I am one of those who believes that life elsewhere must exist. For us to be the only citizens of this vast universe is a preposterous idea, in my view.

Perhaps the reason we have not made contact with other intelligent creatures is because our detection technology is not yet sufficiently advanced. Since the late 1940's, an international group of astronomers has been listening intently to their radio telescopes to discern a faint signal—perhaps a radio wave sent out by some creature on another planet. Thus far, no such signal has been detected amid the noisy radiation sent out by the stars.

There is the possibility that we are known by others. Some of our earliest radio signals may have traveled 40 or 50 light years into space. If our activity has not been detected, perhaps our planetary system has been—or at least our Sun has been observed by another civilization.

In a stimulating article on this subject that appeared in the November-December 1980 issue of the *American Scientist* (ref. 3), John Ball guessed that humans are in the median level of intelligent civilizations of the universe. About half are more advanced and an equal number are less advanced. In our galaxy, several cosmologists have estimated that one-tenth of one percent of the stars are capable of having systems that could support life (approximately one billion stars).

The possibility that life exists elsewhere in the universe is not a new conjecture. A 16th century Dominican monk, Giordano Bruno, was burned at the stake because he dared to proclaim that "beings inhabit an infinitude of worlds." Christian Huygens, a 17th century physicist, argued that our Sun was just another star and that "other stars also had great retinues of planets with their moons around them."

The 18th century English poet, Alexander Pope, wrote these words (ref. 4):

"See worlds on worlds compose one universe,  
Observe how system into system runs,  
What other planets circle other suns,  
What varied being peoples every star,  
May tell why Heav'n has made us as we are..."

I believe that some time in the future (it may be centuries away) humans will be made aware of other civilizations coexisting in the universe. That will be the most sensational news story of all times.

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