Section I-1

introduction

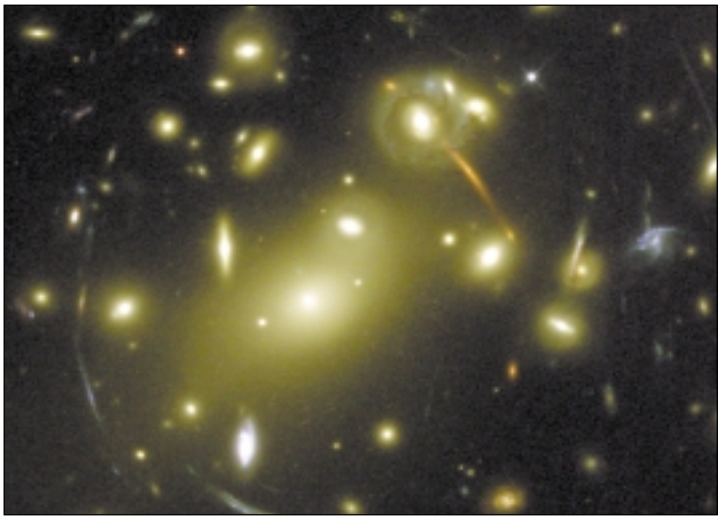
Thousands of years ago, on a small rocky planet orbiting a modest star in an ordinary spiral galaxy, our remote ancestors looked up and wondered about their place between Earth and sky. On the threshold of the 21st century, we ask the same profound questions:

- How did the universe begin and evolve?
- How did we get here?
- Where are we going?
- Are we alone?

Today, after only the blink of an eye in cosmic time, we are beginning to answer these profound questions. Using tools of science that range from abstract mathematics and computer modeling to laboratories and observatories, humans are filling in the details of the amazing story of the universe. In the last 40 years, space probes and space observatories have played a central role in this fascinating process. Today, NASA addresses these four profound questions through its many space science activities.

How did the universe begin and evolve? We seek to explain the earliest moments of the universe, how stars and galaxies formed, and how matter and energy are entwined on the grandest scales. We study astrophysical objects, such as neutron stars and black holes, with extreme conditions that demonstrate fundamental laws of physics at work. We study the behavior of matter, radiation, and magnetic fields under less severe conditions, in the giant laboratory of our Solar System. The understanding thus gained applies directly to the history and behavior of stars and galaxies.

How did we get here? We investigate how the chemical elements necessary for life have been built up and dispersed throughout the cosmos. We look for evidence about how the Sun has behaved over time and what effect this has had on Earth and everything on it. We send probes to other planets to learn about their similarities and differences as keys to how they formed and evolved, and study the comets and asteroids in our Solar System for clues to their



Following the successful December 1999 servicing mission, the Hubble Space Telescope observed the gravitational bending and focusing of light from very distant objects by a massive foreground cluster of galaxies.

effects on the evolving Earth. We carry out ground-based research on the environmental limits of life to learn how it might have arisen and evolved on early Earth.

Where are we going? Our ultimate place in the cosmos is wrapped up in the fate of the universe. Nearer to home, the variability of our Sun and vulnerability of Earth to possible impacts by small Solar System bodies are being investigated. We are comparing the climate histories of Earth and its sibling planets. Humanity has taken its first steps off our home world, and we will contribute to making it safe to travel throughout the Solar System and will ascertain what resources possible destinations could offer to human explorers.

Are we alone? Beyond astrophysics and cosmology, there lies the central human question: Are we on Earth an improbable accident of nature? Or is life, perhaps even intelligent life, scattered throughout the cosmos? We seek to explain how planets originated around our Sun and other stars—planets that might support life. We observe nearby stars for indirect evidence of other planets, and look to the future when advanced observatories in space might be able to directly image such relatively small objects across the vast interstellar void. Beginning with life found in astonishing places on Earth, we conjecture about what kinds of environments could bear and support life, and how common habitable planets might be. Is there now, or has there ever been, life in our own Solar System other than on Earth?

Answers to these deep questions will not be extracted from narrow

Some Recent Space Science Discoveries

In recent years, space research has returned momentous results. Observations from the Hubble Space Telescope have yielded much better estimates of the age and size of the universe and the amount of matter within it, while x-ray observations from the Rossi X-ray Timing Explorer have led to the discovery of magnetars, a special type of neutron star that has the most powerful magnetic field known. By mapping the structure of leftover radiation from the Big Bang, NASA balloon-borne experiments have provided the first firm evidence to date for the "inflation" theory in cosmology. Exotic objects like black holes, for most of a century just a prediction of abstract mathematics, are now known to be commonplace. We are revealing secrets of the inconceivably luminous quasars and gamma ray bursters, now known to be in the remotest regions of the early universe. The Chandra X-ray Observatory has revealed a new class of medium mass black holes. Dozens of planet-like objects have been discovered around other stars, suggesting that our Solar System is not unique. Interest in the possibility of life elsewhere than on Earth has been galvanized by images of Mars from the Mars Global Surveyor and by evidence from the Galileo spacecraft that Jupiter's moon, Europa, might have a liquid water ocean under an icy outer crust. The structure of our own star, the Sun, and its complex effects on Earth are becoming much better understood. U.S. instruments on the European Solar and Heliospheric Observatory and the Japanese Yohkoh mission have detected "rivers" of flowing gas beneath the Sun's surface, as well as new predictors for the occurrence of solar activity that can affect Earth. We have learned much about causes of the solar wind, and even traced individual solar disturbances all the way from the Sun to Earth.

inquiries, but will be built up by combining innumerable individual clues over the years to come. The broad outlines of much of the puzzle are discernible now, but a clear picture of the whole awaits years of varied research that will undoubtedly produce many surprises along the way.

This Space Science Enterprise Strategic Plan tells about the science goals and objectives that will lead us toward answers to the fundamental questions. It lays out our near-term program of activities to pursue these goals and objectives. It tells how we will invent and demonstrate the new technologies that we need to pursue our ambitious vision, and how we will contribute to human space flight. And it explains how we plan to share the excitement and understanding from our discoveries with teachers, schoolchildren, and the general public.

In Part I of the Plan, we describe our science goals and objectives, outline how progress in technology goes hand in hand with our ability to pursue them, and then present our approach to sharing our findings with the public on whose behalf we are conducting this important task of discovery.

In Part II we present in more detail our plans and hopes for the program. We describe some exciting recent accomplishments and projects currently under development, general principles that guide us in structuring and carrying out the program, and our specific mission and research plans for new activities beginning in 2003. In subsequent sections we give more detail about the technology program that supports our bold vision, about our basic research programs, and about our public education and outreach programs. NASA cannot succeed without the active participation of scientists, technologists, and engineers all over the U.S. and collaboration with other nations as well. We therefore describe our many partnerships within the Federal Government, across the country, and around the world. The last section of Part II presents a vision of the future of the scientific exploration of the cosmos.

Astrobiology: Science of Synthesis

Answering our fundamental questions will call on all of modern science's tools of inquiry, ranging from astronomy, biology, and chemistry, through zoology. To gather these capabilities together and focus them on our fundamental questions, NASA is nurturing a new multidisciplinary science, Astrobiology. The place of life in the universe and its roots in the origin of the cosmos itself are the themes that run through this Strategic Plan to weave the Space Science Enterprise's many programs together into a unified voyage of discovery.