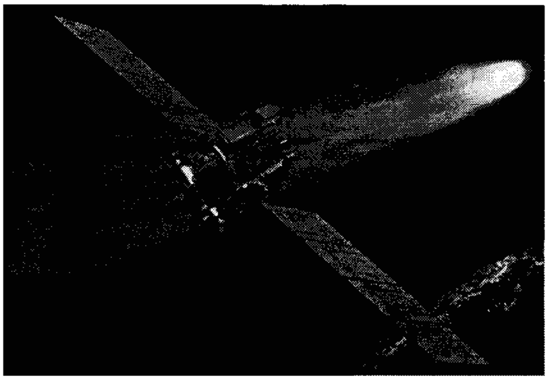
NASA NEW MILLENNIUM PROGRAM

Deep Space 1

PROPELLED BY XENON IONS



Solar concentrator arrays provide the energy to ionize and accelerate the xenon gas fueling the ion propulsion engine.

Exerting less force than does a single sheet of paper resting on your hand, **Deep Space 1's ion propulsion system** will slowly, yet continuously accelerate the spacecraft well beyond speeds attainable by conventional chemical propulsion. What's more, the engine gives about 10 times more thrust for the same amount of propellant than do engines using chemical propulsion.

Deep Space 1 is the first space mission to rely primarily on **solar electric** (ion) **propulsion** to reach its destination. If successful, this advanced technology will be further developed and used in future missions. The first of NASA's New Millennium program missions, Deep Space 1 is also a platform for testing several other new technologies with the potential for greatly advancing space exploration into the next century.

In addition to technology validation, Deep Space 1 has scientific objectives. The mission plan calls for rigorous experiments that will reliably and quickly demonstrate the ability of the new instruments to handle the science missions of the future.

In addition to solar electric propulsion, Deep Space 1 will test—

Autonomous Navigation System

Using images of asteroids and stars collected by the onboard camera system (which is part of the Miniature Camera and Imaging Spectrometer described below), the **onboard navigator system** will compute and correct the spacecraft's course. Current spacecraft navigation systems rely on human controllers on Earth.

Miniature Camera and Imaging Spectrometer

The camera-imaging spectrometer package combines narrow-angle imaging, wide-angle imaging, and infrared and ultraviolet imaging spectrometry into one small instrument. For comparison, pictures will also be taken with a standard charge-coupled device (the technology used in digital cameras) and a new active pixel sensor, which integrates the electronics and the light detector on a fingernail-sized chip.

Solar Concentrator Array

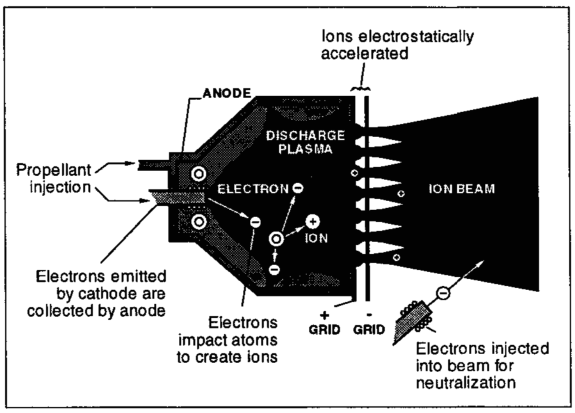
The advanced solar power concentrator arrays that provide electrical power to the ion engine, as well as the rest of the spacecraft, are more efficient than conventional solar panels and cost and weigh less.

Beacon Monitor Operations

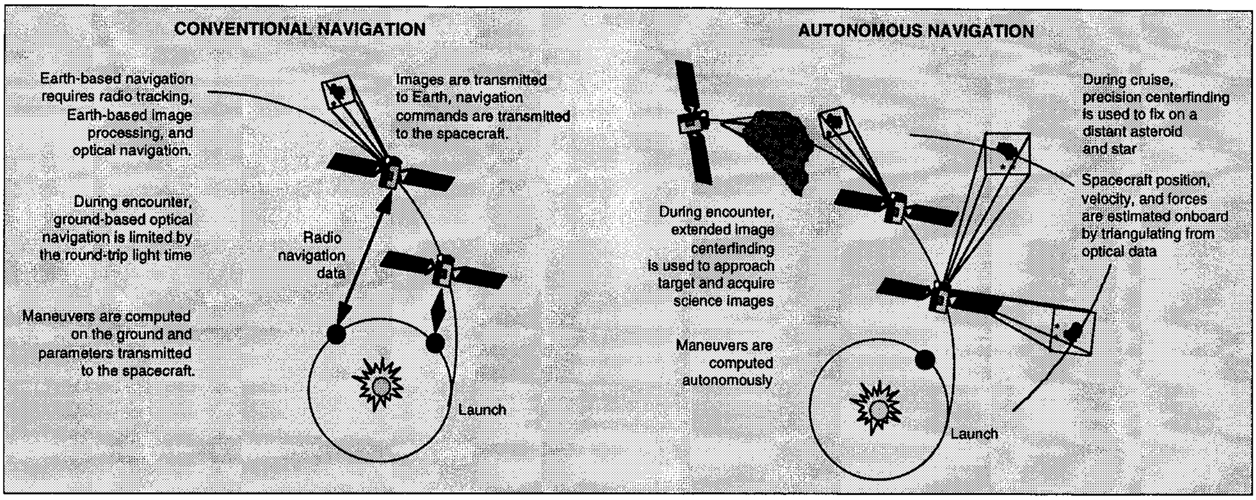
This technology may eventually reduce the need for mission controllers on Earth to continuously monitor the health of the spacecraft. The spacecraft's beacon monitor will send one of just four easily detectable status reporting signals to Earth. The status signal will tell the mission controller if the spacecraft should need human intervention.

Telecommunications Devices

New low-mass communications devices include a miniaturized transponder (combination receiver-transmitter) that weighs just 2.95 kilograms (6.5



In Deep Space 1's ion engine, electric power from the solar arrays is used to ionize ***xenon gas.*** *An electrically charged grid then accelerates the xenon ions, shooting them out in a 30-kilometer-per-second stream, propelling the spacecraft in the opposite direction.*



The diagram on the left shows current navigation techniques, while the one on the right shows Deep Space 1's autonomous navigation. By photographing reference asteroids against the background of fixed stars, the spacecraft triangulates to calculate exactly where it is. It then projects its path to its destination and uses its propulsion system to make any needed course corrections.

pounds). A transponder with similar capability using current technology would be more than twice as heavy and cost three times as much. A high-frequency, solid-state amplifier that amplifies the transponder radio signal is also being tested.

Microelectronics and Spacecraft Structure

Ultraminiaturized electronics that consume less power and a multifunctional structure that integrates electronics with the spacecraft structure will demonstrate futuristic technologies for making the spacecraft smaller, lighter, and more efficient.

Autonomous Commanding System

Sophisticated software programming will create an "agent" that can plan, make decisions, and operate by itself, without human intervention or guidance. The agent also finds out when a failure has occurred, then decides what to do about it and whether to call for help.

Miniature Ion and Electron Spectrometer

This "space physics package" will help determine whether space physics measurements can be made from a spacecraft operating on ion propulsion. The insturment is one-fifth that of currently used comparable instruments and uses about one-third the power.

Deep Space 1 launches in October 1998. It will fly by asteroid 1992 KD in late July 1999. The flyby will be used as a final occasion to test the Miniature Camera and Imaging Spectrometer, the Miniature Ion and Electron Spectrometer, and the Autonomous Navigation System. Most of the technology validation experiments will have been done before the flyby, with many being completed during the first two months after launch.

On September 18, 1999, the primary mission will be complete. Depending on the exact time of launch and the performance of the new technologies, the spacecraft could be left in a trajectory that would take it near Comet Wilson-Harrington in January 2001 and Comet Borrelly in September 2001, giving further opportunities for technology validation and scientific discovery.

The technologies tested on Deep Space 1 and other missions of the New Millennium Program are being developed to support NASA's vision of frequent, exciting, affordable missions. Likely beneficiaries of these new technologies will be future missions to planets, moons, comets, asteroids, and perhaps even the sun.

The Jet Propulsion Laboratory, California Institute of Technology, manages the Deep Space 1 mission for NASA.

For more information write to:

Deep Space 1 Education and Public Outreach
Jet Propulsion Laboratory, MS 301-235
4800 Oak Grove Drive
Pasadena, CA 91109-8099

Or visit **http://nmp.jpl.nasa.gov/ds1**

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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JPL 400-XXX 8/98