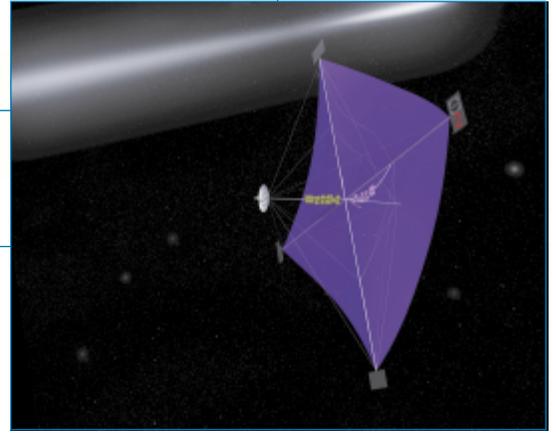


# Advanced Space Transportation Technology Summary

## Space Sails



**S**ailing in space could be one way to go to the stars. Researchers at NASA's Marshall Space Flight Center in Huntsville, Ala., are pursuing space sails as an advanced concept for interstellar travel.

Thin, reflective sails could be propelled through space by sunlight, microwave beams or laser beams—just as the wind pushes sailboats on Earth.

The concept of space sails is nothing new. About the same time Jamestown was being established as America's first permanent colony, German astronomer Johannes Kepler penned a letter to Italian astronomer Galileo, advocating "ship or sails adapted to the heavenly breezes" to travel to Jupiter or the Moon. Having observed that a comet's tail always faces away from the Sun, Kepler concluded light from the Sun exerts a force that pushes its tail away.

The rays of light emanating from the Sun provide tremendous momentum that could push a solar sail about 150,000 mph. Space sails could make interplanetary travel four to six times faster than today's propulsion systems. In addition to moving remarkably faster than traditional systems, solar sails require no fuel. The Sun supplies all the energy.

And while the notion of sailing in space has been around for centuries, it's only become a real possibility in the last few years—with the advent of strong, lightweight composite materials.

Sails in space would have a very large surface area—almost a half-mile wide—but could be thinner than cellophane. The density of a space sail is less than one-tenth ounce per square yard, the equivalent of flattening one raisin to the point that it covers a square yard. A solar sail might be composed of a carbon fiber material with a thin coating of reflective aluminum.

Another space sailing concept, dubbed mini-magnetospheric plasma propulsion, or M2P2, uses a huge magnetic bubble as a sail. The "sail" would be pushed along by charged particles of the solar wind, instead of rays of sunlight. The charged particles of the solar wind would interact with the magnetic field to push the magnetic bubble, or sail.

Sail propulsion will be used initially for robotic missions and eventually could be considered for human space travel. A space sail may power an interstellar precursor mission NASA hopes to launch in the next decade to explore the edge of our solar system and study its interaction with nearby interstellar space.

The Marshall Center is leading NASA's propulsion research for the unmanned probes that will venture billions of miles in space. Its engineers are conducting laboratory experiments as they begin to evaluate and characterize materials for space sails. Challenges include how to build, package and unfurl a solar sail and control its direction of travel through space. Since the sail would get very close to the Sun, thermal protection is also of major importance.

Marshall is partnering with NASA's Jet Propulsion Laboratory in Pasadena, California, and the University of Washington in Seattle to develop sail propulsion for interstellar precursor missions. The Marshall effort is managed by the Advanced Space Transportation Program, NASA's core technology program for all space transportation. The Advanced Space Transportation Program is pushing technologies that will dramatically increase the safety and reliability and reduce the cost of space transportation.