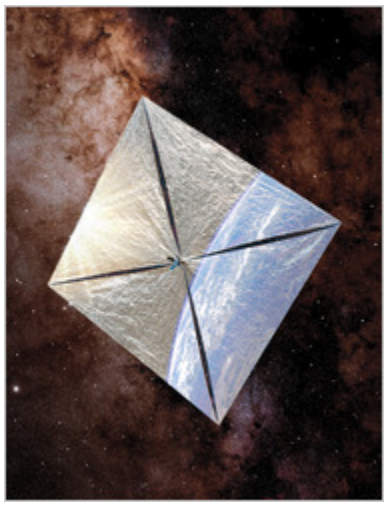
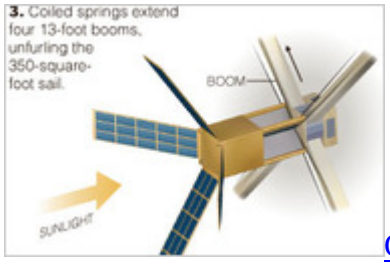
Setting Sail Into Space, Propelled by Sunshine



Rick Sternbach/Planetary Society

DEEP-SPACE TRAVEL If the launching of LightSail-1 goes off according to plan next year, humans may soon be solar-sailing, as shown in this illustration.

Multimedia



Graphic

Traveling on Light

Science Times

About a year from now, if all goes well, a box about the size of a loaf of bread will pop out of a rocket some 500 miles above the Earth. There in the vacuum it will unfurl four triangular sails as shiny as moonlight and only barely more substantial. Then it will slowly rise on a sunbeam and move across the stars.

LightSail-1, as it is dubbed, will not make it to Neverland. At best the device will sail a few hours and gain a few miles in altitude. But those hours will mark a milestone for a dream that is almost as old as the rocket age itself, and as romantic: to navigate the

cosmos on winds of starlight the way sailors for thousands of years have navigated the ocean on the winds of the Earth.

“Sailing on light is the only technology that can someday take us to the stars,” said Louis Friedman, director of the Planetary Society, the worldwide organization of space enthusiasts.

Even as the National Aeronautics and Space Administration continues to flounder in a search for its future, Dr. Friedman announced Monday that the Planetary Society, with help from an anonymous donor, would be taking baby steps toward a future worthy of science fiction. Over the next three years, the society will build and fly a series of solar-sail spacecraft dubbed LightSails, first in orbit around the Earth and eventually into deeper space.

The voyages are an outgrowth of a long collaboration between the society and Cosmos Studios of Ithaca, N.Y., headed by Ann Druyan, a film producer and widow of the late astronomer and author Carl Sagan.

Sagan was a founder of the Planetary Society, in 1980, with Dr. Friedman and Bruce Murray, then director of the Jet Propulsion Laboratory. The announcement was made at the Hart Senate Office Building in Washington at a celebration of what would have been Sagan’s 75th birthday. He died in 1996.

Ms. Druyan, who has been chief fund-raiser for the society’s sailing projects, called the space sail “a Taj Mahal” for Sagan, who loved the notion and had embraced it as a symbol for the wise use of technology.

There is a long line of visionaries, stretching back to the Russian rocket pioneers Konstantin Tsiolkovsky and Fridrich Tsander and the author Arthur C. Clarke, who have supported this idea. “Sails are just a marvelous way of getting around the universe,” said Freeman Dyson, of the Institute for Advanced Study in Princeton, N.J., and a longtime student of the future, “but it takes a long time to imagine them becoming practical.”

The solar sail receives its driving force from the simple fact that light carries not just energy but also momentum — a story told by every comet tail, which consists of dust blown by sunlight from a comet’s core. The force on a solar sail is gentle, if not feeble, but unlike a rocket, which fires for a few minutes at most, it is constant. Over days and years a big enough sail, say a mile on a side, could reach speeds of hundreds of thousands of miles an hour, fast enough to traverse the solar system in 5 years. Riding the beam from a powerful laser, a sail could even make the journey to another star system in 100 years, that is to say, a human lifespan.

Whether humans could ever take these trips depends on just how starry-eyed one’s view of the future is.

Dr. Friedman said it would take too long and involve too much exposure to radiation to sail humans to a place like Mars. He said the only passengers on an interstellar voyage — even after 200 years of additional technological development — were likely to be robots or perhaps our genomes encoded on a chip, a consequence of the need to keep the craft light, like a giant cosmic kite.

In principle, a solar sail can do anything a regular sail can do, like tacking. Unlike other spacecraft, it can act as an antigravity machine, using solar pressure to balance the Sun's gravity and thus hover anyplace in space.

And, of course, it does not have to carry tons of rocket fuel. As the writer and folk singer Jonathan Eberhart wrote in his song "A Solar Privateer":

No cold LOX tanks or reactor banks, just Mylar by the mile.

No stormy blast to rattle the mast, a sober wind and true.

Just haul and tack and ball the jack like the waterlubbers do.

Those are visions for the long haul. "Think centuries or millennia, not decades," said Dr. Dyson, who also said he approved of the Planetary Society project.

"We ought to be doing things that are romantic," he said, adding that nobody knew yet how to build sails big and thin enough for serious travel. "You have to get equipment for unrolling them and stretching them — a big piece of engineering that's not been done. But the joy of technology is that it's unpredictable."

At one time or another, many of NASA's laboratories have studied solar sails. Scientists at the Jet Propulsion Laboratory even once investigated sending a solar sail to rendezvous and ride along with Halley's Comet during its pass in 1986.

But efforts by the agency have dried up as it searches for dollars to keep the human spaceflight program going, said Donna Shirley, a retired J.P.L. engineer and former chairwoman of the NASA Institute for Advanced Concepts. Dr. Shirley said that the solar sail was feasible and that the only question was, "Do you want to spend some money?" Until the technology had been demonstrated, she said, no one would use it.

Japan continues to have a program, and test solar sails have been deployed from satellites or rockets, but no one has ever gotten as far as trying to sail them anywhere.

Dr. Friedman, who cut his teeth on the Halley's Comet proposal, has long sought to weigh anchor in space. An effort by the Planetary Society and the Russian Academy of Sciences to launch a sail about 100 feet on a side, known as Cosmos-1, from a Russian missile submarine in June 2005 ended with what Ms. Druyan called "our beautiful spacecraft" at the bottom of the Barents Sea.

Ms. Druyan and Dr. Friedman were beating the bushes for money for a Cosmos-2, when NASA asked if the society wanted to take over a smaller project known as the Nanosail. These are only 18 feet on a side and designed to increase atmospheric drag and thus help satellites out of orbit.

And so LightSail was born. Its sail, adapted from the Nanosail project, is made of aluminized Mylar about one-quarter the thickness of a trash bag. The body of the spacecraft will consist of three miniature satellites known as CubeSats, four inches on a side, which were first developed by students at Stanford and now can be bought on the Web, among other places. One of the cubes will hold electronics and the other two will carry folded-up sails, Dr. Friedman said.

Assembled like blocks, the whole thing weighs less than five kilograms, or about 11 pounds. “The hardware is the smallest part,” Dr. Friedman said. “You can’t spend a lot on a five-kilogram system.”

The next break came when Dr. Friedman was talking about the LightSail to a group of potential donors. A man — “a very modest dear person,” in Ms. Druyan’s words — asked about the cost of the missions and then committed to paying for two of them, and perhaps a third, if all went well.

After the talk, the man, who does not wish his identity to be known, according to the society, came up and asked for the society’s bank routing number. Within days the money was in its bank account. The LightSail missions will be spread about a year apart, starting around the end of 2010, with the exact timing depending on what rockets are available. The idea, Dr. Friedman said, is to piggyback on the launching of a regular satellite. Various American and Russian rockets are all possibilities for a ride, he said.

Dr. Friedman said the first flight, LightSail-1, would be a success if the sail could be controlled for even a small part of an orbit and it showed any sign of being accelerated by sunlight. “For the first flight, anything measurable is great,” he said. In addition there will be an outrigger camera to capture what Ms. Druyan called “the Kitty Hawk moment.”

The next flight will feature a larger sail and will last several days, building up enough velocity to raise its orbit by tens or hundreds of miles, Dr. Friedman said.

For the third flight, Dr. Friedman and his colleagues intend to set sail out of Earth orbit with a package of scientific instruments to monitor the output of the Sun and provide early warning of magnetic storms that can disrupt power grids and even damage spacecraft. The plan is to set up camp at a point where the gravity of the Earth and Sun balance each other — called L1, about 900,000 miles from the Earth — a popular place for conventional scientific satellites. That, he acknowledges, will require a small rocket, like the attitude control jets on the shuttle, to move out of Earth orbit, perhaps frustrating to a purist.

But then again, most sailboats do have a motor for tooling around in the harbor, which is how Dr. Friedman describes being in Earth orbit. Because the direction of the Sun keeps changing, he said, you keep “tacking around in the harbor when what you want to do is get out on the ocean.”

The ocean, he said, awaits.

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