

Child of the 1970s is the first to sail out of the solar system

BY BROOKS BARNES

Its technology was laughable by today's standards: the spacecraft carried an eight-track tape recorder, a radio communication system that relies on a 12-foot dish with an antenna, and computers with 240,000 times less memory than a low-end iPhone. When it left Earth 36 years ago, it was designed to survive a four-year mission to Saturn, and everything after that was gravy.

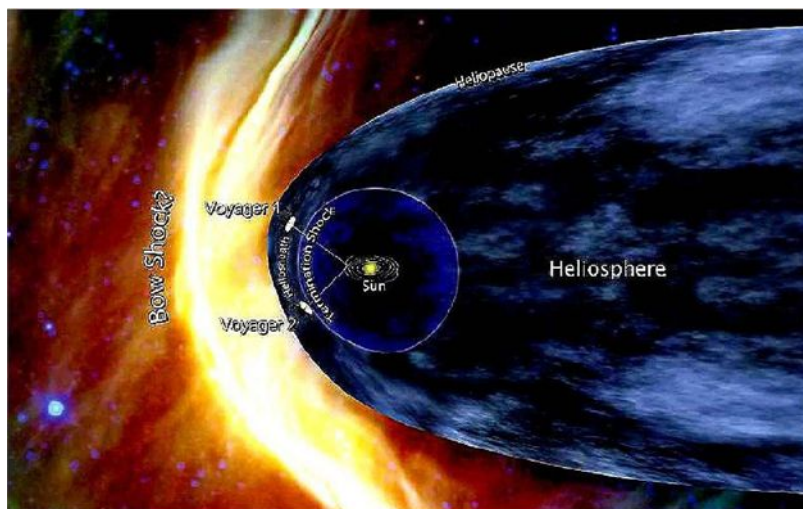
But that craft, Voyager 1, has become — unexpectedly — the Little Spaceship That Could: On Thursday, scientists declared that it had become the first man-made object to exit the solar system, a breathtaking achievement that NASA could only fantasize about when it was

launched in 1977, the same year "Star Wars" was released.

And Voyager is not only still flying — it continues to send back information, the first time scientists have been able to scoop up data directly from interstellar space.

"I don't know if it's in the same league as landing on the moon, but it's right up there — 'Star Trek' stuff, for sure," said Donald A. Gurnett, a professor of physics at the University of Iowa and a co-a-

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An artist's rendering from 2012 showed Voyager 1 and Voyager 2 at the edge of the solar system. Voyager 1 has crossed into interstellar space, the first probe to have done so.

Voyager 1 says goodbye to the solar system

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thor of a paper published on Thursday in the journal Science about Voyager's feat. "I mean, consider the distance! It's hard even for scientists to comprehend."

Even among planetary scientists, who tend to dream large, the idea that something they built could travel so far for so long and escape the Sun's reach is an impressive one. Plenty of telescopes gaze at the far parts of the Milky Way, but Voyager 1 can now touch and feel this unexplored region and send back detailed dispatches. Given the distance, it takes about 17 hours for Voyager's signals to reach the Jet Propulsion Laboratory, an arm of NASA in Pasadena, California.

"This is historic stuff, a bit like the

first exploration of Earth, and we had to look at the data very, very carefully," said Edward C. Stone, 77, NASA's top Voyager expert, who has been working on the project since 1972. Ever the stoic scientist, he does get excited about what comes next. "It's now the start of a whole new mission," he said.

The probe, which is 11.7 billion miles, or about 18.8 billion kilometers, from Earth and hurtling away at 38,000 miles per hour, has long been on the verge of bursting through the heliosphere, a vast, bullet-shaped bubble of particles blown out by the sun. Scientists have spent this year debating whether it had done so.

But now it is official that Voyager 1 has passed into the cold, dark and unknown

vastness of interstellar space, a place full of dust, plasma and other matter from exploded stars. The article in Science pinpointed a date: August 25, 2012.

"This is the moment we've all been waiting for!" Jia-Rui C. Cook, the media



Peso: 7-27%, 1-9%

liaison at the Jet Propulsion Laboratory, said in an e-mail. "I can't even sleep it's so exciting!!"

Coincidentally, the month that Voyager 1 left the reservation was the one that Curiosity, NASA's state-of-the-art rover, landed on Mars and started sending home gorgeous snapshots. Soon after, Curiosity's exploration team, with about 400 members, dazzled the world by driving the robot across a patch of Martian terrain, a feat that turned the Red Bull-chugging engineers and scientists of Building 264 of the Jet Propulsion Laboratory campus into rock stars. A spoof video, "We're NASA and We Know It," recorded to the beat of the song "We're Sexy And I Know It," generated 2.8 million views on YouTube.

Voyager, meanwhile, stopped sending home pictures in 1990, to conserve energy. In its heyday, it pumped out never-before-seen images of Jupiter and Saturn, but lately there has not been much to see.

As the mission lost its sizzle, its 12-person staff was been booted from the laboratory's campus and sent to cramped quarters down the street next to a McDonald's. Suzanne R. Dodd, the Voyager project manager, said that when she had attended meetings in Building 264, she had kept a low profile in deference to the Mars team.

"I try to stay out of the elevator and take the stairs," Ms. Dodd said. "They're doing important work there, and I'll only slow them down."

Now she and her team seem poised to be thrust back into the spotlight, perhaps for years to come. Dr. Stone, vice provost for special projects at the California Institute of Technology and former director of the Jet Propulsion Laboratory, expects Voyager 1 to keep sending back data — with a 23-watt transmitter, about the equivalent of a refrigerator light bulb — until roughly 2025.

Not that the aging spacecraft has made things easy. An instrument that measures the energy of particles in plasma stopped working in 1980. But scientists still have access to a related sensor, a spindly antenna that records electron oscillations in plasma. The catch is that these oscillations do not occur all the time; they typically happen when stirred up by a solar eruption.

Voyager 1's plasma wave antenna picked up audible vibrations in April and May that allowed Dr. Gurnett and his colleagues to calculate the density of the plasma around the spacecraft, which would help them determine whether or not the craft was still in the solar system.

"It was exactly what we expected for interstellar plasma," Dr. Gurnett said.

Moreover, by combing through older oscillation data collected by Voyager 1, the team discovered that the edge of the solar system — the threshold that was crossed in late summer of 2012 — was roughly where Dr. Gurnett predicted it would be back in 1993 by using different solar storm calculations.

"Am I bragging here? No," he said. "All right. I admit it. It's bragging a little."

As the solar system's edge grew tantalizingly close, NASA asked Ms. Dodd and her team to increase the amount of data collection. The problem: eight-track recorders from 1977 are not exactly bursting with extra space. Was there even anyone still alive who specialized in that piece of recording technology?

"These younger engineers can write a lot of sloppy code, and it doesn't matter, but here, with very limited capacity, you have to be extremely precise and have a real strategy," she said.

At 52, Ms. Dodd is a relative newcomer to Voyager, first working on the mission in 1984, when Voyager 2 — a companion spacecraft also launched in

1977, now moving in a different direction than its mate and still inside the solar system — was headed toward Uranus. But she was able to find her man: Lawrence J. Zottarelli, 77, a retired NASA engineer. He came up with a solution. But would it work?

With his striped suspenders and thinning hair, Mr. Zottarelli waited at Voyager mission control one afternoon last month to find out. The first of the newly programmed data dumps was set to come down. Ms. Dodd, Dr. Stone and Mr. Zottarelli watched two old Sun Microsystems computers like children watching for a chick to peck through an egg. "Nine, eight, seven," Dr. Stone counted down.

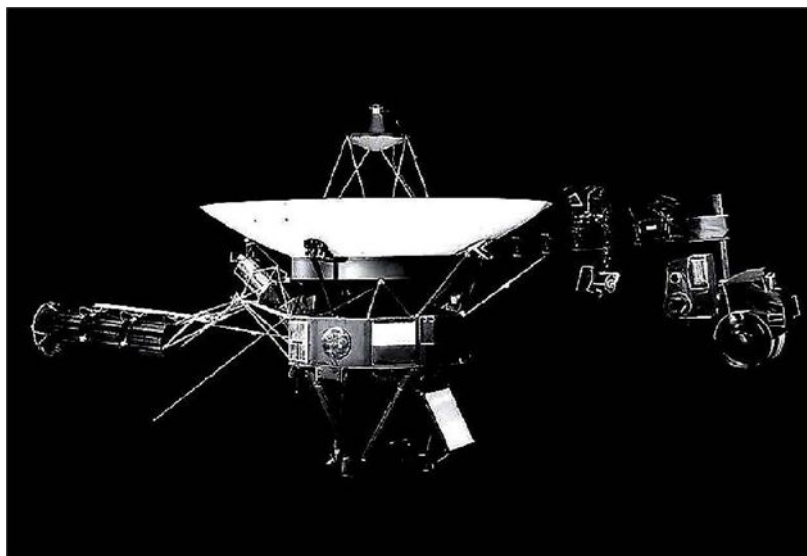
"Everything's fine," said Mr. Zottarelli, flashing a thumbs up and hiking up his trousers. "You're on your own now."

The relief was written all over Ms. Dodd's face, too. "It's not easy flying an old spacecraft," she said.

Her eyes moved to Dr. Stone, who was peering at a computer through his trifocals.

"There are lots of old missions," he responded, a sly smile taking over his face. "But not many are doing exciting new things."

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This image obtained in 2002 from NASA shows one of the twin Voyager spacecraft, launched in 1977. It continues to send back information, now from interstellar space.

