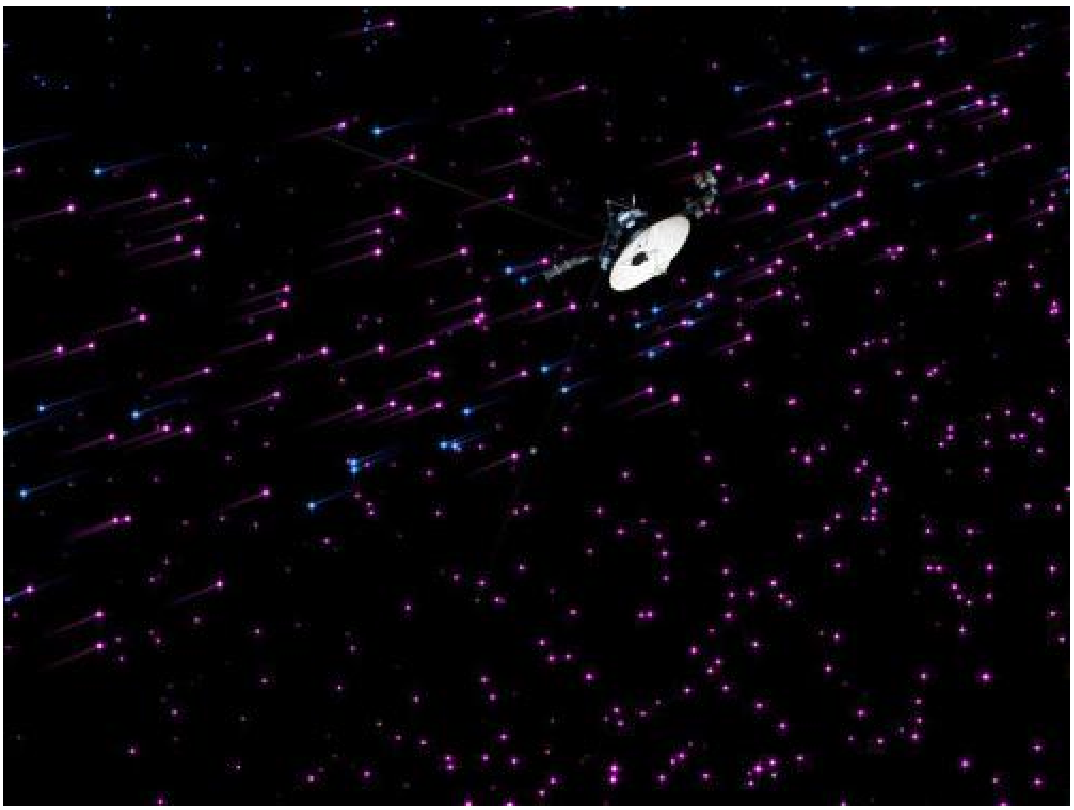
Voyager 1 encounters new region in deep space, NASA says

December 3 2012



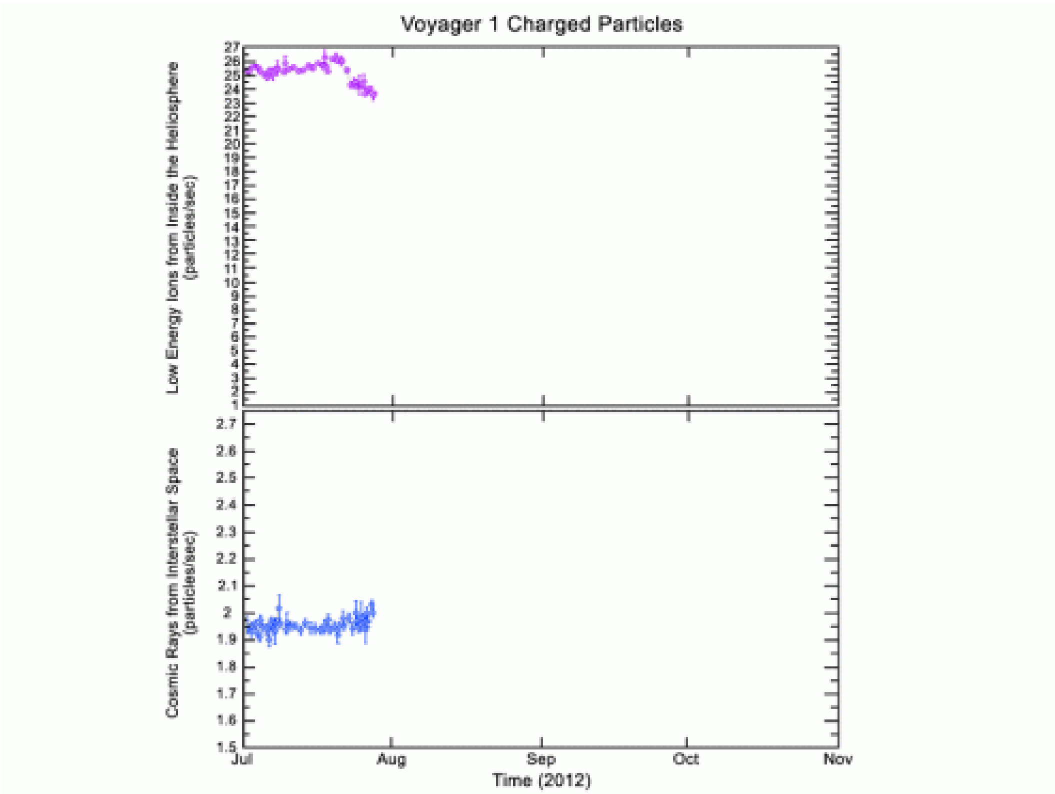
This still image and set of animations show NASA's Voyager 1 spacecraft exploring a new region in our solar system called the "magnetic highway." In this region, the sun's magnetic field lines are connected to interstellar magnetic field lines, allowing particles from inside the heliosphere to zip away and particles from interstellar space to zoom in. Credit: NASA/JPL-Caltech

(Phys.org)—NASA's Voyager 1 spacecraft has entered a new region at the far reaches of our solar system that scientists feel is the final area the spacecraft has to cross before reaching interstellar space.

Scientists refer to this new region as a magnetic highway for charged particles because our sun's magnetic field lines are connected to interstellar magnetic field lines. This connection allows lower-energy charged particles that originate from inside our heliosphere—or the bubble of charged particles the sun blows around itself—to zoom out and allows higher-energy particles from outside to stream in. Before entering this region, the charged particles bounced around in all directions, as if trapped on local roads inside the heliosphere.

The Voyager team infers this region is still inside our solar bubble because the direction of the magnetic field lines has not changed. The direction of these magnetic field lines is predicted to change when Voyager breaks through to interstellar space. The new results were described at the American Geophysical Union meeting in San Francisco on Monday.

"Although Voyager 1 still is inside the sun's environment, we now can taste what it's like on the outside because the particles are zipping in and out on this magnetic highway," said Edward Stone, Voyager project scientist based at the California Institute of Technology, Pasadena. "We believe this is the last leg of our journey to interstellar space. Our best guess is it's likely just a few months to a couple years away. The new region isn't what we expected, but we've come to expect the unexpected from Voyager."

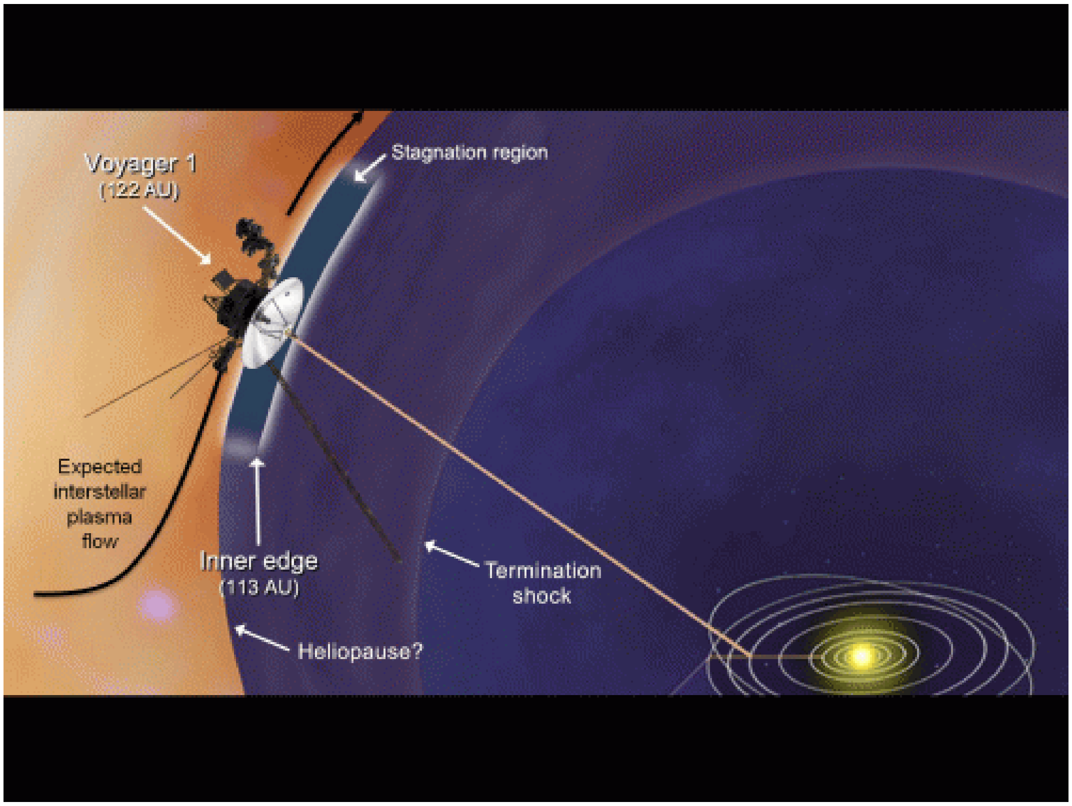


This animated graphic shows the jumps and dips in two key populations of charged particles as NASA's Voyager 1 moved into and out of a new region called the "magnetic highway." The top graph (magenta) shows the prevalence of lower-energy charged particles that originate inside the heliosphere, which is the bubble of charged particles surrounding our sun. The bottom graph (blue) shows the prevalence of cosmic rays, which are higher-energy charged particles that originate from interstellar space. These data were obtained by Voyager 1's cosmic ray instrument. Scientists refer to this new region as a "magnetic highway" because here the sun's magnetic field lines are connected to the interstellar magnetic field lines. This connection allows low energy particles from inside the heliosphere to zip away. It also allows cosmic ray particles from interstellar space to zoom in. The populations of these particles began to change rapidly on July 28, 2012, when Voyager first entered this magnetic highway. Over the next few weeks, the new region lapped and receded from Voyager 1 like an ocean tide. The second step of the animation shows the profound dip in the inside particles and bump in outside particles in the magnetic highway region, with the crossing marked with a solid vertical line. The new region receded outward from Voyager within five days, as evidenced in the jump in inside particles and dip in outside particles (third step of the animation). The dashed line indicates when Voyager left the magnetic highway. By Aug. 13, Voyager 1 had re-entered the highway region, as shown in the fourth step of the animation. But, as shown in the fifth step, Voyager 1 left the region again on Aug. 20. In the sixth step of the animation, the graphic shows how Voyager 1 entered the new region for good on Aug. 25. Since then, the low-energy particles from inside have nearly vanished and the population of cosmic rays from outside has stabilized. Credit: NASA/JPL-Caltech/GSFC

Since December 2004, when Voyager 1 crossed a point in space called the termination shock, the spacecraft has been exploring the heliosphere's outer layer, called the heliosheath. In this region, the stream of charged particles from the sun, known as the solar wind, abruptly slowed down from supersonic speeds and became turbulent. Voyager 1's environment was consistent for about five and a half years. The spacecraft then detected that the outward speed of the solar wind slowed to zero.

The intensity of the magnetic field also began to increase at that time.

Voyager data from two onboard instruments that measure charged particles showed the spacecraft first entered this magnetic highway region on July 28, 2012. The region ebbed away and flowed toward Voyager 1 several times. The spacecraft entered the region again Aug. 25 and the environment has been stable since.



This artist's concept shows plasma flows around NASA's Voyager 1 spacecraft as it gets close to entering interstellar space. Voyager 1's Low-Energy Charged Particle instrument detects the speed of the wind of plasma, or hot ionized gas, streaming off the sun. It detected the slowing of this wind – also known as the solar wind – to zero outward velocity in a region called the stagnation region. Scientists had expected that the solar wind would turn the corner as it felt the pressure of the interstellar magnetic field and the interstellar wind flow. But that did not happen, so scientists don't know what to expect once Voyager actually crosses the heliopause. Voyager 1 crossed a shockwave known as the Termination Shock in 2004. At the Termination Shock, the solar wind slows down abruptly from supersonic speeds. The heliopause is the boundary between the bubble of charged particles around our sun – known as the heliosphere – and interstellar space. Its location is still a mystery. Credit: NASA/JPL-Caltech/The Johns Hopkins University Applied Physics Laboratory

"If we were judging by the charged particle data alone, I would have thought we were outside the heliosphere," said Stamatios Krimigis, principal investigator of the low-energy charged particle instrument, based at the Johns Hopkins Applied Physics Laboratory, Laurel, Md. "But we need to look at what all the instruments are telling us and only time will tell whether our interpretations about this frontier are correct."

Spacecraft data revealed the magnetic field became stronger each time Voyager entered the highway region; however, the direction of the magnetic field lines did not change.

"We are in a magnetic region unlike any we've been in before—about 10 times more intense than before the termination shock—but the magnetic field data show no indication we're in interstellar space," said Leonard Burlaga, a Voyager magnetometer team member based at NASA's Goddard Space Flight Center in Greenbelt, Md. "The magnetic field data turned out to be the key to pinpointing when we crossed the termination shock. And we expect these data will tell us when we first reach interstellar space."

Voyager 1 and 2 were launched 16 days apart in 1977. At least one of the spacecraft has visited Jupiter, Saturn, Uranus and Neptune. Voyager 1 is the most distant human-made object, about 11 billion miles (18 billion kilometers) away from the sun. The signal from Voyager 1 takes approximately 17 hours to travel to Earth. Voyager 2, the longest continuously operated spacecraft, is about 9 billion miles (15 billion kilometers) away from our sun. While Voyager 2 has seen changes similar to those seen by Voyager 1, the changes are much more gradual. Scientists do not think Voyager 2 has reached the magnetic highway.

Provided by JPL/NASA