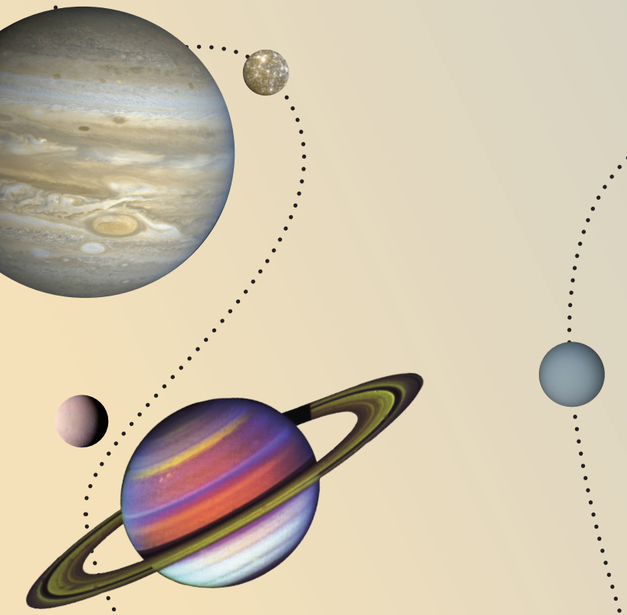
INTO THE DEEP:

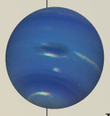
VOYAGER 2 *Sails through* Interstellar Space



In November of 2018, NASA's Voyager 2 became only the second spacecraft in history to leave the heliosphere, the protective bubble of particles and magnetic fields created by our sun. At a distance of 11 billion miles from Earth, well beyond the orbit of Pluto, Voyager 2 had entered interstellar space, or the region between stars. Now, scientists are able to describe what they have observed during and since Voyager 2's historic crossing, which helps to paint a picture of this cosmic shoreline, where the environment created by our sun ends and the vast ocean of interstellar space begins.

Both the heliosphere and interstellar space are filled with plasma, a gas that has had some of its atoms stripped of their electrons. The plasma inside the heliosphere is hot and sparse, while the plasma in interstellar space is colder and denser. The space between stars also contains cosmic rays, or particles accelerated by exploding stars. Voyager 1 discovered that the heliosphere protects Earth and the other planets from more than 70 percent of that radiation.

Scientists have confirmed that Voyager 2 is not yet in undisturbed interstellar space: Like its twin, Voyager 1, Voyager 2 appears to be in a perturbed transitional region just beyond the heliosphere.



"The Voyager probes are showing us how our sun interacts with the stuff that fills most of the space between stars in the Milky Way galaxy," said Ed Stone, project scientist for Voyager and David Morrisroe Professor of Physics at Caltech.

The two Voyager spacecraft have now confirmed that the plasma in local interstellar space is significantly denser than the plasma inside the heliosphere. Voyager 2 has now also measured the temperature of the plasma in nearby interstellar space and confirmed it is colder than the plasma inside the heliosphere.

Back in 2012, Voyager 1 observed a slightly higher-than-expected plasma density just outside the heliosphere, which indicated that the plasma is being somewhat compressed. Voyager 2 observed that the plasma outside the heliosphere is slightly warmer than expected, which could also indicate it is being compressed. (The plasma outside is still colder than the plasma inside.) Voyager 2 also observed a slight increase in plasma density just before the spacecraft exited the heliosphere, which indicates that the plasma is compressed around the inside edge of the bubble. But scientists do not yet fully understand what is causing the compression on either side.

Scientists also learned that the protective bubble is not impenetrable. One of Voyager's particle instruments showed that a trickle of particles from inside the heliosphere is slipping through the boundary and into interstellar space. Voyager 1 exited close to the very "front" of the heliosphere, relative to the bubble's movement through space. Voyager 2, on the other hand, is located closer to the flank of the heliosphere, and this region appears to be more porous than the region where Voyager 1 is located.

The Voyager probes launched in 1977, and both flew by Jupiter and Saturn. Voyager 2 changed course at Saturn in order to fly by Uranus and Neptune, the only close flybys of those planets in history. The Voyager probes completed their Grand Tour of the planets and began their interstellar mission to reach the heliopause in 1989. Voyager 1, the faster of the two probes, is currently more than 13.6 billion miles from the sun, while Voyager 2 is 11.3 billion miles from the sun. It takes light about 16.5 hours to travel from Voyager 2 to Earth. By comparison, light traveling from the sun takes about eight minutes to reach Earth.

Learn more about the Voyager program at **voyager.jpl.nasa.gov**