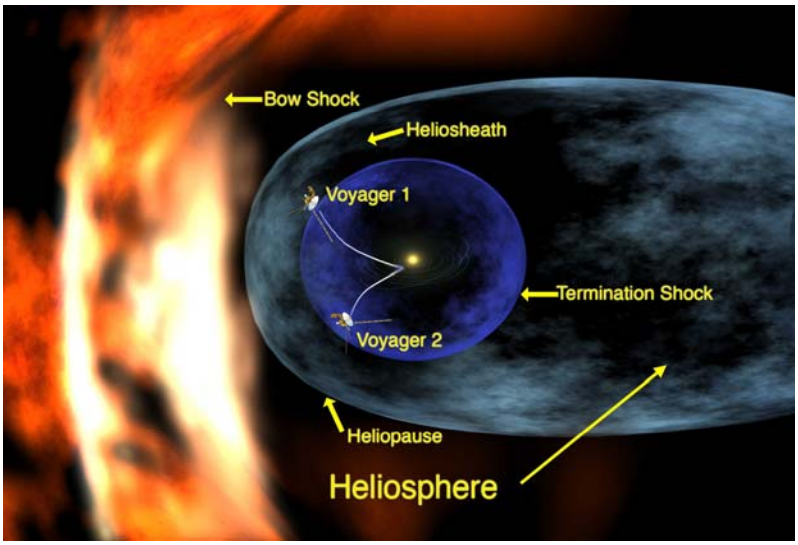
RESEARCH SPOTLIGHT

the Photon online

After a 27-year Journey, Voyager 1 Enters the Heliosheath

By: Dr. Douglas Hamilton

On December 16, 2004 the Voyager 1 spacecraft crossed the boundary between the supersonic solar wind and the much slower, denser and hotter solar wind plasma of the heliosheath. The boundary, known as the solar wind termination shock, has been anticipated for years and was encountered at distance of 94.0 AU from the sun or 94 times the Earth-Sun distance. That's more than twice the distance to Pluto, the last planet. The crossing was obvious in data returned by a number of instruments on Voyager 1 that measure charged particles and magnetic fields including the Low Energy Charged Particle (LECP) instrument.

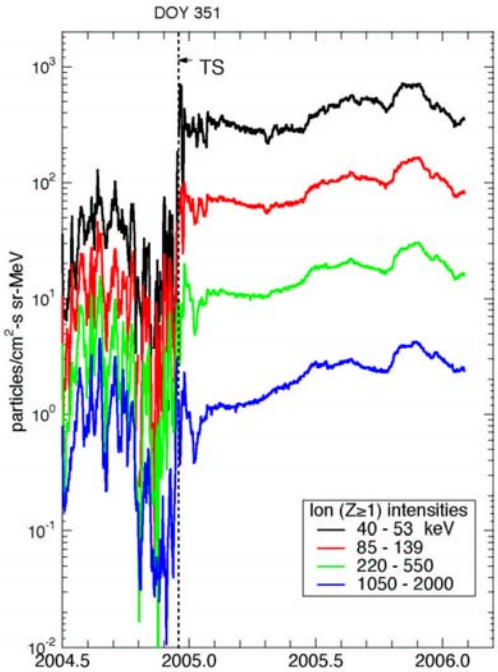


The department's Space Physics Group built much of the LECP instrument in the mid-1970's, and since their launch in 1977, Voyager 1 and its twin Voyager 2 have been setting endurance and distance records. I came to the University of Maryland as a postdoc in 1978 to work with Prof. George Gloeckler on the Voyager data. The early part of the mission featured flybys of all the gas giant planets starting with Jupiter in 1979 and ending with Neptune in 1989. After Neptune , NASA renamed the mission the Voyager Interstellar Mission. The goal is to explore the outer reaches of the solar system for the first time, including the heliosheath and eventually the interstellar medium. When Voyager 1 eventually crosses the heliopause, it will leave the heliosphere, a bubble formed in the Milky Way by the solar wind produced by the Sun. It will then enter the clouds of dust, gas and charged particles of the interstellar medium. Models predict that

Research Spotlight continued: Voyager 1 may reach that final goal well before 2020, when power supplied by its RTG's (radioisotope thermoelectric generators) falls below the minimum required.

In the meantime, Voyager 1 will continue to explore heliosheath and, within the next couple years, will be joined there by Voyager 2, which is about 17 AU behind. It's not easy to predict when Voyager 2 will cross the termination shock even with the knowledge of Voyager 1's crossing. The termination shock is not stationary and responds to solar wind pressure, which changes with the 11-year solar cycle. It appears likely that Voyager 1 did not cross the shock because of the spacecraft's outward motion but rather the shock crossed Voyager 1 on its way inward. The shock should be about as close as it gets to the Sun now. We're approaching solar sunspot minimum when the solar wind pressure actually increases. Although it only takes the solar wind four days to travel from the Sun to the Earth, it takes over a year to reach the termination shock. So there is a delay in the effect of the faster solar wind being felt there. Since Voyager 2 is at a southerly solar latitude, its actual crossing distance will be of great interest. It will shed light on north-south asymmetries expected to exist because of the orientation of the interstellar magnetic field.

The termination shock had been universally thought to be a prodigious accelerator of charged particles, and our findings largely confirm that. The LECP observed large increases in ion fluxes at energies up to about 2 MeV. At somewhat higher energies of tens of MeV, there is population of particles known as anomalous cosmic rays. They are called anomalous because they consist mostly of noble gas elements rather than reflecting the usual abundances of the periodic table. For the last 25 years, it has been thought that anomalous cosmic rays were accelerated at the termination shock. Much to our surprise their intensity did not peak at the termination shock but continues to increase as Voyager 1 travels deeper into the heliosheath. Obviously, their origin has yet to be discovered.



Voyager 1 LECP

More surprises are certain to come our way as the two Voyager spacecraft continue their journeys.

Dr. Hamilton is a professor for the University of Maryland. He is a member of the Space Physics group. Visit the group website at, http://space.umd.edu/ or contact him at, douglas.c.hamilton@umail.umd.edu