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The Ulysses spacecraft -- on its way to explore the polar regions above the sun -- has reached a latitude south of the ecliptic plane in which the solar wind is speeding at double the rate normally found at lower latitudes.

Measurements from Ulysses' solar wind plasma experiment, presented today at the 1993 fall meeting of the American Geophysical Union in San Francisco, showed wind speeds of 800 kilometers per second (about 2 million miles per hour) in this uncharted region of space, twice the speed at which the solar wind is known to flow in lower latitudes.

"This change in speed coincided with the spacecraft's passage above a sheet of electrical current," said Dr. Edward J. Smith, NASA project scientist on the joint NASA-European Space Agency (ESA) mission.  "This current sheet separates the solar wind that originates in the northern solar hemisphere from that originating in the southern hemisphere."

The current sheet rotates with the sun and has folds like the skirt of a whirling ballerina. Ulysses is now south of the folds of this current sheet.

When spacecraft are above the current sheet, they detect magnetic fields directed outward from the sun. When spacecraft are below the current sheet, they observe inward-directed fields, according to Dr. Richard Marsden, ESA project scientist.

"Far south of the sun's equator and well out of the equatorial region, Ulysses is now observing magnetic field lines pointing inward only," Marsden said.

A pair of magnetometers, each able to measure the magnetic fields above the sun's poles, will continue to measure the strength and direction of these field lines as Ulysses nears the region above the sun's southern pole.

Ulysses has also observed the presence of shock waves emanating through this unexplored region of space. When the progress of a fast solar wind stream is obstructed by slow flowing wind, a shock wave may be generated.

A "forward" shock continues in the direction of the overtaking fast wind, while a so-called "reverse" shock propagates in the opposite direction.

Shock waves in the solar wind are somewhat analogous to the acoustic waves, or sonic booms, generated in Earth's atmosphere when an airplane flies faster than the speed at which sound waves can travel. A lot of energy is concentrated in the compressed region close to the shock and charged particles passing through a shock can acquire part of this energy.

"Acceleration at shocks is an important process, believed responsible for many of the high energy charged particles in the universe," Smith said.

At low solar latitudes, within the domain occupied by the wavy current sheet, the interaction of fast and slow solar wind is a common occurrence, but it is not obvious that this shock-generating mechanism would be found at high solar latitudes. As Ulysses began to escape the wavy current sheet, quite a few reverse shocks, but very few forward shocks, were observed.

"This interesting new observation is explained by noting that, because the current sheet is tilted with respect to the sun's equator, outward-propagating forward shocks travel toward the equator, while reverse shocks travel poleward," Smith said.

Shock waves are believed to be responsible, too, for the acceleration of hydrogen, helium and certain other atoms which enter the solar system as low velocity neutrals from interstellar space, and which become ionized, or charged, in the solar wind. Eventually, they reach energies at which they appear as "anomalous" cosmic rays.

Acceleration to cosmic ray energies was generally believed to take place in the outermost regions of the heliosphere. However, Ulysses has for the first time recorded acceleration of these particles by shock waves -- suggesting, Smith said, "that a significant increase in the energy of anomalous cosmic rays may take place much closer to the sun than was earlier believed."

Ulysses is a five-year mission managed jointly by NASA and ESA to study the regions above the sun's poles. The spacecraft begins its primary mission in June 1994, when it begins to pass over the sun's southern pole.

The experiment teams responsible for these recent discoveries included the solar-wind plasma experiment, led by Dr. John Phillips of Los Alamos National Laboratory; the magnetometer experiment, led by Dr. Andre Balogh of Imperial College, London; and the solar wind-ion composition experiment, led by Professor Johannes Geiss of the University of Bern, and Dr. George Gloeckler of the University of Maryland.

The Jet Propulsion Laboratory manages the U.S. portion of the Ulysses mission for NASA's Office of Space Science, Washington, D.C.

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