Topic Page: Ulysses (Spacecraft)

Definition: **Ulysses** from *The Hutchinson Unabridged Encyclopedia with Atlas and Weather Guide*

Space probe to study the Sun's poles, launched in 1990 by a US space shuttle. It is a joint project by NASA and the European Space Agency. In February 1992, the gravity of Jupiter swung Ulysses on to a path that looped it first under the Sun's south pole in 1994 and then over its north pole in 1995 to study the Sun and solar wind at latitudes not observable from the Earth. Ulysses continues to return data to Earth.

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Ulysses

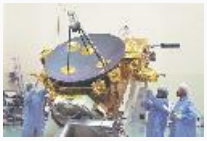

Image from: **Ulysses The Ulysses spacecraft is shown here...** in *Astronomy Encyclopedia*

Summary Article: **Ulysses**
From *Encyclopedia of the History of Astronomy and Astrophysics*

Ulysses was a joint European Space Agency (ESA)/NASA mission to explore the heliosphere, or the region of space outwards from the solar corona, at almost all heliographic latitudes. ESA provided the spacecraft, and NASA the launcher and the spacecraft's radioisotope power generator. Launched in 1990, it was the first spacecraft to fly over both poles of the Sun.

The concept of a spacecraft to measure the solar wind, and the interplanetary environment away from the ecliptic plane, was first proposed by astrophysicists on both sides of the Atlantic in the first few years of the Space Age. NASA and ESRO (ESA's predecessor) had other priorities at the time, but in 1974 they agreed on a joint study into what was to become the Out-of-Ecliptic programme. Its title was later changed to the International Solar Polar Mission (ISPM), and finally to Ulysses.

Over the years this programme was the subject of a great deal of acrimony between ESRO (later ESA) and NASA, mainly caused by NASA's high-handed attitude. For example, NASA unilaterally rejected the electric propulsion system for getting the spacecraft out of the ecliptic. They then unilaterally changed the launch vehicle, then the launch date, and finally the name of what was supposed to be a joint programme. At that time there were to have been two spacecraft which would observe opposite poles of the Sun, using Jupiter's gravity to swing them out of the ecliptic. One spacecraft was to have been provided by NASA and one by ESA, with American and European experiments on both. Then in 1981 NASA unilaterally cancelled their spacecraft, which left a number of European experimenters with no spacecraft on which to put their experiments, and a great deal of money wasted. Eventually relations between ESA and NASA were patched up, but not before high-level protests at ambassadorial level had taken place.

The 370 kg Ulysses spacecraft was finally launched into low Earth orbit by the Space Shuttle Discovery on 6 October 1990. The spacecraft then used two propulsion modules to send it to intercept Jupiter on 8 February 1992, where it used Jupiter's gravity to swing it out of the ecliptic. The spacecraft carried five European and five American experiments. These were to investigate the solar wind, the solar and heliospheric magnetic field, solar emissions, gas and dust in interplanetary space, cosmic rays and cosmic gamma-ray bursts.

Ulysses' heliocentric orbit, following its Jupiter intercept, was inclined at about 80° to the solar equator, with an orbital period of 6.2 years. Its aphelion and perihelion were at about 5.4 and 1.3 AU from the Sun. Over its more than 17 years of operation the spacecraft passed over both poles of the Sun three times, first in 1994–95, then in 2000–01, and finally in 2006–08. Although Ulysses had been launched at solar maximum, the first and third pair of passes over the Sun's poles were at about solar minimum, and the middle pair at solar maximum.

Ulysses found that around solar minimum the slow solar wind (~350 km/s) was constrained to equatorial regions. Whereas the fast (~750 km/s) solar wind, which originated from cooler coronal regions near the Sun's poles, fanned out to fill about 70% of the heliosphere. At low heliographic latitudes, where the solar wind velocity was generally low, its density was relatively high, whereas at high latitudes, where the velocity was high, its density was low. The fast solar wind was found to have quite a different isotopic and atomic composition from the slow wind. At solar maximum the clear differences of solar wind velocity with heliographic latitudes broke down.

The spacecraft also found that the heliospheric magnetic field was more complicated than expected, as it did not follow an ordered spiral, but was more chaotic, undergoing large excursions in latitude. As a result, particles emitted during solar storms could reach higher and lower heliographic latitudes as they got further from the Sun.

Ulysses found that the Sun's magnetic dipole was aligned with the Sun's rotational axis at solar minimum. By solar maximum the dipole had moved to lie perpendicular to the rotational axis, and by the next solar minimum it was aligned with the rotational axis once more, but oriented in the opposite direction. Ulysses also provided valuable information on dust and gas in interplanetary space, the distribution and lifetimes of cosmic rays, and gamma-ray bursts.

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