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SOLAR PLASMA EXPERIMENT

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On the first day of the mission to Mars, Mariner IV detected the shock wave produced by the "solar wind" on Earth's magnetic field at a greater altitude than this phenomenon has ever before been observed.

At a distance of about 138,000 miles from Earth, the solar plasma probe aboard the spacecraft began to measure a plasma energy spectrum that is characteristic of interplanetary space, indicating that Mariner IV had passed out through the "bow shock" produced by the impact.

This shock had been observed repeatedly in recent months by the Interplanetary Explorer (IMP) satellites but at significantly lower altitudes.

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Two additional changes in the plasma spectrum--at about 145,000 miles and at 154,000 miles--during the first 24 hours of the mission also indicated shock passages, showing that the shock expanded and moved out beyond the Mariner and that later the spacecraft again passed through it.

Prior to making these observations on launch day--last November 28--the instrument measured the plasma trapped in and flowing around the Earth's magnetic field.

Solar plasma, nicknamed solar wind because of its high velocity, is an extremely hot, ionized gas composed of electrons and the nuclei of the atoms of light elements, principally hydrogen and helium. The Mariner IV instrument, which measures the solar wind at 32 energy bands within a range of 30 to 10,000 electron volts, was able to separate the hydrogen and helium components of the plasma more accurately than had been done in any previous experiments.

Properties of the solar wind change with time as plasma that originated from different regions of the Sun's cornona is encountered. Some fluctuations in the solar wind are easily detectable on Earth, as in the case of a disturbance on the Sun which results in a geomagnetic storm or radio blackout 93 million miles away on Earth,

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Since the second day of flight the instrument has been making observations on the interplanetary plasma.

Mariner II, which flew to Venus in 1962, showed that a measurably large solar wind blows at hypersonic velocity through our region of the solar system from the direction of the Sun. Mariner II is the only other spacecraft that has made prolonged continuous plasma observations at great distances from Earth. Other plasma experiments have been flown on a number of Earth satellites.

It is believed that the density of solar plasma outside of Earth's orbit decreases as the distance from the Sun increases. Mariner II showed that the density increases as the spacecraft neared the Sun.

Quantitative results, which would prove this variation, however, are not yet available, partly because of a resistor failure in the instrument's high voltage circuitry on the eighth day of the mission.

This malfunction caused the instrument to sweep over the plasma energy spectrum in a manner not precisely known. Since that time, however, analysis of the component failure allowed scientists to recalibrate the instrument, and it has been possible to interpret about half the data directly. The other half requires a much more extensive analysis than that necessary had the failure not occurred.

During the past three months, it has been possible to derive reasonably accurate values of the solar wind velocity, but its other properties have not yet been calculated.

Further analysis of data telemetered from the Mariner IV is expected to help resolve a conflict in solar wind data from instruments on other spacecraft.

SOLAR PLASMA PROBE INSTRUMENT

The solar plasma probe is composed of three major parts: a collector cup, a high voltage power supply and circuitry to provide an output signal to the data automation system that conditions the data for transmission to Earth.

A mesh of fine tungsten wire in front of the collector is given a negative voltage that alternates rapidly between two limits. Thus, protons having a range of energies corresponding to these limits are alternately repelled and passed through to the collector, producing an intermittent current that is detected.

The voltage limits on the mesh are repeatedly cycled through 32 voltage levels to allow detection of protons at 32 energy bands within a range of 30 to 10,000 electron volts.

The plasma probe is mounted on top of the spacecraft bus at an angle 10 degrees off the spacecraft-Sun line. It weighs 6¼ pounds and utilizes three watts of power.

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