ULYSSES DETECTS LONG-SOUGHT WAVE MOTIONS OF THE SUN

Periodic oscillations originating from deep within the Sun's interior have been detected for the first time in interplanetary space by the Ulysses mission to the poles of the Sun.

The discovery was reported in this week's issue of Nature magazine by three scientists, Drs. Louis J. Lanzerotti, Carol G. Maclennan and David J. Thomson, from Bell Laboratories in Murray Hill, NJ. The measurements were made by particle detectors onboard the Ulysses spacecraft, a joint NASA-European Space Agency mission to study regions of the Sun never before explored.

In addition to finding that these signals affect energetic particles far from the Sun, the scientists reported that their experiment was able to identify oscillations, or wave motions, that have long been sought -- but never detected -- by Earth-based observers.

"This is a breakthrough for studies of the Sun, the interplanetary medium and the detrimental effects of energetic particles on terrestrial systems," said Lanzerotti, who is the principal investigator of the Ulysses particle detector experiment.

Solar physicists imaging the Sun through narrow-band optical filters have spent decades measuring this life-giving center of the solar system -- an ordinary star in mass and age -- as it writhes, churns and resonates with sound waves rising up from deep within its interior.

Like a cymbal when it is struck, the Sun vibrates to produce a number of discrete "musical" tones simultaneously. These tones represent waves that travel through the Sun and arrive at the surface, much like seismic waves caused by earthquakes, which propagate through the Earth's crust to the planet's surface.

At the surface of the Sun, these sound waves appear as weak inward and outward motions, said Dr. Edward J. Smith, Ulysses Project Scientist for the U.S. portion of the mission at NASA's Jet Propulsion Laboratory, Pasadena, CA.

Much of scientists' knowledge of the Earth's interior comes from studying these waves, a scientific discipline known as seismology. The discovery of solar oscillations about 20 years ago revolutionized the study of the Sun by providing a new means for probing the Sun's interior, a relatively new field of inquiry known as "helioseismology." Scientists believe that such wave motions are also characteristic of stars other than the Sun, and they are actively searching for stellar oscillations.

The Ulysses scientists did not use solar images to identify the oscillations but rather analyzed energetic particle measurements in search of narrow bandwidth tones. Using a

sophisticated method of analysis, they found a large number of tones corresponding with those identified by solar observers.

Tones cluster around wave periods of about five minutes, Thomson said. Each five-minute period represents the time it takes for the Sun's motion to change from moving outward to moving inward and then back outward again. These waves are equivalent to normal sound waves traveling through the Earth's atmosphere, but the periods are too long for the human ear to hear. In addition, the rarefied gas in space is not expected to transmit sound waves from the Sun to distant spacecraft like Ulysses, which is currently about 176 million miles from the Sun.

Lanzerotti and his co-investigators said their signals are probably the result of the effects of the solar motions on the magnetic fields which originate in the Sun's interior and are stretched outward into space by the solar wind, a continuous outward flow of particles from the Sun's uppermost atmosphere known as the corona.

"As the magnetic lines of force oscillate in response to the passage of the waves, their motion is communicated to the energetic particles traveling along them," Lanzerotti said.

In an attempt to confirm their particle results, the investigators also sought the corresponding motions of the magnetic field. When they studied magnetic field measurements from spacecraft using the same method of analysis, they found corresponding tones in the magnetic field data.

An even more surprising result of the energetic particle analysis was the presence of oscillations with even longer periods of about three hours. Waves with these periods have been sought by solar observers since they were first predicted to exist theoretically. Once observed, they can be used to probe even more deeply into the solar interior than is possible with the shorter, five-minute oscillations.

"Observations of these oscillations in the energetic particle data are truly astounding," Smith said.

The Ulysses spacecraft currently is about 78 degrees north of the Sun's equator and one month into its pass over the northern pole of the Sun. The spacecraft will continue climbing to higher latitudes until July 31, when it reaches its maximum latitude of 80.2 degrees north of the Sun's equator. In late October, the spacecraft will complete the northern polar pass and begin to journey back out to the orbit of Jupiter, not returning again to the vicinity of the Sun until September 2000.

Ulysses is managed jointly by NASA and the European Space Agency to study the regions above the Sun's poles. The Jet Propulsion Laboratory manages the U.S. portion of the mission for NASA's Office of Space Science, Washington, DC.

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