A Breeze from the Stars

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by Dr. Tony Phillips

Every year in early December, something happens that can throw your horoscope out of whack. The sun enters Ophiuchus, the little-known 13th house of the zodiac.
You've probably heard of Capricorn, Aquarius, Pisces, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio and Sagittarius. The sun passes through these constellations, one by one, throughout the year. They're the ancient signs of the zodiac.
But Ophiuchus?

Image: The Sun's gravity deflects the interstellar helium breeze and causes it to pile up downstream from the sun. This concentration is helpful to spacecraft observing the wispy-thin flow. Credit: American Scientist

Modern astronomers don't divide the sky the same way ancient astronomers did. According to modern star maps, the sun cuts through a

13th constellation, Ophiuchus the Serpent Bearer, between Nov. 30th and Dec. 17th. Astrologically speaking, if you were born between those dates you're no longer a Sagittarian, you're an Ophiuchi! But that's another story....

This story is about what really happens when the sun enters the zodiac's 13th house: An interstellar wind hits our planet.

It's a helium-rich breeze from the stars, flowing into the solar system from the direction of Ophiuchus. The sun's gravity focuses the material into a cone and Earth passes through it during the first weeks of December. We're inside the cone now.

"There's no danger to anyone on Earth," says space physicist George Gloeckler of the University of Maryland. "The helium breeze is a thousand billion billion times (1021 times) less dense than Earth's atmosphere. It cannot penetrate to the surface of our planet."

Nevertheless, astronomers are keen to study it.

The breeze is a telltale sign of what lies outside the solar system. Interstellar space, the "void" between the stars, is not empty. It's filled with gigantic clouds of gas and dust. These clouds are the birthplace of stars and planets; they're also the debris left behind when stars explode. The solar system is running into one. Astronomers call it the Local Interstellar Cloud. The sun's magnetic field holds much of the cloud at bay, but some of the cloud's gas does penetrate--hence the breeze.

NASA's ACE (Advanced Composition Explorer) spacecraft, located at the first Lagrange point directly between Earth and the Sun, is perfectly situated to study this breeze. "When Earth moves through the focusing cone (the region of space where the sun's gravity focuses the breeze), so does ACE," explains Gloeckler, who is one of ACE's Lead Co-

investigators. "We've been through the cone seven times--once a year since the spacecraft was launched in 1997."

ACE's mission is to study the solar wind, the hot breeze from our own star, so the spacecraft is well equipped to study the interstellar breeze, too. An instrument onboard ACE called SWICS detects helium ions in the breeze, measuring their density, temperature and direction of flow. Using these measurements, along with data from other spacecraft (chiefly SOHO and Ulysses), Gloeckler and colleagues have calculated the properties of the Local Interstellar Cloud.

It's a hot cloud, the gas temperature is 6000 C, about the same as the temperature of the sun's surface. It's also very wispy, only 0.264 atoms per cubic centimeter. The sun's magnetic field has little trouble deflecting this diaphanous material before it crosses the orbit of Pluto. Only a trickle (0.015 atoms per cubic centimeter) penetrates the inner solar system.

One day the solar system might run into something more massive. There are clouds in the galaxy thousands of times denser than the Local Interstellar Cloud. University of Chicago astronomer Priscilla Frisch has studied what might happen if we plowed into one of those. Writing in the magazine American Scientist she reports, "a cloud with 1,000 atoms per cubic centimeter could compress the sun's magnetic field to within a few AU of the sun. (1 AU or "one astronomical unit" is the distance between the sun and Earth). Planets such as Saturn, Uranus, Neptune and Pluto would be fully exposed to interstellar atoms and molecules. Interstellar gas would overwhelm the solar wind at 1 AU," transforming the space-environment of our planet.

The first signs of such a transformation could be the helium breeze thickening or shifting directions, heralding something new to come.

ACE has already detected changes. "We see strange gusts, ebbs and flows," says Gloeckler. "We doubt these variations are interstellar." Instead, the sun is probably responsible. The helium breeze must blow through the much denser solar wind, which can push the breeze around. Sunspots also affect the breeze. Ultraviolet radiation shining from sunspots ionizes the breeze and changes the way it appears to instruments like SWICS.

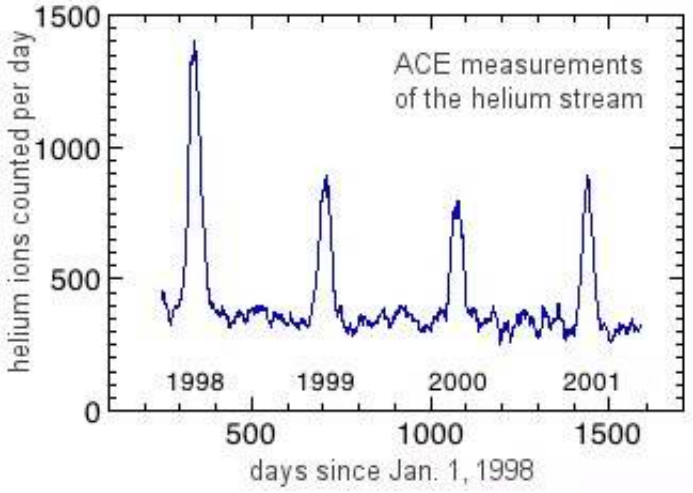

Image: ACE/SWICS measurements of the helium stream. Peaks denote annual passages through the focusing cone. Click on the image to see the complete 7-year data set.

"What we're doing now," explains Gloeckler, "is learning how solar activity affects the breeze. When we can reliably account for the sun, in detail, then we can use these measurements to diagnose interstellar space."

What's out there? What's coming? The answer lies in a breeze from the stars of the 13th house.

Source: Science@NASA (by Dr. Tony Phillips)