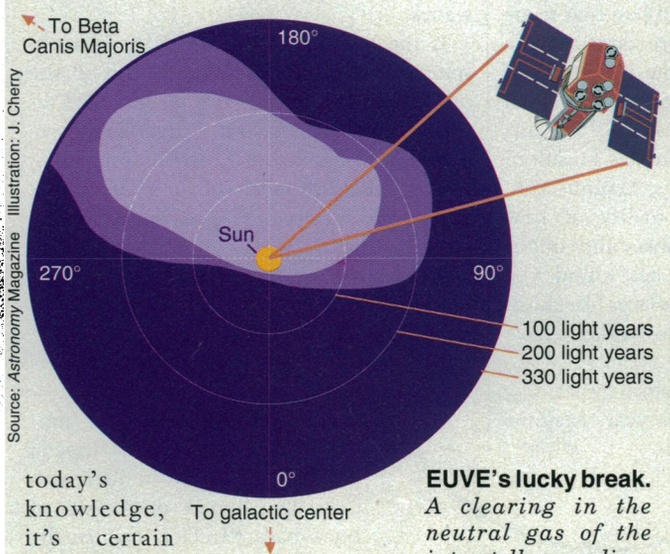
A Long Look in the Extreme Ultraviolet

Astronomers get ready to launch a satellite to observe radiation they once thought they could never see

FOR MOST ASTRONOMERS, PUBLIC ENEMY #1 has always been Earth's atmosphere. But for astronomers fascinated by the hot objects that shine at extreme ultraviolet wavelengths, such as young white dwarfs and the hot gas around other stars, the enemy is a thin haze of hydrogen atoms scattered across the galaxy. This interstellar medium soaks up extreme ultraviolet photons so effectively that getting a good view of distant stars in the extreme ultraviolet once seemed about as likely as taking in a scenic panorama on a foggy day.

In recent years, though, that received wisdom has been revised—so much so that early next year, NASA will launch a satellite dedicated to extreme ultraviolet astronomy. Astronomers are confident that in spite of the fog, the $200-million Extreme Ultraviolet Explorer (EUVE) will have much to tell about the formation of white dwarfs, the processes that heat stellar atmospheres, and the contours of the interstellar medium itself. Says Stuart Bowyer, an astronomer at the University of California at Berkeley, "Given today's knowledge, it's certain EUVE will provide fascinating new results."



EUVE's lucky break. *A clearing in the neutral gas of the interstellar medium will give the satellite a clear view.*

Bowyer doesn't question the ability of the interstellar medium to play havoc with extreme ultraviolet light: The photons, at wavelengths of between 100 and 912 angstroms, have just enough energy to ionize—and be swallowed by—neutral hydrogen. What has made astronomers and NASA engineers willing to bet millions on the EUVE mission was the discovery that, at least in the neighborhood of the sun, neutral hydrogen is not nearly as abundant as had been thought.

"Twenty years ago," says Berkeley astronomer Mark Hurwitz, "uniform densities of one neutral hydrogen atom per cubic centimeter were bandied about. In that picture, there is very little room for extreme ultraviolet radiation to get anywhere, because the soup is just too thick."

Fortunately, says Bowyer, "Mother Nature didn't build the interstellar medium the way the gurus said." Bowyer had long suspected the medium of being patchy, and the first sign that he was right came in 1975, when the Apollo-Soyuz mission carried into orbit an extreme ultraviolet telescope that Bowyer's group had built. The telescope detected four stars other than the sun—the first time extreme ultraviolet light had been seen from beyond the solar system. Says Bowyer: "It was an immediate and obvious verification that you could do extreme ultraviolet astronomy."

During the 1980s, astronomers mapped out the gaps in the local interstellar medium by looking at the absorption of starlight by the gas. In 1983, astronomers Priscilla Frisch and Donald York of the University of Chicago reported that the sun resides in a void swept clear of neutral hydrogen, perhaps by nearby supernova explosions. Called the local bubble, the void stretches for 100 light-years in most directions. More recently, Barry Welsh of Berkeley found that in one direction this void is elongated into an interstellar tunnel at least 1000 light-years long.

This vast clearing is what EUVE will plumb. "EUVE is really the first extreme ultraviolet observatory," says Berkeley astronomer Roger Malina, who led the team that designed the telescopes on the spacecraft, which was built at NASA's Goddard Space Flight Center. After the satellite's launch on a Delta II rocket, EUVE will scan the sky for six months, then choose the most interesting objects for further study. Among them are likely to be newborn white dwarfs—stellar cinders formed as larger stars die.

Mature white dwarfs such as the nearby star Sirius B, which has a surface temperature of 26,000 degrees Kelvin, are brightest at visible and ultraviolet wavelengths. But newly formed white dwarfs, with surface temperatures more than twice that high, make their biggest splash in the extreme ultraviolet.

The satellite will also observe the mature white dwarfs that belong to tempestuous stellar couples called cataclysmic variables. Cataclysmic variables consist of a white dwarf so close to another star that it tears material from its companion. Falling toward the white dwarf, the material gets heated by gravity and forms a hot accretion disk, which glows in the extreme ultraviolet. By observing the accretion disks, EUVE investigators hope to study the instabilities that send matter tumbling inward onto the white dwarf, generating the bursts of visible light for which these systems are named.

EUVE won't be looking only at such stellar exotica. It will also map the extreme-ultraviolet-absorbing neutral gas that remains within the local bubble. And it will take a look at cool stars like the sun—specifically at their outer atmospheres, or coronae, which seethe at over a million degrees and are a copious source of extreme ultraviolet radiation. "We've been looking at the sun for a long time," says Andrea Dupree of the Harvard-Smithsonian Center for Astrophysics, "and we still don't understand what heats the corona. One of the most powerful ways of understanding what heats the corona is by looking at stars other than the sun."

The denser neutral hydrogen outside the local bubble may still hide many emitters of extreme ultraviolet, such as quasars. And Bowyer doesn't think EUVE is likely to find any completely new types of objects. "Lewis and Clark explored west of the Mississippi, and they discovered lots of things, so it was a worthwhile venture. But in general they were extensions of what we had already discovered east of the Mississippi, not six-headed monsters and other such things," he says.

Even so, the lure of virgin territory is irresistible for Bowyer and his colleagues. They're already at work on another extreme-ultraviolet telescope with better spectral resolution than EUVE. It's slated to fly on the space shuttle in 1993. ■ KEN CROSWELL

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