That bias evaporated when Swiss astronomers announced last year that faster paced wobbles had revealed a massive planet whirling around a sunlike star with a period of just 4.2 days (*Science*, 20 October 1995, p. 375). So about a month ago, Marcy and Butler crunched the data for about 60 of their stars. "It took 3 minutes from the time we looked at [the star in Virgo] until we had a data fit," says Butler, and not much longer for the Big Dipper star. Given the nearly perfect sine waves traced out by the wobble velocities—exactly what the tug of orbiting planets should produce—other astronomers think the results are solid. "I'm pretty sanguine about the reality of these [planets]," says the University of Chicago's Douglas Duncan.

The wobbles' size and period imply that the Big Dipper planet has a mass at least 2.3 times that of Jupiter and circles the star 47 Ursae Majoris in 1103 days. That orbit would place it just outside Mars in our own solar system and gives it a temperature well below freezing. The planet circling the star 70 Virginis is even more massive—at least 6.5 Jupiters—but has an elliptical 117-day orbit with an average separation from its star of about half the Earth-sun distance. With a calculated average temperature of 80°C, "similar to the tea that you drank this morning at breakfast," says Marcy, it could bear liquid water.

That conclusion has already led to rampant speculation about the possibility of life there. But William Cochran of the University of Texas's McDonald Observatory cautions that "[liquid water] by itself does not make life." Theorists, meanwhile, are puzzling over how these planets ended up so close to their parent stars. Giant planets are thought to take shape around an icy "embryo," or core, explains Alan Boss of the Carnegie Institution in Washington, D.C., and an icy body probably couldn't form close enough to a star to explain any of the planets detected so far. They may have been born farther out and then drifted inward—a process theorists have never really explored, Boss says. "You don't turn a knob unless you really have to. Here, we really have to turn a knob."

Marcy hints that there may be still more planets lurking in the Lick database. If so, theorists like Boss could soon be turning more knobs—and coffee shop conversations may become even more otherworldly.

–James Glanz

ASTRONOMY

Digging Deeply Into Galaxies' Pasts

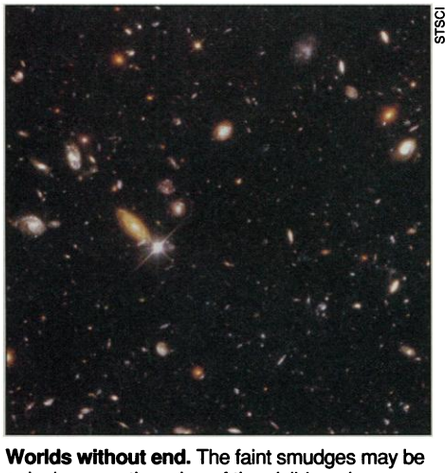
SAN ANTONIO—One of the brightest attractions at the American Astronomical Society meeting here last week consisted of the dimmest objects ever seen. Late last month, the Hubble Space Telescope (HST) gathered light from the same small area in the sky for 10 days straight. Just over 2 weeks later, the image was on display in San Antonio, revealing thousands of objects—almost certainly far-distant galaxies—that are fainter by a factor of two than any astronomical objects ever seen before.

The galaxies' faintness suggests that they lie at great distances in space, and hence in time. As a result, the image, known as the Hubble Deep Field (HDF), "is the deepest archaeological dig astronomers have ever done" into the history of galaxies, says Andrew Fruchter, a member of the HDF working group at the Space Telescope Science Institute in Baltimore. Although astronomers have seen extraordinarily bright objects known as quasars that probably lie even farther away, the Hubble image appears to provide the most distant look at "ordinary" galaxies like our own, but much younger.

The abundance of these faint galaxies raises a puzzle, however. At these great distances, perhaps five-sixths of the way to the edge of the visible universe, some astronomers expected galaxy numbers would drop off. The fact that they don't expands the known population of galaxies and leaves an uncomfortably short time for galaxies to form after the origin of the universe itself. But astronomers are convinced that the data will eventually yield answers as well as questions. Says Alex Filippenko of the University of California, Berkeley, "I think it's an amazing observation that promises to give us a lot of information about the [distant] universe."

The HDF project, which is led by Space Telescope Science Institute Director Robert Williams, set out to take a hard look at a patch of ordinary sky. Just 0.04 degrees of arc on a side, the target area lies close to the Big Dipper in a region that the HST can view continuously while it orbits Earth. The telescope took picture after picture from 18 through 28 December; the HDF researchers then merged the exposures into a single image. While HST results are ordinarily kept under wraps for a year to give the scientists who proposed the observation a chance to analyze the data, the HDF team regards the data as a resource for the astronomy community and is making it available to all comers. "The sociology should be very interesting," says Mark Dickinson, a member of the working group, "because you'll have all these astronomers competing to see who can derive the most significant conclusions."

Much of the competition will focus on the faintest objects in the image. These 1500 to 2000 bluish dots resemble similar blue spots in previous HST and ground-based observations that did not probe quite so deeply. Many astronomers believed those spots are young galaxies in the distant universe. To be certain that these faint objects are even more distant galaxies, astronomers would have to measure their redshifts—the displacement of their light toward longer wavelengths by the expansion of the universe. That's not possible for objects as faint as these.



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Worlds without end. The faint smudges may be galaxies near the edge of the visible universe.

But the HDF data do offer clues to their distances. The exposures were made through four different filters, including ultraviolet and blue. By comparing the galaxies' brightnesses through these two filters, astronomers can search for the "ultraviolet dropout"—the absorption of the galaxies' ultraviolet light by intergalactic hydrogen atoms. The dropout affects wavelengths shorter than those ordinarily transmitted by the ultraviolet filter. For galaxies lying more than five-sixths of the way to the edge of the visible universe, however, those wavelengths should be redshifted within range. The working group astronomers have spotted this distance marker in two or three of the faint objects, and they think other, equally faint galaxies can't be much closer.

Astronomers trying to discern the nature of these galaxies will get plenty of help from their ground-based colleagues. Among others, radio astronomers working at the Very Large Array in New Mexico will be searching the same patch of sky for the characteristic signals of young galaxies, and optical astronomers at the Keck Observatory in Hawaii will be taking spectra of dozens of the brighter galaxies.

The implications extend well beyond one tiny patch of sky. A survey of the entire sky to the same depth would reveal a total of 50 billion faint objects—if the HST had a million years to make such a map.

–Donald Goldsmith

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