Brown Dwarf Candidates Abound

Astronomers' long and frustrating quest for "brown dwarfs"—planet-sized globes of gas that don't quite make it as stars—may at last be nearing an end. Using new infrared imaging techniques and a new search strategy, observers have begun to turn up possible brown dwarfs in record numbers.

"It's really surprising, even frightening," says University of Rochester's William Forrest, who thinks that he and his co-workers have found at least four brown dwarf candidates in the Taurus-Auriga complex, a star-forming region 450 light-years distant.

Four is actually a big number in this context, Forrest maintains, because they were found in just a few minuscule patches of the Taurus cloud. If the candidates are real, and if those patches are at all typical, then Taurus-Auriga as a whole could contain up to a million brown dwarfs. And if that figure is then extrapolated to the galaxy as a whole—admittedly a huge extrapolation, says Forrest—brown dwarfs would outnumber the visible stars by a very large factor.

That would go a long way toward explaining the mysterious dark matter, an invisible ectoplasm that seems to permeate this and every other galaxy, and that makes itself known only by the gravitational forces it exerts on the visible stars. Indeed, says Forrest, it's conceivable that dim, insignificant-seeming brown dwarfs could be a major component of dark matter, and thus dominate the universe.

Be that as it may, brown dwarfs have been tantalizing astronomers for a long time. By definition they are star-like blobs of gas just a little too small to ignite thermonuclear fusion and shine under their own power. (The cutoff is about 80 times the mass of Jupiter, or equivalently, about 8% of the mass of the sun.) But that would make them cool, dim, and exceptionally hard to find against the blackness of space. No surprise, then, that astronomers' best efforts to date have turned up little more than some suggestive hints: here a perturbation in the motion of a visible star; there a bit of extra infrared heat emission from another star; none of it conclusive.

Enter infrared arrays, solid-state detectors that have allowed astronomers to take their first real images at infrared wavelengths. Introduced into observatories only in the last 2 or 3 years, they have inspired a number of researchers—Forrest and his group among them—to try a new approach: home in on young clusters of stars and try to image the brown dwarfs directly.

The advantage of looking at clusters, he says, is that stars of all kinds are obviously more abundant there. Furthermore, all the stars in a given cluster are born at the same time, which means that easily obtained data from the brighter stars can be used to calibrate the age and composition of the hard-to-see dwarfs.

The advantage of looking at young clusters, he says, is that brown dwarfs ought to be at their greatest brightness immediately after birth. They should start out glowing from the turmoil of formation, and then spend the rest of eternity cooling off. In other words, catch them while they are hot.

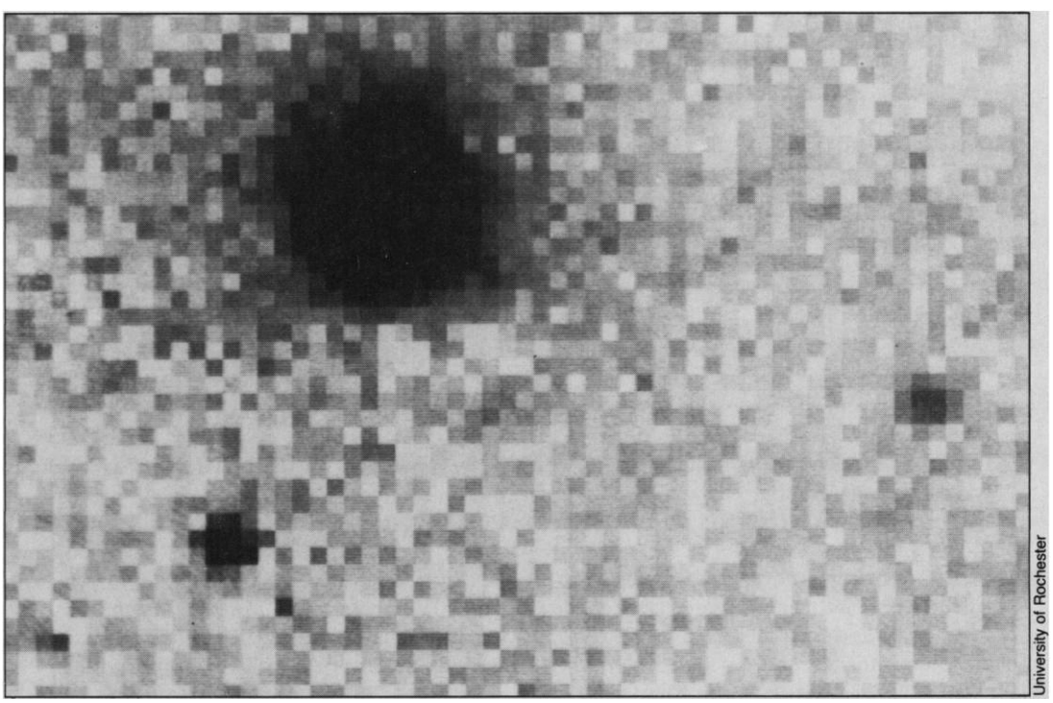
Forrest and his co-workers accordingly chose to study the Taurus-Auriga cluster, whose 450-light-year distance puts it next door in galactic terms, and whose age of 1 million years makes it a cosmic infant. And they quickly struck pay dirt.

Taking images at 2.2-micrometer wavelength in the vicinity of known T Tauri stars, which are sun-like stars just emerging from their stellar birth pangs, the astronomers found a total of 20 dim objects that appeared to be floating free in the cluster. Of these, they were able to select nine objects whose infrared colors were consistent with their being brown dwarfs.

"Now, if this were the only data we had," says Forrest, "it would be interesting and suggestive—but nothing to write home about." What lifted the finding out of the ordinary was an independent measure of distance, which allowed Forrest and his colleagues to rule out confusion from foreground or background stars that just happen to lie along the line of sight. The measure came from Burton F. Jones of the Lick Observatory, who found that six of the nine brown dwarf candidates could be seen on the plates of the Palomar Sky Survey taken in the 1950s. This allowed him to determine their "proper motion," their infinitesimal shift in position on the sky over the intervening third of a century.

The upshot: four of the candidates shared the known proper motion of the Taurus cluster in both direction and magnitude (about 2 or 3 arcseconds per century). Barring some outrageous coincidence, they were moving with the cluster and thus had to be part of it.

So, with the distance to the four candidates now pinned to the known distance of the cluster, says Forrest, the infrared brightness measurements could be used to determine the objects' true luminosity. And with their age pinned to the known age of the cluster, theoretical cooling curves could be used to estimate their masses. The result of that calculation was that the objects all fell in



Portrait of a dwarf? *The small spot on the right of this infrared image is a prime brown dwarf candidate.*

the range of 5 to 15 times the mass of Jupiter, he says, "way, way below what you would expect a low mass star to be."

Forrest presented these finding at the recent meeting of the American Astronomical Society in Ann Arbor, Michigan, and got generally good reviews. However, as Forrest admits and as other astronomers are quick to point out, this argument is far from ironclad. Indeed, a few astronomers dismiss it entirely. "The conclusions can't be supported and are probably wrong," declares Ben Zuckerman of the University of California, Los Angeles, who has been working on a similar infrared approach to finding brown dwarfs and who has been Forrest's most vociferous critic. For one thing, says Zuckerman, those theoretical cooling curves are very uncertain. And for another, the very fact that some of Forrest's candidates show up in the Palomar plates indicates that something is fishy. In the red and blue wavelengths used to take the plates, these objects should have been far too dim to appear.

"Occam's razor says that these have to be low mass stars" that are suffering some kind of obscuration by interstellar dust, says Zuckerman. On the other hand, he admits that he has no clear idea of how such obscuration could explain the observations as they stand. "If these four objects truly are in Taurus," he says, "then I really don't know what is going on."

Happily replies Forrest, there is a definitive test that will soon end the arguments: spectroscopy. "If these things are really brown dwarfs they ought to have temperatures of about 2500 K," he says. And if that is the case, then standard stellar theory says that molecules such as water and carbon monoxide will form in their outer layers and produce strong absorption features in their infrared spectra. So the whole controversy could be settled by this autumn, when Forrest and his co-workers will try to obtain those spectra.

They will not be alone in that effort. Not only is Zuckerman looking for brown dwarfs, along with colleague Eric Becklin of the University of Hawaii, but so is a third team. One of its leaders, John R. Stauffer of the University of California, Santa Cruz, recently told *Science* that he and his colleagues have identified several brown dwarf candidates in the famous Pleiades cluster. They used optical imaging techniques, not infrared, to find the objects, and they have no proper motion data, since their candidates don't appear on the Palomar plates. Nonetheless, they too have infrared images in the works, and they likewise plan to obtain spectra this autumn. So we may not have much longer to wait for some real answers. ■ **M. MITCHELL WALDROP**

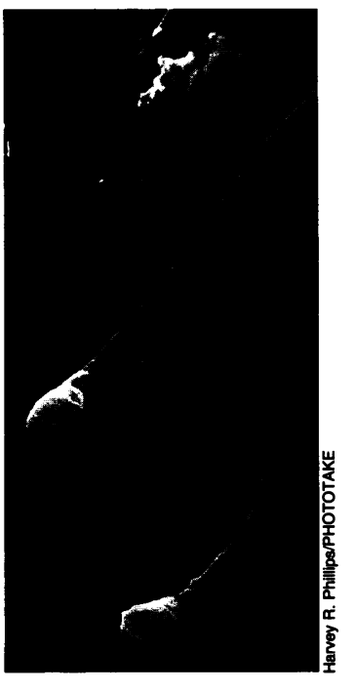
Do Sperm Spread the AIDS Virus?

Most AIDS researchers think that sperm have little to do with AIDS virus transmission, at least as direct vehicles of the virus. If so, it could mean that infected men might be able to have children of their own. Some researchers find intense interest in this prospect, especially from hemophiliac men, who are now living long enough to want families, but do not want to infect their wives or babies.

But if recent observations by Virginia Scofield of the University of California School of Medicine in Los Angeles and her colleagues are correct, sperm may after all help the AIDS virus spread, even if they do not actually carry the virus themselves.

At the recent AIDS conference in Montreal, Scofield reported that sperm can fuse, not just with egg cells, but with many other types of cells as well. They do this by binding to a specific receptor, the HLA-DR histocompatibility molecule, on the cell surface. "Since HLA-DR is expressed on the surfaces of some cells lining the rectum and female reproductive tract," Scofield says, "it is possible that sperm can gain access to tissues at either location by this pathway."

If so, Scofield suggests, the sperm may make the cells they contact more susceptible to infection by the free virus particles or virus-carrying white blood cells known to be present in semen. Together with Michael Barish of the University of California, Irvine, she has obtained preliminary evidence to back this up.



Harvey R. Phillips/PHOTOTAKE

But there is another possibility. If—and it's a very big if—sperm carry the AIDS virus, they could then introduce it directly into the cells.

This may happen in some circumstances, says Scofield, who has probed the point with Irvin Chen, also of UCLA. "We can incubate normal donor sperm with [the AIDS virus], and such sperm can transfer the virus into target cells in culture, but we don't know whether they do this in vivo," she explains. Scofield's group previously found that sperm from two men who carry the AIDS virus infected cultured cells, but she notes that neither her group nor several others have been able to reproduce the result.

If sperm are free of the virus, then it should be possible to purify sperm from infected men who want to have children and use the material to impregnate their wives either by artificial insemination or by in vitro fertilization methods.

Proving that sperm are totally free of the AIDS virus is very difficult, however. Moreover, last year Omar Bagasra and his colleagues at the School of Osteopathic Medicine of the University of Medicine and Dentistry of New Jersey in Camden reported in the *Journal of Acquired Immune Deficiency Syndrome* that the AIDS virus can penetrate the membranes of human sperm if the sperm are incubated with concentrated virus preparations.

Other researchers have expressed doubts about whether this would happen in human seminal fluid. Jay Levy of the University of California School of Medicine, San Francisco, points out, for example, that the virus concentrations used by Bagasra may be 100 to 1000 times higher than those in seminal fluid.

At Montreal, however, Bagasra also reported that they could detect AIDS virus particles by electron microscopy in about 10 to 20% of the sperm obtained from each of three infected men. This is likely to be greeted with some skepticism in view of the fact that researchers have generally—although not always—found that sperm from men carrying the AIDS virus are not infectious in culture. In addition, Scofield and Chen have not been able to find AIDS virus DNA in sperm analyzed with the polymerase chain reaction, a method of amplifying DNA that permits the detection of sequences present in extremely low concentrations. Still, no one is willing to rule out absolutely the possibility that sperm can actually carry the AIDS virus.

■ **JEAN L. MARX**