More Than a Planet, Almost a Star

The faint companion of van Biesbroeck 8 is the first known "brown dwarf"—a cosmic ember not quite massive enough to ignite

Somehow, it seems wrong to call the thing a "planet." It is an enormous ball of hydrogen and helium with roughly the same composition as a star. At 1400 K it is hot enough to glow like an ember. It has several dozen times the mass of Jupiter, which is by far the largest planet in our own solar system. In fact, it is not much less massive than the body it orbits: its parent star, van Biesbroeck 8, lying about 21 light years from Earth in the constellation Ophiuchus, is one of the reddest and faintest stars known.

And yet this new object—dubbed van Biesbroeck 8B when it was announced last month by Donald W. McCarthy and Frank J. Low of the University of Arizona and Ronald G. Probst of the National Optical Astronomy Observatories—is not quite a star, either: it is too small and too cool to sustain fusion reactions in its core. (The critical level is 0.08 solar masses, or about 80 times Jupiter's mass.) The heat pouring out of van Biesbroeck 8B is simply the thermal energy left over from its formation.

In fact, van Biesbroeck 8B is the first known example of a class of objects intermediate between stars and planets: "brown dwarves." Brown dwarves have been the subject of a good deal of speculation in the astronomical community, since they may be the most abundant objects in the galaxy. (They are presumably produced in interstellar gas and dust clouds by the same processes that bring forth the more massive stars.) They may even comprise an appreciable fraction of that mysterious ectoplasm known as the "missing mass" of the galaxy (*Science*, 1 June, p. 971). But they have been little more than a speculation until now, because it has been virtually impossible to detect them against the dark backdrop of space.

The Arizona group actually started out to look not for brown dwarves but for very faint stellar companions of ordinary stars; basically the idea was to look in the infrared, where the primary would be relatively dim and the cooler companion would be brightest. "Then in the process of planning all this," says McCarthy, "I realized we might have a chance of detecting brown dwarves, especially if we looked at very faint nearby stars."

Two obvious candidates were van Biesbroeck 8 and 10, first cataloged in 1961 by the Belgian-born American astronomer George van Biesbroeck. Barely over the 0.08 solar mass limit for thermonuclear burning, they are among the intrinsically faintest stars known. Moreover, in 1983 the U.S. Naval Observatory announced astrometric data suggesting companions around them both. Thus, in May 1984, the Arizonans began a 5-day observing run at the Kitt Peak 4-meter telescope.

In practice, of course, the distortion caused by the atmosphere made it hopeless to attempt any direct imaging of the companions, even in the infrared. So McCarthy, Low, and Probst employed the technique of speckle interferometry, which was developed in the early 1970's. Instead of taking one long exposure of the object, which allows the atmosphere to smear the image into a blur, the observer takes a lot of very short exposures, each of which freezes the pattern of distortion at a particular instant. With a good deal of image processing, he can then disentangle the distortions and produce something approximating a clear image.

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The upshot was that van Biesbroeck 8 showed a definite companion some 1 billion kilometers from the primary star. The Arizona astronomers accordingly announced van Biesbroeck 8B in December as "the first planet discovered outside the solar system"—and thereby provoked an immediate controversy over nomenclature. "It's stretching the use of the word 'planet'," says Robert Harrington of the Naval Observatory, who coauthored the 1983 astrometric reports. Still, he says, the Arizonans did make the first direct detection. "And that's a very significant thing."

Interestingly, van Biesbroeck 10 showed no evidence for a companion in the infrared observations, although it had produced a much more pronounced astrometric wobble in the Naval Observatory data. "I'm actually rather pleased by that," says Harrington. "It suggests a bit more prominantly that the companion to van Biesbroeck 10 is truly Jupiter-sized, which was one of the possibilities we suggested in 1983." As McCarthy himself points out, a planet as small as Jupiter would be far too cold to show up in his images.

Whatever the nomenclature, the discovery of van Biesbroeck 8B clearly has implications for the existence and abundance of planetary systems. Indeed, the infrared speckle technique nicely complements last year's discovery of circumstellar dust rings in data from the Infrared Astronomy Satellite (*Science*, 26 August 1983, p. 846). The rings show up as an excess of infrared radiation in stellar spectra and are thought to be flat disks of dust and gas around very young stars—planetary systems in the act of formation, perhaps. McCarthy's infrared speckle technique, by contrast, is able to image individual objects in mature systems. (Van Biesbroeck 8 may be as much as 5 billion years old.)

"In the next 10 or 20 years we're going to see lots of applications of astronomical techniques to finding other planetary systems," says McCarthy. "We want to find whole collections of these objects so we can begin to understand the systematics." How abundant are planetary systems, for example? How do they correlate with such things as the age of the parent star, its spectral type, and its angular momentum? Do planets form in multiple star systems? And how abundant are brown dwarves? Is our own solar system unusual in having a planet as massive as Jupiter, or is it unusual in having nothing more massive?

An immediate goal for McCarthy and his colleagues is to improve the sensitivity of their apparatus. The van Biesbroeck observations were made with a single infrared detector; with the two-dimensional detector arrays now under development, he says, "we could easily find brown dwarves in quantities."

Looking further, the Arizona group is planning to submit a proposal for an infrared instrument to fly on the Hubble Space Telescope in the 1990's. "Without the obscuration of the atmosphere," he says, "the gain in sensitivity will be phenomenal." —**M. Mitchell Waldrop**