Beta Pictoris: Young, not middle-aged?

Observations over the past decade show that dusty disks are a dime a dozen around young stars. Such a disk probably encircled our own sun in its infancy, providing the raw material for planets.

Beta Pictoris, in contrast, has reigned as one of the few middle-aged stars known to possess such a dust shroud. Researchers have suggested that instead of priming the formation of planets, the dust around this nearby, seemingly mature star represents debris left over from planets and moons that formed much earlier, in the star's youth.

But new evidence suggests that Beta Pictoris isn't old after all. Astronomers have often ascribed an age of 100 to 200 million years to the star, but the new work suggests it may have been born no more than 12 million years ago. This would make Beta Pictoris far too young to qualify as a main-sequence star, burning hydrogen at its core. Rather, it may still be undergoing gravitational contraction. In that case, the dusty disk surrounding it may indeed represent the material of future planets.

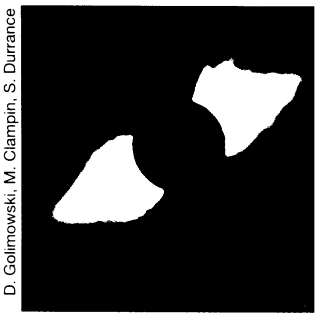
"Given the observed rate of evolution of dust disks, we expect that the disk [surrounding Beta Pictoris] is still in a protoplanetary phase," write Thierry Lanz, Sara R. Heap, and Ivan Hubeny of NASA's Goddard Space Flight Center in Greenbelt, Md., in the July 1 ASTROPHYSICAL JOURNAL LETTERS.

"It's always been a puzzle to understand how this star could hold onto its disk for 200 million years," says Heap. "Now we may not have to answer this question."

The astronomers base their conclusion on a new analysis of the evolution of Beta Pictoris, along with measurements of two key properties—the star's chemical composition and surface gravity. Reviewing visible-light spectra of Beta Pictoris, the team concluded that the star has too little surface gravity, or too big a diameter, to have only recently contracted and begun to burn hydrogen.

The same spectra indicate that Beta Pictoris has an abundance of "metals"—astronomical parlance for any element heavier than helium—similar to that of the sun. Ultraviolet spectra recently taken by the Hubble Space Telescope confirm this result, the team adds. Astronomers had previously interpreted the visible-light spectra to indicate a metal abundance one-fourth that of the sun, which they believed would make Beta Pictoris middle-aged.

The new findings allow two possibilities, the team notes. Either the star is so young that it hasn't finished contracting or so old—about 500 million years—that it has had time to expand its girth after becoming a main-sequence star. Both explanations could account for the star's low surface gravity. But because they don't believe the star's disk can survive for long, the researchers think the old-age solution less likely.



D. Golimowski, M. Clampin, S. Durrance

Beta Pictoris' dusty disk, with the star blocked out.

However, there's at least one reason for preferring the older of the two possible ages, according to Stephen E. Strom of the University of Massachusetts in Amherst. The star lies at least 330 light-years from any known starbirth region, he notes, and doesn't have an especially high velocity. So if it's young, Strom asks, how could it have traveled so far from its birth site?

By comparing Beta Pictoris with stars of known age that also sport disks, astronomers should eventually pin down its age, he adds. The Infrared Space Observatory, scheduled for an October launch, should help make such comparisons. —*R. Cowen*

Quiet hints preceded Kobe earthquake

Months before last January's devastating earthquake, the ground beneath Kobe, Japan, started showing signs of an impending crisis. Subsurface water displayed chemical changes that intensified in the days before the disaster, two teams of Japanese scientists report in the July 7 SCIENCE.

The chemical hints came to light only after the Jan. 17 quake, so they could not help scientists predict the catastrophe, which killed more than 5,000 people. The findings are important, however, because they represent some of the best-documented cases of precursory phenomena—signals produced before a quake, says Urumu Tsunogai from the University of Tokyo.

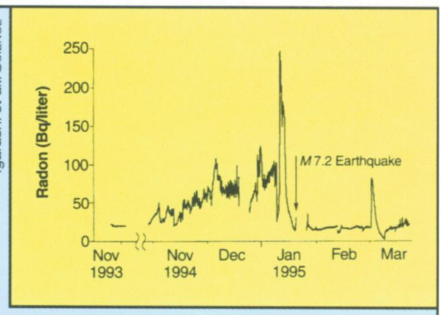
Tsunogai and Hiroshi Wakita studied the concentration of dissolved chloride and sulfate ions in groundwater. The researchers had not collected water samples before the quake, so they took the innovative step of buying bottled water pumped from an aquifer near the quake's epicenter. Kobe's high-quality mineral waters are collected for drinking and for brewing sake, a rice wine. Because the bottles are stamped with a date, Tsunogai and Wakita could track chemical changes that occurred before and after the tremor.

From mid-1993 to mid-1994, concentrations of chloride and sulfate ions remained constant. Five months before the quake, the concentrations started climbing; they peaked in late February, after the jolt.

George Igarashi of Hiroshima University and his colleagues documented prequake changes in the concentration of dissolved radon gas measured at a monitoring site 30 kilometers from the tremor's epicenter. Radon readings began rising slowly in October 1994 but jumped dramatically 9 days before the quake. Readings then dropped abruptly.

Both sets of researchers suggest that the chemical signals stem from geologic changes leading up to the quake. According to Igarashi, microcracks may have developed in the rock months before the main shock, allowing increased amounts of radon to dissolve in underground fluids. To explain the drop 9 days before the quake, he proposes that accumulating strain in the crust started to seal cracks immediately before the tremor.

According to Tsunogai, the new finds demonstrate that the crust began to prepare itself long before the Kobe earthquake. "This time scale may be very important for understanding the mechanism of earthquakes," he says.



Igarashi et al./SCIENCE

Groundwater radon peaked before Kobe quake.

Chi-Yu King of the U.S. Geological Survey in Menlo Park, Calif., calls the new findings "a small but significant step in a long journey toward achieving earthquake prediction."

Researchers in Asia have observed several cases of groundwater precursors in the past. But U.S. geoscientists have remained skeptical of such reports because they could not rule out other causes of the precursors.

King cautions that scientists must observe many well-documented cases of chemical precursors before they can try using them for predictions. Even then, a prediction program would have to include various prequake clues, because groundwater changes might not precede all earthquakes. —*R. Monastersky*