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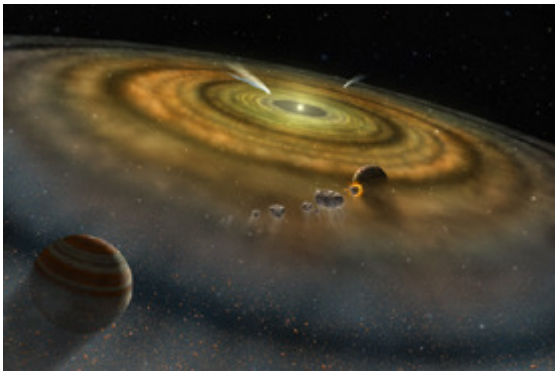
The Birth of Carbon Planets?

By Selby Cull



For two decades, astronomers have speculated that planets might have formed in the thick disk of dust and gas that surrounds the young star Beta Pictoris. As asteroids and comets collide in the disk, they release carbon-rich gases, which might account for the extraordinarily high abundances of carbon. *Courtesy Lynette Cook / NASA / FUSE.*

June 8, 2006 | Exotic planets, dense with diamonds and graphite, might be forming around a nearby star. Astronomers announced this week that the disk around the young star Beta Pictoris is brimming with carbon, raising the possibility that abnormally carbon-rich planets might be forming there.

The rocky planets in our solar system are made mostly of silicate minerals such as quartz and feldspar. But last year, Marc Kuchner (NASA/Goddard Space Flight Center) and Sara Seager (Carnegie Institution of Washington) presented models showing that silicate planets aren't the only possibility. If the protoplanetary disk from which planets form has more carbon than oxygen, then planets based on carbon minerals would be the norm.

Now, a team studying spectra from NASA's Far Ultraviolet Spectroscopic Explorer (FUSE) satellite has found just such a disk. The well-studied debris disk that surrounds Beta Pictoris has almost 20 times more carbon than oxygen; whereas the Sun has only *half* as much carbon as oxygen. The roughly 12-million-year-old Beta Pictoris system is just 63 light-years from Earth, and has long been considered the classic example of an evolving young planetary system. But the extraordinary amount of carbon has researchers wondering how typical it actually is.

Aki Roberge (NASA/Goddard), who led the FUSE team, suggests that this disk might represent another kind of planetary system. Rocky planets in such a system would be distinctly different from Earth, and not just because the crust would be made of graphite (i.e., pencil lead) and studded with diamonds.

"Imagine a planet where water and oxygen are extremely scarce but compounds like methane, propane, butane, tar, and soot are all available in abundance," says Kuchner. "Life would be very strange on a carbon world."

But carbon planets aren't the only possibility for Beta Pictoris. Roberge's team speculates that, alternatively, the Beta Pictoris disk might represent a carbon-rich phase that all planetary systems undergo — including ours. "Beta Pictoris could be like a time machine, offering us a glimpse of our solar system in its infancy," says Roberge.

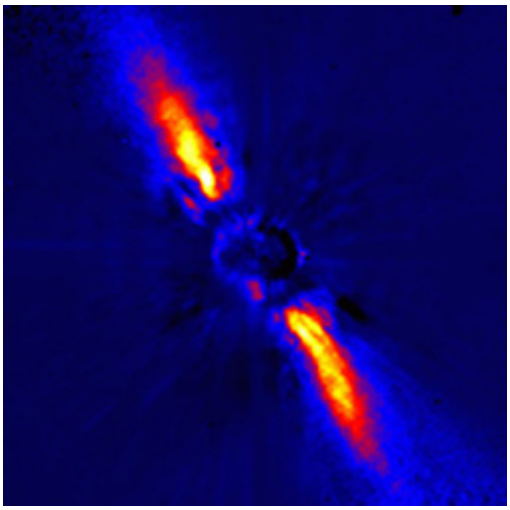
If so, Roberge says she would expect to find other debris disks that are just as carbon-rich. Her team has only studied Beta Pictoris with FUSE so far; however, astronomers know of many more young disks that can be studied.

But if our solar system was just as carbon-rich in its youth, where did all the carbon come from – and where did it go? Conel Alexander, a cosmochemist at the Carnegie Institution of Washington, thinks asteroids and comets might be to blame. A debris disk is a particularly violent place, where asteroids and comets routinely collide. The collisions literally knock

the carbon-rich gas out of them, leaving excess carbon in a system with otherwise silicate planets. Strong stellar winds might have then swept away the excess carbon over millions of years.

Astronomers find evidence for this scenario in primordial dust particles in our solar system. Some of these dust grains retain their ancient carbon, suggesting that our system once had much more carbon.

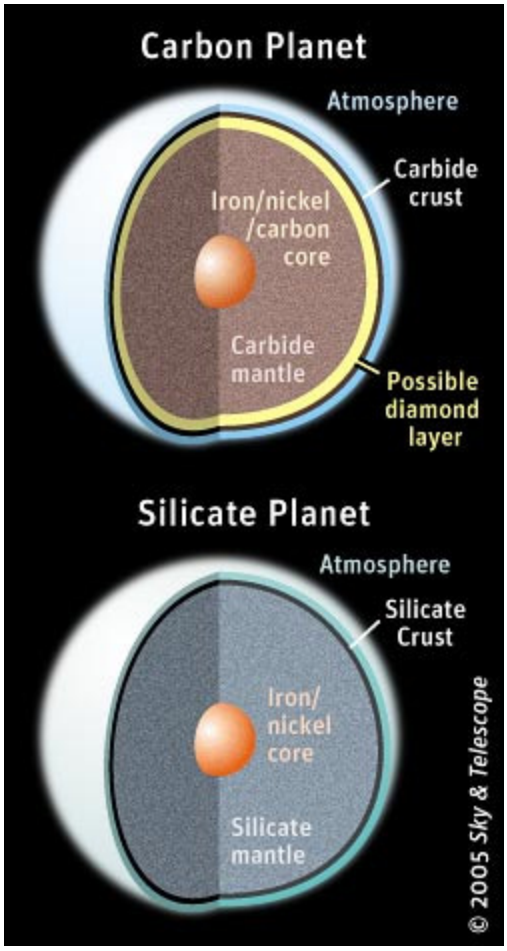
"But, nevertheless, these dust particles are not carbon-rich enough to explain the composition of the gases that we see in Beta Pictoris," says Alexander. "We need to consider a more exotic explanation."



The thick disk of gas and dust that surrounds the star Beta Pictoris is strangely rich in carbon. The young star is blocked out in this false-color infrared image, showing the warm glow from dust. The image was taken by the 3.6-meter telescope at the Grenoble Observatory. *Courtesy Jean-Luc Beuzit / GO / European Southern Observatory.*

Roberge and her team, who published their results in the June 8th *Nature*, suspect that new instruments will be needed to further explore the carbon-rich disk around Beta Pictoris, and to hunt for more. They speculate that the Cosmic Origins Spectrograph, which may or may not be added to the Hubble Space Telescope, or the Atacama Large Millimeter Array, to be completed in Chile in 2012, will be sensitive enough to study the carbon-rich gas in detail.

"Maybe Beta Pictoris is a glimpse of our own solar system," says Kuchner. "Or maybe it's telling us about the starling variety of other kinds of planetary systems that might be out there."



A carbon-based planet *(top)* might have a core similar to Earth's *(bottom)*, but its mantle and crust would be far more carbon-rich. Researchers speculate that the high pressures in the crust might create a thick layer of diamonds within the planet's crust. *S&T: Gregg Dinderman. Source: Marc Kuchner / Sara Seager.*

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