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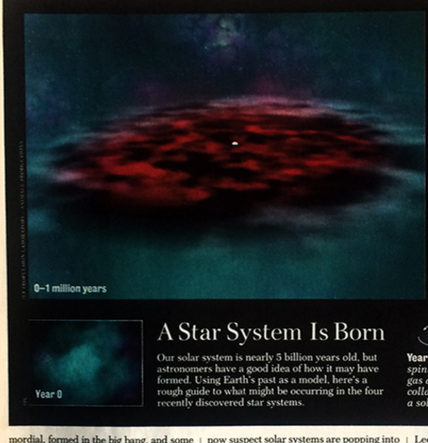
THE BIRTH OF PLANETS

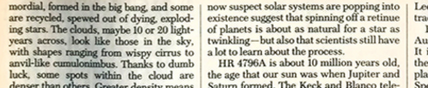
Scientists Discover New Solar Systems...

...and Rethink the Odds of Life Beyond Earth



A Star System Is Born

Our solar system is nearly 5 billion years old, but astronomers have a good idea of how it may have formed. Using Earth's past as a model, here's a rough guide to what might be occurring in the four recently discovered star systems.



Year 0 *A dense, spinning cloud of gas and dust starts collapsing, forming a solar nebula*

0–1 million years *Spin increases and a star forms. Dust particles coalesce into proto-planets.*

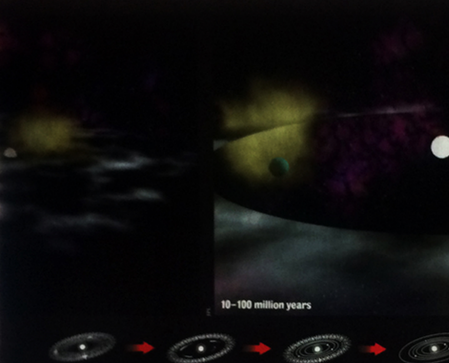
mordial, formed in the big bang, and some are recycled, spewed out of dying, exploding stars. The clouds, maybe 10 or 20 light-years across, look like those in the sky, with shapes ranging from wispy cirrus to anvil-like cumulonimbus. Thanks to dumb luck, some spots within the cloud are denser than others. Greater density means more matter in a given volume; more matter means more gravity, and more gravity means that this spot attracts more dust to it. "Eventually," says Telesco, "it forms a knot that becomes hot enough and compressed enough for atomic nuclei to start fusing." A star, as they say, is born.

The remaining dust rotates faster. The resulting centrifugal force flattens the dust cloud, much like spinning a hunk of pizza dough flattens it into a disc. Again, there are randomly scattered lumps. These lumps attract the dust around them. That makes them even denser, and thus more attractive, and after a few million years planets form. Jupiter- and Saturn-size gasbags take shape first, far out. Rocky Earths and Marses form later, closer in. Or, at least that's what happens in computer simulations. The four stars where astronomers now suspect solar systems are popping into existence suggest that spinning off a retinue of planets is about as natural for a star as twinkling—but also that scientists still have a lot to learn about the process.

HR 4796A is about 10 million years old, the age that our sun was when Jupiter and Saturn formed. The Keck and Blanco telescope observations show that it is surrounded by a hot, tenuous disc of dust, apparently made of silicates, water ice and perhaps iron, graphite and other compounds. But the disc is shaped more like a bagel than a pancake. It's the invisible stuff—the hole—that got everyone excited. Tiny dust particles left over from the star's own birth are warmed by the star and therefore glow with radiant heat. This glow is what infrared telescopes capture. But larger objects are too faint to detect. Since infrared cameras captured no glow near the star, the astronomers made much ado about this nothing: they believe that planets are forming, or may already have formed, in the dark, seemingly empty region. "The reason for the hole could be that the gravity of one or more inner planets has [pulled] out the leftover dust," says Lee Hartmann, much like a magnet attracts iron filings.

Fomalhaut is the brightest star in Piscis Austrinus, another southern constellation. It is about 200 million years old, roughly the age our sun was when the rocky, inner planets, from Mercury to Mars, formed. Special detectors on the Keck II telescope found that a huge disc of dust around Fomalhaut has a hollow center like HR 4796A's. A ho-hum explanation is that either Fomalhaut's stellar wind blew out the nearby debris or its gravity slurped up the dust. The more interesting possibility is that in this hole—also about the size of our own system of planets—the missing dust has coalesced "into rocky planets like the Earth," says Wayne Holland of the Joint Astronomy Centre.

The UCLA-JAC astronomers did *not* target Vega because the movie "Contact" depicted a civilization orbiting this star. Vega, in the constellation Lyra, is some 350 million years old. Like Fomalhaut, it is of the right age to be circled by Earth-like planets. Vega, too, is veiled in glowing dust, though its dust disc is more tenuous than Fomalhaut's. Most of the dust is concentrated in a blob 6.5 billion miles away from the star. This is almost twice as far out as Pluto is from the sun. "This bright blob is a real mystery," says UCLA's Benjamin Zuckerman. If life imitated "Contact," it might be "a dust cloud around a giant planet orbiting Vega." The only hitch is that a planet taking shape so far from its star flouts all the laws of planet formation. "That could be the most interesting thing to come out of this," says Zuckerman. "The theory of planetary formation doesn't predict that we would find these things that far out."



1–10 million years *The cloud flattens into a disc. In outer regions, the cores of giant planets form.*

By 10 million years *Any gas that hasn't been absorbed by the star or its giant planets dissipates*

10–100 million years *Proto-planets in the inner ring smash together to form rocky planets like Earth*

To 600 million years *Remaining proto-planets crash into the star or are ejected into deep space*

To 600 million years

SOURCE: UCLA ASTRONOMY; RESEARCH BY BILL VOURVOULIAS; ICONS BY STANFORD KAY—NEWSWEEK

IF GIANT GASEOUS PLANETS CAN form so far away, it might clear the way—literally—for life on Earth-like planets. The giants, through their immense gravity, act like solar-system Hoovers: they vacuum up rocks left over from the original dust cloud that are still smashing into everything in their path. "This is not a trivial thing for life," says Penn's Koerner. "It's possible that if you don't clear out this stuff quickly we would have a lot of [asteroid-induced] extinctions." In terms of life, a planet might never get past the pond-scum stage.

Beta Pictoris, in the constellation Pictor (the "Painter's Easel"), seems to be only 30 million years old. Astronomers had taken its picture before, when the Infrared Astronomical Satellite pointed its telescope that way in 1983. That's when scientists first saw dust discs around stars. But since the disc seemed not to have a swept-out region in its center, it didn't make the cut as a hatchery for planets. The UCLA-JAC team didn't see any hole in the disc this time, either. But they did see, as at Vega, a mysterious blob in Beta Pic's disc, more than 10 times as far from Vega as Pluto is from the sun. Again, that's supposedly too far out for a planet. Still, Zuckerman says, this may well be "a planetlike object surrounded by dust, which is completely unexpected, a total mystery." If it is a planet, then "planets are a common phenomenon," says Holland, and the supposed rules for where they can form are laxer than astronomers thought.

Even before last week's finds astronomers were starting to suspect that the creation of planets might not follow the rules. In 1995, researchers in Switzerland discovered the first of what are now eight planets orbiting stars far beyond our solar system (star maps). Five of them defy the textbooks by being as large as or larger than Jupiter—yet orbiting even closer to their stars than Mercury does. "No one expected to find *any* giant planet so close to a star," write astronomers Geoffrey Marcy and Paul Butler, who discovered six of the eight new planets. "No one knows for sure how they could have gotten there." The best guess is that the newborn star's magnetic field clears out a hole—like those around HR 4796A and Fomalhaut—by flinging dust outward or slurping it up. This hole provides a safe parking place for a planet that formed farther out and is swept toward the star by dust. The planet stops once it reaches the cleared-out zone because there is no flow of dust to pull it along like a leaf in a river current. That suggests that just because a planet forms too far from its star to sustain life doesn't mean it will stay in the frigid zone forever.

It's not exactly practical to keep telescopes trained on 4796A in order to check