New Evidence of Budding Solar Systems

With visions of young solar systems dancing in their heads and potential candidates captured by their telescopes, astronomers this week reported new evidence that many stars – some less than 100 light years away – possess disks of hot gas and dust that may already have begun evolving into planet-sized objects. "Some of the new findings are very uncertain, but these stars may allow a glimpse of what it was like early in our solar system," notes Steven V.W. Beckwith of Cornell University in Ithaca, N.Y.

Researchers had previously gathered strong hints that young, solar-type stars in the Milky Way have disks similar to the one believed to have given birth to the solar system's planets some 4.5 billion years ago. But how many of these stellar disks will eventually become planetary systems? The answer to that astronomical question has eluded scientists because of poor estimates of the amount of mass in circumstellar disks and uncertainties about whether most disks stick around long enough to form planets.

New studies provide some preliminary answers. One research group combined previous optical and infrared data with newer infrared studies to track 83 solar-type stars in Taurus-Auriga, one of the nearer dark clouds of dust and gas that serve as stellar birthing places. Half the stars younger than 3 million years emit larger-than-expected amounts of infrared radiation, indicating the presence of grainy, glowing disks that extend to the stellar surface, reports Stephen E. Strom and his co-workers at the University of Massachusetts at Amherst and the NASA Infrared Telescope in Hawaii.

Strom notes that due to their larger surface area, heated dust grains, unlike a belt of solid matter, can generate the excess radiation observed. His team also measured radiation from stars in the same group that had an estimated age of 10 million years. The investigators found that less than 10 percent emitted excess infrared radiation, indicating that if these older stars had possessed circumstellar disks, the disks had been destroyed "or had begun to assemble distributed gas and dust into larger bodies, such as planets," Strom says. The findings suggest circumstellar disks may survive no more than 10 million years, he says.

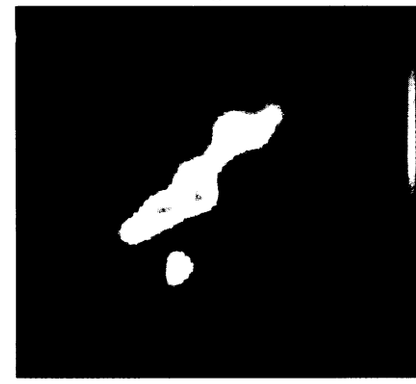
Perhaps most dramatically, he adds, infrared observations of 33 stars surrounded by disks suggest three of them have holes or gaps near their center. These inner holes may be caused by dust grains clumping together, under the influence of gravity, possibly to form "the first stages of planet building," Strom says. "[Our] observations may represent the first evidence of a disk in transition from a massive, optically-thick structure to one that may have begun to build planet-like structures." Strom says the study suggests the transition takes about 300,000 years. He presented the findings this week at Protostars and Planets III, a conference held in Tucson, Arizona. The work will appear in the May ASTROPHYSICAL JOURNAL.

In a related report at the conference, researchers presented their findings about excess infrared light among clusters of stars ranging in age from 50 million to 700 million years. Astronomers believe the extra, unexplained radiation could be caused by warm, dusty debris created when asteroids or other massive objects collide.

Astronomer Dana Backman of NASA's Ames Research Center in Mountain View, Calif., and his colleagues found that younger star clusters in the group studied, such as the 80-million-year-old Pleiades, emit double the expected amount of infrared radiation at certain wavelengths. In contrast, a 300-million-year-old cluster of stars that includes those in the constellation Ursa Major produces excess radiation that amounts to just 25 percent over expected levels. Backman notes that the excess radiation, and its decrease in older clusters, supports the notion that many of these stars may be in the final throes of forming a planetary system akin to our own. He adds that the possibility of planet formation in Ursa Major – a relatively close 70 light years to Earth – "is particularly exciting" because of the opportunities for further study.

Not all astronomers find that excess radiation lessens with age. Cornell's Beckwith and his co-workers at the California Institute of Technology in Pasadena and the Max Planck Institute for Radioastronomy in Munich, West Germany, found no such correlation. But their study, also presented at the conference, reveals that of 86 young stars in Taurus-Auriga, 42 percent, or 36, emit an excess glow at millimeter wavelengths. This percentage, says Beckwith, indicates that disk-forming, solar-type stars may be fairly abundant in the dark cloud. The researchers found the disks ranged in mass from one-thousandth to one solar mass, Beckwith says. Most of the 36 disks weighed in at greater than one-hundredth of a solar mass – a value many researchers believe may be required to form a planetary system similar to our own.

Beckwith cautions that not all stars with the apparent ability to form planetary systems may do so. But he finds the work intriguing. "Most people who talk about life in the universe say planets are a prerequisite for it," he notes. – *R. Cowen*



Anneila I. Sargent/Beckwith

Map of millimeter radiation from carbon monoxide emission reveals portion of a disk that surrounds the young star HL Tauri (white cross at center). Yellow connotes high-intensity radiation, blue connotes lower.

Moving tiny things by optical tweezers

A living cell is best handled with cell-sized tools. For three years or so, researchers have been honing their jeweler-like control over the movements of cells, microbes and even organelles within cells by using tightly focused, low-power laser beams as "optical tweezers."

At a meeting of MIT's nanotechnology study group this week, biophysicist Steven M. Block of the Rowland Institute for Science in Cambridge, Mass., reported using optical tweezers to probe the physical properties of "mechanoenzymes," proteins responsible for cellular movements such as the rotary motions of flagella, which propel bacteria.

Laser tweezers don't actually squeeze, but they allow researchers to lift up, move, and position microscopic objects, using the pressure of the laser light itself – a phenomenon akin to a blast of air levitating a plastic ball.

"Laser tweezers are very much like a [science-fiction] tractor beam, except they work in the microscopic rather than the macroscopic domain," Block told SCIENCE NEWS. "You can manipulate living things without damaging them," adds physicist and optical-tweezer developer Arthur Ashkin of AT&T Bell Laboratories in Holmdel, N.J.

Last spring, Block and his co-workers reported experiments in which they used an optical tweezer to twist flagella – the minuscule motor/propeller assemblies

that bacteria and other microbes use to get around – in order to measure their flexibility under applied forces.

Block, physiologist Bruce Schnapp of Boston University, biologist Lawrence Goldstein of Harvard University and others now are training optical tweezers on motion-making proteins – such as myosin, kinesin, and dynein. Myosin works in muscle contraction. Kinesin helps move organelles (a term for a variety of substances within cells) along microtubules – major components of the microscopic "skeletal" systems inside nerve cells. Dynein enables sperm tails to wiggle.

"The molecular mechanisms by which any biological motor works remain obscure," Block notes. One can study kinesin by coating bacteria-sized glass beads with the protein and observing how the coated particles hook onto and move along a microtubule. In these experiments, the beads appear to glide slowly along in a smooth motion that Block suspects emerges from the collective action of many kinesin molecules. "But if each of the kinesin molecules were actually doing a chiggedy-chiggedy moving along [as some models of kinesin-mediated movement propose], you might expect to see some sort of jerkiness."

Fade in optical tweezers. Beads adorned with only one or two kinesin molecules may never encounter a microtubule with an orientation that leads to an interaction. "So you grab a bead with the optical tweezers, and then you physically place it on the microtubule," Block says. Such control enables the scientists to test models of the mechanisms underlying molecular machines.

"As soon as you touch [kinesin] down to the microtubule, it just starts taking off," Block says. But the movements appear jerky, he reported this week. The sparsely adorned beads also spontaneously detach from the microtubule, a process that may reflect the kinesin molecules' natural cycle of operation. In a collaboration with other scientists, Block and his co-workers are studying the molecular mechanisms by which hair cells – the sensory cells of the auditory system – change their positions slightly as they adapt to become sensitive to different wavelengths of sound.

Scientists also use optical tweezers for sorting cells, moving organelles from one place to another within a single living cell, and for moving isolated chromosomes on a microscope slide, Ashkin says. The ability to move organelles from their normal positions opens doors to sophisticated studies of cell function. "Things are where they are [in cells] for particular reasons," Ashkin notes. What happens when you relocate them? Stay tuned, he says. – *I. Amato*

Do-it-yourself evolution appears unlikely

Evolutionary biologists John E. Mittler and Richard E. Lenski performed a few straightforward experiments and got the kind of results that pretty much everyone expected. In this case, that's news.

The University of California, Irvine, researchers set out to test the validity of a controversial report suggesting that bacteria can direct their evolutionary development in ways best suited to their particular needs. That radical proposal, made by John Cairns of the Harvard University School of Public Health in Boston (SN: 9/10/88, p.166), ran counter to traditional Darwinian thought. Darwin held that mutations occur randomly in nature and that helpful mutations simply outsurvive harmful ones when subjected to selective environmental pressures.

Cairns based his conclusion on experiments he performed on a strain of the common gut bacteria *Escherichia coli* that contains a little piece of viral DNA. The so-called Lac- strain cannot metabolize the sugar lactose, so does not grow on media with only lactose as a nutrient. But if a Lac- bacterium mutates in a way that kicks out the viral DNA, it becomes Lac+, regaining the ability to metabolize lactose and triggering growth. Cairns' research suggested that compared to bacteria who are under no pressure to do so, Lac- bacteria placed in an environment where lactose is the only food available are much more likely to mutate into Lac+ variants.

The new work by Mittler and Lenski provides strong evidence that this mutation results not from any process of self-directed mutation, but because bacteria placed in an environment with no available food tend to eject viral DNA insertions more frequently than do well-fed bacteria. "The rate of excision mutation per viable cell per day increases by orders of magnitude as cells sit starving for several days," irrespective of whether lactose is present, they report in the March 8 NATURE.

But the issue remains far from settled. Cairns says he and others have been unable to duplicate the California researchers' findings. And both groups agree that the particular bacteria they've been using may be a less than perfect experimental system, as the viral sequence itself may be responding independently to the pressures of starvation. "In short, it's a bit of a mess," Cairns says.

It's impossible for now to completely rule out the possibility that some degree of directed mutation occurs in nature, says Bruce R. Levin, a population geneticist at the University of Massachusetts in Amherst. However, he adds, the new work "very clearly shows that the observation Cairns made can be explained by more mundane processes." – *R. Weiss*

Cesarean predisposes to long labor later

Women attempting vaginal birth after previously giving birth only by cesarean section normally have long labors, similar to women giving birth for the first time. This new finding may encourage obstetricians and women attempting vaginal delivery after previous cesarean sections to be more patient and to wait longer before opting for another cesarean section, says Cynthia Chazotte of the Albert Einstein College of Medicine in New York, who coauthored the report in the March OBSTETRICS AND GYNECOLOGY.

She and her co-workers studied 204 women: 44 women attempting vaginal birth after previously delivering only by cesarean section; 24 women attempting vaginal delivery who had previously given birth first vaginally and later by cesarean; 68 women in labor for the first time and 68 women who had previously given birth vaginally. The researchers found cesarean-only and first-time mothers averaged six to eight hours longer in labor than women who had previously delivered at least one child vaginally. Longer labor times in mothers who had never delivered vaginally probably result from less efficient uterine contractions and stretching of soft tissues around the pelvis, Chazotte says.

"Although most obstetricians intuitively suspected these results, the study gives us confidence that it's a good practice to allow these women to labor longer," says Russell Laros of the University of California, San Francisco.

Nearly one in four U.S. babies are delivered by cesarean section each year, according to the American College of Obstetrics and Gynecology, who in 1988 recommended that women who had previously delivered by cesarean have the opportunity to try vaginal delivery with subsequent births. But until now, sketchy scientific data existed for obstetricians to determine whether labor abnormalities in these women, including very long labors, should be judged by the same or by different criteria as those used for women who attempt labor without having had a previous cesarean section.

And in a study of 3,917 women in New York City comparing the risks of first-time birth in women 30 years and older with those women between the ages of 20 and 29 finds that women in the older group had more pregnancy complications, including a higher cesarean rate. The study in the March 8 NEW ENGLAND JOURNAL OF MEDICINE also finds that the older group didn't have an increased risk of having babies who were premature, who died shortly after birth, who were small for their gestational age or who had a low Apgar score, which assesses a newborn's physical health. – *C. Decker*