Low-Mass Stars: Born to Make Planets?

Do most newborn stars have the potential to form planets? A new study suggests they do.

Peering deep into the celestial wombs that give birth to low-mass stars similar to the sun, astronomers have uncovered evidence that the vast majority of these infant stars possess disks of tiny dust grains. Such grains may eventually clump together to make planets.

The same research team also reports that most stars are born in small families rather than alone or in large clusters, as conventional wisdom has held.

Karen M. Strom and Stephen E. Strom of the University of Massachusetts at Amherst and K. Michael Merrill of the Kitt Peak National Observatory in Tucson, Ariz., reported their findings last week at a meeting of the American Astronomical Society in Phoenix.

In their study, the researchers relied on a state-of-the-art infrared camera to observe a maternity ward for stars – a giant molecular cloud called Lynds 1641. Located 1,500 light-years from Earth in the constellation Orion, Lynds 1641 is the nearest such cloud and contains so much dust that its newborn stars remain hidden from view in visible light. But emissions from the stars and surrounding dust light up the cloud in the infrared.

To their surprise, the researchers found that the youngest stars in the cloud, which are only a few hundred thousand years old, belong to small families of 10 to 50 stars. Each family was born from the same stellar womb, measuring about a light-year across. Astronomers had previously believed that most stars flame to life in isolation or in rich clusters containing hundreds to thousands of siblings.

Measuring the velocity of gas surrounding older stars that appear to have been born in the same small groupings suggests that the families are short-lived. After the astronomically brief time of a million years, says Karen Strom, members separate from their core family. Perhaps carried by the turbulent motion of gas in the molecular cloud, the stars move an estimated 3 light-years apart in about 1 million years.

Using an infrared array attached to the 1.3-meter telescope on Kitt Peak, the team gathered tantalizing evidence that many of the young stars have the raw material to form planets – and that some of the older stars might already have done so. The researchers recorded much more infrared radiation than expected from the vast majority of the young stars, which range from about one-tenth the mass of the sun to a few times the sun's mass. The infrared excess, however, matches the pattern of emission from a disk of heated dust particles orbiting each of the stars.

False-color infrared image of families of newborn stars in the Orion cloud Lynds 1641. Blue denotes the shortest infrared wavelength (1.25 micrometers), green an intermediate wavelength (1.65 micrometers), and red the longest (2.2 micrometers).

National Optical Astronomy Observatories

In contrast, older stars in the cloud have much weaker infrared emissions, similar to the radiation recorded from the sun and other middle-aged stars of like mass. The difference in emission patterns between young and older stars, says Stephen Strom, fits a popular scenario for planet formation. In this model, young stars have circumstellar disks composed of swarms of dust particles; over a few million years, the particles may come together to form orbiting, asteroid-size bodies – the building blocks of planets – which emit much less infrared light.

Dust rings recently imaged around young stars in the Orion Nebula, as well as a remnant disk encircling an older, nearby star called Beta Pictoris, support this picture (SN: 12/19&26/92, p.421). And given the findings in the new study, says Stephen Strom, "I believe that all [low-mass] stars are born with a disk." Over time, he notes, not only may dust grains gather into "planetesimals," but the entire star may wander from its original family, maturing on its own as a possible solar system in the making.

Lee W. Hartmann of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., says the work "emphasizes that stars don't form in isolation. One can't have a theory without considering that stars . . . form in groups."

Strom suggests that disks play a crucial role in star formation – without them, a condensing gas cloud might spin so rapidly that it would break apart and never form a star. His team, including University of Massachusetts graduate student Lynne A. Hillenbrand, is now investigating whether denser starbirth regions form more massive stars and whether their disks could form planets more rapidly. *– R. Cowen*

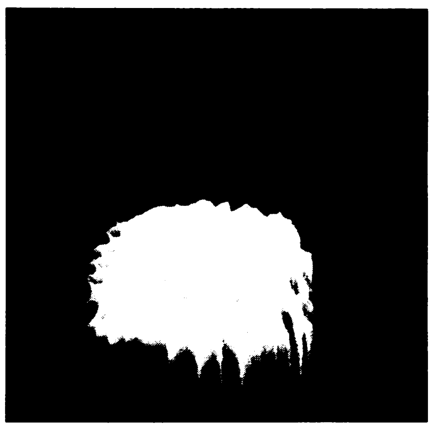
New chemistry boosts promise of natural gas

The world's reserves of natural gas could provide energy equivalent to 1,500 billion barrels of oil. But taking advantage of these reserves, which often exist in places far from big energy users, requires that scientists develop ways of transporting this fuel efficiently.

Toward that end, two research teams have developed new catalytic processes for converting methane, the major component of natural gas, into methanol, an easily transported liquid. They describe these advances in the Jan. 15 SCIENCE.

Typically, natural gas processors first convert methane to "syngas," a mixture of carbon monoxide and hydrogen; they then make methanol or gasoline from syngas.

Now chemists at Catalytica, Inc., have discovered that mercury can catalyze a more direct conversion of methane to methanol. Methane consists of single carbon atoms each tightly bonded to four hydrogen atoms. The Catalytica reaction works because a positive mercury ion can displace one hydrogen ion, report Roy A. Periana and his colleagues at the Mountain View, Calif.-based company. Then, in the presence of sulfuric acid, this displacement leads to the formation of a methyl sulfate compound that converts to methanol with the addition of water.



Methane oxidation causes porous catalytic plug's golden glow.

Schmidt/Univ. Minn.

Currently used reactions usually yield less than 5 percent methanol: In these, carbon dioxide and water tend to form