A Planetary System About to Form

Astrophysicists now tend to agree that as stars form by collapsing from the clouds of matter floating in interstellar space, the matter that may form planetary systems around them condenses with them. These planetary systems should begin to form at about the same time as the stars. The planetary matter should form a disk around the star.

Evidence for the first observation of such a preplanetary disk was presented at last week's meeting of the American Astronomical Society in Atlanta by Roger I. Thompson of the University of Arizona. The work was done by Thompson and P. A. Strittmatter of the University's Steward Observatory and E. F. Erickson, F. C. Witteborn and D. W. Strecker of NASA's Ames Laboratory.

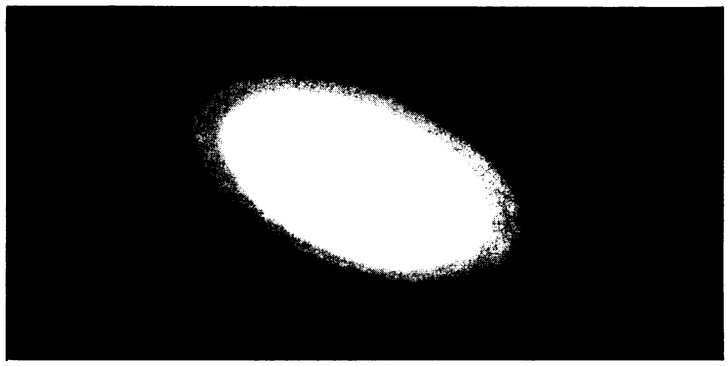
The star in question is MWC 349 located in the constellation Cygnus. It is 7,000 to 8,000 light-years away. It appears to be what is called a zero-age main sequence star. This is a star that has recently begun nuclear burning and entered the main sequence of stellar evolution. Yet it appears to be 11 times as bright as it should be for that classification, indicating that something else associated with the star is contributing light. Furthermore, that brightness has been decreasing by about 1 percent a month for 40 years, a process that places some constraints on what the source of the extra light can be.

Spectral observations were begun a year and a half ago at Steward Observatory, and in June 1976 joint observations were undertaken by Steward and NASA's airborne Kuiper Observatory. The observatory flies above enough of the atmospheric absorption to be able to determine infrared features unobtainable from the ground.

The results gave a very unusual spectrum. As Thompson puts it, "If one couples the infrared and the optical, one gets numbers no one had ever found put together." Study of these numbers showed that they seem to fit a theoretical model of a hot viscous disk with the star in its center seen face on. The disk glows with heat produced by viscous friction as it rotates and thus contributes the extra brightness to the system.

From the data the observers can figure some numerical values for the properties of the disk. The luminous part of the disk extends one or two times as far as the earth is from the sun. Beyond the luminous part extends a dark region of uncertain extent. At the surface of the star the disk's thickness is about 1/20 of the radius of the star. The farther from the star the thicker it is, the thickness at any point being equal to 1/20 the distance from the center of the star.

Artist's conception of newly discovered star surrounded by a viscous disk of preplanetary material. Disk temperature diminishes with distance from the star.



NASA

Near the star the disk is heated by the star, but farther out it glows from its own friction. Its temperature gradually drops off to the thousands and then hundreds of degrees at larger and larger distances from the star until finally the material is so cool that it does not glow. The mass of the matter in the luminous part of the disk is estimated at 0.015 the mass of the sun, and the average density is between 10^{18} and 10^{19} molecules per cubic centimeter. There is thus plenty of mass, high density and a cool region, says Thompson, the expected conditions for a preplanetary disk.

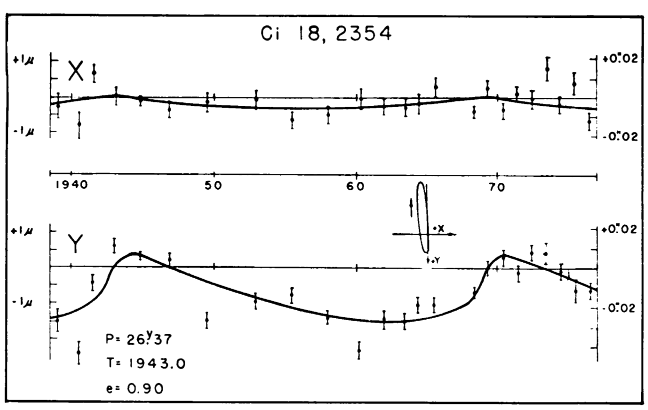
The star has not been engaged in nuclear burning for long, maybe about 10,000 years. The disk has been there longer, probably since the beginning of protostellar collapse, some tens or hundreds of millions of years ago. The star has about 30 times the mass of the sun, and therefore, according to the accepted theories of stellar evolution, it should evolve faster than the sun did. It has taken about 5 billion years to get the sun (and the solar system) to its present state; MWC 349 will get to the sun's present state much faster, but whether the planetary system will evolve in synchrony with the star or by a timescale of its own is unknown.

Thompson says he expects the observation to raise controversy. It infers a great deal from the spectroscopic evidence, a great deal that is novel, and already some muttering could be heard in the corridors. It is also a rare observation. Asked about the probability of seeing such a system, Thompson replied that there ought to be "several we might take a look at. We were lucky to see this one face on." □

A planet for a third nearby star?

If a visible star has a dark companion (dead star or planet) orbiting it, the companion will cause a cyclic wobble in the motion of the visible star across the sky. If the wobble is large enough and the star near enough, the wobble can be discovered by measuring photographs of the star taken over a period of years. Quite a number of dark stars have been discovered by this method, but when it comes to planet-sized bodies, the wobbles are so small that the star has to be very near, and even then a claim causes a lot of controversy.

Nevertheless, the existence of planets or planetlike bodies accompanying two stars has been claimed for two cases, Barnard's star and Epsilon Eridani, by Peter



S. L. Lippincott

Cyclic wobbles in two dimensions plotted for Cincinnati 2354 and the companion's highly elliptical orbit derived from them.

van de Kamp of Swarthmore College's Sproul Observatory. At the American Astronomical Society meeting in Atlanta last week, the director of the Sproul Observatory, Sarah Lee Lippincott, added a third possibility, an 11th-magnitude star a third as massive as the sun called Cincinnati 2354.

Cincinnati 2354 is one of three nearby (16 light-years) red dwarfs recently studied by Lippincott and the only one of the three likely to have a planetary companion that shows up in the evidence. The evidence comes from photographic plates that represent 287 nights of observing between 1938 and 1966. All the plates were remeasured on a new, very accurate Grant plate-measuring machine.

From the results, Lippincott calculates the existence of a companion with a period of 26.4 years. The mass of the companion may lie between that of a large planet and that of the smallest possible star depending on whether it is totally dark or whether it contributes something to the brightness of the image. Lippincott says, "My inclination is that the mass is well below stellar, about 6 or 8 times that of Jupiter." □

Carbon-14 dating: New possibilities

A new technique for radiocarbon dating promises to greatly improve the accuracy of the procedure, more than double its range of validity in time and permit the use of much smaller samples. The new method was developed at the University of Rochester Nuclear Structure Research Laboratory by an interdisciplinary team of American and Canadian scientists.

Carbon dating of biological tissues involves measuring the ratio of radioactive carbon 14 atoms to those of ordinary carbon 12 in a sample. Assuming that the ratio of these two isotopes in atmospheric carbon dioxide is constant, one can determine the age of a biological sample by measuring how much of the C-14 is left. Since the "half-life" of C-14 is 5,730 years, a sample that old would have an isotope ratio only half as large as when the organism was alive.

Previously, the measurement of C-14 was done by detecting its radiation, a technique that earned the Nobel Prize for its inventor, Willard F. Libby. This procedure requires several grams of sample material, however, in order to produce a measurable amount of radiation. The new technique involves counting directly the individual carbon atoms released from a source only a few milligrams in size.

Using a mass spectrometer at the Rochester lab, the physicists produced a beam of charged atoms and molecules sputtered from a biological source. Their great fear was that nitrogen ions would be present in the beam, for these would be virtually impossible to separate from ions of C-14. No nitrogen was found, however, and the C-14 atoms were separated from the rest of the beam by passing them through a series of magnetic fields.

Laboratory director Harry E. Gove told SCIENCE NEWS that by counting the carbon ions directly, three great benefits might be obtained compared with the conventional procedure of measuring radiation. First, sample size could be reduced a thousandfold. Second, accuracy could be increased so that at 5,000 years, a sample's age would be uncertain by only about a decade, compared with about 150 years uncertainty using previous techniques. Finally, the device should now be able to date samples as old as 70,000 years and, with modifications, eventually to push back nearly 100,000 years. Present techniques are limited to about 40,000 years.

The potential importance of these advantages is underscored by Meyer Rubin, the director of the U.S. Geological Survey's C-14 dating lab. He told SCIENCE NEWS that by extending the dating age to 100,000 years, the new technique would enable geologists to study events during the last great interglacial epoch. The greater accuracy may help date past events, such as earthquakes, precisely enough to establish their patterns of recurrence—aiding prediction of future events. Also, smaller specimen size will mean that precious archaeological objects can now be sampled.

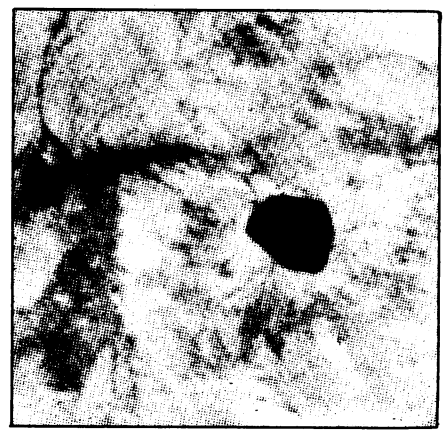
Finally, the use of smaller samples will permit scientists to check the theory that underlies carbon dating itself: Carbon from individual tree rings can be analyzed to find the degree to which the ratio of atmospheric C-14 to C-12 varies from year to year. Since this variation, in turn, is related to solar activity, climatologists may also learn more about how the sun is related to climate changes.

Gove points out that the general technique of separating and counting particular ions in the manner described can also be applied to isotopes other than those of carbon. He suggests, for example, that the new technique might make a very sensitive test for determining the amount of fluorocarbons in the ozone layer of the atmosphere—a subject of much speculation since the discovery that such gases from spray cans may be damaging the ozone layer.

One drawback toward wide application of the new technique will be the cost. Gove estimates that a device built from scratch to perform the new carbon dating procedure might cost half a million dollars. In the existing mass spectrometer facility, however, the individual 6-minute runs required to determine the age of a specimen would not be very expensive compared with conventional carbon dating.

Participants in the research included Harry E. Gove, C.L. Bennett, M.R. Clover and W.E. Sondheim of the Nuclear Structure Research Laboratory (theirs is the mass spectrometer); A.E. Litherland and R.P. Beukens of the University of Toronto (specialists on the physics of C-14); and K.H. Purser and R.B. Liebert of General Ionex Corp. (who supplied the ion source). The work was sponsored in part by grants from the National Science Foundation (U.S.A.) and the National Research Council (Canada). □

Meteorite crater identified in Alaska



Landsat via G.E. Photographic Engineering Lab

Impact rim rings Sithylemenkat Lake.

The earth has a way of concealing its past. The conspiracy of wind, water and geologic upheaval that continuously erase the signs of yesterday make it a special occasion when a meteorite impact crater—symptom of a process that is clearly visible on other worlds—survives to be discovered on the changing earth. Formed literally in one fell swoop, such a crater thereafter provides a reference point against which to study the processes which have tried to wipe it away.

That's why there is a report (in June 17 SCIENCE) devoted to the single conclusion that Alaska's Sithylemenkat Lake appears to occupy the basin created by a meteorite impact.

The lake and its surrounding basin are well enough known, but the features marking the basin as an impact site were only identified as a result of a detailed search of the entire state of Alaska, using photos taken from orbit by Landsat. The problem was enhanced by the fact that Alaska also has many circular features from other sources, such as periglacial lakes and volcanic vents. The Sithylemenkat Lake basin, however, says P. Jan Cannon of the University of Alaska has a number of