ASTRONOMY

Proto-Solar System

Astronomers have postulated the formation of stars and solar systems by the slow coagulation of interstellar matter.

They've calculated the energy transformations and physical processes needed to turn interstellar hydrogen gas into a star and circumstellar dust into planets.

But despite the intensifying search for evidence of such phenomena in recent years, it has never been found —perhaps up to now.

Scientists at the Lunar and Planetary Laboratory of the University of Arizona now believe they have detected for the first time what is probably a star and its planets in the process of formation.

The object under observation is R Monocerotis, a bright, twelfth magnitude object at the head of Hubble's Variable Nebula, north of the constellation Orion, about 2,000 light years from the earth.

The star is classified as a T Tauri variable, a class of celestial objects which astronomers have hypothesized may be stars in the process of formation.

R Monocerotis is distinguished by an excessively large infrared emission. Previous observers had suggested that the emission was caused by an undiscovered infrared companion.

Further observations in the infrared spectrum, made by Dr. Frank J. Low and Bruce J. Smith of Rice University in Houston, Texas, indicate that the emission emanates from R Monocerotis itself. They believe that the object is a star surrounded by a cloud of thick dust, which absorbs and re-radiates the energy produced by its luminous core.

To support this conclusion, Low and Smith constructed a theoretical model representing a luminous central object surrounded by thick circumstellar dust. Then they computed the flux density in the infrared spectrum which would emanate from such an object and compared it with what they had observed coming from R Monocerotis. The spectral energy distribution of the star was in close agreement with the theoretical model.

If R Monocerotis is in fact a new planet being formed, its discovery supports the current theory on the origin of stellar-planetary systems. The theory holds that solar systems originate with a concentration in space of hydrogen gas and dust. As the hydrogen contracts and begins to burn, the dust envelops the central core, spinning around its "sun" and eventually forming the planets of the system. The energy released in this process is believed to be what was seen by Dr. Low in his observations of R Monocerotis.

The composition of the dust particles surrounding the star is unknown, but a major component may be graphite or a similar carbon substance. Ice could be a constituent of the envelope, although not a major one. The mass of the dust cloud is about one-fourth of the sun's planetary system.

The discovery that infrared emissions may indicate stellar systems in formation has led Dr. Low and his associates to search for other infrared stars with similar properties. Working at the Lunar and Planetary Laboratory under grants from the National Science Foundation and the National Aeronautics and Space Administration, they have located at least 10 other protostars, some with dust envelopes so thick that they emit no visible light at all. If enough protostars can be discovered in different stages of development, according to Dr. Low, the evolution of sun-like stars and their planets, including our own solar system, can be studied in detail.

PHOTOSYNTHESIS

Insight to Evolution

The oxygen normally present in the air inhibits photosynthesis, the process by which green plants turn solar energy into food, basic to all life on earth.

The discovery may "significantly influence current concepts of the evolutionary processes of land plants as contrasted with those of algae," according to this year's annual Report of the President of Carnegie Institution. (see page 528).

Although scientists have known since 1920 that high concentrations of oxygen inhibit the rate of photosynthesis, inhibition by the natural atmospheric concentration of 21 percent came as a surprise. The amount of inhibition is constant over a wide range of light intensities in different species and races of plants.

The inhibition is noticeable at as low a concentration as two percent of oxygen, increasing gradually with increasing concentration. Different species of higher plants were remarkably similar in their responses, even though they came from very diverse habitats.

The experiments with higher plants showed that photosynthetic carbon dioxide uptake when no oxygen was present was nearly one and a half times as great as at natural atmospheric concentrations.

This discovery by Dr. Olle Bjorkman of Carnegie's department of plant biology was made simultaneously and independently by Dr. Gleb Krotkov at Queen's University, Kingston, Ontario, and Heinrich Fock at Frankfurt-am-Maim, Germany.

The oxygen-inhibiting effect has an important bearing upon several different aspects of research in photosynthesis, and also upon the evolution of the vegetative system covering the earth. The finding shows the close connection between the opposed processes of photosynthesis and respiration in plants.

Dr. Bjorkman has questioned whether the plant response to oxygen concentration results from inherent properties of the photosynthetic mechanism that evolved when the earth's atmosphere contained a much lower percentage of oxygen than now. Another important question has been raised by Dr. C. Stacy French, director of Carnegie's department of plant biology. He is concerned about the possibility that the regulatory influence of the inhibiting mechanism affects the composition of earth's atmosphere today.

Studying conditions that may have existed much earlier in earth's history, Dr. Philip Abelson, director of Carnegie's Geophysical Laboratory, has devised a new "model" of the primitive atmosphere. He believes the geological and geochemical evidence known today is not consistent with the most widely accepted theory concerning the origin and evolution of life on our planet.

Instead of the methane-ammonia mixture for earth's early atmosphere, Dr. Abelson suggests that the poisonous chemical hydrogen cyanide was the principal ingredient of earth's primeval 'soup," (See biochemistry story on page 534.)