SPACE SCIENCES

Inhospitable stars

The development of advanced life forms on the earth, according to Michael H. Hart of Systems and Applied Sciences Corp., in Maryland, was a near thing. The reason, he says, is that the *continuously* habitable zone about the sun (i.e., the region within which a planet might enjoy moderate surface temperatures continuously throughout the 3 or 4 billion years needed for advanced life forms as we know them to evolve) is surprisingly narrow. A computer simulation of earth's atmospheric evolution, run by Hart a couple of years ago (SN: 1/29/77, p. 68), showed that if the planet were five percent closer to the sun, a runaway greenhouse effect would have occurred about 4 billion years ago; a mere one percent farther from the sun, and runaway glaciation would have taken over about 2 billion years ago.

This conclusion prompted Hart to see how wide a continuously habitable zone (CHZ) might exist around other main-sequence stars. The resulting study, reported in ICARUS (37:351), is a simple one — only the luminosity of the central star and the radius of the assumed planet's orbit were varied in the computer runs — but the results seem to have a place in speculations about the ubiquity of well-evolved extraterrestrial life.

In the study, says Hart, "it was assumed that life would spontaneously arise and continue to evolve on any [suitable] planet provided that the surface temperature was moderate enough for there to be liquid water at some location on the planet's surface, and that evolution to the stage of photosynthetic organism would only require about 8 x 10^8 years."

Smaller, less luminous stars than the sun seem from the study to have CHZ's that are narrower (and closer-in) than that about the sun itself. The sun's own CHZ is barely 5 percent of an astronomical unit (the mean earth-sun distance) in width, and for a star of 0.83 times the sun's mass — a typical K1 star (the sun is a G2) — the CHZ shrinks down to zero. "In other words," Hart says, "there is *no* continuously habitable zone about most K or M stars."

The CHZ is slightly wider around stars slightly more massive than the sun (such as G0 and F8 stars), but by the time they are 4 billion years old, stars greater than about 1.1 solar masses are emitting enough ultraviolet radiation "to seriously inhibit the spread of life to dry land." Above 1.2 solar masses, planets near enough to avoid runaway glaciation for their first 3.5 billion years were probably already too hot after 0.4 billion years.

"It appears, therefore," Hart reports, "that there are probably fewer planets in our galaxy suitable for the evolution of advanced civilizations than has previously been thought."

Slow-spinning asteroids

A pair of asteroids known as 128 Nemesis and 393 Lampetia may be the slowest-rotating objects of their kind yet studied, each taking nearly 40 hours to turn once on its axis, according to a team of European astronomers. Only two other asteroids (654 Zelinda and 164 Eva) have been found with measured periods longer than a day, the authors report in ICARUS (37:133).

The observations — of photoelectric lightcurves — were made by F. Scaltriti and V. Zappalà of the Astronomical Observatory of Torino, Italy, and by H. J. Schober of the Institute for Astronomy in Graz, Austria. The results indicate a period for Nemesis of 39.0 hours and for Lampetia of 38.7 hours.

Furthermore, the authors report, the very slow changes in the projected area of Nemesis as it turns made it possible to detect "without doubt" amplitude variations in the lightcurves as small as 0.01 to 0.02 magnitudes, which could correspond to surface bumps appearing on the object's limb as it turned. Such bumps could represent features about 15 km in height and width on the object, which (if a C-type) is about 150 km across.

TECHNOLOGY

Enzyme-based photographic film

An enzyme from a cow's pancreas is the basis for photographic emulsions being developed by Y. Y. Lee, Paul Melius and Ken Kuan at Auburn University. The emulsions have only been tested with ultraviolet light so far, but when their spectral sensitivity is fully characterized they may prove sensitive into the very-short-wavelength gamma-ray regions, Lee says.

For a negative-image emulsion, the alpha-chymotrypsin enzyme is treated with an acid to make it light sensitive, then mixed with a dye and protein. Spread onto a film base and exposed to light, the enzyme induces a hydrolytic process which liquefies the dye and protein. Washing removes them, leaving a negative image. The resulting textured surface may prove useful in lithographic engraving of electronic circuits.

For positive-image emulsions, the chemical pigment polytyrosine is added to the enzyme mixture. When exposed to light, the pigment darkens, producing a positive image.

These emulsions are slower, more grainy and less sensitive to light than traditional silver-based emulsions, but Lee expects a "significant" increase in sensitivity when another enzyme, trypsynogen, is coupled to the original. And while the team currently relies on slaughterhouse wastes for their enzyme, it can be manufactured more simply and economically with a bacteria, *B. subtilis,* Lee says.

Super super slurpers

What's biodegradable and able to absorb 5,000 times its weight in water? Super slurpers 5,000. They were patented last month by George Fanta and William Doane of the Agriculture Department's Northern Regional Research Center in Peoria, Ill., along with Edward Stout who has since left. Earlier versions developed by Fanta and Doane can drink 1,000 times their weight.

Fanta says the new "laboratory curiosity" is made from polymerized orlon bonded to starch that is combined with a sulfonic-acid compound and treated for 30 minutes with an alkali. The resulting polymer is so large that it cannot dissolve in water, though it would like to, and instead saturates into a highly swollen and tender gel that is little more than water, Fanta says. Used in diapers and cat litter, slurpers also help sandy soil retain water. Coated to plant roots, they decrease plant-transplant shock.

Protein factory harnesses bacteria

Declining productivity of farmlands and decreasing amounts of land devoted to food crops are prompting searches for alternative protein sources. Hoechst AG in Frankfurt, West Germany, is among firms working on bacterial production of protein as a feed supplement to animal fodder. Hoechst found the methylomonas bacteria it uses in earth probes around the Norddeich Harbor. Grown under optimum conditions and then dehydrated, methylomonas is 80 percent protein by weight.

The bacterium's reproductive rate is its principal advantage over livestock as a protein source; while a pig doubles its weight in four to six weeks, the bacterium does it in a few hours. Hoechst's 45-cubic-meter bioreactor grows the biological equivalent (in weight) of several full-grown cattle daily, which amounts to 1,000 tons of protein annually.

Methanol from mineral oil, natural gas or coal provides the carbon in methylomona's diet. Nitrogen comes from ammonia. Phosphates and minerals are injected with water.

Protein derived from bacteria is already economically competitive with fish meal, according to DEUTSCHER FORSCHUNGSDIENST (Vol. 17, No. 6-7).