Everything that makes a star

Stars tend not to get top billing in astronomical popularizations nowadays. There are so many of them. They are truly the "10,000 extras and a host of others" populating the Cecil B. de Mille epic of the universe, the workers toiling up the pyramids, the footsloggers in the Assyrian army. Attention goes to the pharaoh or the shahinshah or maybe the priestly little fellow with the frightening tricks. Galaxies are of interest to the mathematical cosmologist as the primordial articulations of the universe; quasars are God-knows-what and fascinate everybody; black holes generate chilly apprehension.

But is it not the spear carrier who makes the shahinshah even a shah? It is the stars that made the galaxies what they are today. The galaxies started out all hydrogen. The stars produced everything else. A galaxy that has had stars is never the same again. It is polluted, so to speak, with the effluent of stellar manufacturing.

It is this manufacturing that defines the life of the star. It generates its energy, determines its structure, colors its light and specifies its demise. Without stars no nuclear physics, no chemistry, no life.

Now comes a computerized model of a star's history by two scientists from different parts of the University of California, Thomas Weaver of Lawrence Livermore Laboratory and Stanford B. Woosley of the university's Santa Cruz campus, that seems to follow the lifestyles of rather heavy stars quite well, predicting what is seen and what comes out with good accuracy. The first results were described at the recent workshop on Stellar Collapse and Neutrino Physics in Aspen, Colo. Further studies will be reported at the Texas Symposium on Relativistic Astrophysics to be held in Munich (that's a long way from Luckenbach, fellas) in December.

The theory has successfully followed the life histories of a star of 15 times the sun's mass and one of 25 solar masses. Weaver stresses that this is a one parameter theory. Only one arbitrary number need be fed in, the star's mass. There have been partial theories; people have done parts of the problem, Weaver says. "Those other calculations have been characterized by many parameters. In fact they have been criticized for having almost as many parameters as isotopes they predict. This is the first study that describes the complete life history of an entire star."

In the beginning of a star's life, hydrogen fuses with hydrogen to make helium. Helium fuses into carbon and oxygen. Carbon goes to neon and so on until silicon is fused into iron. As this goes on, the star develops a layered structure: The heaviest nuclei present go to the core, and the others form layers on top of the core.

The fusion processes start slowly with the light elements and go faster as the star ages. For a star of 25 solar masses hydrogen burns in the core 7 million years, helium for 500,000 years more. Carbon then lasts only 600 years; oxygen 6 months, and silicon bows briefly for a day.

At iron it abruptly stops. "Iron cannot burn," Woosley says, and the iron core builds up until it collapses under its own weight. At this point Weaver and Woosley incorporated the model of star core behavior worked out by James R. Wilson of Livermore. According to Wilson's model when the iron reaches a trillion times its normal density, nuclear particles stiffen and the core expands outward sharply. This core bounce sends a shock wave through the star that gets to the surface in one day and causes a supernova explosion, and thus what the star has made is broadcast into the galaxy.

The reason for beginning these calculations with such supermassive stars is just that broadcast. The heavier elements can be made only in such stars—a star like the sun has too little mass ever to reach the heavy element manufacturing stage—and there is a hypothesis that a large population of such stars lived their short but raucous lives in the early days of our galaxy 10 billion years ago and contributed most of the heavy elements we have.

The sun has taken it easier, but lived longer, about 4.5 billion years compared to the 7.5 million years calculated for a star 25 times its mass. Extending this theory to the sun and smaller stars generally leads to problems mostly about the ends of their lives. How do they lose mass? When do they end in explosions and when do they not? Rotation, it seems, will be a critical factor. William Fowler and Fred Hoyle have suggested that rotation may delay collapse to give the star time to explode. Weaver thinks a two-dimensional scheme will have to be adopted for the calculations so that rotation can be put in. □

Another Venus flight

Yet another Venus-bound mission has joined the lengthy list of spacecraft headed for December encounters with the cloudy planet. The Soviet Venera 12 was launched on September 14, only five days after its predecessor, Venera 11. Both are believed to be dual-spacecraft missions, each including a landing craft and possibly a flyby vehicle rather than an orbiter. This means that 10 spacecraft are now aimed to reach Venus in December: the U.S. Pioneer Venus orbiter, the three small and one large Pioneer Venus atmosphere probes, the instrumented bus that is carrying the probes from earth, the Venera 11 and 12 landers and their accompanying "flybys," which are expected also to serve as relays for data transmissions. As with past missions, some U.S.-Soviet data exchange is expected. □

New conservation agency proposed

In an unusual move for scientists at a research meeting, participants at the Conservation Biology Conference held recently at the University of California at San Diego adopted two resolutions aimed at rationalizing the funding of conservation research and helping less developed countries protect endangered species. Passed by acclamation at the end of the four-day international conference, the resolutions will presumably lead to new legislative proposals for protecting the world's natural environment for generations to come.

Noting that three-fourths of the earth's tropical forests will be destroyed by the year 2000, the conferees warned that literally millions of animal species will thus be threatened with extinction. To mitigate the impact, the conference called on all wealthy nations to help their poorer tropical neighbors establish and protect "some remnants of natural habitat" before the time is too late.

"Specifically, this conference calls on the U.S. government to take the initiative ... [in setting up] a publically supported major program to aid underdeveloped nations financially in establishing and protecting national parks and biological reserves."

To provide funding for research that will be needed to manage such natural preserves most effectively, the conference proposed establishment of a national endowment for conservation biology analogous to similar endowment institutions for the arts and humanities. The purpose would be to support and coordinate funding for original research on the management of breeding programs for endangered species, the ecology of diminishing habitats, and an interdisciplinary approach to biological problems of population, the environment and conservation.

"In particular, we need an agency to fund research relevant to the stewardship of the earth's remaining natural diversity," the resolution declared.

The small, invitational conference of leading American and commonwealth scholars in conservational biology was sponsored by seven public and private institutions. The meeting focused on presenting hard evidence concerning the fate of tropical habitats and animal species, including:

- The probable end of vertebrate evolution by the turn of the century, with the extinction of many large mammals;
- the inadequacy of even the largest parks now planned to preserve most higher animal species indefinitely;
- the increased proliferation of undesirable species, such as rats and cockroaches, because of their ability to co-exist with humans. □