

## THE LIFE CYCLE OF STARS

Stars are a primary example that our universe is dynamic. Stars are not the same forever; they go through a complete life cycle. The scientific model of a stellar life cycle is very solid, explaining many observations and successfully predicting the properties of new stars and star clusters that are discovered. How a star changes over its life cycle is described below.

- Star Life. A typical star, like our sun, is stable for a very long time. It uses fusion reactions that convert hydrogen into helium, the same energy source as a hydrogen bomb. But unlike the explosion of a nuclear bomb, the fusion in a star happens at a steady rate. Although the fusion does exert tremendous outward pressure on the star, the force of gravity pulls the star in, exactly balancing the pressure and holding the star together. Astrophysicists calculate that this stable balance between pressure and gravity can last for a very long time (10 billion years for a star like our sun), for as long as the fusion reactions continue.
- Star Aging. At some point, the fuel for fusion gets used up, like a car running out of gas. When all the hydrogen in the core is converted into helium, that fusion reaction stops. This means less pressure is available to counter gravity, and the star starts to shrink. What follows are several complicated and shorter stages in which other fuel sources are used, like emergency fill-ups for your car. For a while helium fuses to carbon, and later on, carbon might fuse to oxygen. The star expands and contracts as the different fusion reactions start and stop and exert different amounts of pressure. During these stages the star produces many of the different types of atoms we are familiar with, including carbon, nitrogen, and oxygen.
- Star Death. Eventually the core of the star runs out of fuel entirely, upsetting the balance between pressure and gravity; then the star dies. It may die gently, with the outer layers of the star drifting away from the core, or it may die dramatically in a supernova explosion in which most of the star's material is blown outward in a powerful burst of light, energy, and particles. A supernova can release so much energy that for a while it outshines a whole galaxy! (See photo below.) The atoms produced in the star do not stay trapped in it but at its death are spread through space, enriching the thin cloud of gas and dust between the stars.



This supernova explosion was discovered on Februar y 24, 1987. The image on the left shows the star before it exploded. The image on the right shows how much brighter it was after the explosion.<sup>24</sup>

- Star Birth. The atoms produced by the previous generation of stars become part of a new generation. New stars called nebulae are formed inside rich clouds of gas and dust (see photo next page). Within this stellar nursery, a small dense pocket of gas and dust begins to collapse under gravity. This protostar gets denser and hotter in its center as it collapses, and eventually the core is hot enough for fusion to begin. When fusion starts, the star is born. A nebula typically produces many stars, resulting in a star cluster in which all the stars have about the same age.
- Planet Birth. Planets are born alongside their parent star. As the core of the protostar is heating up, the outer parts of the cloud are still falling inward, and they form a disk of material swirling around the protostar. The disk consists of gas and dust particles from the parent nebula. The dust grains are made of the elements produced by the earlier generations of stars, such as carbon, oxygen, silicon, and iron. The dust grains gradually clump together, and the clumps grow in size. Some clumps become as large as boulders, and the boulders collide together to make even larger objects called asteroids. These eventually crash together to make planets.



The cycle of stars illustrates the constant change happening throughout our galaxy and universe. These are the natural processes God used to create our own planet. The atoms that make up Earth and our bodies were formed in an earlier generation of stars long ago. Those stars exploded, scattering their atoms throughout the nebulae. In one of these nebulae, a new star formed with a dusty disk swirling around it. From that disk, Earth and other planets formed. Thus, the oxygen we breathe was once part of a glowing nebula between the stars. A Christian might say, "God made us from stardust."