Giant Stars

By Ka Chun Yu
Center for Astrophysics and Space Astronomy, University of Colorado, Boulder

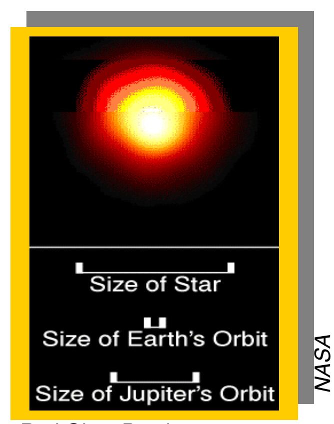
There are two kinds of very large stars. **Giant stars** have masses from eight times to as much as 100 times that of the mass of our sun. These massive stars have hotter and denser cores than dwarf stars (stars that are smaller than five times the mass of our sun). Therefore, giant stars have a greater rate of the **nuclear reactions** that light up stars. Massive stars also use up the hydrogen fuel in their core faster, despite starting out with much more of it, meaning they live much shorter lives than **dwarf stars**. A giant star will also end its life in a spectacular fashion, via a **supernova** explosion, leaving behind a strange object such as a **neutron star** or an even more bizarre **black hole**.

Giant stars, with their increased nuclear reaction rates, are more luminous than our sun. The smallest of the giant stars, with eight solar masses (that is, having eight times the mass of our sun) have **luminosities**, or brightnesses, about 1000 times that of our sun. More massive stars use up their fuel even more quickly: a 40 solar mass star can be 50,000 times as bright as our sun! A 100 **solar mass** star (which is about as large as stars can get) will blaze with several hundred thousand times the energy that the sun puts out.

This immense output of energy is not without consequence. Massive stars behave substantially different from dwarf stars like our sun. Giant stars use up their hydrogen fuel quickly, resulting in short lifetimes. An eight solar mass star will live less than 100 million years. At 10-15 solar masses, the lifetime of the star drops to only 10-20 million years. The most massive giant stars are believed to live no more than a few million years. These lifetimes might seem long when compared to the time-scales that humans are familiar with, but they are a blink of an eye when compared to the 10 billion-year lifetime of the sun.

All stars have some form of **stellar winds** (like the sun's solar wind). The most massive stars' immense winds push out large quantities of gas from the stellar surface into interstellar space at speeds up to 3000 km/sec. The rates at which mass is being lost can be as much as one solar mass over a million years. The most massive giant stars can lose as much as 1/10th of their mass in such winds over their lifetimes, thus end up with substantially less mass at the end of their lives than they had at the start of their lives.

These winds, plus the intense **ultraviolet radiation** emitted by giant stars, can dramatically alter the environment within their immediate stellar neighborhood. A giant star that has formed inside a **molecular cloud** will quickly begin to disrupt and break apart the cloud. This disruption can prevent the formation of other protostars. Any portion of the cloud that is left untouched by the giant star can still be affected when the star explodes in a spectacular supernova.



Red Giant Betelgeuse

Another category of giant stars is the **red giants**. In fact these are not massive stars, but are late evolutionary stages of low-mass stars with eight solar masses or less. As a low-mass star runs out of hydrogen fuel in its central core, the energy generated from the nuclear reactions slows, resulting in less outward force to counteract the weight of the outer layers of the star. The star begins to compress due to gravity. From this compression, the star heats up until helium begins to fuse together to form carbon in the core. Because the temperature and pressure has increased throughout the star, hydrogen can begin fusing further out from the core. This layer of hydrogen fusion outside the core results in extra energy that pushes against the outer material of the star. As a result, the star expands in size into a red giant, or even a **red supergiant**. When our sun becomes a red giant in another five billion years, it will grow to be 70 times its current size, which would place the surface of the sun near Earth's orbit! Other red giants are even larger. Betelgeuse is about 300 times the size of our sun. If placed where our sun is currently, the surface of Betelgeuse would be almost at the orbit of Mars and what remained of the Earth would be orbiting inside the star!

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