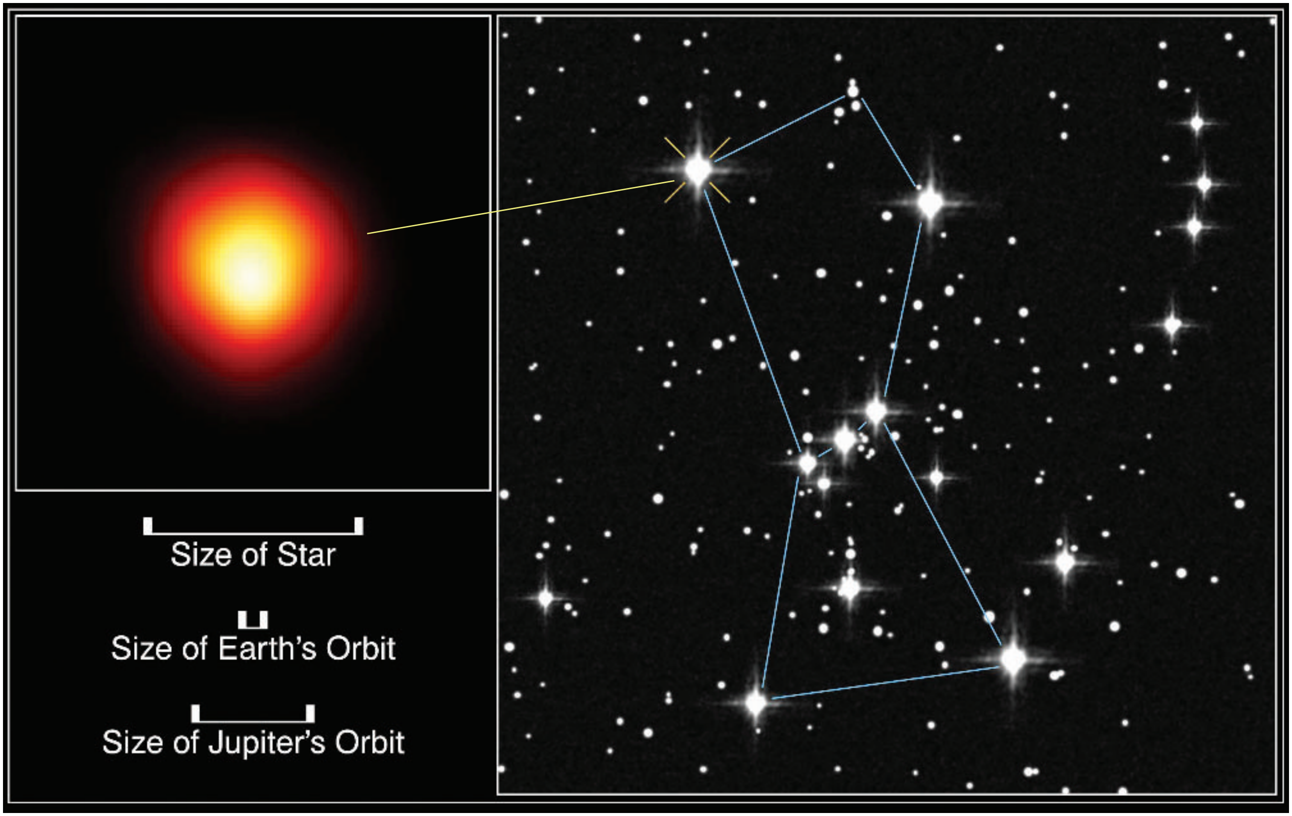

Betelgeuse (see also #27), one of few stars whose surface has been directly imaged, displays an unexplained hot spot. *(Hubble Space Telescope, A. Dupree [Harvard-Smithsonian Center for Astrophysics], R. Gilliland [STScI], NASA, and ESA.)*

Residence:	ORION
Other name:	ALPHA ORIONIS
Class:	M1 RED SUPERGIANT
Visual magnitude:	0.55 (SOMEWHAT VARIABLE)
Distance:	430 LIGHT YEARS
Absolute visual magnitude:	–5.1
Significance:	A BRIGHT RED SUPERGIANT WITH A HUGE DUST SHELL AND THE FIRST TO HAVE ITS SURFACE DIRECTLY IMAGED.

BETELGEUSE

One of the sky's two first magnitude supergiants (the other, **ANTARES** of northern summer), Betelgeuse is so large and nearby that it presents a notable disk. Angular sizes of stars are measured by interferometry, which makes use of the way in which light radiated by different parts of the stellar surface interferes with itself. Betelgeuse was among the first to have its size determined in this way by A. A. Michelson in 1920. Modern measures give a base angular diameter of 0.045 seconds of arc, a physical diameter 650 times that of the Sun. In our Solar System, the star would extend to 2.8 AU, into the middle of the Asteroid Belt. Unlike the Sun, however, Betelgeuse has no sharp apparent "edge." Various measures, made at wavelengths in which the star's gases are particularly opaque, extend the size to 800 times solar, a radius of nearly 4 AU. The distance of 430 light years and the addition of infrared radiation from the 3600-K surface yield a luminosity 55,000 times that of the Sun.

Betelgeuse is so big that it has the honor of being the first star to have its surface imaged directly by the Hubble Space Telescope in 1996. And it looked nothing like we expected. The observations, made in ultraviolet light, showed an even bigger disk over 8 AU in radius, twice the size at which the star appears at optical wavelengths. The increase is the effect of an extended "chromosphere," a tenuous circumstellar magnetically heated atmosphere of the sort that surrounds the Sun. Moreover, offset from the center, the star showed off a large bright spot. It may be a convective bubble rising from below, but no one really knows. The spot is probably related to the star's erratic brightness variations, which take place over intervals of days, months, and years, and make it rival Rigel, supporting Johannes Bayer's seventeenth-century "Alpha" designation.

The spot may also be related to mass loss. Betelgeuse is surrounded by a complex envelope that includes a partial ring of dust with a radius about three times that of the star. It is nested inside yet another dusty ring that peaks about 50 stellar radii away. Still more dust is found from dust grains reflecting starlight up to 90 seconds of arc from the star, 12,000 AU, or 3000 times the stellar radius. And where there is dust, there must be gas, which too is found out to 1000 or so times the stellar radius.

Betelgeuse's remarkable characteristics can be explained only by high mass coupled with an advanced state of evolution. The star's central hydrogen fuel supply has run out, and as a result, its core has contracted into a hot dense state, while the exterior has swelled outward. The star ought now to be in the process of fusing its core helium into carbon and oxygen. Its luminosity and temperature can be explained only with a mass about 15 times that of the Sun, which will force the star to fuse elements all the way to iron. The iron core will collapse, and Betelgeuse will explode, most likely leaving a compact neutron star about 20 kilometers across. If it were to go today, it would be as bright as a crescent moon. If the mass is near or under the lower end of the allowed range, however, Betelgeuse may eventually become a shrunken white dwarf about the size of Earth. Even then the star intrigues. Most white dwarfs are made of carbon and oxygen, whereas Betelgeuse has enough mass to become one of the exceedingly rare neon-oxygen white dwarfs. The only way we will really know is to wait a million years.