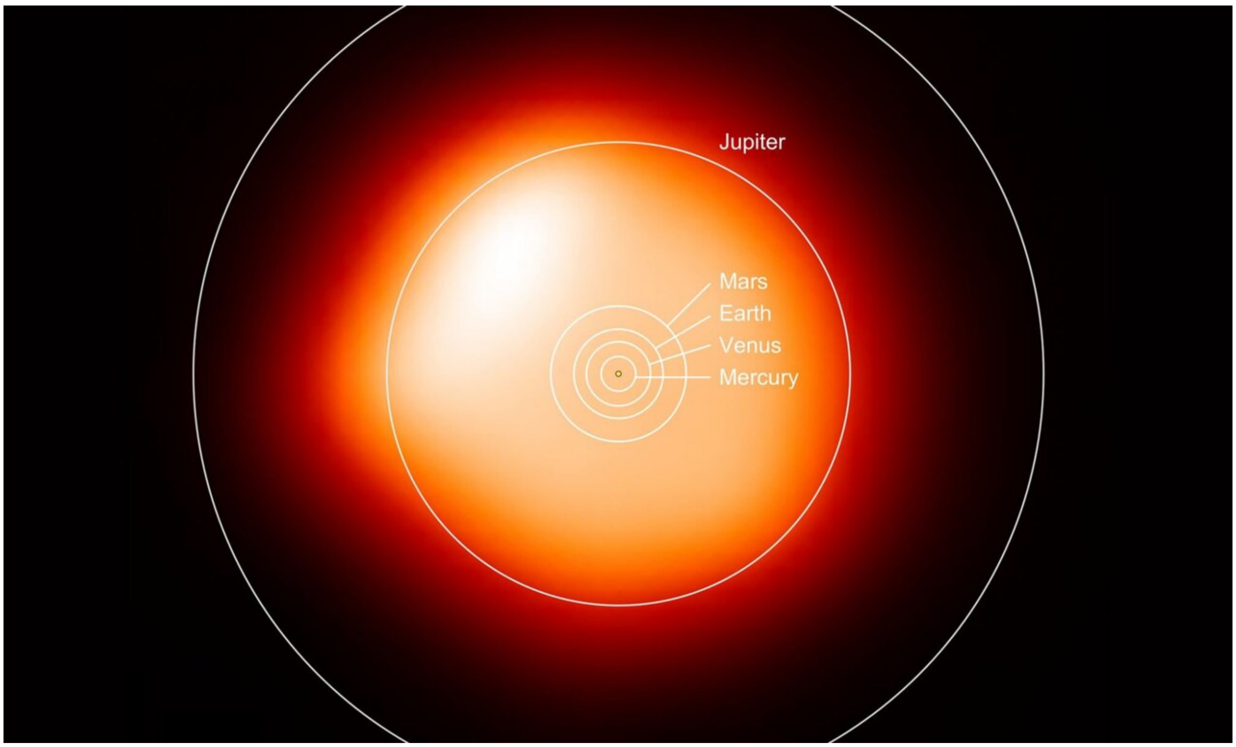
Is Betelgeuse actually a binary star?

August 29 2024, by Mark Thompson



This image, made with the Atacama Large Millimeter/submillimeter Array (ALMA), shows the red supergiant Betelgeuse—one of the largest stars known. In the millimeter continuum the star is around 1,400 times larger than our sun. The overlaid annotation shows how large the star is compared to the Solar System. Betelgeuse would engulf all four terrestrial planets—Mercury, Venus, Earth and Mars—and even the gas giant Jupiter. Only Saturn would be beyond its surface. Credit: ALMA

Betelgeuse has been a favorite among amateur astronomers for many years. However you pronounce it, its unexpected dimming draws even more attention to this red supergiant variable star in Orion. It has a few cycles of variability. One of them occurs over a 2,170 day period, five times longer than its normal pulsation period.

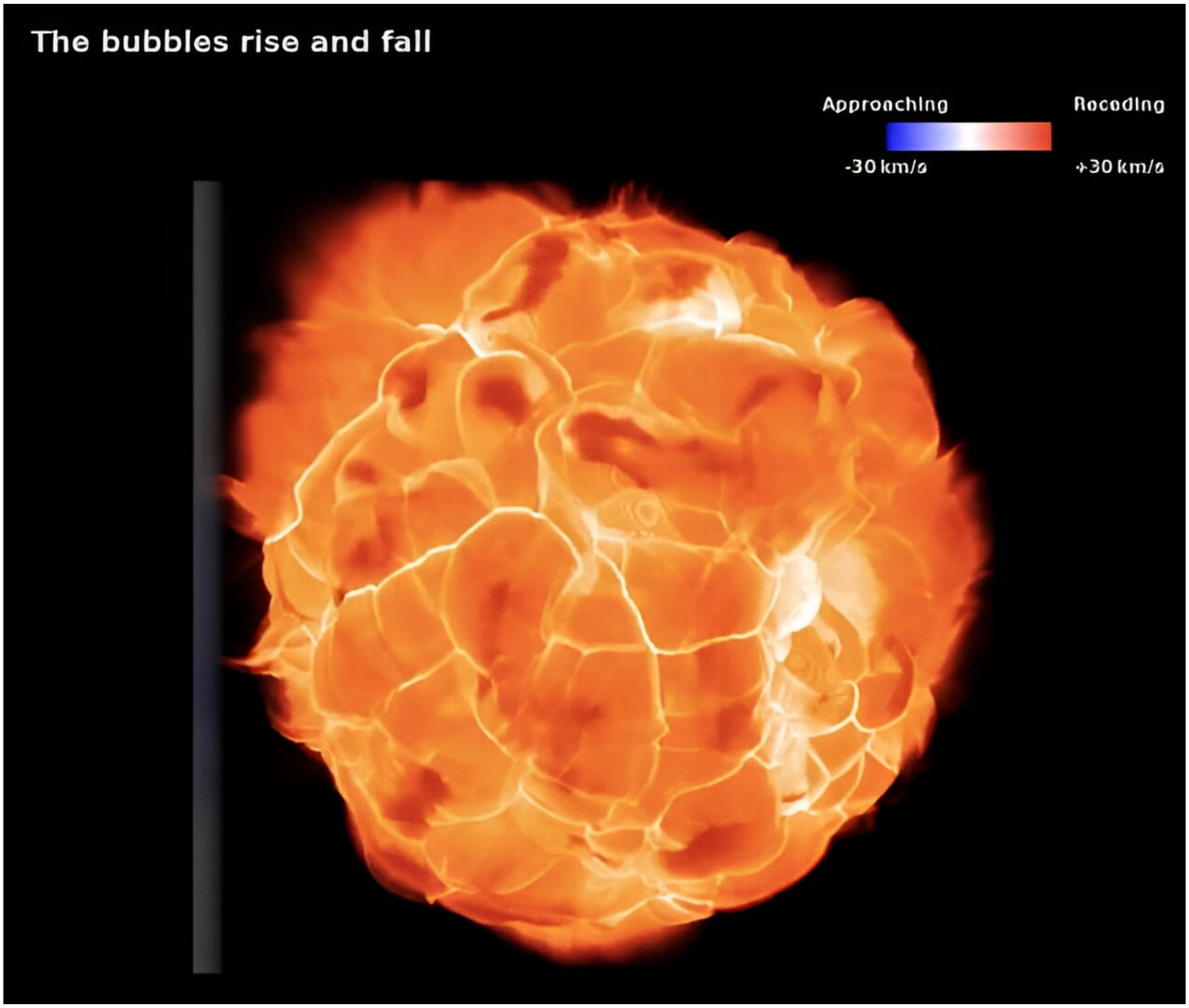
A paper has just been published on the *arXiv* preprint server that suggests a companion star of 1.17 solar masses could be the cause. It would need an orbit about 2.43 times the radius of Betelgeuse and it might just lead to the modulation of dust in the region that causes the variations we see.

One of the brightest stars in the sky, Betelgeuse is a red supergiant found situated prominently at the upper left of the constellation Orion. It represents the shoulder of the hunter, although some translations suggest it refers to "the armpit of the giant." It's one of the largest stars visible to the unaided eye with a radius about 1,000 times the sun.

At a distance of 642 light years away, its brightness in our sky tells us it must be giving out about 100,000 times more light than the sun. Over the last five years, it's been getting special attention due to its unexpected dimming.

The dimming occurred toward the end of 2019, returning to normal in the first half of 2020. It's generally accepted that the dimming was caused by a dust cloud in the event that has now been dubbed the "Great Dimming."

The observations of the dimming led to a change in our understanding of the behavior of Betelgeuse and its surrounding environment, such as the apparent 5 km/s surface rotation, models of the nature of its variability and pulsation models (the periodic expansion and contraction of the star's outer layers.)



Simulation of Betelgeuse's boiling surface. Credit: *The Astrophysical Journal Letters* (2024). DOI: 10.3847/2041-8213/ad24fd

As a well-known variable star, the light curve of Betelgeuse displays a long secondary period (LSP) of approximately 2,100 days. It's not unusual for stars in the Red Giant Branch of the Hertzsprung-Russell diagram and can range from a few hundred days to thousands. To date, though, the mechanism behind the LSP is unknown, but it certainly does seem to be a secondary cycle to a shorter one. Interestingly, the duration of the LSP seems to be generally in the region of a few tens of times slower than the star's radial pulsation.

It's the nature of this longer-term variability in Betelgeuse that is the focus of the new paper published by Jared A. Goldberg and his team. A greater understanding will lead to a greater clarity of Betelgeuse's evolutionary stage and ultimately to its death.

One solution points to it simply being the result of the pulsation of the outer layers. If this were the case, then it means Betelgeuse is larger than expected and would be further along its evolution branch and that a supernova explosion may be imminent within the next few hundred years, an exciting prospect for the stargazers among us.

Interestingly, though, the team concludes that the most likely explanation for the long-term variability of Betelgeuse is a low-mass companion star, named α Ori B (Betelgeuse bears the alternative name α Orionis.) It is possible that this binary star could be modulating the dust surrounding the system and when the companion is in transit, the dust leads to a reduction in brightness.

If α Ori B were to be confirmed, it would have a significant impact on our evolutionary understanding of Betelgeuse. It is expected to go supernova soon, but this is largely because observed variations led to the conclusion it was close. Instead, α Ori B being the cause means we may have some time to wait after all.

More information: Jared A. Goldberg et al, A Buddy for Betelgeuse: Binarity as the Origin of the Long Secondary Period in α Orionis, *arXiv* (2024). DOI: 10.48550/arxiv.2408.09089

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