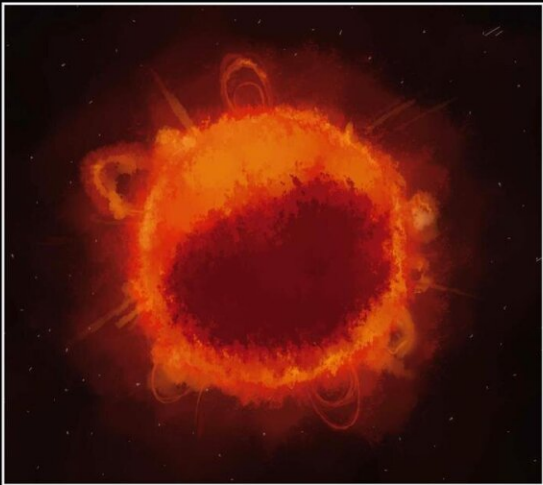


# New study sheds light on the mysterious dimming of Betelgeuse

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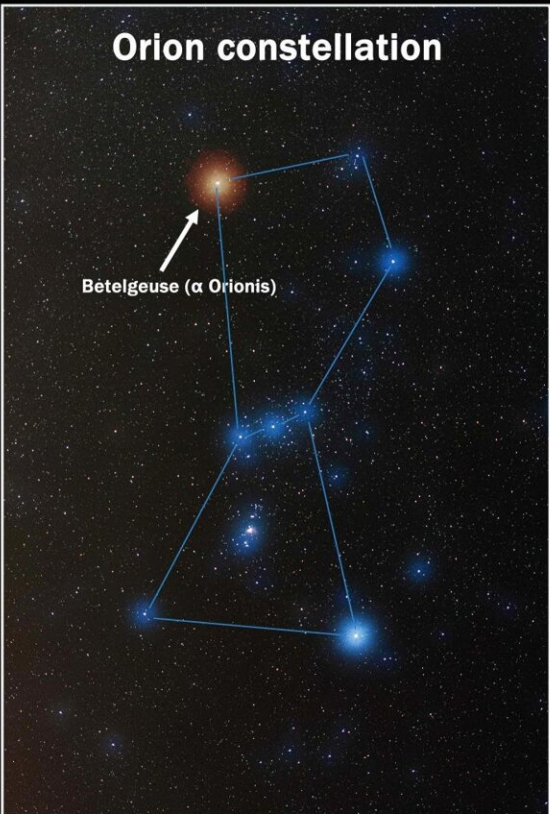
**Spectroscopic evidence for a large spot on the dimming Betelgeuse**

**Red Supergiant**  
Diameter  $\approx 1180 * D_{\odot}$   
Mass  $\approx 18 * M_{\odot}$   
Age  $\approx 10$  million years  
Distance to Earth  $\approx 430$  light years  
It may explode anytime within 100 000 years



*Artist's impression of the dimming Betelgeuse, Alena ALEXEEVA*

**Orion constellation**



*Image from Da-Yong REN (Weihai Observatory, Shandong University)*

During the end of 2019 and the beginning of 2020, Betelgeuse ( $\alpha$  Orionis) became fainter by more than 2.5 times and this is the most significant dimming observed in the recent decades. Credit: Alena Alexeeva and REN Dayong

Betelgeuse ( $\alpha$  Orionis) is the bright reddish star located in the shoulder of the Orion constellation and can be seen by the naked eye in the night sky.

From October 2019 to March 2020, Betelgeuse demonstrated a mysterious dimming, capturing the attention and imagination of both astronomers and the public. While being a [variable star](#) that exhibits periodic and sometimes irregular light change, this dimming is the most significant observed in the last 50 years. It became fainter by more than 2.5 times, which even can be noticed by the naked eye in the night sky. Several scenarios have been put forward by astronomers around the world: pre-phase of supernova explosion, obscuring dust, or changes in the photosphere of the star.

A new study led by Prof. Zhao Gang from National Astronomical Observatories of Chinese Academy of Sciences (NAOC) sheds light on the nature of the mysterious dimming of Betelgeuse. Scientists from Shandong University and the University of Missouri (U.S.) also joined this study.

The study was published in *Nature Communications* on August 5, 2021.

Betelgeuse is the [brightest star](#) in the night sky in the near-infrared wavelength range. This is the most suitable wavelength range for investigating red supergiants like Betelgeuse.

The research team investigated the high-resolution near-infrared spectra of Betelgeuse obtained at Weihai Observatory of Shandong University on January 31, March 19, April 4, and April 6, 2020, covering the dimming and post-dimming phases. "Taking our advantage in [spectroscopic analysis](#), we aim to understand the possible cause of the mysterious dimming of Betelgeuse," said Prof. Zhao Gang, the corresponding author of this study.

To this end, the team developed a special technique for determining the effective temperatures of red supergiants.

"Our method is based on the measurement of titanium oxide (TiO) and cyanide (CN) molecular lines in stellar spectra. The cooler a star is, the more these molecules can form and survive in its atmosphere and the molecular lines are stronger in the stellar spectrum. In a hotter atmosphere, these molecules dissociate easily and do not survive," said Dr. Sofya Alexeeva, the first author of this study.

"We have found that at the minimum of its luminosity, the effective temperature of Betelgeuse on January 31, 2020, was 3476 Kelvins. However, after it recovered its brightness, on April 6, 2020, the effective temperature was 3646 Kelvins. The changing of the effective temperature by 170 K is sufficient to explain this mysterious dimming," said Dr. Sofya Alexeeva.

What could lead to a [temperature](#) drop by 170 K? It could be caused by a large dark star-spot on the surface of Betelgeuse. The presence of spots on red supergiants is a well-known phenomenon. These spots are likely a consequence of convective flows or cool convective cells, which are widely believed to be present in such stars.

"Our findings offer insight in to the nature of red supergiant [stars](#), the main contributors to the enrichment of heavy elements in the Universe," said Prof. Zhao Gang.

**More information:** Sofya Alexeeva et al, Spectroscopic evidence for a large spot on the dimming Betelgeuse, *Nature Communications* (2021). [DOI: 10.1038/s41467-021-25018-3](https://doi.org/10.1038/s41467-021-25018-3)

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