

Will Betelgeuse explode?

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Abstract

The question on when Betelgeuse will explode was risen by the Editors of AGB Newsletter in the January 2020 issue.

Under the invitation of them I wrote this paper to move the attention of the educational and general science community on the stellar variability instead of on the last pre-supernova stages, which imply much shorter timescales (tens of minutes).

Riassunto

La questione relativa all'imminente esplosione di Betelgeuse come Supernova è stata di pubblico dominio nei mesi di gennaio e febbraio 2020. C'è stato persino chi ha associato uno pseudo-segnale di onde gravitazionali da Orione con l'esplosione di Betelgeuse, da vedersi da lì a qualche giorno... idee sulla bocca di astrofisici, ovviamente "esperti" di qualcos'altro rispetto ad evoluzione stellare e collasso gravitazionale.

È vero che siamo di fronte ad una disciplina sempre più specializzata, dove apparentemente tutti sono in comunicazione con tutti, firmando in migliaia lo stesso articolo, specialmente relativo a rilevazioni di segnali di possibili onde gravitazionali, ma è anche vero che cominciano ad emergere alcune grosse lacune di fisica di base, sempre più mascherate da maquillages mediatici...

Una supernova da una stella di varie masse solari, come Betelgeuse, ha luogo dopo il collasso gravitazionale del nucleo. Questo avviene in un tempo di caduta libera, che per una massa stellare è dell'ordine di una mezz'ora al più. Mesi di diminuzione della luminosità della stella, per giunta in concomitanza con il minimo periodico di 1.2 anni, non hanno nulla a che vedere con la dinamica del nucleo stellare, che è compatto, non esteso come la superficie della fotosfera di questa stella supergigante.

Per uno che ha studiato un ciclo 3+2 ottenendo una laurea specialistica in Astrofisica queste dovrebbero essere le basi, non si tratta di un segreto acquisibile dopo anni di ricerca, bensì di nozioni di base.

Per questa ragione ho accolto di buon grado l'invito di Jacco van Loon, editore di AGB newsletter, di rispondere alla domanda nella rubrica "food for thoughts" di Febbraio 2020 che dà il titolo a questo articolo. Domande come questa tengono costantemente la rotta del vero ricercatore: approfondire ciò che si sa, e studiare quello che non sappiamo. Senza la ricerca del sensazionale e del nuovo a tutti i costi. Specialmente se quello che è stato già acquisito richiede ulteriori approfondimenti, magari noiosi e poco *appealing*, di richiamo.

Il commento dell'editore a questo testo, in cui sono andato a briglia sciolta, è stato "brilliant!". E lo ha pubblicato integralmente su AGB newsletter di Marzo. La considerazione sulla ricerca del sensazionale segue quanto hanno dichiarato su AGB di Luglio 2020 a proposito di un meeting che l'IAU non ha loro supportato per il 2020 perché i contenuti potevano essere gli stessi di 20 anni fa. C'è progresso senza riflessione?



Introduction

When Betelgeuse will explode?

The question originates itself from the recent dimming of the star, which has been larger than a whole magnitude, since september 2019.

Many media presented to simulation of the aspect of the sky in the case Betelgeuse would become the new galactic supernova, and more have attributed to this forthcoming event the unusual behaviour of this star.

I had the privilege to follow on a daily basis the evolution of the light curve of Betelgeuse since december 2011, as part of my observative project within the AAVSO, American Association of Variable Stars Observers, and I would like to spend some words in describing and motivating it.

First magnitude variable stars

Betelgeuse is a first magnitude variable stars. Semi-regular. The secular AAVSO database (1911-on) allows to see at first sight two main periods, 1.2 and 5.9 years modulation, but identifying its regularities it is only our way to try to understand the complexity with a simple model.

I have chosen to follow Betelgeuse and Antares after starting to observe Delta Scorpii from my window when I was working at Rio de Janeiro Observatory. This star was aiming to the zenith, I noticed its brightness and after identification, I read about its variability discovered only in 2000 by Sebastian Otero, an AAVSO member who provided visual observations with 0.01 magnitudes of accuracy.

Until 2011 my variable star targets were preferably novae, for their relevance in the History of Astronomy, that I taught at Sapienza University of Rome.

Betelgeuse and Antares were choosen in order to have always the instrument for measuring them: the naked eye, and to maintain the eye contact with observative astronomy in an historical epoch of strong mediation between the astrophysical objects and us, made primarily by automated (electronic) detectors.

The addition I made to my observative pipeline was including the airmass correction since the reference stars were usually very far from the target star, at different altitudes above the horizon.

This operation was declared in each of my naked eye observations, which



are more than 1000 for both stars, with also a didactic objective in mind: to spread the spirit and the technique of accurate measurements, also with the unaided eye.

In AAVSO database you can find these observations under the observer's acronym SGQ assigned to me in 1999.

After so many years, this occasion of Betelgeuse great minimum, is giving an additional value to my effort: the possibility to give an effective contribution to the science community and to the amateurs one.

Detectors for galactic supernovae

Dr. Paolo Ochner, a colleague of Asiago Observatory (Italy), has commented the present situation with the following statement: if a galactic supernova explodes only amateur astronomers can classify it! Yes because the 1.22m Galileo telescope of Asiago cannot do spectra of Betelgeuse at 1.5 magnitude, or photometry without diaphragming the instrument to a unusual level, let imagine if the star would shine a -9 magnitude or -14... all detectors saturated or burned!

Stellar variability as public outreach

The occasion of such deep minimum of Betelgeuse is a great opportunity to present a variable star to the great public.

A variable star behaves exactly like that!

Mira, that I studied in depth on the historical data 2 decades ago, does not have a maximum equal to another...its period is averagly constant but its magnitude is unpredictable.

Our Sun also has a constant period for the solar spots, the 11 years cycle, but its maximum value is still unpredictable, and we don't know whether the Sun will enter a new Maunder minimum (no spots for several decades as in 1645-1715) or not...

Betelgeuse is behaving according to its statistical behaviour... and a delay of few days on the 1.2 years period is normal. The depth of this minimum is the first time we see it after 100 years, but there is nothing extraordinary if compared with other long period variable stars. Needless to say it is worth to be studied.



Stellar evolution and gravitational collapse

Finally this event is another occasion to speak about stellar evolution to the great public.

A 3 months long dimming of a star which undergoes periodically such events can be an announcement of an imminent explosion?

The Supernova event for a star with more than 10 solar masses like Betelgeuse is the result of the gravitational instability after the inner nuclear engine becomes endo-thermal and cannot sustain any more the weight of the outer mass shells.

This instability sets in the free fall time, about some tens of minutes for a stellar nucleus, nothing to do with months.

The Betelgeuse great dimming of 2019/2020 is then the occasion, for professional astronomers, through interviews, conferences, papers, lectures, to make acquainted many people with stellar variability achievable also with the naked eye from urban sites (with light pollution), and to free-fall Supernova dynamics at the end of stellar evolution for high mass stars.

A much stronger goal than predicting its explosion!

References

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