Betelgeuse 2020 dimming: getting the minimum

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Abstract

The historical minimum of the red supergiant Betelgeuse (alf Ori) is occurring in 2020 January 28±4 days, as from simple weighted average of parabolic fits of V-band (29±5 Jan 2020) and Visual data (22±9 January 2020).

It has been a negative interference, a beat, of some major variability periods of the star, and the 425 days periodicity completes a whole cycle minimum-to-minimum on February 29 after the previous minimum of 1st Jan 2019.

These analyses are presented after an introduction to Betelgeuse Fourier analysis and AAVSO multispectral database; a brief discussion of pre-Supernova stages and free fall timescales; the future problem of Galactic Supernova classification with professional instruments, and the utility of amateurs observations (citizen science) and measurements.

The Fourier analysis of Betelgeuse as in Karovska (1987)

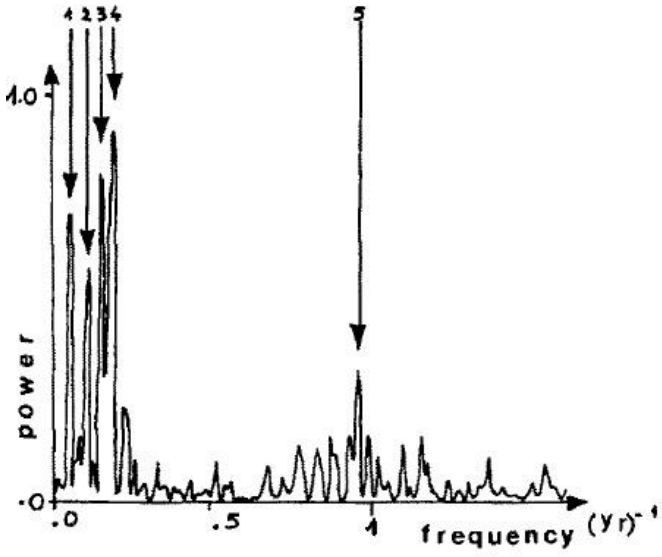


Fig 1 - Power spectrum obtained as a result of Fourier analysis of the AAVSO data.

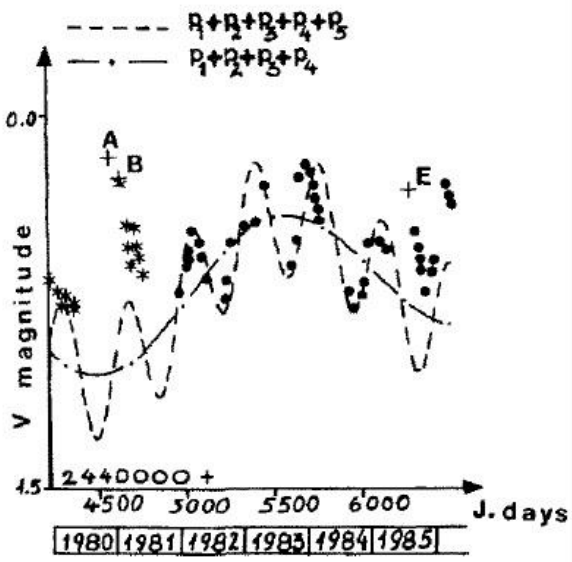


Fig 2 - Measurements of α Ori visual magnitude by Krisciunas (stars) and Guinan (dots), Guinan (1986).

This Fourier analysis has been based on AAVSO data, as reported in the original paper of M. Karovska, with special data treatment to reduce the unavoidable noise of variable stars data due also to the yearly limitation due to Sun proximity. Incidentally the observer E. F. Guinan is the co-author of the Astronomer's telegrams about Betelgeuse fainting mo. 13341 and 13365 (2019), he observed it at least since 40 years!

The period indicated with number 5 in the power spectrum, corresponds to the well visible main period of Betelgeuse oscillation around 425 days (also in Sigismondi, 2019 with SGQ/AAVSO visual data and VOL/AAVSO V-band data discussed, as in the present work).

The combination of the various periods suggests the possibility that the present minimum is a negative interference of all main periods. Moreover the main oscillating period of 425 days is going to have its minimum around February 29 2020, when checking the previous oscillations of the last 8 years (see Sigismondi, 2019).

The role of the dust ejections

Betelgeuse is the brightest IR star of our sky. The dust in such waveband is well visible and the observation in such wavelengths can explain better the present situation of the star, and the past brightening.

The light scattered toward us from a dust ejection far from our line of sight can enhance the luminosity of the star (figures 3 of Karovska 1987), while the dust interposing in the line of sight dims the light of the star, as it can occur now. This can be one of the physical concurrent causes of the present very deep dimming.

Karovska (2020, Betelgeuse Dimming meeting) suggest to study as analog cases R Aqr and CH Cyg light curves. Sigismondi (2020, Betelgeuse Dimming meeting) recalled the case of Eta Carinae dust ejections, which determined its dimming down to 8^{th} magnitude (1900-1940) and recovering to 4^{th} magnitude as it is now after a bright outburst of 1843 when it reached negative magnitudes, brighter than Canopus.

The free fall time and stellar photosphere; the pre Supernova-stages

In the physics of gravitational collapse, when the thermal energy arising from the stellar nucleus does not sustain any more the mass, the gravity force prevails and the collapse starts.

The typical time scale of such event is of the order of 30-60 minutes for a nucleus of more than 10 solar masses, as the one of the red supergiant Betelgeuse is.

This time scale has nothing to do with the two months dimming ongoing with Betelgeuse.

The red supergiant extends its atmosphere up to 900 solar radii, the density of such stellar object is extremely low, out of its nucleus where the Helium burning occurs. Associating this dimming with a nuclear collapse is not physically reliable, again for typical physical timescales of nuclear free fall with respect to stellar atmosphere response.

Moreover the only one Supernova of which we know its pre-Supernova stage is SN 1987A: the progenitor star was Sanduleak -69 202 a blue supergiant star of visual magnitude 12.

1987A reached at maximum, after 23 february 1987 23 UT, visual magnitude 2.8, with a rise of 9 magnitudes.

The problem of Galactic Supernova classification

When a “local” Supernova would explode, it will reach negative magnitudes, putting in problem the saturation of most professional instruments.

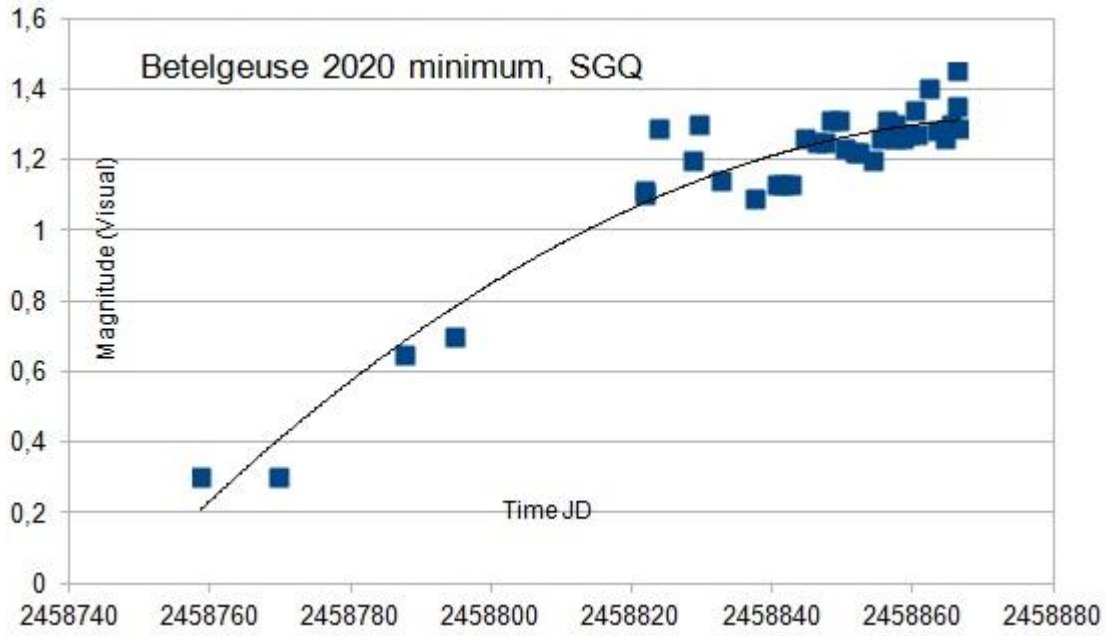
Spectra of Betelgeuse taken at its minimum in January 2020 with T122 Galileo Netwonian telescope of Asiago, require diafragming the main mirror with a mechanical iris to ¼ of its 122 cm of diameter.

A negative magnitude with a rising of 9-10 magnitudes from a naked eye visible star is corresponding to an increase in flux of 10000 times. Therefore a corresponding reduction of the collecting area is needed, and in diameter the ratio is 100 times.

This is not possible with professional instruments of the 1-m class, ad above. Small instruments can perform appropriate spectroscopy: Paolo Ochner (2020) of Asiago Observatory (Italy) says that the next Galactic Supernova will be classified by amateur astronomers!

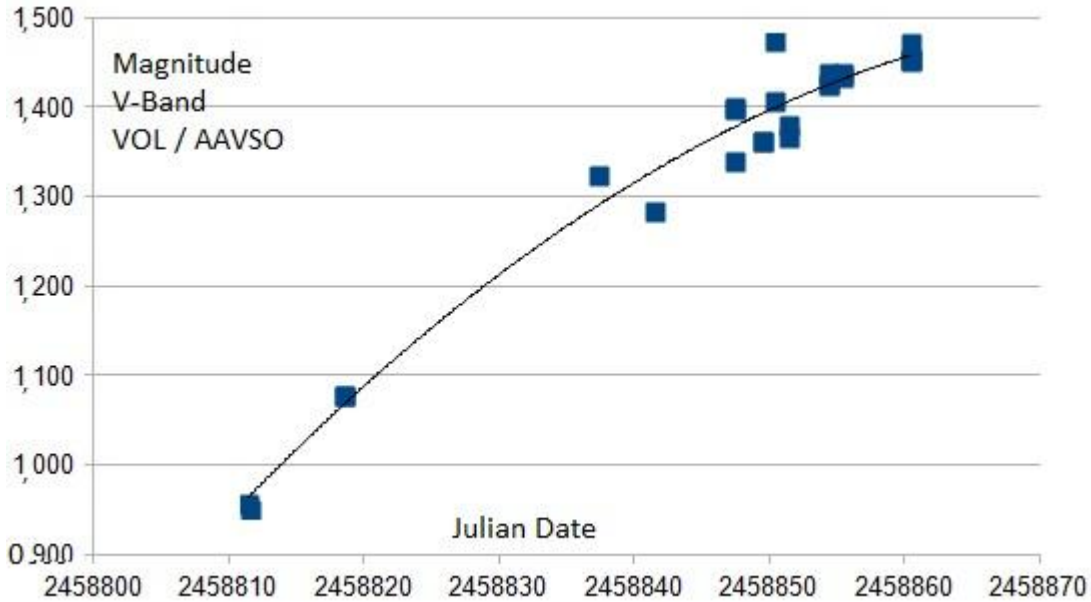
The minimum of Betelgeuse from visual SGQ and V-band VOL , AAVSO data

The visual data of the last 180 days of Betelgeuse light curve (August 2019 to January 2020) have been separated between visual SGQ (C. Sigismondi) and V-Band VOL (Wolfgang Vollmann) and fitted to a parabola.



The maximum magnitude (minimum flux) corresponds to Jan 22 ±9 days.

For the V-Band data from DSLR images and with the pipeline for data analysis as in (Vollmann, 2013) the result is the following: maximum magnitude on 29 ±5 days.



Beyond the slightly different bandwidth (vis vs Johnson V-band) the two datasets adopt slightly different magnitude per airmass: 0.20 for VOL and 0.236 for SGQ, due to different heights above sea level (170 m for VOL, Vienna (Wien) and 0 to 60 for SGQ, Rome and Pescara (0 level)).

Grouping the data of the same day has been done to appreciate the errorbar of the single observations, which can be affected also by invisible clouds (Vollmann 2013 and Sigismondi 2016 who claimed a first magnitude outburst of Del Sco+ Steele 2016 who did not confirm it, this was an effect of an invisible veiling cloud over the comparison stars).

The accuracy of visual data has been estimated on Jan 17 in three different observations by me in Pescara: at local 18:18; 19:35 and 20:35, with Betelgeuse and Pollux at different angular altitudes, from low (20°-30°) with haze to almost meridian value (50°-60°) without haze.

The value of 1.36 ±0.08 shows the standard deviation of 0.08 magnitudes, which has to be considered as the maximum errorbar of these visual observations, since the proximity to the sea of Pescara allows heavy evening hazes.

Also the data of Wolfgang Vollmann present three data points for the 11 January (the last available on 20 Jan) and I use them to evaluate their standard deviation: V= 1.458±0.011

My visual data are affected by a larger error than the VOL-digital ones, and this is reflected in the uncertainty on the maximum dates. The weighted average of the two independent datasets is January 28, 2020 ±4.3 days for the minimum, occurring with 1 month of advance with respect to the average period of 425 days. The previous minima were separated by 325 days and 428 days, then the fluctuation of such periods can be significant and a study like the one of Eddington and Plakidis (1929) realized on Mira can be worth.

The quadrant proposed by Sigismondi (2019) has been realized by the students of Galileo Galilei Scientific Lyceum of Pescara and will introduce them to the airmass correction algorithms for visual observations.

References

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C. Sigismondi 2016 http://www.astronomerstelegram.org/?read=8618

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C. Sigismondi (chair) 17 January 2020 Betelgeuse Dimming Workshop, ICRANet Pescara

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Media selection, often all oriented toward an interpretation of such minimum of Betelgeuse as a Supernova alert, they missed the opportunity to present correctly the stellar variability phenomena**:**

ES 2020https://www.abc.es/ciencia/abci-explosion-supergigante-betelgeuse-inminente-segun-astronomos-202001190057_noticia.html

BR 2020 https://jornal.usp.br/ciencias/ciencias-exatas-e-da-terra/possivel-supernova-na-galaxia-empolga-mas-tudo-indica-que-betelgeuse-ainda-nao-explodiu/

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US 2013 https://slate.com/technology/2013/01/betelgeuse-infrared-picture-shows-it-will-hit-a-wall-of-galactic-dust.html

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