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 parabolic fit of V band (29±5 January) and Visual data (22±9 January) of the data on AAVSO database observed by the author (SGQ) and by Wolfgang Vollmann (VOL) before 20 January 2020.

The discrete derivative of data points binned each 15 days has been also used to predict the instant of the minimum, obtaining February 1, 2020 ±18 days.

The 425-days cycle of variability of Betelgeuse, ends on February 29, 2020, following the previous minimum of 1st Jan 2019. This seems to be a negative modulation with longer period of such oscillations, and further analyses on the whole database available on Betelgeuse are required to better understand the behaviour of this star.

Introduction: the Fourier analysis of Betelgeuse as in Karovska (1987)

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 no. 13341 and 13365 (2019) and 13410 (2020).

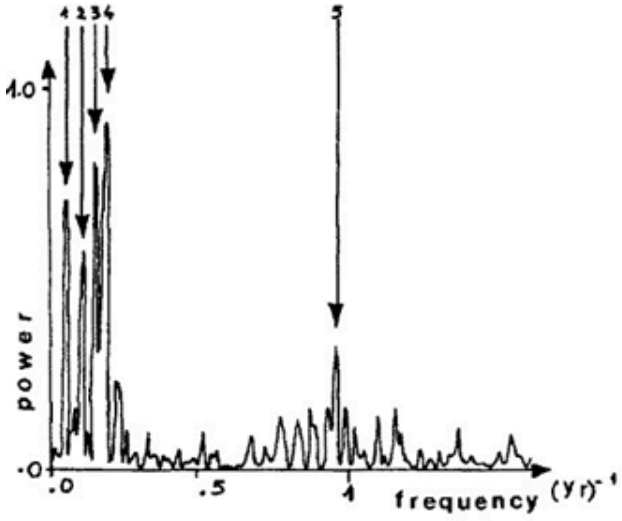


Fig 1 - Power spectrum obtained as a result of Fourier analysis of the AAVSO data.

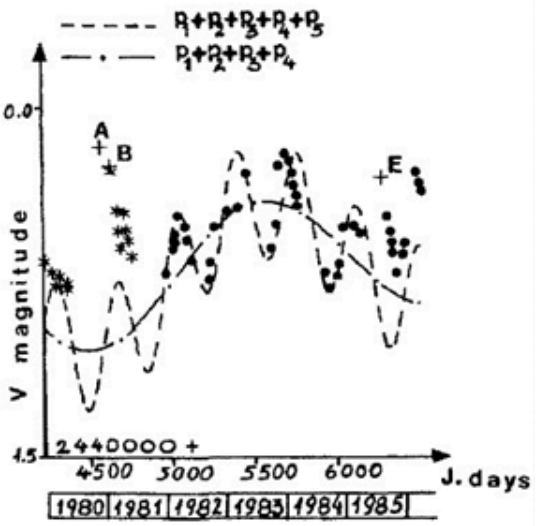


Fig 2 - Measurements of α Ori visual magnitude by Krisciunas (stars) and Guinan (dots), Guinan (1986).

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

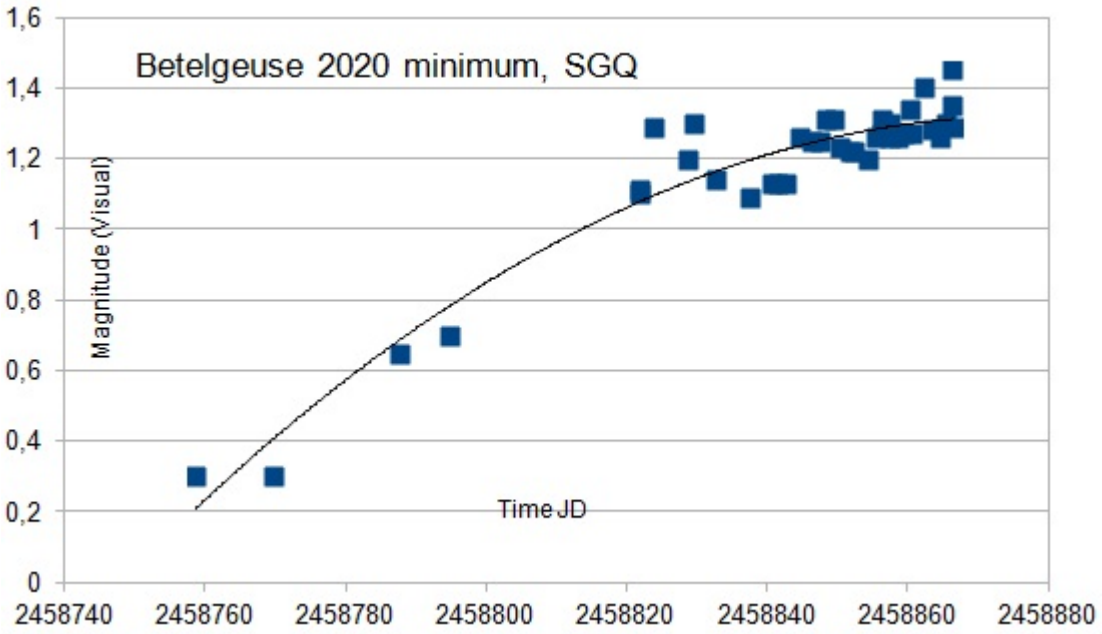
Betelgeuse is the brightest IR star of our sky. The dust in such waveband is well visible and the observation in such wavelengths can explain better the present situation of the star, and the past brightening.

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.

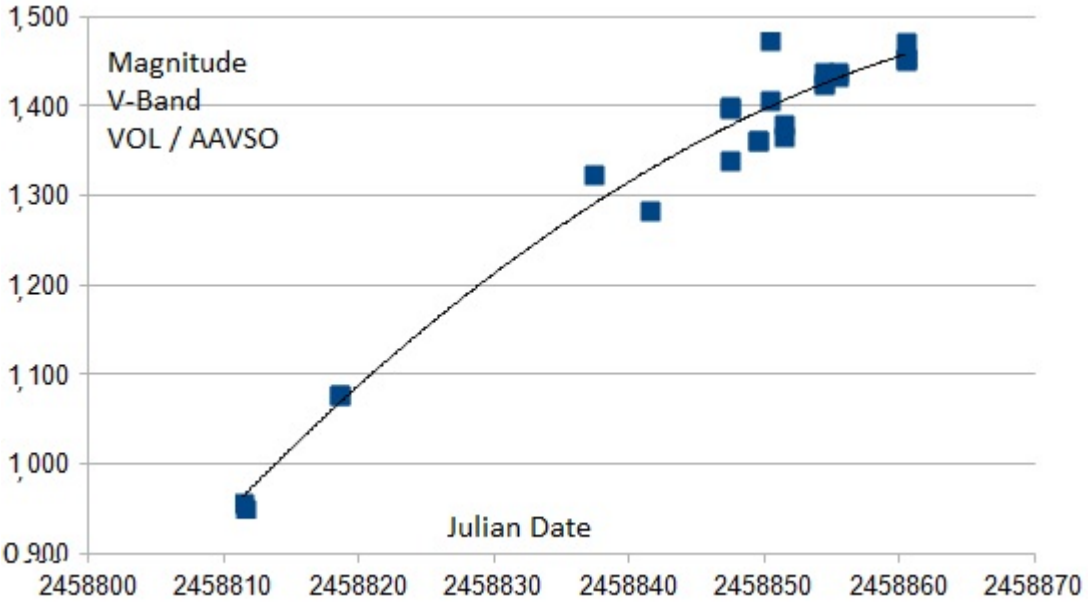
Karovska (2020, Betelgeuse Dimming meeting) suggest to study as analog cases R Aqr and CH Cyg light curves. Sigismondi (2020, Betelgeuse Dimming meeting) recalled the case of Eta Carinae dust ejections, which determined its dimming down to 8^{th} magnitude (1900-1940) and recovering to 4^{th} magnitude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

The 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 Scorpii + 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 mv= 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 Adriatic 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

The discrete derivative and linear fit of Betelgeuse V magnitudes

In the hypothesis that the minimum of the light curve of Betelgeuse can be locally fitted by a parabola, it is meaningful to calculate a discrete derivative, binning the data each 15 days in order to reduce the fluctuations of instrumental and observational origin above described.

Associating to the intermediate date n+7.5 the result of each discrete derivative ΔV(n+7.5)= V(n+15)-V(n) the following graphics have been obtained.

The linear fit has been done over the last 3, 4 and 5 data points, which appear to be monotone, and the average and semi-dispersion of the linear parameters has been obtained. In order to evaluate the statistical uncertainty the following result is the average of last 3, 4 and 5 data: February 1, 2020 ±18 days. This is the zero derivative point, the "tropical" or turning point of the light curve.

Combined with other predictions by parabolic fit 2020 January, 28±4.3 days, this value shifts the prediction of +0.2 days and reduce the uncertainty to ±4.1 days.

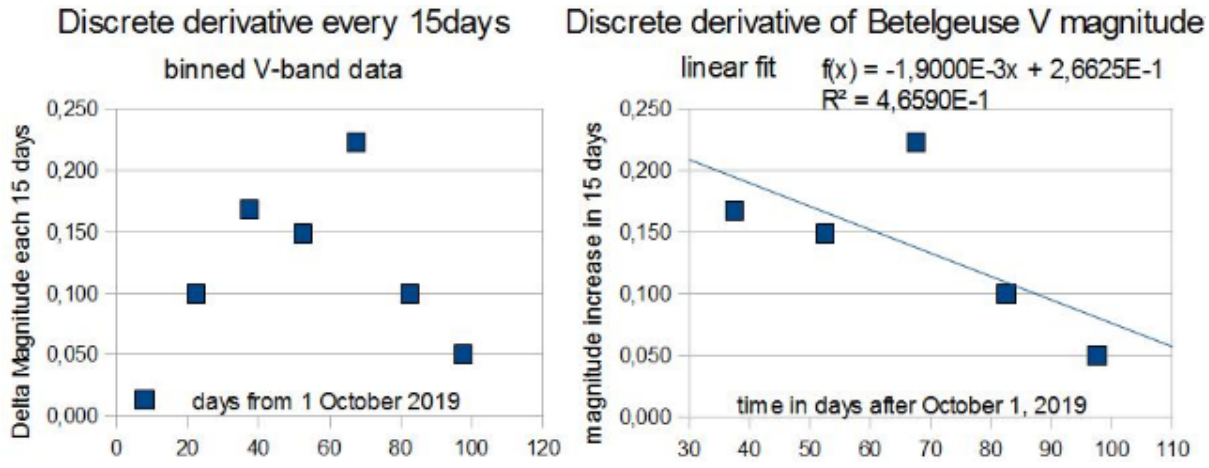


Fig. 3 Discrete derivative applied to V-band data predict minimum on 1 Feb 2020±18 days.

Conclusions

The SGQ 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 as the analysis of Eddington and Plakidis (1929) realized on Mira can be worth for Betelgeuse.

Acknowledgments

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The careful observative work of Wolfgang Vollmann, near Wien, made in the same 8 years of my Betelgeuse monitoring, has been an invaluable source of information and validation for my visual data.

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