Photometry of Betelgeuse at daylight

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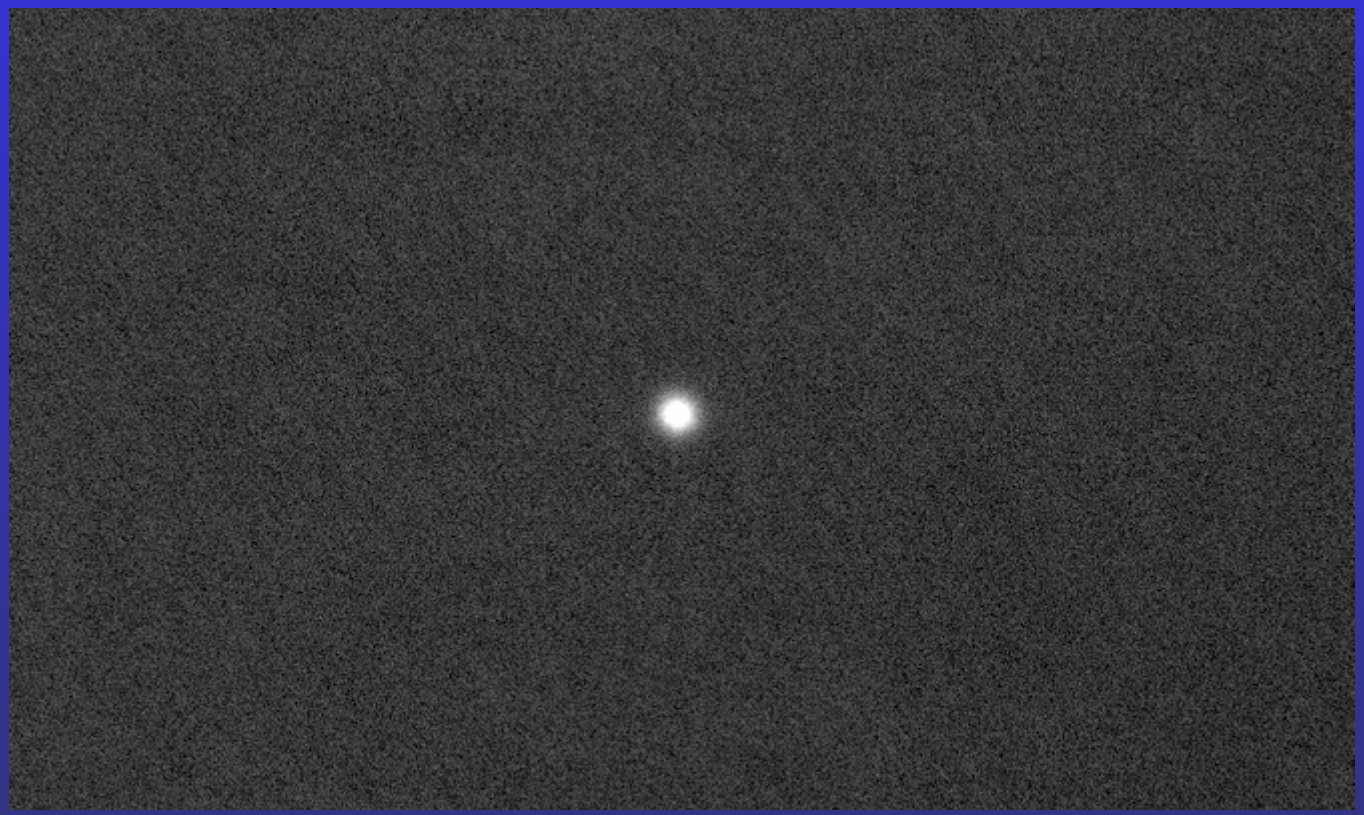
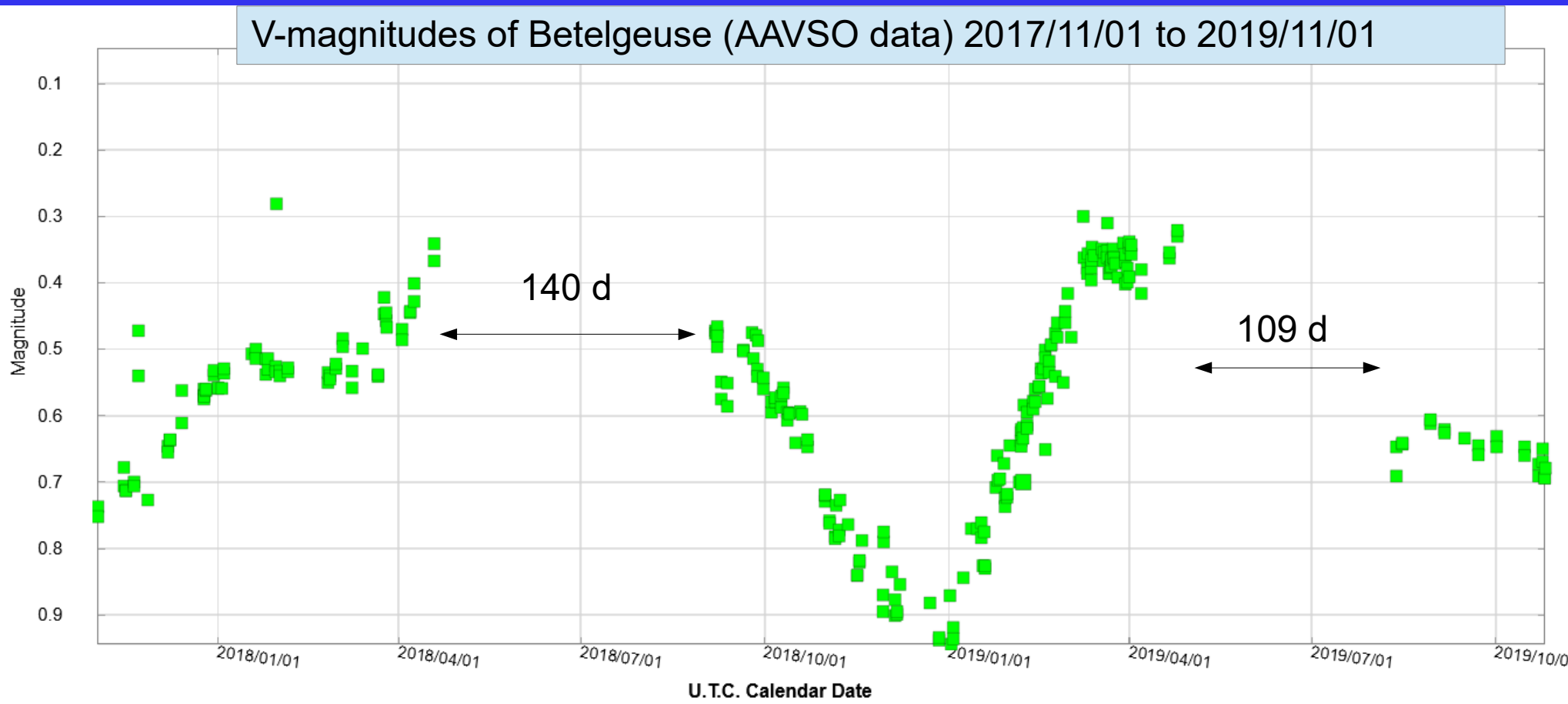


Sixteenth Marcel Grossmann Meeting 5-10 July 2021

Lightcurve of Betelgeuse



Reference: Kafka, S., 2021, Observations from the AAVSO International Database, https://www.aavso.org

Ways to fill the gap in the lightcurve at conjunction

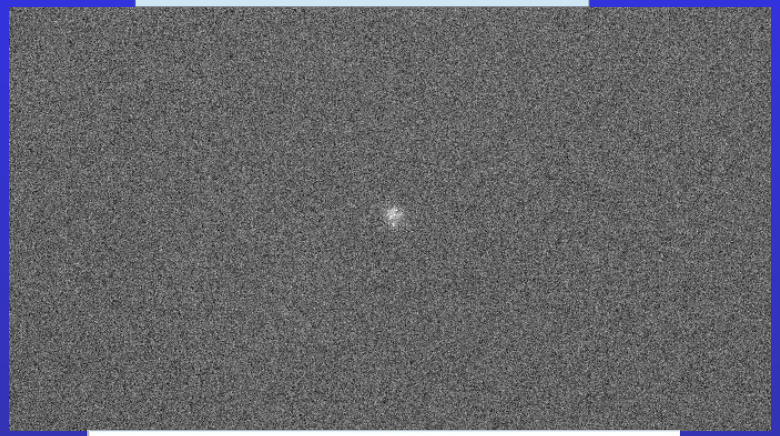
- Observations in twilight close to horizon (preferable in the southern hemisphere)
- Observations with space probes distant from earth (e.g. STEREO-A)
- Observations at daylight

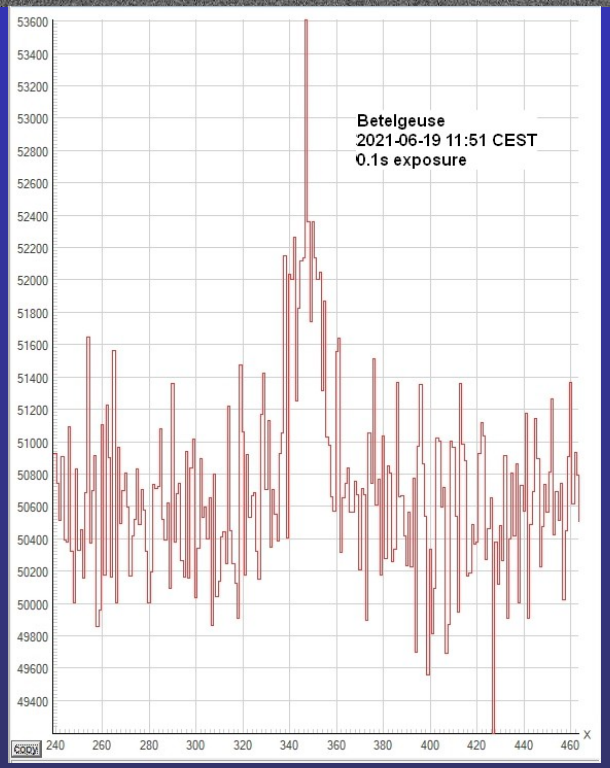
Equipment

- Newton telescope 25cm F/5
- Equatorial mount:
  ASA DDM60 (direct drive,
  encoders in both axes)
- CCD camera: ATIK 460exm with
  filter wheel
- Filters: Johnson V
  and ND2 (1% transmission)
- Control software (Windows PC)
  over ASCOM interface

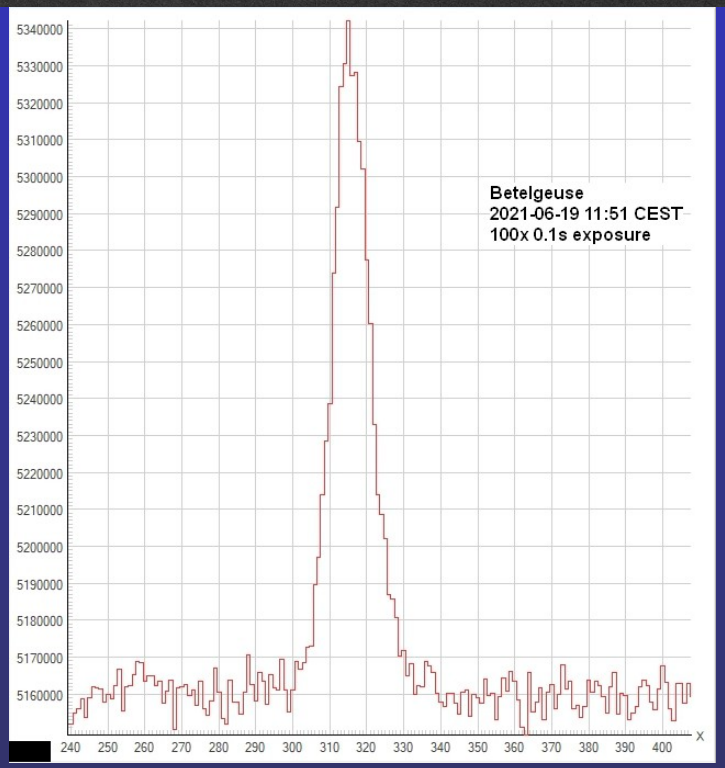
Images of Betelgeuse close (16°) to sun (June 19)

Single image (0.1s)





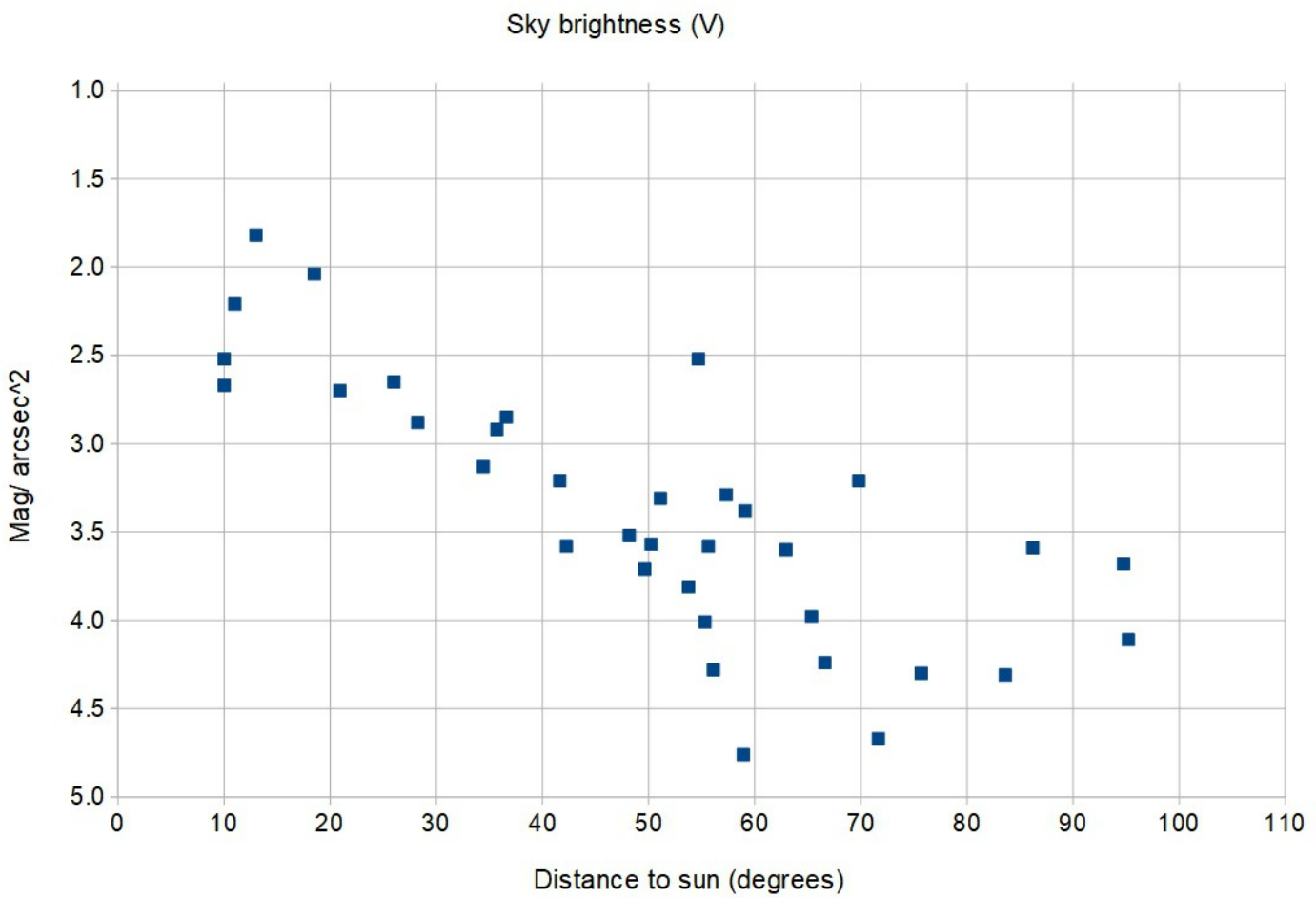
Stack of 100 images



<Star max
0.18 $\cdot 10^6$ /pixel
= 3.5% of sky photons

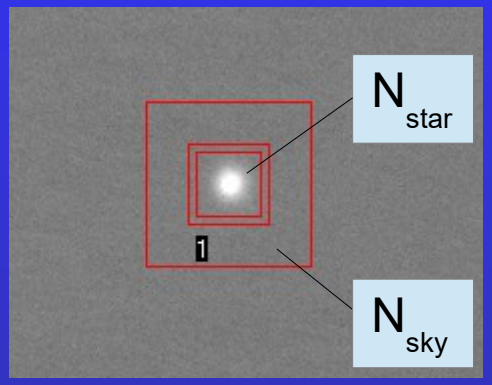
<Sky photons
5.16 $\cdot 10^6$ /pixel

Sky brightness



Brightness of clear sky in Mainz, 2020-2021

Photometry



Instrumental Magnitude $m_{inst} = -2.5 \log((\sum(N_{star} - N_{sky})) /T)$

Calculation of standardized magnitudes

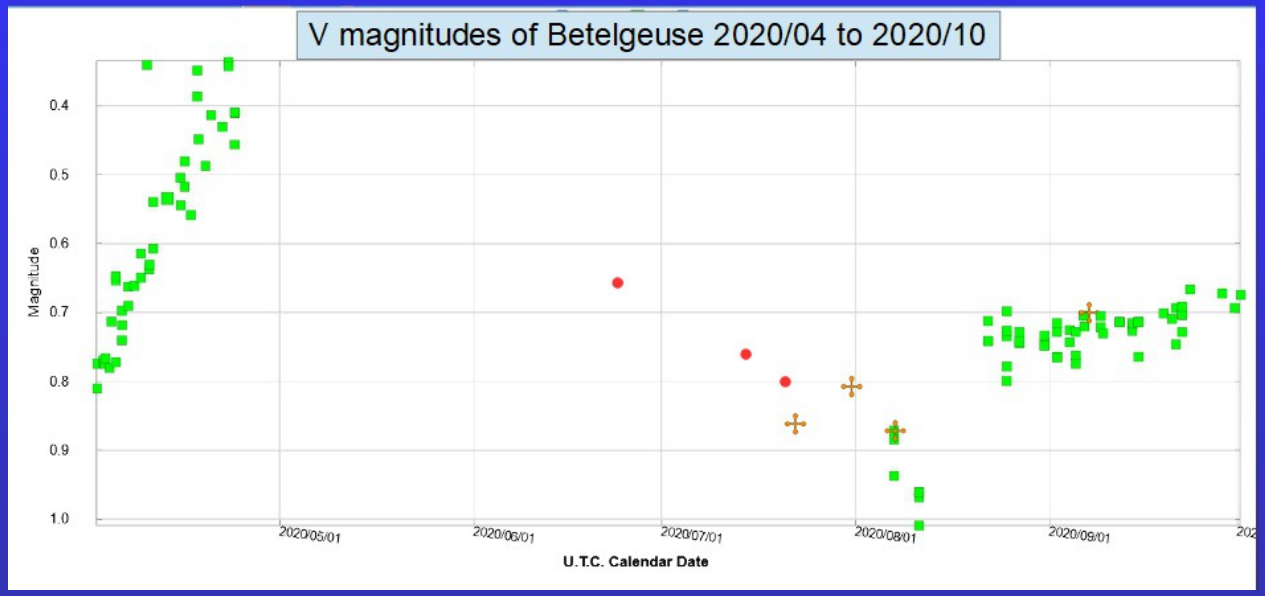
Standardized differential magnitude M(var):
Magnitude calibration by one comparison star with known magnitude M(comp)

In 2020 comparison star was Aldebaran (Alpha Tau)

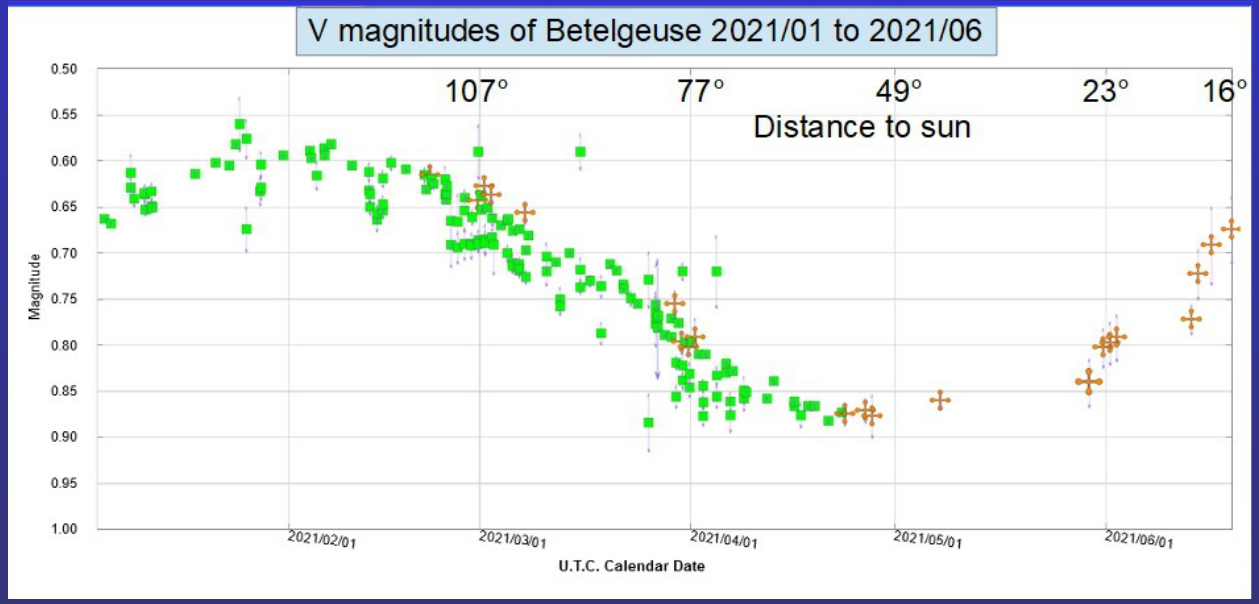
Improvement of method in 2021:

4-6 comparison stars were measured together with Betelgeuse

Results 2020/21



Green: Vmag data from AAVSO
Crosses: daylight Vmag data
Red: STEREO-A



Green: Vmag data from AAVSO
Crosses: daylight Vmag data

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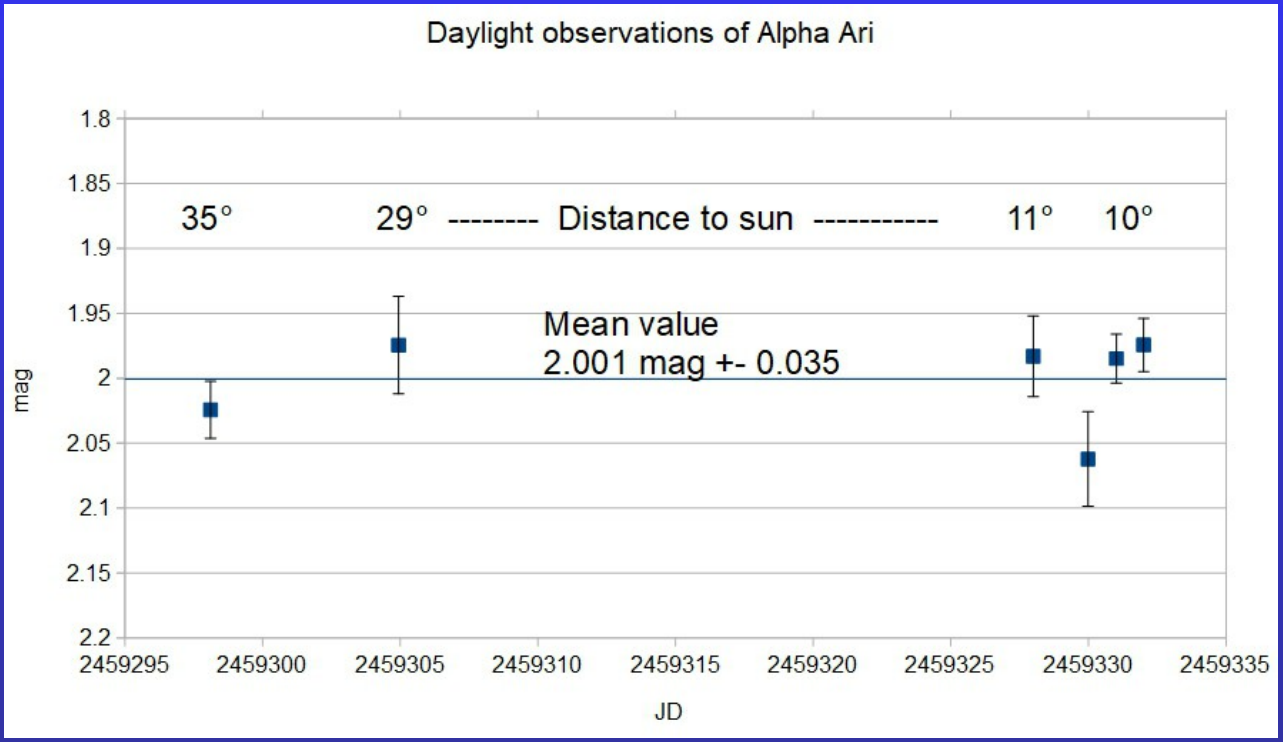
Light curve of Alpha Ari at daylight



Mean value corresponds closely to Hipparcos V magnitude (2.01 mag)

Conclusions

- Measurements of the V magnitude of Betelgeuse is possible with astronomical cameras at daylight, even at closest distance to sun
- The method gives reliable results with an error of less than 0.05 mag (clear sky provided)
- The solar conjunction gap of the lightcurve can be filled, if the method is used also by other observers