Is Shedir Variable?

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ABSTRACT

Before the age of modern photographic and CCD observations $\alpha$ Cassiopeiae was labelled as a variable star, though this variability has not been seen with modern instrumentation. We present an analysis of 3 years of high precision space-based photometric measurements of the suspected variable star $\alpha$ Cassiopeiae, obtained by the broad band Solar Mass Ejection Imager (SMEI) instrument on board the Coriolis satellite. Over the 3 years of observations the star appears to not show any significant variability. Also, data from the Hipparcos epoch photometry annex shows no significant variability.

Subject headings: Stars: individual: $\alpha$ Cas stars: variables: general

1. Introduction

$\alpha$ Cassiopeiae (RA: 00h40m30.5s, Dec:+56°32′14.5″) is the brightest star in the constellation of Cassiopeia with an apparent magnitude of 2.25. It has the traditional name Shedir (which may also be spelt as “Shedar”, “Shadar”, “Schedir”, or “Schedar”). It is a class K0 IIIa star (Morgan & Keenan 1973) at a distance of 68 pc (Perryman et al. 1973). In the past it has been classified as a variable star (American Association of Variable Star Observers 1937). Birt (1867) observed that the star changes in magnitude from 2.2 to 2.8 but showing no clear structure to this brightening (about 80% of observations the star were found at the brighter limit). No significant variability has been detected since the 19th century. It is worth noting that there are three known companions to the star have been listed in the Washington Double Star Catalog (Mason et al. 2001), though they are just line-of-sight optical components (the nearest companion is some 20″ away, and is 14th magnitude). The question - is Shedir variable was posed by Sir Patrick Moore in the January issue of the BBC Sky at Night Magazine whilst summarising the year ahead Moore, and is the initial motivation behind this analysis.

In this letter we present SMEI observations of $\alpha$ Cassiopeiae with the aim of determining if the star is variable via high precision space based photometry. The data reduction and analysis is described in Section 2. In Section 3, we discuss the results from SMEI along with the the Hipparcos epoch photometry annex data with conclusions presented in Section 4.

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2. Data Reduction and Light-curve extraction

The photometry we present here were obtained using SMEI. The reader is refereed to Spreckley & Stevens (2008) for an overview of the processing of SMEI data in relation to the Cepheid variable star Polaris, with a more detailed description of the data extraction and processing pipeline given in Spreckley & Stevens (2009). In summary, the SMEI instrument consists of three cameras facing respectively along, perpendicular to, and away from the Earth-Sun direction. Each of the cameras has a field of view of $60^\circ \times 3^\circ$. SMEI has a roughly triangular pass band with a peak quantum efficiency of 47% at 700 nm and falling to 5% at 430 nm and 1025 nm. Due to the satellite’s orbital path the entire sky is imaged with approximately a 100-minute cadence. The individual $60^\circ \times 3^\circ$ raw images are bias subtracted, have a temperature scaled dark current signal removed, and are flat fielded. Hot pixels and high energy particle hits are corrected on the images via interpolation, before aperture photometry is performed. Aperture photometry based on a modified from of the DAOPHOT routines (Stetson 1987) are then performed. The produced light curves are then corrected for systematic instrumental effects. The data under consideration were gathered between Julian date 2452739.526 and 2453816.389 (April 2003 to March 2006). While the SMEI data extend beyond this date, subsequent data are still undergoing processing. The full light curve can be found in Figure 1 with no distinct variability seen (a maximum point to point scatter of 0.01 mag).

3. Results

The data was analysed for periodicities with the PERIOD04 package (Lenz & Breger 2005). The Fourier analysis reveals features at 1 day and harmonics of 1 day which are a feature of the SMEI data and are associated with stray light and daily periodicities in the cosmic ray level. Significant power is seen at 1.0, 2.0, 3.0, 4.0 and 5.0 d$^{-1}$. These are removed using the sine-wave fitting in PERIOD04. After removal of these features the Fourier spectrum clearly shows significant power in the data-set and can be seen in Figure 1.

We have also used data obtained from the Hipparcos epoch photometry annex (Perryman et al. 1973) and the resulting time series can be found in Figure 1. This data was obtained during the 4 year Hipparcos mission and like the SMEI data shows no significant variability of the source.

4. Conclusions

Based on the 3 years of continuous SMEI coverage and the past Hipparcos observations we are able to determine that there appears to be no significant variability in the optical emission from $\alpha$ Cassiopeiae. Past observations have suggested that the star is variable over periods of days. We do not detect any variability on these timescales. Of course we are comparing observations over a
century apart and it is intriguing that the variability has since ceased. If the star was genuinely variable and now has ceased then this is an interesting possibility for stellar evolution. Possibly the star experiences variability over larger time scales than our data-set and as such is a perfect target for amateur observers.

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REFERENCES

Campbell L., American Association of Variable Star Observers, 1937, Popular Astronomy, 45, 92

Birt W. R., 1867, Astronomical Register, 5, 138

Lenz P., & Breger, M., 2005, CoAst, 146, 53

Mason B. D., Wycoff G. L., Hartkopf W. I., Douglass G. G., Worley, C. E., 2001, AJ, 122, 3466

Moore P., 2009, Sky at Night Magazine, 44, 27

Morgan W. W., Keenan P. C., 1973, ARA&A, 11, 29

Perryman M. A. C., et al., 1973, ARA&A, 11, 29

Spreckley S.A., Stevens I.R., 2008, MNRAS, 388, 1239

Spreckley S.A., Stevens I.R., 2009, in prep

Stetson P.B., 1987, PASP, 99, 191
Fig. 1.— **Top Left:** The complete 3 years of the SMEI time-series showing no appreciable variability. **Top Right:** The Fourier spectrum of the SMEI data. **Bottom:** 4 years of data obtained by the Hipparcos satellite, showing no significant variability of the source.