COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3198

Konkoly Observatory
Budapest
30 May 1988
HU ISSN 0374-0676

FURTHER AUTO-CORRELATION ANALYSIS OF dMe FLARE STARS

PROXIMA CENTAURI (V645 CEN)

A modified auto-correlation technique which utilizes least-square successive differences was previously applied to multi-colour photometric data of the flare star, V1285 Aql (= G735), and found to reveal quasi-periodic trends in the B- and R-bands of a few minutes sustained for up to 1 hour (Andrews 1988). Burki et al. (1978) developed the method we follow for quasi-periodic trends, which stems from a paper by Baines (1951). The most probable "period" for V1285 Aql for the 0.013 mag. oscillations in the R-band was about 160 seconds. The wave-like variations do not appear to be micro-flares since these were not detected in the ultraviolet where amplitudes are invariably larger than in the longer-wavelength photometric bands, and the amplitude of the corresponding B-band "waves" would suggest that flaring in the U-band should certainly have been detectable. The interpretation of the results is difficult except perhaps in terms of a "characteristic time-scale" of re-processing of radiation within a remnant dust cloud in the stellar environment (Kenyon and Hartmann 1987), although asteroseismological pulsations are an attractive alternative.

The technique has been applied to another flare star, Proxima Centauri (= V645 Cen = Gliese 551, Sp. dM5e, V = 11.0 mag.). The photometric material was obtained in 1985 using the 50-cm telescope at the South African Astronomical Observatory using pulse-counting techniques already described (Andrews 1988). Prox Cen was monitored on 25 August 1985 from 17^h50^m to 19^h14^m UT using 1^s integrations in the U band, and from 19^h18^m to 20^h01^m UT using continuous multi-colour $UBV(RI)_{KC}$ integrations of 5,2,1,1,1 seconds, respectively. We have selected a subset of the 1^s data, consisting of 14.4 minutes of continuous U-band data, 860 data points, obtained during good sky conditions. Auto-correlation analysis using a time lag of 2.5 seconds was performed and, following previous methods, the power spectrum of the auto-correlation parameter was constructed for frequencies

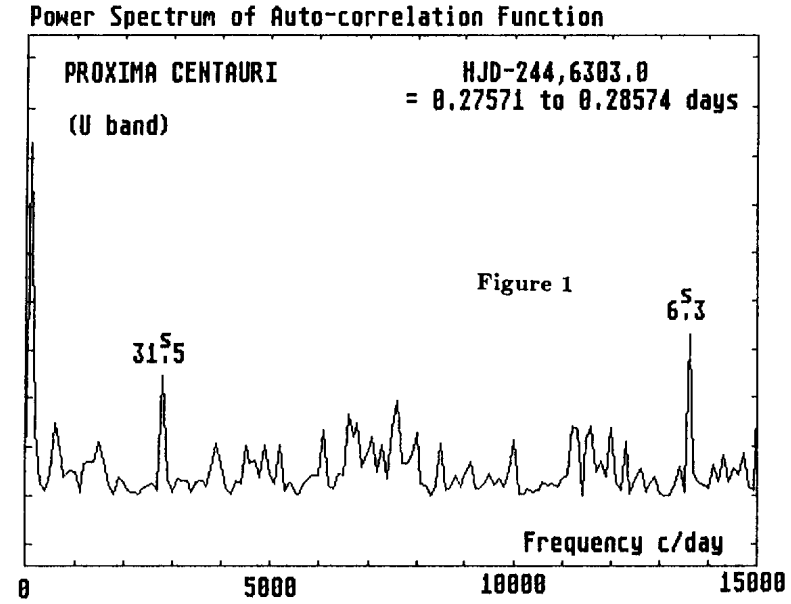

Figure 1

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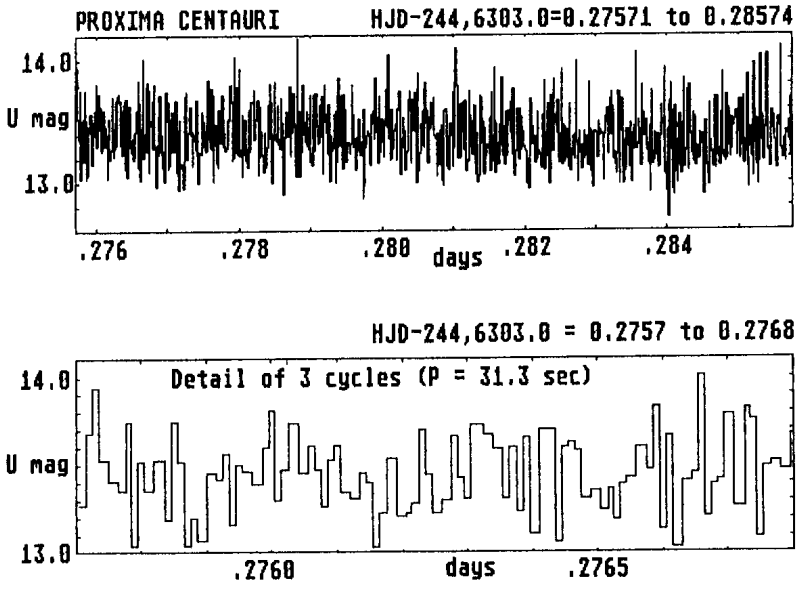

Figure 2

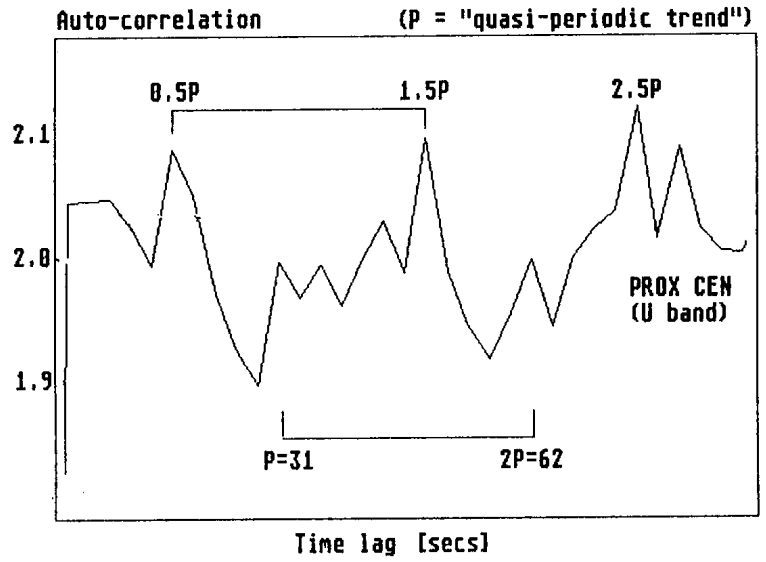

Figure 3

from zero to 15000 cycles per day (down to periods of 5.76 seconds). In the frequency domain we find three peaks, the lowest frquency corresponding to the gradual trend in the data due to slight departure from the adopted mean atmospheric extinction, and two lesser peaks at frequencies corresponding to periods of 31.3 and 6.3 seconds (Figure 1). The longer of these two periods is almost exactly five times the shorter period. During the observations we repeatedly noticed flare-like features of duration about 7 seconds. In Figure 2 we show the subset of U-band data and the first section of the data in more detail for exactly three "periods" of 31.3 seconds. A quasi-sinusoidal fit to the running mean shows an amplitude of about 0.3 mag. Clearly the data is very noisy and the statistics is shown to be poor from the auto-correlation. Crow et al. (1960) give tables for the significance level of our auto-correlation parameter for up to only 60 data points, from which we can only estimate a value of 85 to 90 percent confidence level. In Figure 3 we show the auto-correlation parameter plotted against multiples (m) of the time lag in seconds, up to m = 35. We see peaks and troughs corresponding to the "period" of 31.3 seconds. No large flares occurred during this subset nor during the total 2 hours' monitoring of Prox Cen. The "period" may

be another example of a characteristic time scale of fluctuations, as was found in V1285 Aql. As a light travel time, the "periods" of 31.3 and 6.3 seconds correspond to 45 and 9 stellar radii (c.f. 230 radii for V1285 Aql). It is, however, possible that we are recording atmospheric fluctuations, and it would be essential to eradicate this possibility. Further analyses of Prox Cen will be performed for the R- and I-band data which was obtained on the same night, and for which the signal-to-noise is considerably better.

A.D. ANDREWS

Armagh Observatory,
Armagh BT61 9DG,
Northern Ireland

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