COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3203

Konkoly Observatory
Budapest
15 June 1988
HU ISSN 0374-0676

REMARKS ON MODIFIED AUTO-CORRELATION ANALYSES AND THEIR APPLICATION IN A SEARCH FOR "TIME SIGNATURES" OF MICRO-VARIABILITY IN THE dMe FLARE STAR, V1285 AQL

Characteristic time intervals between low-amplitude photometric variations in dMe stars (henceforth termed flare star "time signatures") have been suspected in several wide-band observations, notably in the U-band for three dMe stars, V1285 Aql, V645 Cen and V1045 Oph (Andrews 1988a). The modified auto-correlation (MAC) technique utilized, which employs a statistic defined by the means of the squares of successive differences for equally-spaced samples, stems from the work of Baines (1951) and Burki et al. (1974). In order to test the method we have investigated the results from several sets of synthetic data generated from a pure sinusoidal signal with superposed gaussian noise. To a sinusoid of period 30 seconds and semi-amplitude 0.15 units we have added gaussian noise with a sigma of 0.30. The synthetic data consisted of 110 points, sampling continuously with 1-second integrations. Performing the MAC analysis of this synthetic data we have the result shown in Figure 1. The 30-second signal is clearly detected over the entire range even though the noise in the data was substantial. The "data" is plotted against time in days in Figure 2. The periodogram of the MAC parameter was useful in this case since the MAC statistic was weak (see Figure 2). For a good comparison with the data from V645 Cen (Andrews 1988b) we have employed a larger number of data points (860) for our synthetic data, again with 1-second integrations from a "star" monitored continuously. This time we introduced two frequencies as shown in

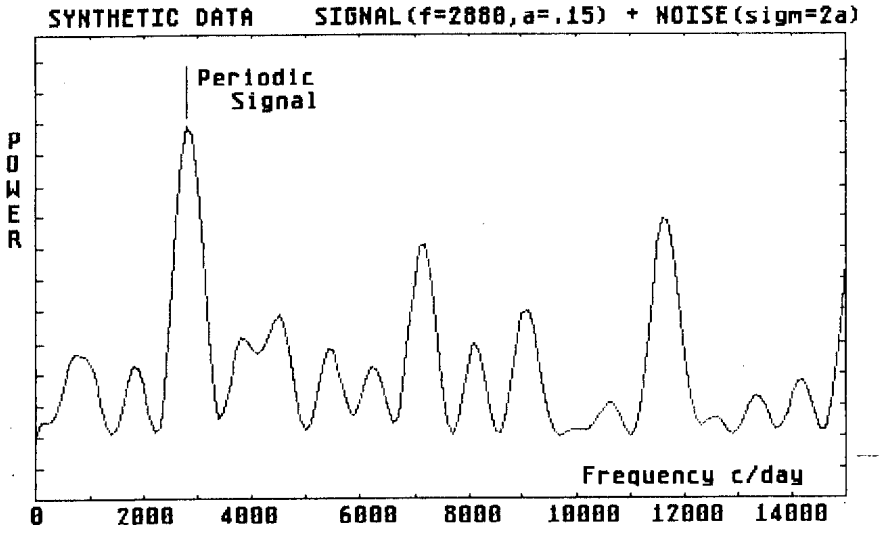

Figure 1

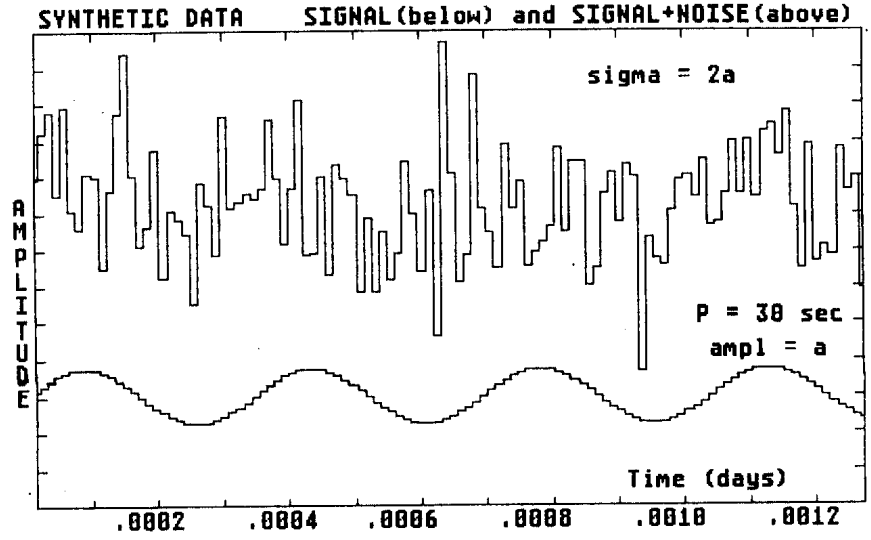

Figure 2

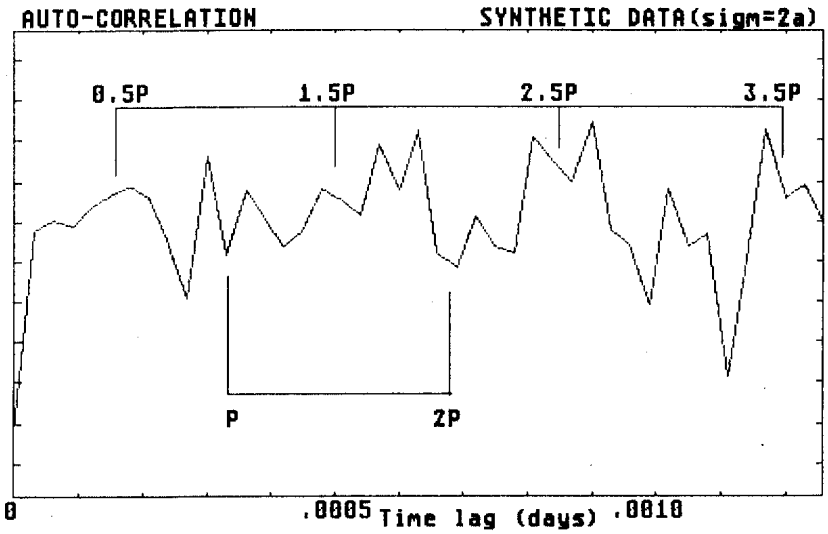

Figure 3

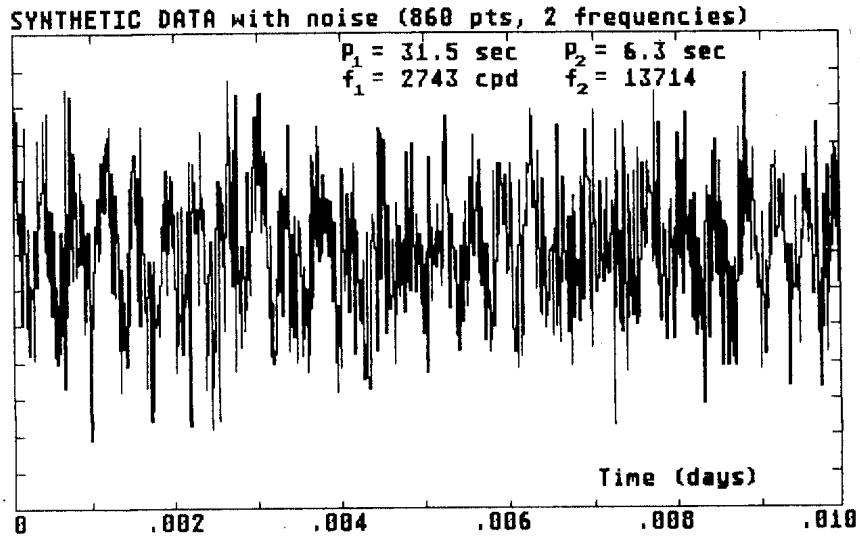

Figure 4

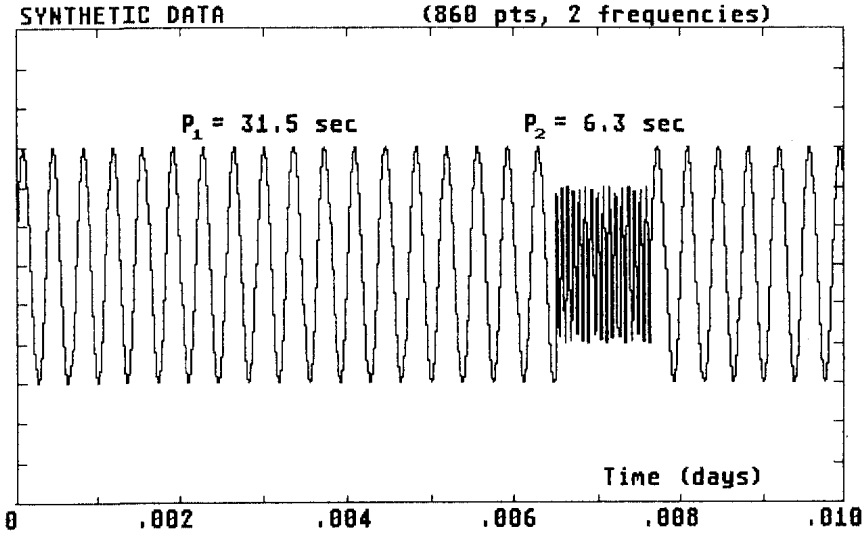

Figure 5

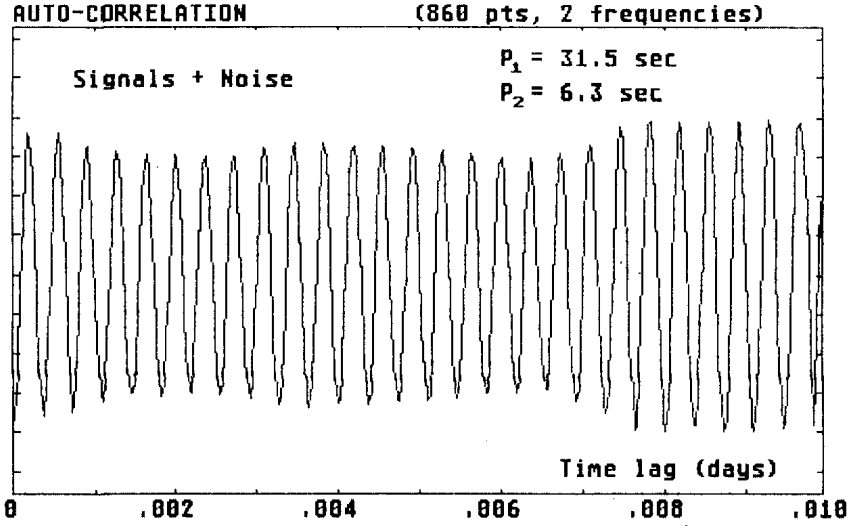

Figure 6

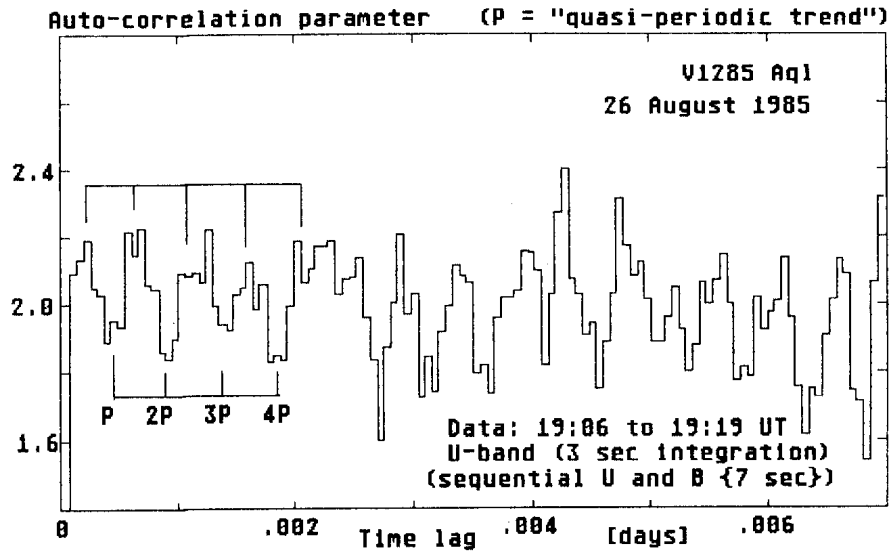

Figure 7

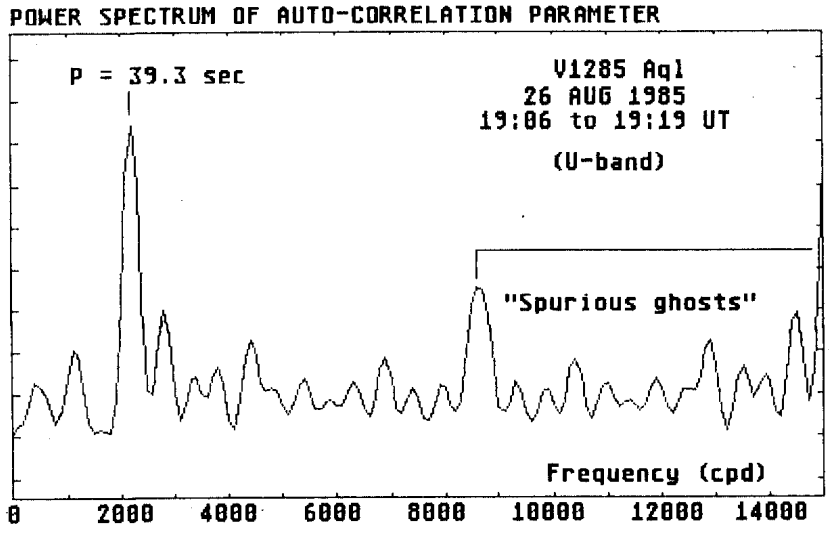

Figure 8

the "data" plot, and gaussian noise with a sigma of 0.3 (twice the semi-amplitude, a, of the stronger sinusoidal signal; see Figures 4 and 5). The weaker sinusoidal signal (period 6.3 seconds) was not detected in the MAC analysis using a unit time lag of 0.00003 days, but the stronger signal (31.5 second) was detected (Figure 6). We see an amplitude modulation caused by the time interval when this weaker signal occurred. The detection was so clear that we did not construct the periodogram of the MAC parameter. We find in the case of real stellar data that the MAC analysis is more powerful than a straight-forward classical periodogram analysis and although there are ambiguities in selecting "time signatures" for dMe stars, the method appears sufficiently interesting to pursue further. As an illustration we show new results for V1285 Aql using U-band data sampled at 7-second intervals (see Figure 2 in Andrews 1988a). The U-band time signature was 39.3 seconds (Figures 7 and 8), i.e. at a frequency too high to have been previously detected using longer sampling intervals (Andrews 1988a). The unit time-lag employed in the present work was 0.00003 days (near 2.5 seconds). The results for V1285 Aql show the difficulties of spurious ghost frequencies in periodograms which are present when there is insufficient sampling at high frequencies. Further investigations into dMe time-signatures during "quiescent phases" and near large flares, and in several photometric bands and in spectral emission-line strengths, would be worthwhile.

A.D. ANDREWS

Armagh Observatory
Armagh BT61 9DG,
Northern Ireland

References:

Andrews,A.D., 1988a, IAU Comm. 27. Inf.Bull.Var.Stars, No. 3197.
Andrews,A.D., 1988b, IAU Comm. 27. Inf.Bull.Var.Stars, No. 3198.
Baines,A.H.J., 1951, "Statistical Manual: Methods of making experimental inferences", 1951 revised edition, ed. Churchman.C.W., Frankford Arsenal, Philadelphia USA.
Burki,G., Maeder,A., Rufener,F., 1978, Astron.Astroph. 65, 363.