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THE PHOTOMETRIC VARIABILITY OF KX ANDROMEDAE

Introduction. KX And (HD 218393) is a bright (V = 6.9 - 7.1), active Be star which shows remarkable variations in light, colour and spectrum; see Štefl et al. (1990) for a recent, comprehensive review. There are (i) short-term variations with a possible time scale of 0.35 day (Pavlovski and Ružič 1989) or 0.4716 and/or 4.8635 days (Stagg et al. 1988), due to pulsation or perhaps rotation; (ii) medium-term variations on a well-established time scale of 38.919 days (Štefl et al. 1990), which bear some resemblance to what is observed in strongly-interacting binaries; and (iii) long-term variations on time scales of months to years, due to the changing amount of gas in the circumstellar disc. In an effort to disentangle these variations, we have subjected a large body of existing photometric data to a simple form of period analysis.

Observations. The input data consisted of several hundred UBV observations made between 1974 and 1986, mostly at Hvar Observatory (Štefl et al. 1990), and several dozen BV observations made during the 1980's at the University of Toronto (Percy et al. 1988).

Analysis. The autocorrelation of the observations was studied on time intervals ("lags") of 0 to 2 days and 0 to 40 days. Each interval was divided into approximately 40 bins. All pairs of observations $((m_i,t_i,), (m_j,t_j))$ for which t_j-t_i fell in a given bin were averaged: $<|(m_j-m_i)|>$, and the averages plotted against the time difference (Figures 1, 2). If the magnitude was periodic with period P, the curves would show minima of level σ (the observational scatter) at lags of 0, P, 2P, 3P etc., and maxima of level σ + about 1.2 Δm (Δm is the semi-amplitude) at lags of 0.5P, 1.5P, 2.5P etc.

Results. The results are shown in Figures 1 (V data) and 2 (U data); the results for the B data are very similar to those for the V data, indicating that variations of (B-V) colour are small. The 38.919-day variations are dominant. There is little or no evidence in Figures 1 and 2 (top panels) for maxima or minima corresponding to 0.35 day, 0.4716 day, or any other short period (except possibly ~ 1.2 days); the amplitude of any such short-term variability must be 0.02^m at most. The 38.919-day variations, on the other hand, show up clearly in Figures 1 and 2 (bottom panels). The maxima correspond to full amplitudes of 0.13^m in V, and 0.33^m in U, indicating that variations in (U-B) colour are large, in good agreement with the phase diagrams shown by Štefl et al. (1990). The rather unusual shape of the

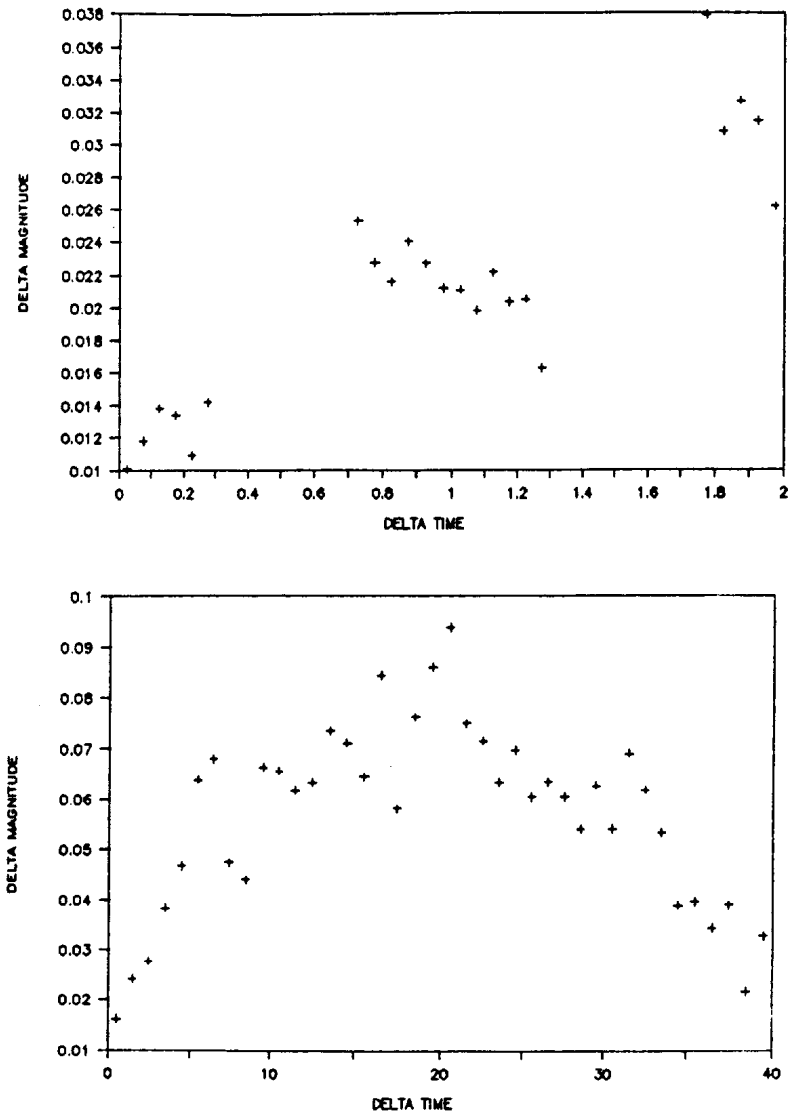

Figure 1. Autocorrelation diagram for V observations of KX And. Top panel: "lags" of 0 to 2 days; note the lack of clear maxima and minima. Bottom panel: "lags" of 0 to 40 days; note the maxima and minima corresponding to the 39-day period.

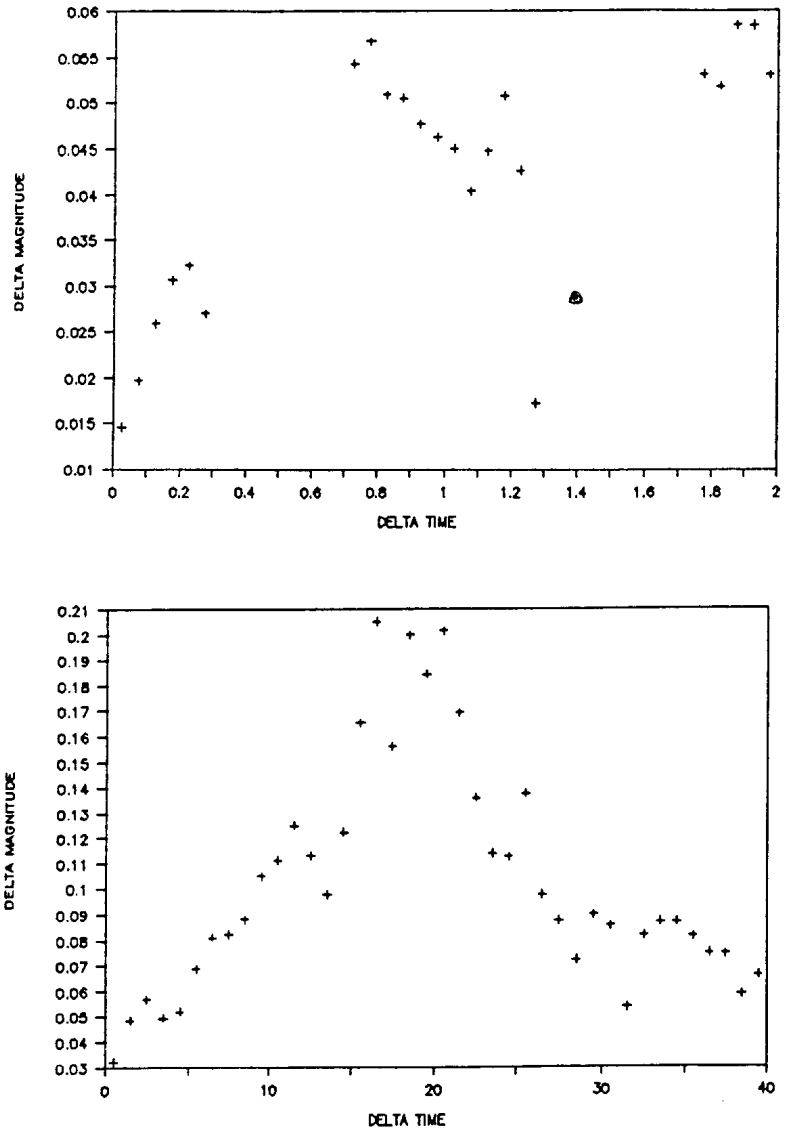

Figure 2. Autocorrelation diagram for U observations of KX And. Top panel: "lags" of 0 to 2 days; bottom panel: "lags" of 0 to 40 days.

autocorrelation diagram for the U data suggests that the variations are non-sinusoidal. Note that Štefl et al. (1990) found strong cycle-to-cycle changes in the light curve, especially in U. In particular, there were two distinct shapes of the U light curve, with different depths of minimum. The fact that Figures 1 and 2 (bottom panels) show clear, low minima at 39 days indicates that the long-term variations are insignificant on time scales of about a month; this is confirmed by light curves for individual years. We attempted to study the long-term variations in V by subtracting the "average" 38.919-day variation, but we found that the amplitude of this variation changed markedly from cycle to cycle, by factors of two or more. The long-term variations seem to have a typical range of 0.1^m, and a time scale of a year or more.

We have since used the simple autocorrelation method to study other stars with complex, irregular variations, and have found it to be very useful for analyzing the time scales, amplitudes and irregular and irregularities in such stars.

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