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LQ And /HD 224559/:
THE 0.62-DAY /OR THE 0.31-DAY/ PERIOD CONFIRMED

In a recent issue of this Bulletin, Hildebrandt /1985/ published 49 differential UBV observations of LQ And, a B3Ve star, secured during five observing nights in a period of 11 days in 1978. Analyzing the data by means of Deeming's /1975/ power-spectrum technique, he concluded that LQ And is probably a non-radial pulsator pulsating with periods of $0\overset{d}{.}2365$, and $0\overset{d}{.}2647$.

Light variability of LQ And was discovered by Provin /1953/. The variable has very intensively been studied by Percy and his collaborators /see Percy and Lane 1977, Percy 1979, 1981, 1983, and Percy et al. 1981/. Percy originally suspected a period of about $0\overset{d}{.}24$, but later he concluded that a period of $0\overset{d}{.}307$, with an amplitude of about $0\overset{m}{.}03$, was present in all B and uvby colours, and in all observing runs. Harmanec /1984a/ re-analyzed all the observations by Percy et al. using Stellingwerf's /1978/ phase dispersion minimization technique. He found that it was possible to fold all the data with a period of $0\overset{d}{.}310049$, with an uncertainty of some ± 2 cycles over the time interval covered by the data. He thus proved that the variation was truly periodic, since the data spanned an interval of several years. However, the main finding of Harmanec's study was that a better fit was obtained for a double-wave light curve with a period of $0\overset{d}{.}622832$. He called attention to three cases of rapidly variable Be stars with double-wave light curves /σ Ori E, EM Cep, and LQ And/ and proposed that their light variations were connected with rotation of non-uniformly bright objects rather than with pulsation. The existence of the group recognized by Harmanec has firmly been established by subsequent

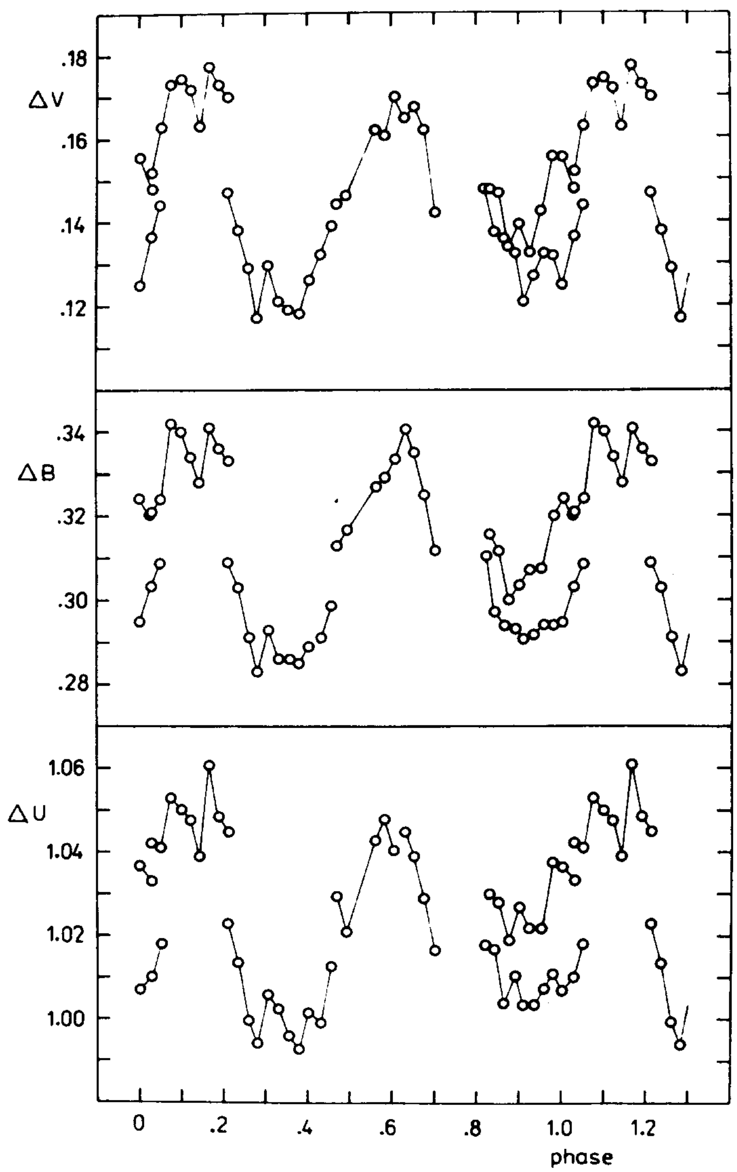

Figure 1. The light curve of LQ And for the 0.6206-day period

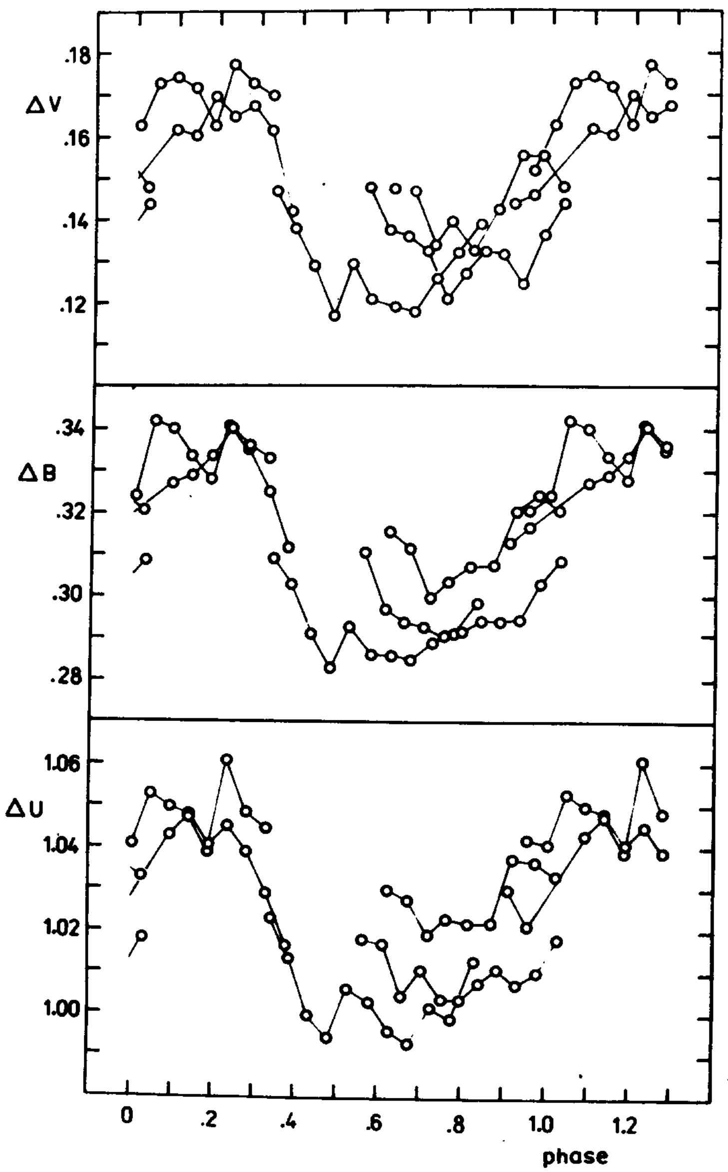

Figure 2. The light curve of LQ And for the 0.3095-day period

discoveries of about fifteen Be variables with the double-wave light curves - so far the most systematic work being carried out by Balona and Engelbrecht /1985/. Lists of confirmed or suspected rapidly variable Be stars have recently been compiled by them, and by Percy /1986/.

Hildebrandt /1985/ was clearly unaware of the recent studies of LQ And. As his data represent a good series of observations, I decided to undertake their independent period analysis using Stellingwerf's technique. The analysis clearly showed that a period of $0^d.6206$ /or $0^d.3095$ / is present also in Hildebrandt's data with a high significance - undisputably much higher than any periods near $0^d.25$ - in all three colours. The phase diagrams for both possible periods are shown in Figs. 1 and 2, respectively. Observations obtained on each particular night are connected by a broken line.

Although also these data seem to give a slightly better fit for the 0.62-day period, the ambiguity between a double-wave and a single-wave light curve for LQ And still persists. Baade et al. /1984/ analyzed RV and profile variations of a series of rather noisy 18 Å/mm photographic spectrograms of LQ And and preferred - somewhat surprisingly - the $0^d.31$ /and a very short $0^d.12$ / periods, although the $0^d.62$ period, and *not* the $0^d.31$ period, was clearly detected in their analyses of several of the best defined parameters /e.g. in radial velocities of H6 and higher Balmer lines or in estimated strength of He I lines/ - see their Fig. 1. Also Percy /1986/ still clearly prefers the $0^d.31$ period. Considering the fact that practically all well studied rapidly variable Be stars known to date exhibit double-wave light curves, I am personally almost convinced that also LQ And will be of the same type. However, it is extremely important to prove or to disprove such a conclusion observationally beyond any doubt. To this end, new very accurate narrow-band photoelectric observations, or spectroscopic observations with signal-generating detectors may be decisive, and should be carried out.

The following methodological remarks seems to be appropriate:

1. In my experience, the power spectrum analysis of observational data containing non-sinusoidal variations is a rather debatable, and often misleading technique, which should be avoided.

2. In spite of mathematically founded warnings, many astronomers still continue to search for multiperiodicity using very limited strings of observational data. They are often apparently successful in their effort, but the periods thus found need not reflect a true pattern of variations of the star in question. Quite often, even finding a true period in a short string of data is uneasy or impossible. For instance, the above-discussed Hildebrandt's data for LQ And can also be fitted with periods of $0^{d}.4483$, $0^{d}.8195$, $1^{d}.281$, $1^{d}.652$, $2^{d}.215$, $4^{d}.314$, etc. Without knowing the results of independent analyses of longer data sets, one would be unable to indicate a correct period.

3. When searching for periodicity in astronomical data, a possibility of a more complicated curve should always be kept in mind, and checked, before concluding that two or more periods are present in the data.

What conclusions can be made about the physical model of the rapid light variations of Be stars? As the situation appears now, it may turn out that *all* rapidly variable Be stars have double-wave light curves with periods in the range of possible rotational periods. This is not to say that rotation must be the ultimate cause of the variations observed, but some connection seems to be indicated anyhow. Another important piece of evidence arises from the fact that both the amplitude and the shape of the double-wave light curves of Be stars were found to vary gradually with time. At the same time, it appears that these variations are causally connected with the long-term spectral variations of the H I emission. Probably the first recognized, and the best documented case of such behaviour is o And /see Archer 1959, Harmanec 1983, 1984b, and references therein/. Also spectroscopic observations with a sufficiently high S/N ratio led to discoveries of rapidly variable Be stars, the first such cases being 28 CMa /Baade 1982a,b/, ζ Oph /Walker et al. 1979, 1981, Vogt and Penrod 1983/, and λ Eri /Bolton 1982/. Baade and Bolton advocated non-radial pulsations as the cause of the variations observed, while Walker et al. considered inhomogeneities in the Be envelope carried across the stellar disk by rotation to interpret their data. Vogt and Penrod applied both models and found both - inhomogeneities in the form of spokes separated by about 45°, and high-order non-radial pulsations - to give good fits to observed line--profile variations. Using somewhat debatable photometric evidence, they refuted the former model, however. Since then, their paper became quite famous and their modelling of profile variations of one star is amazingly often quoted as a firm proof of the fact that Be stars are non-radial pulsators. However, 28 CMa and λ Eri are known to exhibit the double-wave light curves, and the light of ζ Oph is suspected to vary on time scales of $0^{d}.98$ and $0^{d}.14$ /Balona and Engelbrecht 1985, Percy 1986, and references therein/. It is interesting to note that the two periods of ζ Oph - if confirmed - could be identified with the rotational period, and with occultation effects of 7 rotating spokes. These facts should not be neglected, I think.

The only possible conclusion is that future observational and theoretical studies should be carried out without too a strong preconception for one particular model. The nature of rapid variations of Be stars has not satisfactorily been explained so far, and various concepts are still possible.

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