ABRUPT LIGHT CHANGES AND MULTIPERIODICITY IN Be STARS: EW LACERTAE REVISITED*

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(Received 13 May, 1992)

Abstract. The combined 1983 campaign and Seoul data on the variable Be star EW Lac is reanalyzed. CLEANing of the Fourier transform of the present time series clearly shows more than a single period. A multiperiodic fit can account also for a sudden brightness change through frequency beating. Comparison with previous multiperiodic solutions based on data obtained in different seasons shows highly variable amplitudes of the pulsational frequencies. The consequence of this finding to variable shell activity of EW Lac is briefly pointed out.

1. Introduction

The Be and shell star EW Lac (HD 217050, HR 8731) is among a small number of Be stars for which observations span almost a century. It was recognized as a light variable already in the early days of modern photoelectric photometry by Walker (1953). This happened only by chance as Walker used it as a comparison star in an observational study of the β Cephei variable 16 Lac. By simply counting its light minima and maxima, he found that the star keeps on some kind of 'pseudo-period' around 0.7 d. He had some difficulty in finding a proper explanation of its light variability. First, there was no β Cephei variable with such a long period and, moreover, its period was not constant. Walker hypothesized that rotation of a spotted star was the most plausible explanation, and to escape problems with the non-periodicity he even speculated on spot migration – i.e., in modern terminology he invoked differential rotation. He was quite intrigued with the photometric behaviour of this star while organizing an international observational effort to study its light variability. Quite surprising, a few years later EW Lac did not show the previous prominent variability, making things even more complicated and puzzling (Walker, 1958).

Hence, more than twenty years elapsed before EW Lac was again observed photo-

* Yonsei University Observatory Contribution No. 98.

metrically. It was Lester (1975) who in the early 1970’s carried out an intermediate passband photometry of this Be variable. In his analysis, he argued that the variability is due to temperature changes in a stellar atmosphere, and not in its circumstellar shell. He proposed some kind of damped oscillations, an idea which was not adequately dealt with at that time. The presence of no strict periodicity was confirmed in the early 1980’s by several investigators (see Pavlovski, 1987, and references given therein). Also, pronounced long-term light and colour variations were recognized in a long-term photometric project on Be stars from Hvar Observatory (Harmanec et al., 1980).

Two papers directly precede the present work. The first one is by Pavlovski (1987) who analysed two data sets: his own observations from Hvar in 1982, and Walker’s original observations from 1950, respectively. His analysis aimed at finding out if strict periodicity, either of a single or double-wave light curve shape, holds for light variations of EW Lac. He found that only a multiperiodic solution satisfied the observational data, which explained the scattered phased light-curves for strict single periods, for single and double-wave light-curve shapes respectively. Evidence of multiperiodicity has been further elaborated by Pavlovski as an argument for nonradial pulsations in Be stars. The second paper is by Stagg et al. (1988) which deals with an analysis of an intercontinental effort for concerted observations of selected bright northern Be stars. Since it was found that a large number of light variable Be stars have periods around 1 d, an international collaboration is necessary to avoid troublesome 1 cycle d\(^{-1}\) aliases. EW Lac was among the target objects of this 1983 so-called ‘mini-campaign’. Again, photoelectric measurements of EW Lac revealed very complex photometric behaviour. Data cannot be phased on a single period, unless one supposes that its amplitude is highly and irregularly variable (see Figure 25 in Stagg et al., 1988). Even more, an abrupt change, in the terminology of Stagg et al., was observed, when light changes reached an amplitude of a quarter of a magnitude! Stagg et al. argued that this speaks against the magnetic oblique rotator model, or some variant of the spotted model in general. In leaving an explanation open, they however gave little preference for some kind of nonradial pulsations.

During the 1983 mini-campaign a large body of observational data was obtained from several observatories at different longitudes, and with good time resolution. Such an observational data set is very suitable for search for multiple periods. Particularly, we were interested if large changes in amplitudes of light variations could be explained by beating of different frequencies, hence, could be a natural consequence of multiperiodicity. It should be recalled that a quite similar abrupt change in stellar brightness is seen in Walker’s data, and was well matched by Pavlovski in his multiperiodic solution.

Almost simultaneously with the mini-campaign on five northern Be stars, EW Lac was also independently observed from Yonsei University Observatory near Seoul, Korea (Jeong et al., 1986). This data set enlarged the campaign observations even more, particularly in terms of the proper 24-hour coverage of the star’s variability.