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Observation of transient high frequency optical oscillations on three weak flares of the red dwarf EV Lac

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Abstract: In this paper we present the results of the analysis of the B-light curves of three weak flares of the red dwarf EV Lac In accordance to the results of the previous studies the results of the present study indicate that transient high frequency oscillations occur during the flare event and during the pre-flare state as well

1 Introduction

Thorough investigations on the red dwarf EV Lac [5], [6],[1], [2]and [3], indicate that transient high frequency oscillations occur during the flare event. Similar phenomena has been observed on other flare stars i.e. EQ PegB [4]. These results were deduced from the analysis of large flares. Nevertheless some indications on EV Lac [2] point to the fact that high frequency transient optical oscillations occur during weak flares even during the quiet state of this star. In addition, the logarithmic power spectrum of EV Lac in the quiet state present permanently a deviation from the Brownian Walk pattern at a frequency around of 0.3Hz which is an indication that brightness fluctuations with lower frequencies are not random. So in this paper we investigate the presence of hight frequency oscillations in three weak flares of EV Lac by analysing of the B-light curve, which were observed with the help of the 30-inch Cassegrain telescope of the Stephanion Observatory, Greece.

2 The Observations

The observations were curried out with the help of the 30-inch Cassegrain telescope of the Stephanion Observatory ($\lambda = 22°049'45''$, $\phi = 37°045'09''$ and $h = 900$m) which is equipped with a Johnson photometer. The digitized recording system has a recording resolution ranging from 0.0997s to 1.2s. Our observations on EV Lac consist of continuous monitoring in the B-band during the flare patrol periods from 12 to 20 of October, 2001. Table 1 displays the characteristics of these flares.

3 Analysis

The data consist of a sample of relative intensities i.e. (I-Io)/Io, where I is the flare intensity and Io is the quiet star intensity. The extent, as well as the resolution, of the observational sample permit a reliable Discrete Fourier Transform analysis of sufficient light-curve parts for the determination of possible transient oscillations in the frequency domain and their approximate location in the time domain. So the analysis comprises the following steps: (1) With the help of DFT-analysis we deduce the power spectra and the logarithmic power spectra of the flares and the quiet state star deflection.

The logarithmic power spectrum will enable us to separate the random part of the spectrum from the non random. (2) We isolate by filtering the random part of the spectrum and we estimate the standard deviation of the random noise σ_{BW}. (3) We identify the potential frequencies of star brightness oscillations from the power spectrum. To do this we use the Ho hypothesis test (see [1]) in which

Table 1: Characteristics of the observed flares

Flare No	Date	UT(max)	Duration (min)	$[\frac{I-I_o}{I_o}]$	σ_{BW}	sampling gap (sec)
1	13/10/01	$19^h44.866^m$	0.18	0.11	0.0129	0.11
2	14/10/01	$20^h24.466^m$	7.80	0.39	0.0129	0.0997
3	17/10/01	$19^h41.400^m$	6.6	0.28	0.0100	1.2

$\sigma = \sigma_{BW}$. (4) We filter out the identified frequencies from the star deflection. (5) We estimate the confidence level of those frequencies identifications comparing the amplitudes of the oscillations with the respective σ_{BW}.

4 Results

The analysis of our data indicate that transient high frequency oscillations occur on all the Flares with amplitudes higher than 2% during the flare event and during the pre-flare state as well. Since the standard deviation of the noise is 1.29% the confidence levels of the identifications are higher than 90%. The Figure 1 display a sample of these oscillations with period 8.6 sec. on the Flare No2. The Observed brightness oscillation frequencies range between 0.003Hz (period 36 second) and 0.278Hz (period 3.5second) not rigorously bounded and of varying amplitudes. The oscillations with period of 36 seconds are blurred by oscillations of smaller period. The existence of these transient oscillations during the pre-flare and the whole flare period of the weak flares, their varying magnitude and phases are in favour of the explanation which were offered by [6].

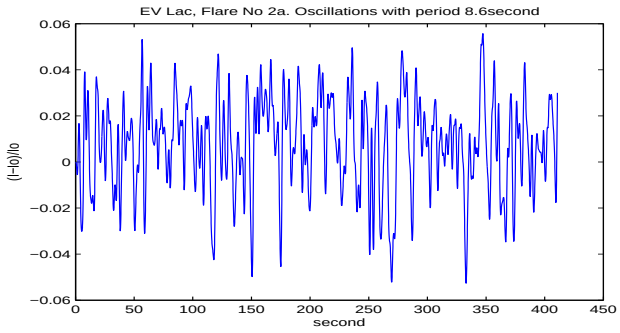

Figure 1: EV Lac, Flare No 2:Oscillations with periods 8.6 seconds.

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