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Photometric observations of the AM CVn star EC 15330-1403

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AM CVn stars are a group of hydrogen deficient, blue (U-B ~ 1.0) variables. EC 15330-1403 was found to be a bright (B~13.5) blue object in the Edinburgh - Cape blue object survey. It was then discovered to be the sixth AM CVn star based on photometric and spectroscopic observations conducted in 1994 (O'Donoghue et al. 1994).

The other five AM CVn stars are CR Boo, V803 Cen, CP Eri, GP Com and AM CVn. The first three of these objects undergo large luminosity variations of upto 4 mag. taking place over less than a day with no accompanying color change. All AM CVn stars exhibit low amplitude oscillations of < 0.1 mag. with periods in the range 500 - 2000s for different objects. The objects show the presence of broad shallow absorption lines of He I in the optical spectra. The model which explains many of their observational properties is that of a binary system with a low mass (~0.02 $M_{\odot}$) DB white dwarf transferring matter to another white dwarf.

EC 1530-1403 is a bright UV star with V = 13.66, B-V = –0.12 and U-B = –0.95 α_{1950} = $15^h\ 33^m\ 05.7^s$, $\delta_{1950} = -14° \ 03' \ 18''$). Its spectrum contains only broad shallow absorption lines of He I. Non-sinusoidal oscillation with a period of 1119s with a modulation amplitude of 10% is observed (O' Donoghue et al. 1994).

We had observed this object during 1995 (Ashoka et al., 1998). The predominant peaks seen in all the data sets are around 1119s and their harmonics around 559s and occasionally around 372s. We also observed excess power around 243-254s. The binary variation, if any for this system has so far not been detected. To confirm the excess power around 250s and to search for longer periods we observed this object again in 1997-98. This paper gives the results of these observations.

1. Observations and data analysis

We conducted the photometric observations in March/April 1997 and again in April 1998 using the 1m telescopes at Kavalur and NainiTal and our three channel photometer. The integration time used was either 5s or 10s. To maximise the signal no filter was used. The data were collected using a PC based software (Nather et al. 1990). Table 1 shows the log of different runs. N48-0363 is the longest run lasting 4.4 hour on 28 April 1998. Hence this run was subjected to a Discrete Fourier Transform (DFT). The light curve is shown in Figure 1 and the

Table 1. Log of observations.

Run no.	Date	Duration S	Duration H
KM 0329	13 Mar 97	5130	1.42
		4890	1.36
KM 0331	14 Mar 97	8155	2.26
NM 0333	1 April 97	2460	0.68
NM 0334	4 April 97	6895	1.91
		890	0.25
N48 0363	28 April 98	15920	4.42
N48 0365	29 April 98	6340	1.76

Table 2. Peaks observed in DFT of N48-0363

Freq. (mHz)	PERIOD (s)	AMP (mmi)
0.869	1115	19.7
1.7881	559.24	12.9
3.547	279.7	3.9

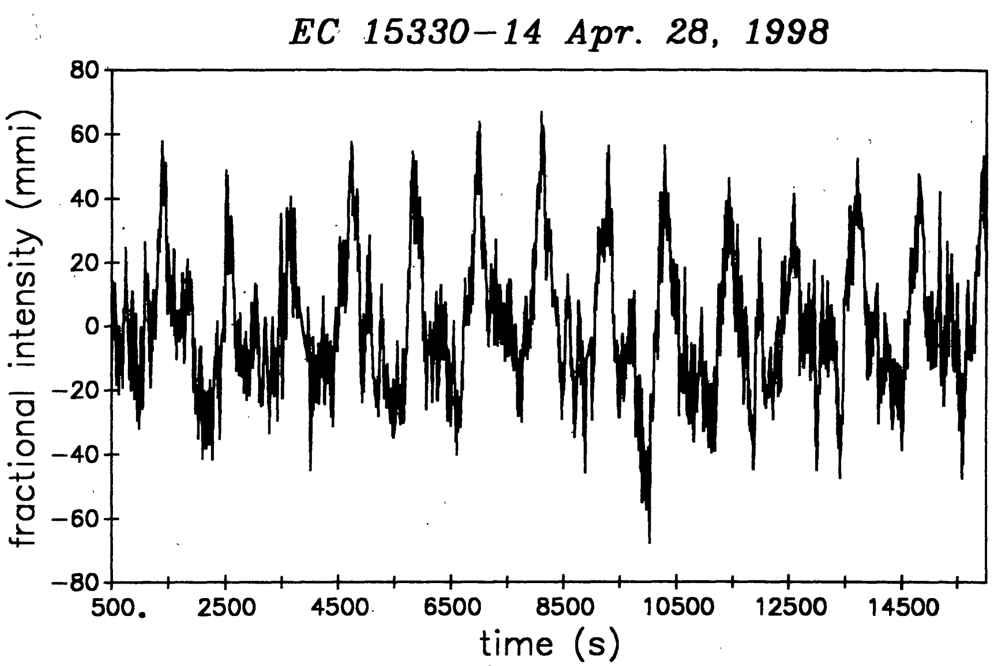

Figure 1. Light Curve of run no. N48-0363

DFT in Figure 2(a). The variation in amplitude in both these figures is expressed in terms of milli-modulation intensity (mmi). (The unit mi refers to the fractional intensity relative to the mean brightness of the star. Hundred percent modulation is defined = 1000 mmi). The frequency and the period of the observed peaks in the DFT are given in Table 2.

We also computed the DFT of all the combined runs of 1997. We then observed an additional peak at 0.402 mHz (Figure 2b). Finally all runs of 1997 and 1998 were combined together and we still see some excess power around 0.4 mHz (Figure 2c).

2. Results and discussion

The main peak at about 1119s and its harmonics are evident in all individual runs. However the main peak does not always occur at 1119s but occurs between 1100 and 1125s in different runs (see also Table 1 of O'Donoghue et al. 1994). In our longest run we observe the peak at 1115s. On combining the different runs the alias pattern is quite complicated. However it may be noted that when all the 1997 and 1998 runs are combined the alias pattern around 1115s and around the harmonics are different (Figure 2b & 2c).

This may be the effect of the existence of another period close to 1115s which may also explain the different period of the main peak in different runs.

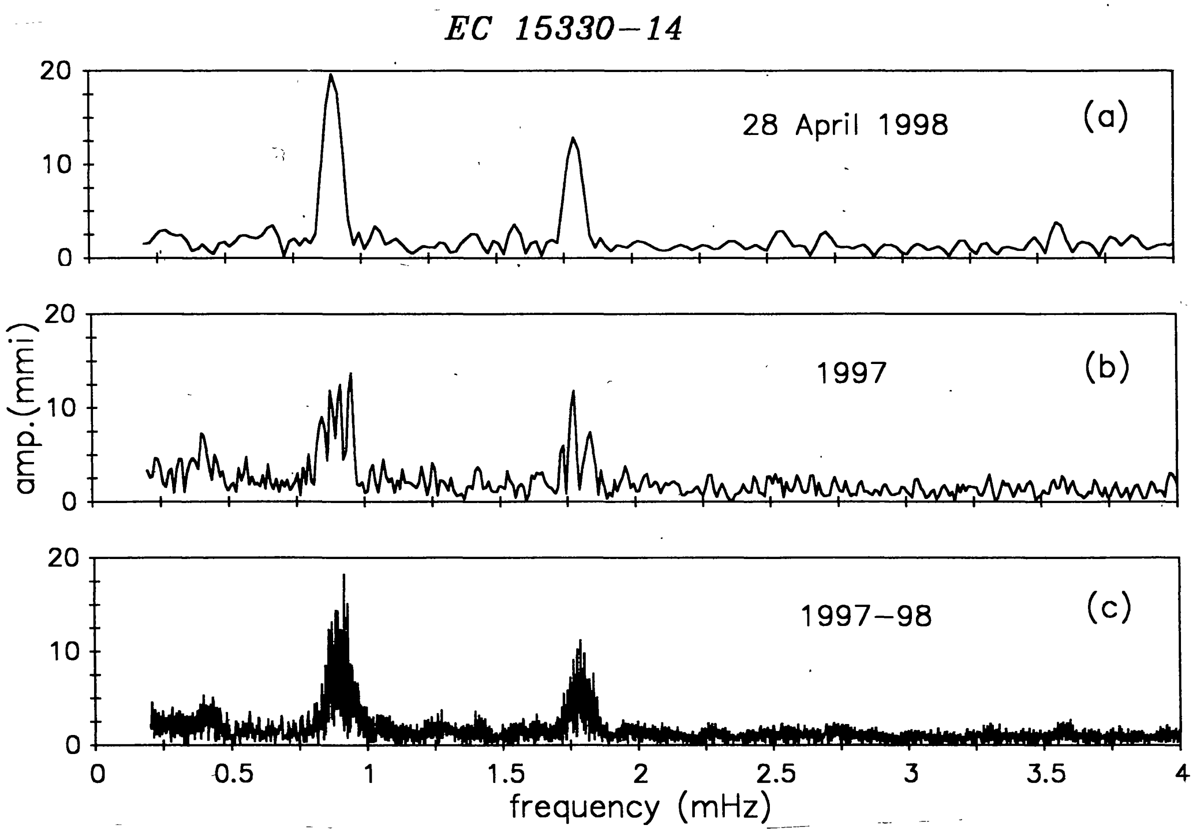

Figure 2. a) The DFT of run N48-0363 b) The DFT of combined runs of 1997 c) The DFT of combined runs of 1997 and 1998

Additional evidence for this is provided by the amplitude of the first harmonic with respect to the amplitude of the main peak which is different in different runs. This could be due to pulse shape modulation with time (or orbital period) or amplitude modulation due to two closely spaced frequencies. This cannot be resolved with our data set since the data breaks between runs are variable and long leading to a variety of aliases.

In order to improve the resolution and search for closely spaced frequencies a mini-Whole Earth Telescope (WET) campaign was conducted in April - May 1998, under which a few other observatories have been enlisted to continuously observe this object. A similar effort was undertaken for AM CVn (see Solheim et al. 1998). This data set will, most likely, be useful in resolving close periods, if any, and also determining the orbital period of the system.

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