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Photometric observations of cataclysmic variables from UPSO, NainiTal

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Abstract. We present time series optical photometric observations obtained from UPSO on five cataclysmic variables, namely - RE 0751+14, 1H 0857-24, EC1533-14, PG1711+33 and AE Aqr. The importance of the individual objects, the sample data obtained from UPSO, NainiTal and the preliminary results are highlighted.

Keywords: photometry - binary stars - cataclysmic variables

1. Introduction

Photometric observations of cataclysmic variables (CVs) with high time resolution provide important information on the geometry of the systems and short time scale phenomena around accreting compact objects. Exact determination of periods and their changes with time give clues about the evolution of these binary systems.

2. Observations

Observations were made using the 1m telescope facility of UPSO. The instrument is an ISRO two star/three channel photometer using uncooled RCA 8850 or Hamamatsu R647-04 PMT. The data acquisition, storage and real time display on PC were made using University of Texas interface card and Q9 software. Some of the data were obtained as part of the Whole-Earth-Telescope (WET) observing campaigns conducted on selected objects to obtain uninterrupted data for few hundred hours (Nather et al. 1990).

3. Individual objects

1. RE 0751+14 (PQ Gem) : is a magnetic cataclysmic variable (CV) discovered from ROSAT EUV sky survey (Mason et al., 1992). This star exhibits both the properties of intermediate polars and polars. A 13.9 min rotational period has been seen in x-ray, optical and in IR bands (Hellier et al., 1994; Potter et al., 1997) together with the reprocessed period at 14.5 min.

Therefore, the implied orbital period of this system is around 5-6 hrs. From all the above properties, this star was classified as an intermediate polar. However the estimated magnetic field of 8-18 MG (Piirola et al., 1993) and the modulation of circular polarization at the spin period of 13.9 min classified the star as a polar.

RE 0751+14 shows colour dependent amplitudes and profiles for spin and orbital side band periods. Spin pulse profile is sinusoidal in UBV bands and double peaked in R and I bands. The spin pulse profile in x-ray is highly energy dependent. In optical band, a modulation around 1.14 hr is also reported.

Observations were made during March/April 94 in UBV bands with an integration time of 10s. The sample light curve and its DFT is shown in Fig 1. Our results confirm the presence of 13.9 min spin period. The 14.5min period is barely resolved. No periodicity at 1.14 hr is noticed. Orbital period modulation could not be seen in our light curves. Therefore it may imply that either the system is of low inclination or the data length is not sufficient.

A Whole-Earth-Telescope (WET) observation campaign was conducted in Feb 96. The WET observations may throw more light on this enigmatic object (Marar et al. 1997).

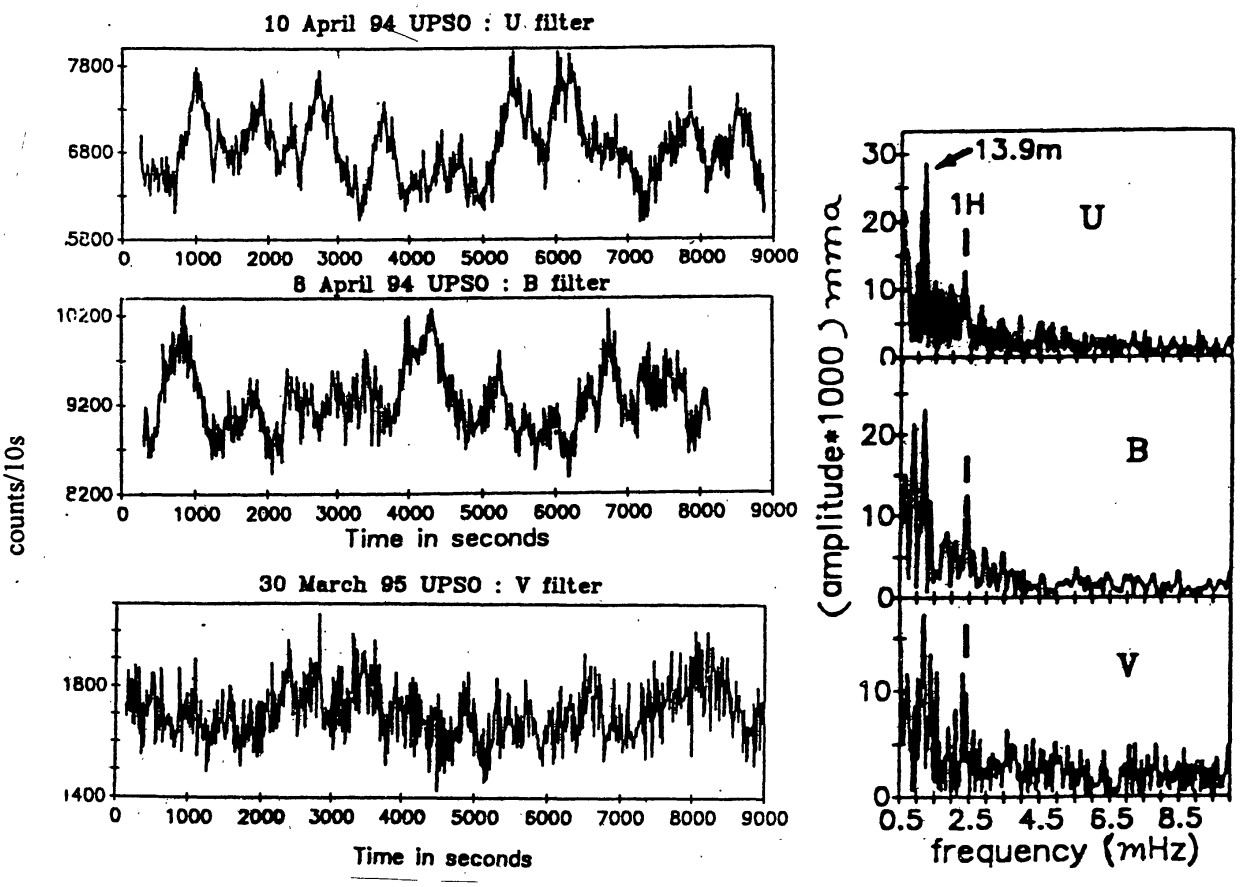

Figure 1. Light curves of RE 0751+14 and its power spectra

2. 1H 0857-24: is a magnetic CV discovered from HEAO-1 as a hard x-ray source. The object was classified as an intermediate polar (Buckley, 1992) with an orbital period around 1.9 hrs. A photometric period is suspected around 52 min. This star is also a dwarf nova with brightness varying from 12-16 V mag. WET observations were carried out during Feb/Mar 92.

We observed the star during 4-12 April 92 with 5s integration in white light. During that time the star was in its outburst state around 13 V mag. The light curve together with its power spectrum is shown in Fig. 2.

During our observations the star faded from 13-15 V mag. We detect modulation at 114 min. A second peak at 52 min. is also seen. Rapid fluctuations in the light curves are also noticed. The star stayed in its outburst state nearly for 8 days. Combining our data with the previous data from the literature, the estimated outburst period is around 30 days. Observations are continued to study the star during different phases of its outburst cycle.

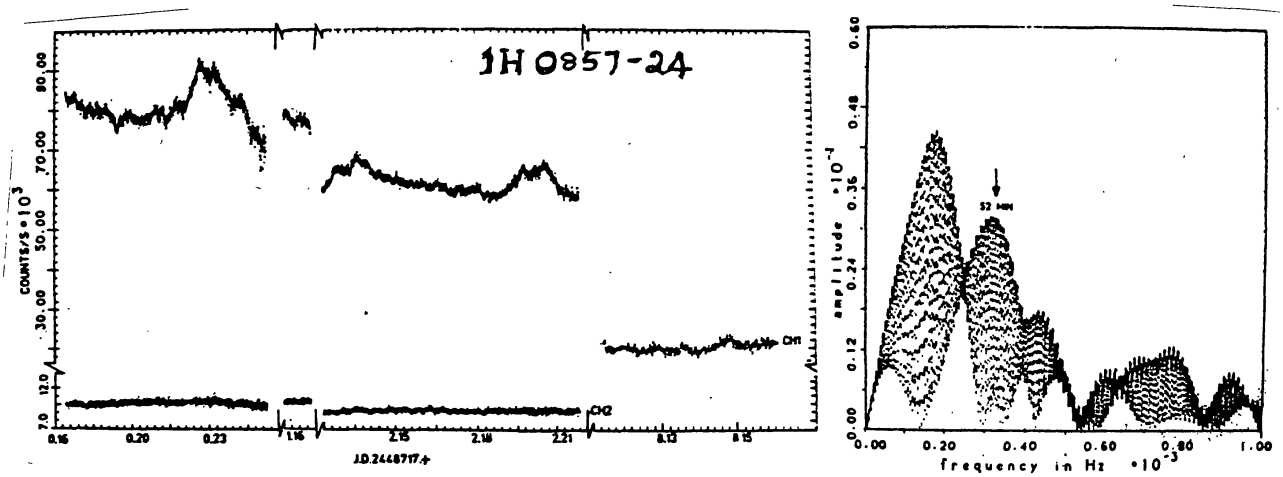

Figure 2. Light curve of IH0857-24 and its power spectra

3. EC1533-14: is discovered as the sixth AM CVn type star from Edinburgh-Cape blue object survey (Donoghue et al., 1994). This is an interacting binary white dwarf system. The optical light varies with a period of 1119s. Eventhough the interacting binary white dwarf model (IBWD) explains the observed properties of this system, still some of the most pressing questions of this group include; 1. What is the mechanism for the short-period oscillation seen; 2. What are the orbital periods of these systems and how is the orbital period related to the period of the oscillations? We observed the star during March/April 95 with 5s integrations in white light. The sample light curve and its DFT are shown in Fig. 3.

Even the short run of data could show clearly the modulations at 1119s. First and second harmonics at 559s and 372s respectively are detected. Few more periods at 254-243s are also noticed. Further observations are continued.

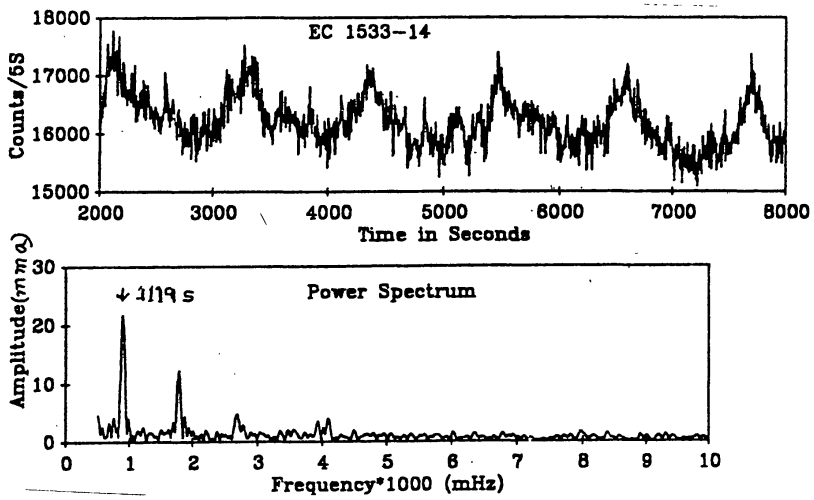

Figure 3. Light curves of EC 1533-14 and its power spectra

4. PG1711+33: is an intermediate polar in the period gap of orbital period distribution of CVs. Many controversies still exist on the exact nature of the periodicity in the system (Patterson & Skillman, 1994). The photometric period is 2.8 hrs. Spectroscopic period from the radial velocity measurement is either 2.6hr or 14.76 hr. Therefore if 2.8 hr is considered as the beat period and 2.6hr as the orbital period then rotational period should be 1.56hr or 1.77 hr (Shafter et al., 1989). No evidence for the presence of these periods is seen in the light curve. EXOSAT observations showed no x-ray emission, hence the rotation period could not be confirmed. Recent report is that the 2.8hr photometric period is disappearing and the star brightened by 0.3 mag.

Observations were made during April 92 with 5s integrations in white light. A sample light curve and its DFT is shown in Fig 4.

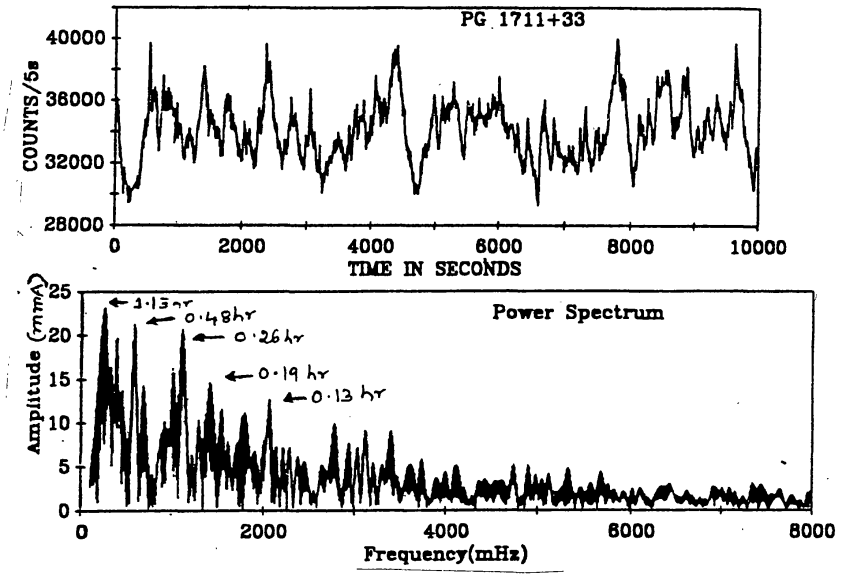

Figure 4. Light curve of PG 1711+33 and its power spectra

Results show that there is no evidence of the presence of 2.8 hr period confirming that it has disappeared. Many other periods mainly at 1.13 hr, 0.72 hr, 0.48 hr are seen in the DFT. Some of the periods could be quasiperiodic. More observations are needed for better understanding of this system.

5. AE Aqr: is an intermediate polar with orbital period of 9.8 hr (Patterson, 1979). The DFT of the light curves show periods at 33s and 16.5s. Since x-ray emissions were seen at 33s period, 33s is confirmed as the rotation period of the white dwarf in the system. The light curve also shows flickers. The more interesting property of this star is the presence of large amplitude flares up to 1 mag lasting for minutes to hours. What is unknown about these flares are their large amplitude, sudden onset and blue colour. "Gated accretion model" is proposed to explain the properties of the flares in this system (van Paradijs et al., 1989).

WET observations were made during October '93. We observed for 4 nights from UPSO during the campaign with integration time of 4s in white light. A sample light curve and its DFT are shown in Fig. 5. The 33s rotation period and its first harmonic at 16.5s are clearly evident in the Fourier spectrum. The WET data is under analysis and more interesting results are awaited. (Donoghue et al., 1995).

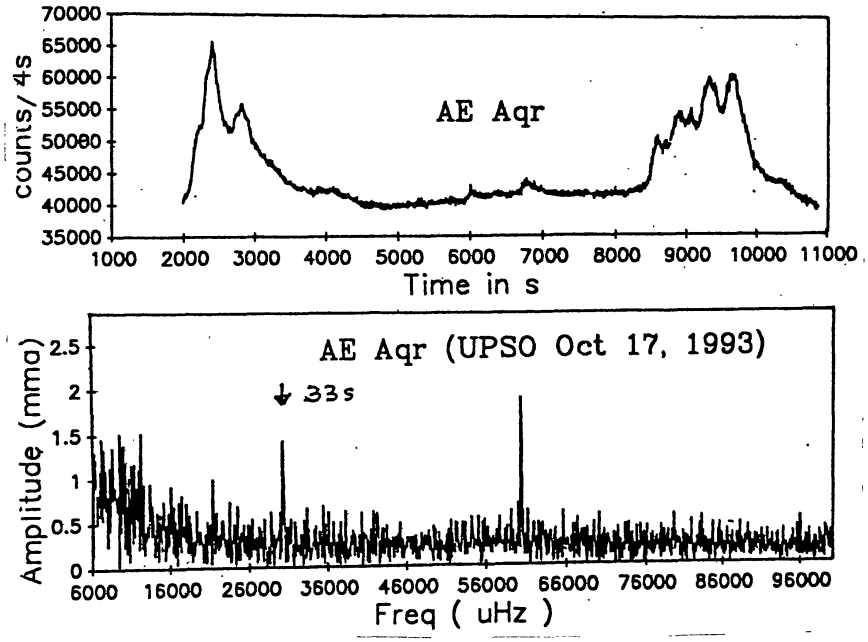

Figure 5. Light curveof AE Aqr and its power spectra

4. Conclusions

In this presentation, we have brought out the importance of time series photometric data for the detailed study of a few selected targets and samples of data obtained on those targets from UPSO 1m telescope facility. Detailed analysis on each object will be made and published elsewhere after combining the data obtained at UPSO, VBO and WET facilities.

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