DETECTION OF AN EXTREMELY ACTIVE STATE OF AM CANUM VENATICORUM

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ABSTRACT: We report fast photometric observations on AM CANUM VENATICORUM (AM CVn) the ultra short period, hydrogen deficient variable. We have detected on 24th February, 1985 an intense flare of (Δm)peak $\approx$0.34 in white light lasting over 200s. Following this flare we observe an enhanced double humped structure lasting for 1051s which is the dominant periodicity exhibited by AM CVn. We have also detected the 525s and 1051s periods. In addition, we report flickerings, lasting typically 1-2 minutes, that are characteristic of cataclysmic variables.

1. INTRODUCTION

AM Canum Venaticorum (HZ29) is one of the fastest known white dwarf variables currently thought to consist of a degenerate semi-detached binary system. During its chequered career in the astronomical literature it has been considered as a white dwarf, a hot subdwarf, a magnetic rotator, a system of pair of subdwarfs, a triple system and even as a quasi stellar object.

First noted by Malmquist (1936) this system exhibits broad and probably double HeI absorption lines and is conspicuous by the total absence of hydrogen lines. The He spectrum is found to be too shallow and too wide (Greenstein and Matthews, 1957) which initially led to the conclusion that it may be a DB white dwarf. Smak (1967) who made the first detailed photometric observations detected a double humped structure with a maximum variability of 0.05 mag. He determined a period of 1054s and was the first to propose a binary theory for the system. Later Ostriker and Hesser (1968) improved on the period determination (1051.118s) and

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also detected a 525.53 s period. They found that a model of a close pair of white dwarfs will necessitate much shorter periods for the assumed masses and therefore proposed a model consisting of hot subdwarfs or a magnetic white dwarf. However, during later observations no circular polarisation has been detected in the system and the 525s period is not always present. Krzeminski (1972) found that a single period did not fit all data sets and determined two periods namely 1051.043s and 1051.056s. The model he put forward was that of a triple system.

Warner and Robinson (1972) conducted fast photometric observations with an integration time of 1 s. They refined the period value as 1051.0505s but could not detect any significant rate of change of this period. They reported in addition, several flickerings with periodicities ranging from 20s to 150s. Their observations supported the binary system model which was later expounded by Faulkner et al (FFW,1972). Spectroscopic data obtained by Robinson and Faulkner (1975) showed no doubling of helium lines and also confirmed absence of radial velocity variation. However the white dwarf binary model seems to best fit the peculiar profile and strength of the spectrum. Patterson et al., (1979) determined a period increase on a time scale of 10^5 years with a mass transfer of $3(\pm1.5)\times10^{-7}$ $M_{\odot}$/year which is much higher than that predicted by the FFW model. They determined a period of 1051.212 $\pm$0.015s and a coherent periodicity of 26.3s.

More recently, Solheim et al., have reported that the 1051s period is infact slowly decreasing and hence concluded that this period may represent the rotation period of the accreting white dwarf in the binary system. Elsworth et al., (1982) had observed a possible outburst from the system, the like of which has not been reported earlier. The outburst (flare) showed a 30% ($\sim$0.28 mag) increase in intensity in white light which lasted a total duration of about 50s.

Keeping in view all these enigmatic and variable characteristics of this object we decided to monitor it in the course of our regular program of optical observations of X-ray emitting cataclysmic variables. Our main objective was to look for transients and short term flickerings, if any.

2. OBSERVATIONS

The fast photometric observations of AM CVn were conducted during February-March 1985. We employed a photometer using a thermoelectrically cooled RCA C31034 photomultiplier tube attached to the 1 metre telescope at the Kavalur Observatory. The output of the tube was amplified using an ORTEC system consisting of a preamplifier (9301)and an amplifier discriminator (9302). This amplified signal was fed to a photon counter (9315) and the data was fed through a sampling/control unit (9320) to a printer.

The star was observed in U,B,V, filters with the respective sky observations, but the long runs (four hours) were conducted in white light. The comparison stars observed were BD+39 2541 (V=10.11), a comparison star east of AM CVn (RA 1985)≈12^h 35^m Dec (1985)≈+37° 41'; V=10.4)and a check star Landolt 104-306 (V=9.36). The integration time was 1 s and diaphragm used was 24 arc sec for all observations. Fig.1 and 2 show part of the light curves obtained by us.

3. RESULTS AND DISCUSSION

We observed a flare lasting about 3.4min (fig.1) on 24 Feb 1985 at around 20h 17m UT.The flare shows a peak intensity increase of about 37% (≈0.34 mag) in white light above

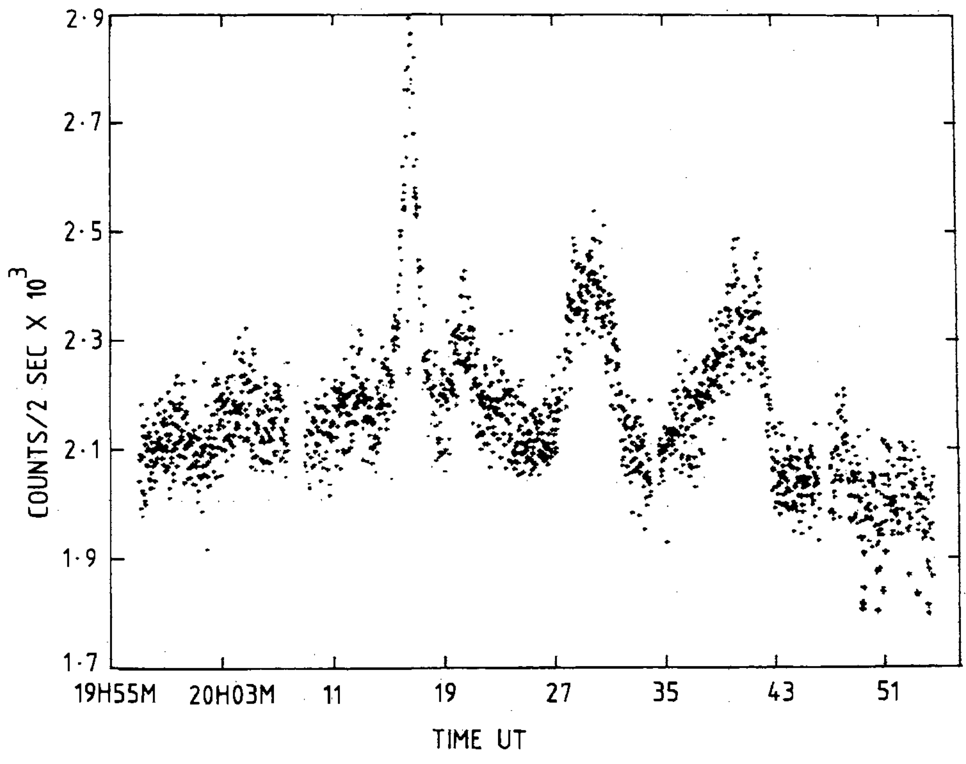

Fig.1. Light curve of AM CVn in white light(Feb.24, 1985)

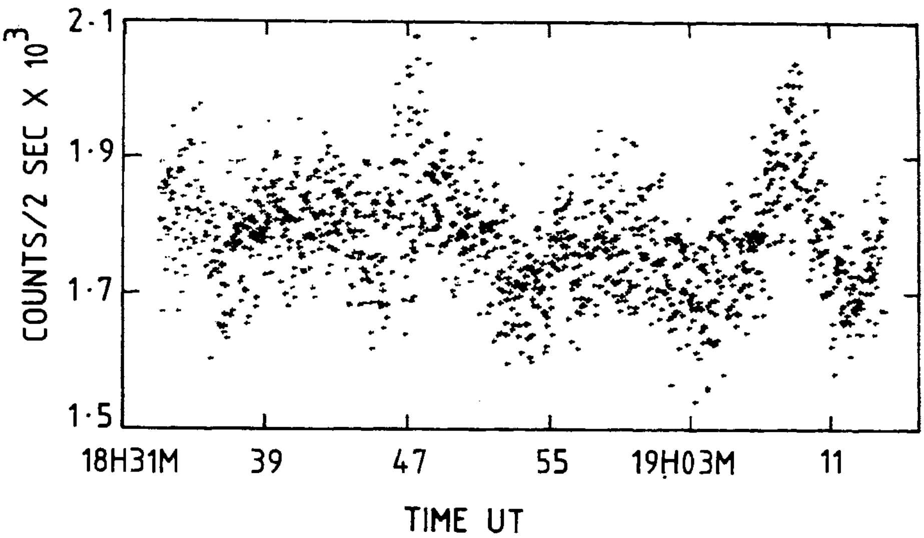

Fig.2. Light curve of AM CVn in white light (March 19, 1985)

the quiescent level. The equivalent duration P of this flare calculated using the relation,

$$P=\int \frac{I_{o+f}(t)-I_o}{I_o}\, dt$$

is found to be 15 s. Here $I_{o+f}(t)$ is the intensity of the star as a function of time t during the flare, I_o is the quiescent level intensity before the flare and the integration is carried out over the whole duration of the flare. The rise to peak intensity of this outburst is complete in 108s and it decays to ambient level in 96s.

Following this flare we observed a double humped structure, typical of AM CVn light curves, lasting for 1050s which is the dominant period exhibited by AM CVn. The amplitude of this 'M' structure is however much higher than that reported before by other authors. The first hump with a $\Delta m=0.15$ mag, is nearly symmetric and lasts for about 7.5min, whereas the second hump with a $\Delta m=0.12$ mag, is skewed to the right and lasts for about 10 min. We point out that the primary minimum (between the two humps) has the lowest intesity level and the duration of these humps are consistent with the phase detected earlier by other observers. Though this double humped structure is observed in other light curves shown in fig.2 (obtained on March 19, 1985) also, the one shown in fig.1 is unique for its enhanced amplitude.

We wish to emphasise that the flare observed by us has a 37% increase in white light and is clearly seperated from the typical 1050s 'M' structure. This is to be compared with the data presented by Elsworth et al., (1982), where a 30% increase in intensity is reported, but shows a triple humped structure lasting for a total duration of about 50s only.

In addition we note in fig.1 small flickerings typically lasting 1-2 min, which are characteristic of cataclysmic variables. Except for the flicker immediately following the flare all other flickers have about 0.05 mag comparable with the largest amplitude variation of the 1051 s period reported by Smak (1967).

The differential visual magnitudes calculated for AM CVn using BD+39 2541 as the comparison star are given in Table 1.

TABLE 1

Date	Time in UT	Visual Magnitude
24 Feb 1985	23h 00m	14.1
17 Mar 1985	21h 28m	14.2
18 Mar 1985	20h 03m	13.9
18 Mar 1985	21h 25m	14.1
19 Mar 1985	18h 16m	14.0
23 Apr 1985	20^h 11^m	13.9

In all our observations we detect a 525 s and 1051s period by the folding technique employing synchronous summation. However due to the short length of our data, we are unable to refine the value of the period obtained by earlier observers.

Searches for the detection of coherent periodicities at 26.3s reported by Warner and Robinson (1972) did not yield positive results.

Additional observations are necessary to confirm the type of variation in the 1051s period and its implication in clinching a suitable model for this system.

4. REFERENCES

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