HIGH-SPEED PHOTOMETRY OF SYMBIOTIC SYSTEMS

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Abstract

We present the results from high-speed photometry observations of the symbiotic systems R Aqr amd CH Cyg, and symbiotic-like systems Mira AB and MWC560 (V694 Mon). The periodogram analyses show multiple periods (or quasi-periods) in MWC560 and CH Cyg ranging from several minutes to hours.

1. Introduction

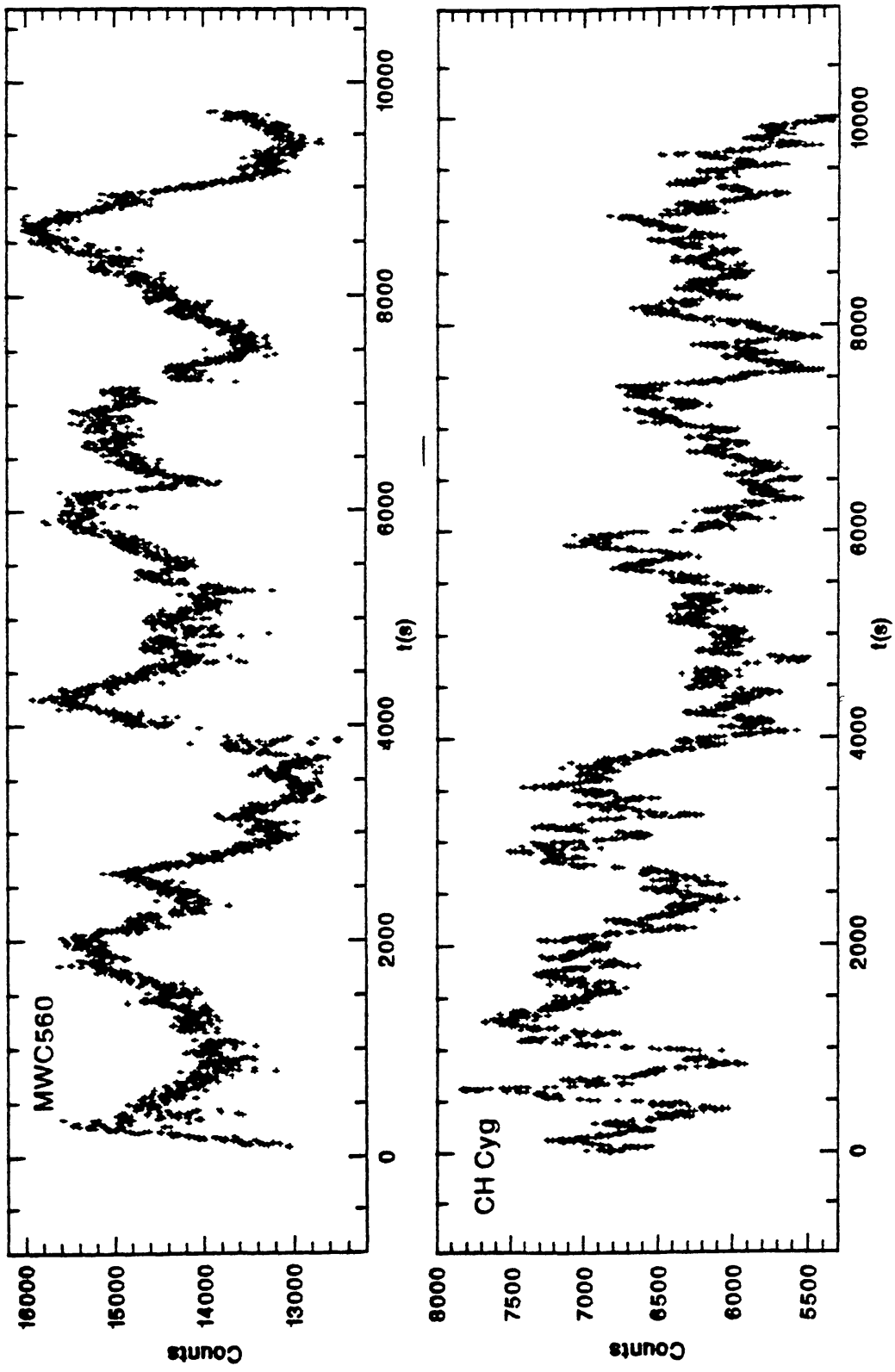
We carried out high-speed photometry observations of two symbiotic systems (R Aqr and CH Cyg) and two symbiotic-like systems (Mira AB and MWC560) on several occasions since July 1991. The observations were made using the McDonald Observatory 0.76 m and 0.91 m telescopes and a 2-channel photometer with offset guider. The star was centered in channel 1 in a 1.5-mm (30 arcsecond) aperture. A Johnson U-band filter was employed. The integration time was 2 seconds. Channel 2 contained a nearby anonymous star of similar magnitude in a 2-mm (40 arcsecond) aperture. Channel 1 and 2 observations were made simultaneously using two different photomultiplier tubes. We analyzed these observations using the Horne and Baliunas (1986) period searching technique. The periodograms of the object and the comparison star were calculated after subtracting the long term bias.

2. Observations and Results

1946+32 CH Cyg

CH Cyg is an active symbiotic system composed of a red giant and an accreting white dwarf. Recently, Hinkle *et al.* (1993) suggested a presence of a third body (a main sequence star) in the system. This system underwent several active phases, including an outburst from 1977 to 1986. The short term variability during and after the outburst has been studied by several authors. Variations on time scales from a few minutes to 10 minutes were detected during the outburst, while immediately after the outburst the flickering practically disappeared (Mikolajewski and Mikolajewska 1990).

After the outburst, flickering was detected on several occasions by Panov and Ivanova (1992) during their observations from 1991 to 1992. We carried out high-speed photometry on 19 July 1991 and detected significant brightness variations (5–25%) of the hot companion of CH Cyg on several time scales ranging from less than one minute to several hours (Figure 1). It is interesting to note that only 10 days before our observations, Panov and Ivanova (1992) did not detect any flickering. The periodogram



Top: High speed U-band photometry of MWC560 obtained on 25 January 1993. Bottom: High speed U-band photometry of CH Cyg obtained on 19 July 1991.

analyses of our data show periods of about 10 minutes and 25 minutes. The 10-minute period is similar to the period detected by Mikolajewski and Mikolajewska (1990) and could be caused by the rotation of the white dwarf.

2338-15 R Aqr

The R Aqr binary is one of the most peculiar objects in the class of symbiotic systems because of its extremely complex and evolving circumbinary environment, including a number of nebulosities and a jet-like structure (Sopka 1982). The binary is composed of a Mira-type variable and an enigmatic accreting companion, possibly a white dwarf. We carried out high-speed photometry observations of R Aqr in July 1991 in the U band and explored the short-term brightness variations of the companion. The periodograms calculated using the high-speed photometry observations of R Aqr do not show any evidence of significant short term variability, nor any indication of possible outbursts or flickering. This result does not preclude the possible presence of short term brightness variations similar to CH Cyg: it may be that the amplitudes of the oscillations in the case of R Aqr are smaller. Our aim is to continue the search for flickering in R Aqr at other epochs, since the amplitude of the oscillations could increase during a more active phase, as for the CH Cyg symbiotic system. If detected, the brightness variations could specify the nature of the activity of the hot companion.

0214-03 Mira AB

Mira AB is the nearest binary system (at a distance of 77 pc, Jenkins 1952) composed of a Mira-type variable star (o Cet) and a hot companion (VZ Cet). It belongs to a class of detached binaries in which a compact object accretes mass from the wind of a cool giant or supergiant. The system has been resolved and the components have been extensively observed using various ground-based and space techniques. The luminosity of Mira B ($m_v \approx 11$) has been attributed to an accretion disk around a white dwarf (Warner, 1972; Reimers and Cassatella, 1985) or main sequence star (Jura and Helfand, 1984). Variations of Mira B of about 0.1 magnitude on a time scale of 15 minutes to hours have been detected in the optical continuum. Superposed on these variations were rare, short lived flares (Warner, 1972).

We observed Mira AB in July 1991. The U-band observations show brightness variations on time scales similar to those observed by Warner (1972). These variations could be due to accretion disk instabilities (Livio 1988) or to the inhomogeneities in the Mira A wind. However, no significant short term variations were detected that could be associated with flares.

0721-07 MWC560 (V694 Mon)

MWC560 is a fascinating emission-line object whose nature is still not understood. This object, described as a symbiotic-like variable, comprises a red giant and (probably) a hot companion. Since 1990, MWC560 has been undergoing a photometric and spectroscopic outburst. The UV spectra resemble a nova shortly after the outburst, and indicate a dramatic mass-ejection episode (outflow speed reaching 6500km/s). Photometric observations carried out in February–March 1990 detected variations at scales from 15–20 minutes to hours (Michalitsianos *etal.* 1991). Spectroscopic evidence for similar variations in the UV has been found in IUE observations (Michalitsianos *et al.* 1992). We obtained high-speed photometry observations in February 1992 and in January 1993. Similarly to CH Cyg, these observations show variations of 5–20% on time scales ranging from less than a minute to hours (Figure 2). The periodogram analyses of both data sets show multiple periodicities (25 min, 35 min, and 60 min). There is also evidence for short term variations of a few minutes and long term variability on a time scale of several hours. The short time scale flickering is strongly reminiscent of the photometric behavior of CH Cyg and other symbiotics, and is

probably due to the white dwarf rotation or the development of accretion disk instabilities.

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