POSSIBLE JET FORMATION IN THE SYMBIOTIC SYSTEM CH CYG

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Abstract

The light curve of the nearest S-type symbiotic binary, CH Cyg, showed an unprecedented drop in visual magnitude in 1996. This event bears striking resemblance to an earlier outburst phase of CH Cyg when, following extreme fading of the visual magnitude in 1984, a multi-component jet was ejected and first detected at radio wavelengths. In October 1996, we started VLA monitoring of CH Cyg to probe the nature of this recent activity.

1. Introduction

The physical mechanisms of jet formation in symbiotic systems are still unknown. One possibility is that the jet is ejected from an accretion disk around the hot companion. The collimation of the flow very likely occurs early in the process in the close circumbinary environment. Therefore it is critical to observe the jet early in its formation and as close as possible to the region from which it originates. There are few symbiotic systems showing jet activity that are close enough that the jet itself or its interaction with the surrounding medium can be studied in detail; one of them is CH Cyg, at a distance of 268 pc (ESA 1997).

The CH Cyg binary (R.A.= $19^h24^m33.02^s$, Dec= +50°14' 29.7" (2000.0)) is one of the most fascinating objects in the class of symbiotic stars because of its dramatic transformations and its extremely complex circumbinary environment. The system is composed of an evolved M6-7 III star and an accreting white dwarf. Hinkle *et al.* (1993) suggested the presence of a third body in the system, possibly a low-mass main sequence star.

CH Cyg has undergone a number of outbursts in the past several decades, each preceded by extended intervals of quiescence (Karovska and Mattei 1992). The most prominent outburst was observed between 1977 and 1986, in the midst of which outburst a powerful jet formed. The 1984 jet was first detected using the Very Large Array (VLA) radio telescope (Taylor *et al.* 1986). The observations carried out during the period from April 1984 to May 1985 detected a strong radio outburst occurring shortly after the onset of the visual decline in brightness. Radio maps obtained using the highest-resolution VLA configuration at 2 cm revealed jet-like structures, which exhibited significant changes over the following two to three months. An expansion rate of 1.1 arcseconds per year was estimated from these observations.

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Table 1. Radio brightness changes of CH Cyg measured during 1997.

	Frequency		
Date	*8 GHz*	*22 GHz*	*43 GHz*
March 8	8mJy	8mJy	8mJy
April 7	7	13	14
May 18	11	20	6
June 3	11	19	6
August 31	7	18	—

The uncertainty for all measurements is ± 1–2 mJy.

In the summer of 1996, the light curve of CH Cyg showed an unprecedented drop in visual magnitude (Mattei 1996a, b), bearing a resemblance to the 1984–86 outburst phase of CH Cyg when, following extreme fading of visual magnitude in 1984, a multi-component jet was ejected. However, the 1996 fading was much more prominent.

To probe the nature of this most recent activity, we requested VLA observing time, and in late 1996 started monitoring this system at radio wavelengths. We report our preliminary results from these observations below.

2. Observations and results

AAVSO visual observations in the summer of 1996 indicated that the optical magnitude of this dynamic system had dropped dramatically within a period of only a few months from magnitude 9.4 to 10.3. The AAVSO 10-day mean light curve from 1948 to 1997 is shown in Figure 1. Although sudden drops in magnitude had been observed before, the visual magnitude had never been this faint since AAVSO systematic visual observations began in 1948. Following this unprecedented fading, CH Cyg's visual brightness recovered somewhat, brightening up to about 9th magnitude. We note that in recent months the system's visual magnitude seems to be fading again (Mattei 1998).

Alerted by AAVSO observers to the rapid decline in brightness of CH Cyg in the summer of 1996, we started monitoring this system at radio wavelengths at the first available opportunity—in the autumn of 1996. To search for jet formation signatures, we carried out a complementary set of observations: high-angular-resolution imaging, and monitoring of the radio flux density.

Beginning in October 1996, we measured the radio brightness changes from 8 GHz to 43 GHz. Each observation was of about 2 hours' duration. The radio brightness of CH Cyg remained relatively constant at about 6–8 mJy at all frequencies until mid-spring 1997.

In May 1997 we detected a sudden flux increase at several frequencies, as shown in Table 1 above. The quoted errors are dictated by phase stability, and reflect differences in answers obtained with different time ranges of data at a given epoch. The observations carried out in August 1997 showed a decrease of radio brightness at 8 GHz, but remained high at 22 GHz. During the period of increased radio brightness the visual brightness remained at about magnitude 9.5 to 10.

In addition to the flux measurements, in January 1997 we obtained a high-angular-resolution map of CH Cyg at 15 GHz. The observations were carried out with the VLA during its re-configuration from its 30-km to its 10-km configuration (BnA). The angular resolution was about 0.25 arcsecond. The resulting map indicates that the source is resolved. In particular, the image shows a significant North-South elongation.

We are currently continuing the VLA monitoring of this system. We would also like to obtain high-angular-resolution maps of CH Cyg at several frequencies and compare

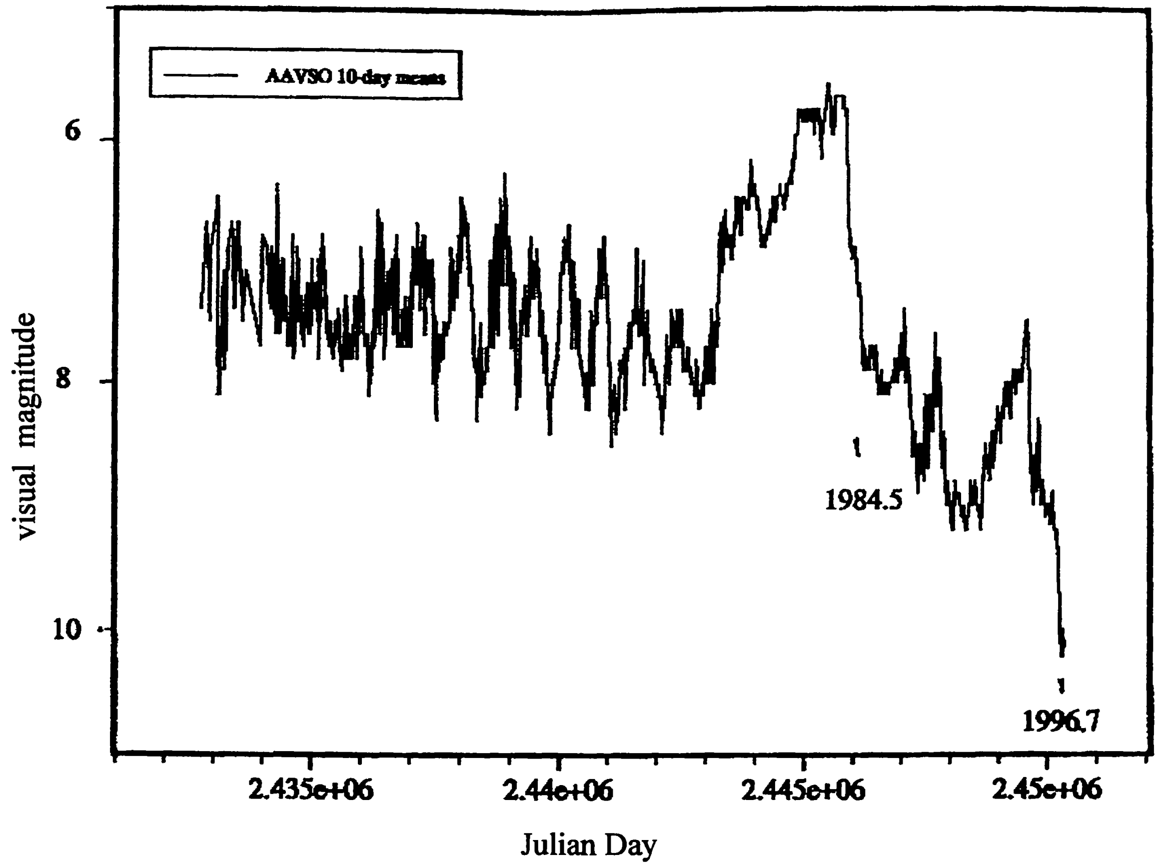

Figure 1. The AAVSO 10-day mean light curve of CH Cyg, July 1948–September 1996.

these maps to the 15 GHz map of the system obtained 16 months ago. Our goal is to study the evolution of the elongated structure detected in January 1997, which could be related to jet formation in the system. Since CH Cyg is less than 300 pc away, changes due to jet motion can be detected using the VLA within a relatively short time interval. Assuming that the jet will be moving with a speed comparable to that in 1984 (800 km/s), it should be easily detectable using the A configuration (the longest baseline and highest resolution).

We currently plan to carry out another set of high-angular observations in May 1998, using the VLA in the A configuration. The VLA high-angular-resolution observations in its A configuration provide a unique opportunity for high-spatial-resolution imaging of the CH Cyg circumbinary environment and for possible detection of jet motion. Timely observations of such a transient phenomenon will provide a unique opportunity to study the early jet propagation in a symbiotic system.

3. Acknowledgements

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