The Nature of V359 Centauri Revealed:
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We detected four outbursts of V359 Cen (possible nova discovered in 1939) between 1999 and 2002. Time-resolved CCD photometry during two outbursts (1999 and 2002) revealed that V359 Cen is actually a long-period SU UMa-type dwarf nova with a mean superhump period of 0.08092(1) d. We identified its supercycle length as 307–397 d. This secure identification of the superhump period precludes the previously supposed possibility that V359 Cen could be related to a WZ Sge-type system with a long persistence of late superhumps. The outburst characteristics of V359 Cen are, however, rather unusual in its low occurrence of normal outbursts. Accretion, accretion disks — novae, cataclysmic variables — Stars: dwarf novae — Stars: individual (V359 Cen)

Introduction

Cataclysmic variables (CVs) are close binary systems consisting of a white dwarf and a red dwarf secondarily transferring matter via the Roche lobe overflow (for a review of CVs, see war95book). CVs are subdivided into several categories, including dwarf novae (DNe) and novae. Both DNe and novae are characterized by the presence of a sudden increase of brightness (outburst). Although the mechanisms of DN-type outbursts (cf. osa96review) and nova outbursts (cf. sta97novaireview, sta99novaireview, sta00novaireview) are different, observational discrimination between rarely outbursting DNe and novae can be sometimes difficult (see dow81wzsge and kat01hvvir for classical and recent examples, respectively). Since rarely outbursting DNe can be easily confused with very fast novae, these confusions may have skewed our statistical view of classical novae dow86novadensity, lil87novarate, sha97novarate.

A large fraction of such confusions turned out to be SU UMa-type dwarf novae or WZ Sge-type dwarf novae kat01hvvir. SU UMa-type dwarf novae are a subclass of DNe. WZ Sge-type dwarf novae are still enigmatic, both in theory and to observations, SU UMa-type dwarf novae, which very infrequently (once in ~10 yr) show large-amplitude (~8 mag) outbursts bai79wzsge, dow81wzsge, pat81wzsge, odo91wzsge. All SU UMa-type dwarf novae, including WZ Sge-type dwarf novae, show superhumps during their long, bright outbursts (superoutbursts). [For a recent review of dwarf novae and SU UMa-type dwarf novae, see osa96review and war95suuma, respectively.] Superhumps have periods (superhump period: \( P_{\text{SH}} \)) a few percent longer than the orbital periods \( P_{\text{orb}} \) vog80suumastars, war85suuma, which is believed to be a consequence of the apsidal motion osa85sHexcex, mol92sHexcex of a tidally induced eccentric accretion disk whi88tidal, hir90sHexcex, hub91sH. WZ Sge-type dwarf novae are known to show a different kind of (super)humps during the earliest stage of superoutbursts kat96alcom, mat98egcnc, ish02wzsgeletter, osa02wzsgehump, kat02wzsgeEx.

These (super)humps in WZ Sge-type dwarf novae have periods close to \( P_{\text{orb}} \), which can be easily distinguished from usual SU UMa-type superhumps. The presence of superhumps thus provides a powerful photometric tool in discriminating novae and SU UMa-type/WZ Sge-type dwarf novae once an object undergoes another outburst.

V359 Cen was originally discovered as a possible nova by A. Opolski (see due87novaatlas). The object was visible on 19 plates taken between 1939 April 20 and 27, and the recorded maximum was \( m_{\text{pg}} = 13.8 \).
due87novaatlas. After an examination of Harvard plates of the corresponding epoch and Opolski’s finding chart, due87novaatlas suggested a 21.0 mag quiescent counterpart. The true nature of the object, however, remained uncertain. The object was even proposed to be a nova in the Galactic halo. From distant nova candidates, kat01lvvir selected V359 Cen as a candidate for a rarely outbursting dwarf nova. A finding chart of the proposed quiescent counterpart was presented in due87novaatlas.

mun98CVspec5 tried to study the proposed quiescent counterpart spectroscopically, but the attempt failed because of its faintness ($V$ fainter than 20.5). gil98v359cen obtained a deep image around V359 Cen, and showed that the profile is indistinguishable from that of a normal star; there was no evidence of a nova shell.

The situation dramatically changed when one of the authors (Rod Stubbings) detected the second historical outburst on 1999 July 13 (vsnet-alert 3216). http://www.kusastro.kyoto-u.ac.jp/vsnet/Mail/alert3000/

Observations

The 1999 observation by the MOA team was performed using a 61 cm Ritchey-Chrétien Cassegrain telescope (f/6.25) with the MOA-cam2 yan00MOAcam2, constructed with three SITe back-illuminated CCDs ($2047 \times 4095$ pixels). The MOA blue filter (MOA B) covers 395–620 nm and MOA red filter covers 620–1050 nm. The exposure times were 300 and 180 s for the 1999 July 14 and 15 data, respectively. The magnitudes of the object were measured with Dophot package. The absolute calibration of the magnitudes was done using an ensemble of ~40 neighboring stars, whose zero-point was determined using about 100 LMC standard stars measured with the Hubble Space Telescope (HST). The MOA magnitudes can be linked to the standard $V$ and $R_c$ systems using Eq. equ:moaconv, where red and blue denote MOA red and MOA blue magnitudes nod02MOALMC. Since the blue and red observations were not completely simultaneous, we list the magnitudes on the MOA photometric system in Table tab:moadata.

\[
V = \text{blue} - 0.16(\text{blue-red}) + \text{const}_1
\]

The 2002 observations were undertaken by the VSNET Collaboration. http://www.kusastro.kyoto-u.ac.jp/vsnet/. The equipment and reduction software are summarized in Table tab:equipment. The Kyoto observations were analyzed using the Java\textsuperscript{TM}-based PSF photometry package developed by one of the authors (TK). The other observers performed aperture photometry. The magnitudes were given relative to GSC 7750.220, whose constancy during the observation was confirmed by a comparison with USNO-A1.0 0450.13739601. All systems are close to $R_c$. The journal of the 2002 observations are summarized in Table tab:log.

Barycentric corrections to the observed times were applied before the following analysis.

table MOA photometric data. tab:moadata center tabularcccc BJD $-$ 2400000 Filter MOA mag Error

table Equipment of the 2002 CCD photometry. tab:equipment center tabularcccc Observer Telescope CCD Software

table Journal of the 2002 CCD photometry. tab:log center tabularccrcrc 2c2002 Date Start–End Exp(s) N Obs

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