INTERFEROMETRIC ASTROMETRY WITH HUBBLE SPACE TELESCOPE FINE GUIDANCE SENSOR 3: THE PARALLAX OF THE CATAclySMIC VARIABLE TV COLUMBAE

B. E. McARTHUR AND G. F. BENEDICT
McDonald Observatory, University of Texas, Austin, TX 78712

J. LEE AND W. F. VAN ALTENA
Department of Astronomy, Yale University, New Haven, CT 06520

C. L. SLESNICK, J. RHEE, R. J. PATTERSON, AND L. W. FREDRICK
Department of Astronomy, University of Virginia, Charlottesville, VA 22903

T. E. HARRISON
Department of Astronomy, New Mexico State University, Las Cruces, NM 88003

W. J. SPIESMAN
McDonald Observatory, University of Texas, Austin, TX 78712

E. NELAN
Space Telescope Science Institute, Baltimore, MD 21218

R. L. DUNCOLMBE, P. D. HEMENWAY, W. H. JEFFERYS, AND P. J. SHELUS
Department of Astronomy, University of Texas, Austin, TX 78712

AND

O. G. FRANZ AND L. H. WASSERMAN
Lowell Observatory, Flagstaff, AZ 86001

Received 2000 March 24; accepted 2001 June 27

ABSTRACT

TV Col is a 13th magnitude intermediate polar cataclysmic variable with multiple periods found in the light curves. Past estimates predicted a distance of 400 pc to greater than 500 pc. Recently completed Hubble Space Telescope fine guidance sensor interferometric observations allow us to determine the first trigonometric parallax to TV Col. This determination puts the distance of TV Col at $368_{-15}^{+15}$ pc. CD$-32$ 2376, a 10th magnitude Tycho Catalog star, is a reference star in the TV Col frame. We find a distance of 127.7 $\pm$ 1 pc.

Subject headings: astrometry — novae, cataclysmic variables — stars: distances

1. INTRODUCTION

Cataclysmic variables (CVs) are binary systems consisting of a white dwarf (the primary) that receives mass from the Roche lobe of a low-mass, late-type companion (the secondary). If the white dwarf is strongly magnetized, the binary is categorized as a magnetic cataclysmic variable (MCV). MCVs have two subclasses depending upon the magnetic field strength: the intermediate polars (IPs), sometimes called DQ Hers) and the polars (sometimes called AM Hers). In IPs, the transferred matter from the secondary moves through an accretion disk until the magnetic field of the white dwarf disrupts the disk and channels the flow along field lines onto the primary. X-rays are produced by the shock-heated gas near the surface of the white dwarf, while the UV and optical emission is mostly from the accretion disk. Unlike polars, IPs rotate asynchronously owing to their greater accretion rate and greater separation (Patterson 1994), weaker magnetic fields on the primaries (Warner 1995), and the geometry of the magnetic field (E. L. Robinson 2000, private communication). IPs represent about 5%–10% of all CVs (see Patterson 1994 and Warner 1995 for reviews of this class). Like most other CVs, distances are very uncertain for most of the IPs (Berriman 1987).

TV Col, an IP star, was first discovered as the hard X-ray source 2A 0526$-$328 by Cooke et al. (1978). The X-ray source was optically identified with TV Col by Charles et al. (1979), being the first CV discovered by its X-ray emission. It has an orbital binary period of 5.486 hr (Hutchings et al. 1981) detected from the emission-line radial velocities. TV Col shows four additional periods: a 1911 s X-ray period representing the rotation period of the white dwarf—the spin period (Schrijver et al. 1985); a 4 day nodal precession of the accretion disc period (Hellier 1993); a $\sim 5.2$ hr period that is the beat between the two longer periods (Motch 1981)—a negative superhump (Ritter & Hellier 2000); and a photometric period of 6.36 hr (Ritter & Hellier 2000)—a positive superhump. It has the longest orbital period of any permanent superhump system. TV Col has 0.1 mag rapid flickering (Barrett, O’Donoghue, & Warner 1988) and frequent, small-amplitude outbursts of luminosity (Szkody & Mateo 1984; Cordova 1995). TV Col also has had dwarf nova–like short outbursts of 4 mag amplitude, observed optically and with IUE (Hellier & Buckley 1993; Hellier 1993; Szkody & Mateo 1984; Schwarz et al. 1988; Schwarz & Heemskerk 1987).

2. OBSERVATIONS AND REDUCTIONS

The observations of TV Col (International Celestial Reference System [ICRS] 2000: $\alpha = 05^h29^m25^s44$, $\delta = -31^\circ 49'04''5$) were made with Fine Guidance Sensor 3 (FGS3) on board the Hubble Space Telescope (HST). Astrometry with the HST FGSs has been previously described (Benedict et al. 1993, 1994), as has the FGS instrument (Bradley et al. 1991). Ten observations (one orbit each)
of TV Col near maximum parallax factors were made between 1995 and 1998 with FGS3 in POS (fringe tracking) mode. HST FGS parallax observing strategies and reduction and analysis techniques have been described by McArthur et al. (1999), Benedict et al. (1999), Harrison et al. (1999), and van Altena et al. (1997).

FGS astrometry is relative to a local reference frame. To obtain an absolute parallax for our target requires estimates of the absolute parallaxes of the stars comprising our local reference frame. To obtain these estimates we require photometry and classification spectra. We obtain $JHK$ photometry from the second incremental release of the Two-Micron All-Sky Survey (2MASS) catalog; $B$, $V$, and $I$ from CCD observations (obtained at New Mexico State University); and Washington-DDO photometry from the University of Virginia. We obtain an upper limit on interstellar absorption in the direction of TV Col from the NASA/IPAC Extragalactic Database (NED) compilation of the Schlegel, Finkbeiner, & Davis (1998) reddening estimates. This provides a color excess, $E(B-V)$, and through the standard relationship, $A_V/E(B-V)$ = 3.1, an absorption value, $A_V$. The effects on the $JHK$ colors are at or below 0.02 mag.

We obtained stellar classifications from two sources: the WIYN telescope\(^2\) multiobject spectrograph (MOS/Hydra) and the Cerro Tololo Inter-American Observatory (CTIO) 1.5m with Cassegrain spectrograph. The two independent estimates of spectral type and luminosity class are listed in Table 1.

The final adopted spectral types are the result of plotting the photometry (collected in Table 2) on several color-color diagrams ($B - V$ vs. $V - K$ and $J - K$ vs. $V - K$) upon which are impressed a mapping between colors and spectral types from Bessel & Brett (1988) and Allen’s Astrophysical Quantities (Cox 2000, hereafter AQ2000). Because both sources for our spectral types and luminosity classes expressed some doubt as to the luminosity class, we use Washington-DDO photometry (Majewski et al. 2000) to confirm their estimates. Plotting our reference stars on the giant/dwarf discrimination plane (Fig. 1, $M-D$ vs. $M-T_2$), reference stars 1, 2, and 3 are clearly dwarfs. Reference star 4 is a borderline dwarf/giant or a metal-poor dwarf. Because we obtain a better solution (the ratio of $\chi^2$ to the number of degrees of freedom is smaller), we adopt a dwarf luminosity class for star 4. $V$ magnitude and colors are listed in Table 2.

Absolute magnitudes, $M_V$, are taken from the AQ2000 tables as a function of spectral type. We assume an error for each $M_V$ consistent with the spectral type and luminosity class differences among WIYN, New Mexico State University (NMSU), and Washington-DDO photometry (Tables 1, 2, and 3). The resulting absorption-corrected distance moduli with errors and derived parallaxes are presented in Table 3. These are the parallaxes and associated errors used in the modeling. The spectrophotometric parallax of star 1 and our derived value agree within the errors, providing confidence in our approach.

The average color of the reference stars and our science target differ, with $\Delta(B-V) \sim -0.91$. Therefore, we apply the differential correction for lateral color discussed in Benedict et al. (1999) to the TV Col observations. The

### Table 1

| Star | NMSU | WIYN | Adopted Spectral Type |
|------|------|------|-----------------------|
| 1    | G2 V | G2 IV| G2 V                  |
| 2    | G5 V | G1 V | G2 V                  |
| 3    | K1/2 V | K2 V | K2 V                  |
| 4    | K2 V | G9 V | G9 V                  |

\(^2\) WIYN Observatory is a joint facility of the University of Wisconsin-Madison, Indiana University, Yale University, and the National Optical Astronomy Observatories.

### Table 2

| Star | $V$   | $B-V$    | $V-K$    | $J-K$    | $M-D$   | $M-T_2$ |
|------|-------|----------|----------|----------|---------|---------|
| 1    | 10.46 | 0.62 ± 0.02 | 1.50 ± 0.03 | 0.41 ± 0.04 | 0.01 ± 0.04 | 0.87 ± 0.02 |
| 2    | 14.66 | 0.59 ± 0.04 | 1.58 ± 0.04 | 0.34 ± 0.04 | 0.00 ± 0.04 | 0.92 ± 0.02 |
| 3    | 13.65 | 0.96 ± 0.03 | 2.20 ± 0.04 | 0.53 ± 0.04 | -0.16 ± 0.04 | 1.18 ± 0.02 |
| 4    | 13.82 | 0.72 ± 0.03 | 1.70 ± 0.04 | 0.44 ± 0.04 | -0.01 ± 0.04 | 1.14 ± 0.02 |

**Note:** $B$ and $V$ values are from NMSU; $J$ and $K$ values are from 2MASS. $M$, $D$, and $T_2$ are Washington-DDO filters.
GaussFit–solved equation of condition for TV Col becomes:

\[ x' = x + lc(B - V), \]
\[ y' = y + lc(B - V), \]
\[ \xi = A*\xi' + B*\eta' + C + R_x \times (x'^2 + y'^2) - \mu_x - P_x \pi_x, \]
\[ \eta = -B*\xi' + A*\eta' + F + R_y \times (x'^2 + y'^2) - \mu_y - P_y \pi_y, \]

where \( x \) and \( y \) are the rectangular HST coordinates, \( lc \) is the derived lateral color correction (Benedict et al. 1999), \( B - V \) is the \( B - V \) magnitude, \( A \) and \( B \) are a set of scale plate constants, \( C \) and \( F \) are zero point corrections, \( R_x \) and \( R_y \) are radial terms, \( \mu_x \) and \( \mu_y \) are proper motions, \( P_x \) and \( P_y \) are parallax factors, and \( \pi_x \) and \( \pi_y \) are the parallaxes in \( x \) and \( y \). The spectrophotometrically determined parallaxes of the reference frame stars are modeled simultaneously as observations with errors to produce an absolute, not relative parallax for TV Col.

Comparing Tables 3 and 4 we find that the final adjusted absolute parallaxes for the reference stars agree with the spectrophotometric estimates within the errors. Our derived absolute parallax for TV Col is given in Table 5, along with a relative proper motion. As seen in Table 4, the standard errors resulting from the solutions of the equations for parallax and proper motion are submilliarcsecond. Figure 2 shows histograms of the residuals from the fit of the target and the reference frame stars. The histogram of residuals is by far the best we have seen in dealing with over 20 FGS parallax data sets. Typical Gaussian fits are characterized by sigmas on the order of 1 mas. This was obviously an astrometrically very quiet reference frame. A generous well-characterized reference frame surrounding the target along with exceptional instrument performance evidenced by the small standard error of the guider FGSs contributed to the very low internal errors for these observations. Typical internal errors for FGS parallaxes range 0.3–0.7 mas. This 0.1 mas internal error is the luck of the draw. Our

![Figure 2](image.png)

**TABLE 3**

| Star   | \( V \)   | \( M_v \)  | \( A_v \)  | \( m-M_A \) | \( \pi_{abs} \) |
|--------|-----------|-----------|-----------|-------------|--------------|
| 1      | 10.46     | 4.7 ± 0.1 | 0.1       | 5.7         | 0.0076 ± 0.0007 |
| 2      | 14.66     | 4.7 ± 0.1 | 0.1       | 9.9         | 0.0017 ± 0.0004 |
| 3      | 13.65     | 6.2 ± 0.5 | 0.1       | 7.4         | 0.0022 ± 0.0002 |
| 4      | 13.82     | 5.7 ± 0.3 | 0.1       | 8.0         | 0.0025 ± 0.0002 |

\( ^{a} \) From AQ2000.
\( ^{b} \) From Schlegel et al. 1998.

**TABLE 4**

| Star   | \( \xi \)  | \( \eta \)  | \( \sigma_\xi \) (mas) | \( \sigma_\eta \) (mas) | \( \pi_{abs} \) (mas) |
|--------|------------|------------|------------------------|------------------------|----------------------|
| TV Col | 31.354     | 667.018    | 0.34                   | 0.45                   | 2.717                |
| 1      | 101.968    | 730.702    | 0.30                   | 0.37                   | 7.831                |
| 2      | 2.500      | 784.643    | 0.44                   | 0.72                   | 1.681                |
| 3      | 35.568     | 659.404    | 0.34                   | 0.54                   | 2.193                |
| 4      | -364.898   | 695.884    | 0.4                    | 0.5                    | 2.502                |

**TABLE 5**

| Parameter         | Value |
|-------------------|-------|
| \( HST \) study duration | 2.5 yr |
| Number of observation sets | 10 |
| Number of reference stars | 4 |
| \( HST \) parallax        | \( 2.7 \pm 0.11 \) mas |
| \( HST \) distance        | \( 368 \pm 13 \) pc |
| \( HST \) relative proper motion \( \mu_x \)  | \( 25.99 \pm 0.1 \) mas yr\(^{-1} \) |
| \( HST \) relative proper motion \( \mu_y \)  | \( 9.67 \pm 0.2 \) mas yr\(^{-1} \) |
| \( HST \) relative proper motion \( \mu_k \)  | \( 27.72 \pm 0.2 \) mas yr\(^{-1} \) |
| P.A.                | 69/6 |

\( ^{a} \) The relative proper motion position angle is likely to vary significantly from absolute because of the sparse reference frame (indicated by P.A. of CD—32 2376)
systematic errors in parallax determinations are likely larger.

3. TRIGONOMETRIC PARALLAX AND ABSOLUTE MAGNITUDE OF TV COLUMBAE

Using the weighted photometric parallaxes of the reference frame, the simultaneous modeling of the observations gives an \( \text{HST} \) parallax for TV Col of \( 2.7 \pm 0.11 \) mas, for a distance of \( 368 \pm 11 \) pc (Table 5). The distance estimates from other nonastrometric methods are listed in Table 6.

The distance modulus \( [5 + 5 \log (1/\pi)] \) for TV Col is 7.84. Using Bruch & Engel's (1994) visual magnitude of 13.75 \( \pm \) 0.1 for the apparent magnitude we obtain an absolute magnitude \( (M_v) \) of 5.92 \( \pm \) 0.1. Adjusting the distance modulus with a correction for \( A_v \) \( [5 + 5 \log (1/\pi) - A_v] \) give an absolute magnitude of 5.81 \( \pm \) 0.1. Ritter & Kolb (1998) list visual magnitudes of 13.6 and 14.1. When using a trigonometric parallax to estimate the absolute magnitude of a star, a correction should be made for the Lutz-Kelker bias (Lutz & Kelker 1973). Because of the Galactic latitude and distance of TV Col, and the scale height of the stellar population of which it is a member, we do not use a uniform space density for calculating the Lutz-Kelker bias but use a density law that falls off as the \( -0.5 \) power of the distance at the distance of TV Col. This translates into \( n = -3.5 \) as the power in the parallax distribution. This \( n \) is then used in a Lutz-Kelker algorithm modified by Hanson (1979) to include the power law of the parent population. A correction of \( -0.03 \pm 0.01 \) mag is derived for the Lutz-Kelker-Hanson bias, which makes the absolute magnitude \( 5.89 \pm 0.12 \) (5.78 \( \pm \) 0.12 with the \( A_v \) correction).

TV Col (Galactic coordinates: \( l = 236.79, b = -30.60 \)) is well below the plane of the disk of the Galaxy. From our absolute parallax and relative proper motion we derive a space velocity of 103 km s\(^{-1}\) (relative to our reference frame). The small difference between the relative proper motion derived for CD – 32 2376 (50.097 mas yr\(^{-1}\)) and the absolute motions listed in the United States Naval Observatory (USNO) ACT (50.604 mas yr\(^{-1}\)) and Tycho-2 (49.519 mas yr\(^{-1}\)) catalogs (see Table 7) suggests a small difference between relative and absolute proper motion. The velocity component perpendicular to the Galactic plane, \( W \), is \( -5.1 \) km s\(^{-1}\). Our new parallax places the star 187 pc below the Sun, which locates it 195 pc below the galactic plane. (Discussion of space velocity in CVs can be reviewed in these papers: Sproats, Howell, & Mason 1996, Stehle, Kolb, & Ritter 1997, and van Paradijs, Augusteijn, & Stehle 1996.)

4. THE MASS OF TV COLUMBAE—AN UNRESOLVED ISSUE

ROSAT observations of TV Col (Vrtilek et al. 1996) indicated a ratio of X-ray luminosity to UV and optical luminosity of 0.2 in quiescence. Cropper, Wu, & Ramsay (1999) analyzed the continuum spectra obtained by *Ginga* to estimate a white dwarf mass of 1.2 \( M_\odot \), while Ishida & Ezuka (1999) used *ASCA* data to derive a mass of \( 0.51 \pm 0.22 \) \( M_\odot \). Ramsey (2000) used *RXTE* data to determine a mass of \( 0.96 \pm 0.5 \) \( M_\odot \). Radial velocity measurements by Hellier (1993) provided a \( K_1 \) of 153 \( \pm \) 12 km s\(^{-1}\) corresponding to a mass function of 0.085 \( \pm \) 0.020 \( M_\odot \). The inclination is estimated to be \( 70 \pm 3 ^\circ \) by the width and depth of the eclipse (Hellier, Mason, & Mittaz 1991). Assuming that it is a zero-age main-sequence star, Hellier (1993) estimated a secondary mass of 0.56 \( M_\odot \) and a primary mass of 0.75 \( \pm \) 0.15 \( M_\odot \) (using the Patterson 1984 equation). The secondary star is most likely a late K or early M type (Beuermann 2000; Smith & Dhillon 1998), although it is reported as a K1 in SIMBAD, and a K1–K5 type star in Ritter & Kolb (1998).

A measurement of the total separation of the components, combined with a parallax, would provide a direct determination of their masses. The total estimated mass and measured period implies \( a = 0.0080 \) AU. Our parallax would set the total separation at 21 \( \mu \)as with individual orbits of 9 and 12 \( \mu \)as. TV Col is a potential target for the *Space Interferometry Mission (SIM)*. The component orbits are larger than the anticipated (1–2 \( \mu \)as) *SIM* narrow angle astrometric measurement limits. With \( AV \approx 4 \), much of the system flux is contributed by the white dwarf. Longward of 700 nm, the M dwarf–white dwarf magnitude difference should decrease somewhat. The *SIM* sensitivity \( (\lambda_{\lim} \approx 20) \), wide bandpass (400–1000 nm), and spectral resolution \( (R = 80) \) should allow measurement of position, magnitude, and color for both components. To derive a precise separation will require five to 10 such measurements to establish the component A and B orbits and the mass fraction. *SIM* could also provide an absolute parallax 2 orders of magnitude more precise than that reported here. Together, orbits and parallax could provide masses with \( \approx 5\% \) error.

5. TRIGONOMETRIC PARALLAX AND ABSOLUTE MAGNITUDE OF CD – 32 2376

One of the reference stars in our field was a 10.46 mag Tycho Catalog proper motion star. The HST parallax of CD – 32 2376 was 7.83 \( \pm \) 0.08 mas, which puts the distance

---

3 See http://sim.jpl.nasa.gov.
at $127.7 \pm 1.1$. We derived a relative $\mu_x = 36.9 \pm 0.1$ mas yr$^{-1}$ and relative $\mu_y = 33.9 \pm 0.2$ mas yr$^{-1}$ for this star. Table 7 compares the *HST* proper motions with those listed in the Tycho-2 (Høg et al. 2000) and ACT (Urban, Corbin, & Wycoff 1998) catalogs. We attribute the difference in proper motion position angle to our very sparse and local reference frame.

6. SUMMARY

*HST* trigonometric parallaxes can provide accurate distances to CVs. Accurate distances allow basic quantities such as the absolute magnitude and mass transfer rate to be derived. Understanding the physics of CVs depends upon these derivations.

This research has made use of NASA's Astrophysics Data System Abstract Service and the SIMBAD Stellar Database inquiry and retrieval system. This research has made use of the NASA/IPAC Extragalactic Database (NED), which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA. This publication makes use of data products from 2MASS, which is a joint project of the University of Massachusetts and IPAC/California Institute of Technology, funded by NASA and the National Science Foundation. This work is based on observation made with the NASA/ESA *Hubble Space Telescope*, which is operated by the Space Telescope Science Institute (STSI) of the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS 5-26555. The *HST* Astrometry Science Team receives support through NASA grant NAG 5-1603. We thank Bill Welsh and Rob Robinson for helpful discussions and draft paper reviews. Denise Taylor and Lauretta Nagel provided assistance at STSI.

REFERENCES

Barrett, P., O'Donoghue, D., & Warner, B. 1988, MNRAS, 233, 759
Benedict, G. F., et al. 1999, AJ, 118, 1086
Benedict, G. F., et al. 1999, PASP, 106, 327
Berriman, G. 1987, A&A, 68, 41
Bessell, M. S., & Brett, J. M. 1988, PASP, 100, 1134
Beuermann, K. 2000, NewA Rev., 44, 93
Bonnet-Bidaud, J. M., Motch, C., & Mouchet, M. 1985, A&A, 143, 313
Bradley, A., Abramowicz-Reed, L., Story, D., Benedict, G., & Jefferys, W. 1991, PASP, 103, 317
Bruch, A., & Engel, A. 1994, A&A, 284, 79
Buckley, D. A. H., & Tuohy, L. R. 1989, ApJ, 344, 376
Charles, P. A., Thorstensen, J., Bowyer, S., & Middleditch, J. 1979, ApJ, 231, L131
Cooke, B. A., et al. 1978, MNRAS, 182, 489
Cordova, F. 1995, in X-Ray Binaries, ed. W. H. G. Lewin, J. van Paradijs, & E. P. J. van den Heuvel (Cambridge: Cambridge Univ. Press), 331
Cox, A. N., ed. 2000, Allen’s Astrophysical Quantities (4th ed.; New York: AIP)
Cropp, M., Wu, K., & Ramsay, G. 1999, in ASP Conf. Ser. 157, Annapolis Workshop on Magnetic Cataclysmic Variables, ed. C. Hellier & K. Mukai (San Francisco: ASP), 325
Hanson, R. B. 1979, MNRAS, 186, 875
Harrison, T. E., McNamara, B., Szkody, P., McArthur, B. E., Benedict, G. F., Klemola, A., & Gilliland, R. L. 1999, ApJ, 515, L93
Hellier, C. B. 1993, MNRAS, 264, 132
Hellier, C. B., & Buckley, D. A. H. 1993, MNRAS, 265, 766
Hellier, C. B., Mason, K. O., & Mittaz, J. P. D. 1991, MNRAS, 248, 5
Høg, E., et al. 2000, A&A, 355, L27
Hutchings, J. B., Crampton, D., Cowley, A. P., Thorstensen, J. R., & Charles, P. A. 1981, ApJ, 249, 680
Ishida, M., & Ezuka, H. 1999, in ASP Conf. Ser. 157, Annapolis Workshop on Magnetic Cataclysmic Variables, ed. C. Hellier & K. Mukai (San Francisco: ASP), 333
Lutz, T. E., & Kelker, D. H. 1973, PASP, 85, 573
Majewski, S. R., Ostheimer, J. C., Kunkel, W. E., & Patterson, R. J. 2000, AJ, 120, 2550
McArthur, B. E., et al. 1999, ApJ, 520, L59
Motch, C. 1981, A&A, 100, 277
Mouchet, M., Bonnet-Bidaut, J. M., Ilovaisky, S. A., & Chevalier, C. 1981, A&A, 102, 31
Patterson, J. 1984, ApJS, 54, 443
———. 1994, PASP, 106, 209
Ramsey, G. 2000, MNRAS, 314, 403
Retter, A., & Hellier, C. 2000, NewA Rev., 49, 35
Ritter, H., & Kolb, U. 1998, A&A, 259, 83
Schlegel, D. J., Finkbeiner, D. P., & Davis, M. 1998, ApJ, 500, 525
Schrijver, J., Brinkman, A. C., van der Woerd, H., Watson, M. G., King, A. R., van Paradijs, A. J., & van der Klis, M. 1985, Space Sci. Rev., 40, 121
Schwarz, H. E., & Heemskerk, M. H. M. 1987, IAU Circ. 4508
Schwarz, H. E., van Amerongen, S., Heemskerk, M. H. M., & van Paradijs, J. 1988, A&A, 202, L16
Smith, D. A., & Dhillon, V. S. 1998, MNRAS, 301, 767
Sprouts, L. N., Howell, S. B., & Mason, K. O. 1996, MNRAS, 282, 1211
Stehle, R., Kolb, U., & Ritter, H. 1997, A&A, 320, 136
Szkody, P., & Mateo, M. 1984, ApJ, 280, 729
Urban, S. E., Corbin, T. E., & Wycoff, G. 1998, AJ, 115, 2161
van Altena, W. F., et al. 1997, ApJ, 486, L123
van Paradijs, J., Augusteijn, T., & Stehle, R. 1996, A&A, 312, 93
Vrtilek, S. D., Silber, A., Primini, F., & Raymond, J. C. 1996, ApJ, 465, 951
Warner, B. 1995, Cataclysmic Variables (Cambridge: Cambridge Univ. Press)