FAR-ULTRAVIOLET SPECTROSCOPY OF THE NOVA-LIKE VARIABLE KQ MONOCEROTIS: A NEW SW Sextantis STAR?

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1 INTRODUCTION

Nova-like variables are a subset of cataclysmic variables (CVs), compact, short-period binaries in which a late-type, Roche lobe filling main-sequence dwarf transfers gas through an accretion disk onto a rotating, accretion-heated white dwarf (WD). The spectra of most nova-like variables resemble those of classical novae (CNe) that have settled back to quiescence. However, they have never had a recorded CN outburst or any outburst. Hence, their evolutionary status is unclear: they could be close to having their next CN explosion, or they may have had an unrecorded explosion in the past, possibly hundreds or thousands of years ago. Or, quite possibly, they may not even have CN outbursts at all, in which case their WDs would be steadily increasing in mass to become the elusive progenitors of Type Ia supernovae.

The variability of KQ Mon was discovered by Hoffmeister (1943), who categorized it as an irregular variable. Cameron & Nassau (1956) classified the spectrum of KQ Mon as a carbon star based on a low-resolution objective-prism plate; however, as noted by Stephenson (1989), this classification actually applies to the nearby brighter and unrelated carbon star Case 432. The true nature of KQ Mon was revealed when Bond (1979), who had noted its neutral-to-blue color on Palomar Sky Survey prints, obtained spectroscopy and high-speed photometry showing it to be a CV. The spectra showed very shallow Balmer and He I lines in absorption, and the photometry showed low-amplitude flickering but no obvious orbital modulation. These properties, combined with the lack of any known large-amplitude outbursts or fadings, lead to the classification of KQ Mon as a nova-like variable.

Hoard et al. (2003) identified the object in the Two Micron All Sky Survey (2MASS) survey and found that it is a close visual triple star. Schmidtbredek et al. (2005) determined the orbital period of KQ Mon to be 3.08(4) hr using time-resolved spectroscopic data obtained over two nights at the Cerro Tololo Inter-American Observatory. They also suggested that KQ Mon may be a member of the SW Sex nova-like subclass which are defined by a number of spectroscopic and photometric characteristics including orbital periods between 3 and 4 hr, single-peaked emission lines seen in high-inclination systems, high-excitation spectral features including He II (λ4686) emission, and strong Balmer emission on a blue continuum. KQ Mon’s orbital period lies in the 3–4 hr period range, just above the upper boundary of the CV period gap, where there is a pileup of SW Sextantis stars. It is classified as a probable SW Sex star in the Big List of SW Sextantis Stars.5 We also note that KQ Mon is a cataloged X-ray source, 1RXS J073120.7—102153 (Voges et al. 1999).

In this paper, our objectives are to shed further light on the nature of KQ Mon by (1) presenting new optical spectra obtained with the SMARTS 1.5 m telescope and archival International Ultraviolet Explorer (IUE) far-ultraviolet (FUV) spectra of the nova-like variable KQ Mon are discussed. The optical spectra reveal Balmer lines in absorption as well as He I absorption superposed on a blue continuum. The 2011 optical spectrum is similar to the KPNO 2.1 m IIDS spectrum we obtained 33 years earlier except that the Balmer and He I absorption is stronger in 2011. Far-ultraviolet IUE spectra reveal deep absorption lines due to C II, Si III, Si IV, C IV, and He II, but no P Cygni profiles indicative of wind outflow. We present the results of the first synthetic spectral analysis of the IUE archival spectra of KQ Mon with realistic optically thick, viscous accretion-disk models with vertical structure and high-gravity photosphere models. We find that the photosphere of the white dwarf (WD) contributes very little FUV flux to the spectrum and is overwhelmed by the accretion light of a steady disk. Disk models corresponding to a WD mass of ~0.6 M⊙, with an accretion rate of order 10−9 M⊙ yr−1 and disk inclinations between 60° and 75°, yield distances from the normalization in the range of 144–165 pc. KQ Mon is discussed with respect to other nova-like variables. Its spectroscopic similarity to the FUV spectra of three definite SW Sex stars suggests that it is likely a member of the SW Sex class and lends support to the possibility that the WD is magnetic.

Key words: novae, cataclysmic variables – stars: individual (KQ Mon)

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In this paper, our objectives are to shed further light on the nature of KQ Mon by (1) presenting new optical spectra obtained with the SMARTS 1.5 m telescope and archival International Ultraviolet Explorer (IUE) far-ultraviolet (FUV) spectra of the nova-like variable KQ Mon are discussed. The optical spectra reveal Balmer lines in absorption as well as He I absorption superposed on a blue continuum. The 2011 optical spectrum is similar to the KPNO 2.1 m IIDS spectrum we obtained 33 years earlier except that the Balmer and He I absorption is stronger in 2011. Far-ultraviolet IUE spectra reveal deep absorption lines due to C II, Si III, Si IV, C IV, and He II, but no P Cygni profiles indicative of wind outflow. We present the results of the first synthetic spectral analysis of the IUE archival spectra of KQ Mon with realistic optically thick, viscous accretion-disk models with vertical structure and high-gravity photosphere models. We find that the photosphere of the white dwarf (WD) contributes very little FUV flux to the spectrum and is overwhelmed by the accretion light of a steady disk. Disk models corresponding to a WD mass of ~0.6 M⊙, with an accretion rate of order 10−9 M⊙ yr−1 and disk inclinations between 60° and 75°, yield distances from the normalization in the range of 144–165 pc. KQ Mon is discussed with respect to other nova-like variables. Its spectroscopic similarity to the FUV spectra of three definite SW Sex stars suggests that it is likely a member of the SW Sex class and lends support to the possibility that the WD is magnetic.
he carried out in the late 1970s with a resolution of about 7 Å and covering 3500–5300 Å. At the time, KQ Mon had only been classified as a slowly variable star (type “L” in the GCVS). However, Bond (1979) had noticed a neutral to slightly blue color of KQ Mon on the Palomar Sky Survey prints, and thus added it to the IIDS observing program. On the basis of these initial spectra of 1978 April 11, Bond noted shallow Balmer and He I (4471) absorption similar to those in CD −25°14462 (V3885 Sgr), a well-known UX UMa nova-like star. KQ Mon was observed with the IIDS again on 1978 November 25 and 1979 October 26, with little change noted relative to the first spectrum, both with respect to their continuum slopes and absorption-line strengths.

We obtained an optical spectrum of KQ Mon at a similar spectral resolution and range of wavelengths with the SMARTS 1.5 m telescope and Ritchey–Chretien spectrograph on 2011 December 21. In Figure 1, we display a comparison of the continuum slopes and absorption-line strengths between the SMARTS spectrum of 2011 and the earlier spectra obtained with the IIDS. The 2011 spectrum appears to have a shallower continuum slope and stronger Balmer absorption lines than the spectra obtained in 1978–1979. However, the continuum slope difference seen in the 2011 observation must be viewed with caution since a fairly narrow slit was used. The slit was oriented east–west and not at the parallactic angle, so that wavelength-dependent atmospheric-refraction losses were indeed possible which would affect the blue end of the spectrum more than the red because the guider TV is red-sensitive. Because of these slit losses, and because only two spectrophotometric standards were observed (one at the beginning of the night, the second at the end), only the appearance of the spectrum should be taken into account, not the absolute flux or continuum slope.

For the IIDS spectra on the other hand, the continuum slopes are more reliable since a larger aperture was used. The IIDS spectra in Figure 1 agree quite well with each other. While the flatter continuum slope in the 2011 spectrum taken at face value might suggest a lower accretion rate in 2011, the increased equivalent widths of the absorption features in 2011 (except H β, which is almost completely filled in the 1978–1979 and 2011 spectra) may imply a higher accretion rate in 2011 (Warner 1995). This is especially evident in H δ, H ϵ, and H8.

3. FAR-ULTRAVIOLET SPECTRA

A total of eight spectra is available in the International Ultraviolet Explorer (IUE) archive, five obtained with the short-wavelength prime (SWP) camera and three obtained with the long-wavelength redundant (LWR), between 1981 and 1983. These spectra were first analyzed by Sion & Guinan (1982) who used cruder disk models without vertical structure and blackbody fits. They also determined that the interstellar reddening was low due to the absence of an absorption dip at 2200 Å. This result was supported by la Dous (1991), who quoted an $E(B − V)$ value of 0.0 for KQ Mon. The inclination of the system was unknown according to la Dous (1991) but probably less than 40°, based upon equivalent line widths of Si IV (1393, 1402), C IV (1548, 1550), and Al III (1854, 1862).

We selected a well-exposed SWP spectrum for our synthetic model fitting, SWP15384, which was obtained at low resolution and is displayed in Figure 2.
resolution through the large aperture starting on 1981 November 4 at 12:41:00 UT with an exposure time of 3000 s. As seen in Figure 2, the IUE SWP spectrum reveals the deep, high-ionization, absorption features of C iii (1175), N v (1240), Si ii + O i (1300), C ii (1335), O v (1371), C iv (1550), He ii (1640), N iv (1718), and possibly Al iii (1854). Even though the depths of the absorption lines suggest that the accretion disk is being viewed at low inclination, it is unusual that P Cygni profiles are not seen, at least in C iv, as one sees in RW Sex, V3885 Sgr, IX Vel, and other UX UMa systems, viewed at low inclination. It is also curious that the centers of the absorption lines do not appear blueshifted, which is a measurable displacement at low IUE resolution in other UX UMa systems (Sion & Guinan 1982).

4. SYNTHETIC SPECTRAL MODELING

We adopted model accretion disks from the optically thick disk model grid of Wade & Hubeny (1998). In these accretion-disk models, the innermost disk radius, $R_{\text{in}}$, is fixed at a fractional WD radius of 1.05. The outermost disk radius, $R_{\text{out}}$, was chosen so that $T_{\text{eff}}(R_{\text{out}})$ is near 10,000 K, since disk annuli beyond this point, which are cooler zones with larger radii, would provide only a very small contribution to the mid- and far-UV disk flux, particularly the SWP FUV bandpass. The mass-transfer rate is assumed to be the same for all radii. For a given spectrum, we carry out fits for every combination of $M$, inclination, and WD mass in the Wade & Hubeny (1998) library. The values of $i$ are 18°, 41°, 60°, 75°, and 81°. The range of accretion rates covers $-10.5 < \log(M) < -8.0$ in steps of 0.5 in the log and five different values of the WD mass, namely, 0.4, 0.55, 0.8, 1.0, and 1.2 $M_{\odot}$.

Theoretical, high-gravity, photospheric spectra were computed by first using the code TLUSTY (Hubeny 1988) to calculate the atmospheric structure and SYNSPEC (Hubeny & Lanz 1995) to construct synthetic spectra. We compiled a library of photospheric spectra covering the temperature range from 15,000 K to 70,000 K in increments of 1000 K, and a surface-gravity range of $\log g = 7.0$–9.0, in increments of 0.2.

After masking emission lines in the spectra, we determined separately for each spectrum the best-fitting WD-only models and the best-fitting disk-only models using IUEFIT, a $\chi^2$ minimization routine. A $\chi^2$ value and a scale factor were computed for each model fit. The scale factor, $S$, normalized to a kiloparsec and solar radius, can be related to the WD radius $R$ through $F_\lambda(\text{obs}) = S H_\lambda(\text{model})$, where $S = (4\pi R^2)/(d^2)$ and $d$ is the distance to the source in parsecs. The details of our $\chi^2$ (per degree of freedom) minimization fitting procedures are discussed in detail in Sion et al. (1995). We take any reliable published parameters like the WD mass or orbital inclination only as an initial guess in searching for the best-fitting accretion-disk models. We search for the best fit based upon (1) the minimum $\chi^2$ value achieved, (2) the goodness of fit of the continuum slope, (3) the goodness of fit to the observed Ly$\alpha$ region, and (4) consistency of the scale-factor-derived distance with the adopted distance or distance constraint. In other words, the fitting solution may not necessarily be the model with the lowest $\chi^2$ value but rather all other available constraints are used such as, for example, constraints on the distance or WD mass, and any reliable system parameters, if available. We utilize absorption line profile fits, especially the Ly$\alpha$ wings, but sometimes even Si ii, Si iii, C iii, C iv, Si iv, and Si ii when these features are in absorption and do not have an origin in a wind or corona. For the WD radii, we use the mass–radius relation from the evolutionary model grid of Wood (1995) for C–O cores. We also search for any statistically significant improvement in the fitting by combining the FUV flux of a WD model and a disk model, together using a $\chi^2$ minimization routine called DISKFIT. Once again, we find the minimum $\chi^2$ value achieved for the combined models, and check the combined model consistency with the observed continuum slope and Ly$\alpha$ region, and consistency of the scale-factor-derived distance with the adopted distance or distance constraints. Out of the roughly 900 models using every combination of $i$ and $M_{wd}$, we try to isolate the best-fitting accretion-disk model, WD model, or combination of a disk and WD.

The WD mass is unknown, as are the accretion rate, orbital inclination, and distance. We determined a solid lower limit to

Figure 3. A hot WD photosphere fit to SWP15384 with $T_{\text{eff}} = 21,000$ K, $\log g = 8$ (see text for details).
5. SYNTHETIC SPECTRAL FITTING RESULTS

Our procedure consisted of first trying photosphere models followed by optically thick accretion-disk models. For the WD-only model fits, the WD solar composition photosphere models yielded a minimum $\chi^2$ of 10.4802. This photosphere model gave a WD temperature of 21,000 K and a surface gravity of log $g = 8.0$, giving a distance to the system of 333 pc. This model is shown in Figure 3. We also tried a hotter photosphere model (31,000 K), which was hot enough to have absorption lines of Si iv and C iv that fit the observed absorption features nicely, but the model continuum longward of 1600 Å was far too steep compared to the observed continuum.

For the accretion-disk fitting, we tried disk models in the inclination range 18°, 41°, 60°, and 75° with the WD gravity fixed at log $g = 8.0$. All of the disk models, except two, gave marked shortfalls of flux longward of 1700 Å. Disk models corresponding to a WD mass of 0.55 $M_\odot$, accretion rates no higher than $10^{-9} M_\odot$ yr$^{-1}$, and disk inclinations around 60° yielded distances from the normalization in the range of 144–159 pc. The best-fitting accretion-disk model with an inclination of 60° to the observation is displayed in Figure 4. We note that a significantly better fit is achieved with an inclination of 75°, WD mass of 0.55 $M_\odot$, and an accretion rate of $10^{-9} M_\odot$ yr$^{-1}$. But the distance yielded by this fit is only 90 pc,
placing it below our adopted lower-limit distance of 100 pc from the 2MASS photometry. This fit is shown in Figure 5.

We tried a combined fit (WD plus disk) to determine if a statistically significant improved fit resulted compared with disks alone and with WD fits alone, and to assess the relative flux contribution of disk and star to the overall spectrum of the system. The contribution of the photosphere turned out to be minimal (about 3%), being vastly outshone by the accretion light of the disk. This combined fit is displayed in Figure 6. Hence, the combination of the photosphere with the disk model did not produce a statistically significant improvement in the fit. Thus, it seems reasonable to state that the spectrum of KQ Mon is dominated by the accretion light of an optically thick disk.

We have summarized all of the model fitting results in Table 1. The table reveals that the steady accretion-disk model fits, in all cases, are markedly superior to the model-photosphere fits. The accretion-disk models have \( \chi^2 \) values ranging between 4 and 6 while the WD photosphere fits all have significantly larger \( \chi^2 \) values, ranging between 10 and 17.

Moreover, if the FUV spectrum is due to a WD, then all WD model fits with \( T_{\text{eff}} > 31,000 \) K were ruled out. The best WD fits to the observed FUV continuum were for temperatures too low to account for the strength of C\textsc{iv} (1550) and Si\textsc{iv} (1400). Thus, we can confidently rule out WD photosphere models alone as the source of the FUV continuum.

Turning to the accretion-disk fits in Table 1, we eliminated all of the disk model fits with WD mass \( M_{\text{wd}} < 0.4 \, M_\odot \), because masses this small are not seen among the CV population (except possibly for T Leonis; see Hamilton & Sion 2004). Given the firm lower limit to the distance of 100 pc that we derived from 2MASS photometry and the method of Knigge (2006), we eliminated all model fits with distances closer than 100 pc. The fact that eclipses have not been detected in KQ Mon allows us to eliminate model fits with \( i = 80^\circ \) or higher. A close examination of the plots corresponding to the remaining fits in Table 1 revealed that all of the disk model fits, except three, gave marked shortfalls of flux longward of 1700 Å. Of the three remaining model fits, all have \( M_{\text{wd}} = 0.55 \, M_\odot \), two models have \( \dot{M} = 10^{-9} \, M_\odot \, \text{yr}^{-1} \) with \( i = 60^\circ \), while a third model has \( \dot{M} = 3 \times 10^{-9} \, M_\odot \, \text{yr}^{-1} \) with \( i = 75^\circ \). All three models yielded scale-factor-derived distances between 144 and 165 pc. From a formal error analysis on IUE spectra of comparable quality (Winter & Sion 2003), the estimated uncertainty in the accretion rates is a factor of two to three. Typical uncertainties for photospheric temperatures of the WDs, when exposed in the FUV, are \( \pm 2000 \) K.

### Table 1

| Spectrum | \( M_{\text{wd}} \) | \( T_{\text{eff}} \) | \( i \) | \( M \) | \( \chi^2 \) | Scale | \( d \) |
|----------|----------------|----------------|-----|----------|--------|------|-----|
| SWP15384 | 0.35           | 100 -8          | 60  | 4.63     | 0.077  | 359  |
| SWP15384 | 0.35           | 100 -9          | 60  | 5.03     | 1.259  | 89   |
| SWP15384 | 0.35           | 100 -9          | 75  | 4.89     | 0.230  | 208  |
| SWP15384 | 0.35           | 100 -9          | 81  | 4.88     | 0.651  | 124  |
| SWP15384 | 0.55           | 100 -9          | 41  | 5.53     | 0.228  | 209  |
| SWP15384 | 0.55           | 100 -9          | 60  | 4.45     | 0.479  | 144  |
| SWP15384 | 0.55           | 100 -9          | 60  | 6.26     | 0.123  | 284  |
| SWP15384 | 0.55           | 100 -9          | 60  | 4.99     | 2.008  | 71   |
| SWP15384 | 0.55           | 100 -9          | 75  | 4.78     | 0.368  | 165  |
| SWP15384 | 0.55           | 100 -9          | 75  | 3.42     | 1.568  | 80   |
| SWP15384 | 0.55           | 100 -9          | 60  | 6.09     | 0.208  | 219  |
| SWP16268 | 0.35           | 100 -9          | 75  | 6.12     | 0.190  | 229  |
| SWP16268 | 0.35           | 100 -9          | 81  | 6.10     | 0.538  | 136  |
| SWP16268 | 0.55           | 100 -9          | 60  | 5.30     | 0.396  | 159  |
| SWP16268 | 0.55           | 100 -9          | 75  | 5.97     | 0.304  | 181  |
| SWP16268 | 0.55           | 100 -9          | 81  | 5.95     | 0.859  | 108  |
| SWP16268 | 1.03           | 100 -10         | 18  | 6.63     | 0.382  | 162  |
| SWP16268 | 1.21           | 100 -10         | 18  | 5.91     | 0.745  | 116  |

**Disk Models**

| Spectrum | \( M_{\text{wd}} \) | \( T_{\text{eff}} \) | \( i \) | \( M \) | \( \chi^2 \) | Scale | \( d \) |
|----------|----------------|----------------|-----|----------|--------|------|-----|
| SWP15384 | 0.35           | 100 -8          | 60  | 4.63     | 0.077  | 359  |
| SWP15384 | 0.35           | 100 -9          | 60  | 5.03     | 1.259  | 89   |
| SWP15384 | 0.35           | 100 -9          | 75  | 4.89     | 0.230  | 208  |
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**WD Models**

| Spectrum | \( M_{\text{wd}} \) | \( T_{\text{eff}} \) | \( i \) | \( M \) | \( \chi^2 \) | Scale | \( d \) |
|----------|----------------|----------------|-----|----------|--------|------|-----|
| SWP15384 | 0.5           | 15000          | --- | 16.66    | 0.409  | 156  |
| SWP15384 | 0.5           | 21000          | --- | 10.48    | 0.090  | 333  |
| SWP15384 | 0.5           | 31000          | --- | 15.84    | 0.017  | 763  |
| SWP15384 | 0.6           | 21000          | --- | 11.36    | 0.088  | 337  |
Our synthetic spectral modeling of the FUV spectrum of KQ Mon reveals that the photosphere of the WD contributes little flux to the spectrum of the system, as it is greatly overwhelmed by a luminous accretion disk. We find that the system is being viewed at an inclination of no more than 60°, the mass of the WD is \( \sim 0.6 \, M_\odot \), and the accretion rate is \( \sim 10^{-9} \, M_\odot \) yr\(^{-1} \) at a system distance between 144 and 159 pc. Since there is no record of a previous outburst or of deep lower optical brightness states (such as those shown by VY Scl stars) with which to compare its current state, and since there is an absence of low-excitation emission lines in its optical spectrum, it should be classified as a member of the UX Uma subclass of nova-like variables. However, in UX Uma systems viewed at low inclination, strong, variable, high-velocity wind outflows are manifested in absorption features with large blueshifts and prominent P Cygni profile structure. Examples of these systems are RW Sex (Greenstein & Oke 1982), IX Vel (Sion 1985), V3885 Sgr (Linnell et al. 2009), QU Car (Linnell et al. 2008), and RZ Gru (Bisol et al. 2012).

The question remains whether KQ Mon is also an SW Sex member. In addition to the characteristics of the SW Sextant stars given in the introductory section, they exhibit high-velocity emission S-waves with maximum blueshift near phase \( \sim 0.5 \), a delay of emission-line radial velocities relative to the motion of the WD, and central absorption dips in the emission lines around phase \( \sim 0.4-0.7 \) (Schmidtobreick et al. 2005; Rodriguez-Gil et al. 2007; Hoard et al. 2003). The WDs in many if not all of these systems are suspected of being magnetic (Rodriguez-Gil et al. 2007), although this hypothesis remains unproven. Since SW Sex stars as well as most of the UX Uma systems are found near the upper boundary of the 2–3 hr period gap, a much better understanding of them is of critical importance to understanding CV evolution as they enter the period gap (Rodriguez-Gil et al. 2007), if indeed they even do enter the gap, since evolution across the gap has not yet been definitively proven.

KQ Mon is listed as a possible SW Sex member in the Big List of SW Sextant Stars primarily on the basis of variable, high-velocity wings seen in optical spectra (Rodriguez-Gil 2005). Moreover, its orbital period (\( P_{\text{orb}} = 3.08 \) hr) would place KQ Mon at a position just above the period gap for CVs. The nova-like variables in this period interval tend to be strong candidates for being physical SW Sex type stars (Rodriguez-Gil 2005).

Curiously, the FUV absorption lines in KQ Mon not only lack P Cygni structure but the line centers reveal only relatively small blueshifts. The latter would be the case if KQ Mon is being viewed nearly face-on but the lack of P Cygni structure is puzzling. It is well known that polars and intermediate polars typically do not exhibit wind outflow, with one possible exception (H 0551−819; Mouchet et al. 1996). We speculate that it is possible that SW Sex stars contain WDs with magnetic fields well below the field strengths of intermediate polars/polars but of sufficient strength to have a suppressive affect on the wind-launching mechanism originating in the inner accretion disk. According to this possible scenario, those UX Uma nova-like systems such as RW Sex, IX Vel, V3885 Sgr, QU Car, and RZ Gru are non-magnetic and the wind-launching mechanism is unaffected.

We note that a comparison of the FUV spectra of KQ Mon with other members of the UX Uma class may lend support to this possibility. We have identified three UX Uma-type nova-likes, BP Lyn (Grauer et al. 1994), V795 Her (Shafter et al. 1990), and LS Peg (Taylor et al. 1999), all with low inclinations (<60°) similar to KQ Mon. It is far from clear that the line-formation source region in KQ Mon and the three aforementioned systems lie in wind outflows. All four objects have deep absorption features and variable line profiles, but no clear evidence of the strong wind outflow seen clearly in RW Sex, IX Vel, V3885 Sgr, QU Car, and RZ Gru. Thus, the similarity of KQ Mon’s line spectrum to the FUV spectra of the definite SW Sex members, BP Lyn, V795 Her, and LS Peg, lends additional support for the classification of KQ Mon as an SW Sex member.

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REFERENCES

Bisol, A. C., Godon, P., & Sion, E. M. 2012, PASP, 124, 158
Bond, H. E. 1979, in IAU Colloq. 53, WDs and Variable Degenerate Stars, ed. H. M. van Horn & V. Weidemann (Rochester, NY: Univ. of Rochester), 495
Cameron, D., & Nassau, J. J. 1956, ApJ, 124, 346
Grauer, A. D., Ringwald, F. A., Wegner, G., et al. 1994, AJ, 108, 214
Greenstein, J. L., & Oke, B. 1982, ApJ, 258, 209
Hamilton, R., & Sion, E. 2004, PASP, 116, 926
Hoard, D., Szkody, P., Froning, C. S., Long, K. S., & Knigge, C. 2003, AJ, 126, 2473
Hoffmeister, C. 1943, AN, 274, 36
Hubeny, I. 1988, CoPhC, 52, 103
Hubeny, I., & Lanz, T. 1993, ApJ, 439, 875
Knigge, C. 2006, MNRAS, 373, 484
La Dous, C. 1991, A&A, 252, 100
Linnell, A., Godon, P., Hubeny, I., et al. 2008, ApJ, 676, 1226
Linnell, A. P., Godon, P., Hubeny, I., et al. 2009, ApJ, 703, 1839
Mouchet, M., Siess, L., Drew, J., et al. 1996, A&A, 306, 212
Rodriguez-Gil, P. 2005, in ASP Conf. Ser. 330, The Astrophysics of Cataclysmic Variables and Related Objects, ed. J.-M. Haneury & J.-P. Lasota (San Francisco, CA: ASP), 335
Rodriguez-Gil, P., Schmidtobreick, L., & Gaensicke, B. T. 2007, MNRAS, 374, 1359
Schmidtobreick, L., Tappert, C., Galli, L., & Whiting, A. 2005, IBVS, 5627, 1
Shafter, A., Robinson, E. L., Crampton, D., Warner, B., & Prestage, R. M. 1990, ApJ, 354, 708
Sion, E. 1985, ApJ, 292, 601
Sion, E. M., & Guinan, E. F. 1982, in NASA Conf. Publ. 2238, Advances in Ultraviolet Astronomy: Four Years of IUE Research, ed. Y. Kondo, J. M. Mead, & R. D. Chapman (Washington, DC: NASA), 460
Shafter, A., Szkody, P., Cheng, F.-H., & Huang, M. 1995, ApJ, 444, 97
Stephenson, C. B. 1989, PW&SO, 3, 53
Taylor, C. J., Thorstensen, J., & Patterson, J. 1999, PASP, 111, 184
Voges, W., Aschenbach, B.,oller, Th., et al. 1999, A&A, 349, 389
Wade, R., & Hubeny, I. 1998, ApJ, 509, 350
Winter, L., & Sion, E. 2003, ApJ, 582, 352
Wood, M. 1995, in Proc. 9th European Workshop on White Dwarfs, Kiel, Germany, 1994 August 29–September 1, ed. D. Koester & K. Werner (Lecture Notes in Physics, Vol. 443; Berlin: Springer), 41