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EUVE Observations of Nonmagnetic Cataclysmic Variables[1]

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Abstract. We summarize *EUVE*'s contribution to the study of the boundary layer emission of high accretion-rate nonmagnetic cataclysmic variables, especially the dwarf novae SS Cyg, U Gem, VW Hyi, and OY Car in outburst. We discuss the optical and EUV light curves of dwarf nova outbursts, the quasi-coherent oscillations of the EUV flux of SS Cyg, the EUV spectra of dwarf novae, and the future of EUV observations of cataclysmic variables.

1. Introduction

Cataclysmic variables (CVs) are a diverse class of semidetached binaries composed of a low-mass main-sequence star and an accreting white dwarf. In nonmagnetic CVs conservation of angular momentum dictates that accretion onto the white dwarf is mediated by a disk. While the white dwarf and disk are the dominant sources of optical through FUV light, the boundary layer between the disk and the surface of the white dwarf is the dominant source of higher-energy emission. Simple theory predicts that the accretion disk and boundary layer luminosities should be comparable, with $L_{\rm disk} \approx L_{\rm bl} \approx GM_{\rm wd}\dot{M}/2R_{\rm wd} \sim 3 \times 10^{34}\,(\dot{M}/10^{-8}\ {\rm M}_\odot\ {\rm yr}^{-1})\ {\rm erg\ s}^{-1}$, where $\dot{M}$ is the accretion rate and $M_{\rm wd}$ and $R_{\rm wd}$ are respectively the mass and radius of the white dwarf. When $\dot{M}$ is low ($\dot{M} \sim 10^{-11}\ {\rm M}_\odot\ {\rm yr}^{-1}$, as in dwarf novae in quiescence), the boundary layer is optically thin and quite hot (of order the virial temperature $T_{\rm vir} = GM_{\rm wd}m_{\rm H}/3kR_{\rm wd} \sim 10$ keV); when $\dot{M}$ is high ($\dot{M} \sim 10^{-8}\ {\rm M}_\odot\ {\rm yr}^{-1}$, as in novalike variables and dwarf novae in outburst), the boundary layer is optically thick and quite cool (of order the blackbody temperature $T_{\rm bb} = [GM_{\rm wd}\dot{M}/8\pi\sigma R_{\rm wd}^3]^{1/4} \sim 10$ eV). Hence, the boundary layer emission of high-$\dot{M}$ CVs is radiated primarily in the EUV, where it is easily hidden from us by the interstellar medium.

In addition to the severe effect of photoelectric absorption in the EUV, progress in our understanding of the EUV/soft X-ray emission of high-$\dot{M}$ CVs has been hampered by the poor energy resolution of X-ray detectors, the target-of-opportunity (TOO) scheduling required to observe dwarf novae in outburst,

[1]Dedicated to the memory and accomplishments of Danie Overbeek, a charming man and dedicated "amateur" observer, who, over a period of nearly 50 years, contributed over 287,000 observations of variable stars to the AAVSO International Database.

and the long (10–30 day) exposures required to follow the evolution of dwarf novae outbursts. Absorption by the interstellar medium restricts us to a relatively small number of intrinsically bright, nearby systems with low interstellar column densities ($N_{\rm H} \lesssim 10^{20}$ cm^{-2}). The *EUVE* spectrometers provide a significant improvement in the spectral resolution of proportional counter and microchannel plate detectors of past missions, and although the *EUVE* spectrometer effective areas were small, the necessarily long integration times made it possible for the first time to follow the evolution of all or part of several dwarf nova outbursts. *EUVE*'s ability to observe dwarf novae in outburst was made possible on one hand by the members, staff, and directors of the American Association of Variable Star Observers (AAVSO) and the Variable Star Section/Royal Astronomical Society of New Zealand (VSS/RASNZ), who initiated the TOO requests, and the staff of the *EUVE* Science Operations Center at CEA and the Flight Operations Team at GSFC, who quickly reacted to them.

EUVE was used during its lifetime to observe among other nonmagnetic CVs the dwarf novae SS Cyg in narrow and wide, normal and anomalous outbursts; U Gem in normal outburst (twice); VW Hyi in normal and superoutburst (twice); OY Car in superoutburst (twice), T Leo in superoutburst (Howell et al. 1999), and the novalike variable IX Vel (van Teeseling et al. 1995). These observations were obtained for varying reasons, and on a couple of occasions they were coordinated with other satellites (*HST*, *Voyager*, *Chandra*, *RXTE*) sensitive in other wavebands (UV, FUV, X-rays). Details of the *EUVE* observations are listed in Table 1.

Table 1. Journal of *EUVE* Observations of Nonmagnetic CVs

Star	Date (M/Y)	Interval (JD−2400000)	Exp. (ks)	Type of Outburst	Comment
SS Cyg	08/93	49216.58–222.86	179.4	Anom. Wide	
IX Vel	11/93	49317.99–326.85	222.4	...	
U Gem	12/93	49350.00–361.15	249.0	Normal	
VW Hyi	06/94	49505.46–507.66	89.4	Super	
SS Cyg	06/94	49526.67–536.69	147.8	Normal Wide	
VW Hyi	07/95	49906.70–917.29	183.8	Normal	+ *Voyager*
VW Hyi	05/96	50210.58–218.47	55.4	Super	+ *RXTE*
SS Cyg	10/96	50366.40–379.45	208.1	Normal Narrow	+ *RXTE*
T Leo	02/97	50500.60–506.54	96.1	Super	+ *RXTE*
OY Car	03/97	50534.46–537.64	94.8	Super	
U Gem	11/97	50760.27–766.85	150.0	Normal	+ *RXTE*
SS Cyg	06/99	51336.84–349.67	274.0	Anom. Narrow	+ *RXTE*
OY Car	02/00	51597.66–601.26	69.1	Super	& *HST*
SS Cyg	09/00	51800.19–801.96	42.8	Normal	+ *Chandra*

We provide highlights of various aspects of these observations in the next sections, limiting attention to sources which were bright enough to yield detailed EUV light curves and spectra: specifically, the dwarf novae SS Cyg, U Gem, VW Hyi, and OY Car in outburst. The subsequent sections discuss the optical and EUV light curves of dwarf novae (§2), the quasi-coherent oscillations of the

EUV flux of SS Cyg (§3), and the EUV spectra of dwarf novae (§4). We close in §5 with comments about the future of EUV observations of CVs.

2. Optical and EUV Light Curves

Optical light curves of outbursts of SS Cyg, U Gem, VW Hyi, and OY Car were constructed from visual magnitude estimates and CCD photometric measurements obtained by members of the AAVSO and VSS/RASNZ. EUV light curves were constructed from *EUVE* deep survey photometer (DS) data or short wavelength spectrometer (SW) data in those instances when the DS was turned off (during the peak of the 1996 October outburst of SS Cyg, both outbursts of U Gem, and the 1994 June outburst of VW Hyi). The full set of optical and EUV light curves is shown in Mauche, Mattei, & Bateson (2001); in Figures 1–3 we reproduce the light curves of normal outbursts of SS Cyg, U Gem, and VW Hyi. In Figure 3 the *Voyager* FUV (950–1150 Å) flux density light curve of VW Hyi is shown by the filled triangles. In the lower-left panel of Figure 1 the *RXTE* hard X-ray (2–10 keV) count rate light curve of SS Cyg (Wheatley, Mauche, & Mattei 2000) is shown by the open triangles.

These light curves provide important diagnostics of the nature of dwarf nova outbursts because the optical, UV, and EUV flux is produced in physically distinct regions: the optical flux in the outer disk, the UV flux in the inner disk, and the EUV flux in the boundary layer. Dwarf nova outbursts are due to an instability in the rate of mass transfer through the disk caused by the dramatic change in opacity when H becomes partially ionized at $T \sim 10^4$ K (for reviews of the disk instability model, see Cannizzo 1993; Osaki 1996; Lasota 2001). The instability can be triggered at large or small disk radii, resulting in normal, fast-rise outbursts or anomalous, slow-rise outbursts, respectively. In either case, the beginning of the outburst is signaled by a rise of the optical flux, followed by a rise of the UV flux as material sinks through the disk, converting its gravitational potential energy into rotational kinetic energy and radiation. This is followed by a rise in the EUV flux as material passes through the boundary layer, where its prodigious rotational kinetic energy is converted into radiation.

The anomalous outbursts of SS Cyg (upper panels of Fig. 1) manifest the gradual increase of the optical and EUV light curves expected for outbursts triggered near the inner edge of the disk. The optical and EUV fluxes rise during the beginning of these outbursts as the heating wave which transforms the disk from quiescence to outburst sweeps outward, causing more and more material to flow through the disk and boundary layer onto the white dwarf. In contrast, the normal outbursts of SS Cyg (lower panels of Fig. 1), U Gem (Fig. 2), and VW Hyi (Fig. 3) manifest the fast increase of, and the delay between, the optical and EUV light curves expected for outbursts triggered near the outer edge of the disk. As measured from the initial rise of the optical light curves, the delay of the rise of the EUV light curves is $\approx$ 1.5, 1.25, and 0.75 days for SS Cyg, U Gem, and VW Hyi, respectively. In VW Hyi, the FUV light curve rises $\approx$ 0.5 days after the optical light curve and $\approx$ 0.25 days before the EUV light curve, but falls as slowly as the optical light curve, consistent with the expectation that the accretion disk and not the boundary layer is the source of the FUV flux.

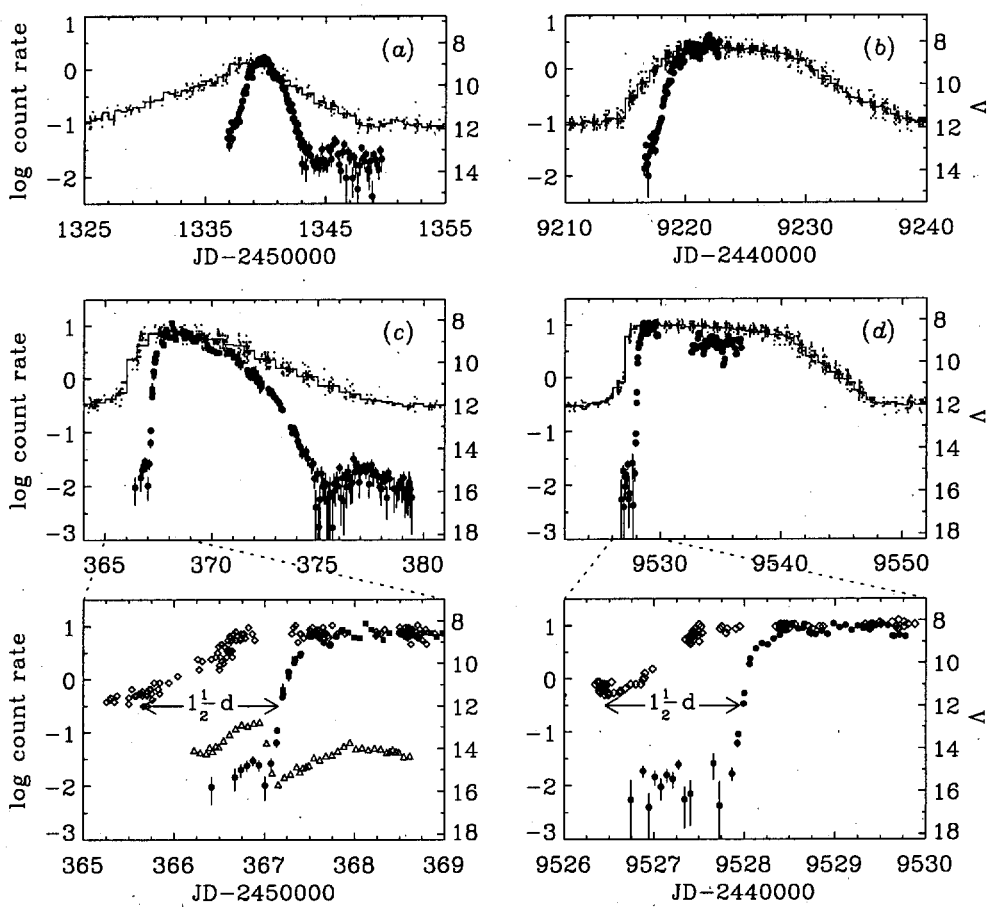

Figure 1. Optical, *EUVE*, and *RXTE* light curves of the anomalous (*a*) 1999 June and (*b*) 1993 August outbursts and the normal (*c*) 1996 October and (*d*) 1994 June outbursts of SS Cyg. DS and scaled SW count rates are shown by the filled circles and squares, respectively; *RXTE* PCA count rates (scaled downward by 2.5 dex) are shown by the open triangles; individual AAVSO measurements are shown by the small dots and diamonds; half-day mean optical light curve is shown by the histogram. For the normal outbursts of SS Cyg the optical-EUV delay is ≈ 1.5 days.

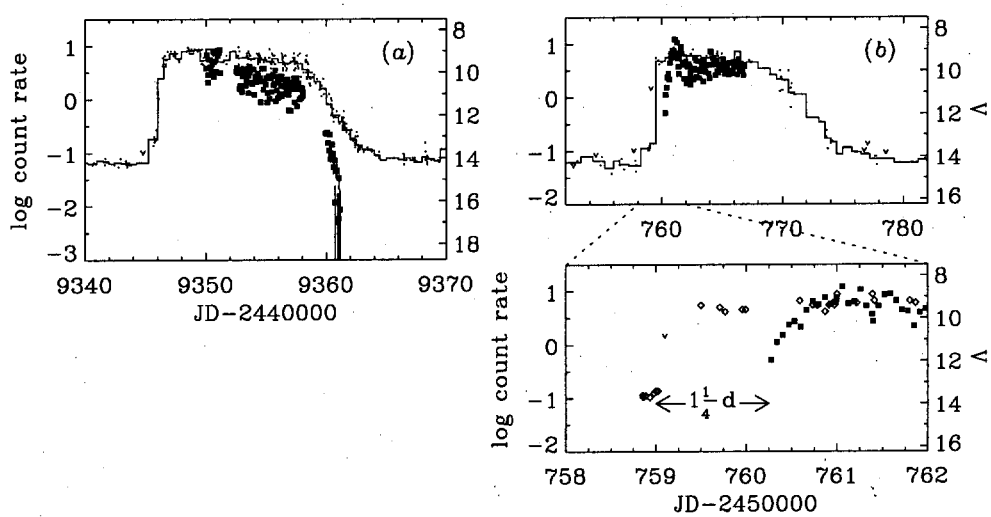

Figure 2. Optical and *EUVE* light curves of the normal (*a*) 1993 December and (*b*) 1997 November outbursts of U Gem. SW count rates are shown by the filled squares, individual AAVSO measurements are shown by the small dots and diamonds, half-day mean optical light curve is shown by the histogram. The optical-EUV delay of U Gem is ≈ 1.25 days.

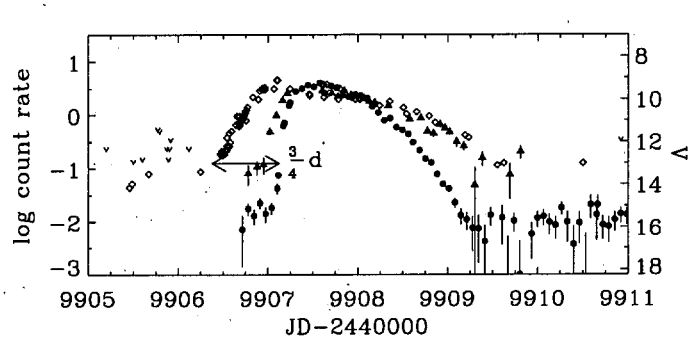

Figure 3. Optical, *Voyager*, and *EUVE* light curves of the normal 1995 July outburst of VW Hyi. DS count rates are shown by the filled circles, *Voyager* FUV flux densities are shown by the filled triangles, individual VSS/RASNZ and AAVSO measurements are shown by the diamonds. The optical-FUV delay of VW Hyi is ≈ 0.5 days and the optical-EUV delay is ≈ 0.75 days.

As detailed by Mauche, Mattei, & Bateson (2001), the optical-EUV delays of dwarf novae can be used to estimate the velocity of the heating wave, and hence the value of the viscosity parameter of high-$\dot{M}$ CVs.[2] Assuming the system parameters (orbital period, white dwarf mass, and mass ratio) tabulated by Ritter & Kolb (1998), that the radius of the disk $R_{\rm disk} \approx 0.7 \times R_{\rm L1}$, and that the disk instability starts at the outer edge of the disk, the velocity of the heating wave $v \approx R_{\rm disk}/{\rm delay} \approx 3$ km s^{-1}. This result is consistent with $v = \alpha c_{\rm s}$ if the viscosity parameter $\alpha \approx 0.2$ and the sound speed $c_{\rm s} = 10\,(T/10^4\ {\rm K})^{1/2}$ km s^{-1} $\approx$ 15 km s^{-1}. For a more in-depth discussion of this topic, see Cannizzo (2001).

3. Quasi-Coherent Oscillations of SS Cyg

Another use of the *EUVE* photometric measurements of dwarf novae is studies of their high-frequency temporal variability: the quasi-periodic and quasi-coherent oscillations known from previous EUV/soft X-ray observations. As in previous *HEAO 1* LED 1 (Córdova et al. 1984) and *EXOSAT* LE (Mason et al. 1988) data, $\sim$ 25 s low-amplitude low-coherence quasi-periodic oscillations were observed in *EUVE* SW photometry of U Gem in outburst (Long et al. 1996). van der Woerd et al. (1987) detected $\sim$ 14 s quasi-coherent oscillations on two occasions in *EXOSAT* LE data of VW Hyi in superoutburst, but it proved impossible to detect oscillations in the *EUVE* data, even though the source was observed extensively.

Far more rewarding is SS Cyg, whose EUV/soft X-ray quasi-coherent oscillations have been detected in *HEAO 1* LED 1 (Córdova et al. 1980, 1984), *EXOSAT* LE (Jones & Watson 1992), and *ROSAT* HRI (van Teeseling 1997) data. Various aspects of the rich phenomenology of the EUV oscillations of SS Cyg are discussed by Mauche (1996a, 1997a, 1997b, 1998) and Mauche & Robinson (2001). We show in Figure 4 a compilation of the variations of oscillation period versus time and oscillation period versus EUV flux for the 1993 August, 1994 June, and 1996 October outbursts of SS Cyg. A tight correlation between oscillation period P and SW count rate I is apparent in the right panels of the figure, with $P \propto I^{-0.094}$. Two conclusions are immediately apparent from these figures. First, we see that the period of the EUV oscillations of SS Cyg is a single-valued function of the EUV flux (hence, by inference, the mass-accretion rate onto the white dwarf). The loops observed in plots of oscillation period versus optical flux (e.g., Patterson 1981) are understood to be the result of the delay between the rise of the optical and EUV flux at the beginning of dwarf nova outbursts (§2). Second, the period-intensity variation of SS Cyg is far "stiffer" than that expected for disk accretion onto a compact star with a dipole magnetic field, for which $P \propto \dot{M}^{-3/7}$. If such a model applies to SS Cyg, an

[2]Upsetting this simple picture is the early rise of the hard X-ray light curve of the 1996 October outburst of SS Cyg (lower-left panel of Fig. 1). This signals that *some* increase in the mass-accretion rate through the boundary layer occurs during the early stages of the outburst, but the increase is not large: the hard X-ray flux rose by a factor of only $\sim$ 4, whereas the EUV flux rose by a factor of $\sim 10^3$ when the boundary layer made the transition from optically thin to thick.

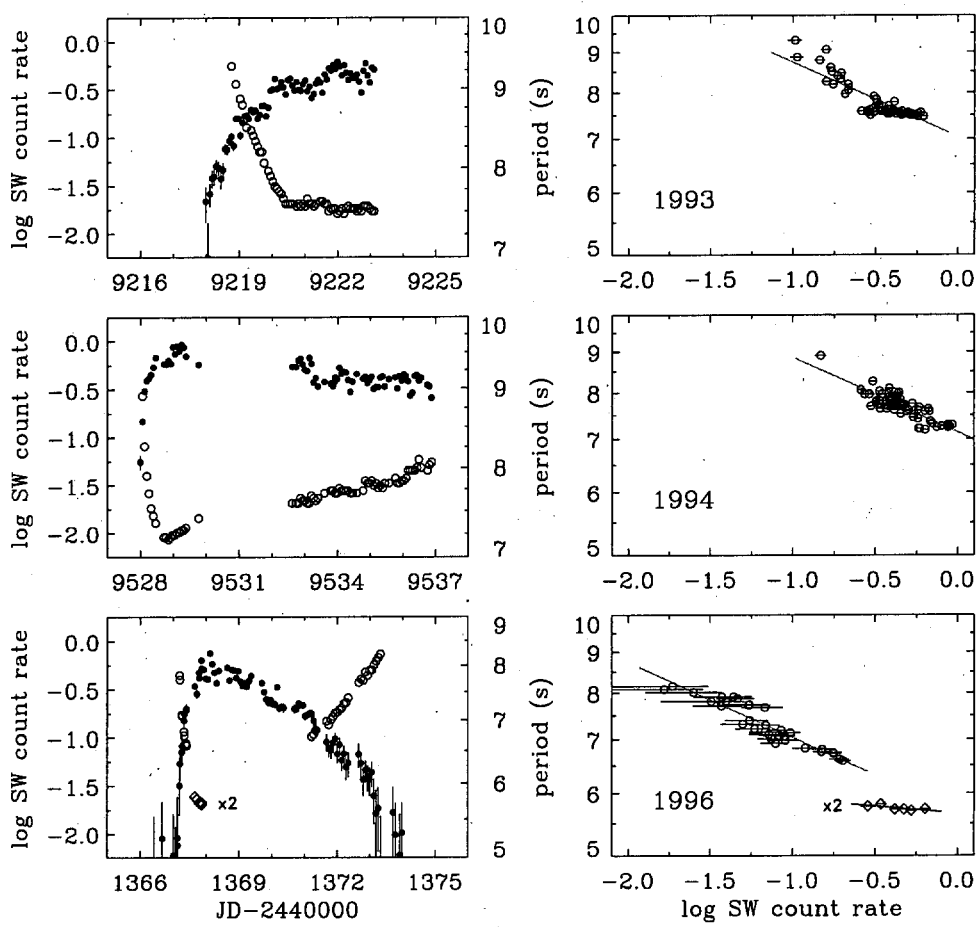

Figure 4. *Left panels*: SW count rate (*filled circles with error bars*) and period of the EUV oscillation (*open symbols*) as a function of time for the 1993 August, 1994 June, and 1996 October outbursts of SS Cyg. *Right panels*: Period P as a function of SW count rate I; straight gray lines are $P \propto I^{-0.094}$ s and $P \propto I^{-0.018}$. Open diamonds in the lower panels are plotted at twice the observed periods.

effective high-order multipole magnetic field is required, with a field strength $B \sim 0.1$–1 MG at the surface of the white dwarf (Mauche 1996a).

An additional phenomenon illustrated in the lower-left panel of Figure 4 is the frequency doubling observed during the 1996 October outburst of SS Cyg: on the rise to outburst the period of the EUV oscillation was observed to *jump* from 6.59 s to 2.91 s (Mauche 1998). Frequency doubling has never been observed before in this or any other dwarf nova in either the optical or EUV/soft X-rays, although similarly short-period (P = 2.8–2.9 s) oscillations were detected by van Teeseling (1997) in *ROSAT* HRI data acquired during the 1996 December outburst of SS Cyg. As the lower-right panel of Figure 4 makes clear, after the oscillation frequency doubled, its dependence on the SW count rate became "stiffer" by a factor of ≈ 5 in the exponent ($P \propto I^{-0.018}$). SS Cyg seems to have been doing what it could to avoid oscillating faster than about 2.8 s. If this is the Keplerian period of material at the inner edge of the accretion disk, then $P_{\rm Kep} \geq 2\pi(R_{\rm wd}^3/GM_{\rm wd})^{1/2} \approx 2.8$ s, requiring $M_{\rm wd} \gtrsim 1.27$ M$_\odot$. If instead, $P_{\rm Kep} \approx 5.6$ s (i.e., the observed 2.8 s period is the first harmonic of a 5.6 s Keplerian period), then $M_{\rm wd} \gtrsim 1.08$ M$_\odot$. Existing radial velocity data favor the second option, but it requires only a $\approx 10\%$ reduction in the inclination angle to accommodate the first option. A secure white dwarf mass is required to determine whether the 2.8 s oscillation is the fundamental or the first harmonic of the intrinsic oscillation.

During the same observations, Mauche & Robinson (2001) observed for the first time in SS Cyg or any other dwarf nova quasi-coherent oscillations *simultaneously* in the optical and EUV. They found that the period and phase of the oscillations are the same in the two wavebands, finally confirming the long-held assumption that the periods of the optical and EUV/soft X-ray oscillations of dwarf novae are equal. The *UBV* oscillations can be simply the Rayleigh-Jeans tail of the EUV oscillations if during outburst the boundary layer temperature $kT \lesssim 15$ eV and hence the luminosity $L_{\rm bl} \gtrsim 1.2 \times 10^{34}$ $(d/75$ pc$)^2$ erg s^{-1} (comparable to that of the accretion disk). Otherwise, the lack of a phase delay ($\Delta\phi_0 = 0.014 \pm 0.038$ or $\Delta t = 0.10 \pm 0.26$ s) between the EUV and optical oscillations requires that the optical reprocessing site lies within the inner third of the accretion disk. This is strikingly different from other CVs, where much or all of the disk contributes to the optical oscillations.

4. EUV Spectra

EUVE's truly revolutionary advancement over previous EUV/soft X-ray missions was the resolving power of its grating spectrometers, which was $\lambda/\Delta\lambda \approx 200$ at 100 Å, compared to $E/\Delta E \sim 1$ at 0.2 keV for proportional counter detectors. *EUVE*'s resolving power is fairly well matched to CVs, which have Keplerian Doppler widths $v \lesssim (GM_{\rm wd}/R_{\rm wd})^{1/2} \approx 3000$ km s^{-1} hence $\lambda/\Delta\lambda = c/v \gtrsim 100$. From the [$N_{\rm H}$, kT] banana plots of past missions we have moved to the frightening level of detail shown in Figure 5, which shows representative *EUVE* spectra of SS Cyg (Mauche, Raymond, & Mattei 1995), U Gem (Long et al. 1996), VW Hyi (Mauche 1996b), and OY Car (Mauche & Raymond 2000) in outburst. The spectral range runs from $\lambda \lesssim 350$ Å for VW Hyi with $N_{\rm H} \sim 10^{18}$ cm^{-2} to $\lambda \lesssim 130$ Å for SS Cyg with $N_{\rm H} \sim 4 \times 10^{19}$ cm^{-2}, and with

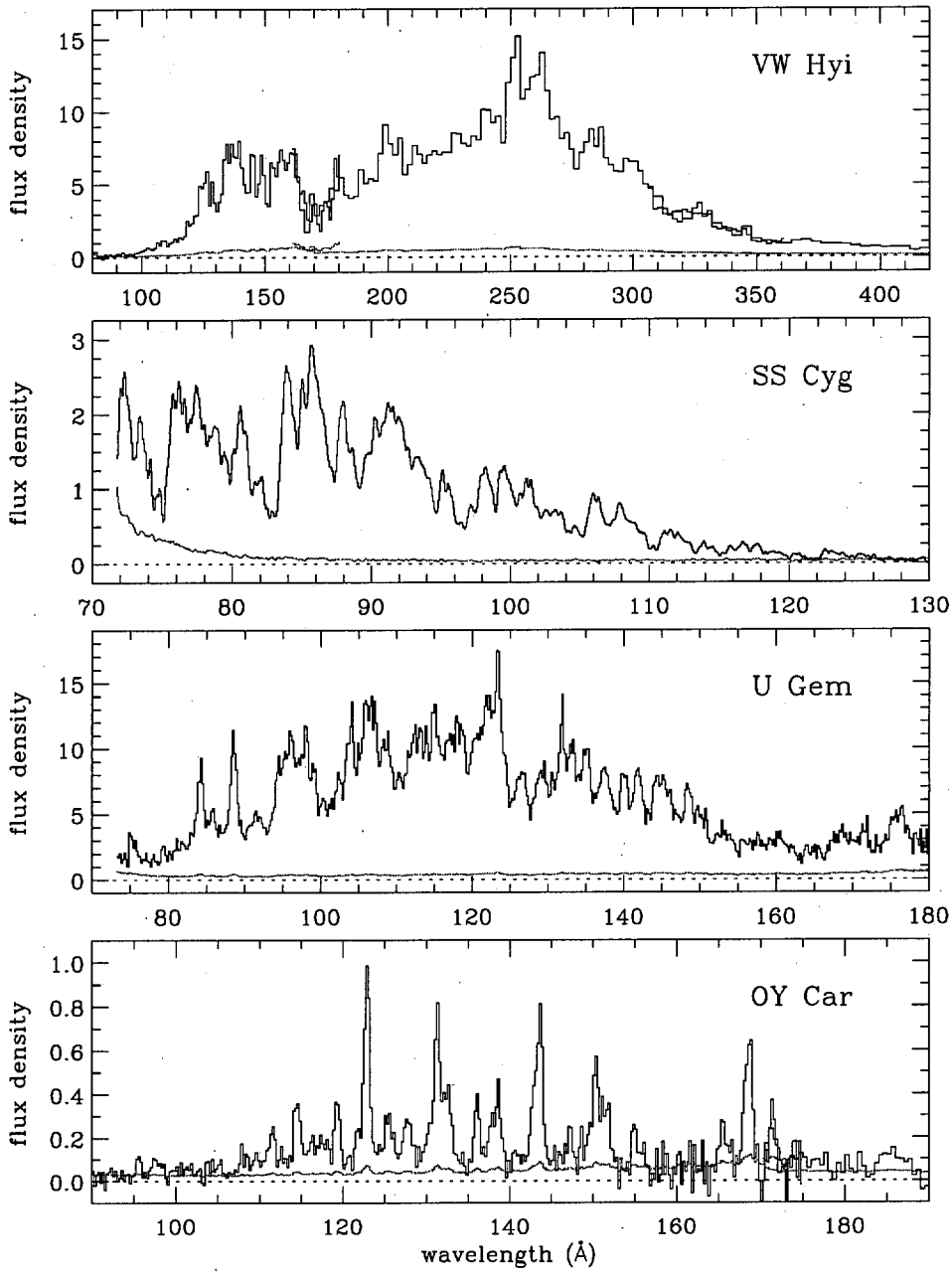

Figure 5. *EUVE* spectra of VW Hyi, SS Cyg, U Gem, and OY Car. Lower gray histograms are the $1\,\sigma$ error vectors. Units of flux density are 10^{-12} erg cm^{-2} s^{-1}.

the exception of SS Cyg none of the sources have any significant flux shortward of $\lambda \approx 80$ Å. This, combined with the severe effect of photoelectric absorption by the interstellar medium, is the explanation for the "nova problem," *aka* the "mystery of the missing boundary layer," as we were assured so long ago by Patterson & Raymond (1985).

It is quite clear from Figure 5 that the EUV spectra of dwarf novae in outburst are not the "simple" emission-line spectra of late-type stars or the continuum spectra of hot white dwarfs. Worse, these four systems differ markedly from each other, so it is difficult to confidently draw general conclusions. No attempt has been made to quantitatively understand the quasi-continuum spectrum of VW Hyi. The EUV spectrum of SS Cyg is only poorly understood. The broad-band spectral energy distribution can be parameterized by a $kT = 20$–30 eV blackbody absorbed by a column $N_{\rm H} = 7.0$–4.4×10^{19} cm^{-2} (in excess of the interstellar value), but the inferred luminosities are distressingly low: $L_{\rm bl} = 20$–$5 \times 10^{32}\,(d/75\ {\rm pc})^2$ erg s^{-1}, whereas the disk luminosity $L_{\rm disk} \approx 3 \times 10^{34}\,(d/75\ {\rm pc})^2$ erg s^{-1}. Tentative identifications can be made of some of the apparent emission features (Mg VII $2p^2$–$2p3d$ at 83.5–84.0 Å, Si VII $2p^4$–$2p^3 3s$ at 85.3–85.7 Å, Ne VIII $2s$–$3p$ at 88.1 Å and $2p$–$3d$ at 98.2 Å), but mostly we have failed in this effort. Some of the spectral features look like the P Cygni profiles seen in UV spectra of SS Cyg and other high-$\dot{M}$ CVs, suggesting that a significant modification of the intrinsic boundary layer spectrum occurs as the photons propagate through the system's accretion disk wind. It may be the case, as in novae, that the apparent emission features in the EUV spectrum of SS Cyg are simply regions of relative transparency is a sea of overlapping emission lines. This impression is supported by the *Chandra* LETG (1–170 Å) spectrum obtained during the 2001 January outburst of SS Cyg, but detailed modeling is required to determine if such a model can be made to work quantitatively.

Compared to the EUV spectrum of SS Cyg, the EUV spectrum of U Gem is relatively simple: it appears to consist of a series of moderately broad (FWHM $\approx$ 1–2 Å) emission lines superposed on a moderately strong continuum parameterized by a $kT \approx 11$ eV blackbody absorbed by a column $N_{\rm H} \approx 3 \times 10^{19}$ cm^{-2} (close to the interstellar value). Happily, the inferred luminosity $L_{\rm bl} \approx 3 \times 10^{32}\,(d/90\ {\rm pc})^2$ erg s^{-1} is comparable to that of the disk. Line identifications include nearly all the high oscillator strength transitions arising from the ground levels of O VI, Ne VI–VIII, Mg VI–VII, Fe VII–X, and Fe XXIII. Long et al. (1996) do not provide a quantitative model, but they argue that the lines are formed by scattering of boundary layer radiation in U Gem's accretion disk wind. That the line-forming region is more extended than the continuum is indicated by the binary-phased EUV spectrum of U Gem (Mauche 1997c), which shows that many of the emission lines (particularly Ne VIII $2s$–$3p$ at 88.1 Å) persist through the partial eclipses centered at binary phases $\phi \sim 0.1$ and $\phi \sim 0.65$.

Even more simple is the EUV spectrum of OY Car in superoutburst, which consists of moderately broad (FWHM ≈ 1 Å) emission lines of N V, O V–VI, Ne V–VII, Mg IV–VI, Fe VI–VIII, and Fe XXIII; a slightly cooler set of ions than that observed in U Gem. OY Car is seen edge-on, so in outburst the white dwarf and boundary layer are hidden from view by the accretion disk at all orbital phases. Neither *EXOSAT* (Naylor et al. 1988) nor *EUVE* saw an eclipse of the EUV flux when the white dwarf and accretion disk were eclipsed by the sec-

ondary, demonstrating that what EUV flux we observe comes from an extended emission region. A consistent interpretation of the *EUVE* photometric and spectroscopic data is supplied by a model wherein radiation from the accretion disk and boundary layer is scattered into the line of sight by the system's accretion disk wind (Mauche & Raymond 2000). It is possible to trade off continuum luminosity for wind optical depth, but reasonable models have a boundary layer temperature $kT \approx 8$–11 eV and a boundary layer and accretion disk luminosity $L_{\rm bl} = L_{\rm disk} \lesssim 4 \times 10^{34}\ (d/85\ {\rm pc})^2\ {\rm erg\ s^{-1}}$, corresponding to a mass-accretion rate $\dot{M} \lesssim 10^{-8}\ {\rm M_\odot\ yr^{-1}}$; an absorbing column density $N_{\rm H} \approx 1.6$–$3.5 \times 10^{19}\ {\rm cm^{-2}}$; and a wind mass-loss rate $\dot{M}_{\rm wind} \lesssim 10^{-10}\ {\rm M_\odot\ yr^{-1}} \approx 0.01\,\dot{M}$. Because radiation pressure alone falls an order of magnitude short of driving such a wind, magnetic forces must also play a role in driving the wind of OY Car in superoutburst.

5. The Future

The near future of EUV observations of CVs is bright in one way but dim in many other ways. On one hand we currently have access to the *Chandra* LETG spectrograph, which provides superior spectral resolution ($\Delta\lambda = 0.05$ Å, compared to $\Delta\lambda = 0.5$ Å for *EUVE*), modestly higher effective area ($A_{\rm eff} \approx 9\ {\rm cm^2}$ at 100 Å, compared to $A_{\rm eff} \approx 2\ {\rm cm^2}$ for *EUVE*), and a harder bandpass ($\lambda = 1$–170 Å, which is better suited to most CVs). *Chandra* also is in a deep orbit, so avoids the frequent Earth occultations which bedevil low-Earth-orbit satellites (this was particularly bad for OY Car, whose orbital period of 91 min was annoyingly close to *EUVE*'s orbital period of 95 min). On the other hand, it is difficult to get *Chandra* observing time, especially for TOO observations, especially for LETG observations, which are necessarily long because of the modest LETG effective area and the high background in the HRC-S detector. No future NASA mission is currently being planned to build on the wide variety of research areas opened up by *EUVE*. The proposed *KRONOS* MIDEX mission, with its coaligned optical, UV, and X-ray telescopes; long exposures; and rapid response to targets of opportunity offers some hope for long-term multiwavelength studies of CVs, but a planned EUV photometric telescope was not included in the baseline mission for cost reasons. In our rush to study sources at $z \sim 10$ we risk losing the ability to study beyond the visual bandpass sources in our own neighborhood.

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