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# Variable ultraviolet emission in SY Muscae

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**Summary**. Following the enhancement in ultraviolet flux which we reported previously, we have continued monitoring the symbiotic variable SY Muscae with the *International Ultraviolet Explorer* (*IUE*). Over the course of one year, the prominent emission lines of N v, O v, C iv, He ii appear to be gradually decreasing in absolute intensity. This appears to coincide with a steady decline in electron density in the emission line forming region, as suggested from the Si iii] λ1892 and C iii] λ1909 intensity ratio. Our data is consistent with a sudden ejection event in which material expelled from the surface of a hot $T_{eff} = 65\,000$ K subdwarf has exposed the underlying UV continuum of the star. A number of strong emission lines that are photo-excited by the intense radiation field of the secondary also exhibit broad pedestal emission that suggest turbulent velocities of ~150–300 km $s^{-1}$ in an expanding shell or possibly in an accretion disc. The radical change of the UV emission properties observed in SY Muscae indicates that our initial observations of this object were obtained during preliminary stages of mass ejection.

## 1 Introduction

SY Muscae is a unique peculiar emission star which exhibits regular light variations over a 623-day period that range ~1 mag and large fluctuations in ultraviolet flux. Its optical composite spectrum was first noticed by Henize (1952) who found [O iii] λ4363 and permitted line emission superimposed on an M-type continuum. *JHKL* photometry of Feast, Robertson & Catchpole (1977) indicate the presence of a normal M3 III giant in the system. Ultraviolet and optical spectra were obtained by Michalitsianos *et al.* (1982b), who discovered that UV emission in the λλ1200–3200 range brightened by a factor ~5 between 1980 September 20 and 1981 June 11. The character of the UV continuum over λλ1200–2000 wavelength range changed radically between these epochs, where the absolute continuum flux was found rising throughout this wavelength range during the enhanced UV emission phase. Previously, the UV continuum exhibited a broad peak centred around ~λ1600. We have continued monitoring SY Muscae with the *International Ultraviolet Explorer* (*IUE*) in order to determine the nature of the strong UV flux variations.

Enhanced emission in the intercombination lines of O IV], N IV], O III] and N III] can be interpreted as variations in electron density, suggesting that material was injected into the surrounding gaseous regions during the UV brightening. High-dispersion spectra obtained on 1981 June 11, however, do not exhibit P-Cygni type structure. Such conditions might be expected if an accretion disc that is formed during an outburst is viewed nearly edge-on and the line emitting wind material is not seen against the intense emission from the disc. Similar conditions have been found for cataclysmic variables, where low inclination systems often exhibit P-Cygni profiles while eclipsing or high inclination systems do not (*cf.* King *et al.* 1983). The line profiles of N V, C IV, He II and O III] consist of two components, a narrow nebular profile and a broad pedestal base, the width of which indicates turbulent velocities of $\gtrsim 100\ \mathrm{km\ s^{-1}}$. These results are discussed in context with models which have been proposed to explain outbursts in symbiotic stars (*cf.* Bath 1978; Kafatos & Michalitsianos 1982). Our observing program and data analysis methods are discussed.

## 2 Observations

*IUE* observations were obtained exclusively with the large 10 × 20 arcsec entrance aperture of the satellite spectrometer (*cf.* Boggess *et al.* 1978) in both the low (~6 Å resolution) and high (~0.1 Å resolution) dispersion modes. The observing program is shown in Table 1. *IUE* data tapes were analysed at NASA-GSFC Astronomical Data Analysis Facility using the FORTH system on the PDP 11/44 computer. In Fig. 1, low-dispersion spectra in the SWP λλ1200–2000 range are shown for each observation date, and absolute line intensities are given in Table 2. The spectra in Fig. 1 were corrected using the average galactic law of Savage & Mathis (1979) for an $E(B-V) = 0.4$, a value which is suggested from the magnitude of the λ2200 absorption feature. Previous estimates of extinction (Michalitsianos *et al.* 1982b) appear to have slightly underestimated the actual level of reddening. Observations on 1980 September 20 closely coincided with minimum visual light that occurred in 1980 November (Bateson, private communication). In 1981 May–June, SY Muscae was near

**Table 1.** *IUE* observing program.

| Date | *IUE* camera image* | Exposure (min) | FES magnitude |
|---|---|---|---|
| 1980 September 20 | SWP 10188 | 90 | 10.7 |
| | LWR 8855 | 60 | |
| 1981 June 11 | LWR 10828 | 50 | 10.4 |
| | SWP 14237 | 45 | |
| | SWP 14238 | 10 | |
| | LWR 10833 | 420 | |
| 1981 December 10 | LWR 12059 | 50 | 10.4 |
| | SWP 15594 | 60 | |
| | SWP 15705 | 9 | |
| | LWR 12116 | 10 | |
| 1982 February 16 | SWP 16381 | 60 | 10.5 |
| | LWR 12631 | 50 | |
| | SWP 16382 | 8 | |
| | LWR 12632 | 10 | |

* SWP λλ1200–2000 Å, LWR λλ 2000–3200 Å.

**Table 2.** Absolute emission line intensities in SY Muscae.

| Ion | λ(Å) laboratory | 1981 Sept. 20 λ(Å) *IUE* | 1981 Sept. 20 Flux*† | 1981 June 11 λ(Å) *IUE* | 1981 June 11 Flux*† | 1981 Dec. 10 λ(Å) *IUE* | 1981 Dec. 10 Flux*† | 1982 Feb. 19 λ(Å) *IUE* | 1982 Feb. 19 Flux*† |
|---|---|---|---|---|---|---|---|---|---|
| N V | 1238.8, 1242.8 | 1235.9 | 1.0 | 1239.2 | 12.1 | 1239.6 | 10.4 | 1239.0 | 6.4 |
| O I | {1302.2, 1304.9, 1306.0 | 1301.9 | 0.2 | 1303.2 | 2.4 | 1305.2 | 2.2 | 1305.8 | 1.0 |
| O V | 1371.3 | 1366.9 | 0.2 | 1370.6 | 1.1 | 1372.2 | 0.6 | 1371.8 | 0.4 |
| Si IV | 1393.8 | 1392.6 | 0.1 | 1393.0 | 1.6 | 1394.0 | 1.4 | 1394.0 | 0.7 |
| O IV] | {1397.2, 1399.8, 1401.2 | 1398.4 | 1.0 | 1402.2 | 4.1 | 1402.4 | 2.8 | 1402.2 | 2.7 |
| N IV] | 1486.5 | 1483.0 | 0.7 | 1487.2 | 3.9 | 1486.6 | 3.5 | 1487.2 | 2.1 |
| C IV | 1548.2, 1550.8 | 1545.2 | ‡ | 1547.8 | 38.2 | 1549.2 | 30.4 | 1549.4 | 19.8 |
| [Ne V] | 1574.9 | 1572.0 | 0.2 | 1573.6 | 0.3 | 1576.0 | 0.4 | 1576.0 | 0.3 |
| He II | 1640.4 | 1637.2 | ‡ | 1639.4 | 15.7 | 1641.4 | 13.7 | 1640.8 | 9.8 |
| O III] | 1660.8, 1666.2 | 1662.2 | 1.0 | 1666.8 | 4.2 | 1666.6 | 4.0 | 1666.6 | 2.8 |
| N IV | 1718.6 | | | 1716.8 | 0.3 | 1719.6 | 0.1 | 1718.8 | 0.2 |
| N III] | {1746.8, 1748.6, 1749.7, 1752.2, 1754.0 | 1748.6 | 0.6 | 1750.4 | 1.5 | 1750.4 | 1.5 | 1750.6 | 1.1 |
| Si II | 1816.9 | | | 1818.2 | 0.2 | 1816.6 | 0.2 | 1816.4 | 0.1 |
| Si III] | 1892.0 | 1888.2 | 0.5 | 1892.9 | 1.8 | 1891.9 | 1.9 | 1892.6 | 1.1 |
| C III] | 1908.7, 1906.7 | 1907.6 | 0.7 | 1909.2 | 1.4 | 1909.2 | 1.3 | 1909.2 | 1.0 |

* Not corrected for extinction. † ($\times 10^{-12}$ erg cm$^{-2}$ s$^{-1}$). ‡ Saturated.

maximum visual light, consistent with *IUE*-FES magnitudes obtained near these dates (Table 1). In the UV brightened phase, the absolute continuum flux distribution between λλ1200–2000 can be fitted with a $T_{\rm eff} = 65\,000$ K blackbody law after correcting for extinction [$E(B-V) = 0.4$]. This is also the minimum effective temperature which a hot subdwarf must have in order to explain He II λ1640 emission.

High-dispersion (SWP 14236) spectra are only available 1981 June 11 during the initial UV enhanced emission phase. The intercombination N III] line intensities enable us to estimate electron densities by using the $I(\lambda 1754.0)/I(\lambda 1752.2)$, $I(\lambda 1748.7)/I(\lambda 1752.2)$, $I(\lambda 1748.7)/I(\lambda 1749.7)$ and $I(\lambda 1746.8)/I(\lambda 1748.7)$ ratios. Nussbaumer & Storey (1979) have computed theoretical line intensity ratios for the N III] multiplet for electron temperatures $T_e$ in the range $3 \times 10^4$ to $10^5$ K. The multiplet line intensity ratios suggest that the prevailing electron densities during the enhanced UV emission phase are $\sim 10^{10}$ cm$^{-3}$, in agreement with our previous analysis (Michalitsianos *et al.* 1982b). The $I(\lambda 1746.8)/I(\lambda 1748.7)$ ratio gives lower values for $n_e \lesssim 10^9$ cm$^{-3}$, but N III] λ1746.8 Å is very weak, and is probably a less reliable indicator than the stronger members of the multiplet. We can obtain lower limits of $n_e \gtrsim 10^6$ cm$^{-3}$ from the absence of C III] λ1906.7 and the N IV] λ1483.7 lines (Loulerque & Nussbaumer 1976). The presence of N IV] λ1486.5 implies $n_e \lesssim 10^{11}$ cm$^{-3}$, while strong C III] λ1908.7 implies $n_e \lesssim 2 \times 10^{10}$ cm$^{-3}$ (Osterbrock 1970).

Over the course of the *IUE* observing program the Si III] λ1892.0 Å to C III] λ1908.7 Å ratio exhibited variations that are likely to be explained by variations in $n_e$. This follows because the $I$(Si III] λ1892.0)/$I$(C III] λ1908.7) intensity ratio is density dependent over the range $10^9 \lesssim n_e \lesssim 5 \times 10^{11}$ cm$^{-3}$ (*cf.* Cook & Nichols 1979). This density range is not

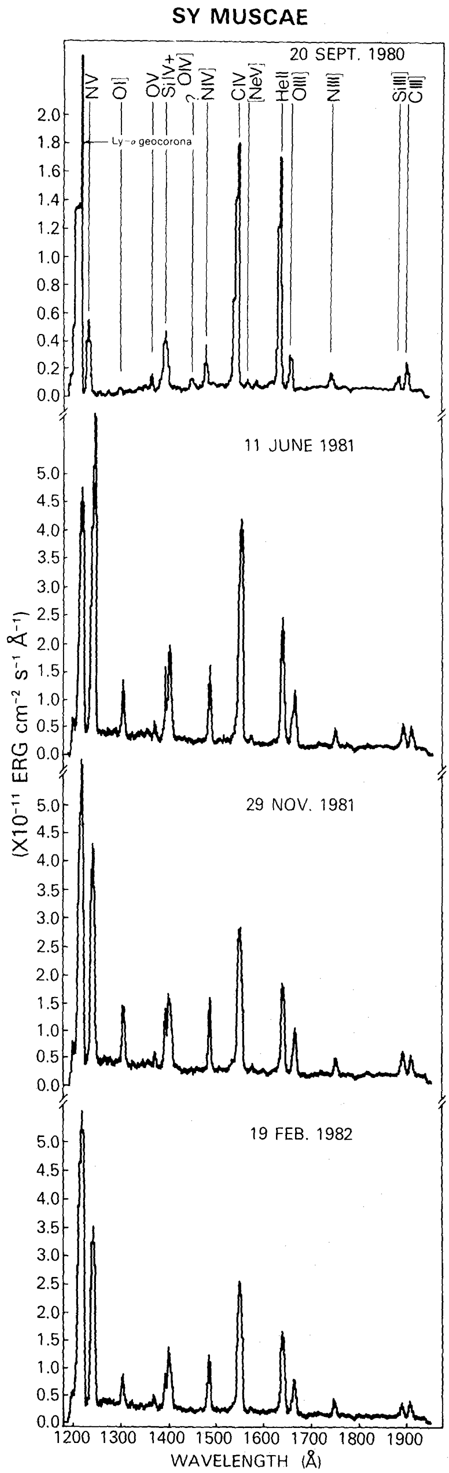


**Figure 1.** Low-resolution *IUE* spectra of SY Muscae obtained in the SWP λλ1200–2000 wavelength range for four observing dates. The spectra are corrected using the average galactic extinction law for an $E(B-V)=0.4$, a value obtained from the magnitude of the λ2200 absorption feature. Note the vertical absolute flux scale for 1980 September 20 is plotted on an expanded scale (different from the three succeeding dates) in order to show weaker emission features. The greatest change in the UV spectral properties occurred between 1980 September 20 and 1981 June 11. The C IV λλ1548, 1550 doublet is overexposed on 1980 September 20. Note the variation in the Si III] λ1892 to C III] λ1909 line intensities. The UV continuum between λλ1200–2000 1981 June 11 can be fitted with a $T_{\mathrm{eff}} = 65\,000$ K blackbody law.

**Table 3.** Electron density variations.

| Epoch | $\{I$ Si III] $\lambda 1892.0\}$ / $\{I$ C III] $\lambda 1908.7\}$ | $n_e$ (cm$^{-3}$)* |
|---|---|---|
| 1980 September 20 | 0.71 | $8\times10^9-7\times10^{10}$ |
| 1981 June 11 | 1.29 | $3\times10^{10}-2\times10^{11}$ |
| 1981 December 10 | 1.47 | $3.5\times10^{10}-2.5\times10^{11}$ |
| 1982 February 19 | 1.09 | $2\times10^{10}-10^{11}$ |

*Cook & Nichols (1979). $T_e$ is assumed to be $10^4$ K for the photo-ionized nebula. The range of $n_e$ reflects uncertainties in the photo-ionizing conditions for the two ions.

very sensitive to the value of electron temperature $T_e$ used in the calculations. Using more recent calculations by Dufton (private communication), the density sensitive range is $4\times10^9 \lesssim n_e \lesssim 5\times10^{11}$ cm$^{-3}$, in close agreement with Cook & Nichols (1979). Because the intersystem decay rate is 100 greater for Si III], where $A_{21}$(Si III) = $1.04\times10^4$ s$^{-1}$ and $A_{21}$(C III) = 90 s$^{-1}$, the de-excitation rate for silicon is controlled by spontaneous radiative decay and is independent of variations in electron density for $n_e \lesssim 10^9$ cm$^{-3}$. Above $5\times10^{11}$ cm$^{-3}$, the de-excitation rate for both ions is controlled by collisions and the line intensity ratio is essentially constant with $n_e$. Accordingly, $n_e \sim 10^{10}$ cm$^{-3}$ obtained from the N III] multiplet is well within the density sensitive range of the Si III] and C III] ratio.

However, the relative ionic abundance of Si III and C III generally depends on a number of parameters that include the ionizing photon flux from the hot component of the system. As seen in Fig. 1, following the initial brightening, the absolute UV continuum flux between λλ1200–2000 and, therefore, the temperature of the ionizing source did not change appreciably from one epoch to the next. The Si III] to C III] line intensity ratio, however, did vary during this period (Table 3). We suspect, therefore, that intensity variations observed in this line ratio during the UV brightened phase are primarily the result of variations in $n_e$. The significant increase in the ratio between 1980 September 20 and 1981 June 11 is probably the result of a combination of effects that include substantial changes in the ionizing photon flux as well as electron density. If due entirely to electron density effects, $n_e$ would have increased by a factor ~3.5–4.5 during initial stages of UV brightening (see Table 3). Since the presence of N IV] and C III] imply densities less than $10^{11}$ cm$^{-3}$, respectively, we prefer the lower values of $n_e$ in Table 3. The line ratio obtained on 1982 February 19 suggests that $n_e$ is declining after having attained a maximum around 1981 December 10, approximately one year following the brightening in the ultraviolet. It is evident from a number of symbiotic stars surveyed with *IUE* that the Si III] λ1892 to C III] λ1909 ratios are generally $\gtrsim 0.5$ (*cf.* Kafatos, Michalitsianos & Hobbs 1980; Michalitsianos *et al.* 1982a). Symbiotics with $I$(Si III λ1892)/$I$(C III λ1909) $\gtrsim 1$ might be indicative of post-eruptive conditions in such systems. If correct, this line ratio could prove an important diagnostic for analysing UV spectra of peculiar emission stars, especially for those objects too faint for high-dispersion observations.

Our estimate of an initial increase of $n_e$ by a factor ~3.5–4.5 is also consistent with the absolute intensities of the intercombination lines of O IV], N IV] and O III] (compare 1980 September 20 and 1981 June 11 in Table 2). Because the intensity for nebular lines $I_\lambda$ is proportional to $n_e$ for the high density limit, an increase in $n_e$ by a factor ~ 3.5–4.5 is reflected in an increase of $I_\lambda \sim 4$, consistent with the relative strengths of the semi-

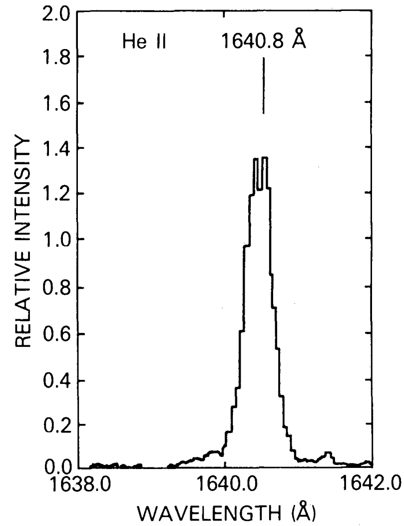


**Figure 2.** He II λ1640 is representative of strong emission lines that exhibit broad pedestal emission at the base of their profiles (obtained 1981 June 11). The pedestal appears more pronounced in the blue wing of He II λ1640 line. The split profile is likely spurious and due to an artifact in data reduction. Emission lines of N V, N IV, C IV and O III] exhibit similar profile structure.

forbidden lines before and after the UV brightening. In contrast, intensity variations of permitted resonance lines, i.e. N v, He II, were far greater $\gtrsim 10$.

High-dispersion line profiles of permitted and intercombination lines obtained on 1981 June 11 reveal a two component structure. In Fig. 2, the He II λ1640 line exhibits a broad emission feature at the base of the profile that appears more pronounced in the blue wing. The O III] λ1660, 1666 lines exhibit similar asymmetric structure. Broad pedestal emission in the C IV λλ1548, 1550 lines is also apparent, but appears more symmetrically spread around the narrow nebular emission profile. The 240-min high-dispersion exposure was not sufficiently long for the underlying continuum to be adequately exposed. Weaker emission lines will probably show similar structure if longer high-dispersion exposures are obtained. Broad pedestal emission in strong emission lines has been seen in at least one other symbiotic star. Flower *et al.* (1979) reported broad emission bases in the C IV doublet in V1016 Cygni. Kindl, Marxer & Nussbaumer (1982) also found similar features in UV lines of V1016 Cygni, where the characteristic velocity broadening, that appears to be

**Table 4.** Emission lines exhibiting broad pedestals,★ 1981 June 11.

| Ion | λ(Å) laboratory | Δλ(Å) Full base width | Velocity width (km s$^{-1}$) |
|---|---|---|---|
| N V | 1238.8 | 0.918 | 220 |
| | 1242.8 | 0.654 | 157 |
| C IV | 1548.2 | 0.106 | 205 |
| | 1550.8 | 0.882 | 170 |
| He II | 1640.3 | 1.600 | 292 |
| O III] | 1660.8 | 0.584 | 105 |
| | 1666.1 | 0.702 | 138 |

★ High-dispersion data not available for 1980 September 20.

excitation dependent, suggests mean velocities of ~300 km $s^{-1}$. Penston *et al.* (1983) also report a correlation between UV linewidth and ionization energy in the symbiotic/slow-nova RR Telescopii. Kindl *et al.* (1982) interpret the broad pedestal features in V1016 Cygni in terms of a high-velocity stellar wind that may signal initial stages of nebula expansion, perhaps reflecting the early phases of planetary nebula formation. Emission lines showing this structure in SY Muscae are given in Table 4, together with the corresponding velocity widths. The velocities shown are comparable with those found by Kindl *et al.* (1982) for V1016 Cygni. A tendency appears present that suggests higher excitation lines have broader base widths. Our small sample of lines which show this effect, however, makes it difficult to establish this correlation for certain. Longer high dispersion exposures are needed to discern the profile structure at the base of weaker emission lines.

## 3 Discussion and conclusions

We have continued monitoring SY Muscae in the ultraviolet with *IUE* following the radical enhancement in ultraviolet emission which this symbiotic variable exhibited. The initial brightening in the UV that occurred between 1980 September 20 and 1981 June 11 is characterized by a large increase in the absolute intensities of permitted resonance emission lines that increased by a factor ≳10, while more moderate gains were observed in high-excitation intercombination lines. Analysis of the N III] line multiplet intensity ratios and the Si III] and C III] intensity ratio suggests that the UV enhanced phase coincided with increased density, where $n_e$ increased by a factor ~3.5 to 4.0. Following the initial brightening, the absolute line strengths of the resonance lines of N V, C IV, He II and O V decreased over a period of ~1 yr and were accompanied by a steady decline in the Si III] and C III] line intensity ratio; this suggests that the ionized line forming region subsequently expanded and cooled. There was little or no indication of outburst activity in the visible region, probably because the M3 III giant dominates the integrated light at optical wavelengths. The gradual decline in emission line intensities over the course of approximately 1 yr does not support the notion that the sudden enhancement in UV-flux was the result of the eclipsed UV-source emerging from behind the M giant (Michalitsianos *et al.* 1982b).

The 100–300 km $s^{-1}$ velocities that we find may be interpreted as turbulent velocities near or in the accretion disc around the hot component of the system. We note that these velocities are too high to be interpreted as escape velocities from the late-type primary, but could still represent escape velocities from the vicinity of the hot subdwarf–accretion disc system. For a binary period of 623 days and assuming that the ionized nebula engulfs both stars (if the nebula was much smaller there would be no special reason why it should always engulf the hot star only), we find a radius of the ionized nebula $R_i \sim 3 \times 10^{13}$ cm for a total mass of 3 $M_\odot$ for the system. This can be compared to the Strömgren sphere radius expected for a 65 000 K hot subdwarf. We find that for the observed UV flux a distance $d \sim 900$ pc, and assuming $T_{eff} = 65\,000$ K (higher than the lower limit of 40 000 K found by Michalitsianos *et al.* 1982b), the secondary has a radius $R_* \sim 10^{10}$ cm and luminosity $L_* \sim 400\, L_\odot$. The Strömgren sphere radius corresponding to such a star is $R_i \sim 10^{13}$ cm, if $n_e \sim 10^{10}$ $cm^{-3}$. Velocities of the order of 100–300 km $s^{-1}$ would arise in an accretion disc ~$10^{11}$–$10^{12}$ cm away from a secondary star of 1 $M_\odot$, i.e. 10–100 stellar radii, a reasonable value.

If, on the other hand, the velocities 100–300 km $s^{-1}$ arise in a stellar wind away from the hot subdwarf–accretion disc (*cf.* Bath 1978), we can estimate the luminosity of the accretion disc and boundary layer as follows: the total accretion luminosity of the disc plus boundary layer as follows: the total accretion luminosity of the disc plus boundary layer (Bath *et al.* 1974) is

$$=\frac{GM\dot{M}_{\rm acc}}{R_*}, \quad (1)$$

where $M$ is the mass of the secondary, $R_*$ its radius and where $\dot{M}_{\rm acc}$ the mass accretion rate on to the secondary. The mass loss rate from the system is

$$\dot{M}_{\rm loss} \sim 4\pi R_{\rm i}^2 n_{\rm e} m_{\rm p} v, \quad (2)$$

where the velocity $v$ is likely ~100–300 km s$^{-1}$. These two mass rates are related to each other by

$$\dot{M}_{\rm acc} = (\epsilon + 1)\dot{M}_{\rm loss}, \quad (3)$$

where we would expect the $\epsilon \gg 1$. The ionizing photon flux arising from accretion is then

$$N_{\rm i} = \frac{GM\dot{M}_{\rm acc}}{I_{\rm H} R_*}\lambda, \quad (4)$$

where $I_{\rm H}$ is the ionization potential of hydrogen and $\lambda$ is a dimensionless number that takes into account the fraction of photons emitted by the boundary layer and disc beyond the Lyman limit (912 Å). For reasonable boundary layer temperatures $T_{\rm bl} \sim 10^5 - 2 \times 10^5$ K, $\lambda$ is approximately ½.

Equating (4) to the total recombination rate $(4\pi/3)R_{\rm i}^3 \alpha n_{\rm e}^2$, we find that

$$R_{\rm i} = 3.1 \times 10^{13} \epsilon\lambda v_{100}(M/1\,M_\odot)(n_{\rm e}/10^{10}\,{\rm cm}^{-3})^{-1}(R_*/10^{10})^{-1}\,{\rm cm}, \quad (5)$$

where $R_{\rm i}$ is the radius of the ionizing zone and $v_{100} = v/100$ km s$^{-1}$. Using equations (1) and (2), we find the total accretion luminosity is

$$L_{\rm acc} \sim 2.8 \times 10^{37}(\epsilon v_{100})^3 \lambda^2 (M/1\,M_\odot)^3 (n_{\rm e}/10^{10}\,{\rm cm}^{-3})^{-2}(R_*/10^{10})^{-3}\,{\rm erg\,s}^{-1}, \quad (6)$$

close to, or exceeding the Eddington luminosity, even for small values of $\epsilon \sim 1$–2. Even though the disc is producing larger luminosities than the hot companion it would not necessarily be directly observable because the periodicity of the light curve – if interpreted as due to eclipses – implies that the disc is seen almost edge-on.

The exact time-scale over which the UV flux increased (sometime between 1980 September 20 and 1981 June 11) cannot be determined because approximately 10 months elapsed between the initial and succeeding observations during the brightened phase. However, we can estimate roughly the brightening time-scale $\Delta t$ by considering the emission properties of the line forming nebular region if material is outflowing. From our analysis of the intercombination line strengths, if the density $\rho$ in the line forming region increased by a factor ~4, the mass of the ionized nebula $M_{\rm neb}$ contained within a constant spherical volume of radius $R_{\rm neb}$ also increased by the same factor. Adopting an upper limit for the mass loss rate from our previous discussion of $\dot{M}_{\rm loss} \sim 10^{-5}\,M_\odot\,{\rm yr}^{-1}$, and a nebula radius $R_{\rm neb} = R_{\rm i} = 10^{13}$ cm, the time-scale for UV brightening is $\Delta t \gtrsim 4$ days. These parameters are similar to those determined for V1016 Cyg which is believed to be presently undergoing a slow-nova type outburst (Kindl *et al.* 1979). Emission line profiles during this eruptive period would likely show P-Cygni structure if the wind material was seen against the UV continuum source. The fact that such structure is not seen in high-dispersion spectra obtained on 1981 June 11 suggests that if an accretion disc formed during the outburst, it was probably seen nearly edge-on and the ejected material was moving orthogonal to our line-of-sight.

We can also estimate the characteristic drift time-scales for an accretion disc and compare it with the time that it took for the symbiotic to brighten, estimated to be $\leqslant 10$ months. The drift time-scale (Kafatos & Michalitsianos 1982) is $t_r \equiv r/v_r \sim \alpha^{-1}$ 6 months $\times (M/M_\odot)^{1/2}(r/10^{13})^{1/2}(T/10^4)^{-1}$, where $\alpha$ is the usual viscosity parameter estimated in the range $\alpha \gtrsim 0.1-1.0$ (Bath & Pringle 1982) and $v_r$ is the radial drift velocity. The drift time-scale from the distance of $\sim 10^{13}$ cm would be ~6 months to 5 yr. We conclude the rise time is shorter than the time-scale the disc will last if $\alpha \lesssim 1$, which is self-consistent.

Alternatively, if the compact secondary in the system slowly develops an optically thick thermal envelope or shroud through accretion, the underlying hot thermal UV continuum would become visible following ejection. We would expect the UV continuum flux distribution to remain constant, while the ionization level of the hot expanding shell gradually declines. This model is generally consistent with the temporal behaviour of emission lines and ultraviolet continuum observed in SY Muscae, but has difficulty in explaining the absence of P-Cygni structure. Spectra obtained on 1980 September 20 could coincide with pre-outburst or very preliminary stages of mass expulsion. Unfortunately, high-dispersion UV spectra were not obtained during this epoch. Continual monitoring of SY Muscae in the UV should be maintained if mass accretion in the system proves to be recurrent or cyclic in nature.

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