UV TIME-DEPENDENT EMISSION IN SY MUSCAE

A.G. Michalitsianos*, M. Kafatos**
* NASA Goddard Space Flight Center, Greenbelt, Md. 20771 USA
** George Mason University, Department of Physics
Fairfax, Virginia 22030 USA

INTRODUCTION

Ultraviolet spectra acquired with the International Ultraviolet Explorer (IUE) of SY Mus = HD 10036 on 20 September 1980 and 11 June 1981 indicate a substantial enhancement of UV emission over a nine month period. The general UV flux level appears to have increased by approximately one order of magnitude between the first and second observing epochs. The strong ultraviolet continuum evident throughout the entire IUE spectral range λλ1200-3200 A on 11 June 1981 is closely approximated by a star with T_{eff} = 40,000 K, where previously on 20 September 1980 the continuum distribution presented a more complex structure that is possibly explained by a combination of thermal emission from an early type main sequence star, and nebular recombination emission (Michalitsianos et al. 1981).

The redistribution of continuum energy flux with wavelength is accompanied by an increase in intensity in permitted high excitation emission lines. High excitation lines of N V λλ1238.8, 1242.8 A, O V λ1371.5 A, Si IV λ1393.8 A, O IV] λλ1397.2, 1399.8, 1401.2 A, C IV λλ1548.2, 1550.2 A, He II λ1640.4 A, N III] λλ1746.8, 1748.6, 1749.7, 1752.2, 1754.0 A, Si III] λ1892.0 and C III] λλ1906.7 and 1908.7 A are among a number of lines that increased in absolute intensity by a factor 1.5 to 5. In contrast, forbidden Mg V λλ2783.2, 2928.7 A, [Ne V] λ1574.9 A decreased in absolute intensity by approximately 15%. A decrease of [Mg V] line emission during an enhanced UV emission phase suggests that SY Mus increased overall in electron density. This is substantiated by high dispersion spectra of the C III] doublet (available for 11 June 1981 only) where I(λ1906.7 A)/I(λ1908.7 A) << 1 ratio suggests $n_e \sim 10^{10}$ cm^{-3}. Alternatively, if created in a region very far removed from the UV continuum forming region, forbidden Mg V might appear to diminish in intensity if the continuum increased substantially. As such, contrast between emission line and continuum might explain the apparent decrease in forbidden line intensities in both [Mg V] as well as [Ne V].

M. Friedjung and R. Viotti (eds.), The Nature of Symbiotic Stars, 191–194.

Mg II resonance doublet emission increased in absolute intensity by a factor ~ 60 between observing epochs. It is of interest to note at this point that the line profiles in low dispersion on 20 September 1980, and low as well as high dispersion on 11 June 1981 do not exhibit anomalous profile structure. There is no evidence for P-Cygni type profiles in any of the high or low ionization lines, and evidence for significant turbulent broadening in any of the emission lines investigated in detail is lacking. As such, the overall increase in UV emission is best described as an enhancement of quiescent emission rather than an outburst or eruption. Based on this, we suspect that SY Mus is an eclipsing symbiotic system in which the hot secondary has recently emerged from behind the cool primary. On 11 June 1981 the UV spectral properties of SY Mus resembles that of RW Hya (Kafatos et al. 1980) and Z And (Altamore at al. 1981).

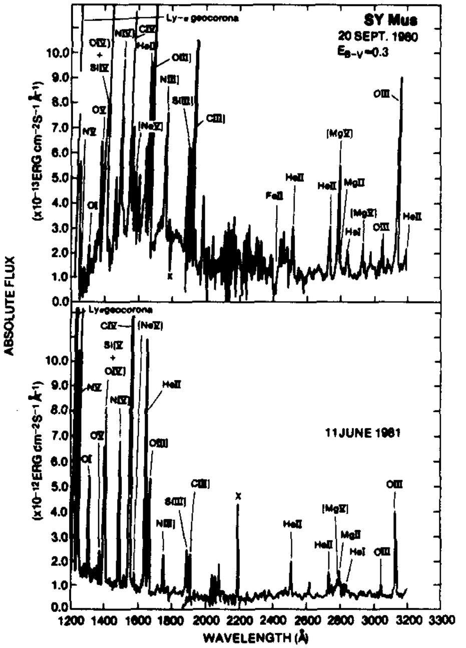

FIGURE 1

DISCUSSION

Feast et al. 1977 identify the cool primary in SY Mus as an M3 III star with absolute magnitude $M_V = -0.4$. They find an interstellar absorption corresponding to $E(B-V) = 0.23$, consistent with our estimate for $E(B-V) = 0.3$ derived from the $\lambda \lesssim 2200$ A continuum dip, and which has been applied to data shown in Figure 1. Given these uncertainties for the primary the distance modulus yields d $\sim$ 1.1 kpc. If we consider the absolute UV continuum flux at $F(\lambda 1400A) = 10^{-12}$ erg cm^{-2} s^{-1} A^{-1}, we can extrapolate the continuum into the visible region by applying a Planckian blackbody curve for a $T_{eff} = 40{,}000$ K star. For d = 1.1 kpc we find the following parameters for the hot companion: $L = 90\ L_\odot$, $R = 0.2\ R_\odot$ and $m_V = 13.6$. This places the secondary in a region of the H-R Diagram occupied by central stars of planetary nebulae. The corresponding relative magnitudes between secondary and primary is $\Delta m_V = 2.9$. Similarly, as an upper limit if we consider a $T_{eff} = 10^5$ K secondary, we obtain $L = 530\ L_\odot$, $R = 0.08\ R_\odot$ and $m_V \cong 14.4$ (or $\Delta m_V = 3.7$).

The enhancement of moderate excitation emission lines such as as Mg II λλ 2795, 2802 A doublet suggests possible photon interaction

https://doi.org/10.1017/S0252921100097694 Published online by Cambridge University Press

between the secondary and primary. Here a hot spot formed from the intense radiation field of the companion that illuminates a small portion of the M giant atmosphere likely results in emission from medium excitation emission lines that generally characterize chromospheres. This is consistent with our model for an eclipsing system because the portion of the M giant atmosphere directly subjected to the radiation field of the companion becomes more visible as the secondary emerges from eclipse. Therefore, monitoring this object is extremely important to determine if in fact this is correct.

Alternatively, the hot companion may have ejected a thick ionizing shell that was created through mass transfer from the cool primary onto the compact secondary. Bath (1978) has suggested that such an object might outwardly give the appearance of being an early main sequence type star in terms of luminosity and surface effective temperature. Instabilities that could develop in the shell envelope due to continuous accretion might result in the dislodging of the envelope, thus exposing the underlying thermal emission from the hot subdwarf. However, high dispersion line profiles do not suggest motion of this character. Rather the line profiles appear narrow and are centered near the laboratory rest wavelength. Continued UV and optical observations of SY Mus are essential in order to determine the nature of this interesting object.

REFERENCES

Altamore, A., Baratta, G.B., Cassatella, A., Freidjung, M., Giangrande, A., Ricciardi, O. and Viotti, R. 1981, Astrophys. J., 245, p. 630.

Bath, G.T. 1978, M.N.R.A.S., 182, p. 35.

Feast, M.W., Robertson, B.S.C. and Catchpole, R.M. 1977, M.N.R.A.S., 179, p. 499.

Kafatos, M., Michalitsianos, A.G. and Hobbs, R.W. 1980, Astrophys. J., 240, p. 114.

Michalitsianos, A.G., Kafatos, M., Feibelman, W.A. and Hobbs R.W. 1981, Astrophys. J., in press.

DISCUSSION ON SY MUSCAE

Kafatos: This is a request to the southern hemisphere observers to follow this particular object in the visible to see if indeed it is an eclipsing system.

Whitelock: We are presently following many of these objects, and if we know dramatic changes we can follow up with observations.

https://doi.org/10.1017/S0252921100097694 Published online by Cambridge University Press