COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 1482

Konkoly Observatory
Budapest
1978 October 6

DETECTION OF EMISSION LINES OF HOT PLASMA IN FIVE PECULIAR ECLIPSING BINARY SYSTEMS

In the course of our observations of the far ultraviolet spectra of eclipsing binary stars with the IUE satellite, we detected strong emission lines in the spectra of the five binary systems (other than β Lyr) listed in Table 1. The emission spectrum is richest in SX Cas. For RX Cas and W Ser the spectra are surprisingly similar, while fewer emission lines are observed in W Cru and V367 Cyg. Nevertheless, the basis pattern is the same, and is well represented by the most prominent emission features seen in W Ser, listed in Table 2. In addition to these lines, the spectrum between λ1200 and λ2000 Å shows over 30 other emission features. Most of these features are blends of two or more components, since the resolving power of the low-dispersion IUE spectrograph is only 6 Å.

The high level of ionization indicated by strong emission lines of Si IV, C IV, and N V is remarkable. It is not yet clear from which region or regions of the systems these emissions come. One possibility is a high temperature, low density plasma surrounding the hotter component. It should be noted that the hot component may well be the spectrographically invisible one if it is surrounded by an optically thick disk of gas. All five systems listed in Table I are most likely at a phase of rapid mass transfer or mass loss, so the presence of a large cloud as well as a thick disk is quite plausible. The hotter component may in turn be a collapsed object or a more "normal" accreting star. Emission lines of N V are known to be associated with stars earlier than O9. Although we have detected blue continua in the systems listed in Table 1, they do not seem to correspond to the continua of O stars. Additionally, the total luminosity of each system does not suggest the presence of a normal O star. Therefore the ionization is probably not due to blackbody thermal radiation, but it may still be radiatively induced, if we assume absorption of X rays generated near the secondary star. Their origin is straightforward if we surmise a collapsed object. In the case of a non-collapsed star later than O-type, one can conjecture X radiation generated by accretion shocks.

It is also possible that the emitting plasma lies in a very extended chromosphere and/or corona of the mass-losing component, perhaps created by an unusually strong stellar wind.

Decision about the location of the emitting plasma is not easy since the low dispersion does not permit accurate measurement of the radial velocities. Also, the phase dependence of the phenomenon is unknown at this time. All five systems listed in Table 1 are very peculiar, and, from previous observations with *Copernicus*, β Lyr is reasonably included in the list. The presence of a black hole in β Lyr, W Ser, W Cru, and V367 Cyg is a distinct possibility. On the other RX Cas and SX Cas are probably stronger cases for the stellar wind alternative. It may be dangerously misleading that we concentrated on peculiar systems. Certainly the occurrence of the phenomenon in various classes of binary stars is yet to be tested, However, we have not observed this type of emission spectrum in ε Aur, μ Sgr, TT Hya, RZ Sct, U CrB, to mention just a few of the systems already surveyed.

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Table 1

Binary Systems Showing Emission Lines of Hot Plasma

Name	Period (days)	$f(\mathfrak{M})(\odot)$	Spectral type
RX Cas	32.3	0.16:	A5e III + (G3 III)?
SX Cas	36.6	0.31:	A6e III + (G6 III)?
W Cru	198.5	5.82	G1e Iab
V367 Cyg	18.6	1.56:	A5e Iab? (shell!)
β Lyr	12.9	8.5	B8e II
W Ser	14.2	0.35:	F5e Ib (shell)

Note: β Lyr was not observed in this program. However, previous observations with Copernicus (Hack et al., 1975, Astrophys J. 198, 453) justify its inclusion in our list.

Table 2

Major Emission Lines Detected in W Ser

1200Å - 1950Å

Observed	Identification		Possible	Comments
λ (A)	Ion	λ (A)	Contributors	
1213	H I (Ly α)	1216		geocoronal
1240	N V(1)	1239,1243		
1263	Si II(4)	1265		
1306	O I(2)	1302-1306	Si II(3), [O V] ?	
1335	C II(1)	1335,1336	Si III(34)	
1394	Si IV(1)	1394		
1401	Si IV(1)	1403	O IV 1401,1405	
1549	C IV(1)	1548,1551		
1641	He II	1641		very broad
1672	Al II(2)	1671		
1766	Al II(5)		O III, Fe II	
1783	Si III(35)		Ni II(5)	reseau-contaminated
1808	Si II(1)	1808	Ni II(2)	
1816	Si II(1)	1817		
1856-62	Al III(1)	1855,1863	Si III, Al II, Fe III	very broad
1888-93	Si III(1)	1892	Fe III, N II?, P IV?	very broad
1910	C III	1909	Fe III	reseau-contaminated
1925	C II	1927,1928	Fe III	reseau-contaminated