EFFECTS OF ECCENTRIC ORBIT OF BF CYGNI ON *IUE* AND OPTICAL SPECTRA

J. Mikolajewska & M. Mikolajewski
Institute of Astronomy, Nicolaus Copernicus University
Chopina 12/18, PL-87100 Torun, Poland

A recent analysis of all available photometric data has resulted in a new ephemeris for BF Cyg: *MIN=JD* 2415058 + 756.8*E*. Simultaneously, optical spectra collected in 1979–1986 showed periodic changes of all emission lines (Mikolajewska 1987; Mikolajewska & Iijima 1987). It is interesting that the forbidden lines of [OIII] varied in antiphase to the permitted emission lines and optical brightness.

IUE spectra taken in 1979–1981 showed a strong hot continuum and high ionization resonance emission lines of NV, SiIV CIV, intercombination lines of NIV], NIII], SiIII], CIII] and OIII] as well as HeII emission. The observed λ2200Å interstellar absorption band suggests $E(B-V)$≃0.3. Taking into account the interstellar reddening distribution in the vicinity of BF Cyg (Lucke 1978; Mikolajewska & Mikolajewski 1980), the observed extinction implies a distance $d \lesssim 1.5$kpc. This distance is in good agreement with the observed low value of the systemic radial velocity (~15 km/s, Fig.1) of BF Cyg and the standard galactic rotation law. The standard extinction curve with $E(B-V)$=0.3 (Seaton 1979) was used for reddening correction of the spectra. The UV continuum of BF Cyg can be interpreted as a combination of a hot subdwarf (T_{eff}≃60000K, L≃2500$L_\odot$ for d=1.5kpc) and hydrogen *bf+ff* emission (T_e≃10000K). The emission measure of the nebular (*bf+ff*) continuum varied from ~4x10^{59}cm^{-3} at maximum to ~10^{59}cm^{-3} at minimum. Assuming cosmic abundance of Si/C the observed SiIII]/CIII] line ratio implies n_e≃2x10^{10}cm^{-3} at the photometric maximum and n_e≃3x10^{9}cm^{-3} at the minimum. We assume that these values are representative of the region where the bulk of the HI Balmer and intercombination line emission is produced.

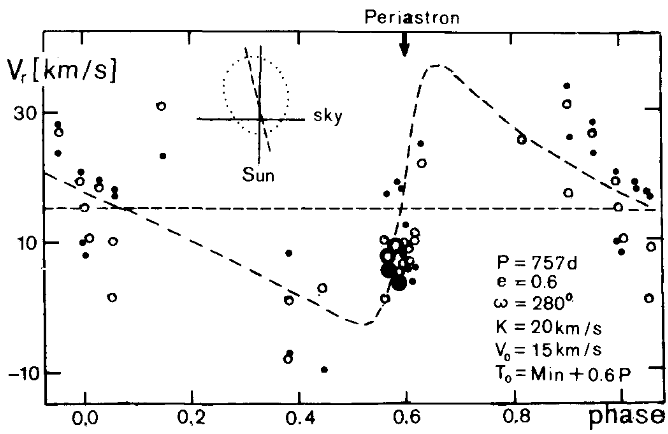

Figure 1

J. Mikolajewska et al. (eds.), The Symbiotic Phenomenon, 299–300.

The ratio of NV(1240)/NIV(1720) gives T_e(NV)≃11500K close to the value derived for the Balmer emission region from the UV continuum fit.

The radio flux at 4.9GHz is equal to 2.06mJy (Seaquist *et al.* 1984) and corresponds to a radio emission measure $n_r^2 V_r \gtrsim 1.6\times10^{57}$cm^{-3} (for d=1.5kpc, T_e≃10000K). Seaquist et al. also estimated the effective radius of the "radio photosphere" to be of order 10^{15}cm. Comparison of the radio emission measure with that of the Balmer emission lines and the *bf+ff* continuum suggests the electron density varies as $1/r^2$ in the nebula. The observed spectral index, α≃1, may suggest that the ionized region is highly asymmetric. We propose that the periodic variations of the emission line fluxes are due to the effects of an elliptical orbital motion of the hot subdwarf ionizing part of the wind from the M giant. The recombination time τ_{rec} is ~1 hour in the region where the bulk of the HI, HeI and intercombination line emission is formed, so the emission region moves with the ionizing star. Fig.1 presents the composite radial velocity curve of HI – *dots* and HeI – *open circles* (see Mikolajewska 1987 for references); the large marks correspond to averaged data. We suggest an eccentric orbit (e ≃ 0.6), with the spectroscopic conjunction coinciding with the photometric minimum. It is remarkable that maximum of HI intensity occurs near periastron (also maximum of the electron density from SiIII]/CIII]), while maximum of [OIII] is at apastron (minimum of n_e). For the [OIII] lines, an additional effect due to (probably) changing electron temperature (by about 10–20% higher at apastron) is possible. The radial velocity curve may be affected by a different wind expansion velocity along the orbit of the ionizing component.

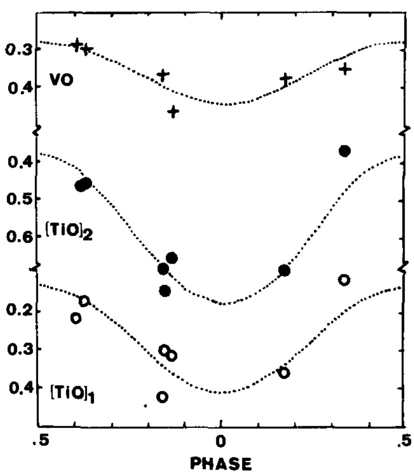

Figure 2

The presence of the hot subdwarf in BF Cyg may cause a substantial reflection effect. The effect may be very strong, because the illuminated hemisphere of the giant is visible when the distance between the components is lowest (periastron). Fig.2 shows the behaviour of $[TiO]_1$, $[TiO]_2$ and [VO] indices of the M giant spectrum given by Kenyon & Fernandez-Castro (1987), as a function of our revised photometric (orbital) phase. They are consistent with M2III (T_{eff}≃3750K at maximum and M4III (T_{eff}≃3550K) at minimum, and require L_{hot}≃$2500L_{\odot}$ (assuming separation between the components of about 200–300$R_{\odot}$ at periastron), consistent with the *IUE* data.

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