

The eclipsing binary model for the variability of Cyg XR-1 as presented in article 1 thus still seems to be consistent with all observations of the object so far.

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## Optical Identification of Cygnus X-1

THE star HD 226868 is coincident, within a 3" error, with a faint and possibly variable radio source which itself is coincident, though with a large uncertainty, with the Cygnus X-1 pulsating X-ray star<sup>1</sup>.

**Table 1** Data on HD 226868 (= BD 34° 3815)

$V = 8.89$ ; $(B - V) = +0.85$ ; $(U - B) = -0.24$ (Hiltner <sup>3</sup> )	
$S_p = \text{BOIb}$ (Morgan, Code and Whitford <sup>2</sup> ; RGO)	
$V_r(*) = -12 \text{ km s}^{-1}$ (Seyfert and Popper <sup>8</sup> )	
$V_r(K) = -24 \text{ km s}^{-1}$	
$= -13 \pm 7 \text{ km s}^{-1}$ (RGO)	
Equivalent width of K line	
$= 0.3 \text{ \AA}$ (Seyfert and Popper <sup>8</sup> )	
$= 0.6 \pm 0.1 \text{ \AA}$ (RGO)	
Central depth of diffuse interstellar line (4430 \AA)	
$= 9 \pm 2\%$ (RGO)	
$Q = -0.89 \text{ mags}$	
$E_{(B-V)} = 1.07 \text{ mags}$	
$m_0 - M = 11.5 \text{ mags}$	
$d = 2.0 \pm 0.5 \text{ kpc}$	

Table 1 lists information about HD 226868 obtained from the literature and from spectrograms taken by observers at the Royal Greenwich Observatory (RGO) with the image tube and photographic spectrographs attached to the 98 inch telescope; the measurements were made between July 26 and August 4, 1971. The RGO spectra were at dispersions of 60, 70 and 180 \AA mm<sup>-1</sup> over the spectral range 3600 to 5200 \AA. The star appears to be a normal BOIb supergiant as classified by Morgan *et al.*<sup>2</sup> (The visibility of the high Balmer lines in HD 226868 is slightly less than the visibility of those in a comparison star HD 192422, BO.5Ib, which tends to decrease its luminosity towards II.)

The allocation of the spectral type BOIb is supported by the photoelectric colours of Hiltner<sup>3</sup> which give

$$Q = (U - B) - 0.72(B - V) - 0.05(B - V)E_{B-V} = -0.89$$

agreeing precisely with the standard value<sup>4</sup>.

The spectroscopic distance modulus of HD 226868, calculated using  $M_v = -5.8$  (ref. 5) and the value,  $R = 3.0$ , for the

ratio of total to selective absorption in this region<sup>6</sup>, is 11.5 mags, corresponding to a distance of 2.0 kpc. The chief uncertainty in the distance modulus arises from cosmic dispersion in the absolute magnitude of the spectral type, and corresponds to an error in the distance of  $\pm 0.5$  kpc. The intensities of the interstellar K-line and 4430 \AA diffuse band are consistent with the amount of reddening and the distance to the star. The kinematic distances of the star and K-line absorption are liable to large uncertainty because the star is near the null points of the galactic velocity field, but they are also consistent with the spectroscopic distance modulus.

The distance of 2.0 kpc which we ascribe to the star is, apparently, inconsistent with the upper limit of 1.0 kpc placed on the distance of Cygnus X-1 by Gursky *et al.*<sup>7</sup> from the low energy turn-off in its X-ray spectrum due to photoelectric absorption in the interstellar medium. But because of the tentative identification of the supergiant with Cyg X-1 and the uncertainties expressed by Gursky *et al.* about the accuracy of their method, we feel it premature to attempt to save the phenomenon. If the double coincidence of position between the Cyg X-1 source, the radio star and the supergiant is too strong to be by chance, the X-ray source may be a companion to the supergiant, rather than identical to it. If the X-ray source has an optical absolute magnitude of +4, like the Crab Nebula pulsar, its optical luminosity is  $10^{-4}$  times that of the supergiant. A distance of 2.0 kpc would imply that the observed power output in the X-ray region (0.5 to 100 keV) would be more than  $10^{37} \text{ erg s}^{-1}$  and comparable with the Crab Nebula.

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## Possible Black Hole in Beta Lyrae

$\beta$  LYRAE is one of the most controversial and puzzling of binary systems<sup>1</sup>. The central issue concerns the absolute masses of the two components. The one-spectrum radial-velocity curve does not reveal what those masses are, but any pair of masses satisfying its mass function make the system remarkable. Table 1 gives pairs of masses which satisfy the observed  $8.5 M_\odot$  mass function<sup>2</sup>. Here  $q = M_{\text{BRT}}/M_{\text{FNT}}$ , and the entries in the table are the minimum masses allowable—that is, the orbital inclination angle is assumed to be  $90^\circ$ . Early investigators, faced with the absence of the secondary component in the spectrograms at all phases, assumed that the components of the system obey a mass-luminosity law and favoured a mass ratio considerably larger than unity. This, however, results in very large masses, especially for the B8 primary. Three arguments have since been put forward which make the choice  $q > 1$  dubious. First, Sahade<sup>3</sup> has called attention to the behaviour of the unusual emission features present in the spectrograms, noting that, should they be asso-