

C.T. Bolton and Douglas R. Gies  
David Dunlap Observatory, University of Toronto,  
P.O. Box 360, Richmond Hill, Ontario, CANADA L4C 4Y6

We have scanned 75 high dispersion spectrograms of HDE 226868 = Cyg X-1 with the PDS microdensitometer of the David Dunlap Observatory in preparation for a detailed spectrophotometric study of the system. The plate material is identical to that described by Bolton (1972a,b, 1975) and includes those plates. We have determined velocities for all of the spectrograms by fitting a parabola to the bottom of each line profile. The lines were divided into three groups, hydrogen lines, He I lines, and high excitation lines (He II, Si III and IV, N III), according to excitation, and separate mean velocities were determined for each group on each plate. We have computed the orbital elements of the system separately for each line group in order to look for differences caused by the effects of mass transfer or stellar wind.

The elements determined from the three groups of lines are in excellent agreement. The only significant difference among the elements is that the H lines give a  $K$  approximately  $5 \text{ km s}^{-1}$  larger than that of the other two groups. Individual plates show weak evidence for a small Balmer progression. We attribute these effects to variable blending of absorption and emission lines. The three groups of lines have essentially the same  $V_0$  velocity, and the few plates taken during x-ray high states fit the velocity curve well. Thus any stellar wind or x-ray heating effects are apparently undetectably small.

The orbital elements obtained from the He I and high excitation line groups are very similar to those derived by Bolton (1975) with two exceptions. First, the eccentricity in the new solutions is not statistically significant. Second, the  $K$  is slightly larger. The origin of these differences is not yet clear.

#### REFERENCES

- Bolton, C.T.: 1972a, *Nature*, 235, 271.  
Bolton, C.T.: 1972b, *Nature Phys. Sci.*, 240, 124.  
Bolton, C.T.: 1975, *Ap.J.*, 200, 269.

## DISCUSSION FOLLOWING BOLTON AND GIES

Zuiderwijk: Which spectral lines are varying?

Bolton: I think that everything varies some. The most variable lines are the He I singlets and the Si III and O II lines.

Simmons: The inclination determined previously by Hutchings from light curves for Cyg X-1 was  $28^{\circ} \pm 1^{\circ}$ . You are now giving, or quoting, a value more like  $60^{\circ}$ . How do you think the error analysis involved in the  $28^{\circ} \pm 1^{\circ}$  result could give such a small error?

Bolton: I don't remember Hutchings quoting such a small error. I certainly never did. You might get such a small error by forcing the visible star to fill to Roche lobe, but that would be an assumption. There is no observational requirement for this.

van Paradijs: How large are the random variations in the spectrum, expressed in spectral and luminosity classes?

Bolton: So far we have found no variation in the luminosity class. There are a number of line ratios defining spectral type. These all show variations from 09.5-B0 with 09.5-09.7 being more common than 09.7-B0. However, I am not yet certain that all line ratios on the same plate give consistent results.

Whelan: Do you assume that CYG X-1 is a binary system, or do your articles of faith permit the existence of a trinity?

Bolton: We are searching for evidence of a third body. We have not yet found anything, but we haven't ruled out too many of the possibilities either. The new enlarged data set has not been exploited in this regard yet, but in a few weeks ... .