CHROMOSPHERIC DENSITY DISTRIBUTION, OPACITY, IONIZATION AND WINDACCELERATION OF 3 K SUPERGIANTS IN ζ AURIGAE SYSTEMS

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Results from 58 chromospheric eclipse spectra of three ζ Aurigae type binary systems - with a K supergiant primary and a B star companion - taken with IUE at high resolution are presented. Curves of growth have been constructed at 20 phases using selected chromospheric absorption lines superposed upon the B star spectrum. In order to fit average density models to the chromospheres, 3 samples of column densities (for ζ Aur., 32 Cyg. (fig.1) and 31 Cyg. K giants) have been used.

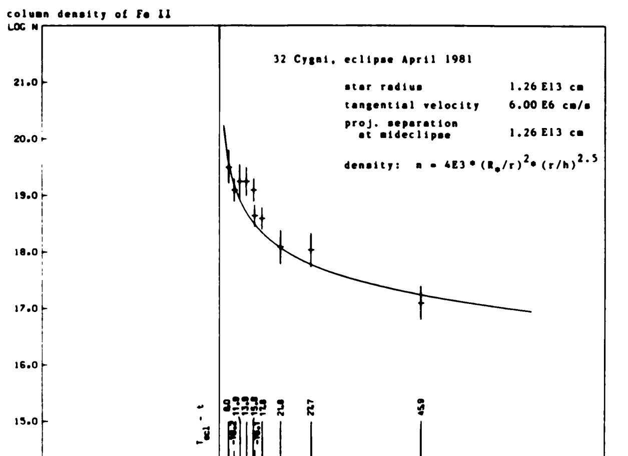

fig. 1: Observed column densities of Fe II from ingress and egress of chromospheric eclipse versus tangential distance from the center of the giant (vertical line indicating the limb of the giant photosphere). Comparison is made to a track of theoretical column densities, calculated by numerical integration over the density function mentioned in the plot. Time intervals from mid eclipse are indicated.

Assuming continuous outflow of matter and knowledge of $\dot{M}$ (Che et al,

I. Appenzeller and C. Jordan (eds.), Circumstellar Matter, 319–320.

1983), wind velocities can be derived. While ζ Aurigae's wind acceleration region shows temporarily a deficiency in density and mass loss at the 1979 eclipse, density gradients and wind acceleration of 31 Cygni and 32 Cygni are very similar in the corresponding eclipses in 1981 and 1982. Their density and velocity structure can be represented by power laws (except for the inner layers):

$$n(r) = n_o \cdot (R_*/r)^2 \cdot (r/h)^a \quad \text{and} \quad v(r) = v_\infty \cdot (1 - R_*/r)^a$$

with $a = 2.5 \pm 0.5$ and $v_\infty = 55 \pm 15$ km/s. $h = r - R_*$ = height.

If pure Rayleigh scattering by neutral hydrogen is assumed for the continuum absorption coefficient, a density model of the inner chromosphere of 32 Cygni is derived. A non-pointlike B star and improved geometric parameters are applied . The density model of the inner chromosphere is in agreement with both the absorption line data and the continuum opacities which have been observed from IUE spectra near total eclipse at 5 selected wavelengths (i.e. from wavelenth dependent eclipse demonstrated by fig. 2).

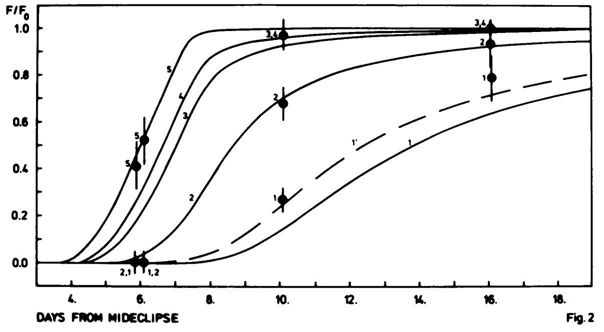

fig. 2: 32 Cygni normalized fluxes at partial eclipse, at 1350 Å (1), 1513 Å (2), 1783 Å (3), 1960 Å (4) and 2992 Å (5). Solid lines: best model of a Rayleigh scattering chromosphere, using the density distribution $n_H(h) = 2.8 \cdot 10^8 cm^{-3} \cdot (R_*/r)^2 \cdot (r/h)^{1.8}$. Geometric parameters are: $R_* = 1.26 \cdot 10^{13}$cm, $R_B = 2.3 \cdot 10^{11}$cm, projected separation at mid eclipse $D = 1.223 \cdot 10^{13}$cm, tangential velocity $v_T = 6.0 \cdot 10^6$cm/s. Line 1' uses $\sigma_R' = 0.7 \cdot \sigma_R(1350Å)$. $\sigma_R(\lambda)$ have been taken from Mihalas (1978).

Using 16 high resolution IUE spectra of ζ Aurigae, 32 Cygni and 31 Cygni taken during chromospheric eclipse, the FeI/FeII ionization equilibrium has been determined empirically as FeI/FeII $\simeq 10^{-3.5}$. Fe (Ti and V also) is ionized by UV radiation from the B star companion while recombination is controlled by electrons from collisionally ionized hydrogen. An attempt is made to estimate average electron densities n_e and electron temperatures T_e consistent with both FeI/FeII ratios and the necessary hydrogen ionization. Typical values as taken from 32 Cygni are about $n_e \simeq 5 \cdot 10^6/cm^3$, $T_e \simeq 10500$ K at $h \simeq 5 \cdot 10^{12}$cm $\simeq 0.4\ R_*$ (where n_H is about $10^9/cm^3$). For Details see Astron.& Astrophys. **147**, p. 103ff (1985) and Astron.& Astrophys., in press (1986), by K.-P. Schröder.