# THE STELLAR WIND OF $\chi^2$ ORI AND ITS VARIABILITY

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**Abstract.** The resonance spectral lines of high-resolution IUE spectra of $\chi^2$ Ori (B2I) have been studied with the aim to determine in more detail the physical status of the stellar wind and its variability due to shell outbursts and clumps superimposed on the isotropic stellar wind. Some general features of resonance spectral line profiles have been studied and explained in physical terms using $\chi^2$ Ori as a specimen.

## 1. General picture

The spectrum of B2Ia star $\chi^2$ Orionis is rich of spectral lines. In our recent investigation (L. Sapar and A. Sapar 1992) we succeeded to recognize, identify and catalogue by computer codes in high-resolution IUE exposures SWP 3436 and LWR 3021 about 1700 observed spectral features, most of them being multiple blends. The heavily extended stellar wind of $\chi^2$ Ori produces P-Cygni type profiles of resonance lines of SiIV, CII, CIV, AlIII and NV. We study them using the theory of resonance spectral line formation in a spherically symmetric stellar wind with an optically thick and geometrically thin layer, where multiple scattering takes place in the Doppler core of Voigt function (A. Sapar and L. Sapar 1990). We use an idealized model stellar wind with sharp and optically thick stratification boundaries throughout the resonance line profile. From the images SWP 2970, SWP 3436, SWP 4302, SWP 6471 and SWP 40669 we tried to sketch the outflow velocity run, the observed stellar wind extension and their possible variations. We found that the observed moderate variations can be due to both shell outbursts and clumps with deviating radial velocities. The extension and the extreme velocity of the expanding envelope differ for resonance line profiles of each ion, thus showing an ionizational stratification in the stellar wind. However, the nature of the short-term variations of the stellar wind can be studied in detail only by analysing the landscape or darkening picture of the resonance line profile temporal variations. In such a picture a shell outburst is observed as a perturbation which appears at line centre, after which it broadens over the whole line profile. The restoration of the undisturbed line profile takes place in the same way. The small migrating dips and peaks in the smooth spectral line profiles appear due to clumps with perturbed velocities and opacities, and their form mimics their areas and perturbation velocities.



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## 2. Formulae for extension and extreme velocity of the envelope

The ratio of stellar radius $r_*$ and the radius of envelope $r$ in the above mentioned idealized picture can be found by (see L. Sapar and A. Sapar 1993)

$$r_*^2/r^2 = 1 - \mu_L^2 = 1 - 1/(2(\Delta\lambda_1/\Delta\lambda_L)^2 - 1)$$

where $\Delta\lambda_1$ and $\Delta\lambda_L$ are the values of the wavelength shifts towards the blue as measured in the spectral line profile at the blue edge corresponding to relative residual flux values 1/2 and 0, respectively. The latter point can be found by extrapolation of the curve of the steep blue edge of the spectral line profile to its zero-flux value.

The extreme velocity for each stratified spectral line can be found theoretically by $V_e = c\Delta\lambda_L/\mu_L$ or, using a quantity $\mu_1$ which is connected with the above given quantities by $\mu_1^2 - \mu_L^2 = \frac{1}{2}\left(\frac{r_*}{r}\right)^2$, can be obtained from $V_e = c\Delta\lambda_1/\mu_1$ .

## 3. Main results

The study of observed resonance lines of CII, CIV, AlIII and SiIV in $\chi^2$ Ori spectra carried out by us showed that they are variable due to deviating wind velocity both in outbursts and in clumps. It is found that the lower the ion recombination potential, the further off in the stellar wind its resonance line originates. The P-Cyg type line formation with extreme velocity of the stellar wind takes place at a relative distance about 0.2 for CIV and reaches 0.4 stellar radii for the CII resonance lines. An unexpected result is that the outflow velocity is decelerating with distance, evidently due to gravity. The extreme velocity of the stellar wind is about −850 km/s in CIV, −800 km/s in SiIV, −700 km/s in AlIII and −600 km/s in the CII resonance lines. An observational feature in favour of deceleration is the presence of wide zero-flux cores in the absorption components of the resonance lines. However, this feature can also be generated by the presence of large-scale turbulence-like instabilities in the stellar wind.

The results of investigation will be published in more detail in our paper L. Sapar and A. Sapar (1993).

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