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ABSTRACT. The calculation of a gas stream offers two modes of the stream. In any case the stream cannot be detected optically. The calculated line profiles caused by the disc are demonstrated.

I. INTRODUCTION

WZ Sge attracted the attention by explosions of 1913 and 1946. Greenstein (1957) measured double emission in H Lines. Kraft (1961) and Kraft et al. (1962) found and studied S-waves. The eclipse nature of the star was found later by Krzemiński (1962). The models of the system were derived by Krzemiński and Kraft (1964) and Krzemiński and Smak (1971). New high speed photometry by Robinson et al. (1978) provoked new suggestions of models - Fabian et al. (1978) and Smak (1979). The explosion of 1978 resulted in several studies of the system but hindered further studies of the quiet phase. Spectra taken by 6-m telescope before and after the 1978 explosion were published by Vojkhanskaya (1983). Smak (1985) described two modes of the origin of the S-wave component of cataclysmic variables, suggesting that the velocity in WZ Sge corresponds to the velocity of the stream in the vicinity of the hot spot.

II. GASEOUS STREAMS

Many calculations of gaseous streams in binaries have been performed by the method of numerical integration of hydrodynamic equations in a 2-dimensional grid, while the 'z-structure' was approximated by the assumption of hydrostatic equilibrium. Lubow and Shu (1975), who developed a semi-analytical method, found that the width of the stream is comparable to its thickness. In their

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subsequent paper (Lubow and Shu, 1976) they showed that the thickness should be calculated dynamically and that its resulting value at the edge of accretion disc is typically several times greater than that calculated under the assumption of hydrostatic equilibrium. Their method was recently used by Smak (1985) who compared the dynamically calculated thickness of the stream with the thickness of the accretion disc in different regimes of accretion. He argued that the different behaviour of the S-wave in different cataclysmic variables can be understood as the consequence of two possibilities:

- 1) the dynamical stream strikes the thin disc which is in the cold mode of accretion (that is the case of WZ Sge) and takes it 'into pincers' or
- 2) the stream penetrates into the thick disc which is in the hot mode.

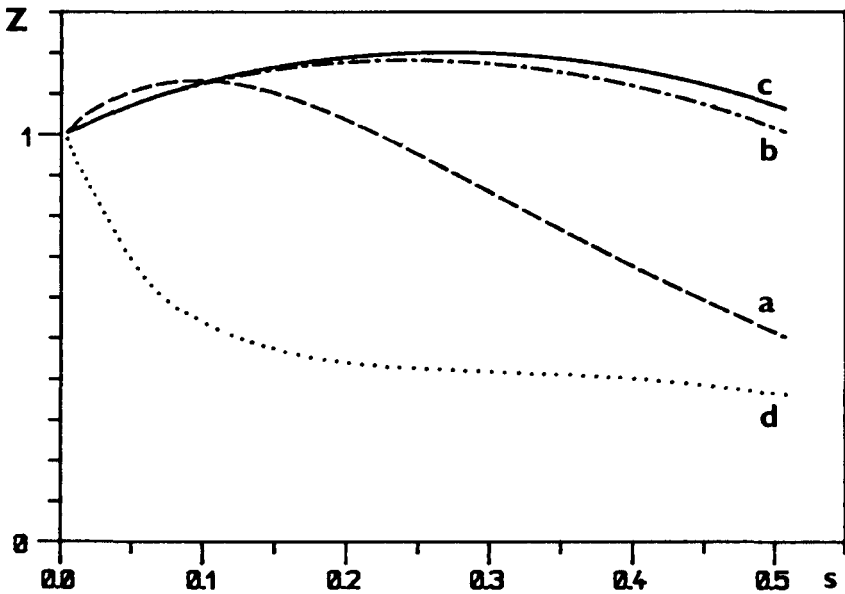


Figure 1. Thickness of the stream along its length.

- | | |
|--------------------------|------------------------|
| a) hydrostatic approach | |
| Dynamical approaches: | b) Lubow and Shu |
| c) radiative equilibrium | d) adiabatic expansion |

We have calculated the behaviour of the stream by a more sophisticated method which was described in detail by Hadrava (1984). The main advantage of our method is that the temperature of the stream is also calculated as a dynamical variable while in the method of Lubow and Shu it is only an ad hoc chosen small parameter.

The resulting change of the stream thickness along its path is given in Figure 1.

The thickness of the stream under the assumption of radiative equilibrium with the radiation of both stars (the screening by the circumstellar matter is neglected) is only slightly larger than in the model of Lubow and Shu. However, under the assumption of adiabatic expansion the stream is quickly cooled and its thickness as well as its width are even less than in the hydrostatic approximation.

The differences in geometry of the regions of interaction of the streams with the discs (hot spots) can thus be explained by different regimes of the stream flowing. Note also that the artificial approximation of the stream geometry by a beam of constant thickness used by Šima (1979) agrees surprisingly well with the results in both regimes of the stream for most of the range of the stream path under interest.

As far as the velocity of the stream is concerned, the linear approximation can be used very well - see Figure 2 - and the semi-analytical method of Šima (1979) can be used for line profile calculation.

Let us assume a mass transfer of $\dot{M} = 1 \times 10^{-10} M_{\odot}/\text{yr}$ i.e. 4.46×10^{15} g/s of hydrogen. The density and the temperature of the stream is so low that the stream will be optically thin both in the continuum and in the H lines. No optical effect of the stream can be detected. In no way can the S-wave component be produced by the stream and its origin can be found only in the neighbourhood of the hot spot.

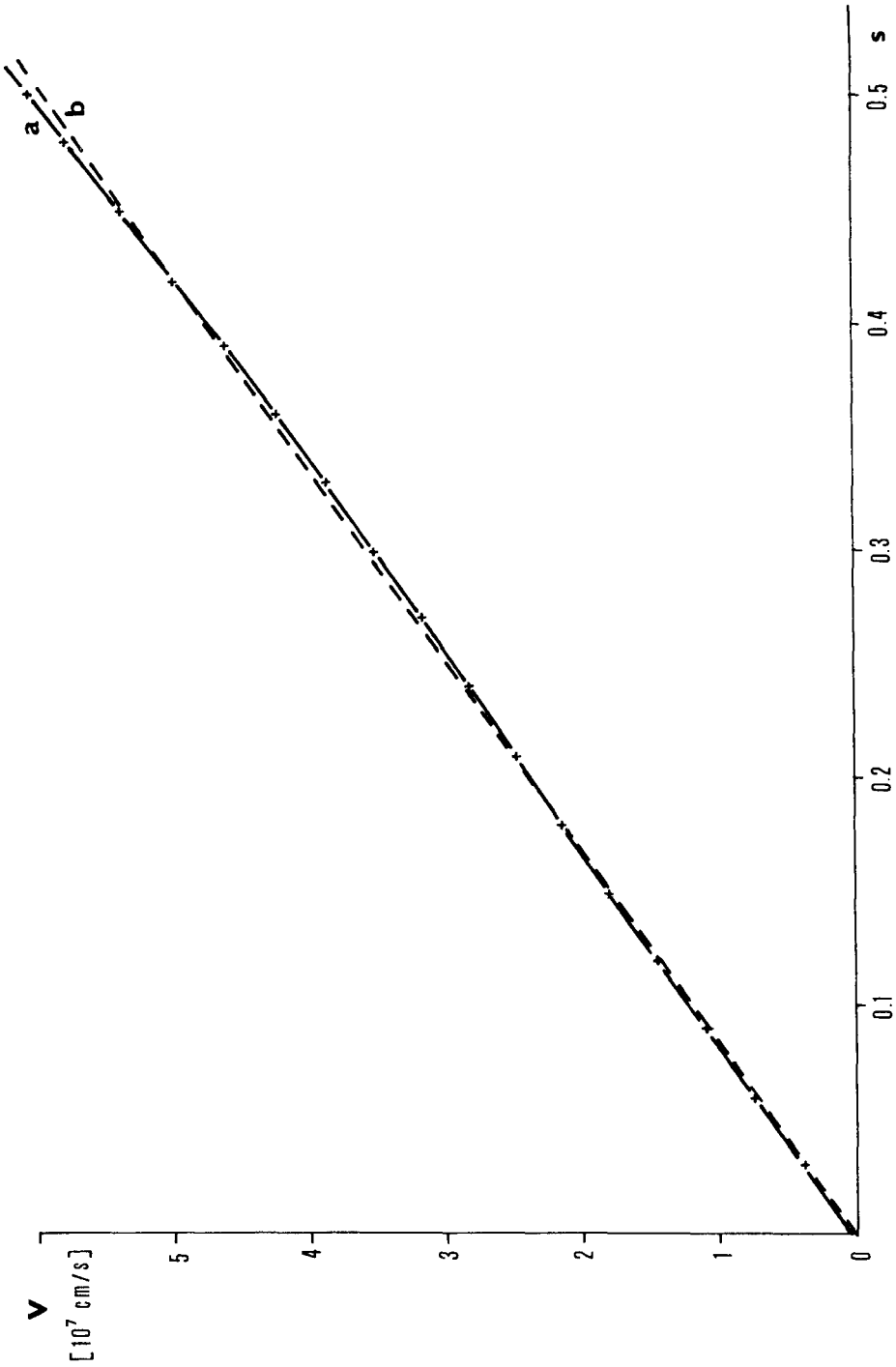


Figure 2. Velocity of the stream along its length.

a) calculated

b) linear: $v = 3.8 \times 10^{-3} \cdot s + 4.7 \times 10^4$ (cm/s).

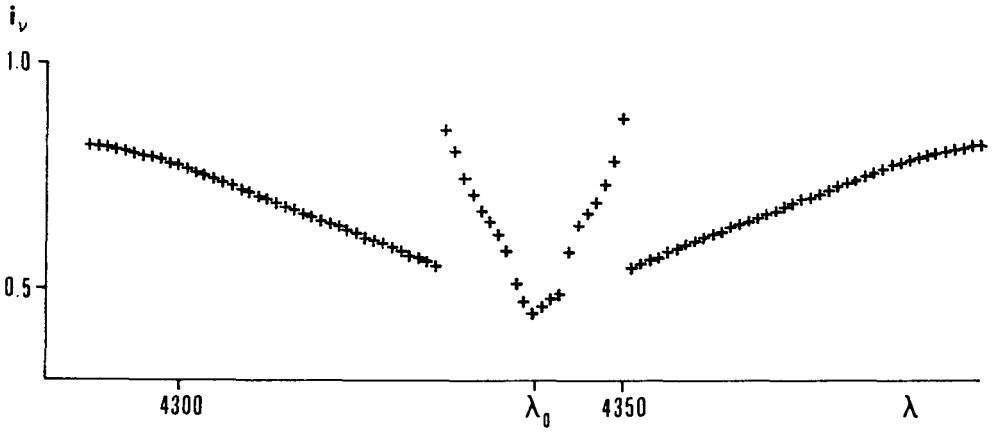


Figure 3. H γ : Robinson - ring.

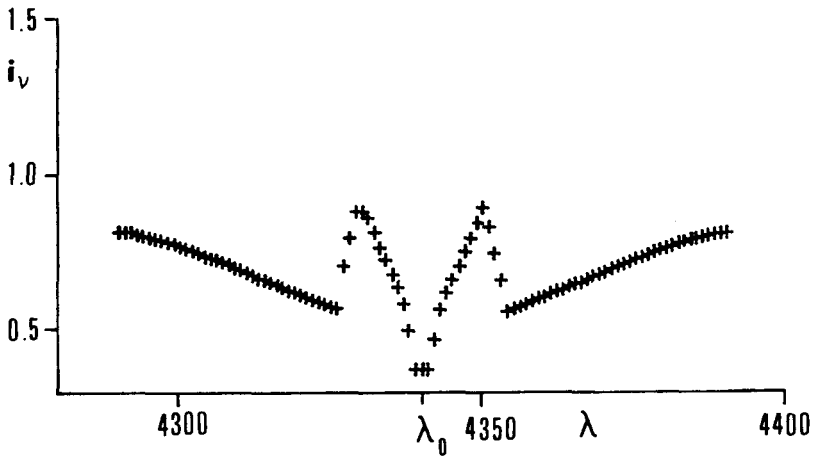


Figure 4. H γ : Large disc.

III. INFLUENCE OF THE DISC

We treated also the disc suggested by Robinson et al. (1978) which can be divided into two parts. The outermost part with a radius $(7.7 - 9.7) \times 10^9$ cm and a thickness in the z-coordinate 2×10^9 cm produces spectral lines of the type shown in Figure 3 (for $n_i = 1.16 \times 10^8 \text{ cm}^{-3}$, $n_k = 7.6 \times 10^6 \text{ cm}^{-3}$ - hot case). For the

innermost part - radius $(1.2 - 7.7) \times 10^9$ cm, z-thickness 3×10^8 cm - the influence on the lines is very small. The profile in Figure 4 is produced by a 'geometrically compact' disc - radius $(5.0 - 10) \times 10^9$ cm, $Z = 2 \times 10^9$ cm, $n_i = 5.8 \times 10^5 \text{ cm}^{-3}$, $n_k = 1.52 \times 10^4 \text{ cm}^{-3}$. The emission peaks are not so sharp. Central absorption is well visible.

IV. CONCLUSIONS

(1) For low mass transfer the stream can be in radiative equilibrium and that is why it is geometrically thick while for higher mass transfer the stream can be adiabatic and geometrically thin. The ratio of the geometrical thickness of the stream and of the disc is thus dependent not only on the accretion regime of the disc but also on the temperature regime of the stream. Smak's (1985) explanation of the dichotomy of the S-wave can thus be modified as a consequence of the stream duality as well.

(2) Linear approximation of the stream used by Šima (1979) is plausible. The stream in WZ Sge can optically not be detected. The S-wave can originate only in the neighbourhood of the hot spot.

(3) The ring produces two emission peaks in the line profile while the rotating white dwarf produces a broad absorption. To screen the white dwarf (especially if $i \neq 90^\circ$) and to find another source of the broad absorption seems to be difficult.

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