RESONANCE LINE PROFILES FROM RADIAL ACCRETION FLOWS

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A compact star in a detached binary system can accrete the matter from the stellar wind of the companion. In this case a more or less radial accretion flow is formed. By analogy to stellar winds from early type stars it is usually believed that the accretion of this sort should produce inverse P-Cygni profiles in resonance lines. However, there are physical differences between the wind and the radial accretion which can alter the outgoing profile significantly.

The matter outflowing from an early type star cools off very fast due to the adiabatic expansion. However, it remains highly ionized as the quickly decreasing density does not allow it to recombine. Therefore the principal mechanism for the resonance line formation here is the scattering of the stellar continuum photons in the wind.

The situation in the accretion flow is qualitatively different. The free-falling gas is compressed which should lead to its heating. More importantly, just above the surface of the accreting star a stand-off shock is formed which heats up the matter to very high temperatures. The UV and X radiation emitted by the shocked gas is then absorbed in the free-falling matter causing its further heating and ionization. Consequently it is expected that the accretion flow itself is a strong source of the resonance-line photons due to collisional excitation of corresponding transitions. Subsequent scattering of these photons in the accretion flow determines the outgoing line profile. The stellar continuum scattering is here less important. The calculations on which we briefly report in this paper show that in these conditions the outgoing profile is mainly constituted of a strong emission component. The absorption feature, if present, is very shallow.

The transfer of resonance-line photons in spherically symmetric accretion flow has been studied using a Monte Carlo scattering code. The principles of the method are the same as those used for similar problems in stellar winds (e.g. Natta and Beckwith, 1986). In an accretion flow the velocity varies as $(1/r)^{1/2}$ while the density is proportional to $(1/r)^{3/2}$. The interdependance between the scattering of the stellar continuum photons and the transfer of the photons originating in the accretion flow has been specified by a parameter P_{env}. It is defined as

$$P_{env} = F_1/(F_1 + F_0)$$

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where F_1 is the photon flux emitted in the accretion envelope while F_0 denotes the flux of the stellar continuum photons which can interact with the accretion flow. The local emissivity of the line photons in the accretion flow is proportional to the square of the density.

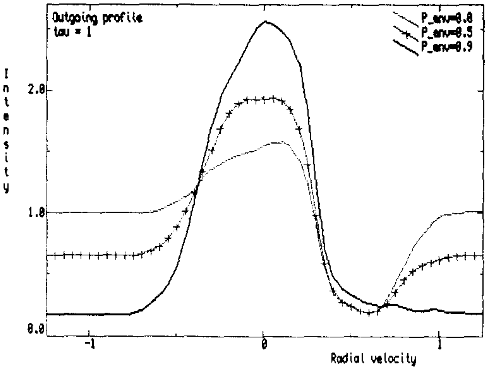

Fig. 1. The resonance line profiles from radial accretion flows with different values of P_{env}. The radial velocity on the abscissa is expressed in terms of the free-fall velocity at the stellar surface.

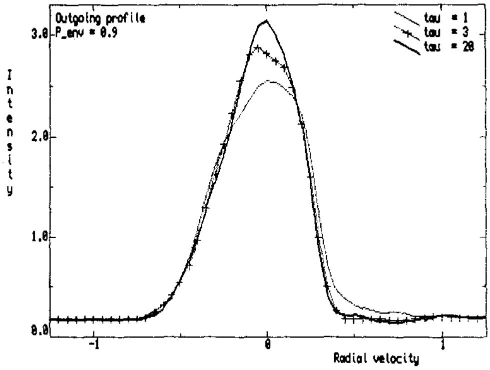

Fig. 2. The line profiles from flows of different optical thickness.

Fig. 1 compares the outgoing line profiles for different values of P_{env}. Note increase of the emission component and disappearance of the absorption feature as P_{env} approaches 1, i.e. when the photon emission from the accretion flow more and more dominates the stellar continuum scattering. As explained above the latter is expected to occur in real radial accretion flows. In this case the absorption feature does not appear even for large optical thicknesses as illustrated in Fig. 2.

REFERENCES

Natta, A., Beckwith, S., 1986, Astron. Astrophys. <u>158</u>, 310.