MNRAS **000**, 1–2 (2018) Preprint 5 July 2018 Compiled using MNRAS LATEX style file v3.0

Wind accretion in Supergiant X-ray binaries II. Disc formation and consequences for Vela X-1 and Cygnus X-1

I. El Mellah[1]★, A. A. C. Sander[2], J.O. Sundqvist[3], R. Keppens[1]
[1]*Centre for mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Celestijnenlaan 200B, B-3001 Leuven, Belgium*
[2]*Institut für Physik und Astronomie, Universität Potsdam, Karl-Liebknecht-Str. 24/25, 14476 Potsdam, Germany*
[3]*KU Leuven, Instituut voor Sterrenkunde, Celestijnenlaan 200D, B-3001 Leuven, Belgium*

Accepted XXX. Received YYY; in original form ZZZ

ABSTRACT

Context

In Supergiant X-ray binaries, a compact object captures a fraction of the intense wind from an O/B supergiant companion star on a close orbit. Proxies exist to evaluate the efficiency of wind accretion, in terms of mass and angular momentum accretion rates, but they depend so dramatically on the wind speed that within the current uncertainty range, they only bring loose constrains. Furthermore, their underlying assumptions bypass the impact of orbital and dissipative effects on the flow structure as it travels from the stellar surface down to the compact accretor. New observational insights on the long and short term evolution of these systems has aroused the compelling need for a more comprehensive description of mass transfer through wind accretion.

Aims

We study the wind dynamics and in particular, the angular momentum it gains and carries as it is accreted. We aim at evaluating the conditions of the formation of a disc-like structure around the accretor and its observational consequences for supergiant X-ray binaries.

Methods

We inject recent results on the wind launching mechanism into the three-dimensional frame of a binary system, accounting for the gravitational and radiative influence of the compact companion. Once it enters the Roche lobe of the accretor, we solve the hydrodynamic equations and evaluate the impact of different cooling prescriptions on the flow.

Results

A shocked region forms around the accretor as the flow is beamed within a few accretion radii. For wind speeds of the order of the orbital speed, the shock is highly asymmetric compared to the axisymmetric bow shock obtained for a purely planar homogeneous inflow, deprived of any net angular momentum. Provided we enable cooling within the shocked region, the flow always circularizes for wind speeds slow enough.

Conclusions

Although the donor star does not fill its Roche lobe, a realistic wind-launching representation can lead to a flow slow enough when it enters the Roche lobe of the accretor to be significantly beamed and bent by the orbital effects. The net angular momentum of the accreted flow is then large enough to witness the formation of a persistent disc-like structure whose properties depend on the cooling mechanisms at stake.

Key words: accretion, accretion discs – X-rays: binaries – stars: neutron, supergiants, winds, outflows – methods: numerical

★ E-mail: ileyk.elmellah@kuleuven.be

1 INTRODUCTION

$$P = C\rho^{\alpha} \tag{1}$$

with $\alpha \in [1, \gamma]$

REFERENCES

This paper has been typeset from a TEX/LATEX file prepared by the author.