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3D SIMULATION OF A DUST-DRIVEN WIND IN A BINARY SYSTEM

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Abstract. We implemented 3D SPH models of stellar winds including a self-consistent treatment of dust formation, radiative cooling, and radiation pressure on dust grains.

1 Introduction

At present there is no formulation available to correctly treat the exchange of mass and angular momentum via stellar winds between the components of long-period binary systems such as the progenitors of barium stars. Based on 3D SPH simulations, we aim to derive prescriptions for the rates of mass and angular-momentum transfer in such systems. A special attention is paid to the wind acceleration mechanisms of the giant star.

2 Physical ingredients

The calculation of the wind acceleration due to radiation pressure is done self-consistently and includes the following physical ingredients. The dust formation and opacity are calculated according to Gail *et al.* (1984): the formalism assumes chemical equilibrium and takes into accound grain growth/destruction and radiation pressure. The radiative cooling is identical to Bowen's (1988) (Lucy approximation). The chemistry, radiative cooling and radiation pressure on dust grains has been included in the PHANTOM SPH code (Price & Federrath 2010, Lodato & Price 2010), which already takes care of the pressure gradient and gravity. The outflow from the primary is assumed stationary and spherically symmetric. See Fig. 1 (left) for a validation of the 3D implementation.

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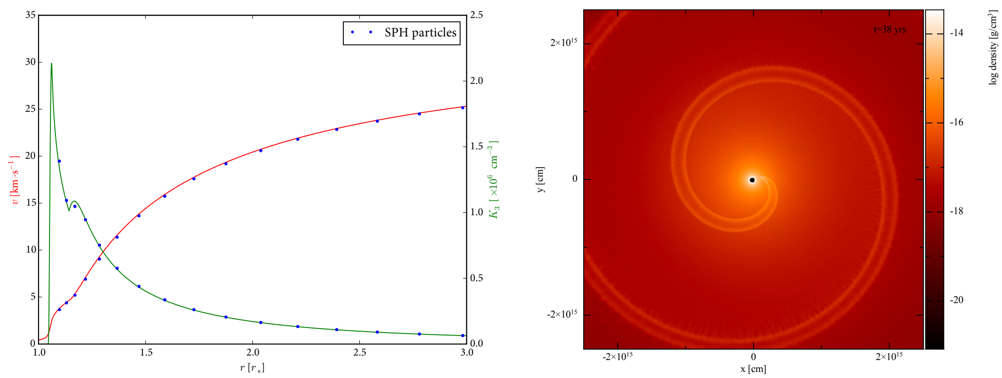

Fig. 1. [left] To test our implementation of the physics of dust formation and wind acceleration in the SPH code, we calculated semi-analytical stationary 1D models (solid lines) and compared them to the SPH results (blue dots). The wind remains perfectly smooth and spherically symmetric, and the agreement with the 1D solution is very good. v is the wind velocity and K_3 the number density of carbon atoms that are bound in dust grains. $M_* = M_\odot$, $T_* = 2500\,K$, $L_* = 10000\,L_\odot$, $R_* = 2.4\,au$, mass loss rate $= 10^{-5}\,M_\odot/yr$, C/O ratio = 2. **[right]** Density cross section of the same wind, but with a companion star: $M = M_\odot/4$, $R = 0.46\,au$ (orbital period = 6710 days).

3 Wind in a binary system

As more gas flows past the secondary, a spiral-shaped accretion wake forms (see Fig. 2). However, with realistic binary system parameters, the wind is accelerated too close to the central star to produce a Wind Roche Lobe Overflow (Mohamed & Podsiadlowski 2012), therefore we obtain a small wind accretion efficiency on the companion, of the order of 0.14 %.

4 Conclusions & outlook

We obtained first results concerning the interaction of a companion star with the wind in a binary system. After some further improvements (stellar pulsations), these models will serve as a basis to compute mass transfer rates during Wind Roche Lobe Overflow (Mohamed & Podsiadlowski 2012) and provide realistic prescriptions to be implemented in 1D stellar evolution codes.

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