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NUMERICAL SIMULATIONS OF THE INTERACTION OF COLLIDING STELLAR WINDS WITH THE ISM

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We investigate the effects of colliding winds on interstellar bubbles. We present the results of numerical simulations of a bubble that is formed by two close (not binary) stars with strong winds. The two winds will collide and form a thick shocked layer with hot, dense material. The edge of the bubble will be shaped by the undisturbed winds and the impact of the wind-wind shock layer on the interstellar medium (ISM).

Numerical simulations are performed with the AMRCART code, a highly flexible adaptive mesh refinement 3-D MHD-code (Walder & Folini 2000). A shocked layer forms from the colliding winds in between the stars. Due to the interaction with the ISM a second, at first thick, shocked layer will form at the edge of the bubble. This layer will expand both inward and outward due to its high temperature and pressure. The inward shock will heat the bubble interior and slow down the incoming wind. Radiative cooling will cause the collapse of the layer within $\sim$ 1000 to 4000 years. The pressure in the bubble interior will be the main force driving the expansion of the bubble. The numerical simulations indicate that we can expect a bumped structure of the edge of the bubble at the place where the wind-wind shocked layer hits the ISM. There are no large density fluctuations seen along the edge. Small-scale density variations will occur due to instabilities.

The conclusions of this work are:

1. The strong winds of two stars at a distance of ~ 0.1 pc will collide and form a thick shocked layer, in which temperatures can get as high as $\sim 10^6$ to 10^7 K and densities are several factors higher than in the undisturbed winds.

2. The numerical simulations show that we can expect a bumped structure of the edge of the bubble formed by two colliding winds.

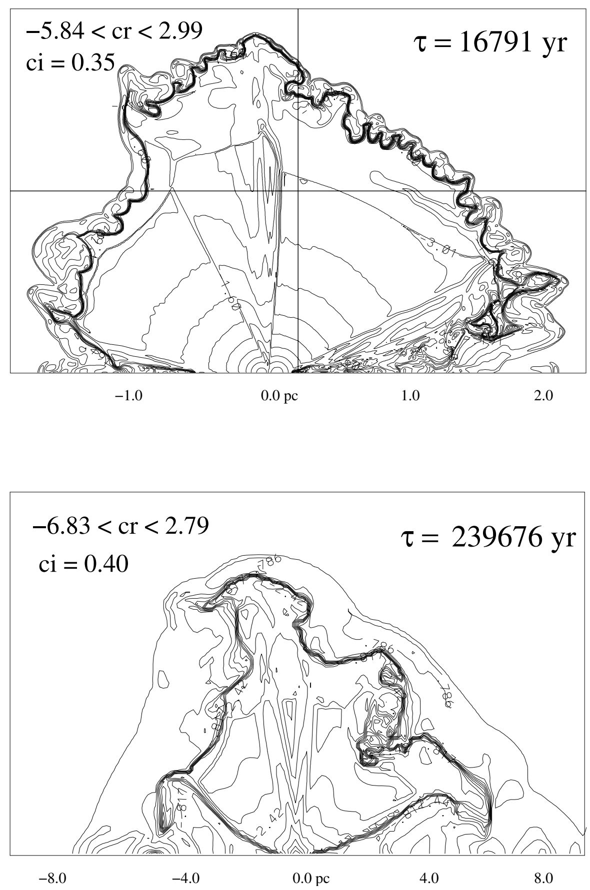

Fig. 1. Density contours from the numerical simulation at several times after the winds have started. In this simulation, the ISM density is $2.1 \times 10^{-24}\,\mathrm{g\,cm^3}$ and the two stars are 0.1 pc apart. The wind of the left star has a mass-loss rate of $1 \times 10^{-6}\,M_\odot\,\mathrm{yr}^{-1}$ and a velocity of $1000\,\mathrm{km\,s^{-1}}$, the right star has wind parameters $1 \times 10^{-6}\,M_\odot\,\mathrm{yr}^{-1}$ and $2000\,\mathrm{km\,s^{-1}}$. The time in years is indicated in the upper right corner of each plot, the contour range (cr) and contour interval (ci) are in the upper left corners. All densities are in log of the particle density.

REFERENCES

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