ON THE LINE PROFILES OF SHELL-SHAPED BIPOLAR OUTFLOWS

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1. INTRODUCTION

High velocity molecular outflows with bipolar morphology are detected in association with young stellar objects within dense interstellar clouds. Recent observations suggest that the flow could be "confined to a relatively thin, swept-up shell surrounding an evacuated wind cavity" (1). A shell structure characteristic of the wind-cloud interaction had been predicted in earlier theoretical works (see for instance (2)). More recently, models with different (not shell-shaped) geometries were presented, e.g. (3).

An evaluation of line profiles of the high velocity molecular gas at different angular resolutions could allow comparison with observation, and help choosing between different models. We present preliminary data with reference to the shell model suggested by Barral and Cantò (4), which gives an explicit description of the velocity field along the shell and allows a simple evaluation of the intensity distribution along the shocked surface.

The model contains several simplifying assumptions: the system is considered to be in a steady state, and "pressure driven"; we are presently studying the time evolution of a thin shell in more general terms.

2. NUMERICAL CODE AND RESULTS

Using the Barral and Cantò model we compute the shock surface configuration for arbitrary angles of the polar axis with the line of sight. The code makes use of a (90x180) matrix with steps of 1 degree in latitude and 2 degrees in azimuth. The gas emissivity is estimated by the equation

$$L = (\text{constant}) \times L_{shock} \times \phi_{beam} \times j_{max} \tag{1}$$

where: $L_{shock} = \rho v^3$, $\phi_{beam} = (1/2)^{(r/B)^2}$ (antenna beam pattern), $j_{max} = \rho c$ (mass mixing, (5)). The code computes the line structure at each point of the array by using Eq. (1) for the intensity, evaluates the li-

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ne-of-sight velocity component for the line center, and estimates the line width resulting from turbulence in the region of mixing.

The turbulent velocity width Δv_{turb} is the main source of uncertainty in the computation. We consider two cases: (a)$\Delta v_{turb} = v_s/8$, (b)$\Delta v_{turb} = v_s/4$ (v_s is the mean square post-shock velocity). All line profiles are normalized over the number of points considered. The minimum beam amplitude contains more than 200 points. Our code cannot be used for estimating the luminosity very close to the star, where the relation for L_{shock} would give an unrealistically high emissivity. Our unit of length is the scale factor R_0 (the shock radius at $\theta=0$); we assume a terminal wind velocity v_* = 100 km/sec. Some results are presented in Fig. 1.

One can see a double peak is present for the lower value of the turbulent velocity (of order 15 km/sec). The structure is in reasonable agreement with observations of Mon R2 (see (1)). A detailed comparison with observational data is in course.

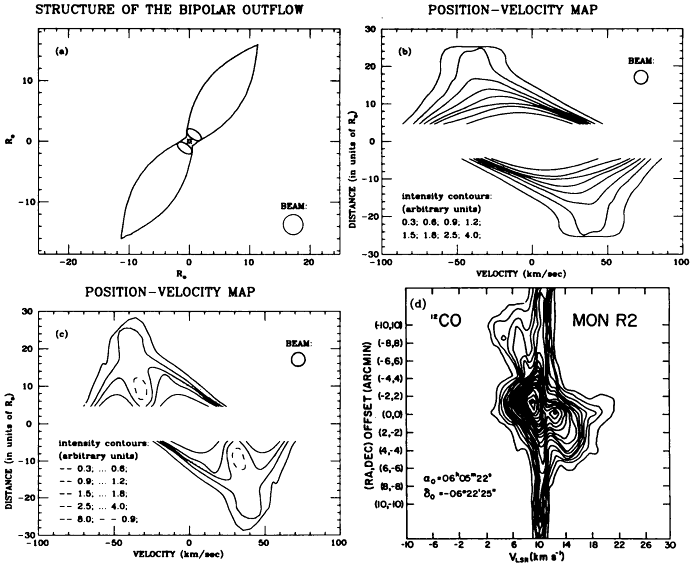

Fig. 1. (a) A typical bipolar outflow having polar axis along the bisectrix of the first octant. (b) Position-velocity map for $\Delta v_{turb} = v_s/4$. (c) The same, for $\Delta v_{turb} = v_s/8$. (d) Observational position-velocity map of the outflow source Mon R2.

LITERATURE

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