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THE COMETARY CAVITY CREATED BY AN ALIGNED STREAMING ENVIRONMENT/COLLIMATED OUTFLOW INTERACTION

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RESUMEN

Presentamos un modelo analítico de "capa delgada" de la interacción de un chorro bicónico y un medio ambiente en movimiento (alineado con la dirección del chorro), así como simulaciones numéricas (axisimétricas) de dicha interacción. Una situación similar, aunque en un escenario más complejo, ocurre en la cabeza de la estructura cometaria de Mira. Por esta razón, en la mayoría de las simulaciones numéricas exploramos parámetros que son consistentes con las observaciones del flujo bipolar de Mira B. Para estos parámetros la interacción es no-radiativa, lo que tiene como resultado una zona de interacción chorro/medio ambiente bastante ancha. A pesar de esto, encontramos que el modelo analítico de capa delgada describe de manera satisfactoria la morfología básica del flujo.

ABSTRACT

We present a "thin shell" model of the interaction of a biconical outflow and a streaming environment (aligned with the direction of the flow), as well as numerical (axisymmetric) simulations of such an interaction. A similar situation, although in a more complex setup, takes place at the head of the cometary structure of Mira. Thus, for most of the numerical simulations we explore parameters consistent with the observed bipolar outflow from Mira B. For these parameters, the interaction is non-radiative, so that a rather broad jet/streaming environment interaction region is formed. In spite of this, a reasonable agreement between the thin-shell analytic model and the numerical simulations is obtained.

Key Words: hydrodynamics — ISM: kinematics and dynamics — ISM: jets and outflows — stars: AGB and post-AGB — stars: mass-loss

1. INTRODUCTION

Prompted by the discovery by Martin et al. (2007) of a striking $\sim 2^\circ$ cometary tail attached to Mira, a series of theoretical and observational studies of this object have been made. Theoretical works include Wareing et al. (2007b); Raga et al. (2008); Raga & Cantó (2008); Esquivel et al. (2010), all of which are devoted to study the interaction between the post-AGB wind (from Mira A) and a streaming interstellar medium (ISM). This streaming medium corresponds to the motion of Mira through the galactic plane. Observations of the cometary tail have been done in several wavebands, including 21 cm (Matthews et al. 2008) and the IR (Ueta 2008).

Optical (Hα) observations by Meaburn et al. (2009) revealed a fast bipolar outflow, which probably arises from the less luminous component, Mira B. This outflow is embedded in the head of the cometary structure. It has radial velocities of ± 150 km s^{-1} (with respect to Mira), is relatively broad, and its projection onto the plane of the sky is approximately aligned with the direction of Mira's proper motion.

The mass loss rate from Mira A has estimated values from 10^{-7} to 10^{-5} $M_\odot$ yr^{-1} (Knapp & Morris 1985; Bowers & Knapp 1988). Part of this mass loss is accreted onto a disk around Mira B (and eventually onto Mira B itself). Ireland et al. (2007) estimated a $\sim 5\times 10^{-9}$ $M_\odot$ yr^{-1} accretion rate. Part of this accretion rate would then be redirected into the bipolar outflow from Mira B.

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