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OBSERVATIONS OF JETS IN H II REGIONS (HH 444)

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RESUMEN

Presentamos espectros de rendija larga de alta resolución espectral de HH 444 y simulaciones numéricas para este objeto Herbig-Haro. De la comparación entre observaciones y simulaciones podemos analizar el escenario físico de este jet.

ABSTRACT

We present high resolution long-slit spectra of HH 444 and numerical simulations for this Herbig-Haro object. From the comparison between observations and simulations we are able to study the physical scenario of this jet.

Key Words: **ISM: HERBIG-HARO OBJECTS — ISM: INDIVIDUAL (HH444) — ISM : JETS AND OUTFLOWS**

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1. INTRODUCTION

Recent observations show the existence of collimated outflows ejected by young, low mass stars which are embedded in H II regions. These jets emerge into the photoionized nebula, and start to be photoionized by the radiation from the nebula itself. We study the case of HH 444, which is part of a system of 4 Herbig-Haro objects (HH 444, 445, 446 and 447) embedded in the H II region excited by σ Orionis (Reipurth et al. 1998).

2. OBSERVATIONS

The kinematical observations were obtained with the MES (Manchester Echelle Spectrograph) at the f/7.9 focus of the 2.1-m San Pedro Mártir Telescope. This spectrometer has no cross-dispersion. For the present observations, filters were used to isolate the Hα and [N II] 6584 Å nebular emission lines. The spectra were calibrated to $\pm$ 1 km s^{-1} accuracy using a Th-Ar arc lamp. Two long-slit positions were used, passing through the most external observed bow shock and through the base of the jet.

3. NUMERICAL SIMULATIONS

We have computed numerical models of an initially neutral jet emerging into an ionizing radiation field with the new “yguazú” code, which is described in detail by Raga et al. (1999). We use two different models to compare with the Hα emission from the jet of HH 444. One of them (M1) has a mean central velocity of 120 km s^{-1}, decaying to a velocity of 10 km s^{-1} at the edge of the jet beam. On this mean velocity, we superimpose a $\Delta v/v = 0.1$ velocity variability with a 60 yr period. The other model (M2) has the same velocity profile and a similar amplitude in the velocity variability but with a 100 yr period, and also an opening angle of 30°.

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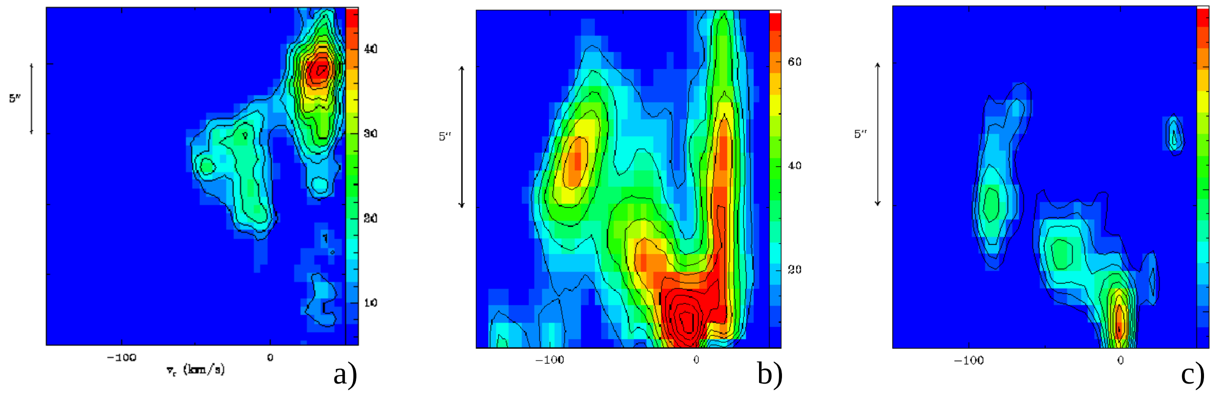

Fig. 1. Contour map with linear intervals of the Hα position-velocity diagram for *(a)* the most external observed bow shock of HH 444 and *(b)* the base of the jet. *(c)* Contour map with linear intervals of the [N II] position-velocity diagram for the base of the jet.

4. CONCLUSIONS

From the spectrum of the bow-shock of HH 444 it is possible to estimate the maximum and minimum radial velocities and with them we can calculate the orientation angle Φ between the outflow axis and the plane of the sky (Hartigan, Raymond, & Hartmann 1987), giving a value of $\simeq 45^o$ assuming that the material is flowing into a stationary medium.

From the comparison of the spectra with the models (see the paper of Raga et al. in these Proceedings) we see that there is a good match, especially in the case of the model with a jet opening angle (M2). With this model we can reproduce the fact that the observed Hα intensity falls with increasing distance from the jet source. The acceleration in the position-velocity diagram as a function of increasing distance from the source is reproduced assuming a decaying velocity from the center to the edge of the jet beam. Finally, the separated knots along the jet beam can be reproduced assuming a time-variability in the ejection velocity.

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REFERENCES

Hartigan, P., Raymond, J., & Hartmann, L. 1987, ApJ, 316, 323
Raga, A. C., Mellema, G., Arthur, S. J., Binette, L., Ferruit, P., & Steffen, W. 1999, RevMexAA, 35, 123
Reipurth, B., Bally, J., Fesen, R. A., & Devine, D. 1998, Nature, 396, 343

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