RevMexAA (Serie de Conferencias), **15**, 134–134 (2003)

Winds, Bubbles, & Explosions: A Conference to Honour John Dyson. Pátzcuaro, Michoacán, México, 9-13 September 2002. Editors: S. J. Arthur & W. J. Henney

AN OPTICAL SPECTROSCOPIC STUDY OF HH 110: A TURBULENT MIXING LAYER?

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The HH 110 jet extends $\sim 3'$ in length and consists of numerous knots forming the flow. Noriega-Crespo et al. (1996) found that the turbulent optical and near-infrared morphology of the HH 110 jet is consistent with that of a boundary layer. In this work, we have analyzed some line ratios along and across the jet in order to make a quantitative comparison with the line ratios predicted by the current mixing layer models.

We present calibrated intermediate resolution long-slit spectra along and across the jet. We calculate different relative line ratios and determine the electronic density (N_e) for all the sub-spectra. Then, we have constructed diagrams where the intensity distribution, different line ratios, and N_e are shown as a function of spatial position. All positions across the jet clearly show a monotonous decrement in the excitation degree from the east edge to the west edge. Along the jet there is no specific tendency for physical parameters.

The mean value for E_{B-V} along the jet is $E_{B-V} = 0.5 \pm 0.4$. Electronic densities derived from the [S II] 6717/31 ratio are within $50 \geq N_e \geq 1500\,\mathrm{cm}^{-3}$. The observed line ratios in the HH 110 jet are similar to HH objects with high excitation, although the [O III] emission lines are not detected.

We compare three line ratios in HH 110 and several mixing layer models (Binette et al. 1999) and plane-parallel shock models (Hartigan, Morse, & Raymond 1994) and line ratios for HH objects with low excitation. The HH 110 line ratios do not fit with plotted mixing layer models. Line ratios predicted by mixing layer models would be classified as low excitation, while we have classified the HH 110 jet as a high-excitation object.

Using the [N II] 6584/Hα and [O I] 6300/Hα ratios and N_e we have estimated a T_e and X (model independent parameter, as in Bacciotti & Eislöffel 1999), assuming that O and N dominate the charge-exchange reactions in an optically thin medium. Figure 1 presents the results for all analyzed slits. Values obtained for T_e in HH 110 are similar and slightly increase from the east edge to the west edge. The average temperature in the jet is $T_e = 4700 \pm 500\,\mathrm{K}$. In the case of the ionization fraction estimated across the jet (slits II, III and IV), we can observe how these values decrease from the east edge to the west edge. These results are clearly consistent with the expected tendency of these physical parameters in a turbulent mixing layer. The values for T_e and X (~ 0.1) are similar to the same parameters estimated in other HH objects (HH 46/47, HH 24E, HL Tau and the Th 28 jet).

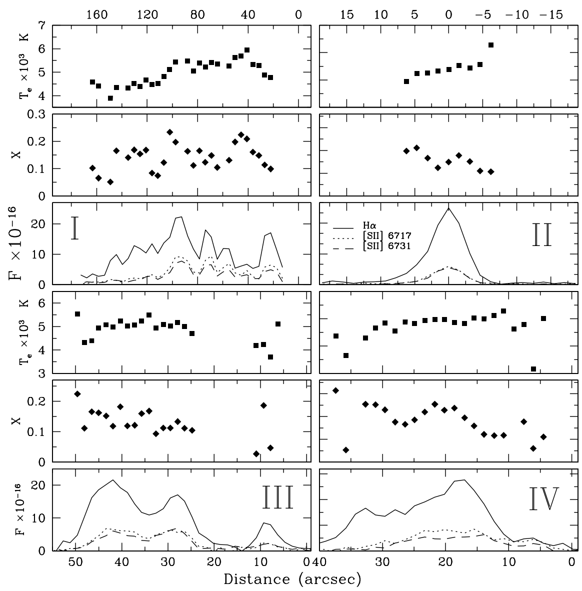

Fig. 1. Spatial distribution of the derived electronic temperature (T_e) and ionization fraction (X) along slits I, II, III and IV. We show the spatial intensity distribution of Hα and [S II] 6717/31 lines.

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