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THE TRANSVERSE VELOCITY STRUCTURE OF HH JETS

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The aim of this work is the study of the velocity and excitation structure across the beam of a selected group of HH jets. With this purpose, we have obtained spectra for positions across HH 110 and HH 111 jets, which allow us to measure the radial velocities and line ratios through the cross section of the jet (see Figure 1).

Long-slit (4′), high resolution spectra ($\sim 30\,\mathrm{km\,s^{-1}}$ at Hα) of the HH 110 and HH 111 jets were obtained in 1998 using the ISIS spectrograph at the 4.2 m WHT telescope of the ORM (La Palma, Spain). The R1200R grating, centered at 6600 Å (covering the Hα, [N II] 6548, 6583 Å, and [S II] 6717, 6731 Å lines) was used. Further details are described in Riera et al. (2001).

We obtained spectra for two slit positions cutting through HH 111 at the position of knots D and F. We find the presence of a low velocity envelope extending up to $\sim 15''$ on each side of the jet axis. We observe a radial velocity stratification with higher velocities on the jet axis and lower velocities away from the axis (see Fig. 1). The heliocentric velocity of the ambient cloud is $+8.5\,\mathrm{km\,s^{-1}}$. The [S II]/H$\alpha$ ratio shows a decrease along the N-S direction across knot D, and a less clear, but similar effect across knot F. The [S II] 6717/6731 ratio is surprisingly constant across knot F. This ratio has a more complex behavior across knot D, indicating the presence of an inner and outer region with $n_e \sim 1000\,\mathrm{cm^{-3}}$ separated by a more dense, $n_e \sim 3000\,\mathrm{cm^{-3}}$, "tube" extending from $3''$ to $7''$ from the jet axis.

We also obtained spectra for four slit positions across the axis of the HH 110 jet, at the postions of knots B, C, I+J, and P. We find that the HH 110 jet has a very complex structure, with spatially dependent radial velocities, line intensities and line ratios. The radial velocity cross sections of the jet show an almost constant velocity for knots B and C, a velocity growth from W to E of $\sim 60\,\mathrm{km\,s^{-1}}$ for knots I and J, and a more complicated, S-shaped cross section spanning a $\sim 30\,\mathrm{km\,s^{-1}}$ velocity range for knot P. The [S II] 6717/6731 line ratio across knots B and C show the presence of a dense (~ 450 to $700\,\mathrm{cm^{-3}}$), central region of the jet beam, with lower density regions (~ 100 to $300\,\mathrm{cm^{-3}}$) on both sides. In knots I, J, and P, the electron density decreases monotonically from W to E (from ~ 200 to $50\,\mathrm{cm^{-3}}$). The other measured line ratios show quite complex cross sections. It is unclear whether or not these results are consistent with a model of deflected jet beam for the HH 110 outflow (Raga et al. 2002, and references therein).

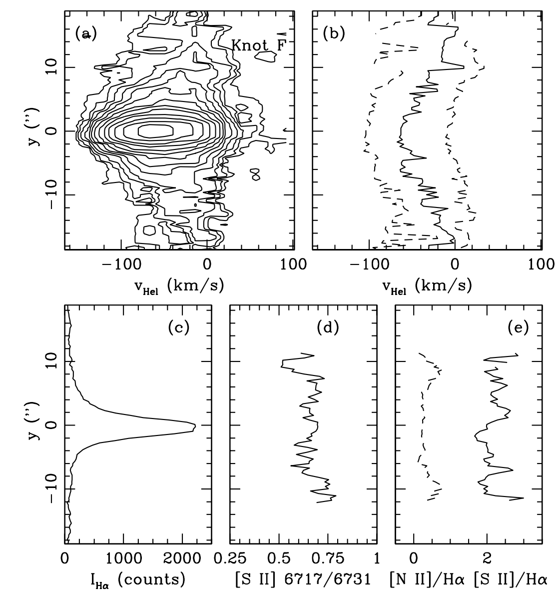

Fig. 1. (a) [S II] 6731 Å position-velocity diagram at the position of knot F, shown with a factor of $\sqrt{2}$ logarithmic contours. The distance y is measured from the jet axis. (b) Heliocentric radial velocity corresponding to the peak of the line profile (solid line) and the velocities of the positions with half the peak emission are shown (dashed lines). (c) Hα intensity as a function of distance from the central axis of the HH 111 jet. (d) [S II] 6717/6731 ratio through the cross section of the jet. (e) The same as (c) but for the [N II]/Hα and [S II]/Hα ratio.

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