HH 34: THE BOW SHOCK OF A JET

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ABSTRACT. Deep CCD imaging of HH 34 in H_α shows that the HH-object has a bow shock-like structure, of which the wings can be traced over about 1 arcmin ($\hat{=}$ 0.15 pc). A knotty jet is pointing towards the apex of the bow shock structure. Long-slit spectroscopy reveals that 1) the jet has approximately a constant radial velocity and electron density. 2). The spectrum of the jet is of a much lower excitation than that of HH 34. 3) HH 34 has a complex velocity and line excitation structure. The extended bow shock is interpreted by a jet of which the working surface is propagating with high velocity ($\approx$ 200 km/s) through a partially ionized medium.

1. CCD IMAGING

Deep CCD images of the HH 34 region has been obtained at the 2.2 m Telescope on La Silla through an H_α-filter (λ_C= 6565 Å, $\Delta\lambda$ = 67 Å, exposure time 1 h). The image is reproduced in Fig. 1. A 12" long, knotty jet points towards HH 34, which has a bow shock-like structure. The jet emanates from a highly reddened young star, which shows strong H_α-emission (Reipurth et al. 1986). A very similar morphology is observed in the case of HH 1 and HH 39 (Mundt, Brugel and Bührke 1986).

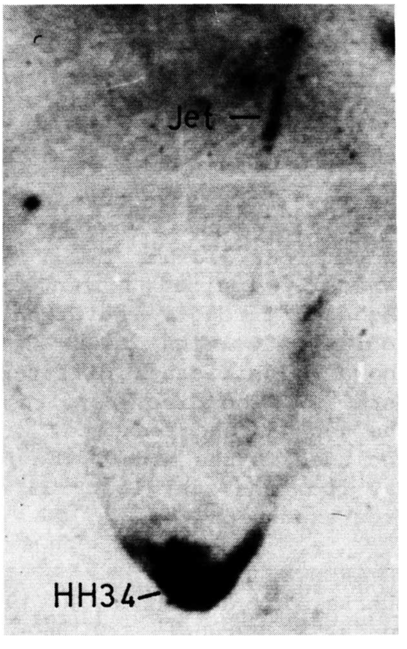

Fig. 1: H_α-frame of the HH 34 region

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2. LONG-SLIT SPECTROSCOPY

We examined the HH 34 Jet by long-slit spectroscopy at the 2.2 m Telescope on the Calar Alto, Spain. The spectral resolution was 60 km/s (FWHM). In the knots of the jet the radial velocity (-85 ±5 km/s) was nearly constant as well as the electron density (N_e = 650 ±200 cm^{-2}), derived from the [SII] $\lambda\lambda$6716/6731 Å line ratio. In HH 34 we observed two components of the forbidden lines with a separation of 50 km/s, which converge to a single line near the leading edge of the bow shock. With increasing distance from the star, both components show a decrease in the radial velocity from -140 km/s to -60 km/s. The electron density varies between 60 cm^{-3} and 400 cm^{-3}. The line ratios imply for the jet a much lower excitation (shock velocity $v_s \approx 50$ km/s) than for HH 34 (v_s = 90 - 100 km/s). The different behavior is shown in Fig. 2:

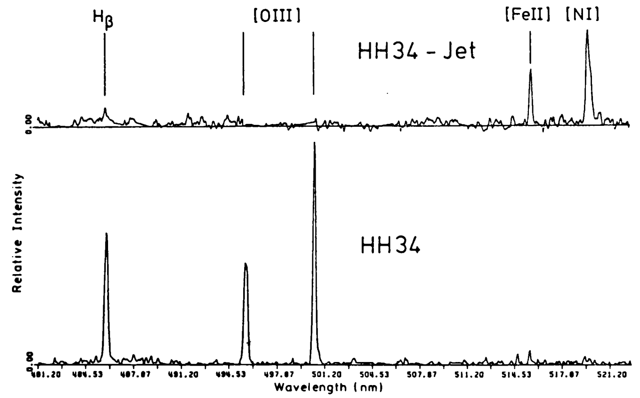

Fig. 2: Line intensities in the jet and HH 34

3. INTERPRATATION

The bow shock structure of HH 34 is explained by the working surface of a jet, which is propagating with a high velocity (200 km/s) through the ambient medium. The model calculations of Raga (1985) show that a partially ionized ambient gas is required in order to observe very extended strongly radiating bow shocks. A comparison of the observed radial velocities in HH 34 with the predicted ones of Raga's model shows significant differences (see Bührke and Mundt 1986 for details). The discrepancies are explained by additional emission from the jet gas shock-excited in or near the working surface, which is not included in the model. The fact that the jet cannot be traced all the way from the star to HH 34 can have various reasons, e.g. sections of free expansion.

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