ELONGATED STRUCTURES NEAR YOUNG STARS: JETS OR PROJECTION EFFECTS?

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Recent observations in radio, infrared and visible wavelengths have revealed the presence of small, elongated gaseous structures that appear to emanate from young stars. These structures are frequently interpreted as jets, perhaps similar in nature to those observed in extragalactic objects. We argue that these apparent "jets" could simply be light emitted by, or reflected from the walls of the cavities expected to be formed when the winds of these young stars drive their surrounding gaseous medium away. When viewed from certain positions the radiation from the walls of these cavities appears to the observer as elongated structures. A simple model is presented to illustrate this projection effect.

We also discuss some well known sources both young and evolved (PV Cep, R Mon, R CrA, G34.3+0.2, R Aqr, and NGC 6302), where this projection effect may be at work.

THE ENERGY SOURCE OF HH34 AND ITS HIGHLY COLLIMATED JET

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We have discovered a highly collimated optical jet emanating from a faint star and pointing towards the Herbig-Haro object HH34 (Reipurth 1985, Reipurth *et al.* 1986).

The jet consists of six knots extending over about 16 arcseconds, which at a distance of 500 pc corresponds to about 8000 AU. At very low light levels the jet can be followed for 9" - 10" to a faint emission line star, which we identify as the energy source. Low and high resolution spectra show that the jet is shock-excited with a characteristic

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low-excitation emission-line spectrum. The red sulphur lines are extremely strong, with a λ6717/Hα ratio of 2.9. The electron density derived from the sulphur line ratio is around 10^3. The jet is a high-velocity object with a heliocentric radial velocity of about -60 km/sec.

The energy source is a low-mass pre-main sequence star with an emission-line spectrum, a red continuum, a near-infrared excess, and a total estimated luminosity of about 0.5 $L_\odot$. The slope of the continuum suggest a rather low visual extinction of $A_V \sim 5^m$. Among the emission lines, [Fe II] λ8617 stands out because of its extreme intensity.

The Herbig-Haro object HH34 shows a striking morphology on red CCD images, with six knots embedded in a tenuous, bow-shaped envelope. Spectra of knots A and C show typical shock-excited emission line spectra, with strong Hα emission and weaker sulphur emission lines. The λλ 6717/6731 sulphur line ratio is very high, around 1.40, suggesting very low electron-densities around $N_e \sim 50$. One knot shows sulphur emission much stronger than Hα on interference band CCD images. The heliocentric radial velocity of knots A and C are about -100 km/sec and -60 km/sec, respectively. A deep search for molecular hydrogen emission of both HH34 and the jet proved negative.

^{12}CO and ^{13}CO observations reveal that the HH34 energy source is embedded in a high density molecular cloud core with an approximate diameter of 0.1 pc and a mass of about 4 $M_\odot$. The mean molecular hydrogen volume density of this clump is estimated to be greater than 10^4 cm^{-3}.

Several other young stars are identified in the vicinity of this molecular clump. No molecular outflow was detected.

We have shown that for jet models, in which the main heating takes place where a confined jet becomes unbounded, we can in principle from our observations derive the dynamical age, space velocity and inclination to the plane of the sky of the visible part of the jet. In the case of the HH34 jet, the *formal* solutions are τ_r = 122 yrs, v_{space} = 323 km/sec and i = 15°. The low inclination is most likely a major reason why a bipolar flow was not detected. Also, we have compared our observations of HH34 with the recent HH-model of Dyson (1984), and find support for the idea that HH objects are bow shocks, where collimated high-velocity beams ram through the interstellar medium.

REFERENCES

Dyson, J.E.: 1984, in *Gas in the Interstellar Medium*, ed. P.M. Gondhalekar, Rutherford Appleton Laboratory Workshop, p. 107.

Reipurth, B.: 1985, *(Sub)millimeter Astronomy*, ESO-IRAM-Onsala workshop, eds. P.A. Shaver and K. Kjaer, p. 459.

Reipurth, B., Bally, J., Graham, J.A., Lane, A.P., and Zealey, W.J.: 1986, Astron. Astrophys., in press.