ROLE AND EVOLUTION OF AMMONIA CLOUDS IN BIPOLAR FLOW SOURCES

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1. INTRODUCTION

Many bipolar flow sources have been found around infrared sources with a wide luminosity range. The bipolar sources are thought to be a common stage of early stellar evolution. Recently, compact dense molecular clouds have been detected, just around the exciting infrared sources of several bipolar flow sources (e.g. Torrelles *et al.* 1983). An investigation of the nature of these surrounding dense molecular clouds should be important to study the acceleration and collimation mechanisms of the bipolar outflow.

We have observed the bipolar flow sources, CRL2591, NGC 2071, and HH7-11, in the NH_3 (J,K) = (1,1) and (2,2) lines with the 100-m telescope at Effelsberg. With a high angular-resolution of 40" and with simultaneous observations of the NH_3 (J,K) = (1,1) and (2,2) lines, we have revealed the precise molecular distribution and the kinematics of such compact dense clouds.

2. RESULTS AND DISCUSSION

In CRL2591, we have found a compact NH_3 cloud of $\sim$ 0.6 pc in diameter around the central infrared source (Figure 1 Takano *et al.* 1986a). This compact cloud shows a velocity gradient in the direction orthogonal to the CO bipolar flow (Lada *et al.* 1984). This could suggest a rotation of the cloud around the symmetric axis of the CO flow.

In NGC 2071, an NH_3 cloud of $\sim$ 0.4 pc $\times$ 0.15 pc, elongated orthogonal to the CO bipolar flow (Snell *et al.* 1984), has been found. The central velocities of the NH_3 lines, as well as its velocity gradient and spatial distribution, are different from the values of the rotating CS disk found by Takano *et al.* (1984) (Figures 2,3, Takano *et al.* 1986b).

In HH7-11, a large streaming structure from the central infrared source SSV13 has been found in the direction of the blue-shifted CO flow along the Herbig-Haro objects HH7-11 and 5, as well as a hint of a disk-like structure orthogonal to the CO flow (Figure 4), Takano, Fukui, and Winnewisser 1986). The mass of this streaming cloud is much higher than that of the disk-like structure. This fact means that it is rather dif-

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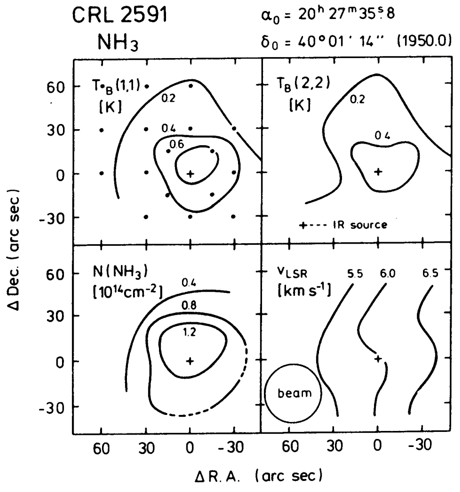

Fig. 1. The distribution of the peak brightness temperature T_B of the NH_3 (J,K) = (1,1) and (2,2) lines, the column density, and the central velocity of the (1,1) line. The ammonia cloud is concentrated in the central 60" (= 0.6 pc at 2 kpc). The cloud exhibits a systematic velocity gradient in the E-W direction. The cross indicates the location of the central infrared source CRL2591.

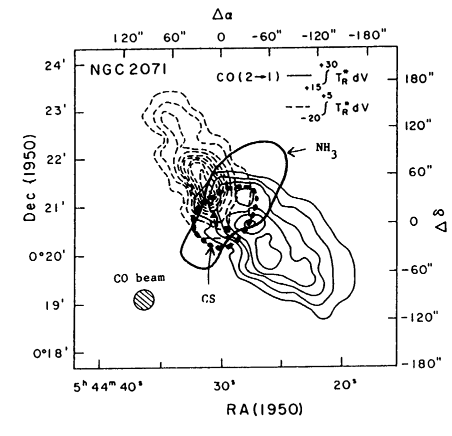

Fig. 2. Outlines of the NH_3 (thick solid contour) and the CS (thick dotted contour) elongated structures in the bipolar flow source NGC 2071 (Takano *et al.* 1984, Takano *et al.* 1986b). Thin contours show the distribution of the CO bipolar flow (Snell *et al.* 1984).

ficult for such a light disk to collimate the outflowing and streaming matter.

The streaming NH_3 cloud reaches about 5 times farther away from the central infrared source than the CO blue-shifted flow does. The cloud has a large knot around HH8, at which the CO blue-shifted flow is stopped abruptly (Sandell and Liseau 1984, Takano *et al.* 1986c). From these facts, we interpret that the streaming cloud has been accelerated by the blue-shifted CO flow. We estimate the dynamical time scale of the streaming cloud to be $\sim 5\times10^5$ years, which is more than 10 times longer than the value estimated for the CO flow.

All of our results imply that the compact, dense elongated cloud cannot collimate an isotropic outflow into the bipolar direction.

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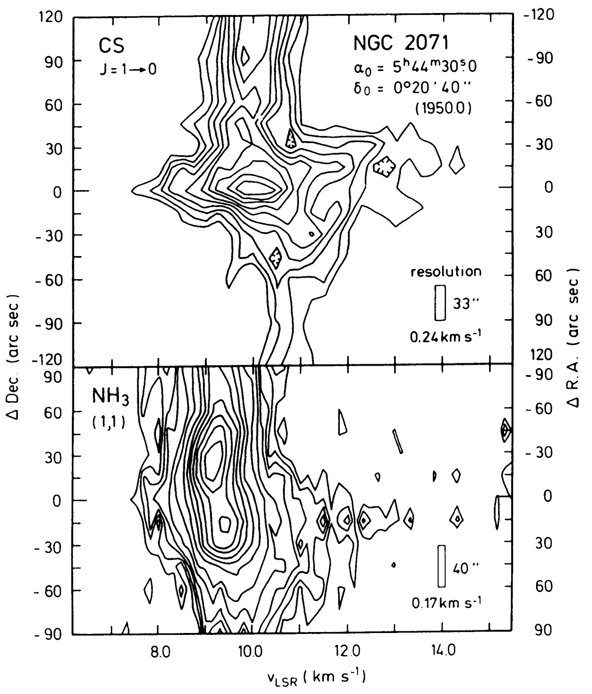

Fig. 3. Velocity-position diagrams of the CS (Takano *et al.* 1984: upper panel) and the NH_3 emission (Takano *et al.* 1986b: lower panel) along the NW-SE direction through the central position. The peak velocities differ from each other by 0.8 - 1.5 km s^{-1}. For the CS diagram, the lowest contour is 0.8 K and the contour interval is 0.2 K. For the NH_3 diagram the contours are 0.2, 0.3, 0.4, 0.5,0.75, 1.0 K, and every 0.5 K after that.

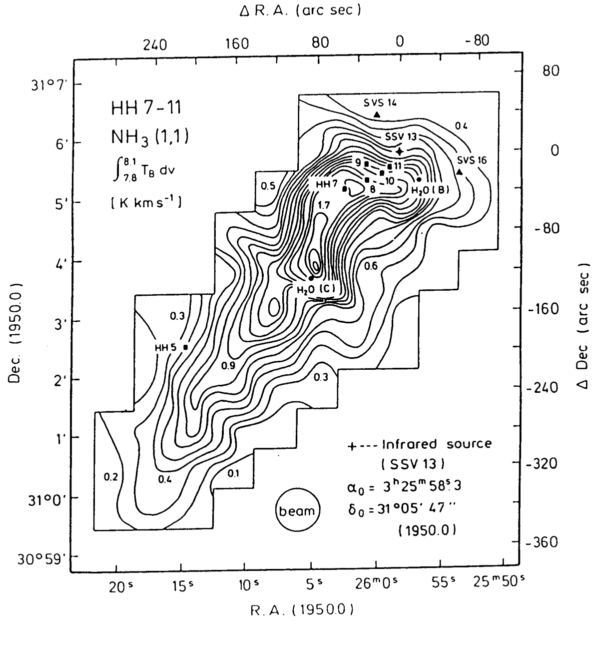

Fig. 4. A large streaming NH_3 cloud in HH7-11 (Takano, Fukui, and Winnewisser 1986). The streaming cloud is ∿0.6 pc long, a value about 5 times larger than that of the blue-shifted flow and also about five times larger than the projected distance between HH7-11 and SSV13.

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THE STAR FORMING REGION IN BOK GLOBULE 210-6a

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The NASA 64-m antenna at Tidbinbilla and the CSIRO 64-m antenna at Parkes have been used to observe the Bok Globule 210-6a ("Valentine's Night") in the (1,1), (2,2), and (3,3) transitions of ammonia. The beam sizes of the two telescopes were 55 arcsec and 81 arcsec, respectively. The observations are summarized below: