PUBLICATIONS OF THE KOREAN ASTRONOMICAL SOCIETY
14: 79 ~ 81, 1999

STRUCTURE OF ^{13}CO EMISSION AND DISTRIBUTION OF IR IN THE DARK CLOUD L1535

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ABSTRACT

We have made an extensive mapping of the ^{13}CO J=1-0 transition line in the dark cloud L1535. We also constructed the 100μm IRAS map in the region. We found a semi-detached cloud component of ^{13}CO in the northeast direction of the ^{13}CO main cloud which forms a dumbbell-like structure. This additional component with an angular size of $20' \times 16'$ has not been observed before in any molecular surveys of the cloud. The IRAS map shows a similar structure with two intensity peaks whose positions coincide with those of the ^{13}CO clouds.

Key words: interstellar clouds, dark clouds, IR, CO

1. Introduction

The molecular line and infrared observations show that L1535 is a condensed dark cloud lying toward the eastern end of the Taurus complex. The cloud appears fairly well-isolated in all directions except the southwest direction where there seems to be an extension in visual extinction and H_2CO distributions. The cloud contains a small clump which was found to be a region of low-mass star formation (Myers and Benson 1983, Benson and Myers 1989). The region is embedded by strong infrared sources (Chini et al. 1985). Ungerecht et al.(1982) mapped the central part of L1535 in the (1,1) transition of NH3, and found a systematic velocity gradient in the cloud core which is assumed to be an evidence of rotation. Goldsmith and Sernyak (1984) mapped this cloud in ^{12}CO and ^{13}CO, and found one peak condensation of these molecules and an indication of systematic rotation. The distance of the cloud is about 140 pc as determined by objects in the Taurus region (Elias 1978). The mass is $20M_\odot$ and the linear size is 0.5 pc (Goldsmith and Sernyak 1984). The cloud seems to be extended further into the southwest direction beyond the area covered by the maps. Lee et al.(1996) compared the distributions of H_2CO, ^{13}CO, and visual extinction in this cloud. They found there is a good correlation between them. However, the intensity center of the NH3 seems to be shifted about 1 arcmin to the southwest direction from the H_2CO center (Ungerecht, et al. 1982). In this study we compared the map of the ^{13}CO antenna temperature distribution in L1535 which we observed with the previously published results. We also compared the ^{13}CO map with the 100μm Infrared Astronomical Satellite (IRAS) map of approximately $40' \times 50'$ area in the core of this cloud.

2. ^{13}CO observations and the IRAS map

We mapped the ^{13}CO (J=1-0) line extensively in the region of the dark cloud in L1535 with the 14-m radio telescope at Daeduk Radio Astronomical Observatory, January, 1998. The half-power beamwidth of the telescope was about 57 arcsec at the rest frequency of 110.201353 GHz, and the beam efficiency was $\eta = 0.45$. The spectra were obtained with a cooled 80-120 GHz Schottky diode mixer. We used the 1024 channel autocorrelator with spectrometer.

The observed region of the cloud is about $26' \times 40'$ and the entire region was covered by 801 spectra. The angular resolution is $1' \times 1'$. The center position of L1535 used for this mapping is $\alpha(1950)$ = 04h 32m 38s and $\delta(1950)$ = +24o 02' 00". The observations were made in two parts; the first one covers the area of = $-14' \sim 10'$ and = $-10' \sim 10'$, and the other one covers the area of = $10' \sim 26'$ and = $2' \sim 14'$. The 100μm map is constructed using the data took by the IRAS which observed in four bands of 16, 25, 60, and 100μm. We used the IRAS HCON3 sky maps (IRAS Explanatory

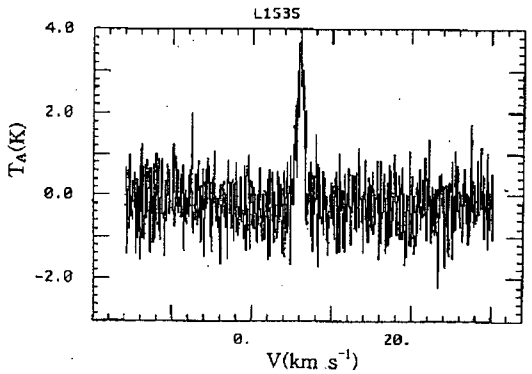

Fig. 1.— A ^{13}CO line profile observed at the center of L1535.

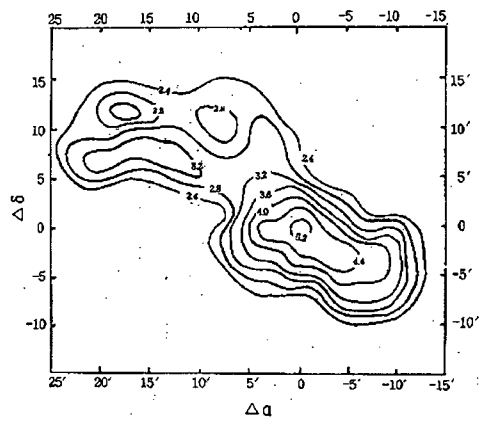

Fig. 2. — The Contour map of ^{13}CO antenna temperature in L1535. The center of the map is $\alpha(1950) = 04h\ 32m\ 38s$ and $\delta(1950) = +\ 24°\ 02'\ 00''$.

Supplement, 1985) to obtain the 100μm IRAS map of approximately $40' \times 50'$ field centered on the core of the cloud. Ecliptic and galactic backgrounds were removed and the images were destriped (Clark et al., 1986).

3. Results and discussion

A line profile observed at the central area of the cloud is given in Figure 1. The antenna temperature at this position is 3.9 K, the line velocity is about 6.3 km s^{-1}, and the line halfwidth is 0.4 km s^{-1}. The ^{13}CO distribution map of antenna temperature (TA) in L1535 is shown in Figure 2. Figure 2 shows that the cloud consists of two parts; the main component and an additional component extended into the northeast direction. The size of the extension is about $20' \times 16'$ (0.6×0.5 pc) which is

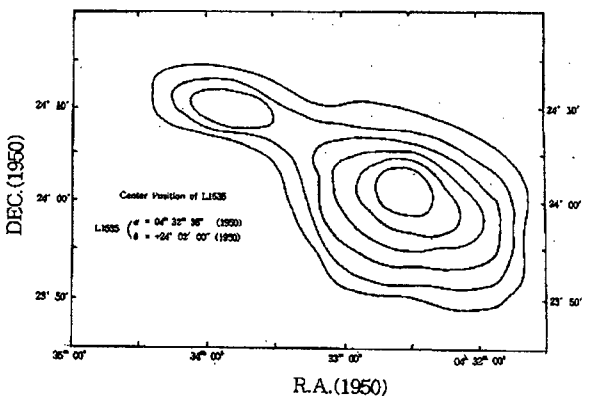

Fig. 3.— The 100μm band IRAS map of L1535. The contour levels are 2, 4, 6, 8, 10, and 12 MJy sr^{-1}.

comparable to the main component, but the extension is much fainter than the main one. The peak temperature of the secondary component is 3.2 K which is far lower than that of the main cloud. This additional component has not been observed before in any molecular surveys in L1535. In the previous ^{13}CO survey made by Goldsmith and Sernyak (1984) and in the H_2CO map made by Lee et al.(1996), this component was not shown. The 100 μm IRAS map we constructed is shown in Figure 3. In this figure, there are also shown two components of IR distribution whose positions and shapes are very similar to those of ^{13}CO clouds. The size of the main IR component is larger than that of the ^{13}CO main cloud, while the minor IR component is much smaller than the ^{13}CO minor cloud. The IR flux density of the main component is derived to be 12 mJy sr^{-1} which is about twice the flux density of the minor component. The minor component is hardly seen on the POSS red print. The minor cloud is not apparent in the map of extinction distribution derived from star counts Minn et al.(1996). As the minor component is not shown in the extinction map of this cloud, it can be speculated that this component is located at a farther distance than the main cloud of L1535 and that the foreground stars mask the molecular and dust clouds. We cannot tell if this component is physically connected to L1535 until we analyze the kinematical behavior of the ^{13}CO clouds which will be done shortly.

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