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Molecular Lines of CO Isotopes of the High Galactic Latitude Cloud HSVMT27 ⋆

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Abstract A study on the ^{12}CO, ^{13}CO, and C^{18}O lines of the high Galactic latitude cloud HSVMT 27, located in Ursa Major, was conducted. A relatively low ^{12}CO excitation temperature was found. While some C^{18}O emissions were detected, they were too weak to be mapped. With the spatial resolution of 0.08 pc and the velocity resolution of 0.17 km·s^{-1}, 26 ^{13}CO cores were identified in the dense regions. All the local thermodynamic equilibrium masses of these cores are less than their Virial masses, ranging in 0.5–10 $M_{\odot}$, and have no infrared point sources associated with them. Overall, the data indicate that there is no recent or ongoing star formation in this cloud.

Key words ISM: molecules, stars: formation, ISM: kinematics and dynamics

1. INTRODUCTION

HSVMT 27 ($151.75° \leq l \leq 154.75°$ and $35.25° \leq b \leq 38.25°$), a high Galactic latitude molecular cloud (HLC) in the second Galactic quadrant, was discovered by Heithausen et al.[1] and cataloged by Magnani et al.[2], Reach et al.[3] and Hartmann et al.[4]. This cloud has been identified as a cirrus cloud in the IR-excess cloud list of Desert et al.[5]. Surrounding

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HSVMT 27 are Ursa Major clouds MBM 29−31 and MBM26[6], and Fig.1 shows its location in the 100 μm image of Infrared Astronomical Satellite (IRAS) Sky Survey Atlas.

Like most HLCs, HSVMT 27 has a low radial velocity[1]., usually known as a local cloud ($<$ 500 pc). Lilienthal et al.[7] observed the interstellar absorption lines of the molecular cloud complex Chain A in the second Galactic quadrant and determined the distance to the low radial velocity gas (i.e., local cloud) to be d = 240 pc, which was adopted for HSVMT 27 by Heithausen et al.[1,8]. However, the distance to the Ursa Major complex MBM 29−31 was suggested as 100 pc $< d <$120 pc by the high resolution spectroscopic observation of Penprase[9], and since HSVMT 27 is adjacent to this Ursa Major complex, this distance was adopted by Magnani et al.[2]. An alternate approach of distance measurement is to measure the reddening along the line of sight. Using this technique, Schlafly et al.[10] presented a catalog of accurate distances to many molecular clouds, including the Ursa Major complex. They found the distance to the cloud at (l, b) = (153.5, 36.7) to be 353^{+38}_{-29} pc. Since HSVMT27 is located very close to this position, the distance d = 350 pc was adopted in this paper.

Unlike the nearby molecular clouds in the Ursa Major complex[11], there is no detailed study on the fine structures of the HSVNT 27 region and its molecular cloud. Hence, using the new high-resolution and low-noise data of CO isotope observations, we calculated the physical properties of the cloud and of the 26 newly identified dense cores. HSVMT 27 was identified as a cold and dilute molecular cloud, and the dense cores are not gravitationally bound. However, its isotope emissions are useful for the comparison with other HLCs, such as the molecular dark cloud and Gemini molecular cloud[12]. We found that the relationship between velocity dispersion and size of the ^{13}CO cores in HSVMT27 is a little different from that in dark clouds as described by Myers[13].

2. OBSERVATIONS

Observations were performed on the J = 1 - 0 lines of ^{12}CO, ^{13}CO, C^{18}O (at the rest frequencies 115.271504, 110.201353, and 109.782182 GHz, respectively) with the 13.7 m millimeter wave telescope of Qinghai Station of Purple Mountain Observatory, Chinese Academy of Sciences, from September 2014 to May 2015. The three CO lines were observed simultaneously using the 9-beam superconducting array receiver working in the sideband separation mode, and the fast Fourier transform spectrometer with the frequency resolution 61 kHz and velocity resolution approximately 0.17 km s^{-1}[14]. The basic observation parameters are shown in Table 1.

The observed region was 5.25 square degrees toward 151.75° $\leq l \leq$ 154.75° and 35.25° $\leq b \leq$ 38.25°, as shown in Fig.1, this region was divided into 21 cells of dimension 30′ × 30′. The cells were mapped using the OTF observation mode, and the standard chopper wheel method was used for temperature calibration[15]. In this mode, the antenna beam scans the cells along the RA and Dec directions at a constant speed of 50″ per second, and the receiver