An Investigation of the Molecular clouds toward W50/SS 433

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Abstract: We present a high-resolution CO-line observation towards SNR W50/SS 433 system using IRAM 30m. Some morphological and dynamical signatures of the molecular gas appear to be hints for possible interaction between the system and MC at V_{LSR} ~ 53km/s .

Introduction

The W50/SS 433 system is of great interest to researchers, since the microquasar nature of SS 433 has making it to be one of the very few target within the Milky Way to study the jet-MC physical processes. Though some works have suggested that the jets are interact with the ISM and induce the formation of MCs (Wang et al., 1990; Yamamoto et al., 2008; Su et al., 2018), no kinematic evidence has yet been found for this scenario.

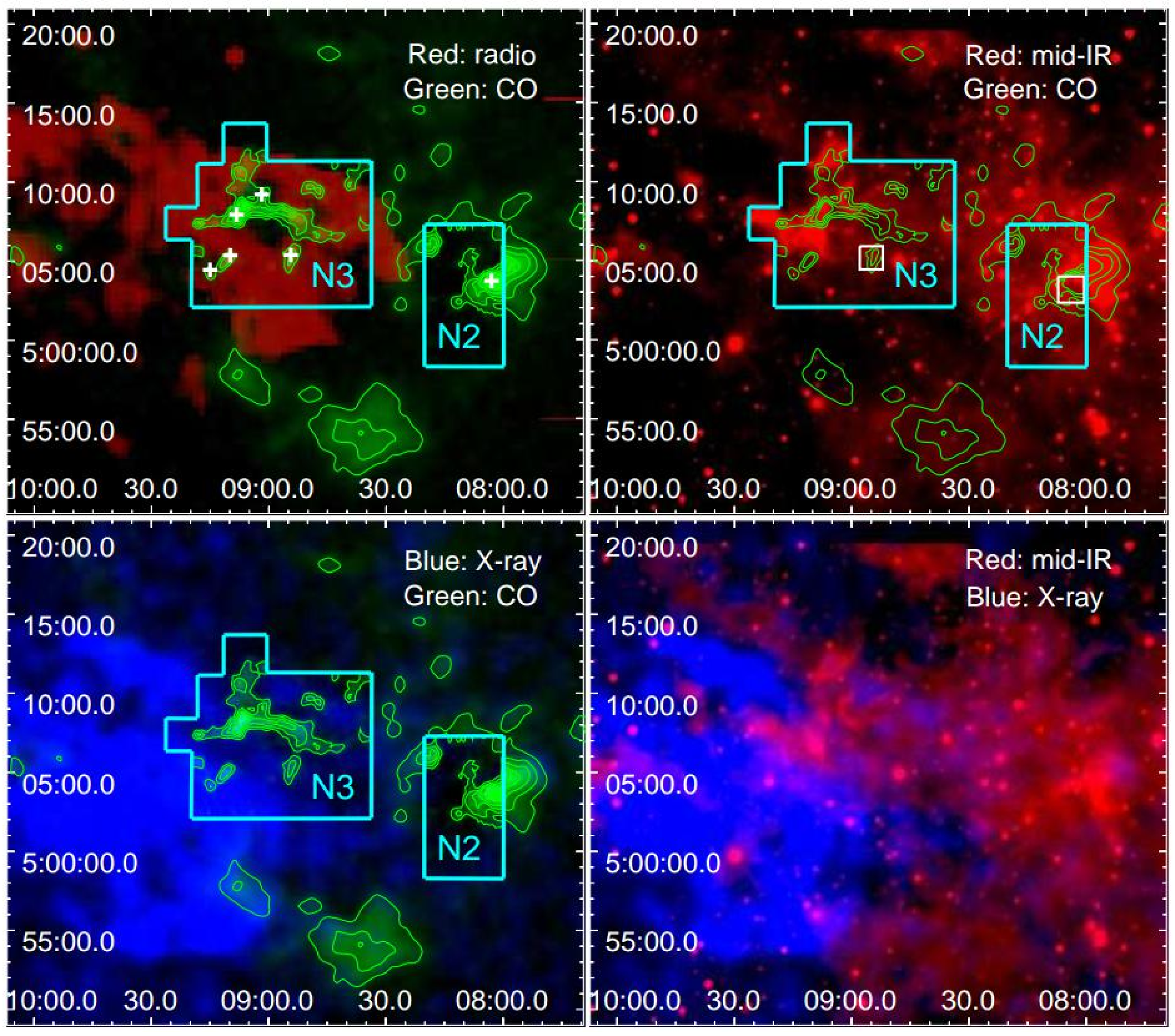

Figure 2. Multiwave map of the western lobe of SNR W50

Morphology

We have observed two regions (N3 and part of N2 in Yamamoto et al. 2008) with IRAM 30m. There are no more than three emission peaks toward each region (Figure 1). A spatial study shows that there seems to be an anticorrelation between the radio emission and the MCs of N3 integrated in 48 - 60 km/s, as well as an anticorrelation between the X-ray emission and the MCs of N3 (Figure 2). That is, the radio continuum and X-ray emission is weaker where there is line emission of CO. Also, it's shown that MCs of N3 has a shell-like structure. In mid-IR band, there is a correlation between the IR and the MC.

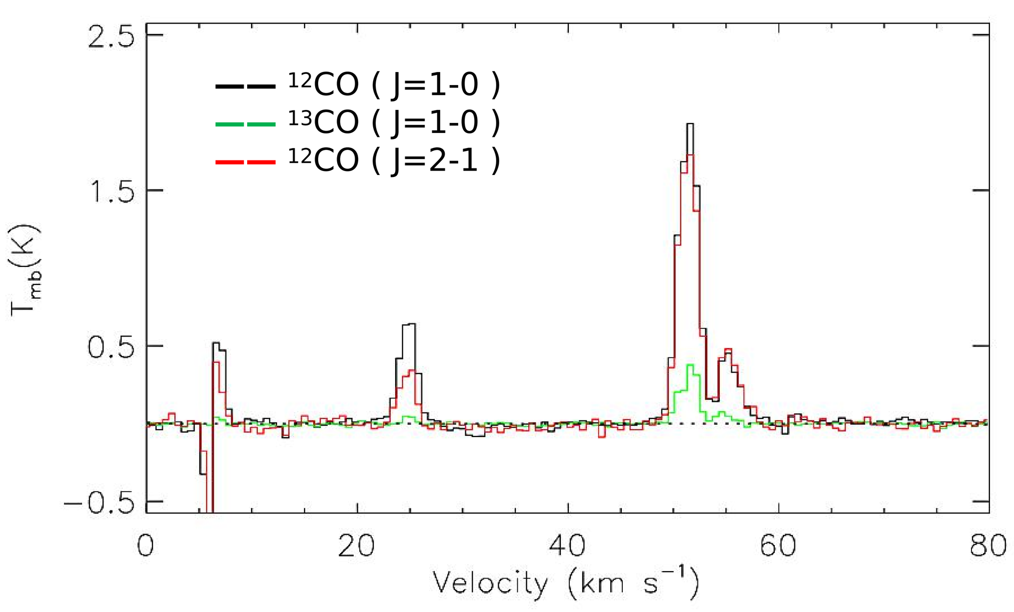

Figure 1. Average CO spectra of region N3

Line profiles

We have inspected the CO line profiles toward the two regions. There are several noteworthy features:

(1) The peak of the main-beam temperature are very high (~30K, Table 1), compared to the typical temperature for interstellar MCs (~10K);

(2) The ^{12}CO J=2-1/J=1-0 line ratios are high for both the main components and its wings (Figure 3);

(3) Both N2 and N3 show some asymmetric broad profiles of the ^{12}CO line (Figure 3).

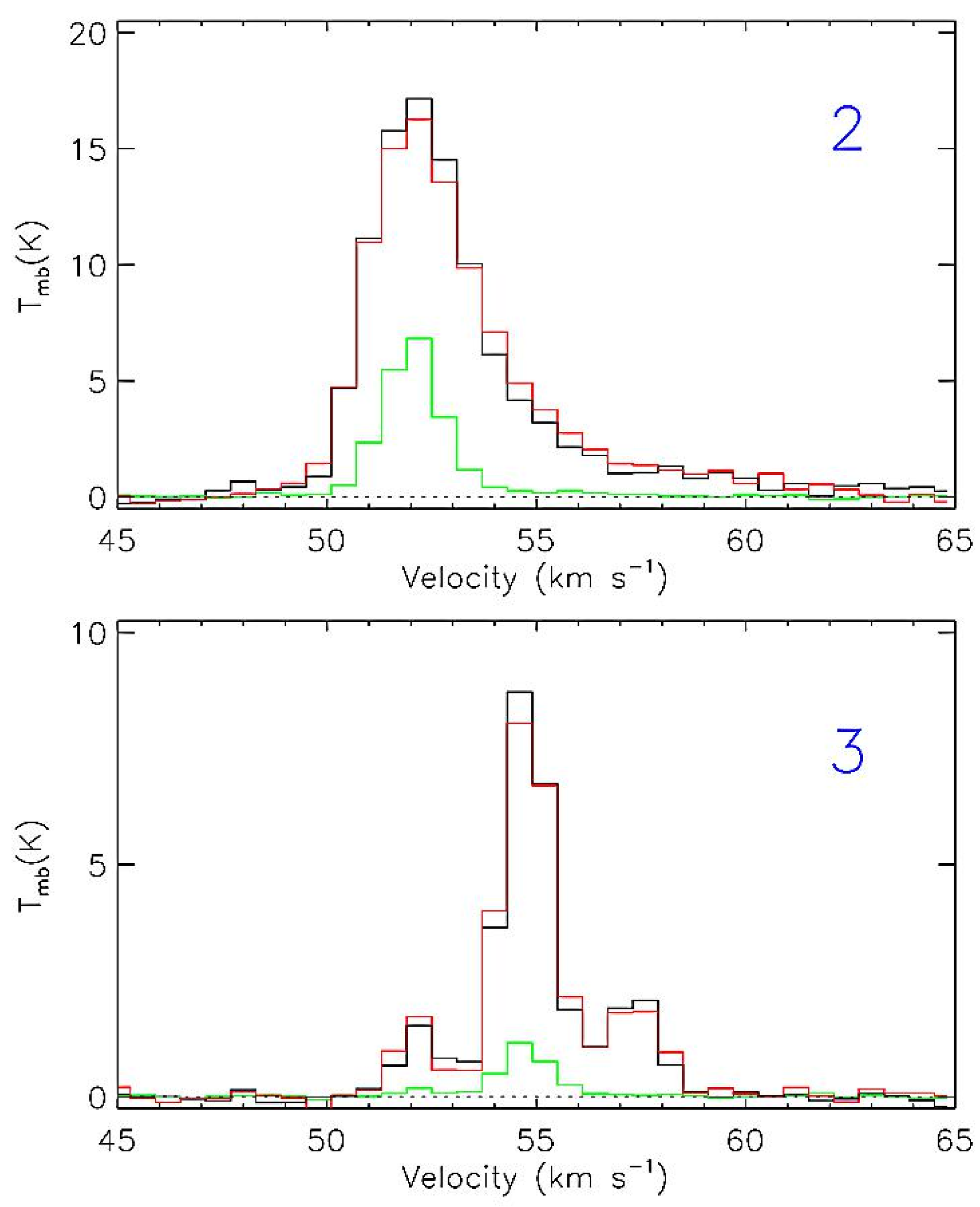

Figure 3. Averaged spectra toward several pixels within regions N2 and N3

Table 1. Estimated parameters for the MCs in 45 - 60 km/s in Regions N2 and N3

Region	$N(H_2)(10^{21}cm^{-2})^b$	$n(H_2)d_{3.5}(cm^{-3})^c$	$Md_{3.5}^{-2}(10^2M_\odot)^d$	$T_{ex}(K)^e$	$\tau(^{13}CO)$
N2	6.7	~ 2200	~ 4.8	28	0.56
N3	3.4	~ 1100	~ 5.1	31	0.34

Properties of the MCs

We have estimated the excitation temperature T_{ex} of regions N2 and N3 using ^{12}CO (J=1-0) emission profiles, and further estimated the distribution of the column density $N(H_2)$ using ^{13}CO lines (Figure 4). The H_2 masses and the averaged H_2 densities are also estimated (Table 1), with a supposed distance of 3.5 kpc to W50/SS 433 system.

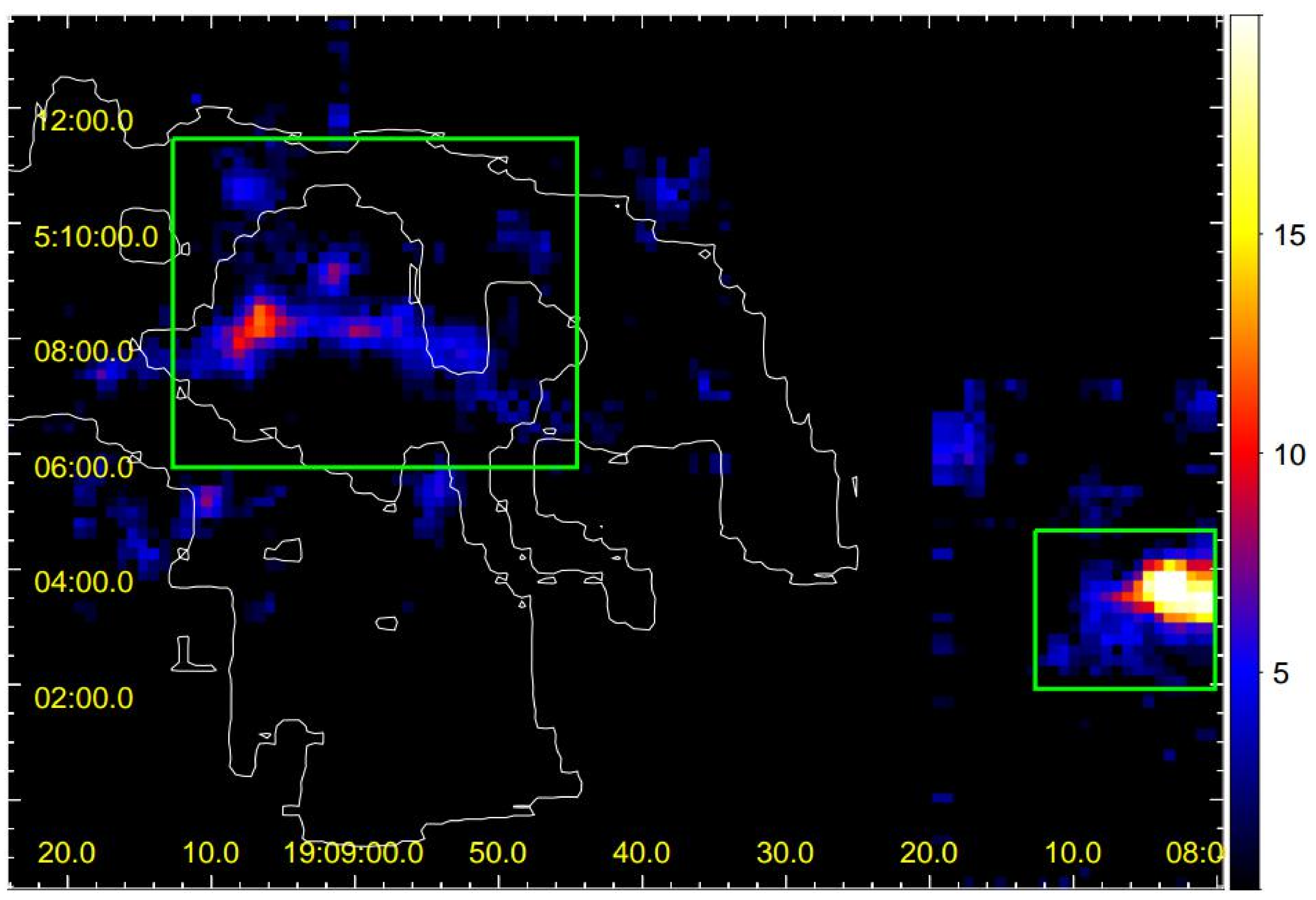

Figure 4. $N(H_2)$ distribution in the velocity range of 45 - 60 km/s in unit of 10^{21} cm^{-2}

Reference:

Asahina, Y., Ogawa, T., Kawashima, T., et al. 2014, ApJ, 789, 79
Asahina, Y., Kawashima, T., Furukawa, N., et al. 2017, ApJ, 836, 213
Furukawa, N., Ohama, A., Fukuda, T., et al. 2014, ApJ, 781, 70
Su, Y., Zhou, X., Yang, J., et al. 2018, ApJ, 863, 103
Turner, B. E., & Gammon, R. H. 1975, ApJ, 198, 71
Wang, Z.-R., McCray, R., Chen, Y., & Qu, Q.-Y. 1990, A&A, 240, 98
Yamamoto, H., Ito, S., Ishigami, S., et al. 2008, PASJ, 60, 715

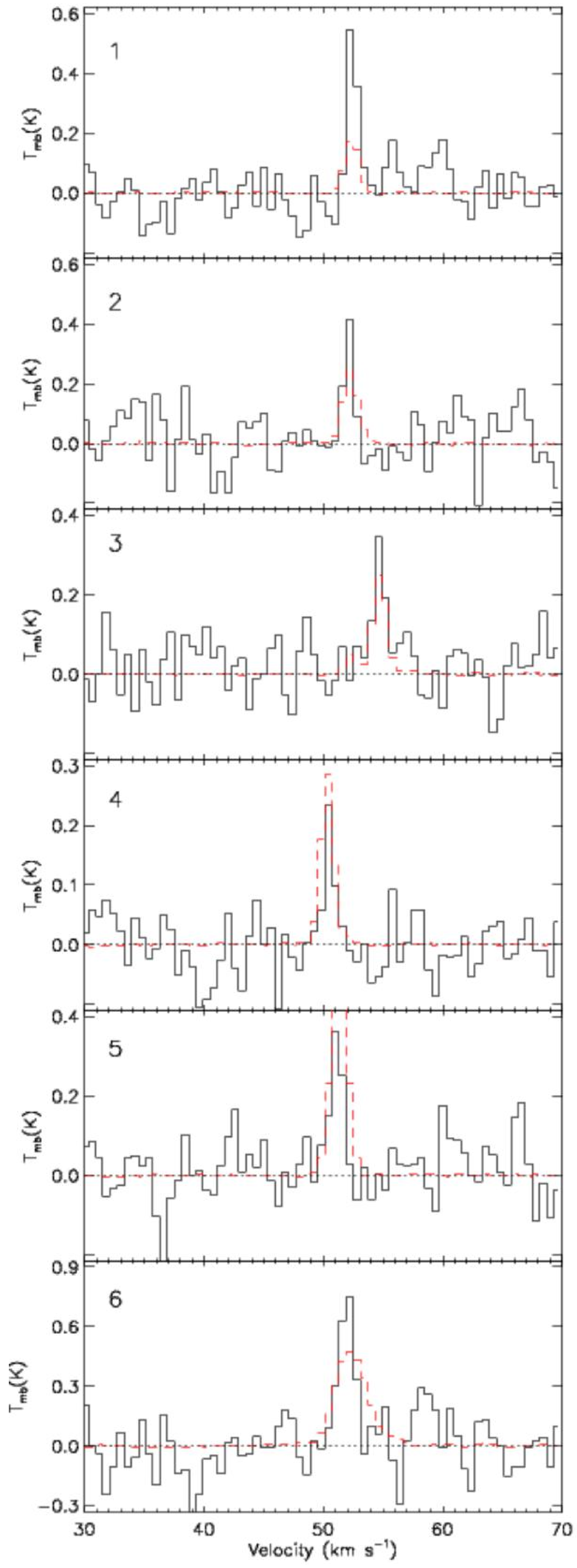

Figure 5. CN spectra for the six regions, with 12CO (J=1-0) spectra from the same regions overplotted (the red dashed lines)

Emission lines of CN

We detected emission lines of CN (J=3/2-1/2) at six small regions (Figure 5). The detection of CN emission lines at 50-58 km/s suggest that the densities of the MCs within the six regions (of order 10^5 cm^{-3}, Turner & Gammon 1975), about two orders of magnitude larger than the averaged results (Table 1).

Are the MCs perturbed?

The two components belong to ten ^{12}CO clouds exhibiting a straight distribution along the axis of the X-ray jet of SS 433 projectively (Yamamoto et al. 2008), and our high-resolution observation shows that the MC of N3 has a shell-like structure, somewhat similar to those of MCs toward Westerlund 2 (Furukawa et al. 2014). Also, MCs can be formed around the interface between the jet and the HI gas (e.g. Asahina et al., 2014; Asahina et al. 2017).

Spatially, MC of N3 shows some (anti)correlation with emission in other waveband, especially in radio. Further, the spectra of the two regions show several features that imply the two MCs could have been perturbed by the jet.