Resolving the Rise and Fall of Star Formation in Galaxies
Proceedings IAU Symposium No. 373, 2023
T. Wong & W.-T. Kim, eds.
doi:10.1017/S1743921322004616

Star formation feedback onto molecular clouds of KAGONMA sources using temperature distribution

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Abstract. This paper reports on four of the sources observed in the KAGONMA (KAgoshima Galactic Object survey with the Nobeyama 45-m telescope by Mapping in Ammonia lines) project for which mapping observations have been completed (KAG35, KAG45, KAG64, and KAG71). In this study, we compiled the analysis results of four sources for which mapping observations were completed in the KAGONMA project and statistically investigated the range to which star formation activity affects the molecular gas. In order to investigate the affected range, we analyzed the heating range by focusing on the temperature distribution of the molecular cloud and found that it is within about 3 pc. This suggests that direct star formation feedback in molecular clouds is very spatially limited.

Keywords. ISM: clouds – HII regions

1. Introduction & Observations

The effects on the interstellar matter by star formation is critical to understand the next generation of star formation and galaxy evolution. This effect is expected by expansion of an HII region, bipolar outflow, intense ultraviolet radiation and shock wave, which produce shock waves and heat up the surrounding gas. Therefore, we have conducted a mapping observation project, named KAGONMA, to figure out the regions affected by star formation activities.

In the project we observed 72 molecular cloud cores with the Nobeyama 45-m radio telescope (NRO) since 2015 December. The NH_3 (J, K) = (1,1), (2,2), (3,3) and H_2O

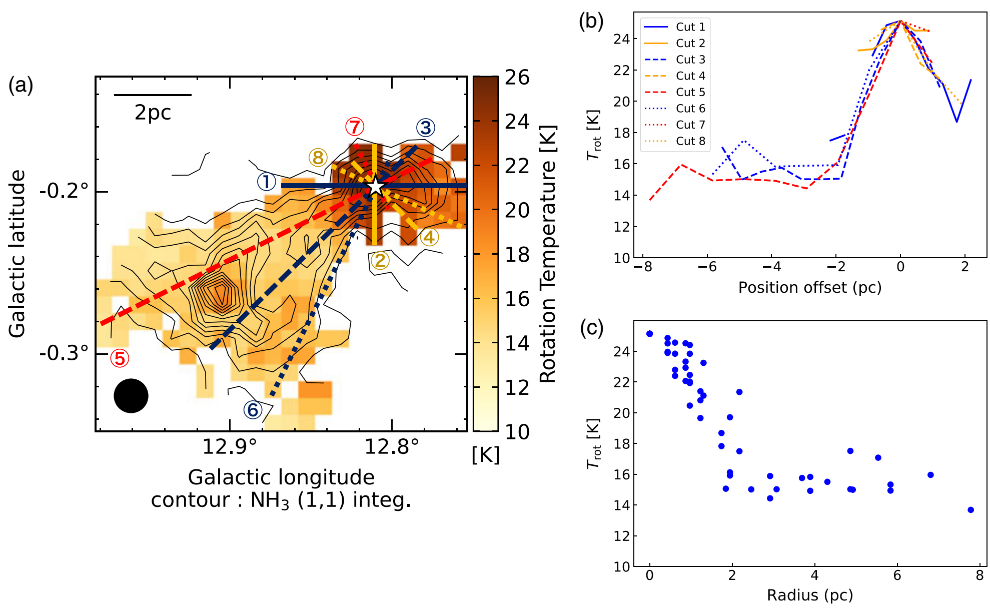

Figure 1. (a) The rotation temperature map of KAG64. The contours correspond to the NH_3(1,1) integrated intensity map. The star symbol is reference point. The 8 lines are the cuts in 8 directions from the reference point. (b) $T_{\rm rot}$ along 8 directions from the reference point. Each color corresponds to the coded color of each cut in (a). (c) The radial distribution of estimated rotational temperature, which is turned around with respect to $x = 0$ at the reference point.

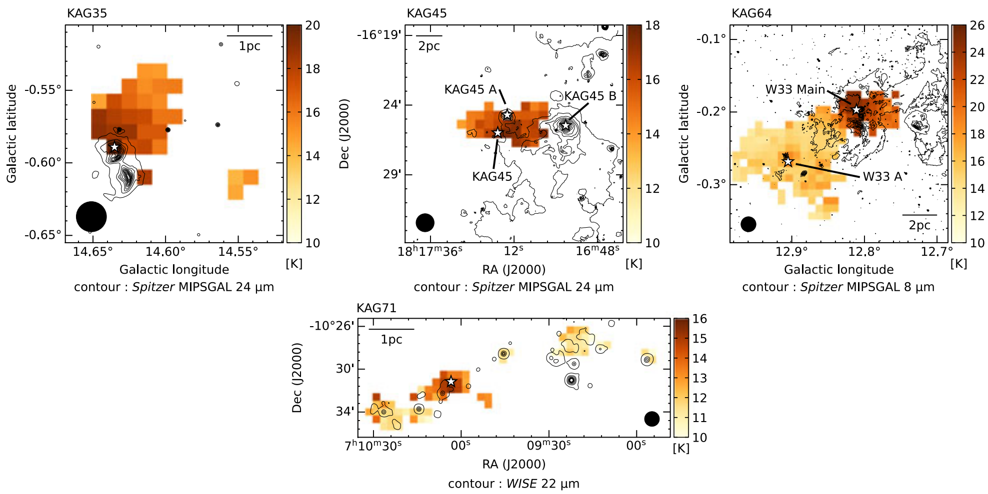

Figure 2. The map of rotation temperature (color coded cells) is overlaid on the infrared brightness distribution (contours). The infrared maps of KAG35 and KAG45 are used with *Spitzer* MIPSGAL 24μm. The maps of KAG64 and KAG71 are used with *Spitzer* GLIMPS 8μm and WISE 22μm, respectively.

maser lines were observed simulaneously. The KAGONMA project was performed over a wide area covering the entire molecular cloud. The telescope beam size was 75$''$ at 23 GHz. The pointing accuracy was checked using known H_2O maser sources and was better than 5$''$. The rms noise level was typically 0.04 K in T_a^* at each observed position.

https://doi.org/10.1017/S1743921322004616 Published online by Cambridge University Press

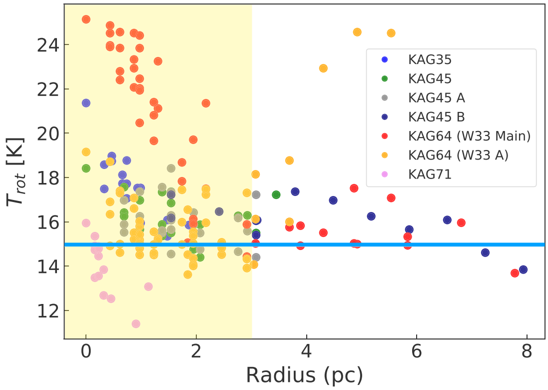

Figure 3. The radial distribution of the rotation temperature for all sources. The horizontal axis is the radial distance from each reference point. The colors of the plots indicate the source. The blue horizontal line is ∼15 K, which is the typical temperature of interstellar molecular gas (Planck Collaboration et al. 2011), and the yellow shaded region is within 3 pc range from the reference point of each source.

2. Analysis Methods

To investigate the extent of the influence of star formation feedback on a molecular cloud, we focused on the temperature distribution of the molecular cloud and investigated the extent of the heated range. The star symbol in Fig. 1(a) indicates the reference point which is defined as the temperature peek position or identified excitation source, and cuts were made in eight directions from the reference point. The result is shown in Fig. 1(b). The radial distribution of estimated rotational temperature, which is turned around with respect to $x = 0$ at the reference point, is shown in Fig. 1(c).

3. Results & discussion

We show the preliminary results of four sources are shown in Fig. 3. For KAG35 (M17 southwest extension) we assigned a reference point at the peak in temperature, and the heated range is within 2 pc. For KAG45 we assigned three reference points at the peak in temperature or intense positions in 24μm, and the heated range is within 3 pc. Although KAG45 B shows a increase beyond 3 pc, it should be due to the influence of KAG45 A. For KAG64 (W33 star formation region) we assigned two reference points at the peak in temperature, and the heated range is within 2 pc. Although W33 A shows a increase beyond 3 pc, it should be due to the influence of W33 Main. The heated range of W33 Main is wider than that of W33 A. For KAG71 (CMa OB1 east filament) we assigned a reference point at the peak in temperature, and the heated range is within 1 pc.

From these results, we conclude that the heated range is within about 3 pc. This suggests that direct star formation feedback in molecular clouds is limited to a few pc.

Reference

Planck Collaboration 2011, *A&A*, 536, A25

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