Triggered Star Formation in a Turbulent ISM
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# Physical and chemical properties of the AFGL 333 cloud

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**Abstract.** We have found massive clumps without any sign of active star formation in the AFGL 333 cloud. We present a study of the physical and chemical properties of the AFGL 333 cloud.

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The AFGL 333 cloud is located in the W 3 giant molecular cloud (W 3 GMC). It is known that the W 3 GMC involves three star forming clouds; W 3 Main, W 3(OH), and AFGL 333 (e.g. Thronson *et al.* 1985). The three clouds exhibit different star-forming activities in spite of their similarity in size and mass. The ratio of the infrared luminosities in W 3 Main, W 3(OH) and AFGL 333 is 1.0:0.25:0.07 (Thronson *et al.* 1980), suggesting that AFGL 333 is less active than W 3 Main and W 3(OH).

We have mapped the $C^0$ $^3P_1$–$^3P_0$ ([CI]) and CO $J$=3–2 lines toward the W 3 GMC by using the Mount Fuji Submillimeter Telescope (Sakai *et al.* 2006). The [CI] emission is found to be strong in the AFGL 333 cloud, where the $^{12}$CO $J$=3–2 emission is relatively weak. To investigate the origin of the strong [CI] emission in the AFGL 333 cloud, we have observed the AFGL 333 and W 3(OH) clouds in the CO isotopomer lines and the CCS and $N_2H^+$ lines with the Nobeyama Radio Observatory 45 m telescope. We have found that $N(C^0)$ linearly increases with $N$(CO) up to $A_V$ of 50 mag. This indicates that $C^0$ exists in the deep inside of the molecular clouds. The $[C^0]/[CO]$ and $[CCS]/[N_2H^+]$ ratios tend to be higher in the AFGL 333 cloud than in the W 3(OH) cloud. These results may indicate the chemical youth of the AFGL 333 cloud relative to the W 3(OH) cloud.

In the AFGL 333 cloud, we have found two massive clumps (Clump A and B) without any sign of active star formation. They are highly gravitationally bound ($M_{\rm VIR}/M_{\rm LTE} \sim 0.4$), and the LTE mass is $2.3 \times 10^3\ M_\odot$ and $1.4 \times 10^3\ M_\odot$ for Clump A and Clump B, respectively. These masses are comparable to those for on-going massive star-forming clumps. We have mapped the CCS, $HC_3N$ and $N_2H^+$ emissions toward the clumps, and have found that the CCS and $HC_3N$ emissions are stronger toward Clump B than toward Clump A. There are several YSO candidates (2MASS sources with $H$-$K$>2) in Clump A, while no YSO candidate is associated with Clump B. These results suggest that Clump B is younger than Clump A and is in a very early stage of cluster formation. Therefore Clump B is a very good target to understand the initial condition of cluster formation.

## References

Sakai, T., Oka, T. & Yamamoto, S. 2006, *ApJ* 649, 268
Thronson, H. A., Jr., Campbell, M. F. & Hoffmann, W. F. I. 1980, *ApJ* 239, 533
Thronson, H. A., Jr., Lada, C. J. & Hewagama, T. 1985, *ApJ* 297, 662

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