

# Submillimeter-wave Observations of Complex Organic Molecules in Southern Massive Star Forming Regions

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**Abstract.** Submillimeter-wave observations of complex organic molecules toward southern massive star forming regions were carried out with ASTE 10m telescope. Methyl formate (HCOOCH<sub>3</sub>) and dimethyl ether (CH<sub>3</sub>OCH<sub>3</sub>) were detected in some molecular cloud cores with young protostars. Differences in chemical composition among neighboring cores were also found.

**Keywords.** astrochemistry — ISM: molecules — radio lines: ISM — submillimeter

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Complex organic molecules (COMs) such as methyl formate (HCOOCH<sub>3</sub>) and dimethyl ether (CH<sub>3</sub>OCH<sub>3</sub>) have been reported to be observed in chemically rich, compact, dense and hot molecular cores in the early phase of massive star formation. However, the production mechanism of the COMs is still controversial in spite of their importance in astrochemistry and astrophysics. It is therefore essential to know how widely they are found in massive star forming regions. Survey observations of COMs are however very limited particularly for southern star forming regions. We observed massive and dense molecular cores in several southern star forming regions. Most of the targets were selected from the cores which were identified in our CS  $J = 7 - 6$  survey.

Single pointing submillimeter-wave observations of the COMs lines were carried out with the ASTE 10m telescope at Pampa la Bola, Chile. We observed  $\sim 800$  MHz bandwidth in around 344 GHz using SC345 receiver and MAC spectrometer, covering frequencies of lines of methyl formate and dimethyl ether. The frequency range also include several lines of some other molecules such as HC<sup>15</sup>N. The typical noise temperatures in all the observations were as low as  $\Delta T_A^* = 20$  mK.

In NGC 6334 region, we observed six cores I, I(N), II, III, IV, V (Kraemer and Jackson 1999) and detected successfully both lines of methyl formate and dimethyl ether in I, I(N) and V cores. This result suggested that the COMs are actually detected in cores with young protostars although they are not detected in relatively evolved regions. The COMs were detected also at G301.12-0.20 core in  $T_A^* \sim 0.2$  K. On the other hand, cores in NGC 3576 and G345.01-1.80 did not show apparent signal of COMs. The difference in chemical composition among neighboring cores were also found in NGC 3576.

## References

- Blake, G. A., Sutton, E. C., Masson, C. R., & Phillips, T. G. 1987, *ApJ*, 315, 621  
Kraemer, K. E. & Jackson, J. M. 1999, *ApJS*, 124, 439