The FUGIN Hot Core Survey – The environment and chemistry of the regions of massive star formation

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We are conducting an unbiased survey of hot cores based on the CH_3CN ($6_K – 5_K$, K = 0, 1, 2, 3) and HNCO ($5_{0,5} – 4_{0,4}$) lines included in the spectral coverage of the FUGIN Galactic survey of the ^{12}CO, ^{13}CO and $C^{18}O$ (1 – 0) lines with the Nobeyama 45-m telescope [1]. As the sensitivity of the observations has been set for the CO lines, the S/N ratio for the CH_3CN and HNCO lines are limited. We stack the five lines (four CH_3CN and one HNCO) to improve the S/N ratio and search for emission guided by the $C^{18}O$ emission strength and velocity. For the source candidates picked in this way, we further make separate pointed observations of a set of hot core lines ($C^{34}S$, SO, OCS, HC_3N, and CH_3OH thermal/maser lines in addition to CH_3CN and HNCO lines) to confirm their existence and characterize the detected sources.

We have applied this method to L=10 – 20 deg part of the FUGIN survey (it covers up to L=50 deg), and identified 25 hot cores (Sato et al., this meeting). In this paper, we present the initial findings for these sources. Many of the hot cores are embedded in regions of vigorous star forming activities, and are under a strong influence of feedbacks from preceding generation of massive stars. For the sources cross-matched with the ATLAGAL-based clumps with clump mass and bolometric luminosity estimates [2], the values of log ($L_{\rm bol}/M_{\rm c}$) range from 0.55 to 2.1 and suggests that they are in a range of evolutionary stages centered at the hot core stage [3]. The intensity ratios of the observed lines show a diversity of chemical abundances. We try a principal component analysis of the line intensity ratios I(X)/I($C^{34}S$) (X = SO, OCS, HC_3N, HNCO, CH_3OH thermal/maser, and CH_3CN) for hot cores with stronger $C^{34}S$ emission. The first principal component (PC1) has almost uniform loadings in the same sign for all the ratios, and its correlation with log ($L_{\rm bol}/M_{\rm c}$) suggests that $C^{34}S$ gets stronger as the core evolves. The loading pattern of the second principal component (PC2) indicates two outstanding groups in the opposite direction; HNCO and CH_3OH (thermal) on one side, and SO and CH_3OH (maser) on the other. This variation between "HNCO and CH_3OH (thermal)-rich" cores and "SO and CH_3OH (maser)-rich" cores does not appear to correlate with the evolutionary stages of the cores, and may arise from other factors such as the environment (in the past and current) and/or the elemental abundances.

References

[1] T. Umemoto et al., 2017, PASJ 69, 78.
[2] J. S. Urquhart et al., 2018, MNRAS 473, 1059.
[3] A. Gianetti et al., 2017, A&A 603, A33.