

Giant Molecular Cloud Evolutions in the nearby Spiral Galaxy M33

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We present a giant molecular cloud (GMC) catalog of the nearby spiral galaxy M33, containing 71 GMCs in total, based on wide-field (121 arcmin² in total) and high-sensitivity ($1\sigma=16\text{--}32$ mK in T_{mb} for a velocity resolution of 2.5 km s^{-1}) CO($J=3\text{--}2$) observations with a spatial resolution of 100 pc using the ASTE 10 m telescope (Fig. 1) [1]. Employing archival optical data, we also generate a complementary new catalog of young stellar groups (YSGs) from the excess of the surface stellar density, and estimate their ages by comparing with stellar evolution models. The physical parameters of YSGs are comparable to those of typical OB associations.

and 22 (34%) are Types A, B, C, and D, respectively. We interpret these categories as stages in a GMC evolutionary sequence. Assuming that the timescale for each evolutionary stage is proportional to the number of GMCs, the lifetime of a GMC with a mass $> 10^5 M_{\odot}$ is estimated to be 20–40 Myr. In addition, we find that the dense gas fraction as traced by the CO($J=3\text{--}2$)/CO($J=1\text{--}0$) ratio is enhanced around SF regions (Fig. 2c). This confirms a scenario where dense gas is preferentially formed around previously generated stars, and will be the fuel for the next stellar generation.

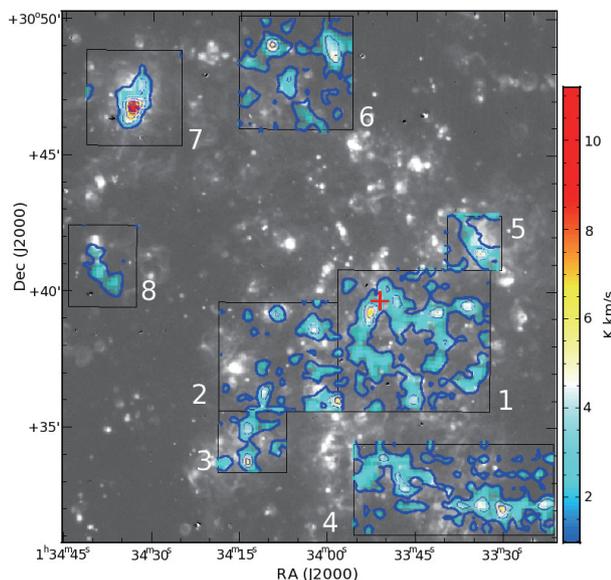


Figure 1: CO($J=3\text{--}2$) integrated intensity map with 100 pc resolution, overlaid on the $H\alpha$ image. The rectangular boxes the eight observed regions with labels. The cross symbol is the galaxy center.

A spatial comparison among the identified GMCs, YSGs, and HII regions from a compilation in the literature enable us to classify GMCs into four categories: Type A, showing no sign of massive star formation (SF); Type B, being associated only with HII regions; Type C, with both HII regions and < 10 Myr old YSGs; and Type D, with both HII regions and 10–30 Myr YSGs (Fig. 2a). Out of 65 GMCs (discarding those at the edges of the observed fields), 1 (1%), 13 (20%), 29 (45%),

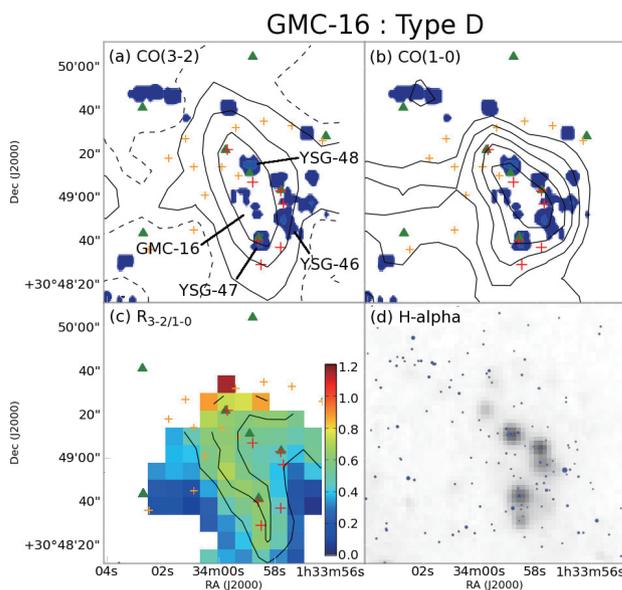


Figure 2: An example of Type D GMC with (a) CO($J=3\text{--}2$), (b) CO($J=1\text{--}0$) integrated intensity map, (c) CO($J=3\text{--}2$)/CO($J=1\text{--}0$) ratio, and (d) $H\alpha$ image. Color contours indicate the surface density of young stars.

Reference

[1] Miura, R. E., Kohno, K., Tosaki, T., et al.: 2012, *ApJ*, **761**, 37.