MUSCLE W49 : Multi-Scale Continuum and Line Exploration of the Most Luminous Star Formation Region in the Milky Way. I. The Mass Structure of the Giant Molecular Cloud.

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The Multi-Scale Continuum and Line Exploration of W49 (MUSCLE W49) is a comprehensive gas and dust survey of the parental giant molecular cloud (GMC) of W49A, the most luminous (L~$10^{7.2}$ Lsun) star-formation region in the Milky Way.
The project has multiple components that cover the entire GMC at different scales and angular resolutions, from 0.1 to 100 pc.
We present a new all-configuration SMA mosaic of the central 10 pc (known as W49N), plus PMO mapping of the full GMC up to scales of 130 pc. We use complementary data from the VLA, JCMT, IRAM 30m, and the CSO.

Results.
1)
The W49 GMC is one of the most massive in the Galaxy. We derive a total mass Mgas~1.4x10^6 Msun within a radius of 60 pc. Around the most prominent cluster W49N at the center of the GMC, within a radius of 6 pc, the total gas mass is Mgas~2.4x10^5 Msun (see figure 1). Therefore ~17% of the gas mass is concentrated in ~0.1% of the volume. The gas mass is dominated by the molecular- rather than the ionized phase (only ~0.1% in the inner region). The W49 GMC has enough mass to form a young massive cluster (YMC), or even a globular cluster with a feasible star formation efficiency.
We compare our results with recent studies of clouds candidate to form YMCs (see figure 2), like the Galactic Center cloud G0.253 (Longmore et al. 2012), the Carina complex (Preibisch et al. 2012), and G305 (Hindson et al. 2010).

2)
The mass of the GMC is distributed in a hierarchical network of filaments that is indeed forming a young massive cluster (YMC), or a system of YMCs. At scales <10 pc, a triaxial, centrally condensed, filamentary structure peaks toward the ring of hypercompact HII regions in W49N known to host dozens of deeply embedded (maybe still forming) O-type stars. This structure is observed to continue at scales from ~10 to 100 pc through filaments that radially converge toward W49N and toward its less prominent neighbor W49S. These large scale filaments are clumpy and could be forming stars at a rate lower than that of the central clusters. This finding suggests that the W49A starburst most likely formed from global gravitational contraction with localized collapse in a "hub-filament" geometry.

3)
Feedback from the central YMCs (with a current mass Mcl > 7x10^4 Msun) is still not enough to disrupt the GMC, but further stellar mass growth within a factor of 2 could be enough to allow radiation pressure to disrupt the cloud and halt star formation. There is no evidence on global scales for significant disruption from photoionization.

4)
Likely, the resulting stellar content will remain as a gravitationally bound massive star cluster, or a small system of star clusters.

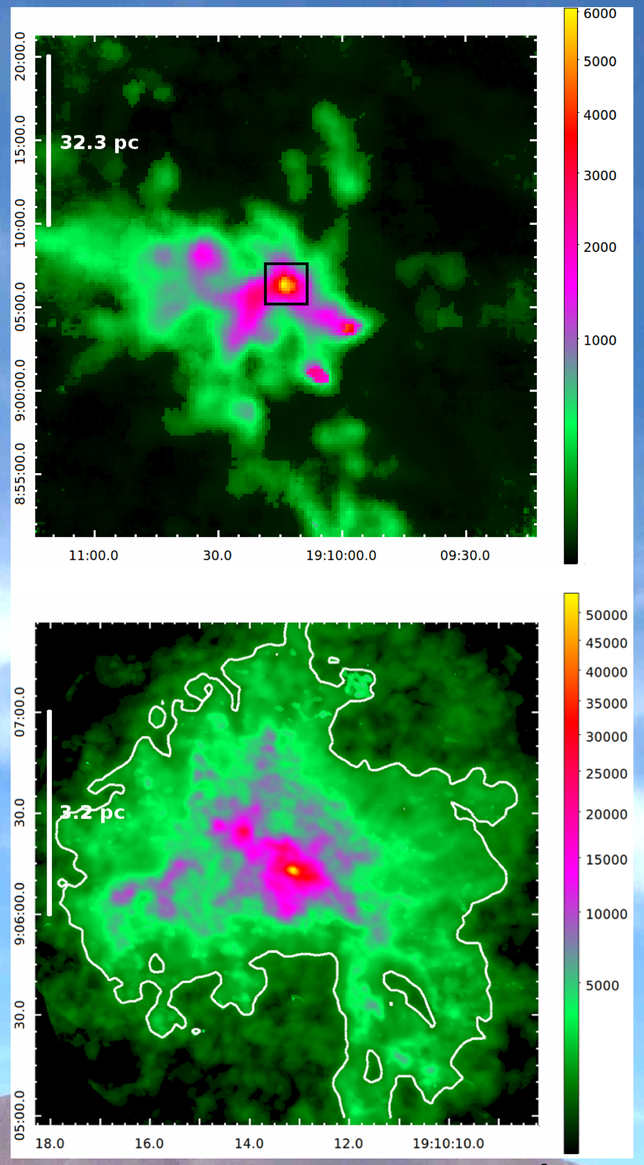

Figure 1. Mass surface density (Σ, in M⊙ pc^{-2} *) maps obtained from CO-isotopologue line ratios. The top frame shows the zoomed-out measurement from the PMO CO and* ^{13}*CO 1–0 maps. The bottom frame shows the zoomed-in measurement from the SMA mosaics combined with IRAM 30 maps of* ^{13}*CO and C*^{18}*O 2–1, covering the area marked by a black square. The contour in the bottom frame corresponds to 1000* M⊙ pc^{-2}.

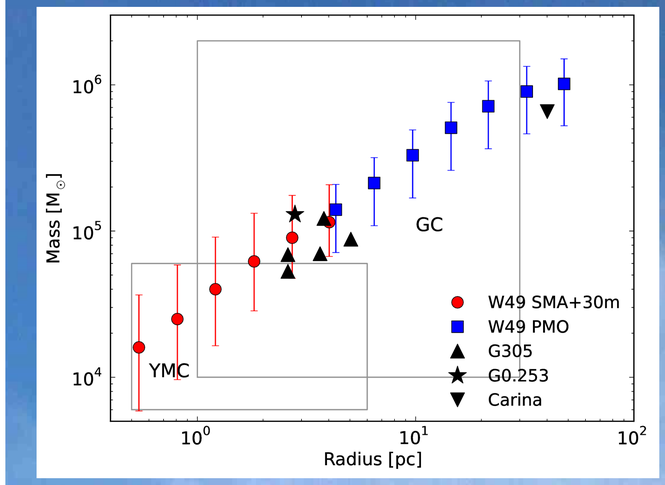

Figure 2. Mass vs radius for Galactic molecular clouds that may form (G0.253) or are indeed forming (the rest of plotted clouds) massive star clusters (Mcl > 10^4 M⊙ in stellar mass). The filled red circles and blue squares show the total mass in the W49 GMC as a function of radius from our work (Galván-Madrid et al. 2013). The open symbols are measurements compiled from the literature: the Galactic Center cloud G0.253 (Longmore et al. 2012), the Carina complex GMC (Preibisch et al. 2012), and the most massive clumps in G305 (Hindson et al. 2010). The typical regimes of stellar mass and radius for Galactic young massive clusters (YMCs) and globular clusters (GCs) are labeled (Portegies Zwart et al. 2010).

References.
- Galvan-Madrid et al. 2013, arXiv:1309.4129
- Hindson et al. 2010, MNRAS, 408, 1438
- Longmore et al. 2012, ApJ, 746, 117
- Portegies Zwart et al. 2010, ARA&A, 48, 431
- Preibisch et al. 2012, A&A, 541, 132

The authors are grateful to the operations staff of the Submillimeter Array and of the Purple Mountain Observatory 14-m telescope.