The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus
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All quiet on the Western front? New evidence for massive star formation in Sgr C

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Abstract. We summarize here our recent findings from near-infrared spectroscopy and 1 mm line and continuum observations of a recently identified extended green object (EGO) in Sgr C, whose observational characteristics suggest early-stage massive star formation is taking place. Located on the outskirts of the massive evolved HII region associated with Sgr C in the Western central molecular zone (CMZ), the EGO measures $\sim 10''$(0.4 pc at 8.5 kpc). We confirm that early-stage star formation is taking place on the periphery of the Sgr C HII region.The data show clear detections of two protostellar cores and several knots of H_2 and Brackett γ emission alongside a previously detected compact radio source. We calculate the cores' joint mass to be $\sim 10^3$ $M_\odot$, with column densities of 1-2 $\times$ 10^{24} cm^{-2}. The host molecular clouds mass is approximately $10^5 M_\odot$. Despite these favorable conditions, the cloud is curiously devoid of any further star formation, making it comparable to other remarkably quiescent clouds, such as G0.253 in the Eastern CMZ.

1. Introduction: Sgr C and EGO G359.44−0.102

Sgr C is the only known star forming region in the Western central molecular zone (CMZ). Its main characteristics are a 10-pc HII region, a distinctive non-thermal filament and a molecular cloud, measuring $\sim$16×9 pc in size and thought to harbor $\leqslant 10^5 M_\odot$ (Lang *et al.* 2010; Liszt & Spiker 1995; Lis *et al.* 1991).

The first evidence of high mass star formation in the Sgr C cloud was reported by Forster & Caswell (2000), who detected a faint 8-9 GHz radio source measuring 0.06×0.01 pc near its tip. Using data from the *Spitzer* GALCEN survey (Stolovy *et al.* 2006), Yusef-Zadeh *et al.* (2009) identify a region of extended 4.5 μm emission - a so-called extended green object (EGO; Cyganowski *et al.* (2008)) - within $\sim 5''$ from the radio source. Numerous studies have found EGOs to be strongly associated with early-stage high mass star formation and outflows (De Buizer & Vacca 2010; Cyganowski *et al.* 2009). Three CH_3OH masers are seen within the EGO at velocities consistent with the Sgr C systemic velocity (-55 to -65 km s^{-1}), supporting this scenario (Chambers *et al.* 2011).

The new data shown here confirm that massive star formation is taking place in the massive Sgr C molecular cloud. We detect the presence of two protostars driving at least one outflow, alongside the previously detected radio source.

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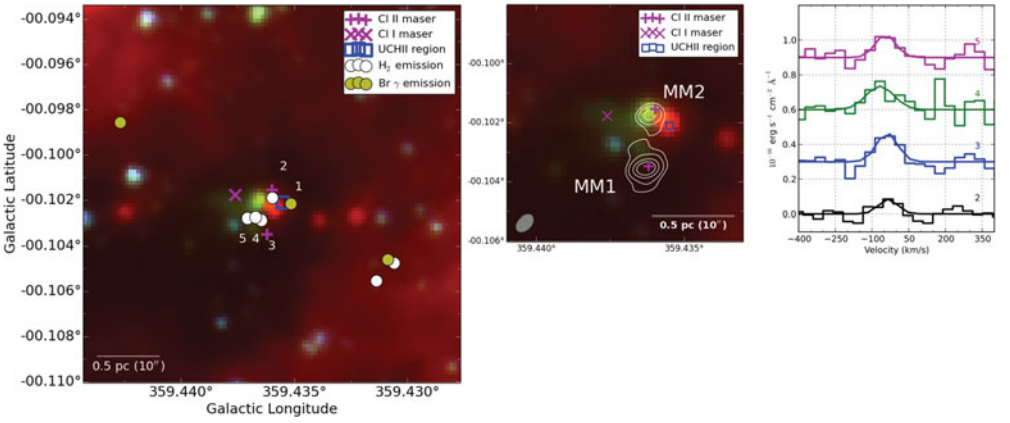

Figure 1. New observational data for the EGO G359.44−0.102. **Left:** 3.6/4.5/8.0 μm*Spitzer* image of G359.44−0.102, indicating the location of CH_3OH masers, the radio source and the IR emission knots. Symbols as indicated in the legend. **Middle:** as left, with the SMA 280 GHz continuum contours showing 2 protostellar sources. **Right:** H_2 spectra at 2.12 μm for the numbered knots. [A color version is available online.]

2. Observations and results

We obtained K-band spectroscopy with the TripleSpec spectrograph on the 3.5-m ARC telescope at Apache Point Observatory, using 4 different slit positions covering the EGO. We detected H_2 emission at 2.12 μm at 4 locations towards 4.5 μm emission (Figure 1), consistent with the possible presence of an outflow.

At millimeter wavelengths, 280 GHz continuum data from the Submillimeter Array (SMA; P. I. Kauffmann) show the presence of two protostellar sources towards the EGO (Figure 1). Using integrated flux measurements and assuming a distance of 8.5 kpc, temperature of 20K, and a dust-to-gas ratio of 76 (Draine 2011), we estimate their masses to be approximate 668 $M_\odot$ for MM1 and 380 $M_\odot$ for MM2 with an uncertainty of a factor 2-4. Peak column densities are 1-2$\times10^{24}$ cm^{-2} for both sources.

The observational data presented here convincingly demonstrate that early-stage massive star formation is taking place in the Sgr C cloud at 3 sites, likely to be driving at least one outflow.

3. No further star formation in the Sgr C cloud

Using 870 μm continuum data from the ATLASGAL survey (Schuller *et al.* 2009; Contreras *et al.* 2013) we calculate the total mass of the Sgr C molecular cloud to be $\sim10^5 M_\odot$, consistent with previous estimates (Lis *et al.* 1991). Source averaged column densities are in the range 1.5-3.5$\times10^{22}$ cm^{-2}. Despite these conditions we find no further tracers of star formation outside of G359.44−0.102. As such, the cloud shares similarities with G0.253 ("the Brick") and its massive quiescent fellow clouds ("Bricklets") on the Eastern side of the CMZ (Lis & Carlstrom 1994; Longmore *et al.* 2012; Kauffmann *et al.* 2013; Immer *et al.* 2012).

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