The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus
Proceedings IAU Symposium No. 303, 2013
L. O. Sjouwerman, C. C. Lang & J. Ott

doi:10.1017/S1743921314001161

Low frequency (74 MHz) radio continuum observations of the inner $13^\circ \times 7^\circ$ of the Galactic center

M. Rickert[1], F. Yusef-Zadeh[1] and C. Brogan[2]

[1]Department of Physics and Astronomy and CIERA, Northwestern University, 2145 Sheridan, Evanston IL 60202

[2]National Radio Astronomy Observatory (NRAO), 520 Edgemont, Charlottesville, VA 22903

Abstract. We analyze a high resolution ($114'' \times 60''$) 74 MHz image of the Galactic center taken with the Very Large Array (VLA). We have identified several absorption and emission features in this region, and we discuss preliminary results of two Galactic center sources: the Sgr D complex (G1.1−0.1) and the Galactic center lobe (GCL).

The 74 MHz image displays the thermal and nonthermal components of Sgr D and we argue the Sgr D supernova remnant (SNR) is consistent with an interaction with a nearby molecular cloud and the location of the Sgr D HII region on the near side of the Galactic center. The image also suggests that the emission from the eastern side of the GCL contains a mixture of both thermal and nonthermal sources, whereas the western side is primarily thermal.

1. Introduction

With the 4 m (74 MHz) receivers of the VLA (Kassim *et al.* 2007), a new age of high resolution ($\sim 1'$), low frequency observations has been made possible. These observations probe low energy ($\sim$ hundreds of MeV) cosmic ray electrons. An accurate measure of these electrons in the Galactic center (GC) can place constraints on the origins of higher frequency observations (for example: γ-ray and X-ray emission, see Yusef-Zadeh *et al.* 2013a). Previous efforts to accurately measure this emission at higher frequencies towards the GC have been met with difficulties in being able to distinguish between this nonthermal synchrotron emission and thermal emission from gas clouds. An advantage of low frequency observations is that only nonthermal sources are identified in emission, while thermal sources are identified in absorption of the diffuse emission from the GC. As this diffuse emission originates from the GC, any thermal sources that display low frequency absorption must be located on the near side of the GC, thus constraining their location. (Kassim 1990).

We have obtained a map of the inner $13^\circ \times 7^\circ$ of the GC at 74 MHz based on VLA observations that were obtained by 2003 (see Brogan *et al.* 2003) with a resolution of $114'' \times 60''$ (the highest still to date). We have recently used this data to show the interaction of the molecular cloud G0.13−0.13 with nonthermal filaments of the radio arc (Yusef-Zadeh *et al.* 2013a). Here we present our current findings of two other selected sources.

2. Results

Sgr D: The Sgr D complex consists of a SNR (G1.05−0.15) and a HII region (G1.13−0.10). There has been much debate as to the location of these sources (see Blum & Damineli

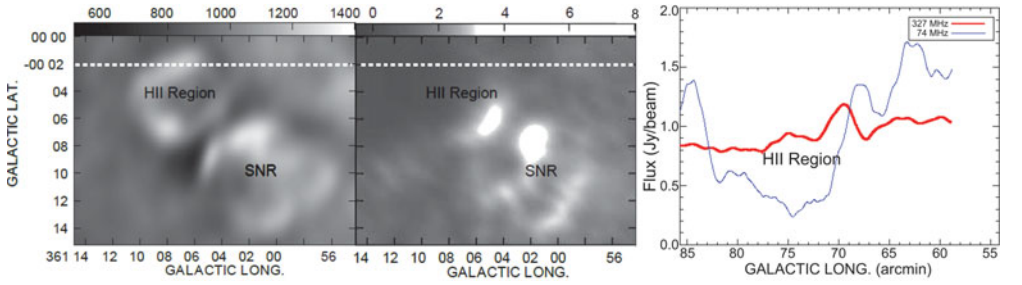

Figure 1. Left: 327 MHz map of Sgr D with 30″ resolution (in mJy/beam). Middle: 74 MHz map of Sgr D (in Jy/beam). **Right:** Plot of flux for the dashed lines in the maps, showing that the HII region displays absorption at 74 MHz and emission at 327 MHz. [A color version is available online.]

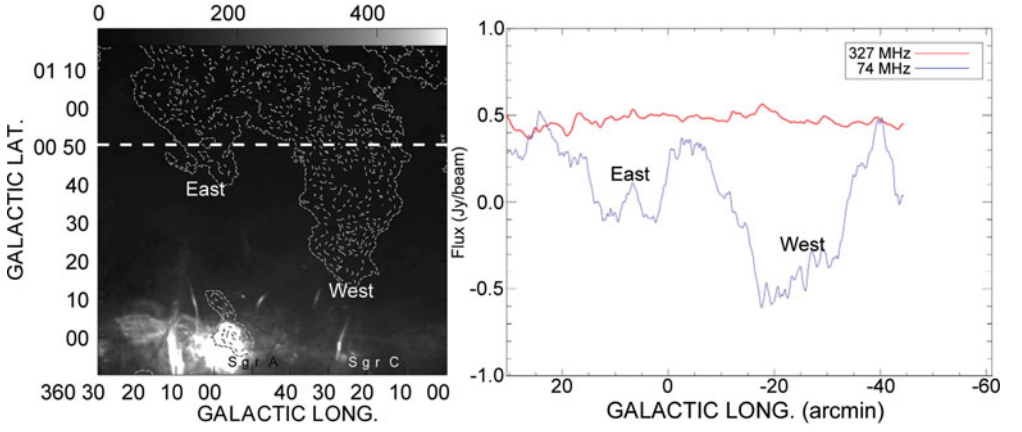

Figure 2. Left: 327 MHz map of the Galactic center, overlaid with a contour map of the GCL. Contour levels are: $-1.4, -1.2, \ldots -0.2$ Jy/beam. **Right:** Plot of flux for the dashed line in the map. The western side displays lower 74 MHz flux (greater absorption) than the eastern side. [A color version is available online.]

1999 and Mehringer *et al.* 1998). We detect 74 MHz absorption and emission tracing the thermal HII region and the nonthermal SNR, respectively (Figure 1).

The thermal absorption (evidenced in the plot in Figure 1) constrains the HII region to be located in the foreground of the GC. We have also identified that our 74 MHz emission coincides with the location of HCN molecular line emission and a 1720 MHz OH maser. This supernova remnant maser is pumped as a result of the collision of the SNR and the molecular gas (Lockett *et al.* 1999) indicating that the SNR is likely expanding into the molecular gas and shocking it in order to produce the OH maser.

The Galactic center lobe (GCL): The GCL is a large scale ($\sim 1°$) Ω-shaped lobe located north of Sgr A. It is detected in absorption in our 74 MHz image (Figure 2, the plot also shows that it is not detected at 327 MHz). We identify that the eastern side contains less absorption than the western side, and we conclude, in conjunction with previous polarization measurements (Haynes *et al.* 1992), that the eastern side likely contains a mix of thermal absorption and nonthermal emission, thus causing the relative difference in the observed absorption.

References

Blum, R. D. & Damineli, A. 1999, *ApJ* 512, 237

https://doi.org/10.1017/S1743921314001161 Published online by Cambridge University Press

Brogan, C. L., Nord, M., Kassim, N., *et al.* 2003, *AN* S1, 17
Haynes, R. F., Stewart, R. T., Gray, A. D., *et al.* 1992, *A&A* 264, 500
Kassim, N. E., Lazio, T. J. W., Erickson, *et al.* 2007, *ApJS* 172, 686
Kassim, N. E. 1990, *AIPCS* 207, 218
Lockett, P., Gauthier, E., & Elitzur, M. 1999, *ApJ* 511, 235
Mehringer, D. M., Goss, W. M., Lis, D. C., *et al.* 1998, *ApJ* 493, 274
Yusef-Zadeh, F., Wardle, M., Lis, D. *et al.* 2013a, *JPC* 117, 9404
Yusef-Zadeh, F., Hewitt, J. W., Wardle, M., *et al.* 2013b, *ApJ* 762, 33

https://doi.org/10.1017/S1743921314001161 Published online by Cambridge University Press