Nonthermal Pressures:

Key to Energy Balance and Structure Formation near SgrA* in the Milky Way

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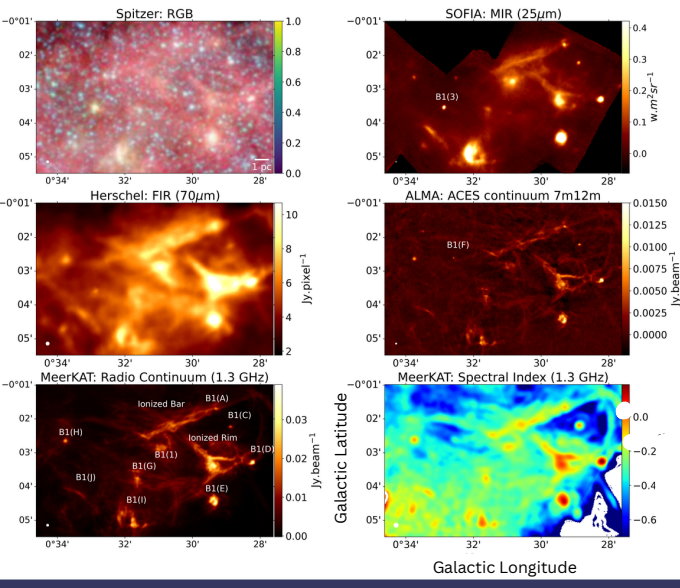
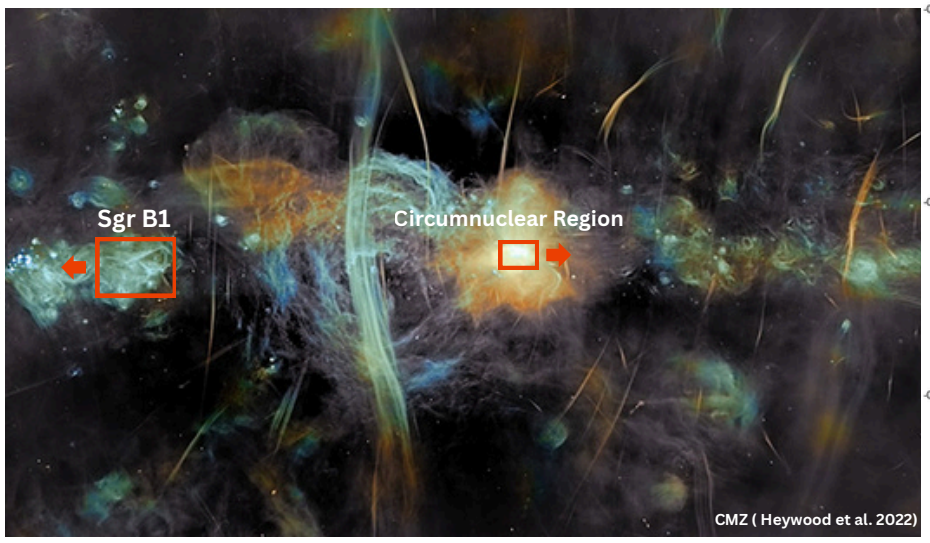
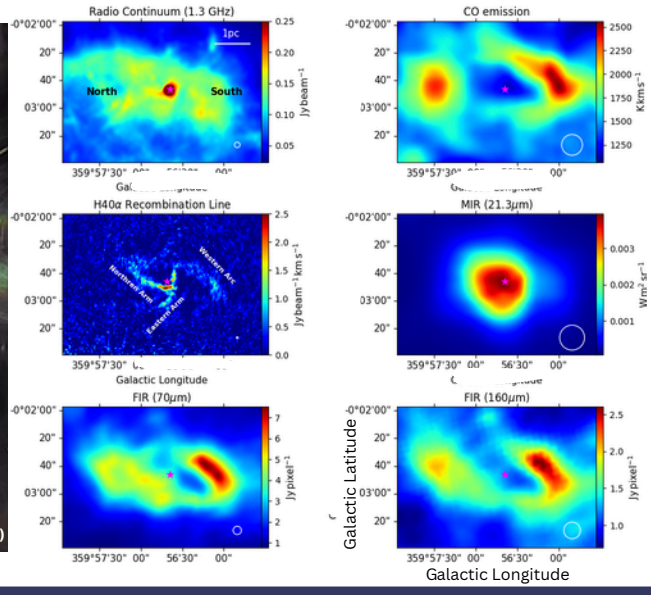
Introduction

Within the Central Molecular Zone (CMZ), the circumnuclear region surrounding Sgr A* includes the Circumnuclear Disk (CND), a 1.5–7 pc structure that is the largest and closest molecular feature to Sgr A*. This region is characterized by strong magnetic fields, supersonic motions, and dense gas. Within the inner ~2 pc lies the Sgr A West minispiral, where intense tidal shear makes star formation difficult, yet massive stars persist [1]. We studied how thermal and nonthermal processes shape the ISM structures near Sgr A*, as well as the role of the magnetic field in controlling the star formation process. Further from Sgr A*, we are studying the extended ionized gas in Sgr B1, a specific HII region, to investigate gas kinematics, star formation, and magnetic-field feedback.



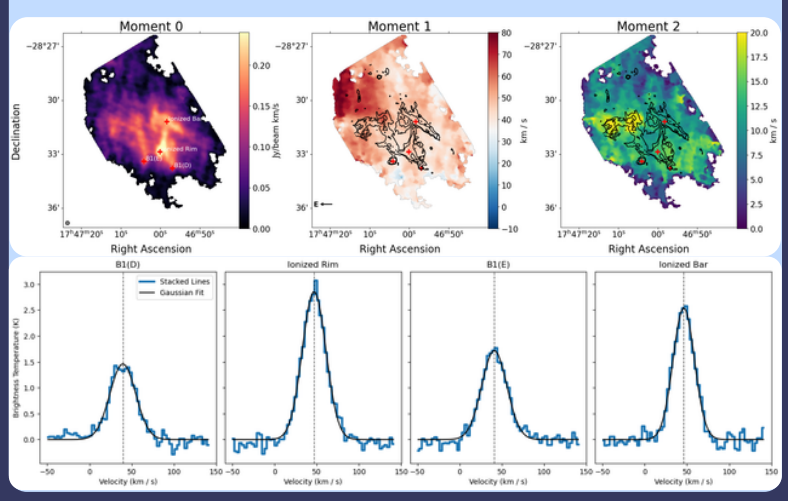




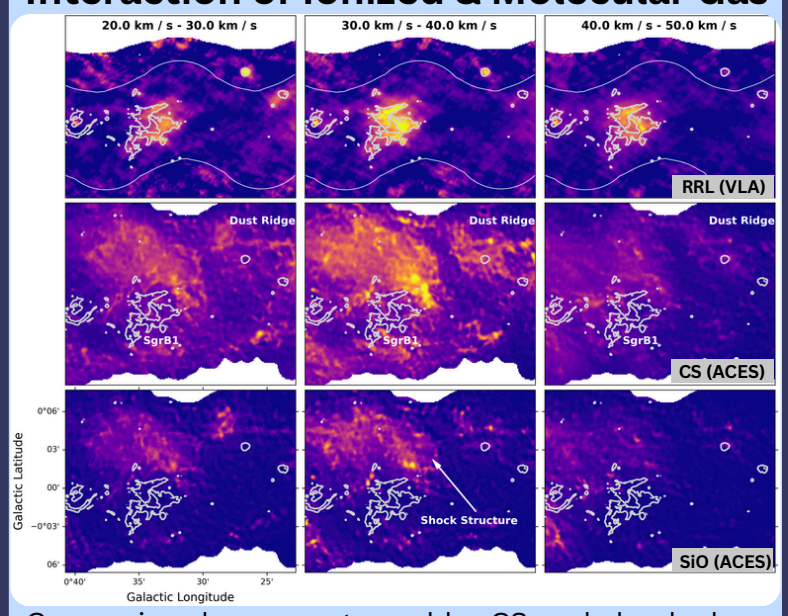
Sgr B1 (in prep.)

Structure & Kinematics of Ionized Gas

VLA recombination lines reveal the extended ionized gas of SgrB1. The ionized gas kinematics increase in complexity eastward toward SgrB2. Spectra from four beam-sized regions confirm the previously reported broad line profiles [5].



Interaction of Ionized & Molecular Gas

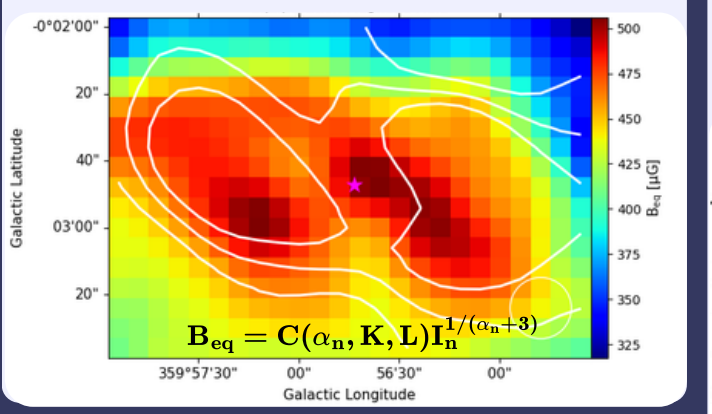


Comparing dense gas traced by CS and shocked gas traced by SiO (ACES) with the VLA RRLs suggests that the molecular gas is being pushed away in this region.

Circumnuclear Region (Mazoochi et al. 2026)

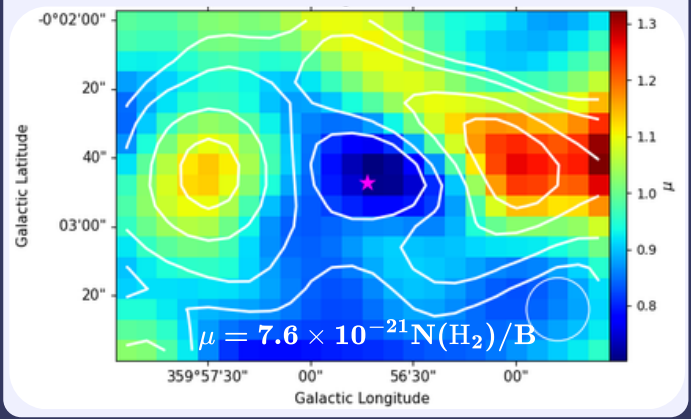
Equipartition Magnetic Field

Based on equipartition between the energy densities of the magnetic fields and cosmic rays, the magnetic field strength is calculated from the nonthermal intensity [3].



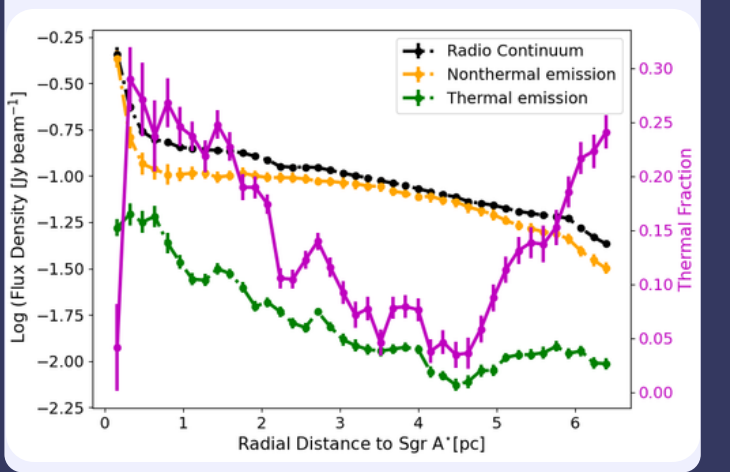
Mass-to-magnetic Flux Ratio

The mass-to-magnetic flux ratio* [4] suggests that this region is mostly subcritical (<1), and the **magnetic field can stabilize gas clouds against gravitational collapse**.



Thermal & Nonthermal Separation

Using MeerKAT 1.3 GHz RC data and the ACES H40α line as a thermal tracer, we separate the free–free and synchrotron emission. Applying the TRT method [2], we derive the pure nonthermal component by subtracting the free–free emission from the RC map.



ISM Energy Balance

Computing the thermal, nonthermal, and kinetic energy densities, and discovering that near SgrA*, **the nonthermal and kinetic energy densities dominate the thermal energy density.**

Properties	Units	R≤ 2 pc	R>2 pc
$E_{th}/10^{-10}$	[erg cm^{-3}]	8.5±0.4	5.1±0.1
$E_{nt}/10^{-8}$	[erg cm^{-3}]	1.9±0.1	1.5±0.1
$E_k/10^{-8}$	[erg cm^{-3}]	6.1±0.2	6.1±0.2

Reference

[1] Yusef-Zadeh, F., Wardle, M., Sewilo, M., et al. 2015, ApJ, 808, 97
[2] Tabatabaei F., Beck R., Krügel E. et al. 2007 A&A 475 133
[3] Beck R. and Krause M. 2005 AN 326 414
[4] Crutcher R. M., Nutter D., Ward-Thompson D. and Kirk J. 2004 ApJ 600 279
[5] Mehringer, D. M., Yusef-Zadeh, F., Palmer, P., & Goss, W. M. 1992, ApJ, 401, 168

Link to the paper