The Galactic Center's enrichment by recent star formation

MIRI/MRS view of the Central Cavity

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Abstract

The Galactic Center provides a unique laboratory for studying the interplay between gas, stars, and the central supermassive black hole.

Using JWST/MIRI-MRS spectroscopy from 5 to 27 μm, we investigate the multiphase structure and chemical composition of the ionized interstellar medium in the Central Cavity.

The emission is dominated by warm ionized gas. Enhanced CNO abundances and depleted Fe relative to α elements are consistent with enrichment by massive stars and core-collapse supernovae, with only a limited contribution from Type Ia supernovae.

Observations

- JWST Cycle 2 GO 3166 observations, PI: A. Ciurlo.
- Two Galactic Center targets were observed: the circumnuclear disk and the Central Cavity.
- This poster focuses on the Central Cavity spectrum and abundance constraints.
- The data were obtained with MIRI/MRS in full four-channel mosaic mode, covering 5 to 27 μm.

Method

- An integrated Central Cavity spectrum was extracted from a continuum and background subtracted JWST/MIRI-MRS cube.
- We fit the observed spectrum using a CLOUDY grid that spans 61 temperatures, 13 densities, and 9261 abundance triplets for CNO, α, and Fe-peak elements.
- For each abundance triplet, we optimize a combination of 793 spectra and compare residuals over the full wavelength range.

Results

- The emission budget is dominated by warm ionized gas with $10^4 \leq T < 10^{4.8}$ K. Molecular and hot coronal components are much weaker than in the circumnuclear disk.
- The relative abundance constraints are robust: $\log(\mathrm{CNO}/\alpha) = 0.27 \pm 0.20$ and $\log(\mathrm{Fe}/\alpha) = -0.78 \pm 0.20$.
- The best model is supersolar, with $(\log \alpha, \log \mathrm{CNO}, \log \mathrm{Fe}) = (1.4, 1.4, 0.4)$, although absolute abundances are more degenerate.

Abundances

- CNO and α enhancement are the expected yields of massive stars, stellar winds, and core-collapse supernovae on short timescales.
- Fe is depleted relative to α elements, indicating limited Type Ia enrichment and possibly additional sequestration into dust grains.
- Relative abundance ratios point to a chemically young environment in the Central Cavity.

Acknowledgements

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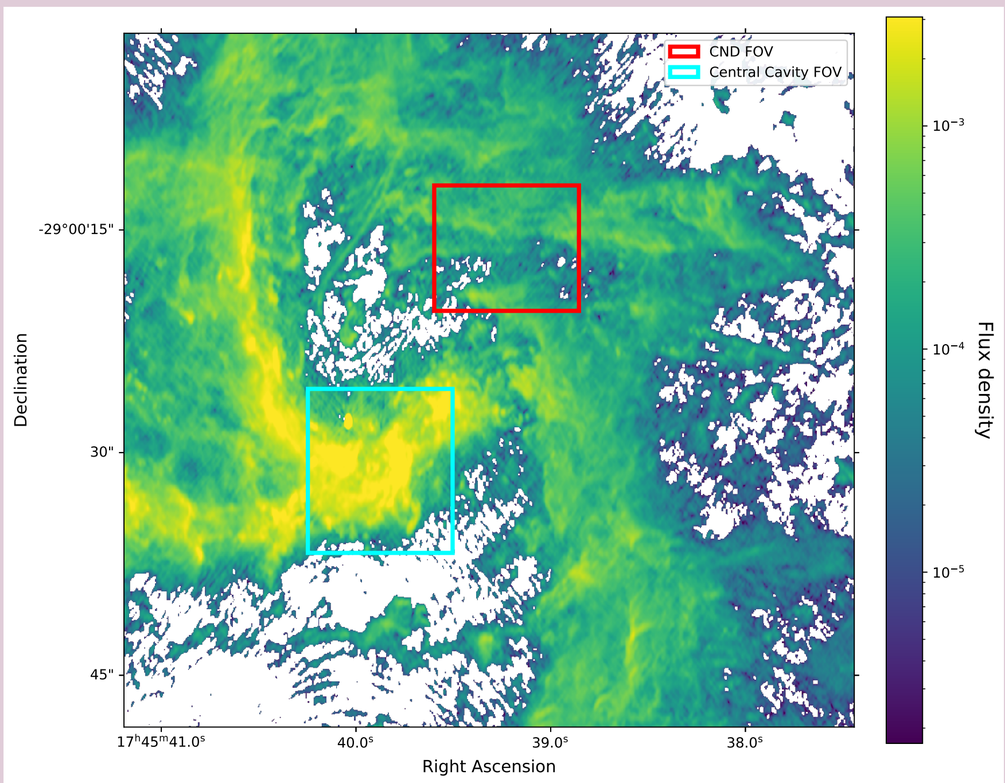
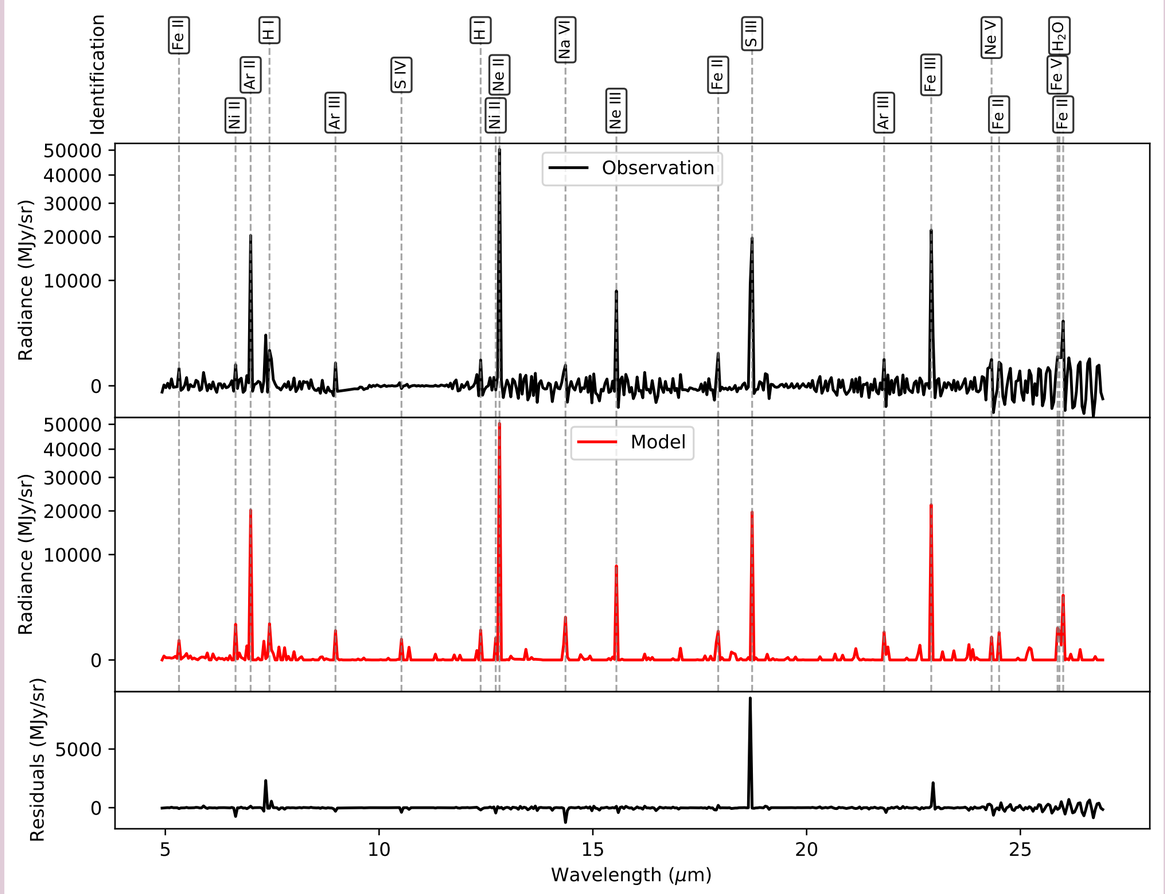
Figure 1. Galactic Center overview



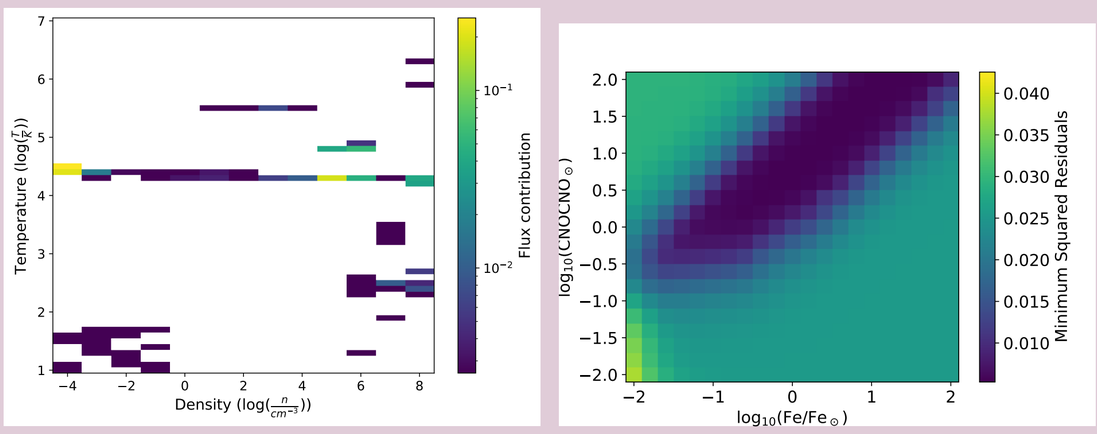
VLA 2cm radio map (Morris et al. 2017) with the JWST/MIRI-MRS footprints overlaid.

Figure 2. Central Cavity spectrum: observed vs model



The best-fit multiphase model reproduces most of the mid-infrared emission lines with a small number of dominant ISM phases.

Figure 3. Multiphase fit and abundances in the Central Cavity



(a) ISM phase diagram (b) Abundance residuals

The phase diagram highlights the dominant CC gas components, while the abundance residual map reveals the Fe depletion relative to the CNO elements.