Characterizing the CMZ foreground clouds

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The central few hundred parsecs of the Galaxy is characterized by a strong concentration of molecular gas, namely, the central molecular zone (CMZ; 1). The environment of the CMZ differs significantly from that in the disk in several important ways: in gas density, turbulence, and temperature (2; 3; 4; 5; 6; 7; 8; 9; 10). The Galactic center is one of the most extreme environments for star formation in our Galaxy.

CHIMPS2 -This project has been awarded 404 hours to extend the JCMT HARP ^{13}CO/C^{18}O 3-2 Inner Milky-Way Plane Survey (CHIMPS) and the ^{12}CO 3-2 survey (COHRS) into the inner Galactic Plane, the Central Molecular Zone (CMZ) and a section of the Outer Plane.

Purpose

The ^{12}CO 3-2 CMZ emission that we see in the CHIMPS2 data is essentially a combination of the high-velocity-dispersion emission from the CMZ itself with narrower absorption from the clouds in the foreground spiral arms. In order to analyze the CMZ emission itself and obtain measurements of the foreground cloud properties we need to find a way to reliably separate the two components.

We have done an initial separation by averaging over the whole tile. We manually blanked out and interpolated over foreground absorption features. By examining the residuals, we get our first characterization of the foreground clouds.

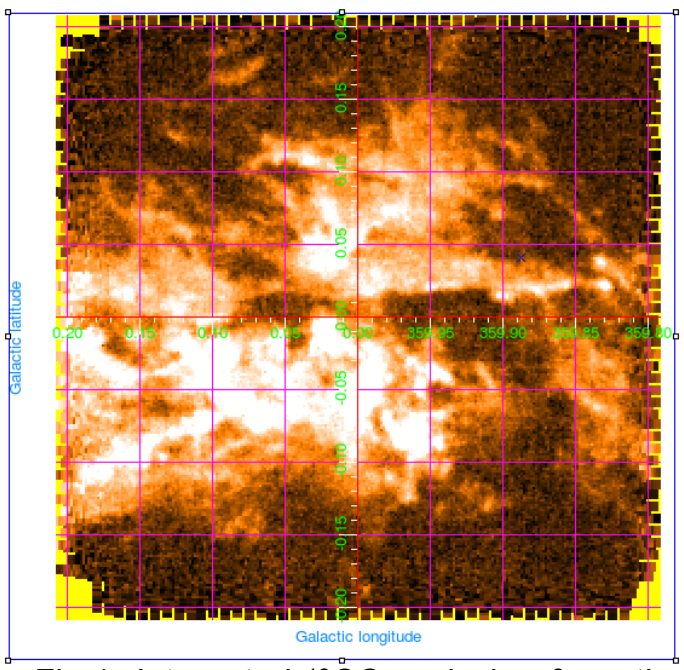

Fig.1. Integrated ^{12}CO emission from the CMZ. A 0.4x0.4 degree^2 tile towards (0,0).

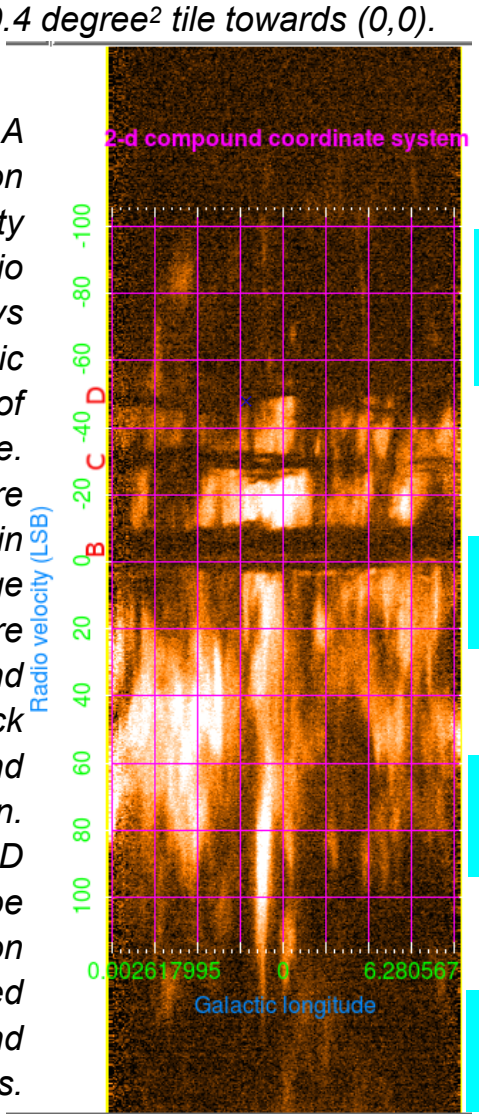

Fig. 2 A Position Velocity diagram (Radio velocity vs Galactic longitude) of the same tile. Evident are dark streaks in the image where foreground clouds block the background CMZ emission. B,C and D appear to be absorption features caused by foreground clouds.

Progress

Survey map Fig.1

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Average spectrum Fig.3

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Fitting the residual spectrum Fig.4

Manually ← SUB app in KAPPA ← Manually FILLBAD app in KAPPA ← Manually CHPIX app in KAPPA

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Getting the absorption parameters

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Next steps

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Smaller tiles 30 x 30 arcsec^2

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Automatically operation

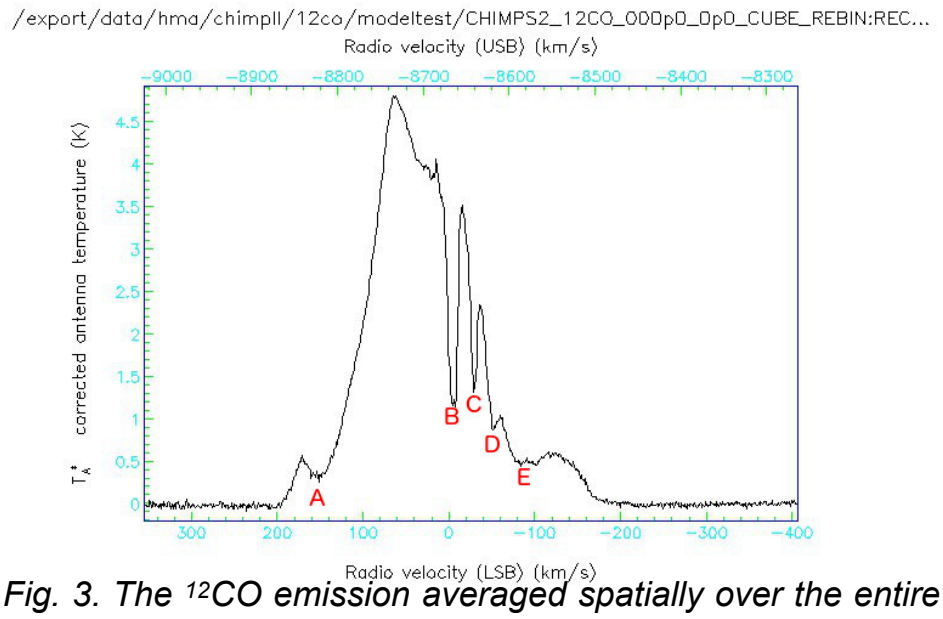

Fig. 3. The ^{12}CO emission averaged spatially over the entire tile shown in Fig.1. A,B,C,D and E mark the dips seen in the emission; B, C and D correspond to the labels in Fig. 2

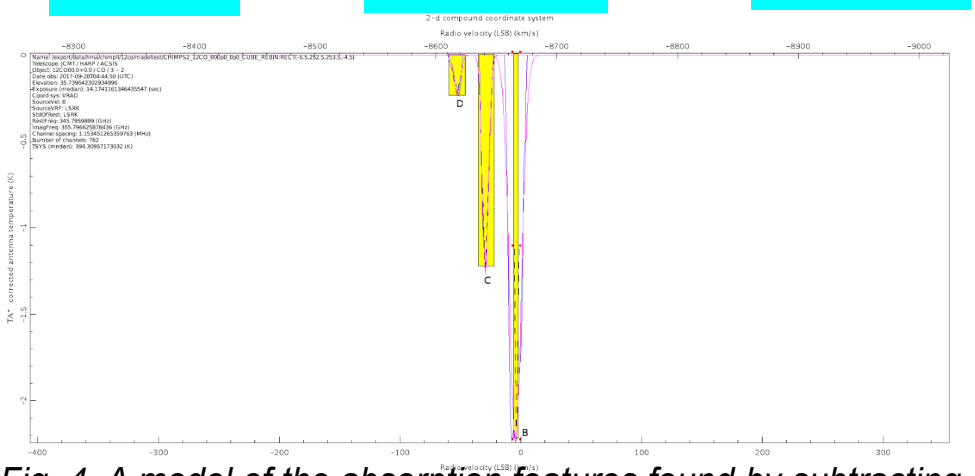

Fig. 4. A model of the absorption features found by subtracting the model average CMZ emission from the original average spectrum, leaving only a model of the foreground cloud absorption at velocities B, C and D.Black=residual spectrum, Red=Gaussian fit using splat, Black dash='quick fit' from Splat. Yellow boxes indicate the regions being fit.

References:

[1] Morris, M., & Serabyn, E. 1996, ARA & A, 34, 645
[2] R. Güsten & C. Henkel 1983, A&A 125, 136
[3] J. Bally, A. A. Stark, R. W. Wilson and C. Henkel 1987, ApJS, 65, 13
[4] M. Morris, N. Polish, & B. Zuckerman, et al. 1983, AJ, 88, 1228.
[5] R. Güsten, & C. M. Walmsley, et al. 1985, A&A, 142, 381.
[6] S. Hüttemeister, & T. L. Wilson, et al. 1993, A&A, 280, 255.
[7] N. J. Rodríguez-Fernández, et al. 2001, A&A 365, 174.
[8] E. A. C. Mills & M. R. Morris 2013, ApJ, 772 105.
[9] Y. Ao et al. 2013, A&A, 550, A135.
[10] A. Ginsburg et al. 2016, A&A 586, A50.