MOPRA CO SOUTHERN GALACTIC PLANE SURVEY

and an augmented reality view of the Galaxy

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SURVEY CHARACTERISTICS

^{12}CO ^{13}CO C^{18}O C^{17}O $J = 1 \rightarrow 0$ transitions

Velocity range -550 to 500 km/s [max]

Spectral 0.1 km/s angular 0.5' resolution matched to ASKAP (HI) and CTA

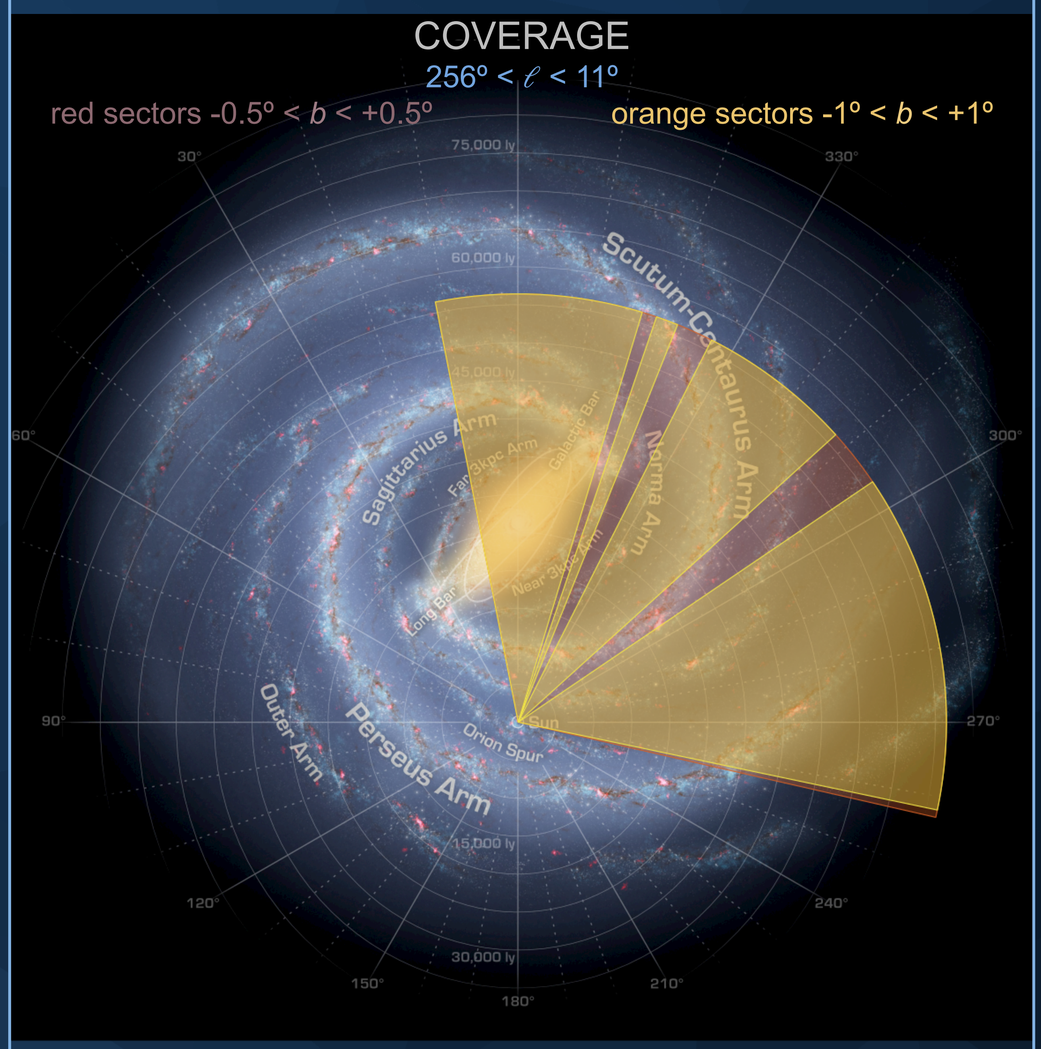
rms: [~0.7K ^{13}CO C^{18}O] [~1.4K ^{12}CO] @[0.1 km/s & 0.5']

COVERAGE

$256^o < \ell < 11^o$

red sectors $-0.5^o < b < +0.5^o$

orange sectors $-1^o < b < +1^o$



HARDWARE

Mopra 22m single dish long-wave mm radio telescope (New South Wales, Australia) 12, 7 & 3mm observations.

77-116 GHz MMIC receiver

T_{sys} ~ 150K (@85GHz) – 600K (@115GHz)

η_{mb} (86 GHz) = 0.49 / η_{mb} (115 GHz) = 0.42

η_{xb} (86 GHz) = 0.65 / η_{xb} (115 GHz) = 0.55

UNSW-MOPS spectrometer

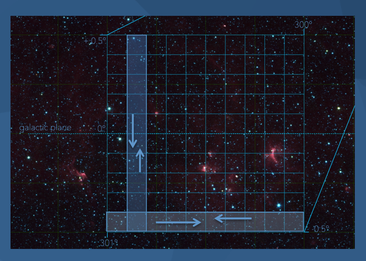
BROADBAND MODE - 8 GHz bandpass 0.8 km/s resolution.

ZOOM MODE - four dual polarisation bands 137.5 MHz wide (4096 channels) for 0.1 km/s resolution @3mm.

OBSERVING SETUP

Fast On-The-Fly Map

Each square degree is divided into 20 stripes 60' x 6', completed in 30^h of effective observational time, paddle scan every 25' for T_A^* calibration.



IF	Fequency [GHz]	Isotopologue J=1-0	V_{range} [km/s]
1+2	110.1	^{13}CO	$-475 < V_{LSR} < +270$
3+4	109.7	C^{18}O	$-495 < V_{LSR} < +255$
5	112.3	C^{17}O	$-235 < V_{LSR} < +130$
6+7+8	115.2	^{12}CO	$-550 < V_{LSR} < +525$

Related papers:

Burton M. G., et al., 2013 | Burton M. G., et al., 2015 | Braiding C., et al., 2015 | Rebolledo D., et al., 2016

DR3 (350º-300º) release soon available!

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SCIENTIFIC MOTIVATION

Follow the C$^+$ - C - CO chain to uncover the formation of molecular clouds in the ISM.

Probe the connection between molecular clouds and "dark" gas inferred from γ-ray data.

Stronger constraints between molecular cloud properties and star formation rate.

Improve X_{CO} factor knowledge (CO-to-H_2).

Understanding the nature of gamma-rays sources from gas dynamics.

Disentangle gamma-rays arcmin scale structures revealed by next generation surveys (like the Cherenkov Telescope Array).

Disentangle dust emission and identify filamentary structures across the Galaxy.

DATA REDUCTION

RPFITS raw recorded data

LIVEDATA
- Position tagging
- Bandpass calibration
- Masking out 400 channels close to the edge

CLEAN STEP 1
- Preliminary cleaning flagging bad data (>5σ)

GRIDZILLA
- Data interpolation inside a data cube grid 15" spacing (262 x 262 pixel) centered on its rest V_{LSR}
- Exclusion of spectral lines outside T_{sys} [400 – 1000K] ^{12}CO or [200 – 700K] for other lines

FITS data cube 1º x 1º

CLEAN STEP 2
- bad pixel, rows and columns cleaning

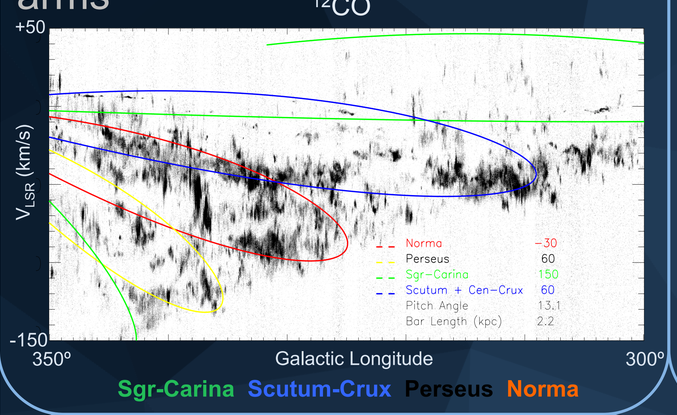
MIRIAD binning to 131x131px 30"

CLEAN STEP 3
- Continuum subtraction with a 4th order polynomial fit for a selected V_{LSR} range
- 7th polynomial fit to all resulting points close to the zero (< 0.5σ)

SCIENCE FROM MOPRA^{CO} SURVEY

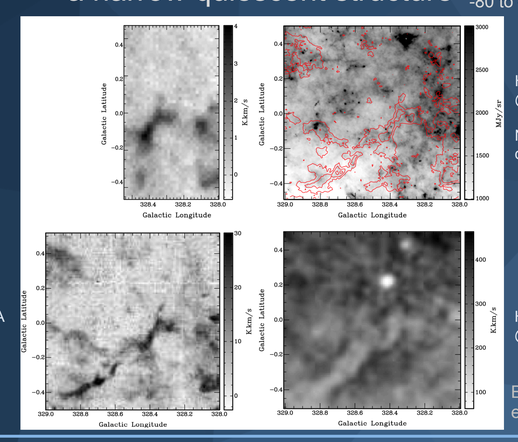
Survey PV diagram and spiral arms

[Vallée Galaxy model 2014]



G328 filament

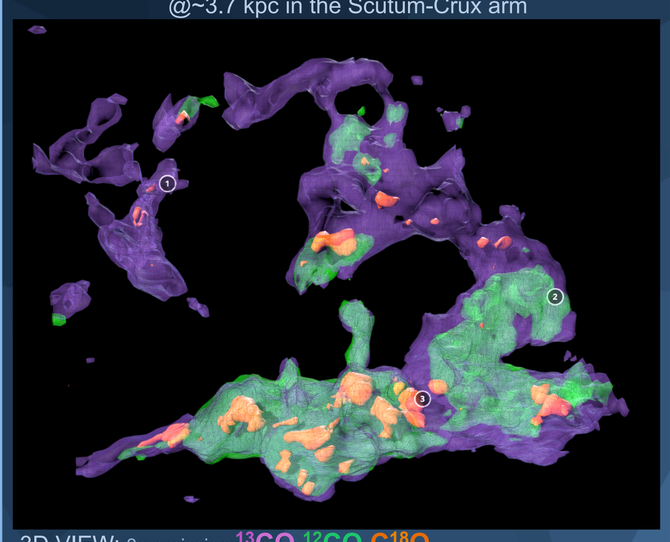
a narrow quiescent structure — 4 km/s wide -80 to -76 km/s V_{LSR}



Burton M.G., et al. 2015

G332 Molecular Ring

Giant CO & [CI] ring ~25pc radius, ~10^5 $M_\odot$ ~6km/s wide @~3.7 kpc in the Scutum-Crux arm



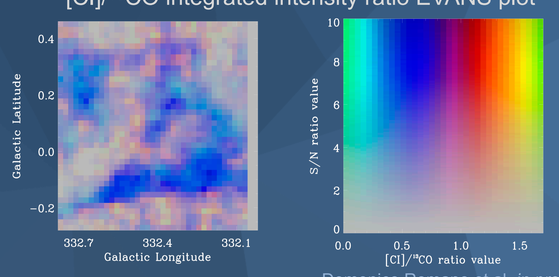
3D VIEW: 3σ emission ^{13}CO ^{12}CO C^{18}O

RING AUGMENTED REALITY VIEWS

^{13}CO ^{12}CO C^{18}O 3D 3σ emission

C^{18}O clump 3D fragments

[CI]/^{13}CO integrated intensity ratio EVANS plot



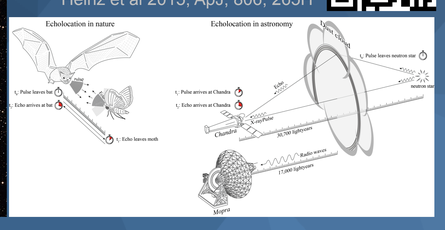
Domenico Romano et al. *in prep.*

Lord of the rings

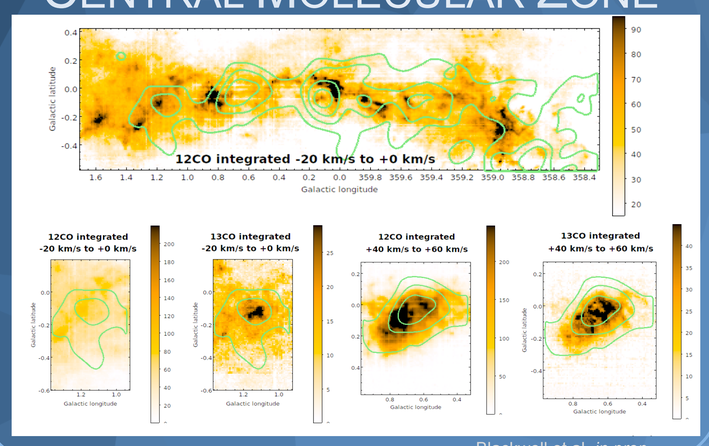
echoes from molecular clouds

Circinus X-1

Heinz et al 2015, ApJ, 806, 265H



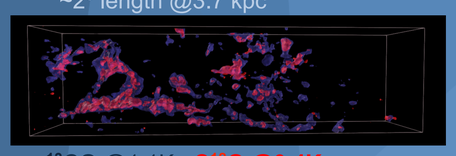
CENTRAL MOLECULAR ZONE



Blackwell et al. *in prep.*

Giant Filament structure

~2º length @3.7 kpc



^{13}CO @1.1K C^{18}O @0.4K

Filament AR 3D VIEW ^{13}CO & C^{18}O

Domenico Romano et al. *in prep.*

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