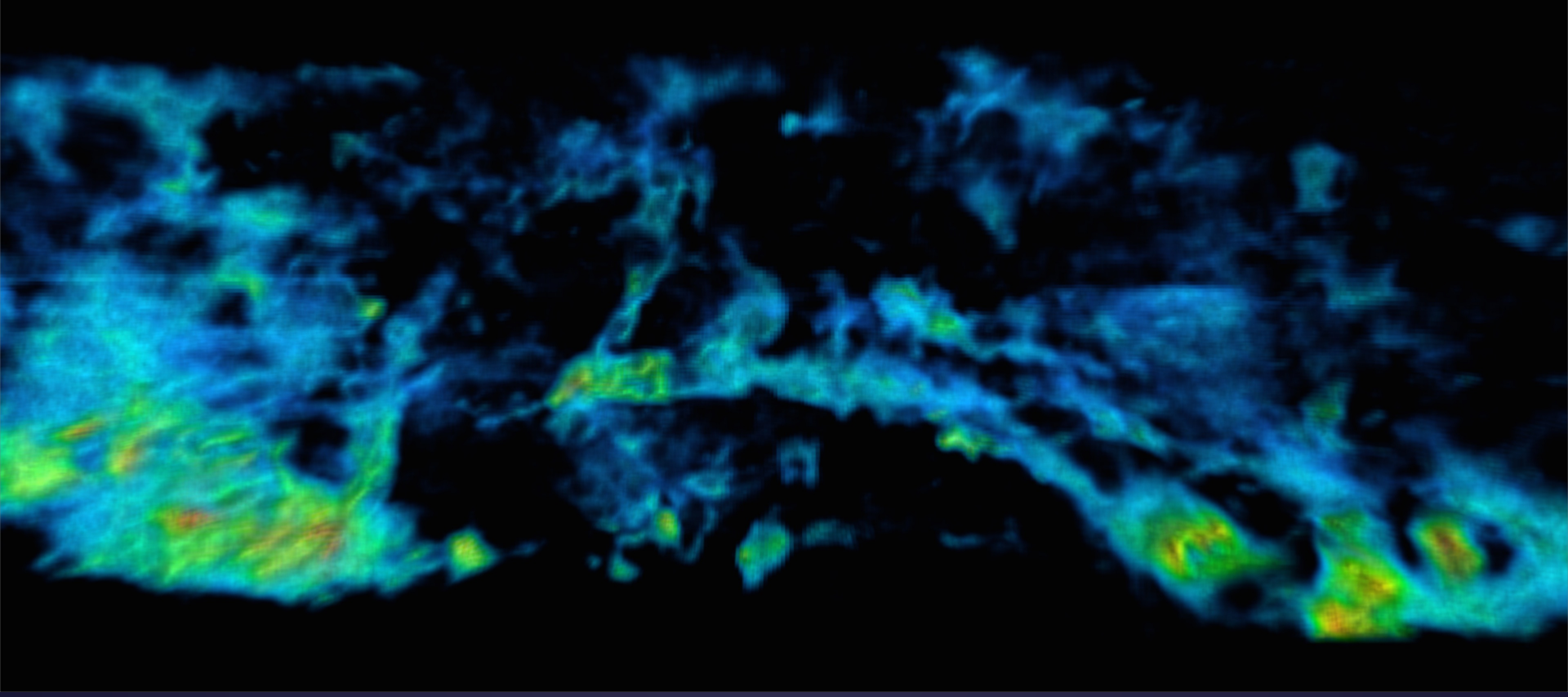

G332 Molecular Ring

Domenico Romano - *PhD candidate*

University of New South Wales

UNSW AUSTRALIA
Science

2015 Mopra Workshop

Overview

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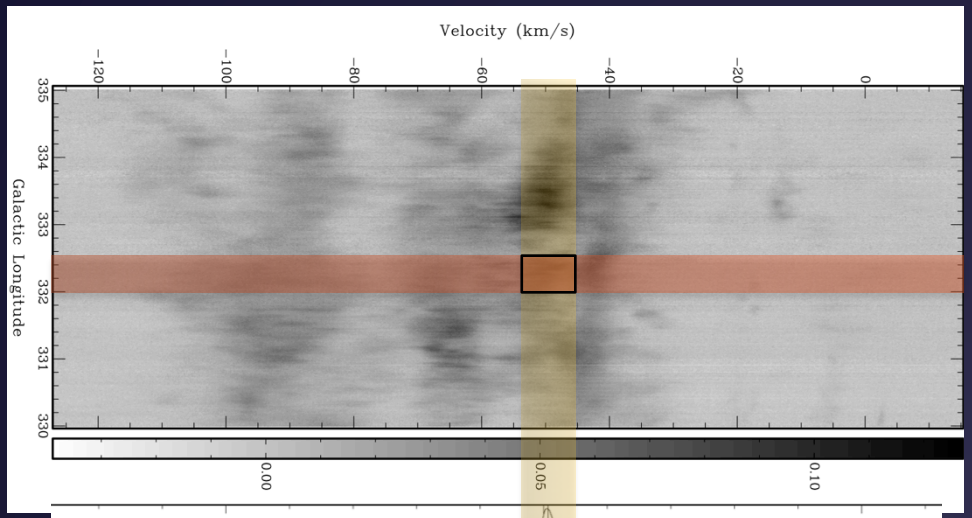
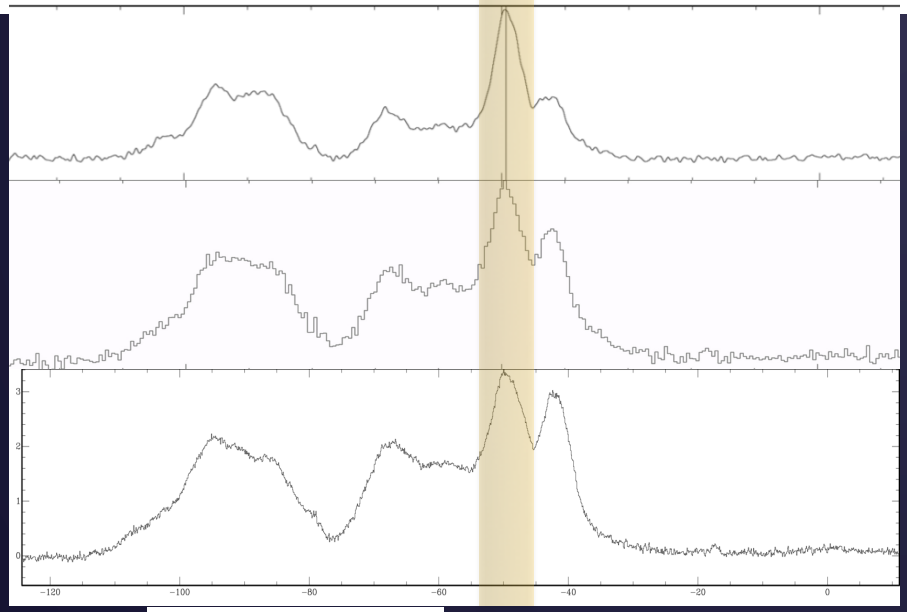




$$\Delta V_{CO} = 0.1 km/s$$
$$\Delta V_{CI} = 0.5 km/s$$

Galactic region:

$332.6° > l > 332.0°$

$-0.2° > b > 0.5°$

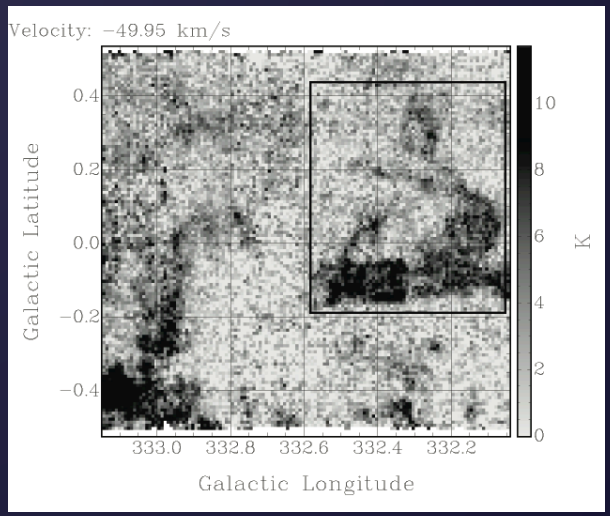
Velocity range

-54 km/s $> V_{LSR} > -46$ km

^{13}CO ^{12}CO CI lines width ~7 km/s

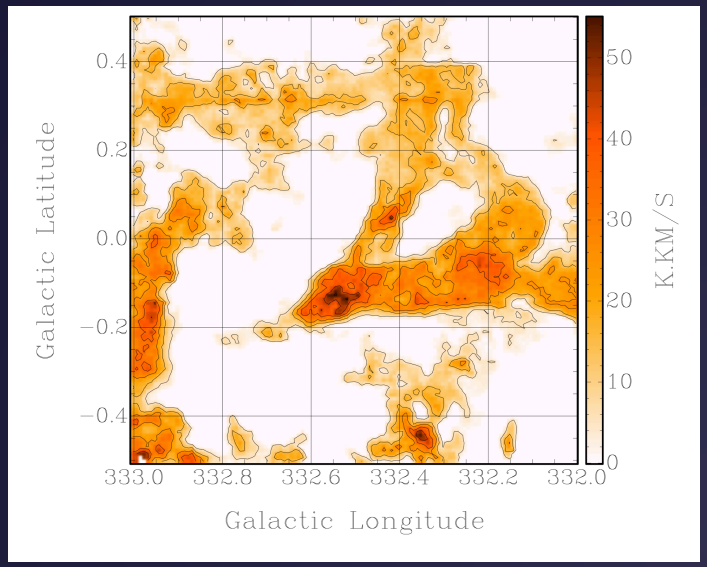
peaks at V_{LSR} ~ −50 km/s

^{12}CO G332 region at V_{LSR} ~ −50 kms^{-1}

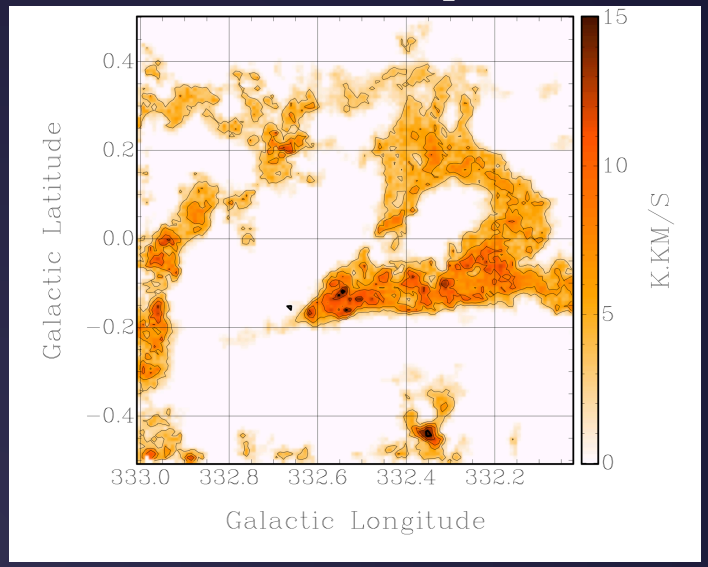


Overview – moment maps

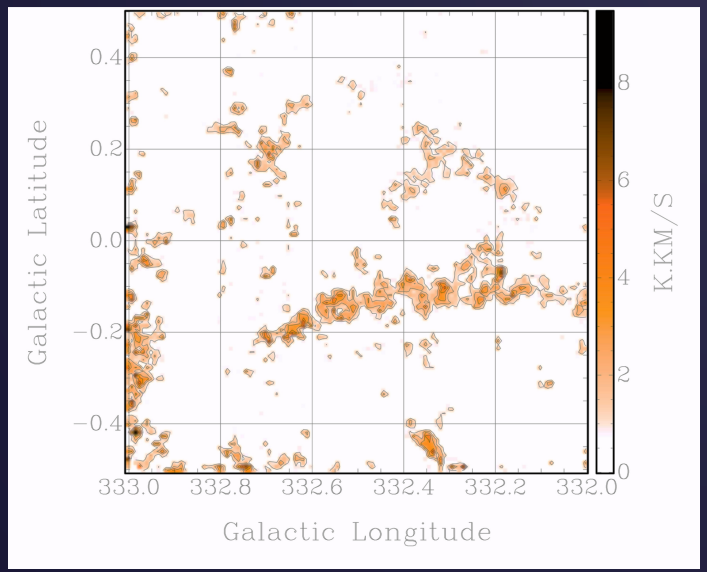
^{12}CO J=1-0 MOPRA 35”



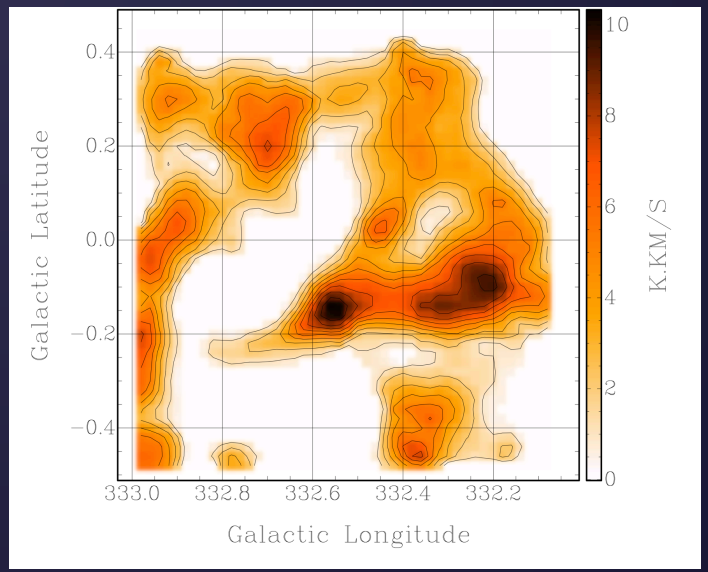
^{13}CO J=1-0 MOPRA 35”



$C^{18}O$ J=1-0 MOPRA 35”



CI J=2-1 HEAT 120”



$-54\ km/s > V_{LSR} > -46\ km$

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Overview – column density

T_{ex} from ^{12}CO peak temperature

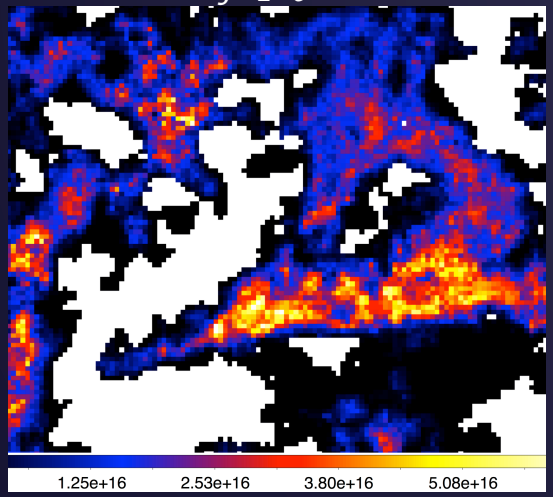
$$T_{ex} = \frac{5.53K}{\ln\left(1+\frac{5.53K}{T_{peak}^{12CO}+T_{CMB}}\right)}$$

Rohlfs & Wilson 2004

T_{ex} ~ 26 K

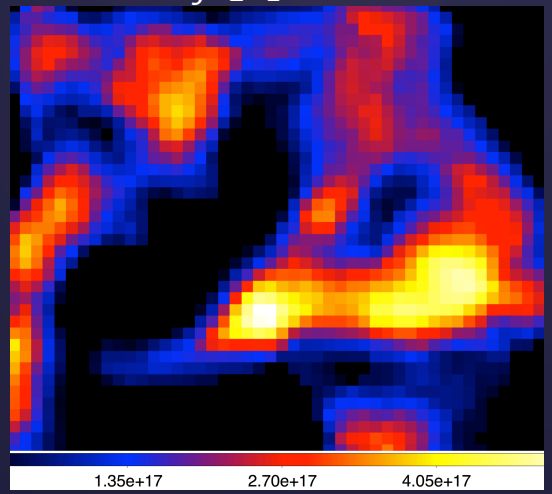
Column density maps

^{13}CO J=1-0



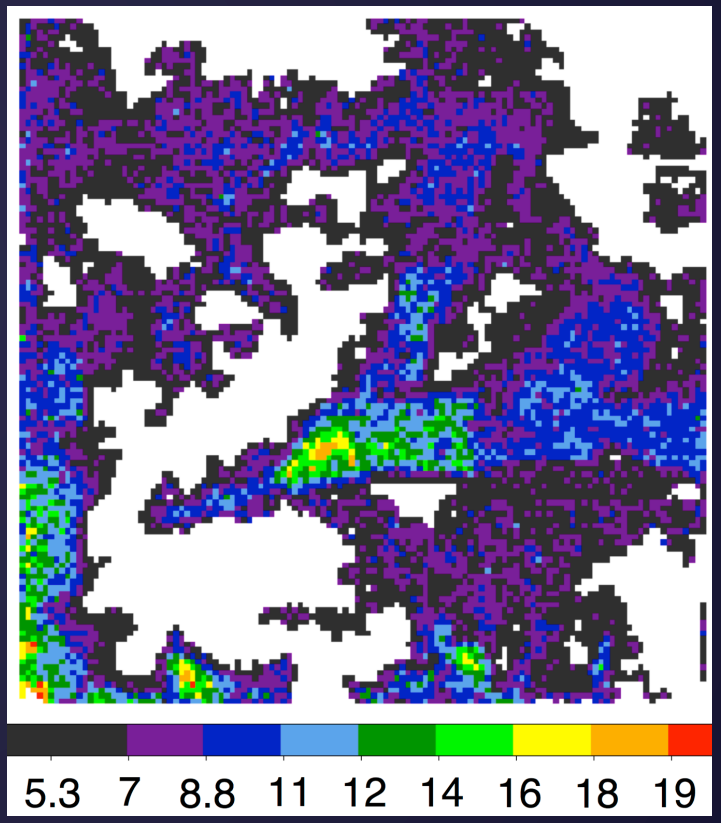
cm^{-2}

CI J=2-1



cm^{-2}

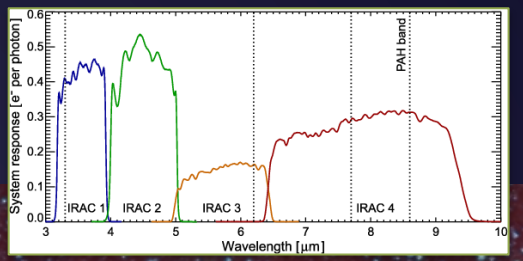
^{12}CO T* peak

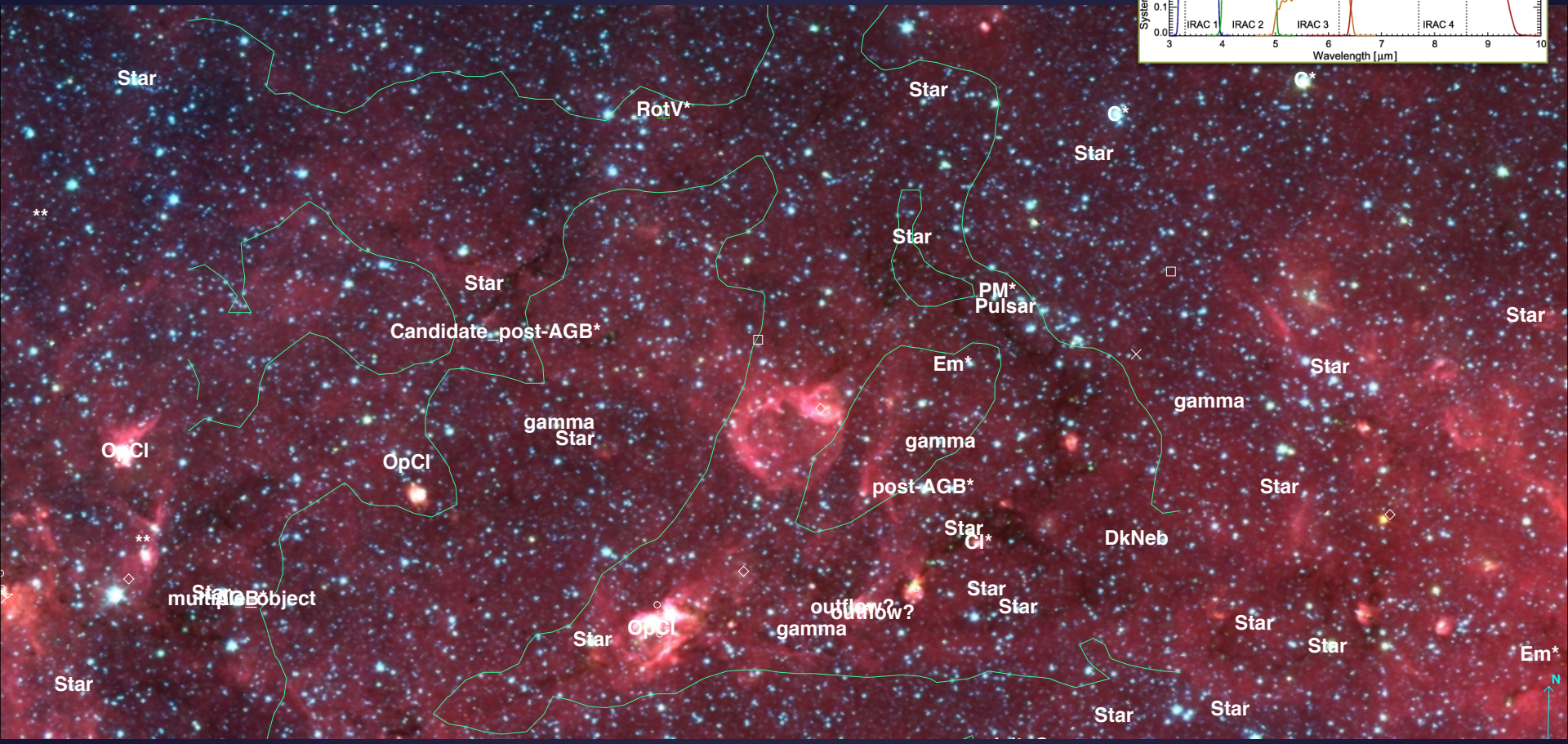


K

A Multiband approach

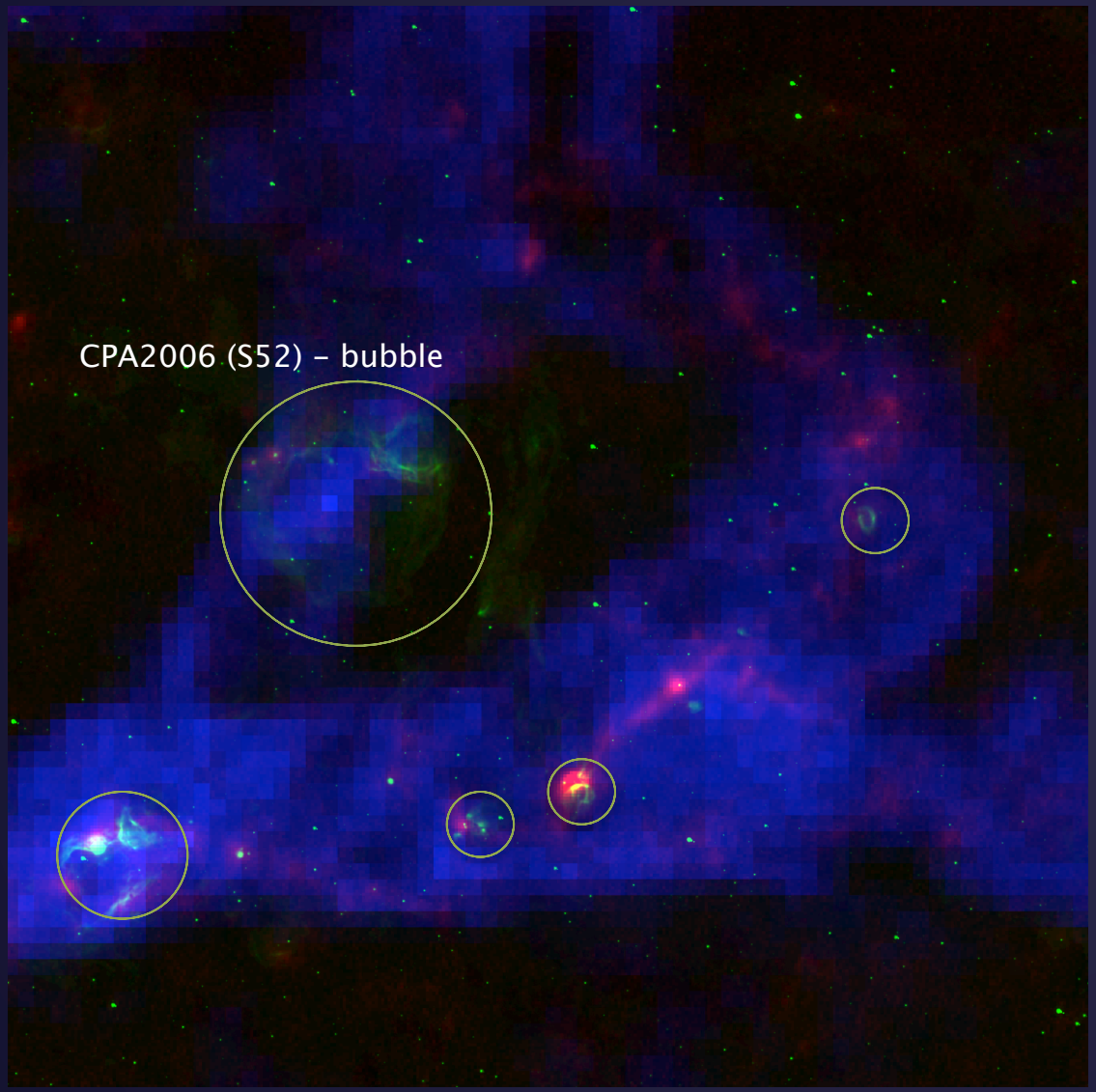
IRAC – I1 I2 I4 bands





many many objects: (masers, HII regions, YSO, Dark Nebula, High energy phenomena…)
for most of them no distance information

A multiband approach



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CO Mopra

8.0 μm Spitzer

870 μm Atlasgal

- Dust filamentary structures
- Could host very early stages of massive star formation
- InfraRed Dark Clouds IRDCs

- Polycyclic aromatic hydrocarbon (PAH) emission – common in intense UV radiation field like MSF regions
- PAH emission located on the edge of HII regions and CI layers

***Leger** & **Puget** 1984; **Allamandola** et al. 1985*

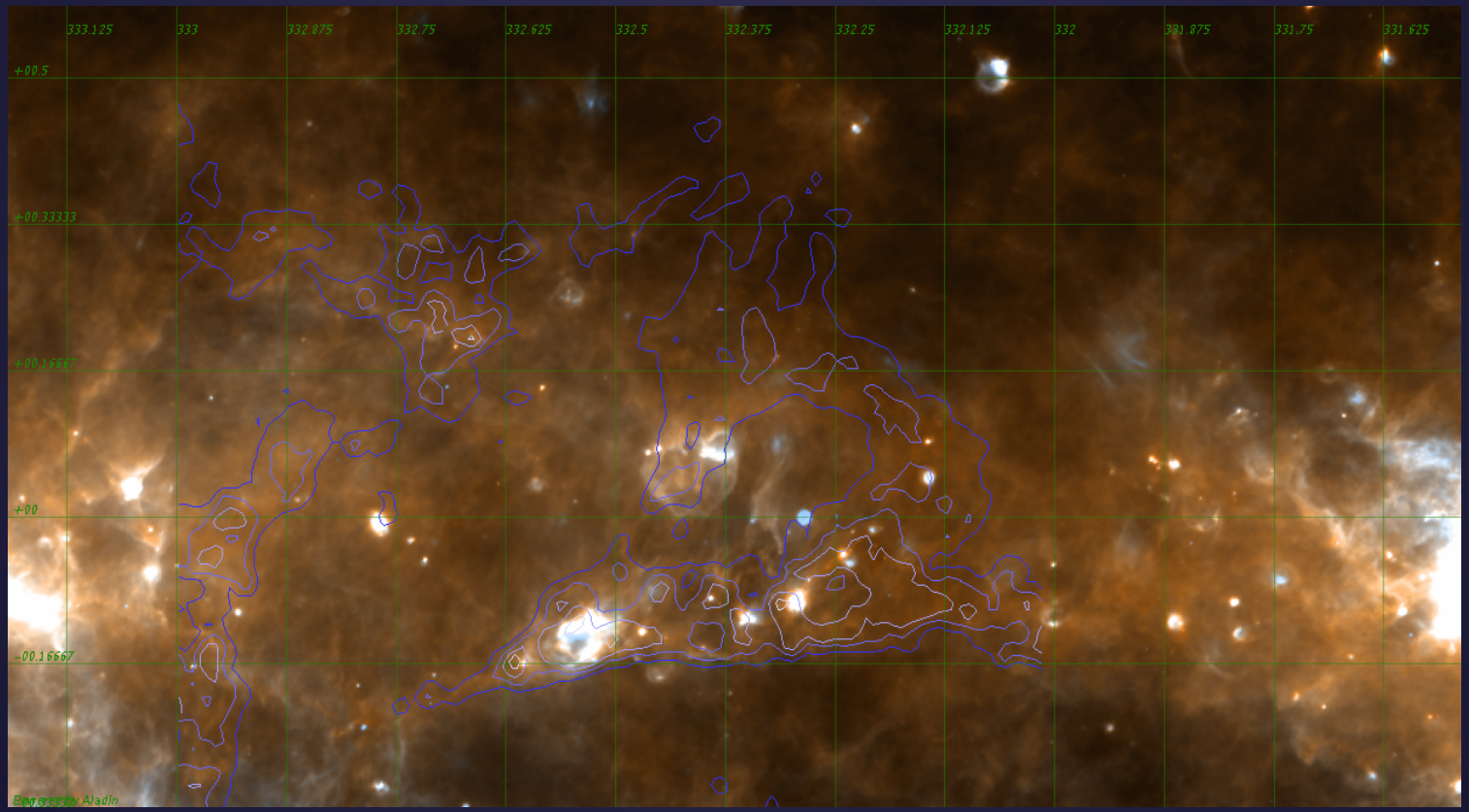
- Molecular hydrogen, CR, Astrochemistry, distance and morphology

Dust Temperature profile

HiGAL PACS

Herschel

500μm *350μm* *250μm* *160μm* *70μm* (Cold dust)

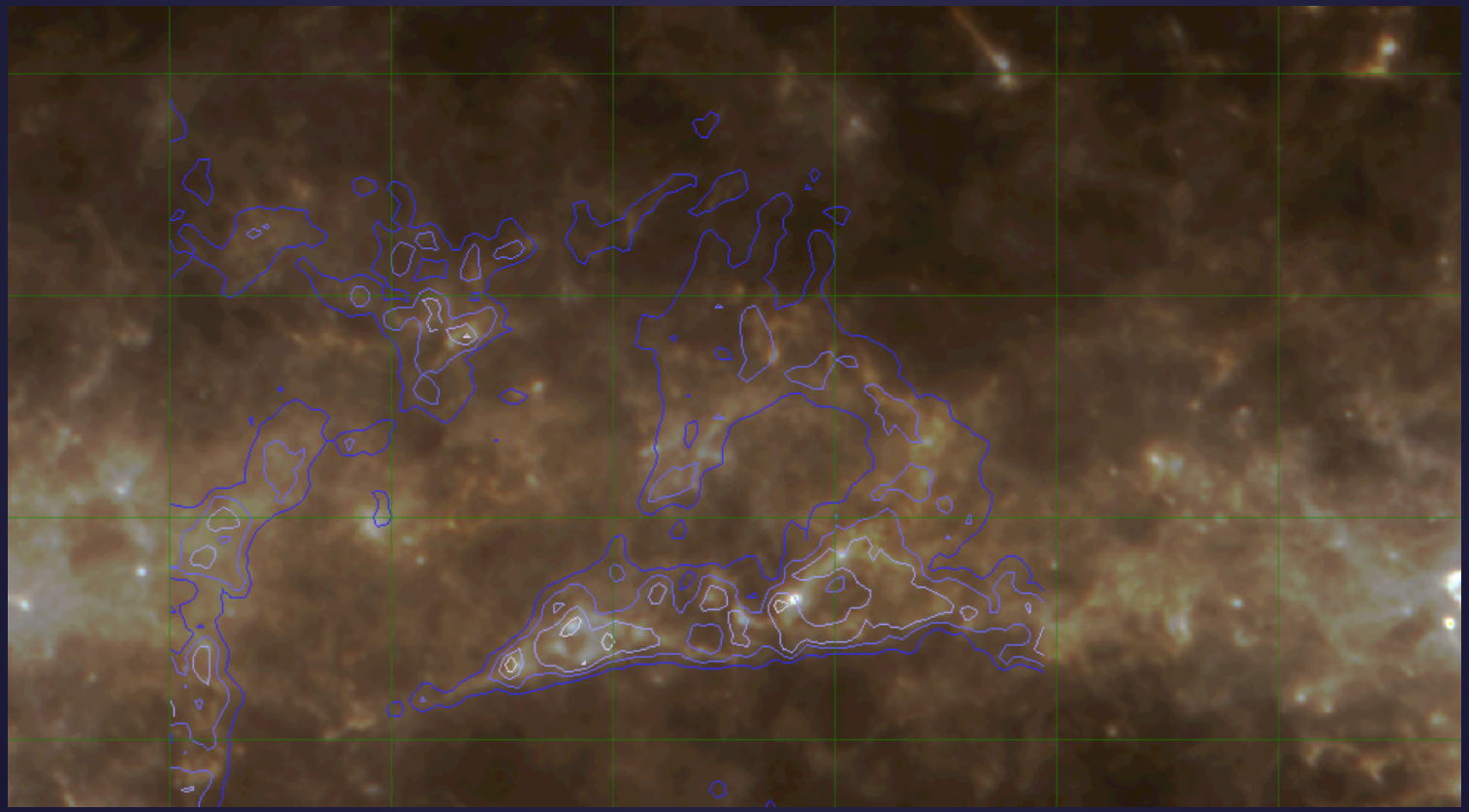


Dust Temperature profile

HiGAL SPIRE

Herschel

500μm *350μm* *250μm* *160μm* *70μm* Cold dust



Dust Temperature profile

Herschel

500μm *350μm* *250μm* *160μm* *70μm* → Cold dust

Modified black body

$$F_\nu = \Omega B_\nu(T_{dust})(1 - e^{\tau_\nu})$$

Burton et al. 2004

dust optical depth

$$\tau_\nu = \kappa_\nu n_{dust}$$

n_{dust} ← dust column density (g cm^{-2})

κ_ν ← dust opacity (cm^2 g^{-1}) (*grain T, size, chemical mix)*

assuming a power law for dust opacity

$$\kappa_\nu = \kappa_0 \left(\frac{\nu}{\nu_0}\right)^\beta$$

β ← dust emissivity index (T)

Assuming dust emission optically thin in the IR

$$1 - e^{\tau_\nu} \rightarrow \tau_\nu$$

$$F_\nu = \Omega B_\nu(T_{dust})\kappa_0 \left(\frac{\nu}{\nu_0}\right)^\beta$$

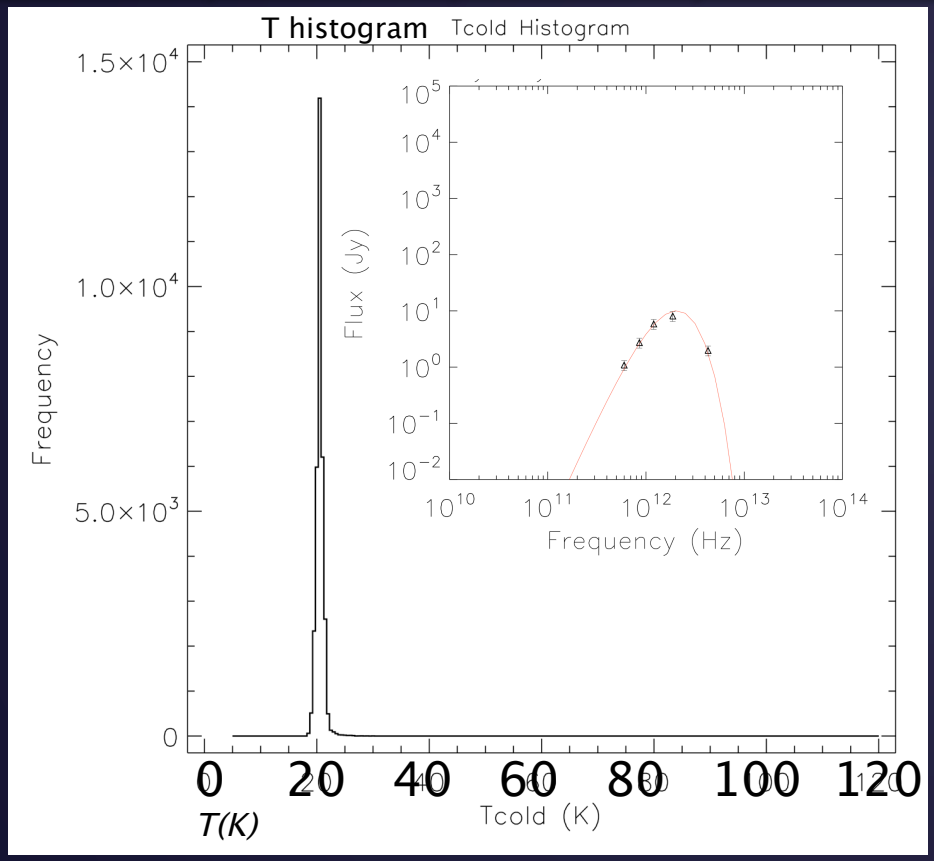
$\beta = 2$ *best fit value*

amorphous & silicate grains

Dust Temperature profile

Herschel

500μm → *350μm* → *250μm* → *160μm* → *70μm* → Cold dust



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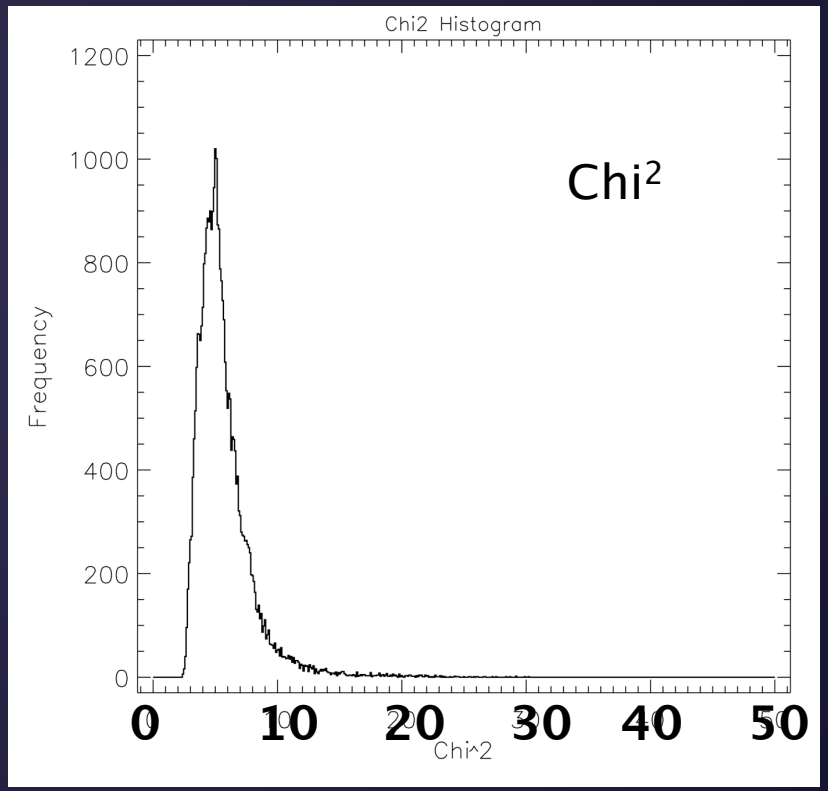
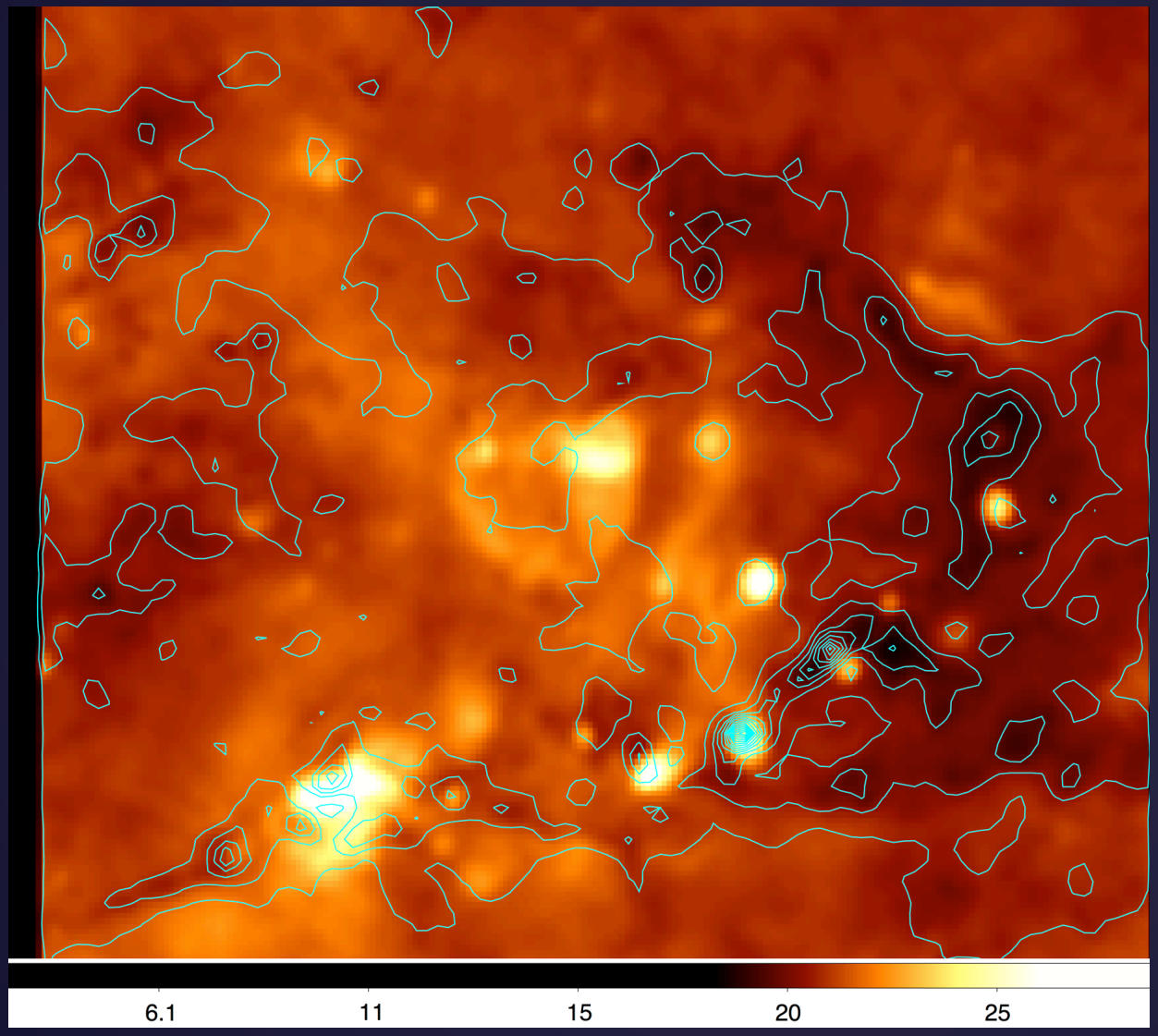


next step implement 870μm

Dust Temperature profile



based on code by Rebolledo D.

dust temperature

dust column density

Herschel data

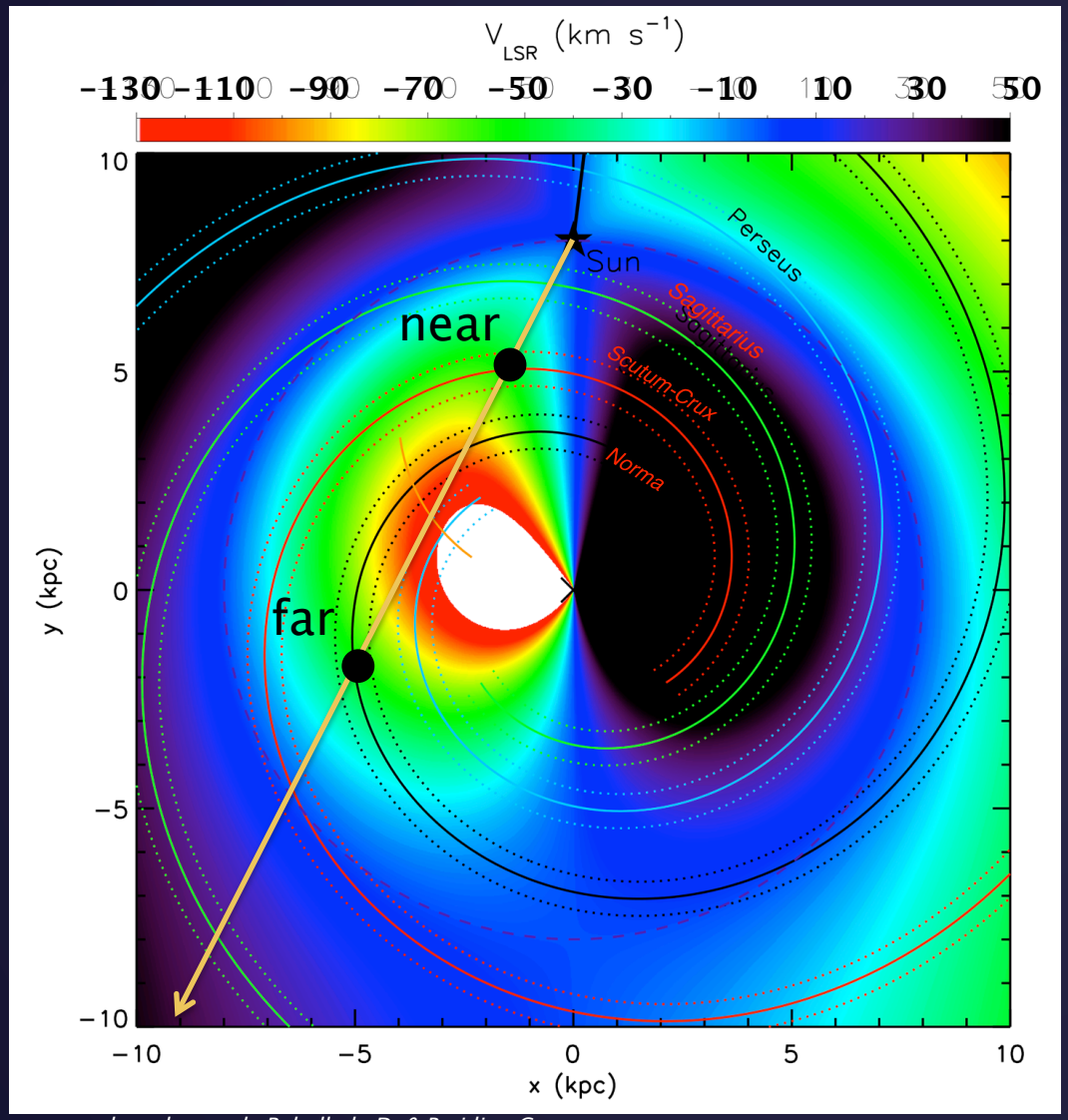
+

CO surveys

↓

dust filamentary structures

The distance



based on code Rebolledo D. & Braiding C.

Galactic rotation curve

McClure-Griffiths & Dickey for Inner Galaxy
Brand & Blitz for Outer Galaxy

Galactic four-arm model parameters

Vallée (2014)

Velocity range

-53 km/s > V_{LSR} > -46 km/s

Velocity peak ~ -50 km/s

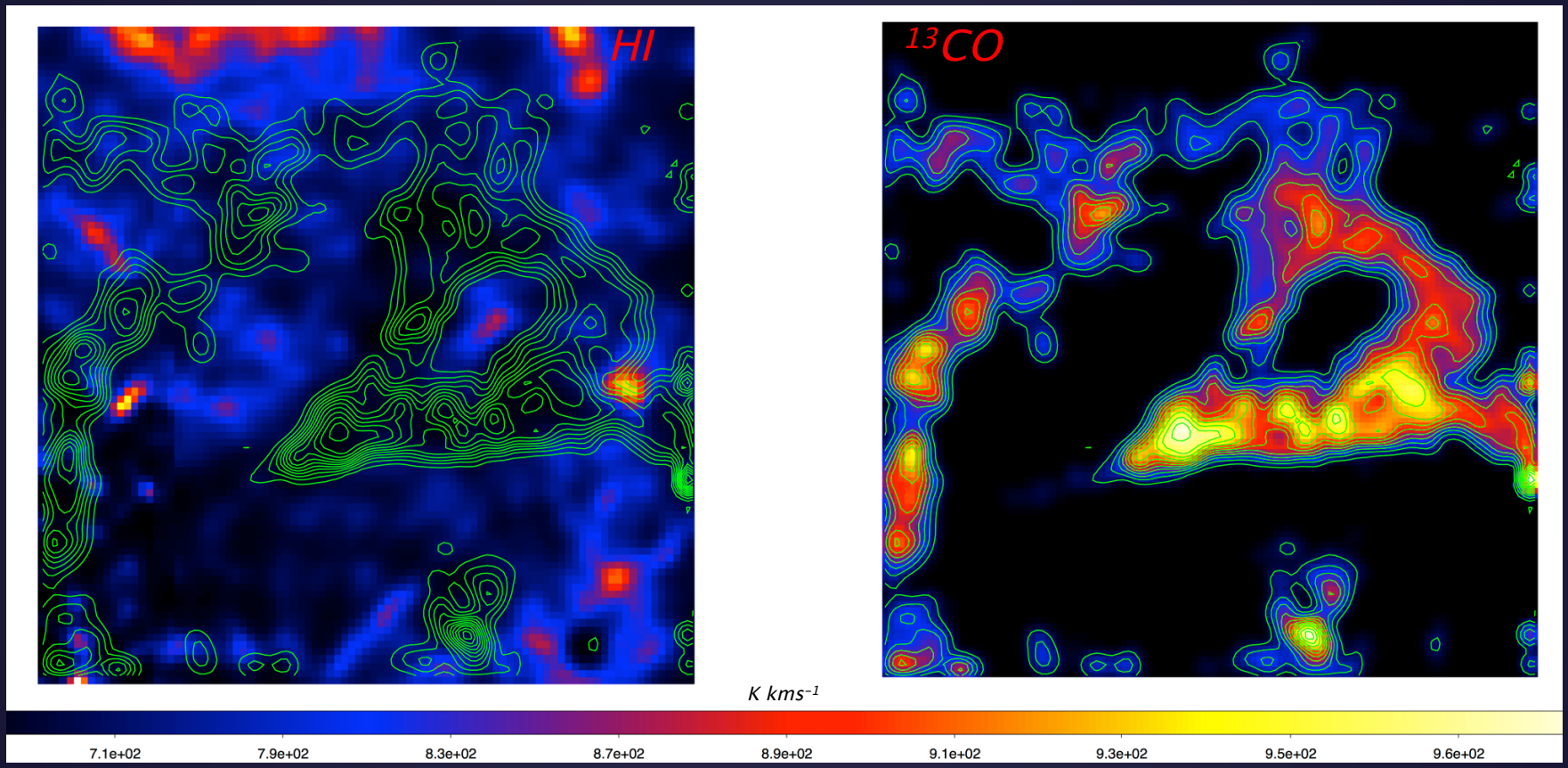
near: ~ 3.7 kpc

far: ~ 11.3 kpc

The distance

SGPS HI survey

Mopra Survey (smoothed)

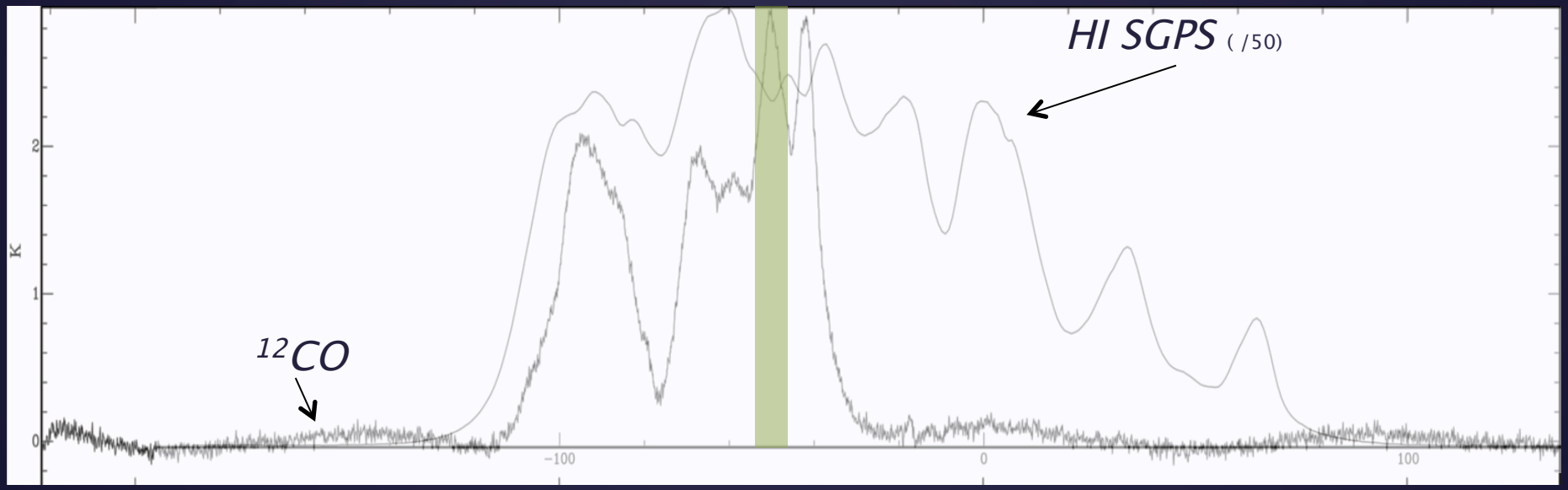


Romano D. et al. in preparation

The ^{12}CO emission matches quite well the low emission region in the HI map.

The distance

the velocities profiles show a ^{12}CO peak emission at the same velocity of the HI local minimum



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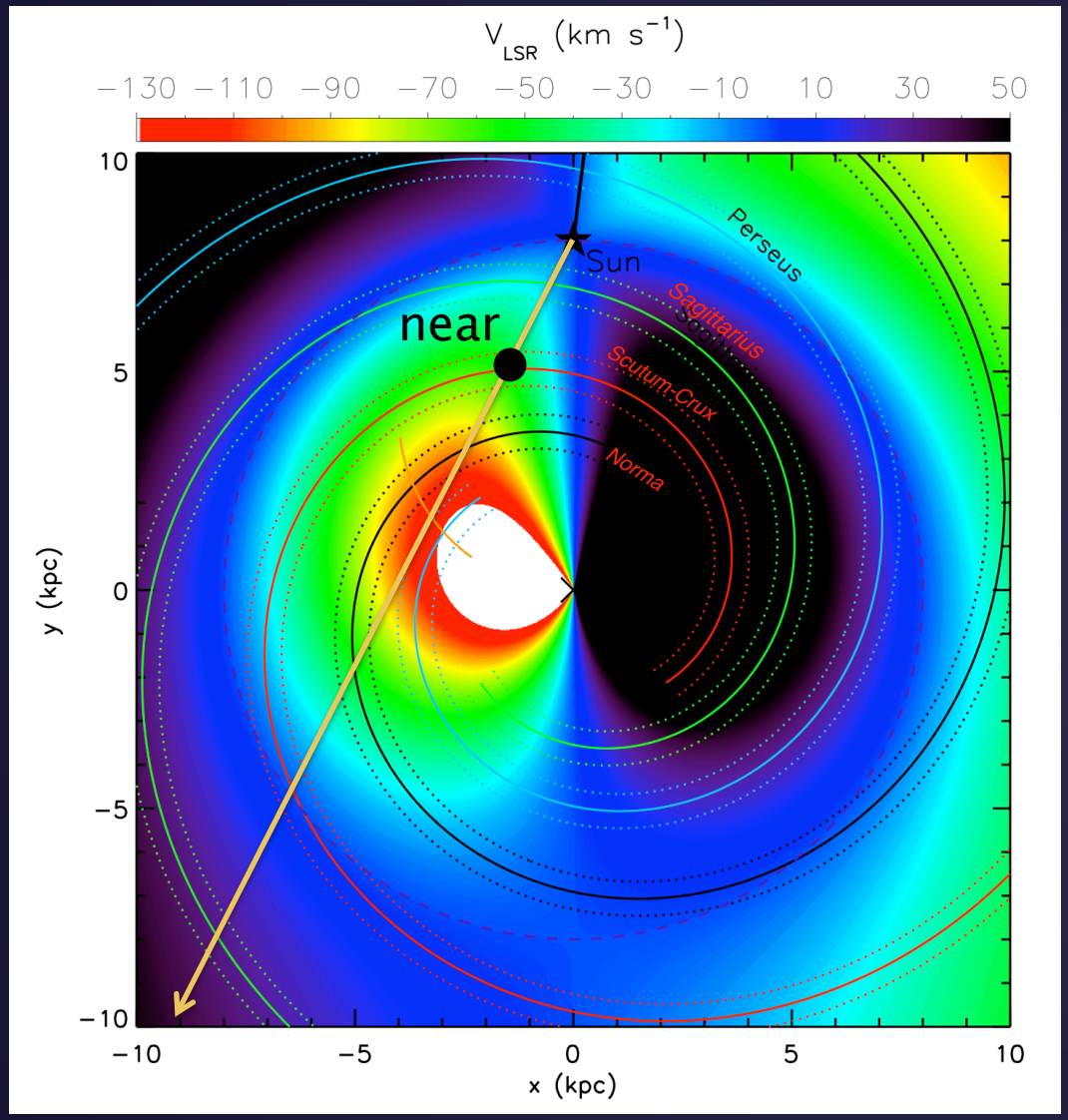
G332 molecular ring region average intensity

The distance



near distance solution
Ring at ~ 3.7 kpc

Inside the

Scutum-Crux arm

ring mass estimate
~4 x 10^5 solar masses

$X_{CO} = 2.7 \times 10^{20}\ cm^{-2}\ K^{-1}\ km^{-1} s$

Dame, Hartmann and Thaddeus (2001)

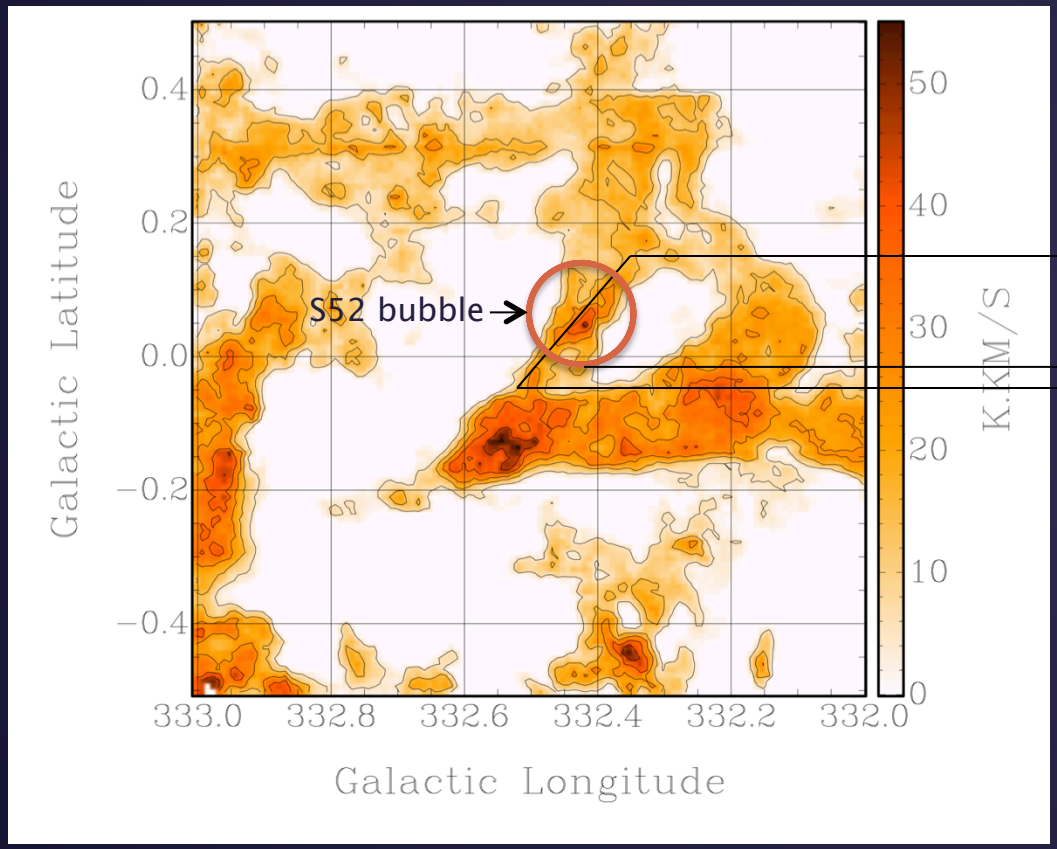
a little bit more…

CPA2006 (S52) – bubble

classified as a complete close ring with multiple bubbles inside
<R> = 2.75’ l=332.412° b=0.048°

Churchwell et al. ApJ 2006

^{12}CO moment zero map



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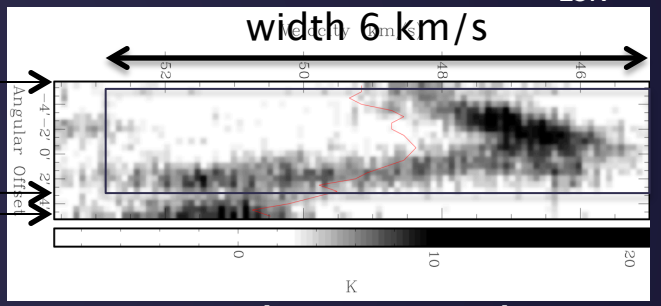
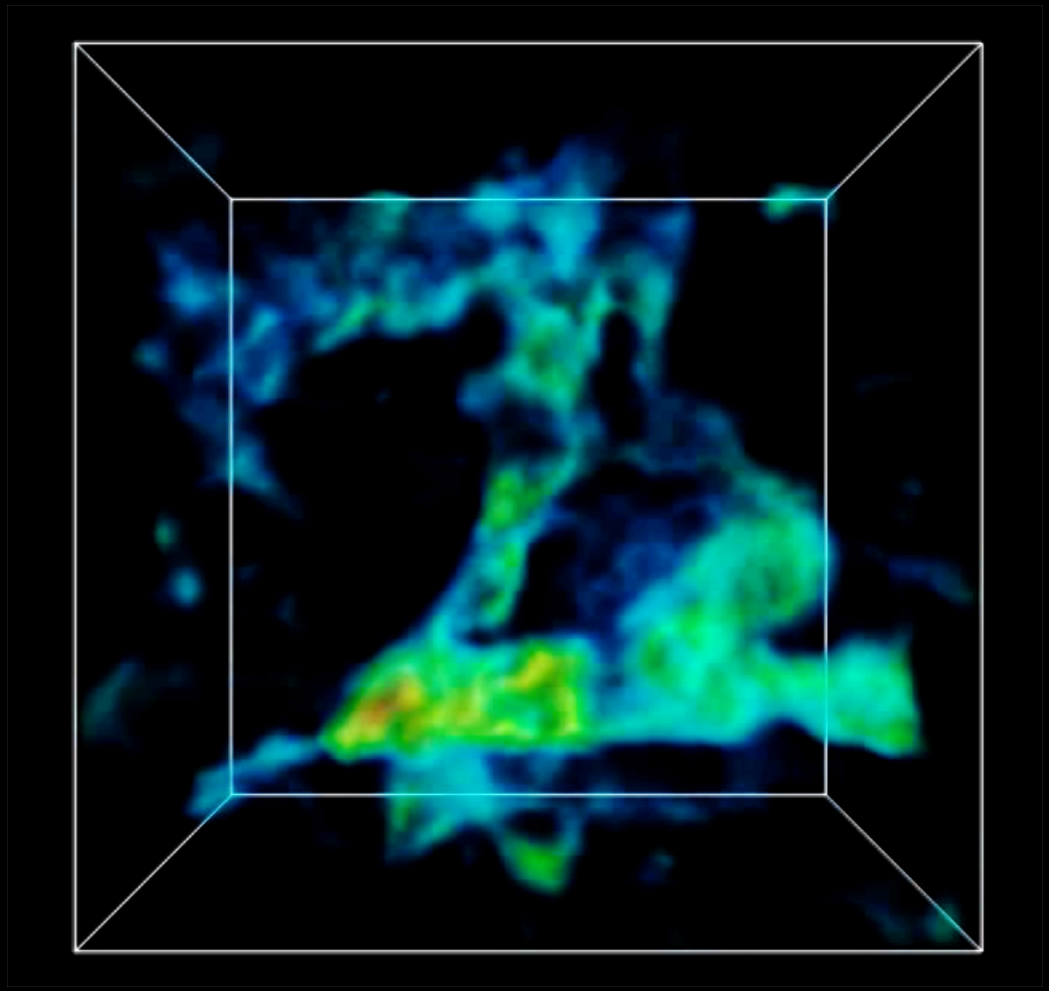
^{12}CO slice profile along V_{LSR}



centered at ~ −49 km/s

is this structure related to the S52 bubble?

further investigations are ongoing…



The Ring ^{12}CO

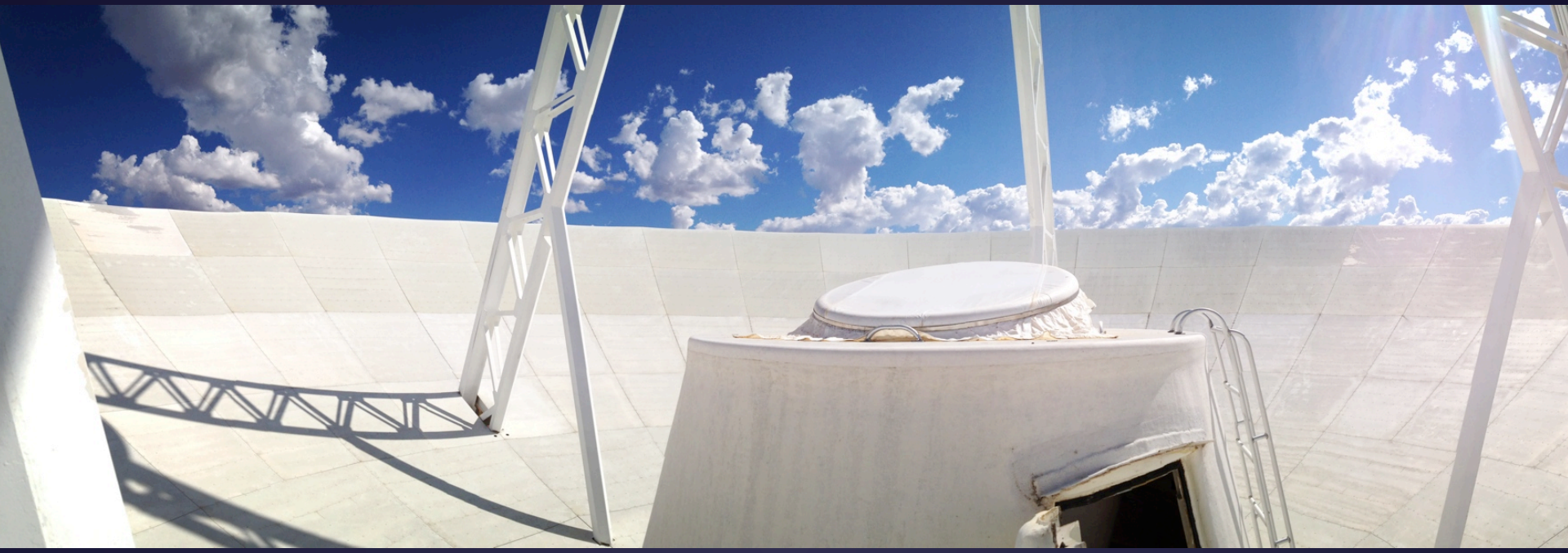
2015 Mopra Workshop

coming soon in the G332 region…

- Improve the physical characterisation of the cloud
- Investigate its dynamics and morphology
- Better understanding of the Dust structures distribution

with intensive use of data visualization tools

Javascript 3d.js
Aladin Processing Three.js
VR implementation python



Thank you
and
Thanks to Mopra

domenico.romano@student.unsw.edu.au

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