Dense gas across the Milky Way – the ‘full strength’ MALT45

Shari Breen | University of Sydney Research Fellow

Tracing the flow – 2018 July

THE UNIVERSITY OF SYDNEY

The team

Shari Breen (USyd)
Andrew Walsh (Curtin)
Simon Ellingsen (UTas)
Chris Jordan (Curtin)
Gavin Rowell (UAdelaide)
Paul Jones (UNSW)
Maria Cunningham (UNSW)
Michael Burton (Armagh)
Christoph Federrath (ANU)
Yanett Contreras (ULeiden)
Jo Dawson (UMacquarie)
Nicola Schneider (UCologne)
Maxim Voronkov (CASS)
Juergen Ott (NRAO)
Phoebe De Wilt (UAdelaide)
Jimi Green (CASS)

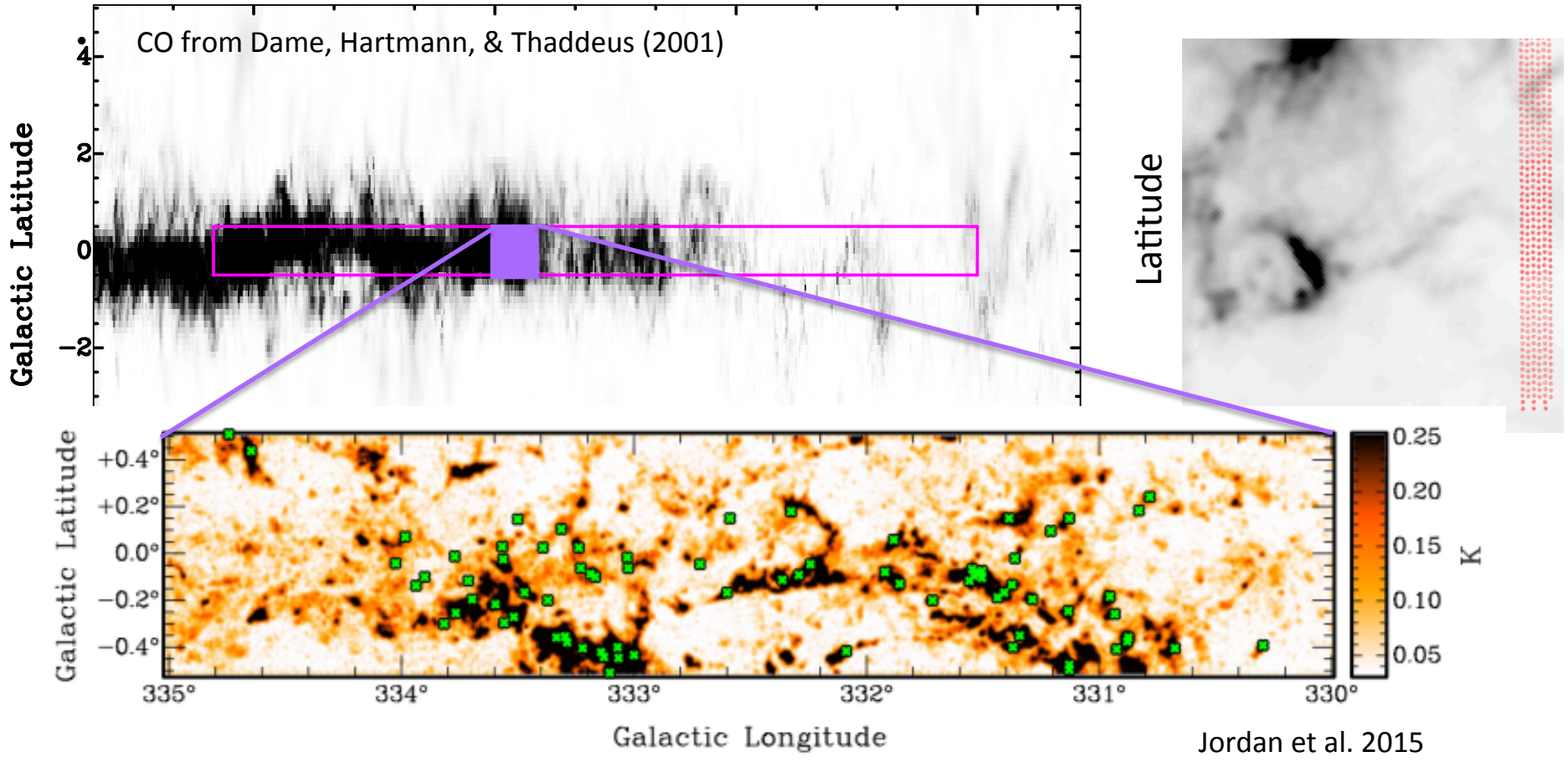
Viktor Tóth (Hungary)
James Jackson (UNewcastle)
Peter Barnes (Florida)
Steven Longmore (Liverpool)
Balt Indermuehle (CASS)
Gary Fuller (UManchester)
Adam Avison (UManchester)
Rowan Smith (UManchester)
Leo Bronfman (Chile)
Giles Novak (Northwestern)
Laura Fissel (NRAO)
Jouni Kainulainen (MPIA)
Chris Phillips (CASS)
Lucas Hyland (UTas)
Tiege McCarthy (UTas)
Nigel Maxted (UNSW)

Opportunities to get involved!

Dense Gas Across the Milky Way – The 'Full-Strength' MALT45

- ATCA legacy survey (2700h)
- 90 square degrees of the Southern galactic plane at 7mm (dense gas, shock tracers, recombination lines, class I methanol masers, SiO masers…. continuum?)
  - 270° < longitude < 5° (i.e. through the GC), latitudes < |0.5|°
  - autocorrelation data!
  - On the fly mapping, 6 seconds integrations (equivalent to **1484190** pointings)
  - scanning only in latitude – fully sampled at the highest frequency
  - Sensitivity to see typical 400 $M_{\odot}$ out to 15 kpc (corresponds to ~44 mK in a single spectral channel)
  - Velocity resolution of ~0.2 km/s, and coverage of ~700 km/s +
  - Started observing end of May 2017 and have so far successfully observed ~418 hours of allocated time + some green time!

Dense Gas Across the Milky Way – The 'Full-Strength' MALT45



Jordan et al. 2015

CH_3OH 1_0–0_0 A+	48.37246	Thermal	58	H53α (RRL)	42.95197	Thermal	65
$C^{34}S$ (1–0)	48.20694	Thermal	58	SiO (1–0) $v = 2$	42.82048	Maser	66
H51α (RRL)	48.15360	Thermal	58	SiO (1–0) $v = 3$	42.51934	Maser	66

Science drivers

- Characterise the dense gas structure of our Galaxy through sensitive CS observations, allowing us to detect molecular clouds out to the far side of the Galaxy and provide us with the clearest picture of Galactic structure to date
- Combined with data from a number of other surveys will allow us to trace the cycle of material through the ISM and into stars
- Gain a new census of high-mass star forming regions (through CS, SiO, methanol masers and radio continuum observations) and directly test theoretical predictions of high-mass star formation and their precursors, feeding directly into future ALMA work on high-mass star formation
- Produce an essential dataset that will underpin the Galactic plane survey in TeV gamma-rays by the forthcoming multi-national CTA facility

Understanding our own Galaxy will allows us to interpret future sensitive, high resolution surveys of external galaxies with new/next generation telescopes

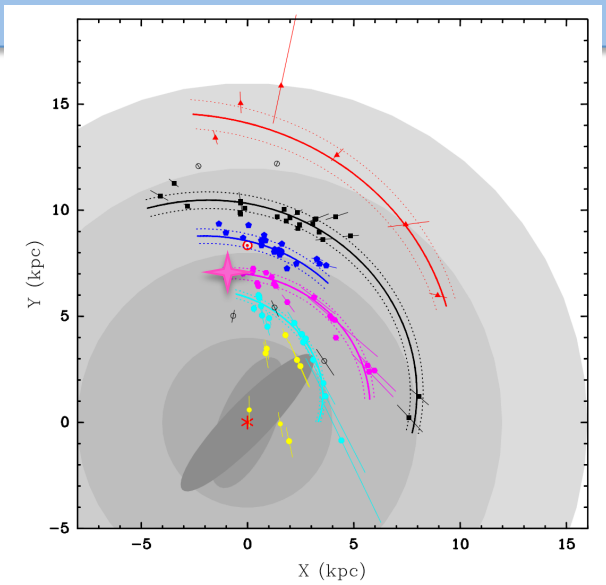
Star formation

- Test predictions of core accretion and competitive accretion
- Determine the relative importance of gravitation and magnetic fields in star formation
- Test theories of filament formation – we have a distinct advantage
- Measure the column density probability distribution functions
- SiO masers and thermal emission
- Characterise how class I methanol masers relate to star formation
- Identify and characterise HCH II regions (maybe…)
- Star formation and environment

Galactic structure

- Uncover the dense gas structure of the Galaxy which we can compare with to the distribution of the older stellar population traced by SiO masers
  - gain a more complete picture of the current structure, and the history of the Galaxy.
  - CS constrained to the spiral arms
  - combine with maser parallax to leverage greatly improved distances (and therefore mass, luminosity etc of young stars

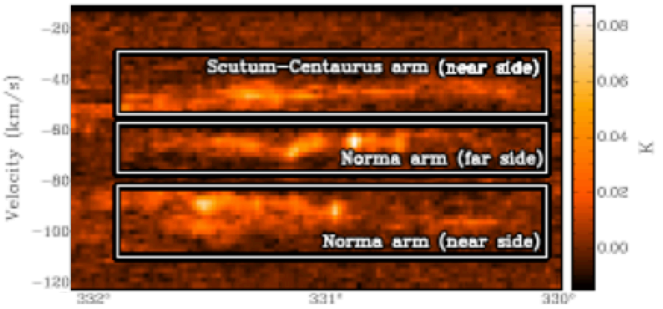
- Determine the interplay between the low density gas that traces molecular cloud formation and the dense gas that traces the formation of stars.
  - CS provides missing density regime, providing unprecedented dynamic range in all density scales.
  - derive density abundances of full range of gas tracers, as well as gas column density -> how do the abundances, morphology and velocity structures change with different phases?



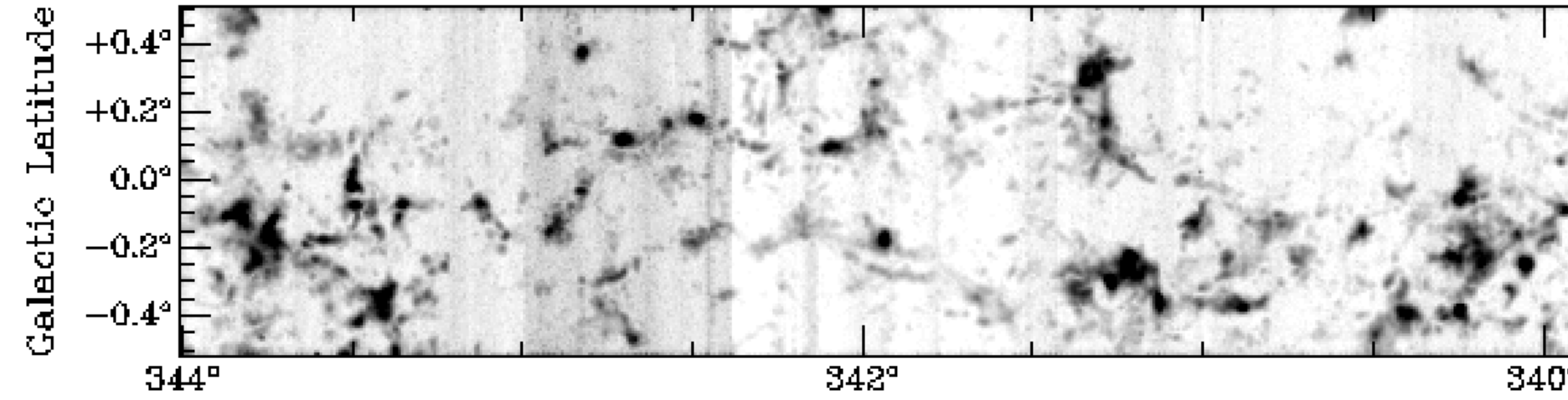
Inner Galaxy
Scutum arm
Sagittarius arm
(from Krishnan et al. (2015)

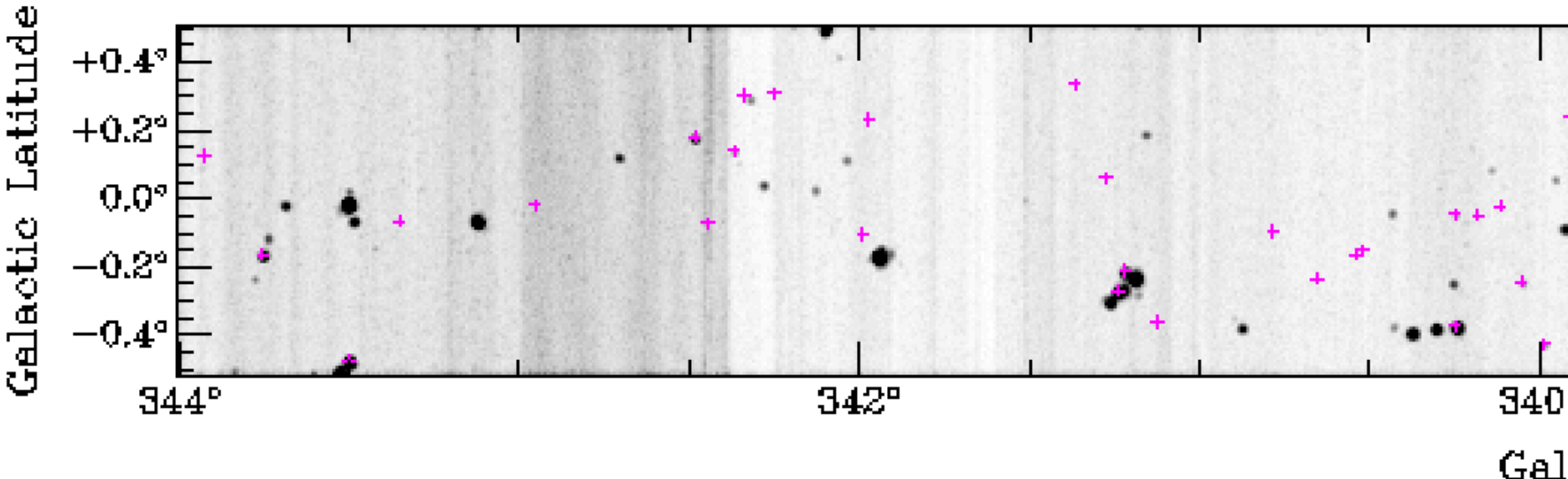
Local arm
Perseus arm
Outer arm

Reid et al. (2014)

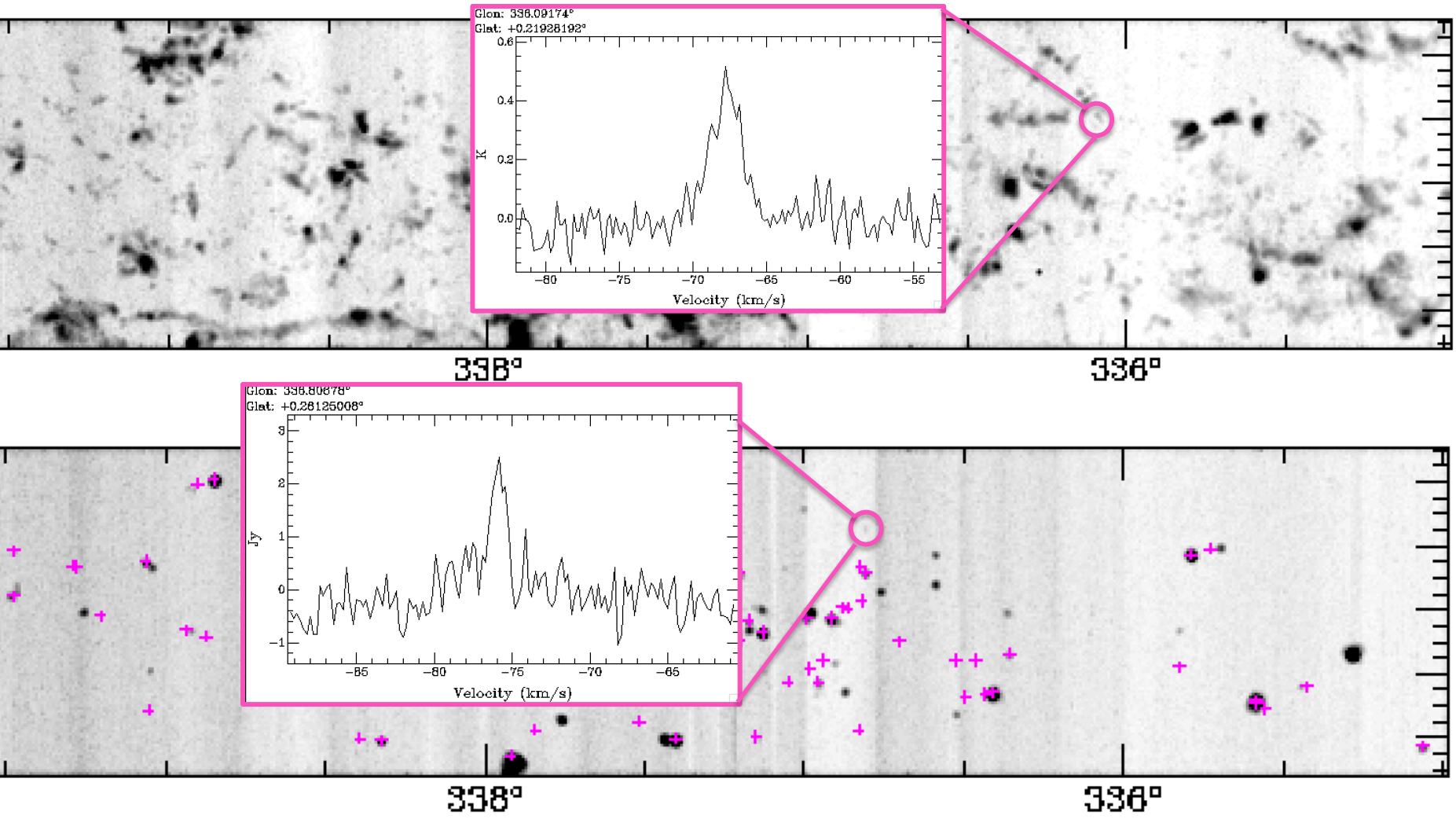


G335 – G345 priority region – CS and class I methanol

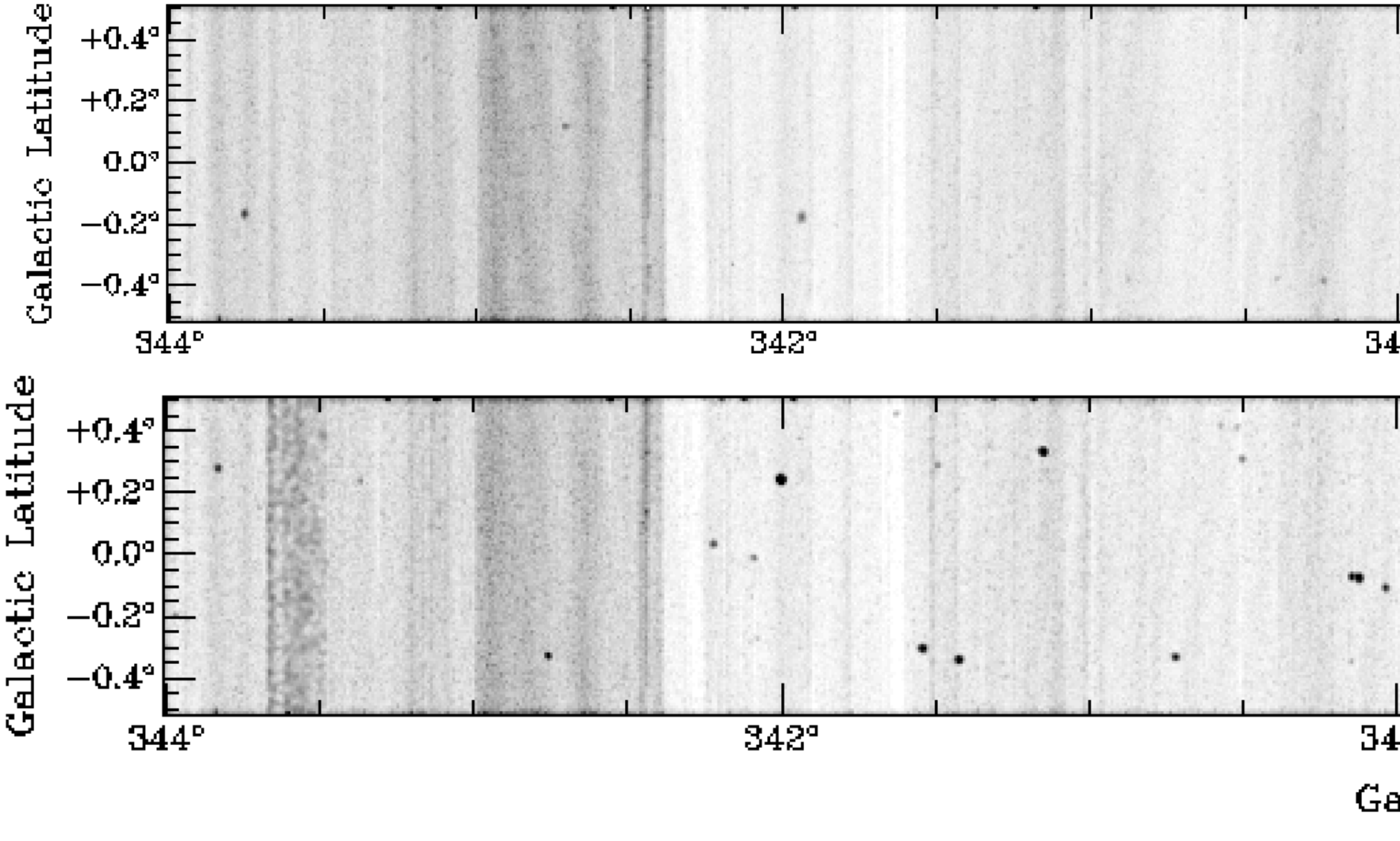




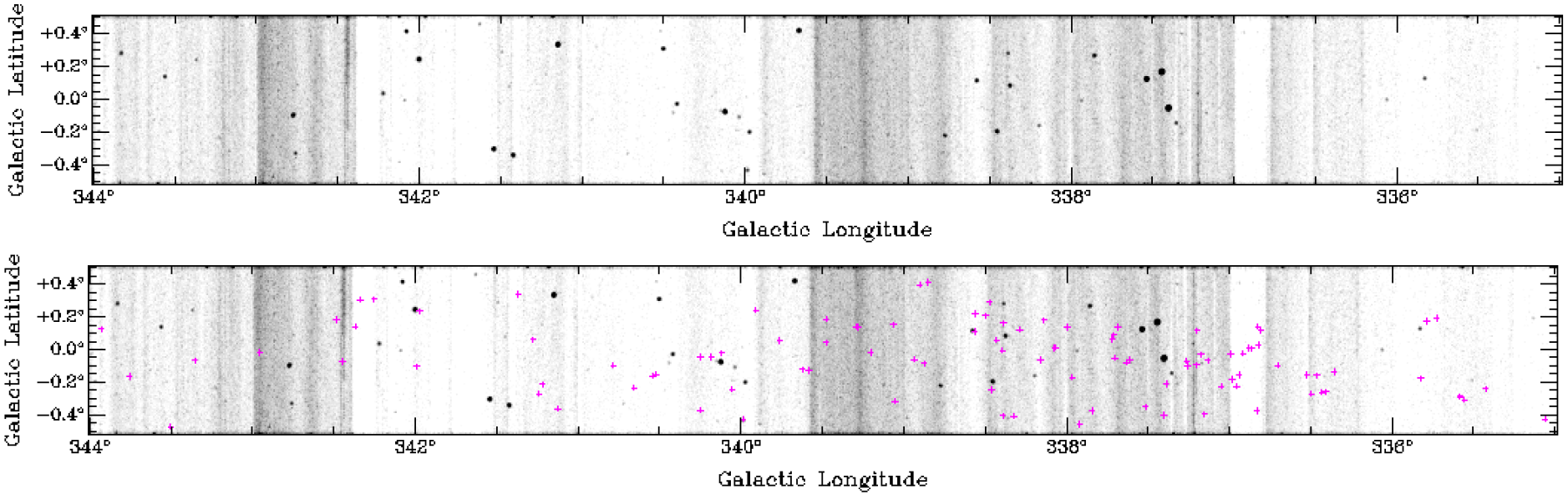
G335 – G345 priority region – CS and class I methanol

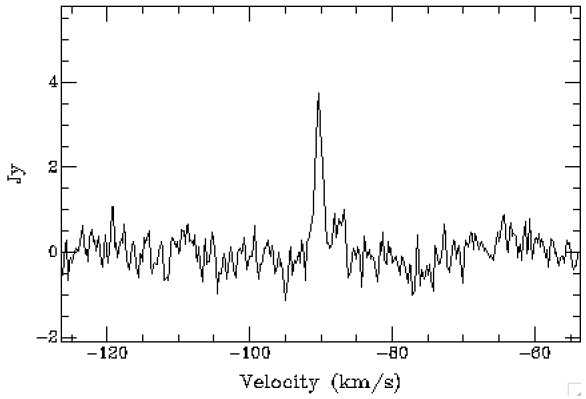


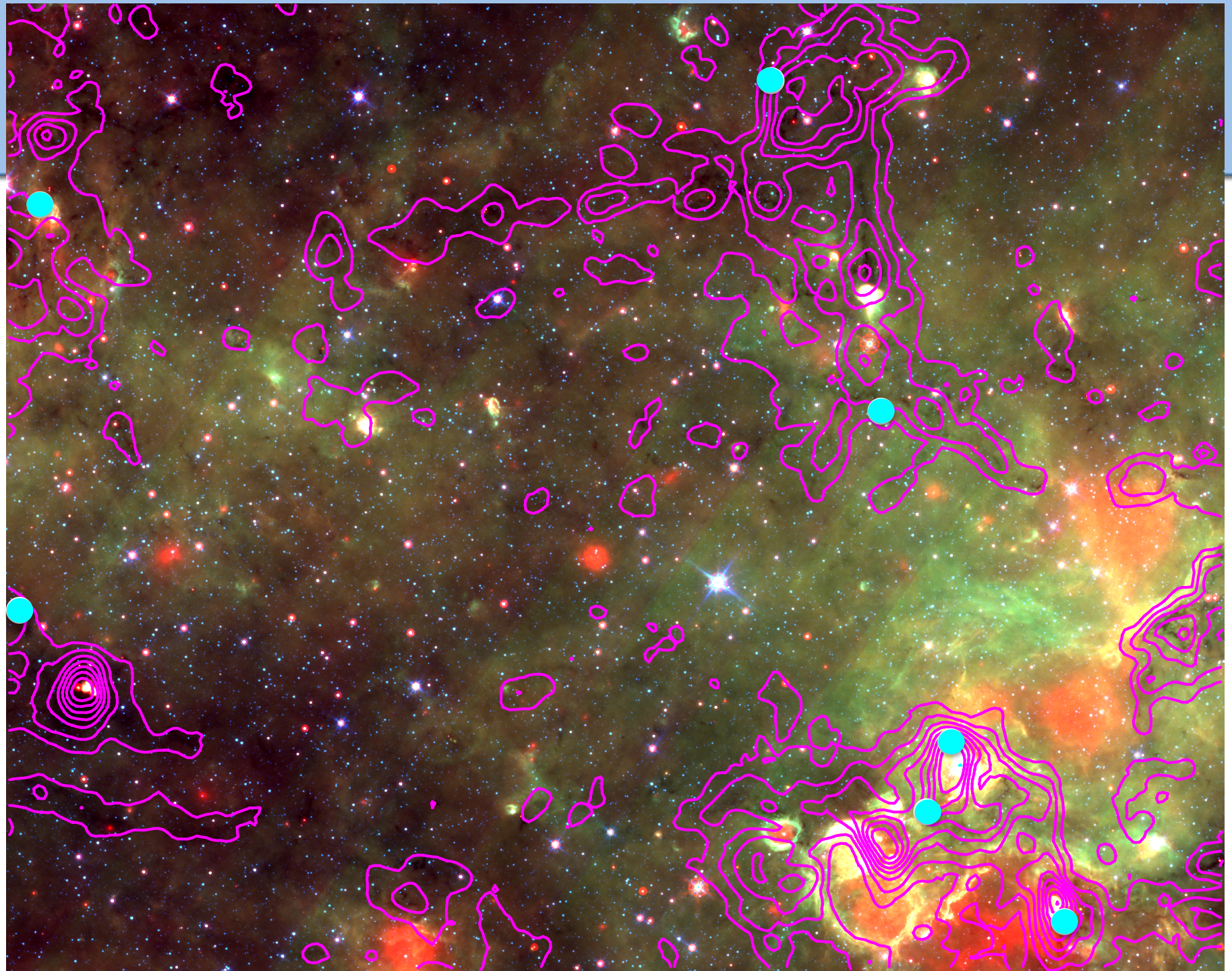
G335 – G345 priority region – SiO v=1 and v=0



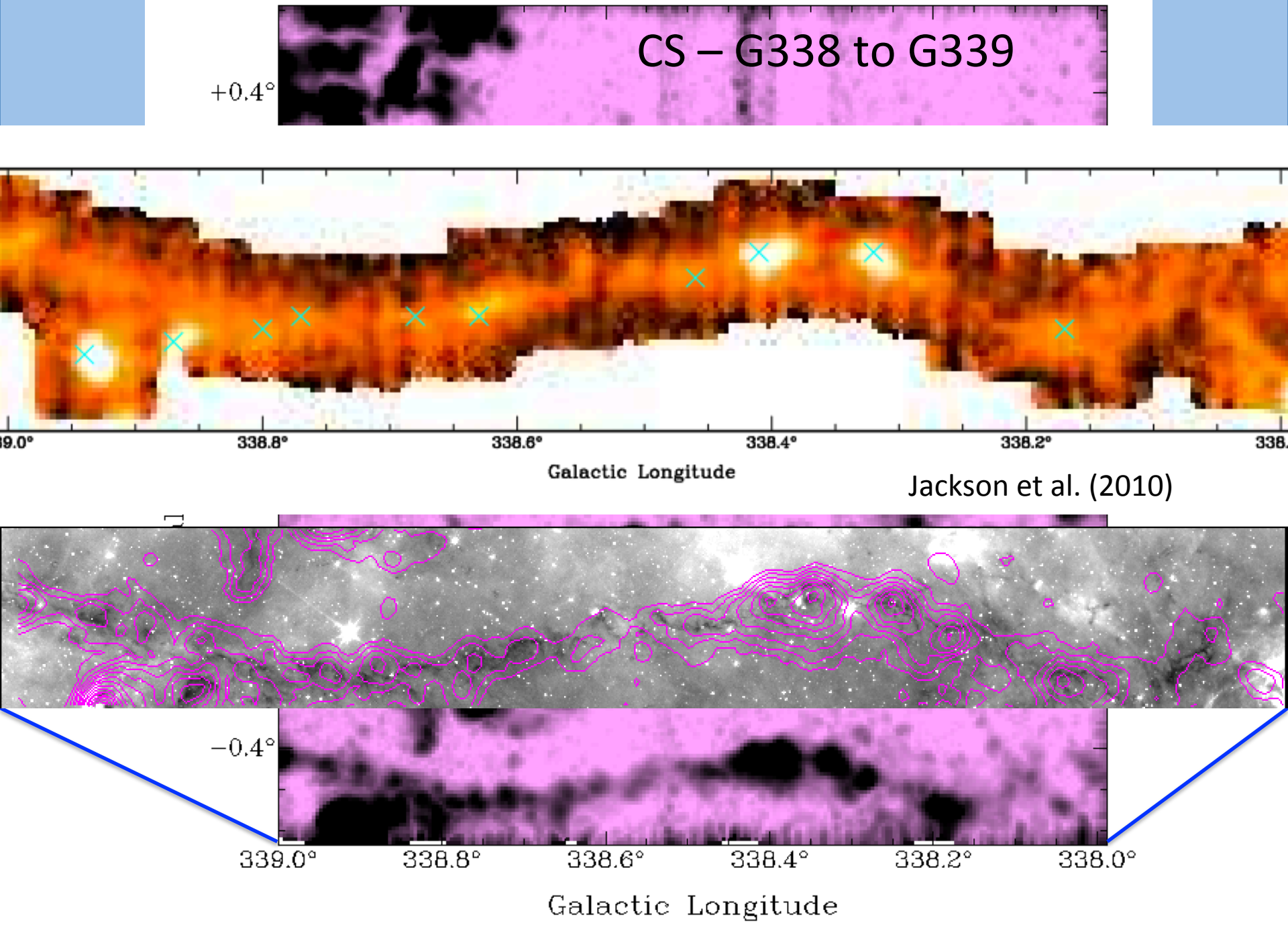
G335 – G345 priority region – SiO v=2





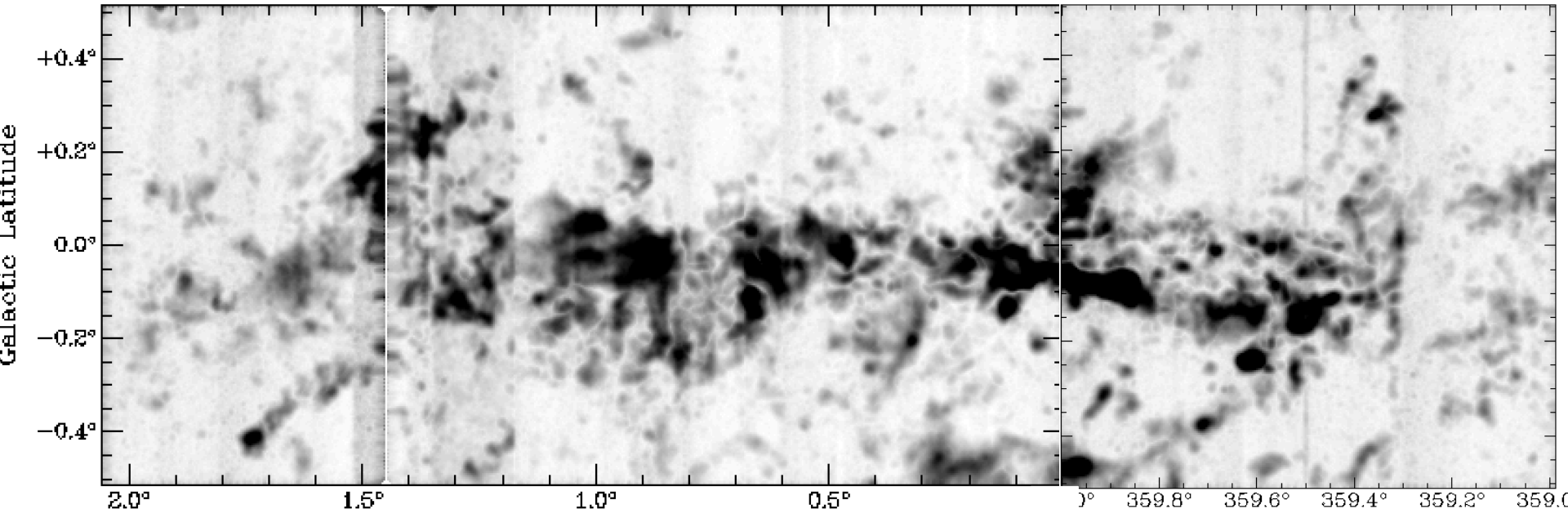


CS – G338 to G339



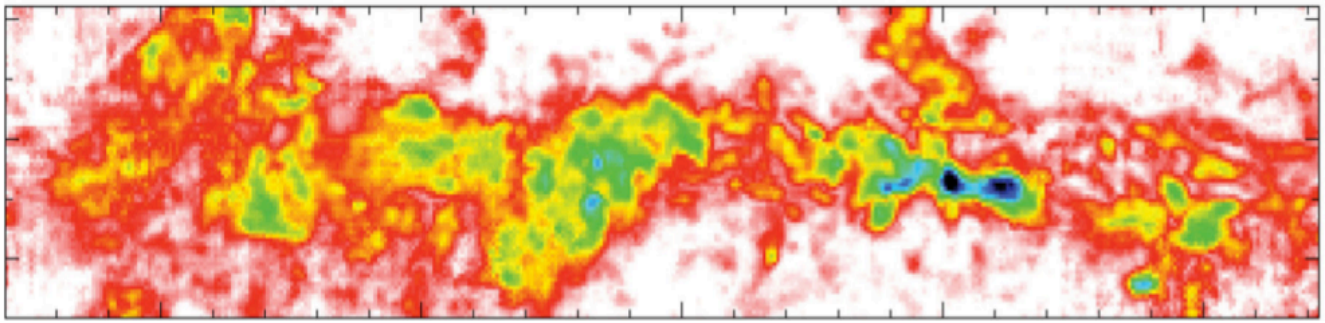
Jackson et al. (2010)

The Galactic Centre



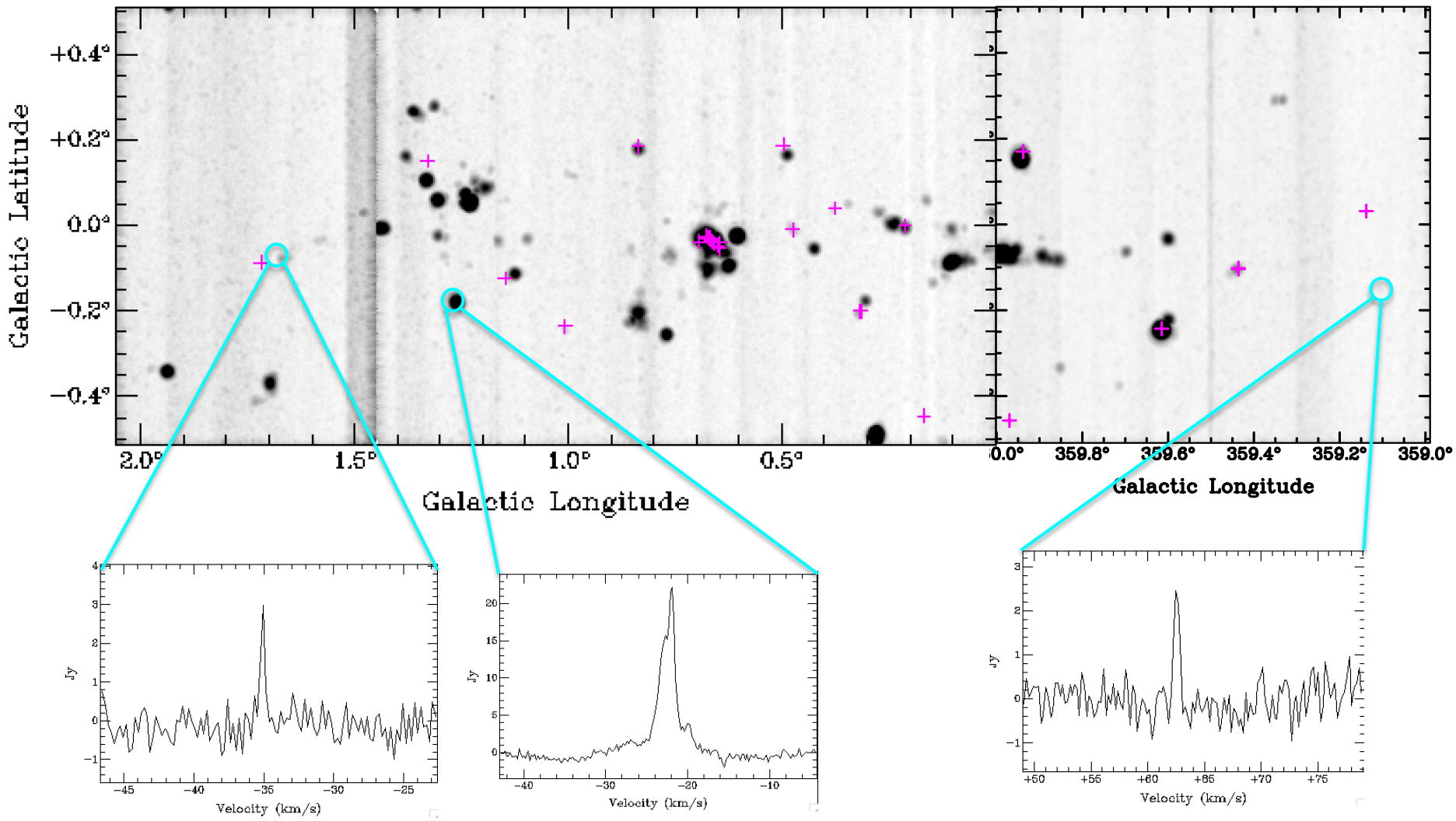
2°

359°

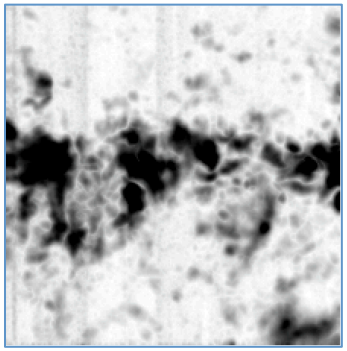


Jones et al. (2013)

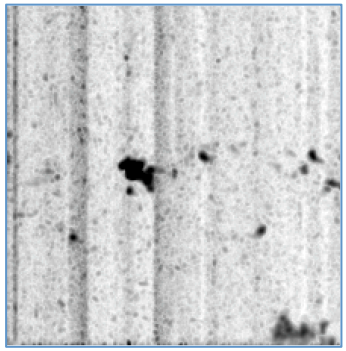
The Galactic Centre – Class I methanol



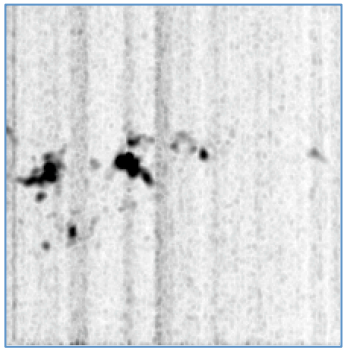
The Galactic Centre (l=1-0)



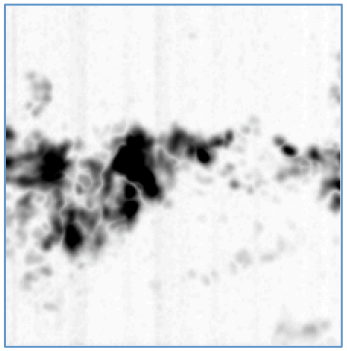
CS



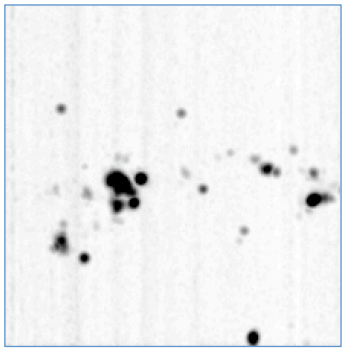
$C^{34}S$



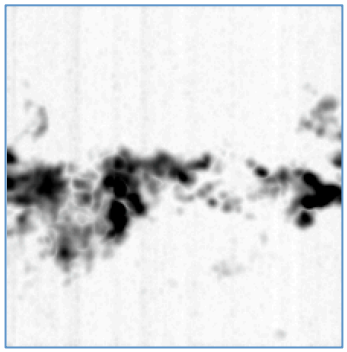
OCS



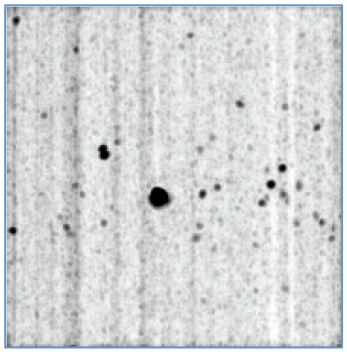
thermal methanol



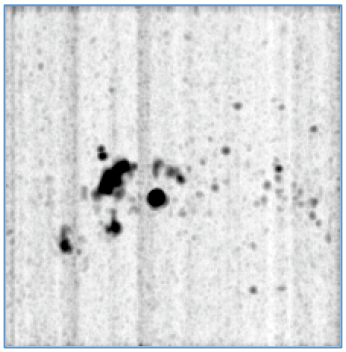
Class I methanol



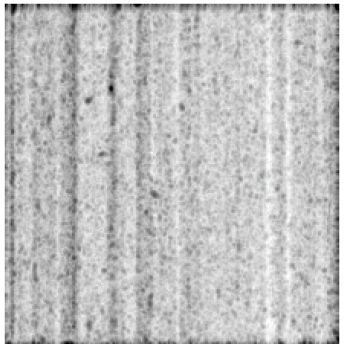
SiO (1-0) v=0



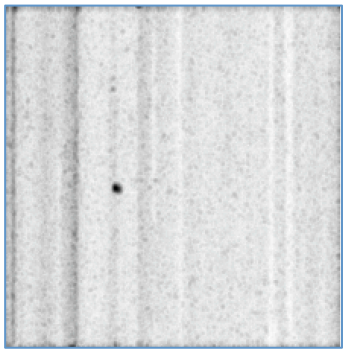
SiO (1-0) v=1



SiO (1-0) v=2

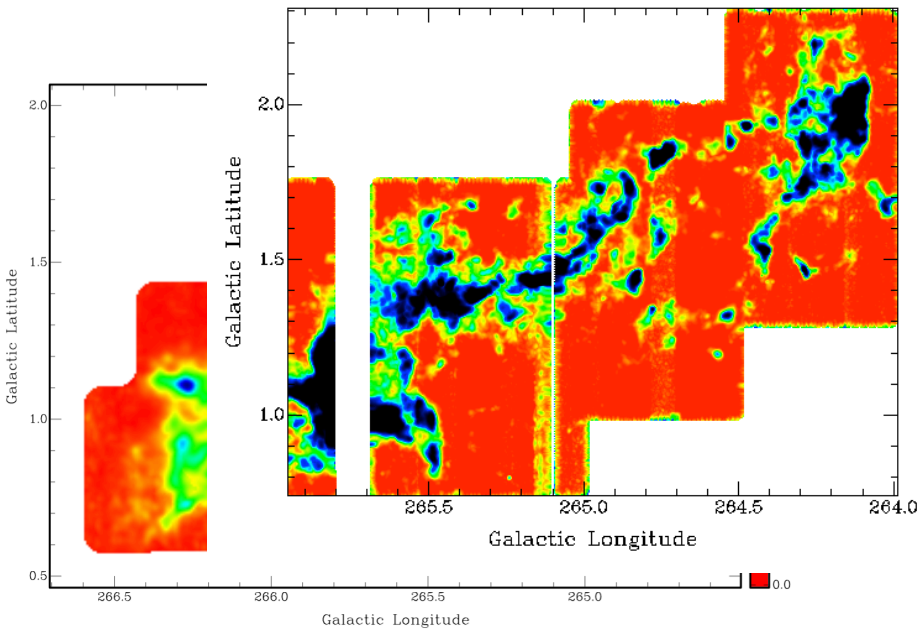


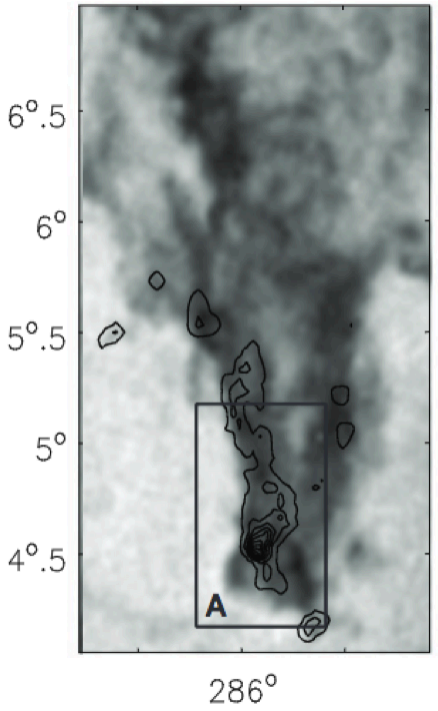
SiO (1-0) v=3

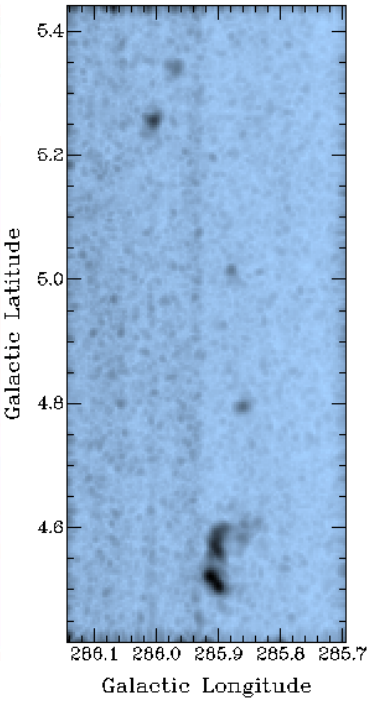


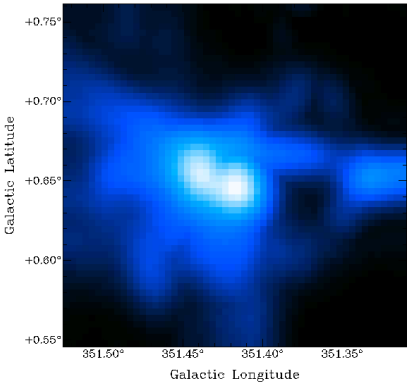
H53alpha

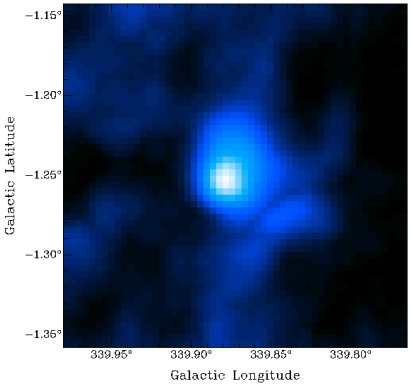
Extra regions

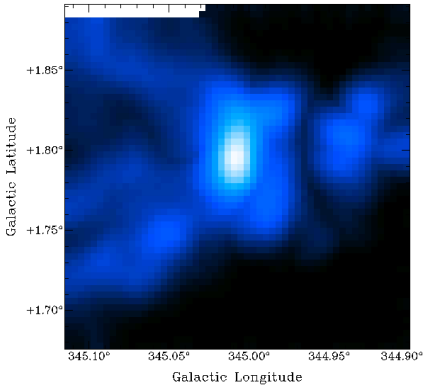


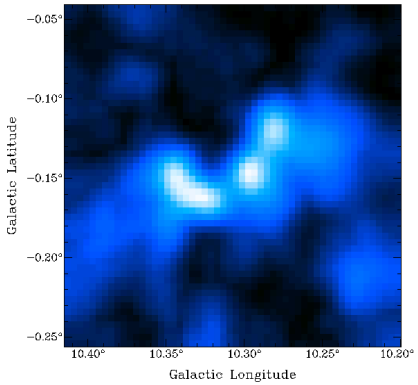




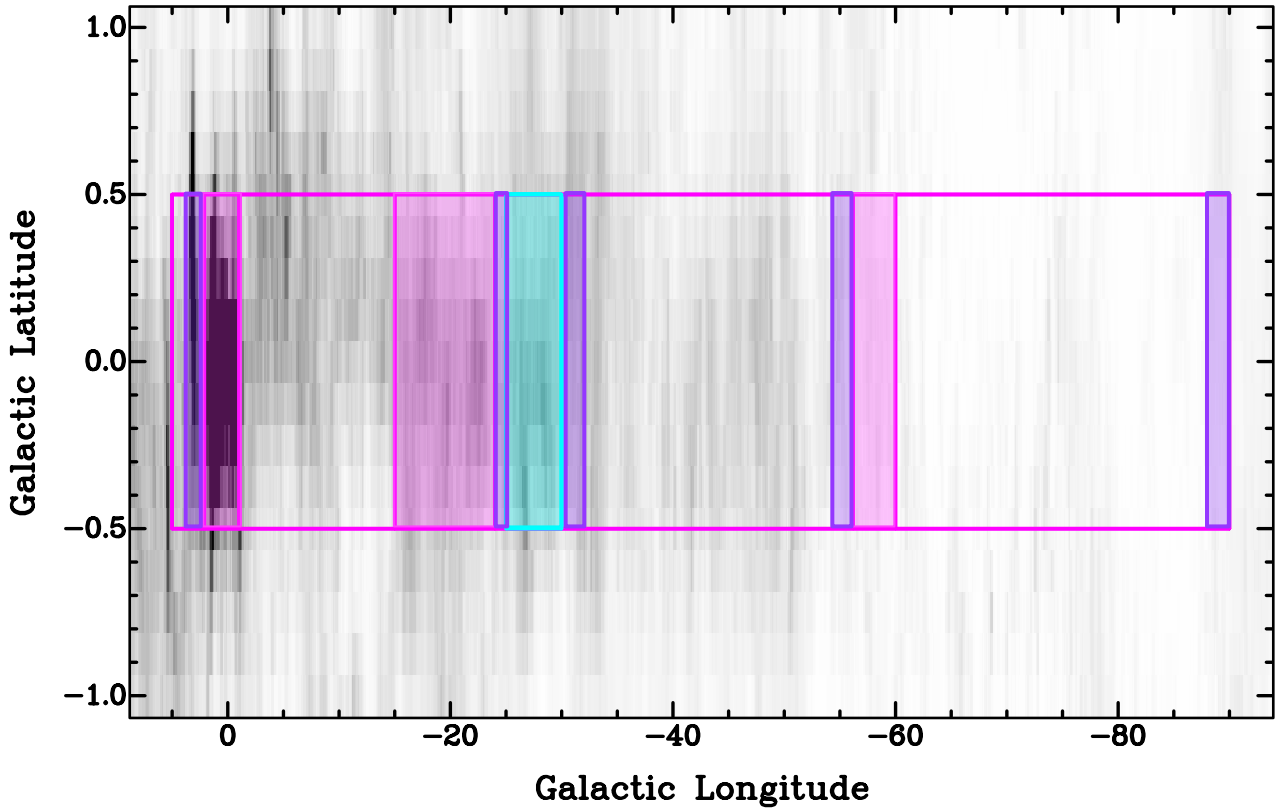








Observing status



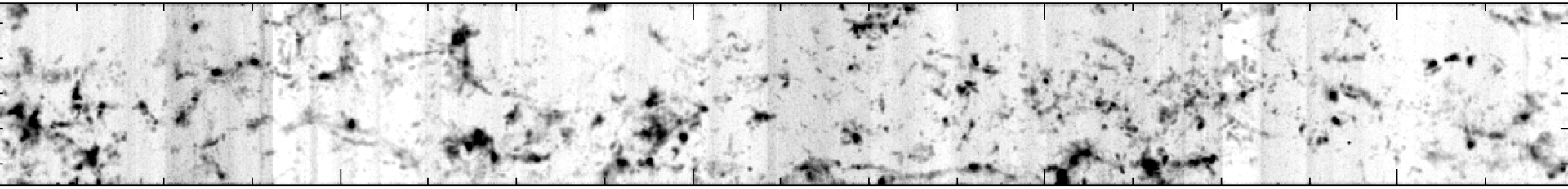
Jordan et al. (2015)

Our current coverage

Planned coverage rest of semester

CO from Dame, Hartmann, & Thaddeus (2001)

Summary



- We are really impressed with the data we are getting
  - lots of interesting detections
  - matches expectations well
  - small tweaks need to be made to the pipeline
- Making good progress towards first paper and data release (whatever that looks like)
- Plenty of science to be done, plenty of opportunities to get involved
- organising a science workshop for later in the year

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S. L. Breen,[1*] C. H. Jordan,[2] M. A. Voronkov,[3] Y. Contreras,[4] M. R. Cunningham,[5] J. R. Dawson,[6] S. P. Ellingsen,[7] J. A. Green,[3] L. Hyland,[7,3] P. Jones,[5] J. F. Kaczmarek,[3] T. McCarthy,[7,3] J. Ott,[8] C. J. Phillips,[3] J. B. Stevens,[3] A. J. Walsh,[2] A. Avison,[9,10] P. Barnes,[11] L. Bronfman,[12] M. G. Burton,[5,13] P. de Wilt,[14] C. Federrath,[15] L. M. Fissel,[16] G. A. Fuller,[9,10] B. Indermuehle,[3] J. M. Jackson,[17] J. Kainulainen,[18] S. N. Longmore,[19] N. Maxted,[5] G. Novak,[20,21] G. Rowell,[14] N. Schneider,[22] R. Smith,[9] L. V. Tóth,[23]

[1] *Sydney Institute for Astronomy (SIfA), School of Physics, University of Sydney, NSW 2006, Australia;*
[2] *International Centre for Radio Astronomy Research, Curtin University, Bentley, WA 6845;*
[3] *CSIRO Astronomy and Space Science, Australia Telescope National Facility, PO Box 76, Epping, NSW 1710, Australia;*
[4] *Leiden Observatory, Leiden University, P.O. Box 9513, NL-2300 RA Leiden, The Netherlands;*
[5] *School of Physics, The University of New South Wales, Sydney, NSW 2052, Australia;*
[6] *Department of Physics and Astronomy and MQ Research Centre in Astronomy, Astrophysics and Astrophotonics, Macquarie University, NSW 2109;*
[7] *School of Mathematics and Physics, University of Tasmania, Private Bag 37, Hobart, Tasmania 7001, Australia;*
[8] *National Radio Astronomy Observatory, P.O. Box O, 1003 Lopezville Road, Socorro, NM 87801, USA;*
[9] *Jodrell Bank Centre for Astrophysics, Alan Turing Building, School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL, UK;*
[10] *UK ALMA Regional Centre Node, Manchester, M13 9PL, UK;*
[11] *Department of Astronomy, University of Florida, Gainesville, FL 32611, USA;*
[12] *Departamento de Astronomía, Universidad de Chile, Casilla 36, Santiago de Chile, Chile;*
[13] *Armagh Observatory and Planetarium, College Hill, Armagh BT61 9DG, UK;*
[14] *School of Physical Sciences, University of Adelaide 5005, South Australia, Australia;*
[15] *Research School of Astronomy and Astrophysics, Australian National University, Canberra, ACT 2611, Australia;*
[16] *National Radio Astronomy Observatory, Charlottesville, NC, USA;*
[17] *School of Mathematical and Physical Sciences, University of Newcastle, University Drive, Callaghan NSW 2308, Australia;*
[18] *Max-Planck-Institut für Astronomie (MPIA), Königstuhl 17, 69117, Heidelberg, Germany;*
[19] *Astrophysics Research Institute, Liverpool John Moores University, 146 Brownlow Hill, Liverpool L3 5RF, UK;*
[20] *Center for Interdisciplinary Exploration and Research in Astrophysics (CIERA);*
[21] *Department of Physics & Astronomy, Northwestern University, 2145 Sheridan Road, Evanston, IL 60208, USA;*
[22] *Laboratoire d'Astrophysique de Bordeaux, Univ. Bordeaux, CNRS, B18N, allÃ¨e G. Saint-Hilaire, 33615, Pessac, France;*
[23] *Eötvös University, Department of Astronomy, Pázmány P. s. 1/a, 1117, Budapest, Hungary*