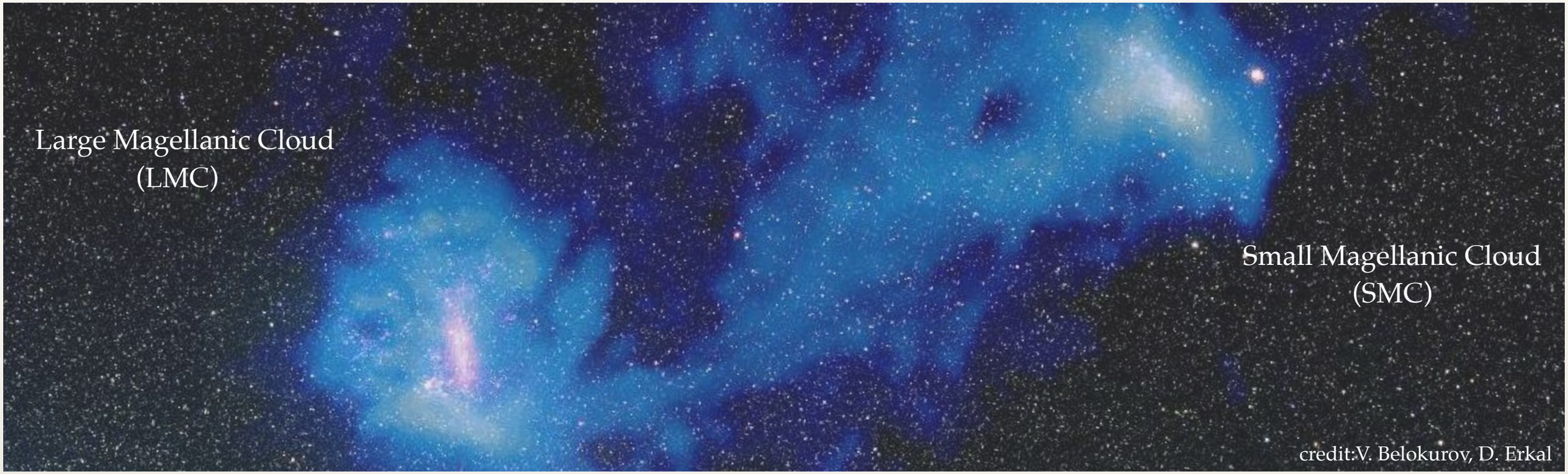


credit:V. Belokurov, D. Erkal

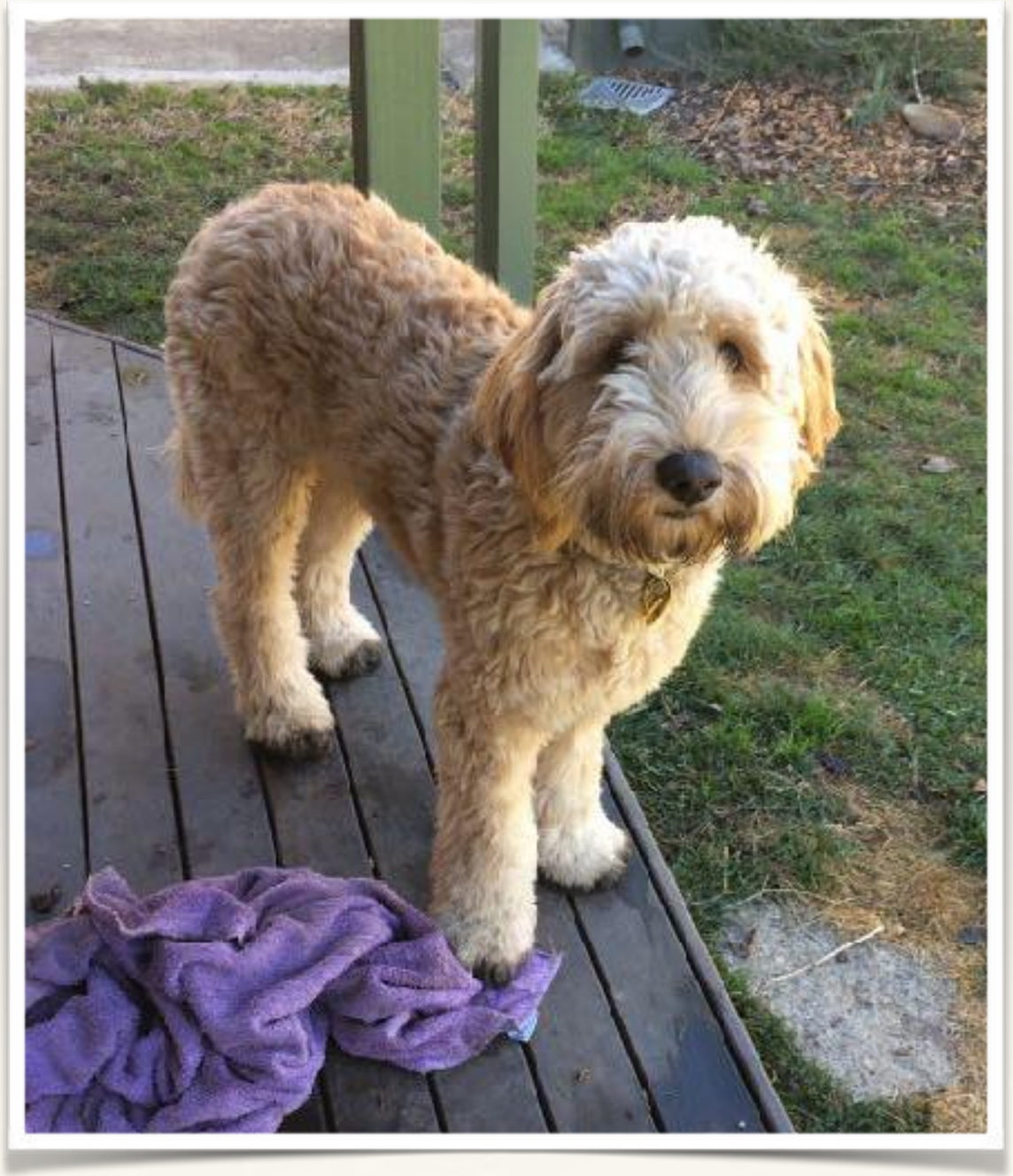
Gas Temperature Demography and the HI-to-H_2 Transition in the Magellanic Clouds

Katie Jameson
Australian National University

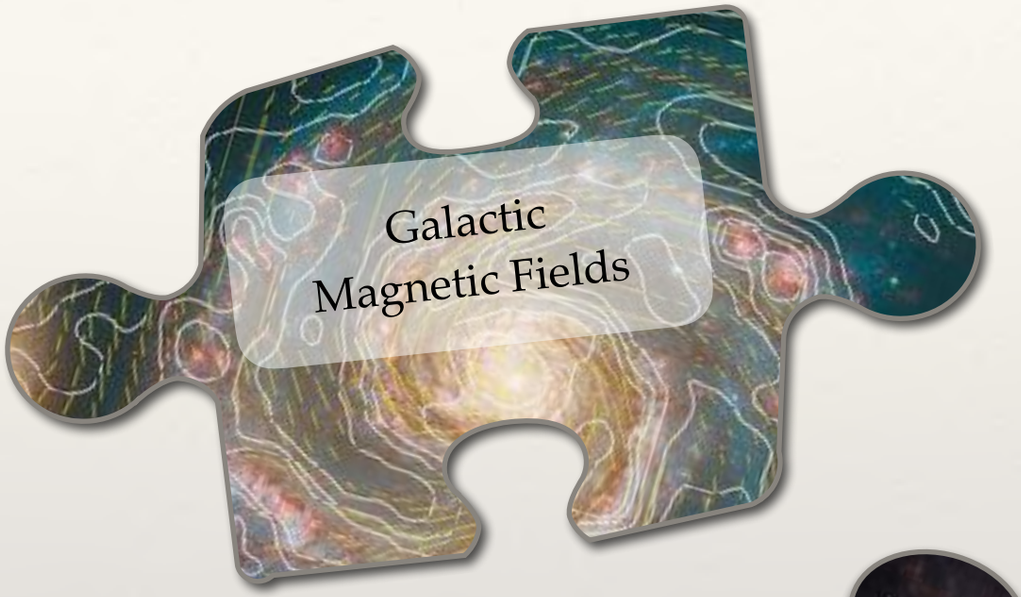
N. McClure-Griffiths, B. Liu,
L. Staveley-Smith, J. Dickey, A. Bolatto,
J. Dawson, H. Dénes, D. Li,
S. Stanimirovic, M. Wolfire, T. Wong

credit: Alex Cherney

The last time I gave this talk…



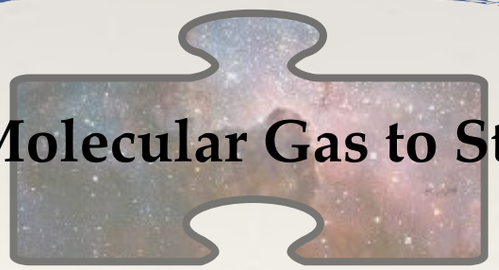
The Larger Galaxy Evolution Puzzle



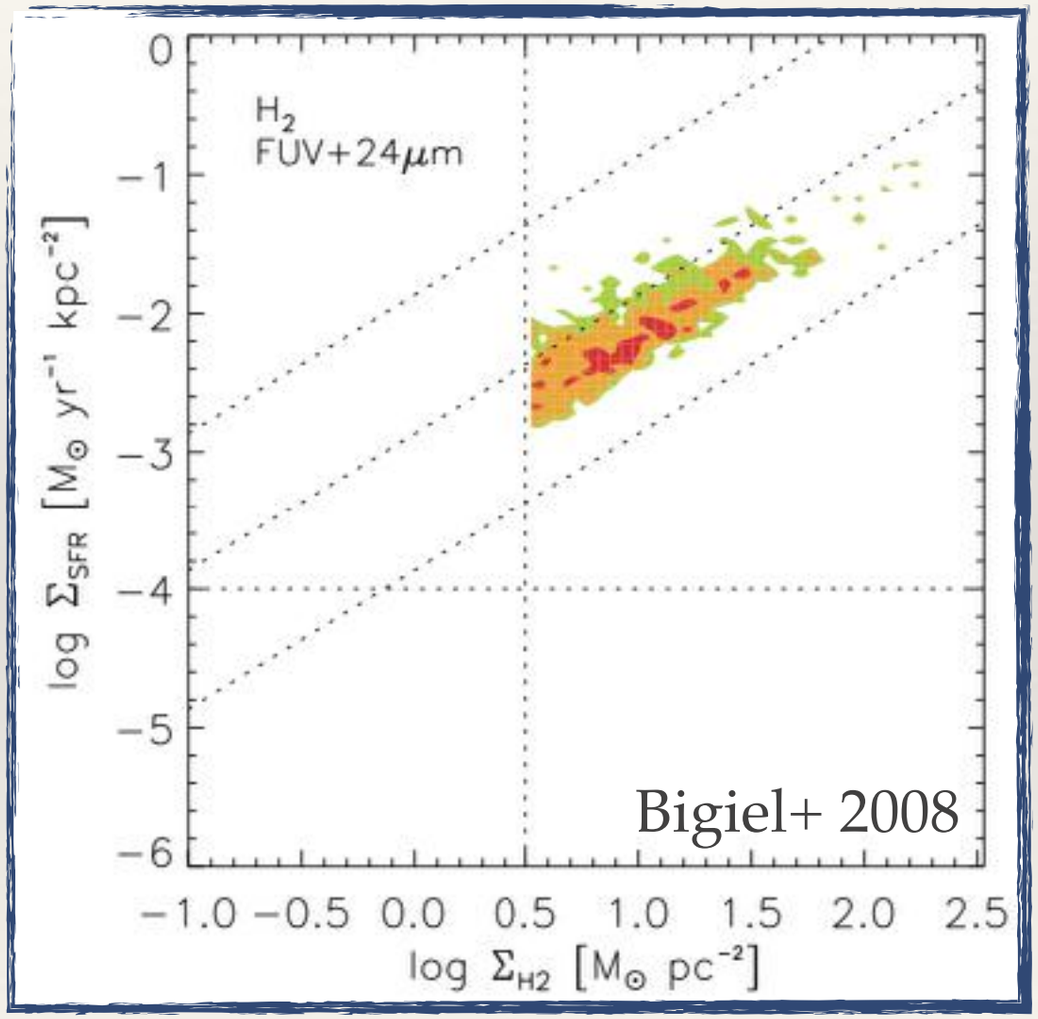
Pieces of the Star Formation Puzzle

1. Warm Neutral Gas to Cold Neutral Gas

2. Cold Neutral Gas to Molecular Gas



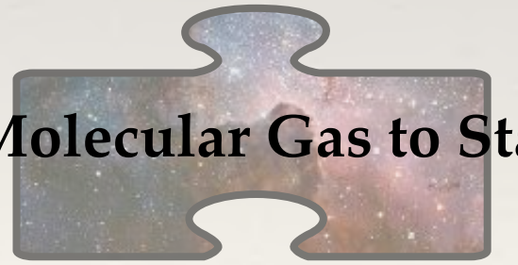
3. Molecular Gas to Stars



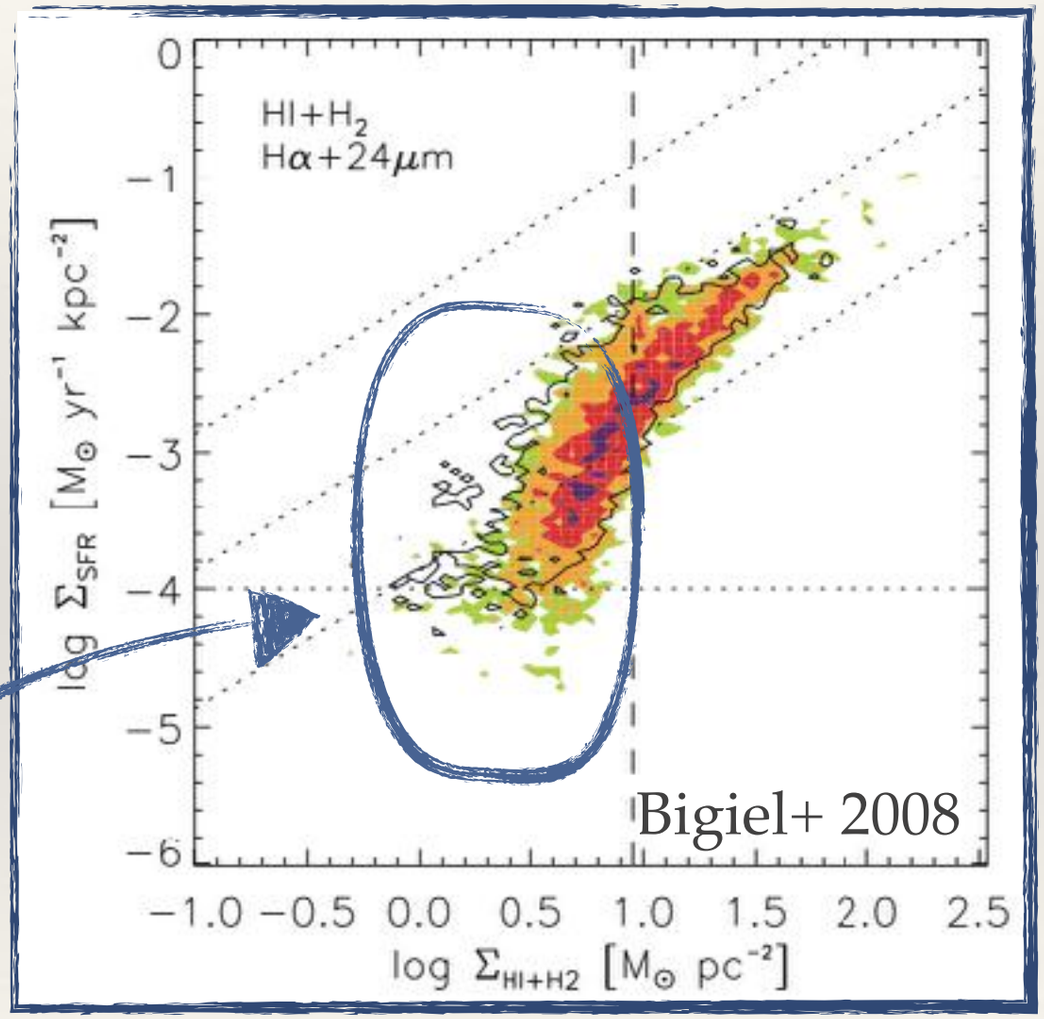
Pieces of the Star Formation Puzzle

1. Warm Neutral Gas to Cold Neutral Gas

2. Cold Neutral Gas to Molecular Gas

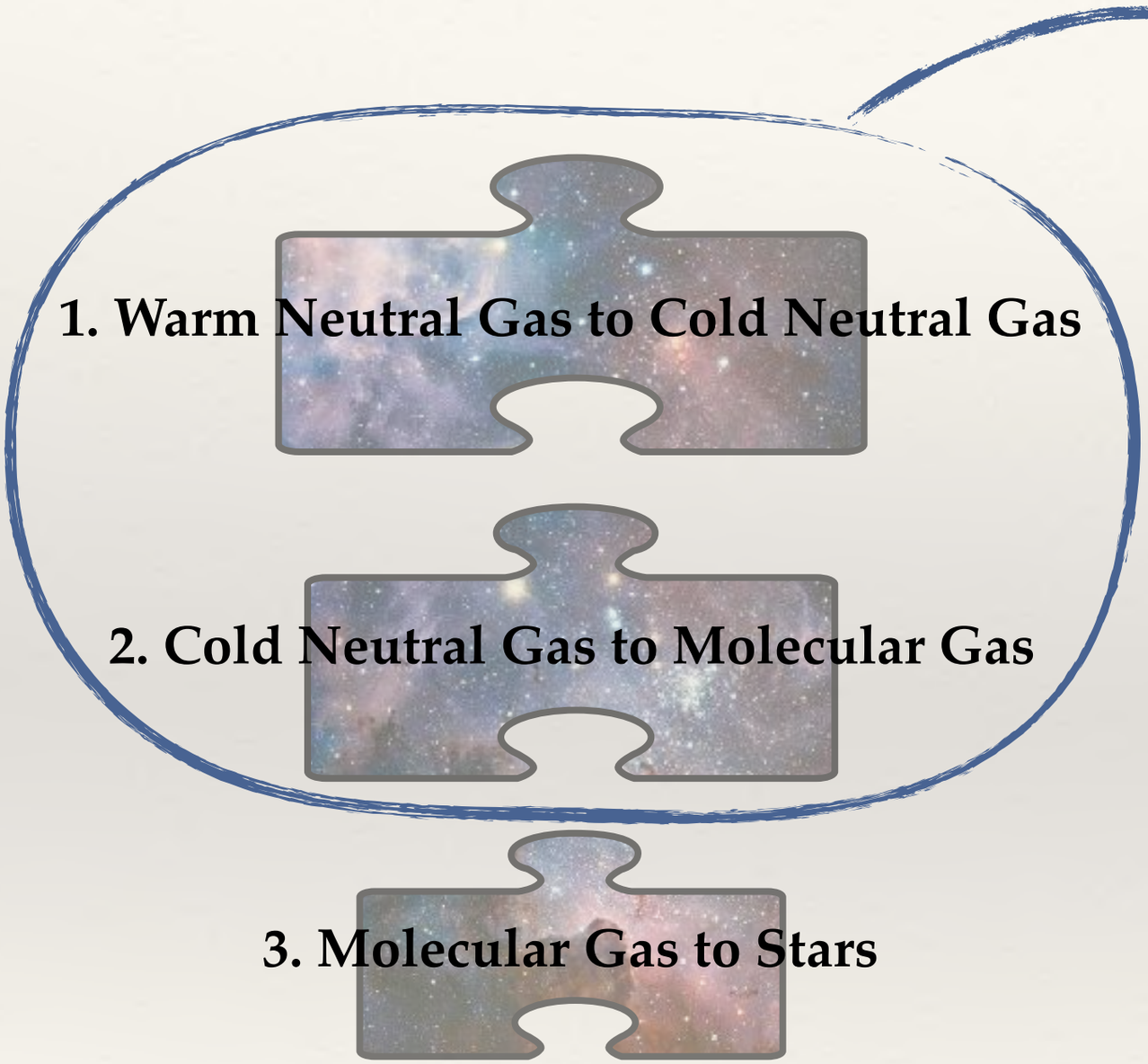


3. Molecular Gas to Stars



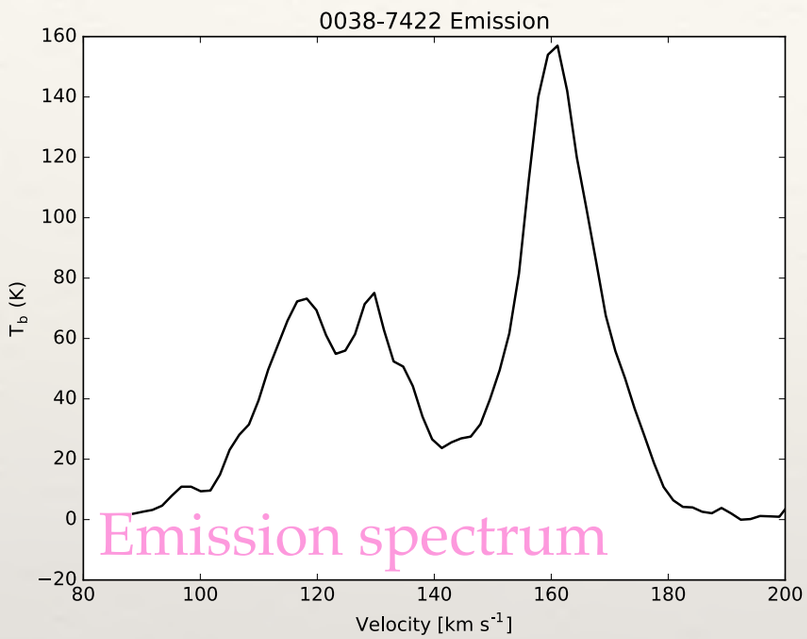
Atomic-dominated

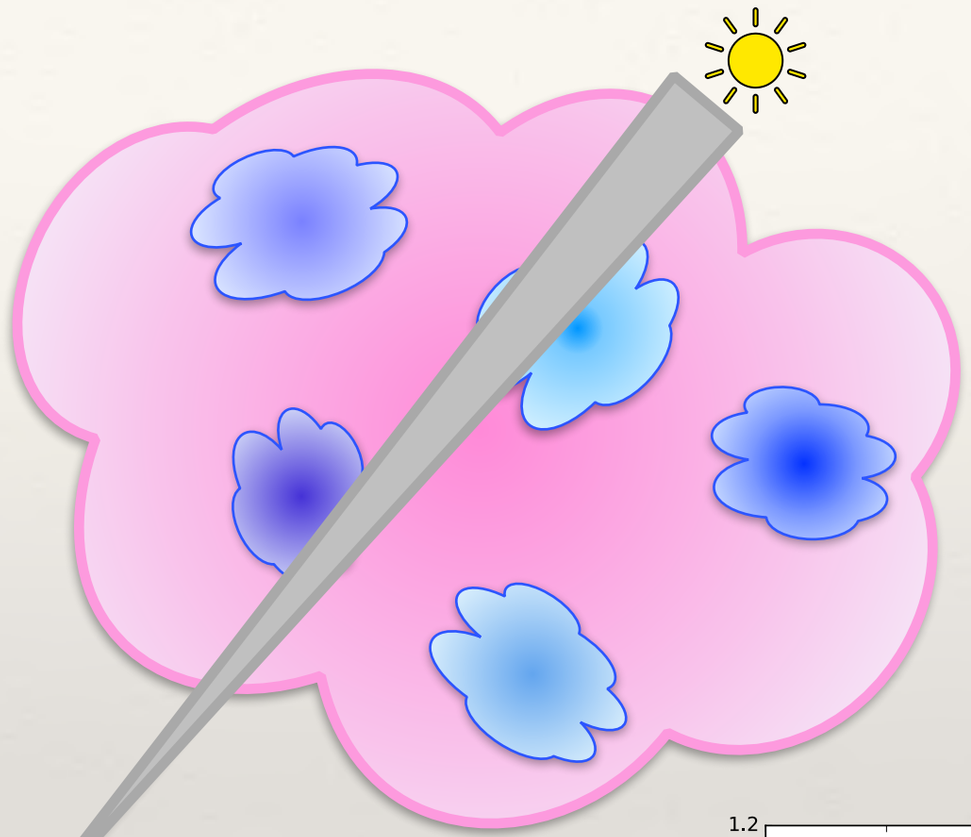
Pieces of the Star Formation Puzzle

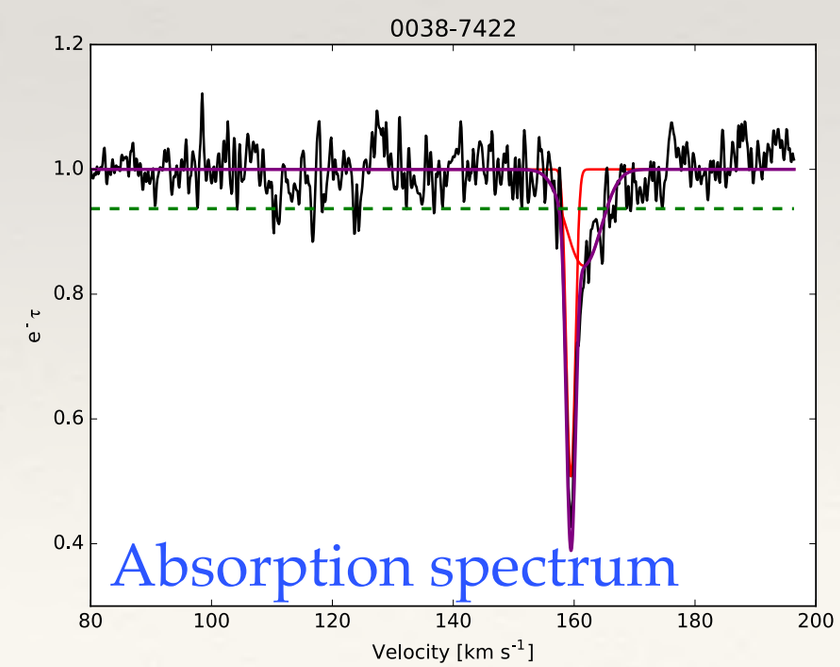


- Measure fraction and conditions of cold neutral hydrogen gas using a new absorption line survey with ATCA
- Compare to molecular gas using OH absorption from ATCA and new data from ALMA

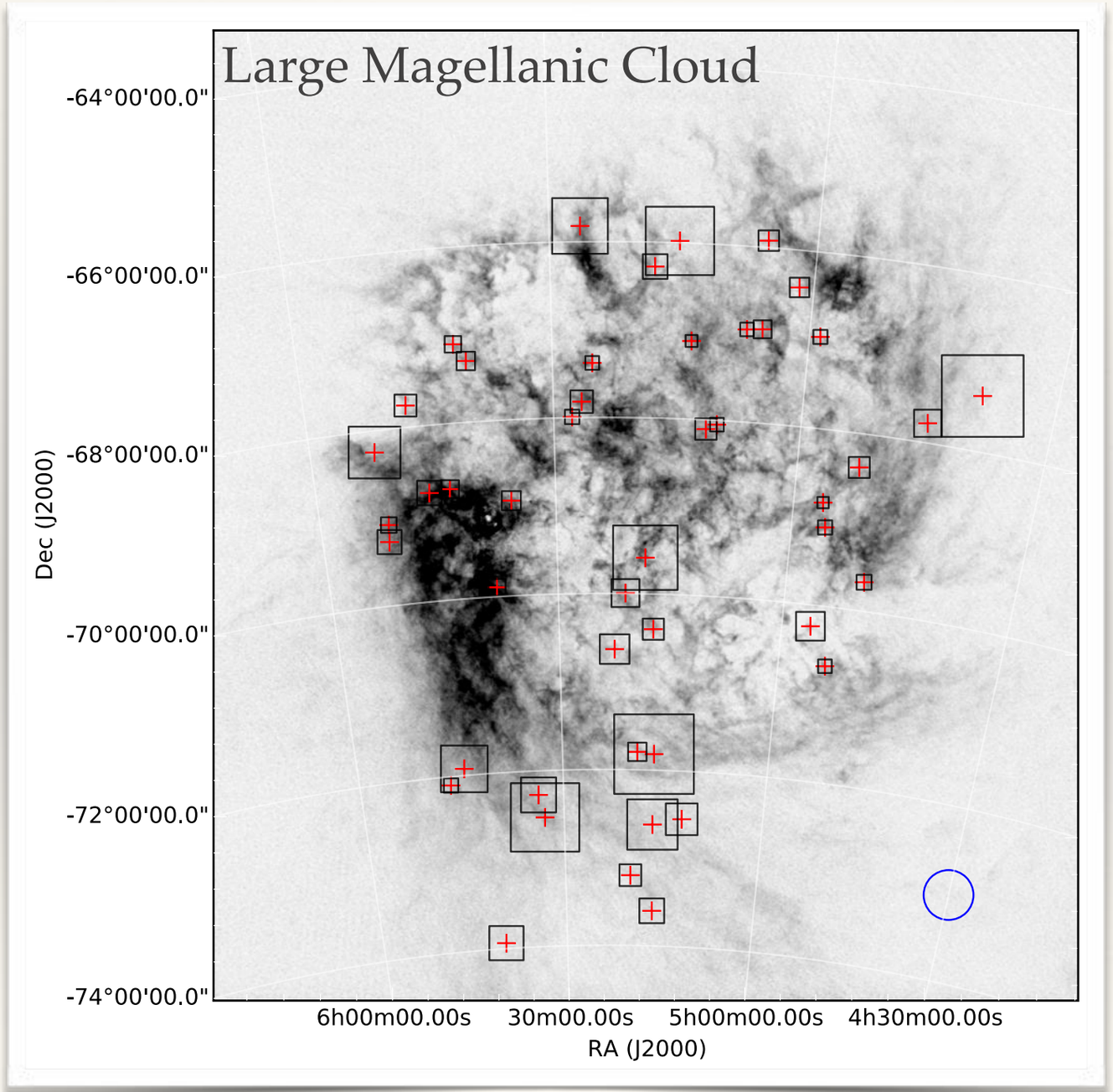
Measuring HI properties using emission and absorption line measurements

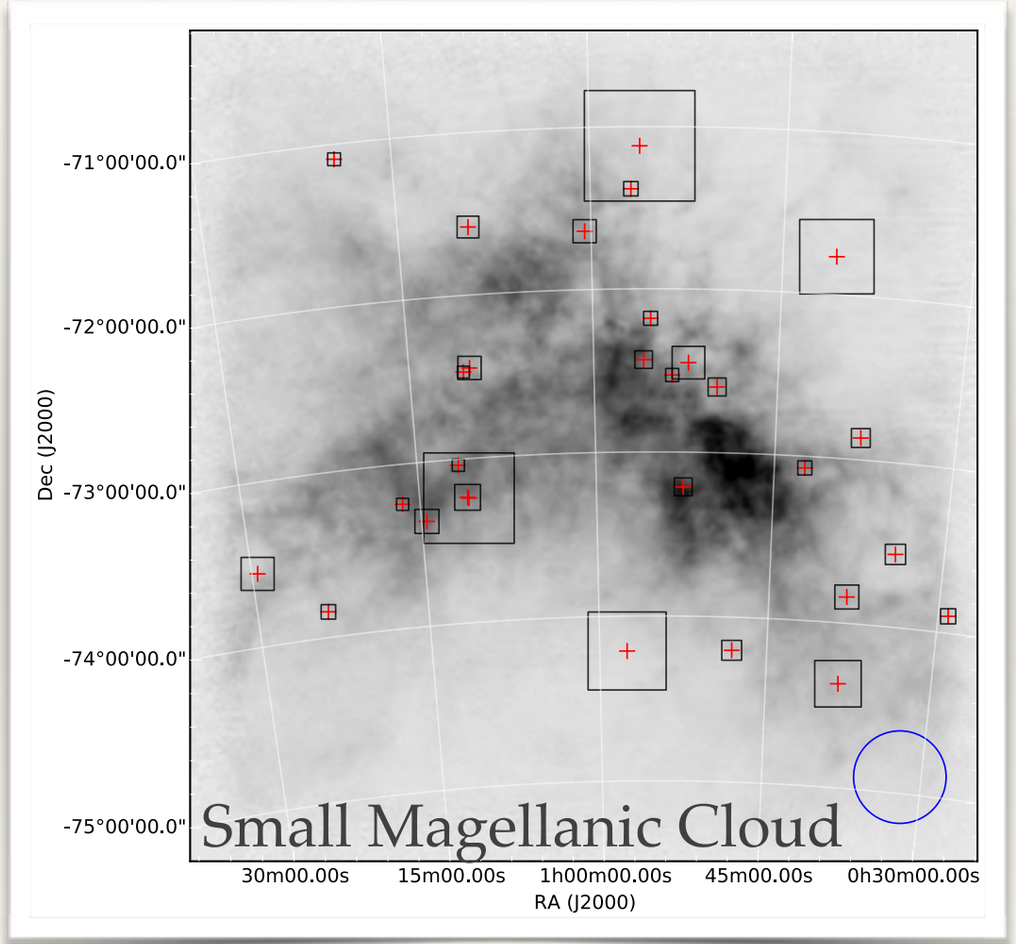






Our new ATCA absorption line survey

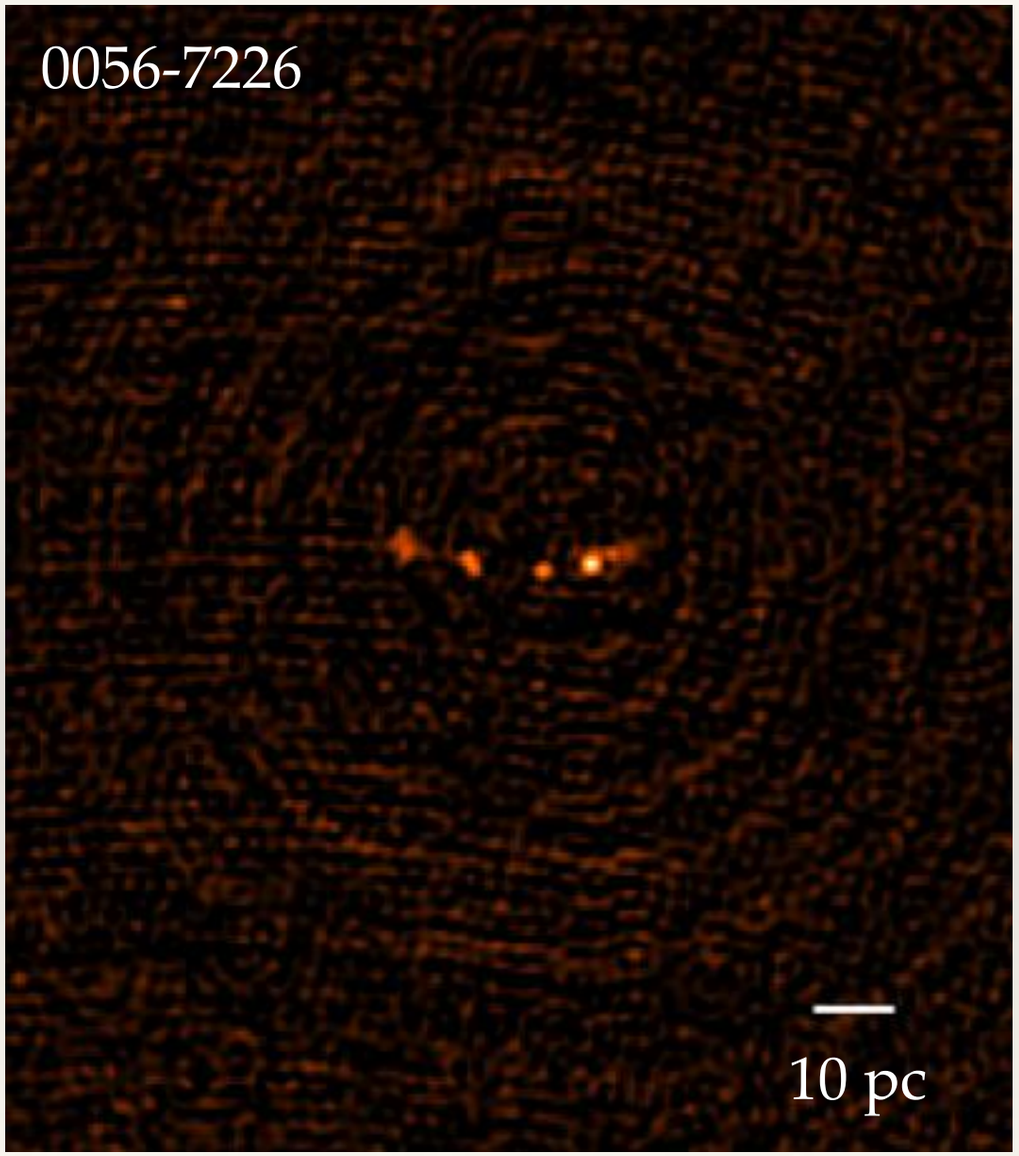


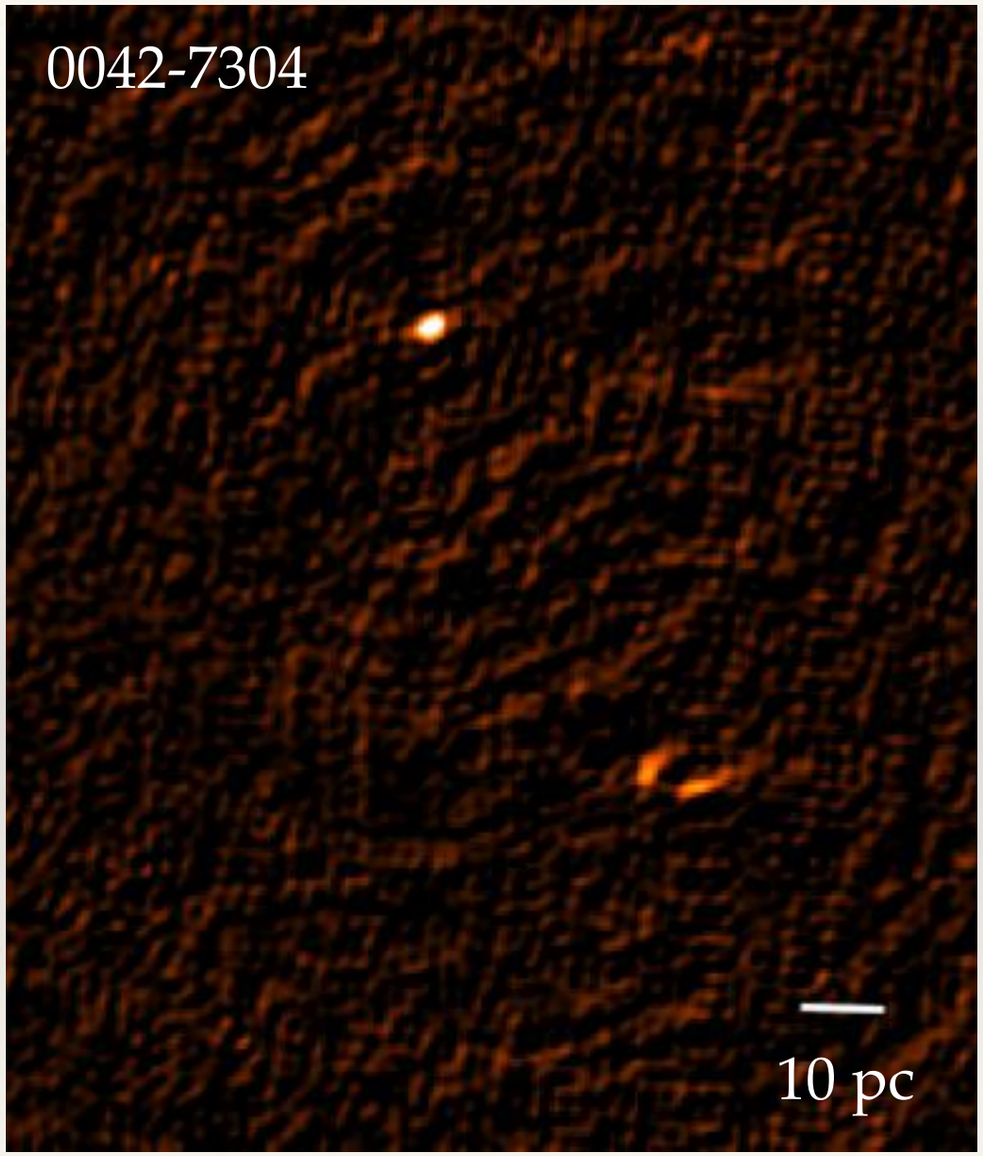


Significant improvement on existing measurements

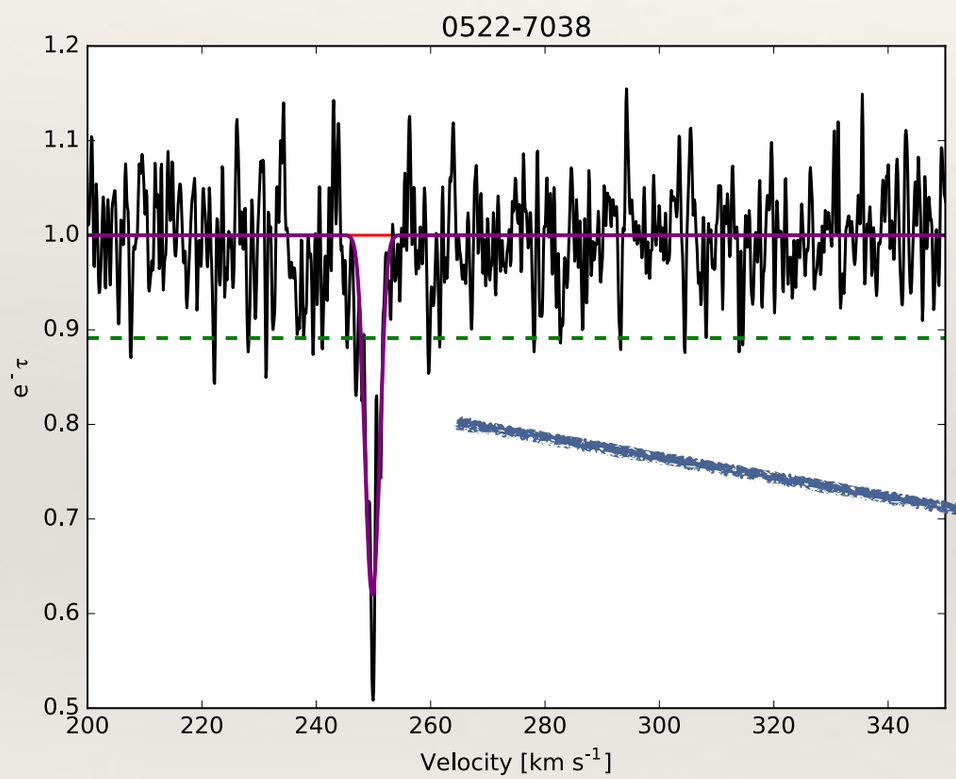
LMC Sources	**28** σ_{τ}~0.05-0.3 (Dickey+94, Marx-Zimmer+00)	→	**> 48** σ_{τ}~0.008-0.05 8x higher spectral resolution
SMC Sources	**13** σ_{τ}~0.05-0.2 (Dickey+00)	→	**> 29** σ_{τ}~0.01-0.1 8x higher spectral resolution

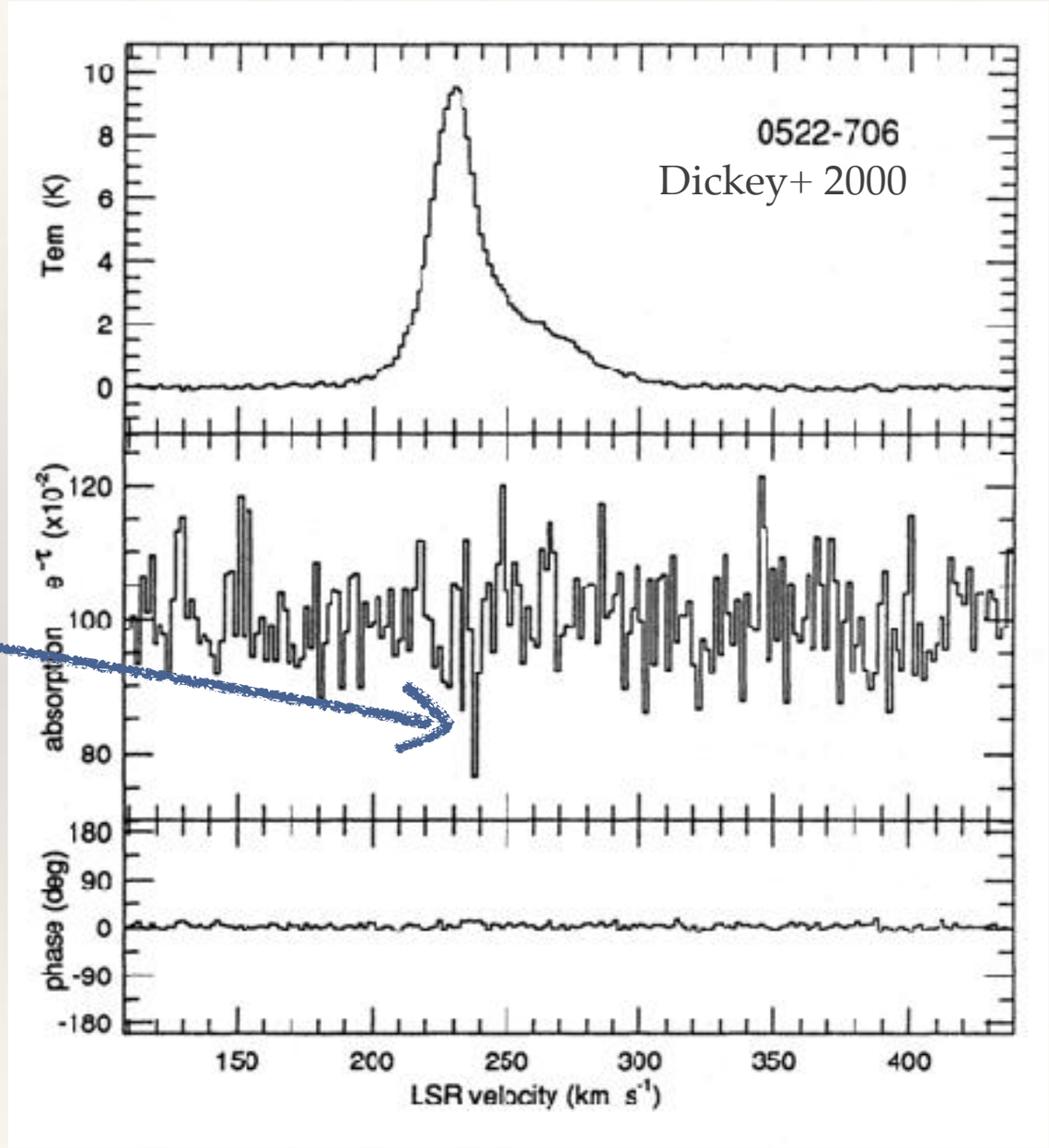
Studying the small-scale structure of cold neutral gas





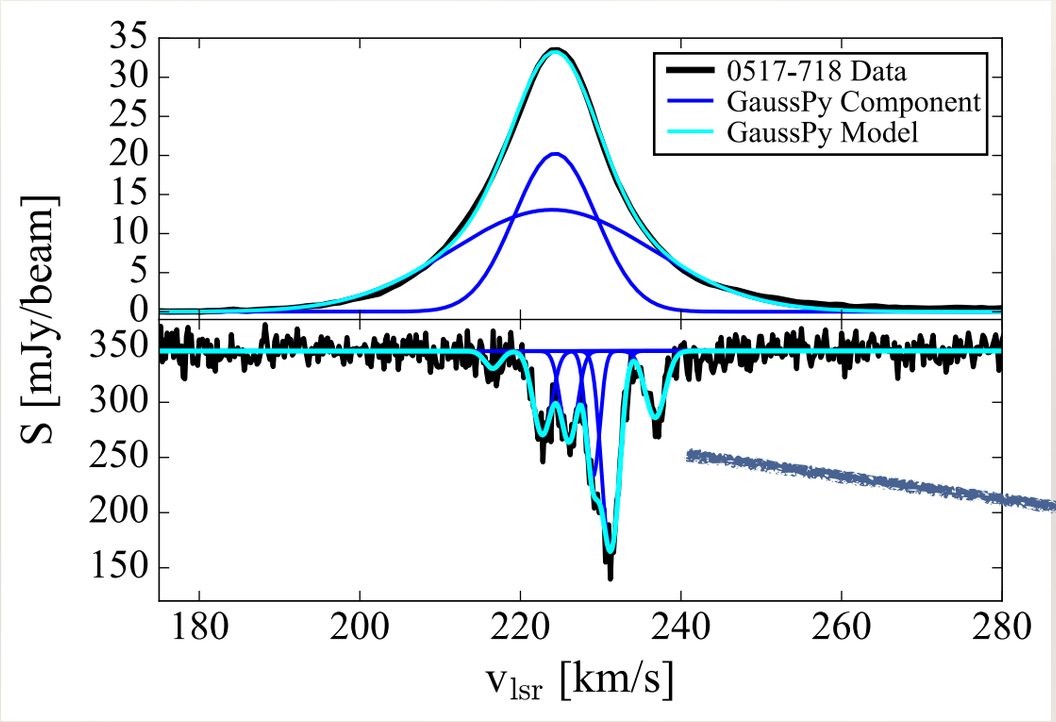
New detections!

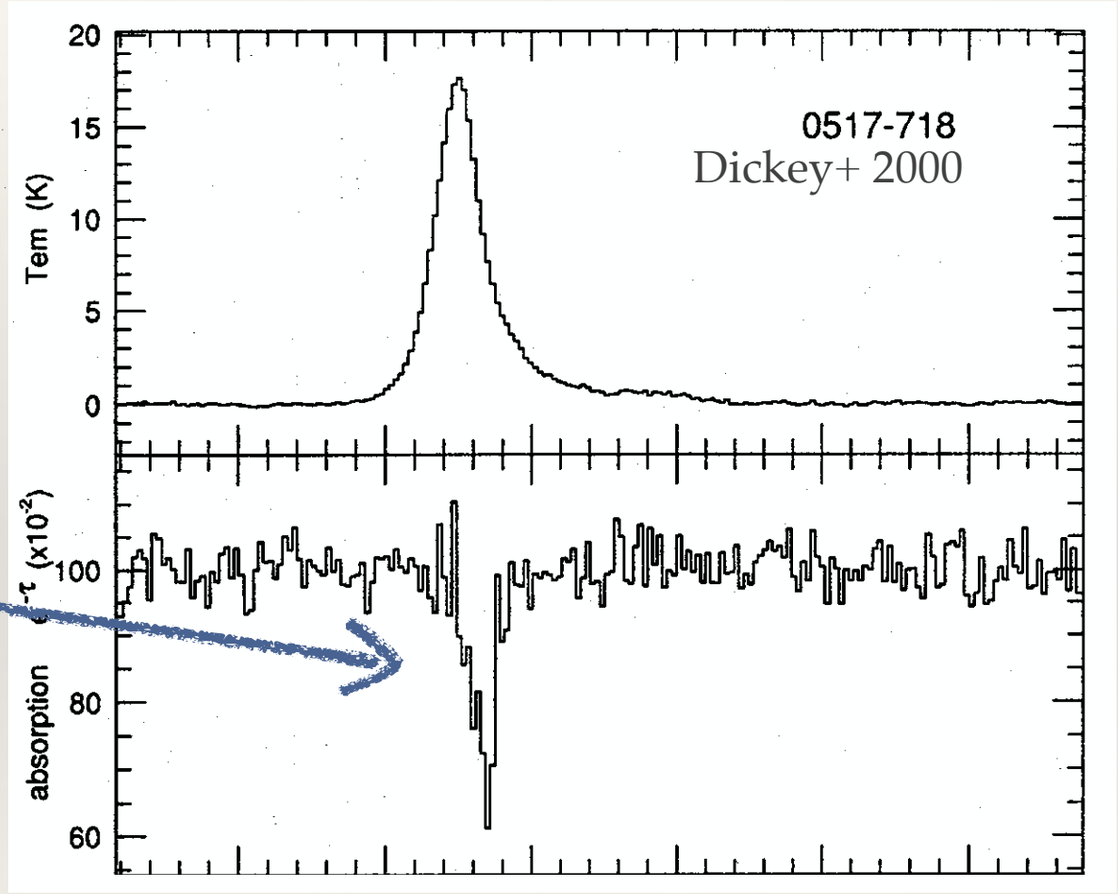




Jameson, Liu, McClure-Griffiths+ *in prep*

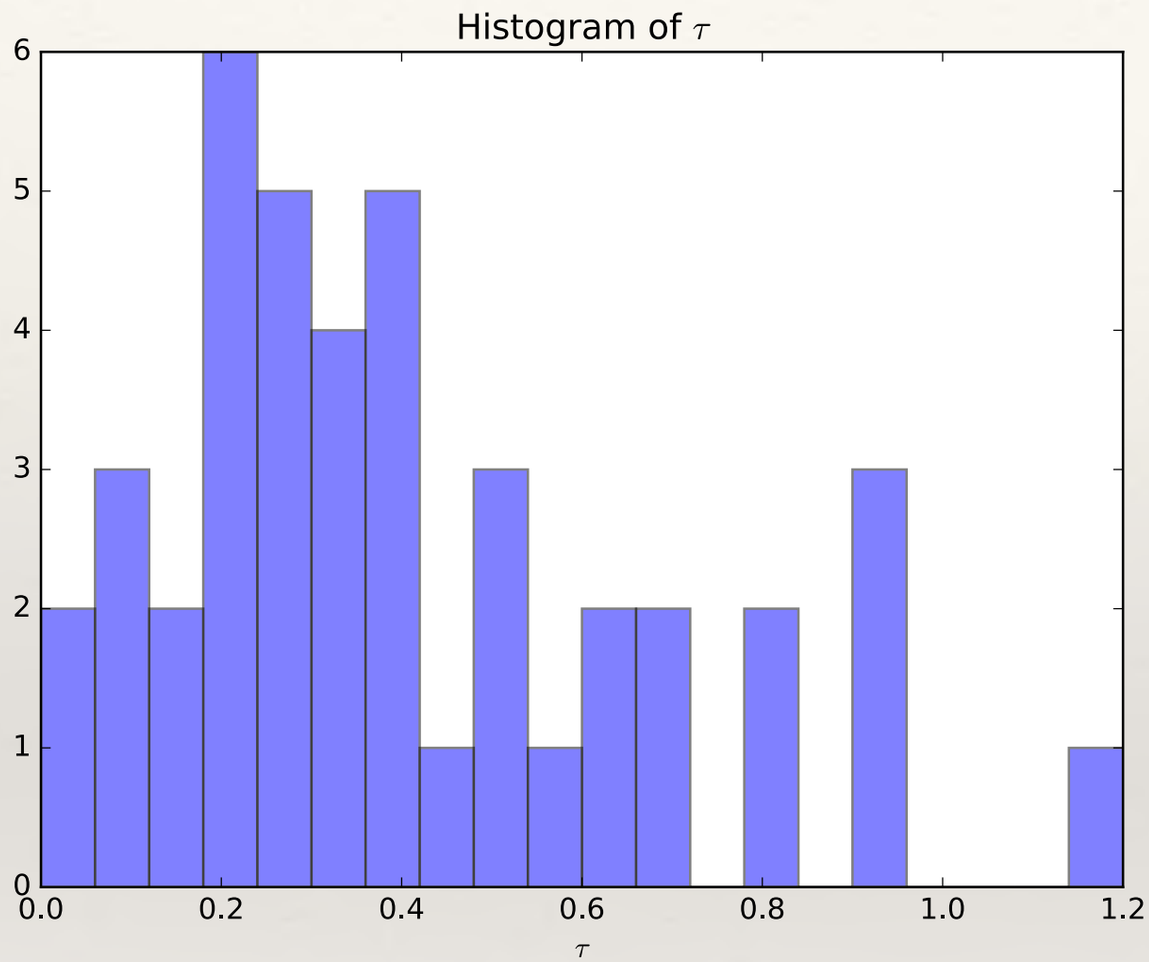
New resolved line components!

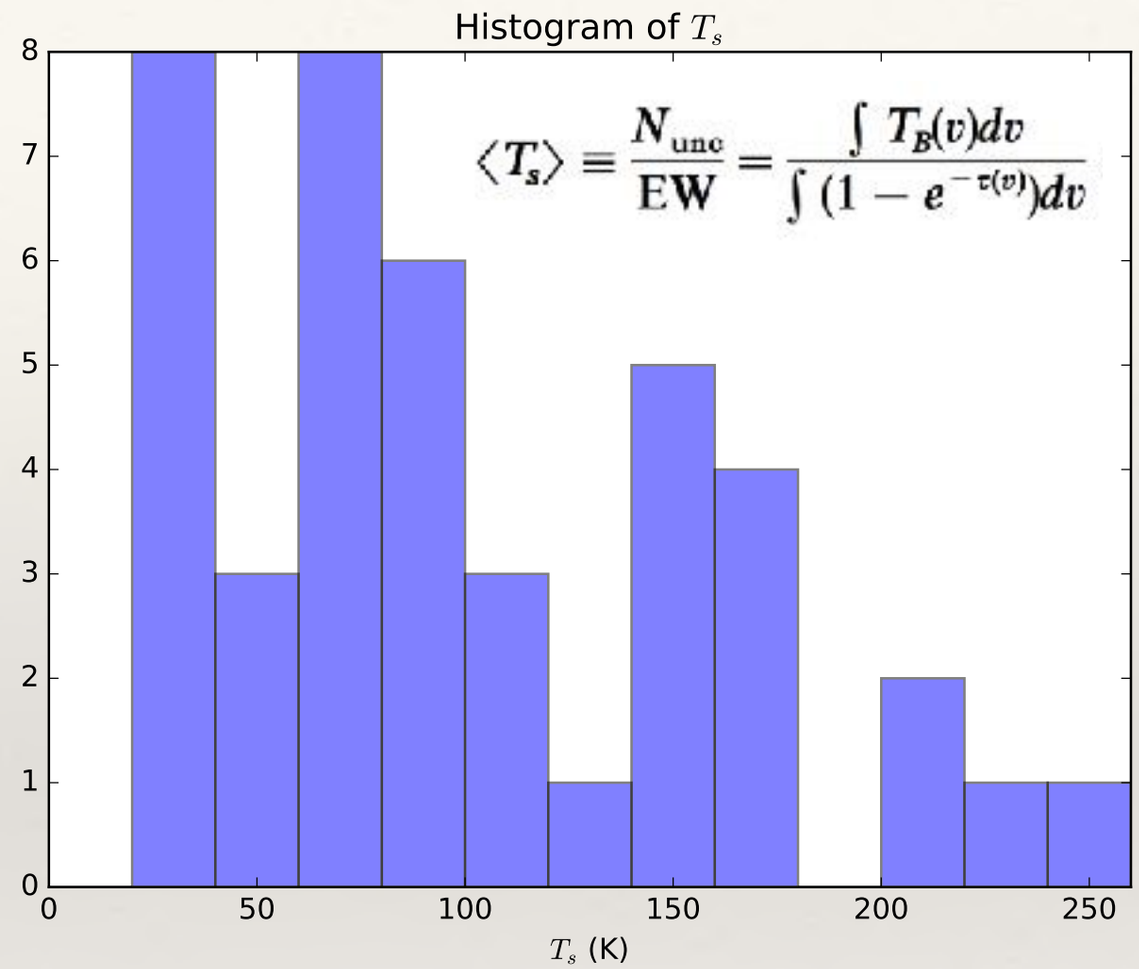




Liu, Jameson, McClure-Griffiths+ *in prep*

LMC Early Results: First 14 Sources





Find <T_s> ~ 240 K

(mass-weighted)

larger by ~40% compared to sources observed in Dickey+94, Marx-Zimmer+00

Liu, Jameson, McClure-Griffiths+ *in prep*

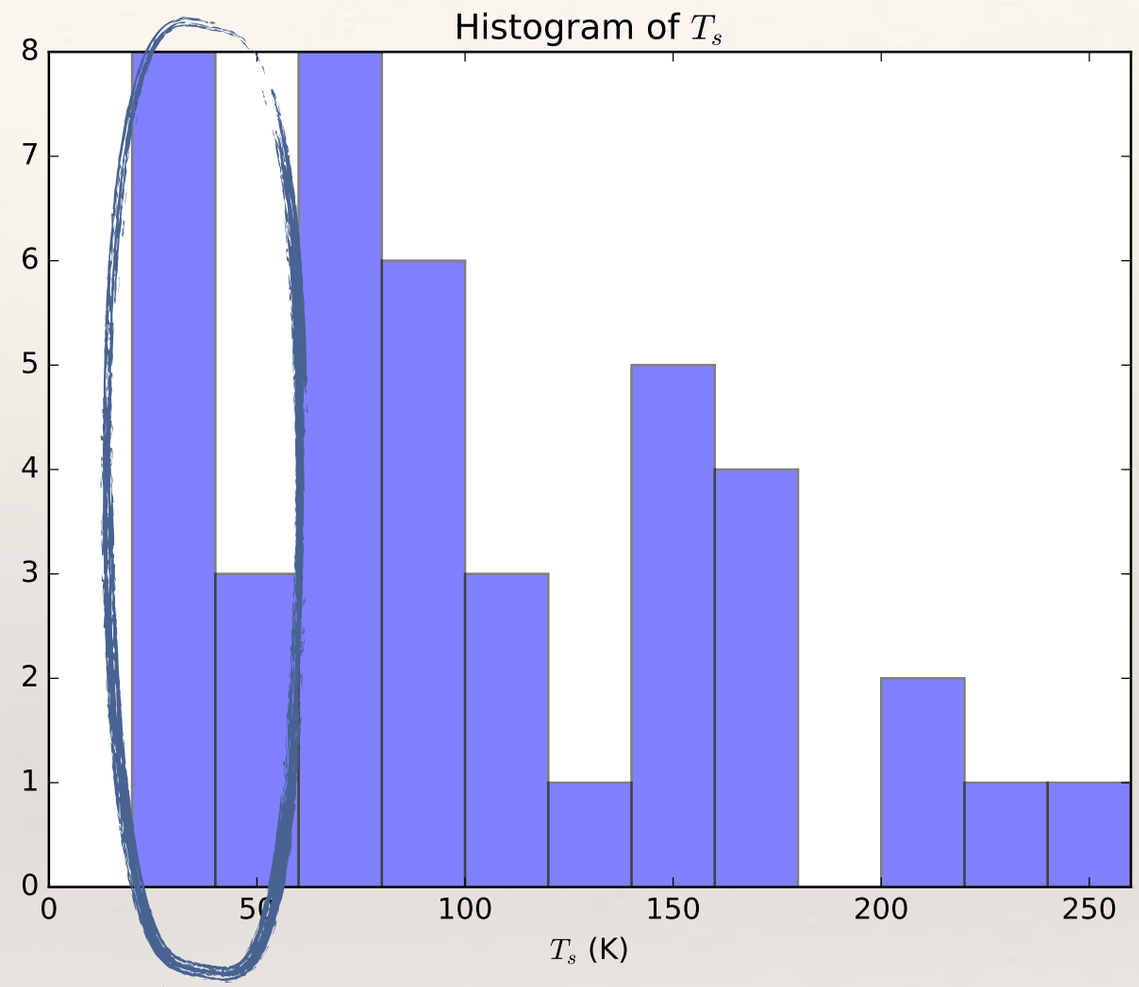
LMC Early Results: First 14 Sources

$$f_c \equiv \frac{N_c}{N_w + N_c} \simeq \frac{T_c}{\langle T_s \rangle}$$

If T_c = 55 K,

find *preliminary* f_c ~22%

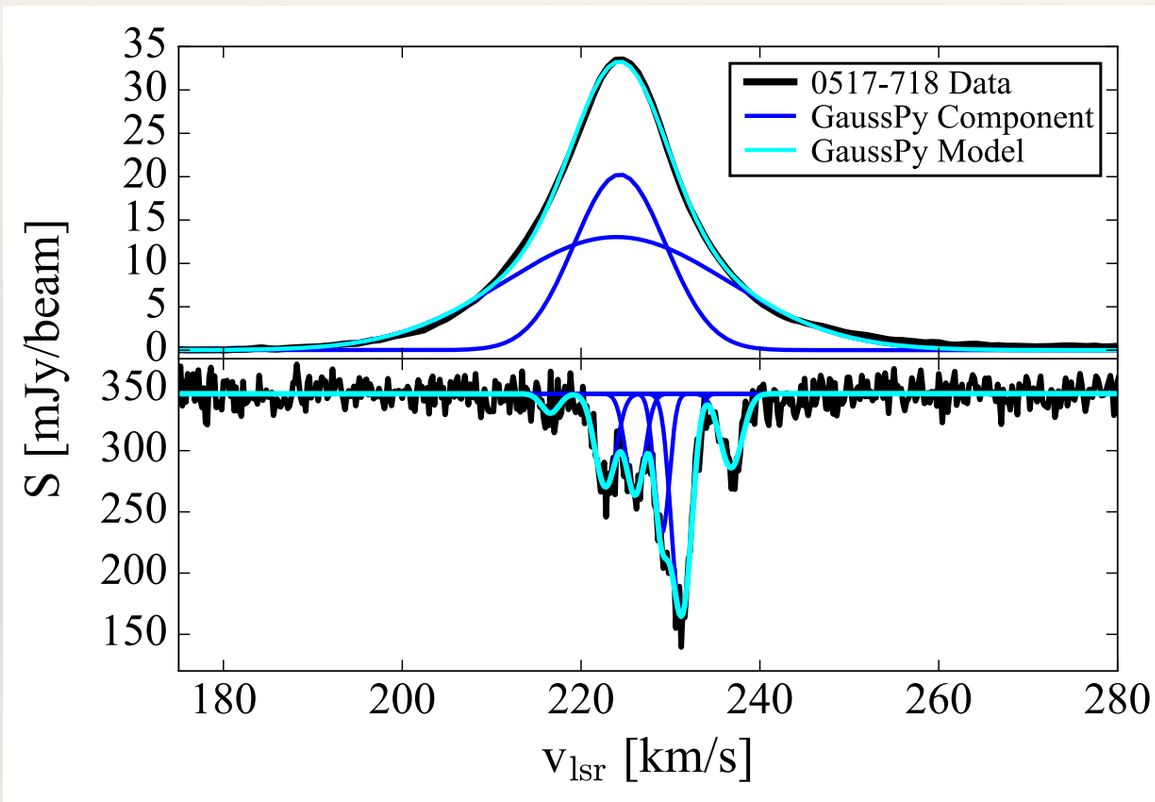
compared to previous 33% (Marx-Zimmer+ 00)

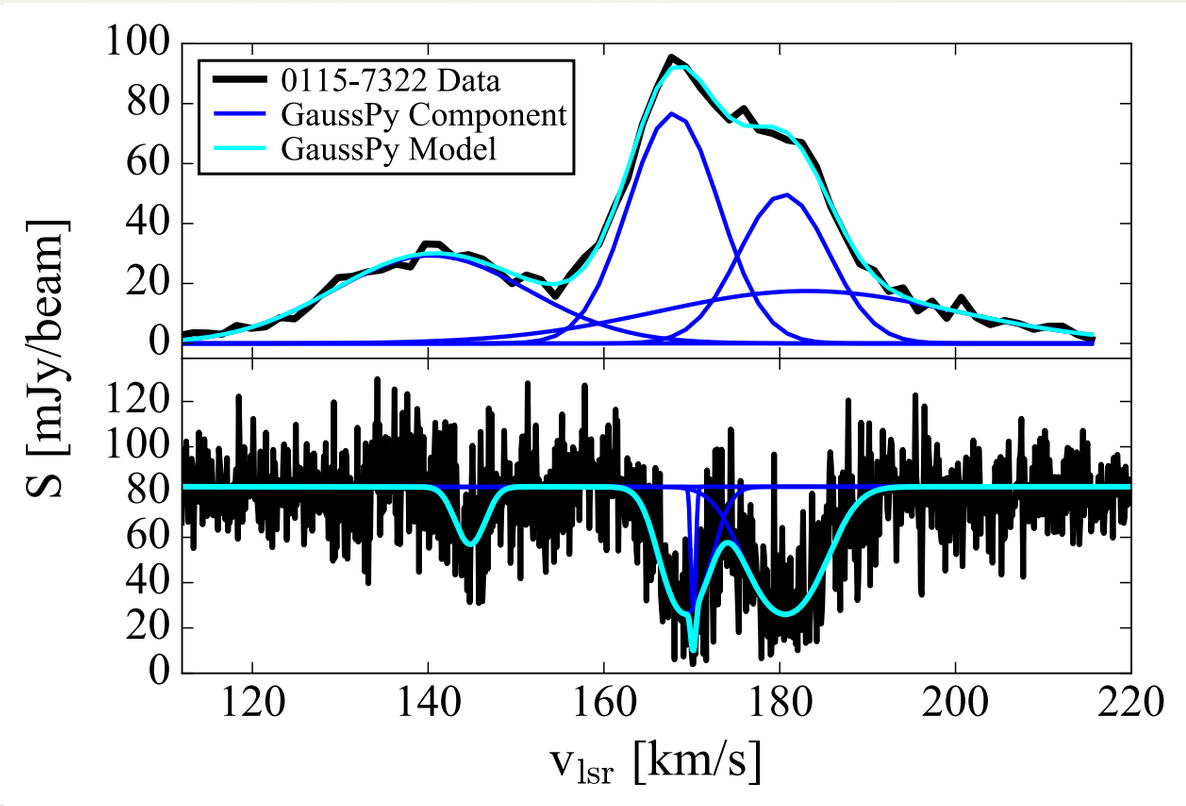


BUT, many T_s values less than 55 K so T_c should be smaller

Liu, Jameson, McClure-Griffiths+ *in prep*

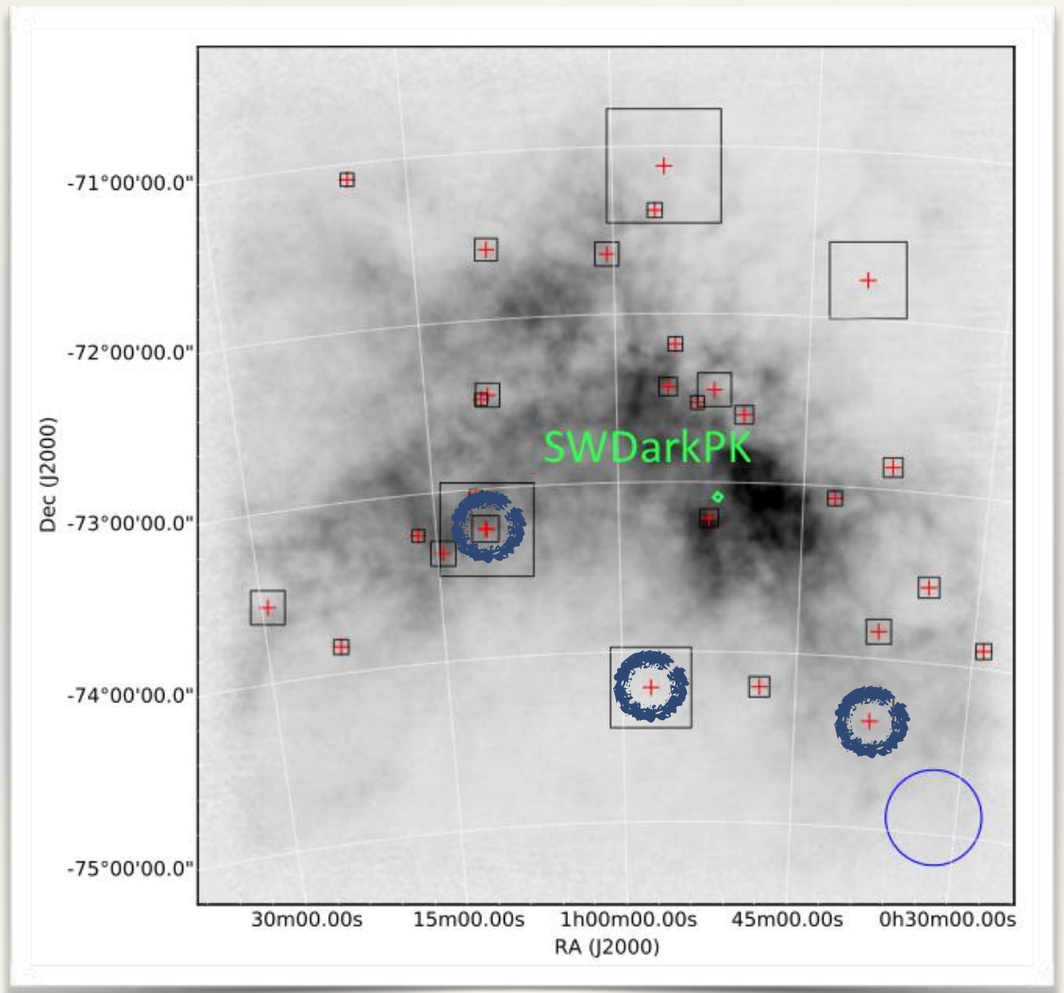
Are the conditions in the neutral gas different in the Magellanic Clouds?

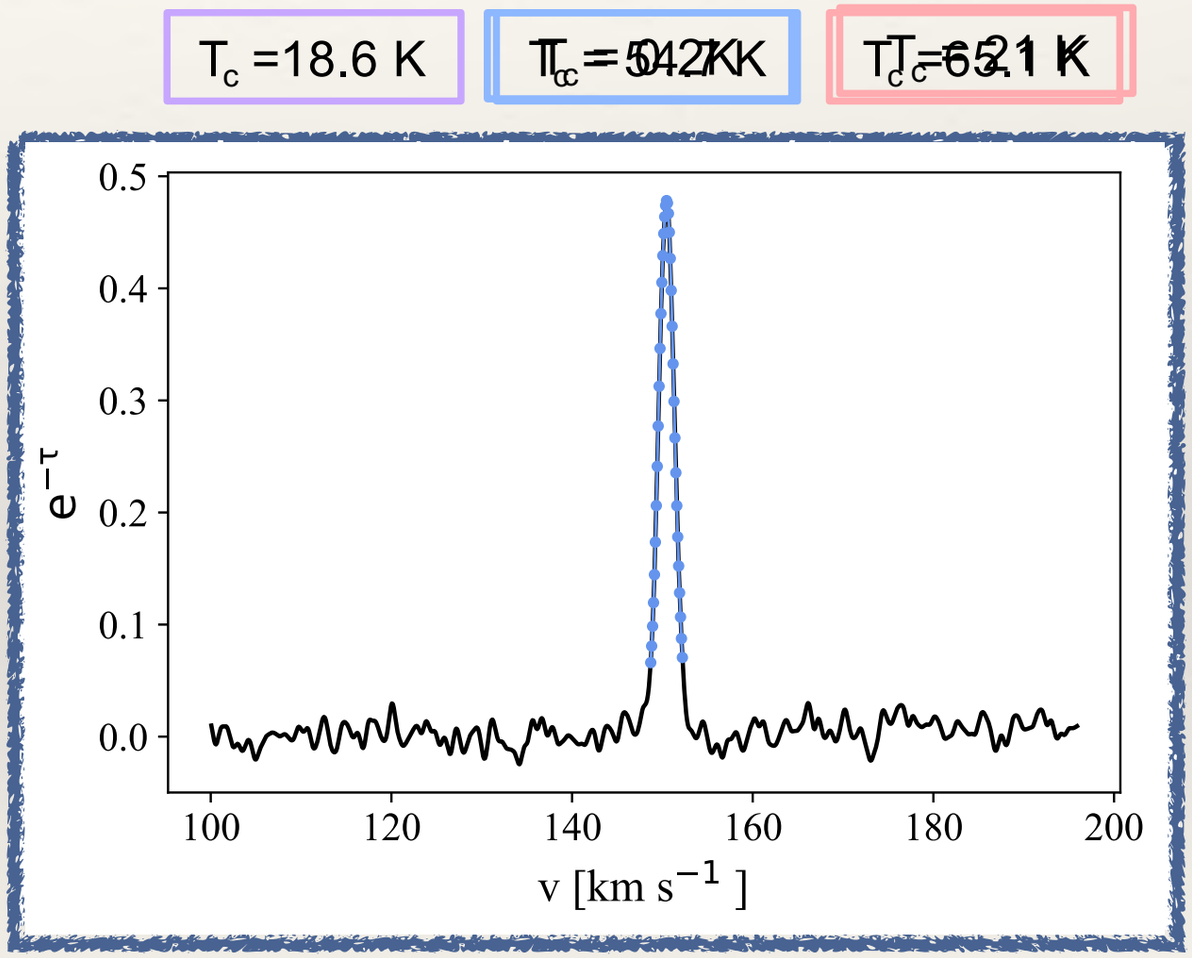




GaussPy: Lindner+ 2015

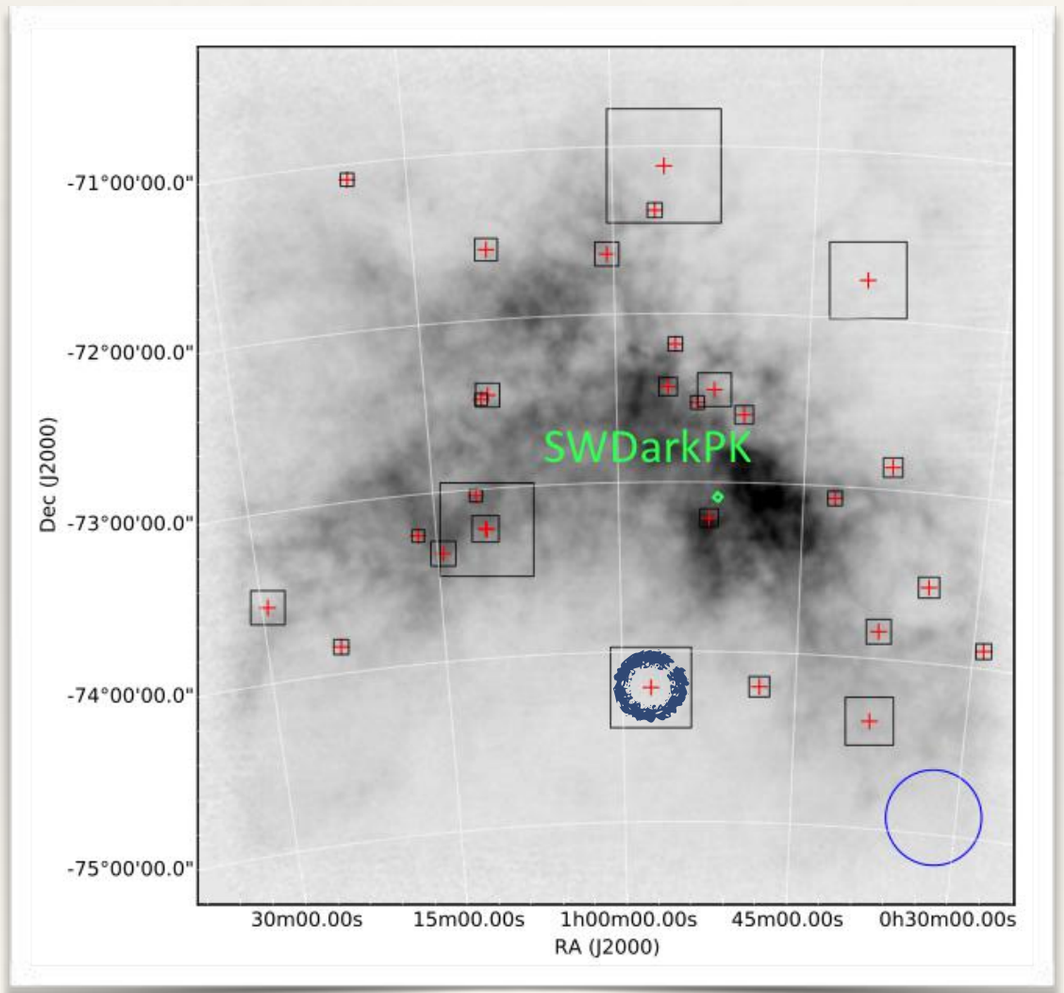
Are the conditions in the neutral gas different in the Magellanic Clouds?

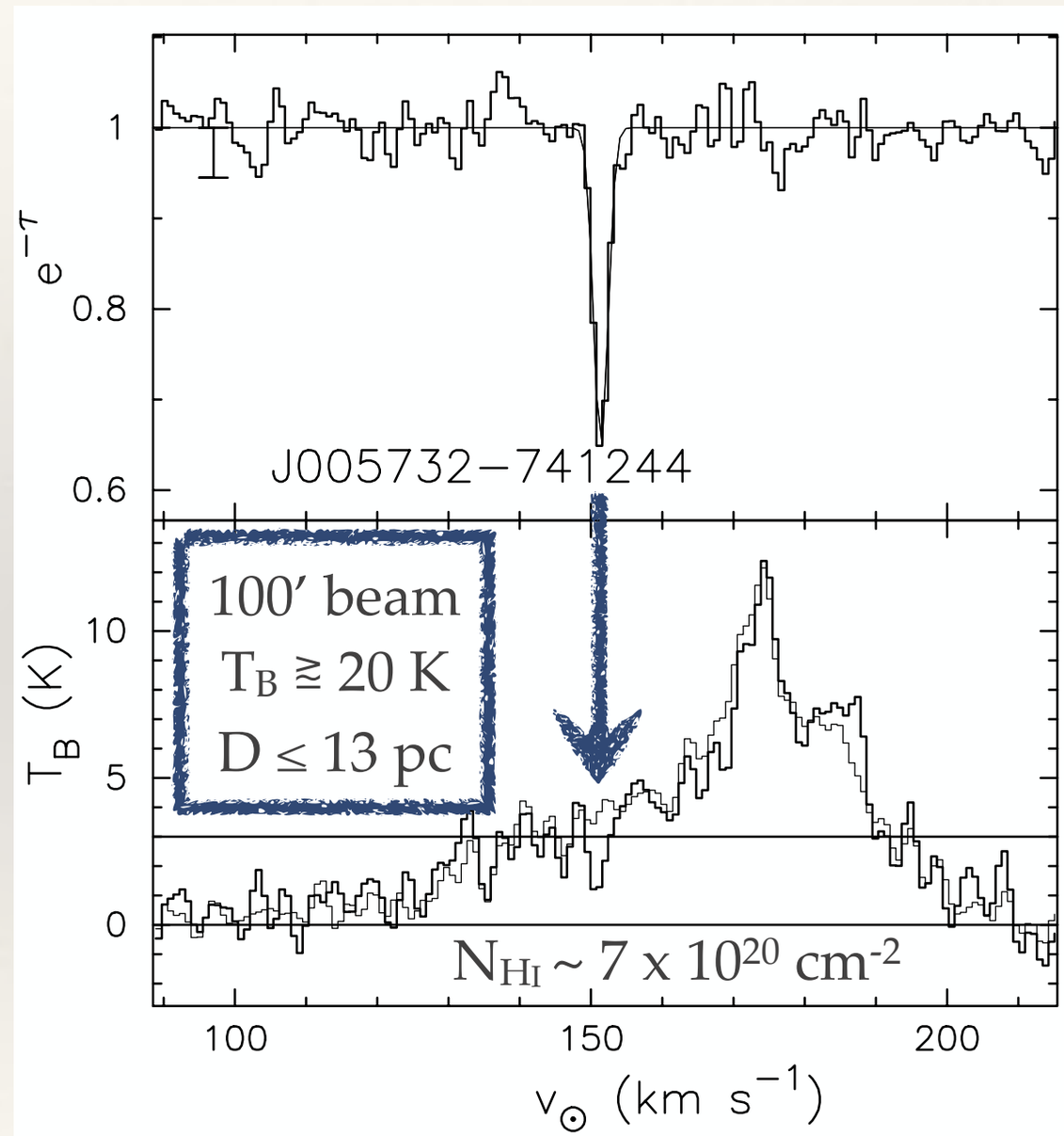




Jameson, Liu, McClure-Griffiths+ *in prep*

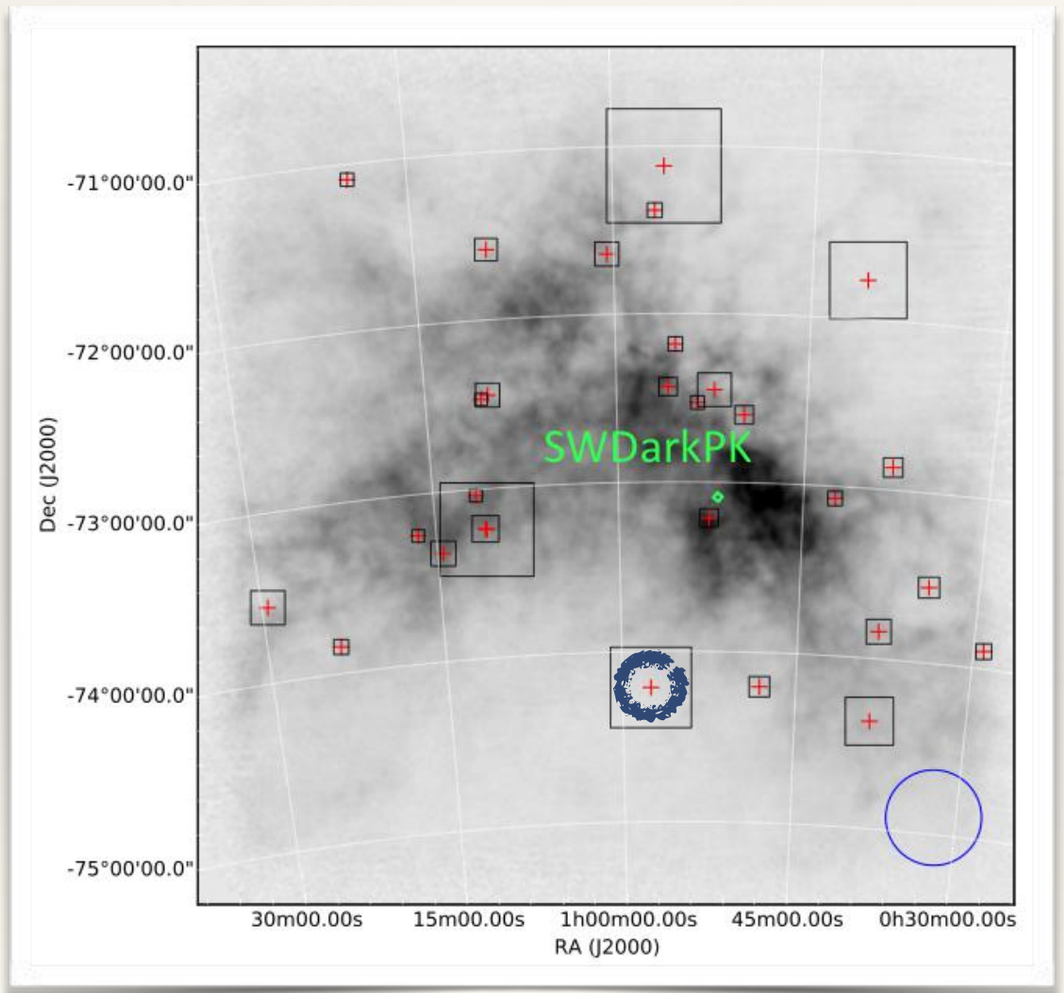
Conditions of cold gas in self-absorption

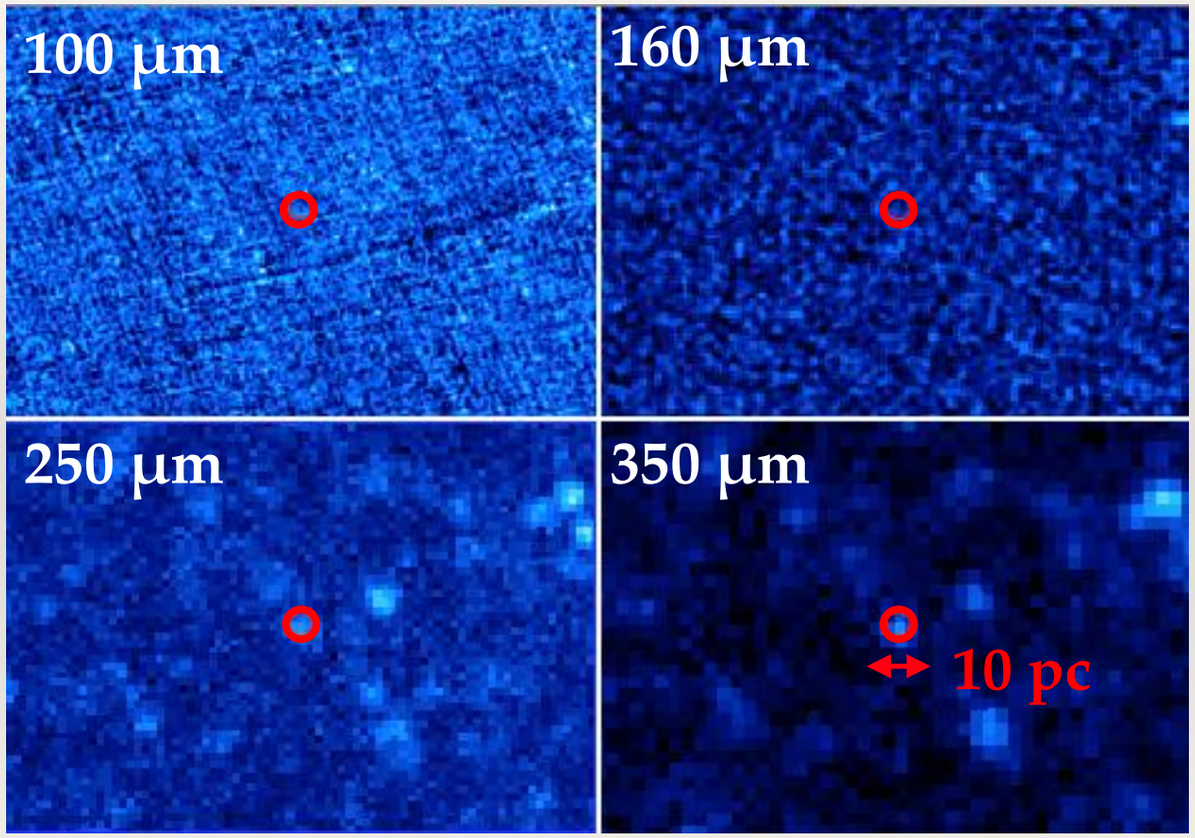




Jameson, Liu, McClure-Griffiths+ *in prep*

Conditions of cold gas in self-absorption

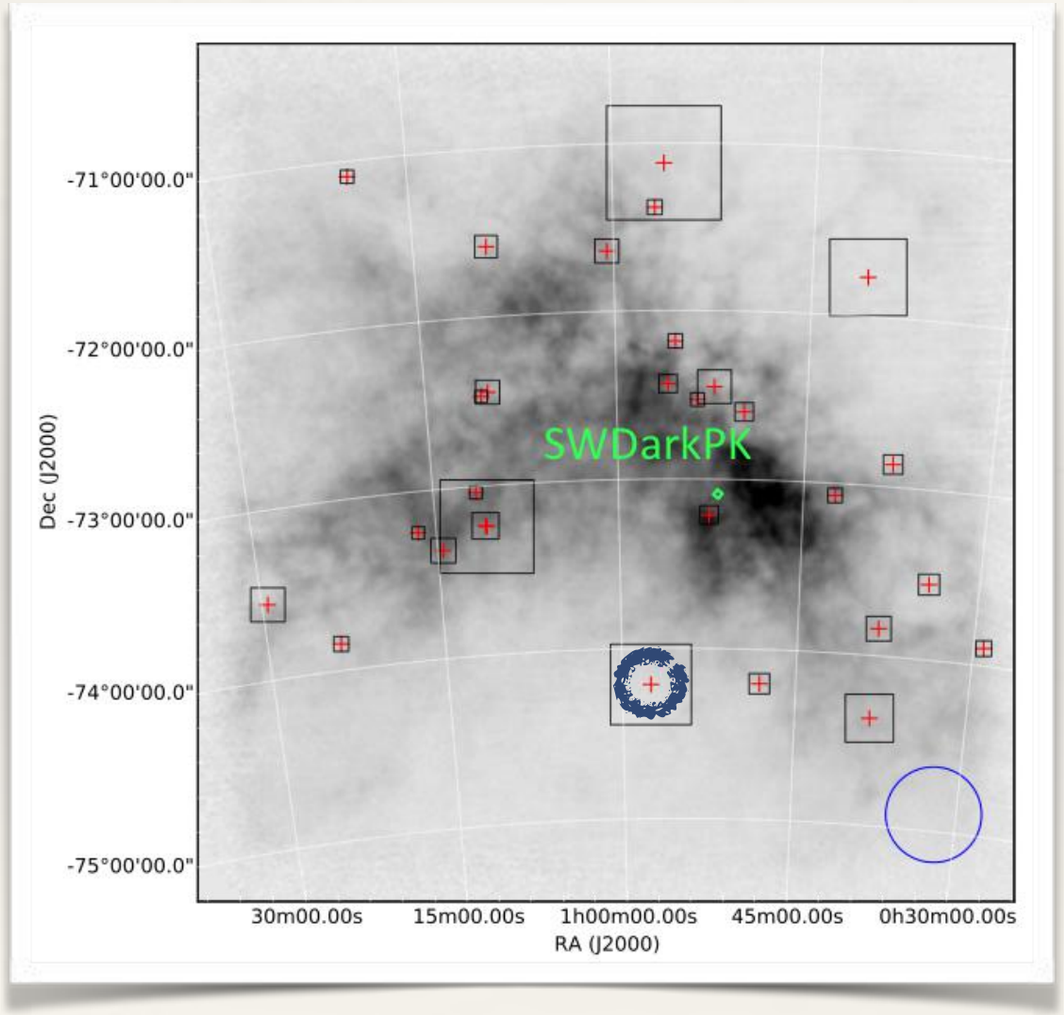




Herschel HERITAGE (Meixner+ 2013)

Jameson, Liu, McClure-Griffiths+ *in prep*

Conditions of cold gas in self-absorption



Assuming $T_c \sim 20$ K, $\tau_{peak} \sim 0.7$

$N_c \sim 5 \times 10^{19}$ cm^{-2}

For $P/k \sim 2000$ K cm^{-3} sphere,

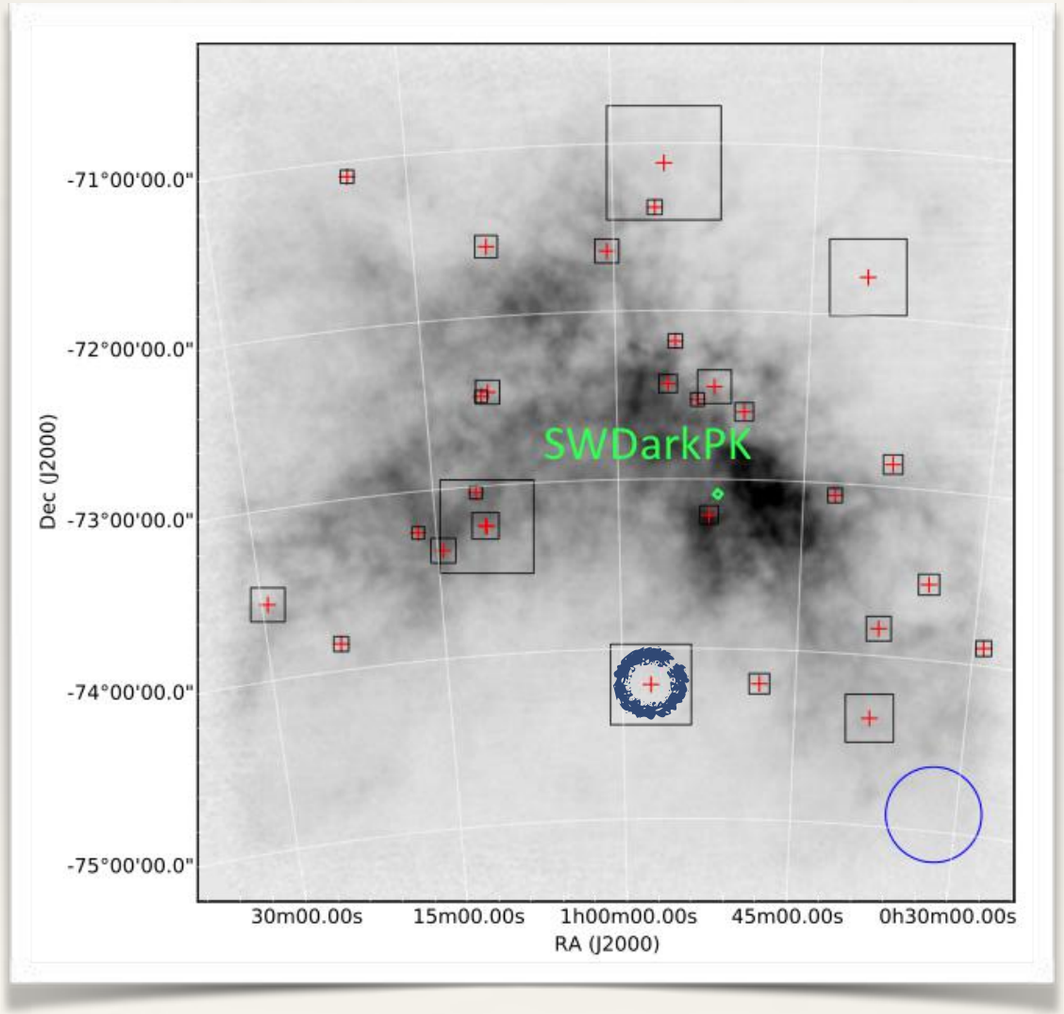
$n \sim 40$ cm^{-3} and $D = 0.14$ pc

(Heiles & Troland 2003)

$M_c \sim 0.003\ M_\odot$

Jameson, Liu, McClure-Griffiths+ *in prep*

Conditions of cold gas in self-absorption



T_d ~ 25 K (β = 1.5), τ_{160} ~ 2.7 x 10^{-5}

for $N_H / \tau_{160} = 4.8 \times 10^{25}$ cm^{-2}

(Jameson+ 2016)

$N_H = 1.3 \times 10^{21}$ cm^{-2}, n ~ 40 cm^{-3}

for $\kappa_{160} = 30.2$ cm^2/g

(Gordon+ 2014)

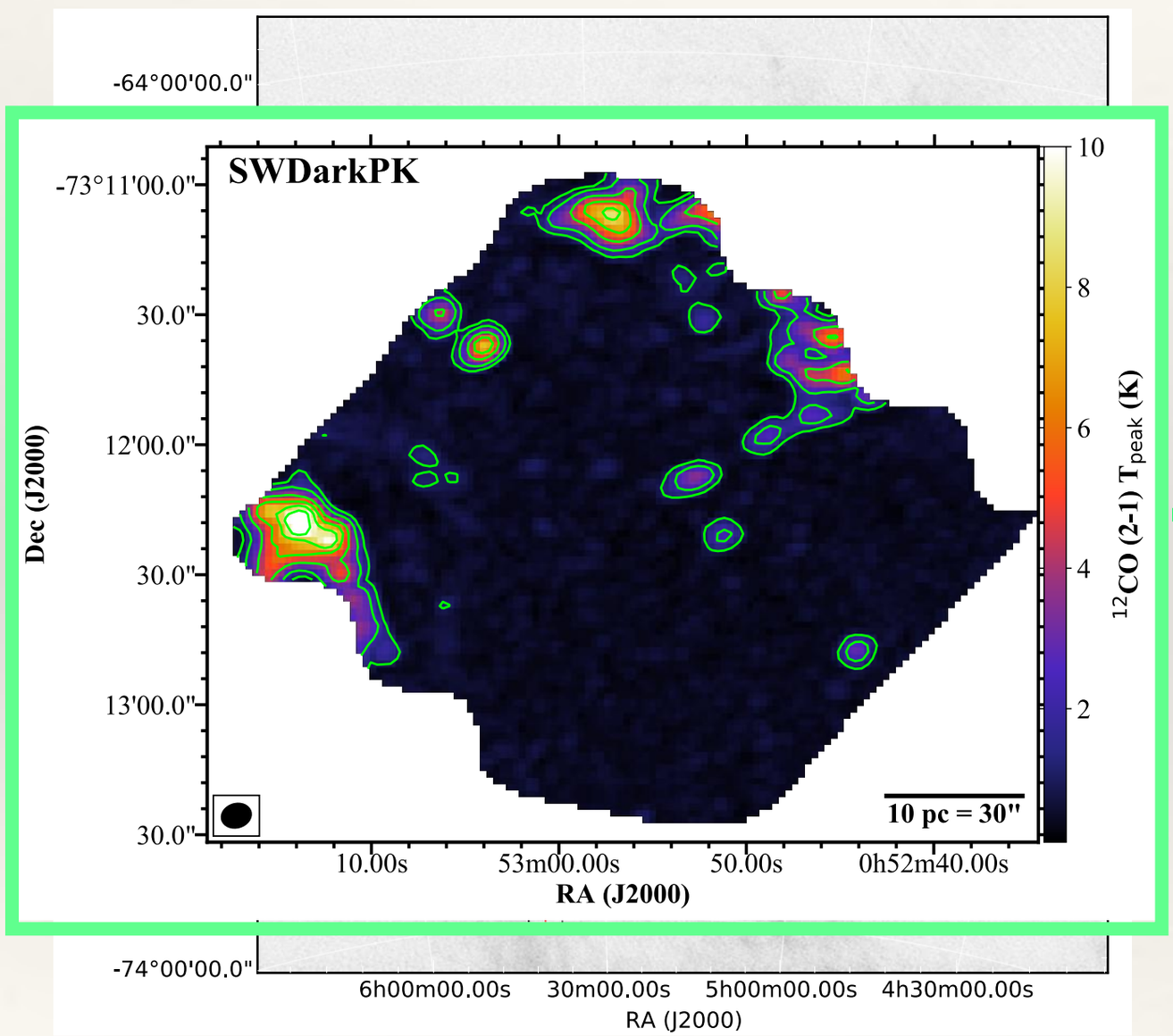
M_{dust} ~ 0.3 $M_\odot$

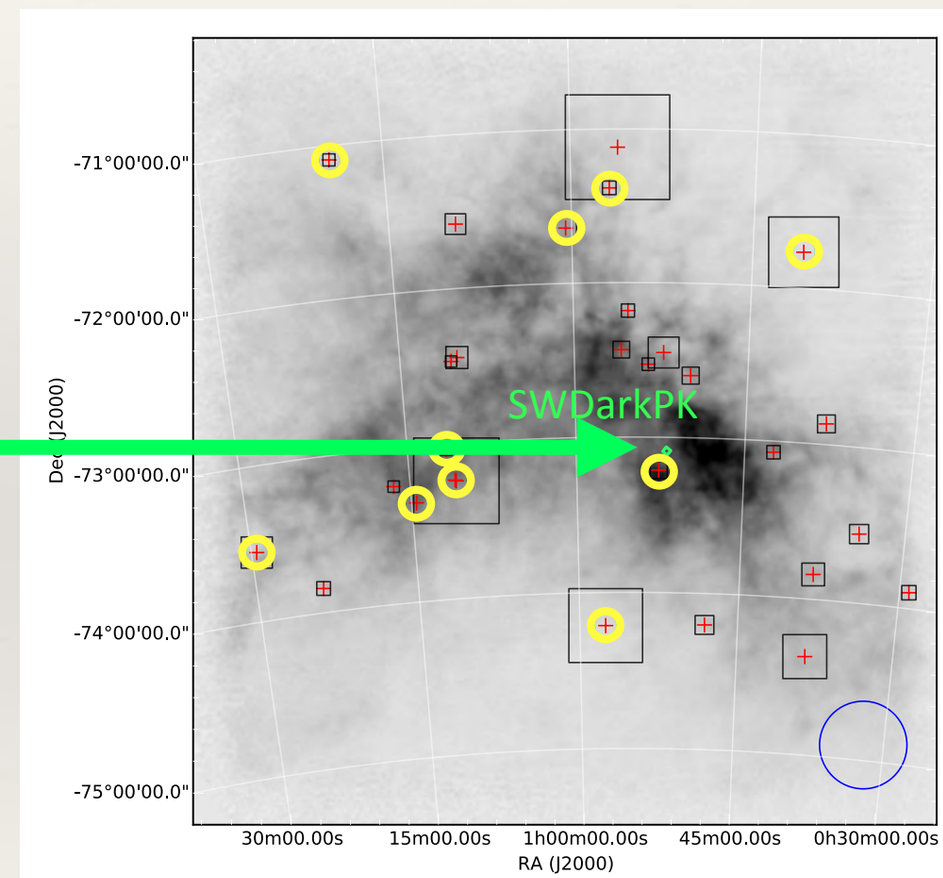
assuming GDR ~ 1400

M_{gas} ~ 420 $M_\odot$, n ~ 33 cm^{-3}

Jameson, Liu, McClure-Griffiths+ *in prep*

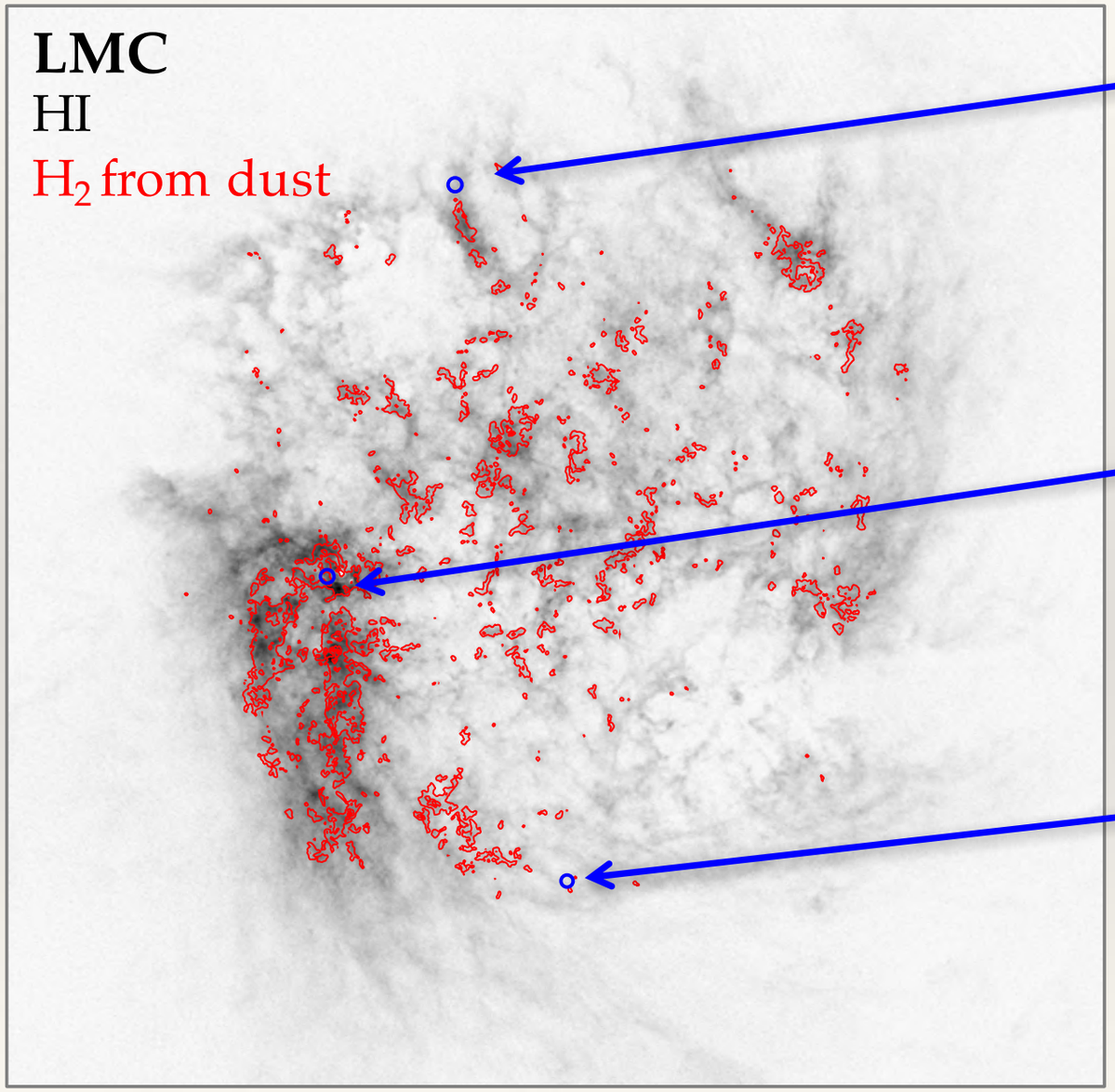
Probing the HI-to-H_2 transition: Future ALMA ACA CO Observations





Jameson+ (2017, *submitted*)

Probing the HI-to-H_2 transition: OH Absorption



0540-6906
$N(OH) < 4.2 – 29 \times 10^{14}$ cm^{-2}
$N(H_2) < 0.6 – 4.3 \times 10^{22}$ cm^{-2}

0527-6549
$N(OH) < 2.0 – 13 \times 10^{14}$ cm^{-2}
$N(H_2) < 0.3 – 2.0 \times 10^{22}$ cm^{-2}

0517-718
$N(OH) < 1.5 – 10 \times 10^{14}$ cm^{-2}
$N(H_2) < 0.2 – 1.5 \times 10^{22}$ cm^{-2}

Work in progress by undergraduates Laurin Gray (U. Arizona), Frances Buckland-Willis (ANU)

Pouch-sized Talk

New HI and OH absorption line survey in LMC and SMC

- >2x more sources
- up to 10x greater sensitivity
- 8x higher spectral resolution
- Ability to study small-scale structure

<u>Preliminary Results</u>

- LMC: $\langle T_s \rangle$ larger, f_c lower than previous work
- evidence for HI self-absorption
- OH absorption upper limits consistent with dust-based H_2 limits

Future ALMA CO data for subset of sources