MALT 90

Millimetre Astronomy Legacy Team

90 GHz survey

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High Mass Stars form within Dense Cores in Infrared Dark Clouds

The "Nessie" Nebula
Jackson et al. 2010

Blue - 3.6μm, Green - 8μm, Red - 24μm

Image credit: NASA/JPL-Caltech/Univ. of Wisconsin

Cores in the Nessie Nebula

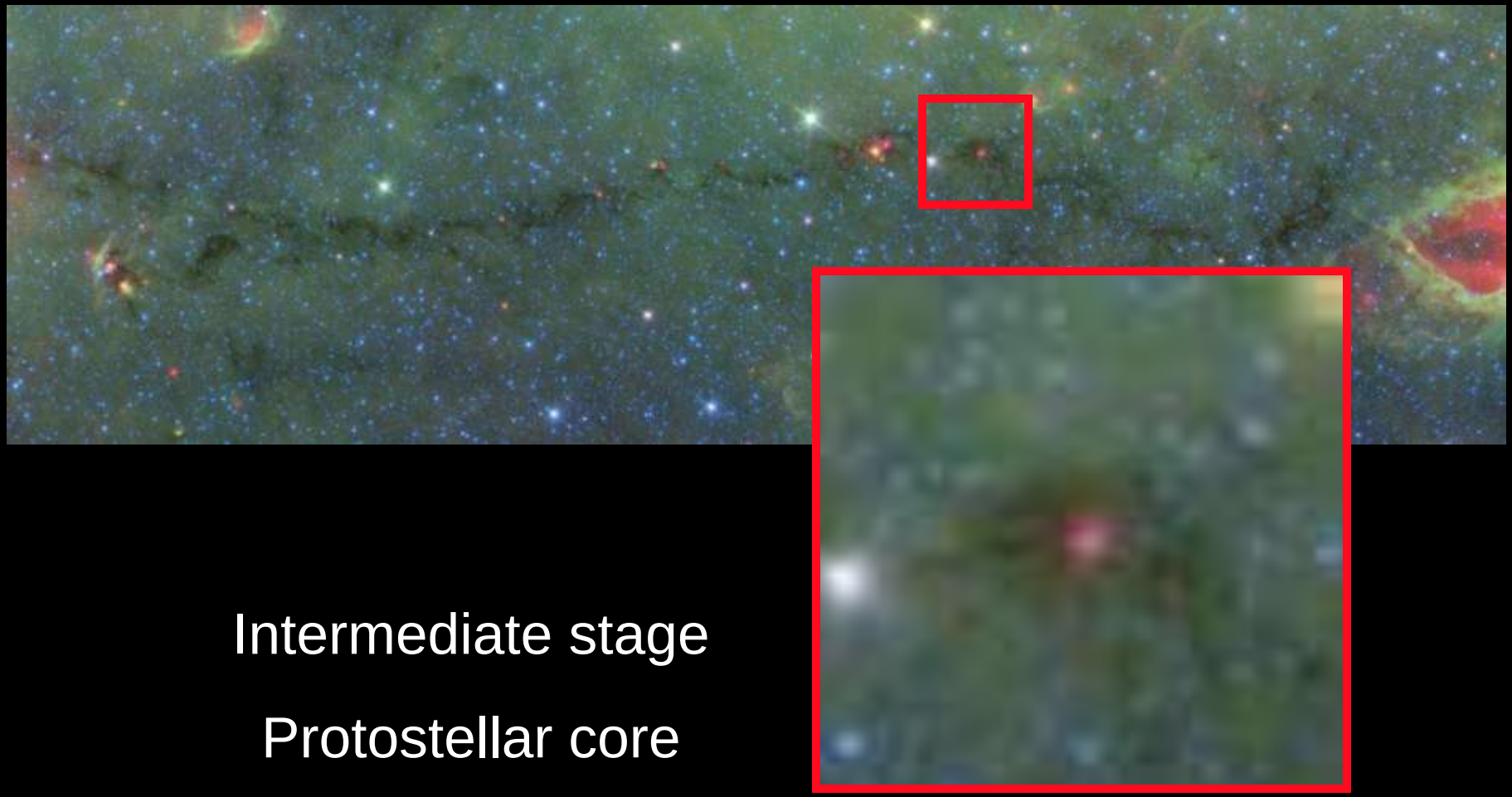
Early stage

Cold pre-stellar core

Blue - 3.6μm, Green - 8μm, Red - 24μm

Image credit: NASA/JPL-Caltech/Univ. of Wisconsin

Cores in the Nessie Nebula



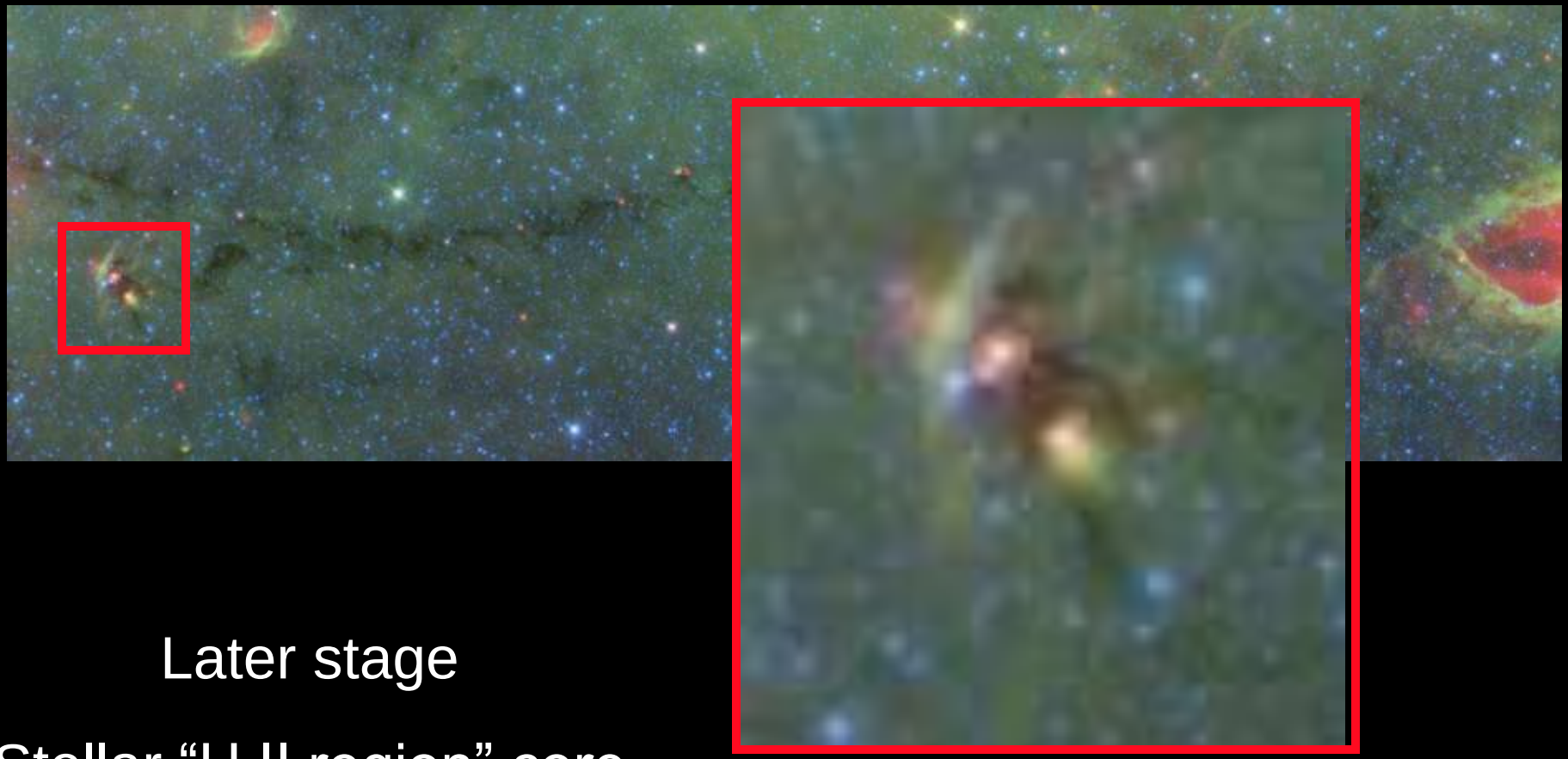
Intermediate stage

Protostellar core

Blue - 3.6μm, Green - 8μm, Red - 24μm

Image credit: NASA/JPL-Caltech/Univ. of Wisconsin

Cores in the Nessie Nebula



Later stage

Stellar “H II region” core

Blue - 3.6μm, Green - 8μm, Red - 24μm

Image credit: NASA/JPL-Caltech/Univ. of Wisconsin

Dense Cores forming High-Mass Stars

- What are their physical properties?
- What is their Galactic distribution?
- How do they evolve?

The Millimeter Astronomy Legacy Team 90 GHz (MALT 90) Survey

Science goal: How do high-mass star-forming molecular cores evolve?

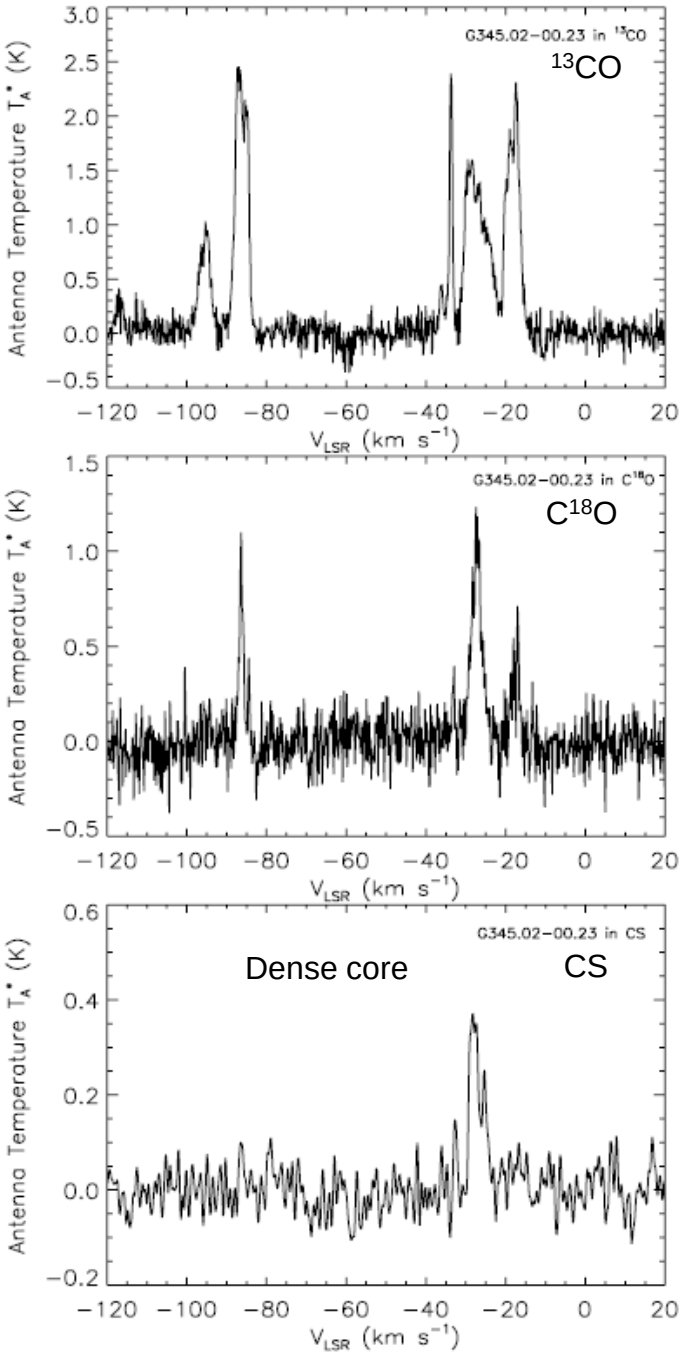
ATNF Mopra 22 m

MALT 90 will provide

- Kinematic distances
- Column densities
- Virial masses
- Core kinematics
- Molecular chemical abundances
- A large sample of the elusive youngest cores

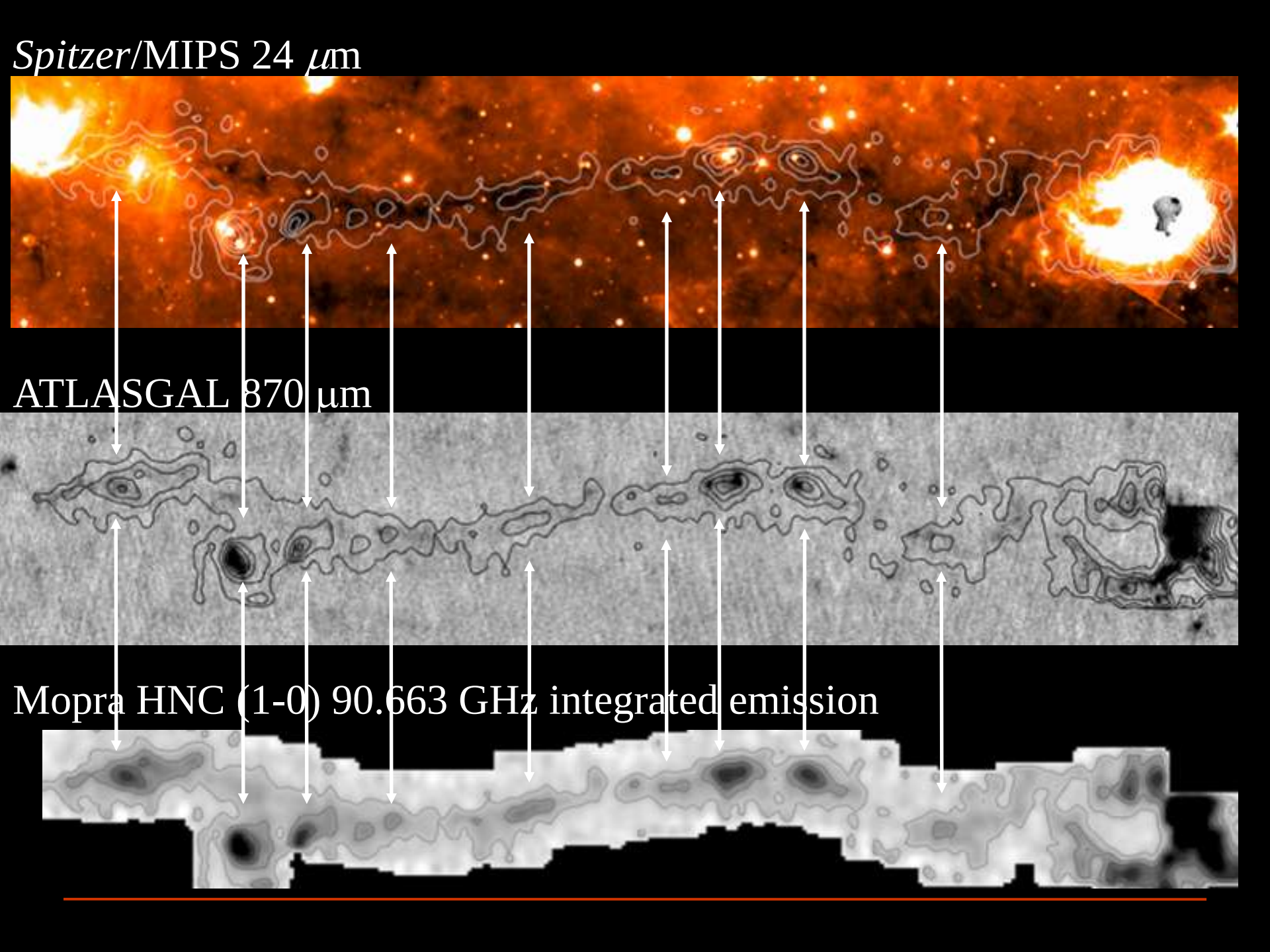
Why 90 GHz ?

- Molecular lines at ~90 GHz require high densities for their excitation ($n > 10^5$ cm^{-3})
- These lines are therefore sensitive ONLY to dense star-forming cores.



The MALT 90 strategy

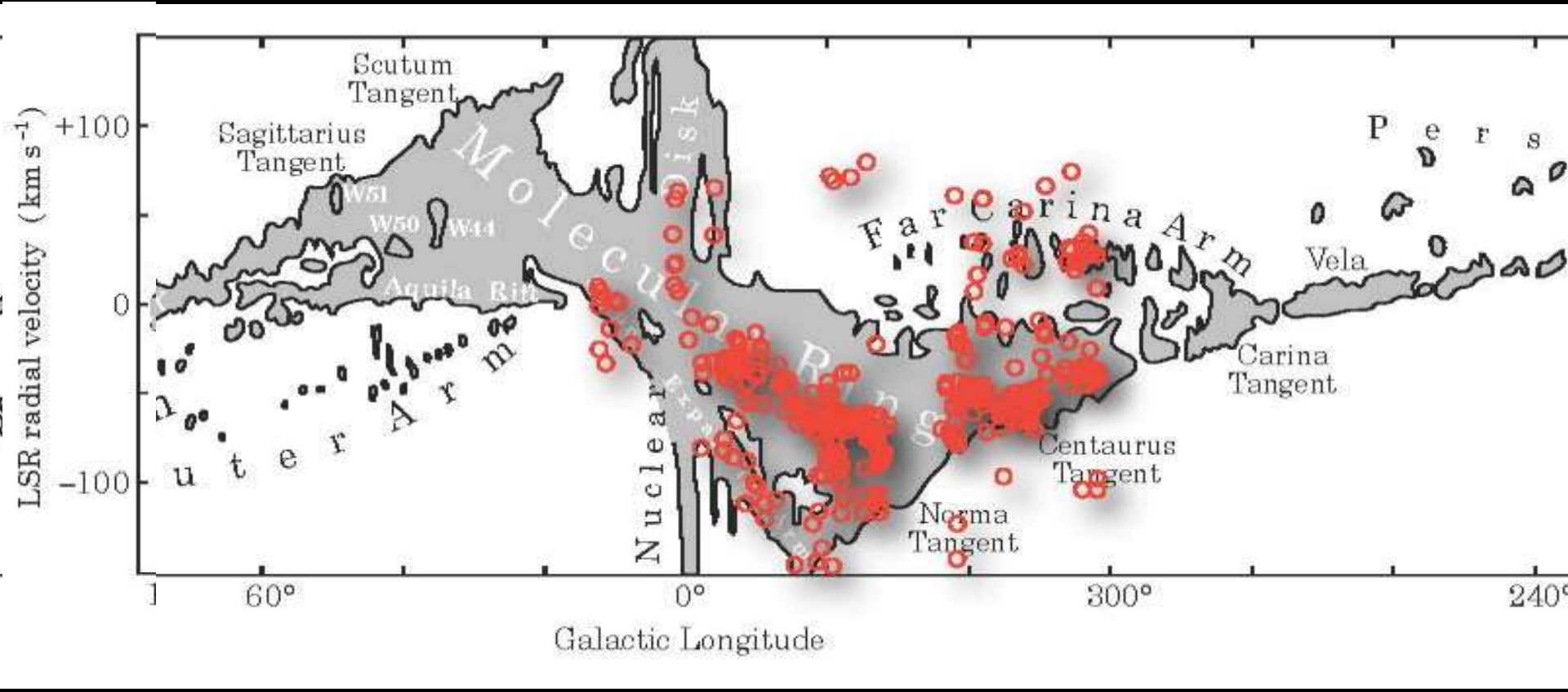
- The ATLASGAL 870 μm survey of the Galactic plane (Schuller et al. 2009) has now identified thousands of cores
- ATLASGAL cores will be simultaneously imaged with Mopra in **16** key 90 GHz molecular lines, e.g. N_2H^+, HCO^+, HCN, HNC…
- The survey will be complete: all high-mass star forming cores (M > 200 $M_\odot$) to 10 kpc.


Spitzer/MIPS 24 μm
ATLASGAL 870 μm
Mopra HNC (1-0) 90.663 GHz integrated emission

Current status

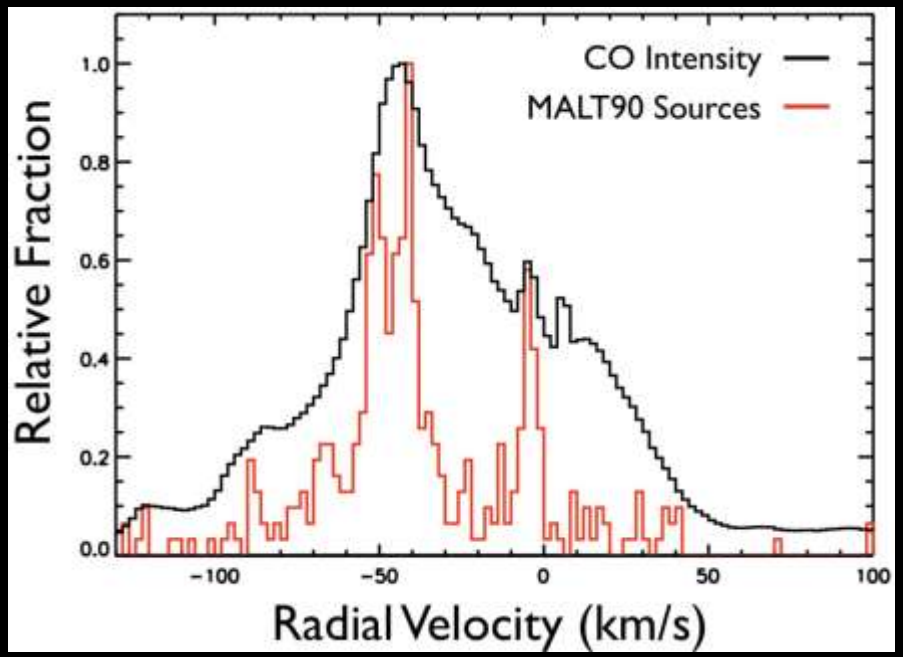
- First season: 499 cores
- Second season underway: 700+
- Automated observing scripts
- Automated data pipeline
- First season data released:
  http://atoa.atnf.csiro.au/MALT90

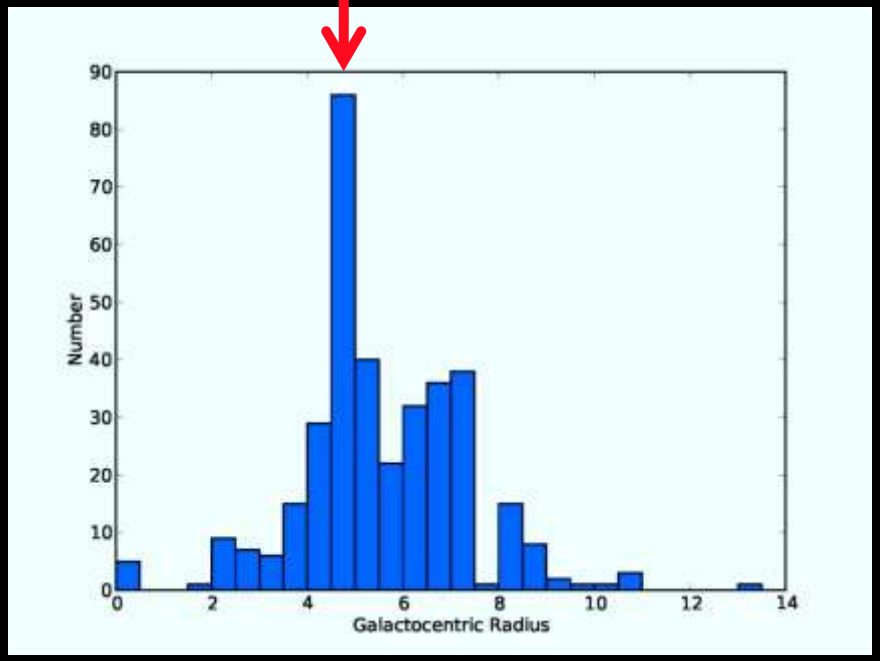
1. Kinematic Distances: Source Velocities



Source: CfA-Columbia CO survey Dame et al. 2001

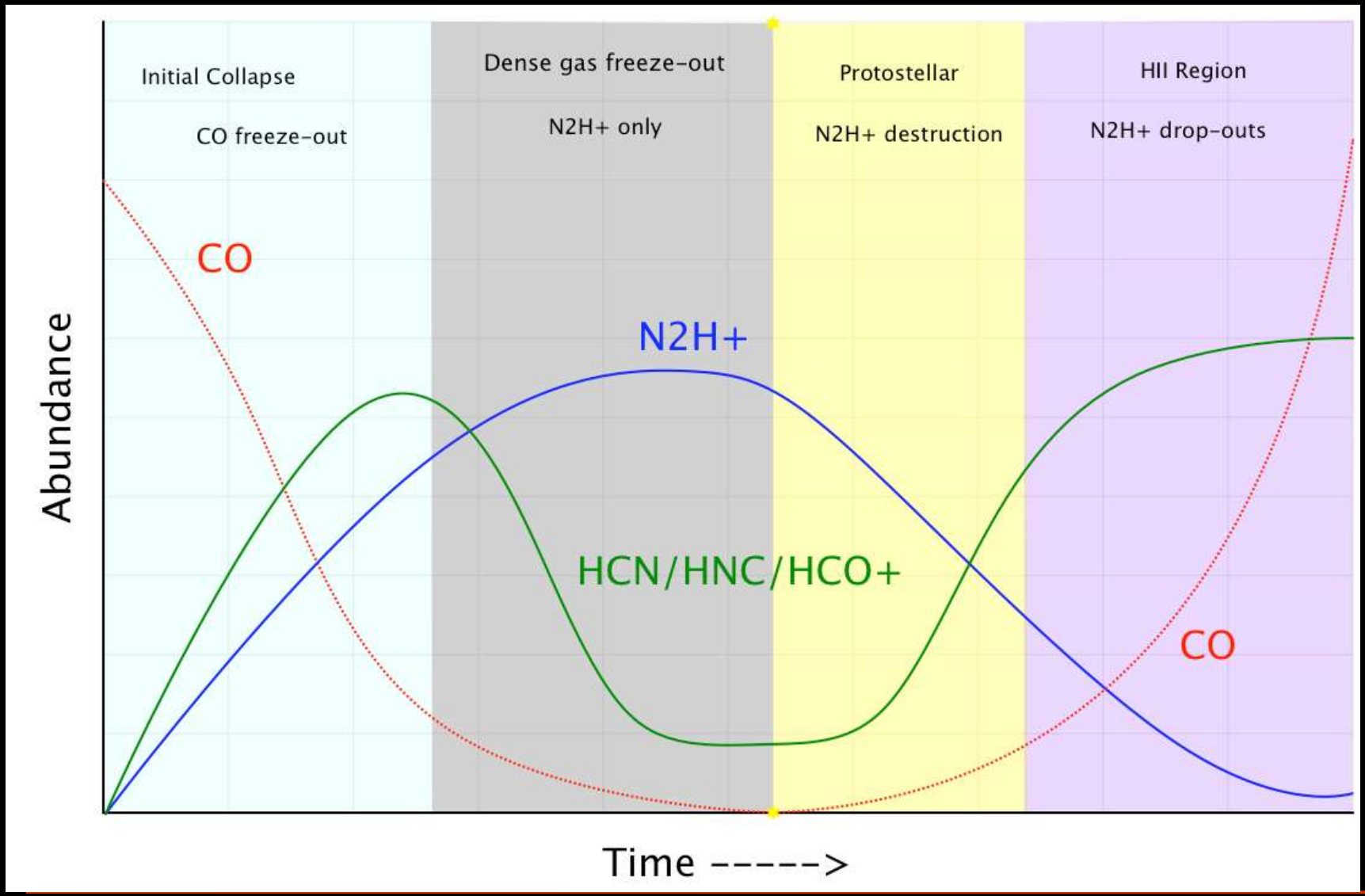
Galactic Distribution of Dense Cores



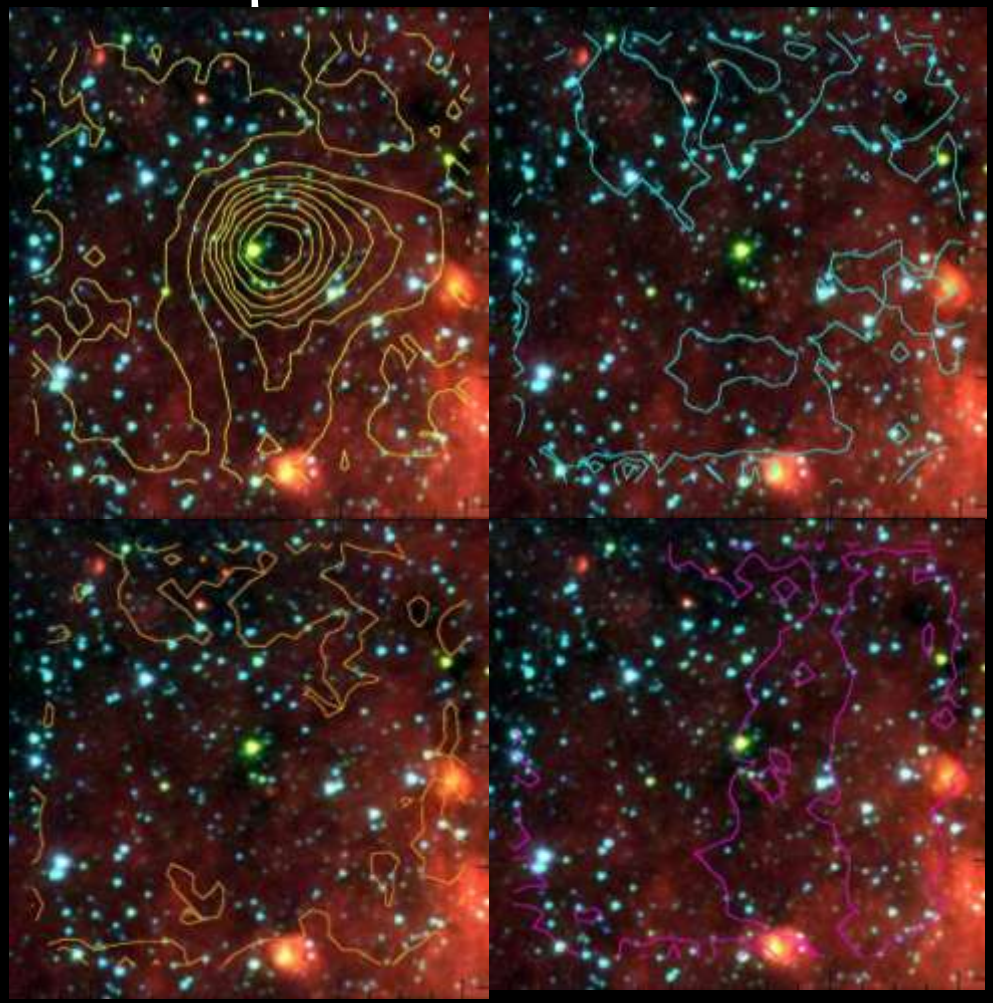


Spiral Arm

2. Chemical Evolution

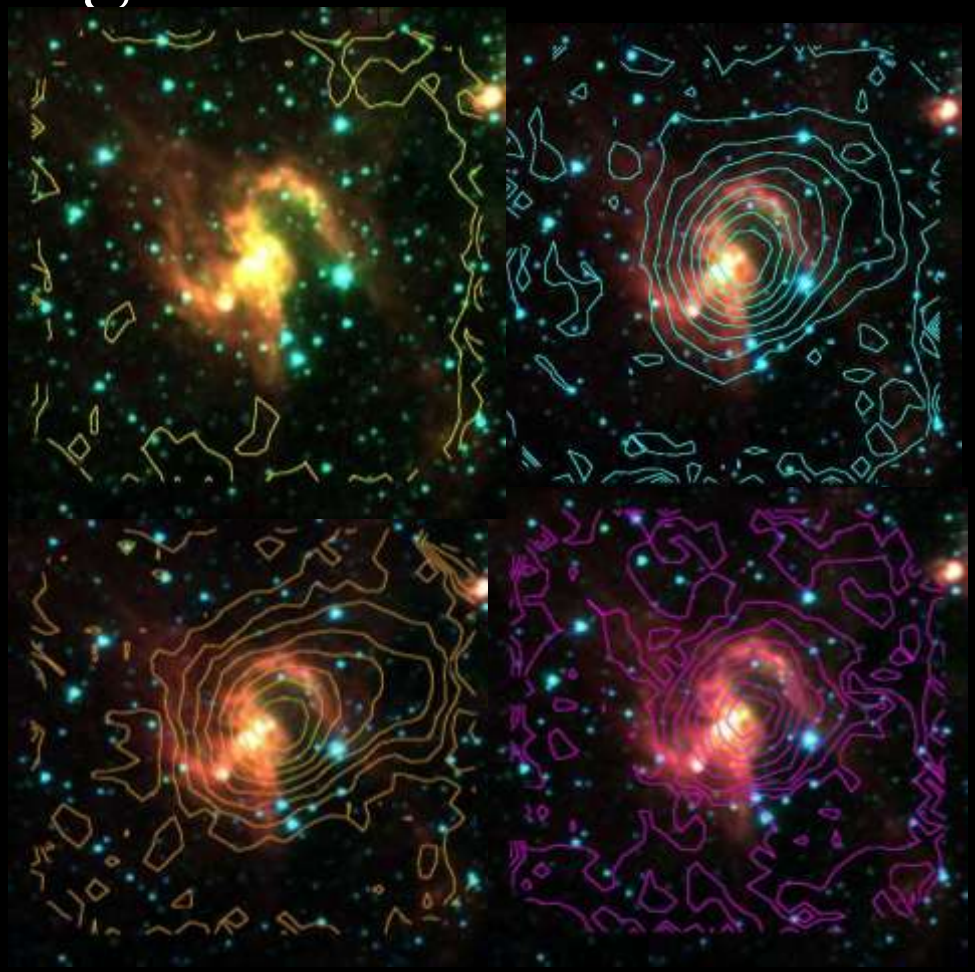


An N_2H^+ "only" source; typically associated with starless or protostellar cores



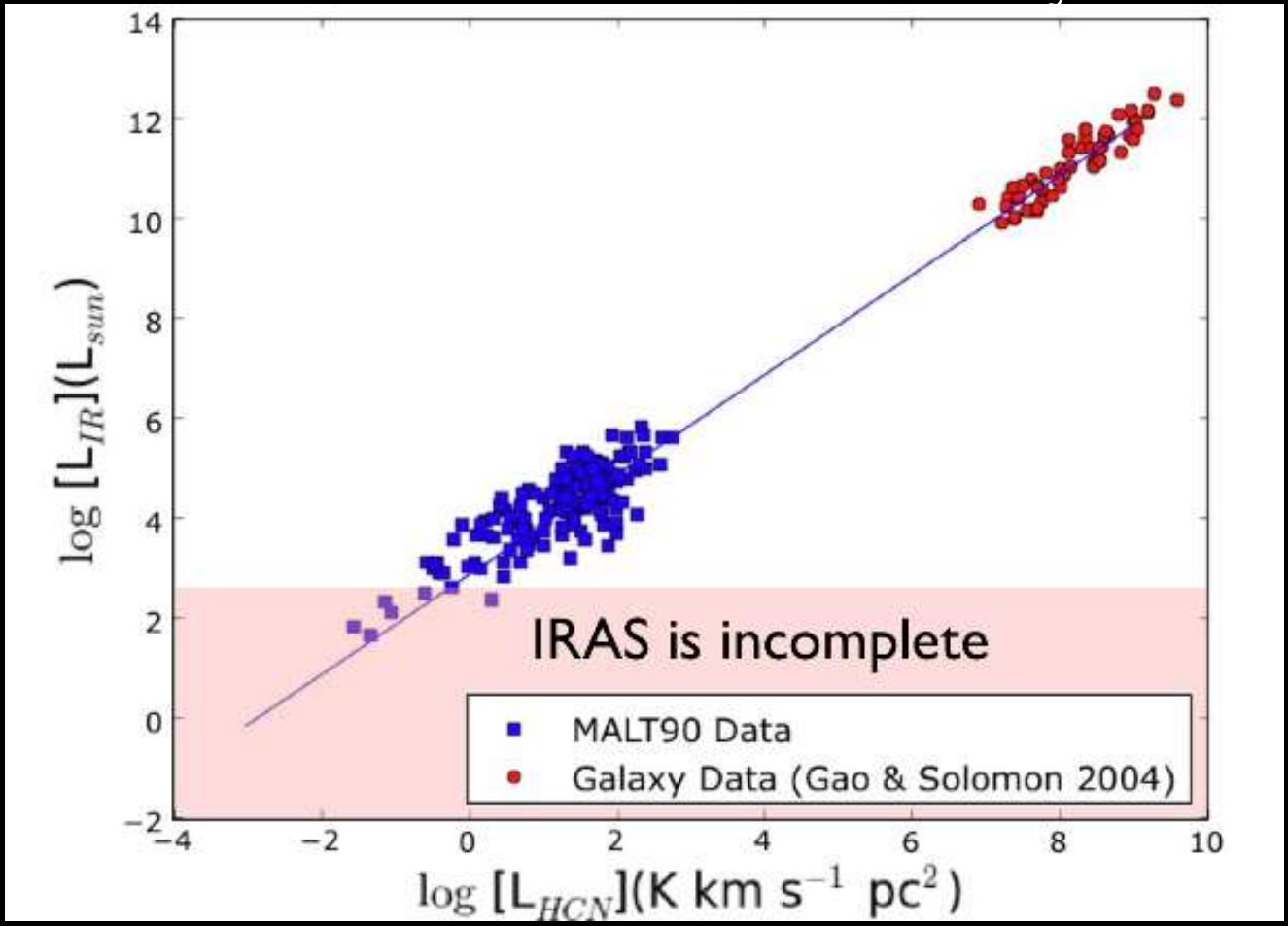
Blue - 3.6μm, Green - 4.5μm, Red – 8 μm from GLIMPSE survey

An N_2H^+ "drop out"; typically associated with H II regions



Blue - 3.6μm, Green - 4.5μm, Red – 8 μm from GLIMPSE survey

3. The HCN-FIR luminosity correlation



The L_{IR}-L_{HCN} relation holds from kpc scales to pc scales; over 10 orders of magnitude!

Summary

- MALT 90 will map ~3000 dense, star-forming cores with the Mopra telescope in 16 different molecular lines near 90 GHz
- ATLASGAL 870 μm cores are the targets
- Initial projects:
  - Kinematic Distances
  - Chemical Evolution
  - The FIR-HCN Relation

MALT 90 will be the largest systematic molecular line survey of dense cores and an excellent resource for Herschel and ALMA