The Science Case for Band 1 (observing the 30-50 GHz Range)

An ALMA Development Plan Proposal submitted by:
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Based on `The Science Case for Building a Band 1 Receiver for ALMA' Johnstone et al. - Astro-Ph

Band 1 Characteristics

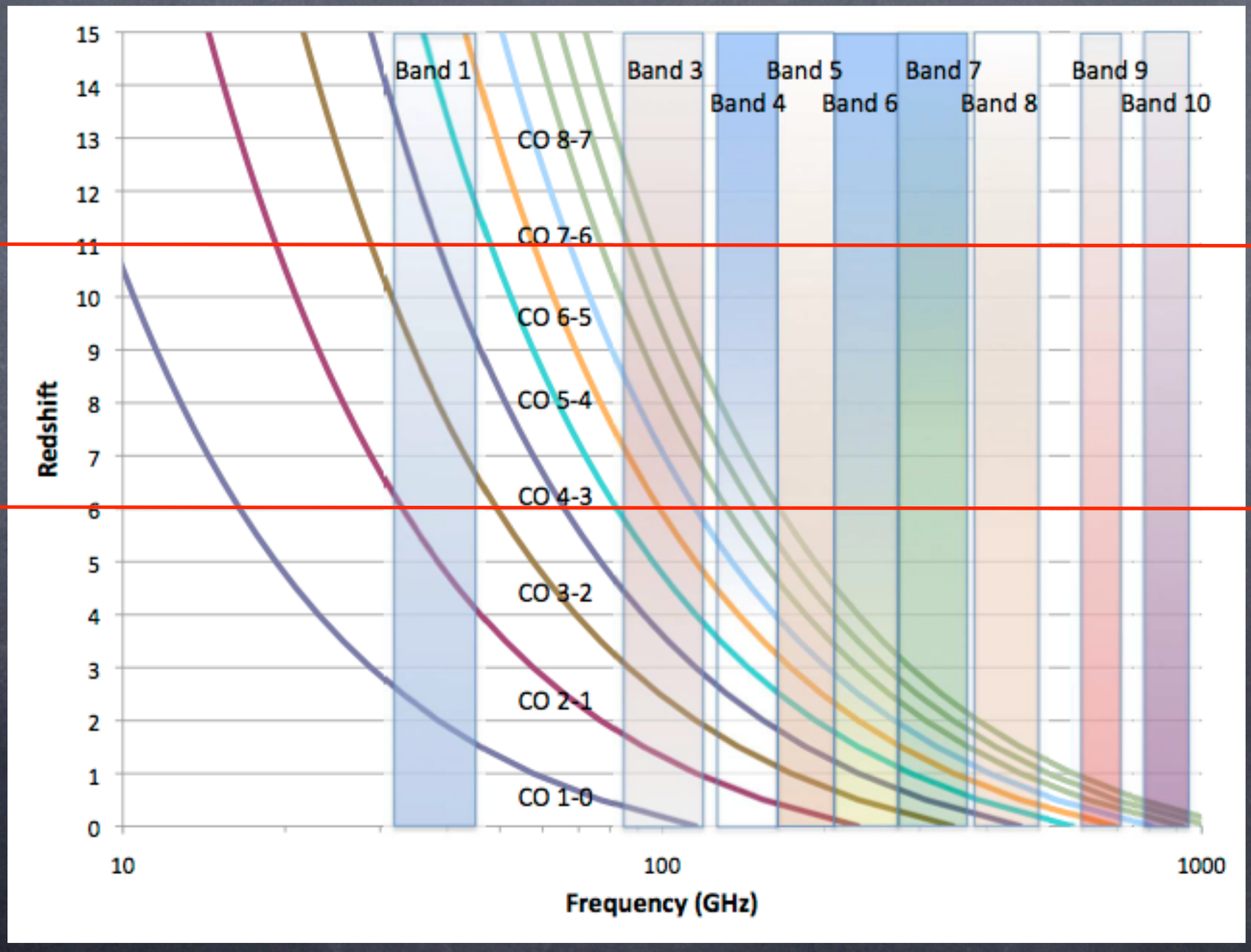
- frequency range -> nominal 31-45 GHz
  - but increasing these frequencies is an option
    - 33 - 50 GHz appears better suited to ALMA
- 8 GHz instantaneous bandwidth
  - excellent for continuum studies
- angular resolution down to about 0.1"

Equivalent to Level 1 Science Goals

- Evolution of grains in protoplanetary discs
  - as a complement to gas kinematics
- Detection of the CO 3-2 line in distant Galaxies
  - probing the era of re-ionization ($6.5 < z < 10$)

ALMA CO coverage vs z

observed frequency of ^{12}CO

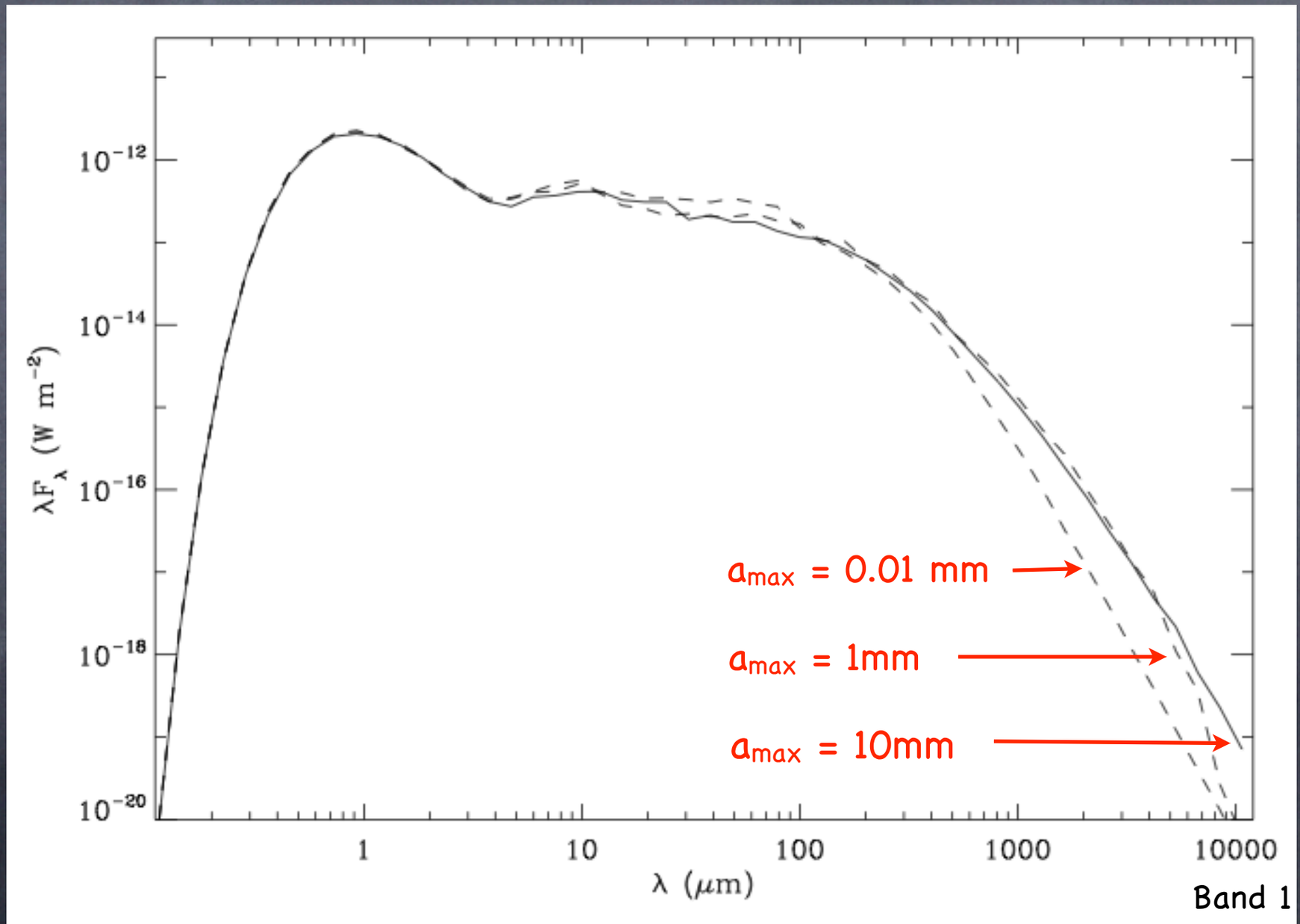


Zone of Re-ionization

Zone of Re-ionization

SED for 3 Disc Models

changing only maximum grain size



A Broad Range of Science

for example: Stellar Jets

- free-free emission from dense ionized gas
- SiO 1-0 emission (shock diagnostic and maser line)

A Broad Range of Science

for example: Stellar Jets

Observational Characteristics of Radio Jets

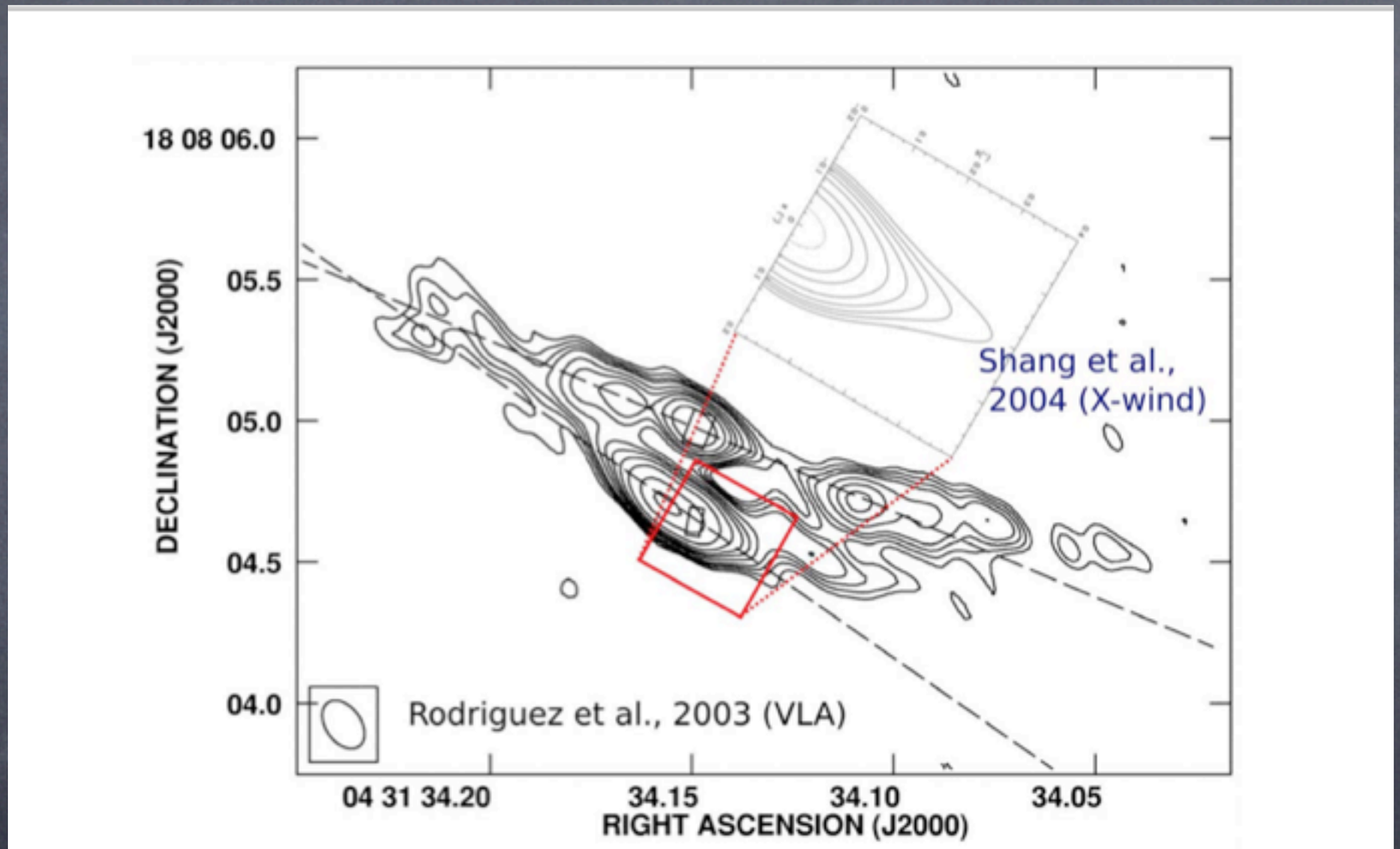
- Elongated, jet-like structures at subarcsecond scale
- Alignment with large-scale outflow
- Typical weak fluxes from 0.2-2 mJy
- Short dynamical lifetime
- Partial association with optical jets or HH objects.
- Positive to flat spectral indices:

$$S_\nu \propto \nu^p ; p \geq -0.1$$

- Association with the youngest stellar objects

A Broad Range of Science

for example: Stellar Jets



Comparing Model with Observation

H. Shang, S. Lizano, A. Glassgold, & F. Shu (2004)

A Broad Range of Science

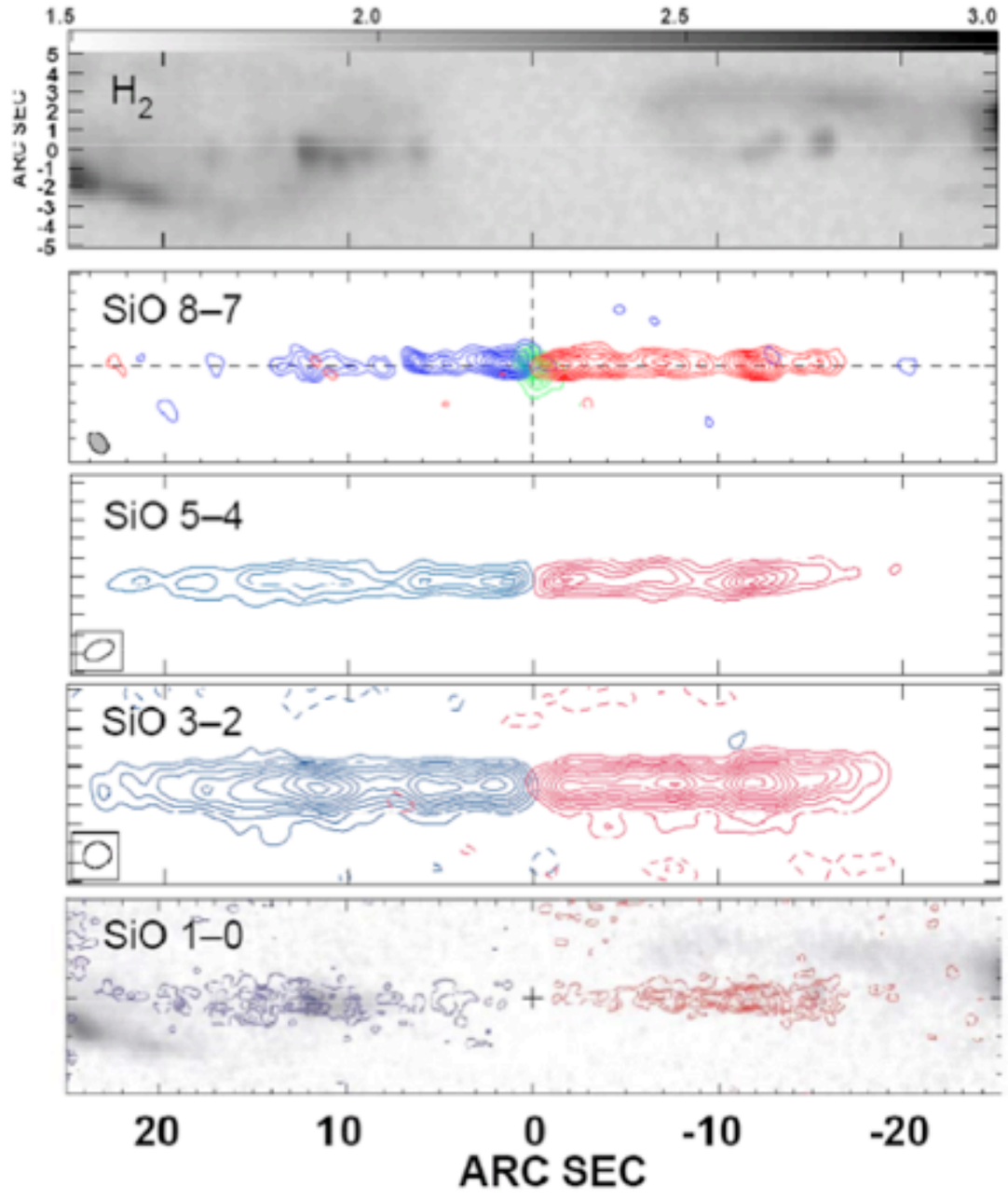
for example: Stellar Jets

Searches for the lowest excitation lines of heavy macro-molecules

SiO (1-0) has not been surveyed around most molecular outflows due to the availability of telescopes that could detect the transition in the past.

A Broad Range of Science

for example: Stellar Jets



- **Higher SiO transitions of unresolved: clumpier and stronger closer to the source.**
- **The innermost knot pairs seen only in the maps of higher transitions. No counter part in the SiO 1-0, CO 2-1, and CO 3-2.**
- **$N_{H_2}>10^6$**
- **T>600-800 K**

A Broad Range of Science

A few other research areas

- very small grains - anomalous dust
- chemical differentiation
  - ability to spatially resolve heavy molecule condensations in dark clouds
  - ability to spatially resolve molecular outflows from young stars
- maser diagnostics
  - need to probe range of conditions - large frequency range
  - two excellent maser candidates are SiO and CH_3OH
- magnetic fields through Zeeman measurements
  - CCS line is considered optimal for this (lines at 33.75 and 45.38 GHz)
- molecular gas content in AGN at high redshift
- star-forming galaxies at redshift $z \approx 2$
- Sunyaev-Zel'dovich

Fin

Band 1 Characteristics Redux

- frequency range: 31-45 GHz (what drives these limits scientifically)?
  - for continuum studies the effect of going to higher frequencies is a wash
    - except for anomalous dust observations where the frequency variation with density is so far uncertain
  - for line studies there appears to be no major loss moving the range higher and the range looks better for high-z CO studies
- in terms of competition from the eVLA, higher frequencies will differentiate the two telescopes much more. At these frequencies ALMA is expected to be ~30 times faster for a point source (same beam) and covers 4x the field of view.