



The ALMA promise: Star Formation

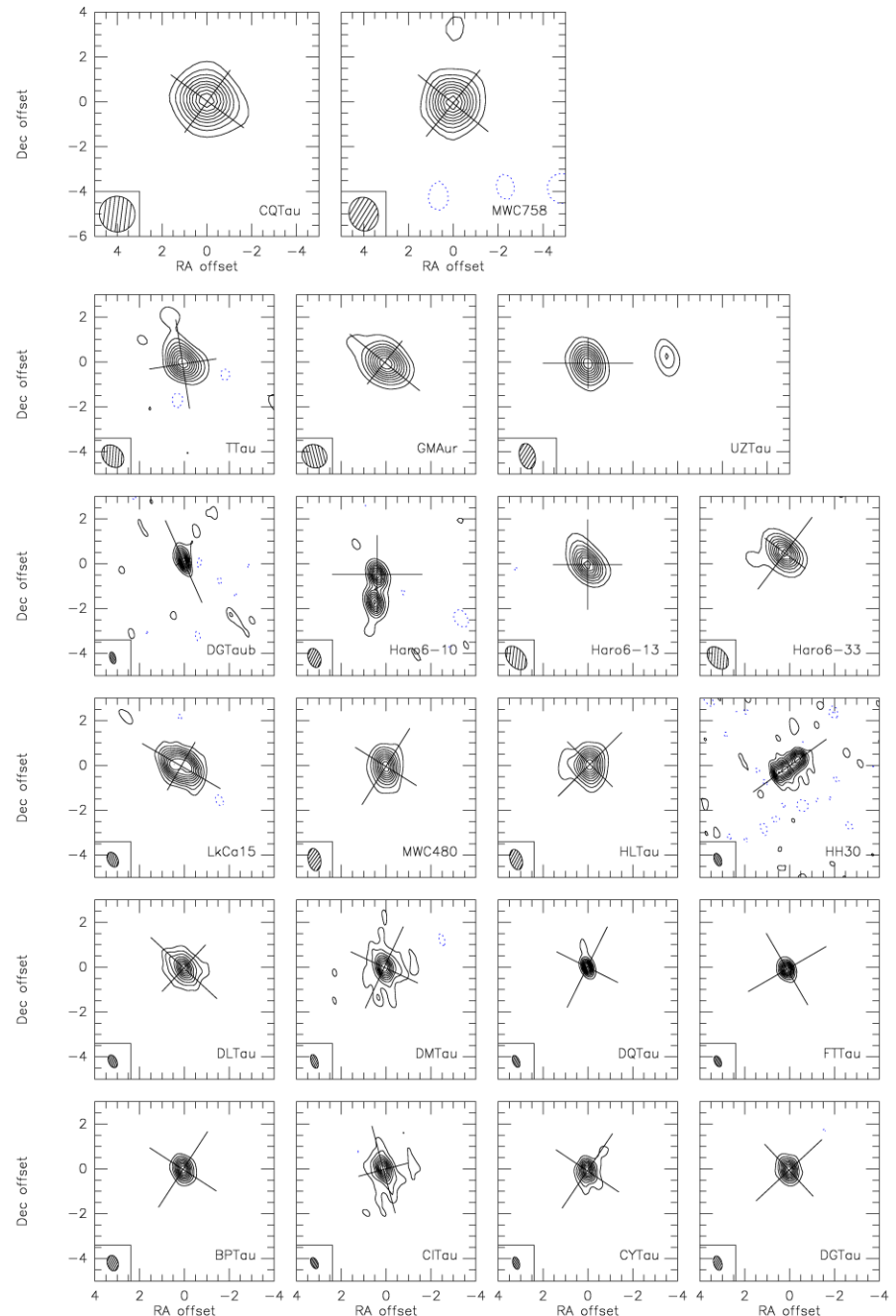
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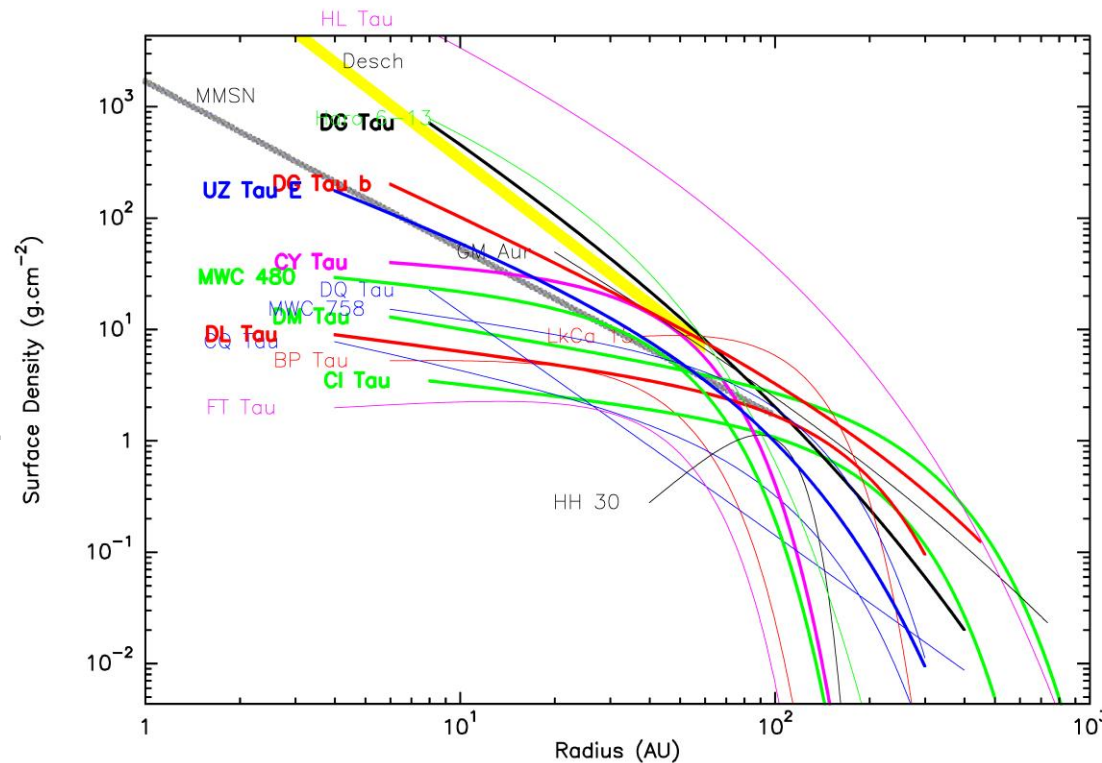
An (illustrative) example

- Dual frequency survey of ~20 discs in Taurus
- 0.4'' at 1.3 mm, 0.8'' at 2.7 mm
- Spread over > 12 years
- Positive evidence for grain size radial segregation (small grains beyond 40 to 80 AU)
- But still model dependent (can't say what the true distribution is...)
- With individual sources, no firm result...
- Shape of radial dust distribution not well constrained.
- Assume circular symmetry...
- Only Taurus...



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Guilloteau et al 2011, A&A

What's new with ALMA ?

1. Sensitivity (specially in continuum)
2. Imaging speed
3. High spectral resolution
4. Ultra high spatial resolution
5. Imaging quality
6. Wide frequency coverage
7. Wide bandwidth & flexible correlator
8. High frequencies
9. Integrated wide field imaging
10. Full polarization capabilities
11. High calibration accuracy

BUT NOT ALL AT ONCE !...

1. Sensitivity & 2 .Imaging Speed

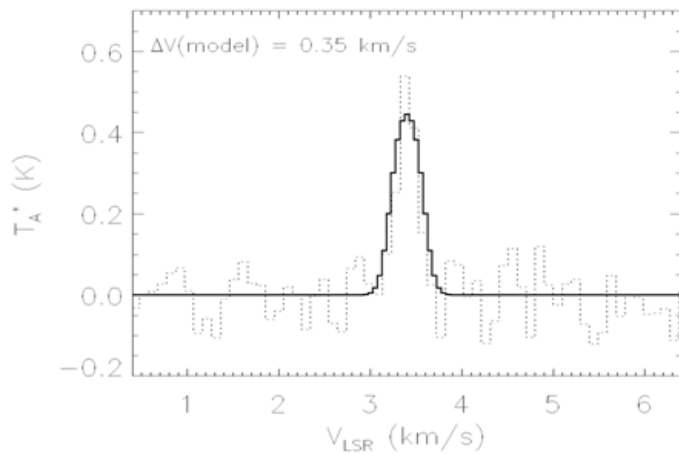
- Large surveys ... STATISTICS !
 - More than one region...
 - Wider age span
 - Core mass distribution (from dust)
- Time variable phenomena ...
 - Outflows ...
 - Others ?..

1.Sensitivity & 4.Resolution

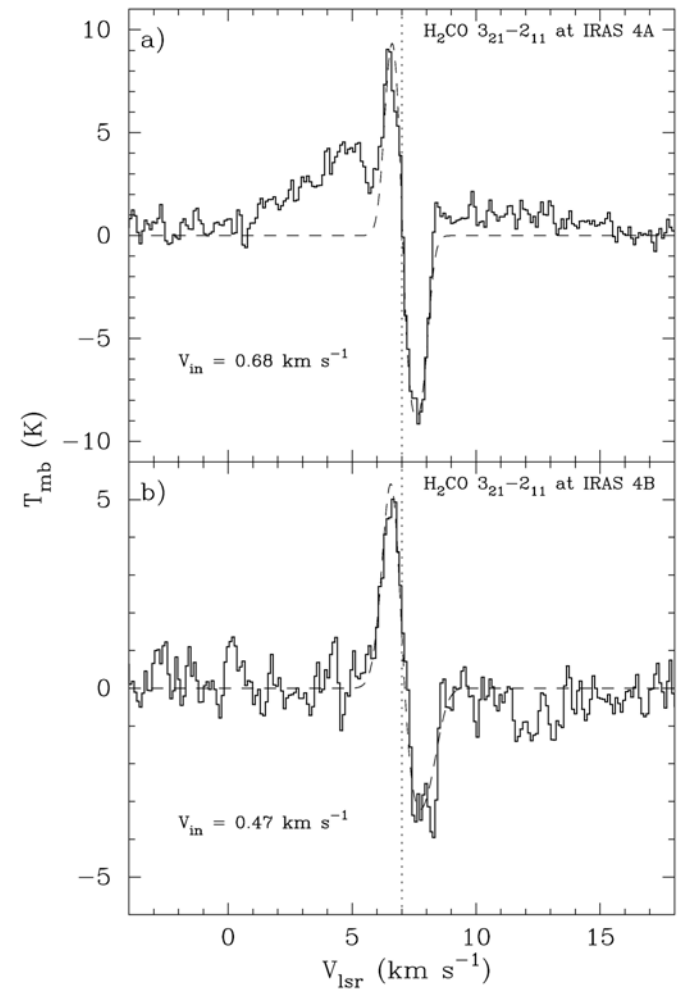
- Go further !...
 - Resolve proto-stellar envelopes and proto-planetary discs up to 500 pc and perhaps beyond
 - Reach dense cluster regime (e.g. Orion)
- Look for details...
 - Characterize radial distribution with no prior...
 - Are sources really symmetric ?

3. High Spectral Resolution

- Infall motions
- Turbulent or Thermal width ?
- e.g. H_2D^+ width $\rightarrow T < 8 \text{ K}$



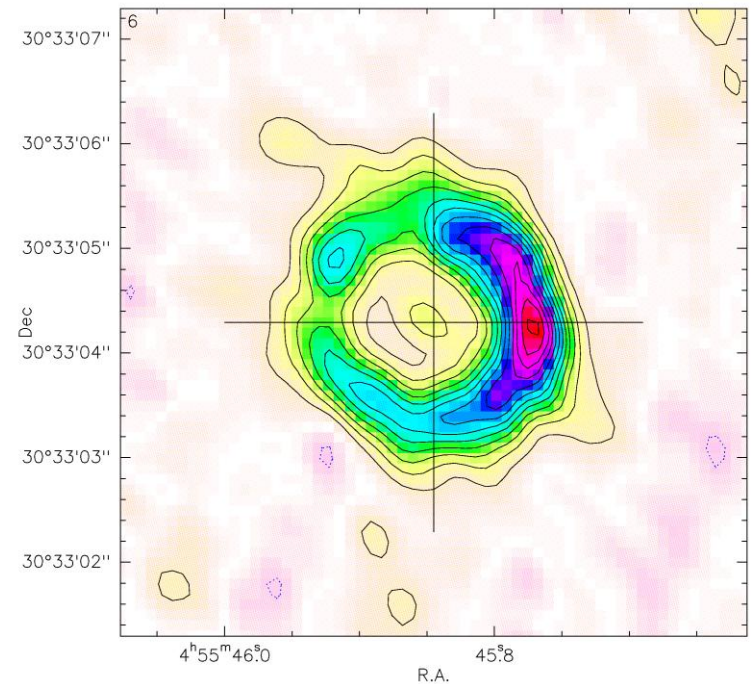
Harju et al 2007



Di Francesco et al 2004

4. Resolution & 5. Imaging quality

- Faint structure in bright sources, low contrast...
 - Searching for small discs in bright cluster environment
- Non symmetric structures



6. Wide Frequency Coverage

- Get dust properties (spectral index)
- Remove free-free contamination
- Complete rotational ladders
- Spectral Surveys

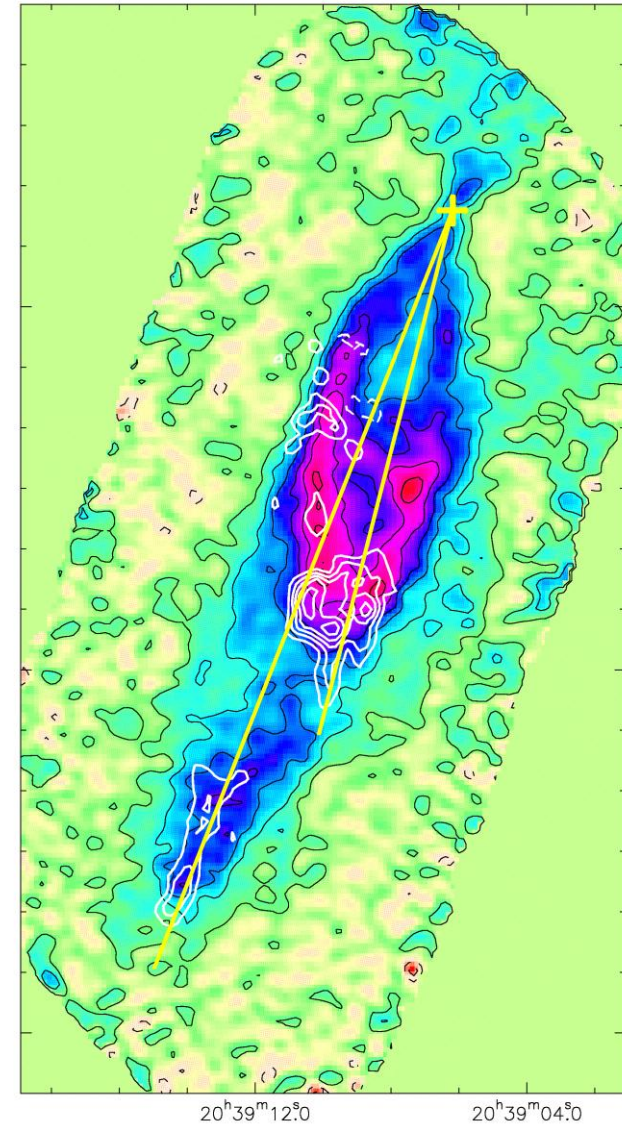
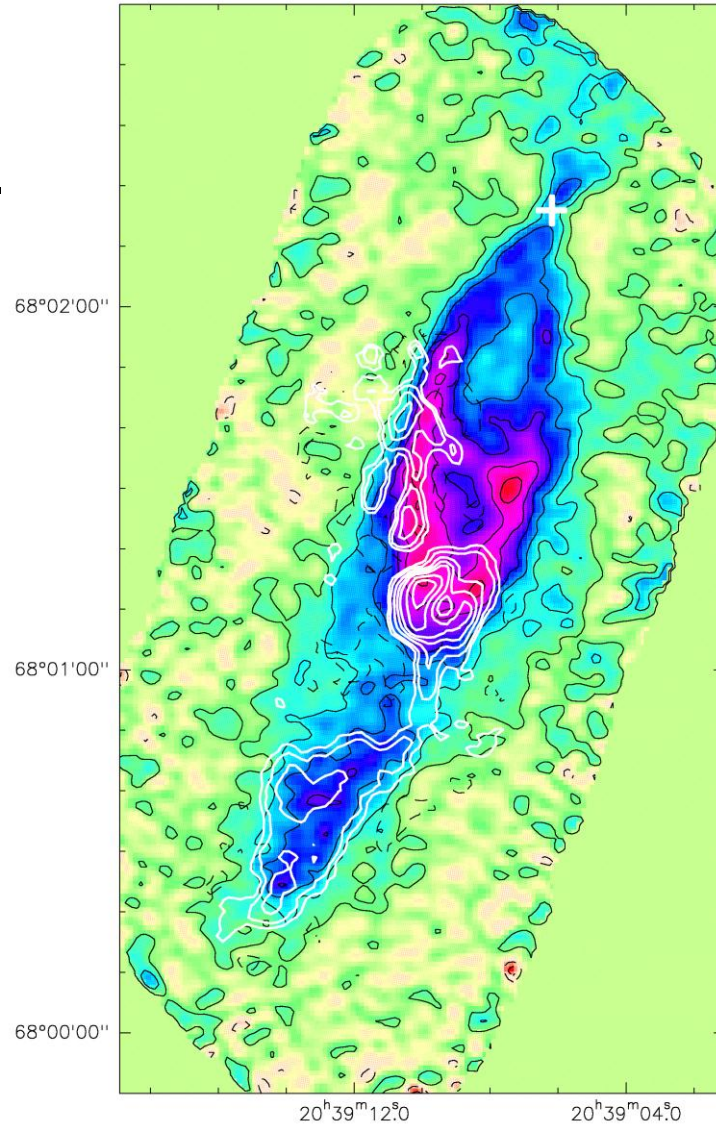
8. High Frequencies

- Warm/Hot media
- Optically thick dust → directly get T
- Unique tracers
 - C I
 - H₂D⁺
- Not worth without 1.Sensitivity
 - SMA can only do optically thick lines at 0.3 km/s resolution...

9. Integrated Wide field Imaging

Study outflows !...

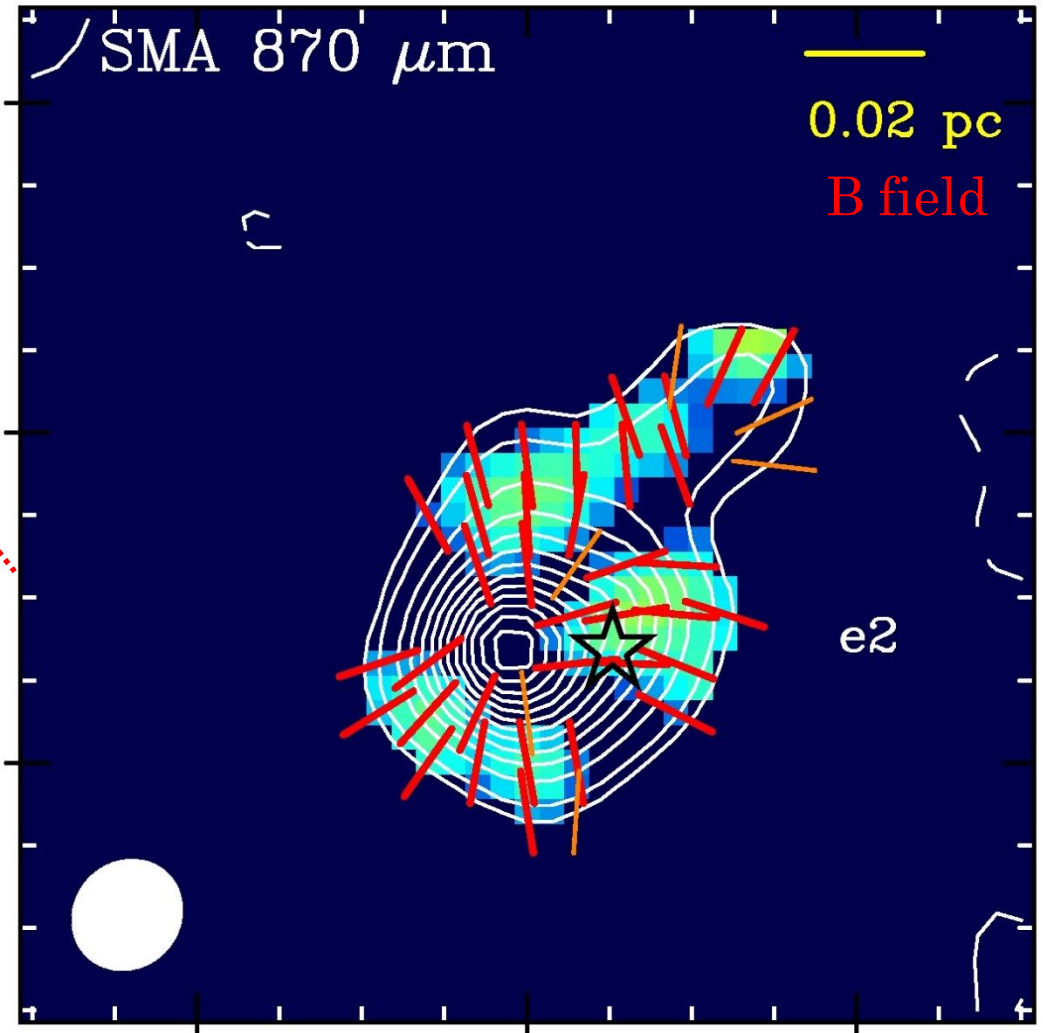
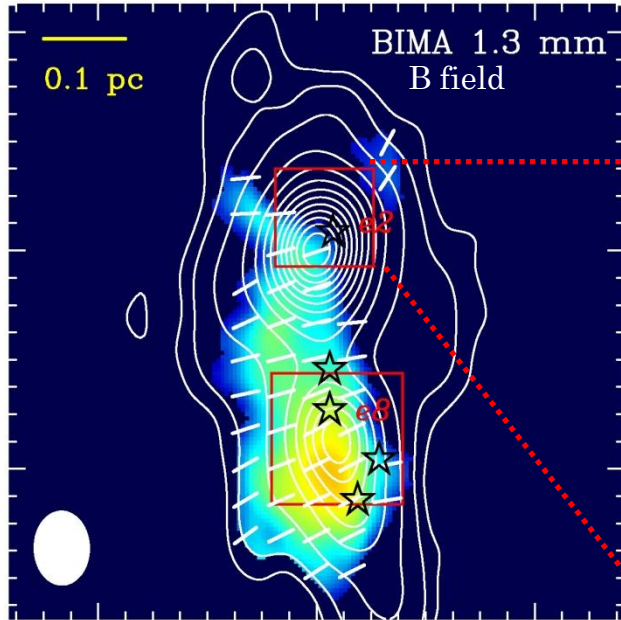
Needs mosaics
AND
high resolution



10.Polarisation & 4.Resolution

Contours: continuum emission
Color scale: polarized emission

Tang et al. 2009b



HourGlass geometry

Tang et al 2009

7. Wide Band & 4.Resolution

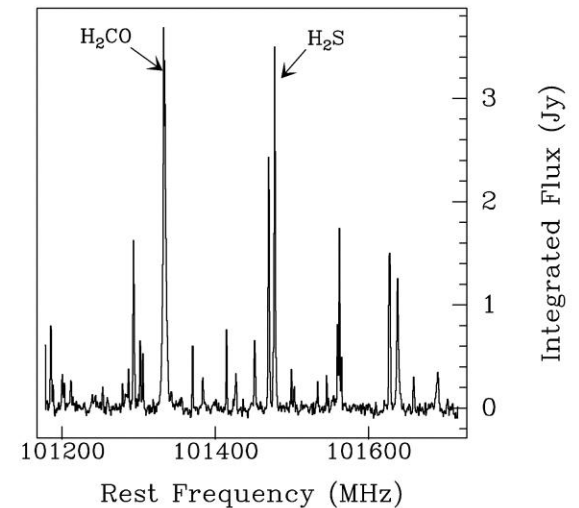
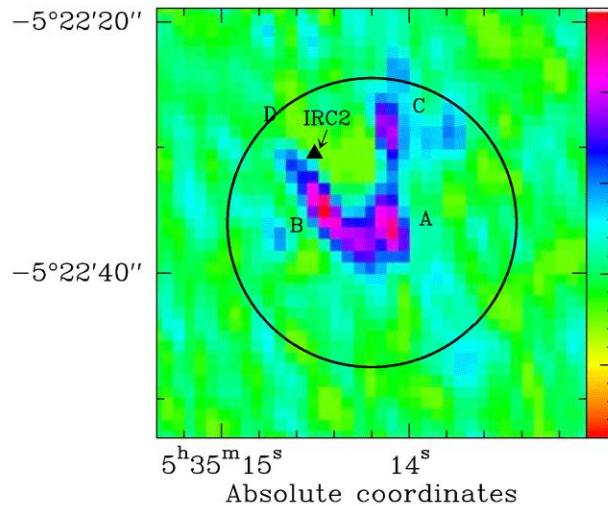
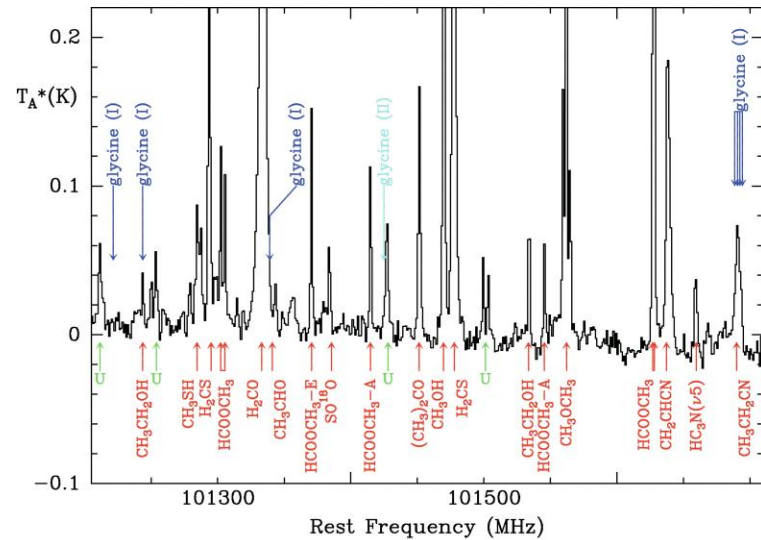
- Reduce confusion...
- Be prepared for COMPLEXITY !...

Hot cores.

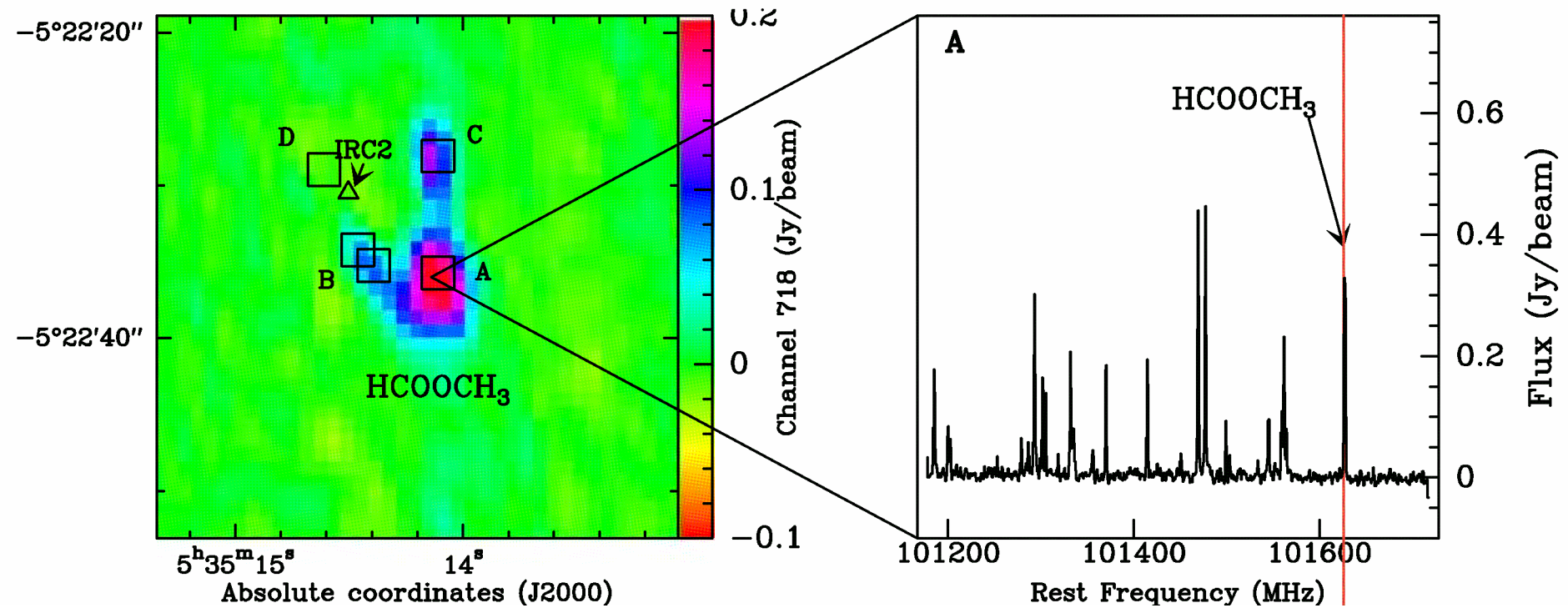
Wanted: High Angular Resolution

Fig. 3 Portion of the 3-mm spectral survey of Orion-IRC2 carried out with the 30-m telescope

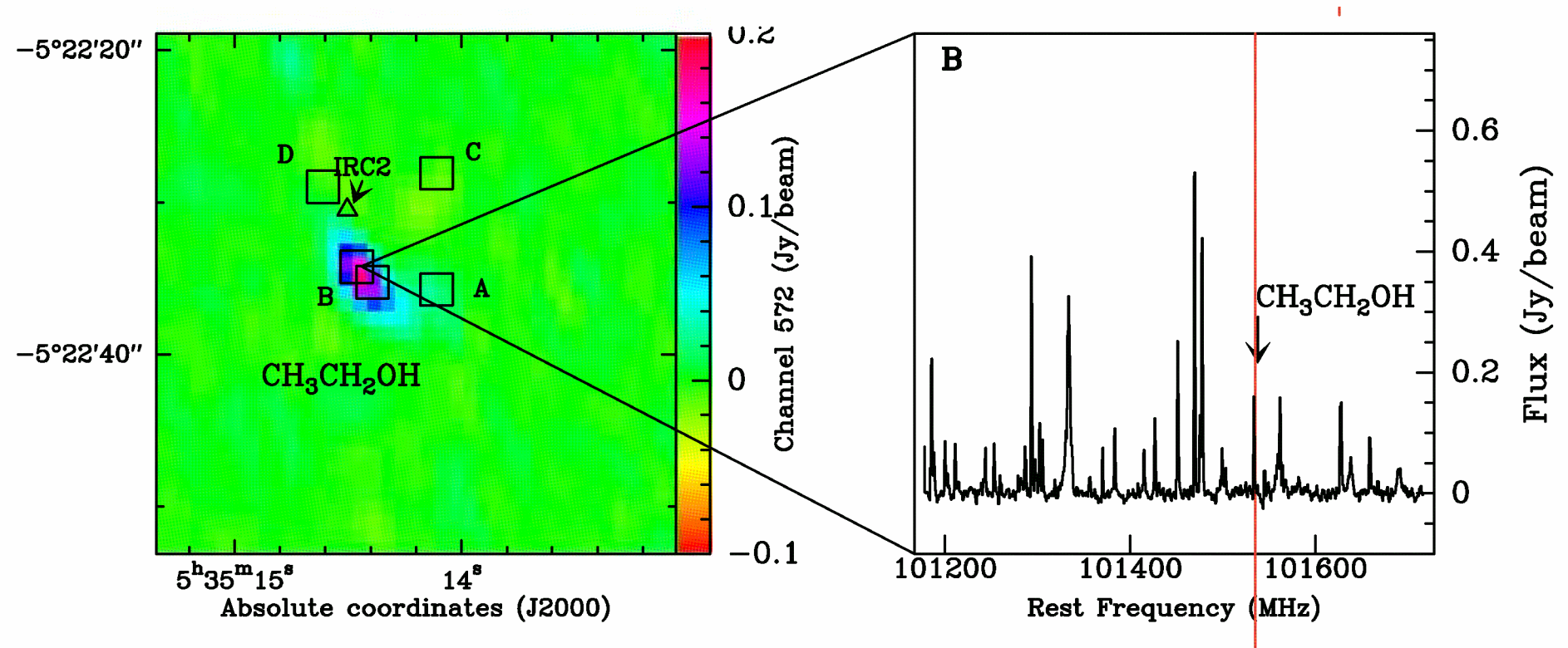
Guélin et al 2007



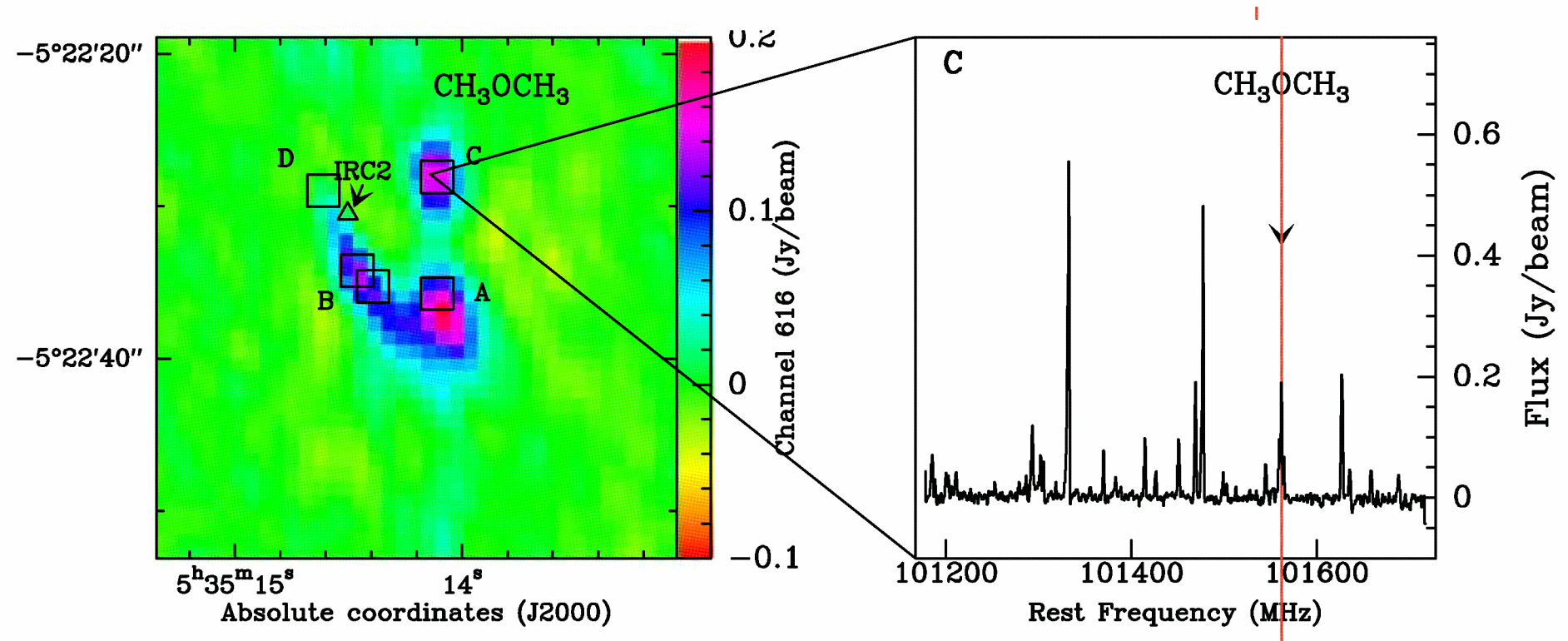
Reducing Confusion



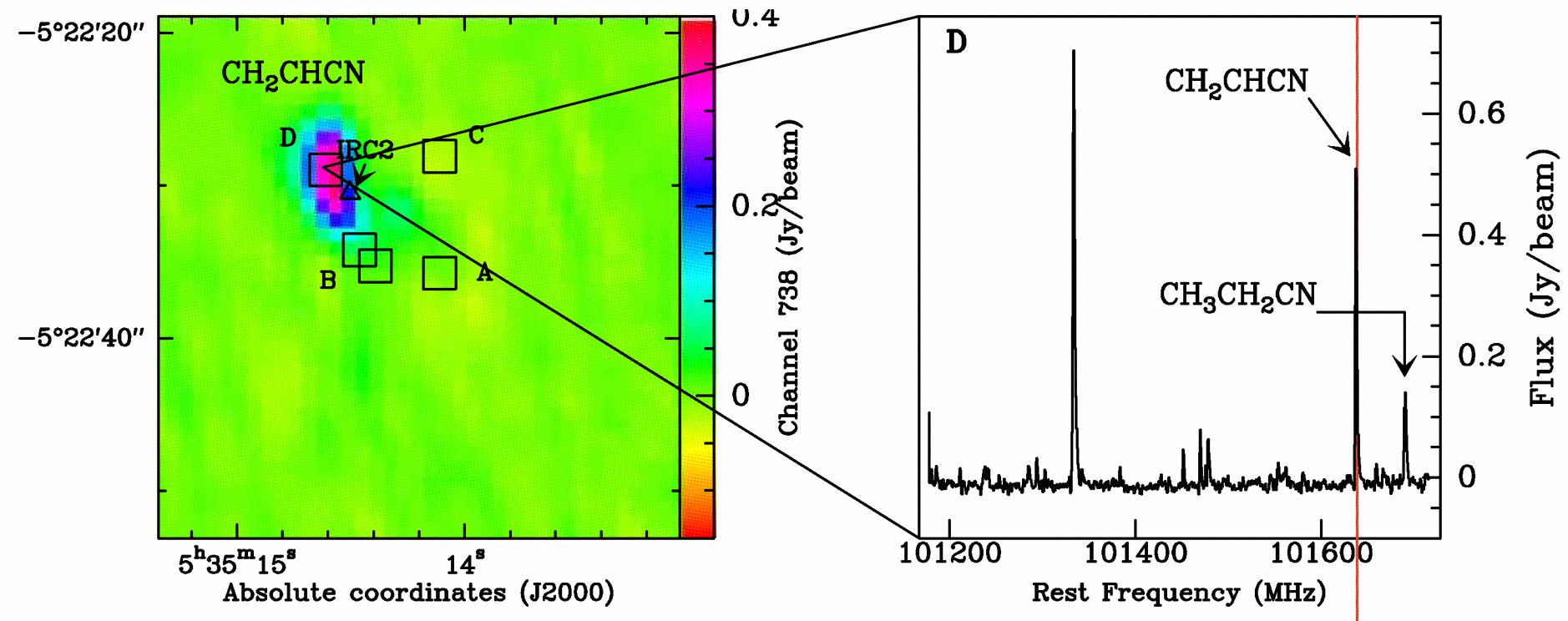
Reducing Confusion



Reducing Confusion



Reducing Confusion



6. Wide Frequency Coverage

- Search for rare molecules
- Example Ethyl Methyl Ether (EME)
- Many lines (Fusch et al)
- But many other molecules with many lines...

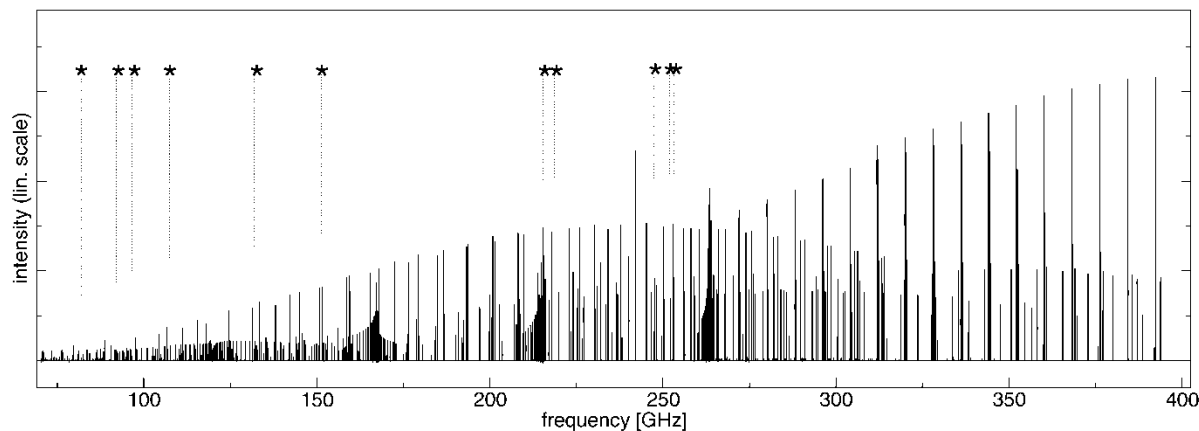
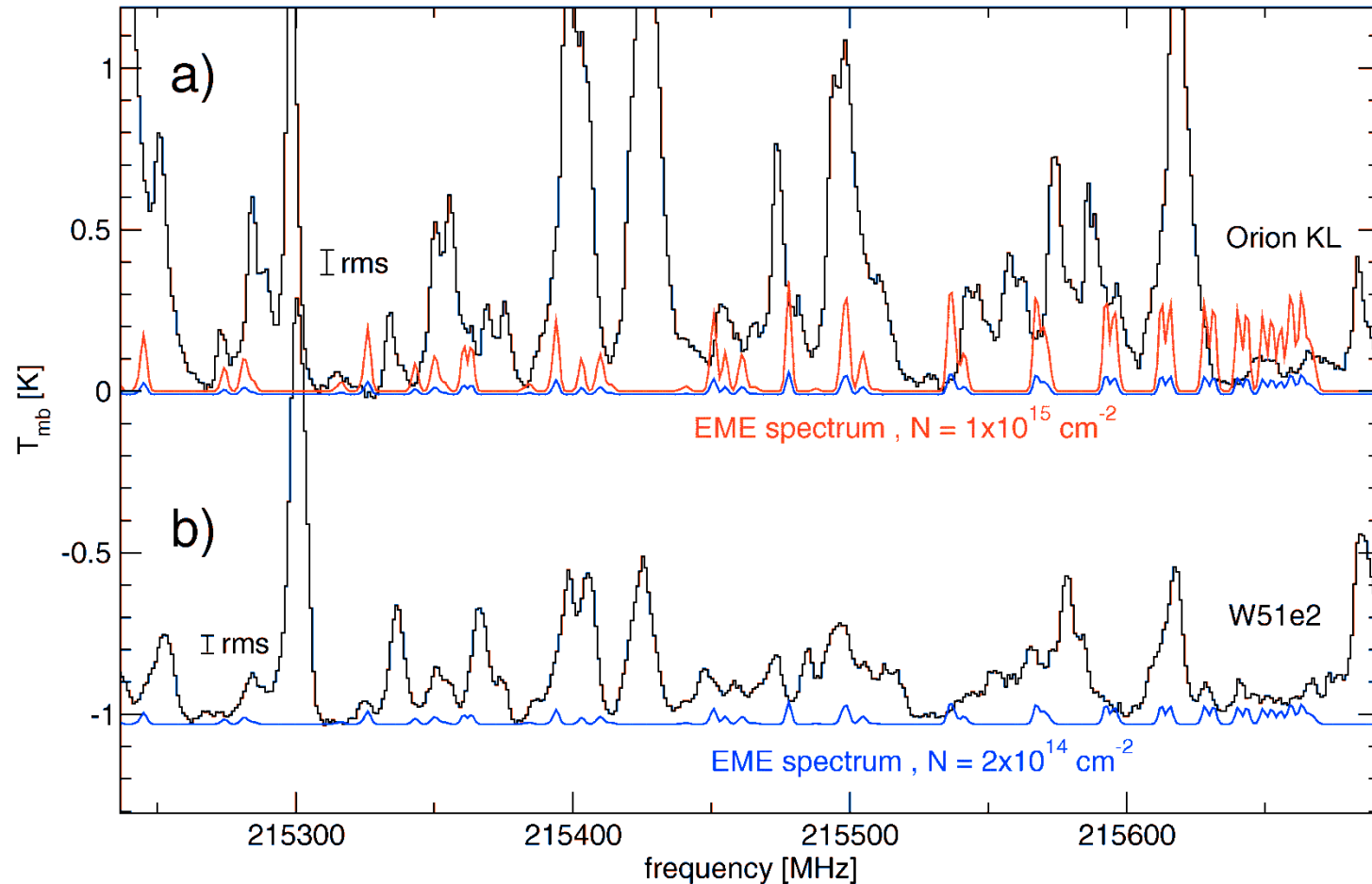


Fig. 1. Stick spectrum of EME at a rotational temperature of 130 K which is typical for complex molecules in hot core regions. EME has a dense spectrum with many characteristic features. The frequencies are taken from Fuchs et al. (2003). The (★) indicate our chosen frequency regions for the W51e2 observations. The intense line at 237 GHz was not selected because of a blending line at the same frequency.

7. Wide Bandwidth



Be prepared for COMPLEXITY

Note expected signal: masked by much brighter lines

In Early Science

In early Science

1. Sensitivity (specially in continuum)
2. Imaging speed
3. High spectral resolution
4. Ultra high spatial resolution
5. Imaging quality (?)
6. Wide frequency coverage
7. Wide bandwidth & flexible correlator
8. High frequencies
9. Integrated some wide field imaging
10. Full polarization capabilities (?)
11. High calibration accuracy ?

BUT ONLY FROM TIME TO TIME

So

- Avoid « The ultimate high angular resolution complete line survey of a typical 1° square molecular cloud »
- Beware of feasibility
- Beware of limited analysis tools
- Focus on
 - Things which were NOT AT ALL possible before
 - Exploratory projects...