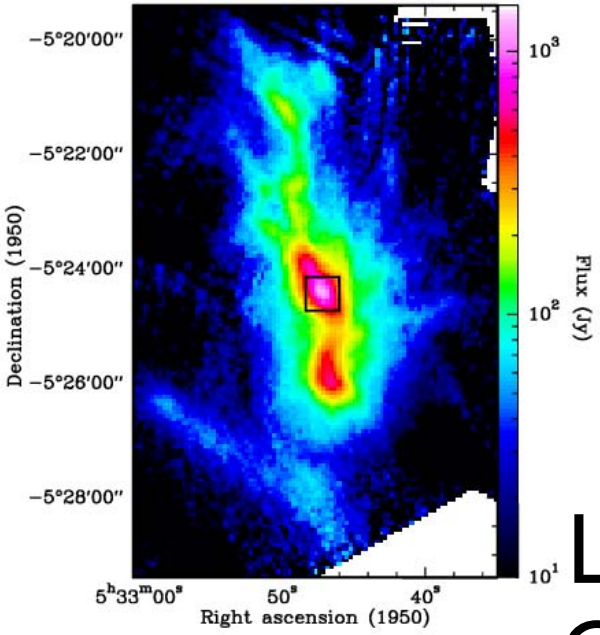
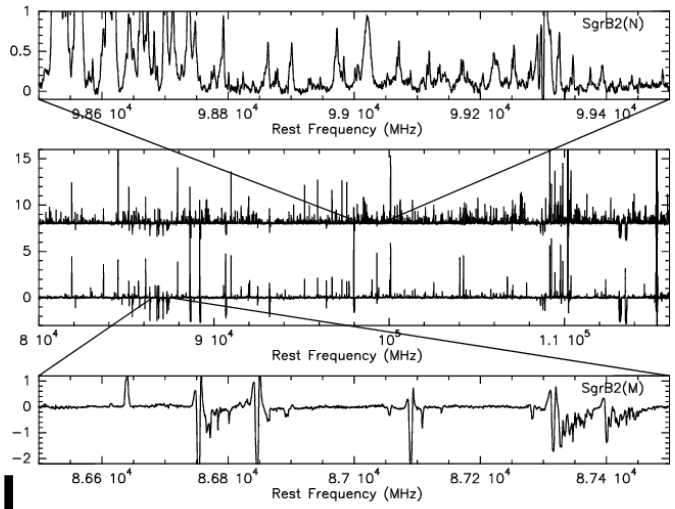
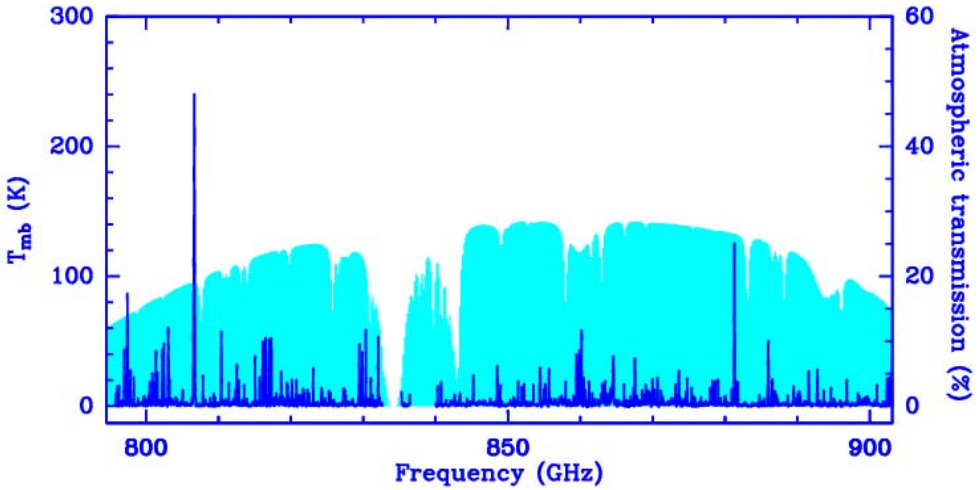
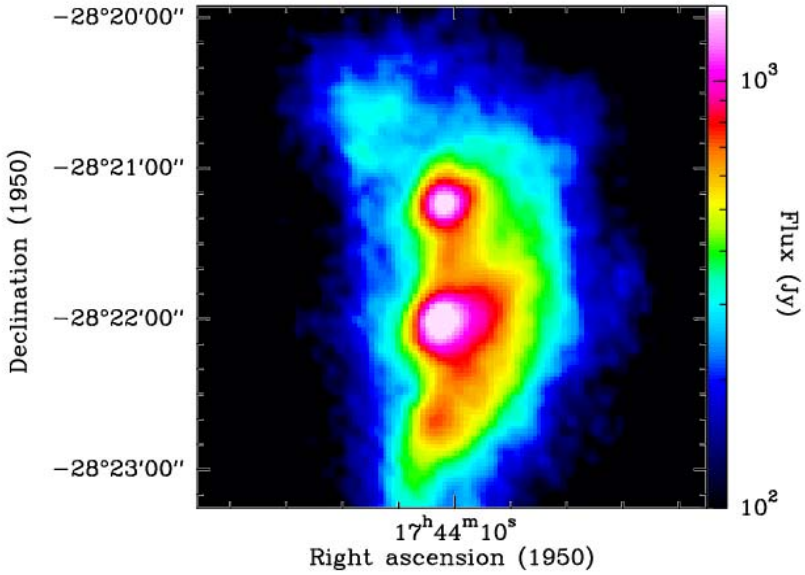




LINE SURVEYS IN ORION AND SgrB2

Claudia Comito, MPIfR Bonn





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LINE SURVEYS: WHAT FOR?

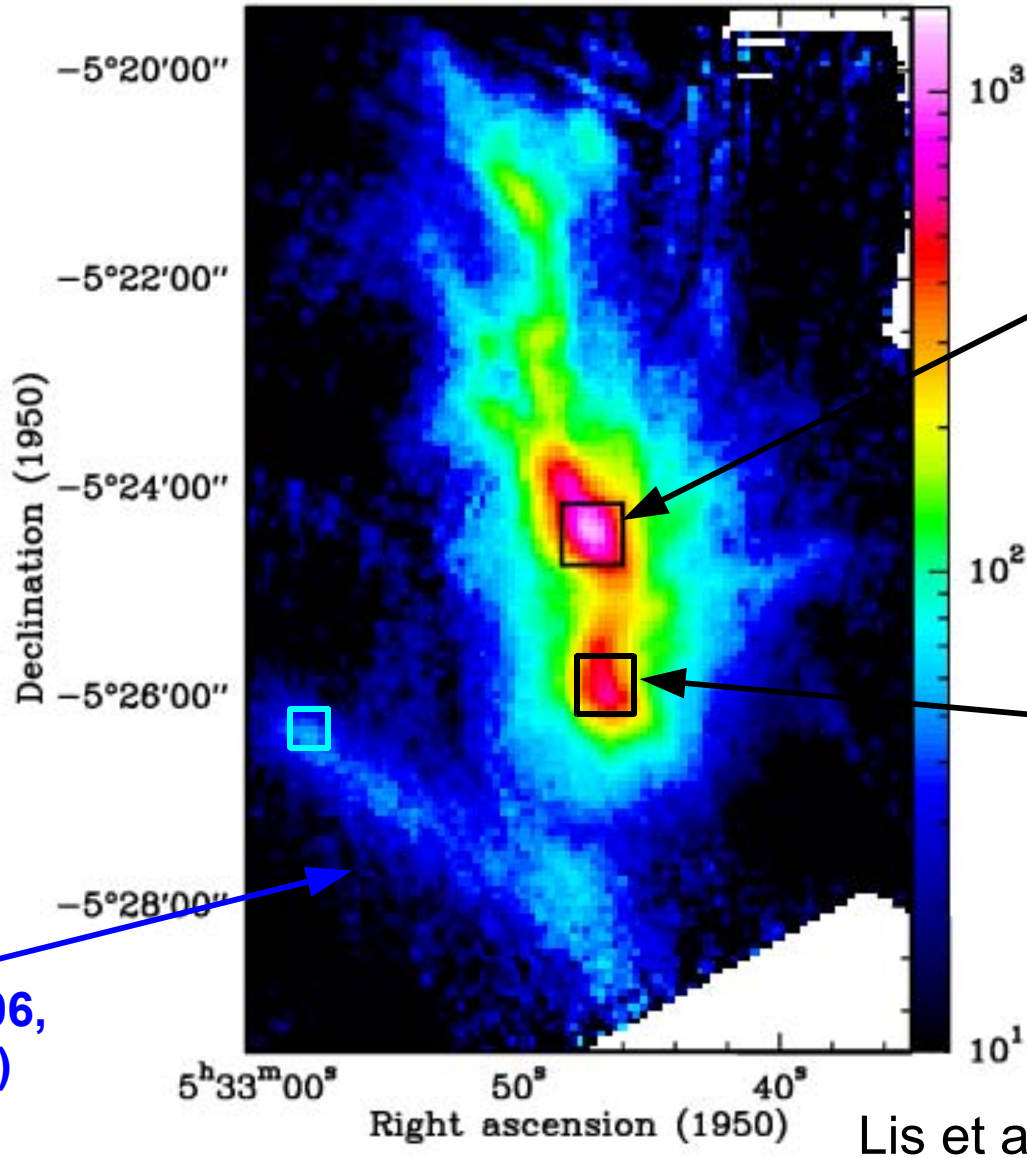
- Many chemically different molecules
  → **chemical history of the source**
- Many transitions from the same species and its isotopologues
  → Reliable determination of **excitation conditions and physical parameters**, tighter constraints on modeling
- Large samples of different classes of objects
  → **classification based on chemical patterns**
- Chance to find **"new" molecules!**

LINE SURVEYS AND THE SEARCH FOR COMPLEX MOLECULES

- Large complex molecules may **exhibit hundreds of lines** in a relatively small frequency range → they should be easy to identify, **but…**
- … are most easily **found in chemically rich sources** at mm wavelengths → **very crowded spectra!**
- In order to detect a new species, and to avoid mis-assignments, a **good knowledge of the global emission (and absorption) spectrum is needed**, for all known species.
- Line surveys ideal tool! → allow **good handle on modeling emission/absorption of known species** → identification of candidates for new detection more reliable *(cf. S. Thorwirth's talk)*

ORION and SgrB2 richest known molecular clouds (so far)!

OMC-1



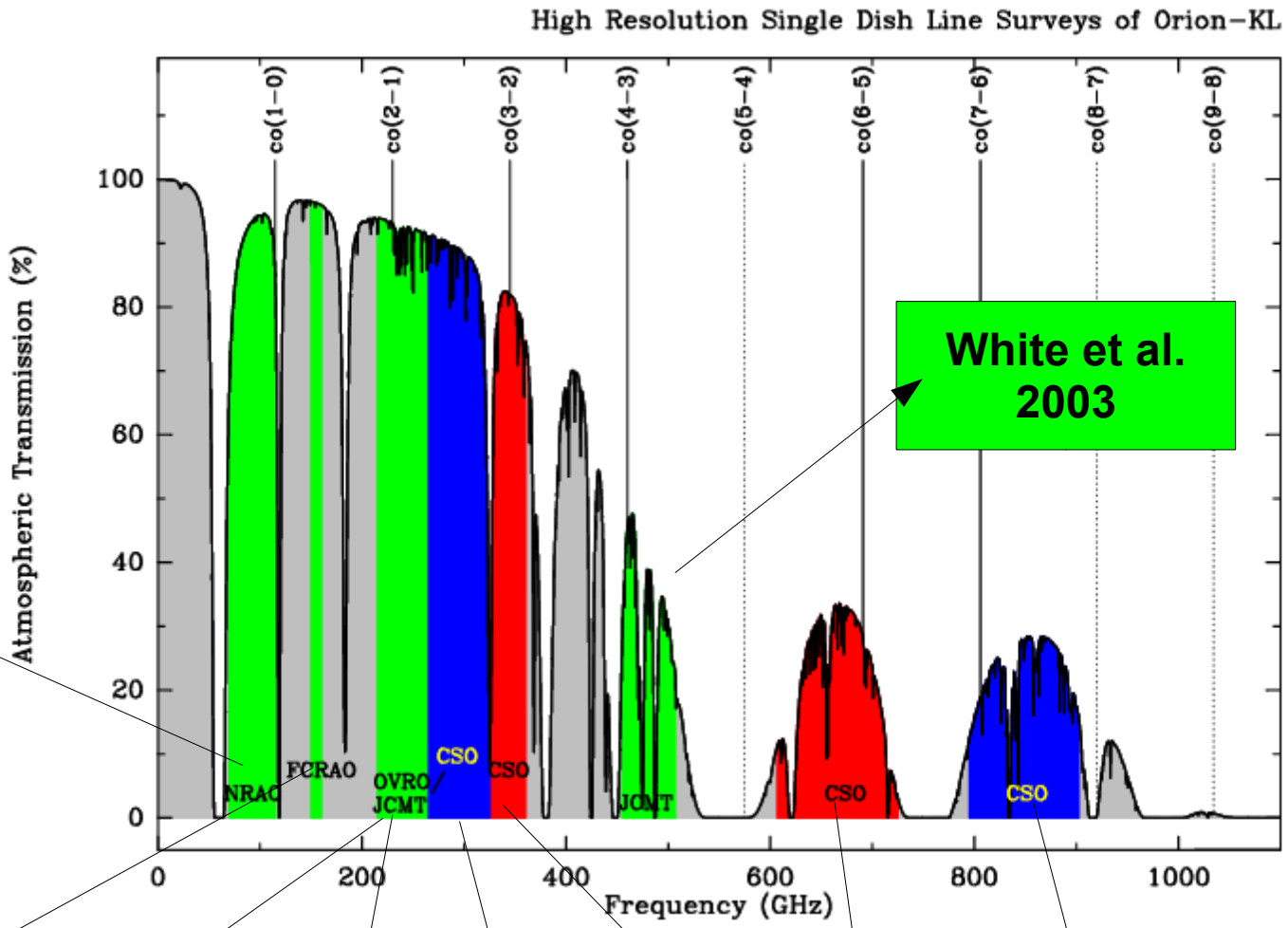
Orion-KL
(...)

Orion-S
(Groesbeck 1995, 345 GHz, CSO)

Orion Bar
(Leurini et al. 2006, 300 GHz, APEX)

Lis et al., 1998

FROM SPACE:
ISO-LWS 45-185 μm
(Lerate et al. 2006)
ODIN, H. Olofsson's talk



White et al. 2003

Turner 1989

Ziurys & McGonagle 1993

Comito et al. 2005

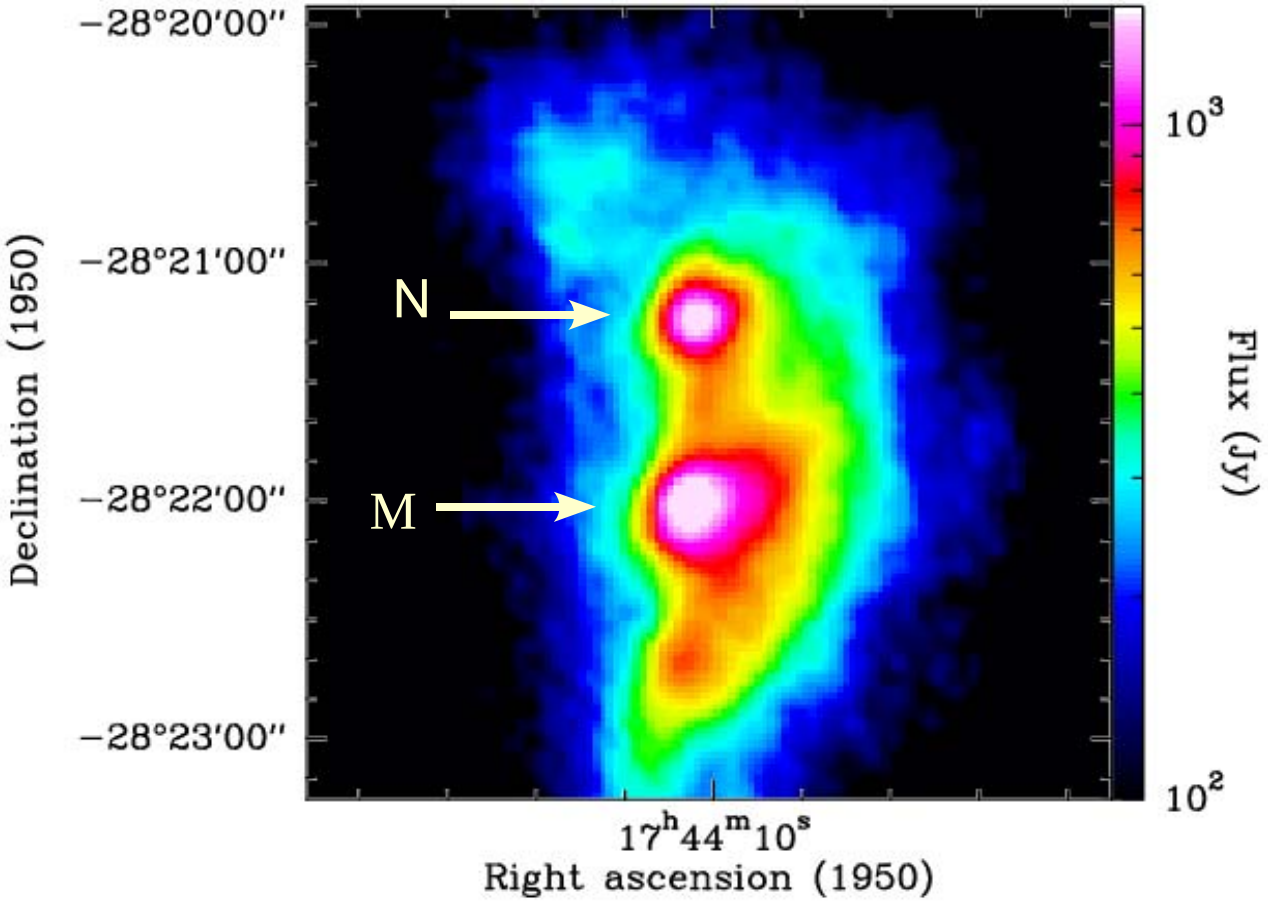
Sutton et al. 1985

Blake et al. 1986

Yoshida et al. in prep.

Schilke et al. 1997, 2001

SgrB2



350-μm continuum
(Dowell et al. 1999)

- Most massive GMC in our Galaxy (10^6 M_{sun}), in GC
- Star formation in extreme environment
- N and M: hot cores at different evolutionary stages
- Complex molecular spectrum (emission hot cores + abs. warm envelope)
- Peculiar chemistry from hot layer

Sgr B2 SINGLE-DISH LINE SURVEYS

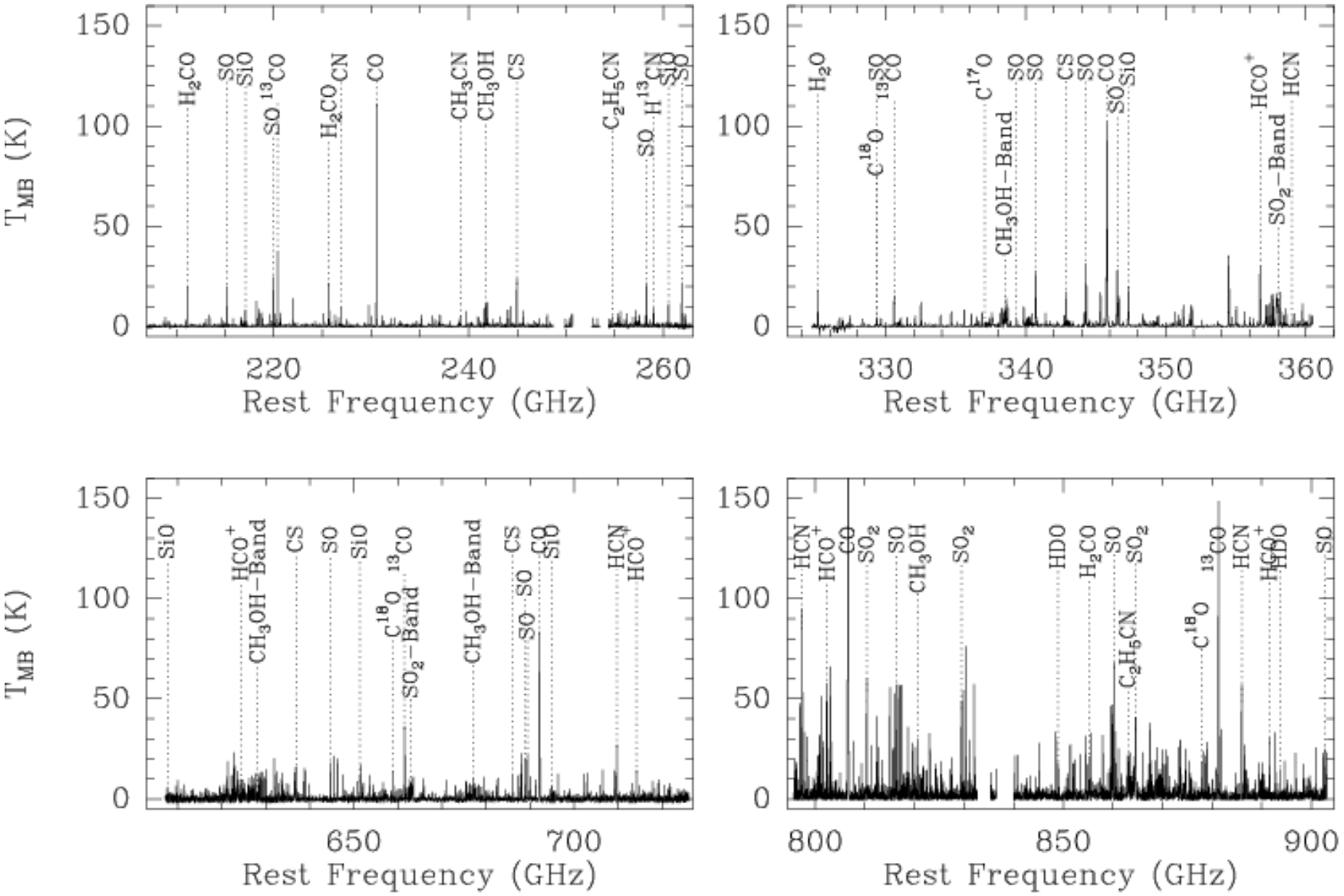
- **80-116 GHz**, Belloche et al. in prep. (IRAM 30m, N and M)
- **218-266 GHz**, Nummelin et al. 1998, 2000 (SEST, N, M, NW)
- **330-355 GHz**, Sutton et al. 1991 (CSO, M)
- **460-GHz and 810-GHz** bands surveys in preparation (APEX)
- **47-197 μm**, Polehampton et al. 2003 (ISO LWS, M+N)

MORE OF THE SAME?

- **mm → submm → (F)IR**
  → molecular spectrum from different excitation regimes
  → molecular spectrum from different molecules!
  (e.g., emission from complex species at mm, absorption from ground-state transitions of light hydrides at submm...)

Sutton et al. 1985, Blake et al. 1987

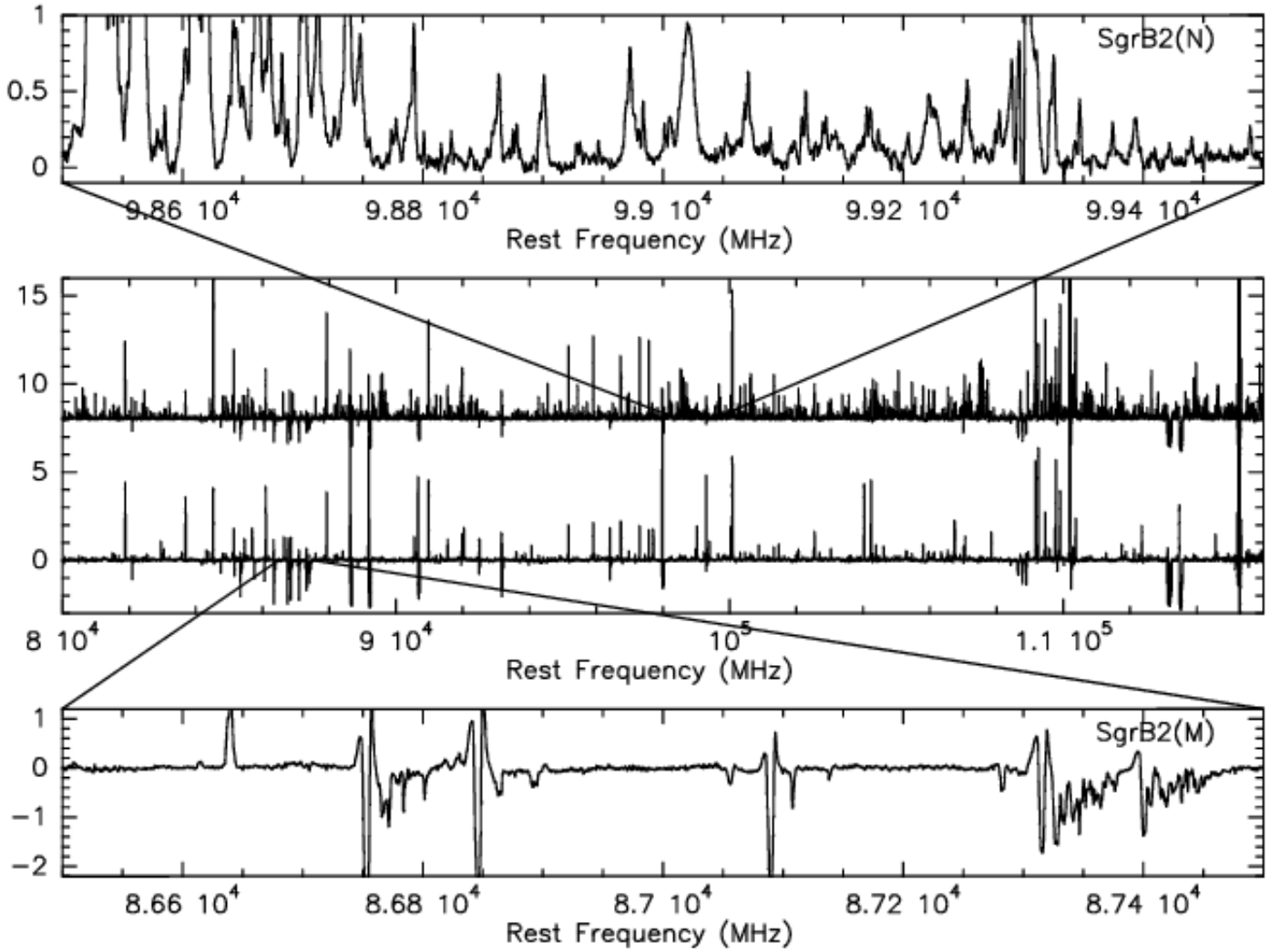
Schilke et al. 1997



cf. P. Schilke's talk for molecular content of Orion

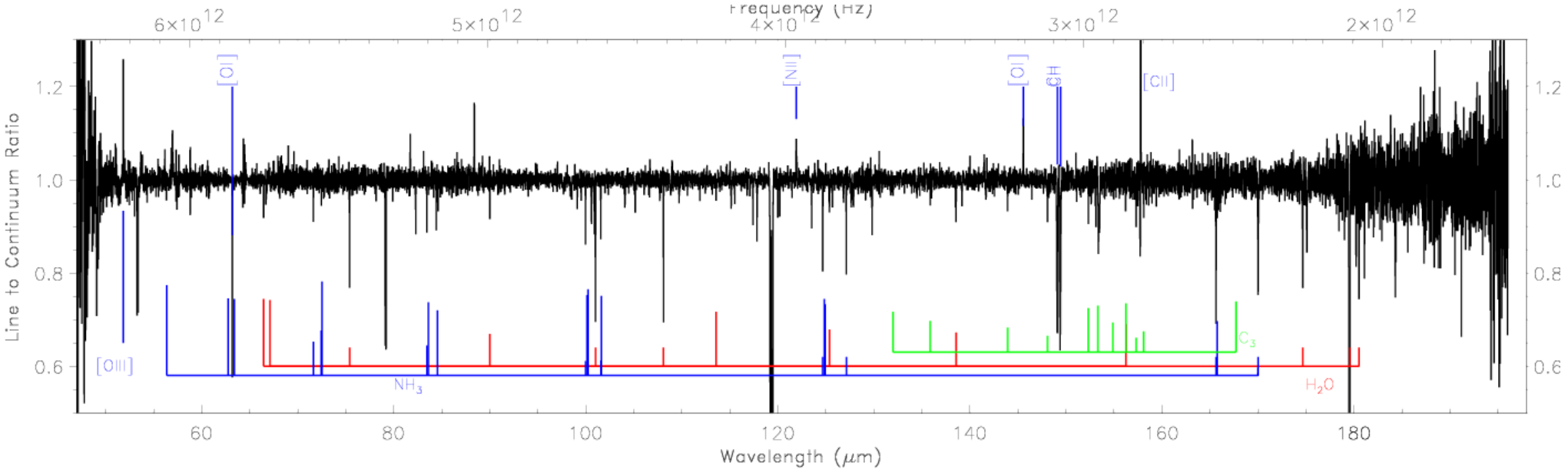
SgrB2 M and N (LMH) @ 3mm

(Belloche et al., Hieret et al. in prep)



ISO-LSW SURVEY OF SgrB2

(Polehampton 2003)



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PROBLEMS - 1
WHOLE LOTTA LINES

- Large number of lines
- Heavy line blending
- High opacity for a fraction of lines

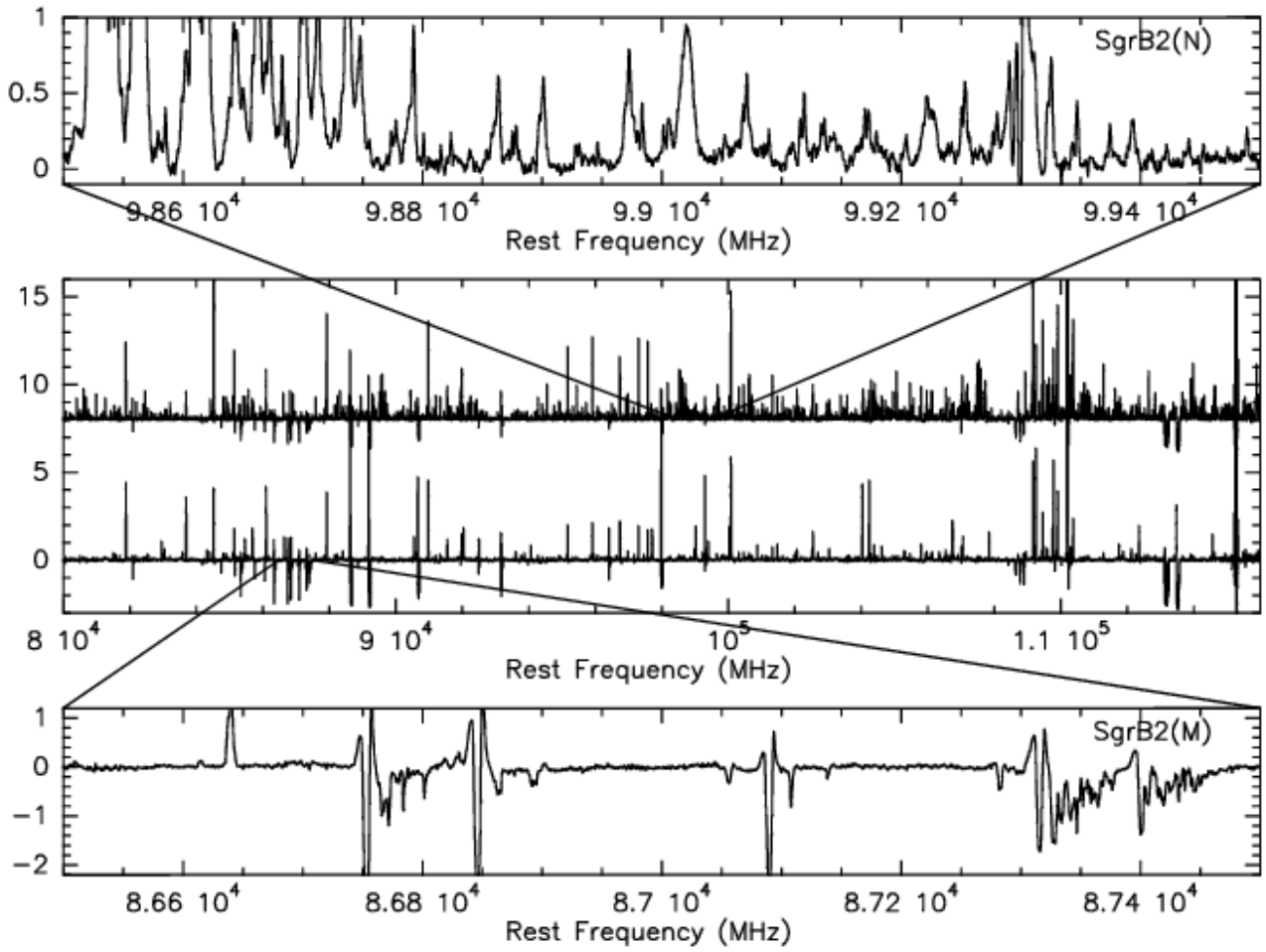
GOAL is to **identify as many transitions/species as possible, *THEN* perform collective analysis** AND/OR search for new (complex) species

MOLECULAR DATABASES!

(cf. H. Müller's talk)

SgrB2 M and N (LMH) @ 3mm

(Belloche et al., Hieret et al., in prep)



SgrB2(N), **~100 lines/GHz, ~63% identified**, U-lines vibrational states?

PROBLEMS - 2
(I CAN'T GET NO) CALIBRATION

- Line surveys are usually acquired over a long period of time (days, months)
- **Calibration not constant** across dataset
- **Pointing errors not constant** across dataset

Analysis more and more complicated

PROBLEMS - 3
SIDEBAND SEPARATION

- At submm wavelengths, **no sideband-separating receivers**
- Line surveys **acquired in double-sideband (DSB), must be analyzed in single-sideband (SSB)** format
- Sideband deconvolution can be performed, but **dramatically affected by quality of data**

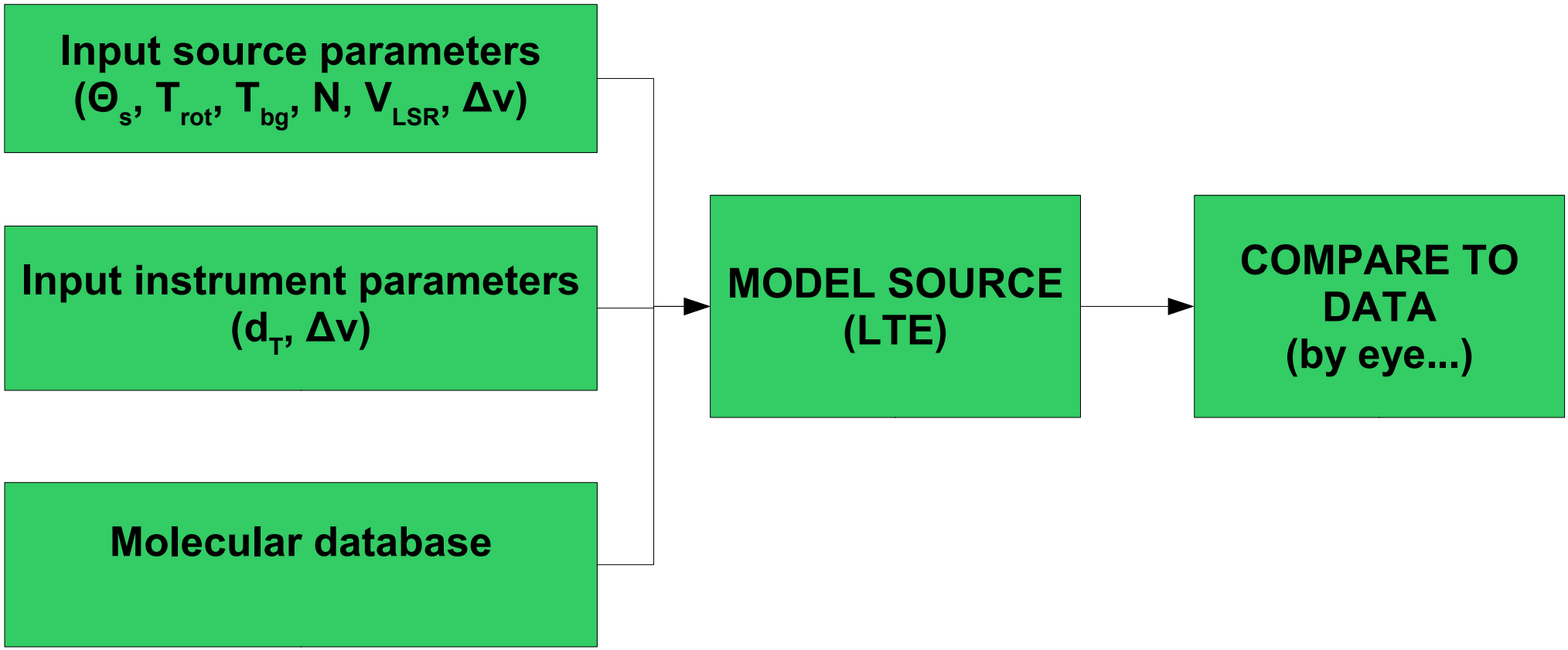
The XCLASS APPROACH

- Line identification of any line (except the strong usual suspects) requires a good model of the *whole* spectrum

- including isotopologues (important to constrain optical depth)

DATA ANALYSIS: DERIVATION OF PHYSICAL PARAMETERS

For every species and isotopologues over the whole band:



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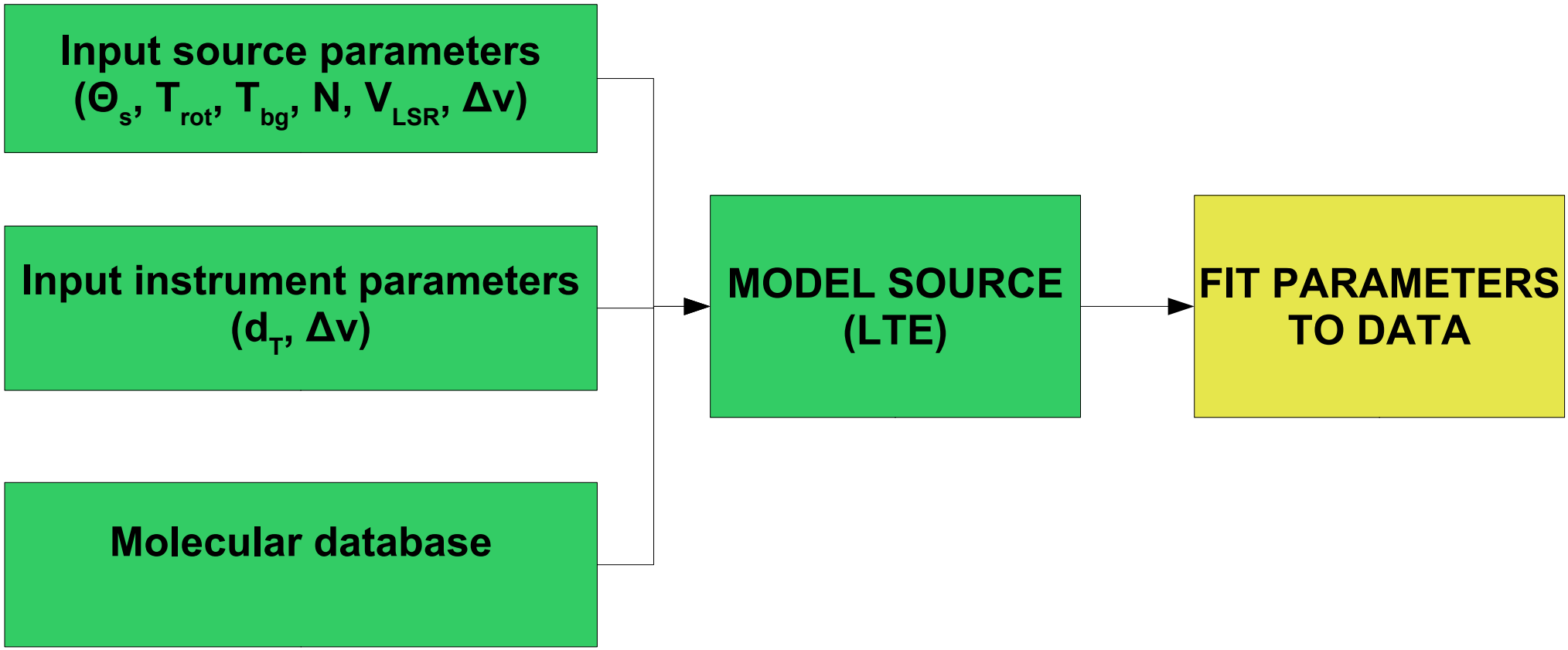
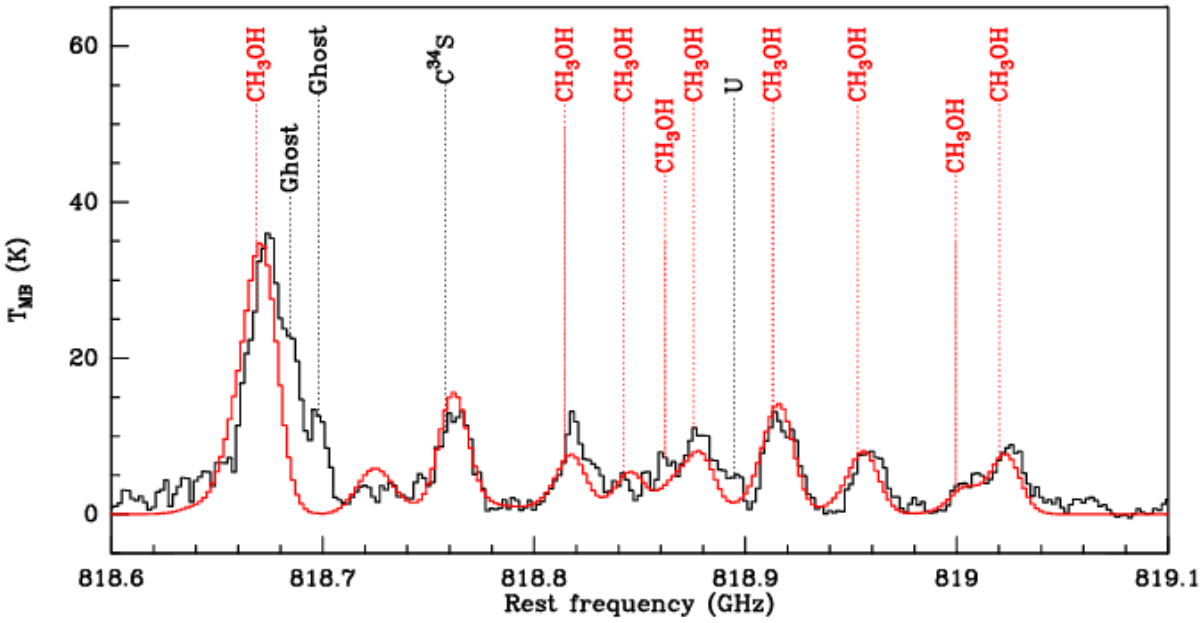


MODELING AND FITTING

✔ the whole spectrum is *fitted/modeled at once* (Schilke et al. 1997)

✔ fit/model all lines of a species and isotopologues at once → *take intra-species line blends and optical depth effects explicitly into account*

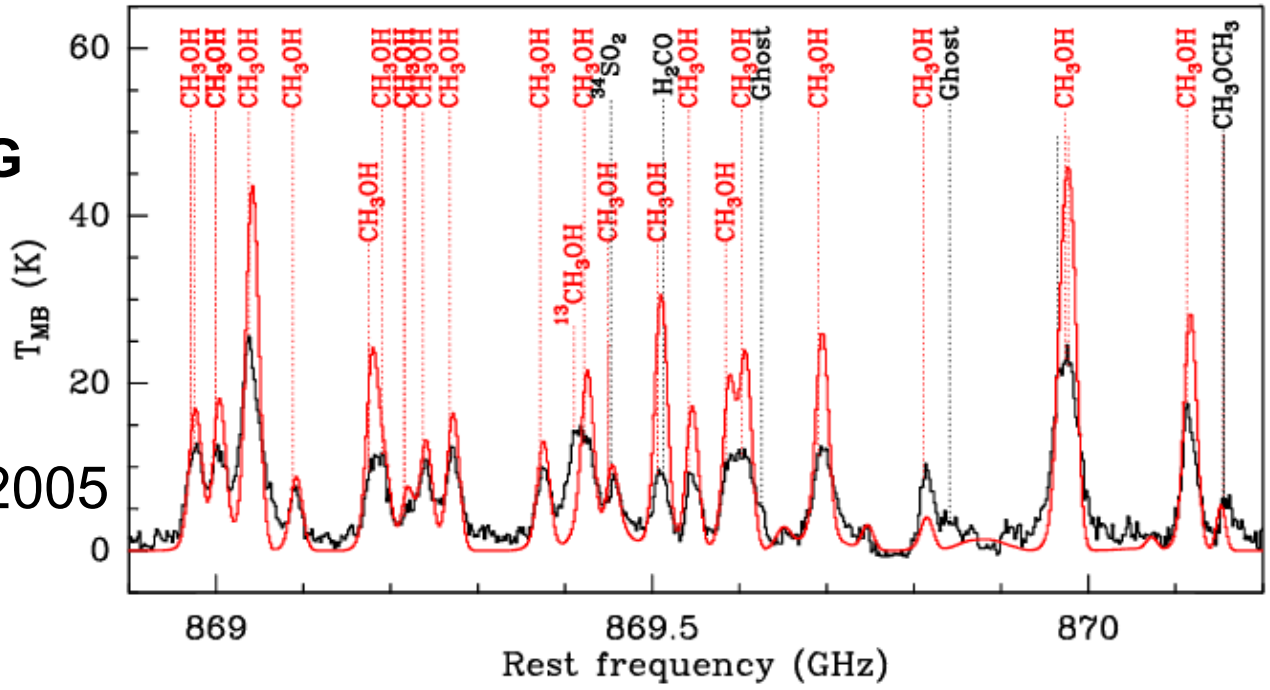
✔ fit all species at once → *take inter-species line blends into account*



CH_3OH:

← GOOD FIT...

... AND BAD FIT → CALIBRATION/POINTING PROBLEM!



Orion-KL, Comito et al. 2005

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HEXOS

(HIFI observations of Extraordinary Orion and Sagittarius)

LINE SURVEYS: STUCK IN FREQUENCY SPACE?

Interferometric line surveys:

- disentangle spatial distribution of molecular species
- better beam-to-source coupling, higher sensitivity
- fundamental for detection of complex molecules
- fundamental for serious physical modeling of a source
- *(cf. H. Beuther's talk for SMA surveys)*