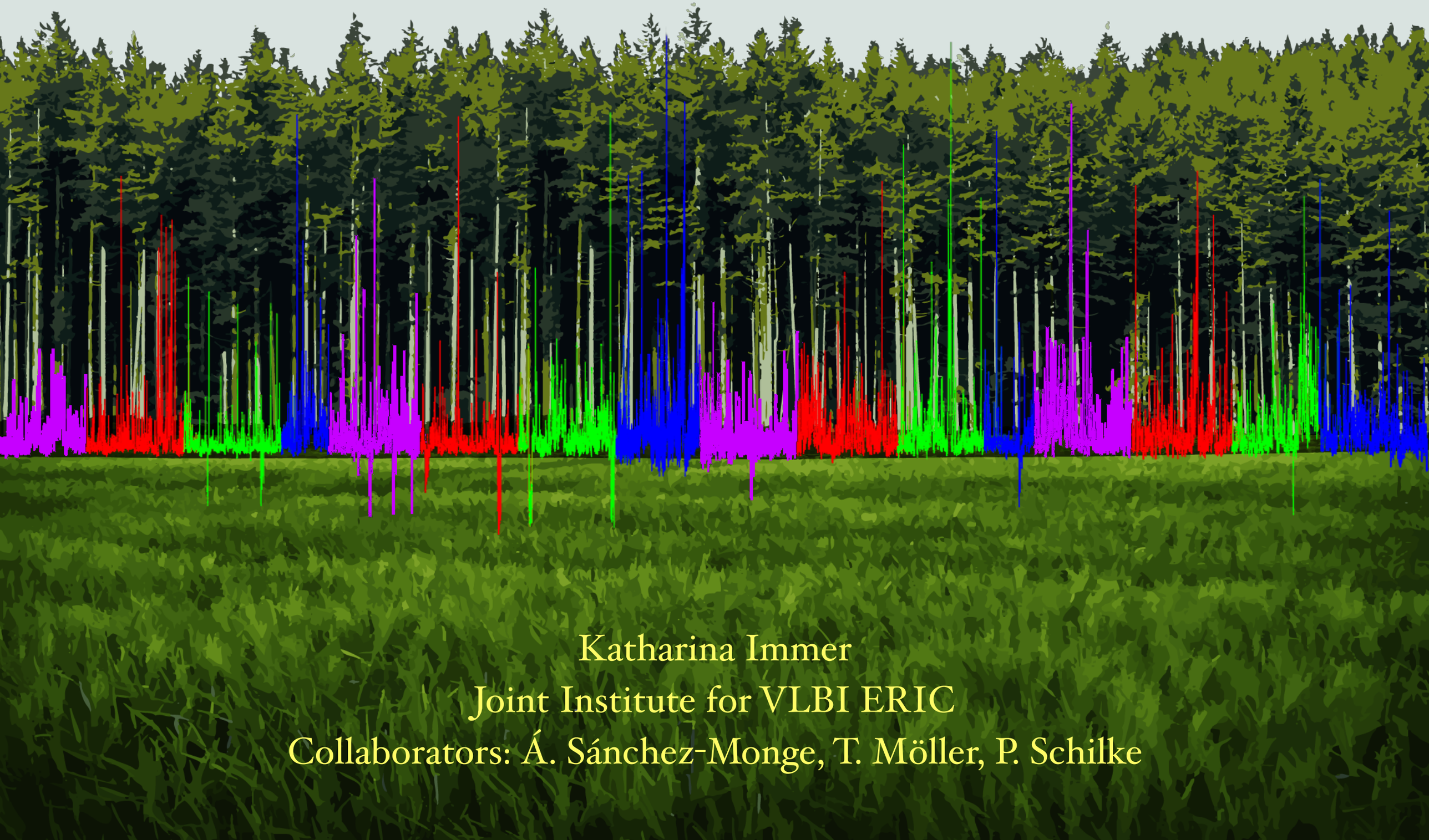
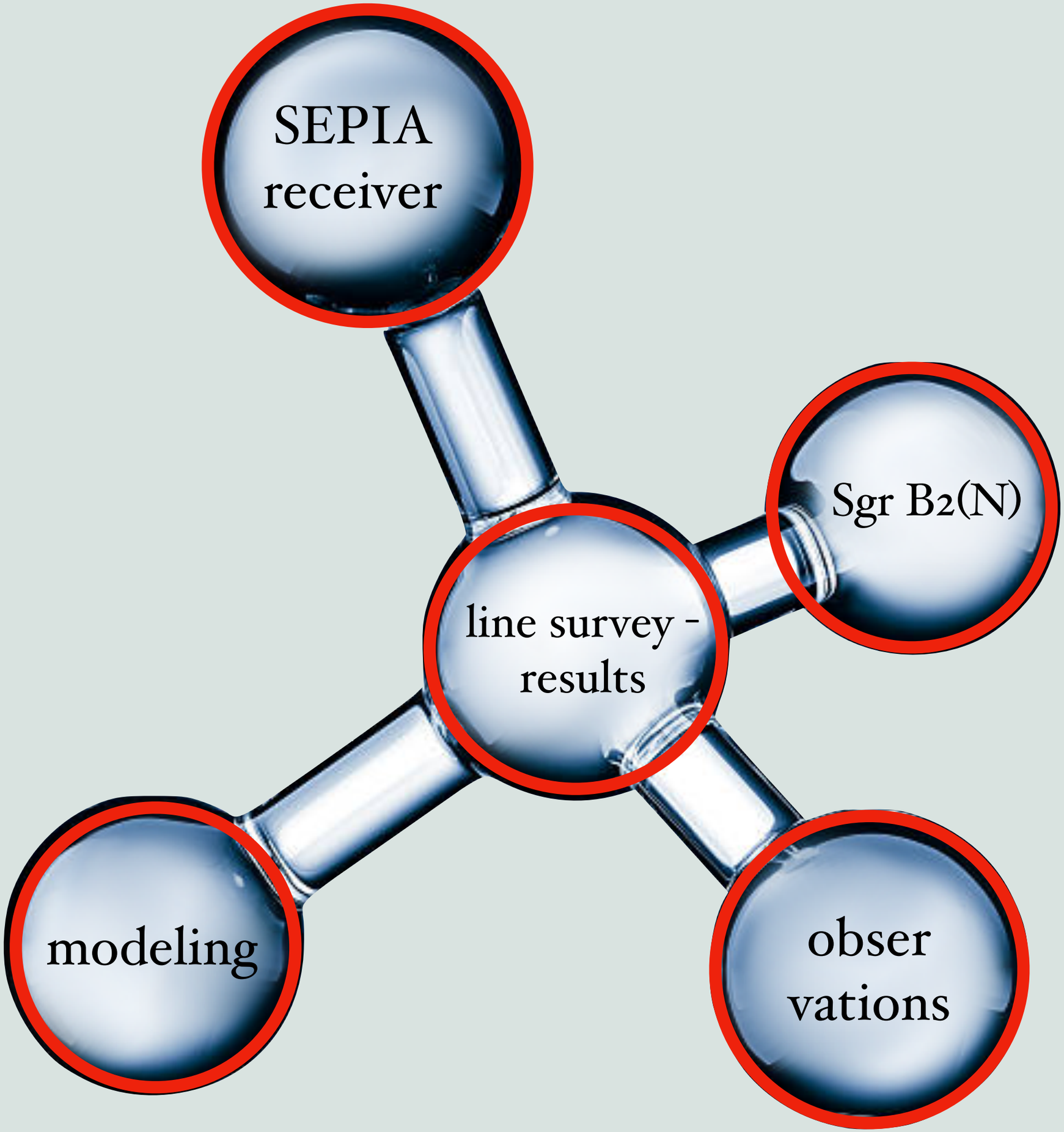
A forest of lines:
A 159–211 GHz spectral line survey of SGR B2(N) with the SEPIA receiver at APEX



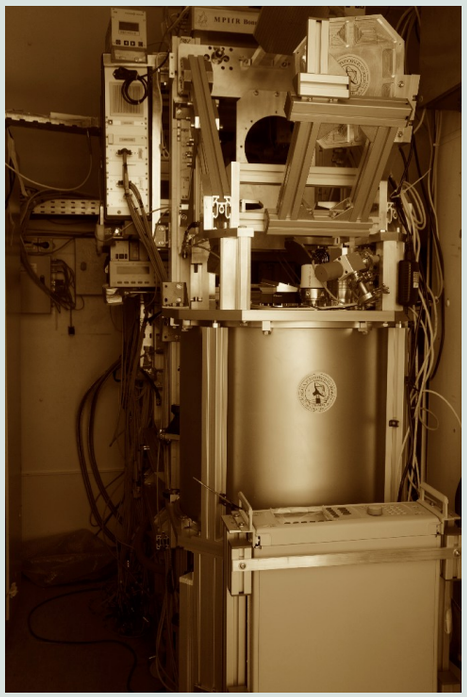
Katharina Immer
Joint Institute for VLBI ERIC
Collaborators: Á. Sánchez-Monge, T. Möller, P. Schilke


SEPIA
receiver
Sgr B2(N)
line survey -
results
modeling
obser
vations

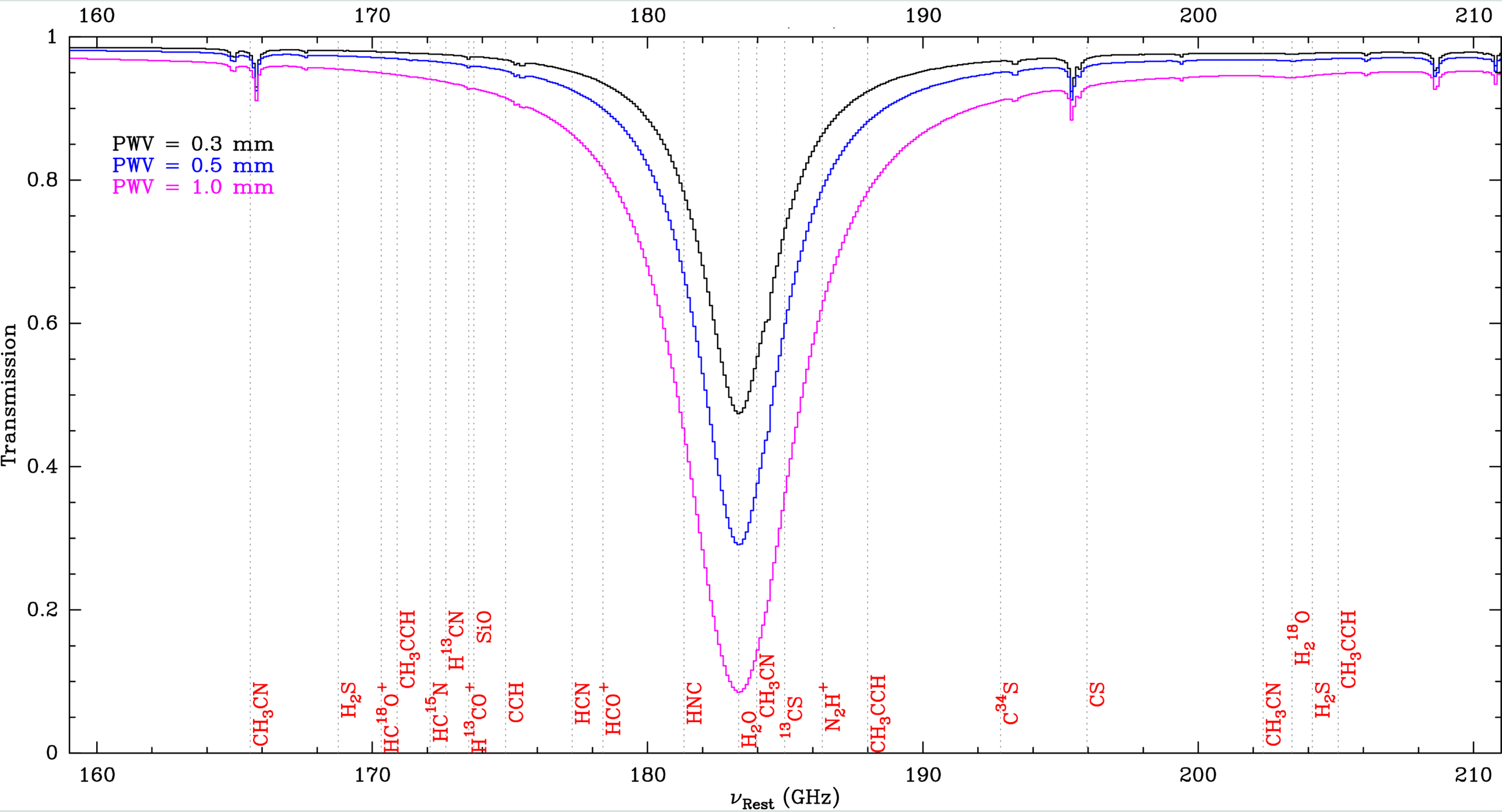
The Swedish-ESO PI receiver (SEPIA)

@APEX since 2015
Band 5, Band 7 (-2019), Band 9

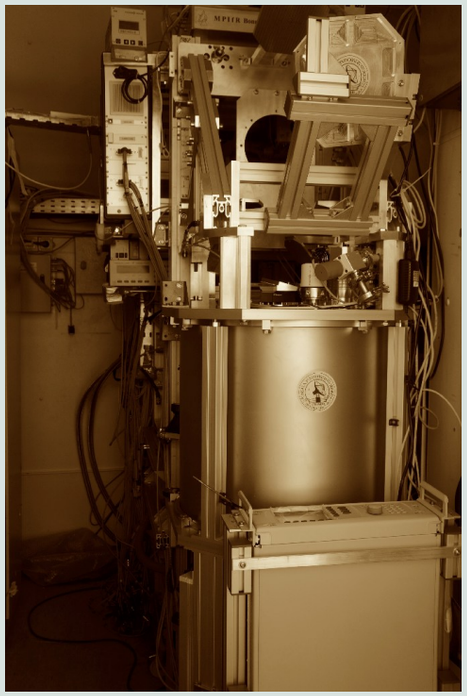
Band 5:
159 – 211 GHz



Atmospheric Transmission



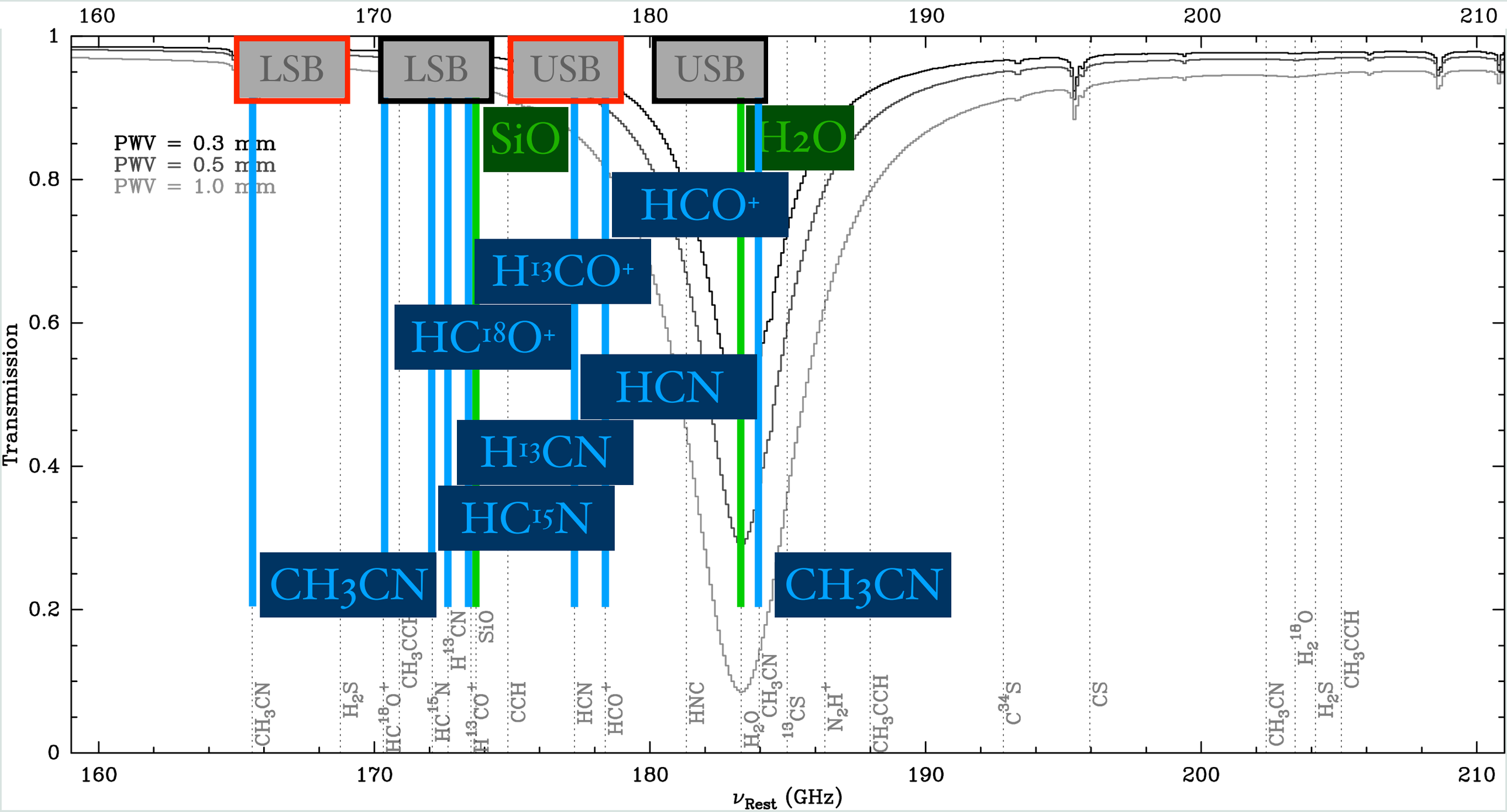
The Swedish-ESO PI receiver (SEPIA)



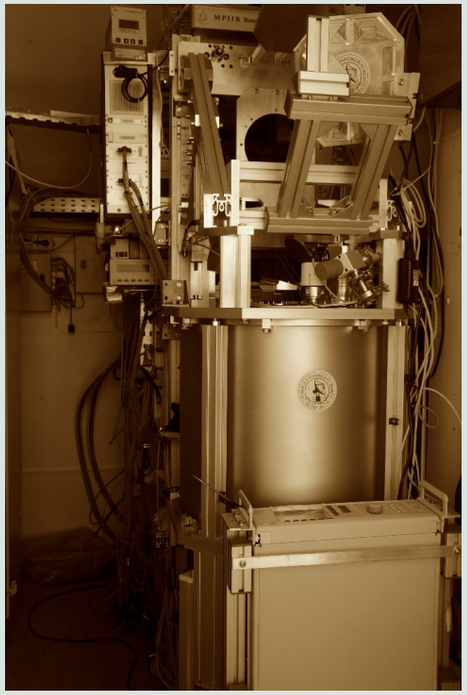
@APEX since 2015
Band 5, Band 7 (~2019), Band 9

Band 5:
159 – 211 GHz
Dual polarization 2-sideband (SB) receiver, 4 GHz per SB, 12 GHz separation
Full velocity resolution: 0.05-0.07 km/s

The Swedish-ESO PI receiver (SEPIA)



The Swedish-ESO PI receiver (SEPIA)



@APEX since 2015
Band 5, Band 7 (~2019), Band 9

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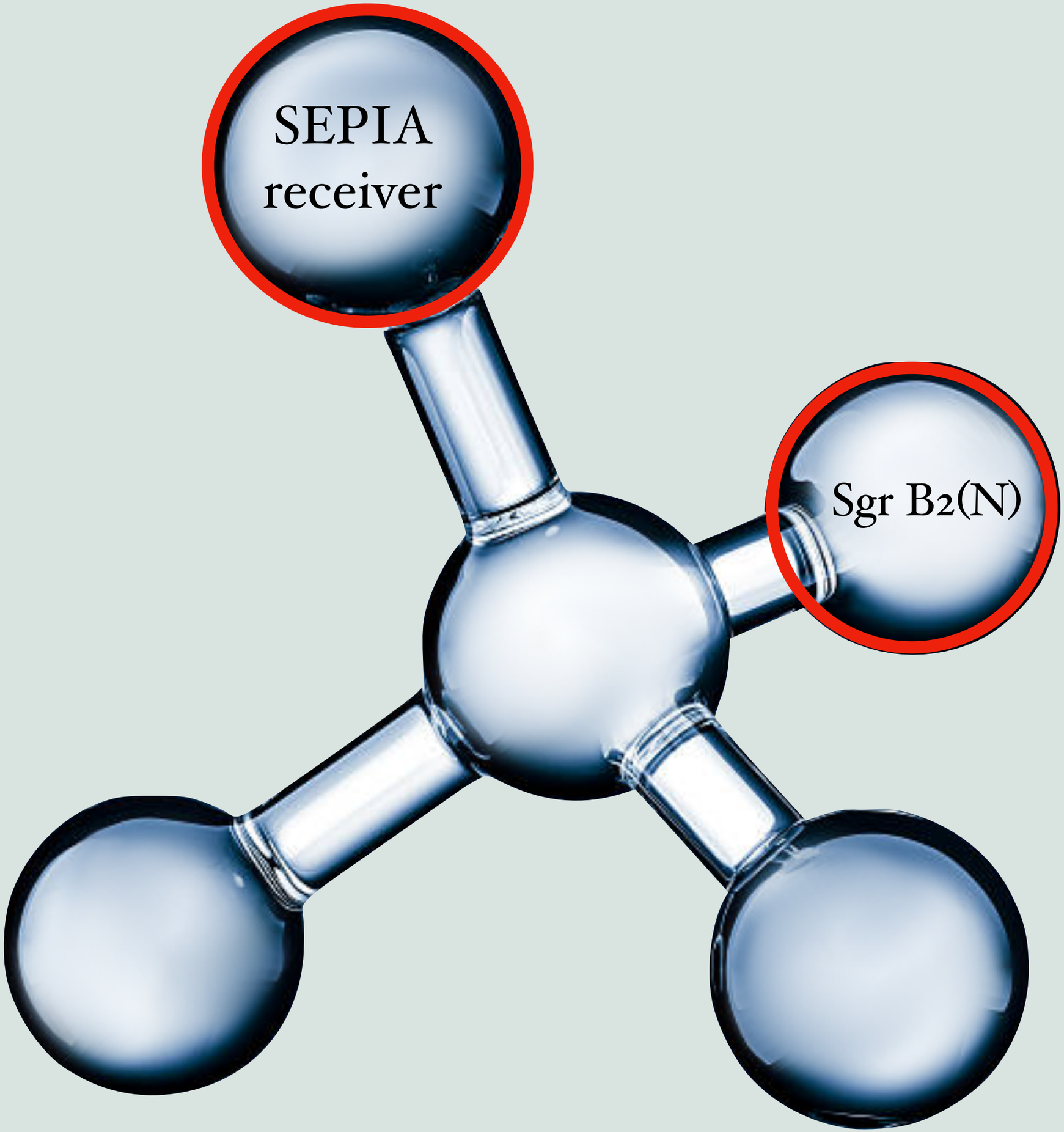
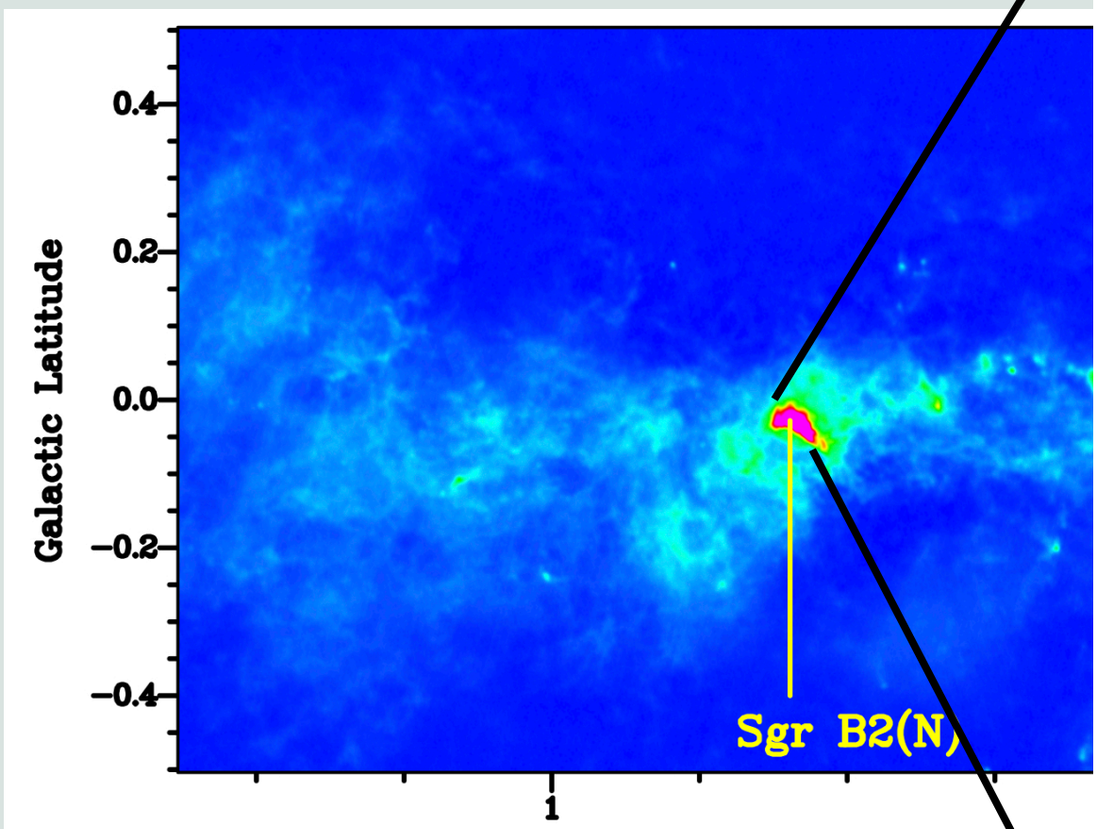
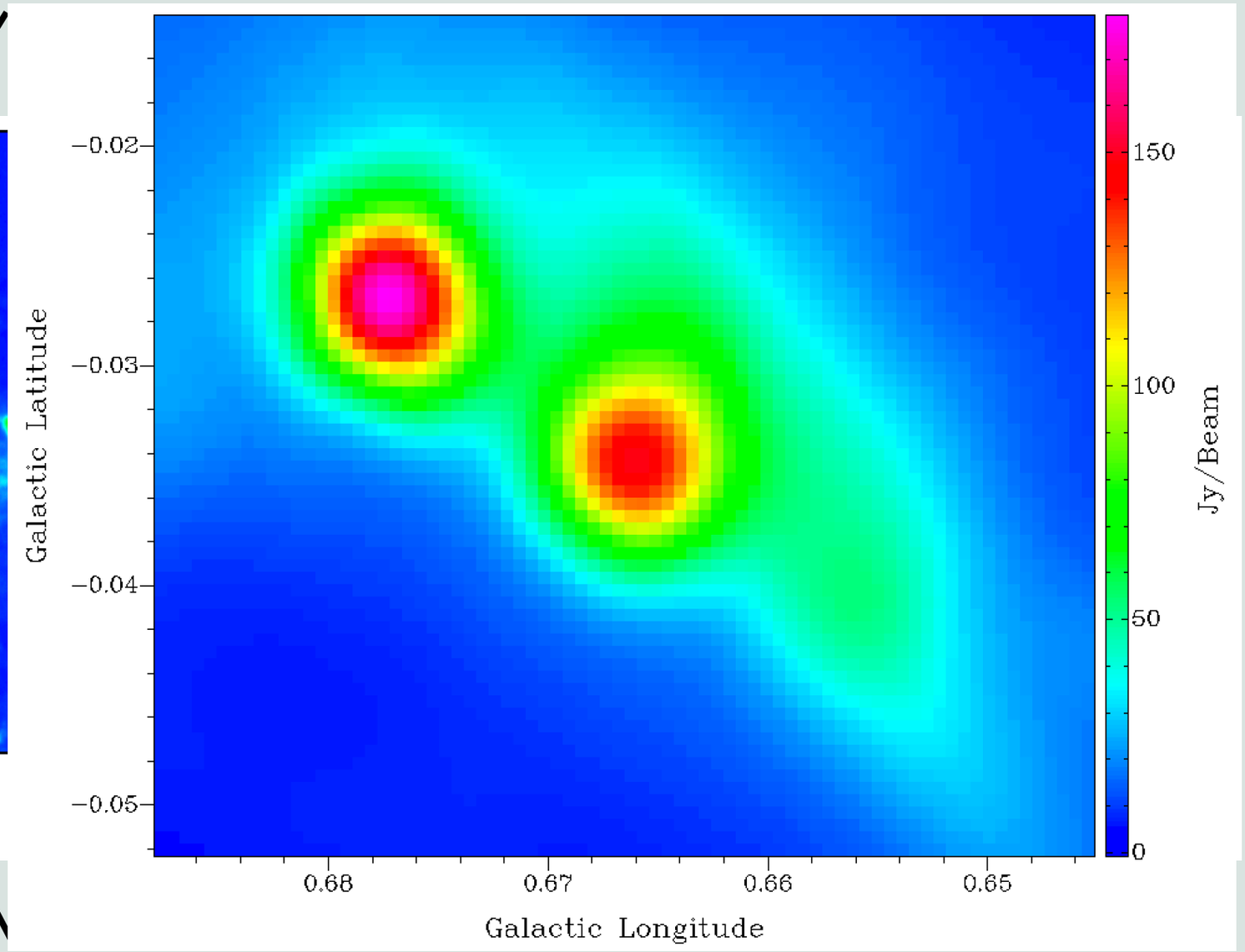
http://www.apex-telescope.org/instruments/pi/sepia/

Now also available at ALMA!

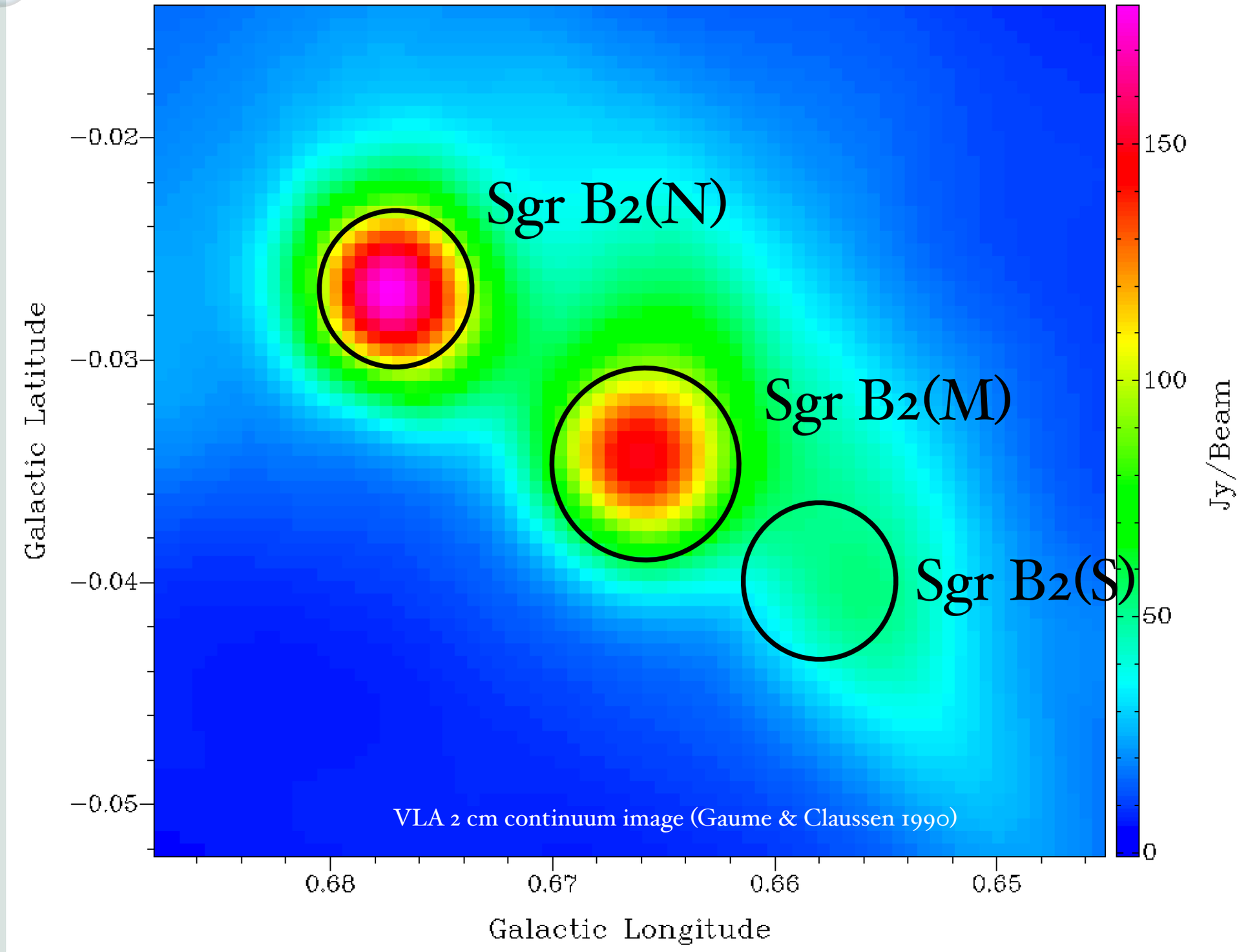

SEPIA
receiver
Sgr B2(N)

Sgr B2


0.4
0.2
0.0
−0.2
−0.4
Galactic Latitude
1
Sgr B2(N)


−0.02
−0.03
−0.04
−0.05
Galactic Latitude
0.68
0.67
0.66
0.65
Galactic Longitude
150
100
50
0
Jy/Beam

Sgr B2(N)



870 μm emission, ATLASGAL survey (Schuller et al. 2009)

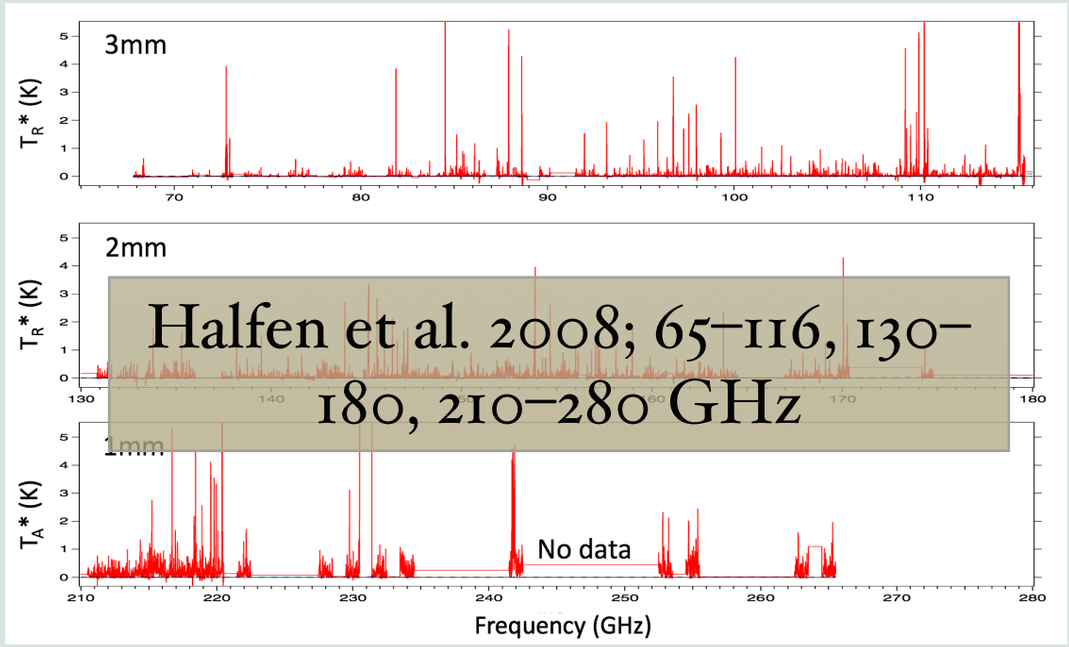
Spectral line surveys of Sgr B2(N) (extract)

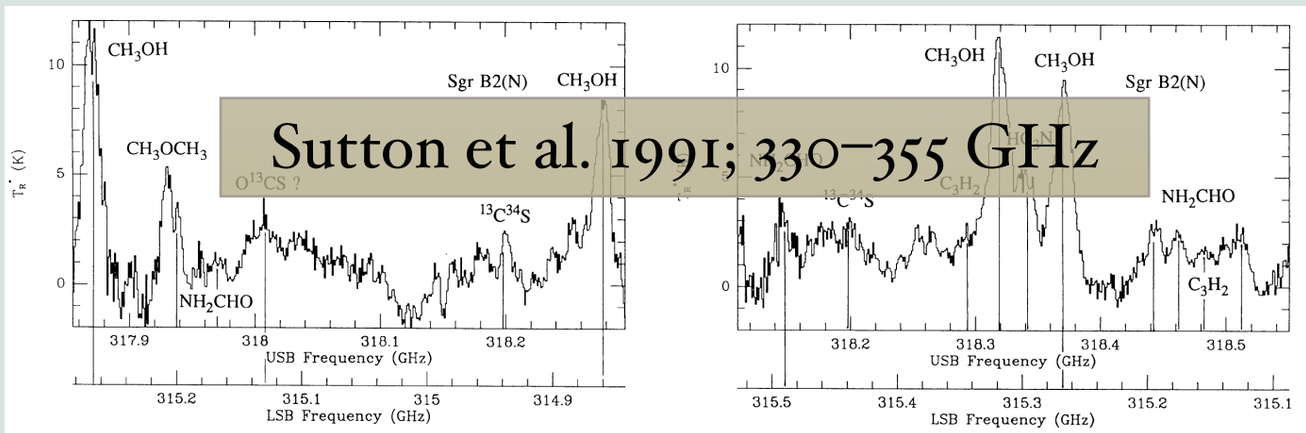
Large frequency range covered!

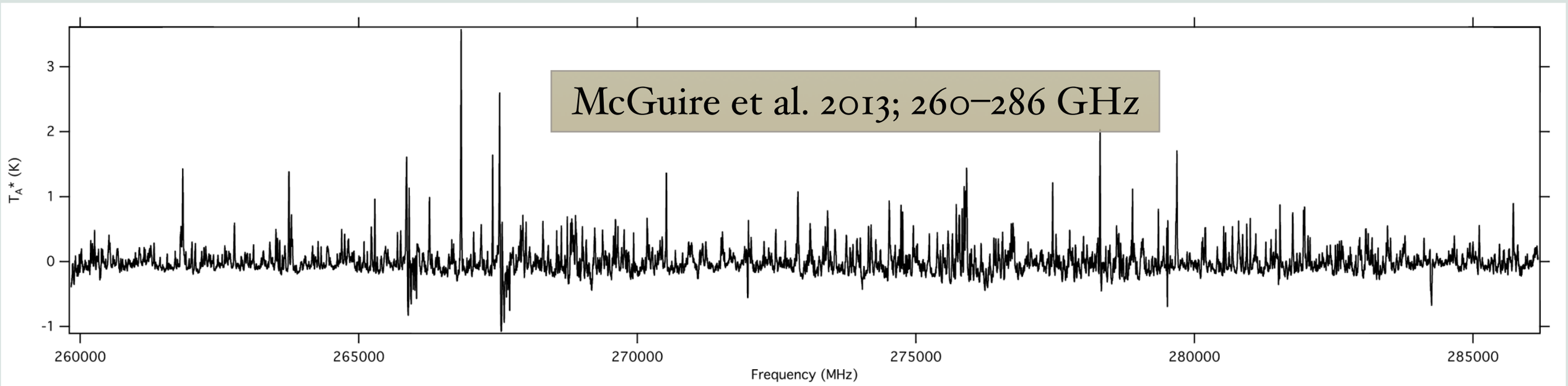
=> many transitions of many different molecules observed

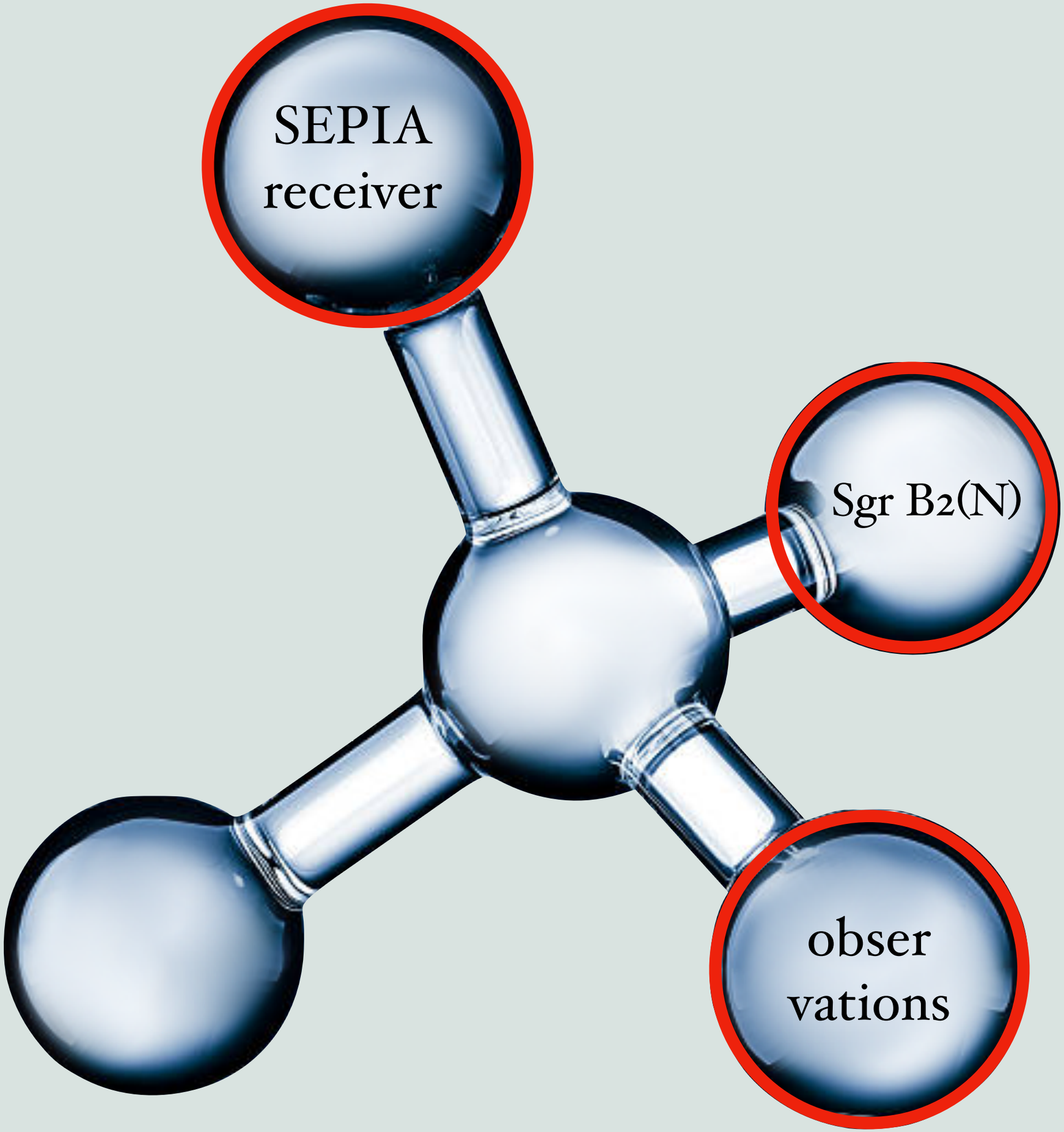
=> reliably identify the presence of a molecule

=> contribution of all detected molecules can be modeled at once, smaller number of misidentified molecules








SEPIA
receiver
Sgr B2(N)
obser
vations

Science Verification Observations

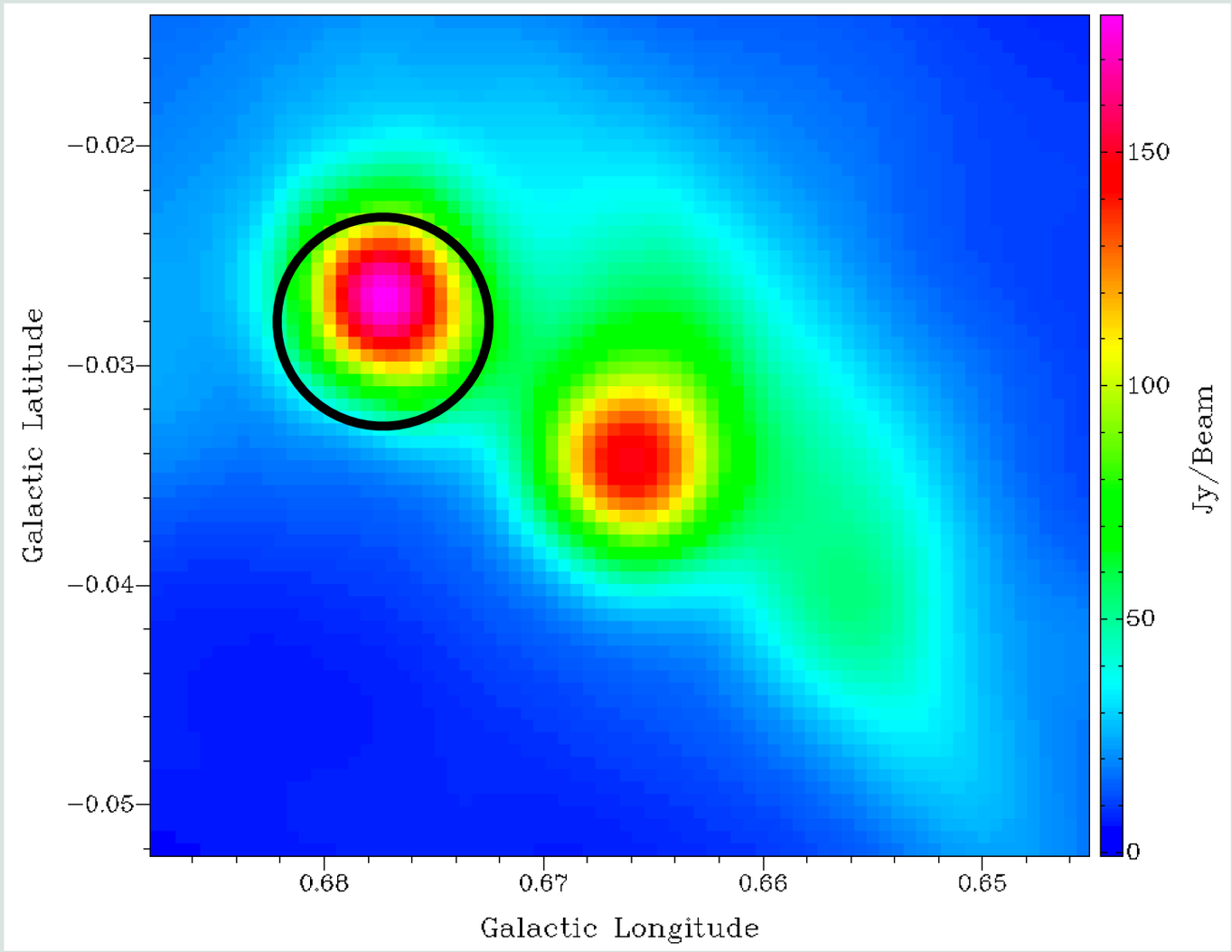
Science verification project for SEPIA Band 5

On/Off observations of Sgr B2(N) in July/September 2015

Spectral coverage: 159.2 – 210.7 GHz; 8 different tunings

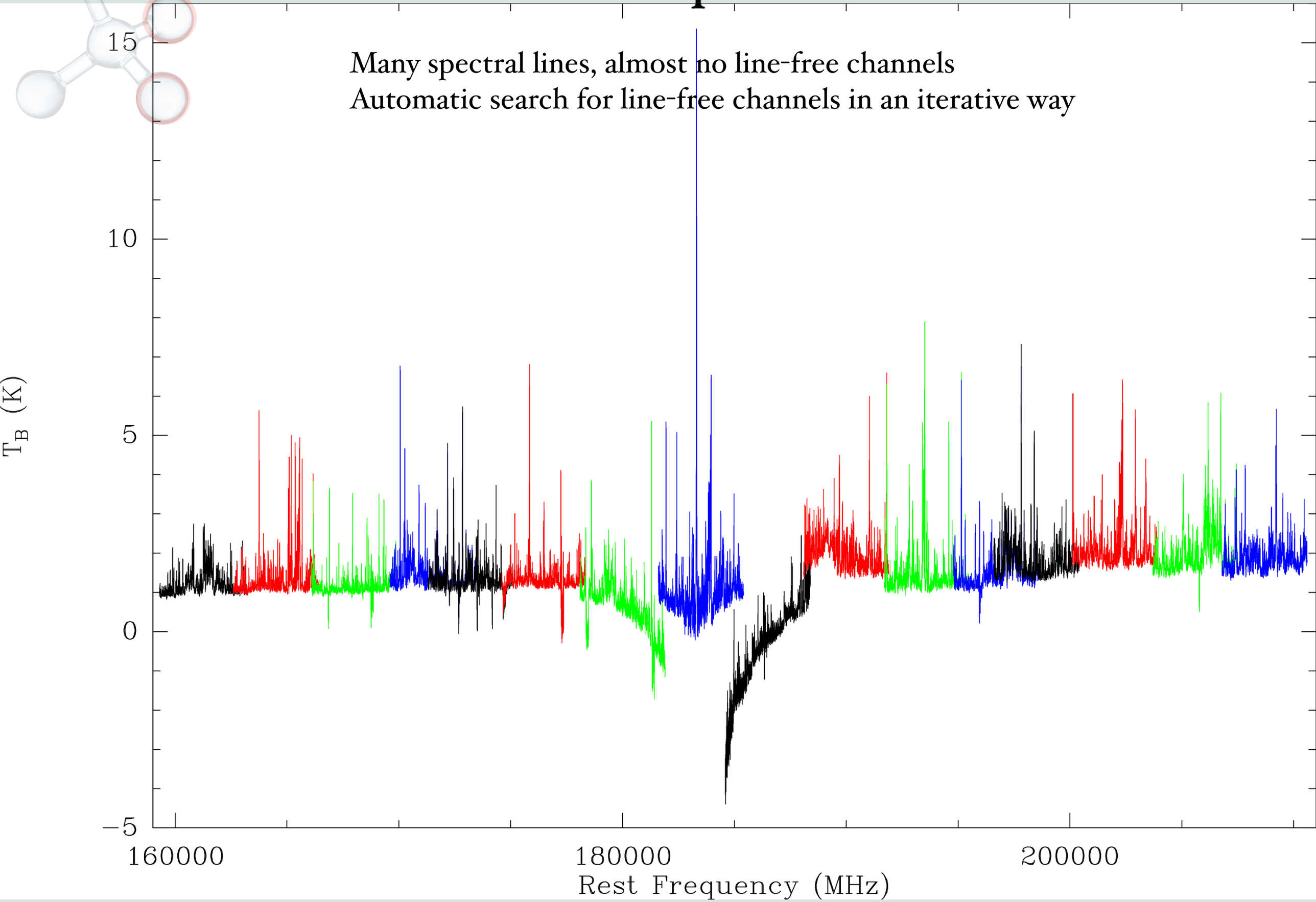
Total on-source time of 172 min

Smoothed velocity resolution: 0.5–0.7 km/s

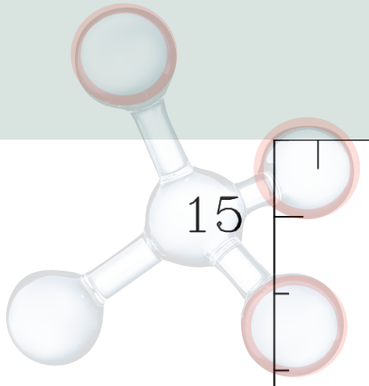


Observed Spectrum

Many spectral lines, almost no line-free channels
Automatic search for line-free channels in an iterative way



Final Spectrum



average rms = 5 mK

760 lines > 1 K

91 lines per GHz (5 sigma detection)

Level of online calibrated data
Recalibration important

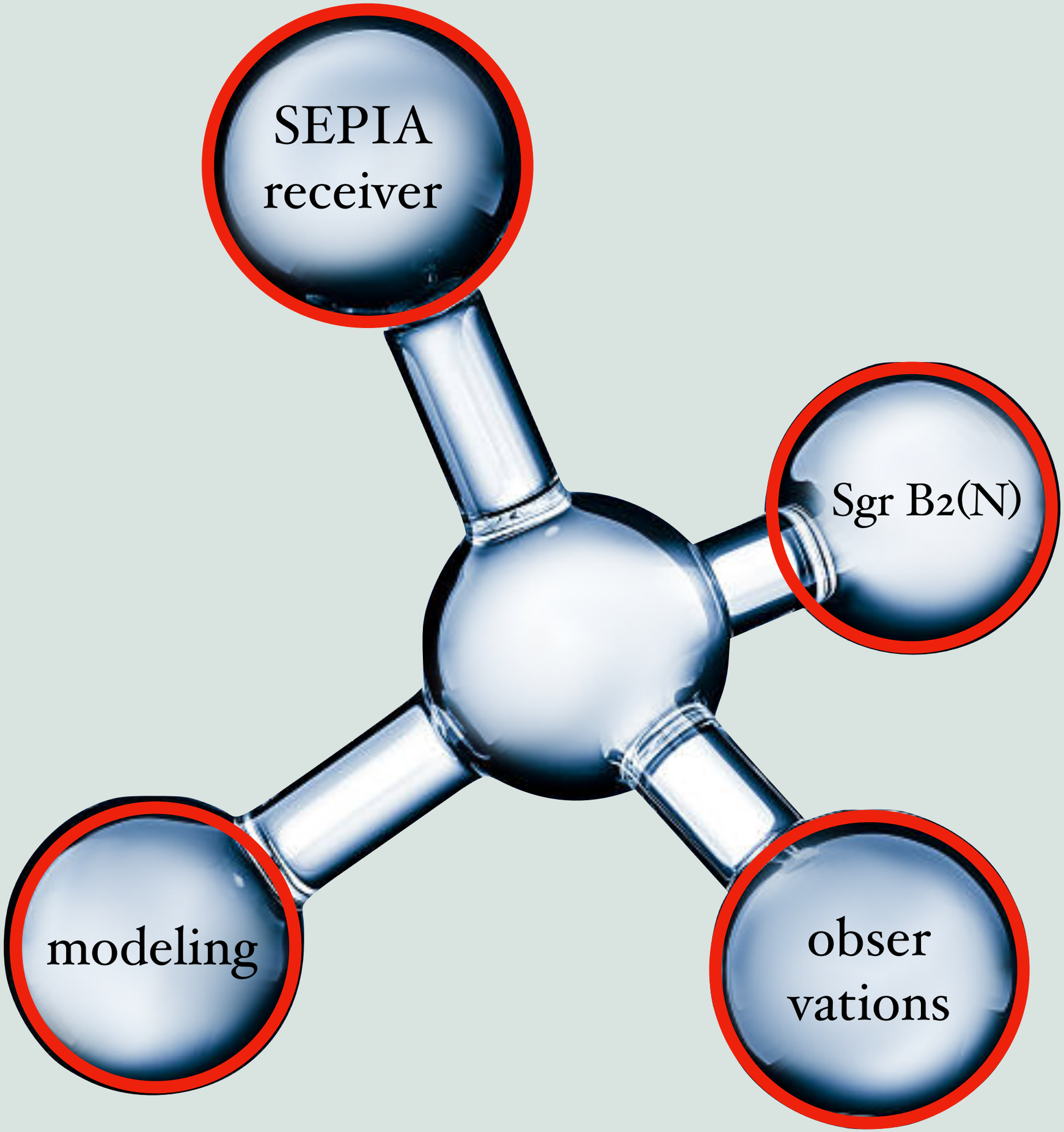
T_B (K)

15
10
5
0
−5

160000
180000
200000

Rest Frequency (MHz)

Immer et al., in prep


SEPIA
receiver
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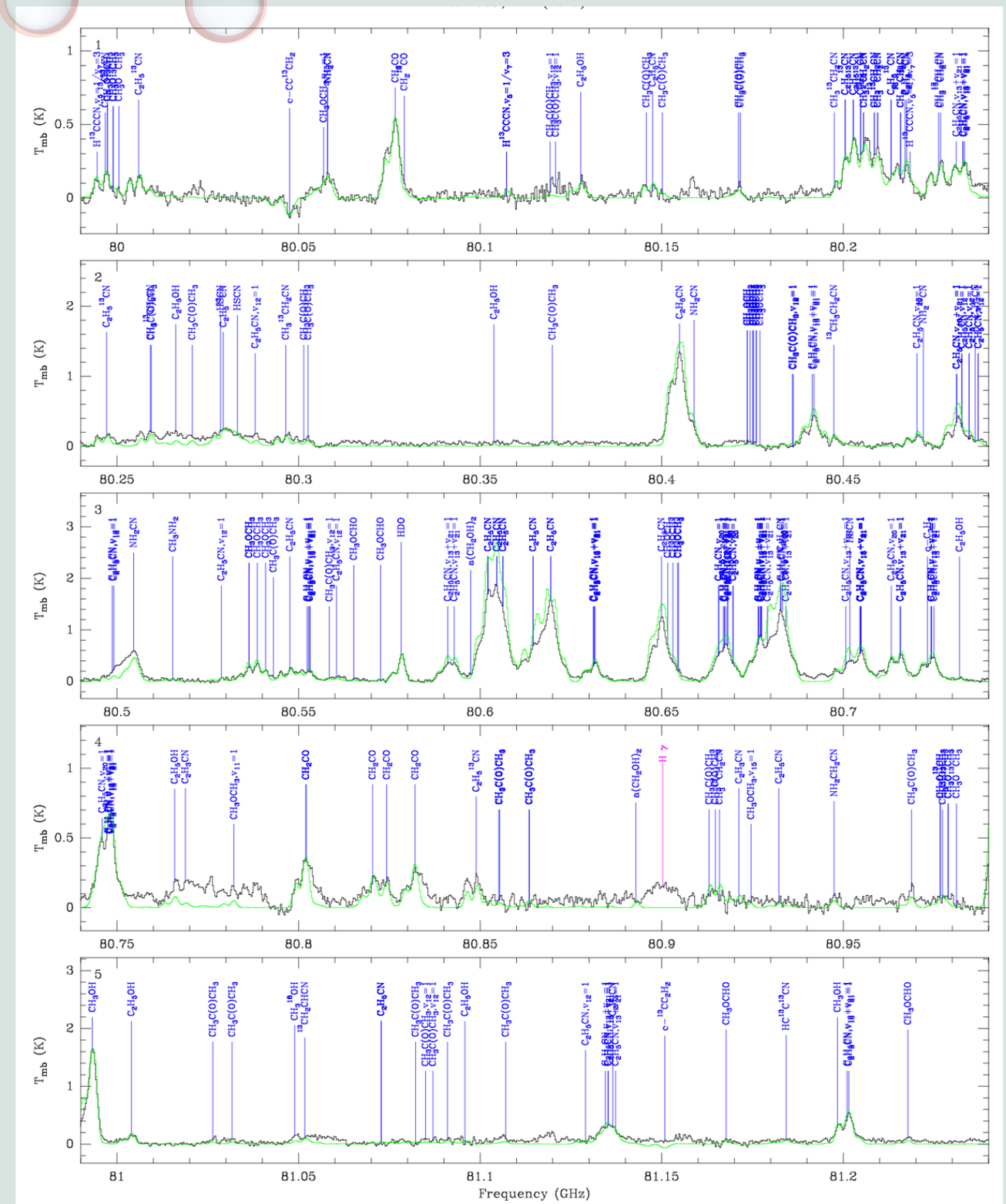
vations

Belloche et al. (2013)

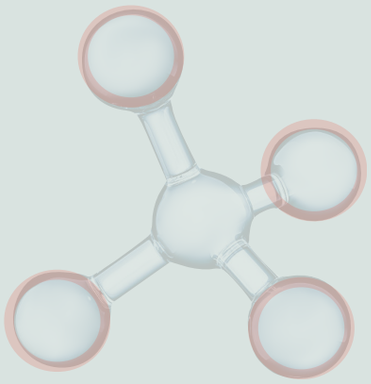


IRAM 30m observations of Sgr B2(N)

Covered frequency range (GHz): 80-116, 136-148, 154-155, 163-173, 176-177, 202-267

3675 spectral lines detected at 3 mm, 70% identified and assigned to 56 molecules, 66 isotopologues, 59 vibrationally excited states of these molecules

Radiative transfer fitting

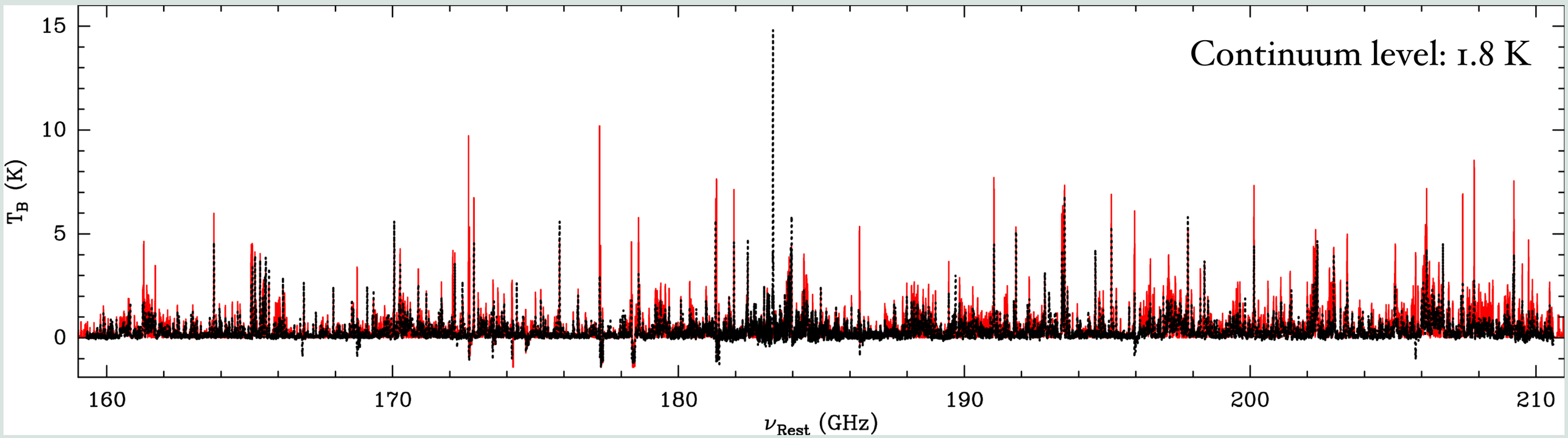


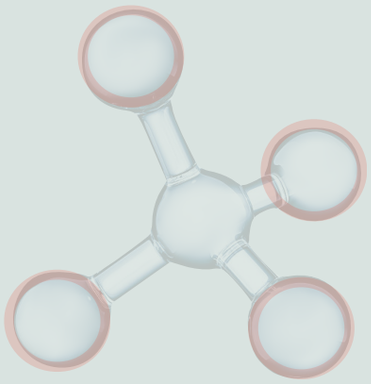
XCLASS modeling

Radiative transfer modeling with XCLASS software (Moeller et al. 2017)

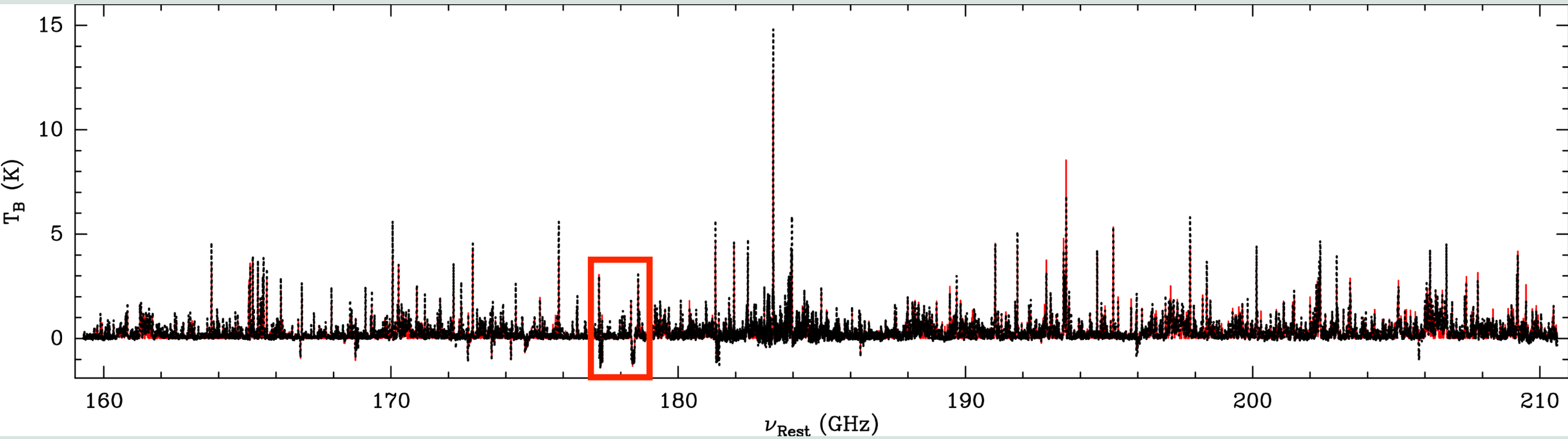
Use Belloche et al. 2013 parameters for synthetic spectrum with XCLASS: 122 species fitted (molecules, isotopologues, vibrational states); 59 species not included in VAMDC (mostly vibrational states)

Fixed parameters: Size of the emission, Central Velocity, Line Width, Tag for Absorption/Emission
Fitted parameters: Temperature, Column Density

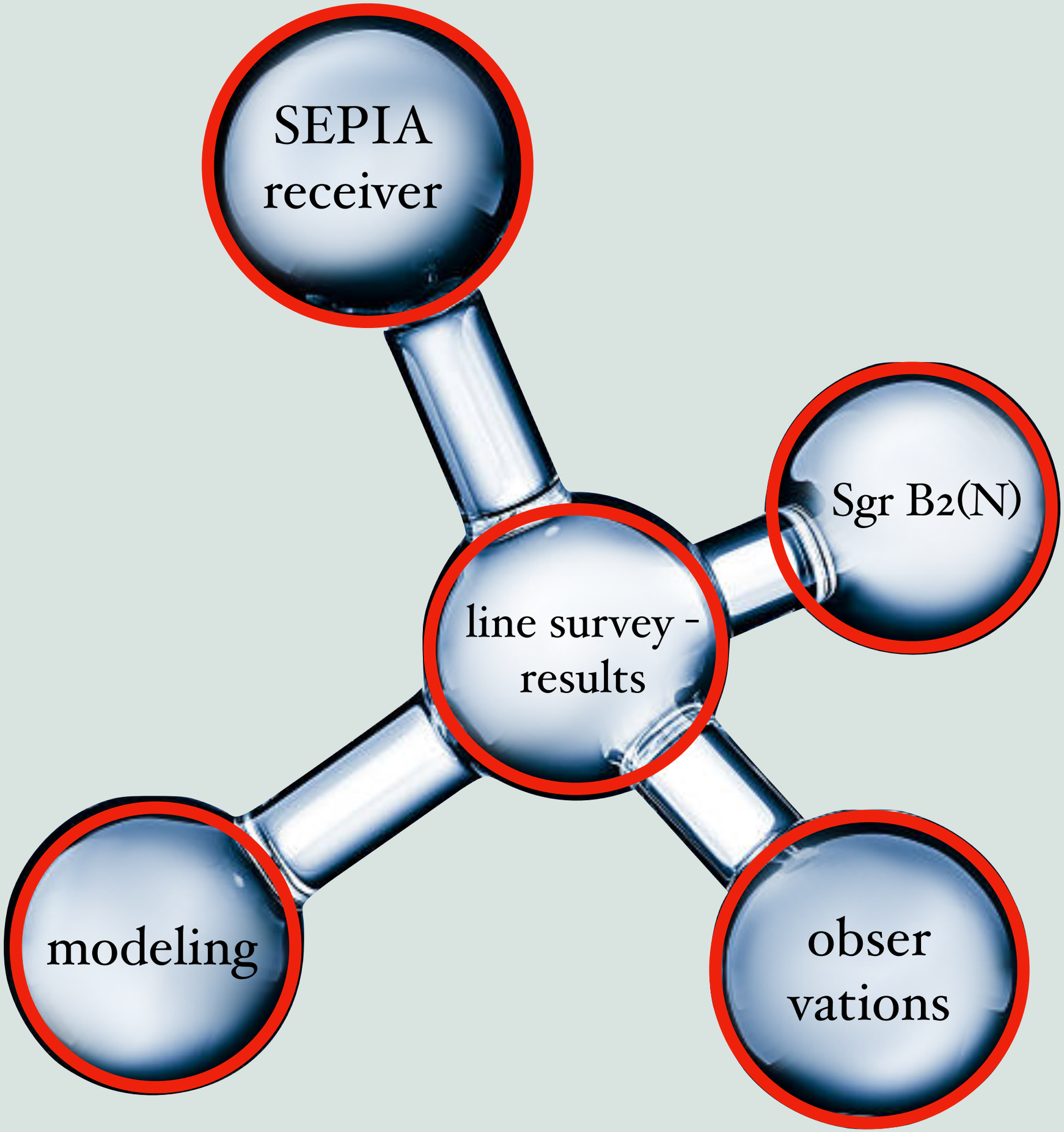




Final modeled spectrum



Immer et al., in prep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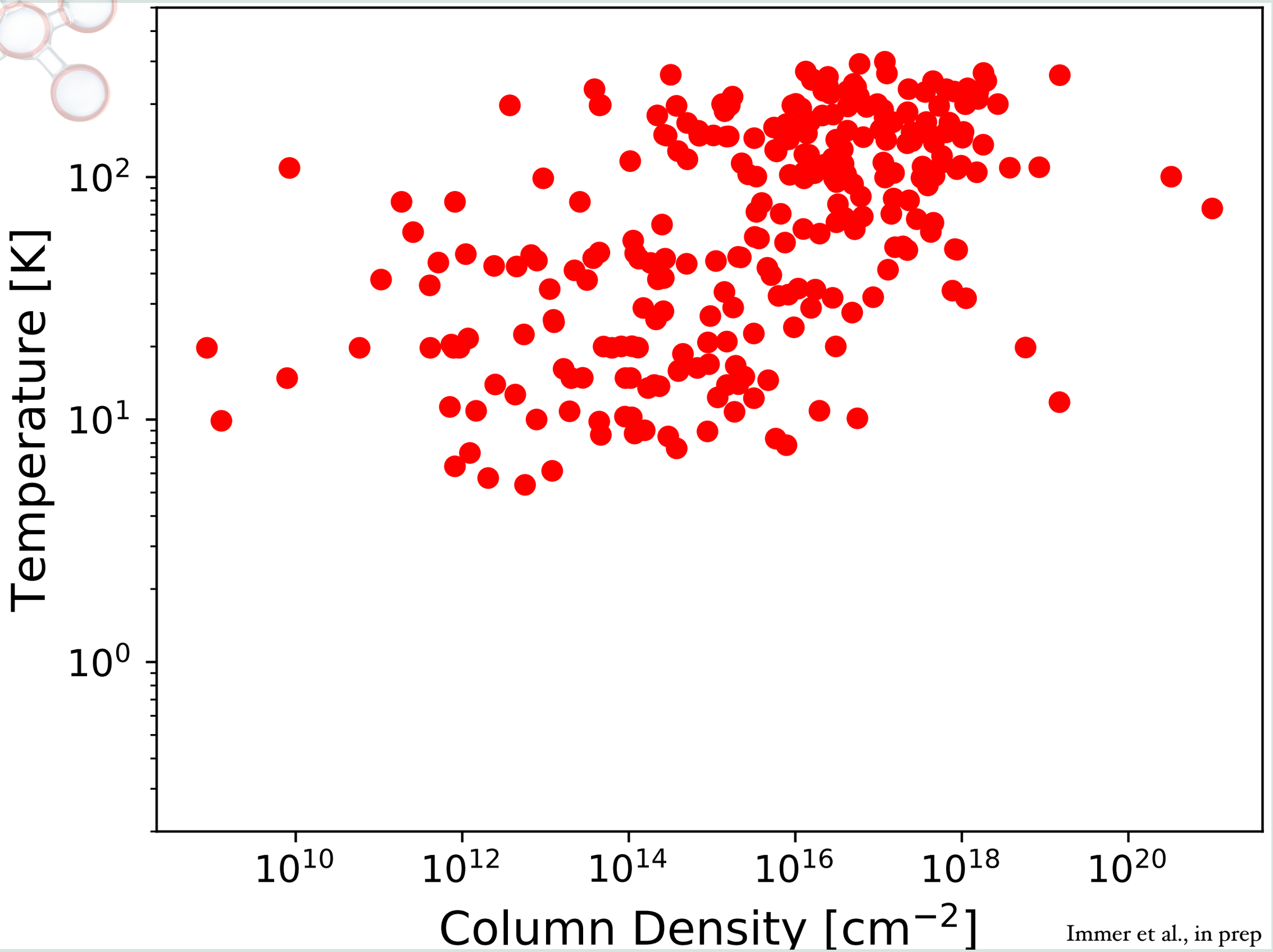
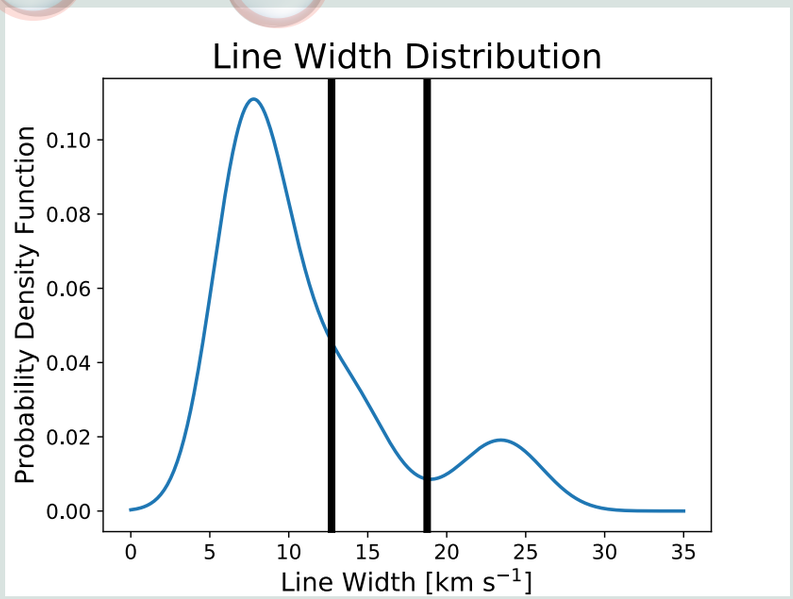
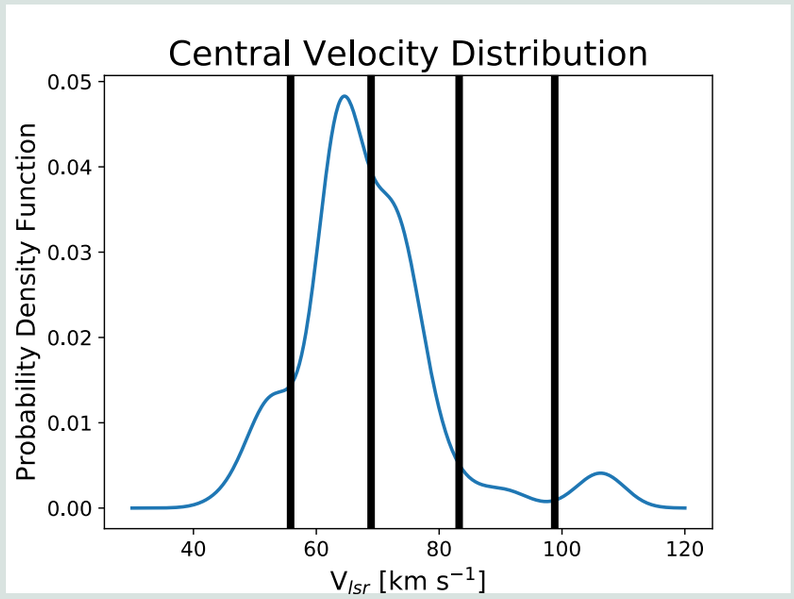
Column density vs temperature

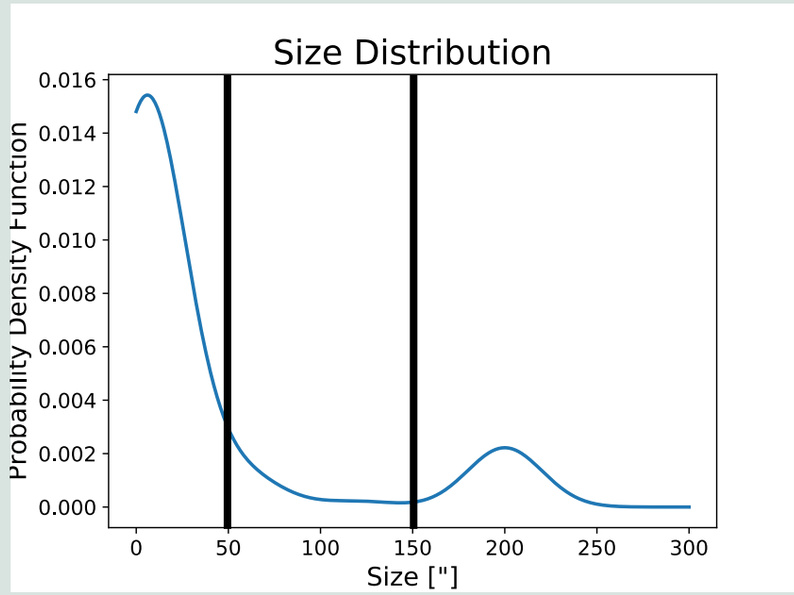


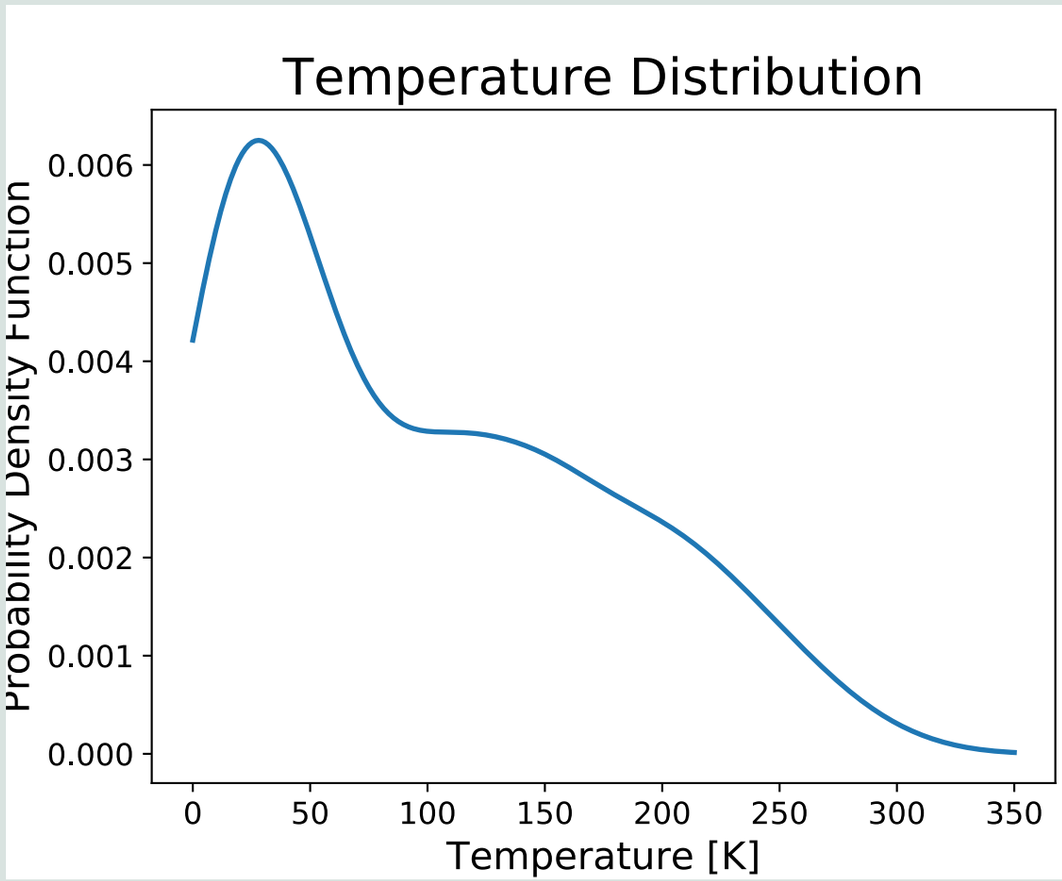
Immer et al., in prep

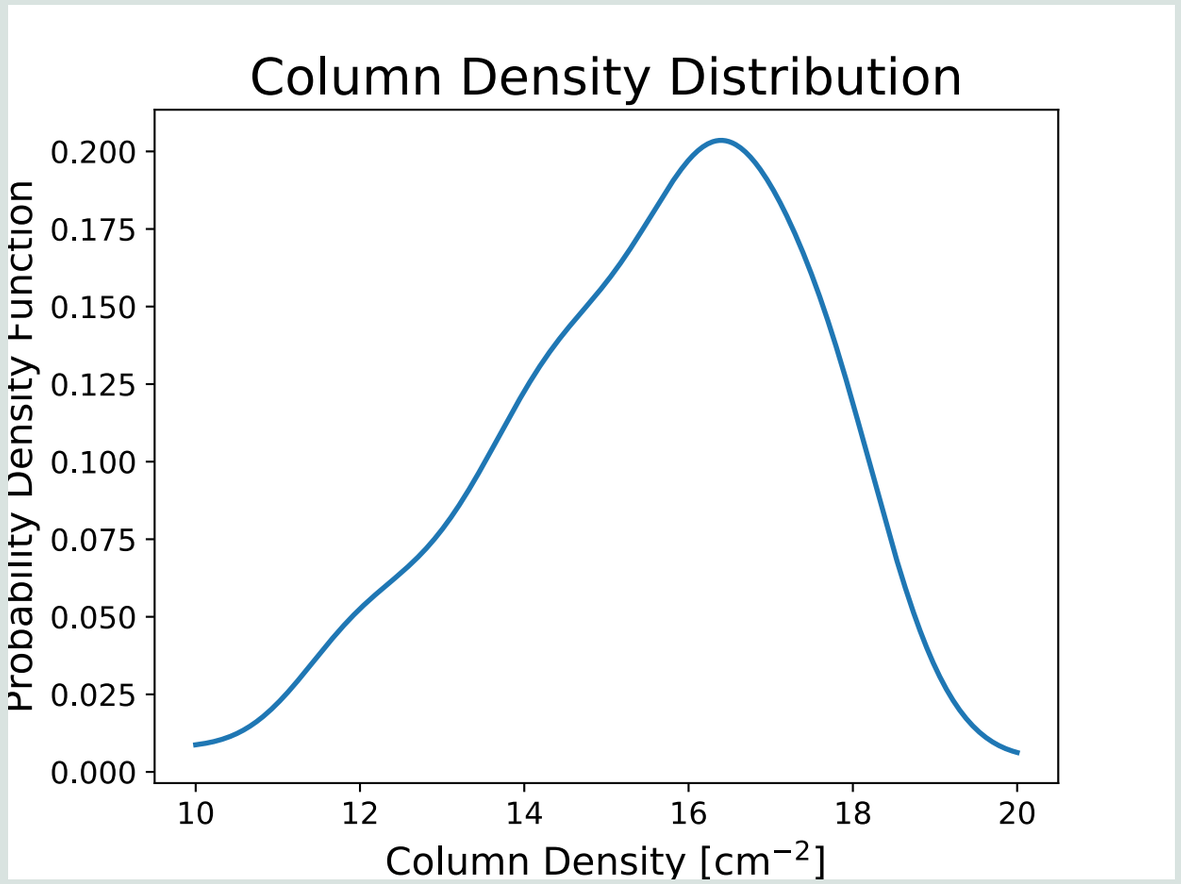
Distribution of parameters





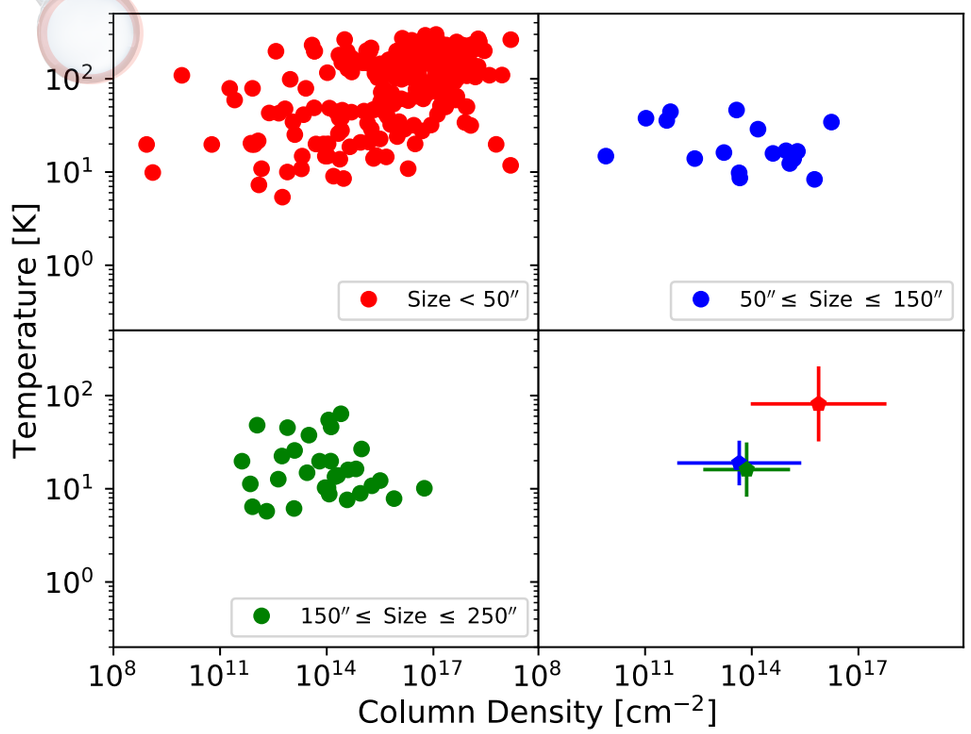




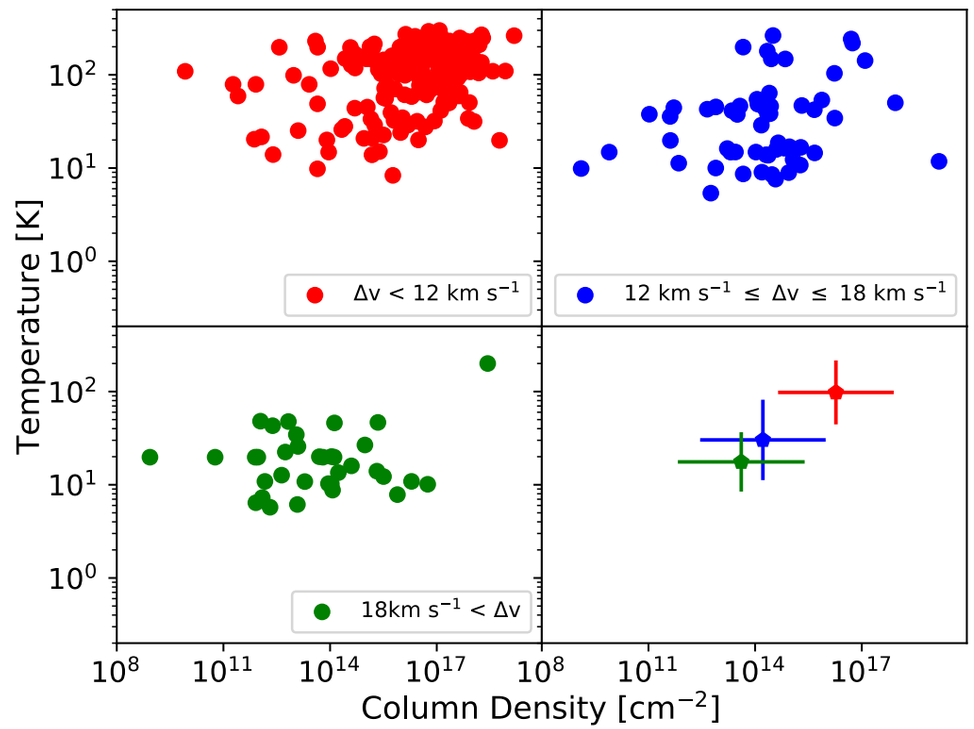


Column density vs temperature

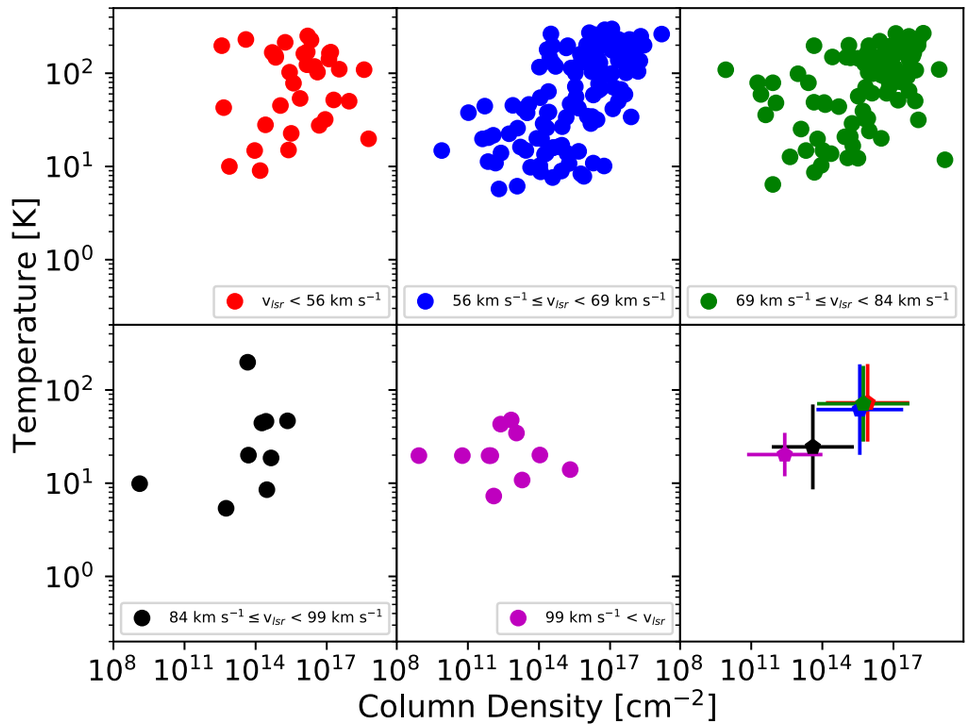
Size of the emission



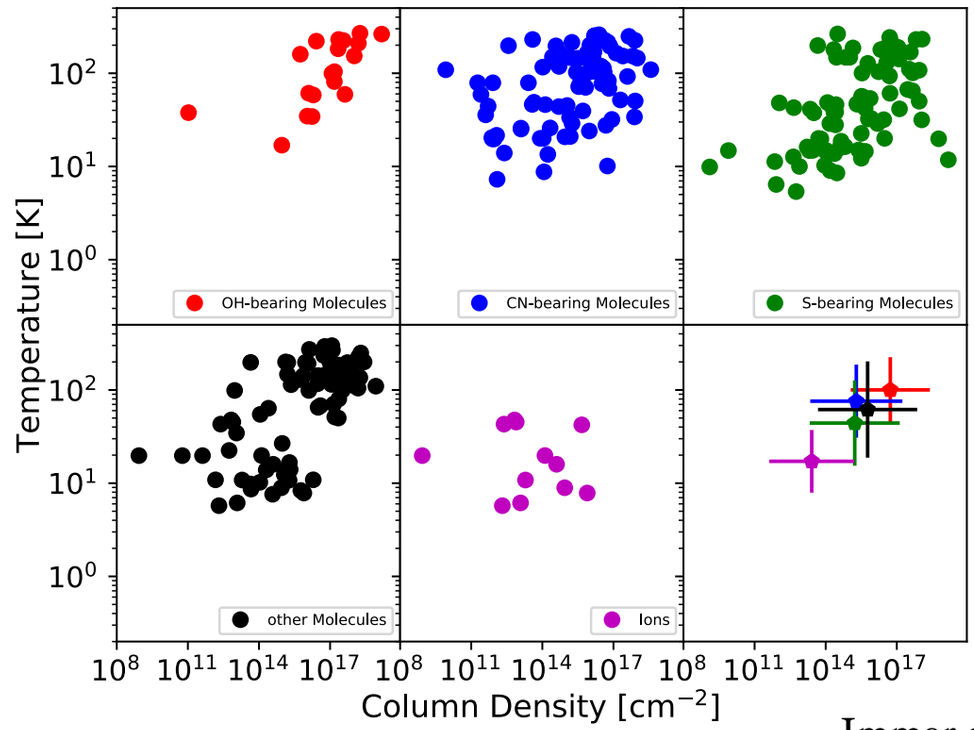
Line width



Central velocity



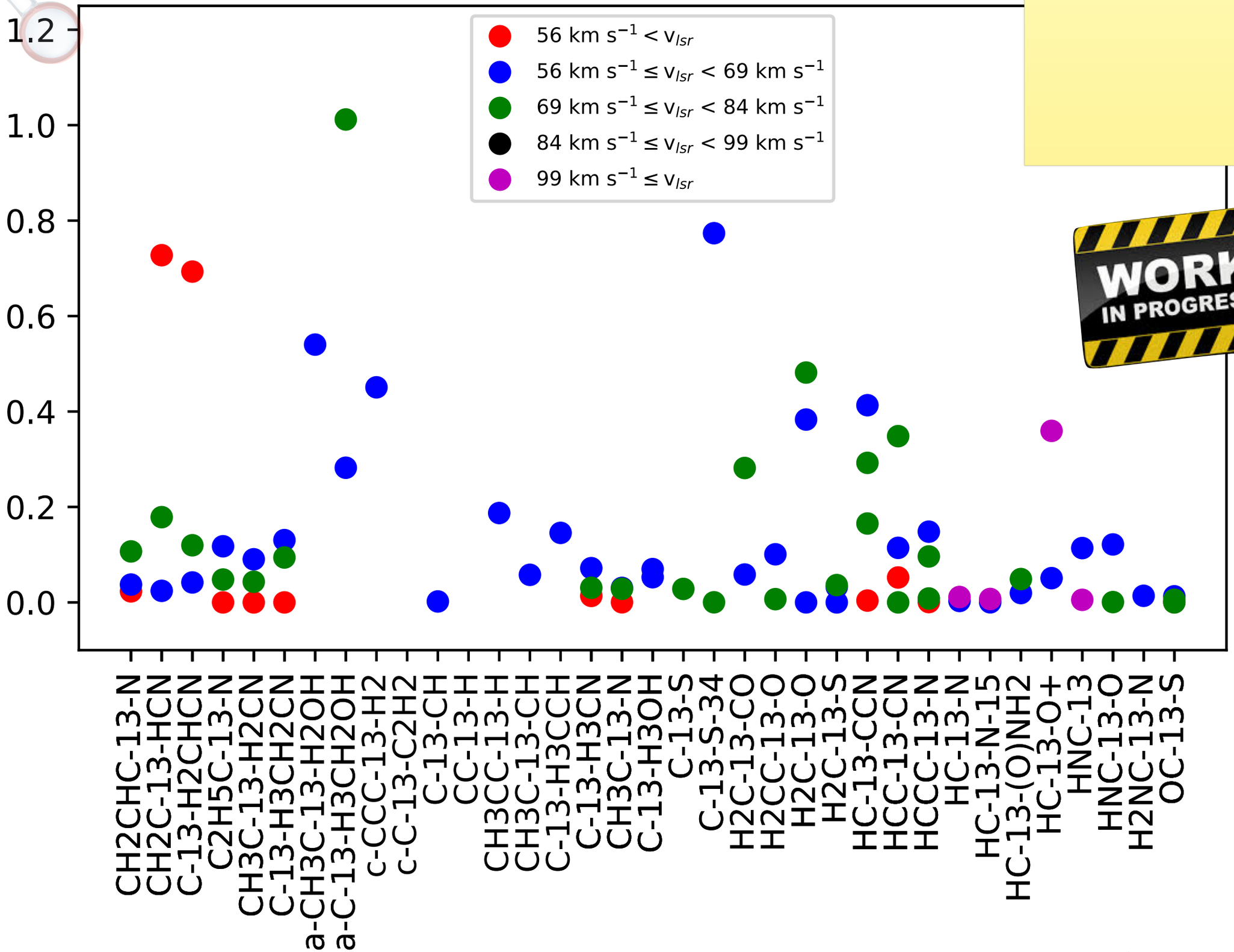
Molecule type



Immer et al., in prep

Isotopologue ratios

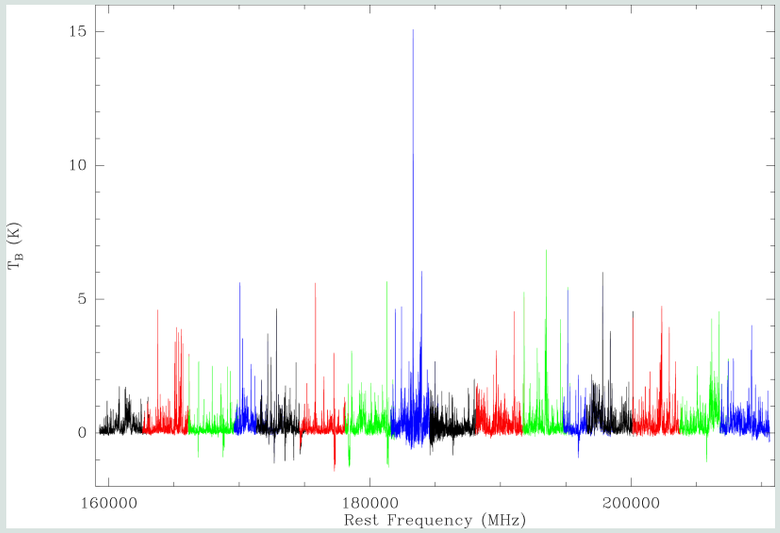
Isotopes fitted independently in XCLASS -> isotopologue ratios



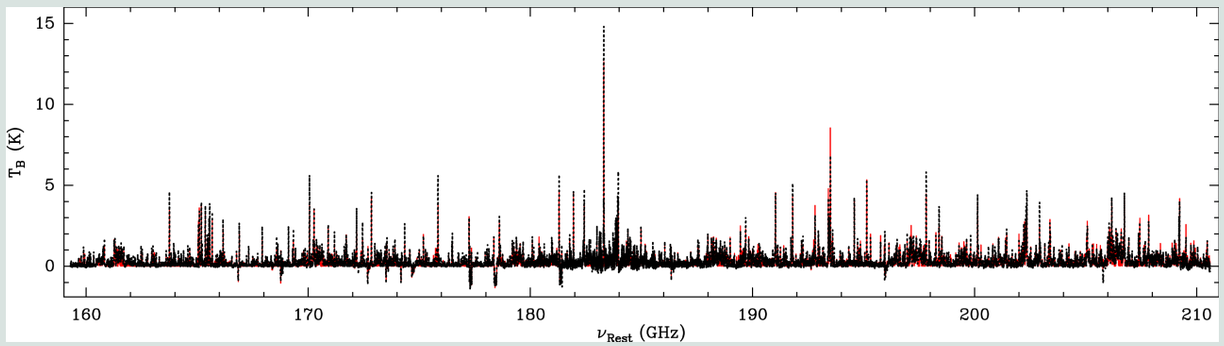
Immer et al., in prep

Conclusion

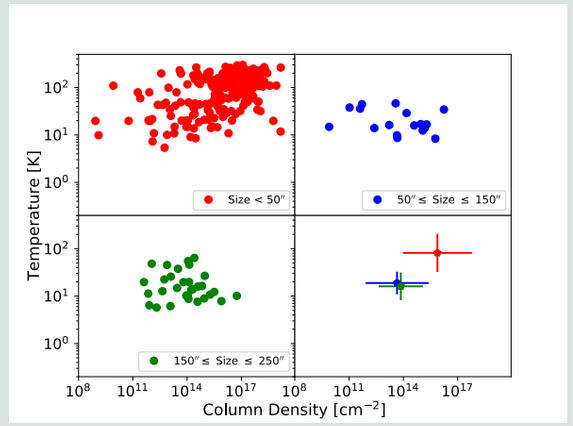
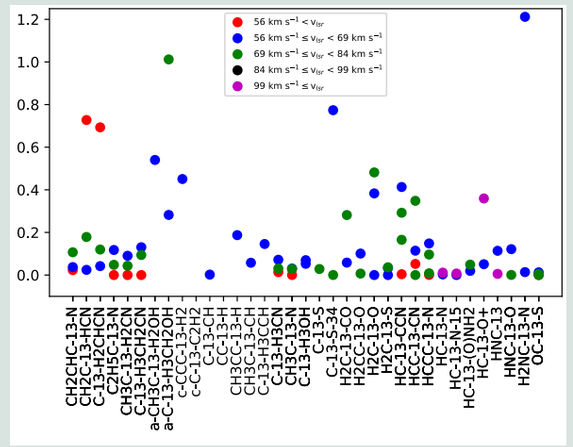
SEPIA spectral line survey of Sgr B2(N)



Radiative transfer modeling with XCLASS



More compact emission is denser and hotter



Isotopologue ratios