The Brick Line Survey in 2024

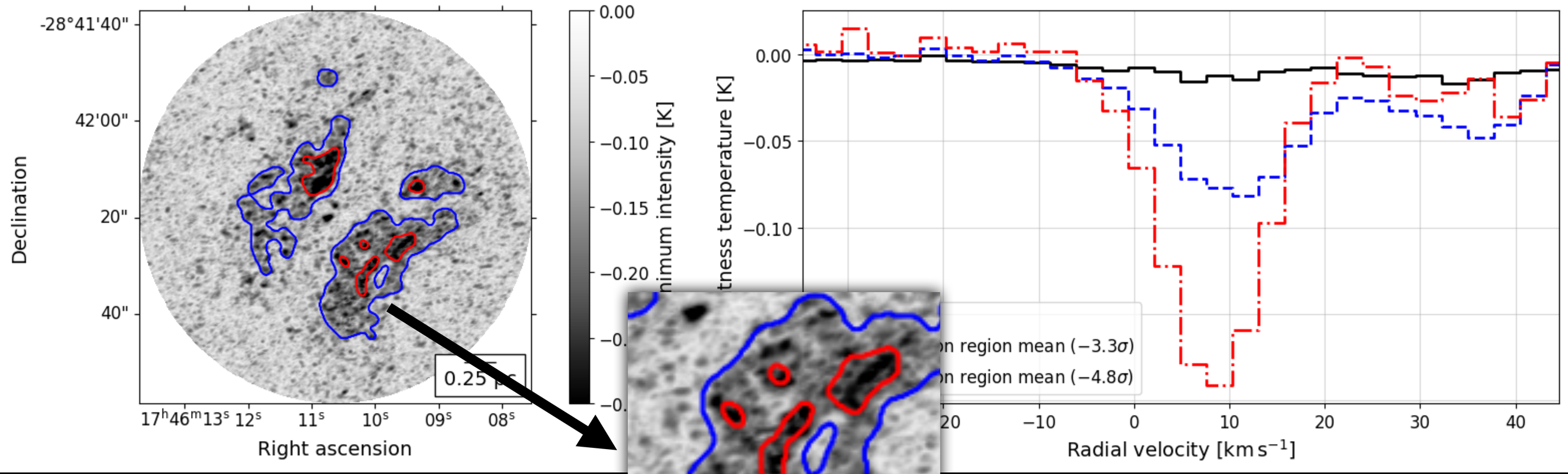
Alyssa Bulatek (she/her)
Committee: Adam Ginsburg, Desika Narayanan,
Jaehan Bae, and John Stanton (UF Chemistry)

November 7, 2024
Graduate Symposium

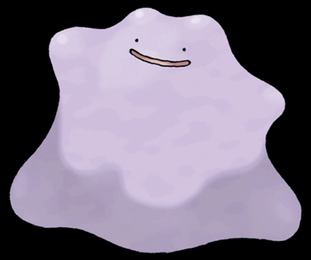
PREVIOUSLY IN

THE BRICK

Dasar spectral extraction (Fall 2023)



The Frown



but if he melted

What has happened since then?

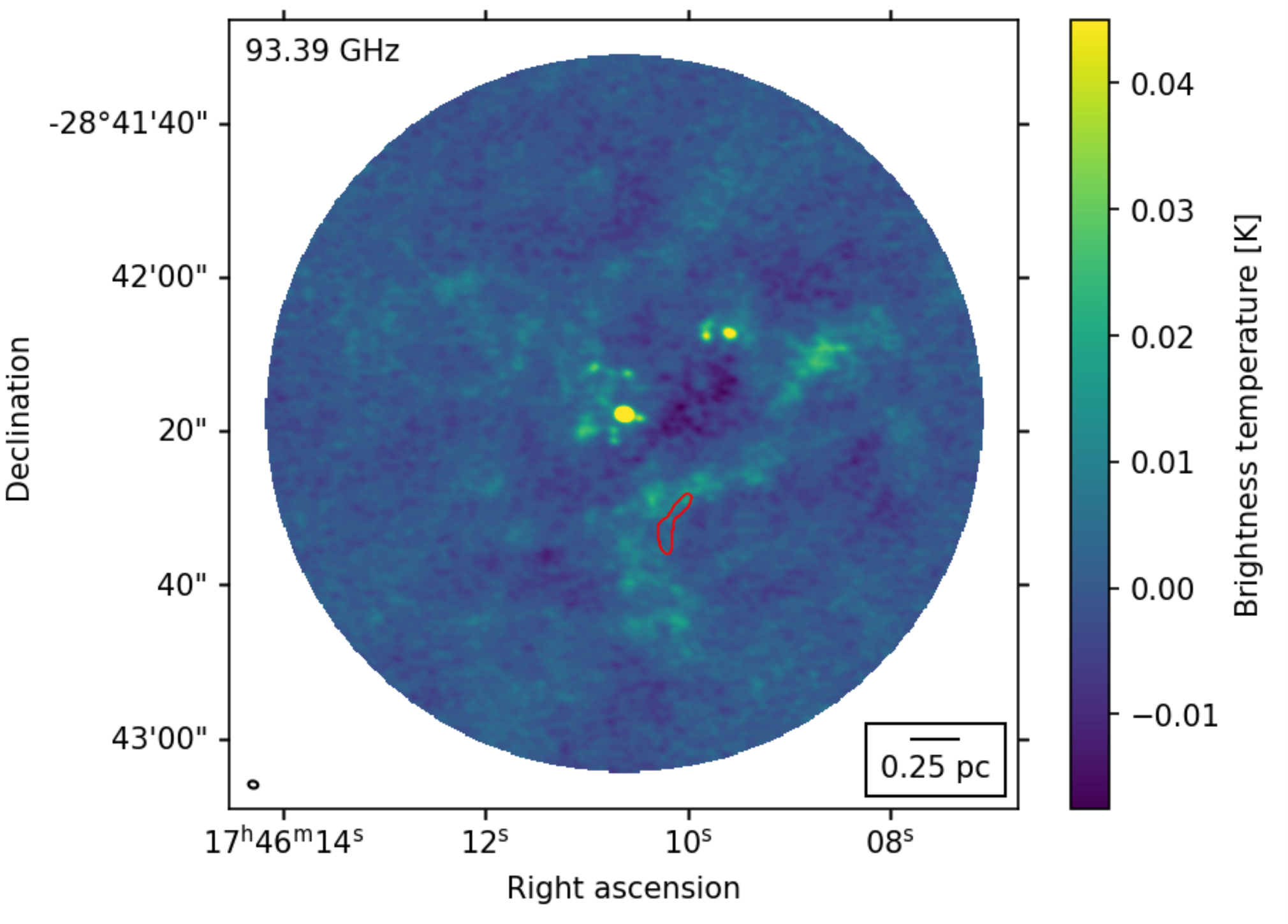
- Continuum imaging
- Line cataloging
- Unsuccessful ALMA proposal writing
- GBT MUSTANG-2 observing/GBO colloquium-giving
- Line cataloging (with improved procedures)
- ACES workshop attending
- Line catalog completing*? big if true

What has happened since then?

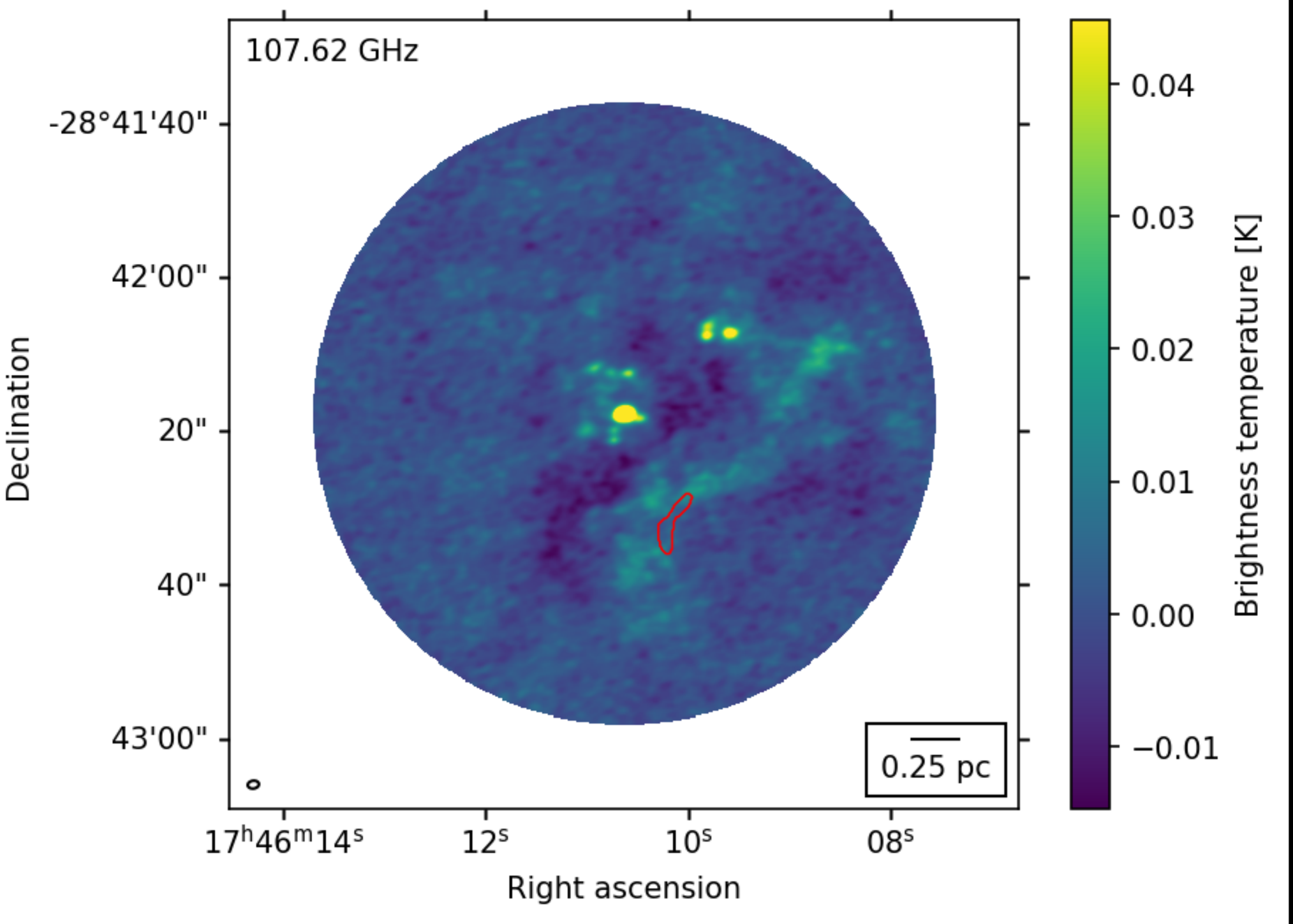
- Continuum imaging
- Line cataloging
- Unsuccessful ALMA proposal writing
- GBT MUSTANG-2 observing/GBO colloquium-giving
- Line cataloging (with improved procedures)
- ACES workshop attending
- Line catalog completing*? big if true

Continuum imaging

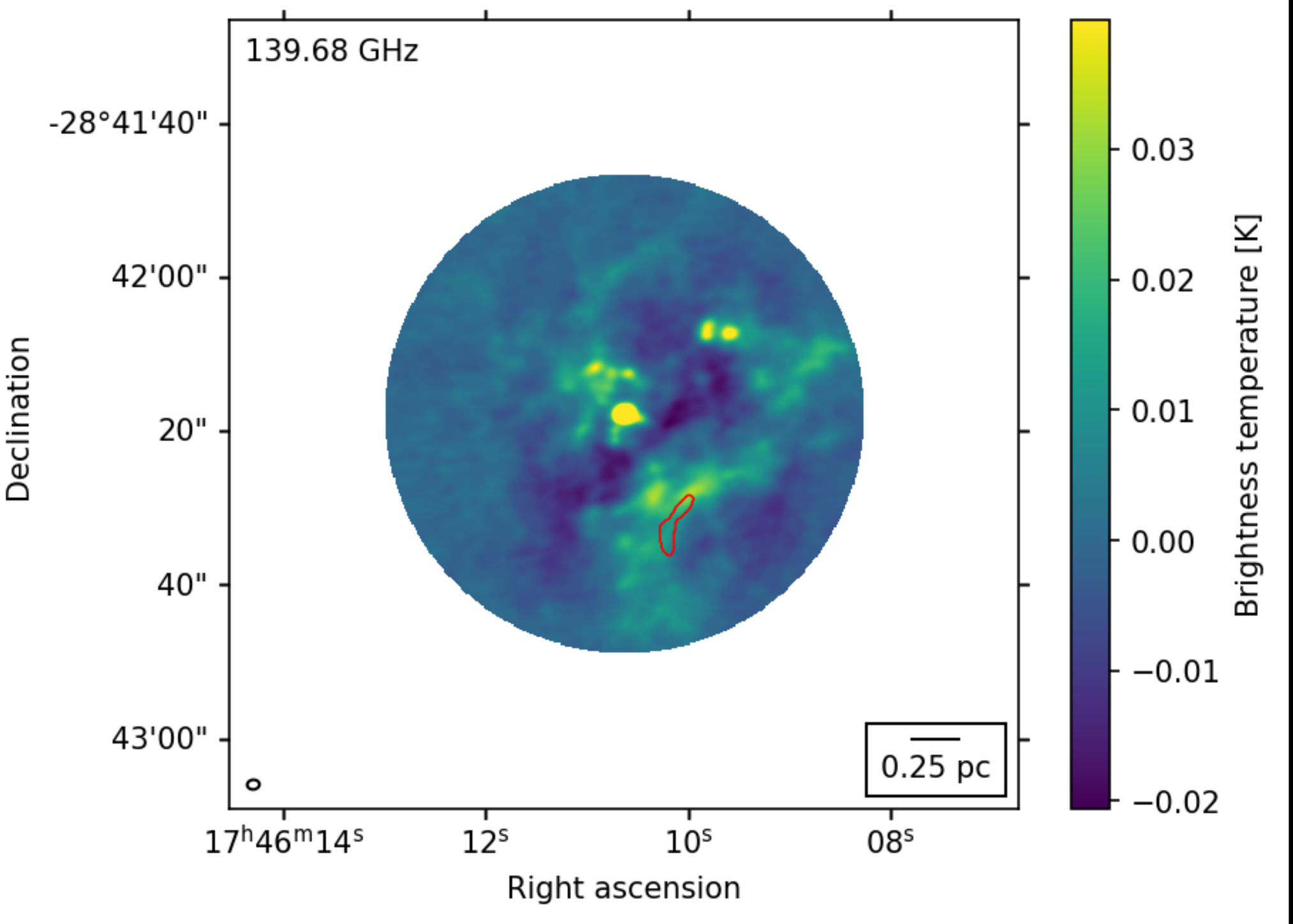
B3


93.39 GHz
-28°41'40"
42'00"
20"
40"
43'00"
Declination
17h46m14s
12s
10s
08s
Right ascension
0.25 pc
0.04
0.03
0.02
0.01
0.00
−0.01
Brightness temperature [K]

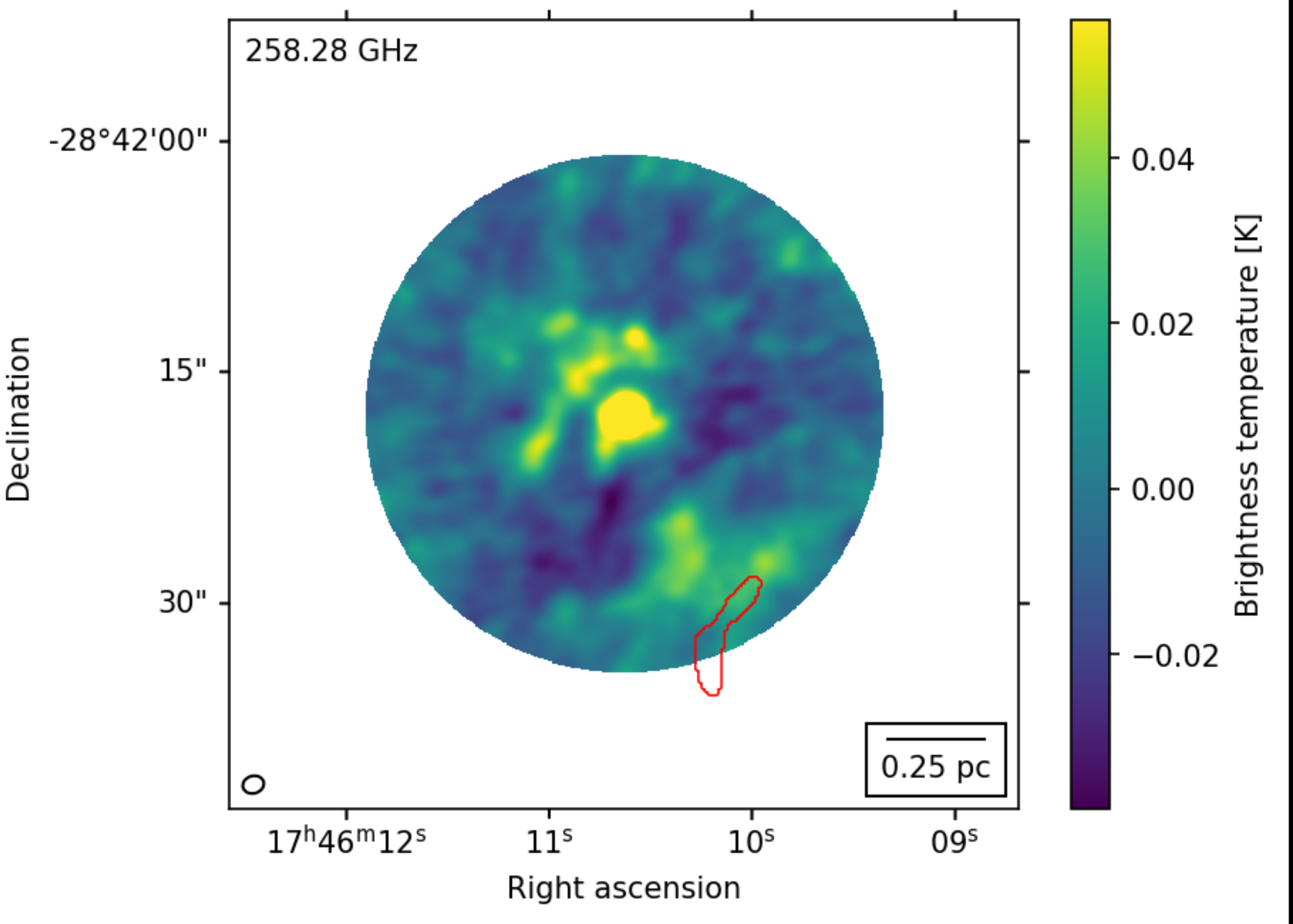
B3


107.62 GHz
-28°41'40"
42'00"
20"
40"
43'00"
Declination
17h46m14s
12s
10s
08s
Right ascension
0.25 pc
0.04
0.03
0.02
0.01
0.00
−0.01
Brightness temperature [K]

B4


139.68 GHz
-28°41'40"
42'00"
20"
40"
43'00"
Declination
17h46m14s
12s
10s
08s
Right ascension
0.25 pc
0.03
0.02
0.01
0.00
−0.01
−0.02
Brightness temperature [K]

B6


258.28 GHz
-28°42'00"
15"
30"
Declination
17h46m12s
11s
10s
09s
Right ascension
0.25 pc
0.04
0.02
0.00
−0.02
Brightness temperature [K]

Improved cataloging procedures

February 20, 2024

- Adam says: stick to this region (the frown) for more ide
- Do SiO next. Then do the rest of the molecules!

Try tight_layout for plots to make them readable :-)

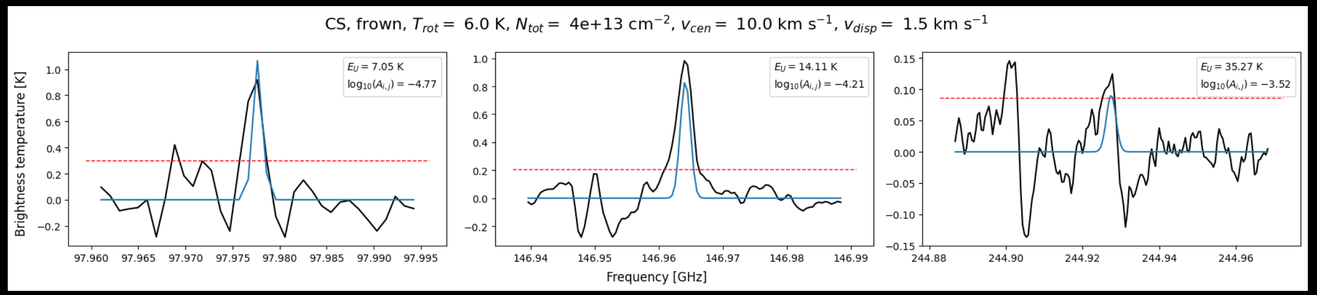
molmodel.py
LTE modeling code suite

- Pulls from JPL and CDMS catalogs
  - Function to list molecule tags—no more name confusion!
- Can extract spectrum from a coordinate or a region (.FITS) file
  - Can model line-by-line or spw-by-spw
- Can fetch only lines above (below) user-specified A_{ij} (E_U) cutoffs
- Optional features
  - Plot 2-sigma level for upper limit measurement
  - Calculate N_uppers for rotational diagrams

mol_model.py | region_comparison.ip | full_model.ipynb | SummaryPlot_v2.ipyr | plot_all_spectra_NEV

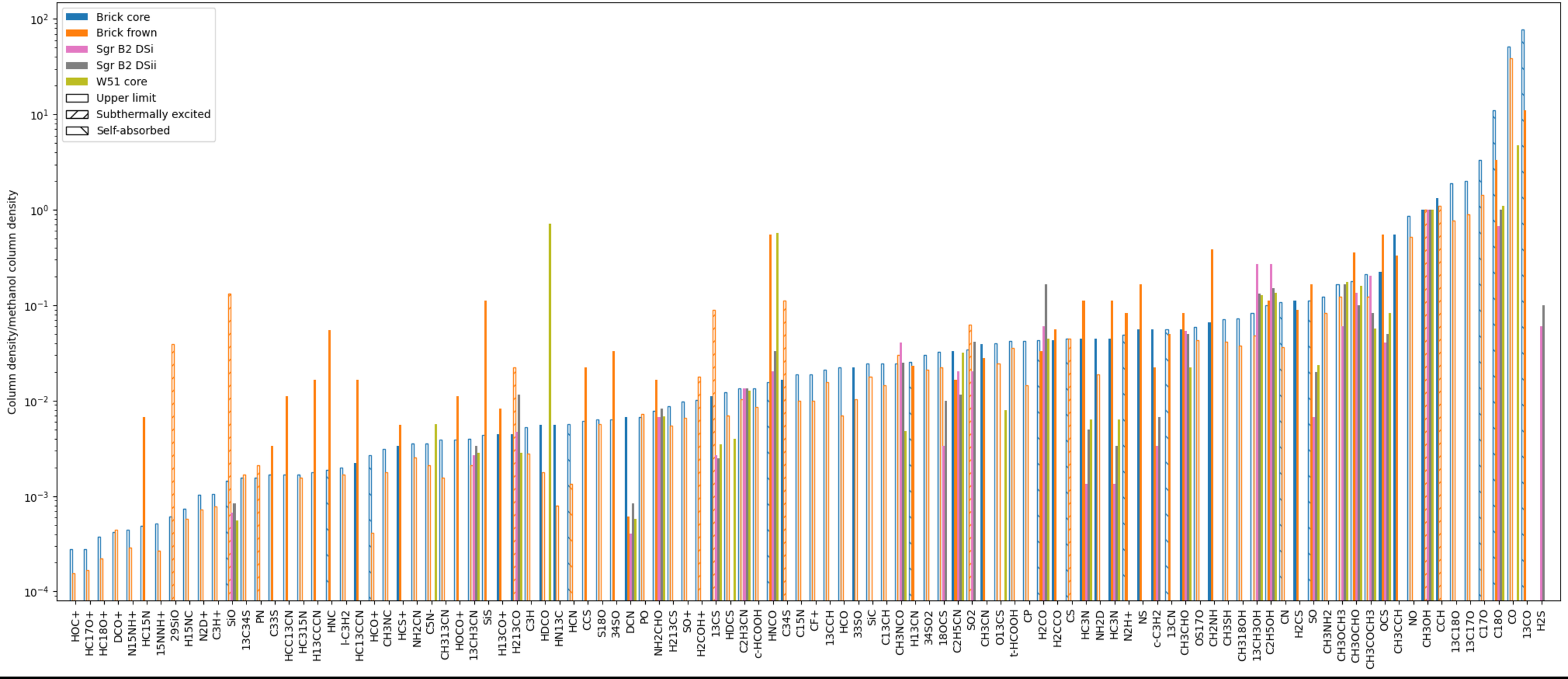
```python
from spectral_cube import SpectralCube
from astropy.io import fits
from reproject import reproject_interp
from astroquery.splatalogue.utils import merge_frequencies, minimize_table
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.patches as mpl_patches
import pyspeckit
from pyspeckit.spectrum.models.lte_molecule import get_molecular_parameters
from pyspeckit.spectrum.models import lte_molecule
from pyspeckit.spectrum.models.lte_molecule import nupper_of_kkms
from astropy import coordinates, constants, units as u
from astropy.stats import mad_std

def fetch_cubes(cubefns, catalog, mol_name_pyspeckit=None, mol_tag_pyspeckit=None, parse_loc=False,
                ret_tbl=False):
    # Get only the cubes that have our line of interest in them
    cubes = []
    tbls = []
    for fn in cubefns:
        molcube = SpectralCube.read(fn, format='fits', use_dask=True)
        try:
            if ret_tbl:
                freqs, aij, deg, EU, partfunc, tbl = get_molecular_parameters(molecule_name=mol_name_pyspeckit,
                                                                              molecule_tag=mol_tag_pyspeckit,
                                                                              catalog=catalog,
                                                                              parse_name_locally=parse_loc,
                                                                              return_table=ret_tbl,
                                                                              fmin=molcube.spectral_axis.min(),
                                                                              fmax=molcube.spectral_axis.max())
            else:
                freqs, aij, deg, EU, partfunc = get_molecular_parameters(molecule_name=mol_name_pyspeckit,
                                                                         molecule_tag=mol_tag_pyspeckit,
                                                                         catalog=catalog,
                                                                         parse_name_locally=parse_loc,
                                                                         return_table=ret_tbl,
```

Ln 16, Col 17 Spaces: 4 mol_model.py

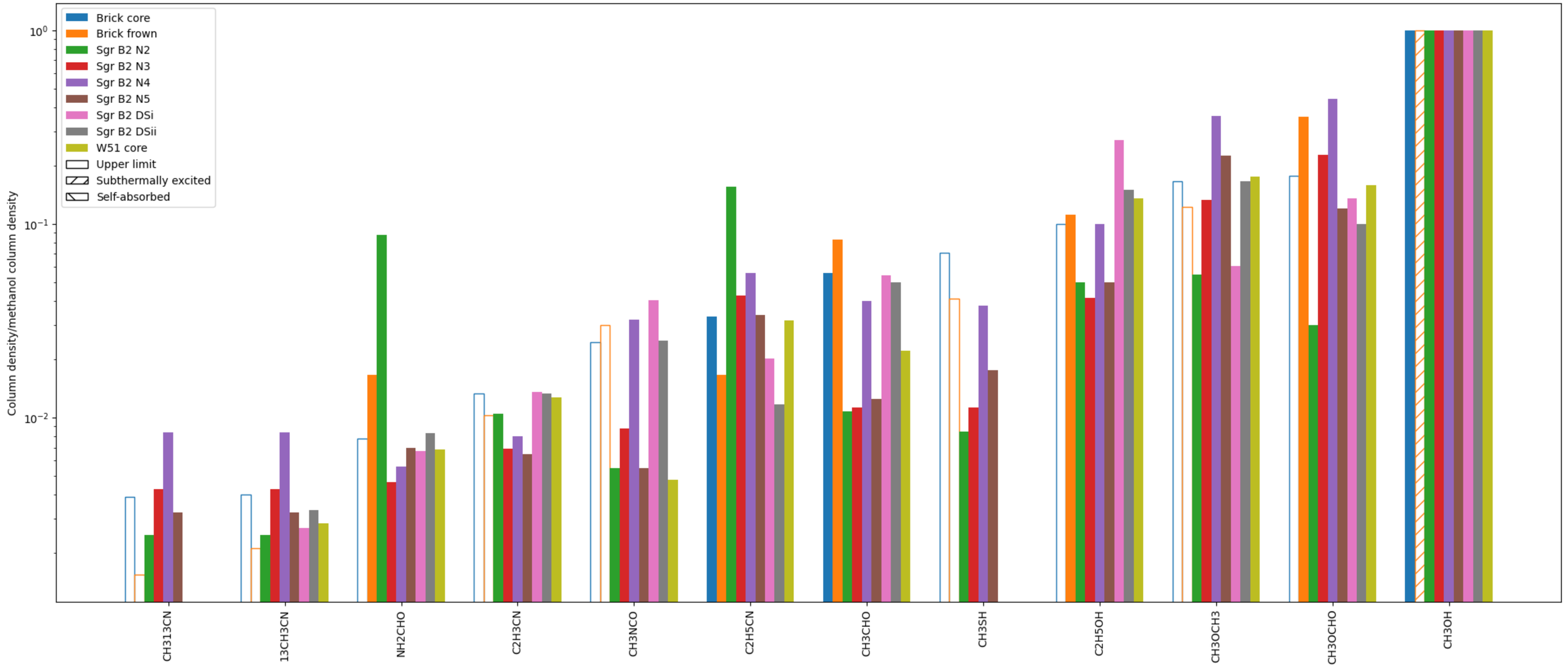


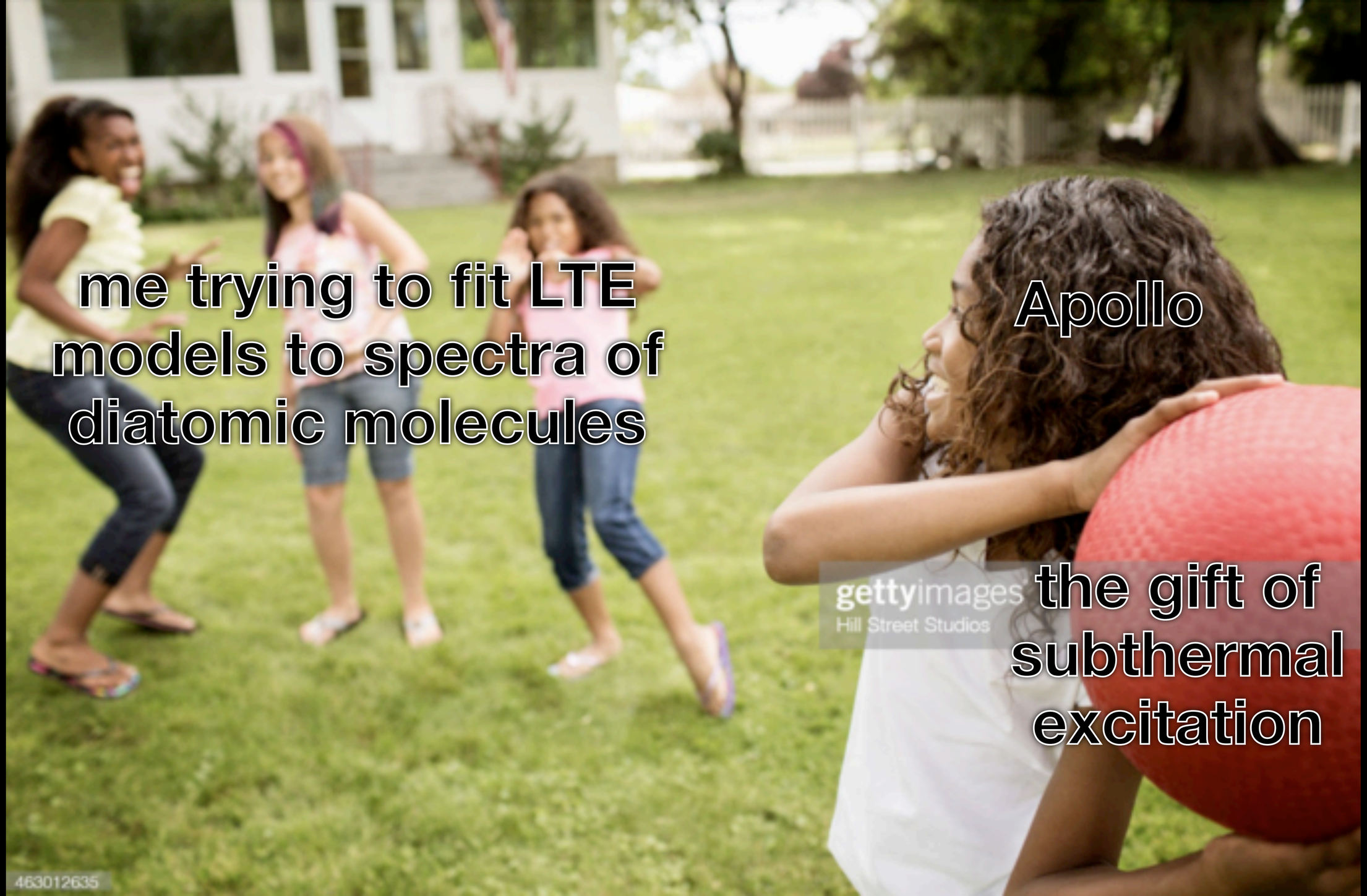
Molecular inventories of the maser core and The Frown (with initial LTE model fits)

A bunch of molecules (initial fits)



Complex organic molecules (initial fits)




me trying to fit LTE models to spectra of diatomic molecules
Apollo
the gift of subthermal excitation
gettyimages
Hill Street Studios
463012635

What else will go in this paper?

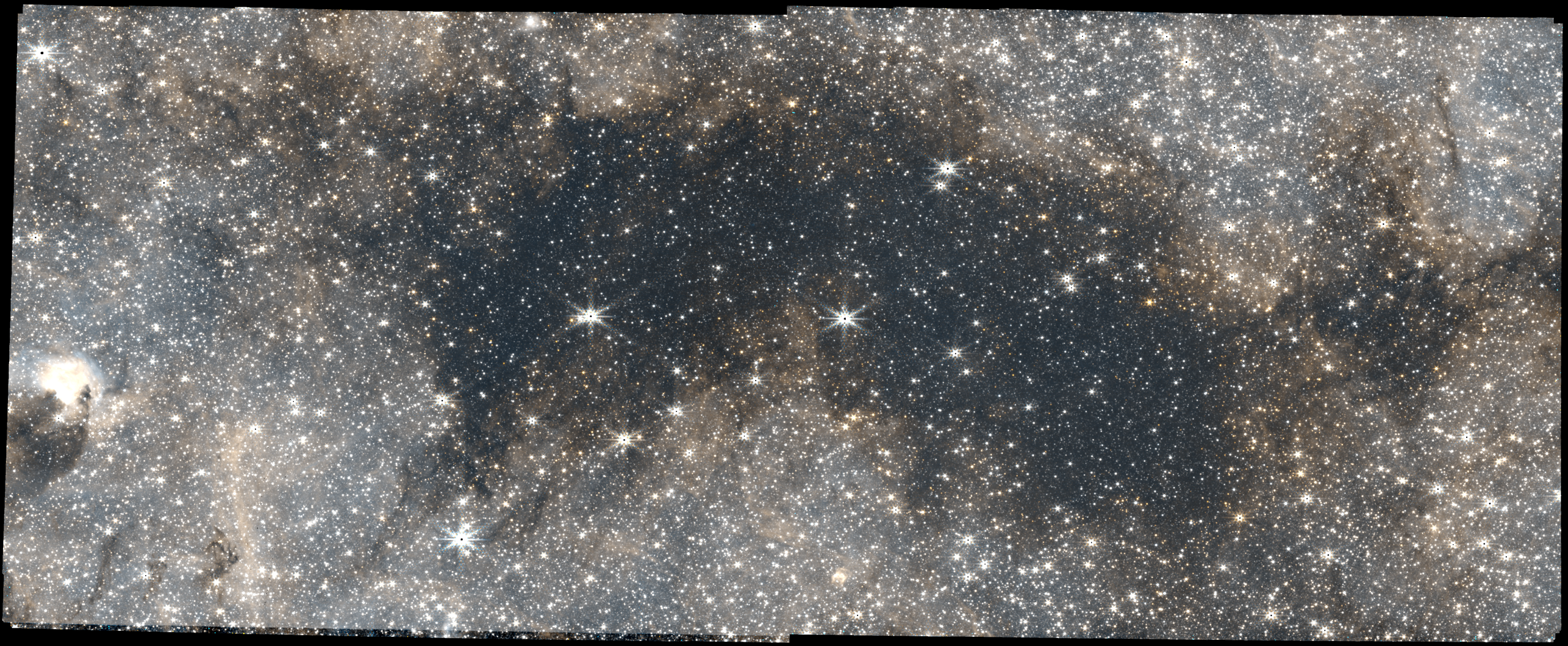
Remaining deliverables for Paper II (BLS I)

- *Analysis:* one big model with all molecules, LTE modeling
  - One ID for every line; corrected molecular catalog and LTE fits (with errors on params)
  - List of unidentified lines
- *Analysis:* doing calculations with the measurements
  - Notes on each molecule; abundance constraints from column densities
  - Doing science; e.g., deriving the chemical history of the cores using SO and SO_2
  - Isotope ratios; e.g., ^{12}C to ^{13}C ratio
- *Discussion:* comparison between regions (measure *X*-factors)

Things that might not be in this paper

- Inventories of the other cores identified in continuum images
- non-LTE modeling for subthermally-excited molecules
- Other things we figure out along the way that we don't have time to include in the paper

Longwave/narrowband JWST NIRCam image courtesy of Adam



Thanks for your time!