Astrobiology Study with ALMA Observations: (1) The first active interstellar comet 2I/Borisov

2021 UCAT Summer Student Program
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Outline

- Profile of 2I/Borisov
- Motivation
- Observations
- Methods
- Results
- Summary

Profile

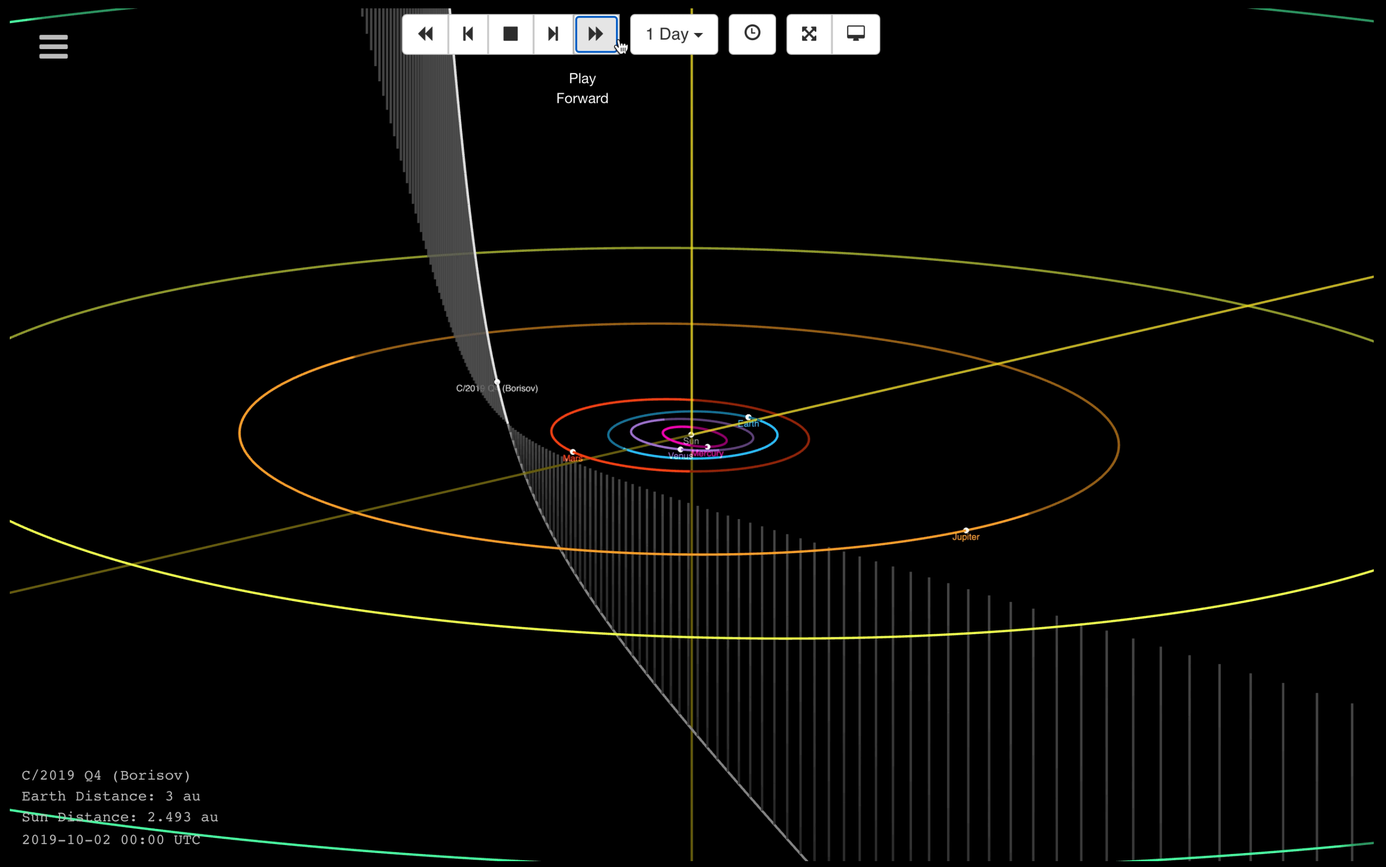
About 2I/Borisov

- Interstellar Comet
- Discovered on Aug. 30, 2019
- Discovered by an amateur astronomer Borisov
- A km-size nucleus

Hubble, NASA, 2019 December

Profile

Orbital trajectory of 2I/Borisov



JPL Small-Body Database Browser

- Perihelion: 2.0 AU (Dec. 19, 2019)
- Closest to Earth: 1.9 AU (Dec. 27, 2019)

Motivation

- Studying the chemical composition of Borisov
- By studying an interstellar comet to provide a great opportunity to understand the chemistry beyond our solar system.

Observations (For my dataset)

- ALMA (Atacama Large Millimeter/ submillimeter Array)
- Date : December 2, 2019
- On source time : 34 min 24 sec
- Frequency coverage : 242.076 ~ 243.951 GHz
- Number of antennas : 41

ESO/C. Malin

Methods

- Problem 1: Two terrestrial ozone lines lie in the spectral window which could influence the spectral profile.

  Method 1: Remove channels where ozone emissions are located.

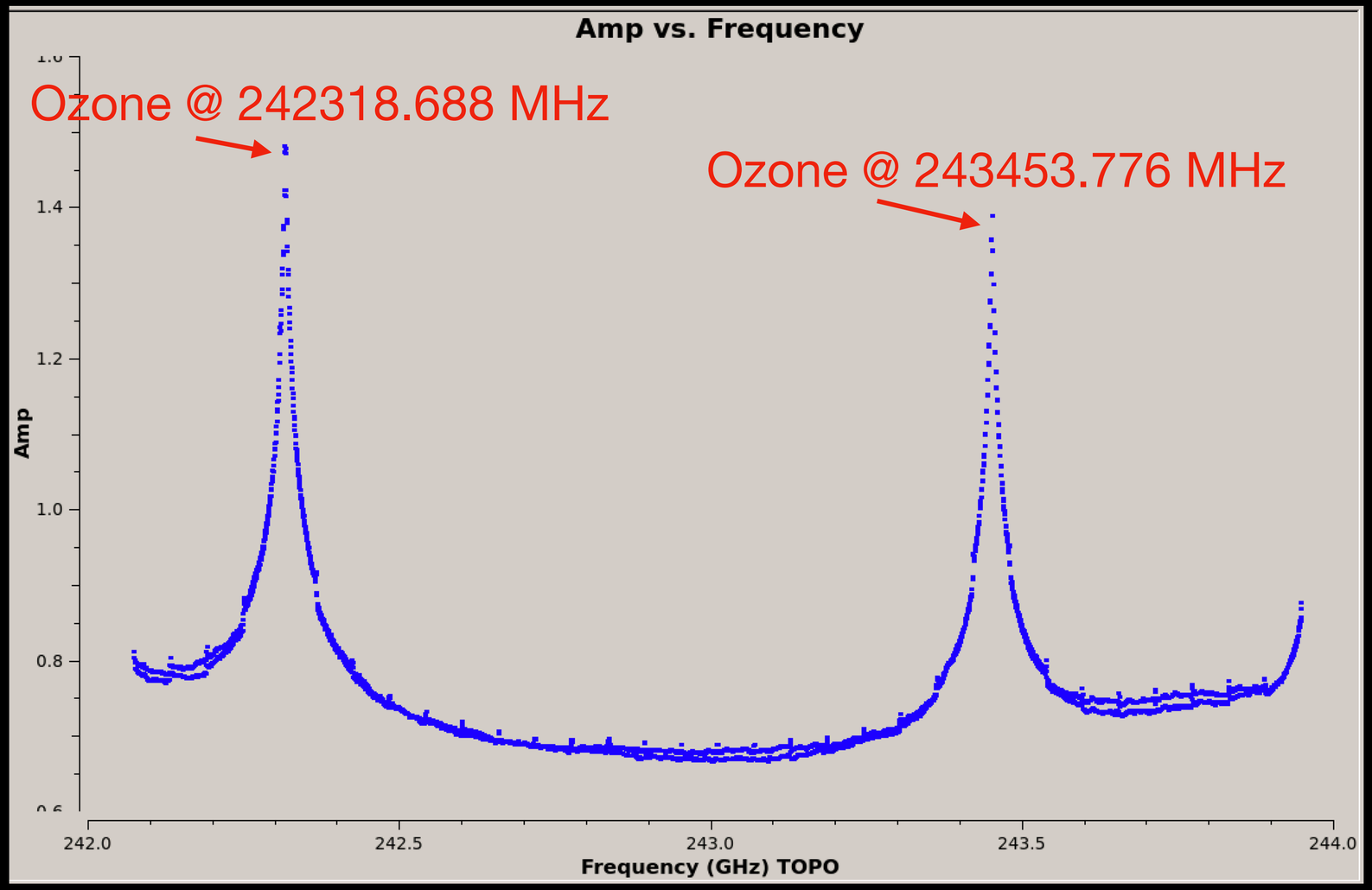
- Problem 2: The continuum map is too noisy and the peak intensity is not close to the center of the map.

  Method 2: Place UVtaper and CLEAN mask.

Results

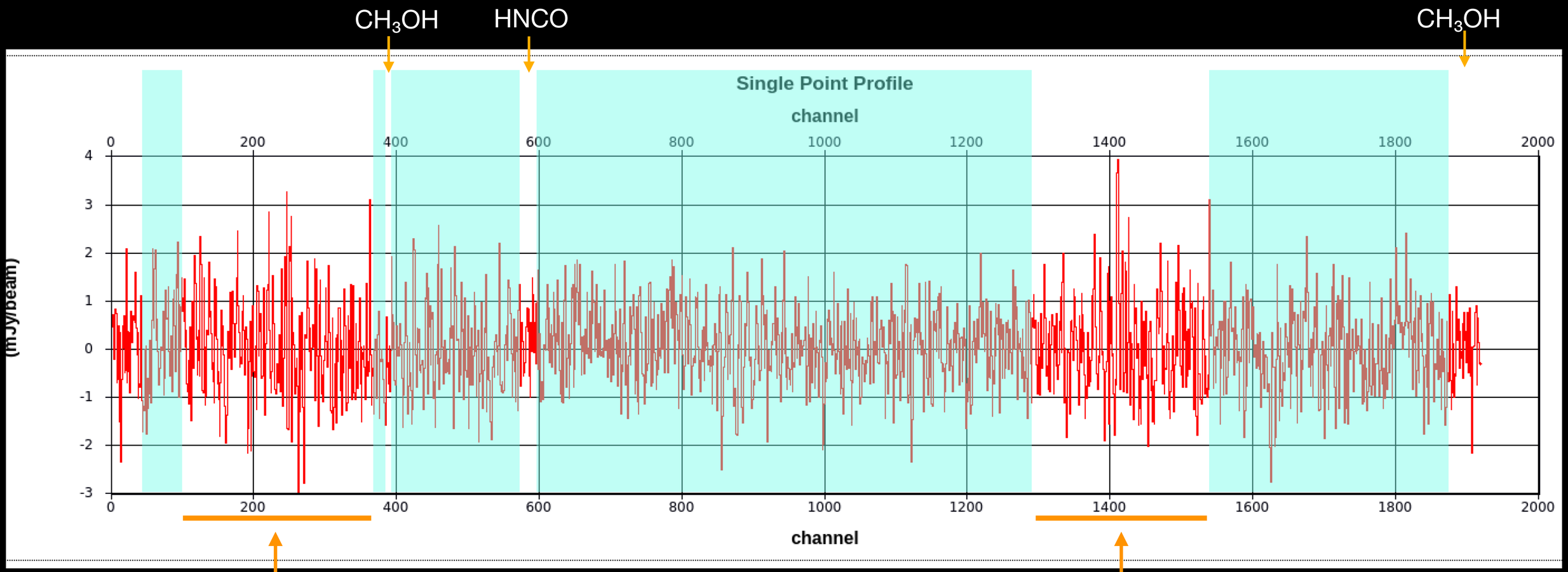
Remove ozone signal

```
            48004   O3
242318.6880   0.0500 -3.7166 3    70.4557 25 -48004140412 210 0     12 111 0
243453.7760   0.0500 -3.7609 3    56.8050 25 -48004140412 012 0     11 111 0
```



Results

Linefree channel selection (from dirty image)



Ozone @ 242318.688 MHz

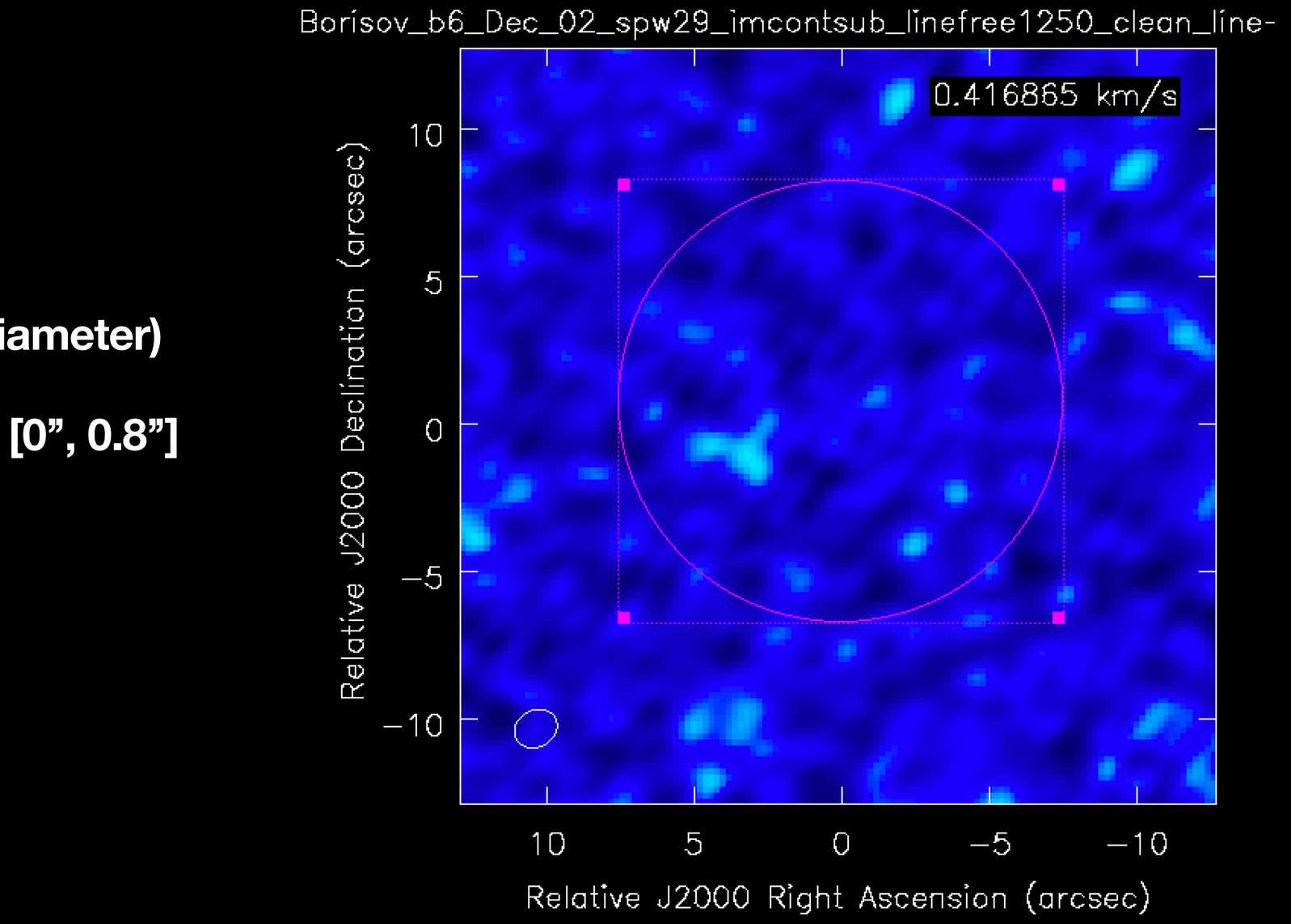
Ozone @ 243453.776 MHz

Results

Mask

Mask: 15 arcsec (In diameter)

Center of circle mask: [0”, 0.8”]



Results

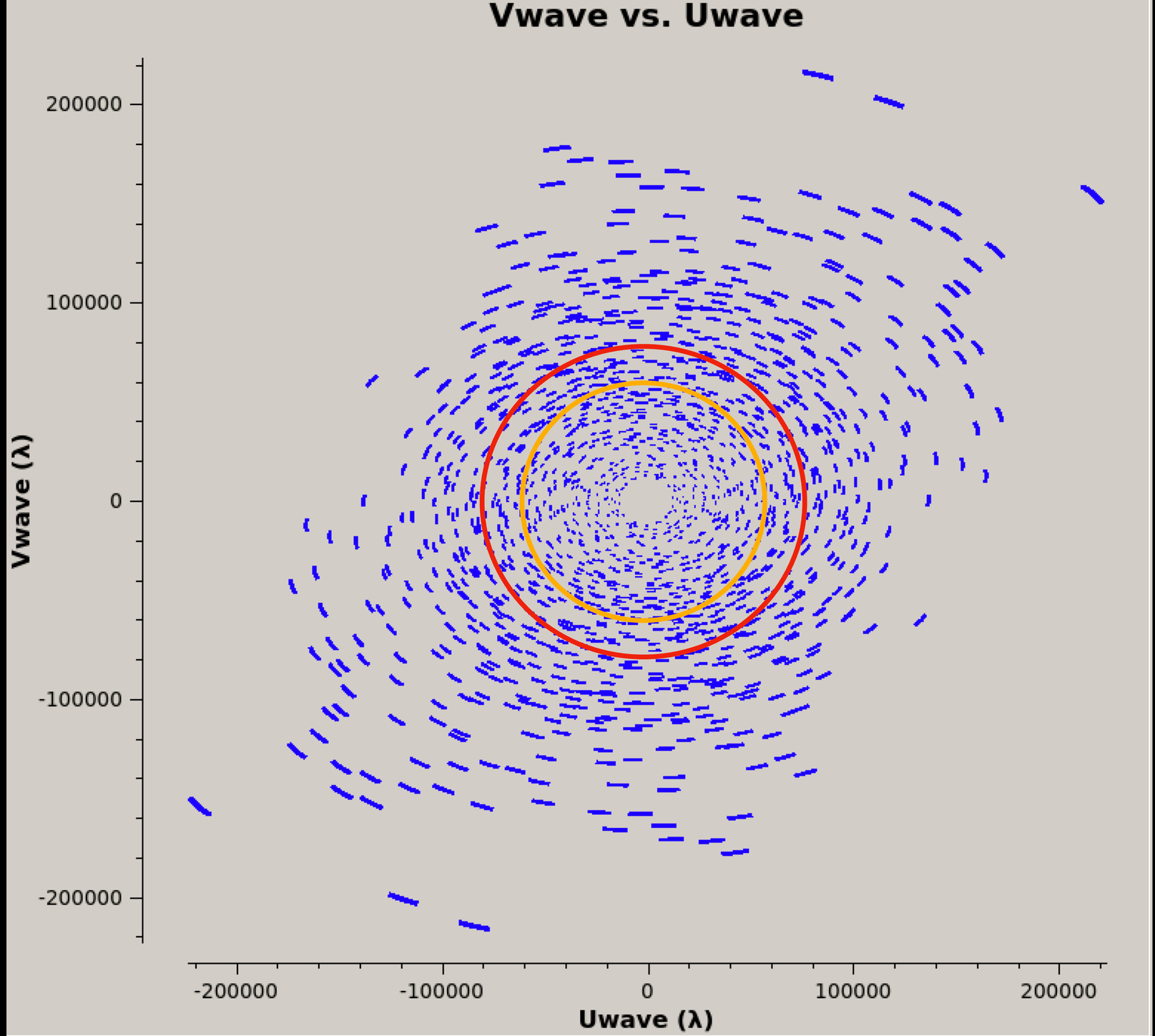
UVtaper

UVtaper Range：

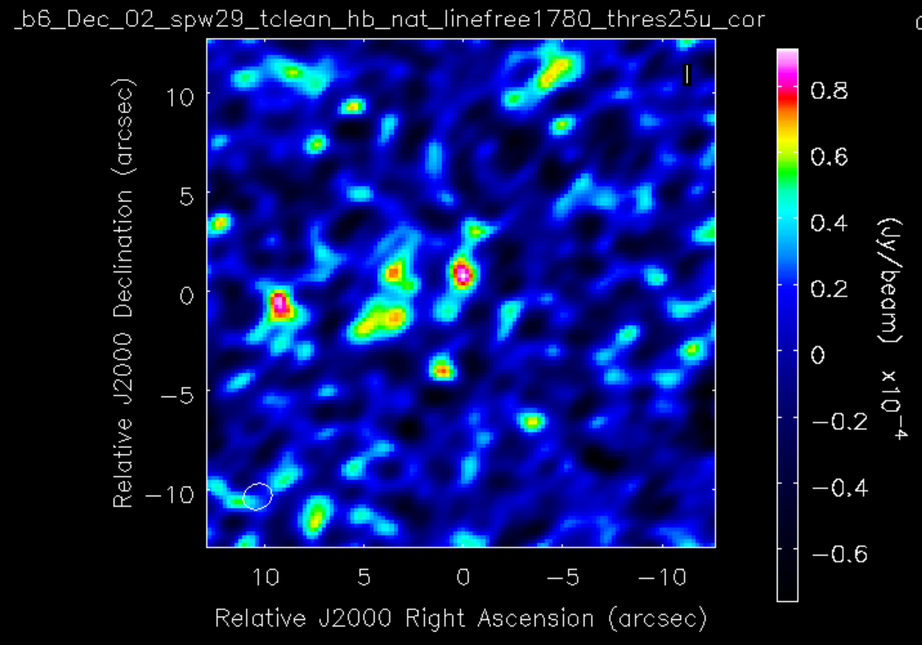
Red: 80 klambda

Orange: 60 klambda

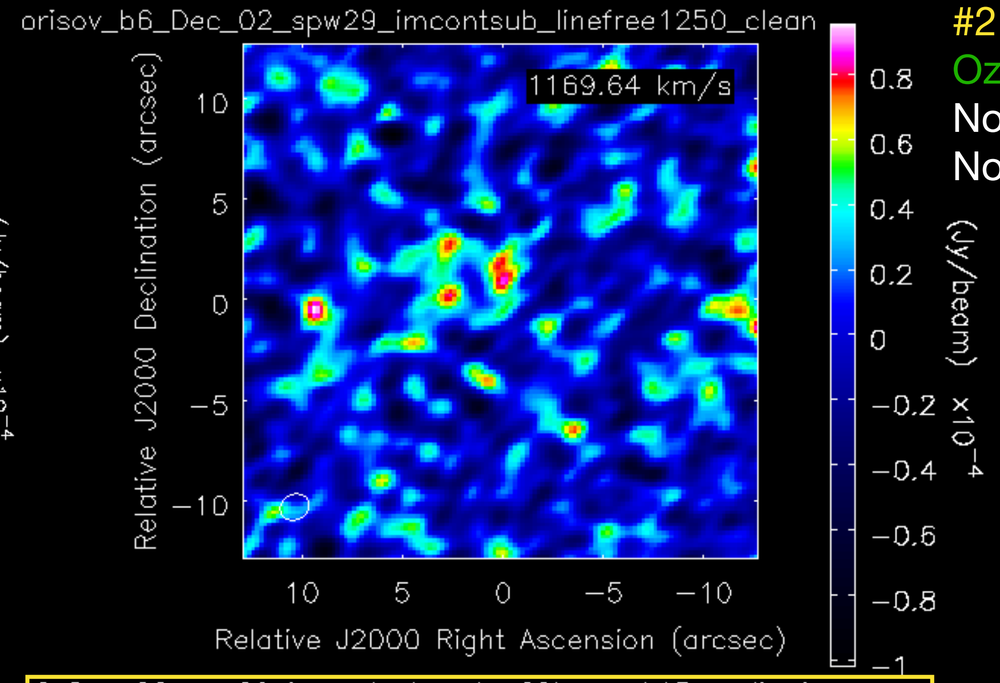
(In radius)



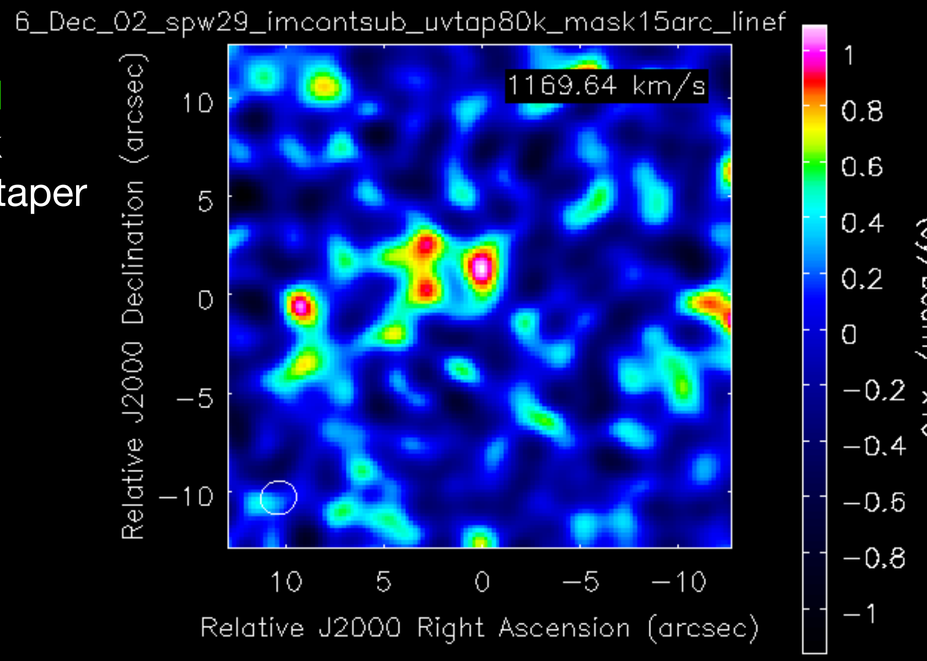
#1
With Ozone
No Mask
No UVtaper



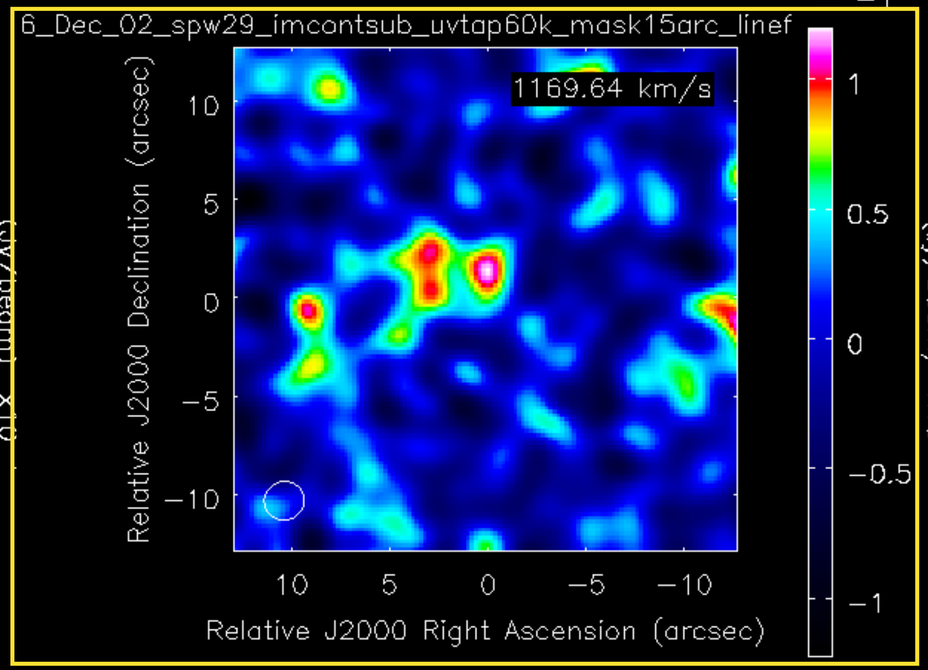
#2
Ozone removed
No Mask
No UVtaper



#3
Ozone removed
15 arcsec Mask
80 klambda UVtaper



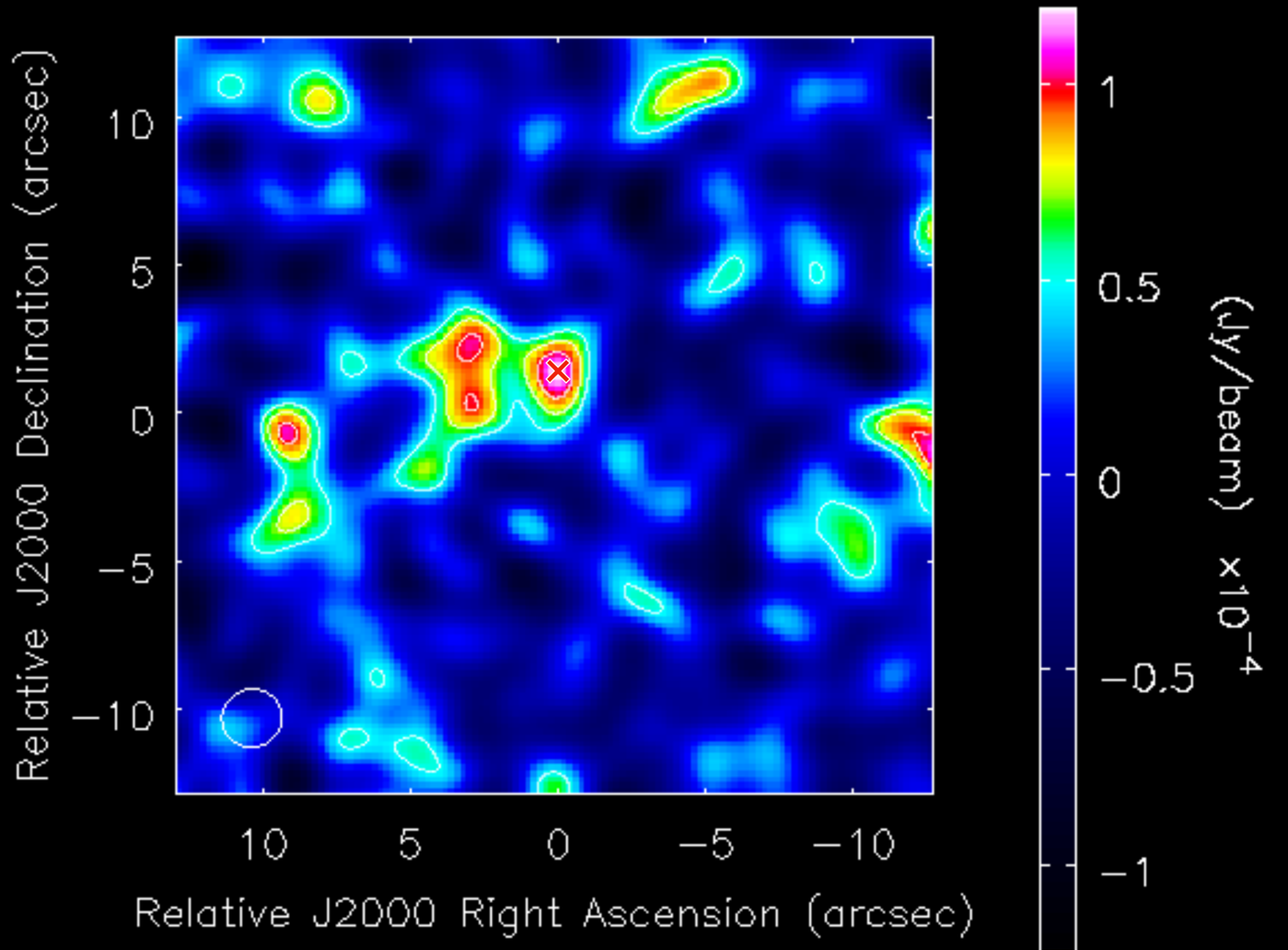
#4
Ozone removed
15 arcsec Mask
60 klambda UVtaper



Results

243-GHz Continuum map

- Beam size: [2.041”, 1.957”]
- Pixel size: 0.02”
- rms: 35 μJy/beam
- Peak: 120 μJy/beam
- S/N: 3.4

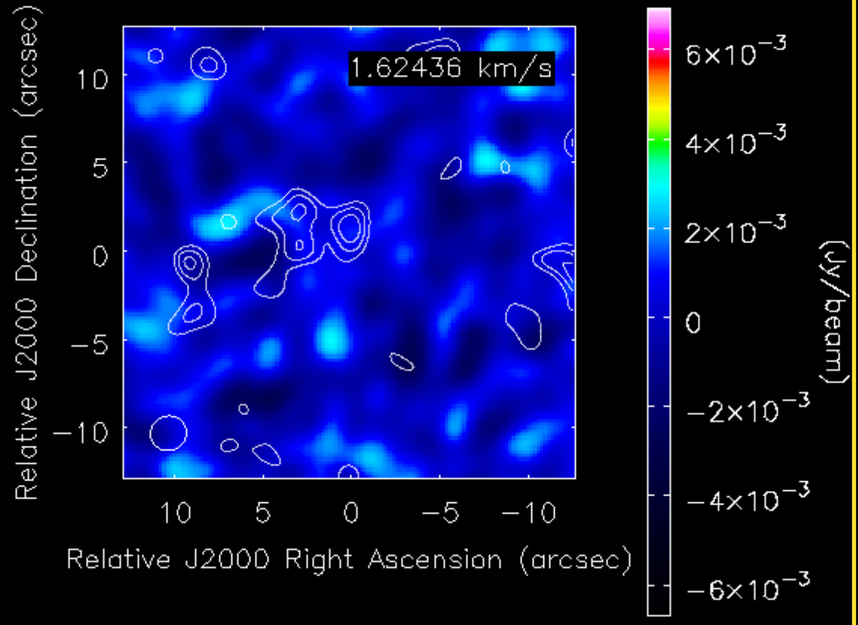


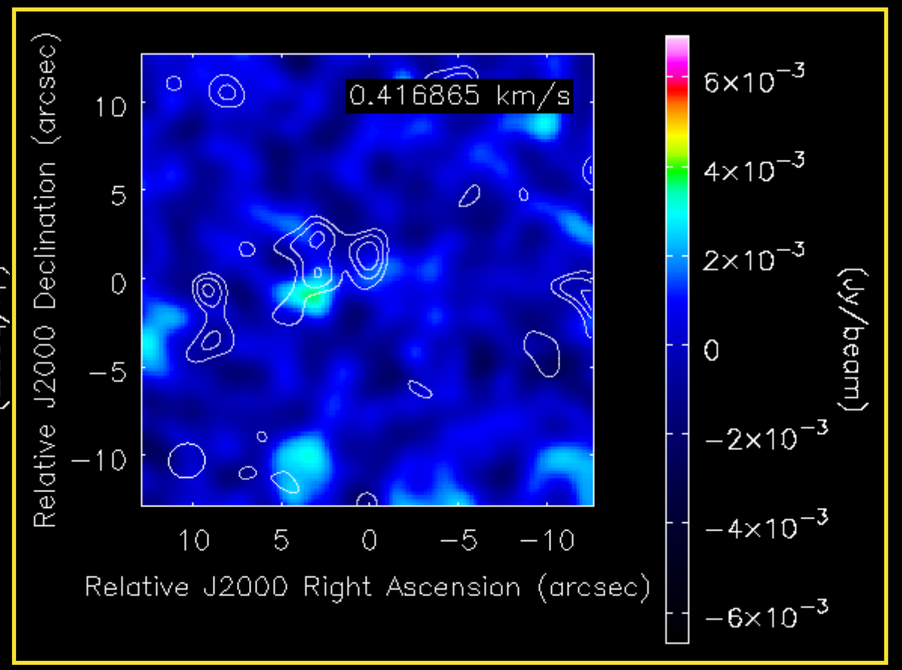
Ozone removed
15 arcsec Mask
60 klambda UVtaper

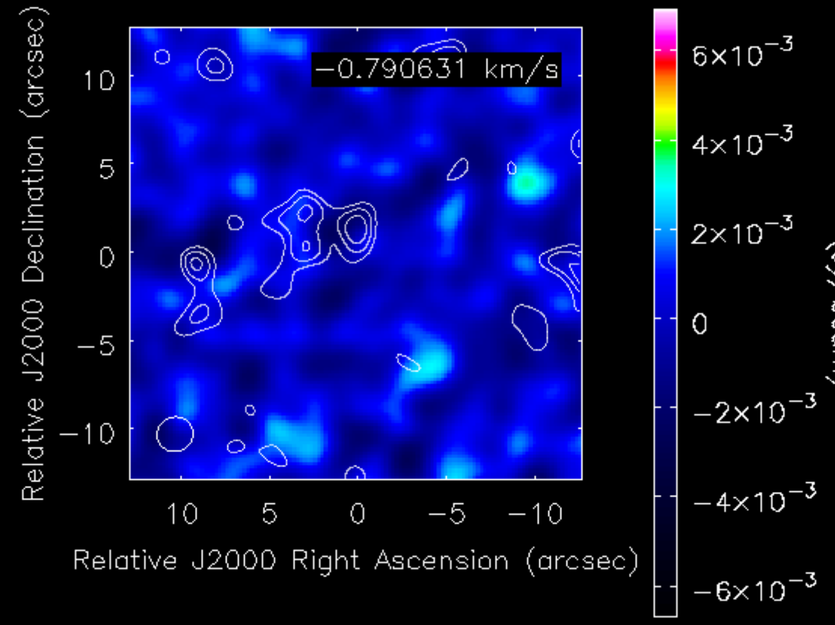
Results

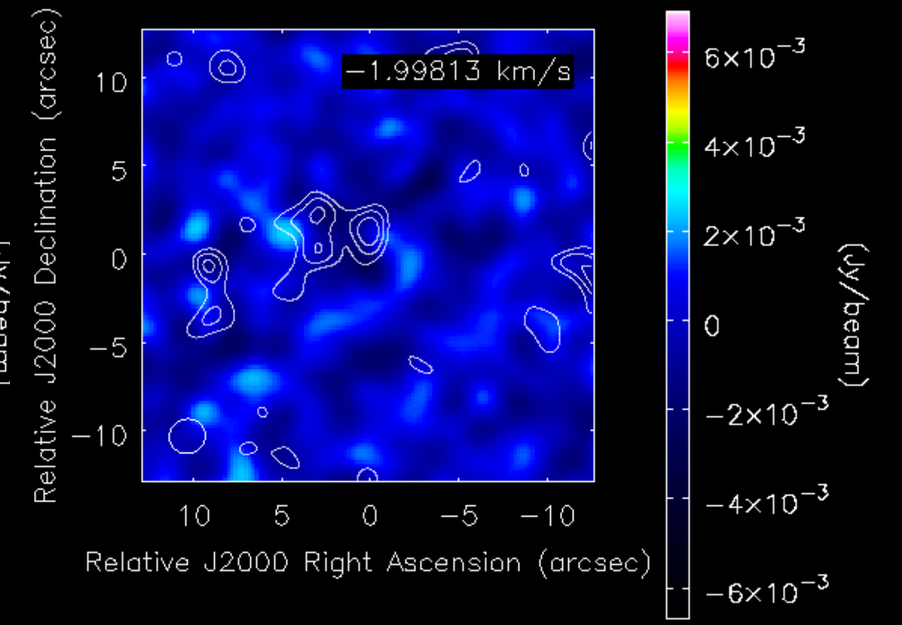
Line Channel maps

- Target line:
  Methanol (CH_3OH) @ 242446.125 MHz
- Task: Imcontsub
- UVtaper: 60 klambda
- Mask: 15 arcsec



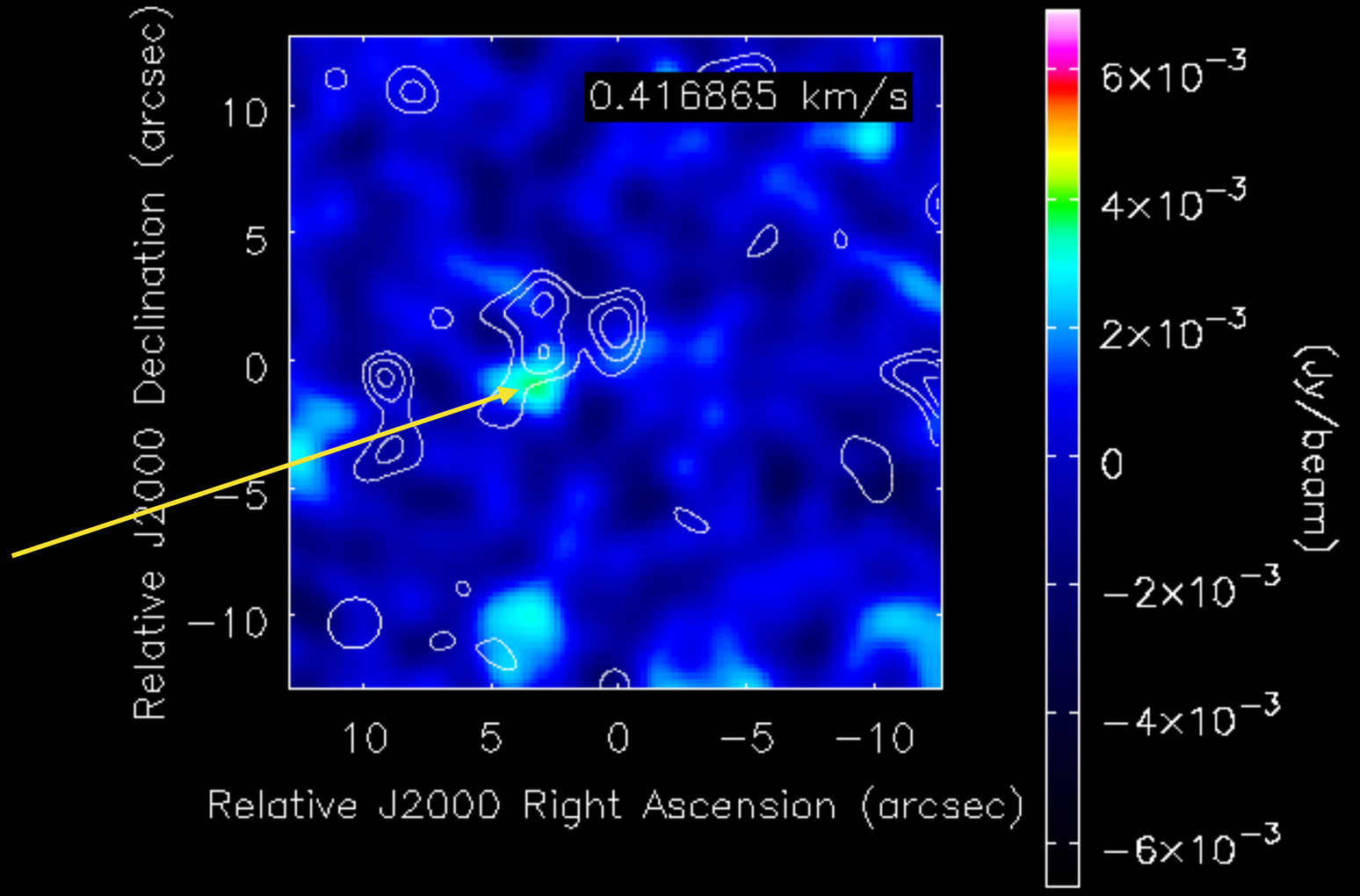






Results

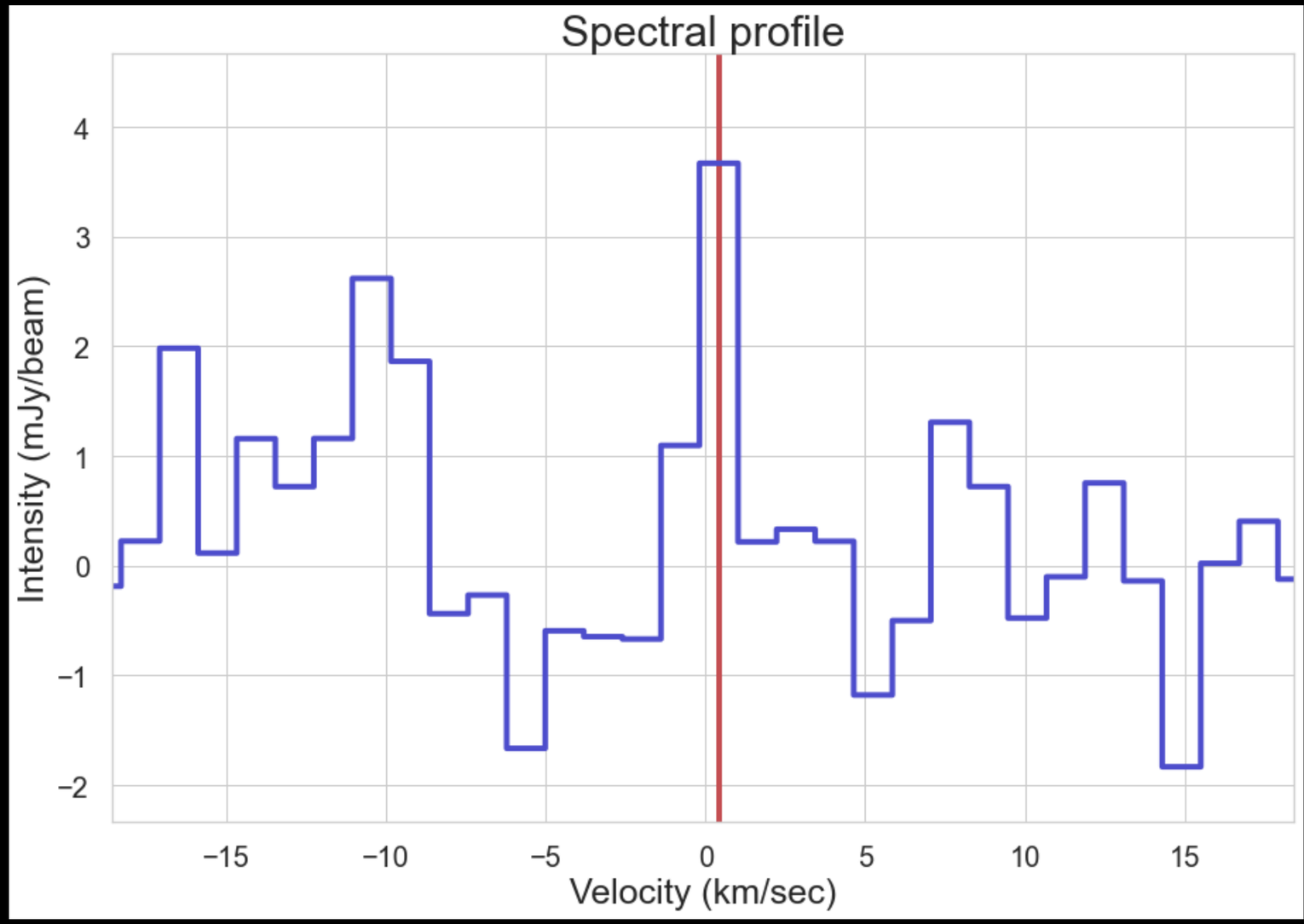
Channel maps



Results

Spectral profile

- Velocity: 0.42 km/s
- Peak intensity: 3.67 mJy/bm
- Rms: 0.99 mJy/bm
- S/N: 3.7



Summary

- CH_3OH (methanol) is tentatively detected, however, more observational evidences are required.
- Future work
  - Looking for more methanol lines in other spectral windows.

Thank you for your time!