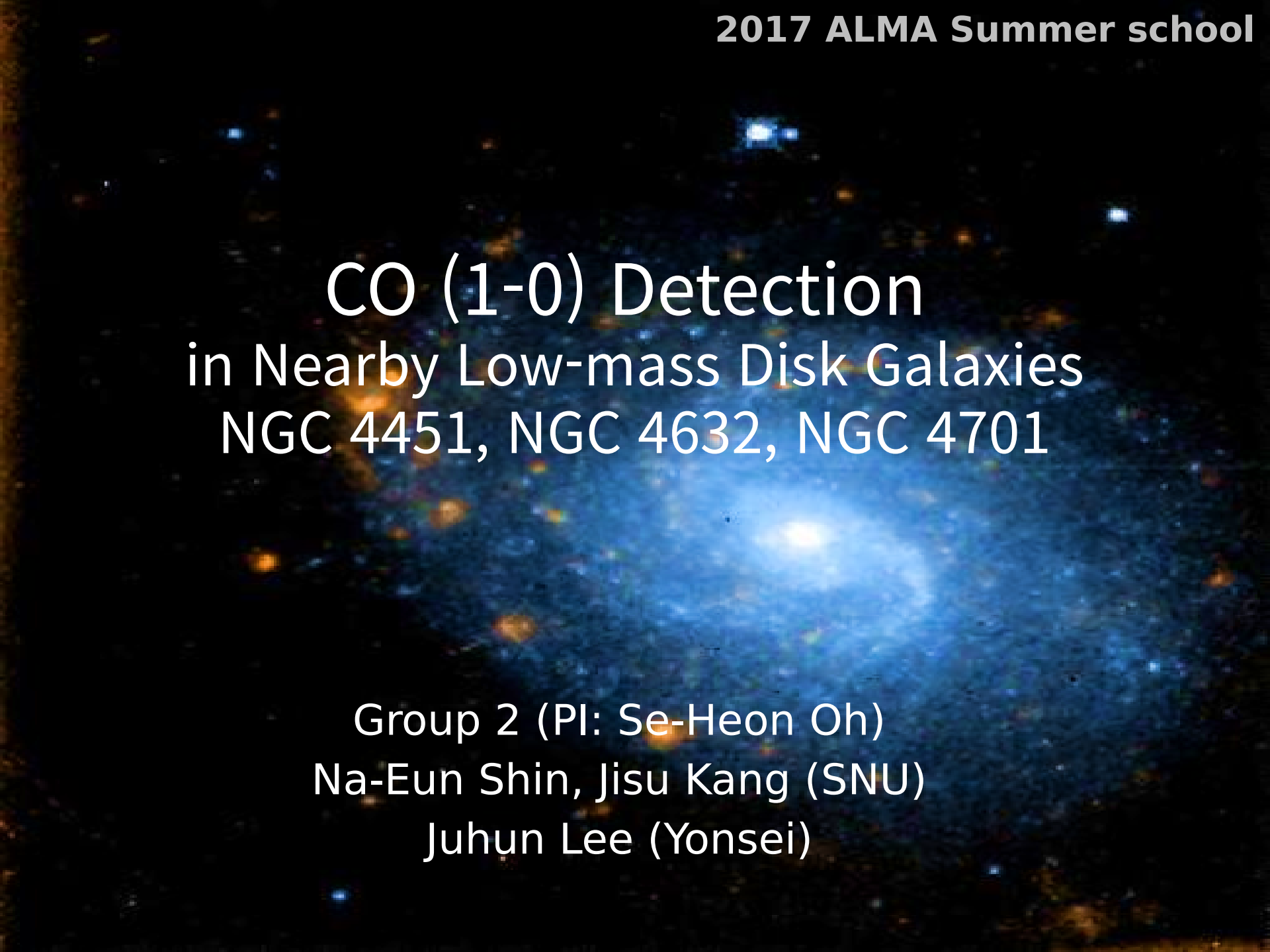


CO (1-0) Detection
in Nearby Low-mass Disk Galaxies
NGC 4451, NGC 4632, NGC 4701

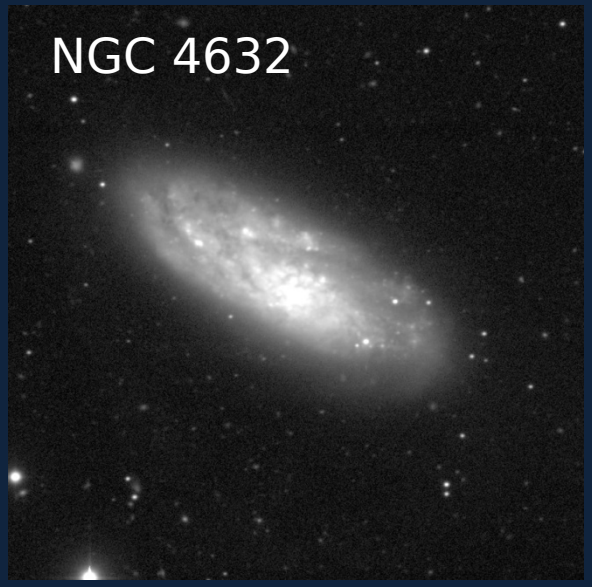
Group 2 (PI: Se-Heon Oh)
Na-Eun Shin, Jisu Kang (SNU)
Juhun Lee (Yonsei)

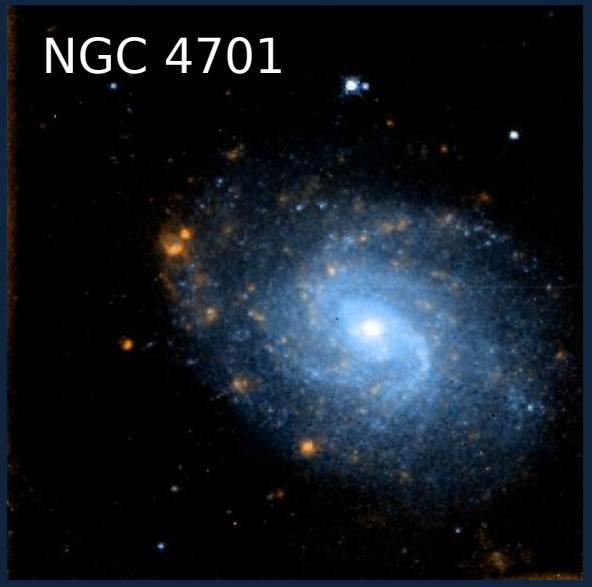
Contents

- Observation
- Calibration & Imaging
- Results
  - NGC 4632
  - NGC 4451
  - NGC 4701
- Analysis

Targets

Name	R.A.	Decl.	v_{rot} (km s^{-1})	v_{LSR} (km s^{-1})	Distance (Mpc)	M_B	Type	Diameter (arcmin)	Diameter (kpc)	Inclination (deg)	PA (deg)
NGC 4451	12:28:40.5	9:15:32	116	868	27	−17.7	Sbc	1.5	11.78	54	160
NGC 4632	12:42:32	−00:04:57	108	1726	18.5	−20.6	Sc	3.1	16.68	71	62
NGC 4701	12:49:11.6	3:23:19	101	725	17	−18.4	Sc	2.8	13.85	43	50





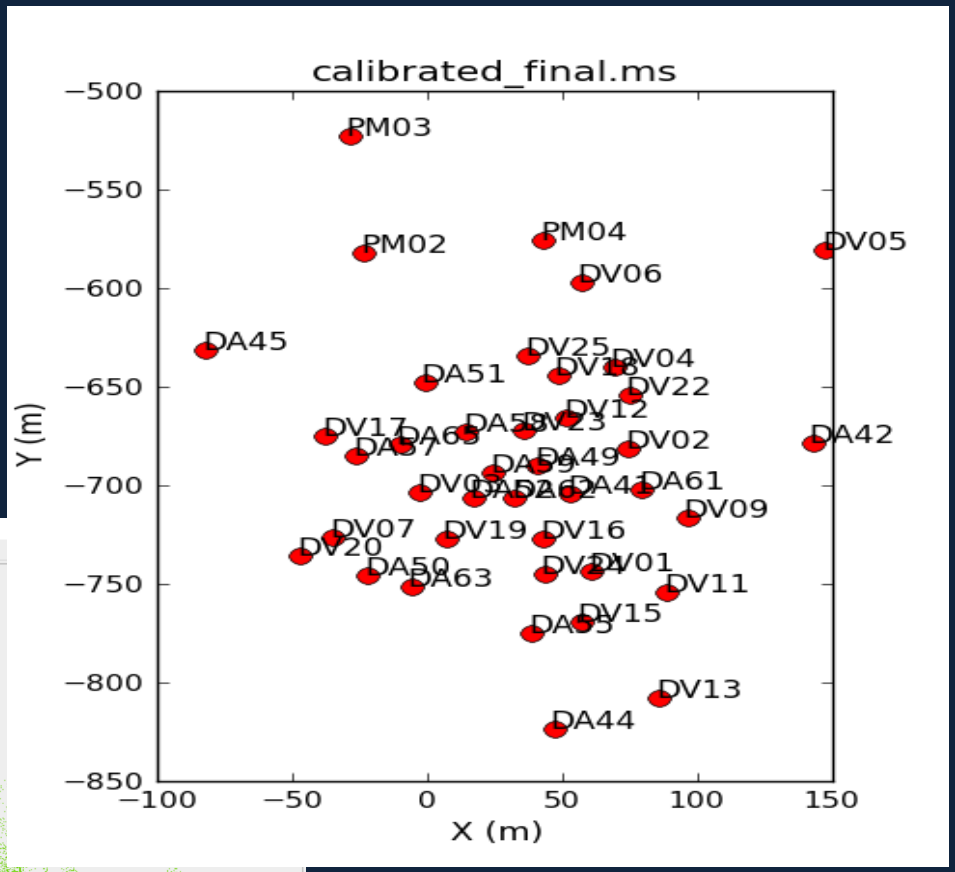
Observation

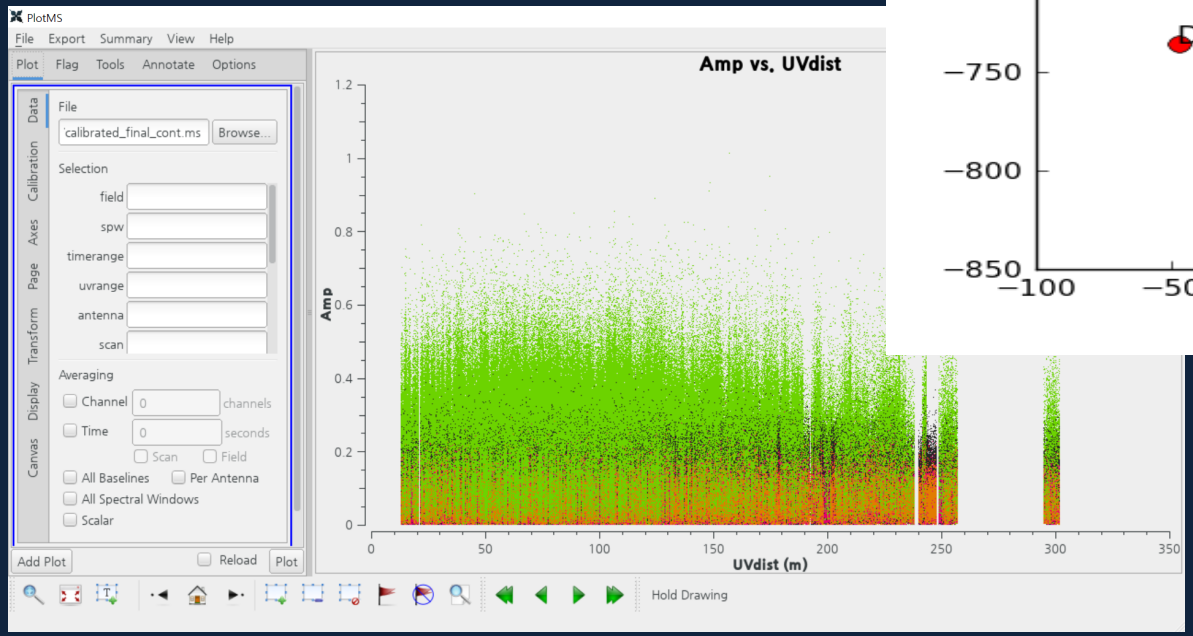
- ALMA 12m
- Band 3
- CO (1-0) 115 GHz

	Beam	RMS	Exp.time
NGC 4632	2.80’’ X 2.09’’	0.0039 Jy/beam	38 min
NGC 4451	2.74’’ X 2.41’’	0.0052 Jy/beam	9 min
NGC 4701	2.72’’ X 2.14’’	0.0067 Jy/beam	3 min

- No continuum detection

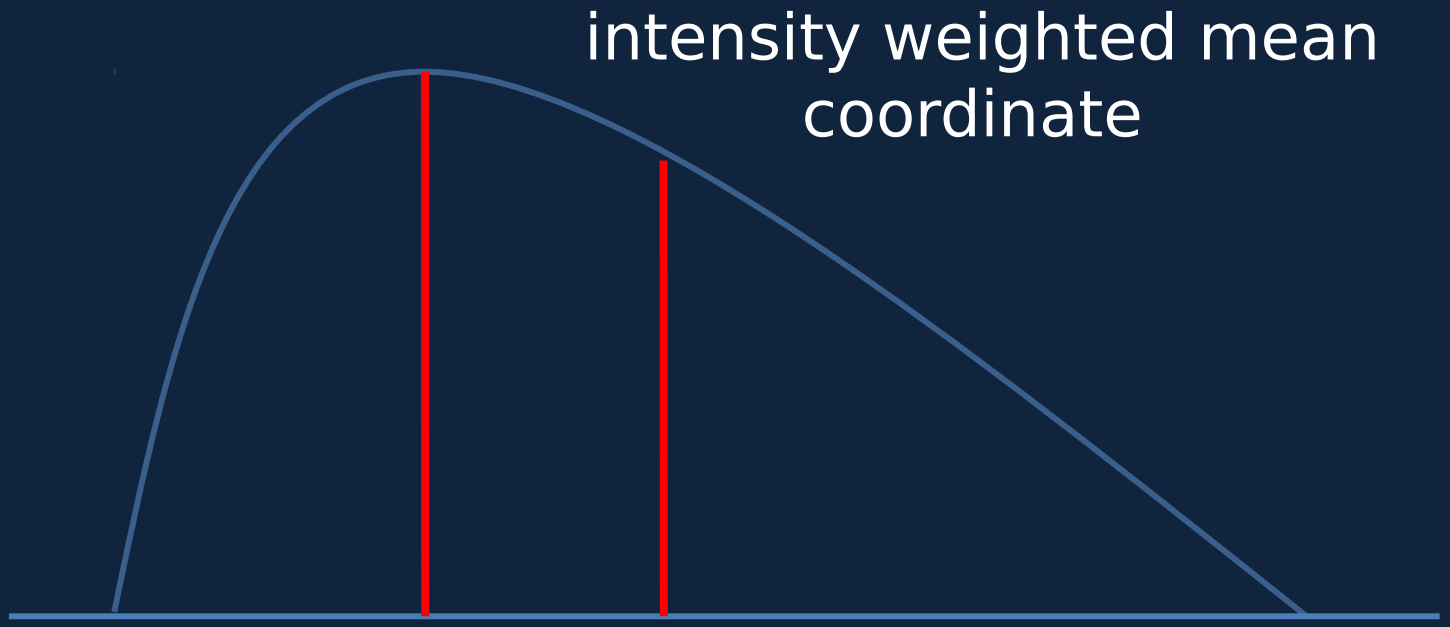
Observation



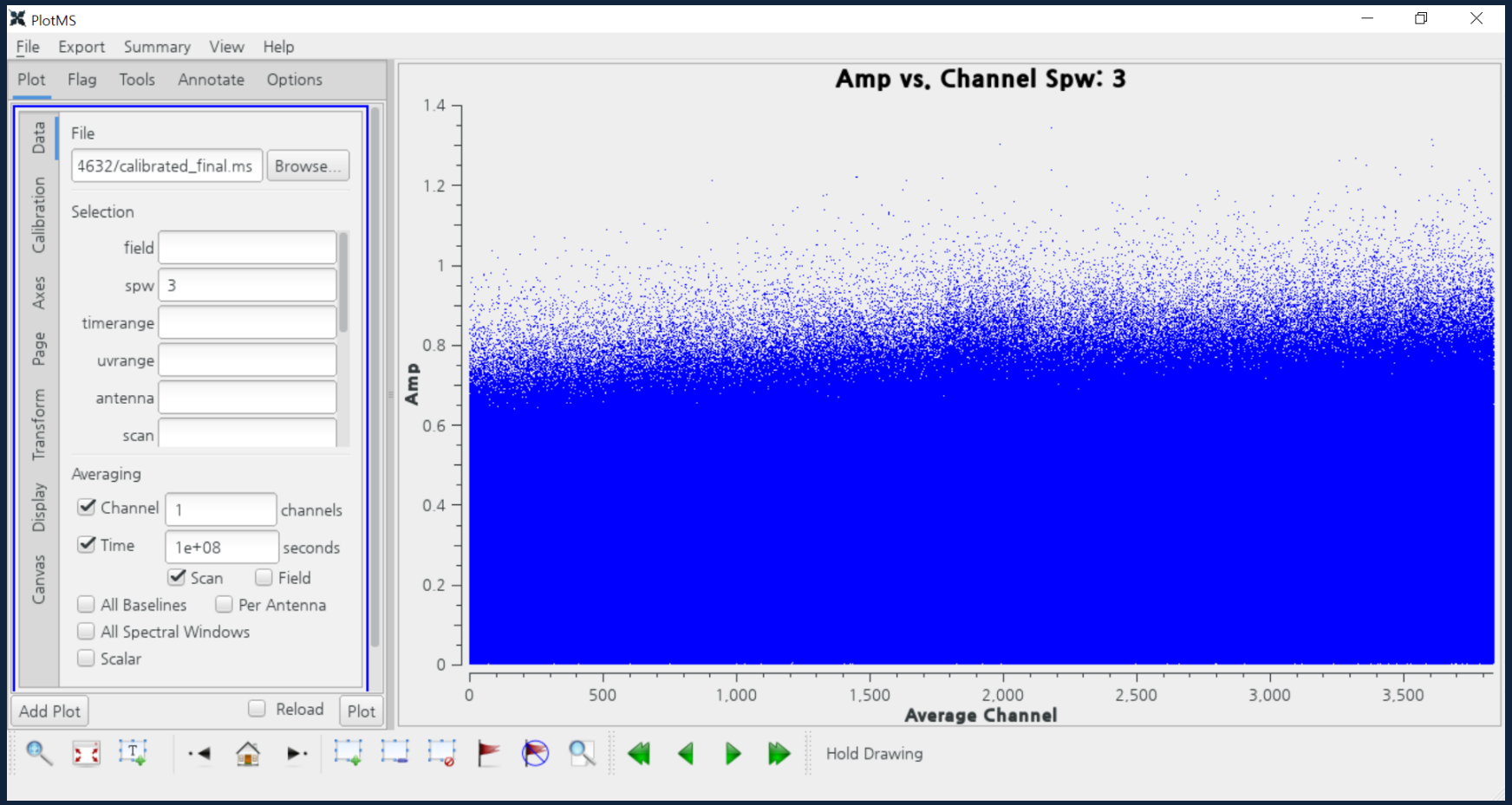


Moments

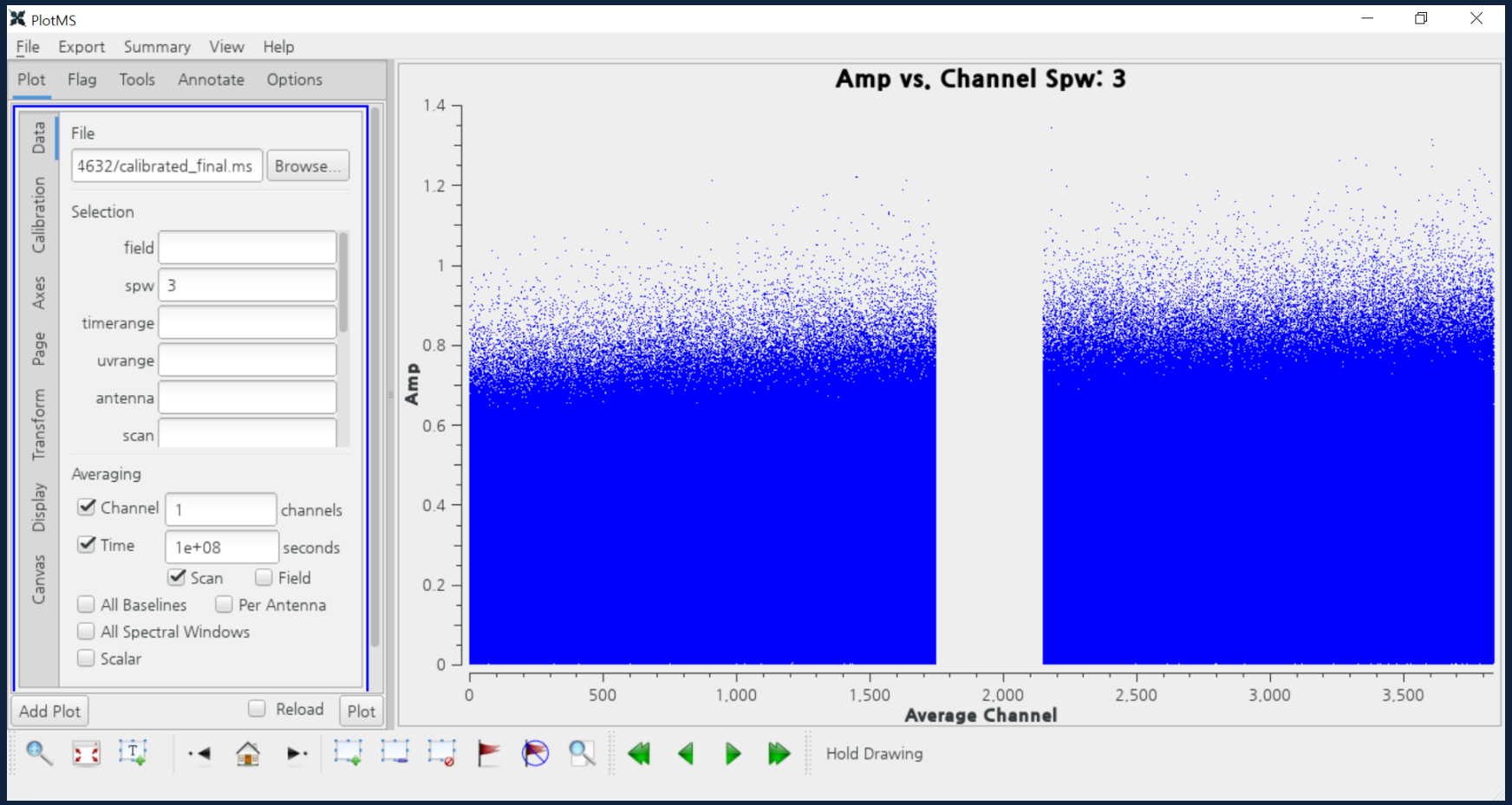
: Difference b/w moments 1 and 9

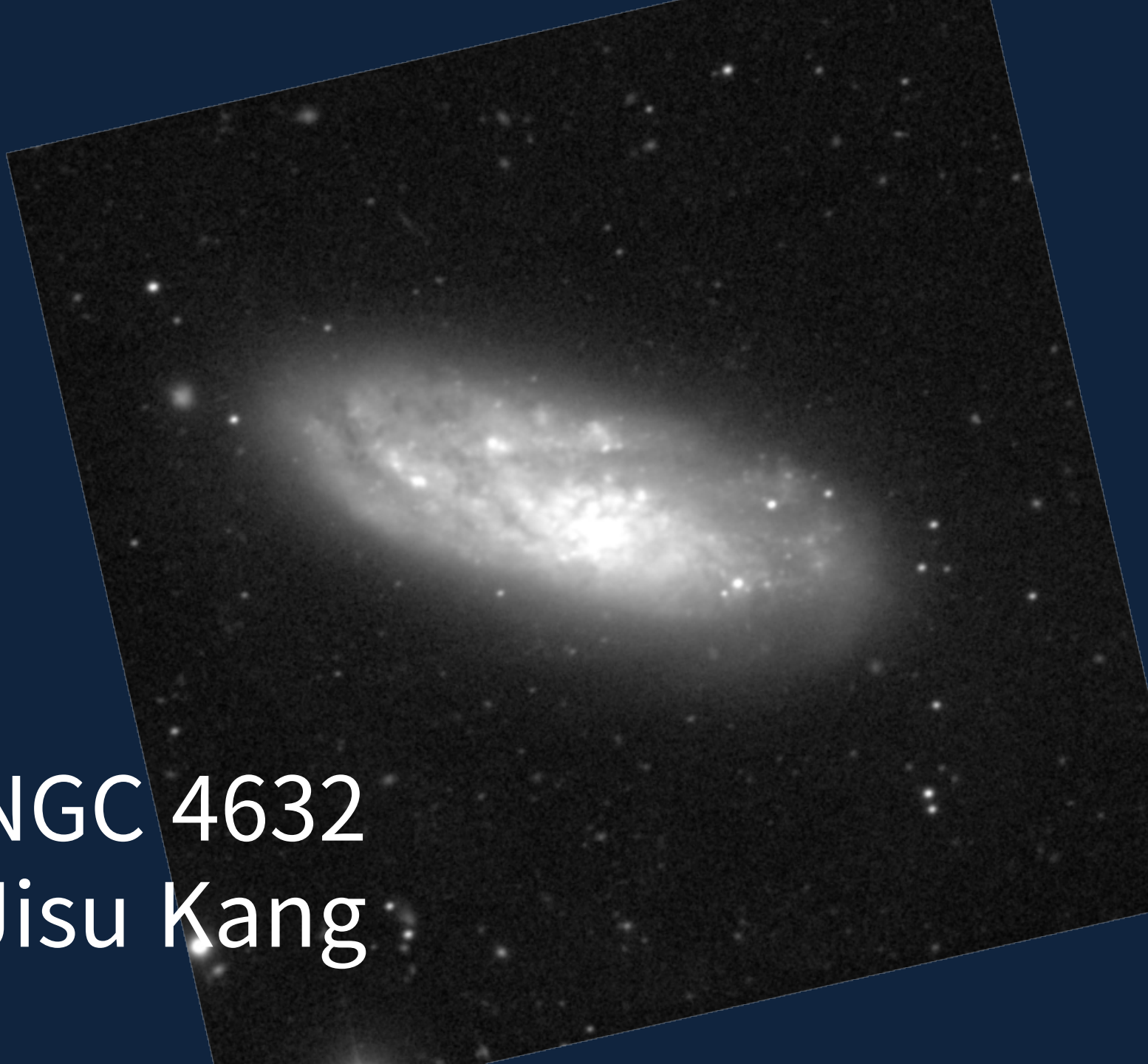


Calibration



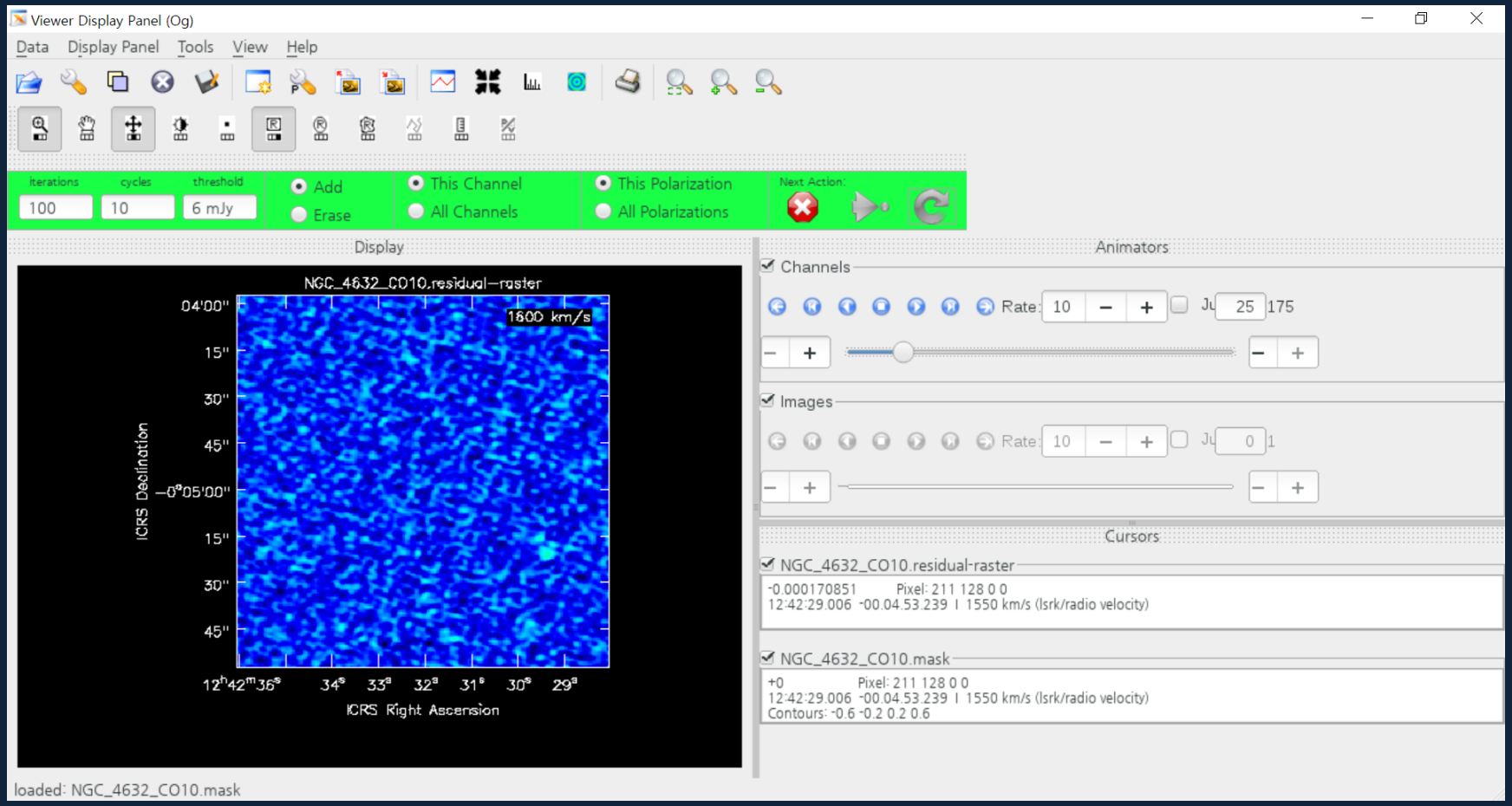
Calibration





NGC 4632

_ Jisu Kang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Data
Display Panel
Tools
View
Help
iterations
cycles
threshold
100
10
6 mJy
Add
Erase
This Channel
All Channels
This Polarization
All Polarizations
Next Action:
Display
NGC_4632_CO10.residual-raster
1600 km/s
04'00"
15"
30"
45"
−0°05'00"
15"
30"
45"
ICRS Declination
12h42m36s
34s
33a
32a
31s
30s
29a
ICRS Right Ascension
Animators
Channels
Rate:
10
25
175
Images
Rate:
10
0
1
Cursors
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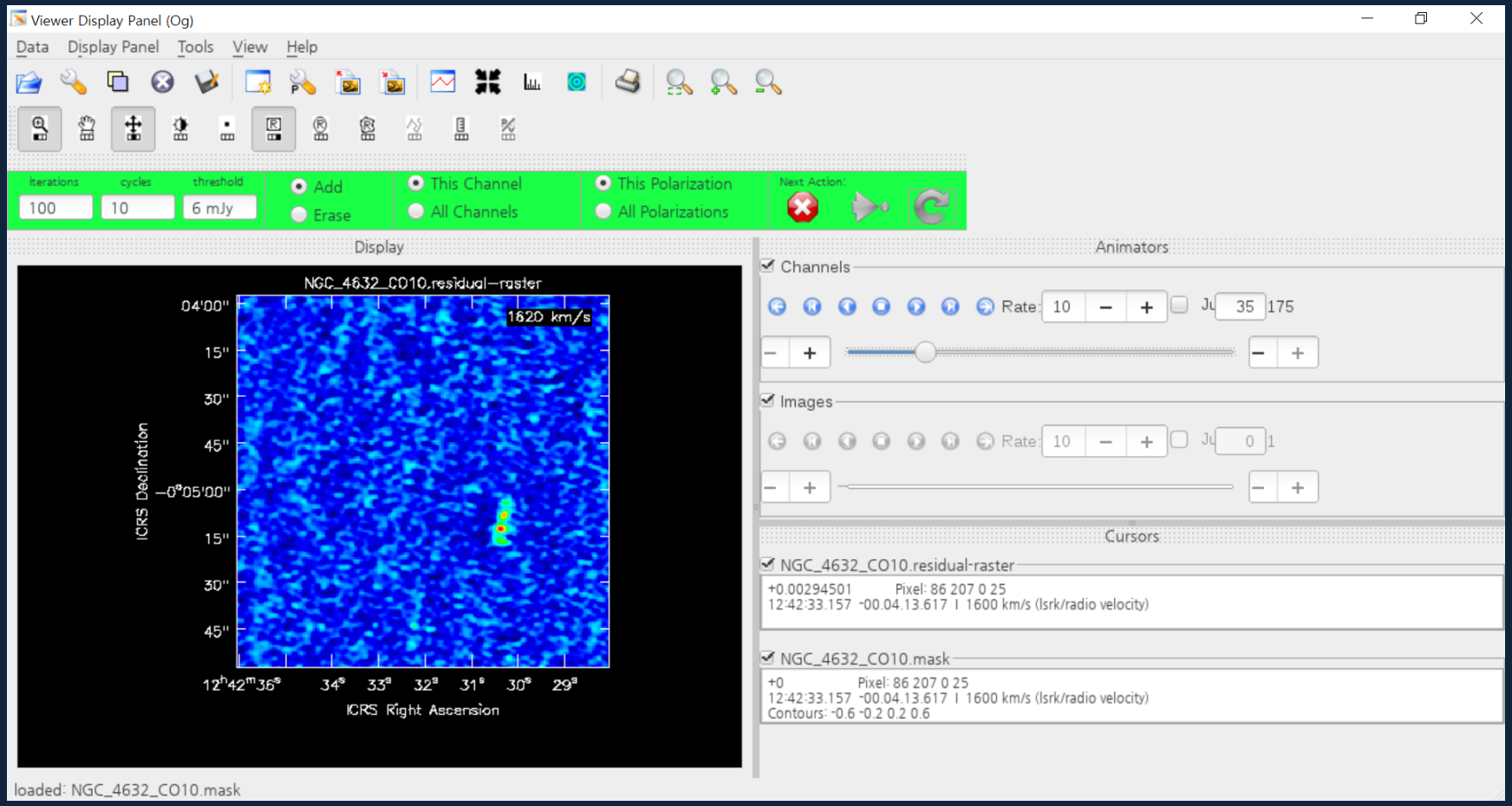
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cycles
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15"
30"
45"
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15"
30"
45"
ICRS Declination
12h42m36s
34s
33s
32s
31s
30s
29s
ICRS Right Ascension
Animators
Channels
Rate:
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Images
Cursors
NGC_4632_CO10.residual-raster
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NGC_4632_CO10.mask
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loaded: NGC_4632_CO10.mask

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Data Display Panel Tools View Help

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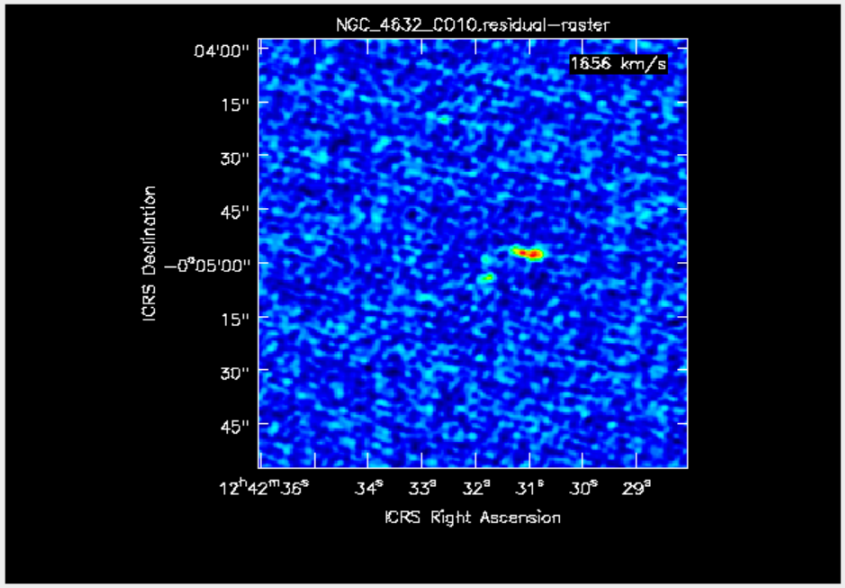
Add / Erase | This Channel / All Channels | This Polarization / All Polarizations | Next Action:

Display



Animators

Channels — Rate: 10 — Ju 53 175

Images — Rate: 10 — Ju 0 1

Cursors

NGC_4632_CO10.residual-raster

+0.00294501 Pixel: 86 207 0 25
12:42:33.157 -00.04.13.617 I 1600 km/s (lsrk/radio velocity)

NGC_4632_CO10.mask

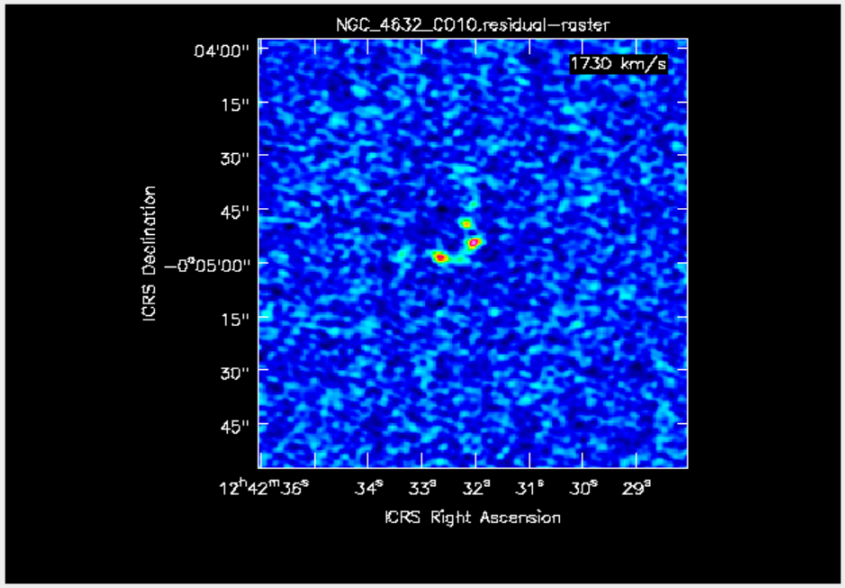
+0 Pixel: 86 207 0 25
12:42:33.157 -00.04.13.617 I 1600 km/s (lsrk/radio velocity)
Contours: -0.6 -0.2 0.2 0.6

Viewer Display Panel (Og)

Data Display Panel Tools View Help

iterations 100 | cycles 10 | threshold 6 mJy | Add / Erase | This Channel / All Channels | This Polarization / All Polarizations | Next Action:

Display



Animators

Channels — Rate: 10 — Ju 90 175

Images — Rate: 10 — Ju 0 1

Cursors

NGC_4632_CO10.residual-raster

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NGC_4632_CO10.mask

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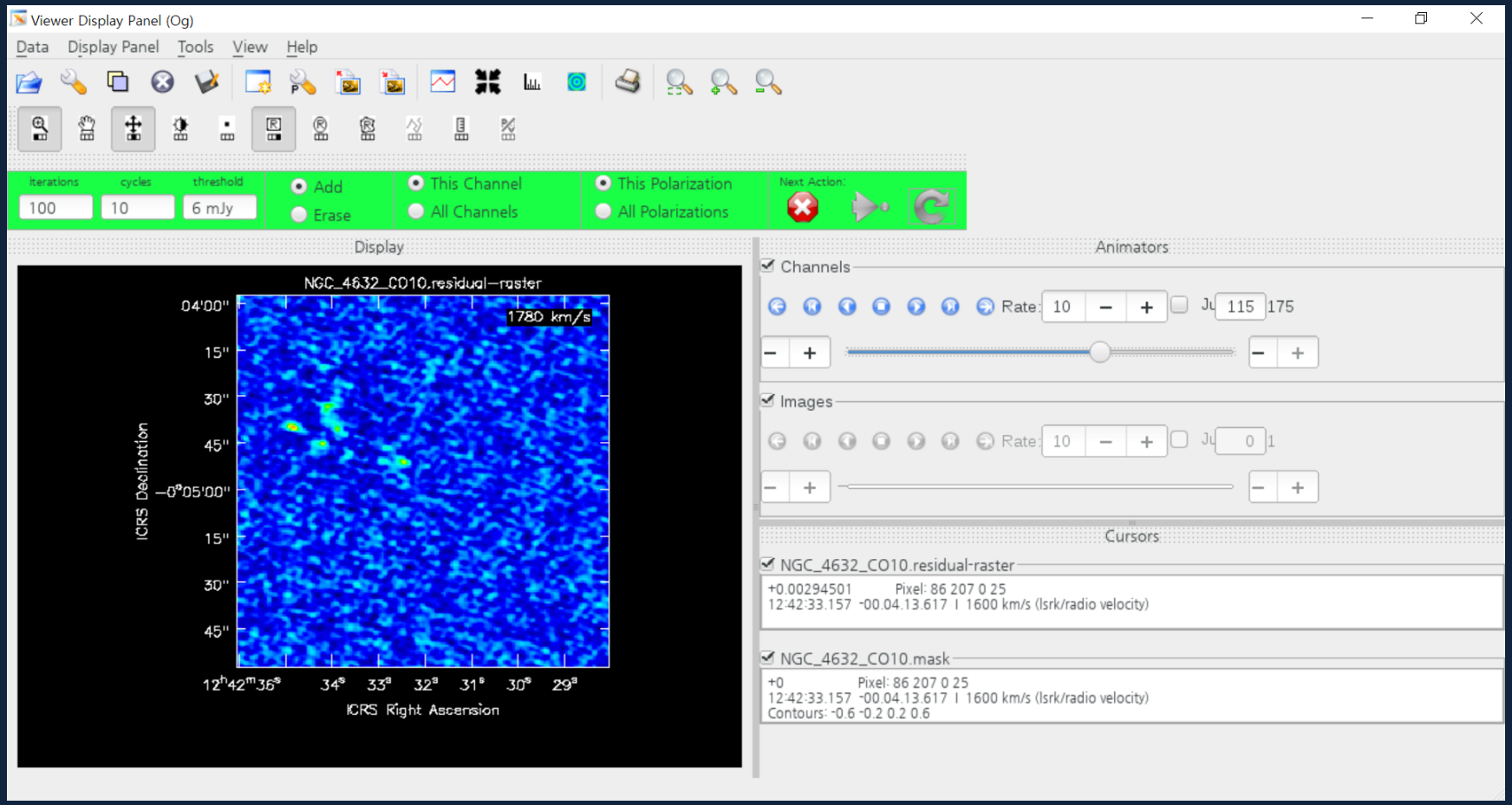
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All Polarizations
Next Action:
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NGC_4632_CO10.residual-raster
1780 km/s
04'00"
15"
30"
45"
−0°05'00"
15"
30"
45"
ICRS Declination
12h42m36s
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33s
32s
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ICRS Right Ascension
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NGC_4632_CO10.residual-raster
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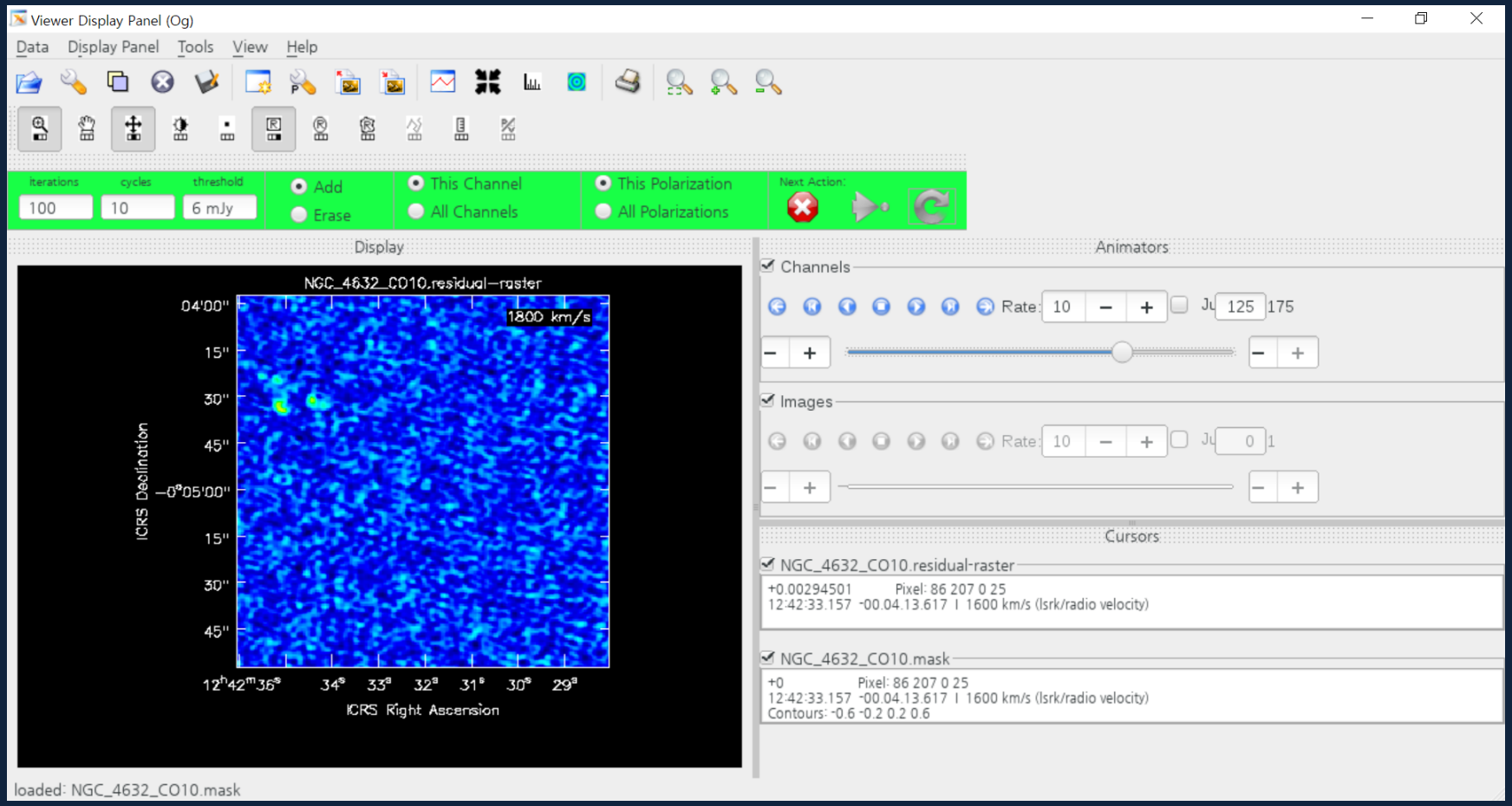
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1800 km/s
04'00"
15"
30"
45"
−0°05'00"
15"
30"
45"
ICRS Declination
12h42m36s
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33s
32s
31s
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29s
ICRS Right Ascension
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Rate:
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Images
Rate:
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NGC_4632_CO10.residual-raster
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12:42:33.157 -00.04.13.617 I 1600 km/s (lsrk/radio velocity)
NGC_4632_CO10.mask
+0 Pixel: 86 207 0 25
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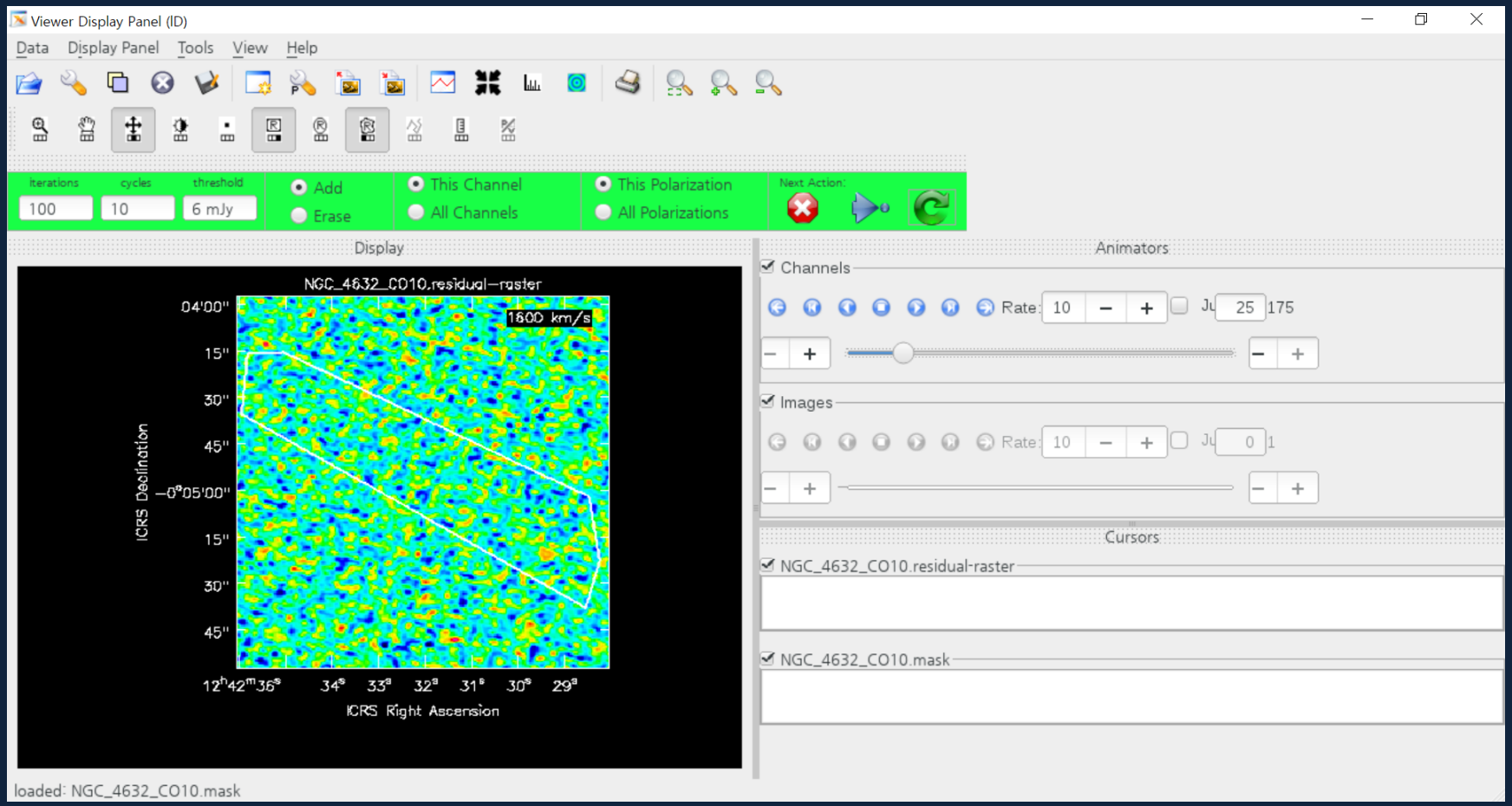
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Add
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This Channel
All Channels
This Polarization
All Polarizations
Next Action:
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NGC_4632_CO10.residual-raster
1600 km/s
04'00"
15"
30"
45"
−0°05'00"
15"
30"
45"
ICRS Declination
12h42m36s
34s
33a
32a
31s
30s
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ICRS Right Ascension
Animators
Channels
Rate:
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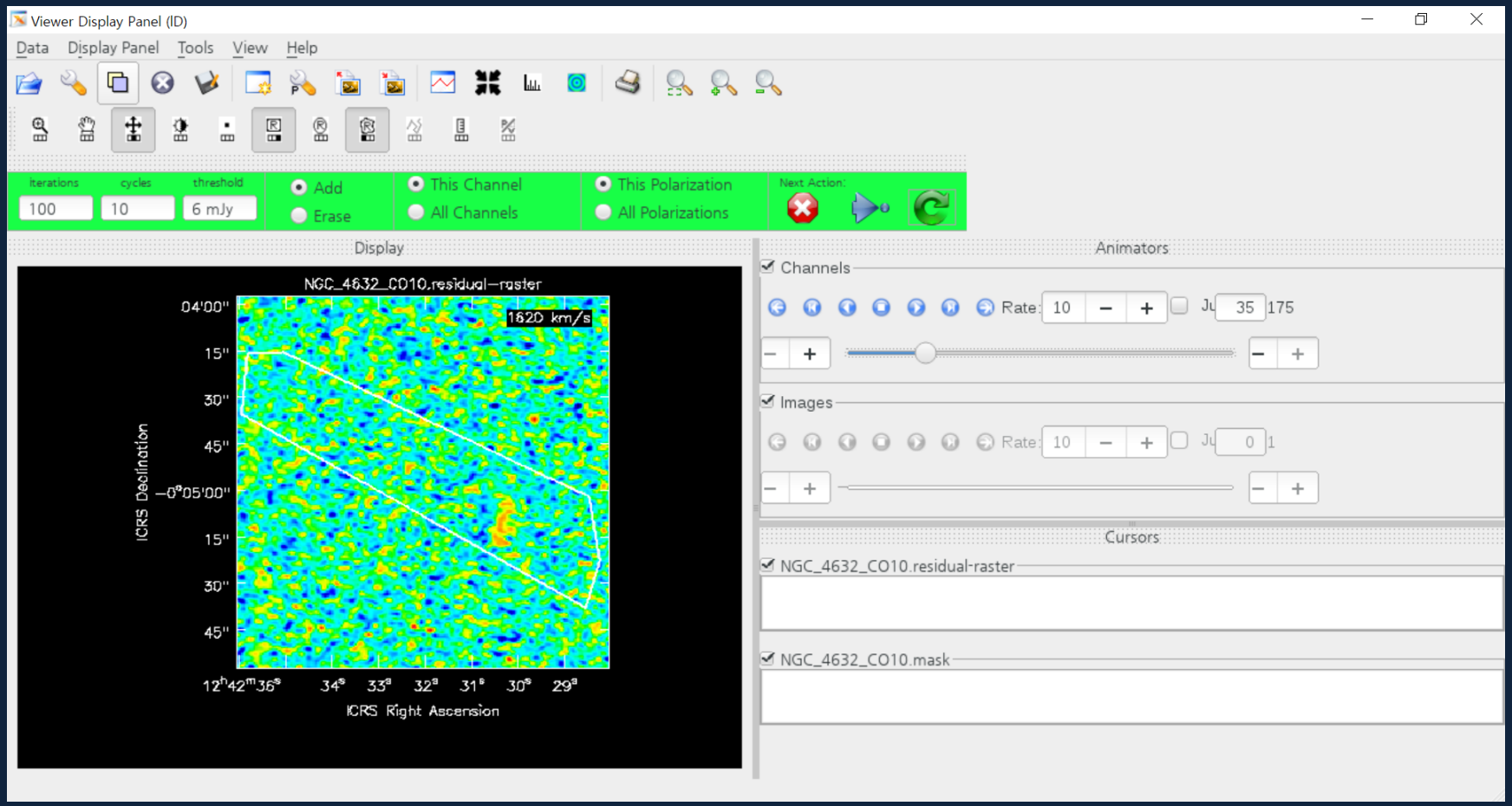
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Display Panel
Tools
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Erase
This Channel
All Channels
This Polarization
All Polarizations
Next Action:
Display
NGC_4632_CO10.residual-raster
1620 km/s
04'00"
15"
30"
45"
−0°05'00"
15"
30"
45"
ICRS Declination
12h42m36s
34s
33a
32a
31s
30s
29a
ICRS Right Ascension
Animators
Channels
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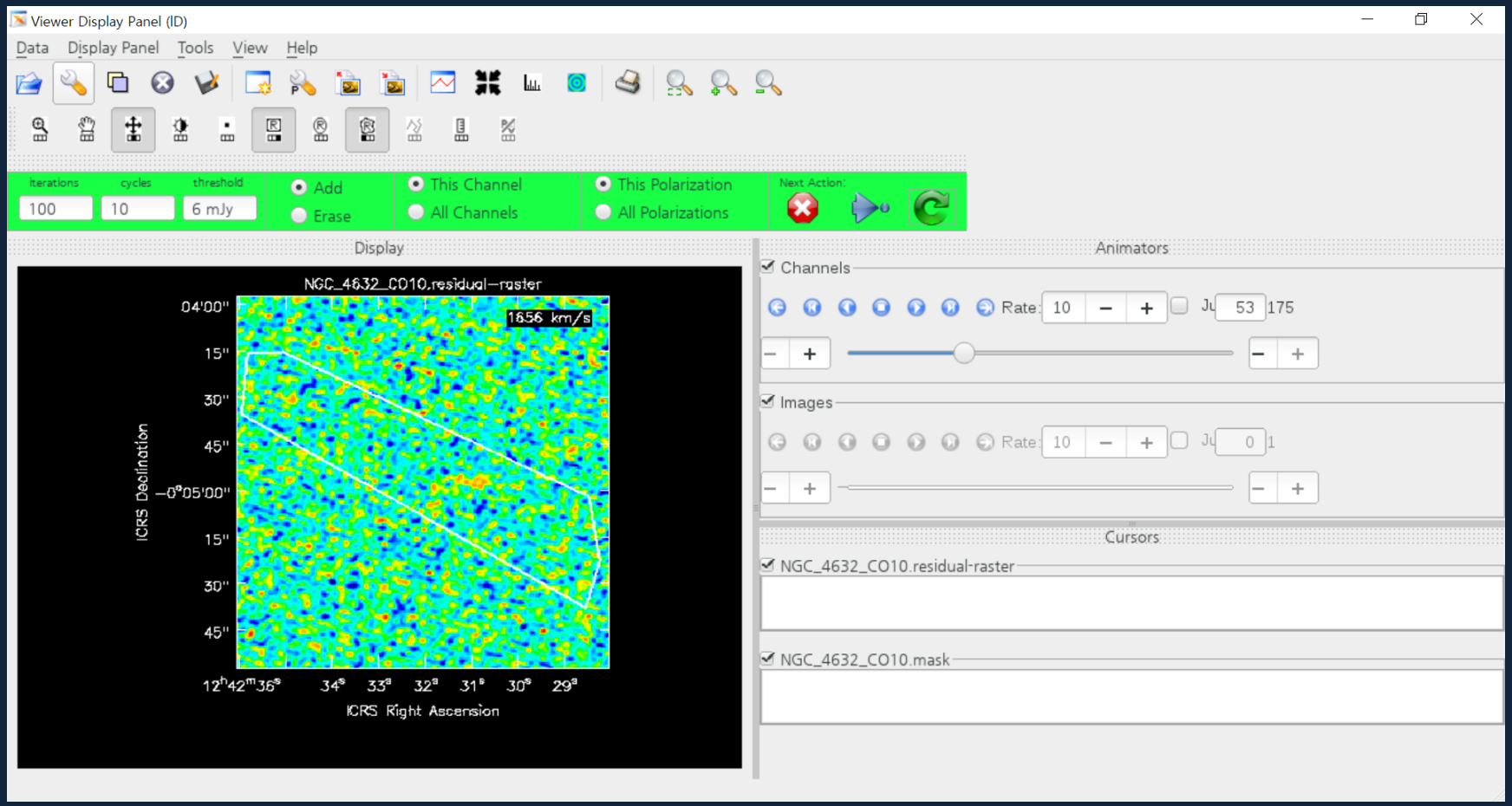
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All Polarizations
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45"
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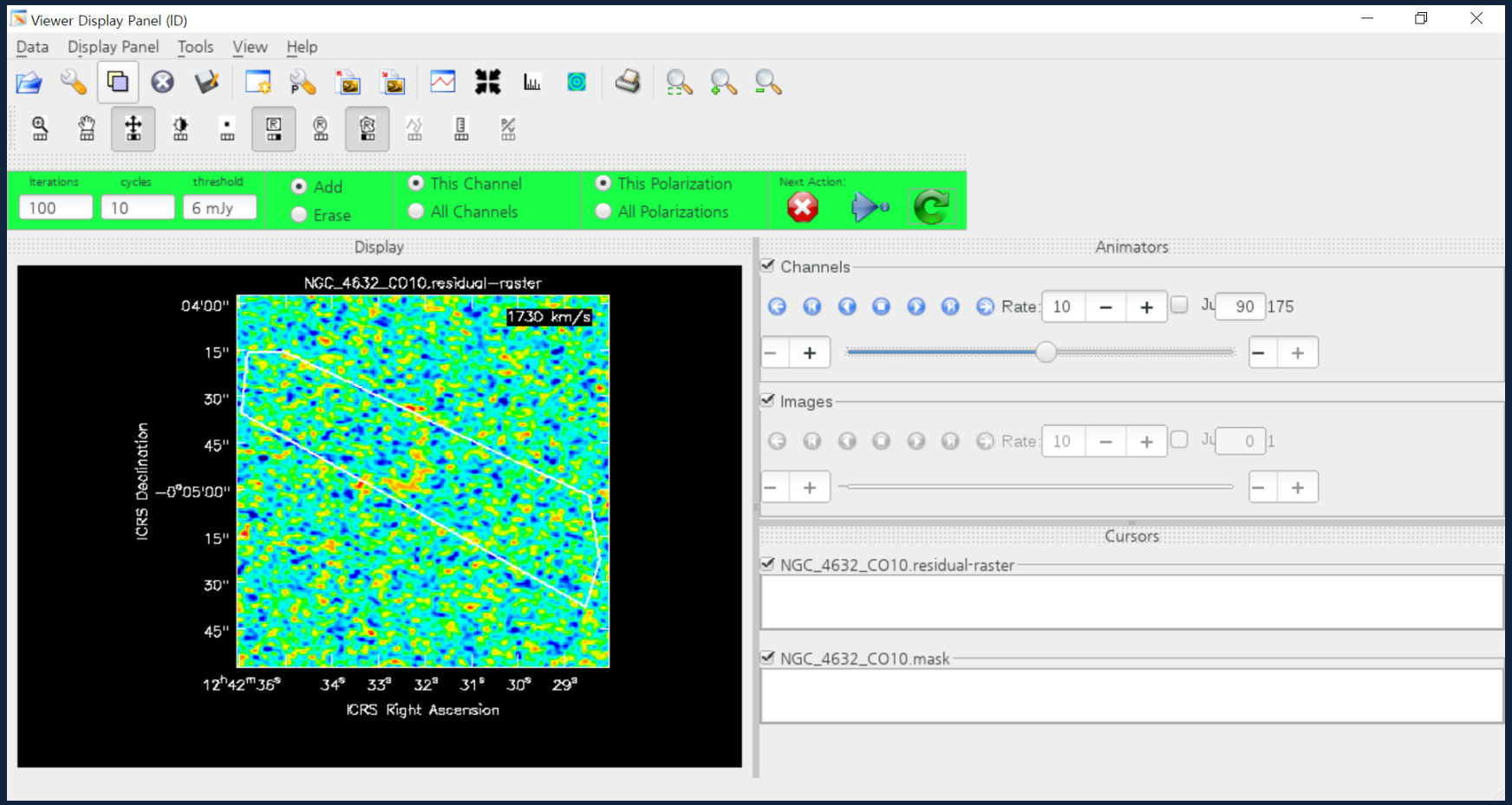
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This Polarization
All Polarizations
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45"
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15"
30"
45"
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34s
33a
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ICRS Right Ascension
Animators
Channels
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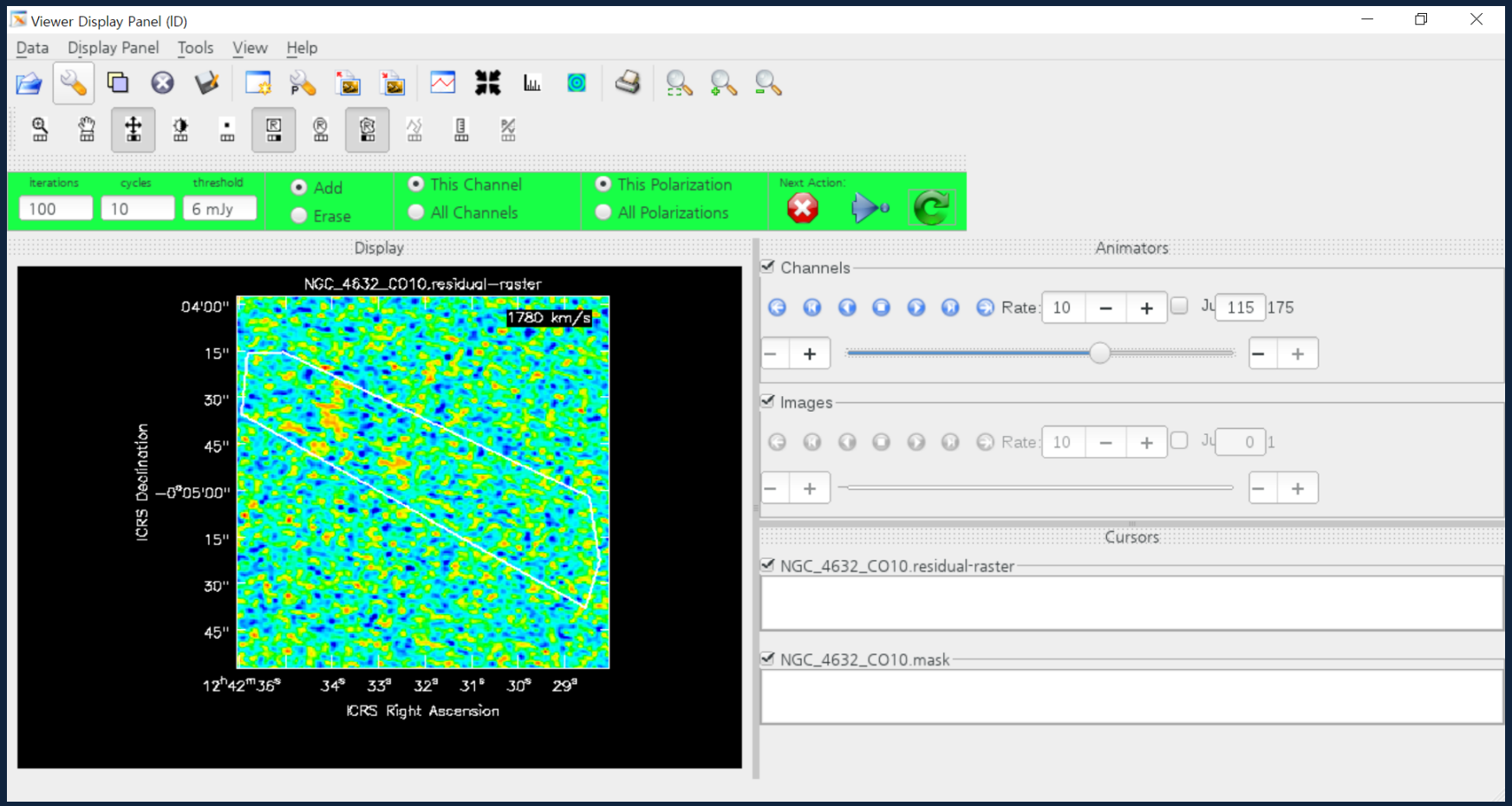
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This Polarization
All Polarizations
Next Action:
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1780 km/s
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15"
30"
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ICRS Declination
12h42m36s
34s
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32s
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30s
29s
ICRS Right Ascension
Animators
Channels
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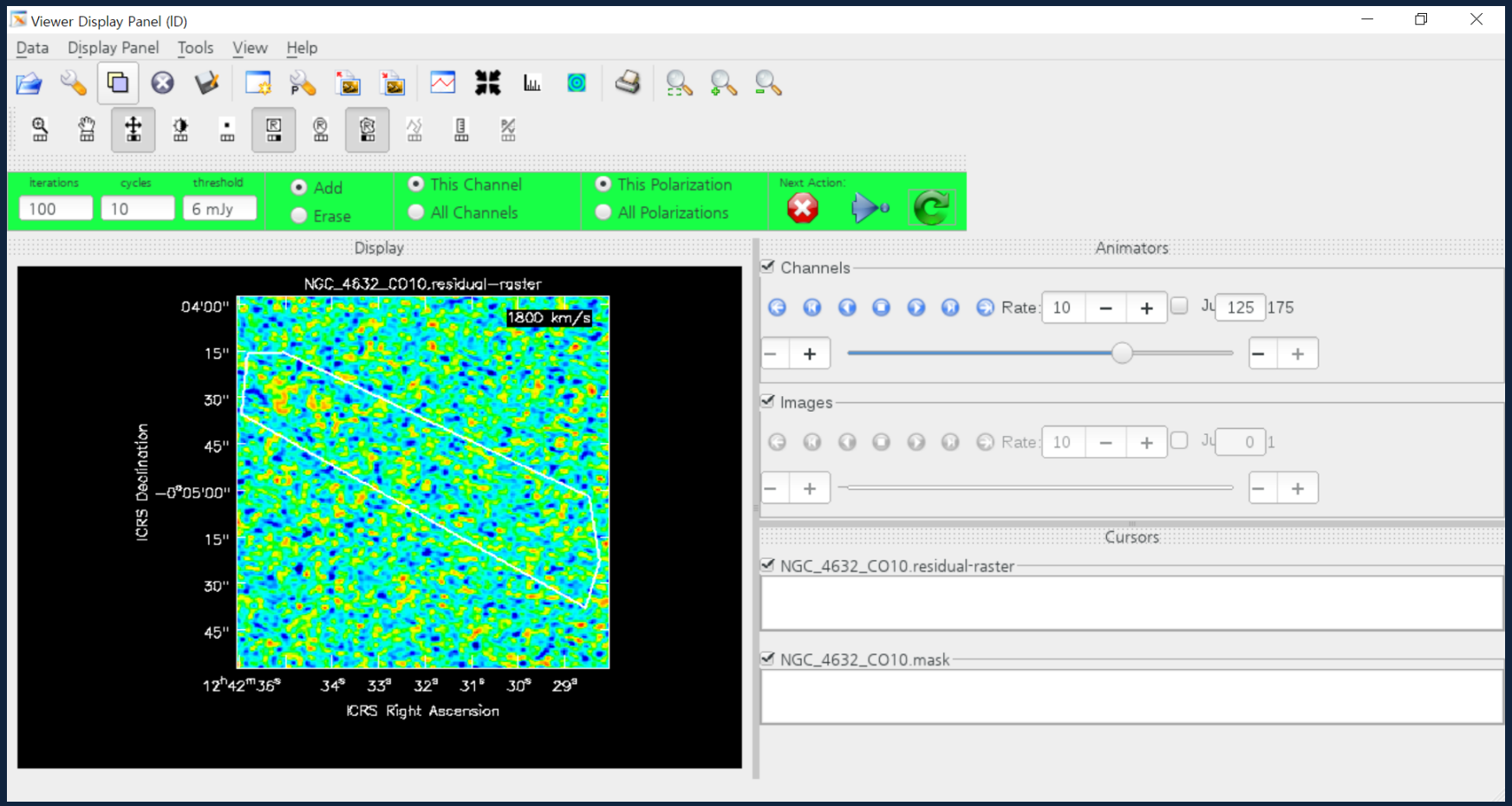
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Help
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cycles
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This Polarization
All Polarizations
Next Action:
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1800 km/s
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15"
30"
45"
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15"
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45"
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29a
ICRS Right Ascension
Animators
Channels
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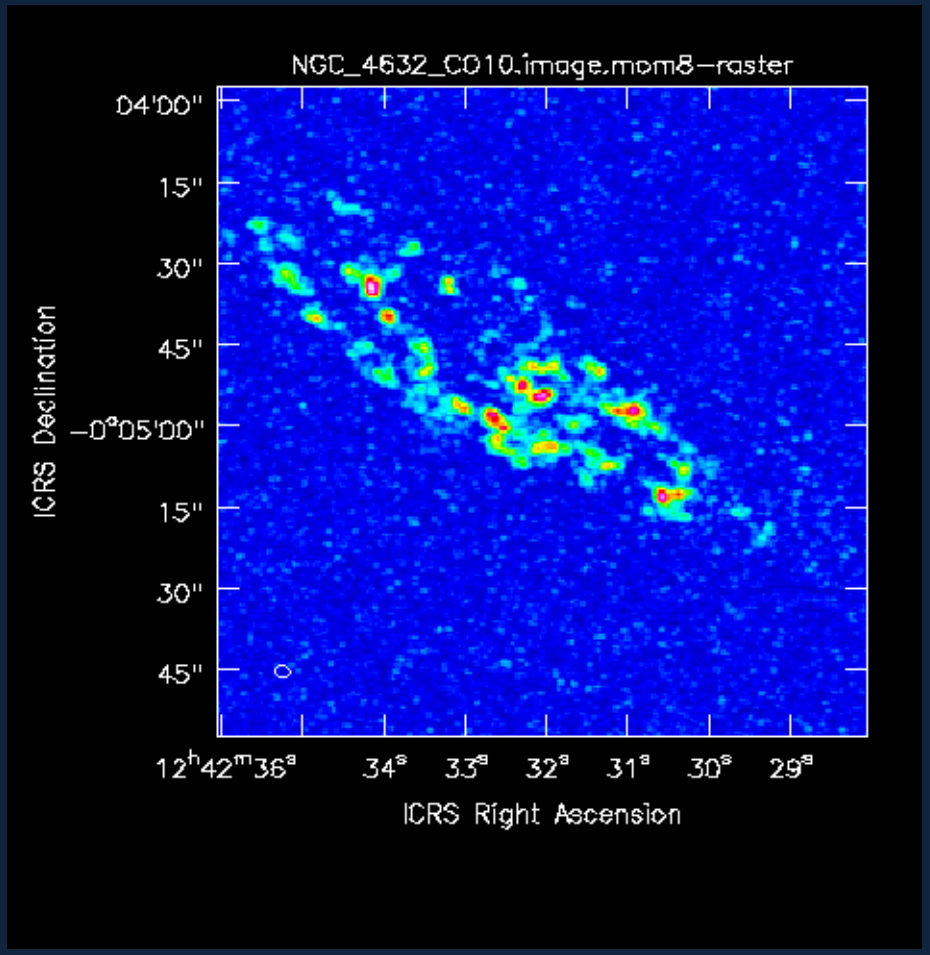
NGC_4632_CO10.mask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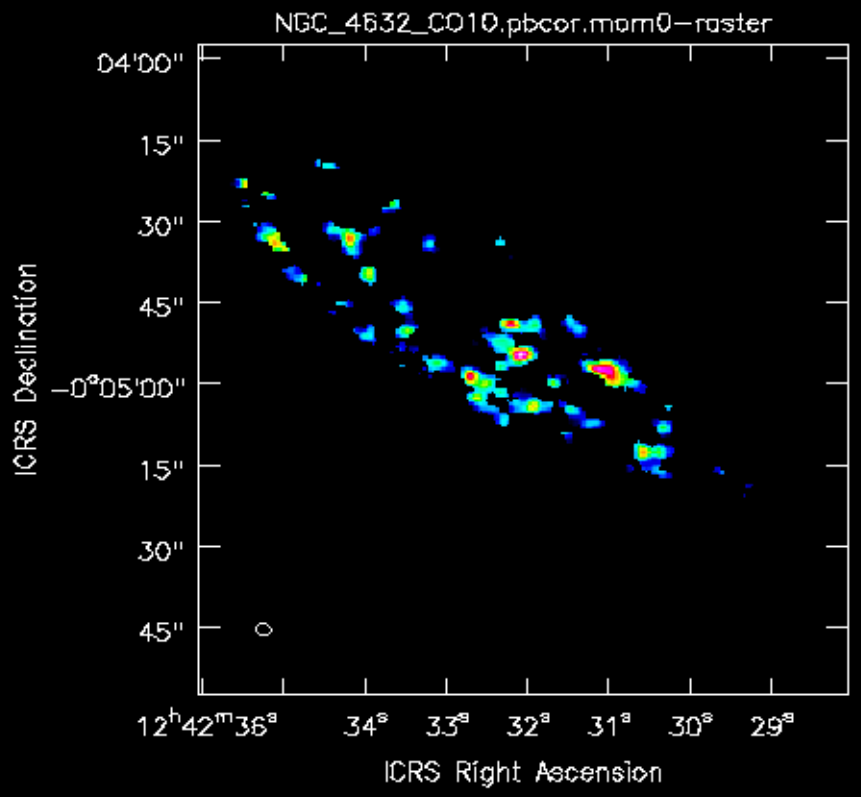
29s
ICRS Right Ascension

Moments 0



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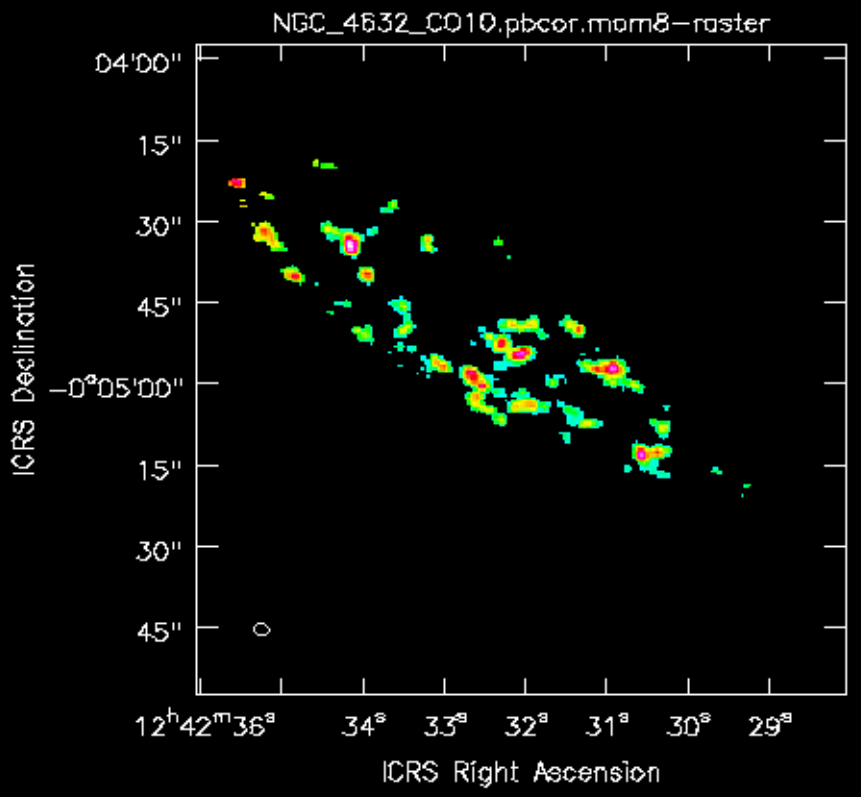
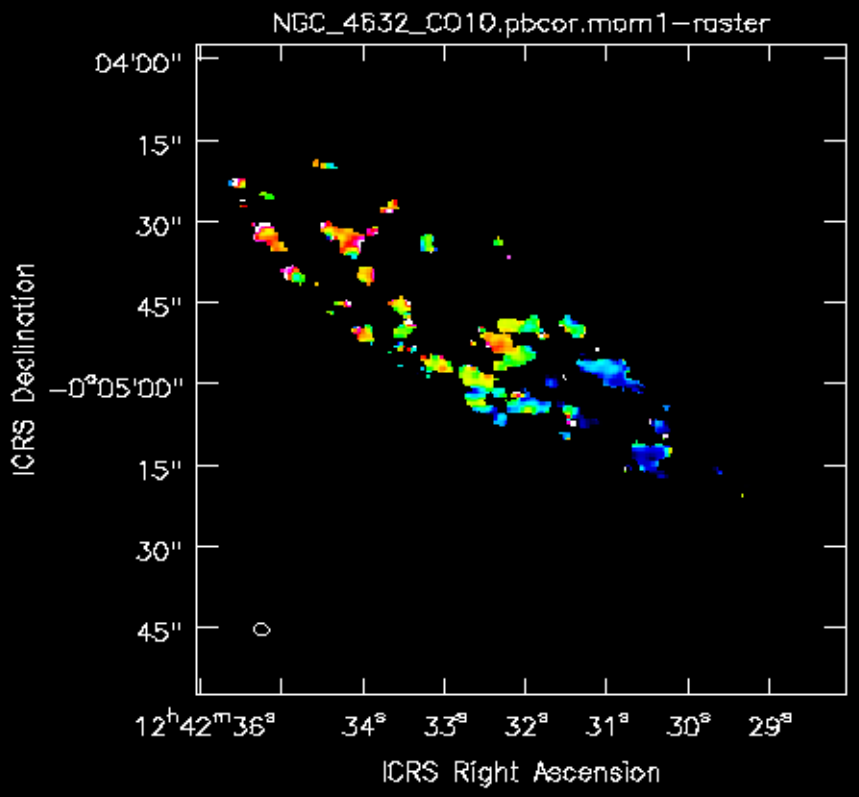
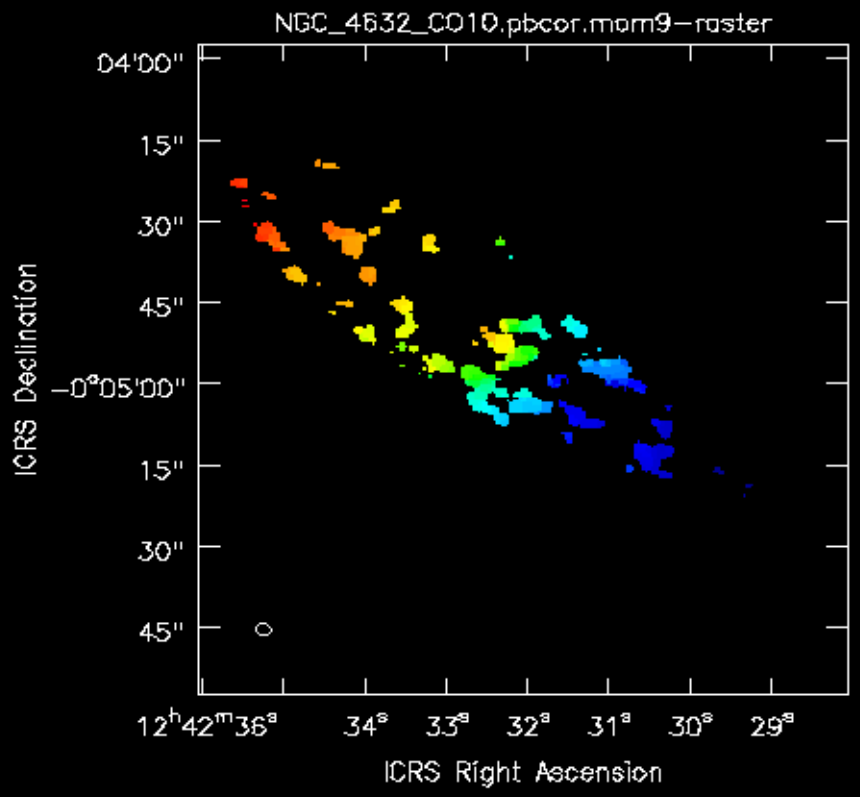


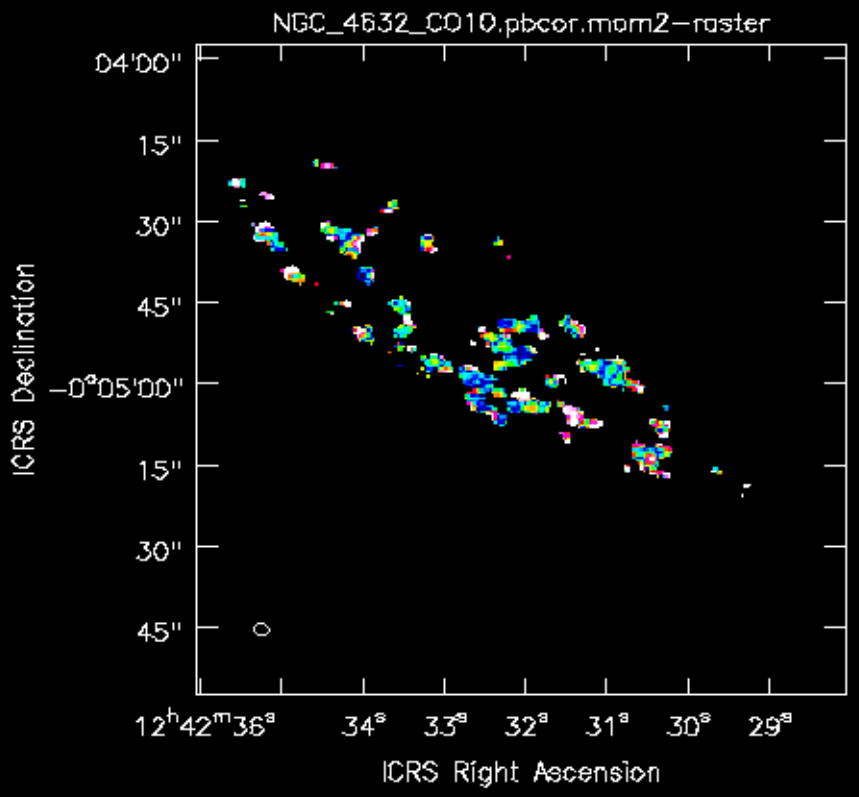
Moments 1



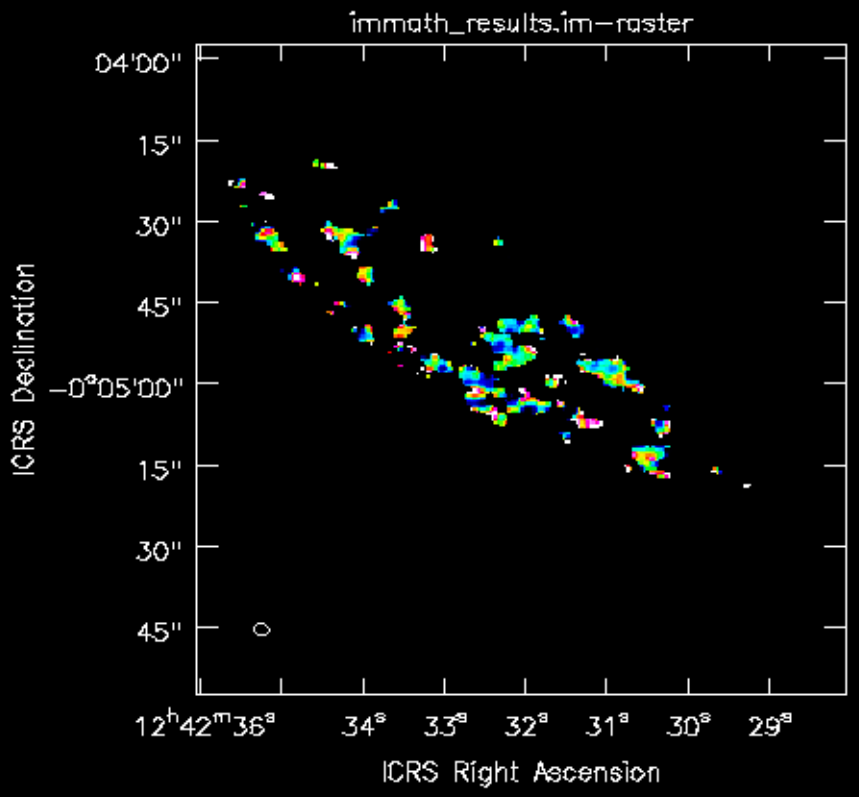
Moments 9



Moments 2



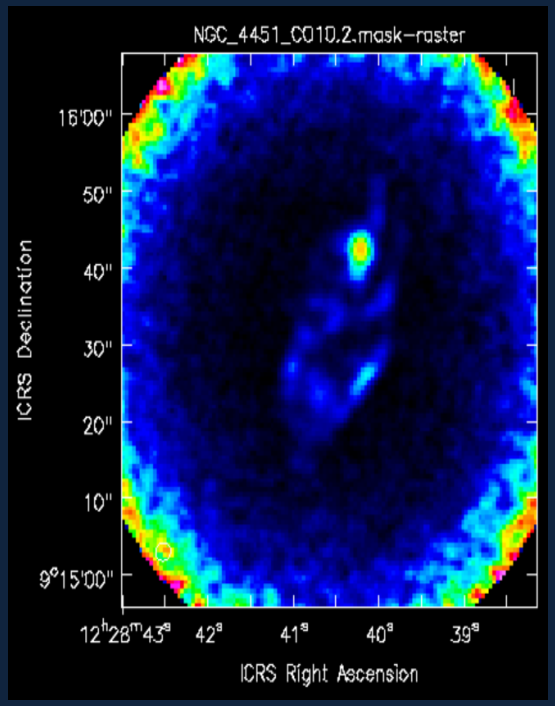
Moments 9-1



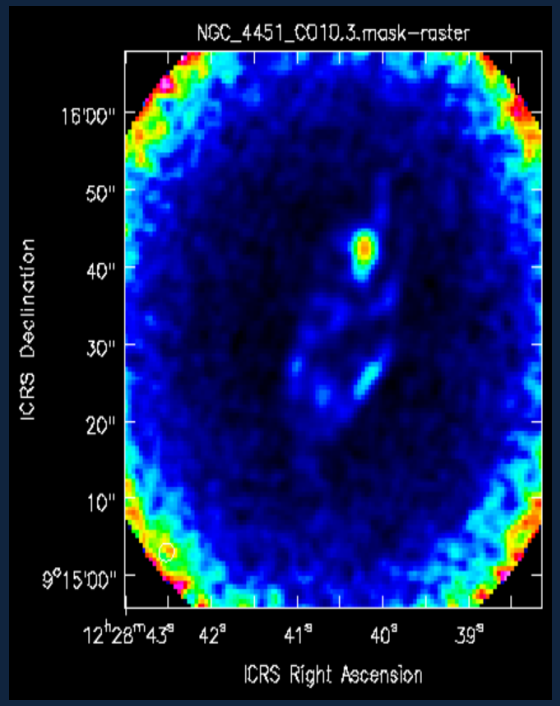
NGC 4451

_ Na-Eun Shin

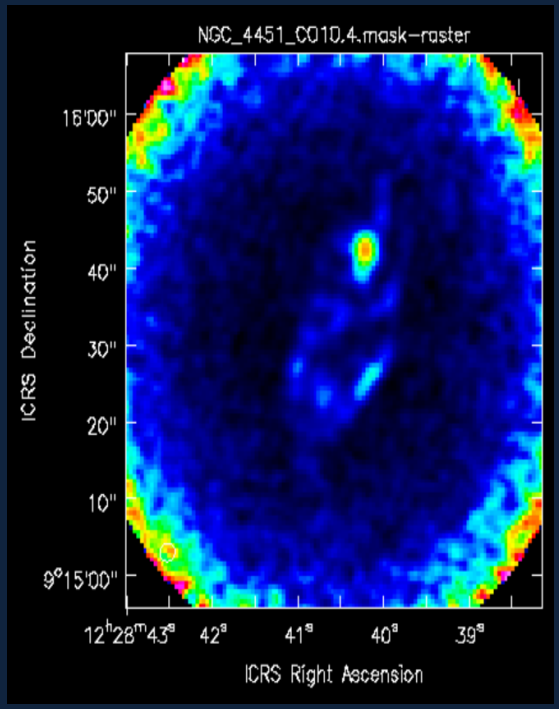
Threshold of moments 1 =



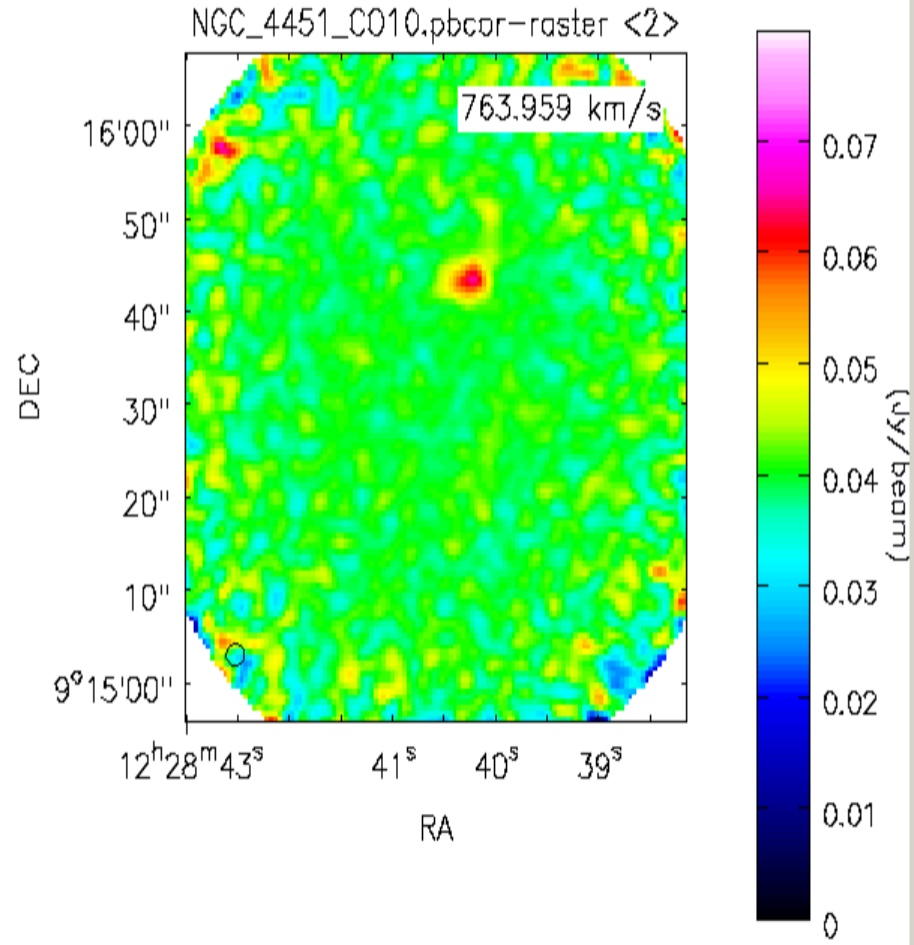
0.01mJy



0.001mJy

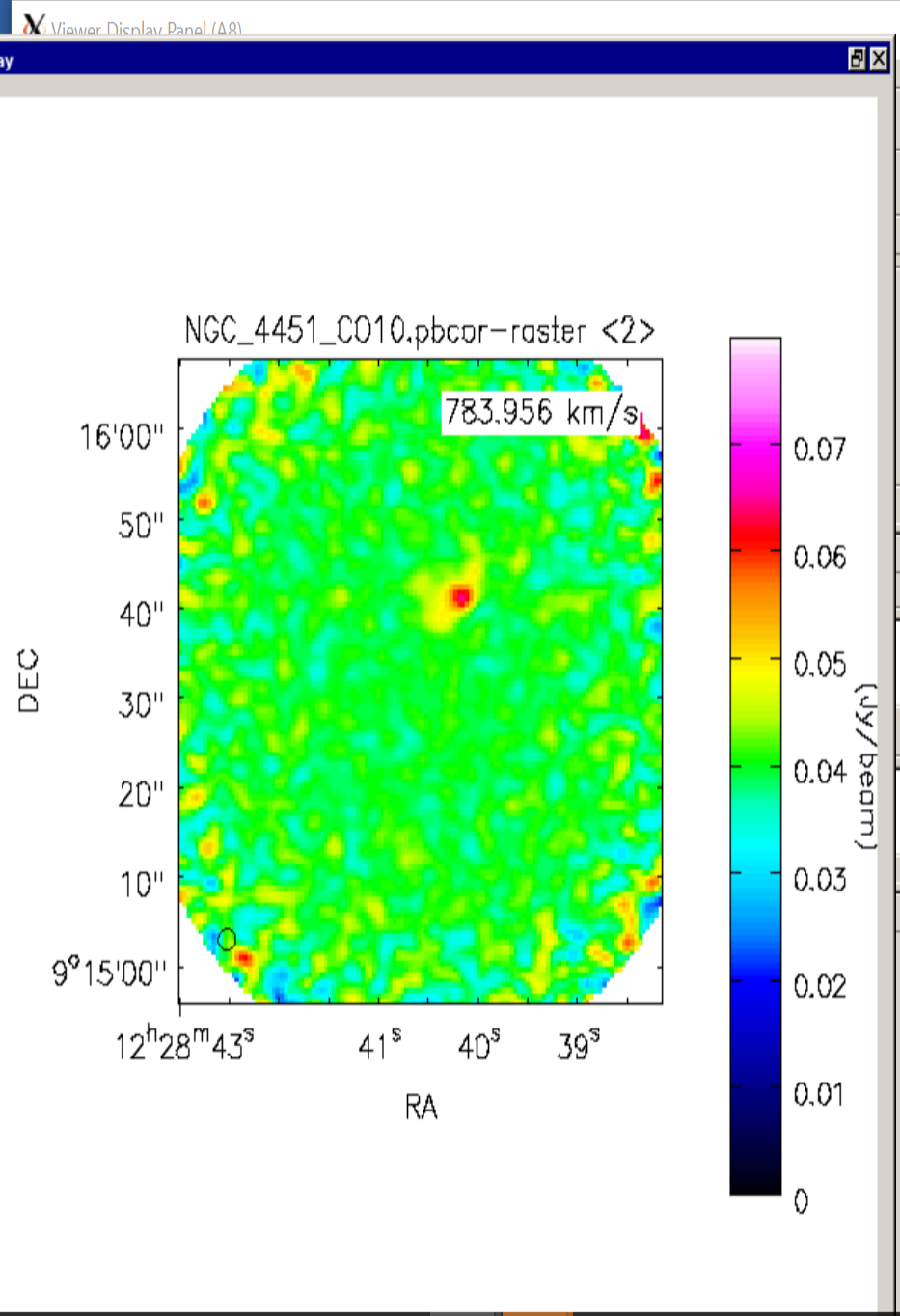


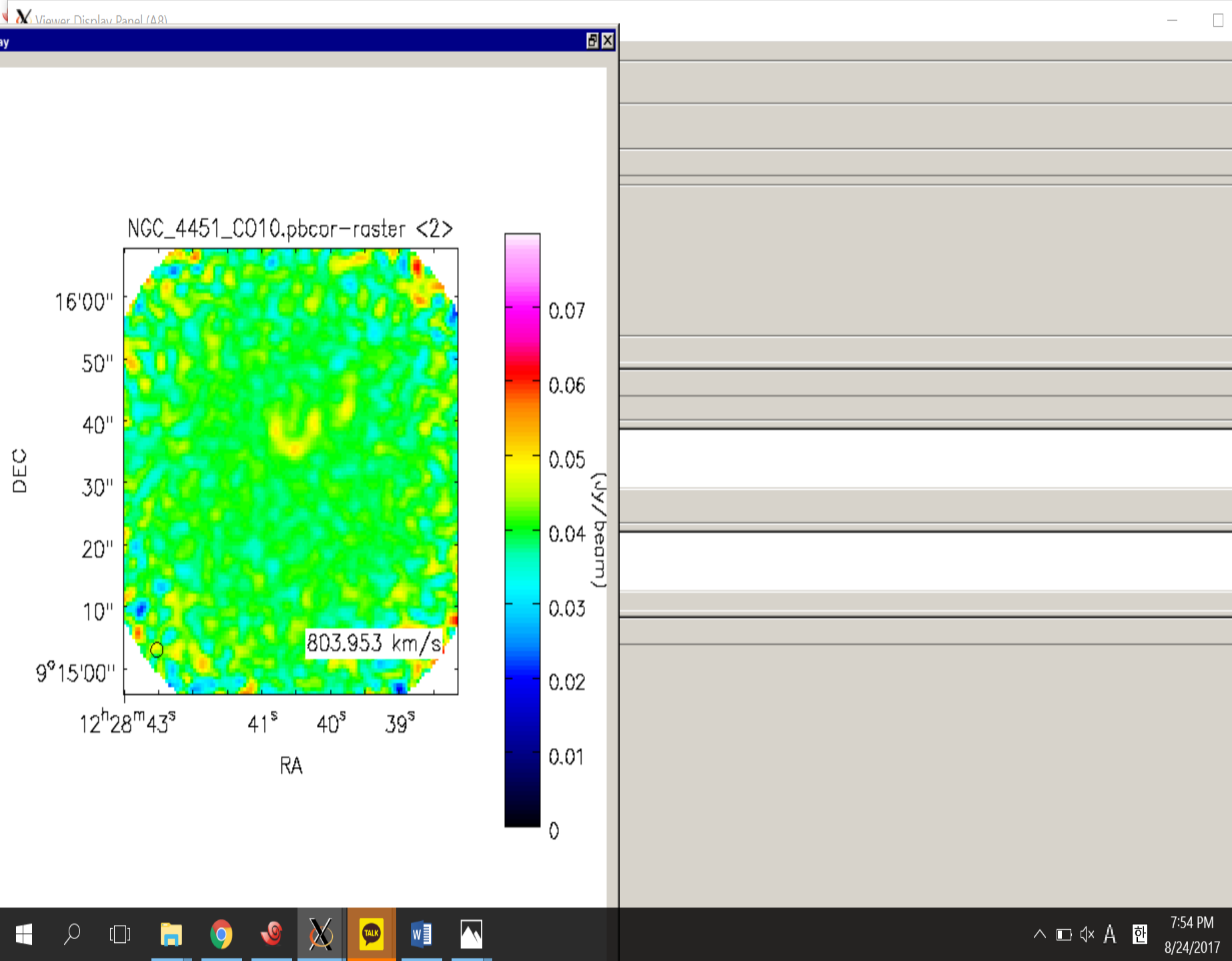
0.0001mJy
= 3sigma

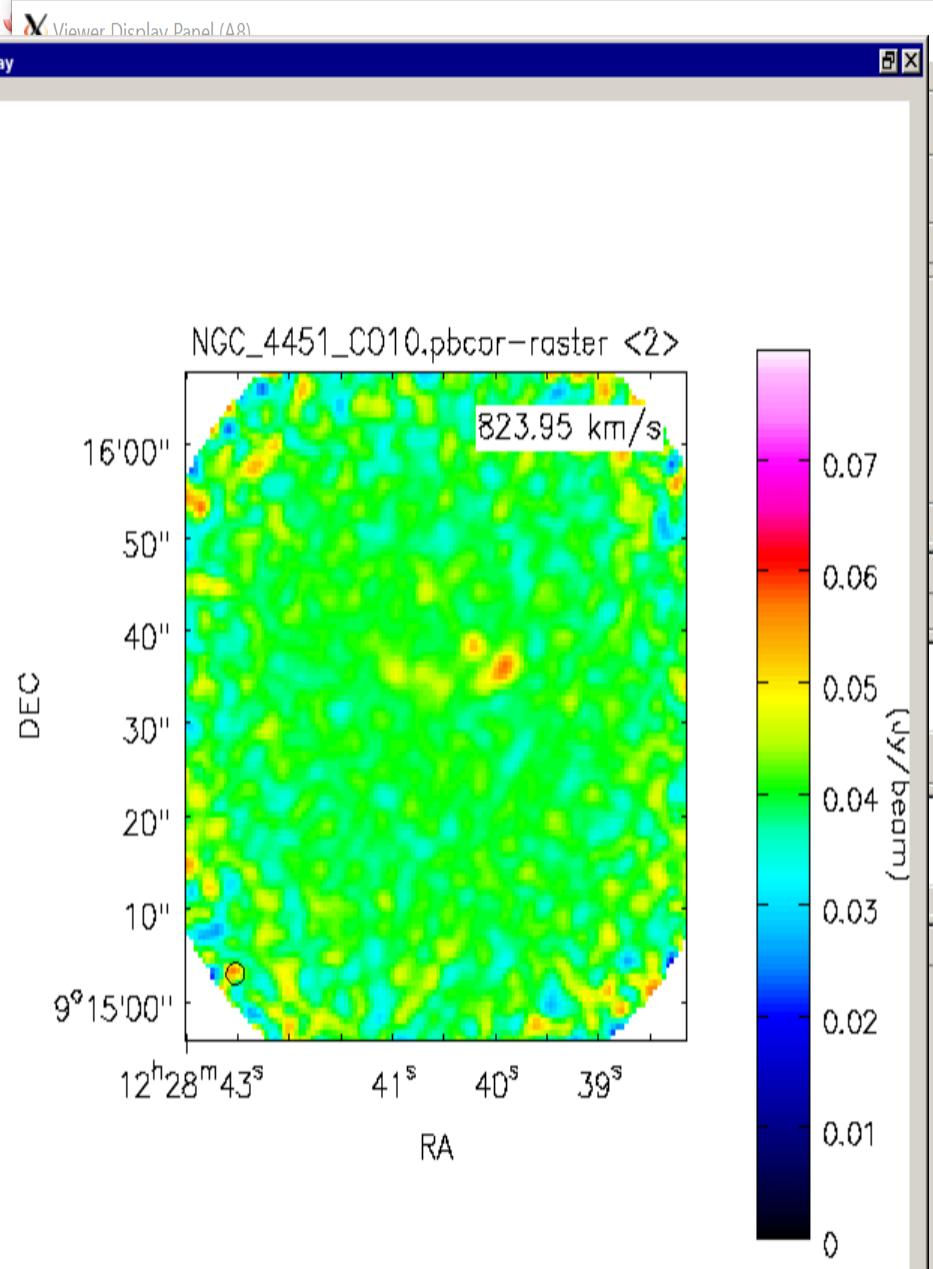


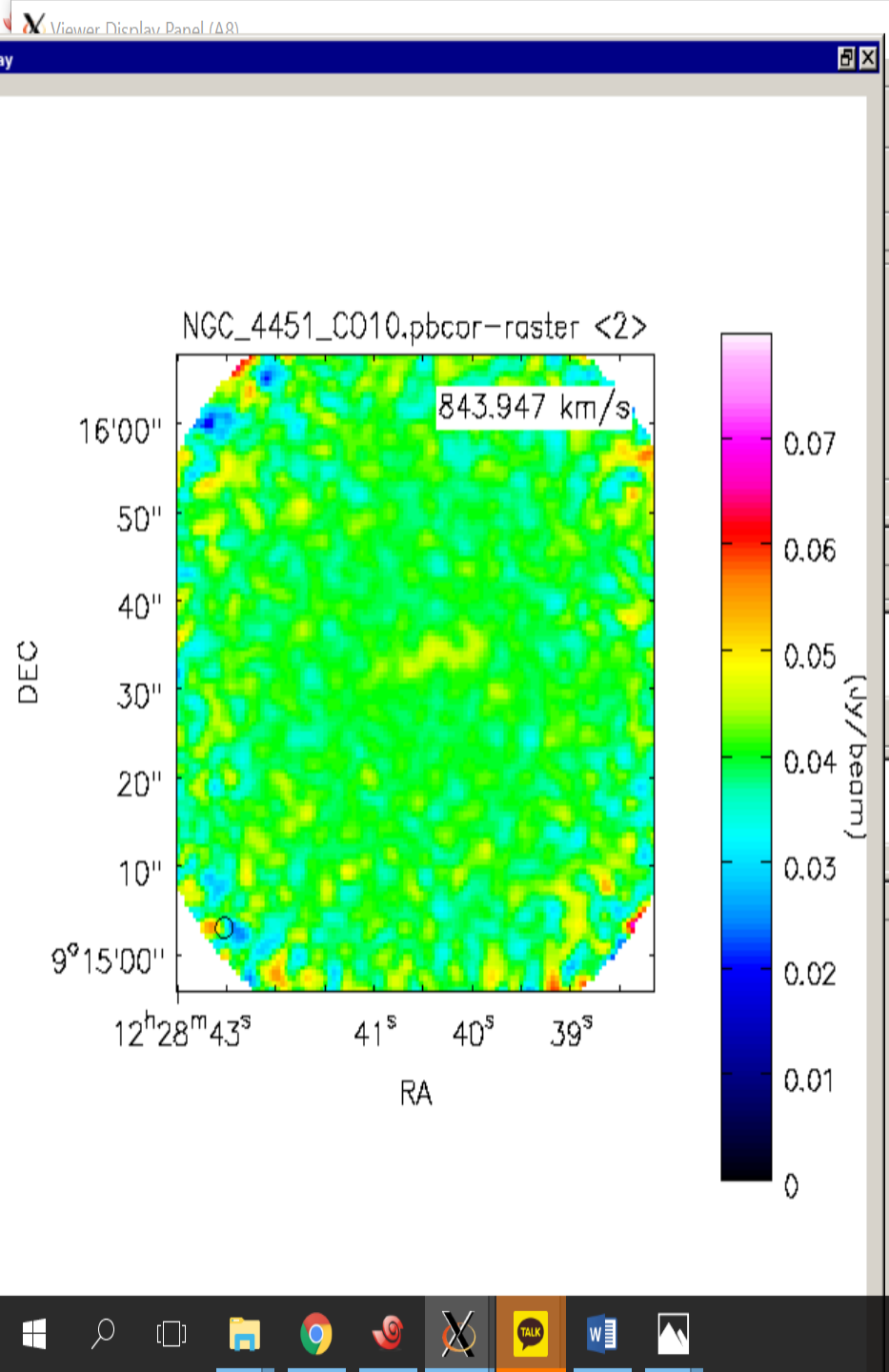
Viewer Display Panel (A8)

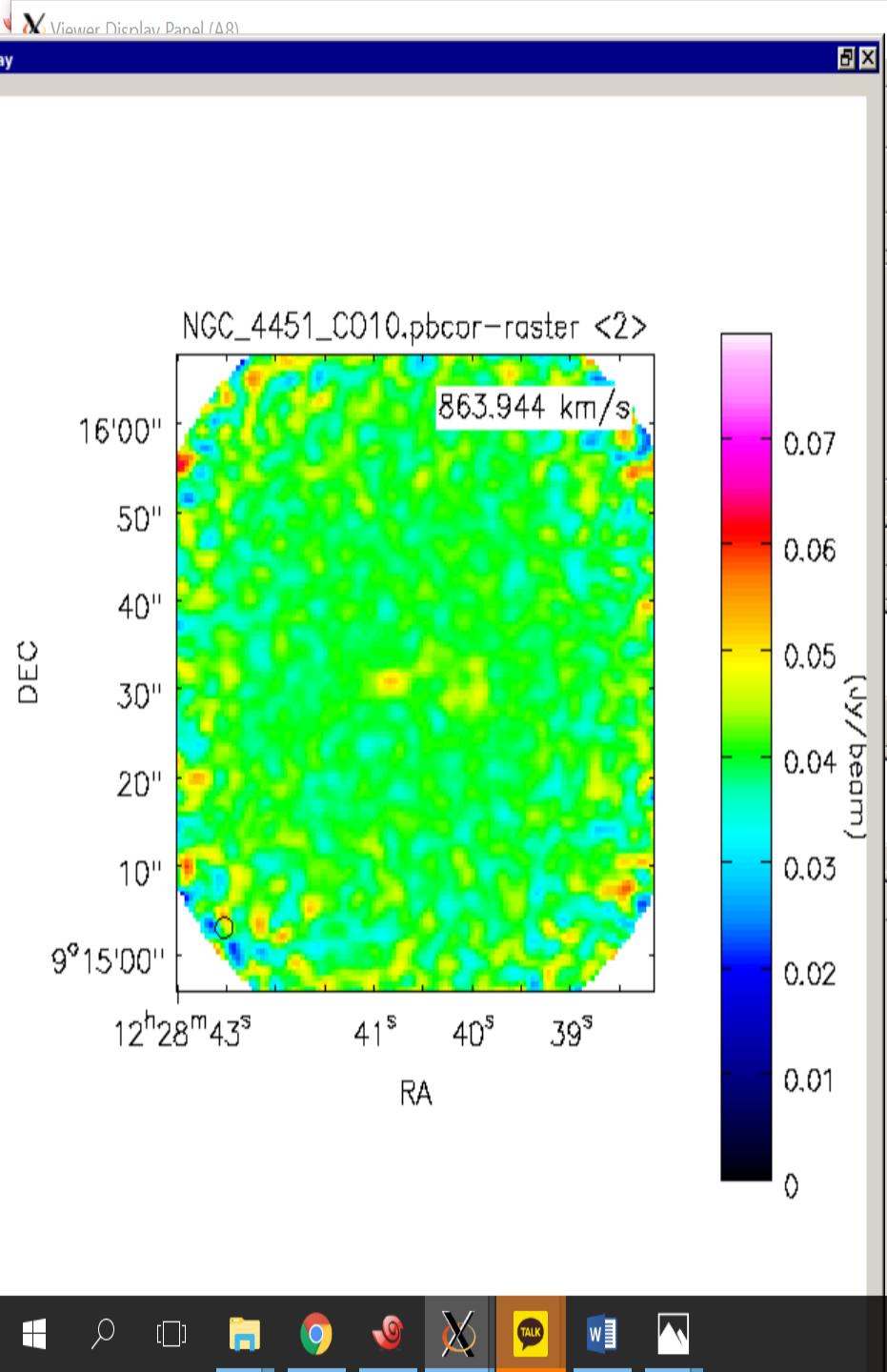
7:53 PM
8/24/2017

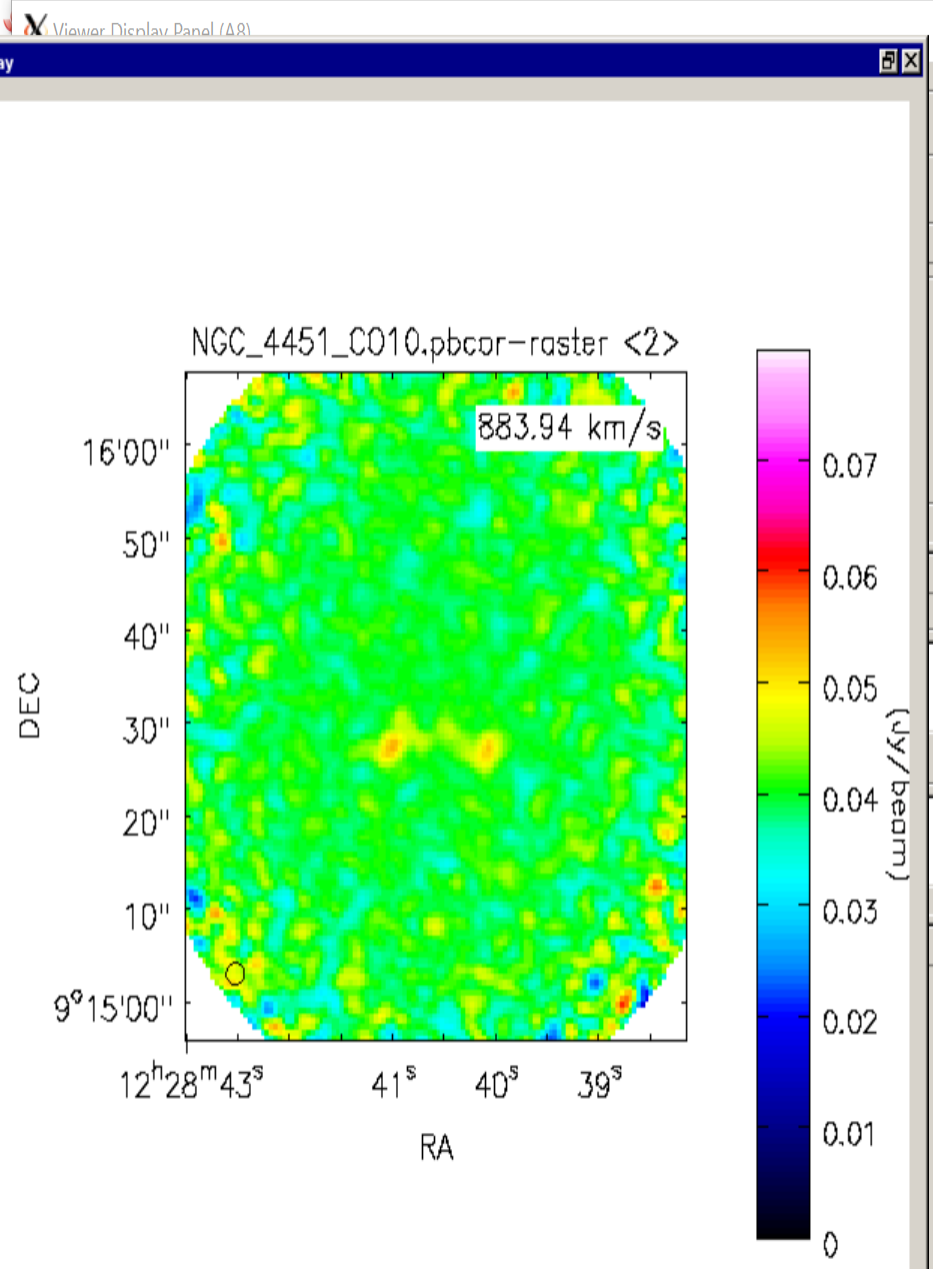

NGC_4451_CO10.pbcor-raster <2>
783.956 km/s
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)

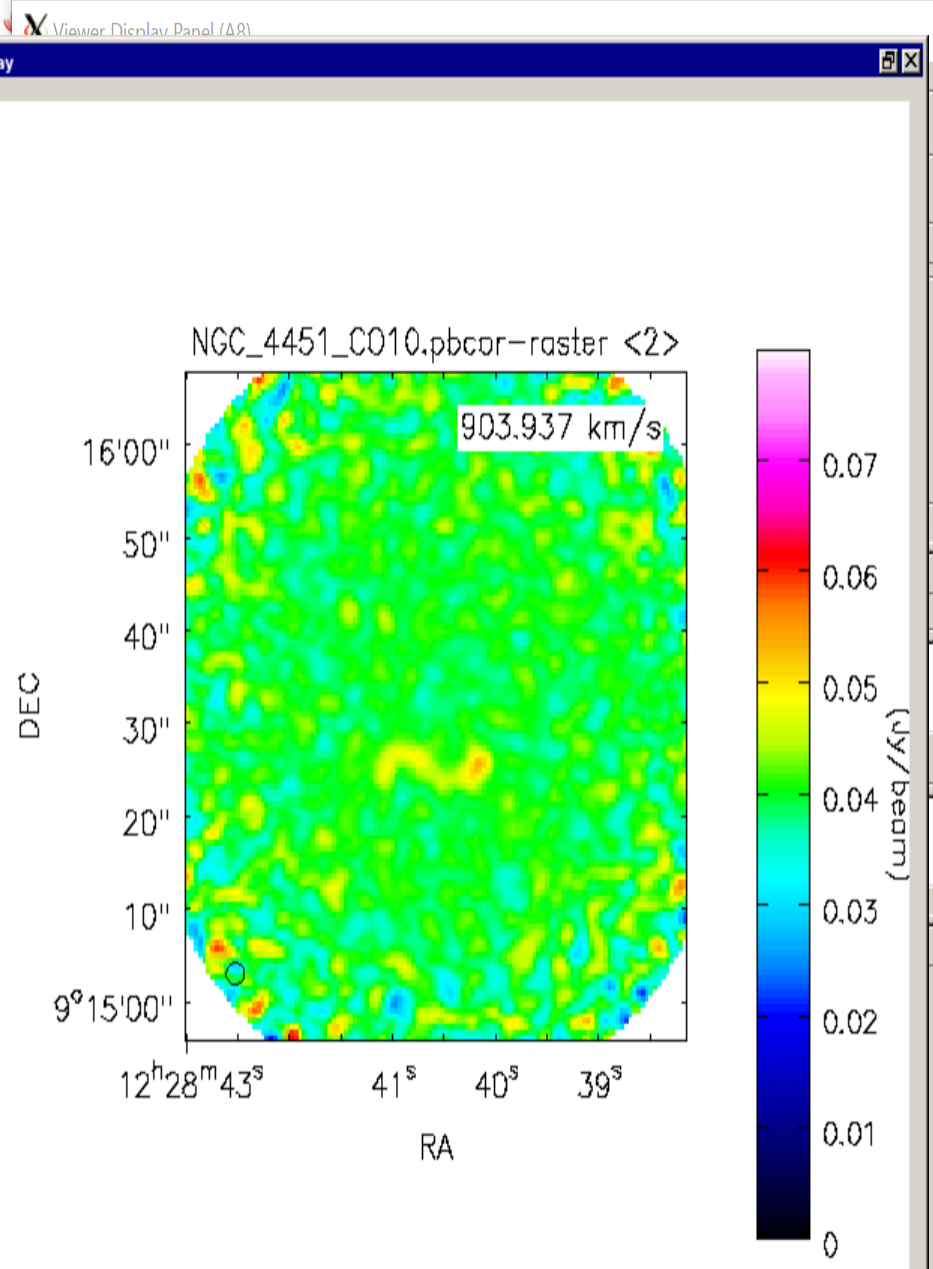

Viewer Display Panel (A8)
NGC_4451_CO10.pbcor-raster <2>
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
803.953 km/s
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)
7:54 PM
8/24/2017

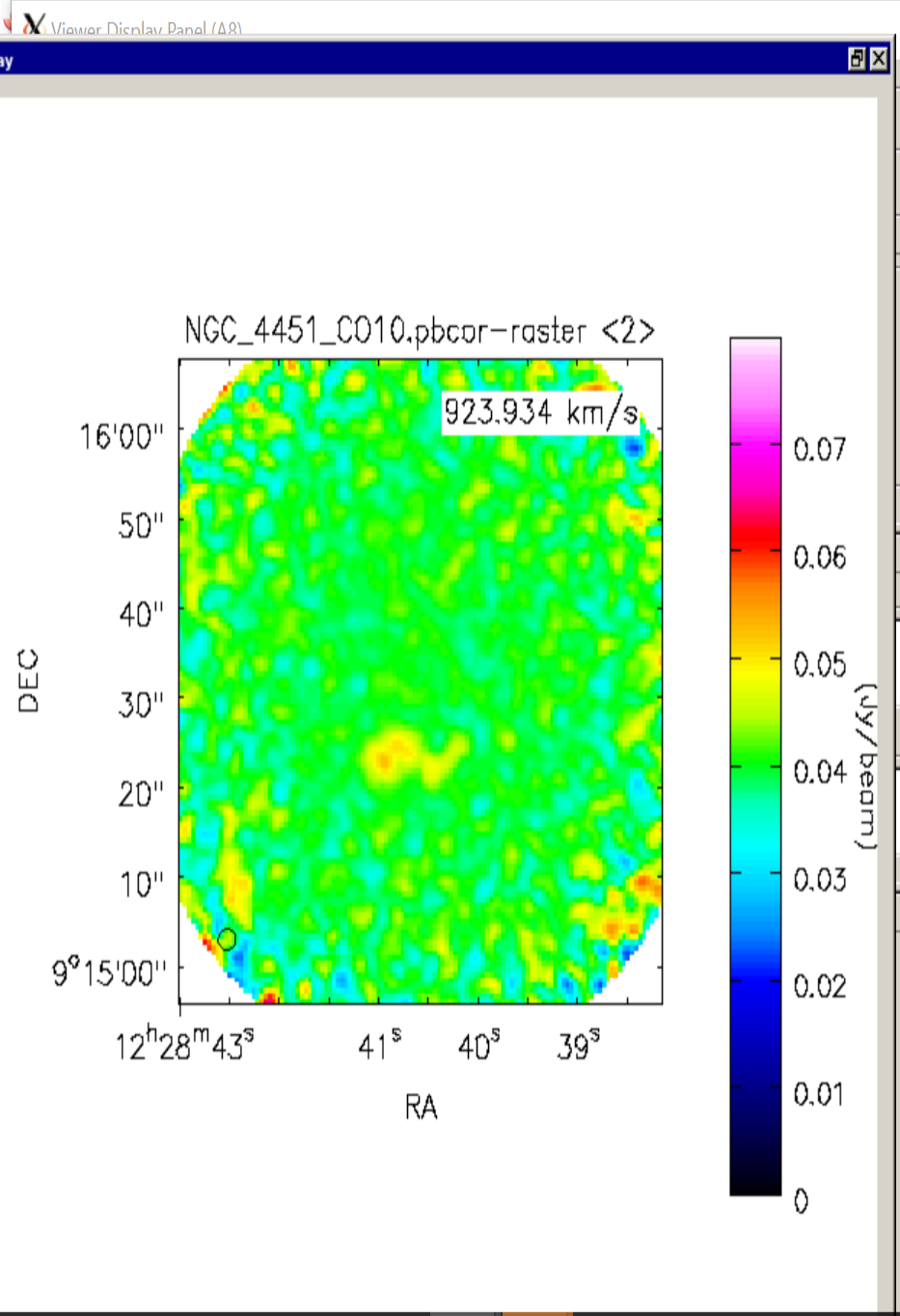

NGC_4451_CO10.pbcor-raster <2>
823.95 km/s
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)

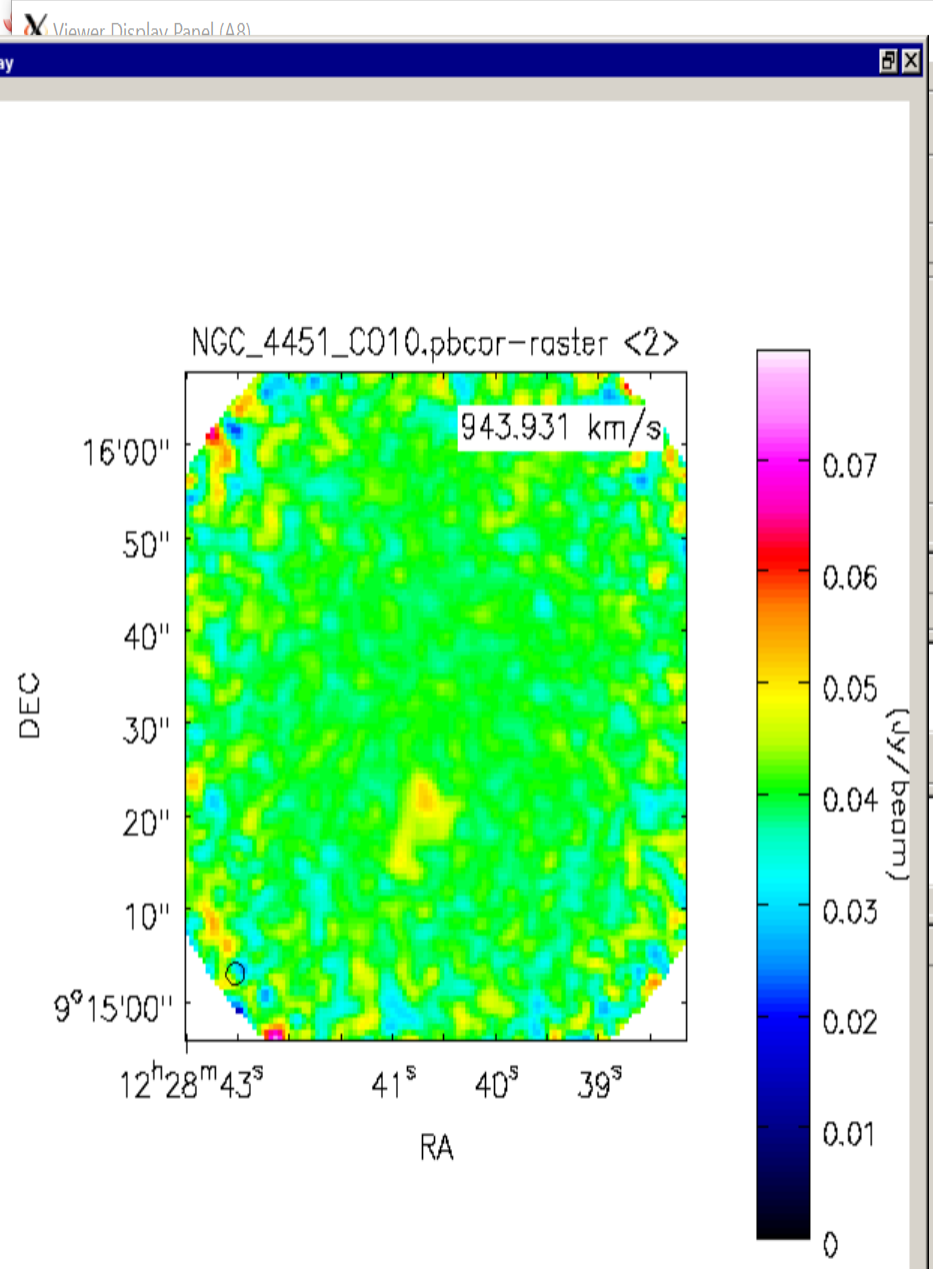

NGC_4451_CO10.pbcor-raster <2>
843.947 km/s
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)

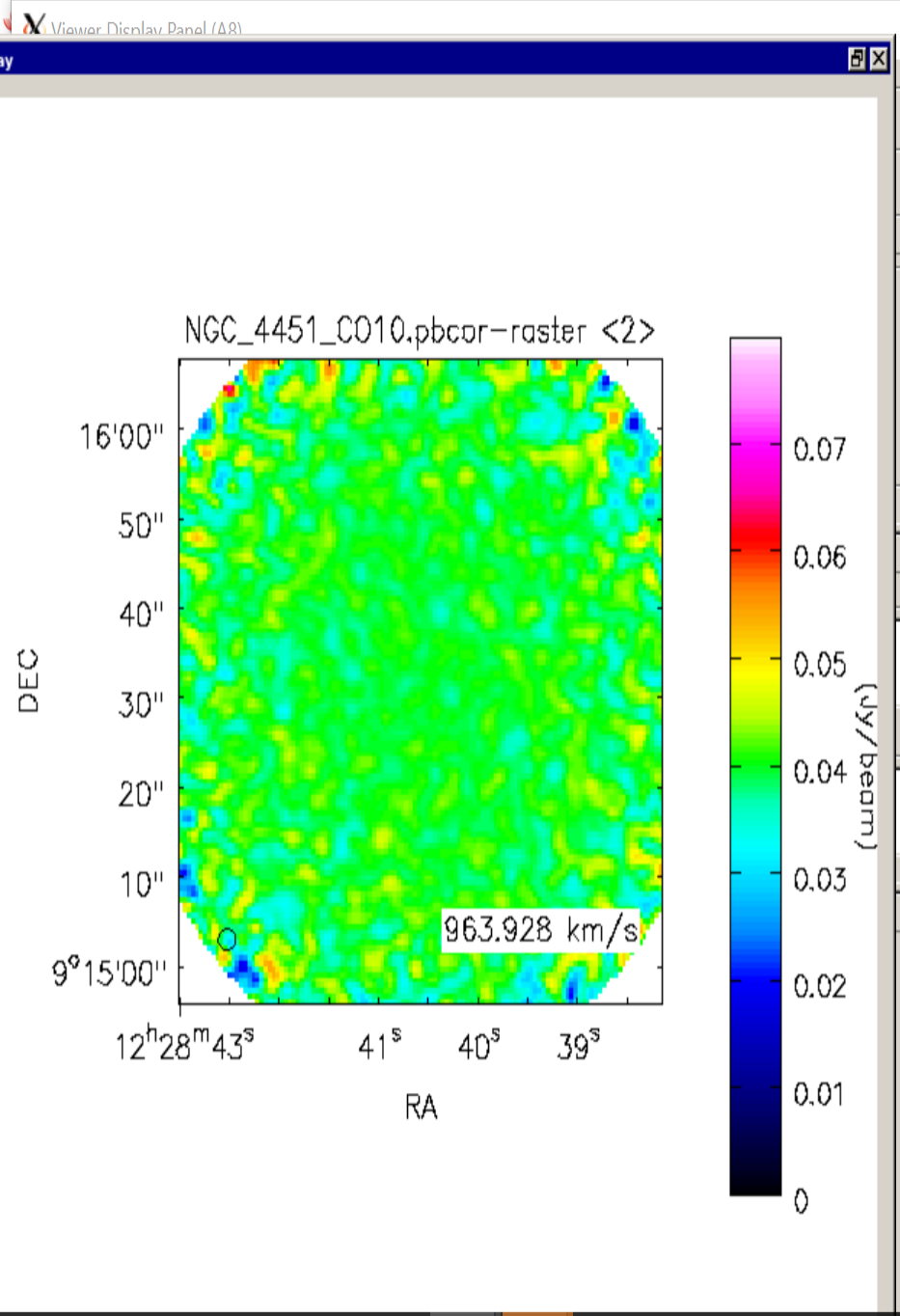

NGC_4451_CO10.pbcor-raster <2>
863.944 km/s
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)

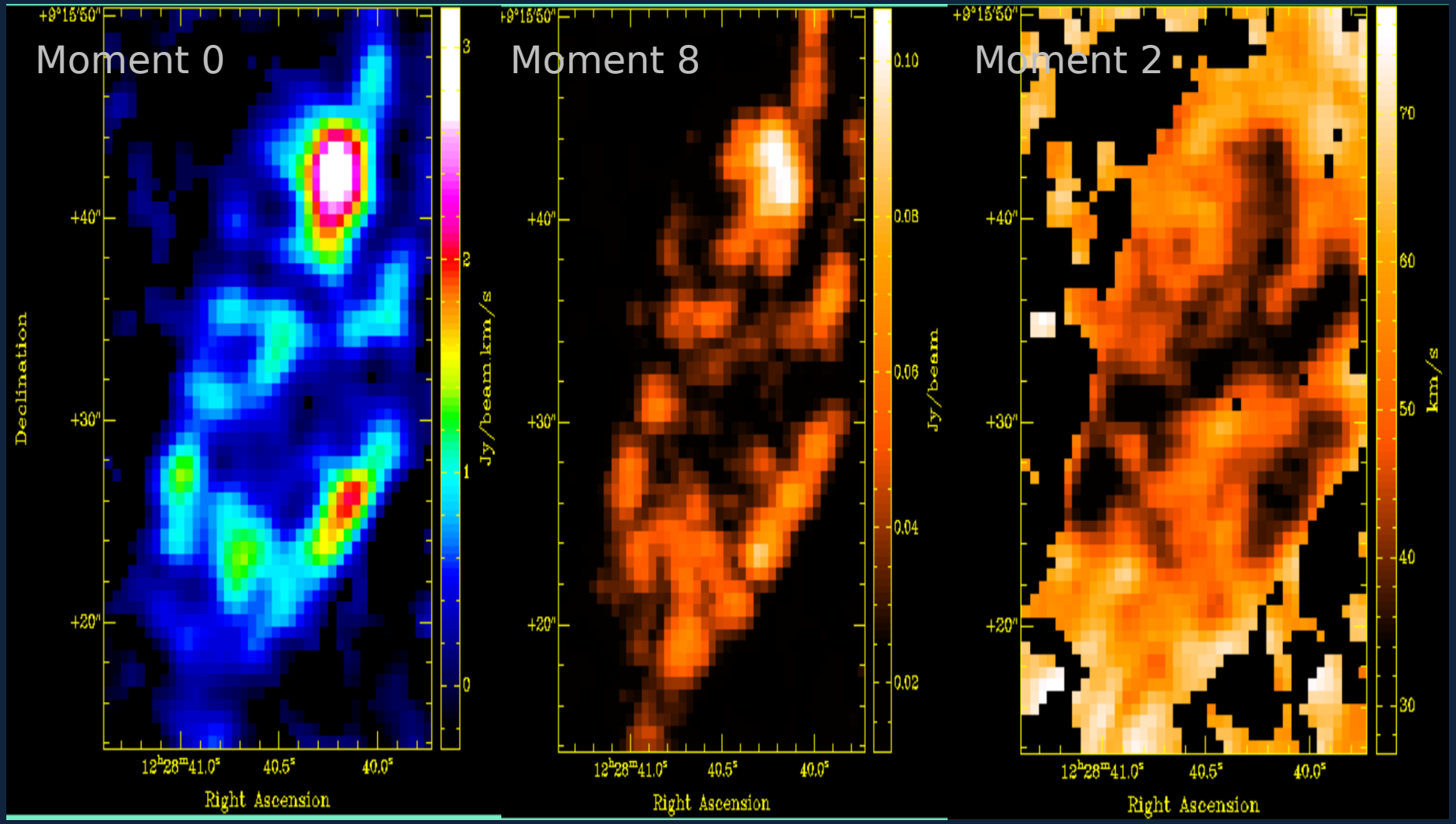

NGC_4451_CO10.pbcor-raster <2>
883.94 km/s
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)

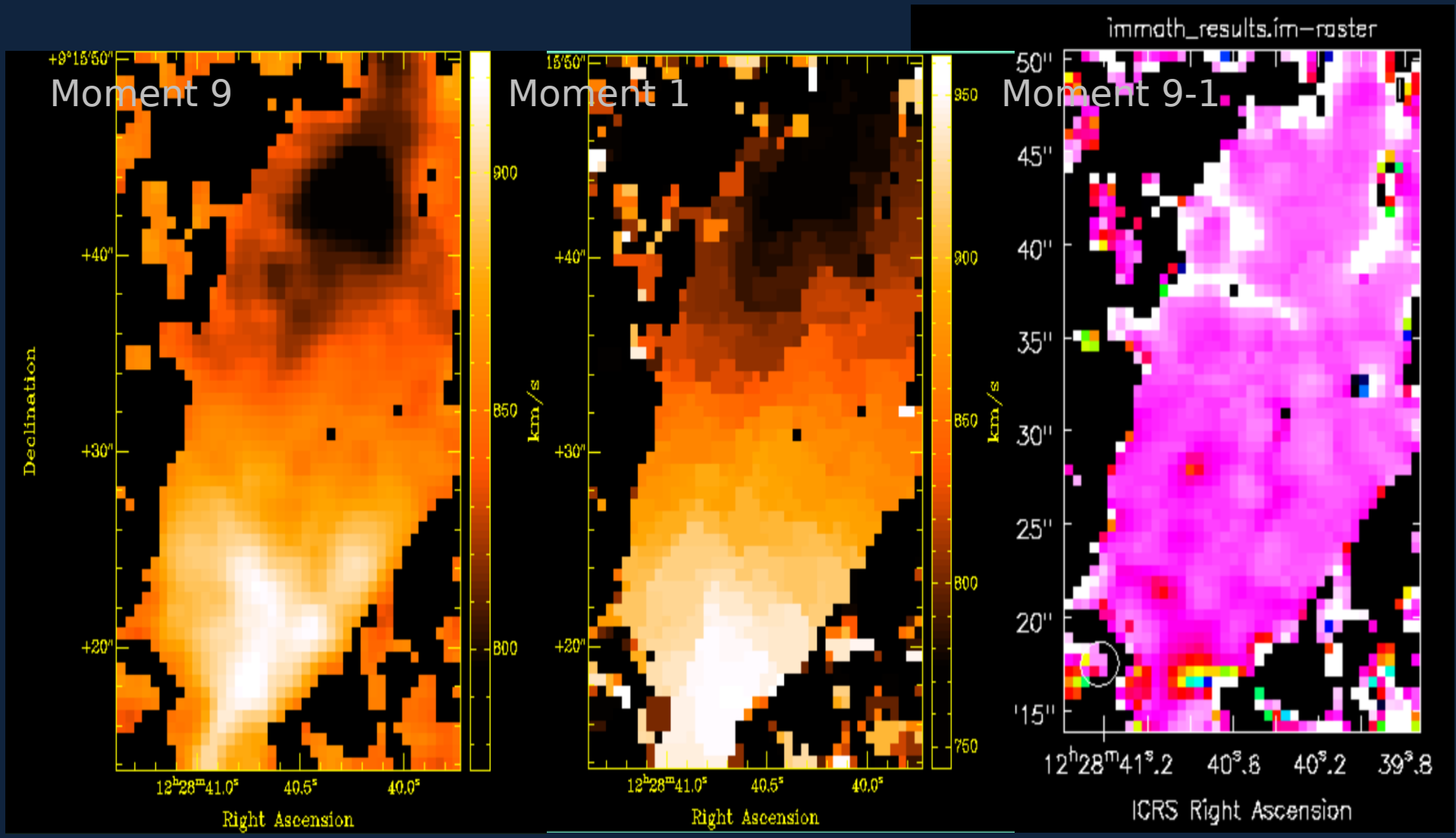

NGC_4451_CO10.pbcor-raster <2>
903.937 km/s
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)

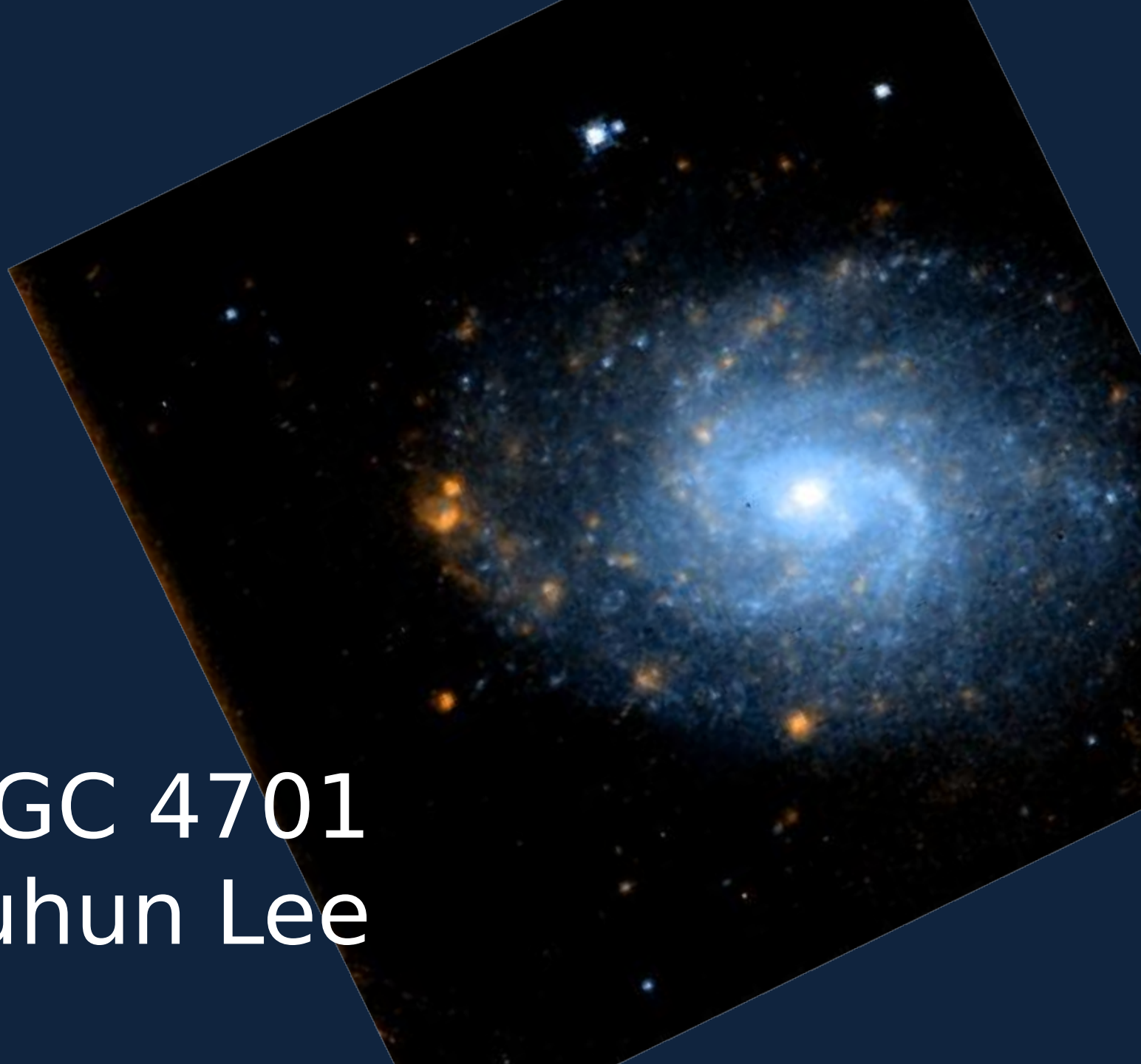

NGC_4451_CO10.pbcor-raster <2>
923.934 km/s
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)


NGC_4451_CO10.pbcor-raster <2>
943.931 km/s
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)


NGC_4451_CO10.pbcor-raster <2>
16'00"
50"
40"
30"
20"
10"
9°15'00"
DEC
12h28m43s
41s
40s
39s
RA
963.928 km/s
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
(Jy/beam)


Moment 0
Moment 8
Moment 2
Declination
Right Ascension
Jy/beam.km/s
Jy/beam
km/s


Moment 9
Moment 1
Moment 9-1
immoth_results.im−raster
Declination
Right Ascension
km/s
ICRS Right Ascension



NGC 4701

_ Juhun Lee

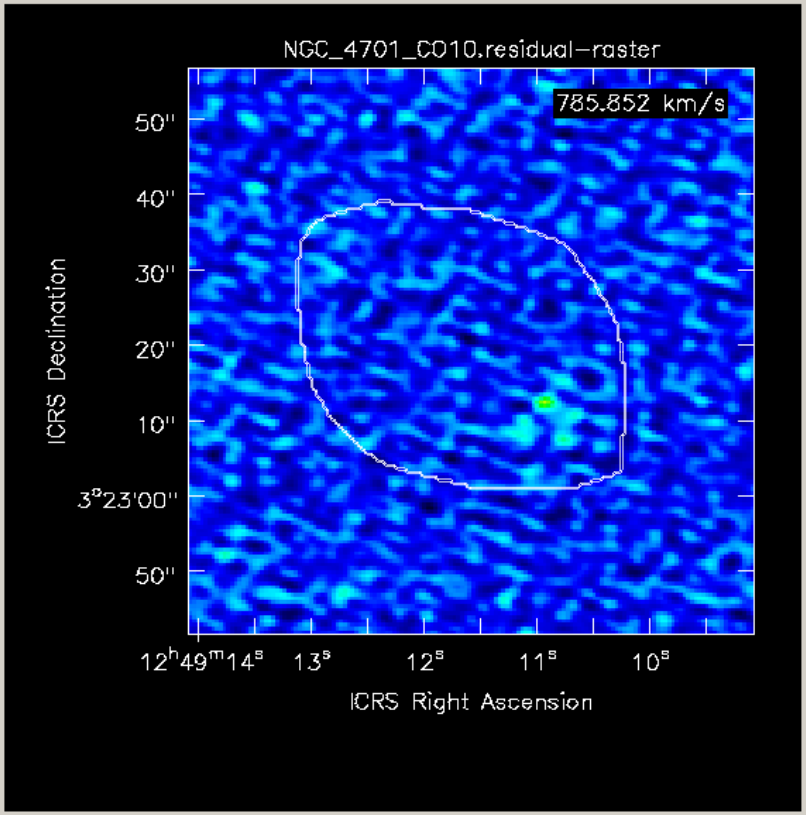
Viewer Display Panel (JH)

Data Display Panel Tools View Help

iterations 100 | cycles 10 | threshold 6 mJy

Add / Erase | This Channel / All Channels | This Polarization / All Polarizations | Next Action:

Display



Animators

Channels

Rate: 10 Jump 118 170

0 169

Images

Rate: 10 Jump 0 1

0 0

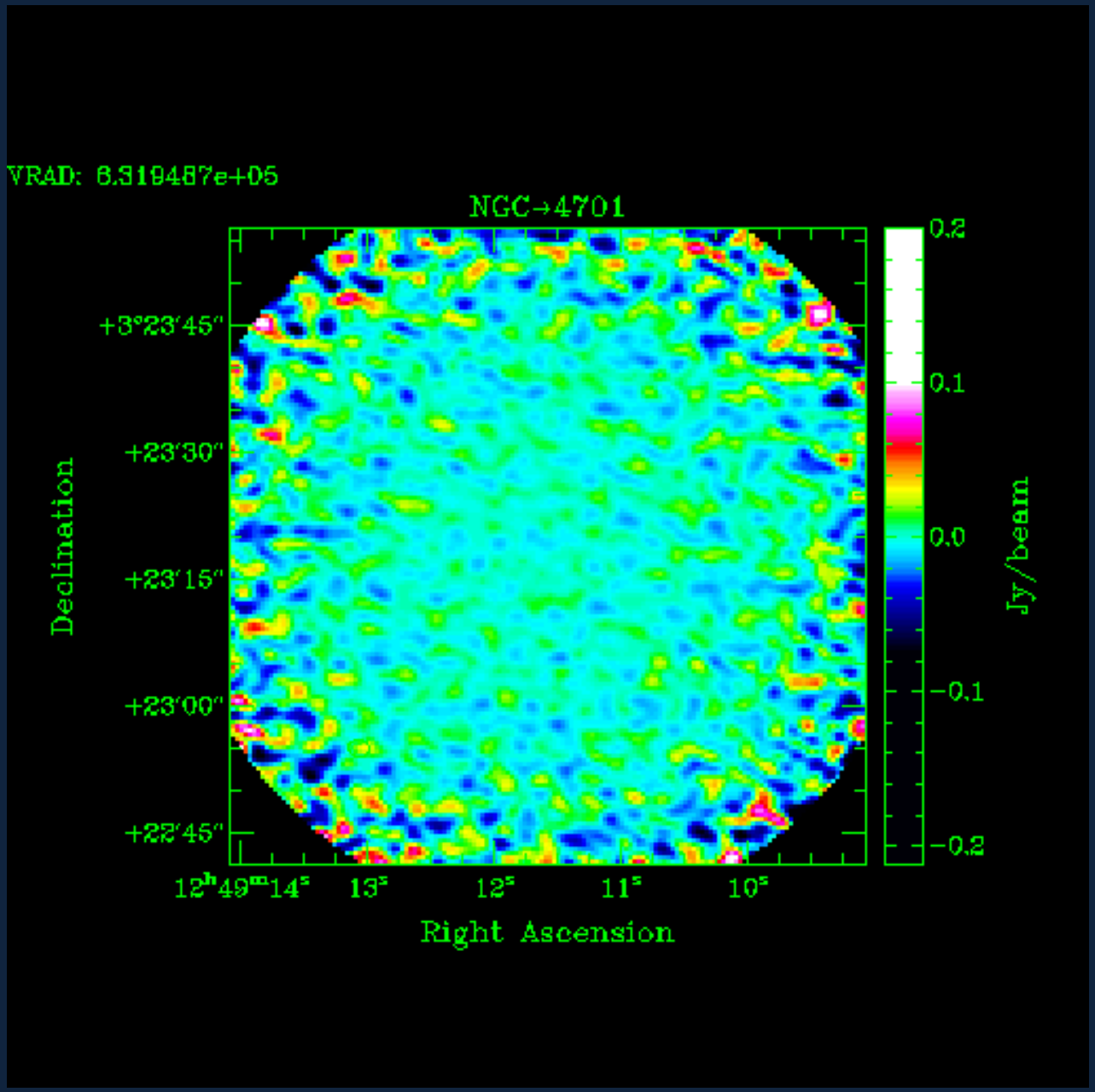
Cursors

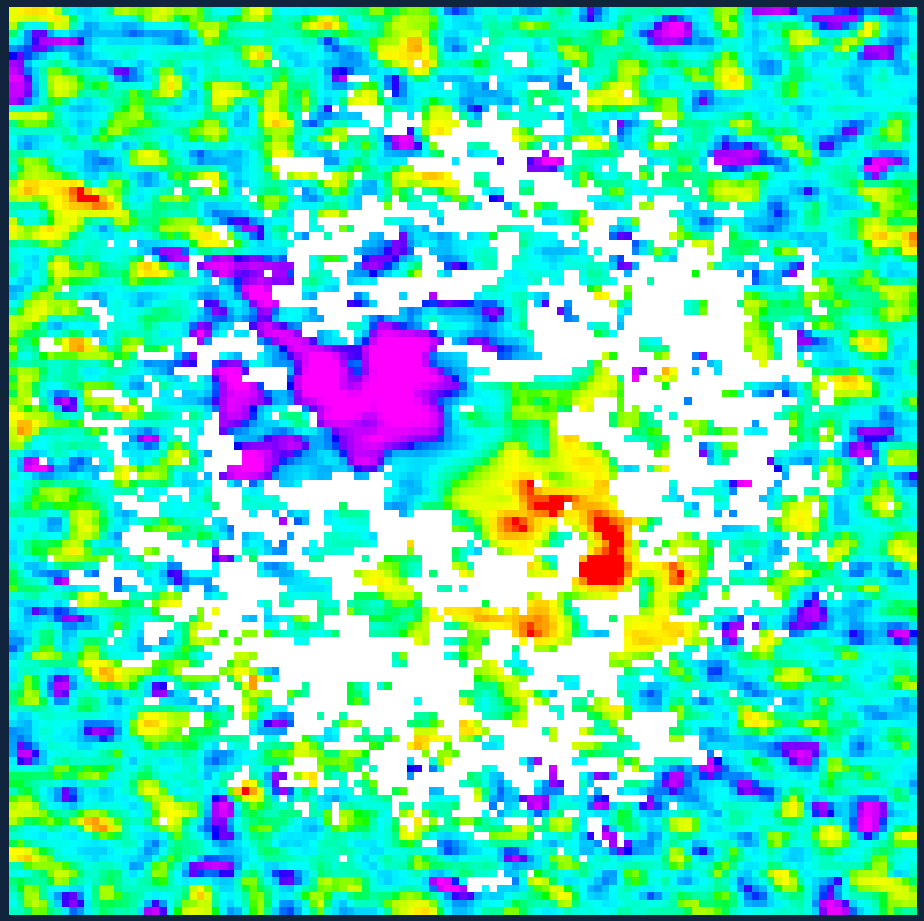
NGC_4701_CO10.residual-raster

```
+0.000324675            Pixel: 139 70 0 118
12:49:09.423  +03.23.17.020  I  785.852 km/s (lsrk/radio velocity)
```

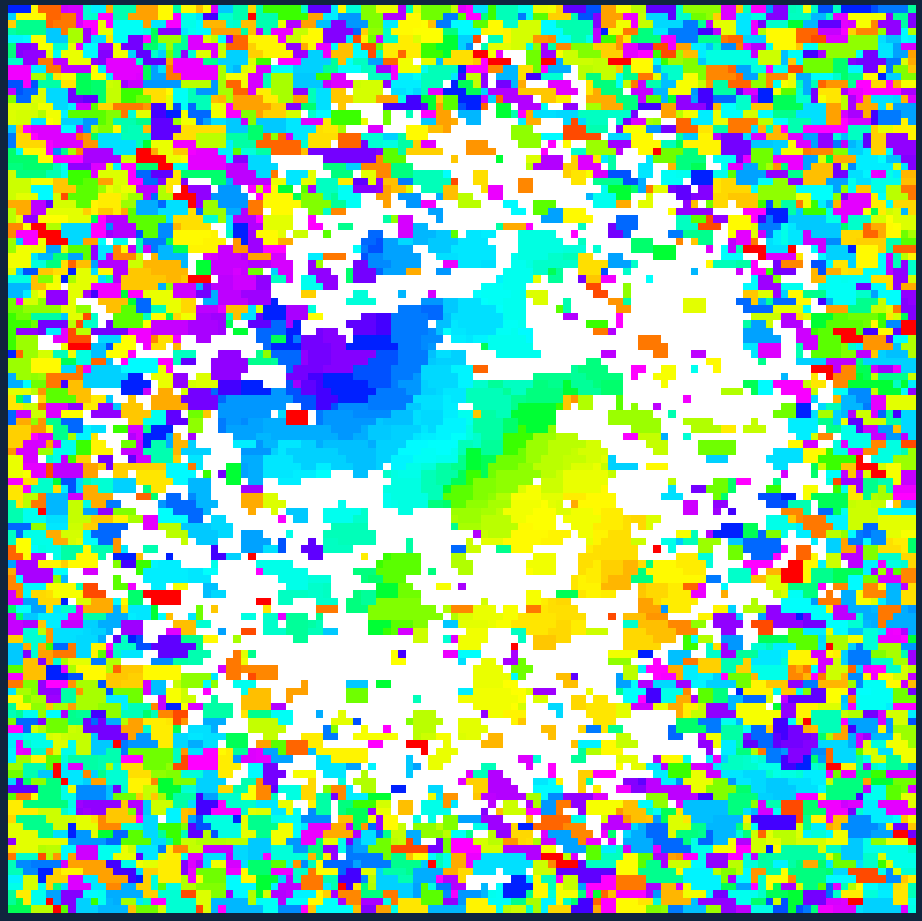
NGC_4701_CO10.mask

```
+0                      Pixel: 139 70 0 118
12:49:09.423  +03.23.17.020  I  785.852 km/s (lsrk/radio velocity)
Contours: -0.6 -0.2 0.2 0.6
```


VRAD: 6.319487e+05
NGC→4701
+3°23′45″
+23′30″
+23′15″
+23′00″
+22′45″
Declination
12h49m14s
13s
12s
11s
10s
Right Ascension
0.2
0.1
0.0
−0.1
−0.2
Jy/beam

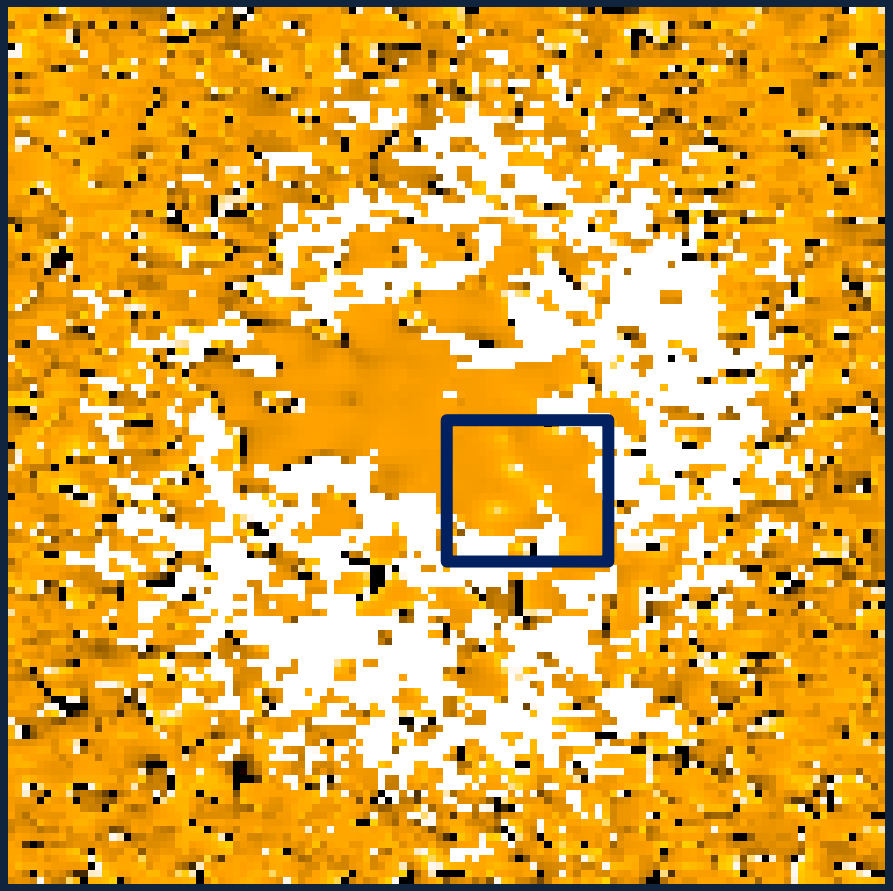


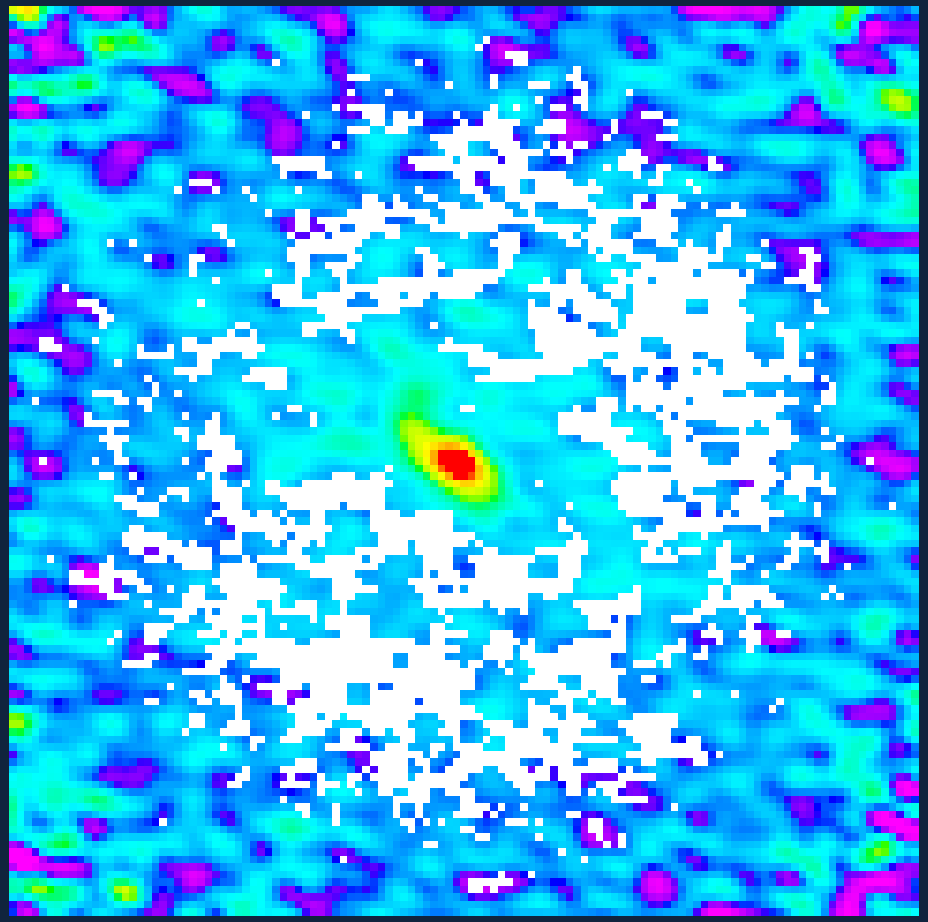
intensity weighted mean coordinate



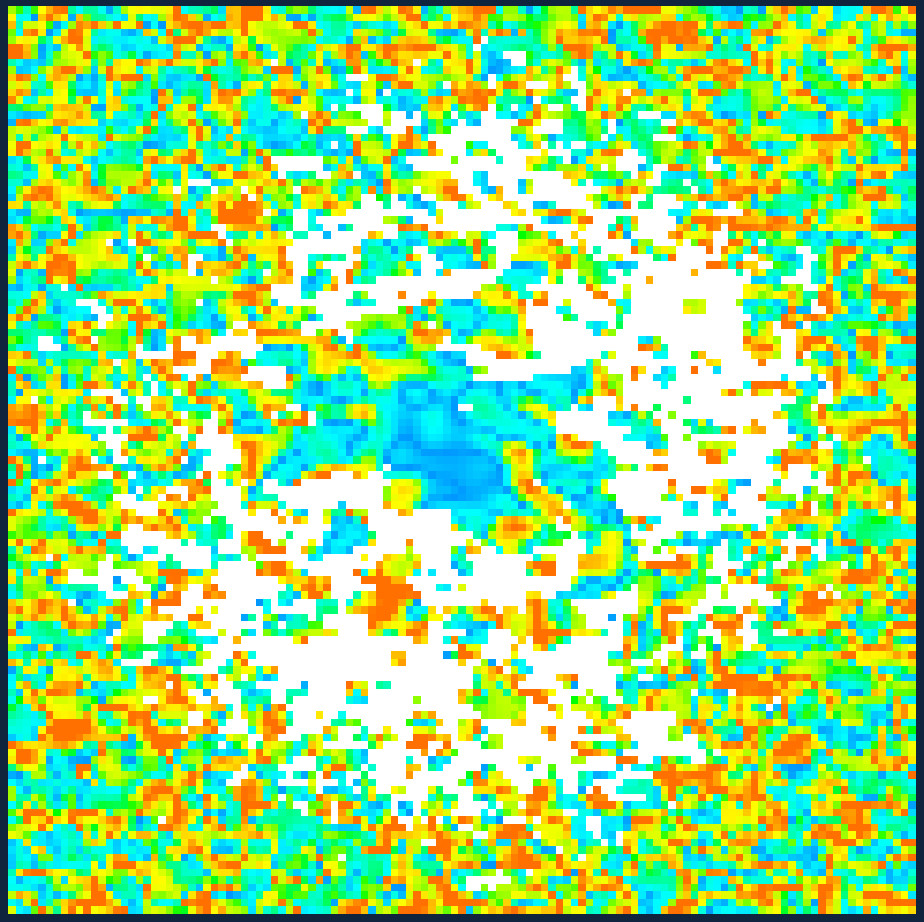
Coordinate of maximum value of the spectrum

Residual Image





Moment 0



Moment 2

kpvslice v2.0.10/Karma v1.7.25 @ubuntu:19340 (64 bit) file:

Image | ▽ Intensity | ▽ Zoom | ▽ Overlay | ▽ Export | Edit | Quit

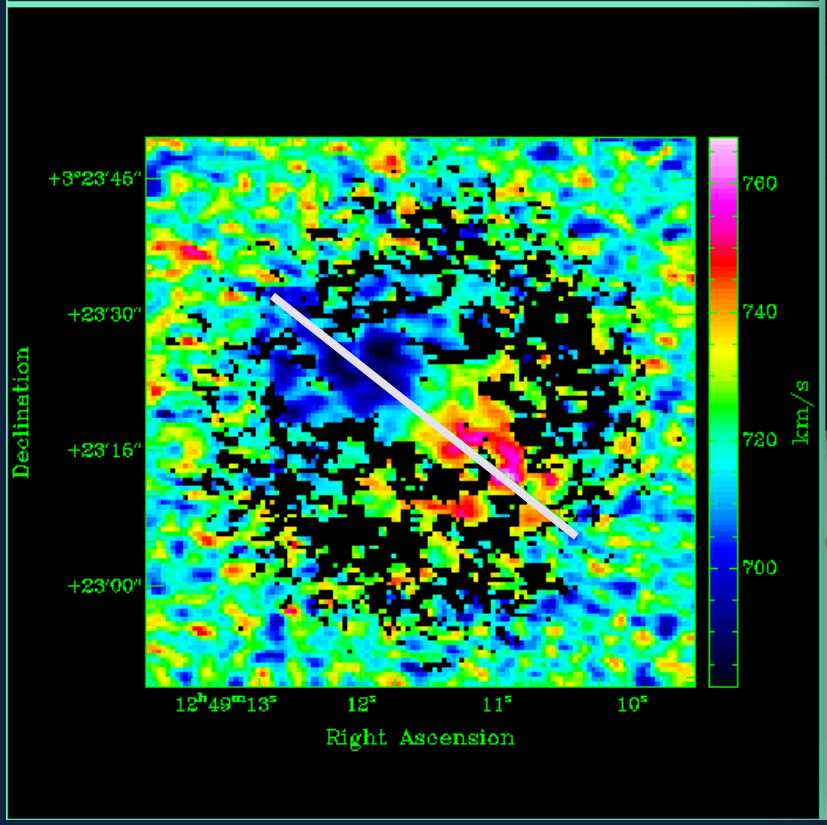
New Cube | ▽ Image Mode: loaded image | ☑ Auto Update | I-Profile

x: 120 y: 55 value: 718.195 km/s

Ra 12h 49m 9.558s Dec 03d 23m 16.92s

VRAD: 629950 Stokes I

Centre: Ra 12h 49m 11.573s Dec 03d 23m 19.60s PA: 232.4 deg



Slice Window for file: NGC_4701_CO10.pbcor.fits

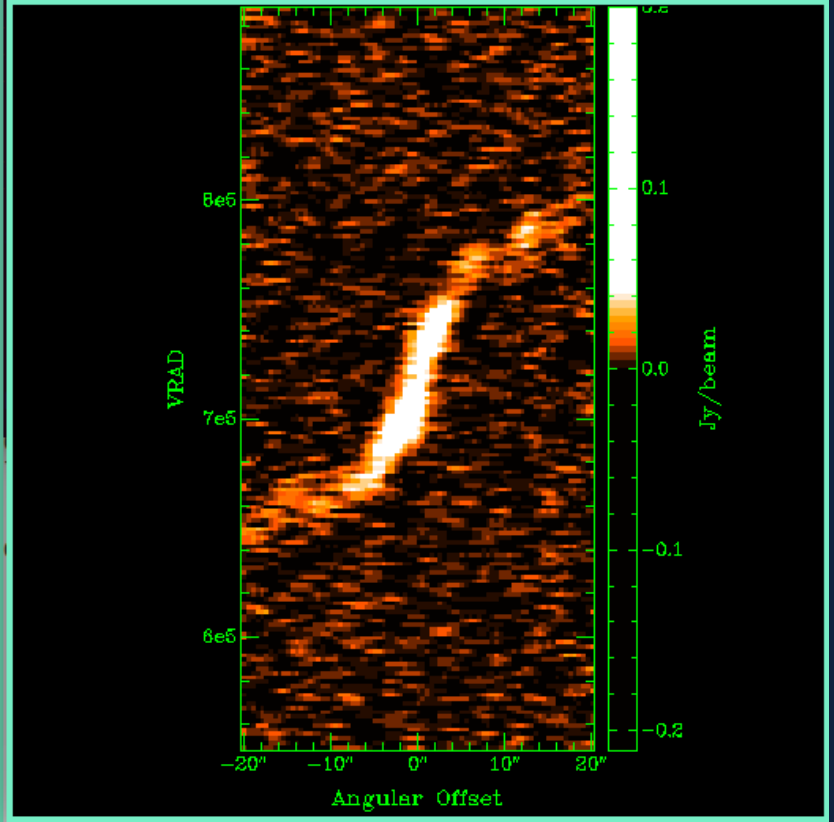
Reload Cube | ▽ Intensity | ▽ Zoom | ▽ Overlay | ▽ Export | Edit

☑ Show Trace | Z-Profile | Discard

x: 80 y: 169 value: 0.00425776 Jy/beam

Offset: 19.94 arcsec v/f: 8.877887e+05

Ra 12h 49m 10.481s Dec 03d 23m 8.16s



kpvslice v2.0.10/Karma v1.7.25 @ubuntu:19340 (64 bit) file:

Image | ▽ Intensity | ▽ Zoom | ▽ Overlay | ▽ Export | Edit | Quit

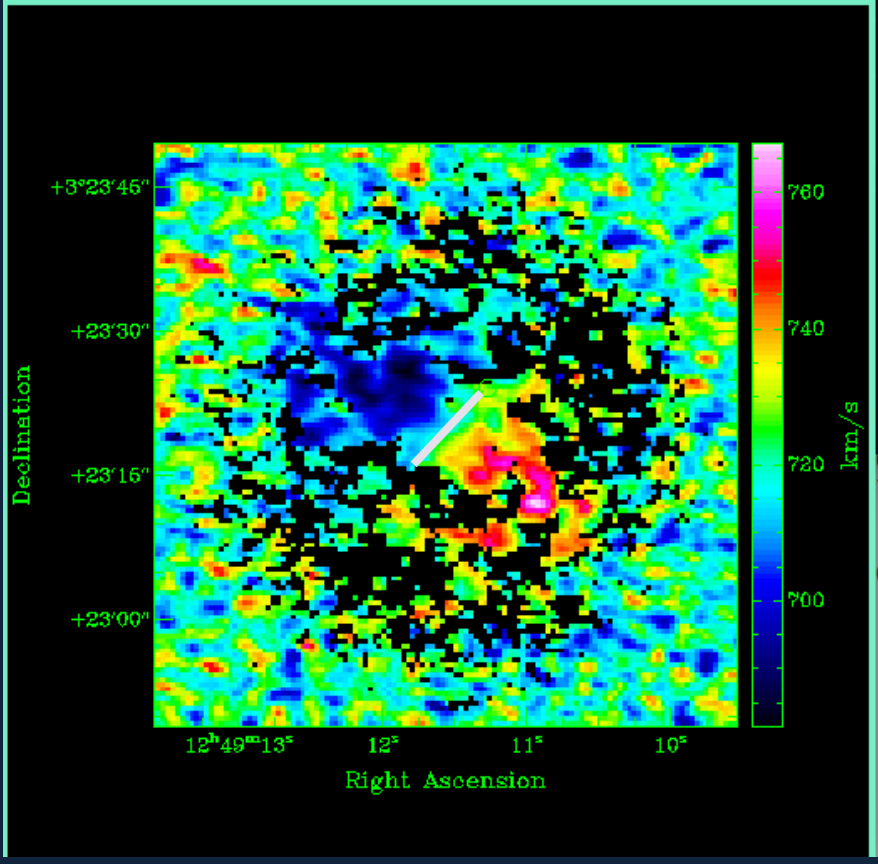
New Cube | ▽ Image Mode: loaded image | ☑ Auto Update | I-Profile

x: 120 y: 78 value: 718.656 km/s

Ra 12h 49m 9.558s Dec 03d 23m 28.42s

VRAD: 629950 Stokes I

Centre: Ra 12h 49m 11.544s Dec 03d 23m 20.21s PA: 315.0 deg



Slice Window for file: NGC_4701_CO10.pbcor.fits

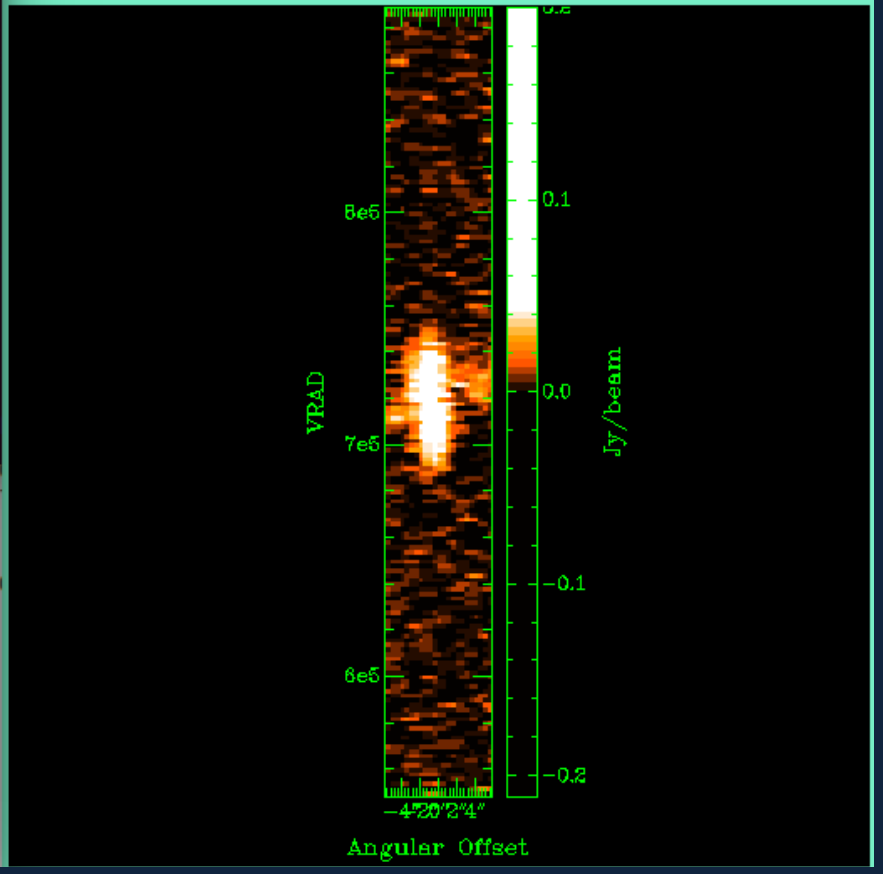
Reload Cube | ▽ Intensity | ▽ Zoom | ▽ Overlay | ▽ Export | Edit

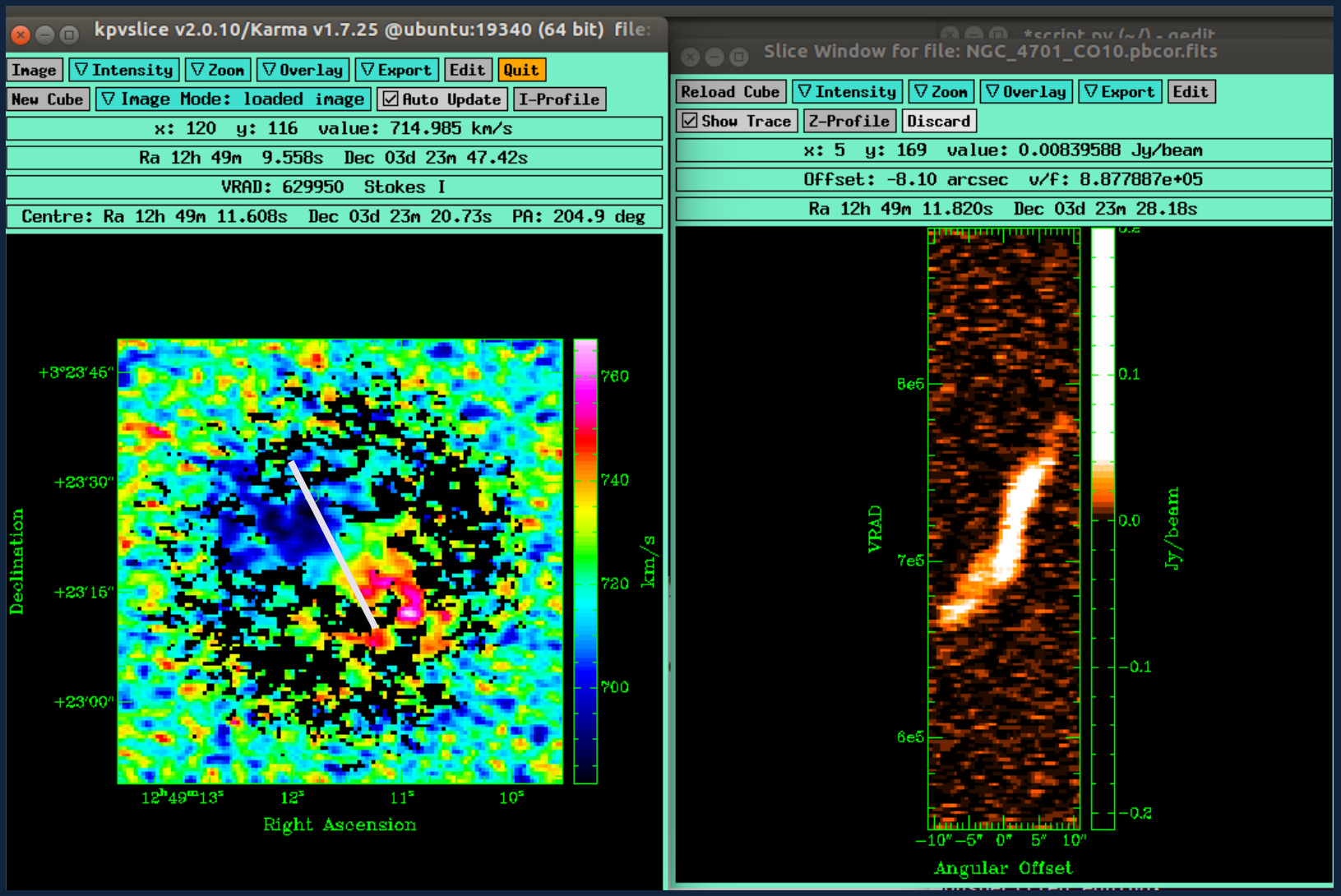
☑ Show Trace | Z-Profile | Discard

x: 22 y: 161 value: -0.00909365 Jy/beam

Offset: 5.66 arcsec v/f: 8.717987e+05

Ra 12h 49m 11.275s Dec 03d 23m 24.20s




kpvslice v2.0.10/Karma v1.7.25 @ubuntu:19340 (64 bit) file:
Image
Intensity
Zoom
Overlay
Export
Edit
Quit
New Cube
Image Mode: loaded image
Auto Update
I-Profile
x: 120 y: 116 value: 714.985 km/s
Ra 12h 49m 9.558s Dec 03d 23m 47.42s
VRAD: 629950 Stokes I
Centre: Ra 12h 49m 11.608s Dec 03d 23m 20.73s PA: 204.9 deg
+3°23'46"
+23'30"
+23'16"
+23'00"
Declination
760
740
720
700
km/s
12h49m13s
12s
11s
10s
Right Ascension
Slice Window for file: NGC_4701_CO10.pbcor.fits
Reload Cube
Intensity
Zoom
Overlay
Export
Edit
Show Trace
Z-Profile
Discard
x: 5 y: 169 value: 0.00839588 Jy/beam
Offset: -8.10 arcsec v/f: 8.877887e+05
Ra 12h 49m 11.820s Dec 03d 23m 28.18s
8e5
7e5
6e5
VRAD
0.1
0.0
-0.1
-0.2
Jy/beam
-10" -5" 0" 5" 10"
Angular Offset

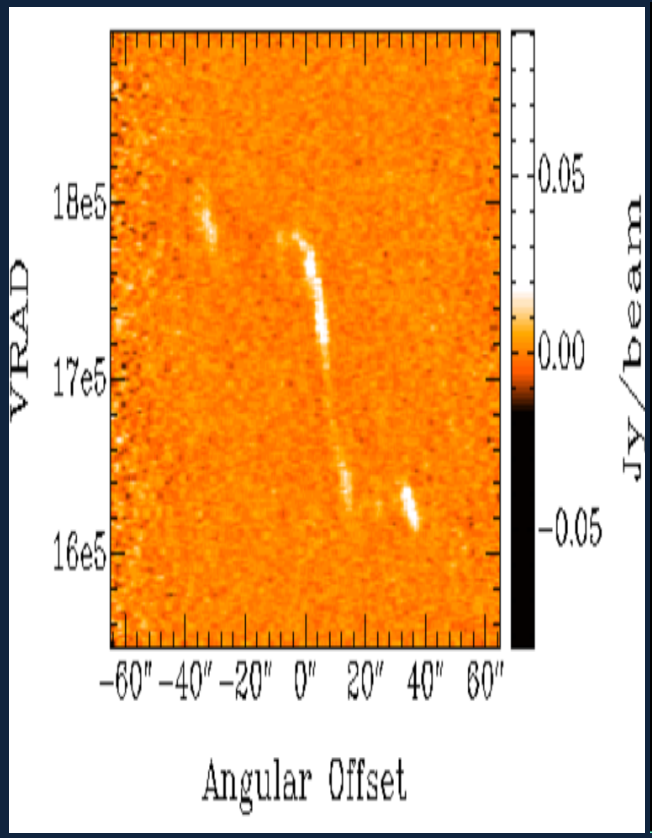
Analysis

$$\Delta v = 88\ km/s$$
$$i = 43°$$
$$v_{200} \approx V_{rad} = \frac{\Delta v}{\sin(i)}$$

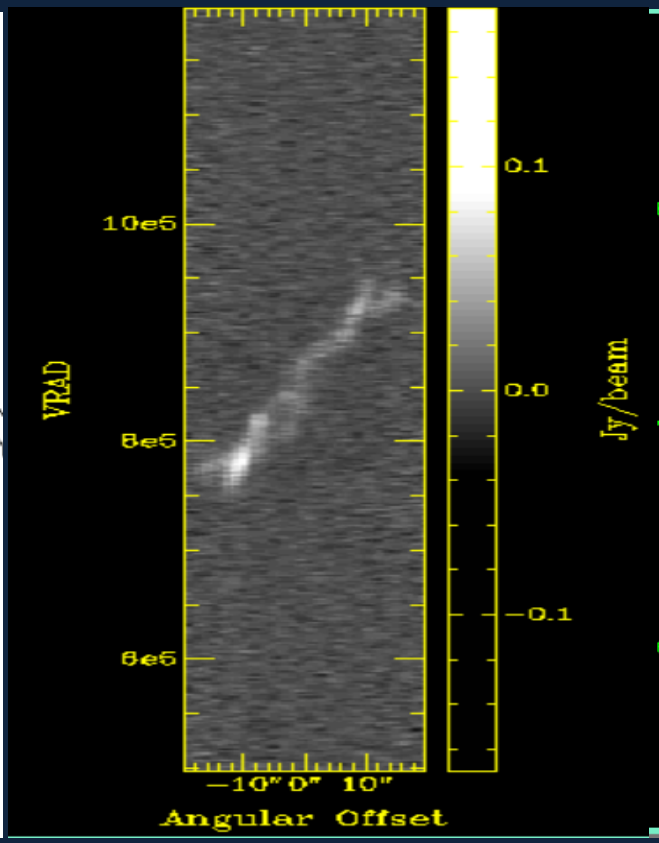
- $$M_{dyn} = 200 \times \frac{3H_0^2}{8\pi G} \times \frac{4\pi R_{200}^3}{3} \approx 3.29 \times 10^5 \times V_{200}^3$$

$$\therefore M_{dyn} = 2.2 \times 10^{11} M_{sol}$$

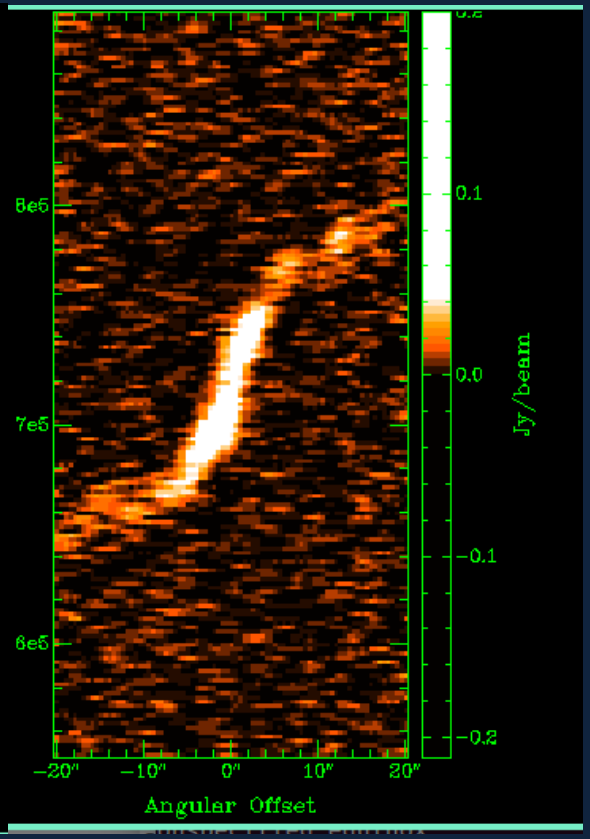
P-V DIAGRAM



$M_{dyn} = 1.7 \times 10^{11} M_{sol}$



$M_{dyn} = 1.13 \times 10^{11} M_{sol}$



$M_{dyn} = 2.2 \times 10^{11} M_{sol}$

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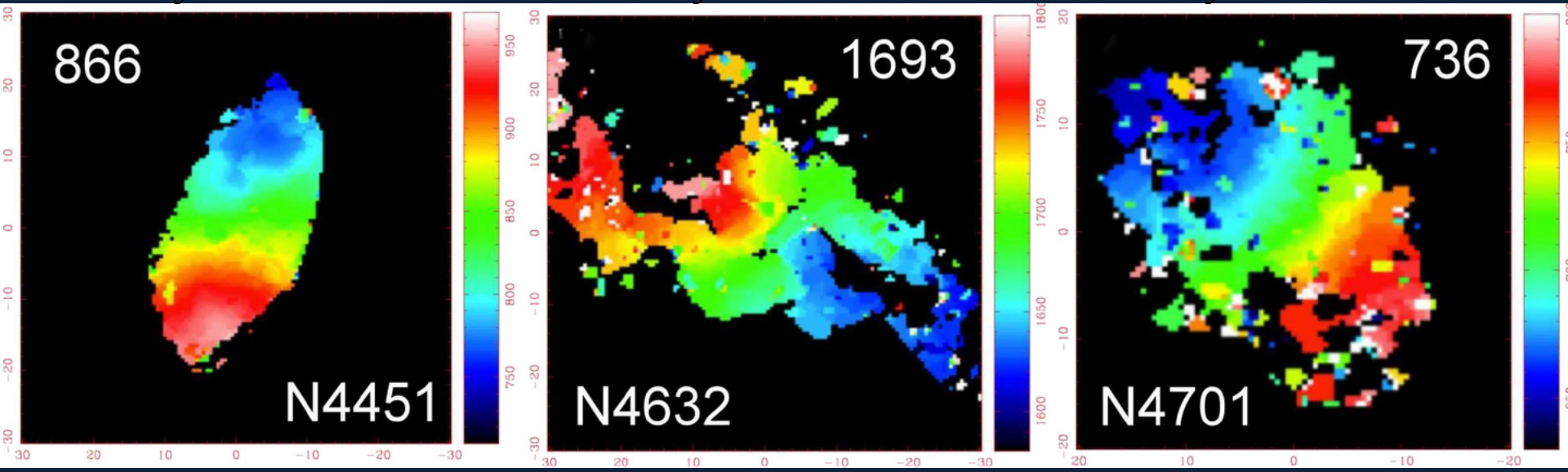
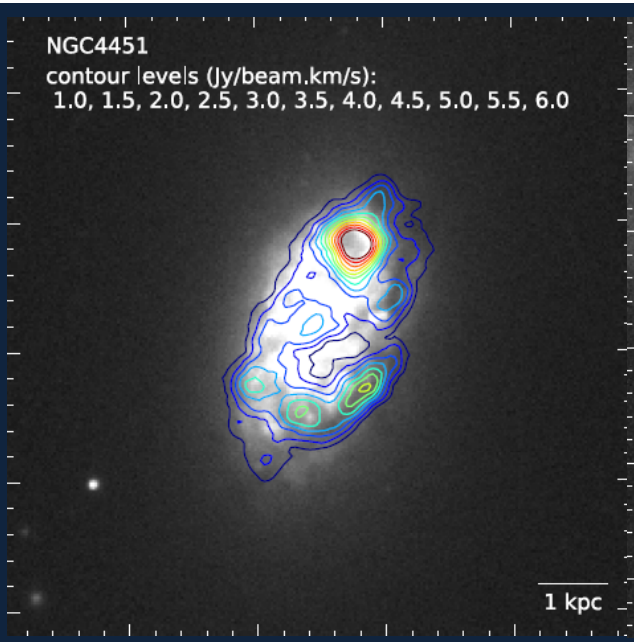
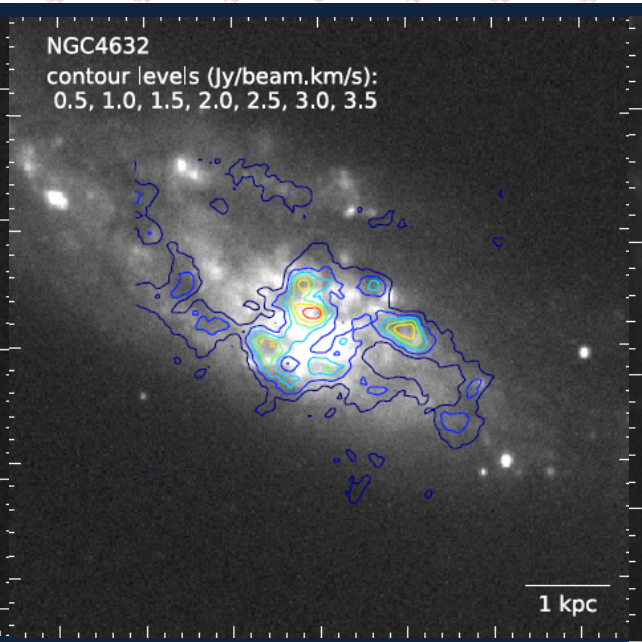
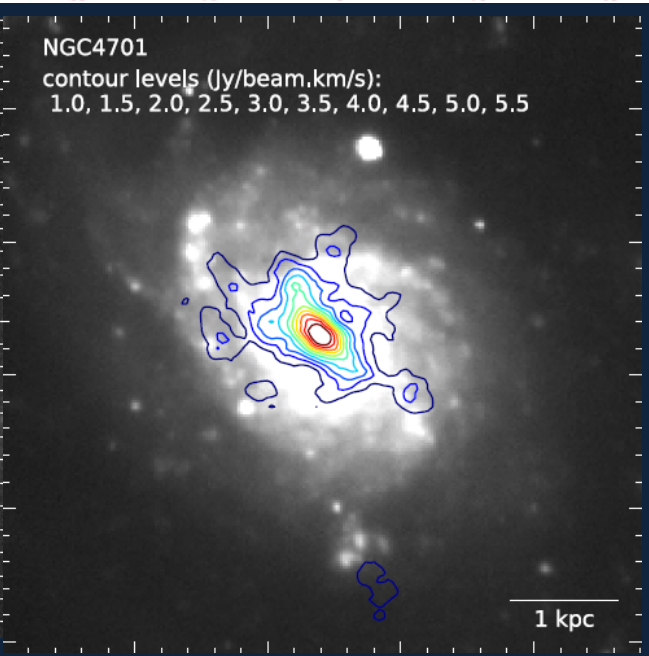
$M_{dyn} = 1.86 \times 10^{10} M_{sol}$ $M_{dyn} = 2.25 \times 10^{10} M_{sol}$ $M_{dyn} = 1.64 \times 10^{10} M_{sol}$









Thank you :D