

Final presentation

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HD 163296

(17 56 21.287 , -21 57 22.39, J2000)

- Herbig Ae star
- 2.3 solar mass
- 122pc from Earth
- inclination :45deg
- gas disc radius:550 au

ALMA SV data

Band6

Antennas: 12m, 24

Baselines : 20-400m

Date:2012/ 6/9, 6/23, 7/7

Total time: 84 minutes

Band7

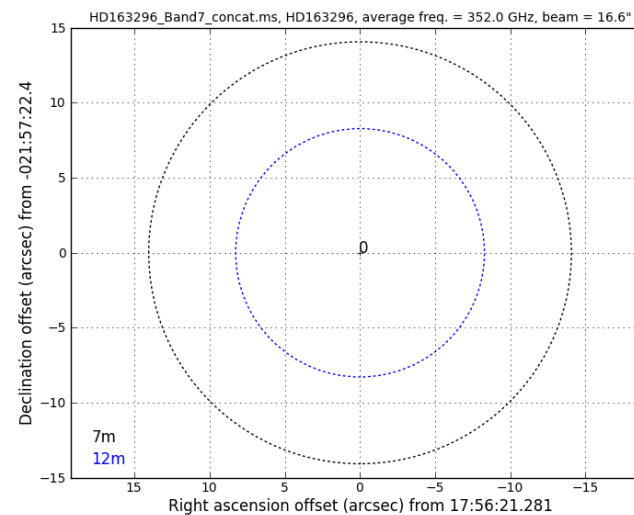
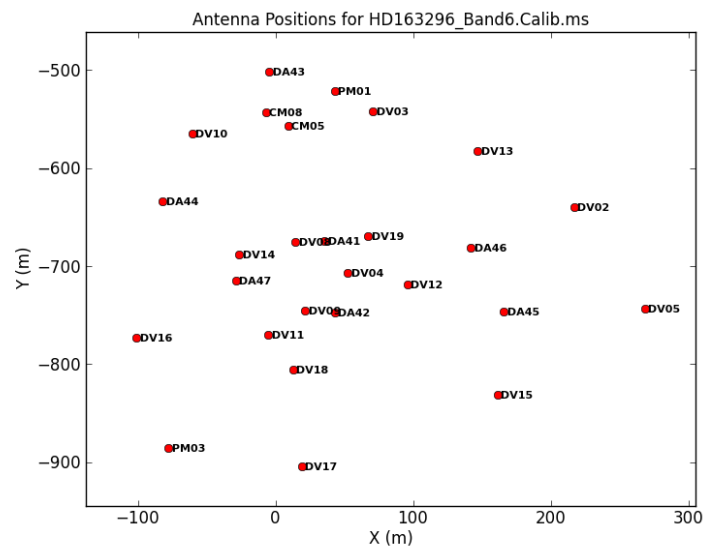
Antennas: 12m, 24

Baselines : 20-400m

Date:2012/ 6/9, 6/11, 7/22

Total time: 140 minutes

(Rosenfeld et al., 2013)



Continuum image

Clean:

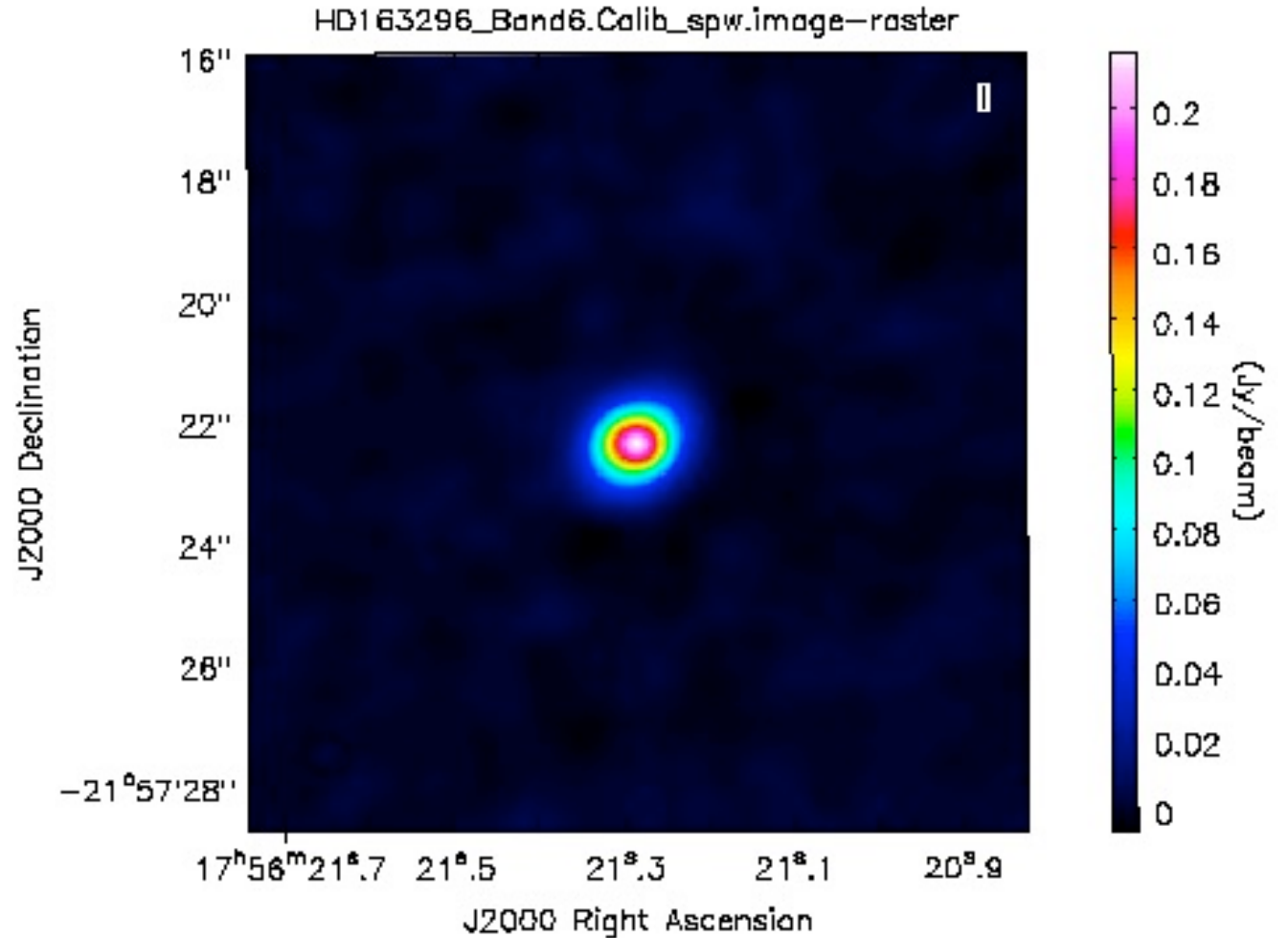
threshold: $3 * 4.531067e-3$ Jy

Beam: $0.789794''$ $0.622658''$, 71.601 deg

Noise: $1.653 * e-3$ Jy/beam

Flux integrated: 486.7 ± 5.4 mJy

Peak : 197.7 ± 1.6 mJy/beam



Clean:

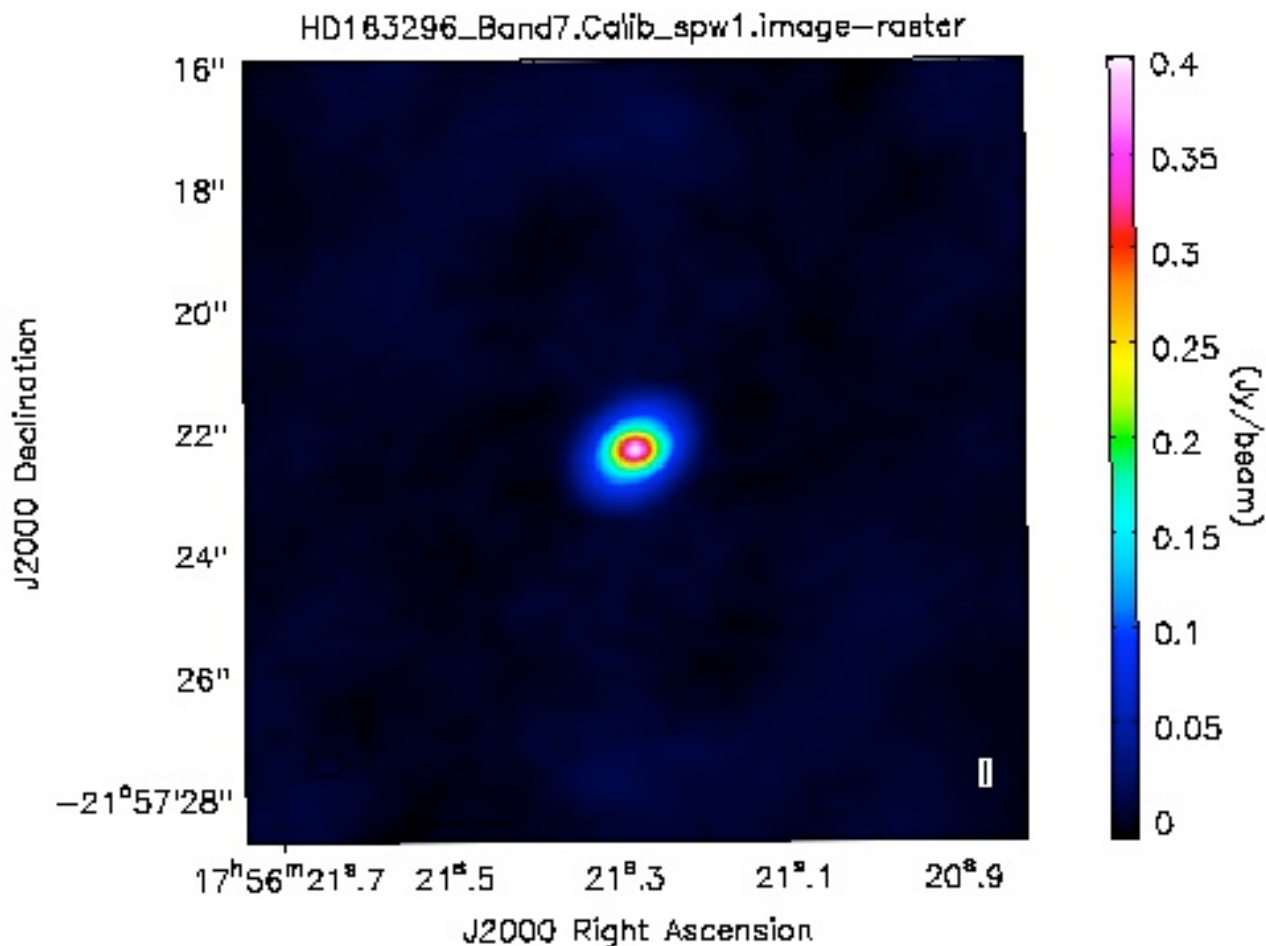
threshold: $3 * 7.045e-3$ Jy

Beam : 0.5495 arcsec, 0.383234 arcsec,
82.9181 deg

Noise: $2.825 * e-2$ Jy/beam

Flux integrated: 1.395 ± 0.014 Jy

Peak : 325.3 ± 2.6 mJy/beam



Spectral line emission

band6			band7	
SpWID2	SpWID1		SpWID2	SpWID1
$^{12}\text{CO}(J=2-1)$	$^{13}\text{CO}(J=2-1)$	$\text{C}^{18}\text{O}(J=2-1)$	$^{12}\text{CO}(J=3-2)$	$\text{HCO}^+(J=4-3)$
230.538GHz	220.399GHz	219.560GHz	345.796GHz	356.734GHz

(Rosenfeld et al., 2013)

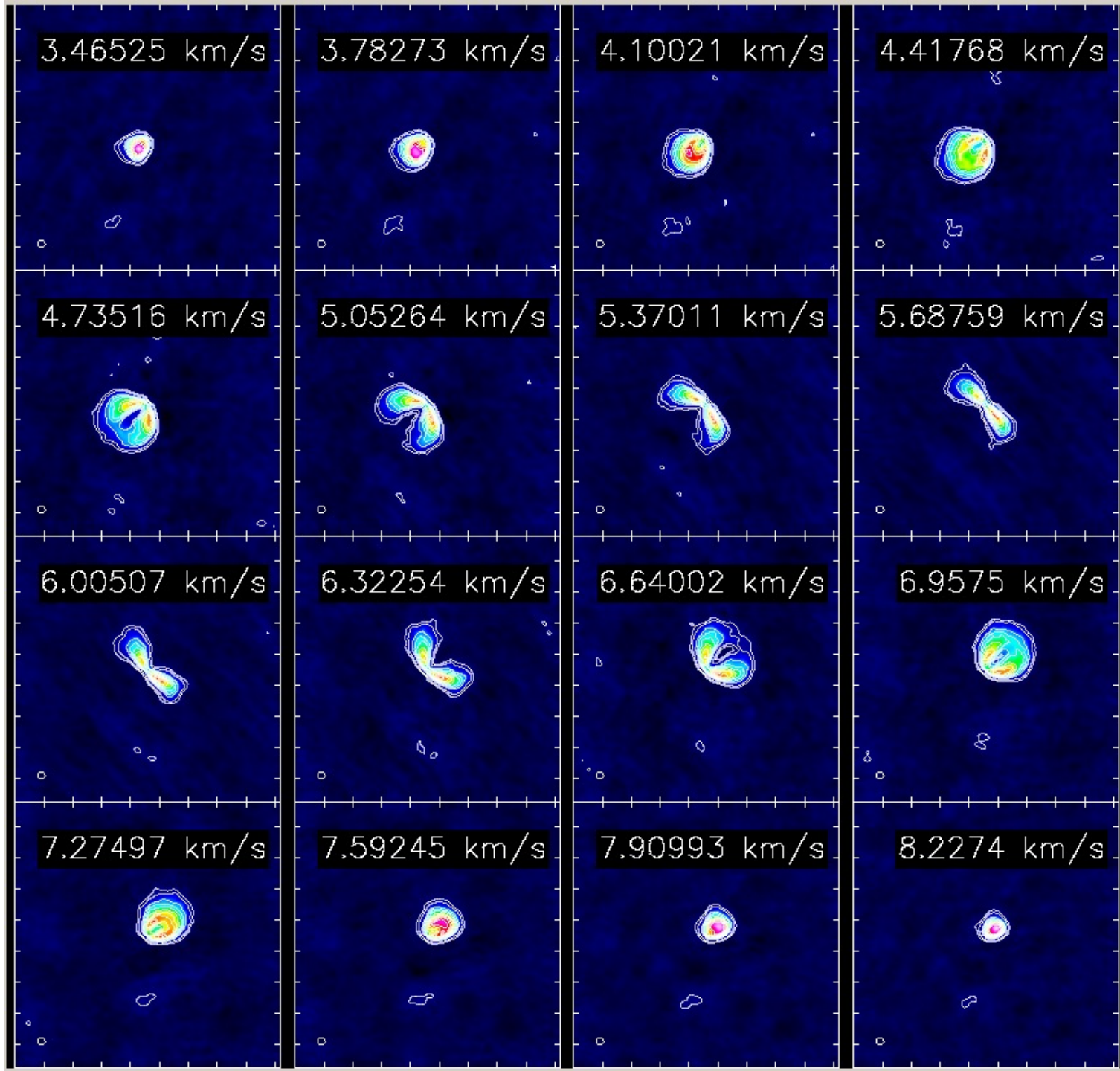
$^{12}\text{CO}(J=2-1)$

Channel width: 0.3175 km/s

$\sigma = 1.455 \times 10^{-2}$ Jy/beam

Contour level:

$\sigma^* [3, 6, 10 + 5n] (n=1, 2, 3, \dots, 8)$



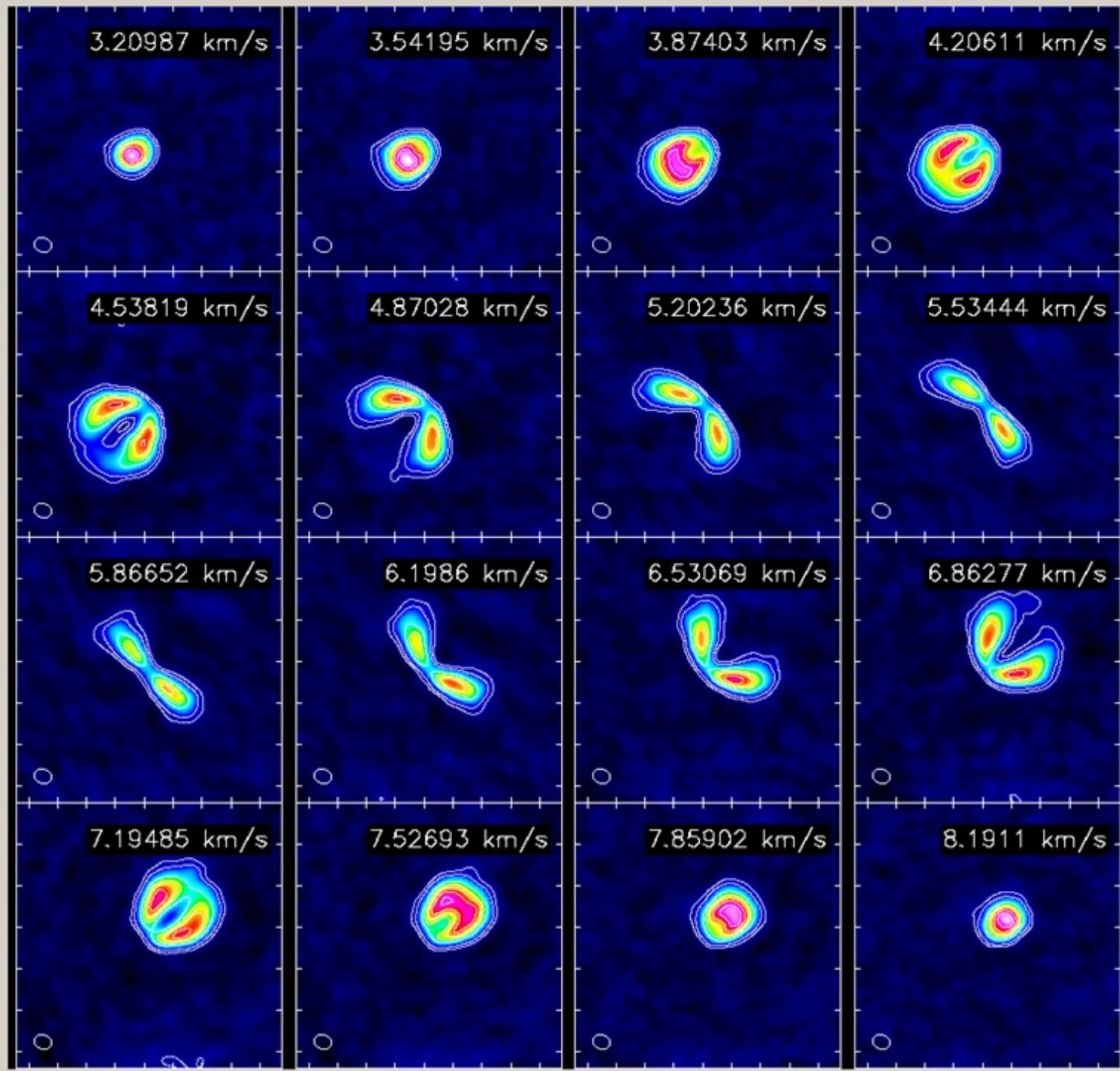
$^{13}\text{CO}(J=2-1)$

Channel width: 0.3321km/s

$\sigma = 1.17\text{e-}2$ Jy/beam

Contour level:

$\sigma^*[3,6,10+5n](n=1,2,3,\dots,8)$



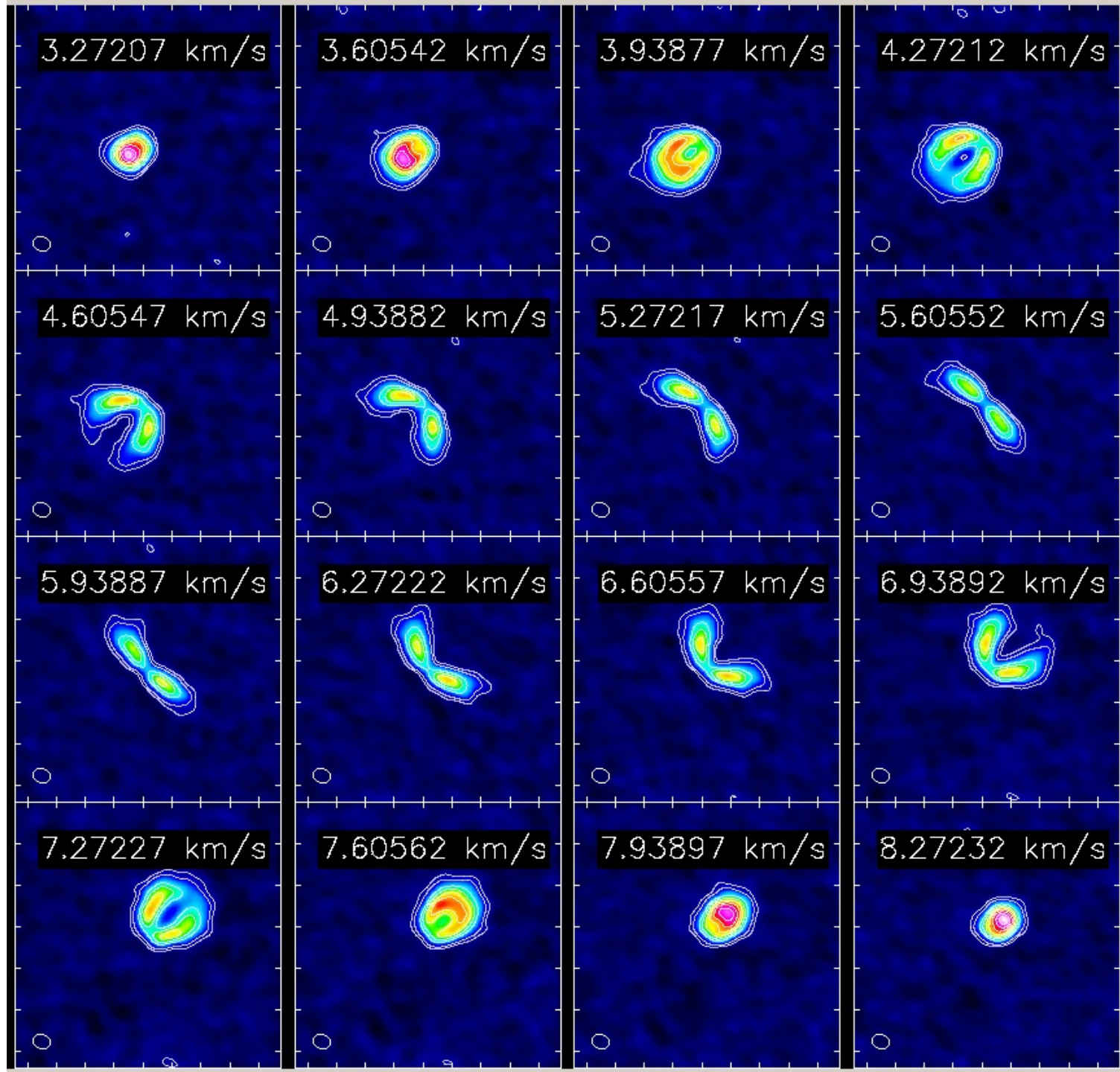
$C^{18}O(J=2-1)$

Channel width: 0.3335 km/s

$\sigma = 5.470e-3$ Jy/beam

Contour level:

$\sigma^* [3, 6, 10 + 5n] (n=1, 2, 3, \dots, 8)$



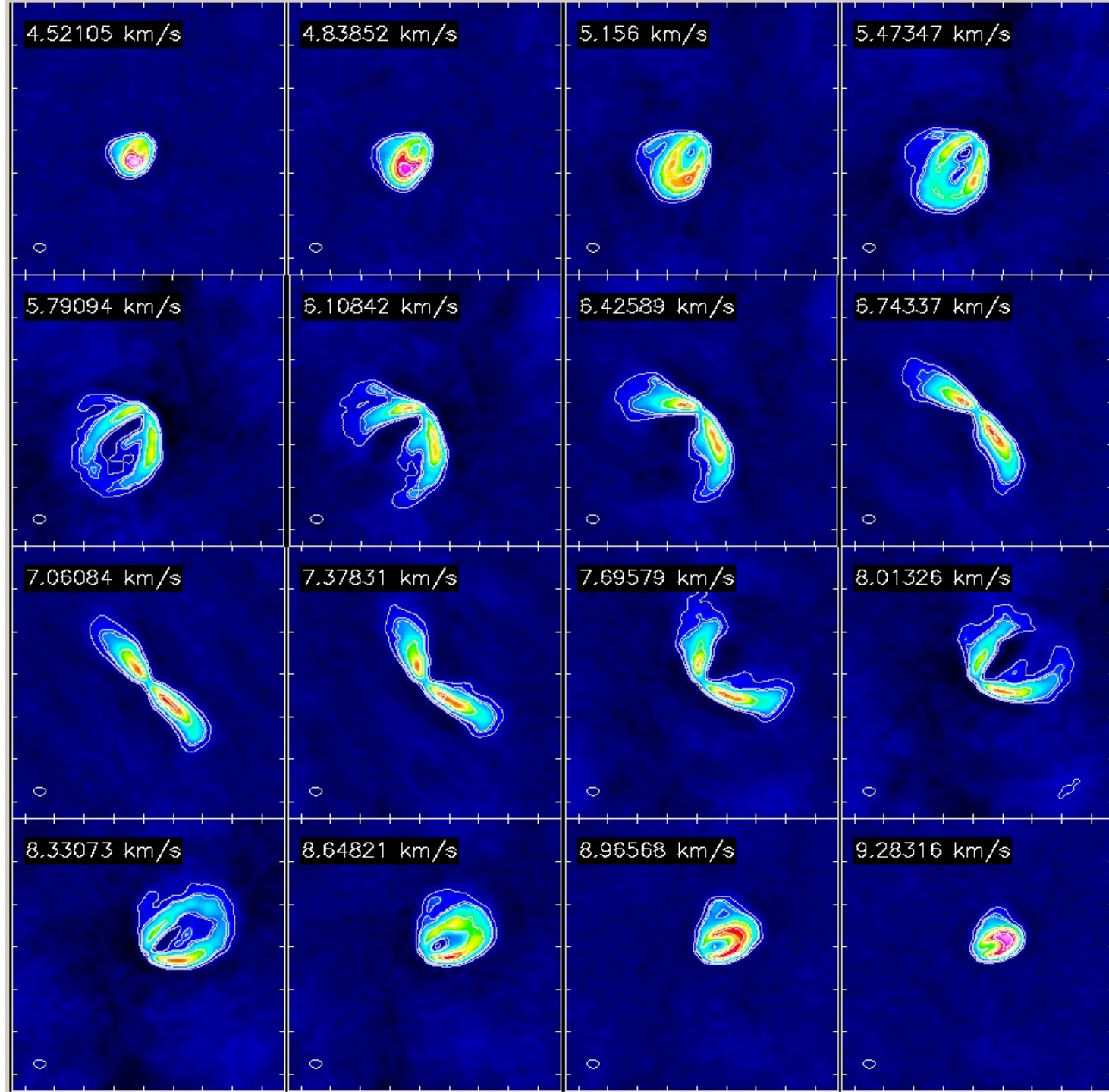
$^{12}\text{CO}(J=3-2)$

Channel width: 0.3175km/s

$\sigma = 1.4317\text{e-}2$ Jy/beam

Contour level:

$\sigma^* [3, 6, 10 + 5n] (n=1, 2, 3, \dots, 8)$



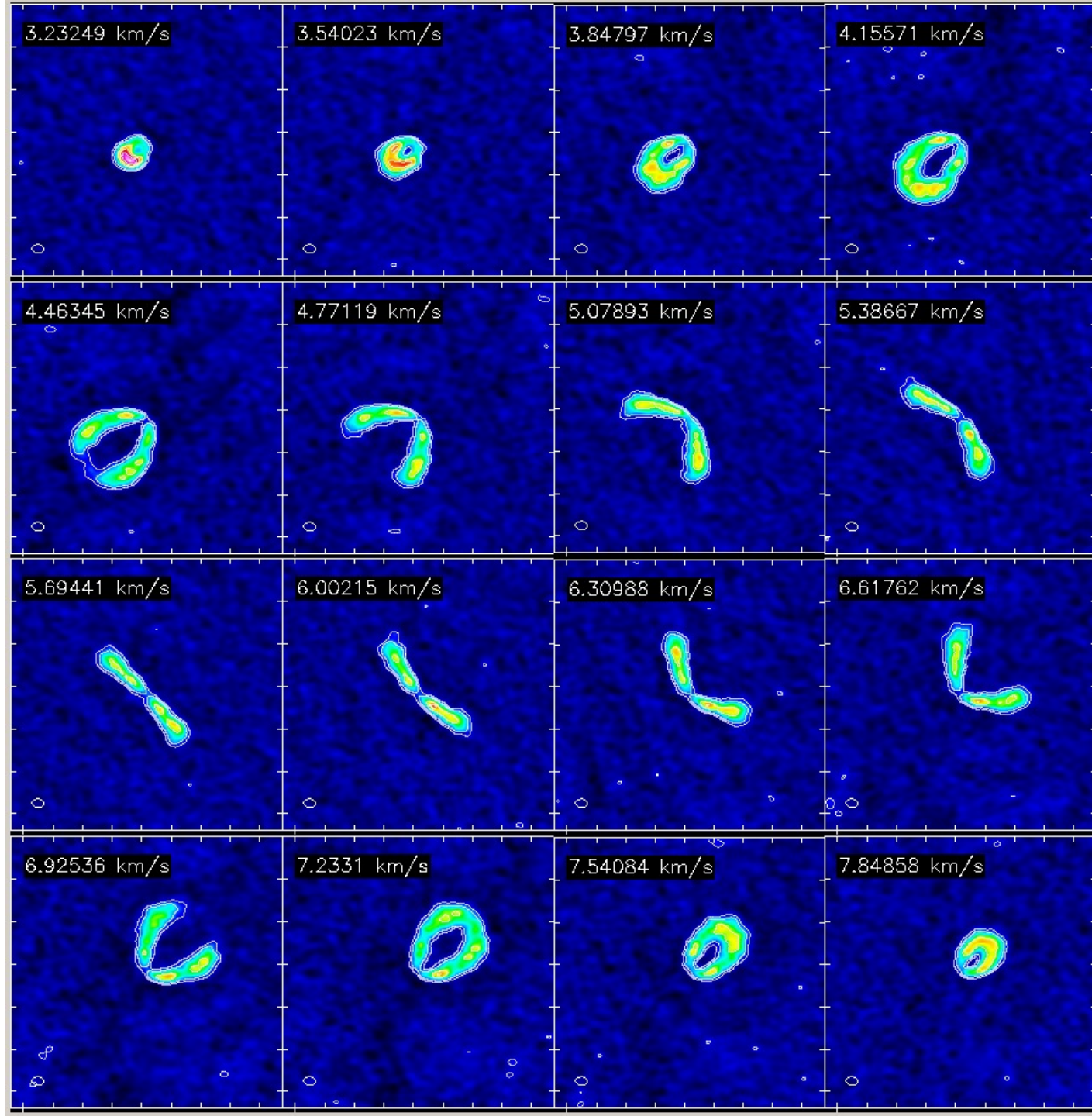
HCO⁺(J=4-3)

Channel width: 0.30774km/s

$\sigma = 1.408 \times 10^{-2}$ Jy/beam

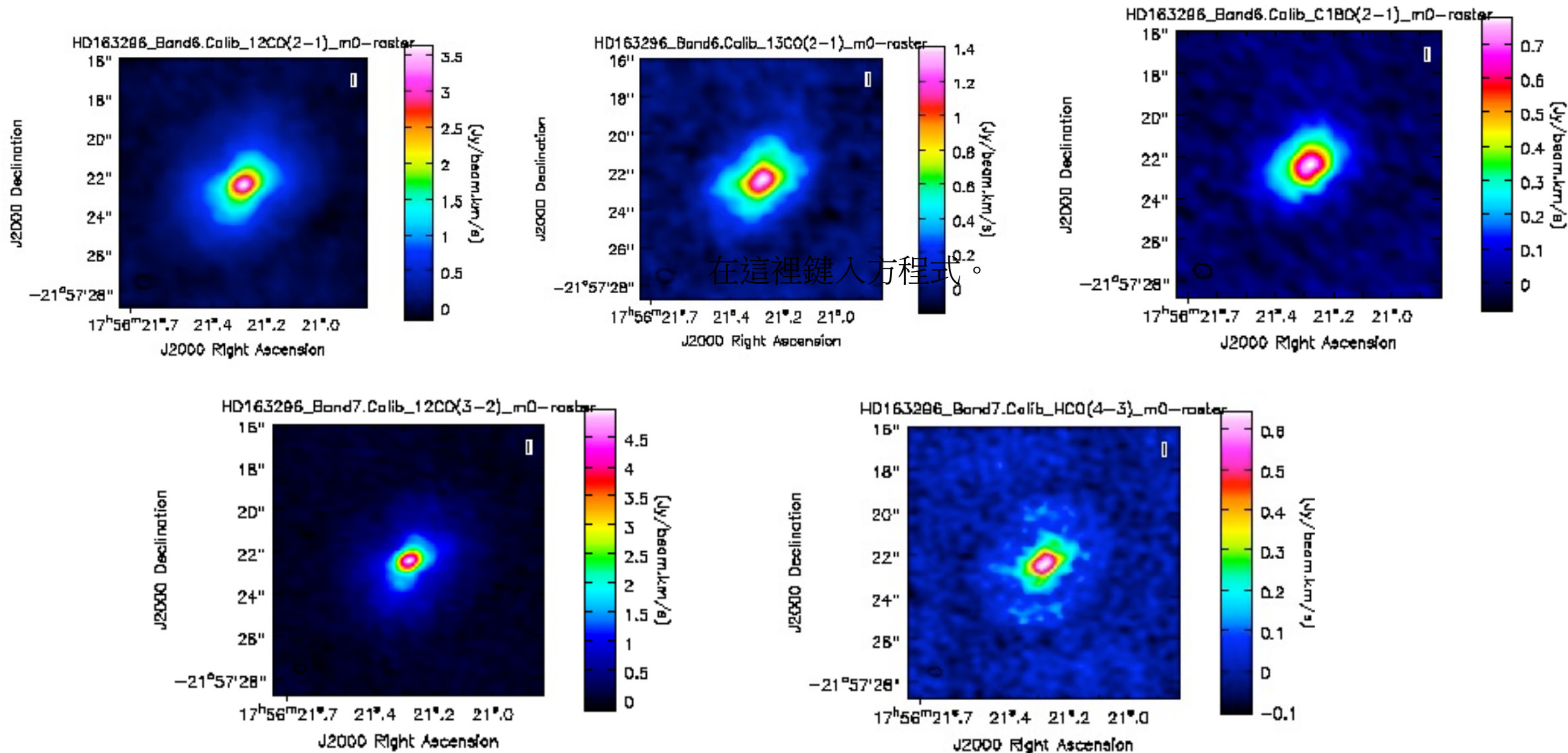
Contour level:

$\sigma^* [3, 6, 10 + 5n] (n=1, 2, 3, \dots, 8)$



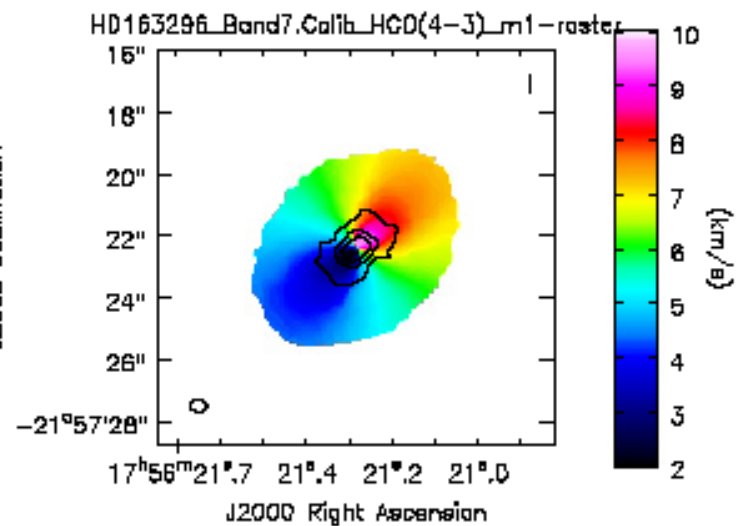
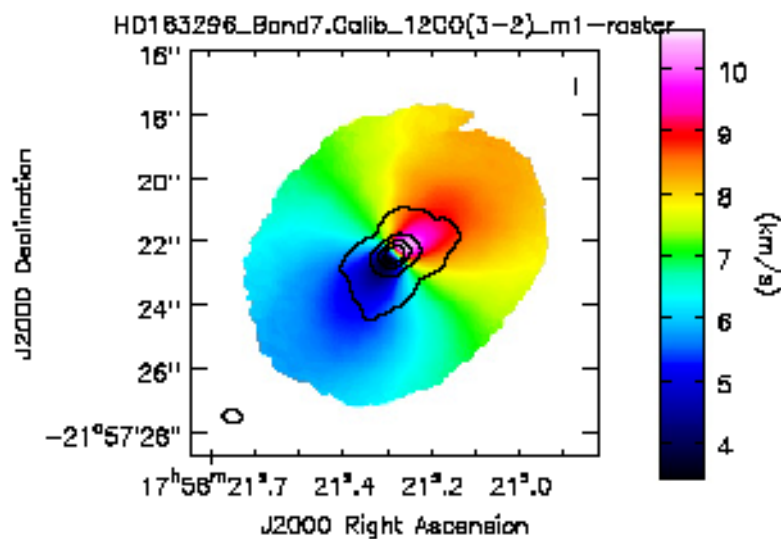
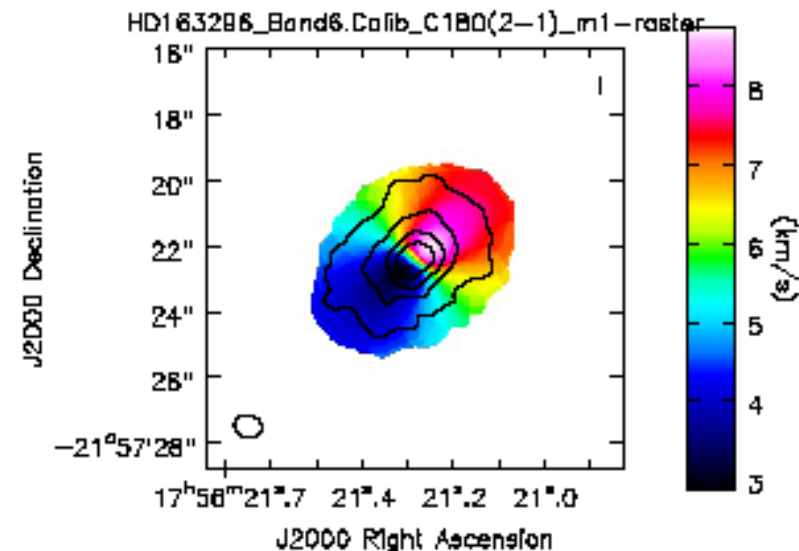
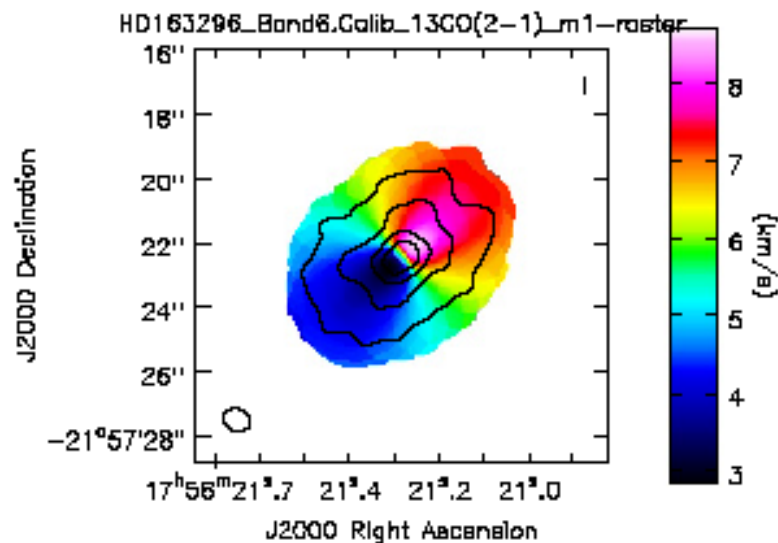
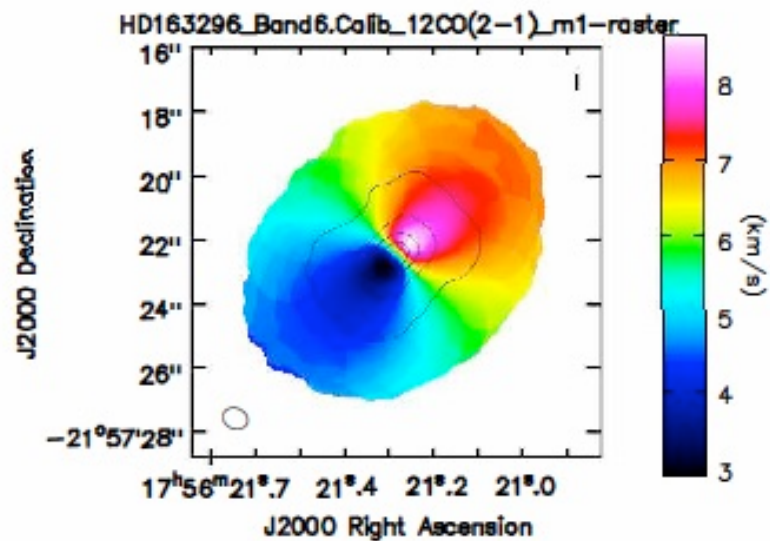
Moment 0

$$M_0 = \Delta v \sum I_i$$



Moment 1 (average velocity fields)

$$M_1 = \frac{\sum I_i v_i}{M_0}$$

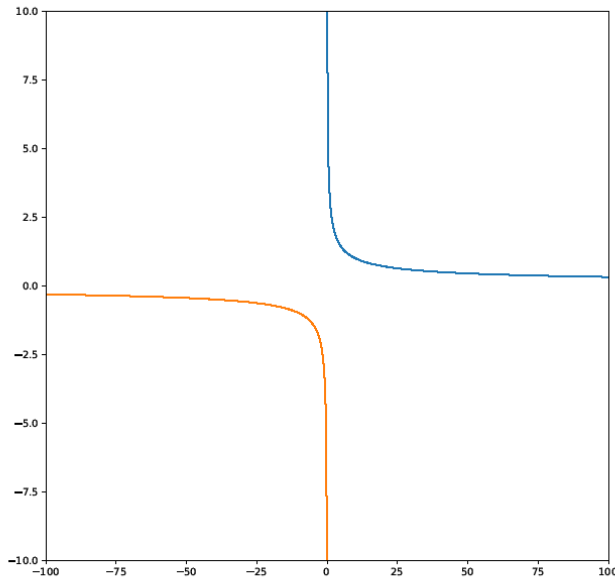


Position-Velocity diagrams

length = '12arcsec'

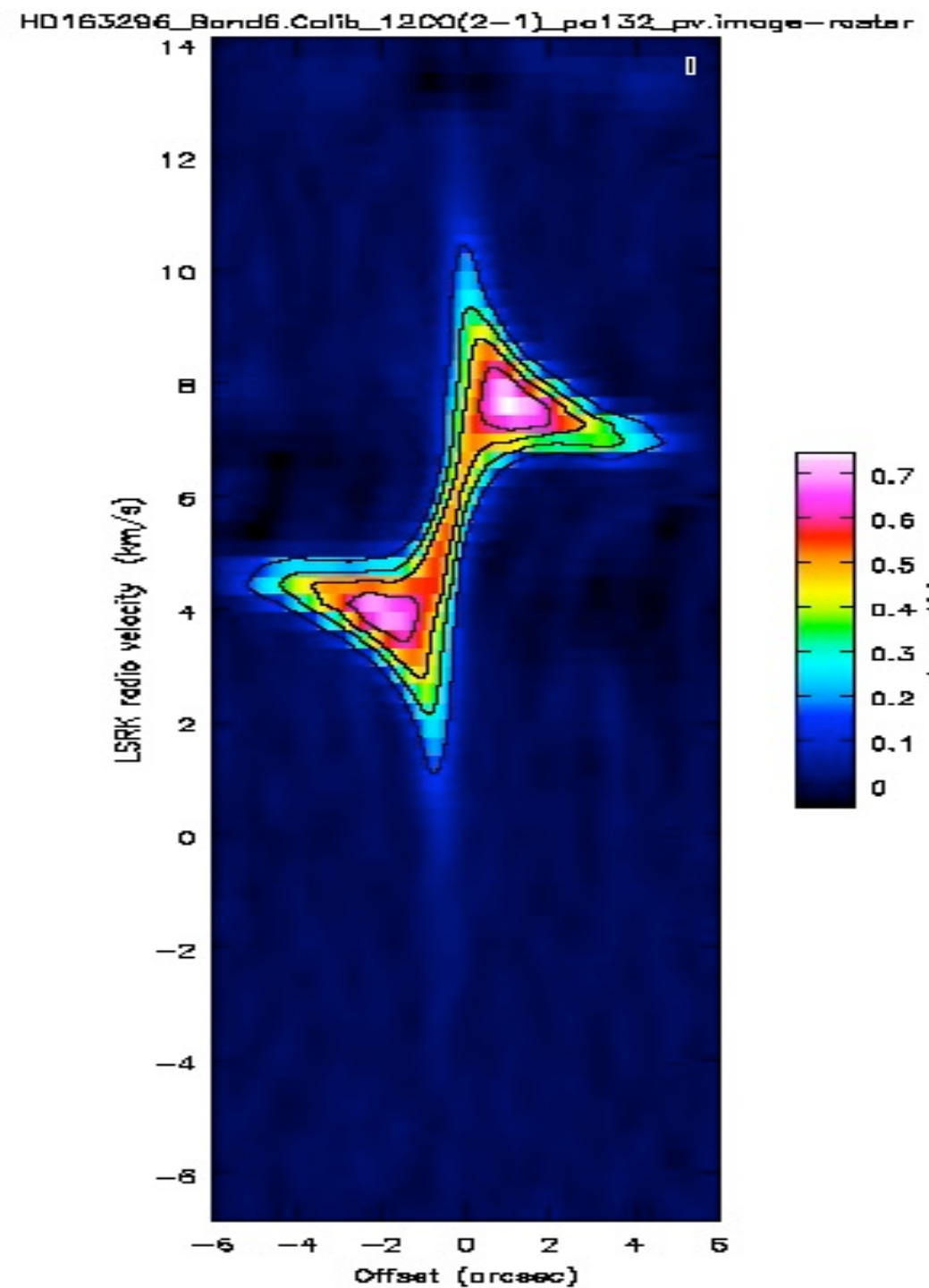
pa = '132deg'(Rosenfeld et al., 2013)

Keplerian rotation $v^2 = \frac{GM}{R}$

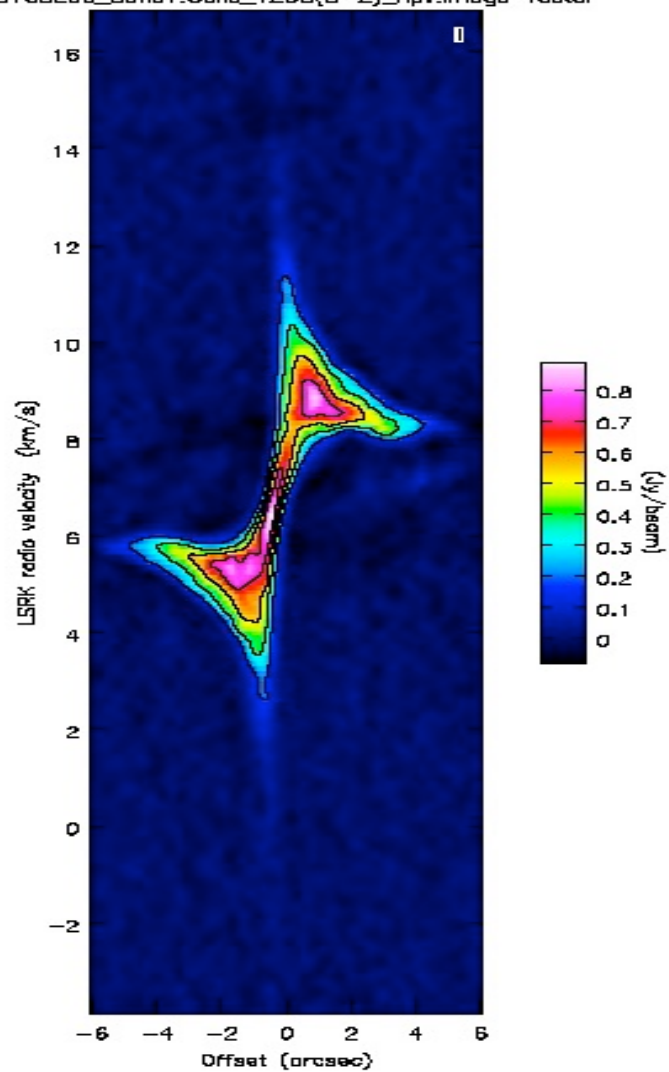


$$y = \sqrt{\frac{GM}{|x|}}, \quad x > 0$$

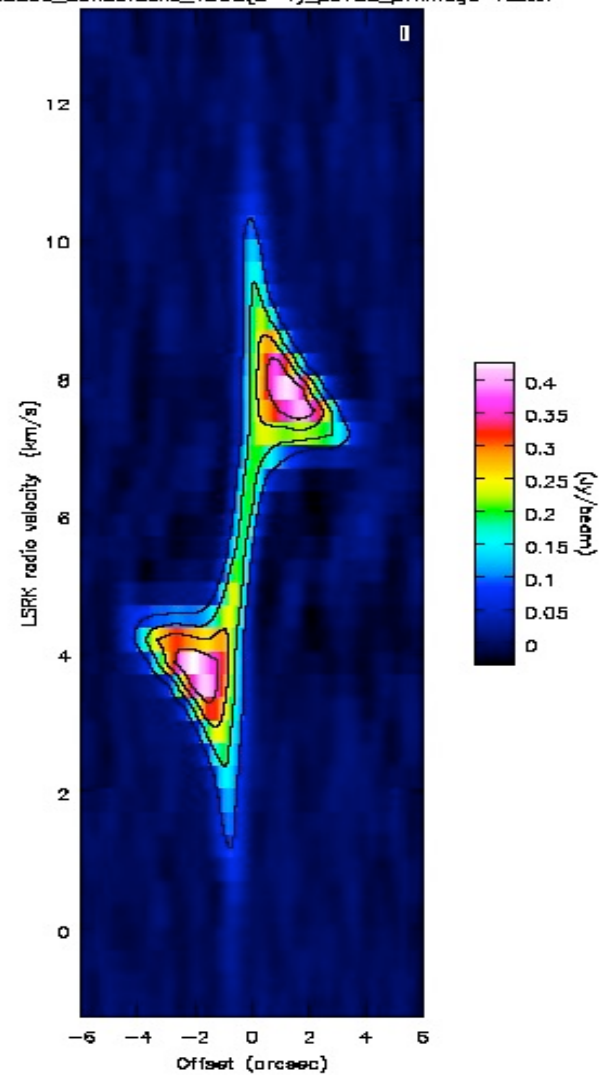
$$y = -\sqrt{\frac{GM}{|x|}}, \quad x < 0$$



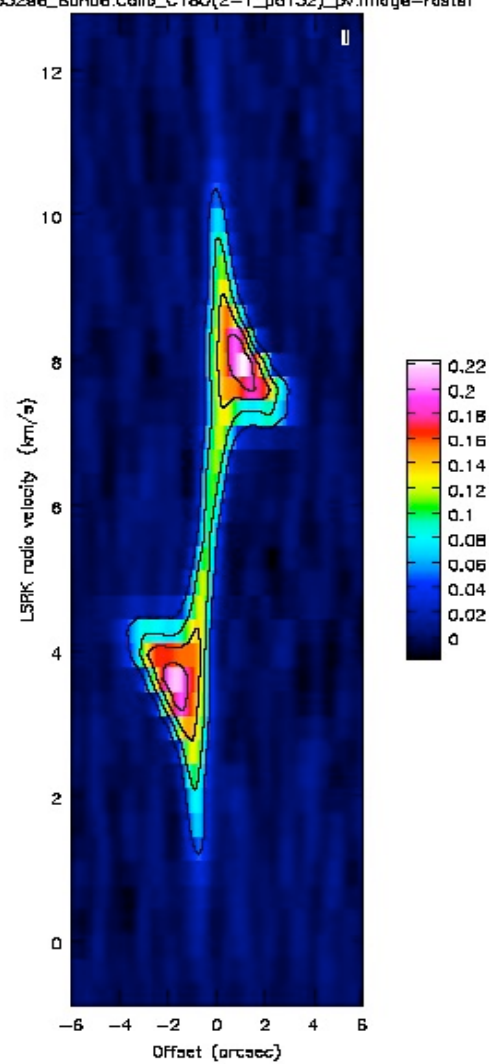
HD163296_Band7_Calib_1200(3-2)_npv.image--raster



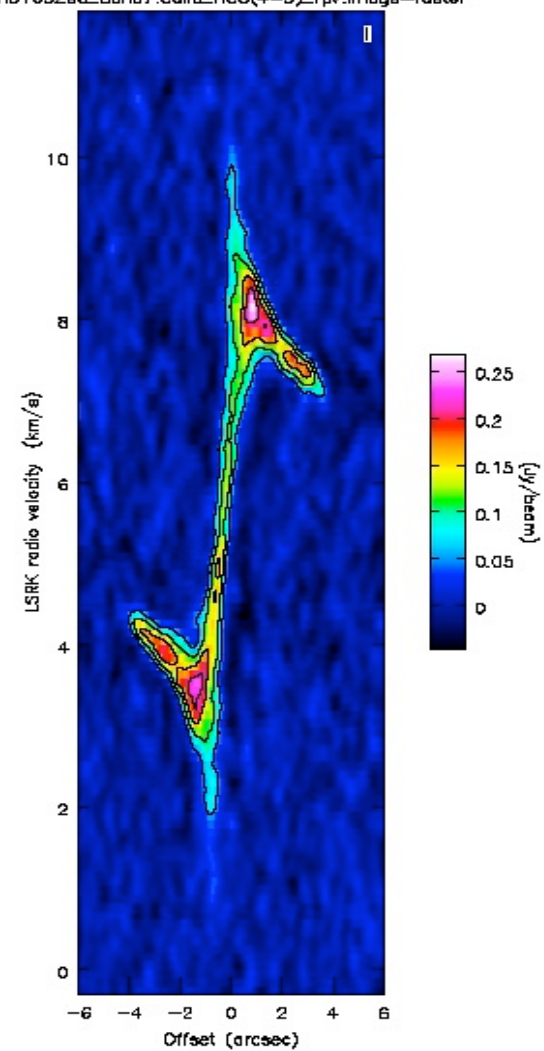
HD163296_Band6_Calib_1300(2-1)_pa132_pv.image--raster



HD163296_Band6_Calib_C180(2-1)_pa132_pv.image--raster



HD163296_Band7_Calib_HCO(4-3)_rpv.image--raster



Estimate of the mass of the central object (Isella et al., 2007)

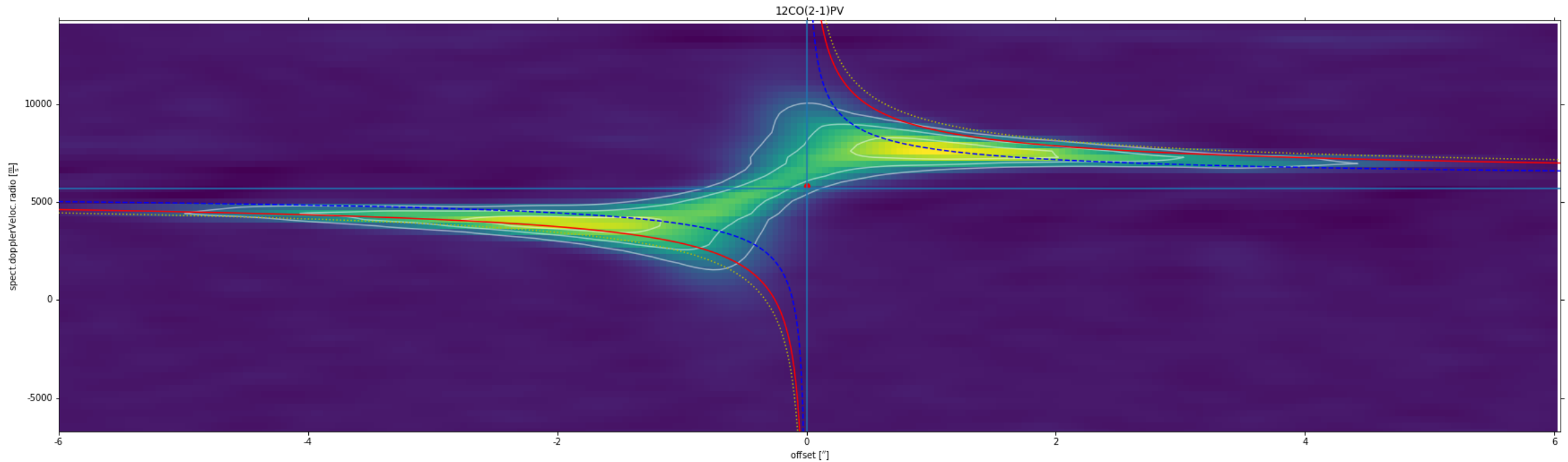
Let *inclination* = 45deg
d=122pc

$$v_{\epsilon} = C \cdot \epsilon^{-\frac{1}{2}}$$

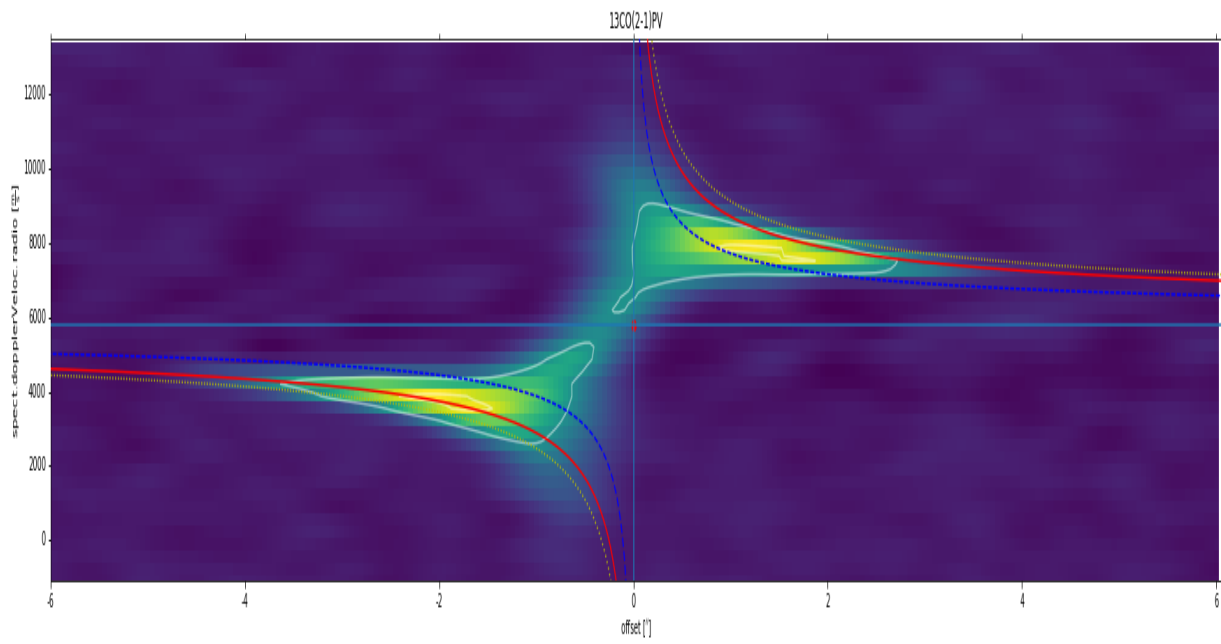
$C \cong$ 2.912 (km/s)
 1.920(km/s)
 3.326(km/s)

M is in solar unit
θ is the disk inclination
d is stellar distance in parsec

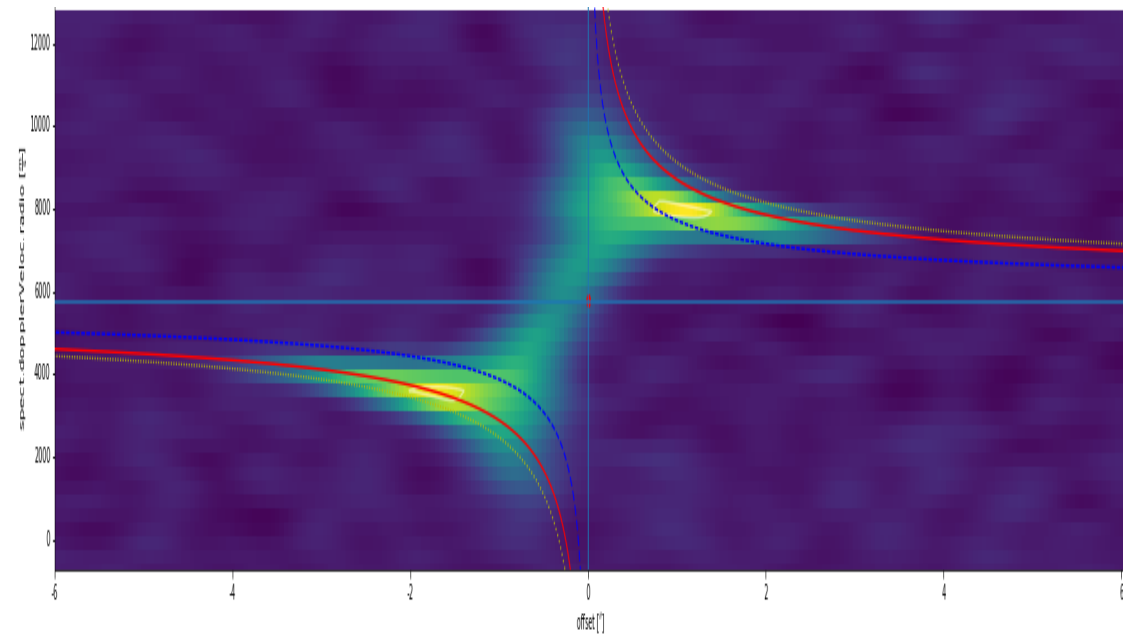
$$C \cong 30 \sqrt{\frac{M}{d}} \sin \theta, \text{ at } \epsilon = 1''$$



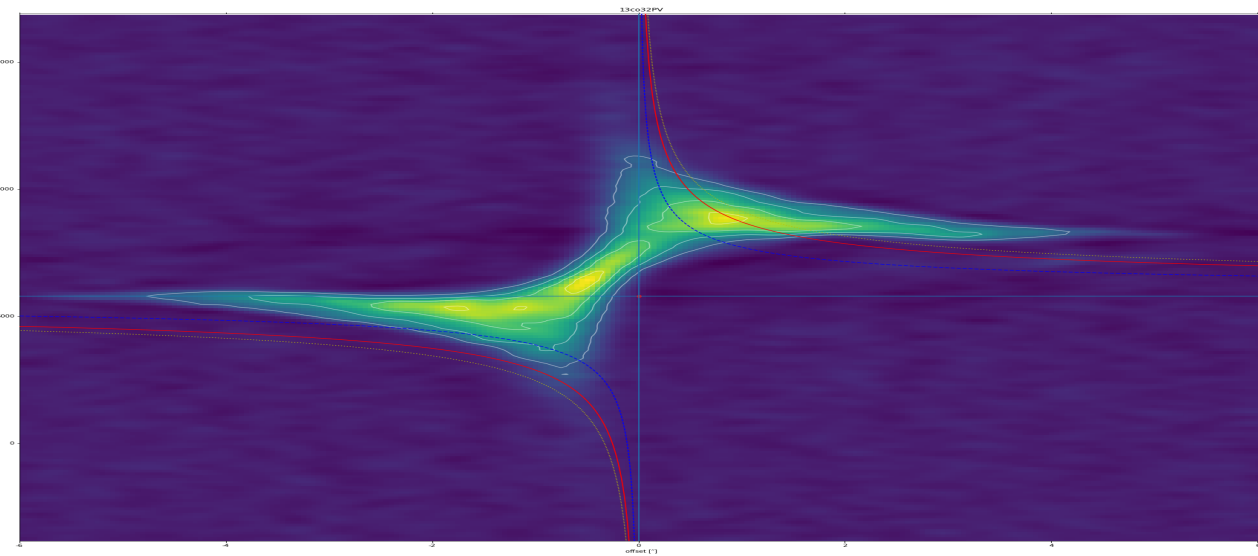
$^{13}\text{CO}(J=2-1)$



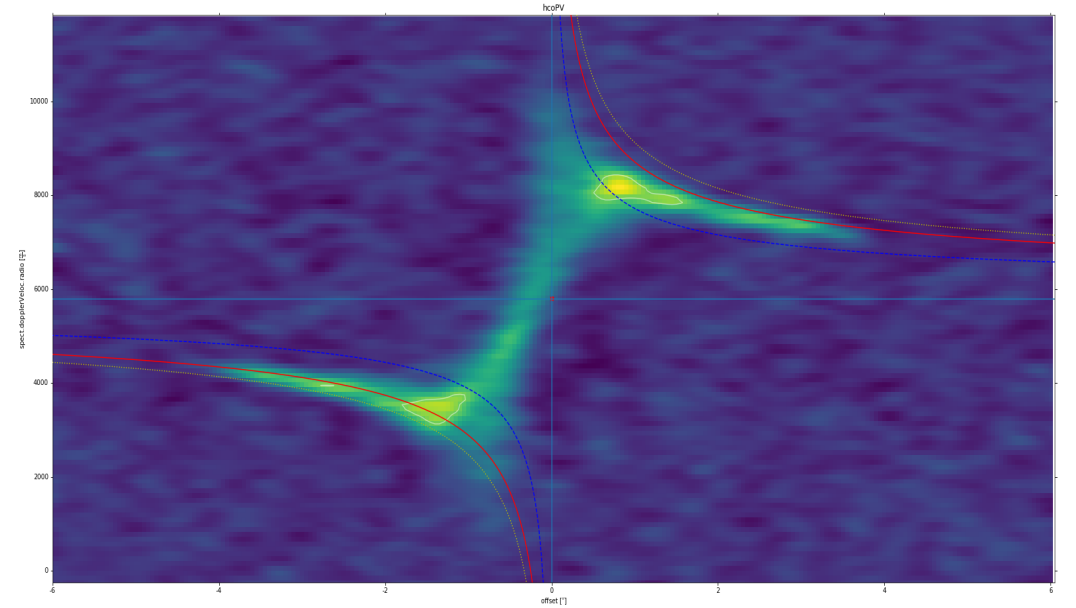
$\text{C}^{18}\text{O}(J=2-1)$



$^{12}\text{CO}(J=3-2)$



$\text{HCO}^+(J=4-3)$



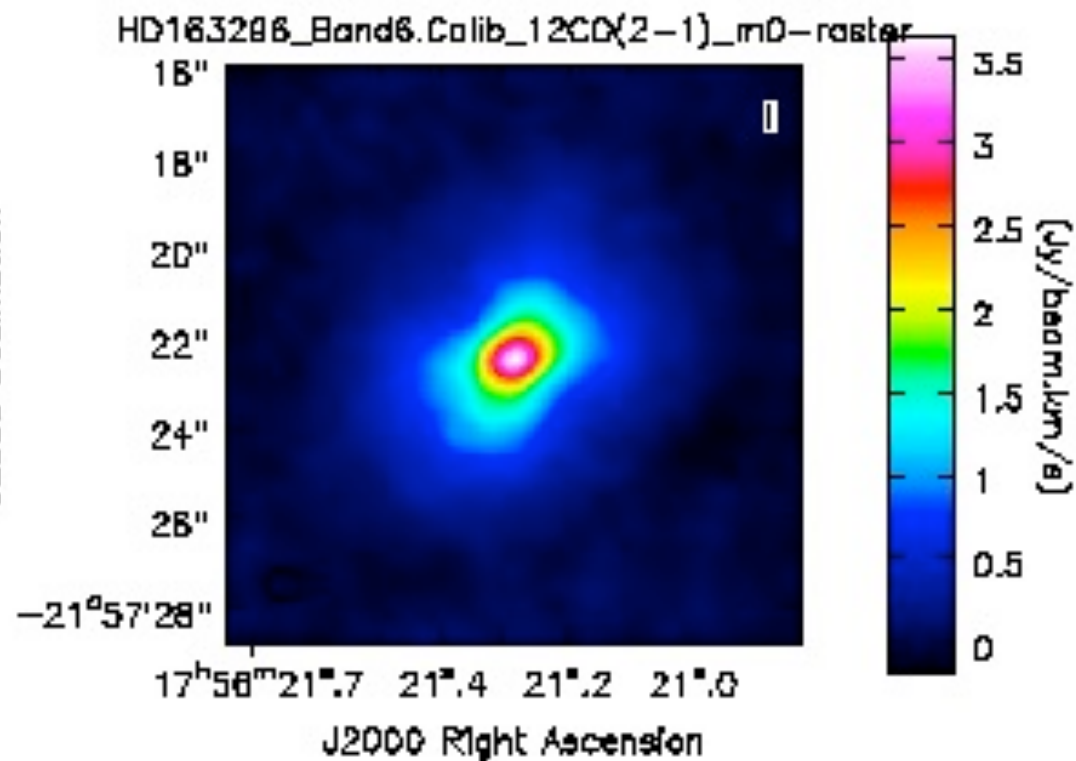
Reference:

Rosenfeld, Katherine A., et al. "A spatially resolved vertical temperature gradient in the HD 163296 disk." *The Astrophysical Journal* 774.1 (2013): 16.

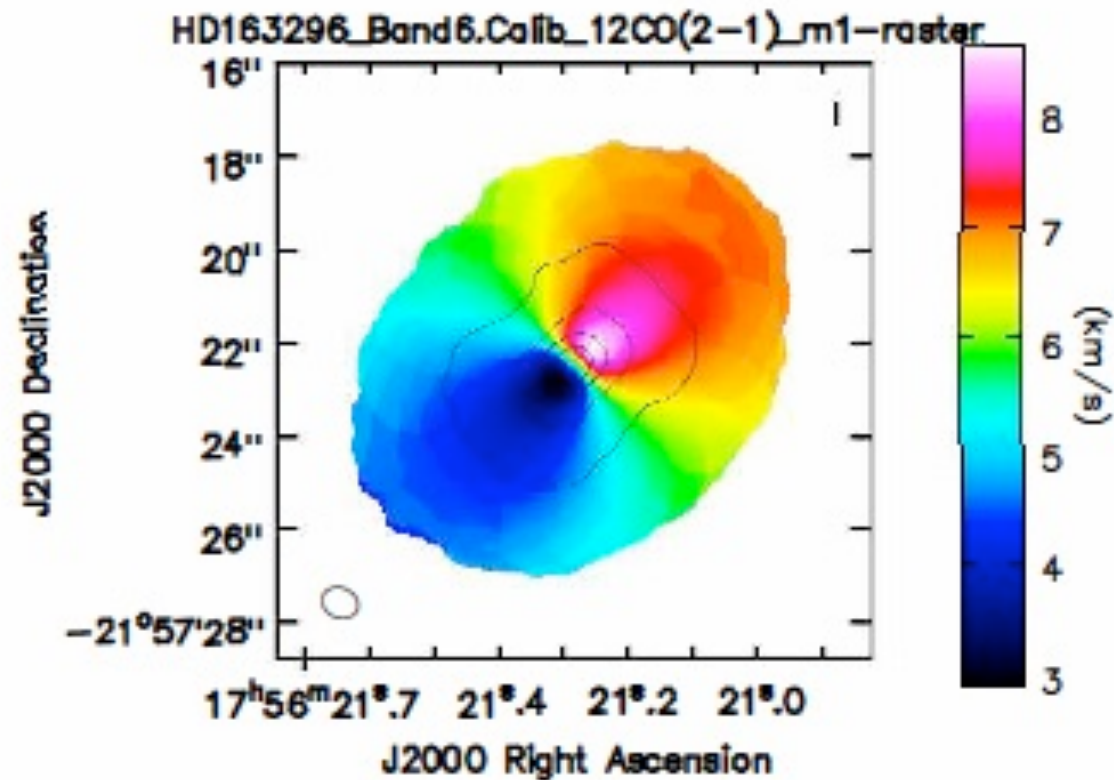
de Gregorio-Monsalvo, Itziar, et al. "Unveiling the gas-and-dust disk structure in HD 163296 using ALMA observations." *Astronomy & Astrophysics* 557 (2013): A133

Isella, Andrea, et al. "Millimeter imaging of HD 163296: probing the disk structure and kinematics." *Astronomy & Astrophysics* 469.1 (2007): 213-222.

Moment 0 and 1

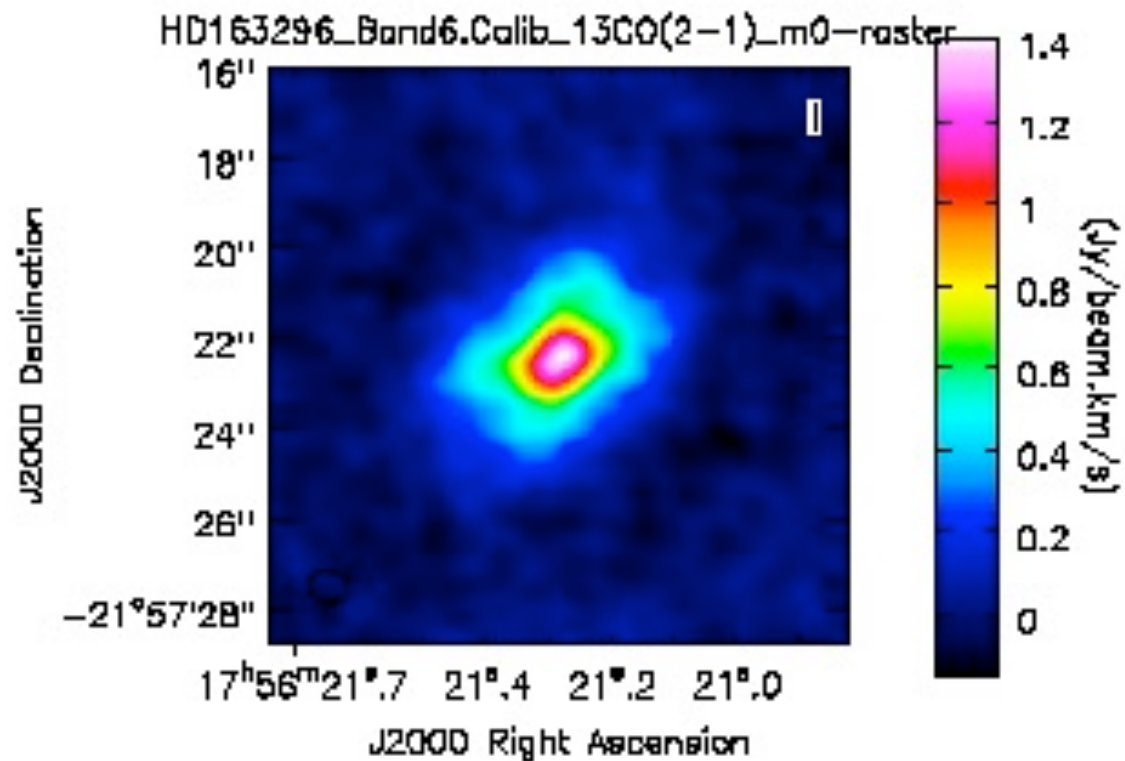


Select chans: 72~135

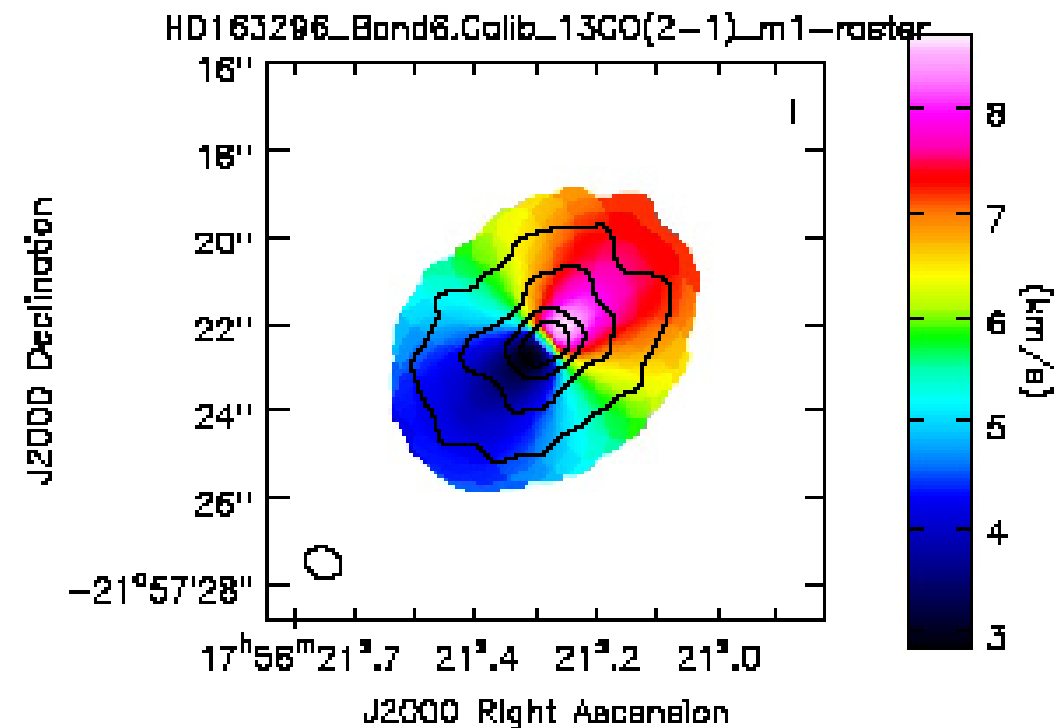


6*($\sigma = 1.455e-2$) Jy/beam cut

Moment 0 and 1

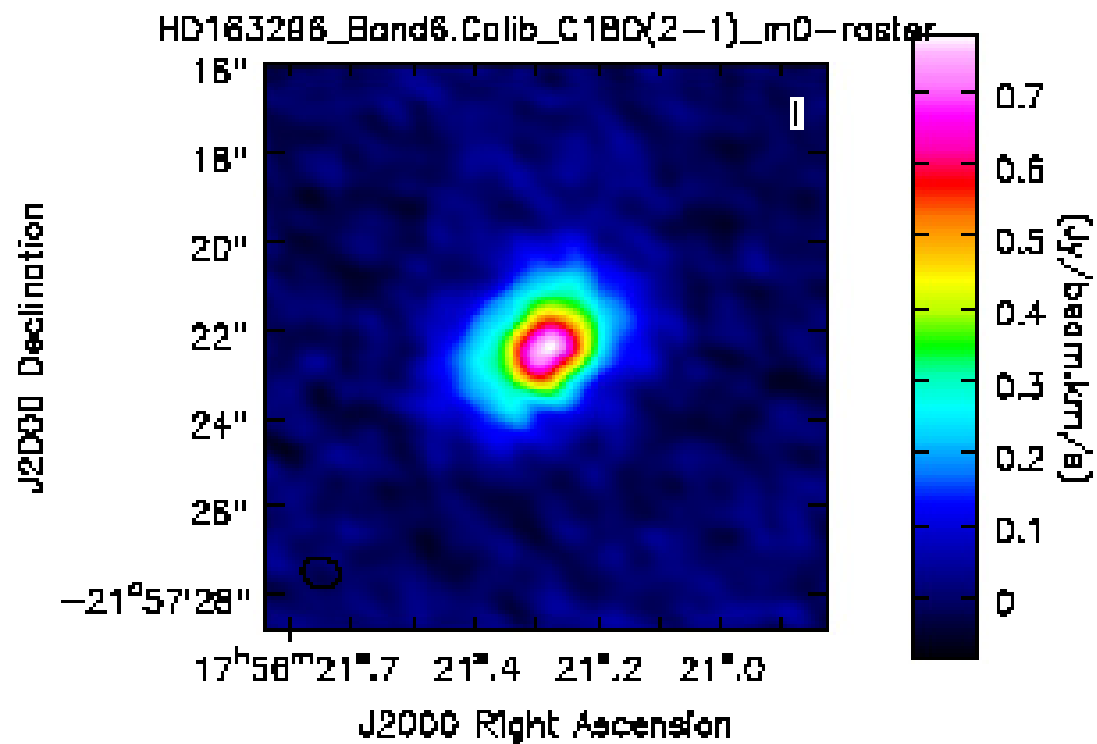


Select chans: 159~202

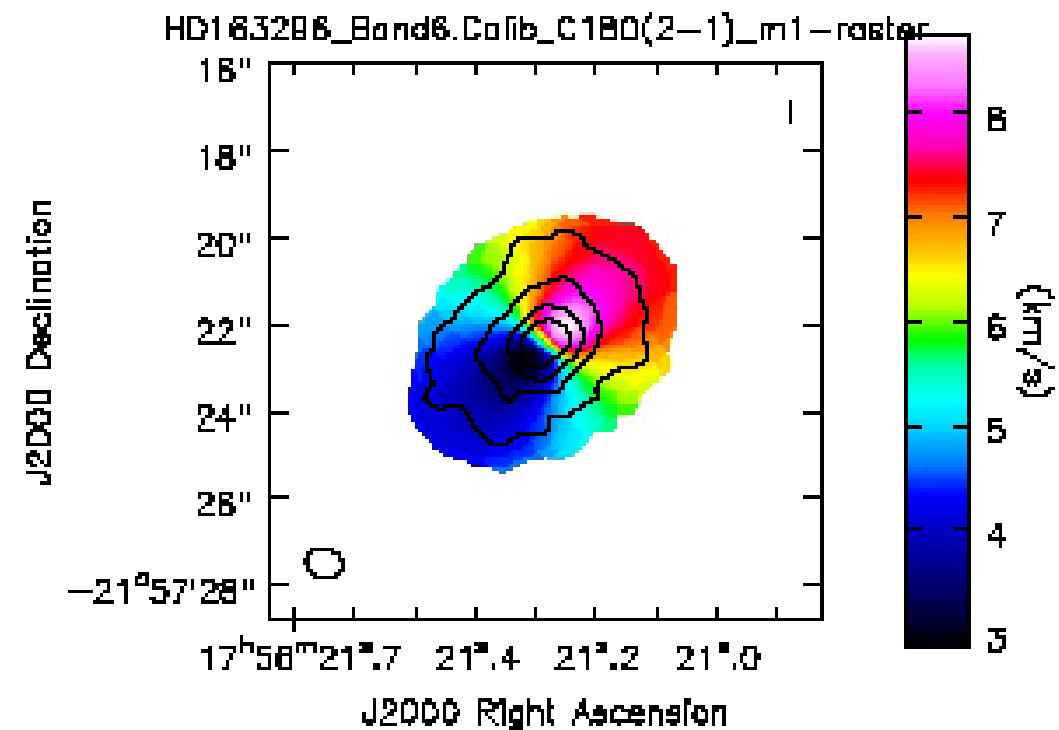


$6 * (\sigma = 1.17e-2)$ Jy/beam cut

Moment 0 and 1

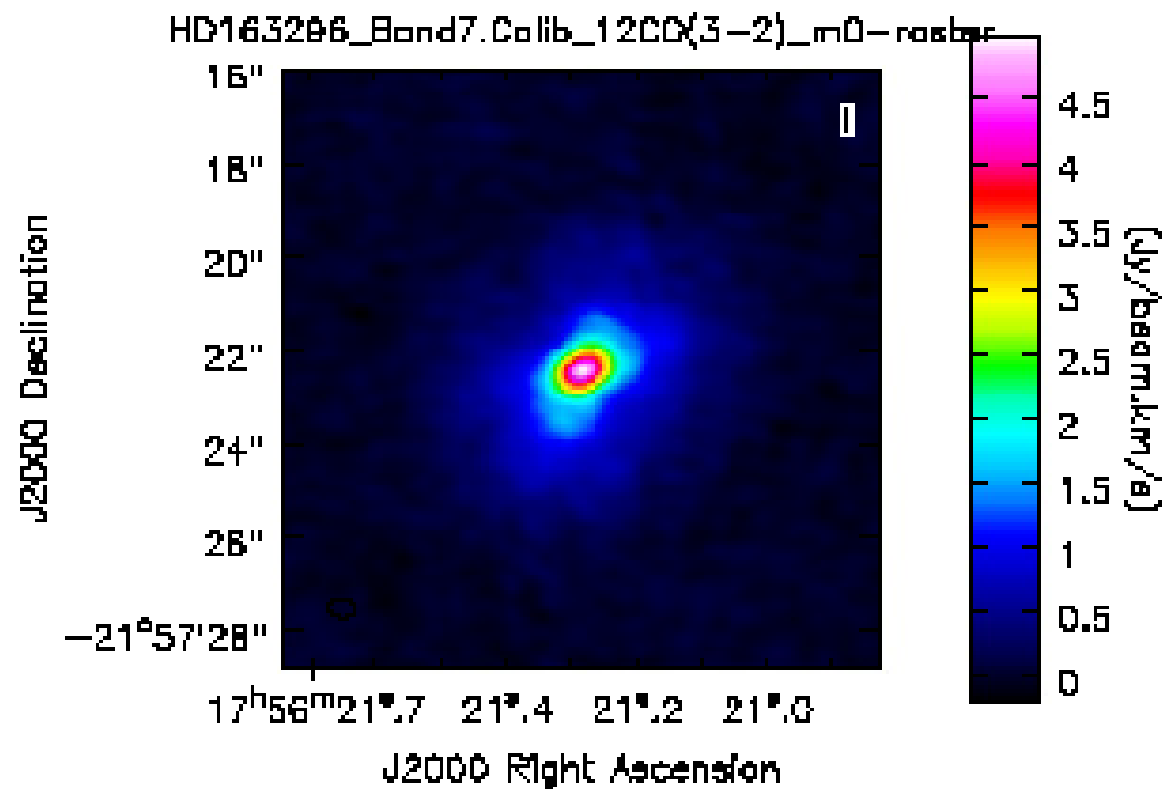


Select Chans:122~162

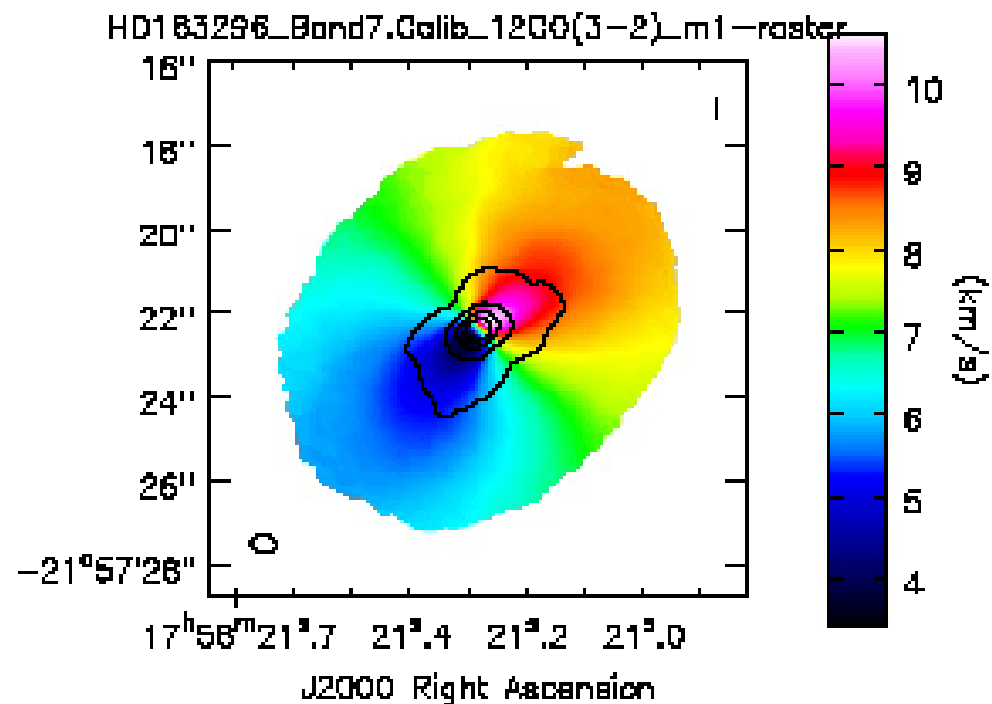


$6 * (\sigma = 5.470e-3)$ Jy/beam cut

Moment 0 and 1

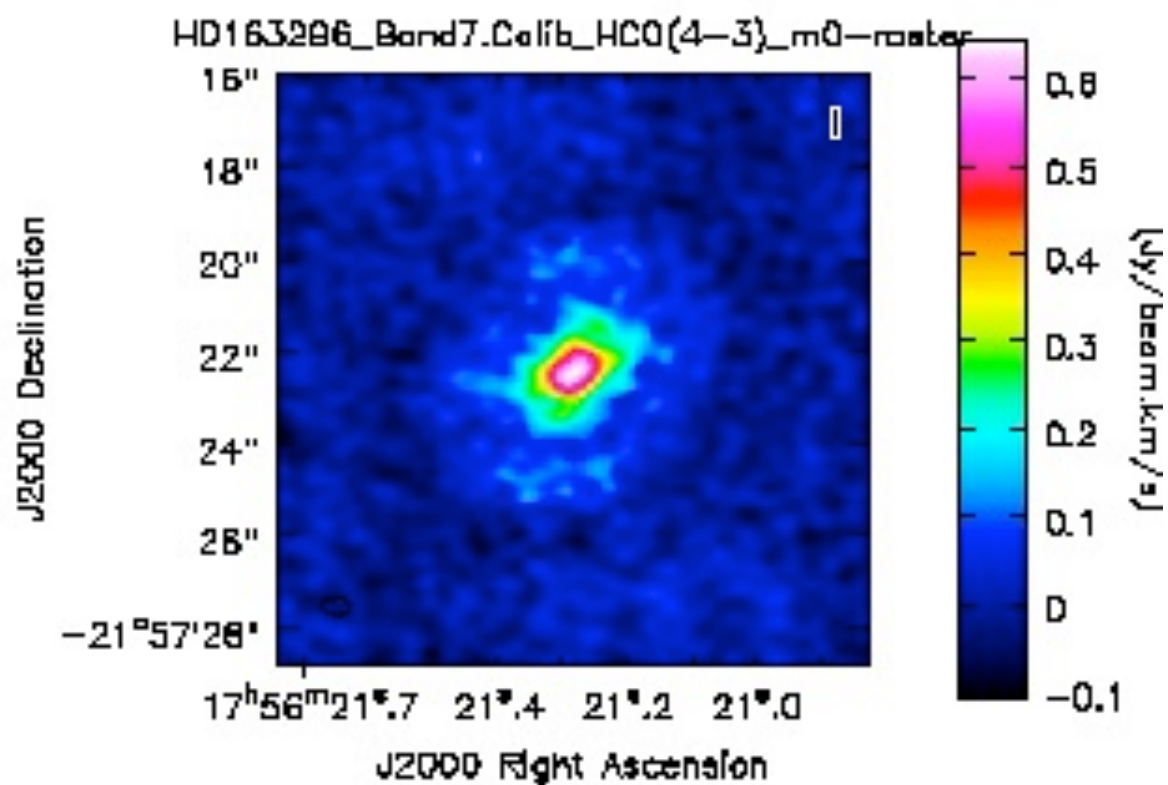


Select Chans:122~162

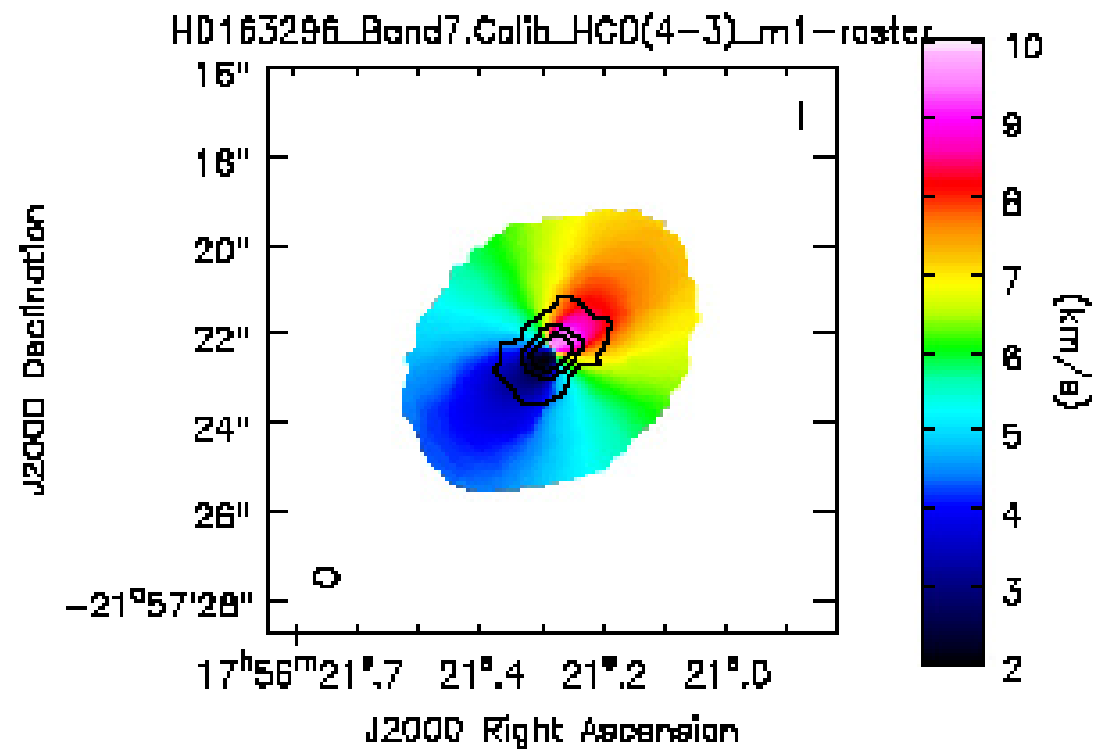


6*($\sigma = 1.4317e-2$) Jy/beam cut

Moment 0 and 1



Select Chans:122~162



$6 * (\sigma = 1.408e-2)$ Jy/beam cut

$^{13}\text{CO}(2-1)$

$\sigma=0.$

```
tclean(  
  vis = 'HD163296_Band6.Calib.ms',  
  imagename = 'HD163296_Band6.Calib_niter0_spw/HD163296_Band6.Calib_niter0_spw',  
  spw='0,1:1~100;200~3422;3650~3839,2:1~100;250~3839,3', #pass emission line  
  specmode = 'mfs',  
  gridder='standard', #antenna='!CM05,CM08', it has flagged  
  deconvolver= 'hogbom',  
  imsize = [1024,1024], # even and factorizable by 2,3,5,7 only  
  cell = ['0.05arcsec'], # what it is no good?  
  weighting = 'briggs',  
  robust = 0.5,  
  niter=0,  
  threshold='0.05Jy',  
  savemodel='modelcolumn',  
)
```

Rms:4.531067e-3 Jy

HD163296_Band6.Calib_test_13CO(2-1).image

chans='134'

[rms]: 0.00612703 Jy/beam

chans='68'

[rms]: 0.0060392 Jy/beam

Chans:97~140

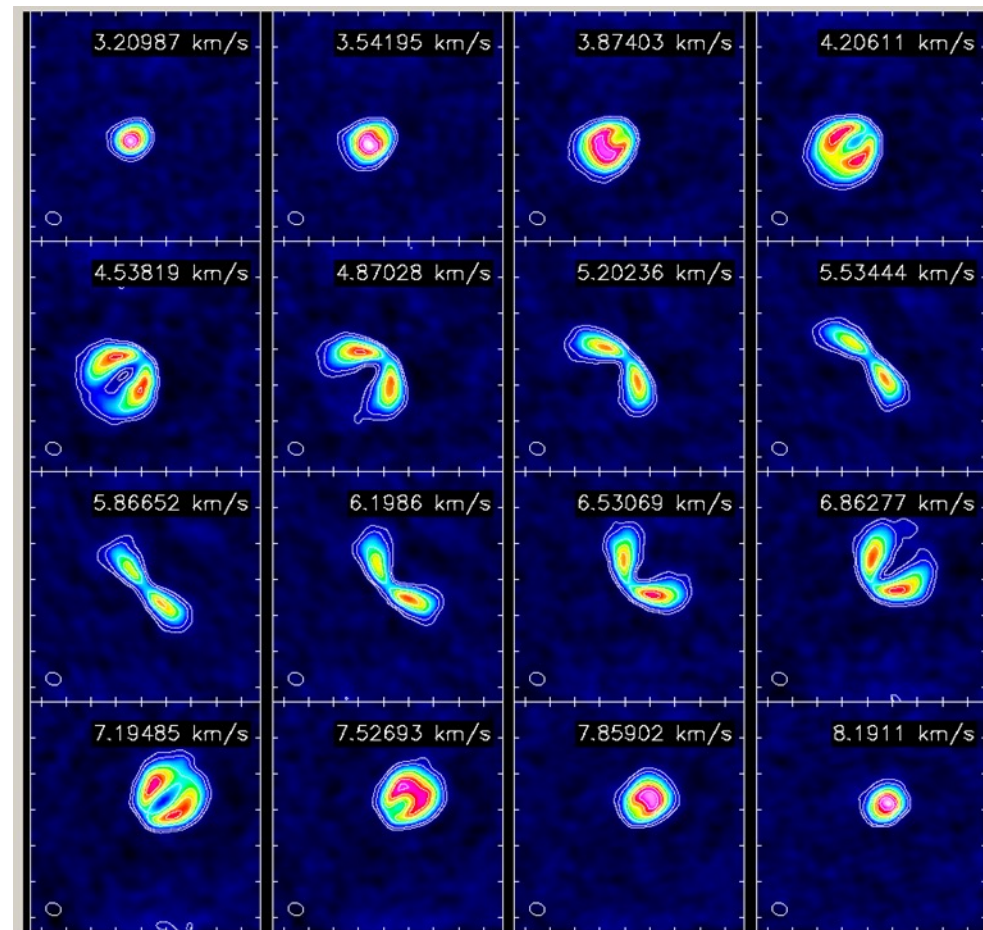
Reverse chan 159~202

Brightest:chans:113

Noise:rms:1.17e-2

center=[17h56m21.2882188601s, -21d57m21.872343282s]

PA=312



HD163296_Band6.Calib_test_12CO(2-1).image

chans='59'

[rms]: 0.00520781 Jy/beam

[3, 6, 15, 20]

Chans='135'

[rms]: 0.0057268 Jy/beam

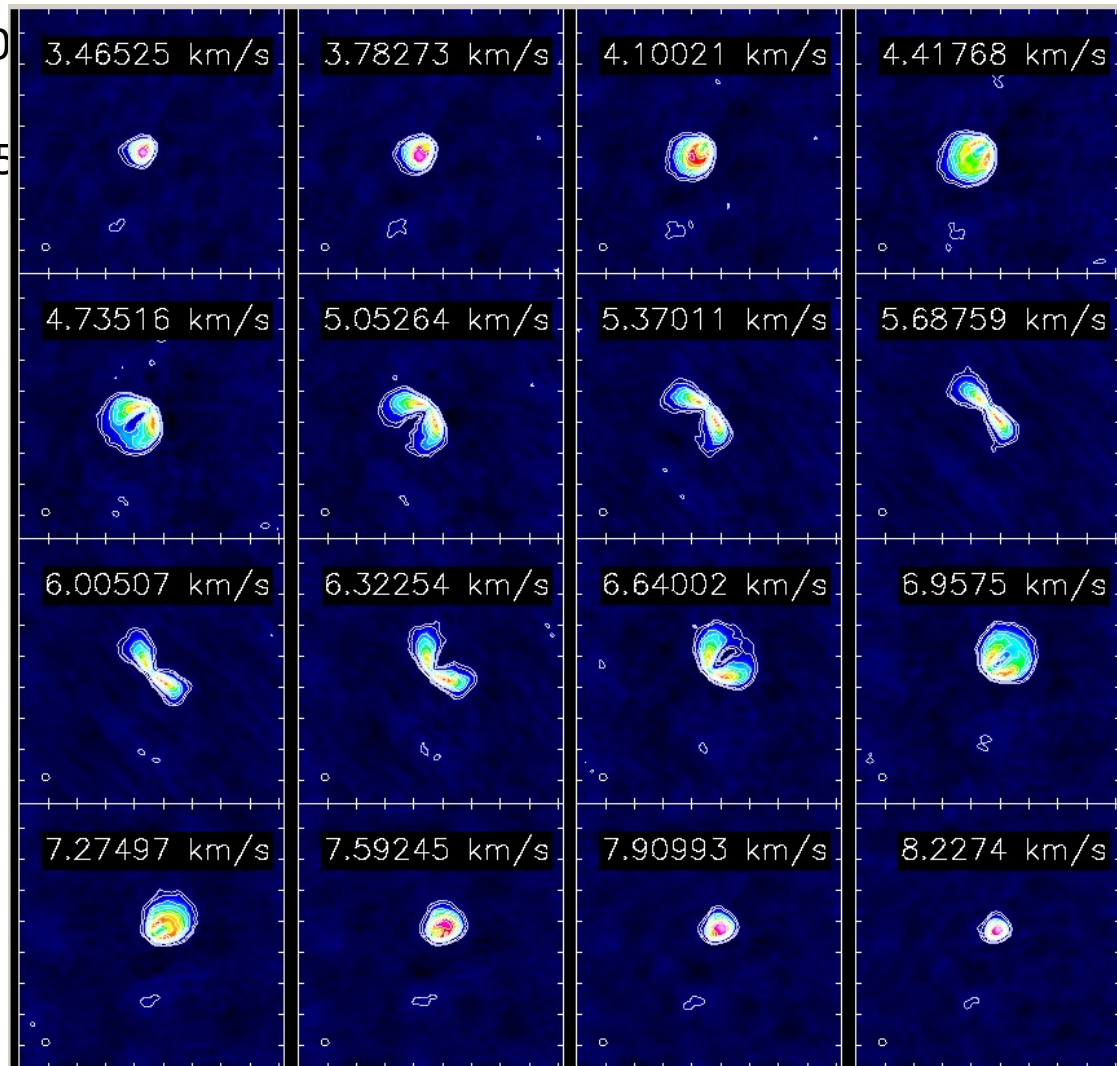
[3, 6, 15]

Chans:72~135

Reverse chan 164~229

Brightest:chans:92

Noise:rms:1.455e-2



HD163296_Band6.Calib_t0.015_test_C18O(2-1).image

Chans:179

[rms]: 0.00427978 Jy/beam

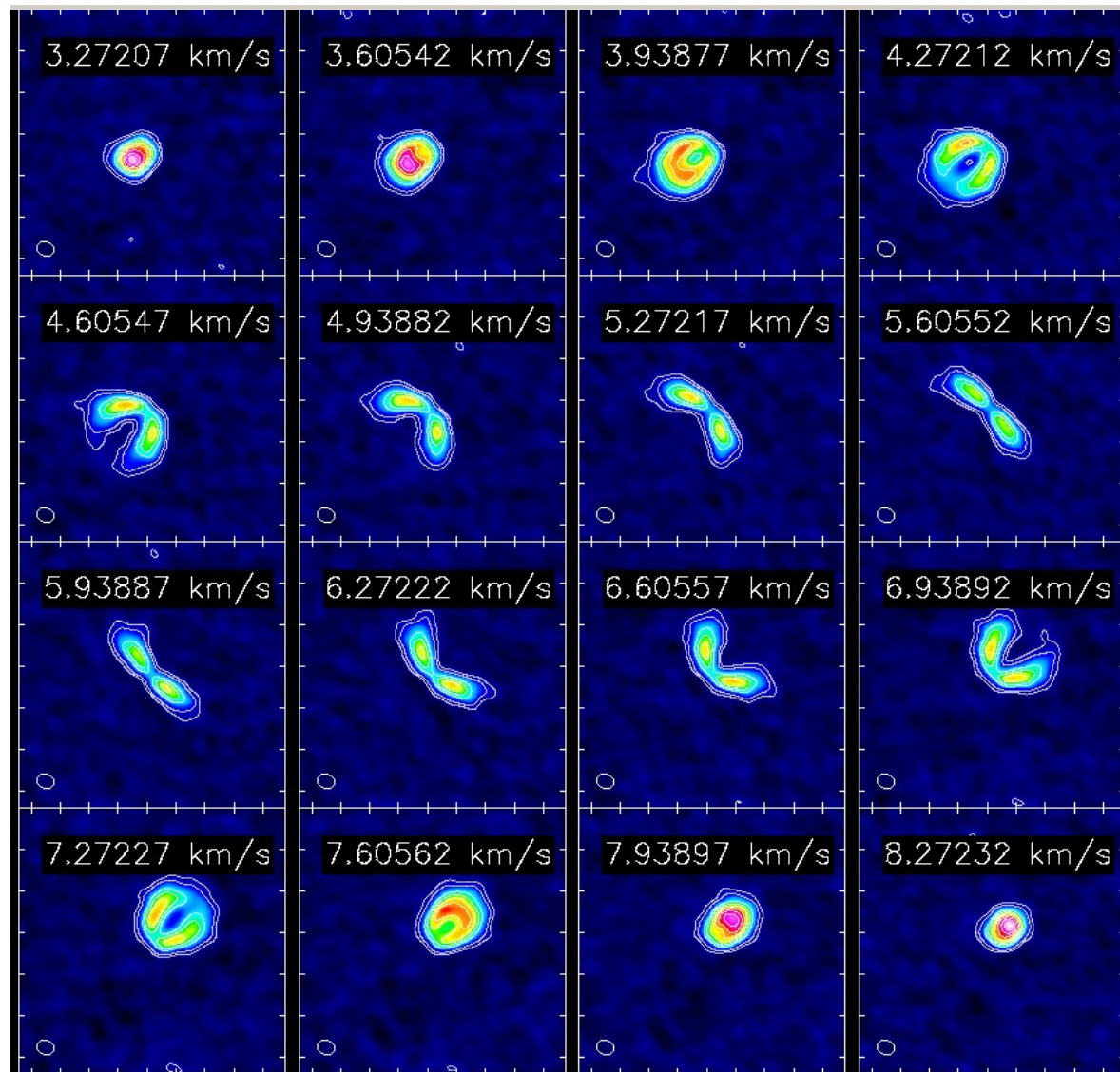
Chans:78

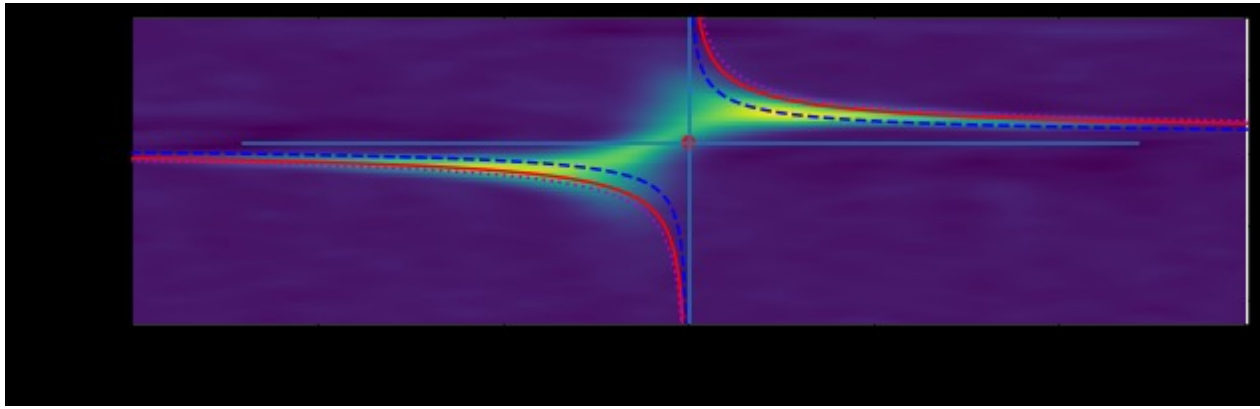
[rms]: 0.00407132 Jy/beam

Chans:122~162

Brightest:chans:136

Noise:rms:5.470e-3






```
tclean(  
  vis = 'HD163296_Band7_concat.ms',  
  imagename =  
'HD163296_Band7_calib.ms_0_spw/HD163296_Band7.Calib_0  
_spw',  
  spw='0,1:50~1500;2300~3800,2:1~1600;2500~3800,3', #pass  
emission line  
  specmode = 'mfs',  
  gridder='standard', #antenna='!CM05,CM08', it has flagged  
  deconvolver= 'hogbom',  
  imsize = [1024,1024], # even and factorizable by 2,3,5,7 only  
  cell = ['0.05arcsec'], # what it is no good?  
  weighting = 'briggs',  
  robust = 0.5,  
  niter=0,  
  threshold='0.02113Jy',  
  savemodel='modelcolumn',  
  interactive = True,  
)
```

Dirty:

Rms:7.045e-3 Jy
threshold: 3-sigma

clean

Noise Rms:1.939321e-3

2D- ftiing :set sigma

```
tclean(  
  vis = 'HD163296_Band7_concat.ms',  
  imagename =  
'HD163296_Band7_calib.ms_0_spw/HD163296_Band7.Ca  
_spw_test',  
  spw='0,1:50~1500;2300~3800,2:1~1600;2500~3800,3', #  
emission line  
  specmode = 'mfs',  
  gridder='standard', #antenna='!CM05,CM08', it has flagg  
  deconvolver= 'hogbom',  
  imsize = [1024,1024], # even and factorizable by 2,3,5,7  
  cell = ['0.05arcsec'], # what it is no good?  
  weighting = 'briggs',  
  robust = 0.5,
```

***** Fit performed at Wed Aug 25 14:31:07 2021*****

Input parameters ---

--- imagename:
/home/myso/ycchen/main1/band7/HD163296_Band7_ReferenceImages/HD163296_continuum_sc3.image

*** Details of fit for channel number 0

Number of pixels used in fit: 2231

Input and residual image statistics (to be used as a rough guide only as to goodness of fit)

--- Standard deviation of input image: 0.00822037 Jy
--- Standard deviation of residual image: 0.00153768 Jy
--- RMS of input image: 0.00823416 Jy
--- RMS of residual image: 0.00153781 Jy

Fit on HD163296_continuum_sc3.image component 0

Position ---

--- ra: 17:56:21.28465 +/- 0.00016 s (0.00227 arcsec along great circle)
--- dec: -021.57.22.36732 +/- 0.00205 arcsec
--- ra: 255.090 +/- 0.045 pixels
--- dec: 255.811 +/- 0.041 pixels

Image component size (convolved with beam) ---

--- major axis FWHM: 1.1020 +/- 0.0059 arcsec
--- minor axis FWHM: 0.8553 +/- 0.0042 arcsec
--- position angle: 125.77 +/- 0.78 deg

Clean beam size ---

--- major axis FWHM: 0.51 arcsec
--- minor axis FWHM: 0.33 arcsec
--- position angle: 83.74 deg

Image component size (deconvolved from beam) ---

--- major axis FWHM: 1.0163 +/- 0.0073 arcsec
--- minor axis FWHM: 0.7367 +/- 0.0063 arcsec
--- position angle: 134.5 +/- 1.1 deg

Flux ---

--- Integrated: 1.5517 +/- 0.0093 Jy
--- Peak: 279.9 +/- 1.4 mJy/beam
--- Polarization: I

Spectrum ---

--- frequency: 352.8974 GHz (849.5174 um)

Input and residual image statistics (to be used as a rough guide only as to goodness of fit)

--- Standard deviation of input image: 0.0505513 Jy
--- Standard deviation of residual image: 0.00815568 Jy
--- RMS of input image: 0.0533089 Jy
--- RMS of residual image: 0.00817769 Jy

Fit on HD163296_Band7.Calib_spw.image component 0

Position ---

--- ra: 17:56:21.28460 +/- 0.00085 s (0.01182 arcsec along great circle)
--- dec: -021.57.22.36723 +/- 0.00924 arcsec
--- ra: 511.10 +/- 0.24 pixels
--- dec: 511.81 +/- 0.18 pixels

Image component size (convolved with beam) ---

--- major axis FWHM: 1.050 +/- 0.028 arcsec
--- minor axis FWHM: 0.848 +/- 0.021 arcsec
--- position angle: 106.3 +/- 4.7 deg

Clean beam size ---

--- major axis FWHM: 0.57 arcsec
--- minor axis FWHM: 0.37 arcsec
--- position angle: 85.72 deg

Image component size (deconvolved from beam) ---

--- major axis FWHM: 903 +/- 41 marcsec
--- minor axis FWHM: 739 +/- 36 marcsec
--- position angle: 120 +/- 12 deg

Flux ---

--- Integrated: 1.333 +/- 0.042 Jy
--- Peak: 313.8 +/- 8.1 mJy/beam
--- Polarization: I

Spectrum ---

--- frequency: 352.8822 GHz (849.5538 um)

'HD163296_Band7_t0.04_test_revese_12CO(3-2).image/'

chans=600
[rms]: 0.0101346 Jy/beam

Chans:146
[rms]:0.00984967 Jy/beam

Chans:378~573

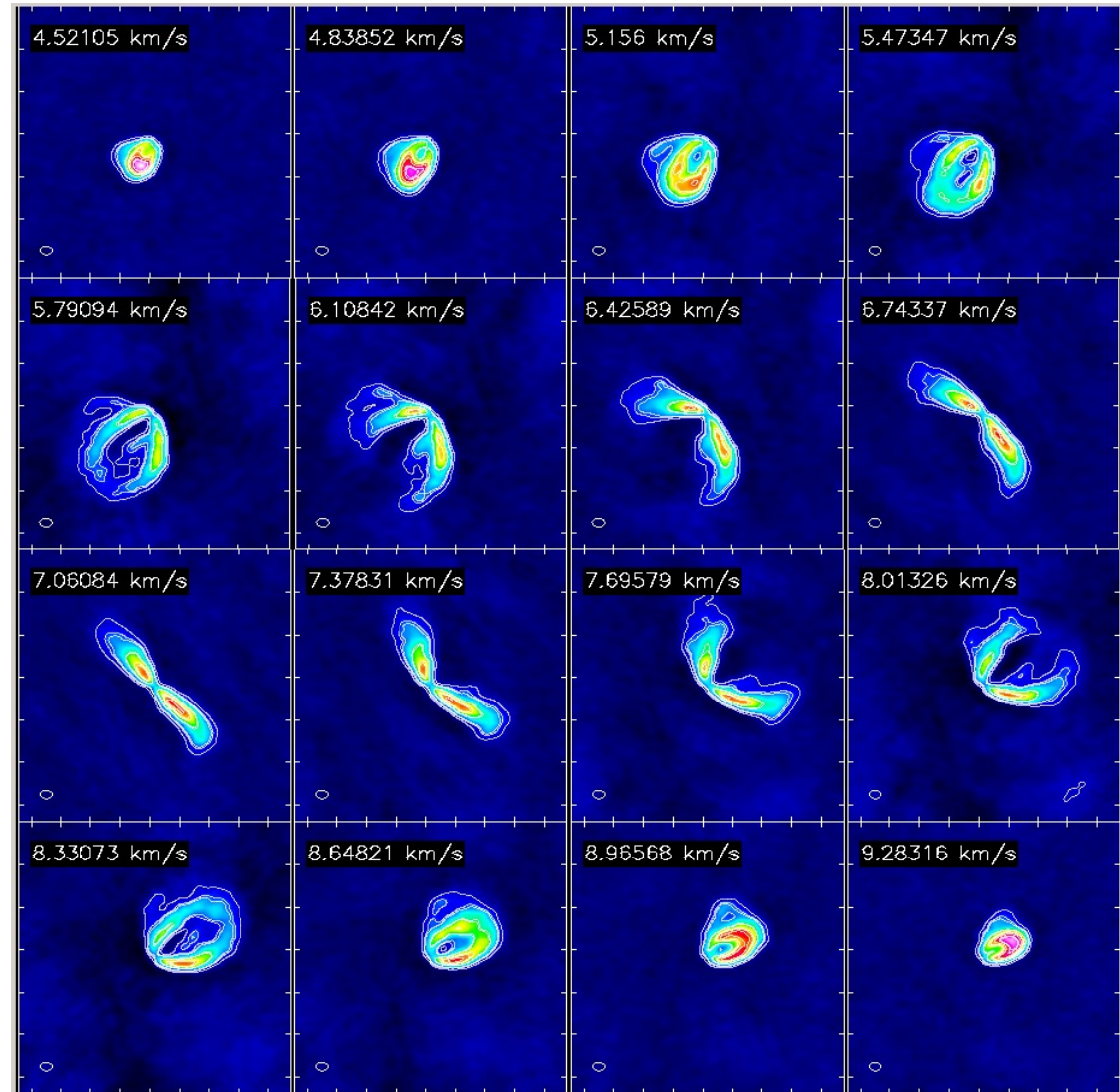
Chans:126~321

Brightest:chans:486
Noise:rms:1.4317e-2
7-sigma

12co(3-2)

dirty 0.025858

0.035716



imagename='cubeimage/HD163296_Band7_concat_t0.02_HCO(4-3).ms',

Ems:1.289586e-2 (t)

imagename='cubeimage/HD163296_Band7_concat_t0.03_HCO(4-3).ms.image/'

chans = '167~284',

Chans:221

[rms]1.407891e-2Jy/beam

Chans:150

[rms]: 0.0106359 Jy/beam

chans = '416~533',

chans310

[rms]: 0.0104935 Jy/beam

chans='449,452,455,458,461,464,467,470,473,476,479,482,485,
,488,491,494,497'

W3 Hco(4-3)

Brightness

rms:1.087e-2

