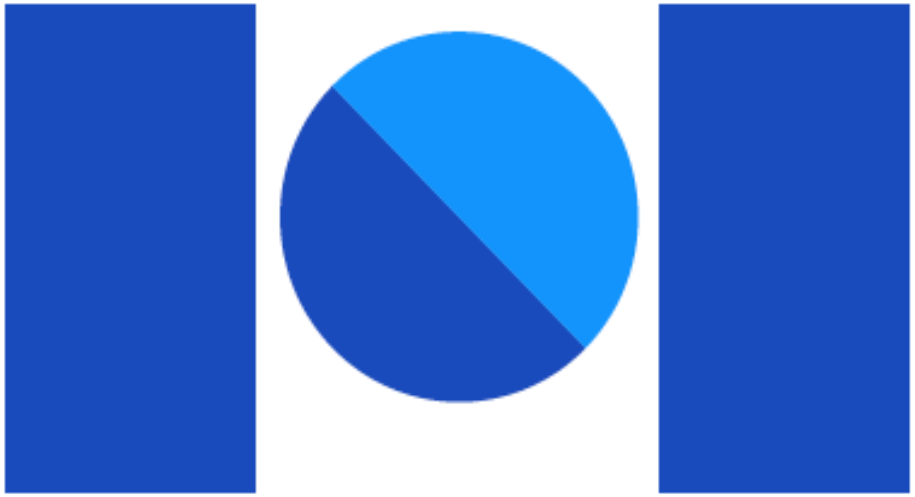
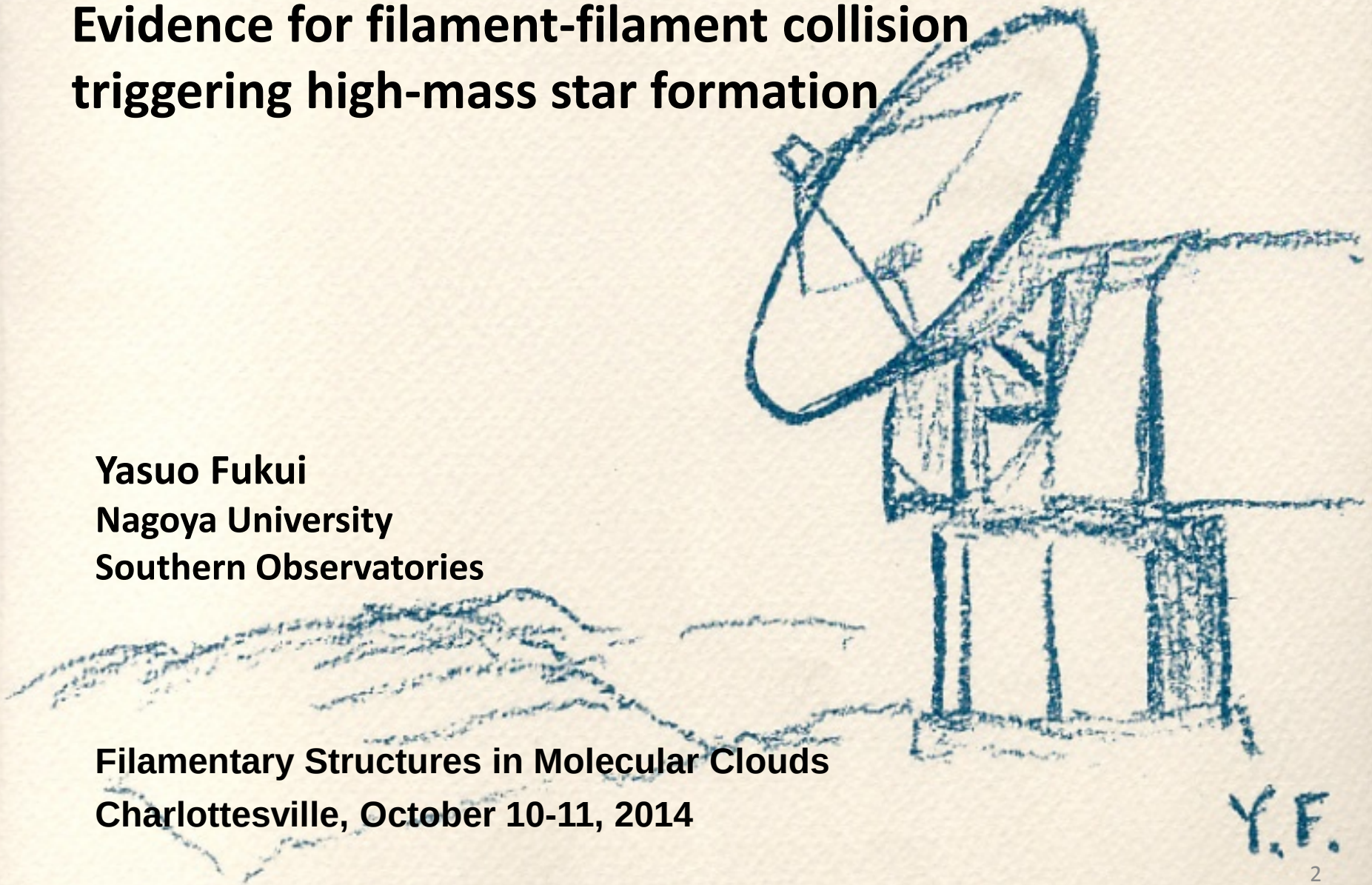


NANTEN

Submillimeter Observatory

Resolved CO filaments in N159; Evidence for filament-filament collision triggering high-mass star formation



Yasuo Fukui
Nagoya University
Southern Observatories

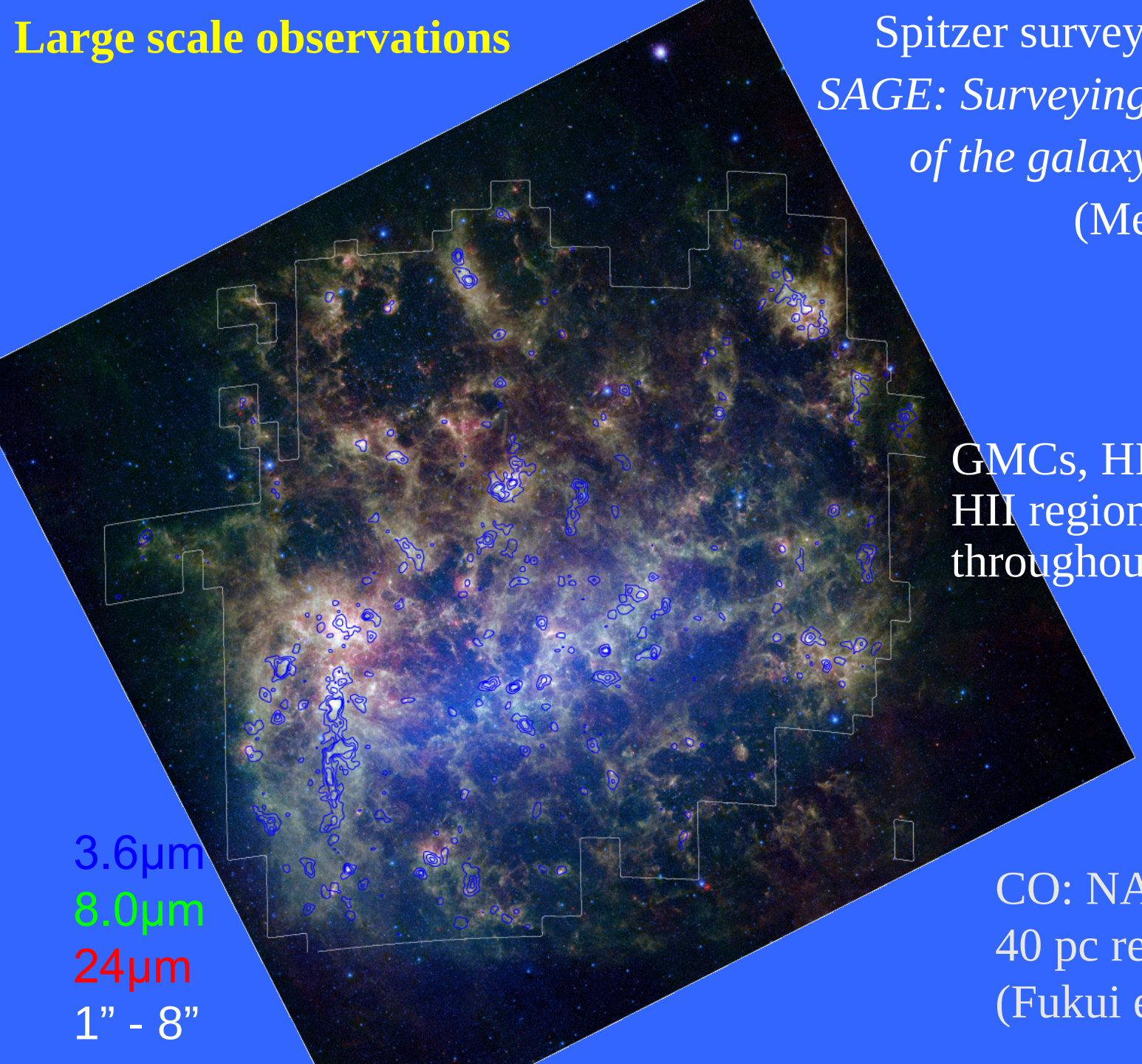
Filamentary Structures in Molecular Clouds
Charlottesville, October 10-11, 2014

Large scale observations

Spitzer survey of the LMC

SAGE: Surveying the Agency of the galaxy's evolution

(Meixner et al.)



GMCs, HI, dust, YSOs, HII regions, SNRs, … throughout the galaxies.

3.6μm
8.0μm
24μm
1" - 8"

CO: NANTEN
40 pc resolution
(Fukui et al. 2008)

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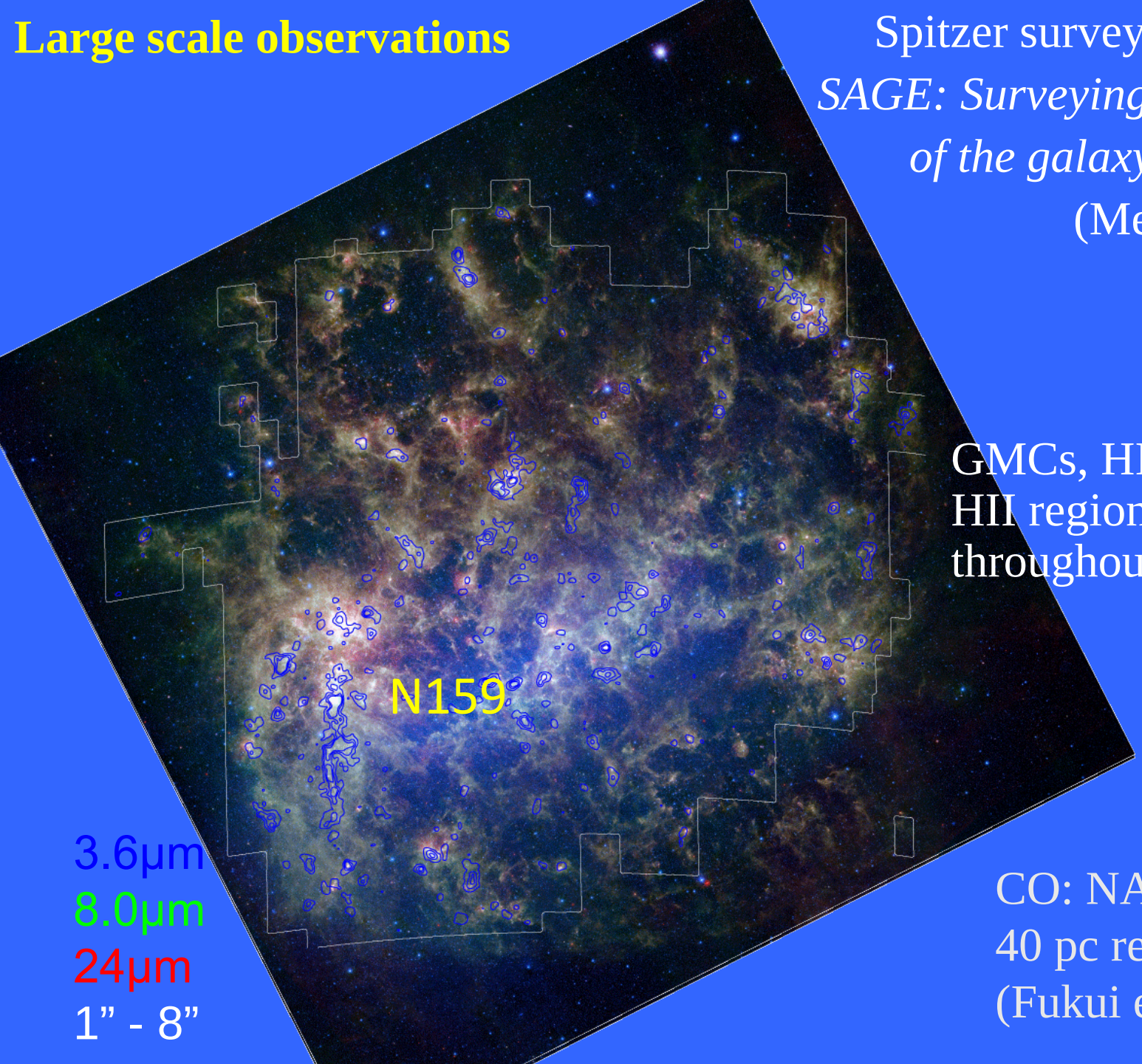

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N159: Most active on-going star formation in the Local Group: Resolving filaments and cloud cores in the LMC

Y. Mizuno et al. 2010

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Minamidani
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Madden
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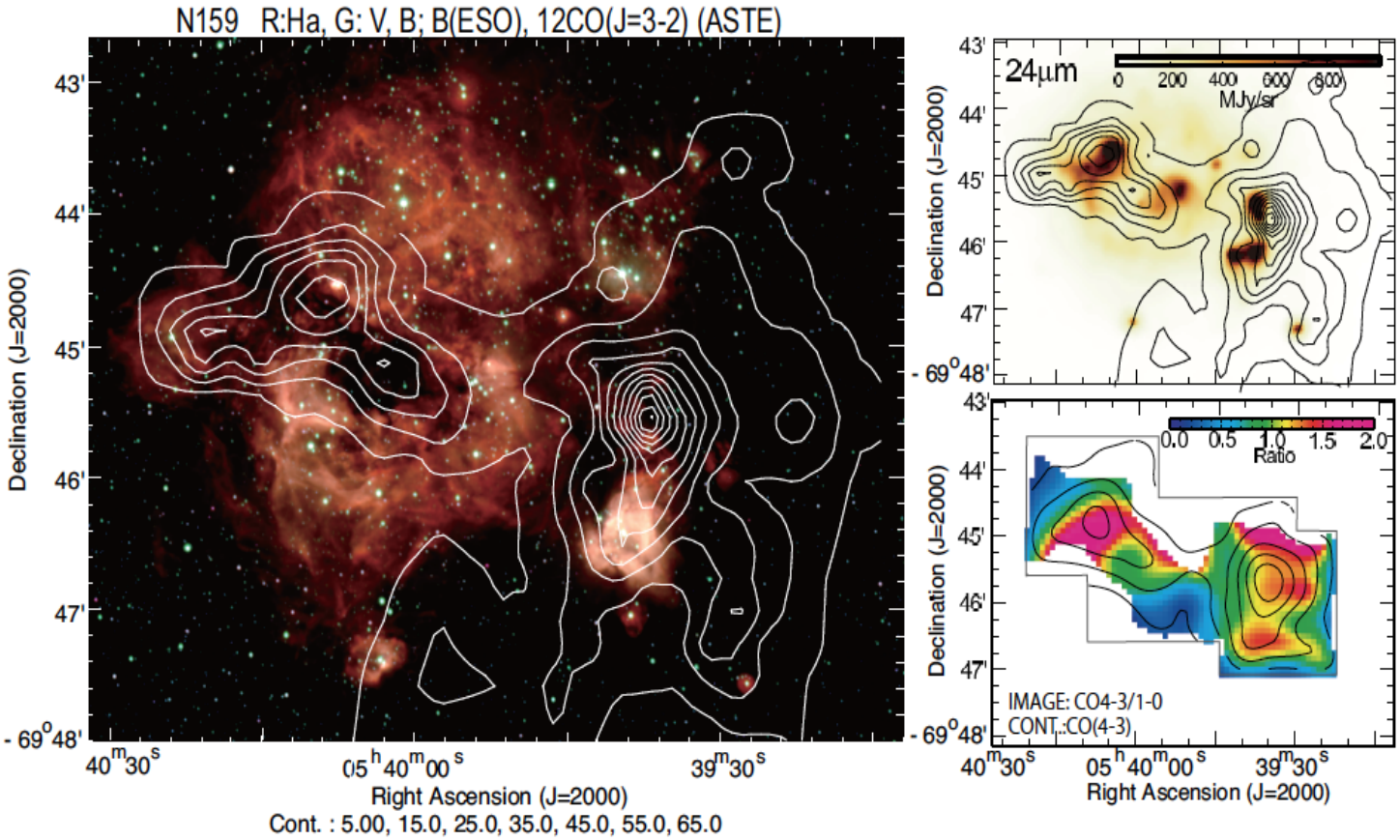
N.Mizuno
R.Chen
Seale
Sewio
Meixner



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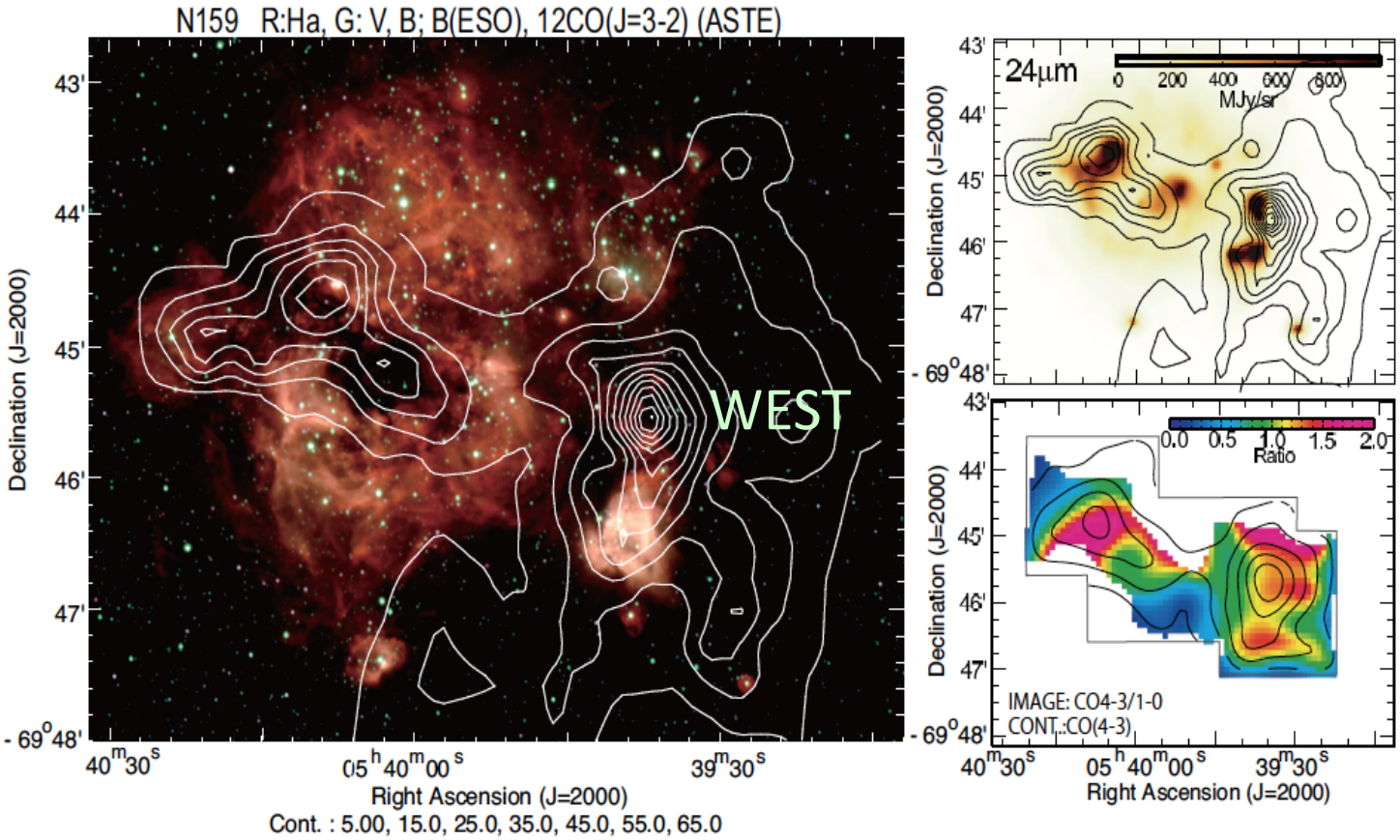
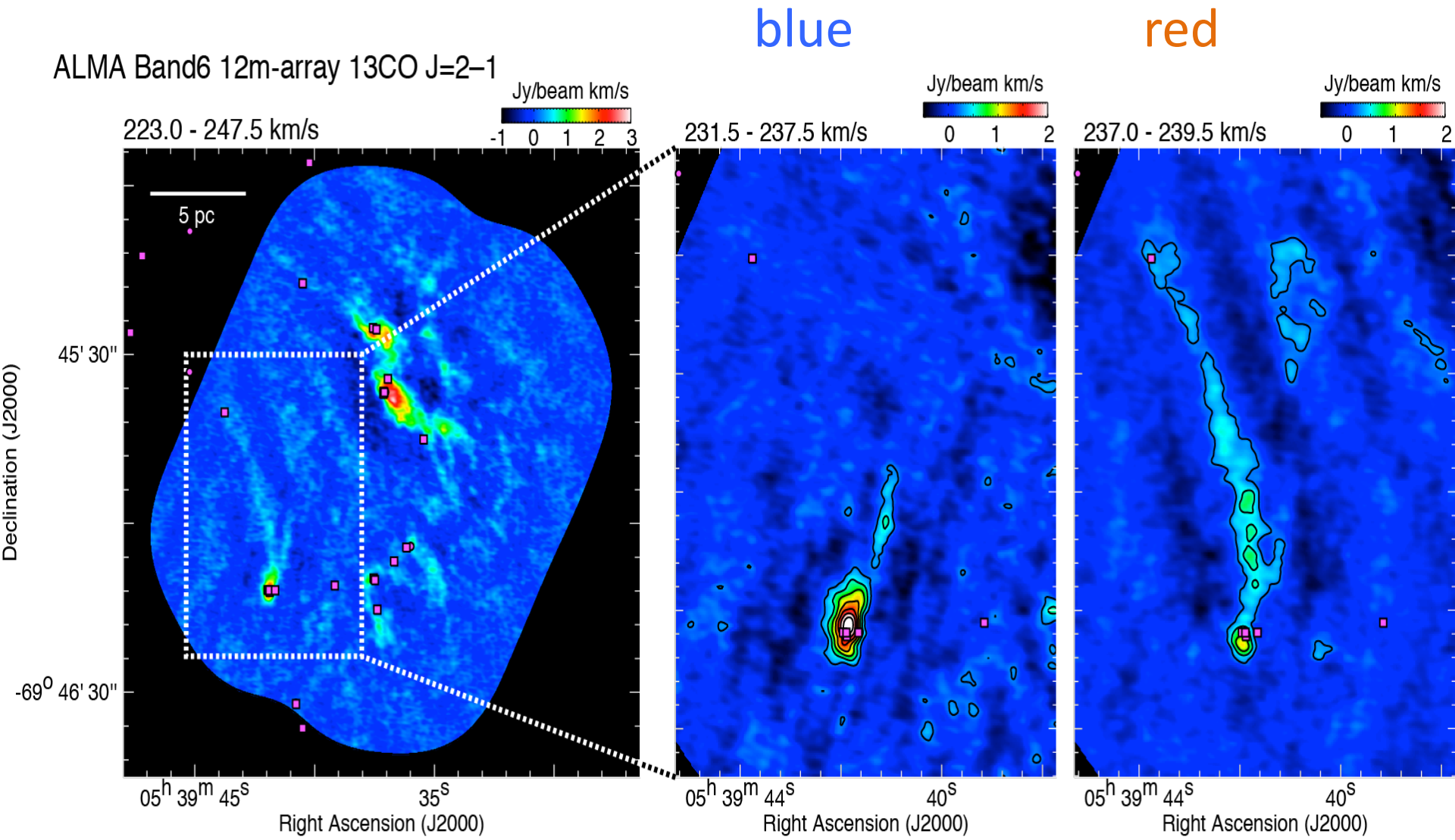
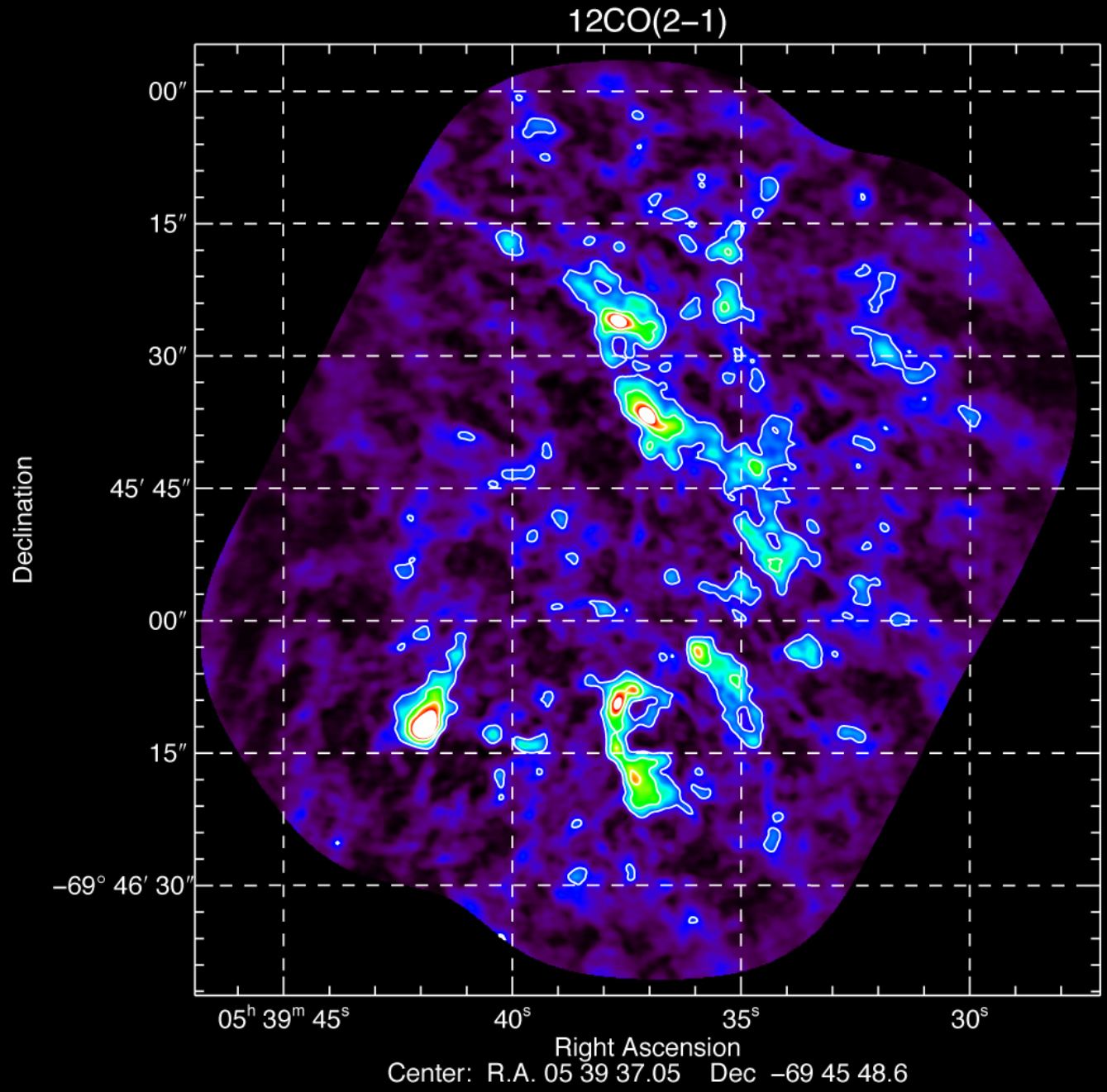
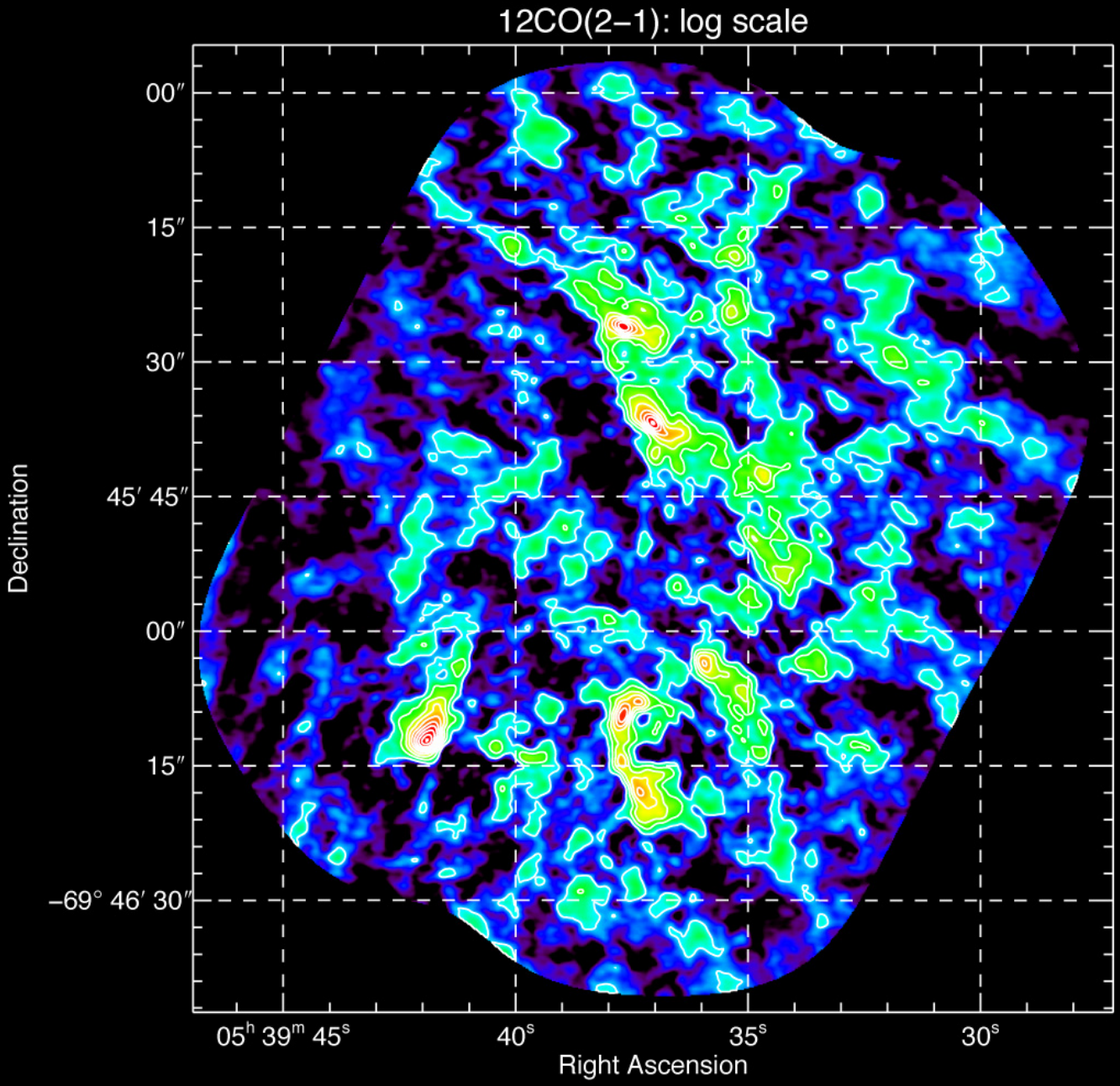


Long filaments in N159W




12CO(2–1)
00″
15″
30″
45′ 45″
00″
15″
–69° 46′ 30″
Declination
05h 39m 45s
40s
35s
30s
Right Ascension
Center: R.A. 05 39 37.05 Dec –69 45 48.6


12CO(2–1): log scale
00″
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30″
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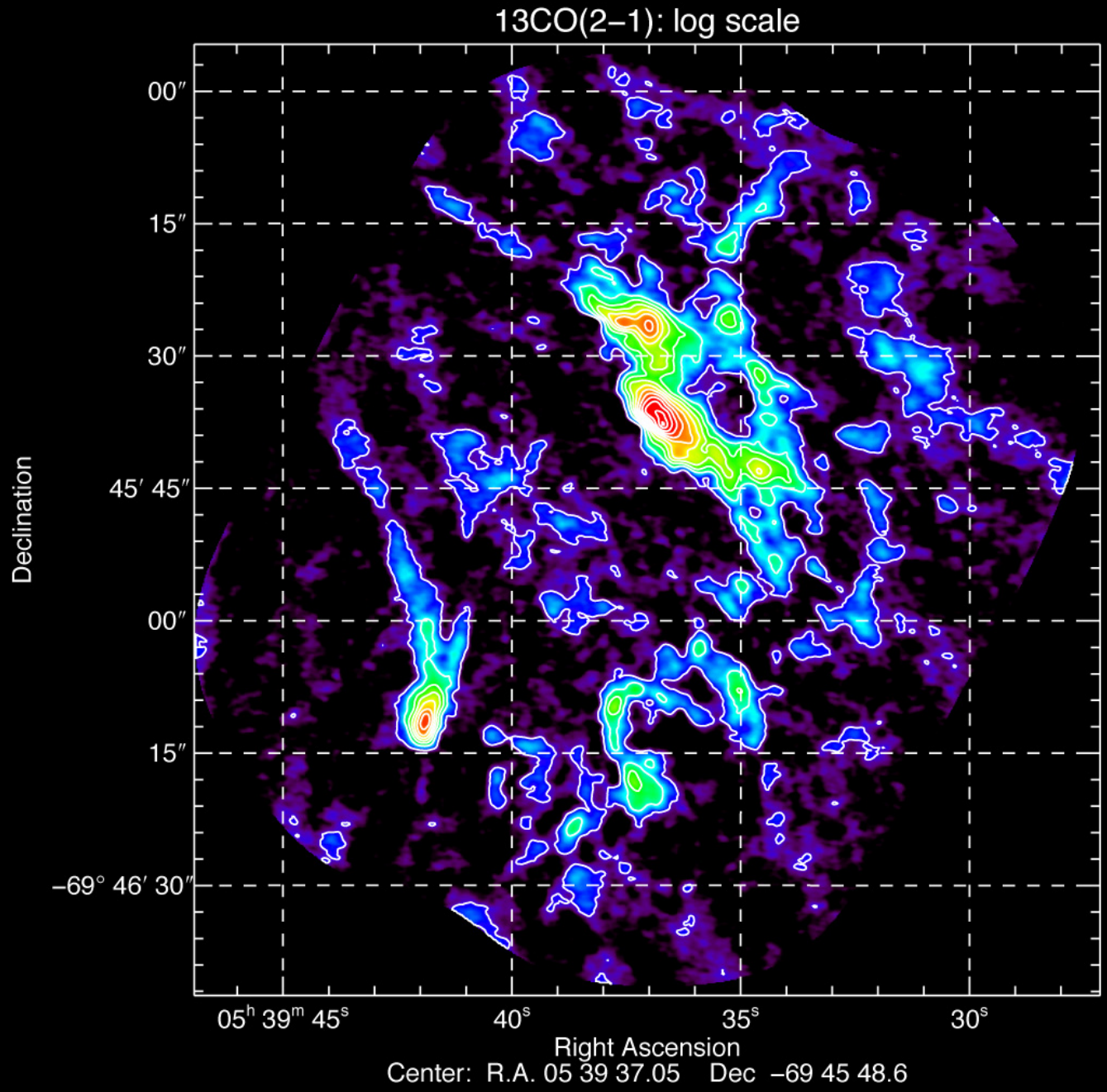
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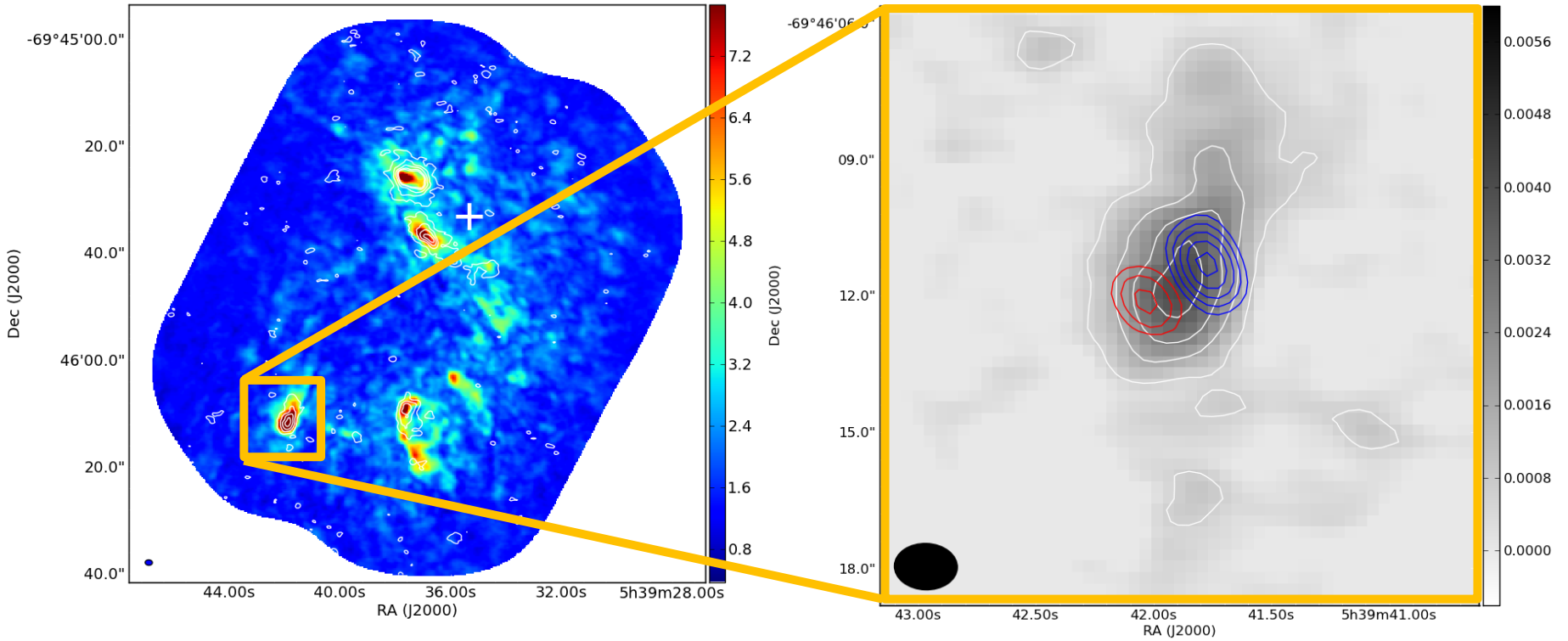
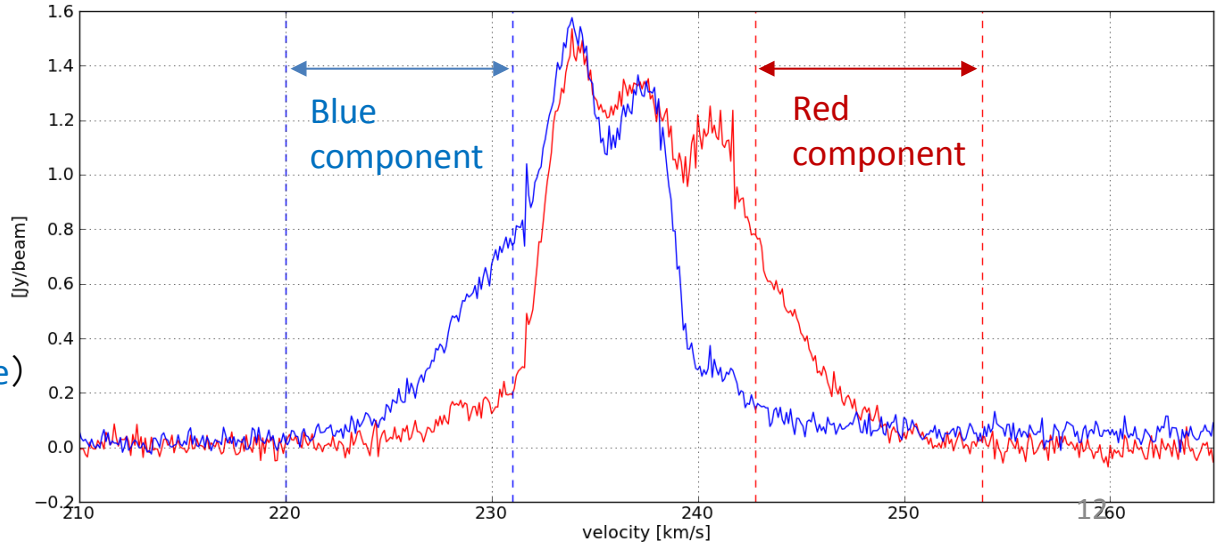
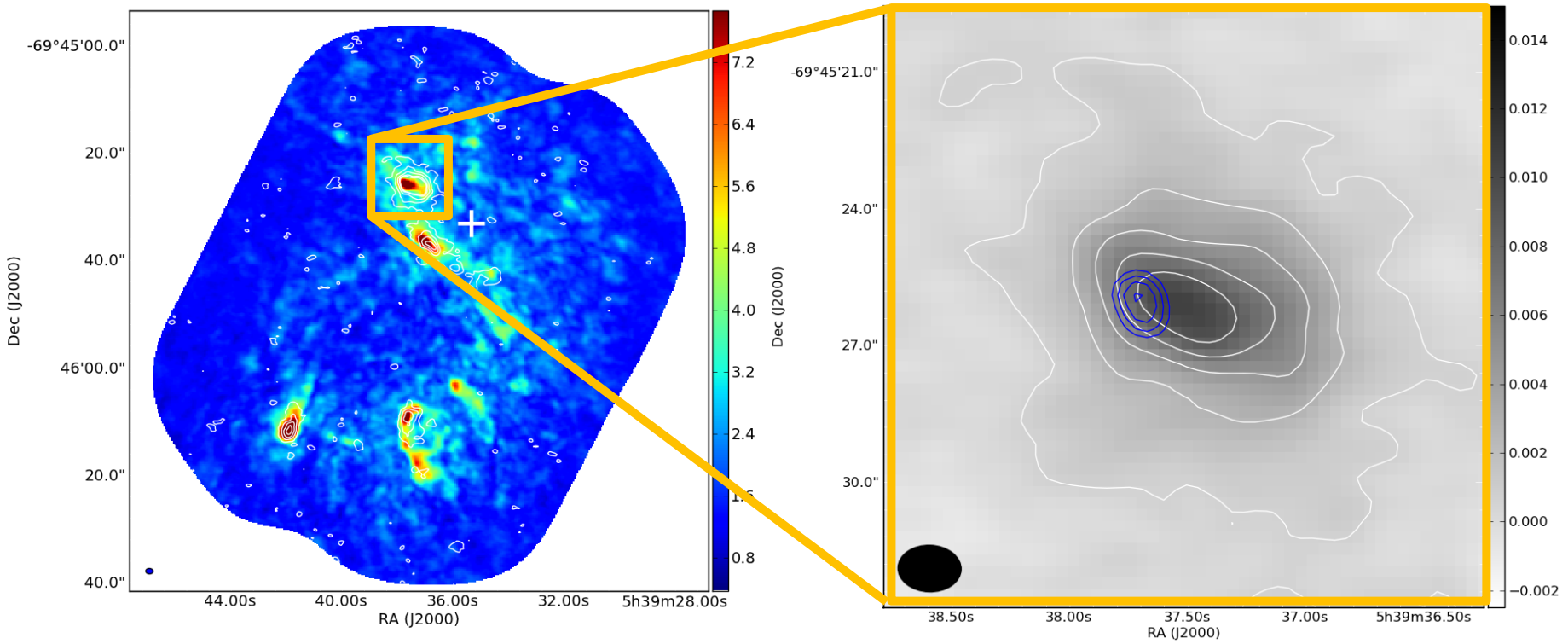


- left
  - color : 12CO(2-1) integrated intensity
  - contour : continuum

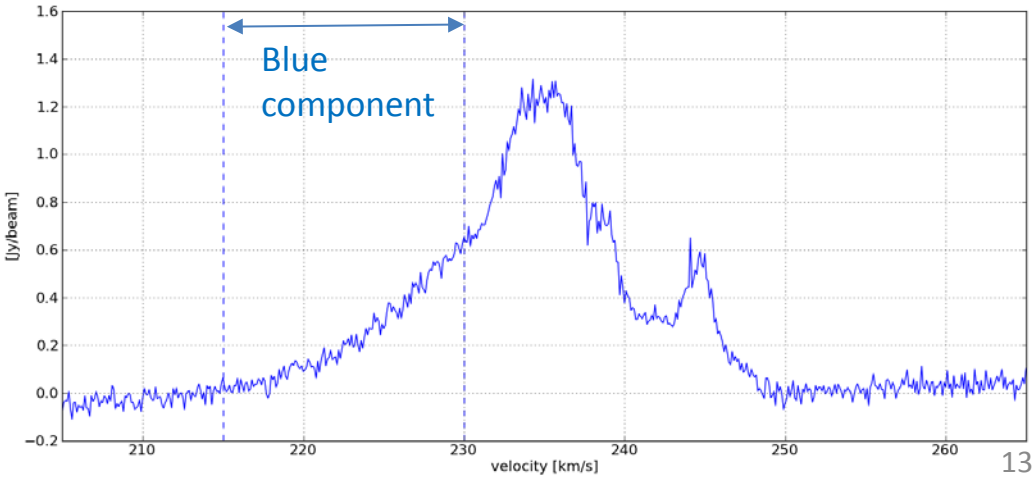
- right
  - color : continuum
  - white contour : continuum
  - blue : 12CO(2-1) integrated intensity (Blue)
  - red : 12CO(2-1) integrated intensity (Red)





・left
color：12CO(2-1) integrated intensity
contour：continuum

・right
color ：continuum
white contour：continuum
blue：12CO(2-1) integrated intensity（Blue）



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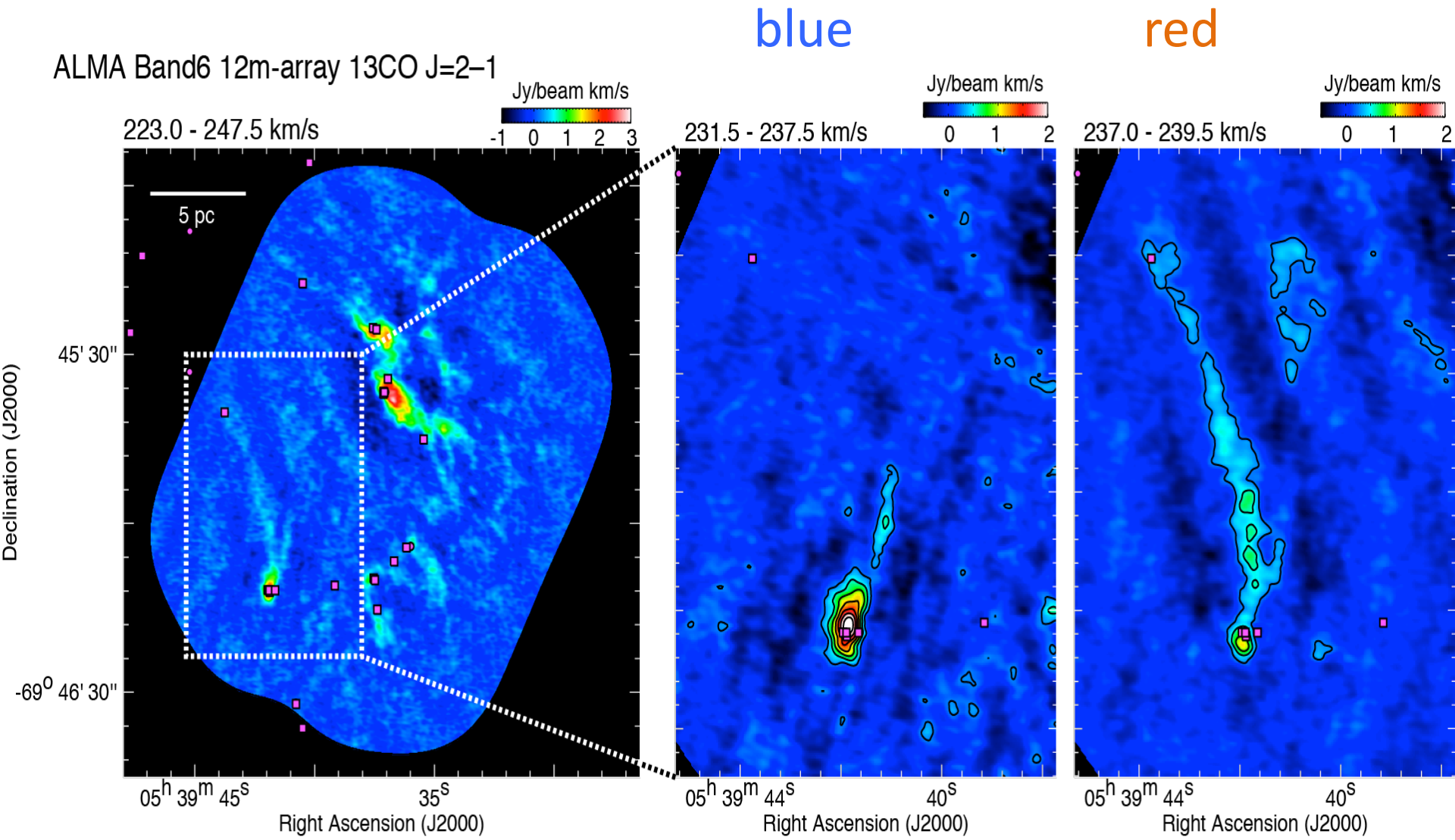
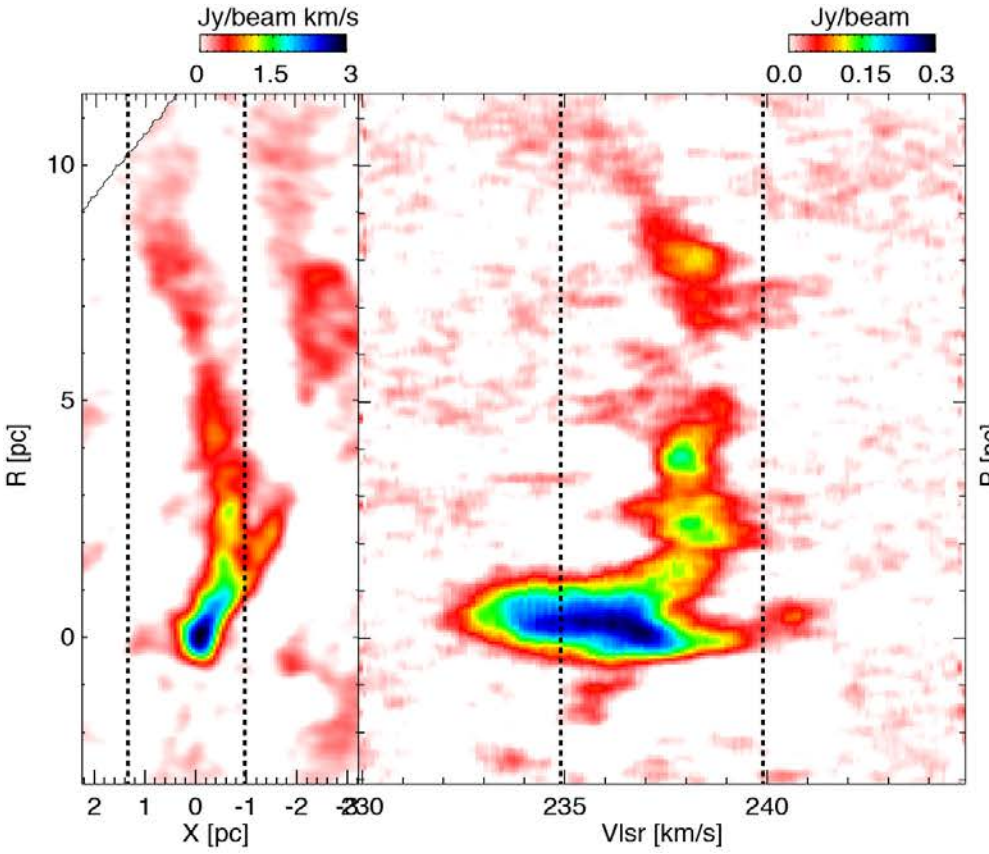


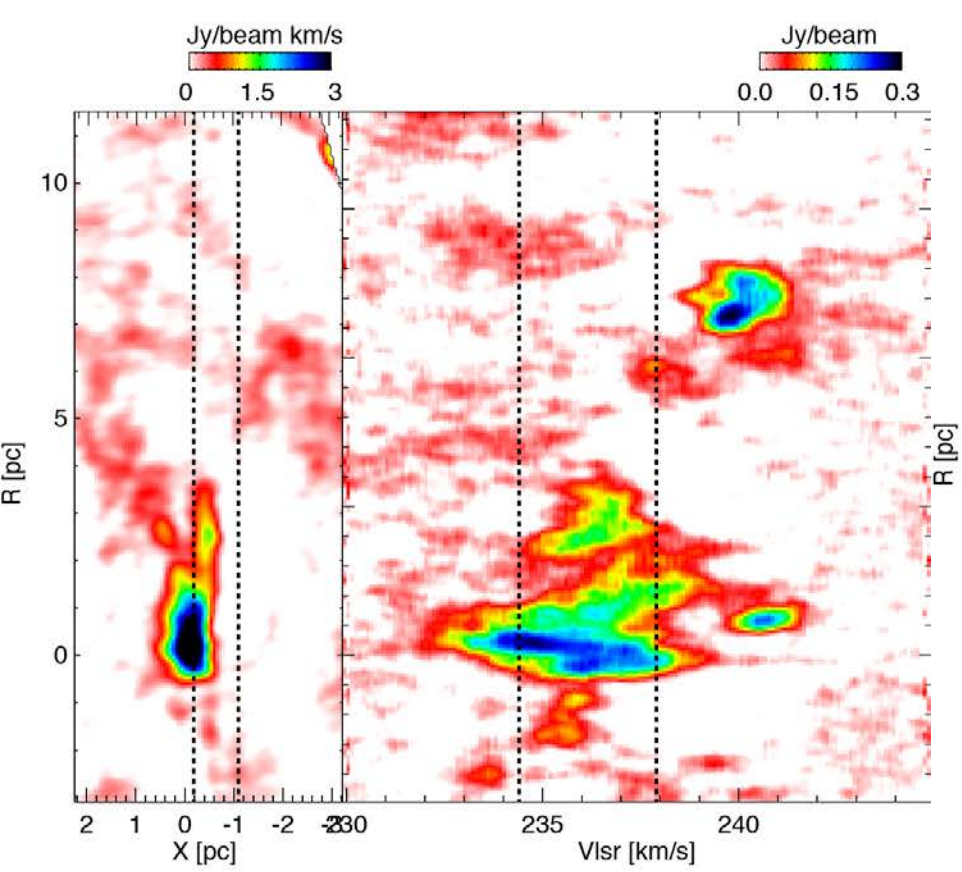
blue

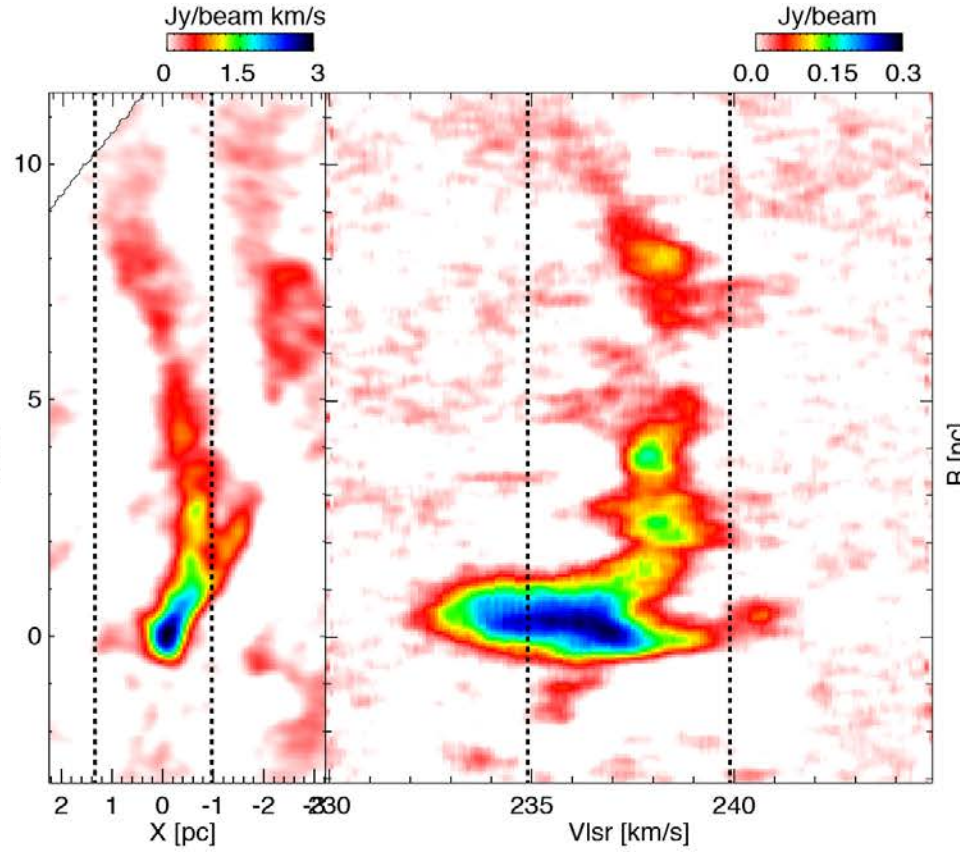
red


Jy/beam km/s
0
1.5
3
Jy/beam
0.0
0.15
0.3
10
5
0
R [pc]
2
1
0
-1
-2
-3
X [pc]
230
235
240
Vlsr [km/s]

blue

red


Jy/beam km/s
0 1.5 3
Jy/beam
0.0 0.15 0.3
10
5
0
R [pc]
2 1 0 -1 -2 -3
X [pc]
230 235 240
Vlsr [km/s]


Jy/beam km/s
0 1.5 3
Jy/beam
0.0 0.15 0.3
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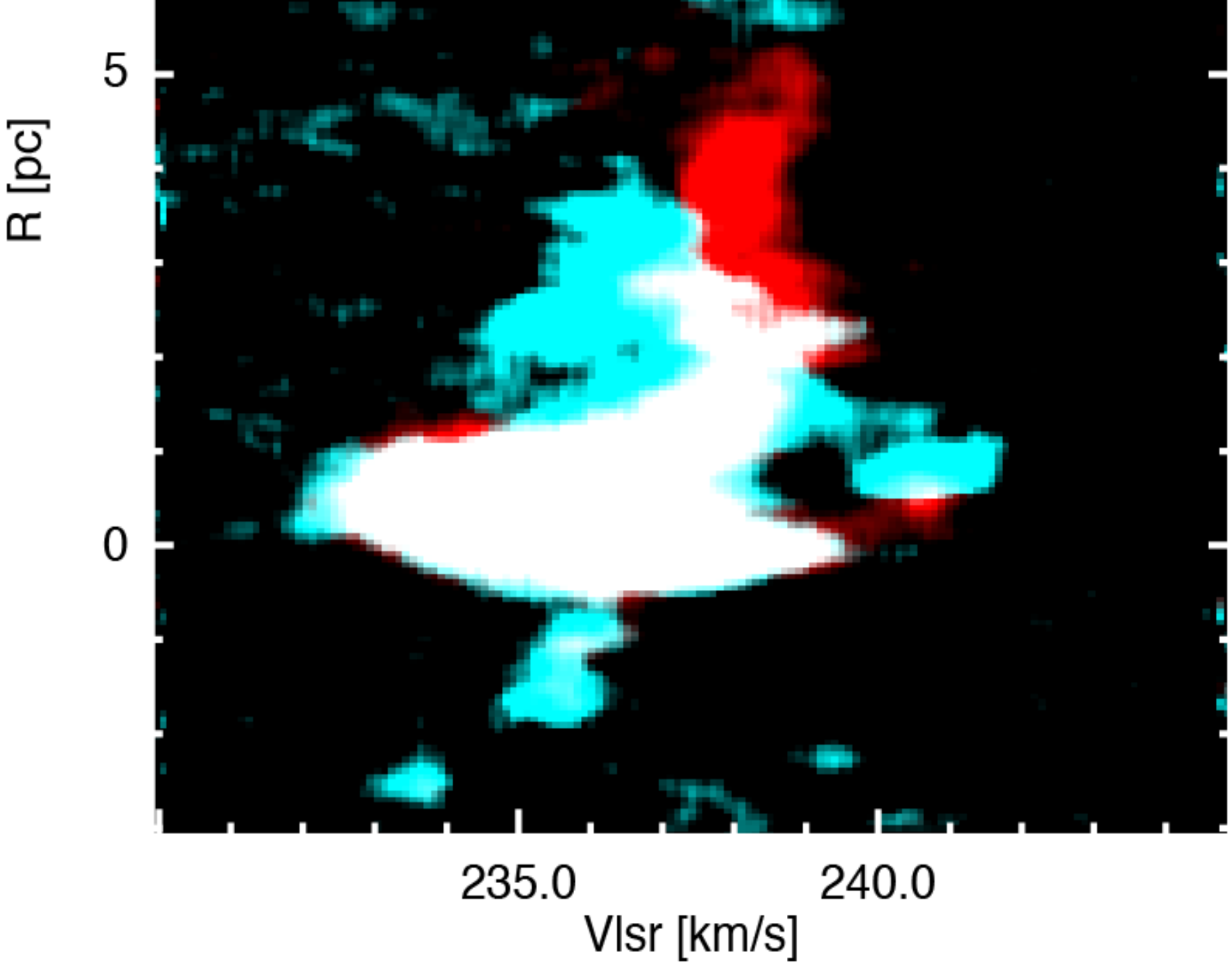
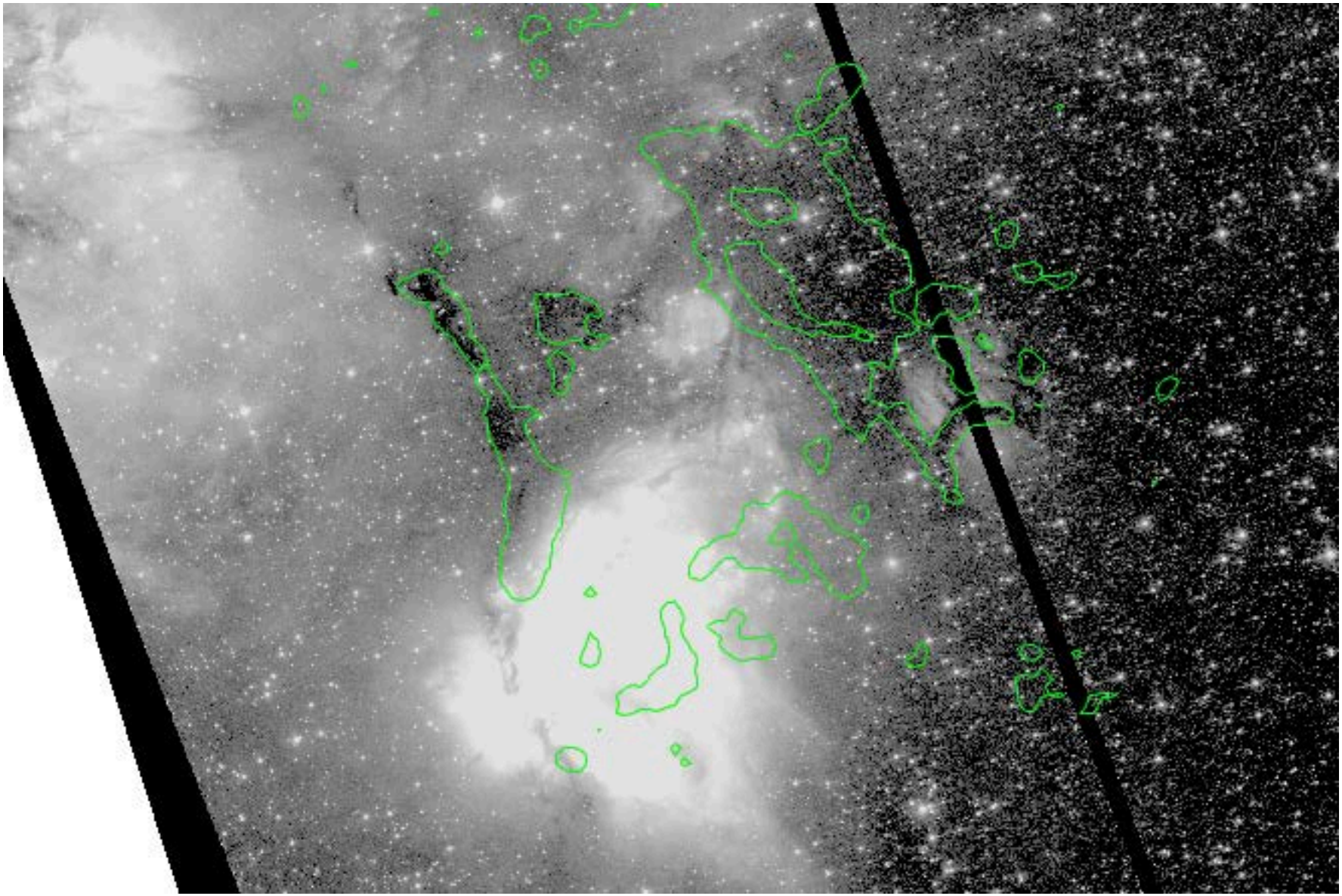
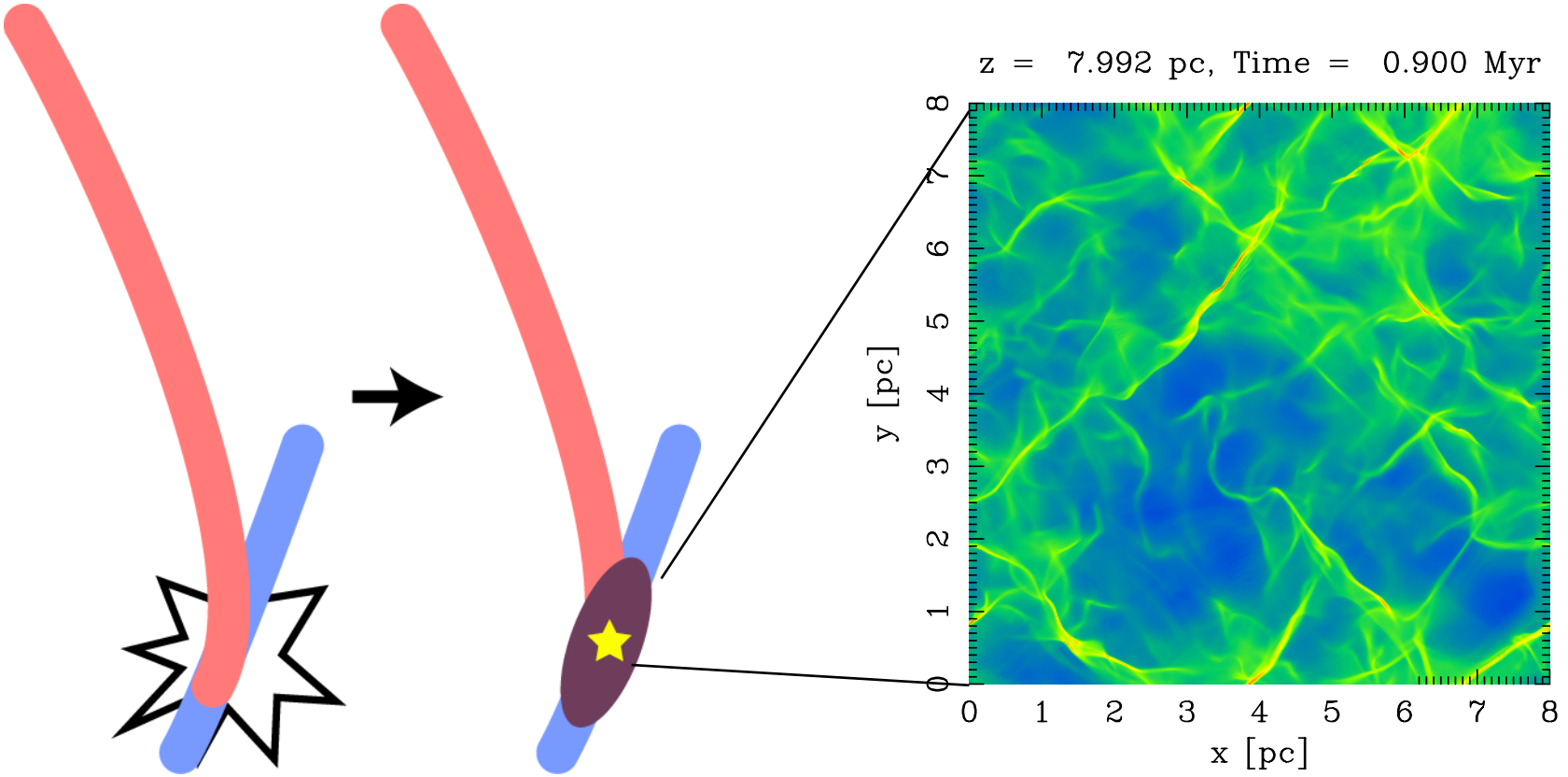
2 1 0 -1 -2 -3
X [pc]
230 235 240
Vlsr [km/s]


5
0
R [pc]
235.0
240.0
Vlsr [km/s]

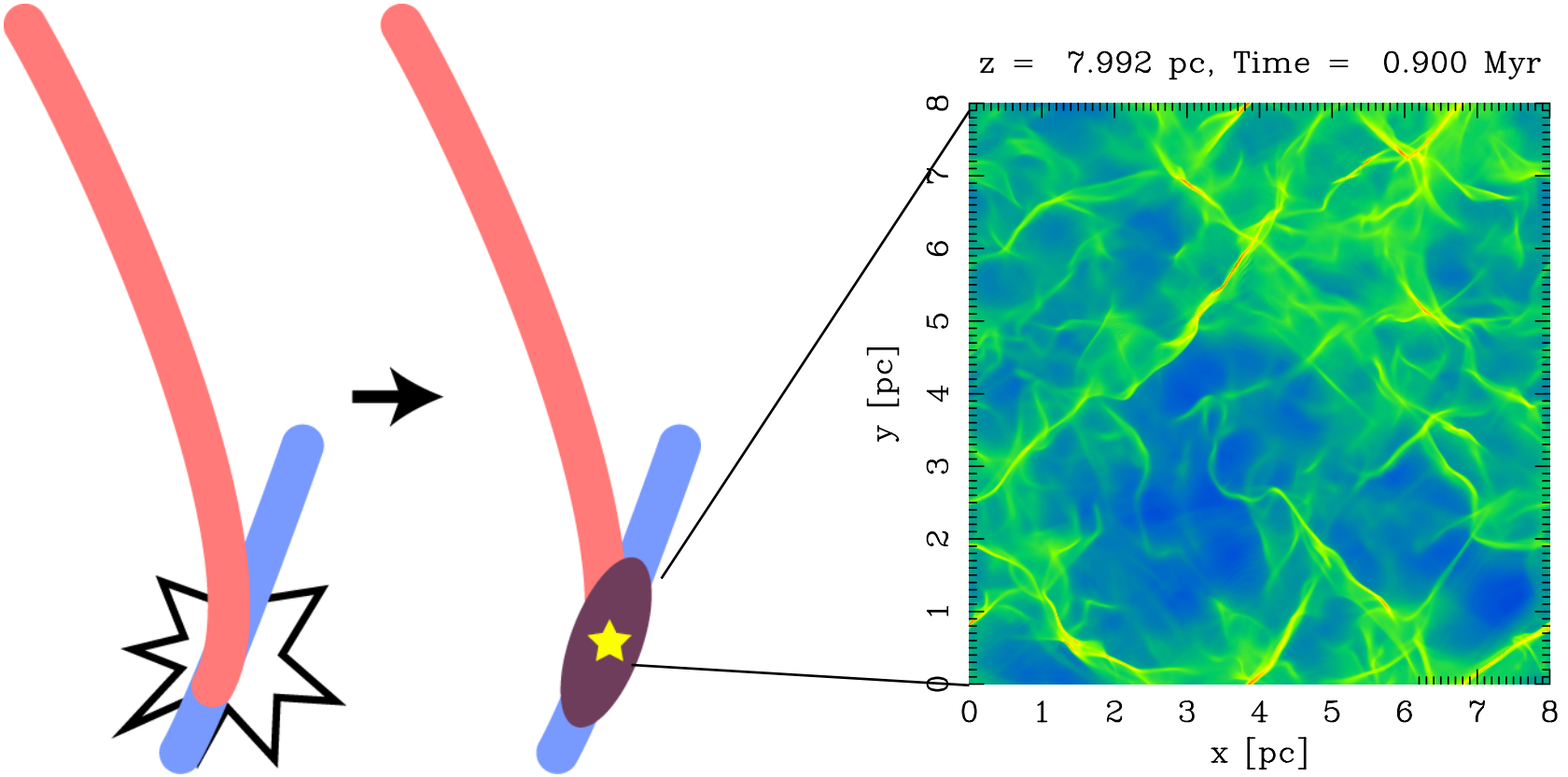


Credit: Remy Inbedetouw



Inoue & Fukui 2013

Filament-filament collision



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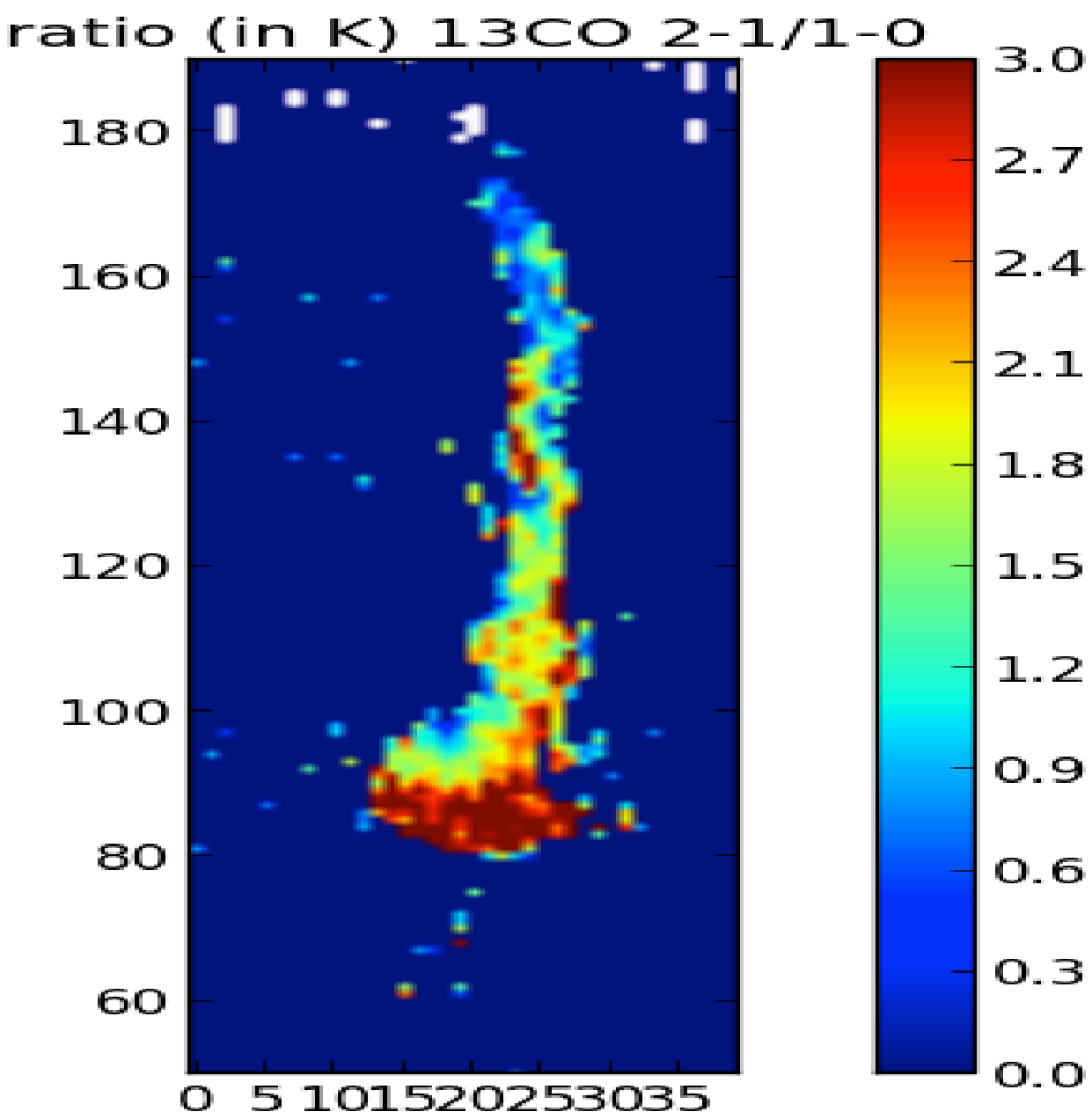
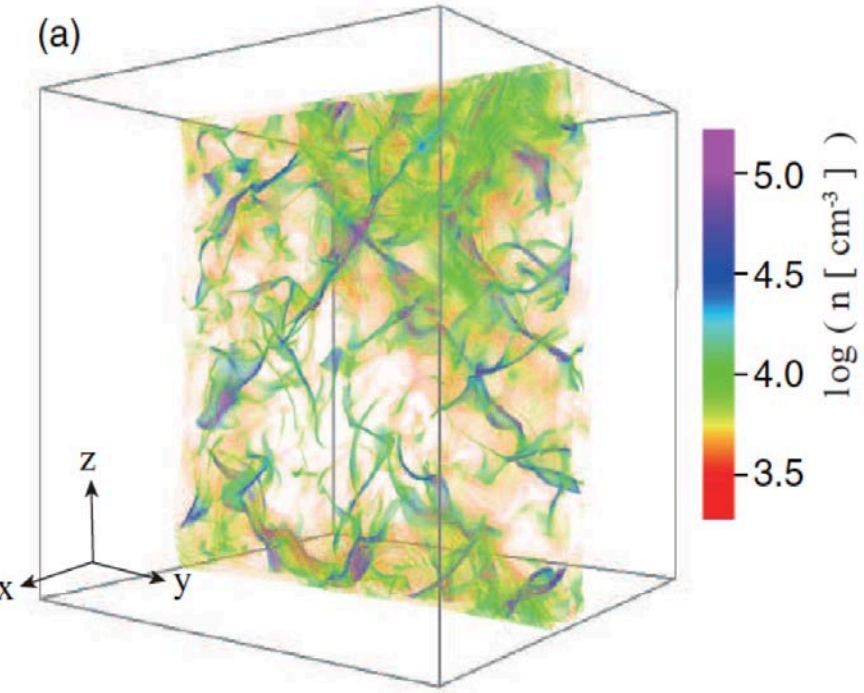


Credit : Remy Indebetouw

Cloud-cloud collision rapidly triggers formation of massive dense cores: MHD simulations



Inoue and Fukui 2013

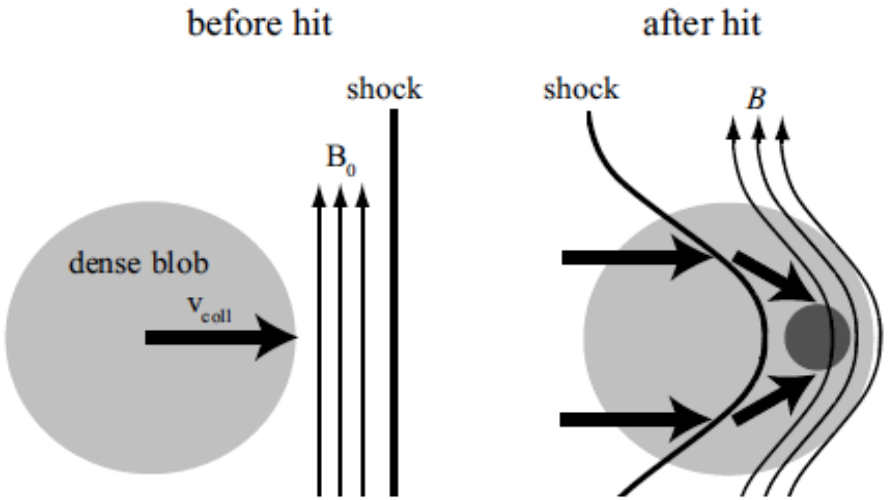
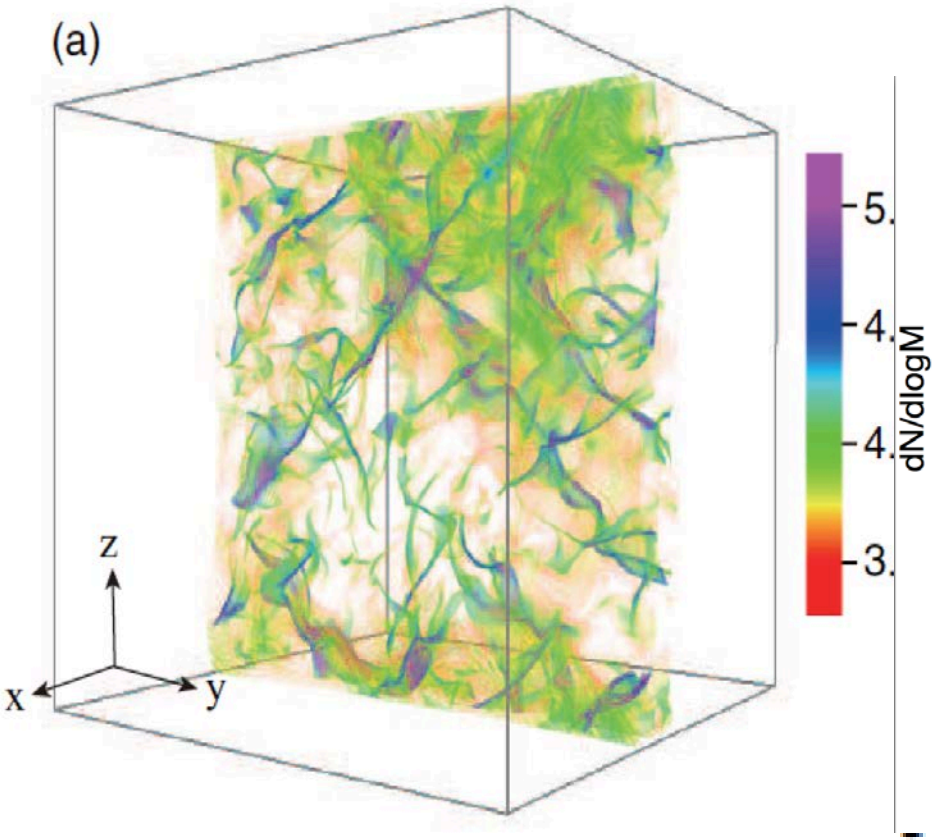
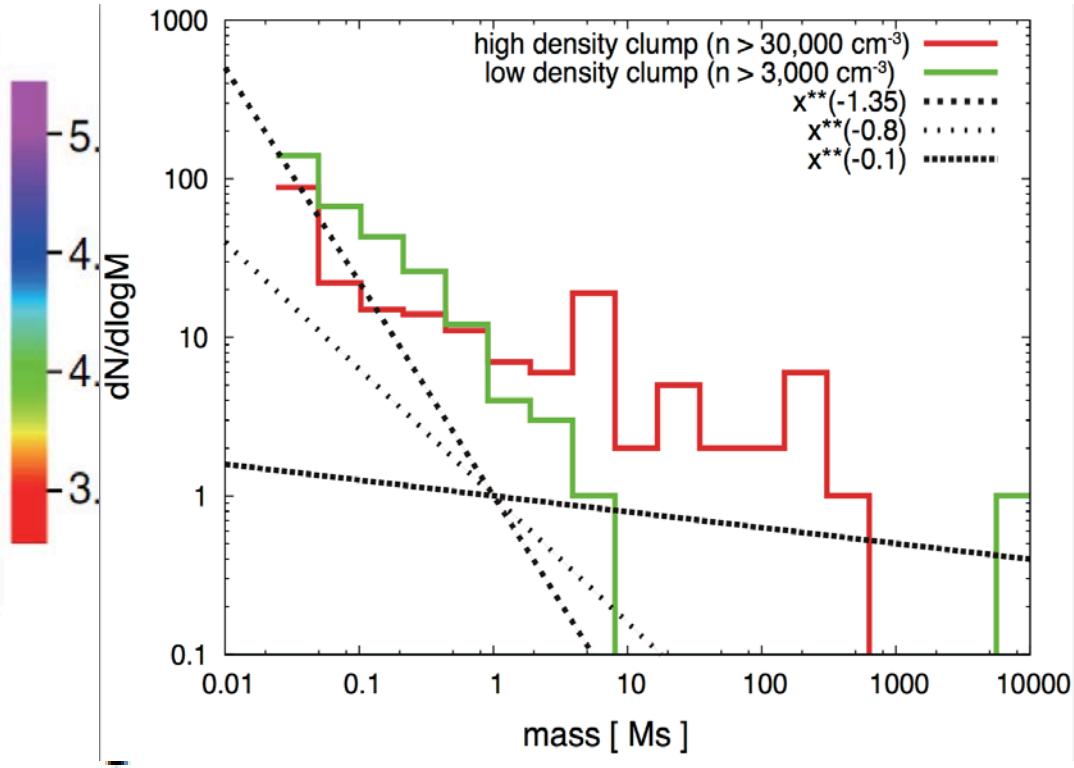


FIG. 1.— Schematics of the gas stream before (*left*) and after (*right*) the interaction between a shock and a dense blob. Because the deformed shock wave leads to a kink of stream lines across the shock, stream lines are headed toward convex point of the deformed shock wave.

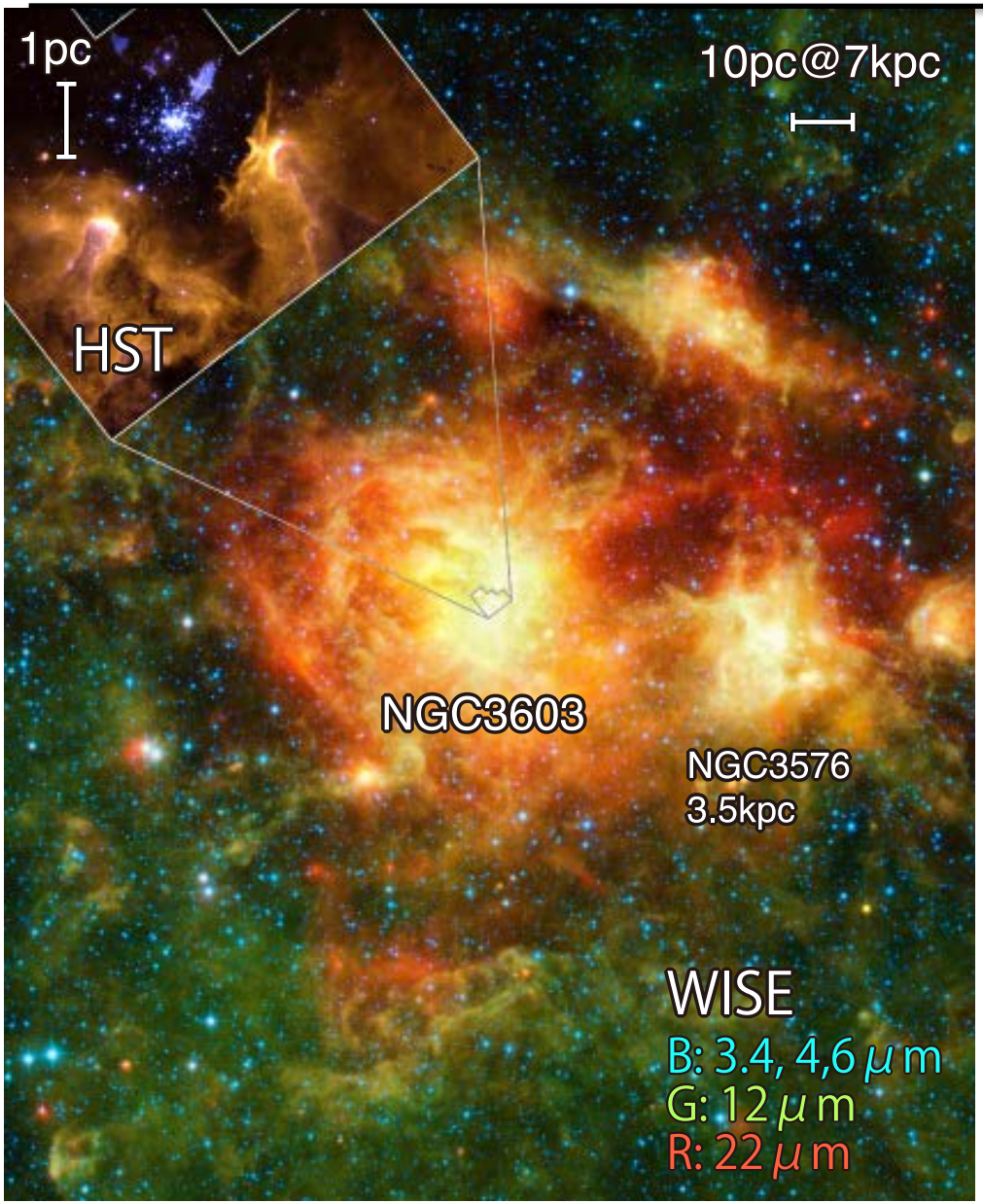
Collision amplifies turbulence and B field





$$M_{\mathrm{J,eff}} \equiv \frac{\langle c_{\mathrm{s}} \rangle^3 + \langle c_{\mathrm{A}} \rangle^3 + \langle \Delta v \rangle^3}{G^{3/2} \langle \rho \rangle^{1/2}},$$

Lesson on the Galactic mini-starburst: NGC3603

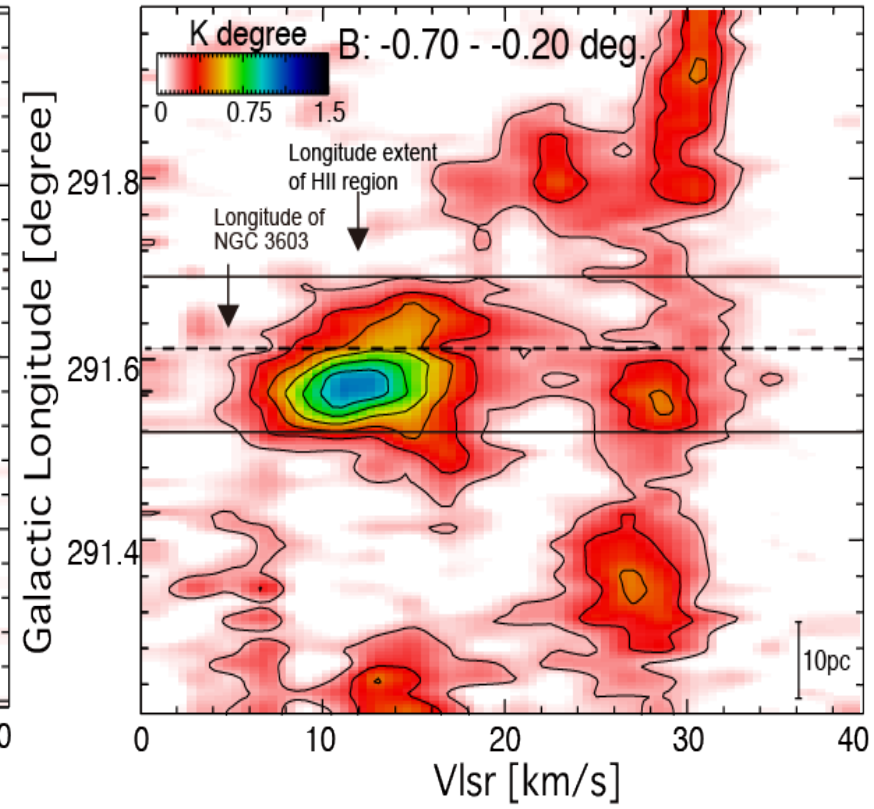


- ◇one of SSC in the Milky Way
- ◇Carina arm
  (l, b) = (291.6, -0.5)
- ◇Distance: 6-8 kpc
  (e.g. Russeil 2003)
- ◇Total mass of stars: >10^4 M_{sun}
  (Harayama et al. 2008)
- ◇Age :1-3 Myr
  (e.g. Sung & Bessell 2004)
- ◇O type Star: more than 30
  (Moffat et al. 2004)
- ◇WR:1-4 (Schmutz W. et al. 1999)
- ◇Star formation in progress
  (Stolte et al.2004)

WISE&HST credit: NASA/JPL-Caltech/UCLA

NGC3603 star formation is quick, in 10^5yrs

Fukui et al. 2014



Kudryavtseva et al. 2012

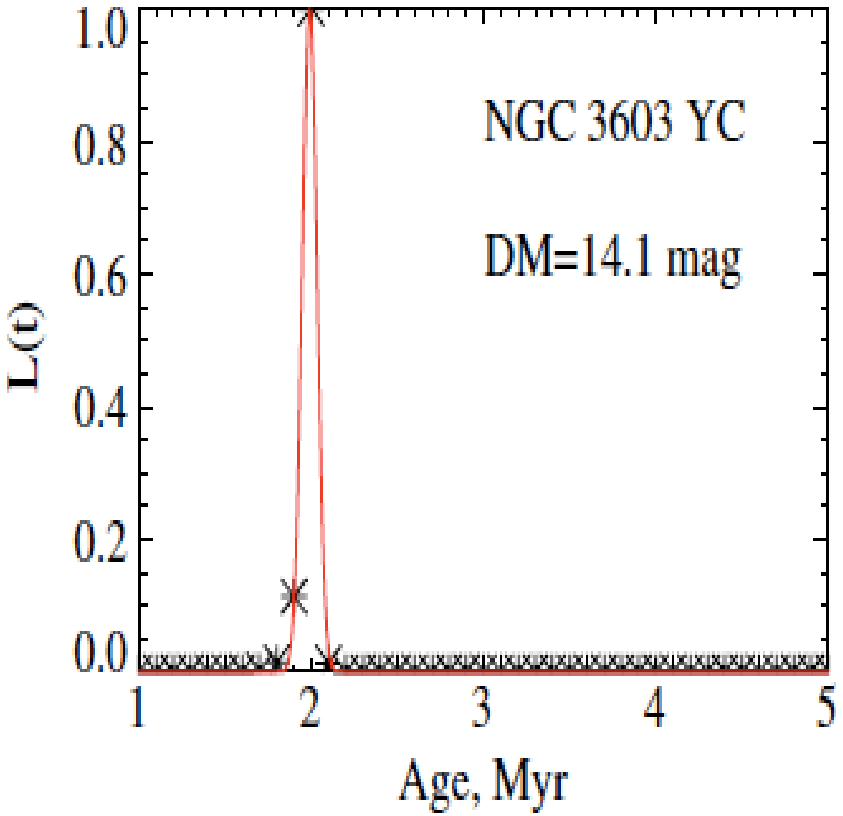


Figure 4. Normalized $L(t)$ for NGC 3603 YC at DM = 14.1 mag. The most probable age is 2.0 Myr. The red curve is a fitted Gaussian function.

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