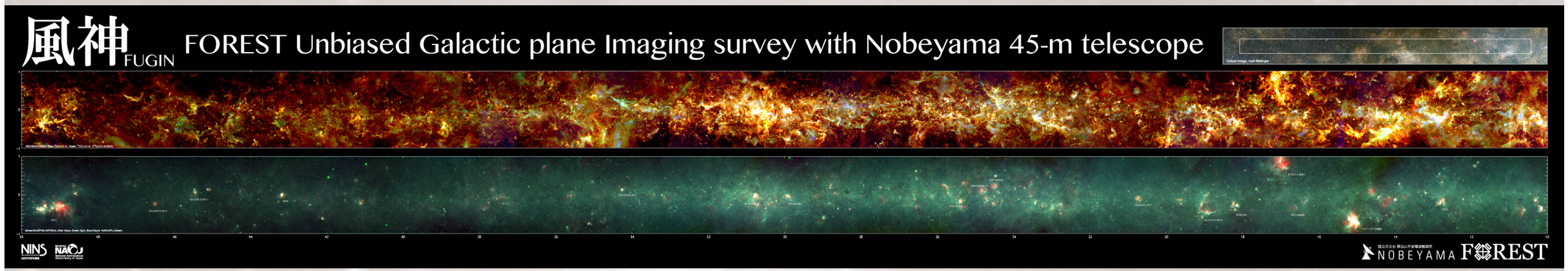


FUGINが見た銀河系の分子雲

Characteristics of Molecular Clouds in the Galaxy indicated by FUGIN data

Hiro Saito（Tsukuba University）

01 About FUGIN

Survey Strategy

- Area : the first quadrant (10d < L < 50d ; -1.0 < b < 1.0)

  the third quadrant (198d < L < 236d ; -1.0 < b < 1.0)

- Line : 12CO, 13CO, C18O

- effective velocity resolution : 1.3 km/s @ 3 mm

- effective angular resolution : 20" @ 12CO

- final map

  * l,b grid = 8".5, velocity grid = 0.65 km/s

    velocity range = -100 km/s < v < 200 km/s

    Noise level ~ 1.5 K @ dV = 1.3 km/s (12CO)

    ~ 0.7 K @ dV = 1.3 km/s (13CO)

01 About FUGIN

Other Survey data

- Dame et al. 1986 ~

  line : ^{12}CO, L = 12 - 60 deg, beam size = 8′

  noise level = 0.45 K @ dV = 1.3 km/s

- Rathborne et al. 2009

  line : ^{13}CO, L = 18 ~ 56 deg, beam size = 46″

  noise level : T_A*= 0.13 K @ dV = 0.21 km/s

FUGIN data

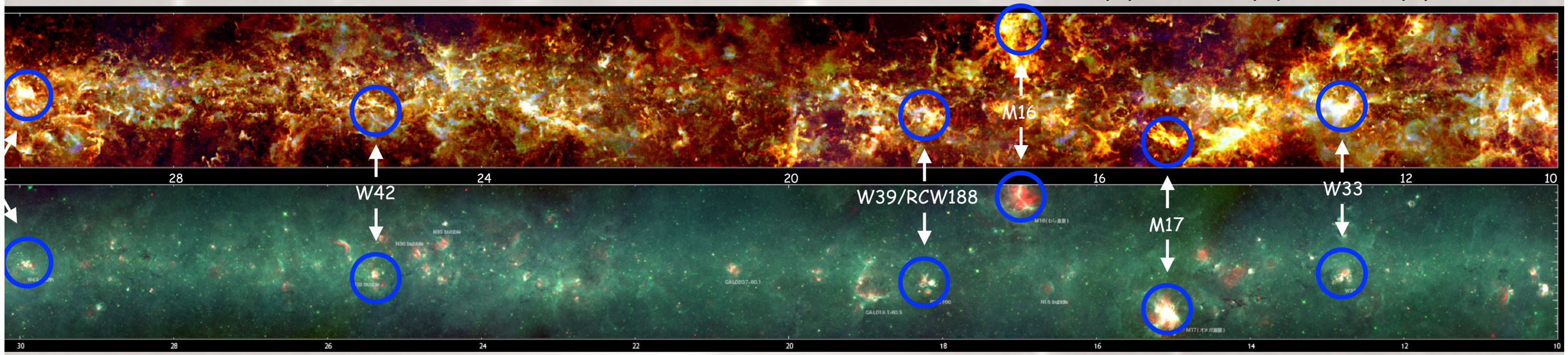
High spacial resolution : detect the structure with various scales

(0.2 ~ 70 pc @ 2.0 kpc (sagittarius arm))

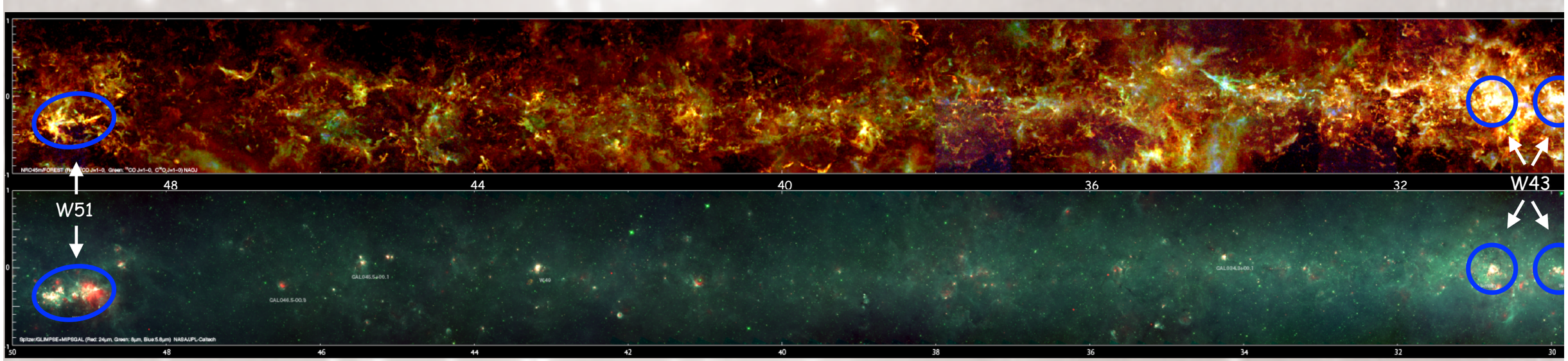
12CO : detect the structure with low column density

02 Results of FUGIN data

FUGIN : 12CO (R) & 13CO (G) & C18O (B) : NAOJ



Spitzer : 24um (R) & 8um (G) & 5.8um (B) : NASA



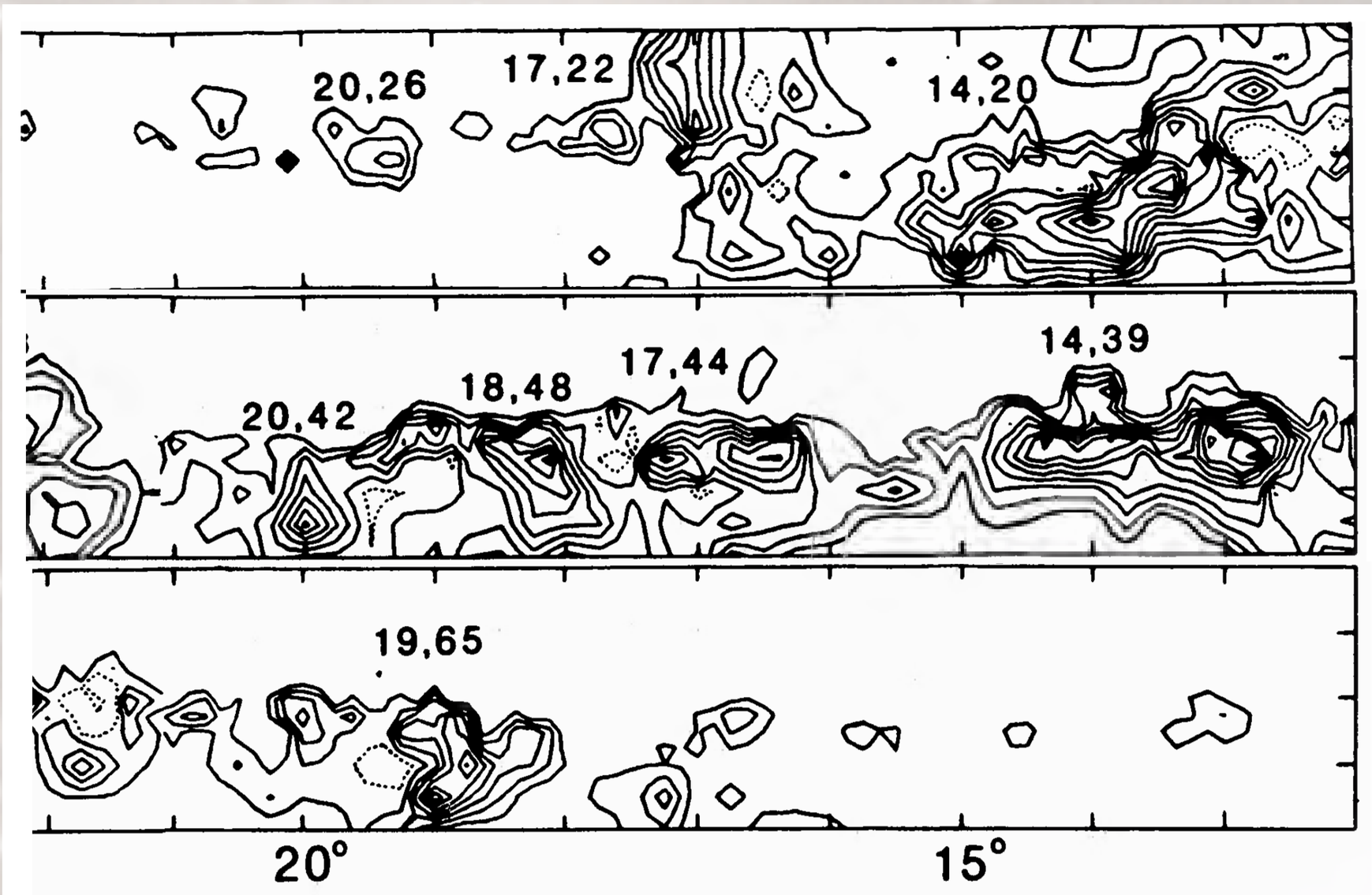
03 Comparison with other data

Dame et al. 1986

Sagittarius Arm

Scutum Arm

4 kpc Arm



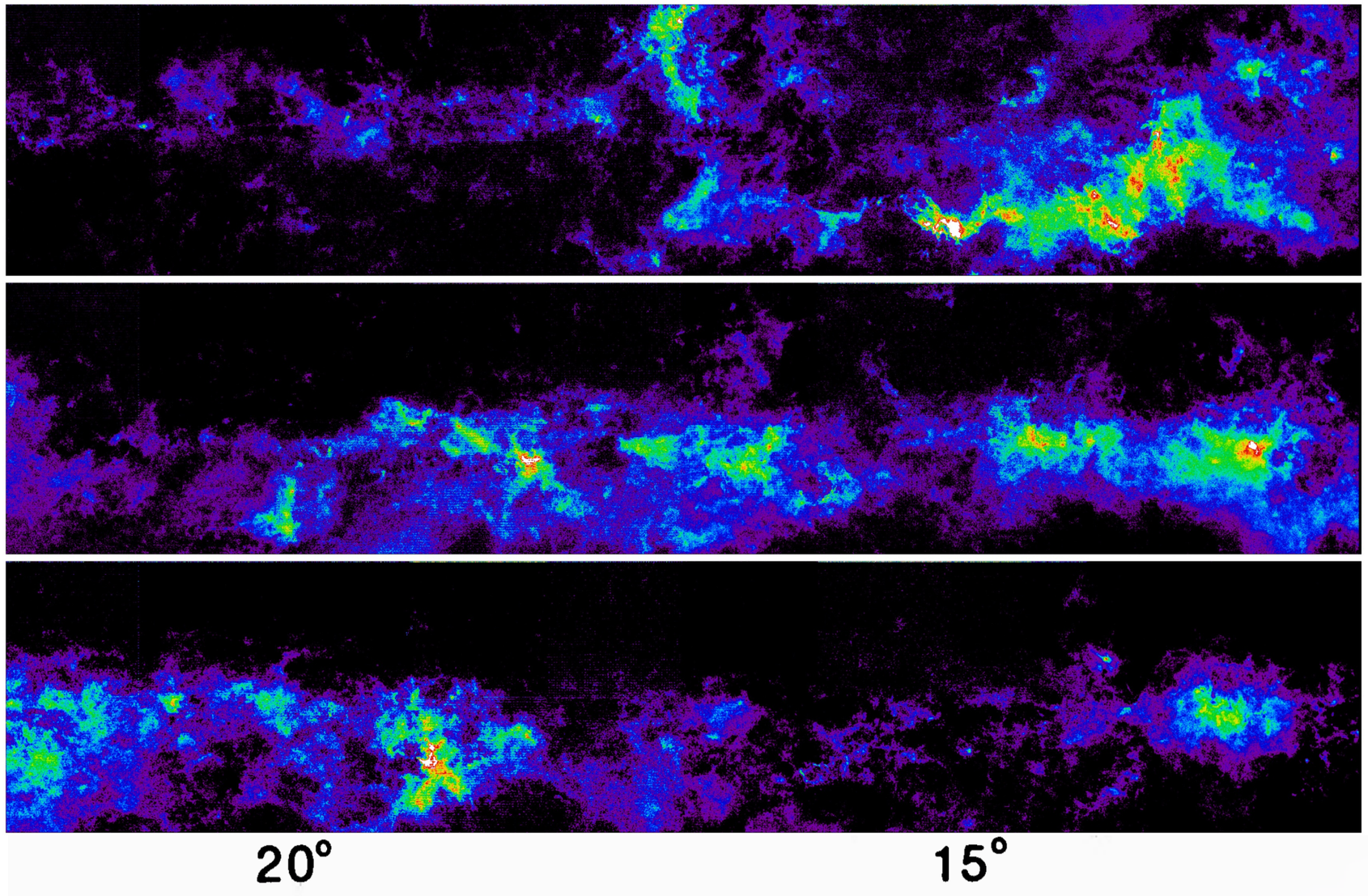
03 Comparison with other data

Dame et al. 1986

Sagittarius Arm

Scutum Arm

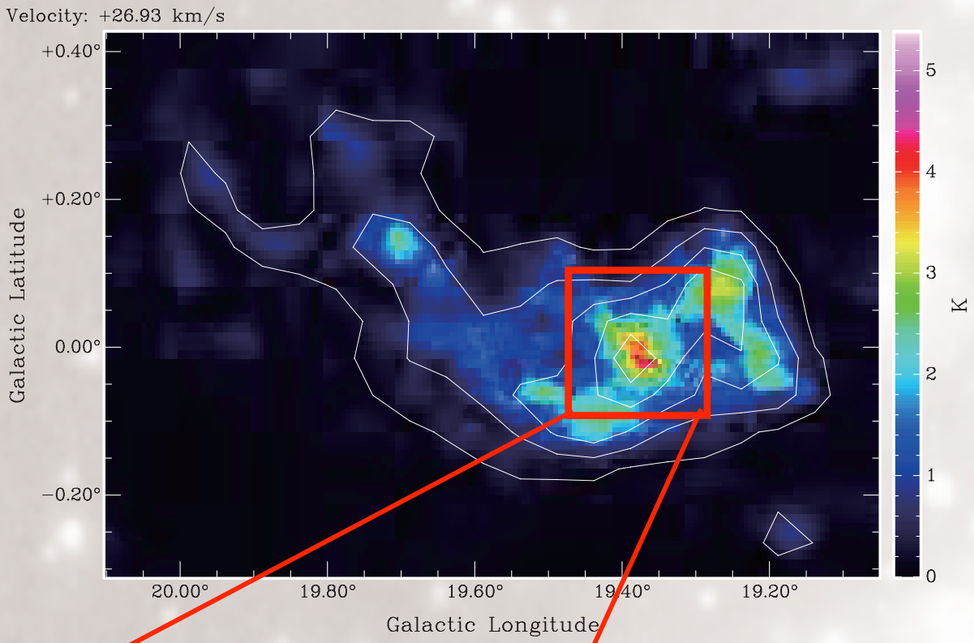
4 kpc Arm

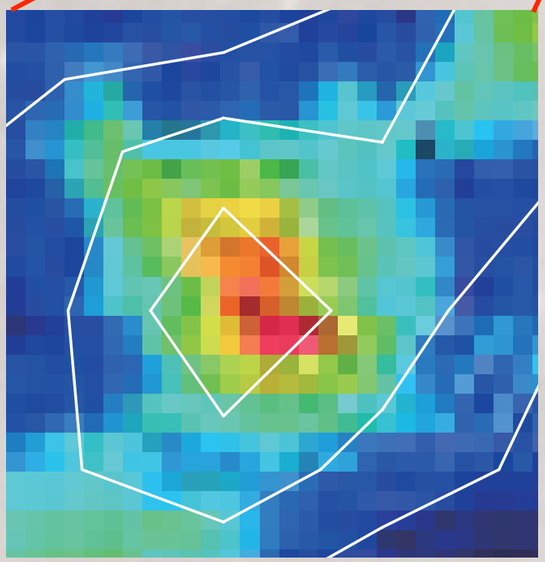


03 Comparison with other data

Rathborne et al. 2009

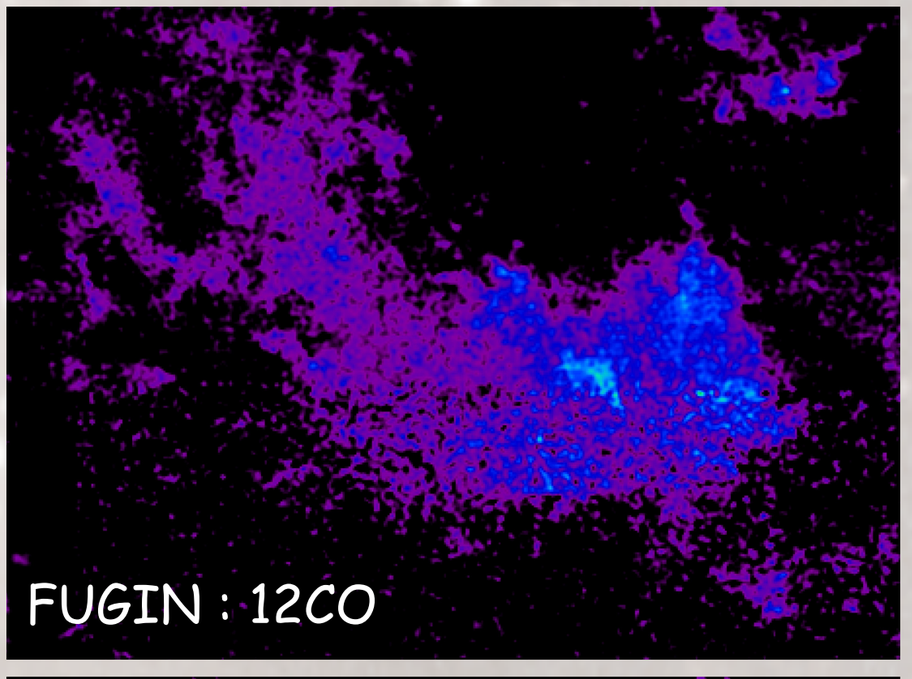
line : ^{13}CO, beam size = 46″

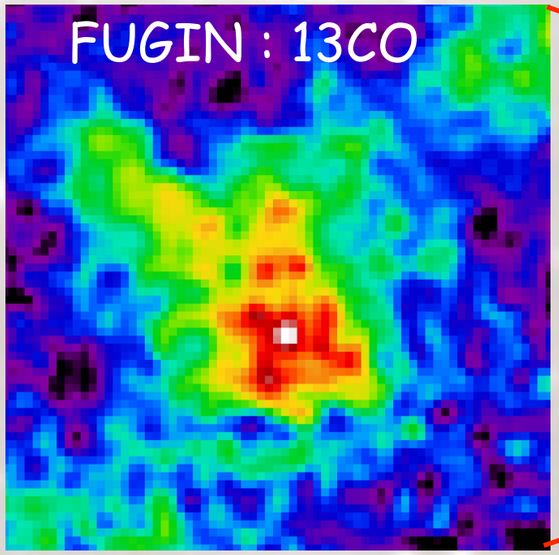


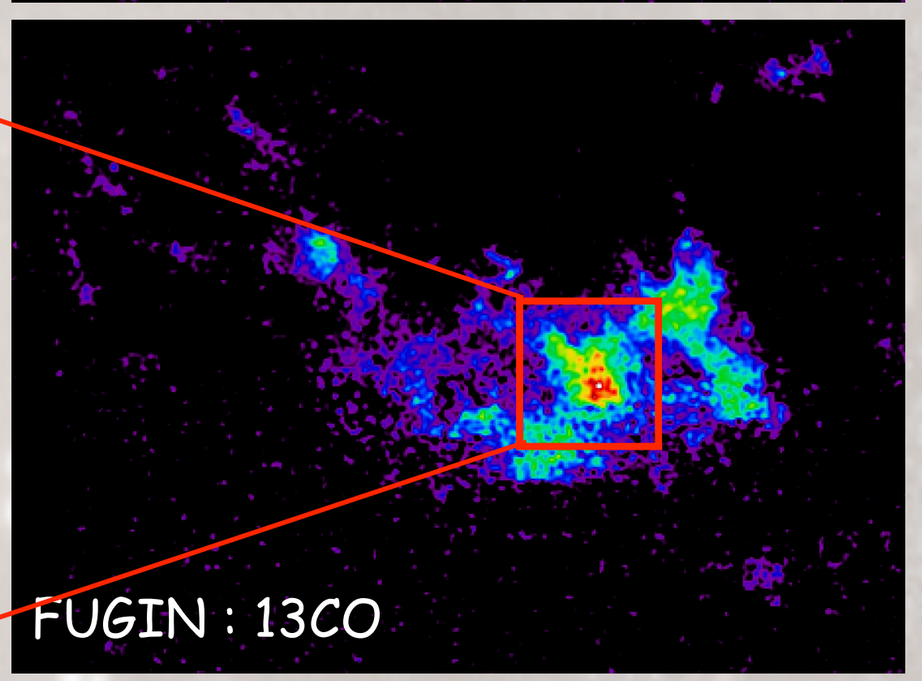


FUGIN

effective resolution = 20″

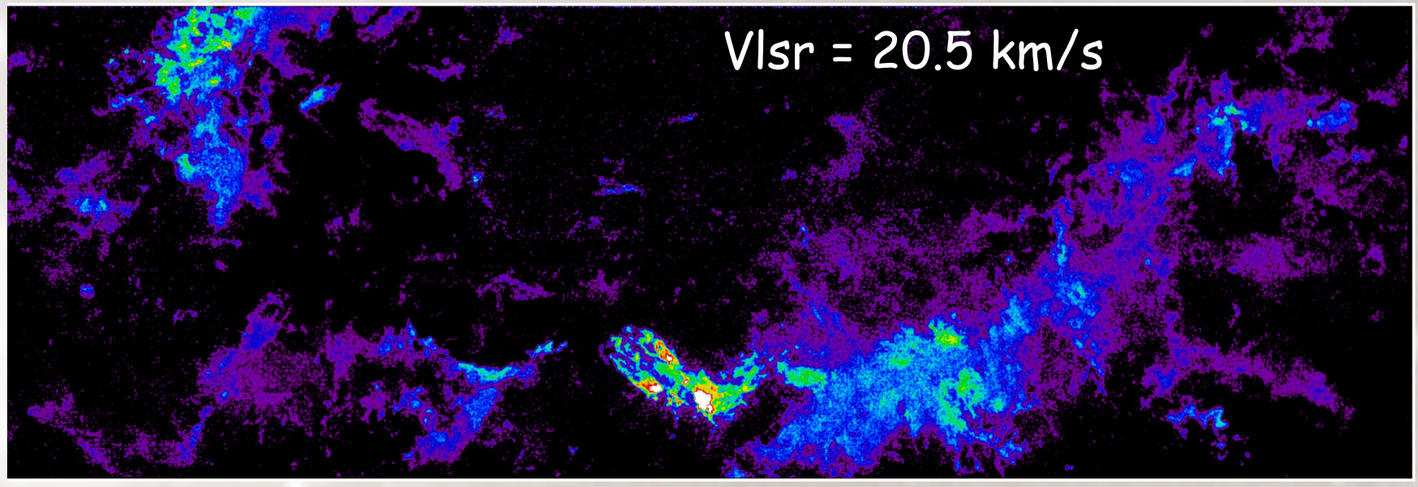






04 distribution of molecular gas

Vlsr = -15 km/s ~ 150 km/s



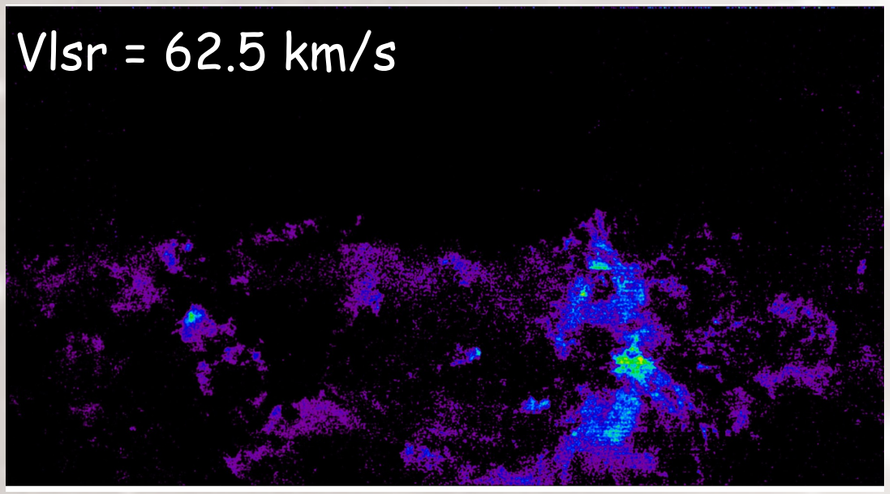
M16 & M17

Large Arc Structure ?

Filament Structure ?

Vlsr = 57 ~ 68 km/s

Large Shell ?



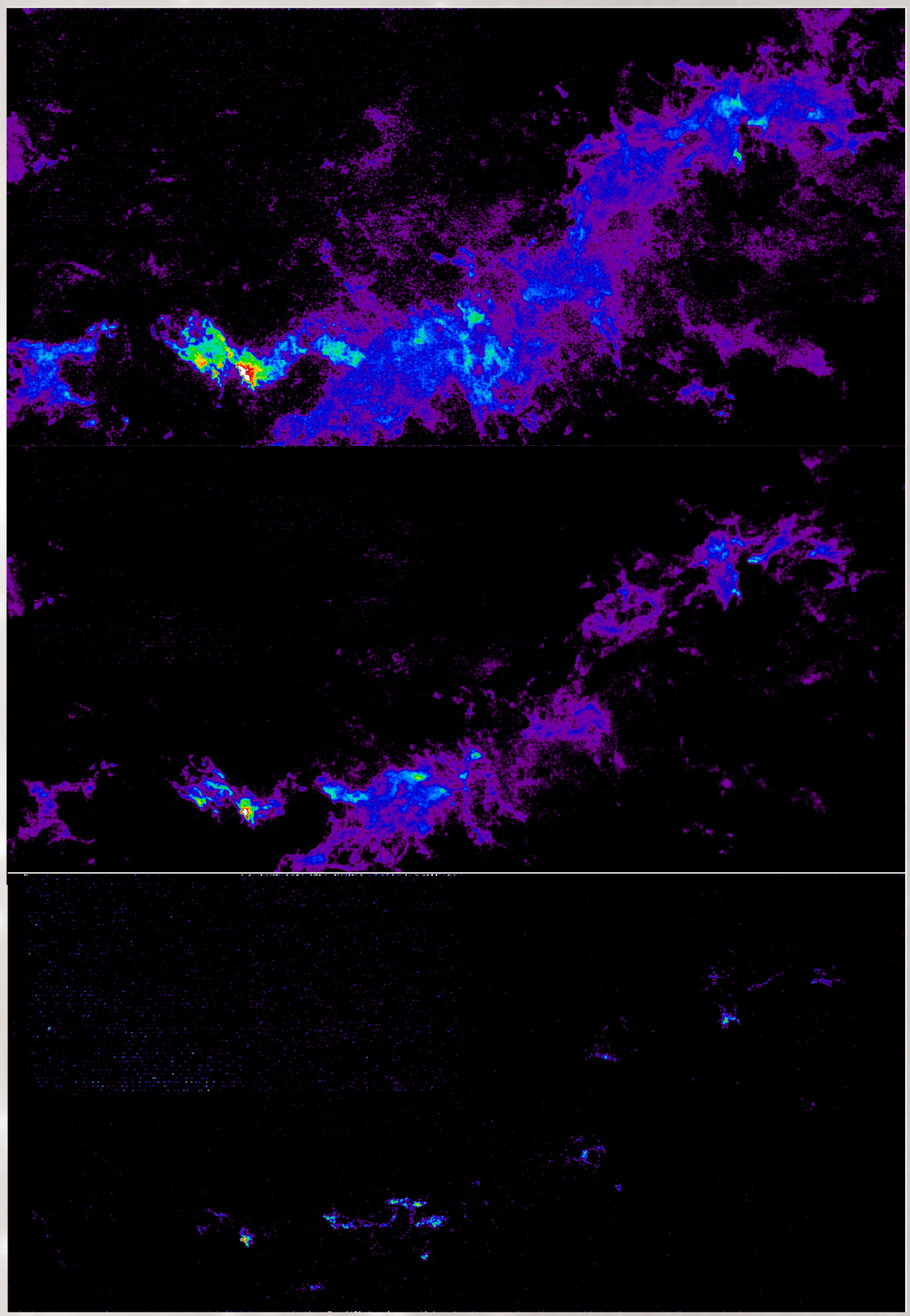
04 distribution of molecular gas

M17 cloud

12CO line

13CO line

C18O line



05 Molecular Cloud Identification

Aims

- Establishment of method of molecular cloud identification
- Calculation of basic physical parameters of molecular clouds
- Reveal inner-structures of molecular clouds
- Reveal size function and mass function of molecular clouds

Verification of Identification method

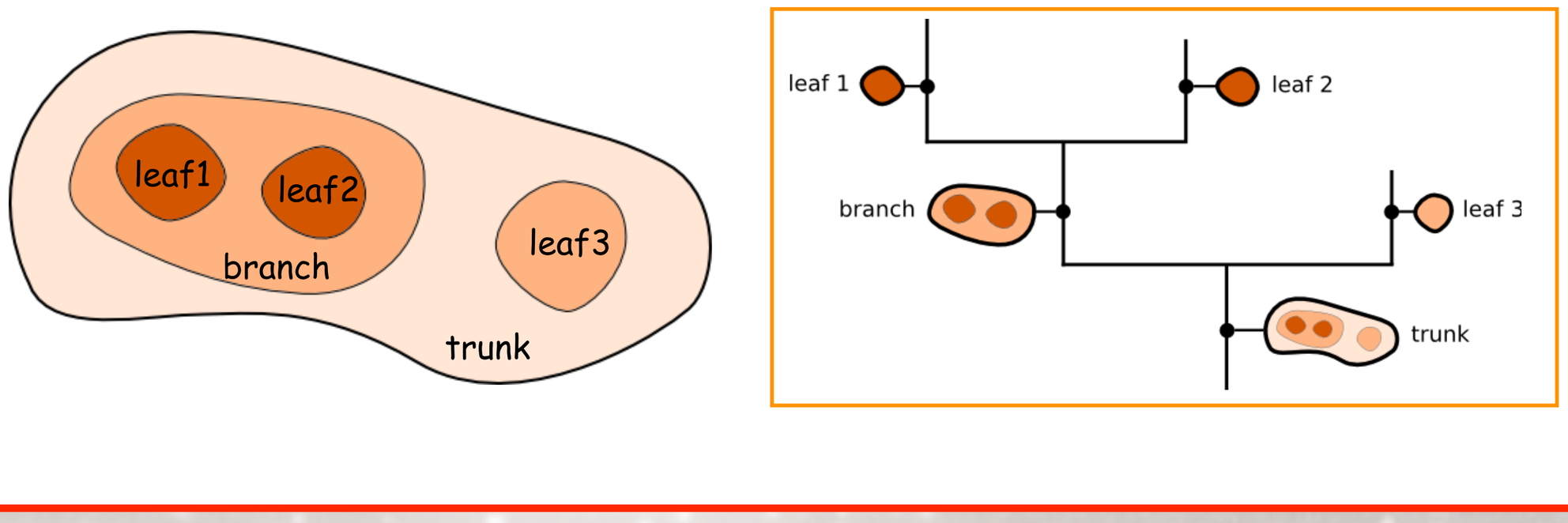
Identification Method using the results of Dendrogram

* Dendrogram : treat as a tree that represents the hierarchy of the structures

- test data : using a part of 1st quadrant data (L = 12 - 16 deg)
- cloud separation method : using the results of Dendrogram & velocity difference

05 Molecular Cloud Identification

Structure Identification using the results of Dendrogram



Dendrogram can identify the structures with various scales at the same time

—> We can identify the molecular cloud as well as the internal structures

05 Molecular Cloud Identification

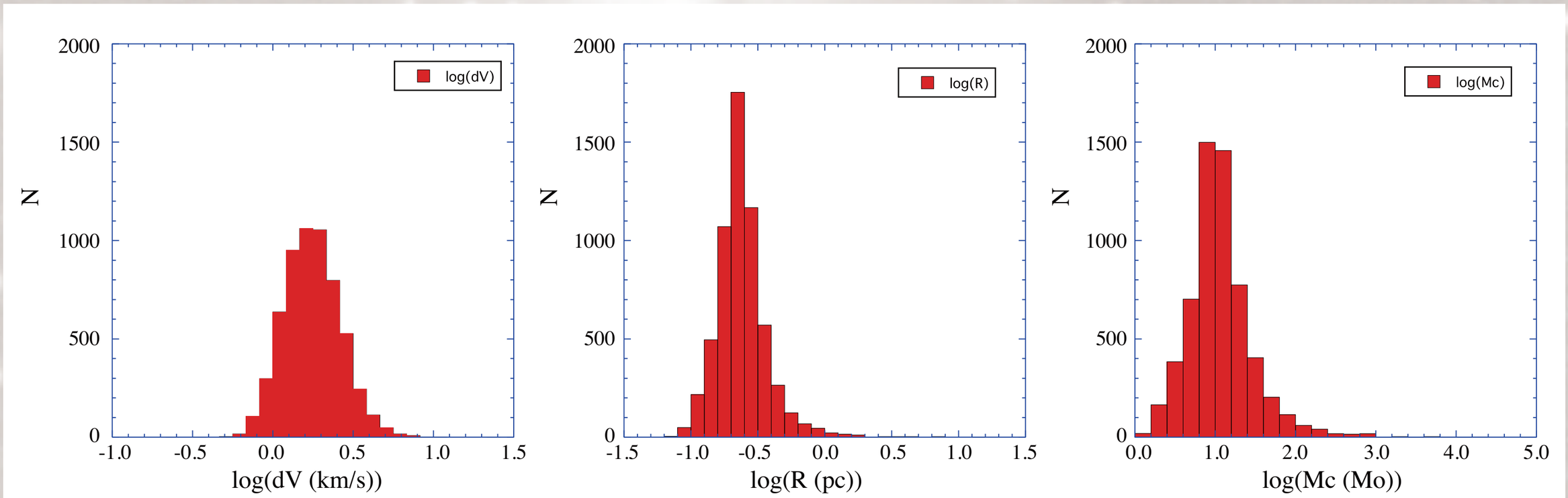
Test Results

Identified Clouds : Using 12CO data

< L = 12 - 16 deg area (Sagittarius Arm) >

identified clouds : 5893 (except for M17 GMC complex)

- R : 0.07 - 14 pc, dV : 0.33 ~ 12.0 km/s, Mc : 1.2 ~ 8.9×10^4 Mo



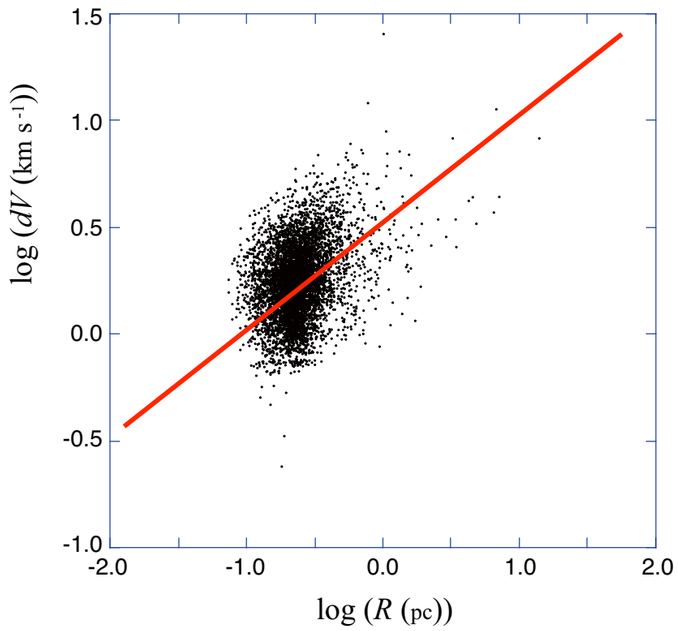
90% of clouds : dV < 3.0 km/s, R < 0.4 pc & M < 35 Mo

05 Molecular Cloud Identification

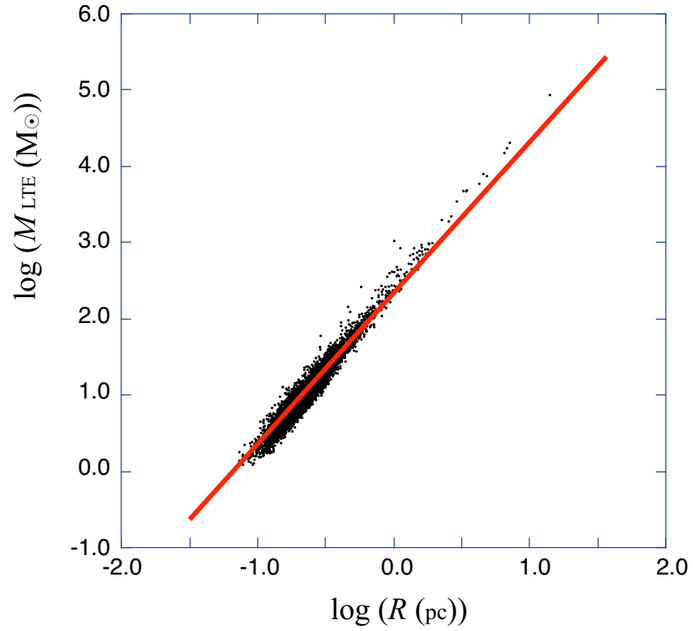
Physical parameter relationships

Test Results

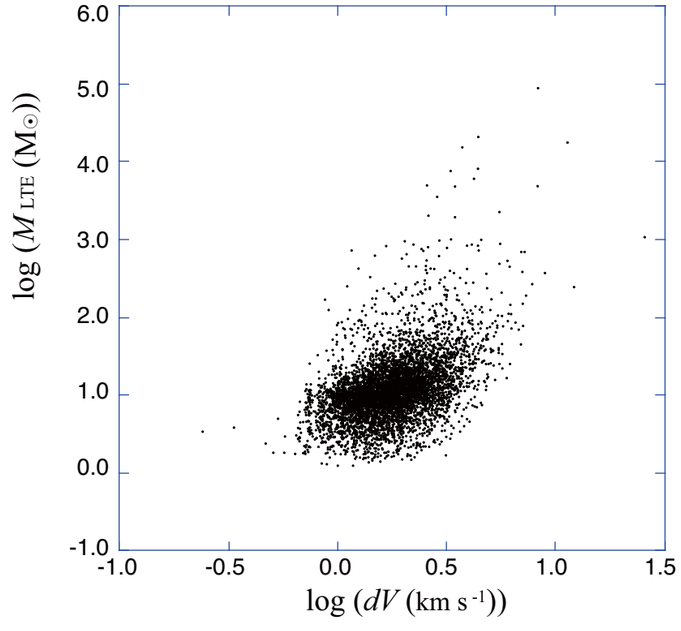
R vs dV



R vs Mc



dV vs Mc



R vs dV : dV increases with R (?)

R vs Mc : Mc ~ R^2 & dispersion is very small —> average N(H2) ~ constant(?)

dV vs Mc : Mc increases with dV (very weak)

Conclusion

FUGIN Survey Data

- Area : the first quadrant (10d < L < 50d ; -1.0 < b < 1.0)
  the third quadrant (198d < L < 236d ; -1.0 < b < 1.0)
- Line : 12CO, 13CO, C18O
- effective velocity resolution : 1.3 km/s @ 3 mm
- effective angular resolution : 20" @ 12CO
- final map
  * l,b grid = 8".5, velocity grid = 0.65 km/s
  * 3 sigma level : N(H2) ~ 1 x 10^{21} cm^{-2} (12CO)
- Revealed many filament and shell/arc structures

Cloud Identification

- Using Dendrogram Program
- Identified many very small molecular gas structures (clouds?)
  * Small molecular gas structures : dV < 3.0 km/s, R < 0.4 pc, Mc < 35 Mo