Full Synthesis CO Imaging of Holoea

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Introduction

Target (Holoea)

(1) an IRAS object
(IRAS 05327+3404)

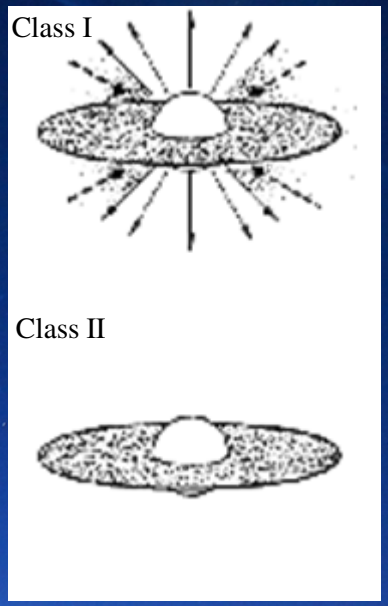
(1) in the direction of M36

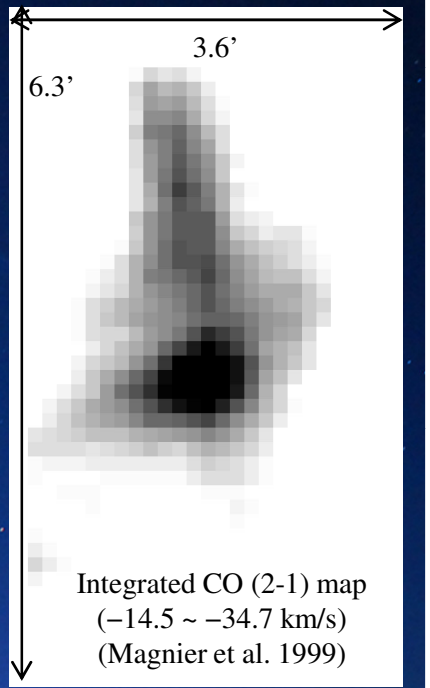
(2) in the southern part of constellation Auriga (御夫座)

(3) is also an Young Stellar Object

(4) has tail-like structure which may symbolize the high-velocity molecular outflow

(5) may be in the transition between Class I (rising spectral energy distribution, outflow) and Class II (optically visible central star)





Integrated CO (2-1) map
(−14.5 ~ −34.7 km/s)
(Magnier et al. 1999)

Observations

Telescopes:

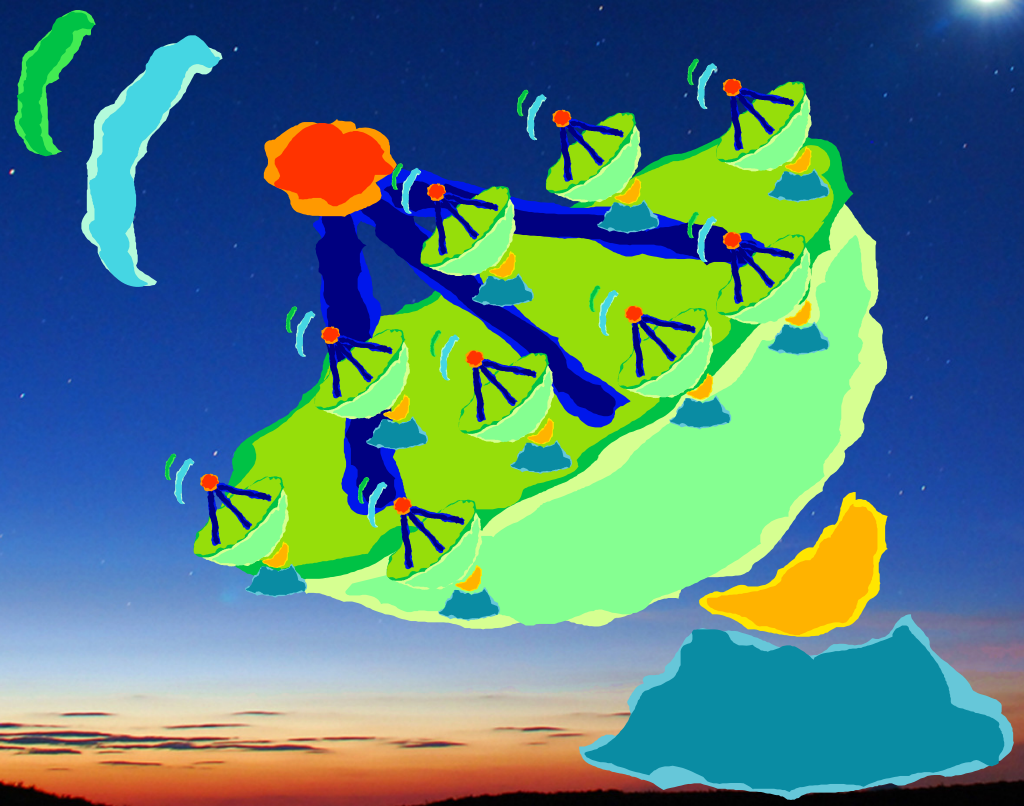
- Interferometer (BIMA array, at Hat Creek, California)
- Single-Dish (Kitt Peak 12m, KP12M)

Observed line:

- Emission line of CO (1-0) at 115.27 GHz (millimeter):
  a tracer of low density gas
  related to high-velocity gas
  →the outflow

Observations

(1) Interferometer (BIMA):



Observations

(1) Interferometer (BIMA):

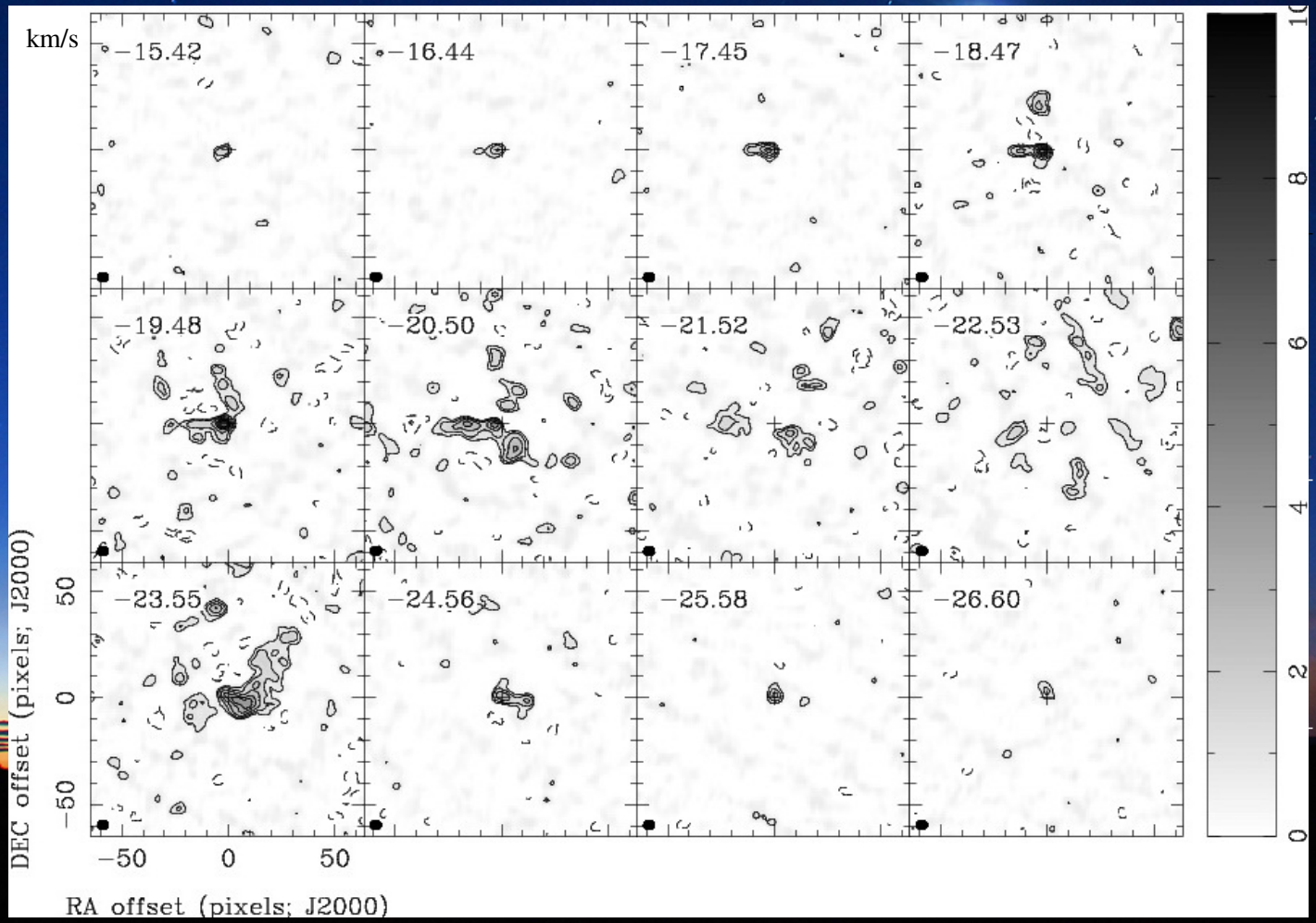
http://spiff.rit.edu/classes/phys230/lectures/sf/sf.html

Observations

(1) Interferometer (BIMA): 4-channel binned channel maps

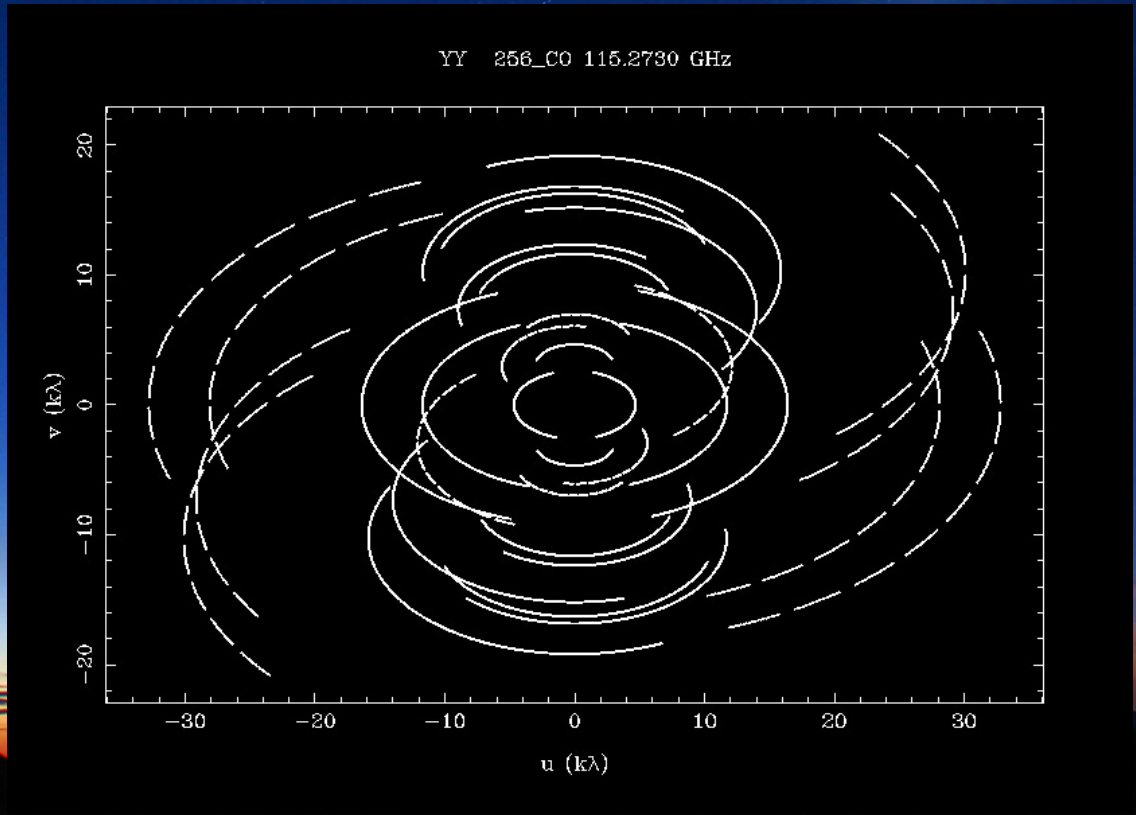
(from LSR velocity -19.48 to -23.42 km/s)

(beam size: 6.1”X 7.6” velocity resolution: 0.254 km/s cell size: 1.5”)



Observations

- (1) Interferometer (BIMA):
  uv-coverage



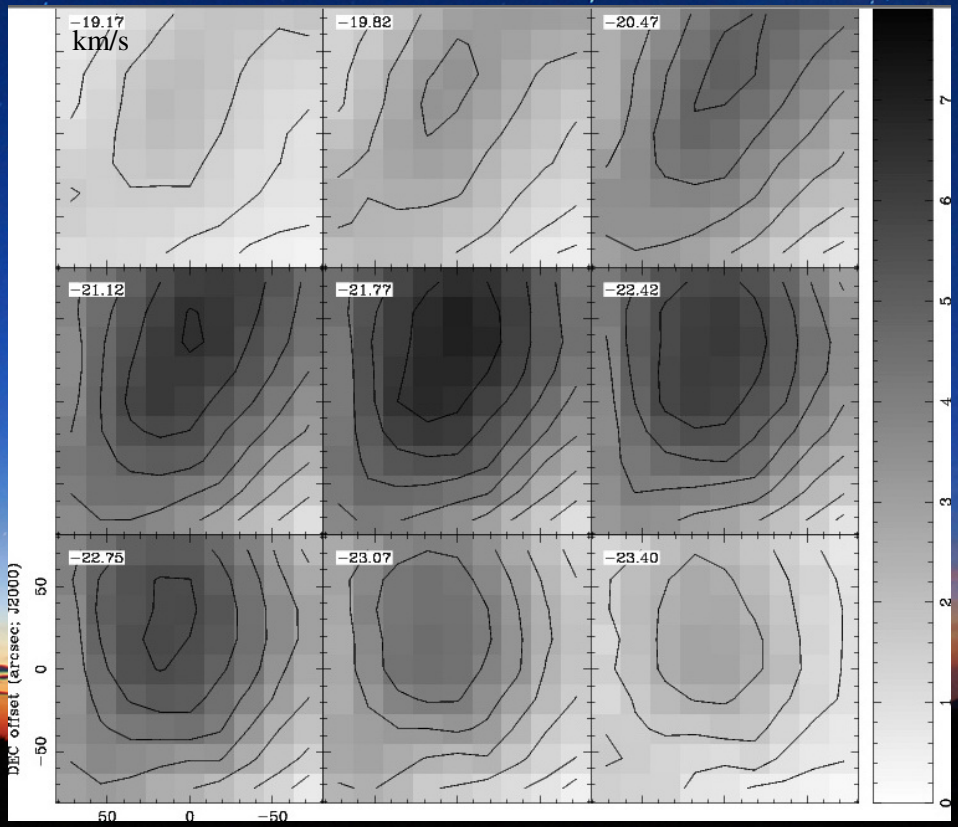
Central hole
→missing flux

Observations

(2) Single-Dish (KP12M):

(from LSR velocity -19.17 to -23.40 km/s)

(beam size: 54.6”X 54.6” velocity resolution: 0.650 km/s cell size: 18.0”)

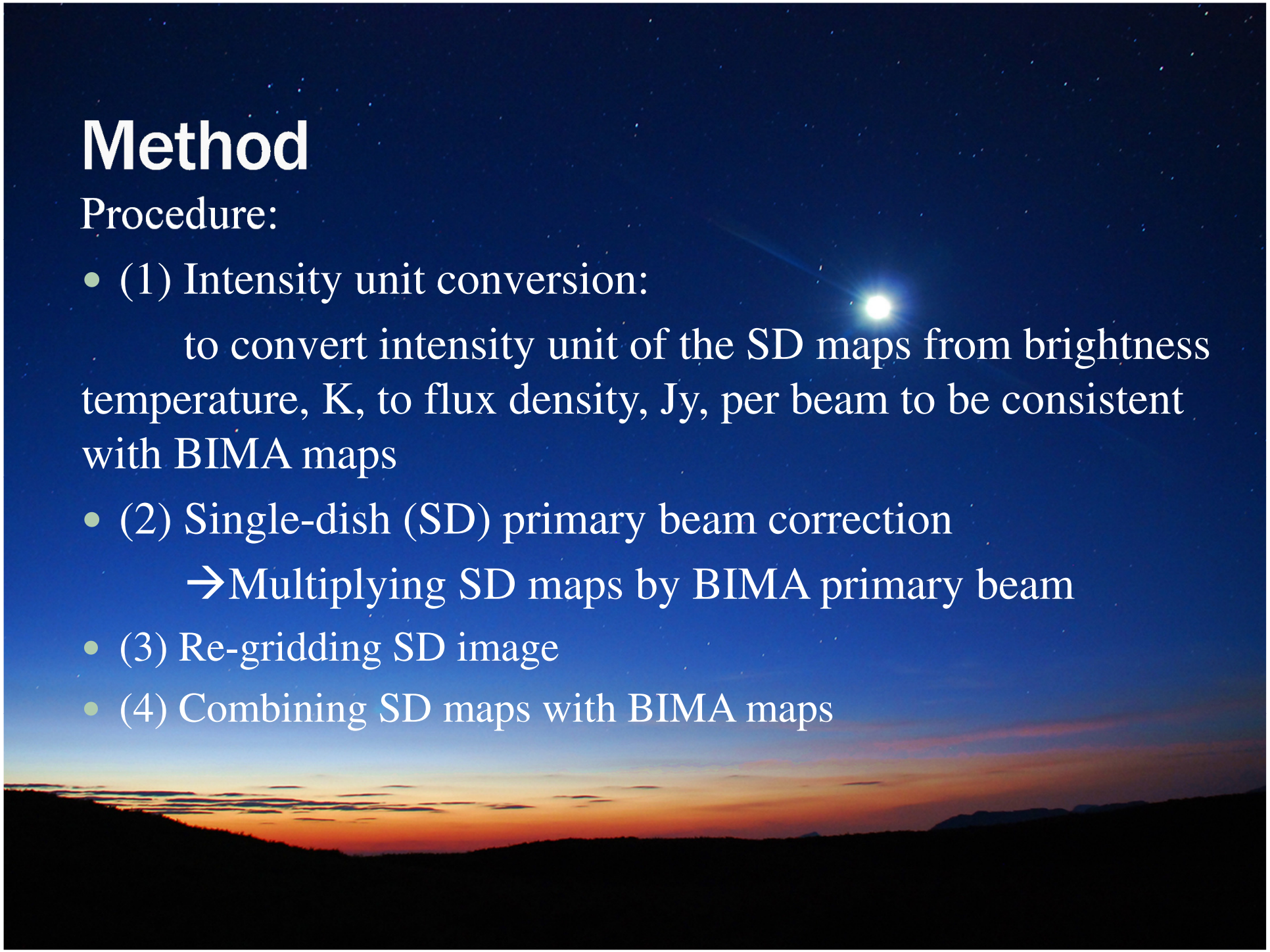



Motivation
(1) Interferometer:
high resolution
(2) Single-Dish:
NO missing flux
➔ Combining interferometer and single-dish data!!

Method

- Use MIRIAD: (Multichannel Image Reconstruction, Image Analysis and Display)
  a software for data reduction and image processing

- Combine single-dish maps and BIMA cleaned maps
  task immerge



Method

Procedure:

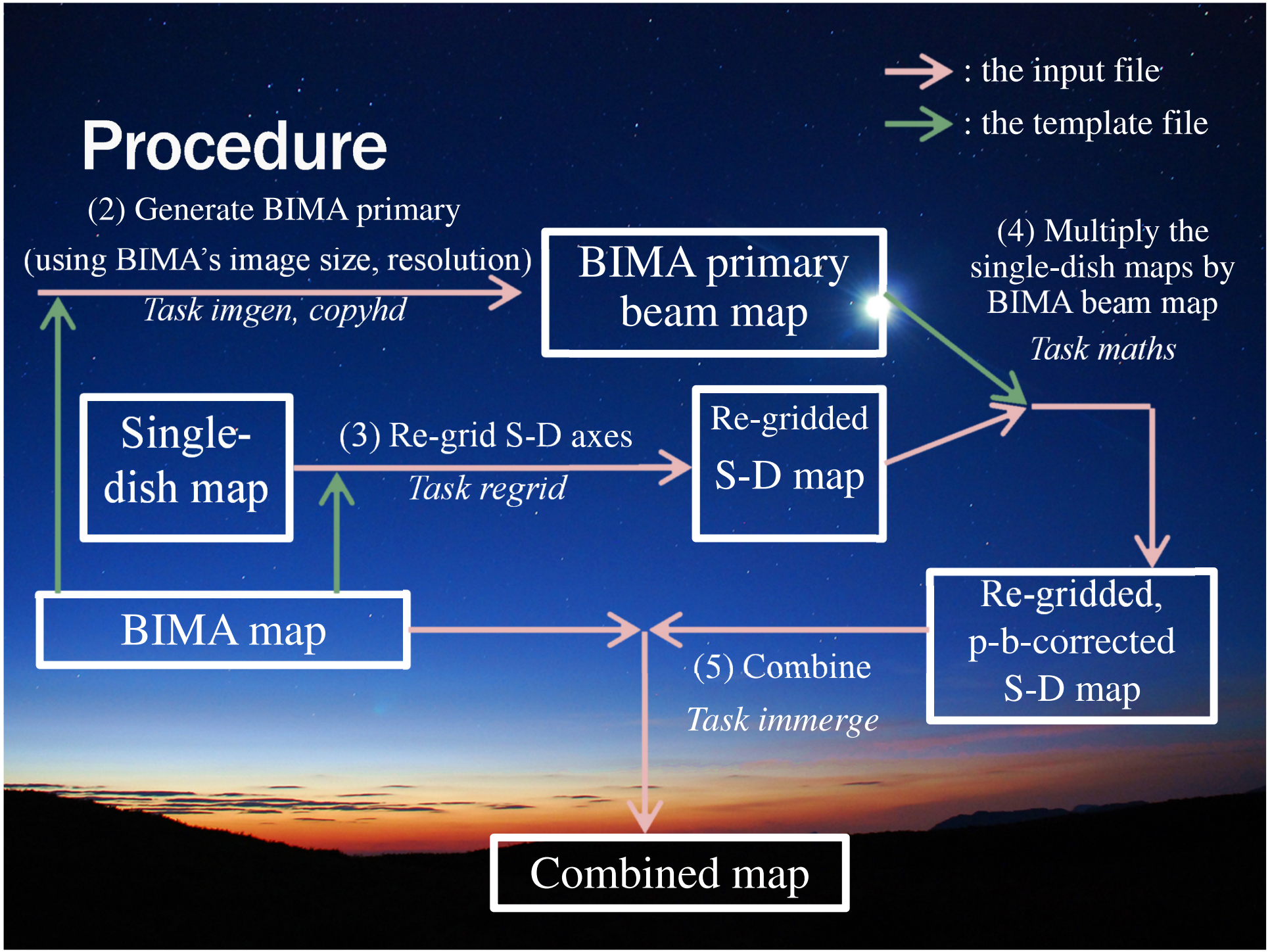
- (1) Intensity unit conversion:

  to convert intensity unit of the SD maps from brightness temperature, K, to flux density, Jy, per beam to be consistent with BIMA maps

- (2) Single-dish (SD) primary beam correction

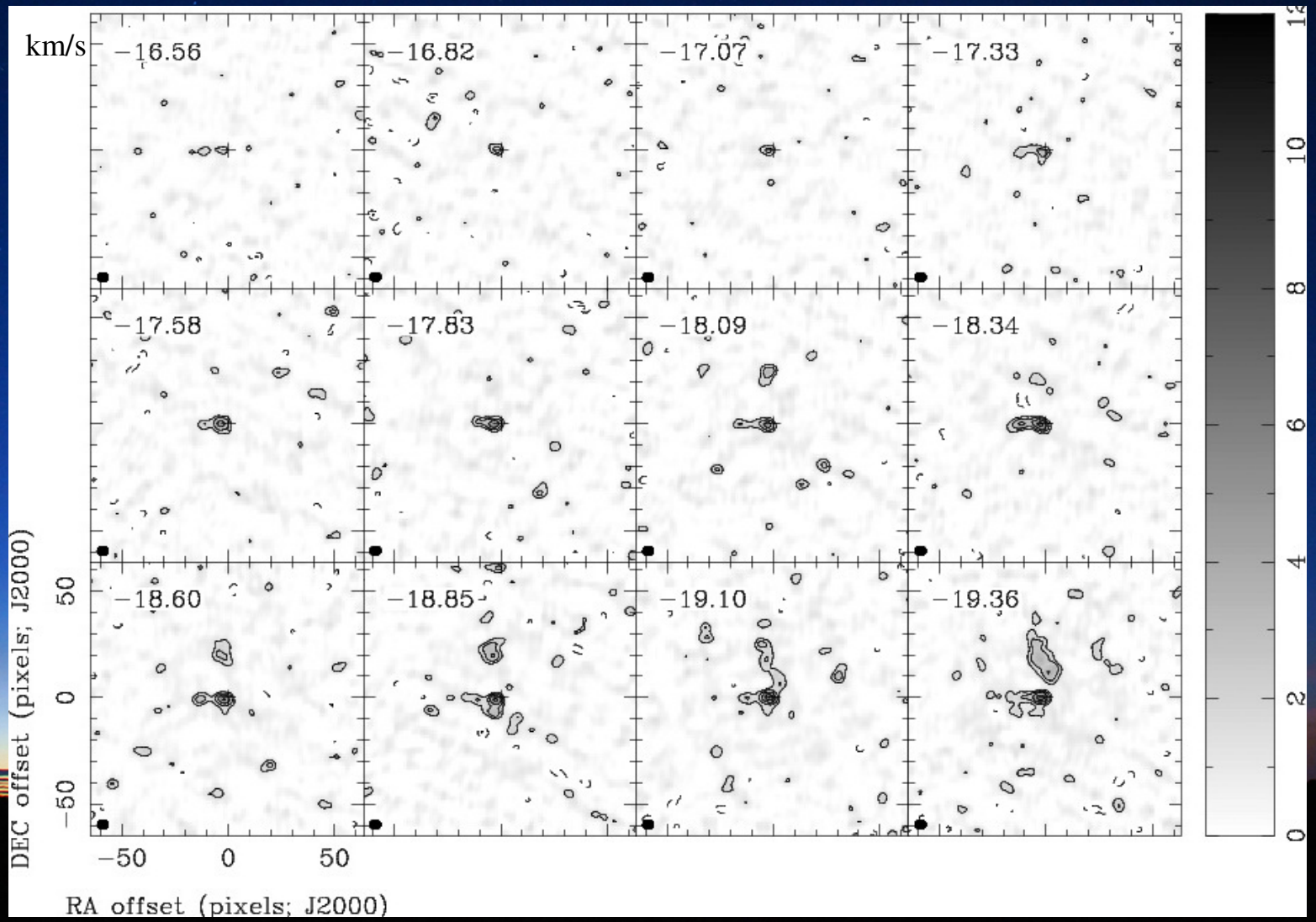
  →Multiplying SD maps by BIMA primary beam

- (3) Re-gridding SD image
- (4) Combining SD maps with BIMA maps


: the input file
: the template file
Procedure
(2) Generate BIMA primary
(using BIMA's image size, resolution)
Task imgen, copyhd
BIMA primary beam map
(4) Multiply the single-dish maps by BIMA beam map
Task maths
Single-dish map
(3) Re-grid S-D axes
Task regrid
Re-gridded S-D map
BIMA map
Re-gridded, p-b-corrected S-D map
(5) Combine
Task immerge
Combined map

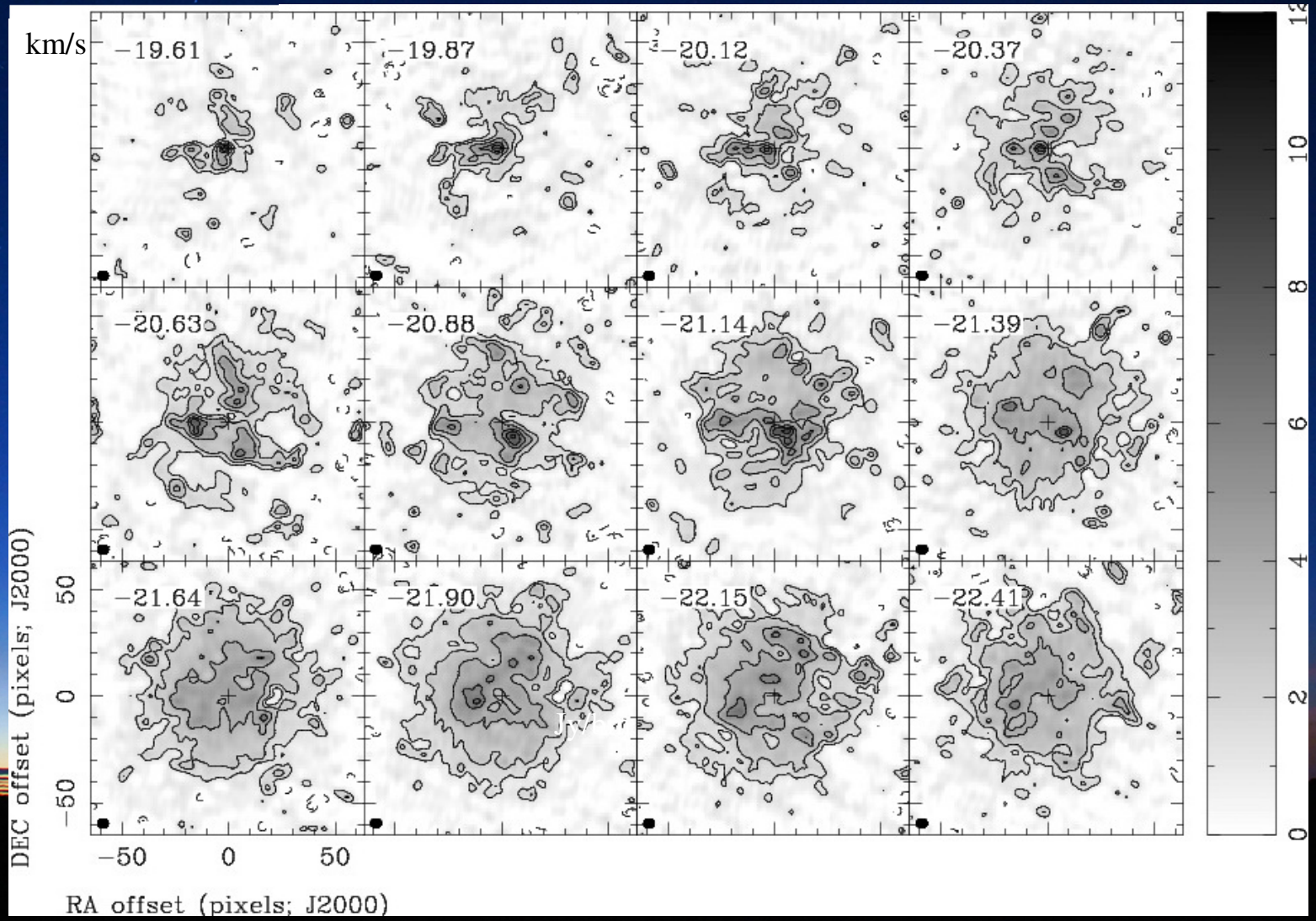
Results

channel maps



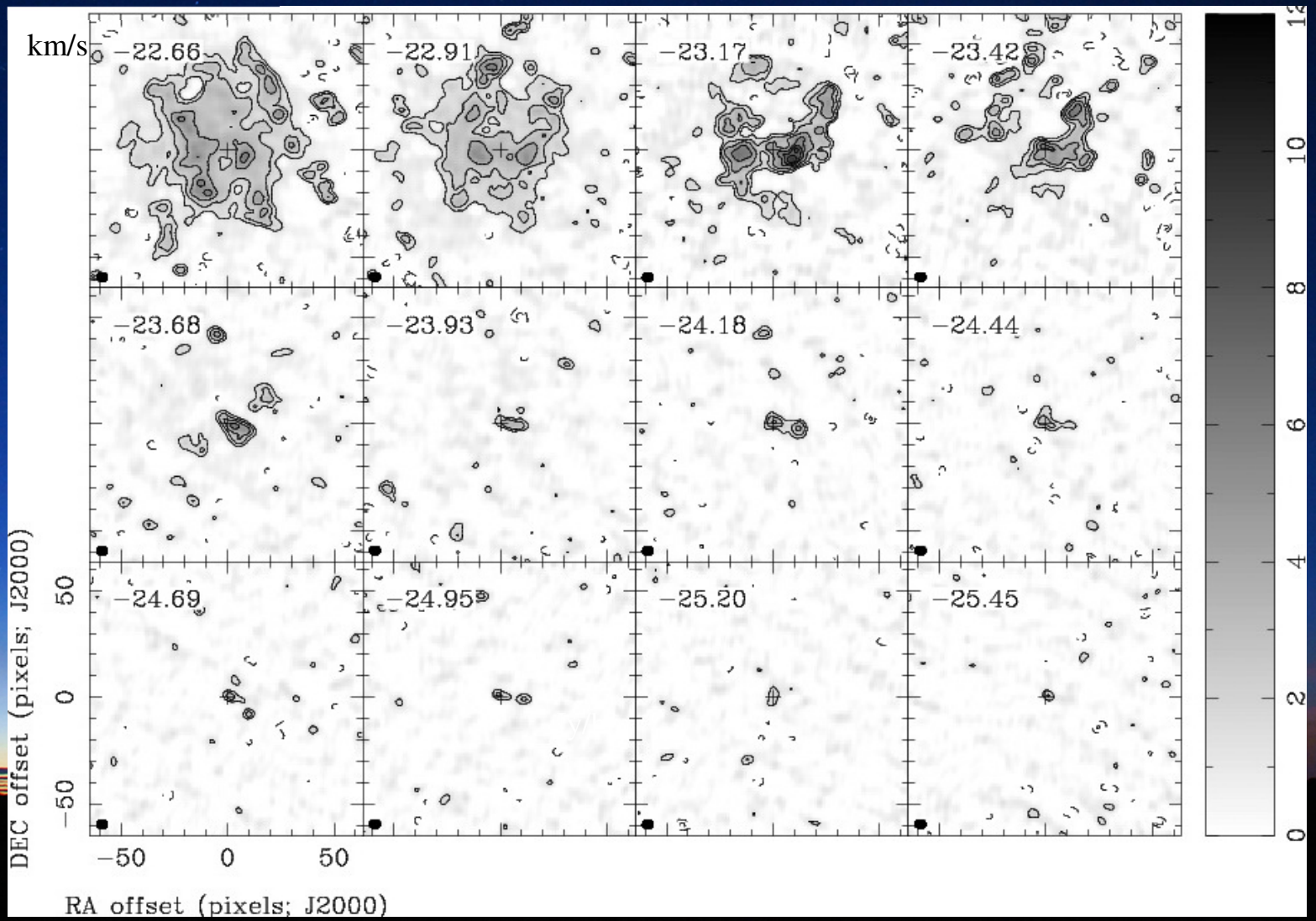
Results

channel maps



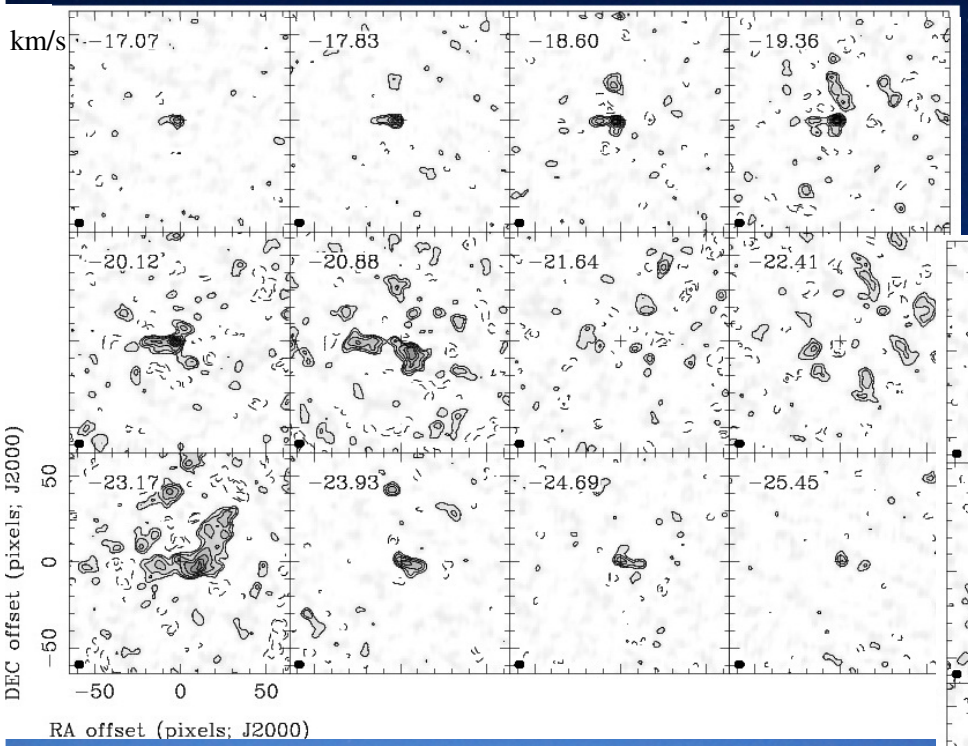
Results

channel maps

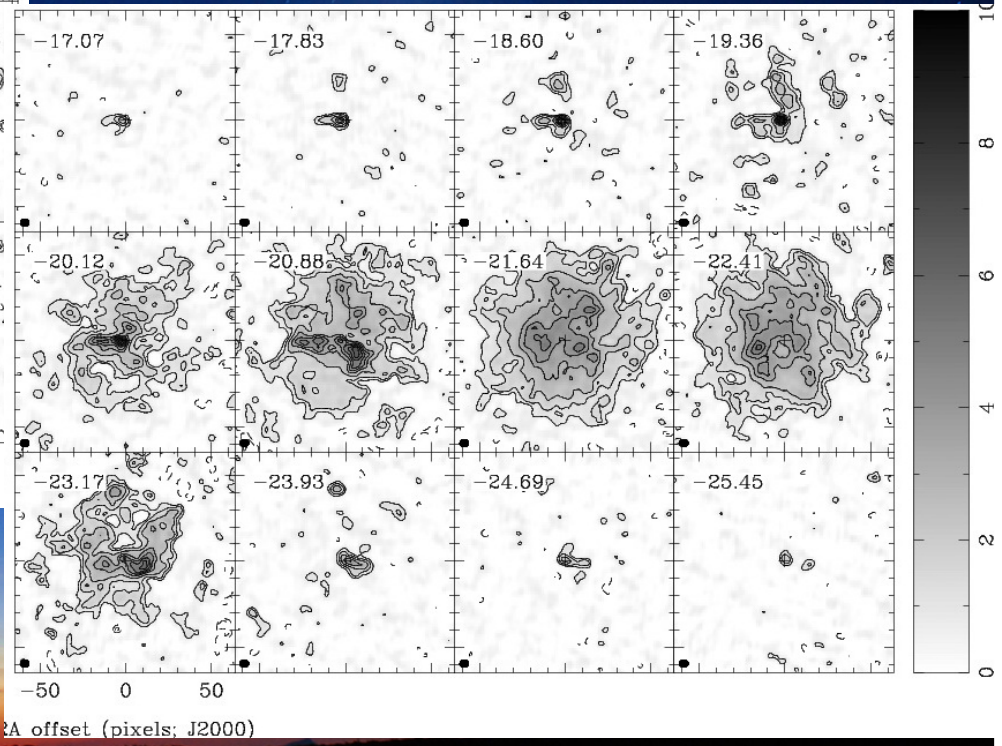


Results - comparison

channel maps (3-ch binned)

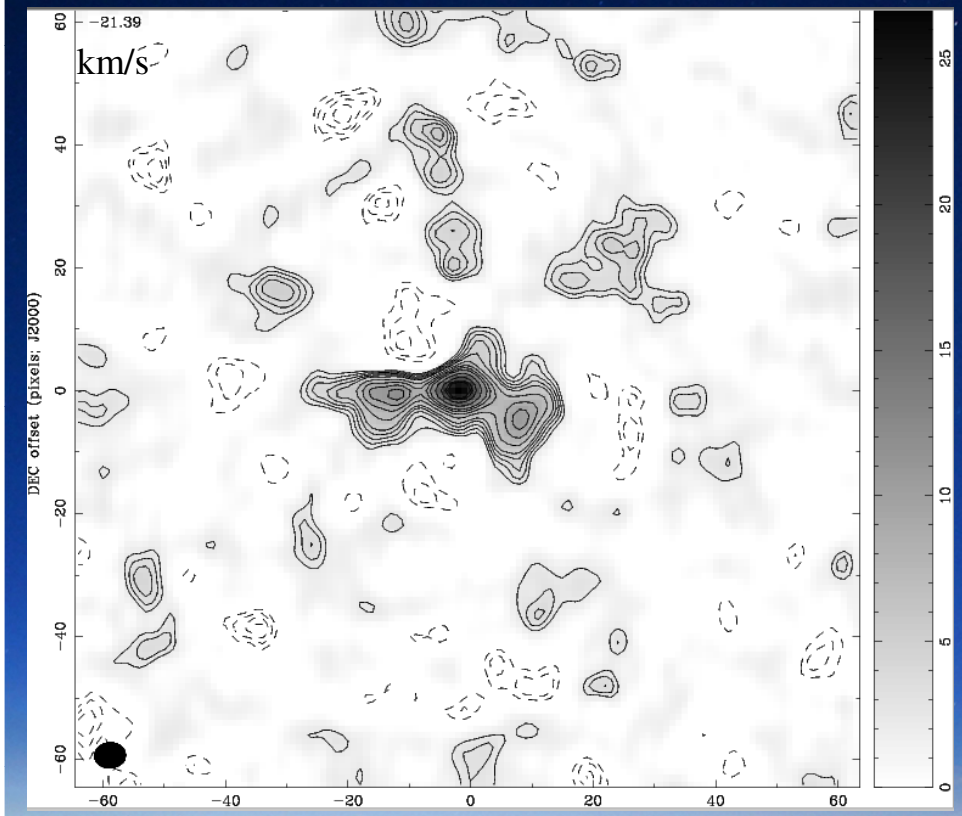


Combined map



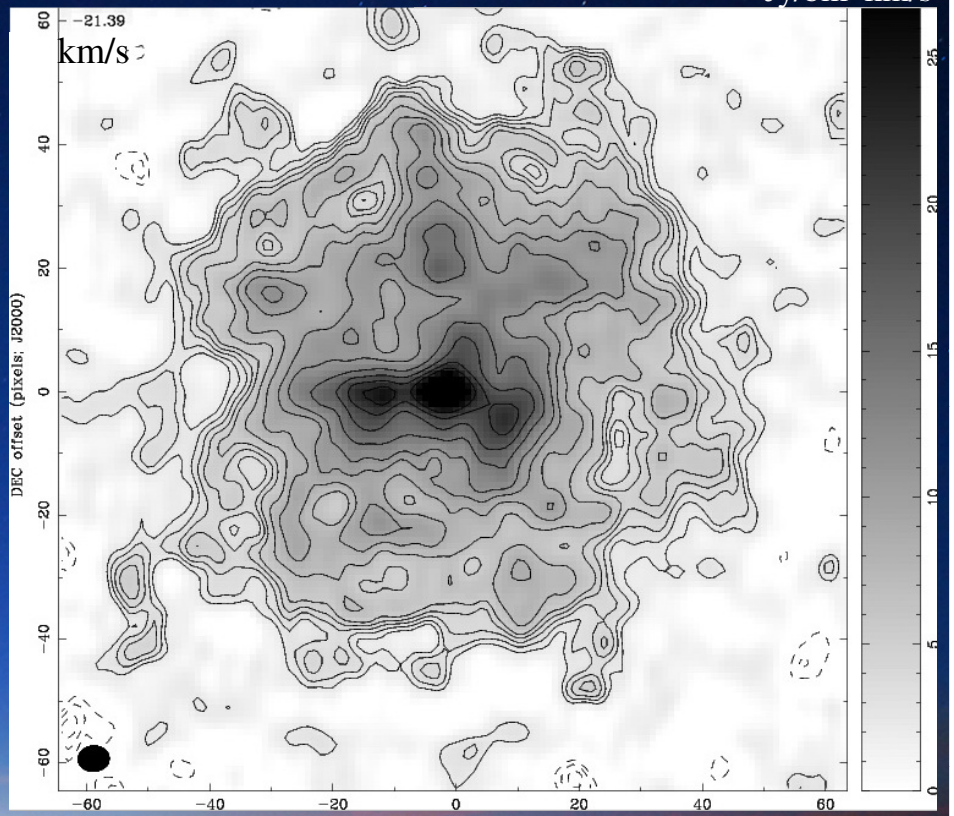
Array map

Results (integrated image)



Array map

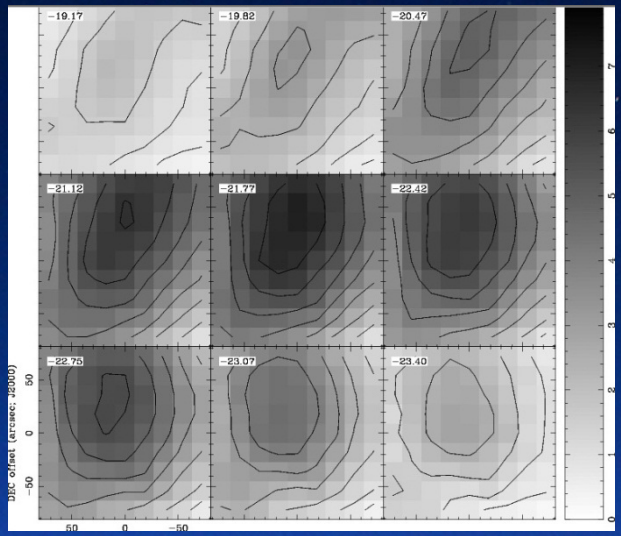
Jy/bm*km/s

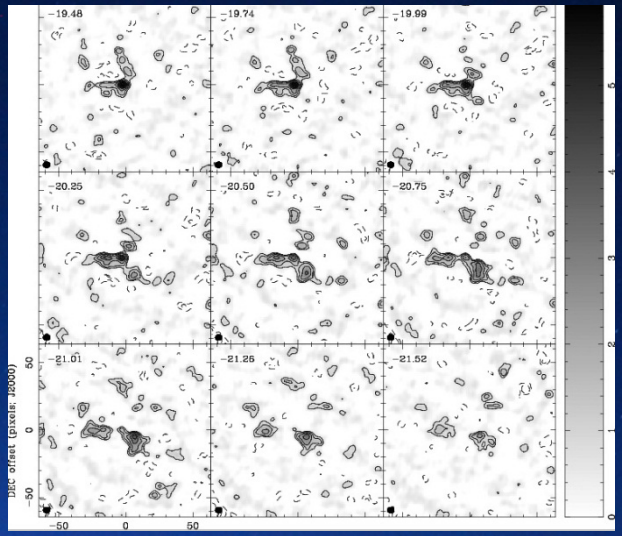


Combined map

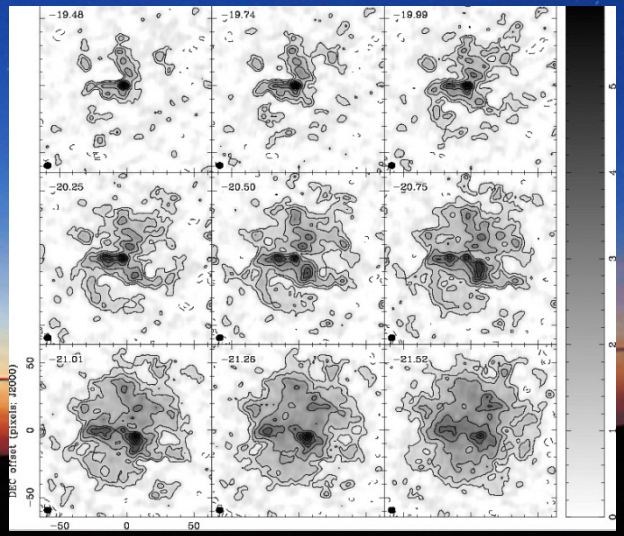
Comparison

SD map





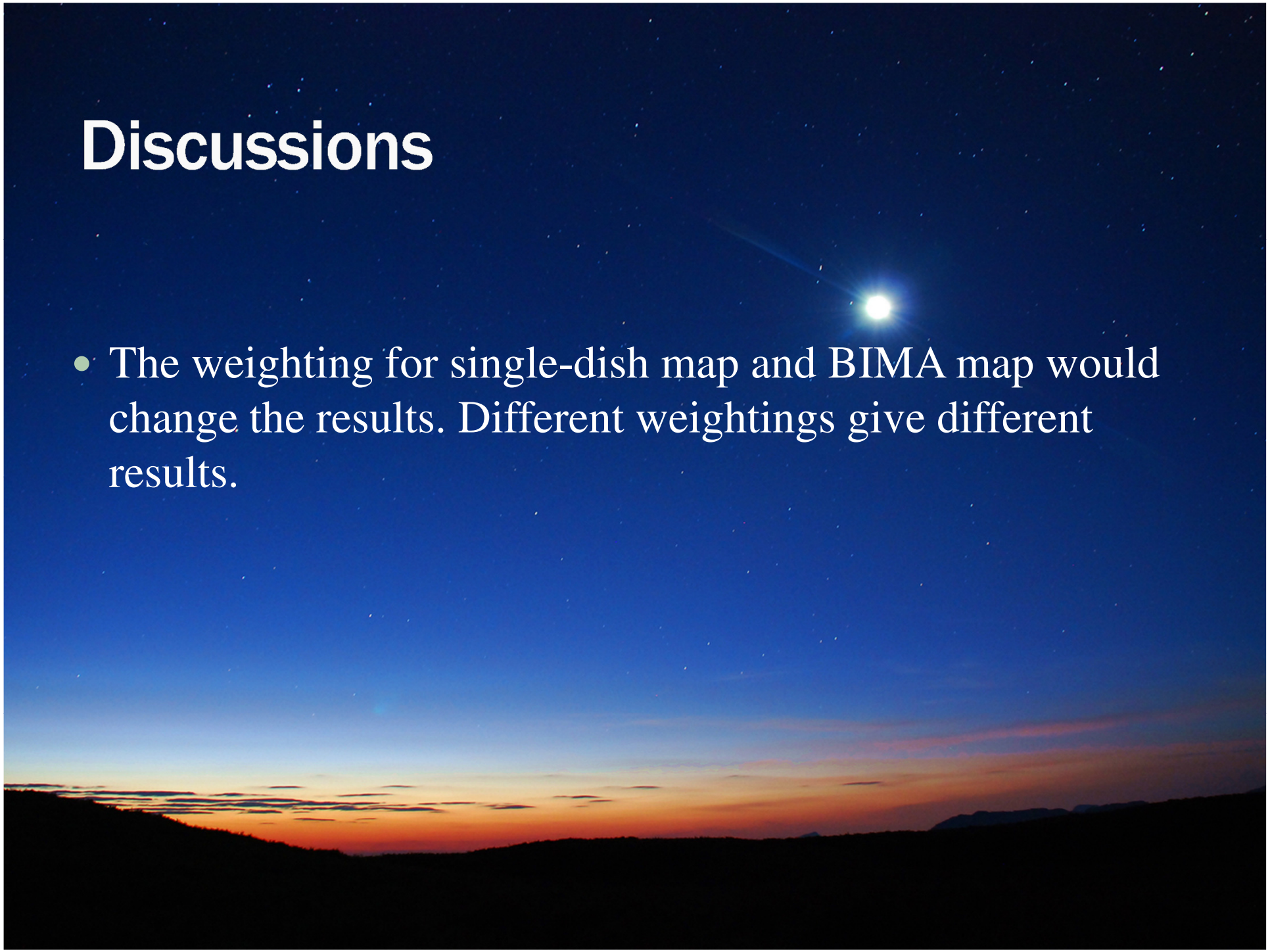
Array map



Combined map

Discussions

- The weighting for single-dish map and BIMA map would change the results. Different weightings give different results.



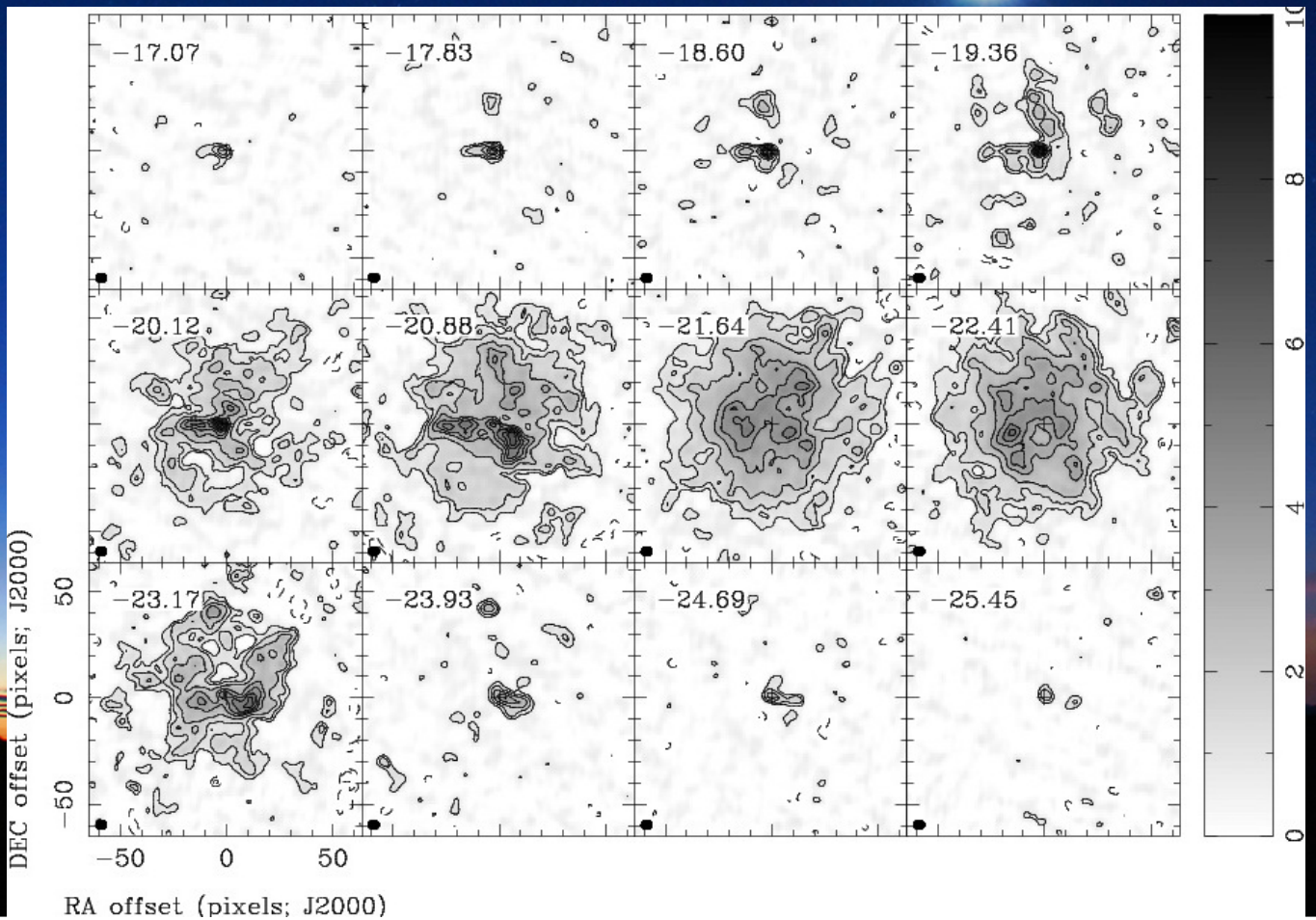
Discussions

Weighting:

Single-Dish map: 1

Array map: 1

3-ch binned Channel maps:



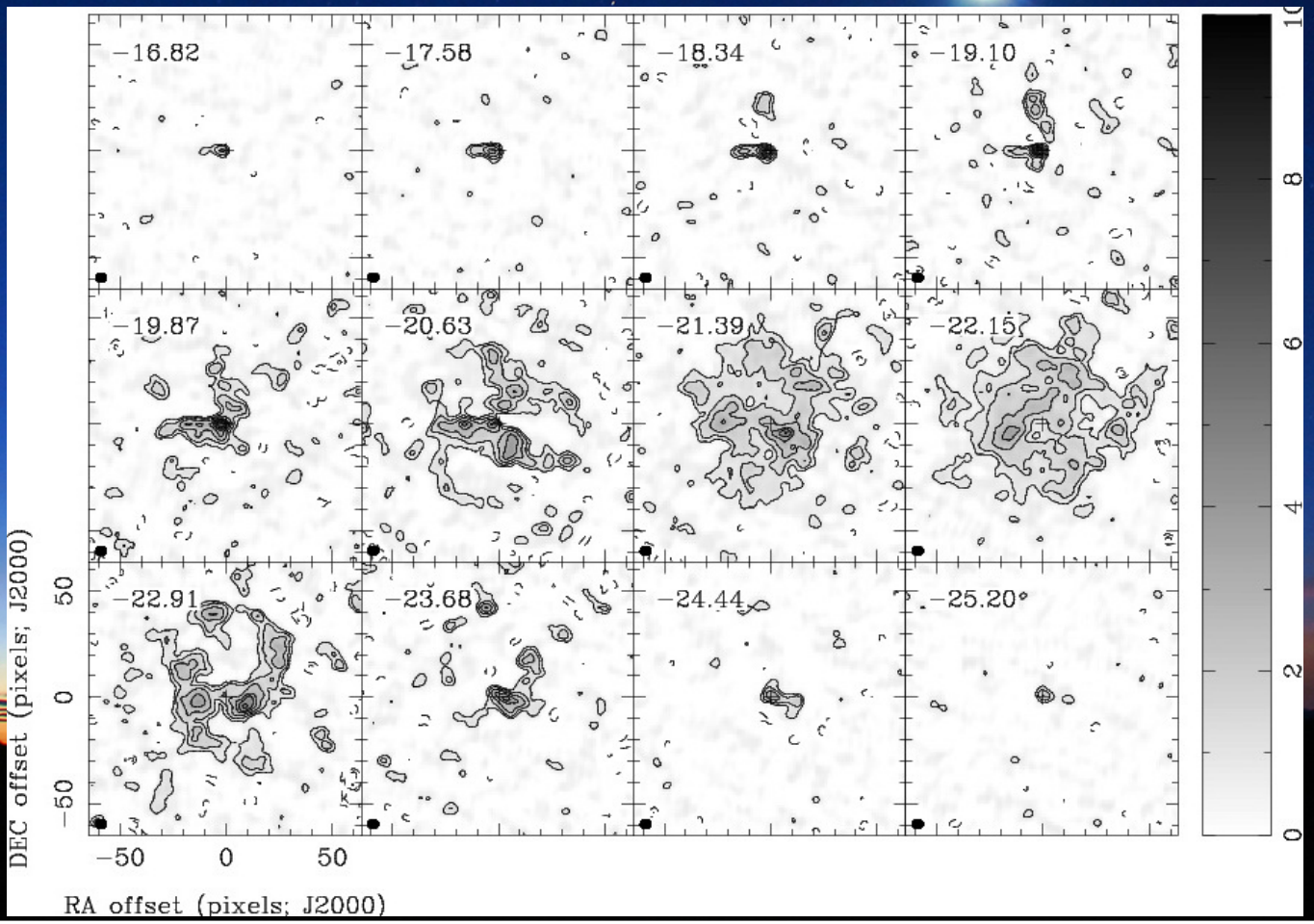
Discussions

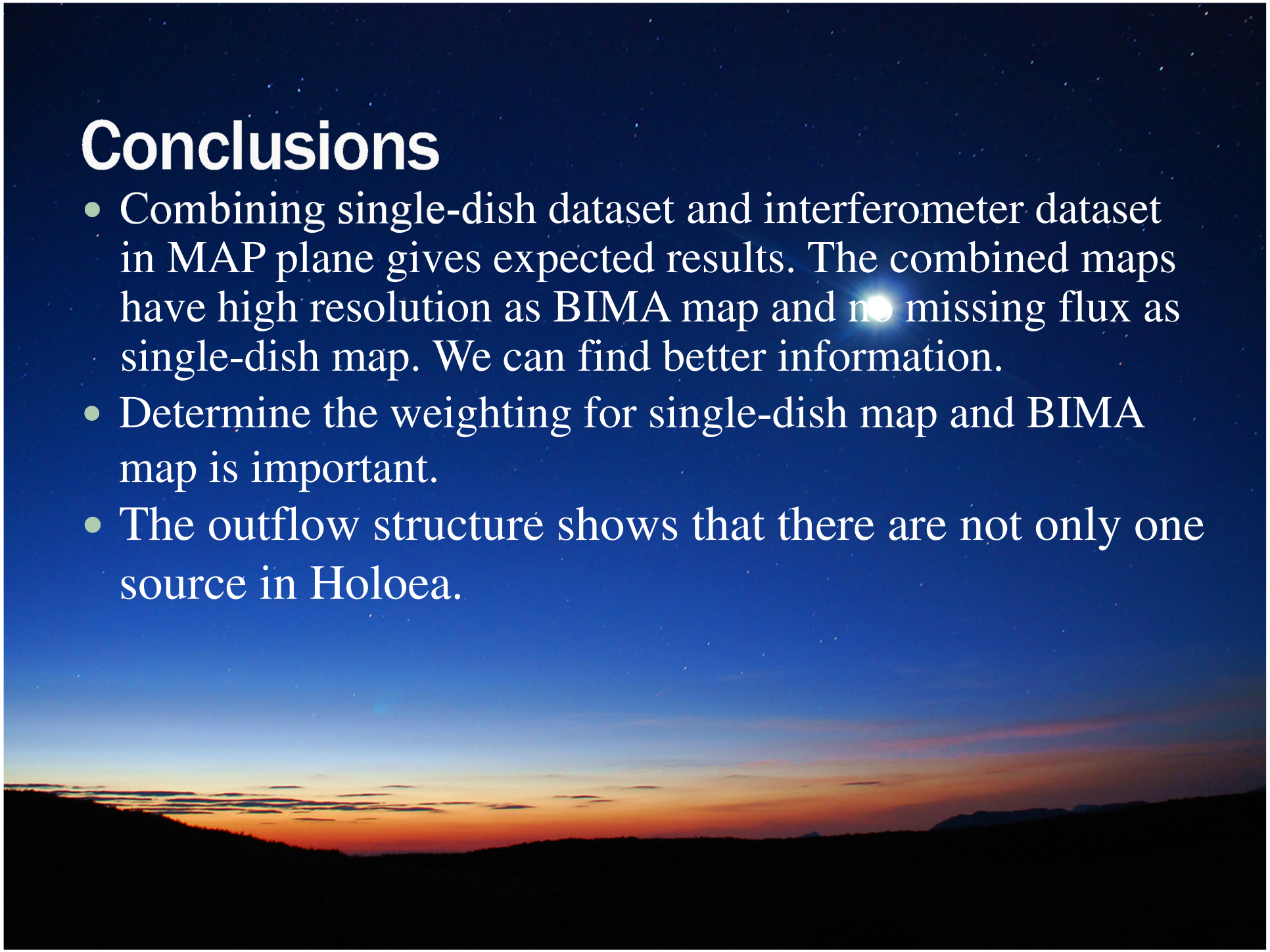
Weighting:

Single-Dish map: 0.4 (match their noise level)

Array map: 1

3-ch binned Channel maps:





Conclusions

- Combining single-dish dataset and interferometer dataset in MAP plane gives expected results. The combined maps have high resolution as BIMA map and no missing flux as single-dish map. We can find better information.
- Determine the weighting for single-dish map and BIMA map is important.
- The outflow structure shows that there are not only one source in Holoea.

Future work

- Try other ways to combine single-dish data and array data

  (1) single-dish maps + BIMA cleaned maps

  → In map plane

  (2) single-dish visibility + BIMA visibility

  → In uv plane

- Weighting factors still can be improved in the future
- Try to analyze the combined data
- Investigate the physical conditions of global environments


Thanks for listening!!

Appendix 1

Intensity unit conversion

- The unit of intensity of single-dish (S-D) data and BIMA data is different [SD is in brightness temperature (K) and BIMA is in flux density per beam (Jy/bm)], so consistent unit should be applied to both datasets first!
- Change the unit of S-D from Kelvin to Jy/beam according to equation:

$$S\,(Jy) = \frac{2k_B\Omega_{beam}}{\lambda^2}\frac{T\,(K)}{\eta_{mb}}$$

k_B: Boltzmann constant
Ω_{beam}: solid angle of beam
λ: the observed wavelength
η_{mb}: mean beam efficiency
T: brightness temperature
S: flux

- Derive the factor of unit conversion:

$$1(K) \approx 38.1\ (Jy\ per\ beam)$$

- *Task maths*

Appendix 2

(2) Interferometer (BIMA):