

FUGIN: FOERST Ultra-wide Galactic Plane Survey In Nobeyama

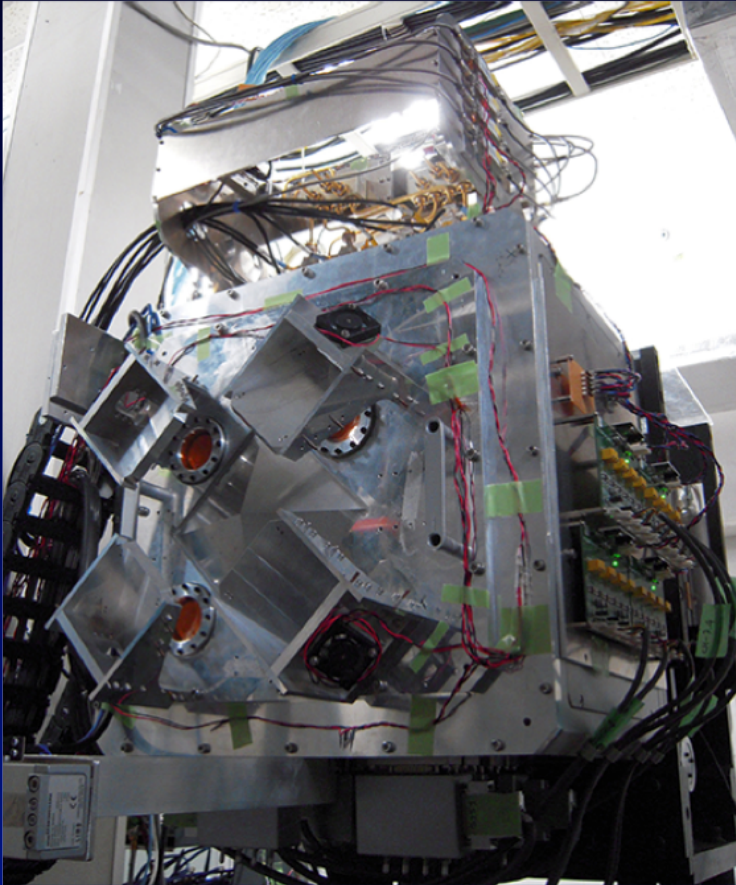
Torii, K., Umemoto, T., Minamidani, T.(NRO), Nishimura, A., Kohno, M.(Nagoya Univ.), Fujita, S., Kuriki, M., Kuno, N. (Univ. of Tsukuba), Matsuo, M.(Kagoshima Univ.), Tsuda, Y. (Meisei Univ.), Ohashi, S.(Univ. of Tokyo), Tosaki, T.(Joetsu Univ. of Edu.), and the FUGIN team

Nobeyama 45m Telescope



- Diameter: 45m
- Frequency coverage: 20-116GHz (6 receivers)
- Beam size @115GHz: ~15"
- Surface accuracy: 180->100 μ m (rms) by panel adjustment
- Main beam (aperture) efficiency@115GHz: 0.36 -> 0.45

FOREST



- **FO**ur-beam **RE**ceiver **S**ystem on the 45-m **T**elescope (Minamidani et al. 2016, Proc. SPIE)
- 80 – 116GHz
- 4 beams x 2 pols. x 2 SBs = 16 IFs
- Beam separation ~50''
- $T_{\text{sys}}=150\text{K}$ @110GHz & 250K@115GHz
- IF 4-11GHz → simultaneous ^{12}CO , ^{13}CO , C^{18}O observation

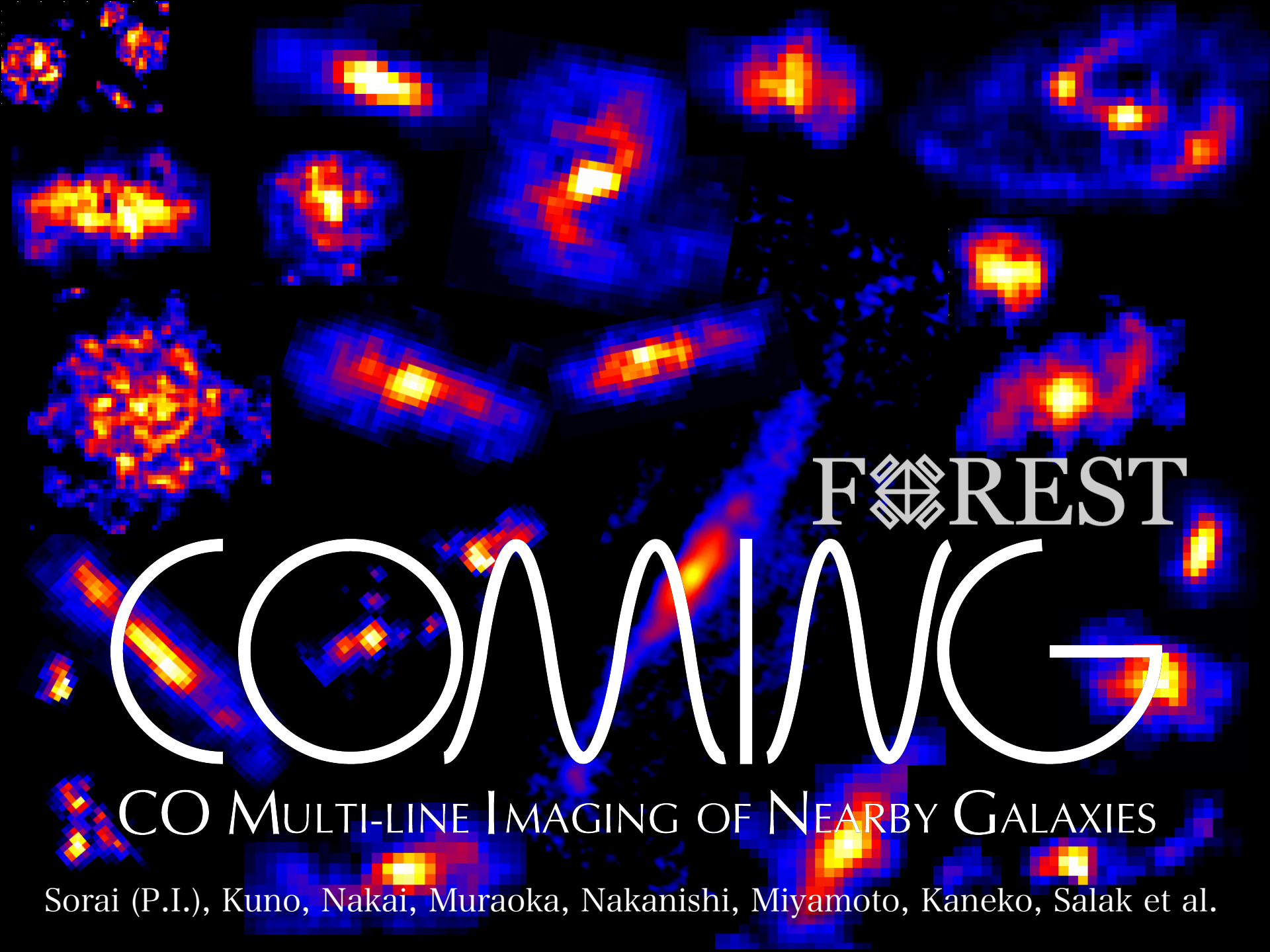
CO J=1-0 observations with Nobeyama45m/FOREST

CO J=1-0 is (still) important!

- Providing mass information of the molecular gas in each velocity bin.
- Covering wide dynamic range of density by observing three CO isotopes.
- Comparisons with high-J CO lines provides excitation condition and physical parameters (temperature and density).

Nobeyama 45m and FOREST

- Large-scale mapping observations within short time
- High-angular resolution, comparable to CO J=3-2 observations with JCMT and infrared images (Herschel/Spitzer/AKARI)

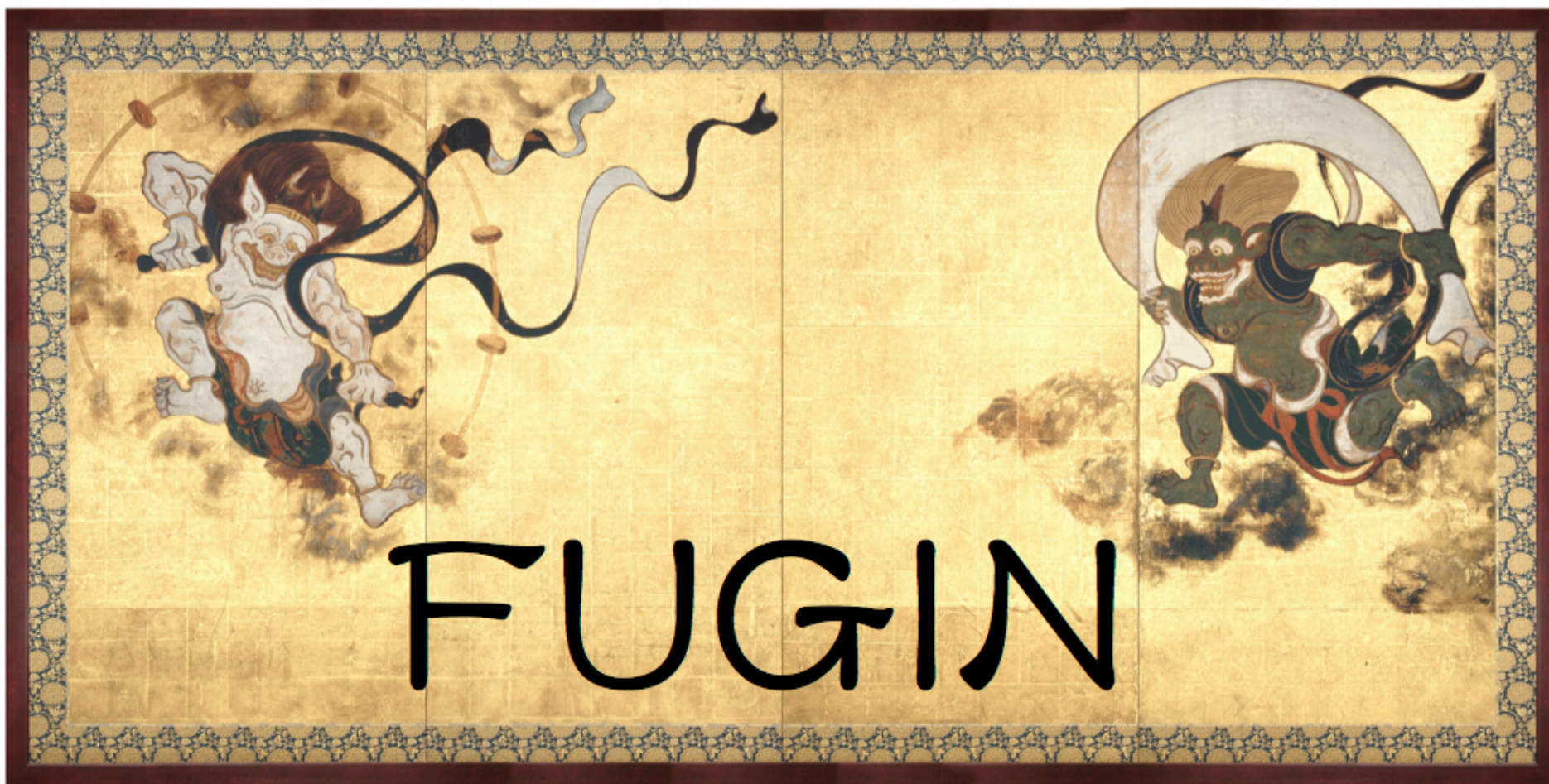


FOREST

COMING

CO MULTI-LINE IMAGING OF NEARBY GALAXIES

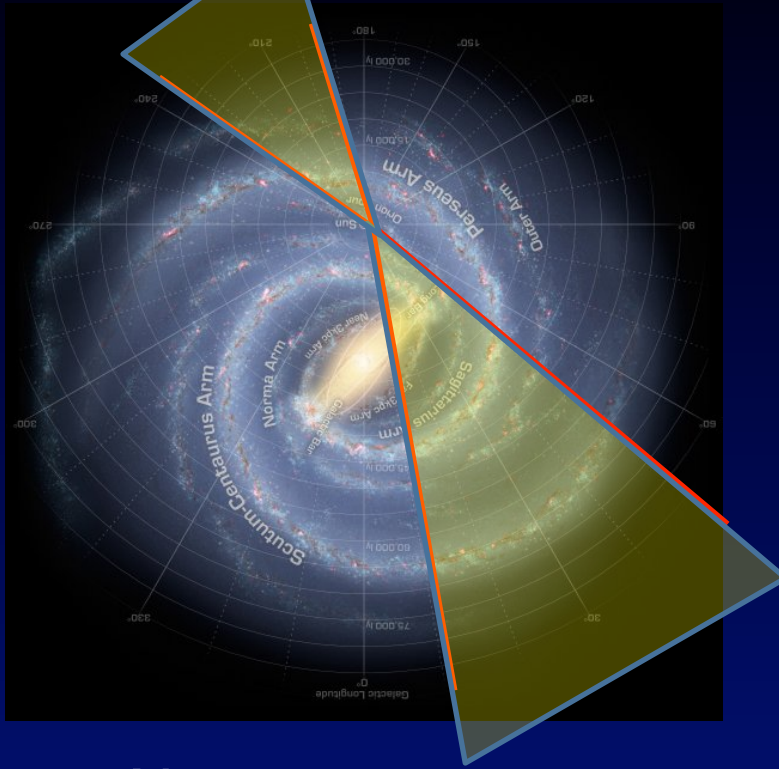
Sorai (P.I.), Kuno, Nakai, Muraoka, Nakanishi, Miyamoto, Kaneko, Salak et al.



FOREST Ultra-wide Galactic-plane survey In Nobeyama

“Wind god and Thunder god” by Ogata Korin

FUGIN Status



Umemoto et al. 2017 submitted.

Large-scale ^{12}CO , ^{13}CO , C^{18}O
 $J=1-0$ observations toward the
Galactic Plane.

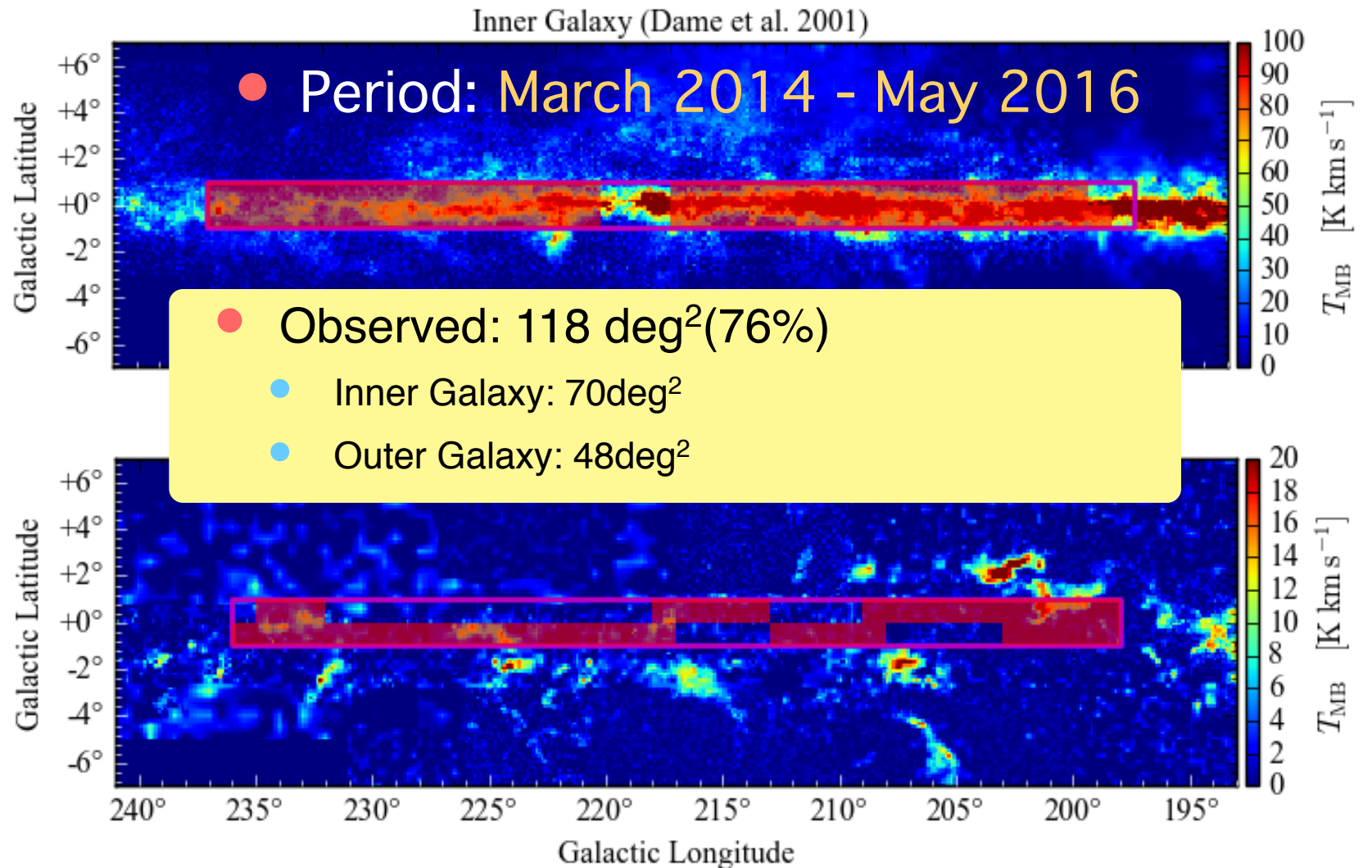
- Inner galaxy: $l \sim 10^\circ - 50^\circ$, $b < |1^\circ|$
- Outer Galaxy: $l \sim 198^\circ - 236^\circ$, $b < |1^\circ|$
- $T_{\text{rms}}(T_{\text{a}^*}) \sim 0.12\text{K}$ @ ^{13}CO at 1.3 km/s
- Data will be public in 2018

Aims:

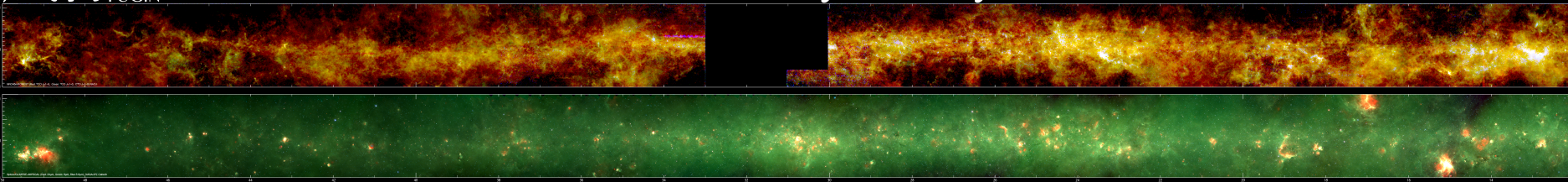
- Understanding ISM and star formation in the MW.
- Understanding the galactic structures in the MW.
- Constructing a bridge between the MW and galaxies.

Observed Regions To Date

- magenta: planned, red: observed



風神 FUGIN FOREST Ultra-wide Galactic Plane Survey In Nobeyama



NINS NAOJ

NOBEYAMA FOREST

M17 Giant Molecular Clouds

W51 Giant Molecular Clouds

Fujita et al. 2017 in prep.

Molecular clouds in the outer galaxy

Matsuo et al. 2017 in prep.

Observing with Nobeyama 45m

Open use program

- 2000–3000 hrs is available for the open use program in every season (from December to May).
 - Regular Program (< 200 hrs)
 - Short Program (< 20 hrs)
 - Large Program (> 200 hrs, up to 600 hrs for 2 years)
 - DDT(Director's Discretionary Time) Program: e.g. for ToO
 - <http://www.nro.nao.ac.jp/~nro45mrt/html/prop/index-e.html>

Near future development plan

- Remote observations using VNC (partly operated)
- Data reduction with CASA (under development)
- NRO45m Science Data Archive (under development)

Summary

- We are conducting the Galactic Plane Survey with the highest angular resolution by simultaneous ^{12}CO , ^{13}CO and C^{18}O J=1-0 lines (FUGIN) as the NRO legacy project using the FOREST installed on the Nobeyama 45m telescope.
- To date, we have covered 118 deg² (76% of the plan).
- In ALMA era, this project must make a linkage between the study of star formation in the Milky Way Galaxy and study of molecular gas in galaxies.
- After the end of the project, open all data, 3-D fits, catalogs of clouds/clumps etc.. We hope the researchers of various wavelengths utilize these data.
- Comparative studies with JCMT CO J=3-2 shall provide important clue to understand ISM and star formation !!

Thank you!