ALMA/45m/ASTE Users Meeting 2016

Dec. 20, 2016 @ NAOJ

NRO Legacy (Galaxies)
– CO Multi-line Imaging of Nearby Galaxies –

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CO Multi-line Imaging of Nearby Galaxies

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Main Goals of COMING

statistically understanding of …

- distribution & kinematics

  What mechanisms do determine molecular gas distribution?

- environmental effect

  How does environment affect on star formation?

- physical properties

  How does the above affect on physical condition of molecular gas?

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Overview of the Survey

- OTF mapping with FOREST
- targets: **238** nearby galaxies
- lines: **^{12}CO**, **^{13}CO**, **C^{18}O** J=1–0 (simultaneously)
- sensitivity: ΔT_{MB} = **80 mK**
- velocity resolution: **10 km s^{-1}**

  → 2.4 × 10^6 $M_\odot$ @ 20 Mpc
- mapping area: **70% of D_{25}**

  ← typically covering the CO disk
- observation time: 1,200 hr

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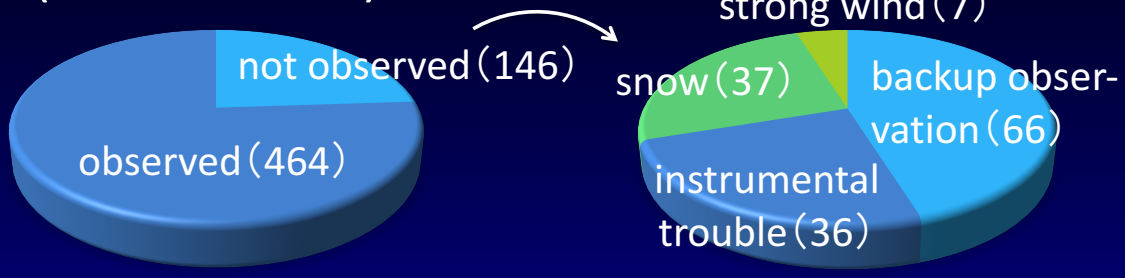
Observations in the Last Season

- allocation: Dec. 21, 2015–May 24, 2016
  (total: 610 hrs)



- (–) higher system temperature (~250 – 450 K)
- (+) improvement of the telescope system
- (+) using an observation ranking system
- (+) using pipe-line analysis system

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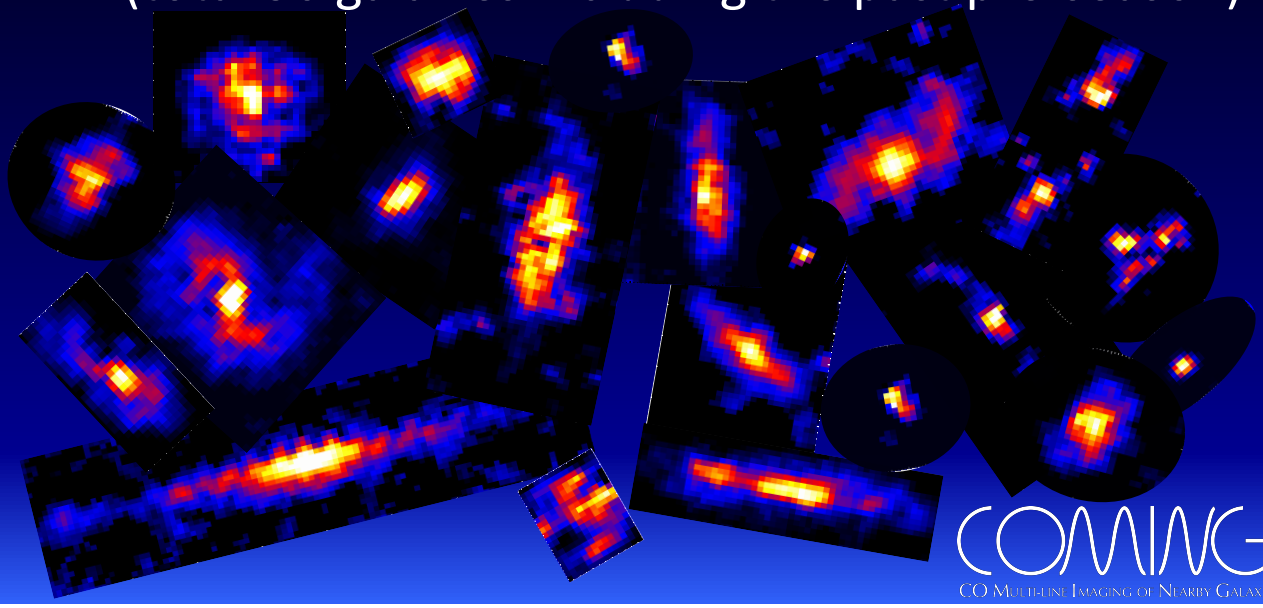
Observations in the Last Season

- galaxies completed to map: 45
  (total 50 galaxies including the past pre-season)



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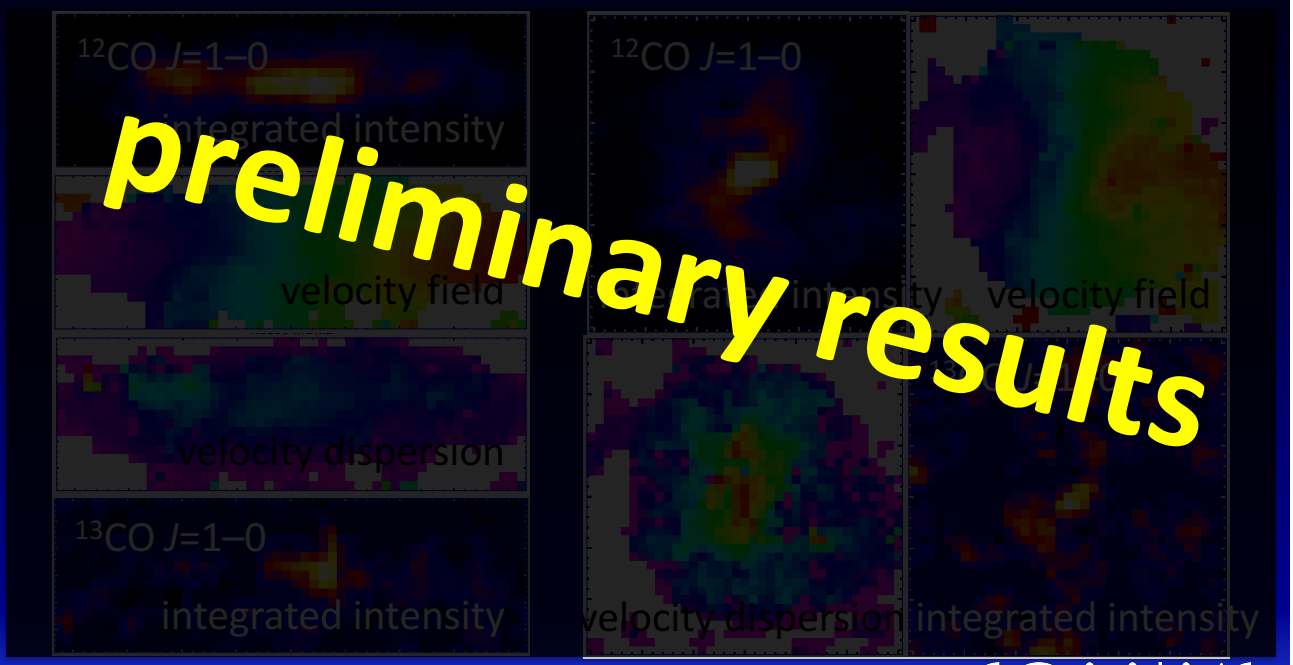
Ex. of Data (NGC 3556, NGC 4303)



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Publication and Scientific Activities

- publication to a refereed journal
  - Muraoka, et al. 2016, PASJ, **68**, 89
  - Hatakeyama, et al. 2016, submitted to PASJ
- Workshop ‘COMING 2016’
  - held on Nov. 17 – 18 @ NAOJ
  - > 50 participants
- ‘COMING-FUGIN’ inter-legacy workshop
  - held on Aug. 31 – Sep. 1 @ NRO

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Development: Observation Ranking

$$R \equiv \eta_{\rm eff}\, \eta_{\rm trk}\, \eta_{\rm point}\, P_{\rm prop}\, f_{\rm comp}$$

- $\eta_{\rm eff}$: observation efficiency = $\eta_{\rm atm}\, \eta_{\rm map}$

  observing at higher EL lower Tsys → larger map
- $\eta_{\rm trk}$: antenna moving efficiency
- $\eta_{\rm point}$: data acquisition rate affected by pointing
- $P_{\rm prop}$: proposal priority within our team
- $f_{\rm comp}$: achievement of observation

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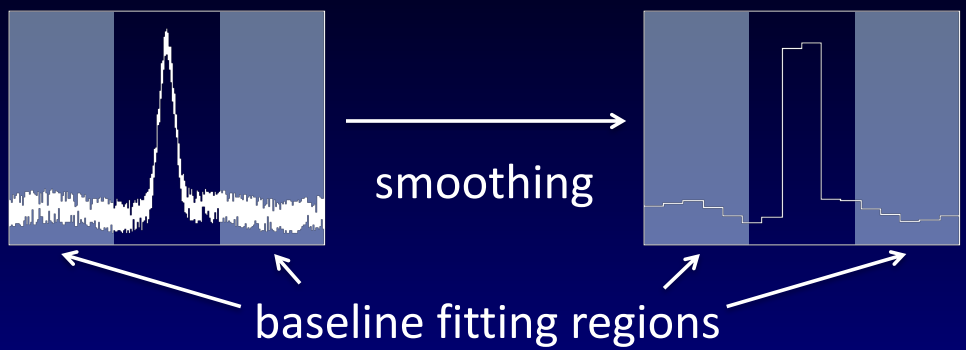
Development: Auto-flagging

- smoothing many channels (32 channels)



- data are removed objectively in the case

$$\frac{rms_{\rm original}}{\sqrt{n}} \times f_{\rm salvage} < rms_{n-{\rm ch\ smoothed}}$$

empirically 2 - 3

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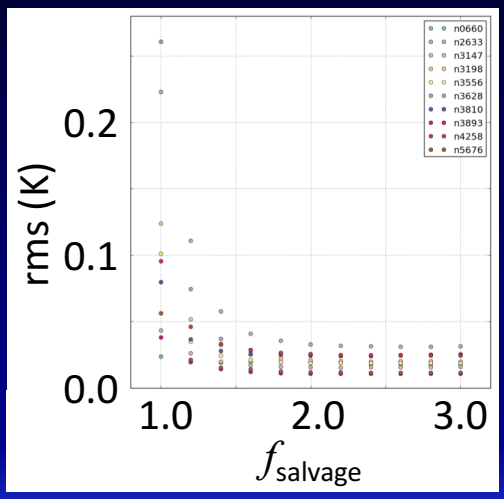
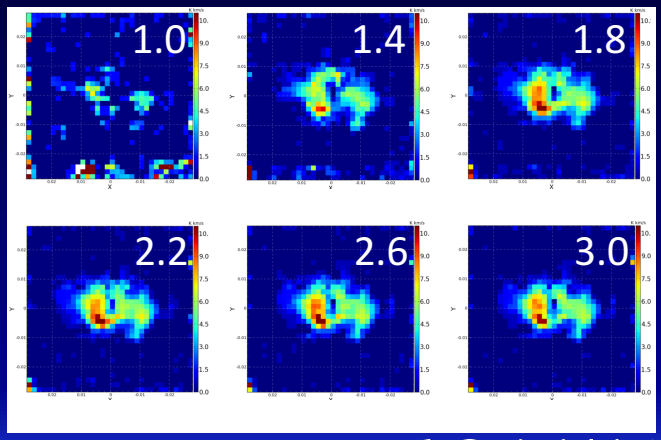
How Does f_{salvage} Works?

- rms vs. f_{salvage}
  32-ch smoothing



- integrated intensity for several f_{salvage} (NGC 3147)



(Yanagitani)

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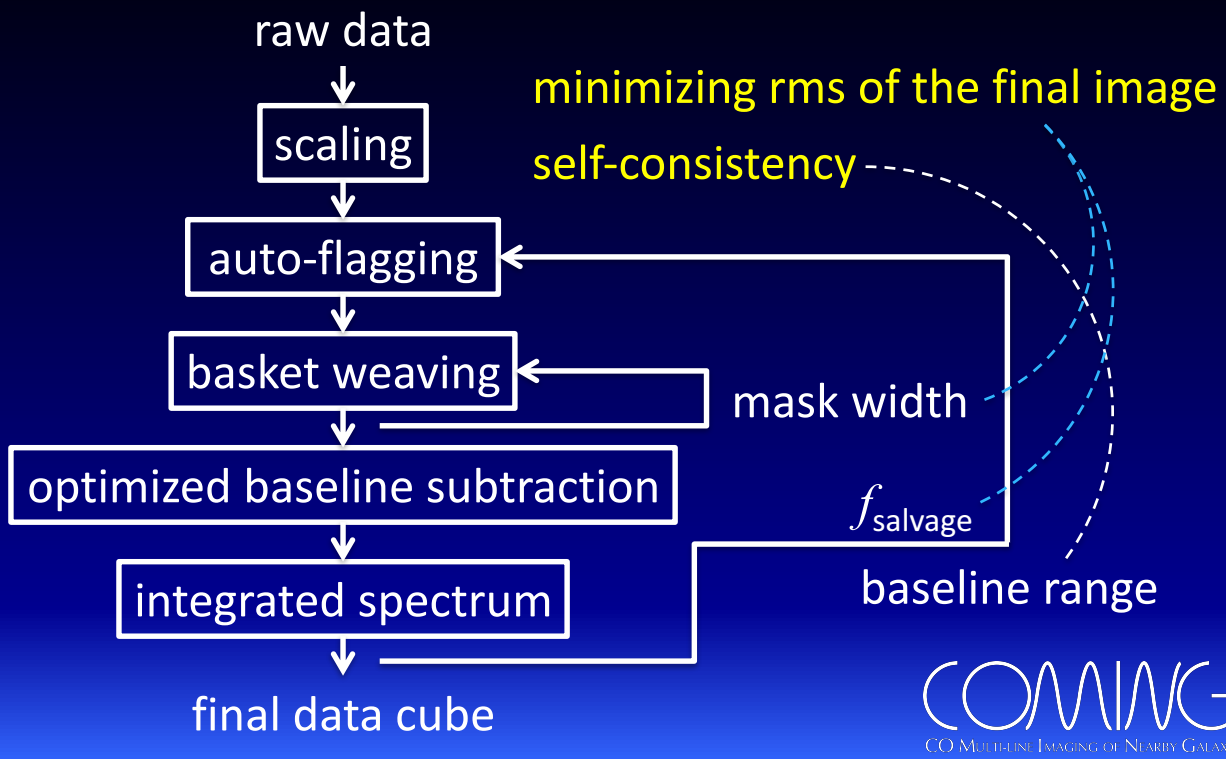
Objective Pipe-line Reduction System



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Distribution & Kinematics

- internal & environmental secular evolution (Kormendy & Kennicutt 04)
- one of the key observables
  = molecular gas concentration
  ← fuel of AGN, materials of nuclear starburst
- how does molecular gas concentrate in galactic disks?

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Preliminary Study (Yanagitani+)

- sample (barred spirals: 42, non-barred: 21)
  – COMING (32) + CO Atlas + HERACLES
  (Kuno+ 07; Leroy+ 09)
- disk radius ≡ R_{K20}, central region ≡ $R_{K20}/8$
- molecular gas concentration index

$$f_{1/8} = \frac{M_{H_2}(r \leq R_{K20}/8)}{M_{H_2}(r \leq R_{K20})}$$

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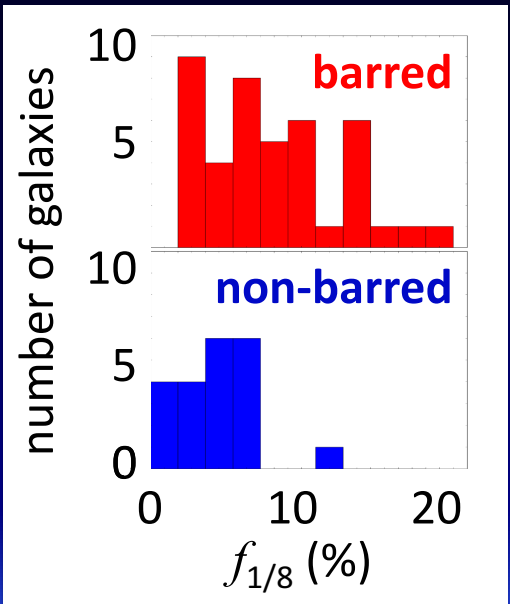
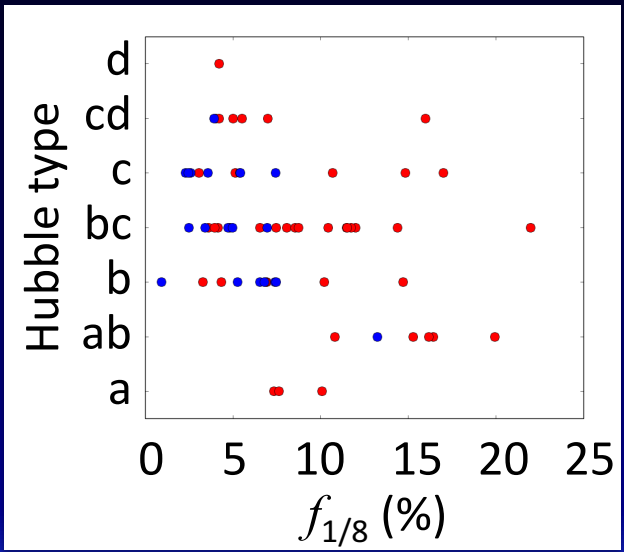
Molecular Gas Concentration

- higher $f_{1/8}$ → barred spirals





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Summary

- completed mapping of 45 galaxies in the last season (+5 galaxies in the pre-season)
- developing objective pipe-line reduction system

  → taking a little while to reduce data
- two master theses, six graduation theses will be published soon
- expanding the members

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