

# ALMA 特別セッション： ALMA アーカイブデータが切り拓く 天文学

林正彦（国立天文台）



Atacama Large Millimeter/submillimeter Array



# Program

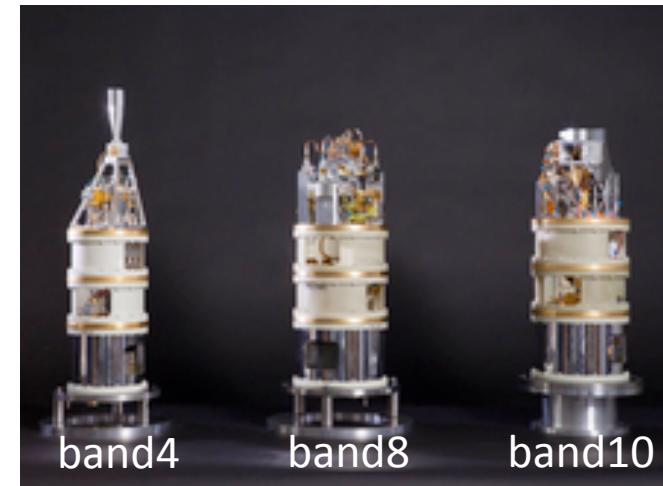
- Introduction: Masa Hayashi (NAOJ)
- Science with ALMA Archive:
  - Galaxy Formation: Tohru Nagao (Ehime)
  - Star Formation: Tomoya Hirota (NAOJ)
- How to use ALMA Archive: Erik Muller (NAOJ)





# ALMA Status

ALMA: a giant array of 66 antennas  
(the 12-m array and Morita array)



All Japanese ALMA Receivers are completed and shipped out





# Science Capabilities

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- **Cycle 0 (2011-2013)**
  - > 16 x 12m antennas
  - Bands 3(3.1mm), 6(1.3mm), 7(0.87mm), 9(0.44mm)
  - Max 400 m baseline (~0.3" resolution)
- **Cycle 1 (2013-2014)**
  - 32 x 12m antennas
  - ACA (9 x 7m, 2 x 12m TP antennas)
  - Bands 3(3.1mm), 6(1.3mm), 7(0.87mm), 9(0.44mm)
  - Max 1 km baseline (~0.1" resolution)
- **Cycle 2 (2014-2015)**
  - 34 x 12m antennas
  - ACA (9 x 7m, 2 x 12m TP antennas)
  - Bands 3(3.1mm), 4(2.1mm), 6(1.3mm), 7(0.87mm), 8(0.74mm), 9(0.44mm)
  - Max 1-1.5 km baseline (~0.1" resolution)
  - Polarization (Band 3, 6, and 7, no ACA)



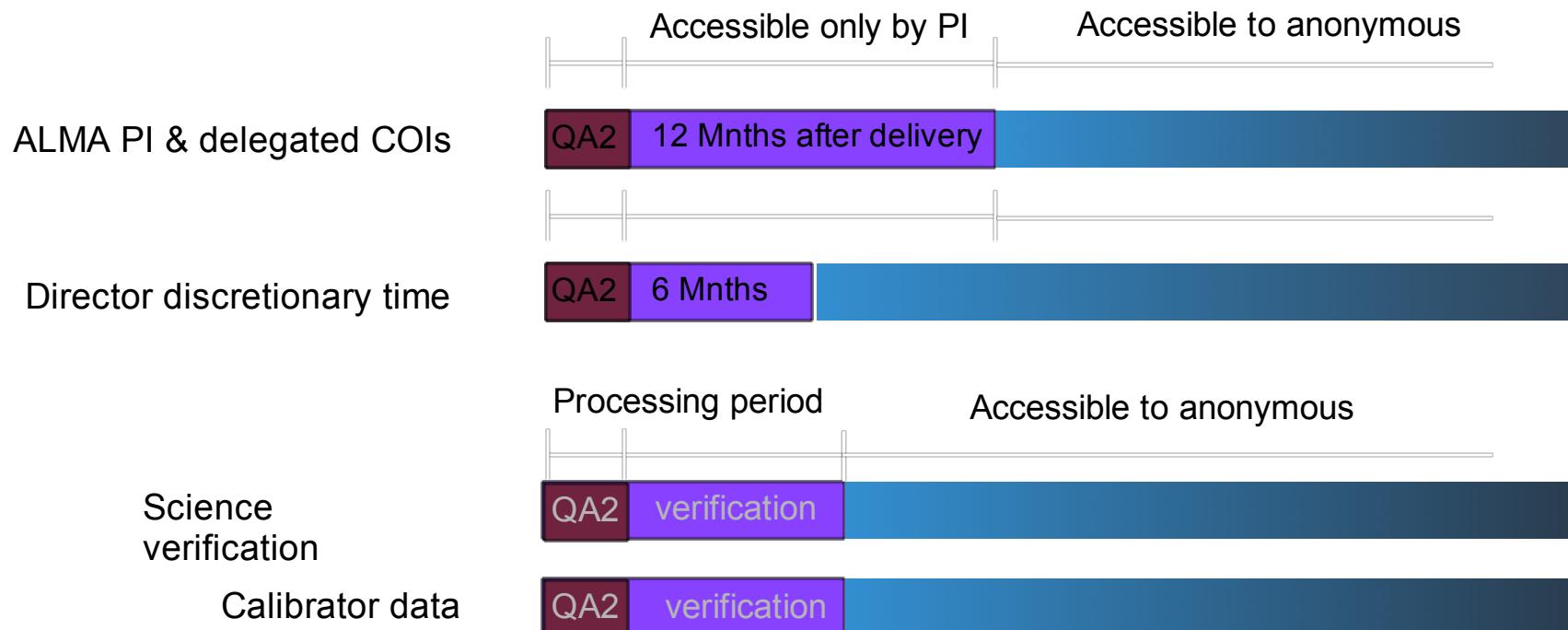
# Proprietary Period (12 months)

Proposed data (standard and DDT proposals)

Instantly available to PI

- Available to anyone after proprietary period (12 or 6 *calendar* months).

Verification and calibrator data are instantly available to anyone



# Proprietary Period (12 months)

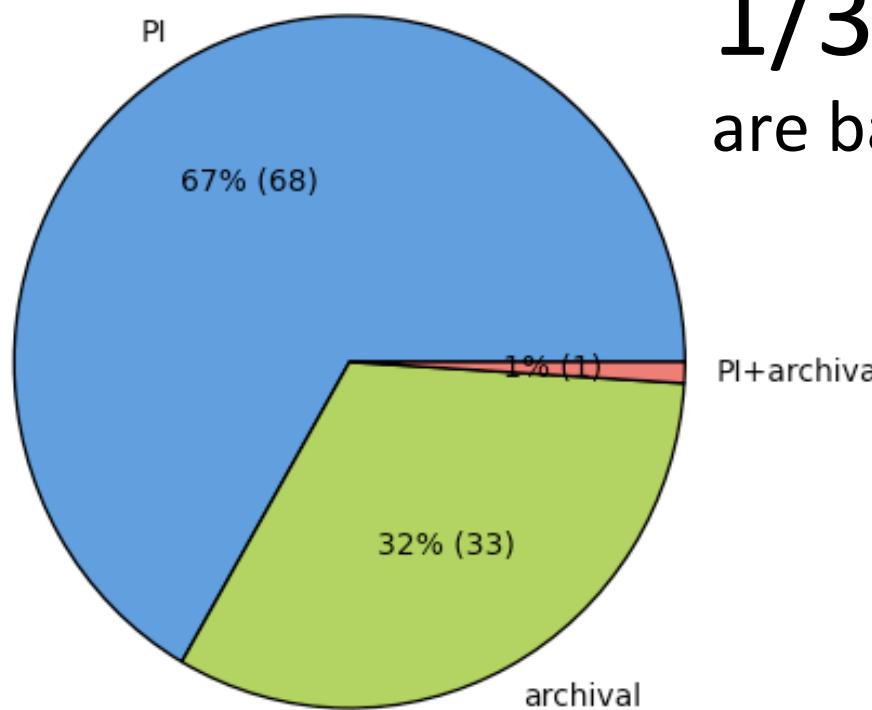
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80% of Cycle 0 data  
(> 100 projects)  
are publically available  
now.



# Publication with ALMA Archive

Refereed ALMA publications (total: 102)



**1/3** of all ALMA publications  
are based on archival data

As of 2014-03-18  
(ALMA publication statistics)

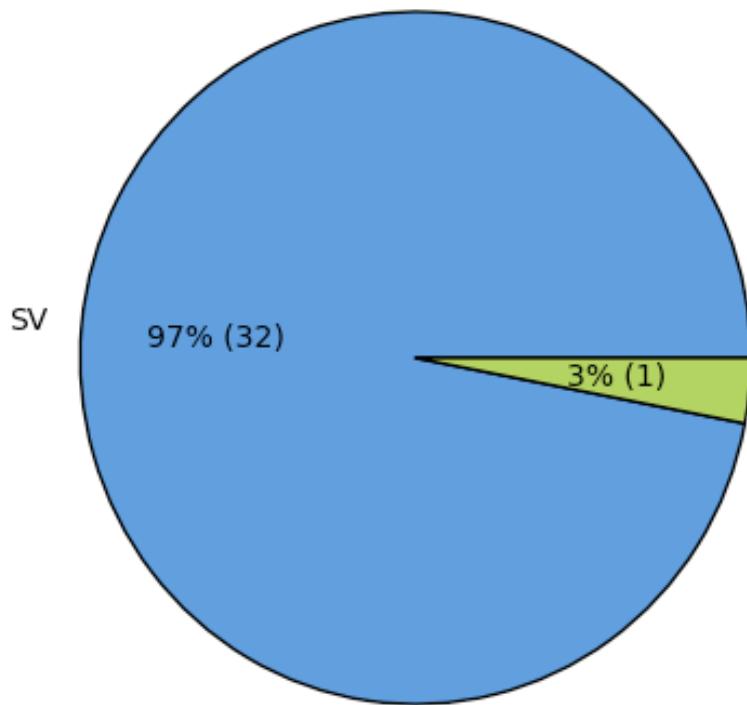
All ALMA Papers



Atacama Large Millimeter/submillimeter Array

# Publication with ALMA Archive

Refereed ALMA publications (total: 33)



No cycle0 archival papers are published yet.

All the 33 archival papers are based on Science Verification (SV) + Engineering data.

As of 2014-03-18  
(ALMA publication statistics)

## ALMA Archival Papers

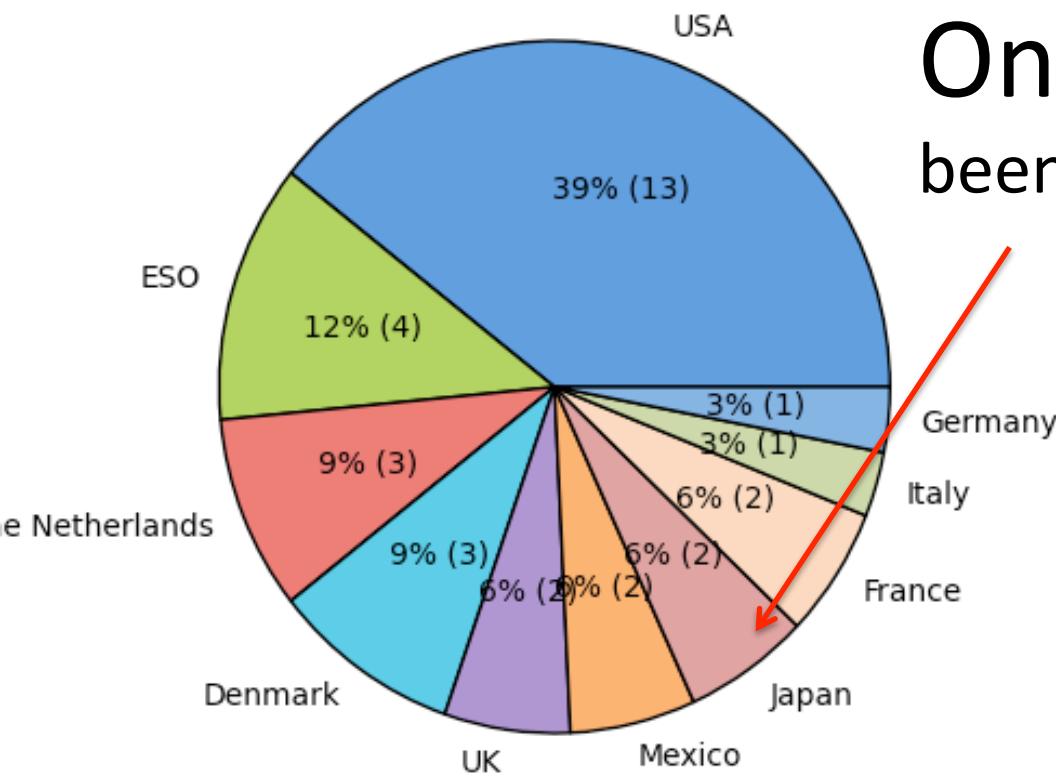


Atacama Large Millimeter/submillimeter Array

# Publication with ALMA Archive



Refereed ALMA publications (total: 33)



Only 2 archival papers have been published from Japan

Hirota et al. 2012, ApJL  
Espada et al. 2012, ApJL

As of 2014-03-18  
(ALMA publication statistics)

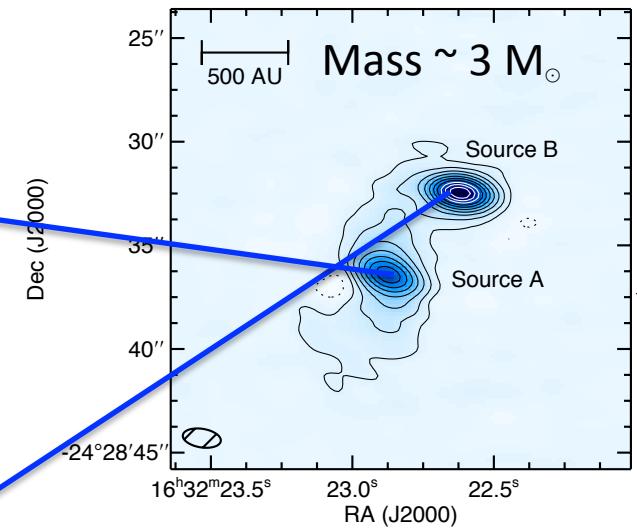
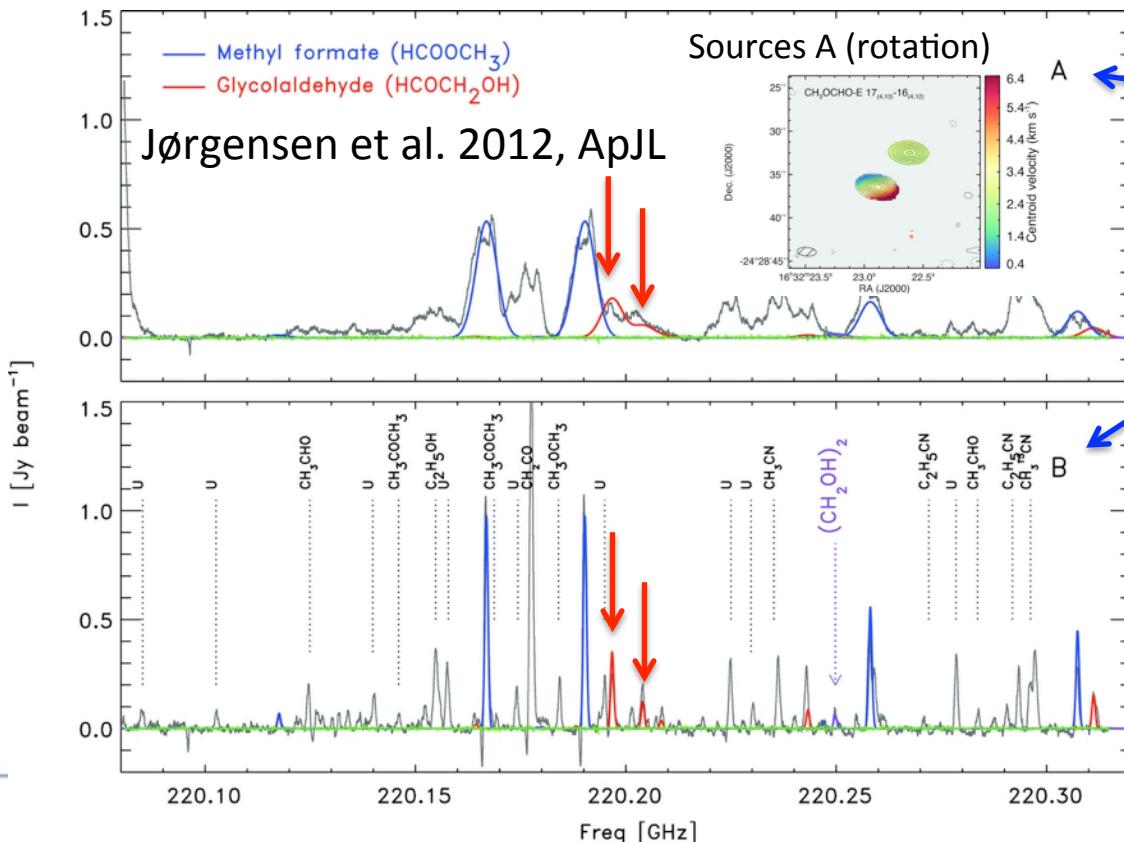
## ALMA Archival Papers



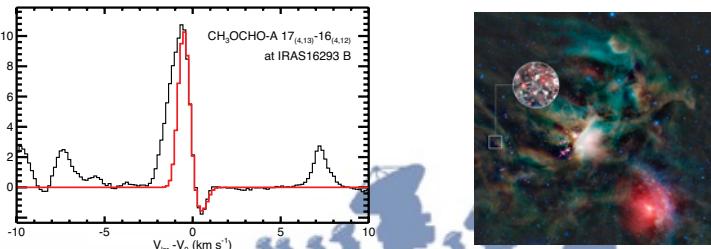
# ALMA Archival Papers

- Discovery of the simplest sugar, Glycolaldehyde ( $\text{HCOCH}_2\text{OH}$ ) from the young “solar-mass” protostellar binary, IRAS 16293-2422

ALMA SV Band 6 Data  
16 antennas, 5.4 hours, 2 pointings



Pineda et al. 2012, A&AL  
Source B (inflow - inverse P-Cygni profile)



# ALMA Archival Papers

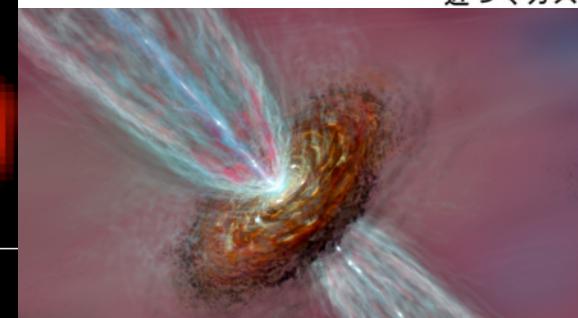
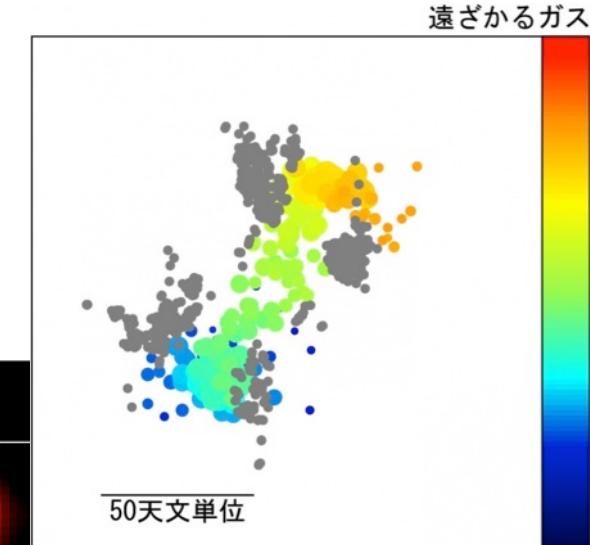
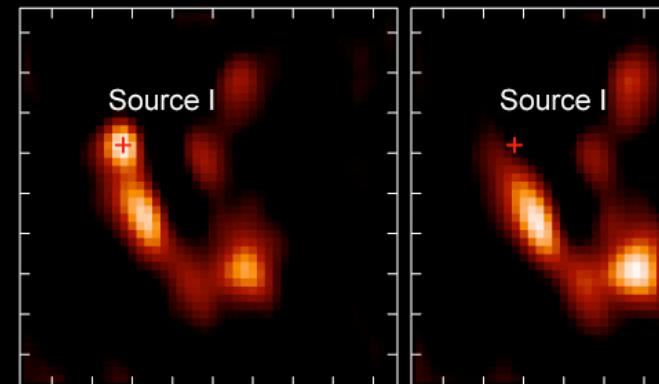
- The First Detection of highly-excited water maser in star forming regions
- A New Tool to explore the vicinity of high-temperature gas around baby stars (Hirota-san's talk)



ALMA SV band 6 Data  
16 antennas, 20 minutes

Hirota et al. 2012, ApJL

a. High-energy water maser (with Methyl formate)



ALMA

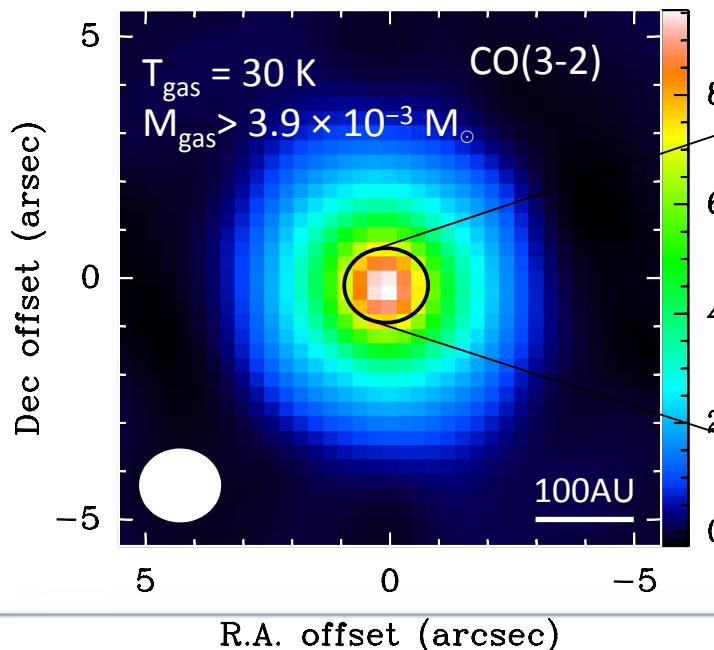
# ALMA Archival Papers

- Measurement of gas temperature and mass of a proto-planetary disk around TW Hydrae

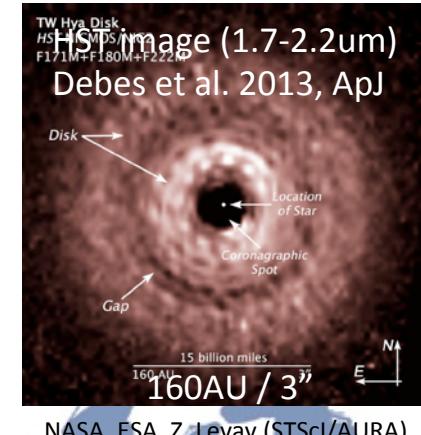
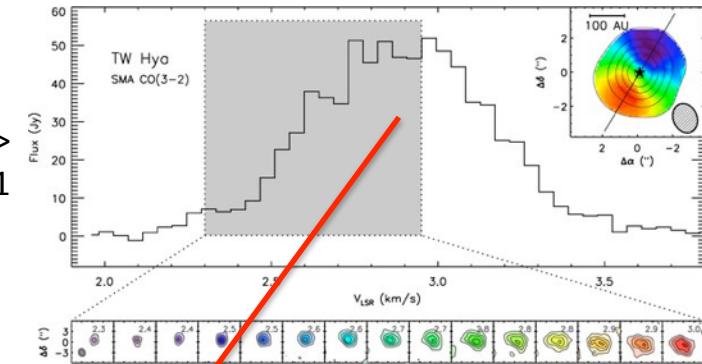
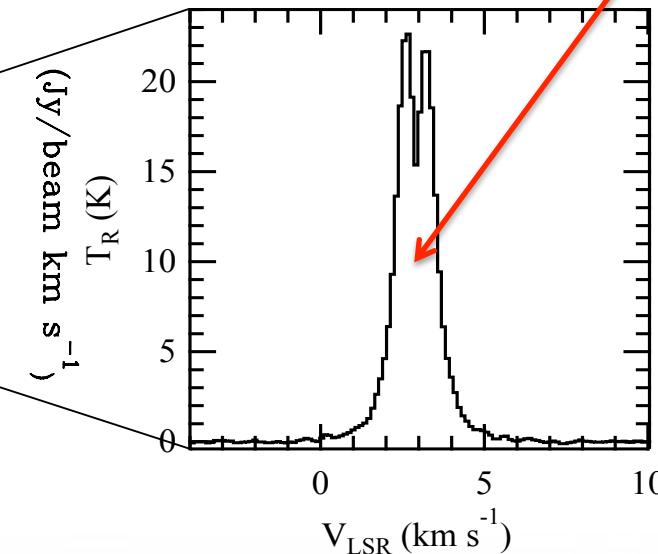
Bergin et al. 2013, Nature

SMA 2 nights =>  
Hughes et al. 2011

ALMA SV band 7 Data, 9 antennas, 2.4 hours  
(x10 more sensitive than the previous SMA observations)



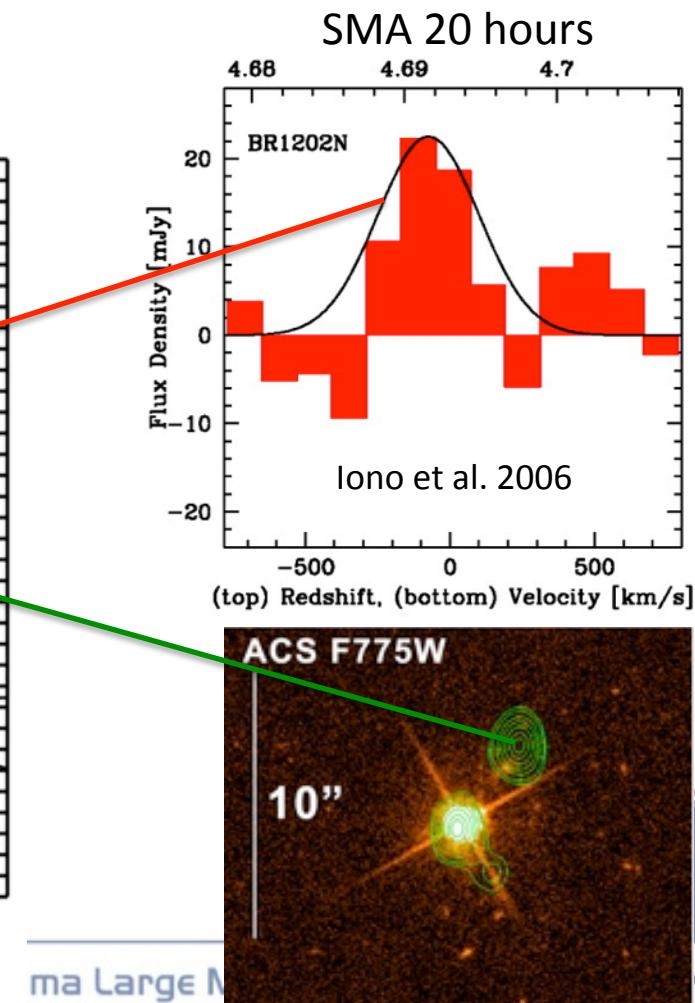
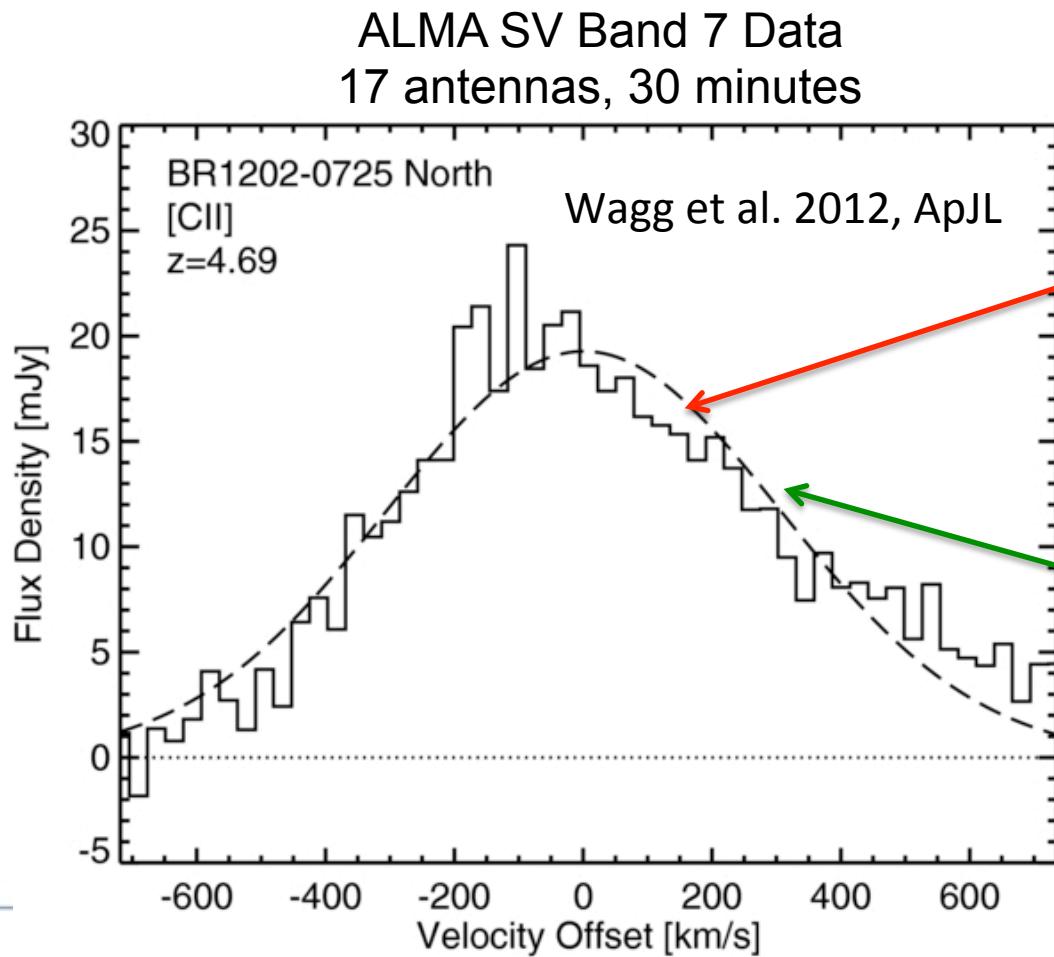
Spectrum of the central region



NASA, ESA, Z. Levay (STScI/AURA)

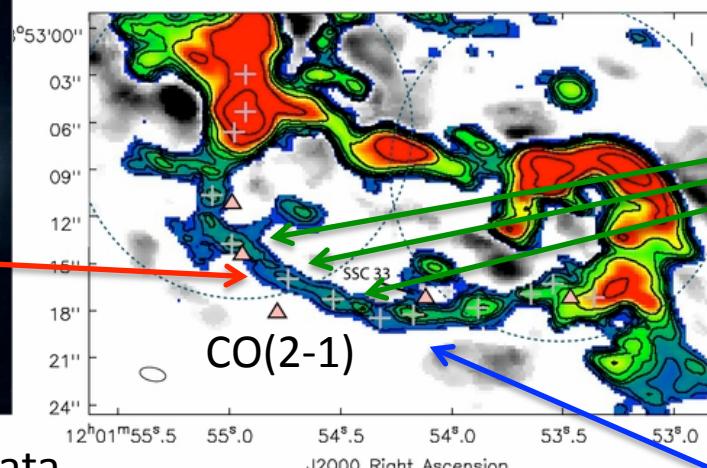
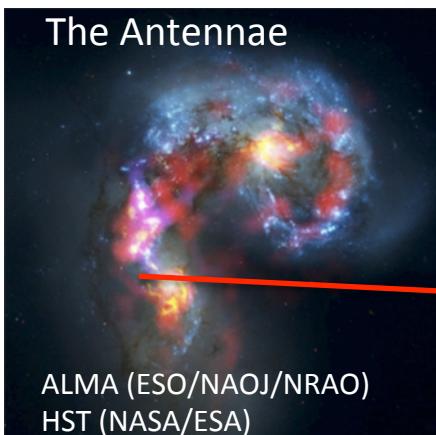
# ALMA Archival Papers

- A clear [CII] 158 $\mu$ m emission line detection from a distant galaxy, BR1202-0725 at  $z=4.7$



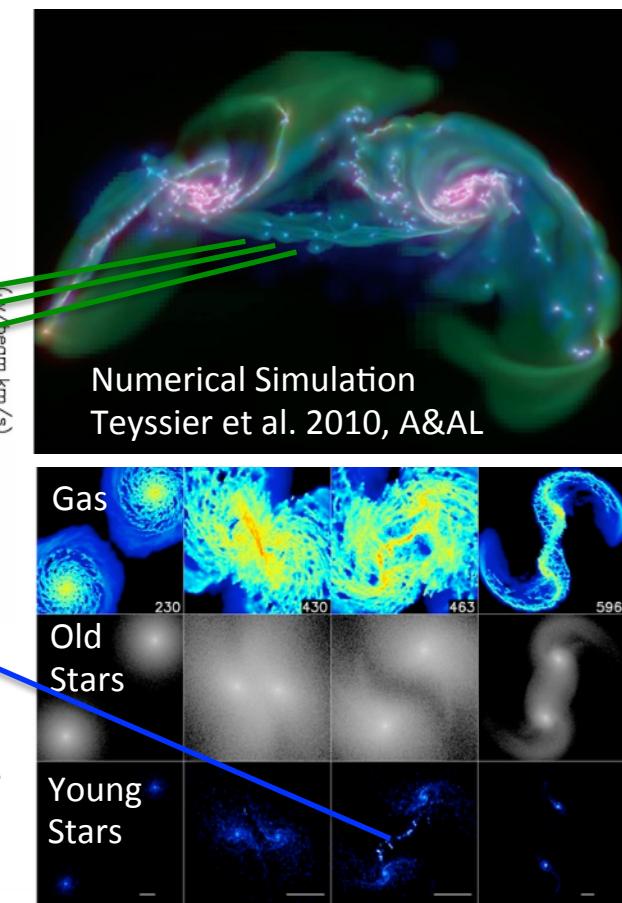
# ALMA Archival Papers

- A discovery of a clumpy molecular gas arm in merging galaxies
- Stars will born in the clumps in the tidal molecular arms as predicted by numerical simulations



ALMA SV Band 6 Data  
14 antennas, 17 pointings      Espada et al. 2012, ApJL

The star formation efficiency in the tidal arm ( $\sim 6 \text{ Gyr}^{-1}$ ) is a factor of x10 higher than those in normal disk galaxies.





# ALMA Archive

<http://almascience.nao.ac.jp/aq/>



Atacama Large Millimeter/Submillimeter Array

In search of our Cosmic Origins

You are here: [Home](#) > [ALMA Data](#) > Archive Query

## ALMA Science Archive Query

[Query Form](#)

[Result Table](#)

[Search](#)

[Reset](#)

[Query Help](#)

### Position

Source name (Sesame)

Source name (ALMA)

RA Dec

Search radius

0:10:00

### Energy

Frequency

Bandwidth

Spectral resolution

Band

### Time

Observation date

Integration time

### Polarisation

Polarisation type

### Observation

Water vapour

Scan intent

Observe target ▾

### Project

Project code

Project Title

PI Name

### Options

Results view

raw data  project

Release status

public data  all data

# Quick Look with JVO



=> Location: Top Page > ALMA > ALMA Archive

## ALMA Archive

### Using the data for publication

The following statement should be included in the acknowledgment of papers using the ALMA datasets obtained from the JVO portal:

"This paper makes use of the following ALMA data: ADS/JAO.ALMA#<Project code>. ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada) and NSC and ASIAA (Taiwan), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ."

You can find the project code (e.g. 2011.0.01234.S) on the dataset info page where you download the data.

Please also include the following sentence on the title page as a footnote to the title or in the acknowledgment of the paper.

"[Part of] the data are retrieved from the JVO portal (<http://jvo.nao.ac.jp/portal>) operated by the NAOJ"

<http://jvo.nao.ac.jp/portal/alma/archive.do>

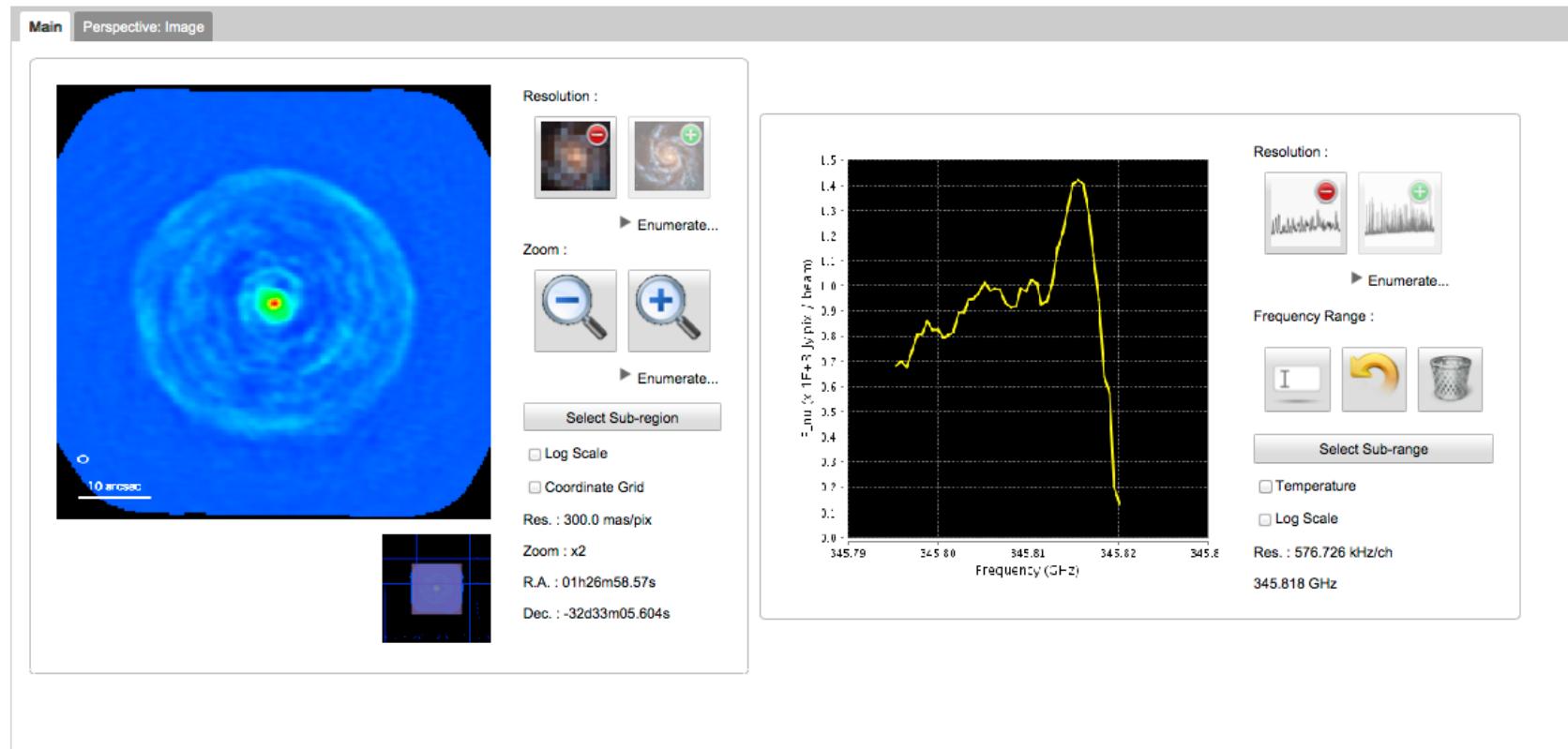
Target Name	Project Code	Coords	Desktop Viewer
<b>#</b> <b>Project Code</b> # of Data			<b>Title</b>
1 2011.0.00020.5 24			Molecular line flux ratios and AGN feedback in gas/dust-rich galaxies
2 2011.0.00028.5 2			The Effect of Extreme Environment on Protoplanetary Disks in Orion
3 2011.0.00039.5 3			The ALMA view of the cool dust in an extreme low-metallicity starburst v1.6
4 2011.0.00046.5 1			The first insight into the resolved molecular gas properties of a host galaxy of gamma-ray burst 980425 v1.3
5 2011.0.00061.5 10			Imaging study of molecules in the nearby galaxies NGC 1068 and NGC 253: Effects of active galactic nucleus and starburst on the shock/dust related molecules SO, HNCO, CH3OH, and CH3CN
6 2011.0.00064.5 6			Clustered Massive Galaxy Formation around a z=5.3 Submillimeter Galaxy
7 2011.0.00083.5 14			The footprints of SF and AGN activity in NGC1068: a case study for ALMA
8 2011.0.00087.5 2			Structure of the beta Pictoris disk in mm dust
9 2011.0.00097.5 88			Evolution of the ISM Contents of Massive Galaxies z = 2.2 to 0.3
10 2011.0.00099.5 40			Reformation of Cold Molecular Disks in Merger Remnants
11 2011.0.00101.5 2			Shedding Light on Distant Starburst Galaxies Hosting Gamma-ray Bursts v9
12 2011.0.00108.5 24			X-ray irradiated dense molecular medium in the active nucleus of NGC 1097
13 2011.0.00115.5 2			Demonstrating Early ALMA Capabilities with the Extremely Luminous Giant Starburst 'Himiko' Discovered at the Redshift Frontier
14 2011.0.00120.5 8			The earliest stages of star and planet formation
15 2011.0.00121.5 15			Search for Submillimeter H2O Maser Towards Active Galactic Nuclei
16 2011.0.00124.5 4			Spatially extended [CI] in a z=4.8 SMG
17 2011.0.00130.5 1			Spectroscopy of a normal star-forming galaxy at z=2 with 300 parsec resolution: physical conditions in the cold ISM at high redshift
18 2011.0.00131.5 8			Piecing the shell together: ALMA and the detached shell around R Scl
19 2011.0.00133.5 24			Can old protoplanetary disks be as tiny as 10AU? v1.7
20 2011.0.00142.5 2			Imaging the Birth Ring of the AU Mic Debris Disk
21 2011.0.00150.5 22			Testing planet and star formation in binary systems
22 2011.0.00170.5 27			Interstellar Glycine
23 2011.0.00172.5 17			The Life Cycle of the Molecular Gas in the Nearest Nuclear Starburst: GMCs, Molecular Superwind, and Feedback v2.5
24 2011.0.00175.5 15			Merging IR-Luminous Galaxies -- Arp 220 and NGC 6240
25 2011.0.00182.5 7			ALMA Exploration of Nuclear Regions of Nearby LIRGs -- Warm Molecular Gas Distribution Down to 100 pc
26 2011.0.00191.5 6			Constraining the Formation Mechanisms of Wide-Orbit Planets: The Case of Fomalhaut b v0.6
27 2011.0.00199.5 29			Bursting Water Maser Feature in Orion KL
28 2011.0.00206.5 19			Dust continuum and [C II] line emission from quasar host galaxies at z~6
29 2011.0.00208.5 8			Feeding and feedback in two nearby Seyfert galaxies
30 2011.0.00210.5 18			Probing Formation of Keplerian Disks around Protostars
31 2011.0.00217.5 10			Globular cluster formation: caught in the act
32 2011.0.00223.5 8			The rotating equatorial disk in the Red Rectangle
33 2011.0.00232.5 2			Molecular Gas and Obscured Star-formation in Host Galaxies of Dark Gamma-ray Bursts
34 2011.0.00236.5 4			The Dynamics of Massive Starless Cores

# Quick Look with JVO



## Data Information

- Data Set ID : ALMA01000003
- Object Name : R Scl
- R.A. : 01h26m58.12s
- Dec. : -32d32m35.754s
- Observation Date (UTC) : 2011-11-03T10:21:50.208Z



## File Information

- Original File Size : 100.42 MB
- Estimated Download File Size : 6.78 MB

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CO(3-2) emission from the AGB star R Sculptoris  
(Maercker et al. 2012, Nature)



# Summary

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- ALMA archival data of >100 Cycle 0 projects are now publically available.
- No cycle0 archival papers are published yet.
- Only 2 archival papers are published from Japan.
- JVO is useful to visually check the archival data.

