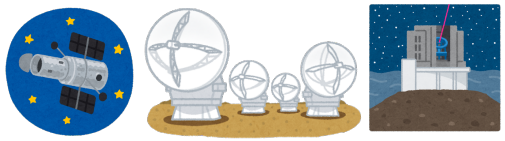
NAOJ Achievements and Future Planning Symposium 2019
December 12-13, 2019 @NAOJ
https://www.nao.ac.jp/for-researchers/naoj-symposium2019/indexE.html



Radio community: Current assessment and expectations for the future

1) Scientific evaluation of NAOJ facilities
2) Future plans discussed in the community, and
3) Expectations for NAOJ

KOHNO Kotaro (The University of Tokyo)

Channels between NAOJ and "Radio astronomy community"

http://www.udencon.sakura.ne.jp/

- Japan Radio Astronomy Forum (JRAF)
  - Steering committee: Sakai, N. (chair, RIKEN), Takakuwa, S. (vice-chair, Kagoshima U.), Akahori, T. (NAOJ), Oka, T. (Keio U.), Tamura, Y. (Nagoya U.), Honma, M. (NAOJ)
  - total number of JRAF members: ~350
- ALMA-J Science Advisory Committee (JSAC)
  - ALMA, NRO, and ASTE (charges from NAOJ D.G.)
  - Kohno, K. (chair, U. Tokyo, ASAC), Sakai, N. (RIKEN, ASAC), Tachihara, K. (Nagoya U., ASAC), Onishi, T. (Osaka Pref. U.), Momose, M. (Ibaraki U.), Inoue, A. (Waseda U.), Nagao, T. (Ehime U.), Imai, H., Shinnaga, H. (Kagoshima U.), Sagawa, H. (Kyoto Sangyo U.) + NAOJ members

This presentation is based primarily on JRAF and JSAC discussions (+ KK's personal view).

1) Scientific assessments of NAOJ facilities

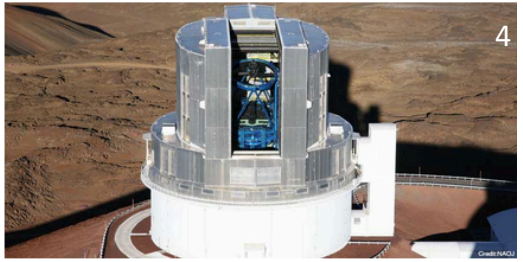
NAOJ facilities

- Here we focus on ALMA, NRO, and ASTE.
  - no statement about EAO (JCMT) in NAOJ website?
- Mizusawa VLBI Observatory & Japanese VLBI Network ➔ Fujisawa-san's talk

It would have been better if we could have a joint discussion between JRAF and Japan VLBI Consortium to assess all these facilities by putting all these in a broad context .. ?

https://www.nao.ac.jp/en/research/telescope/


ALMA


The Subaru Telescope

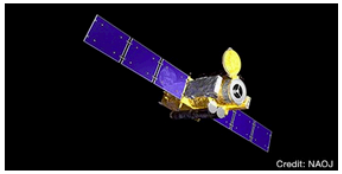

KAGRA


TMT (Thirty Meter Telescope)


45-m Radio Telescope


VLBI


Solar Flare Telescope


Solar Observing Satellite "Hinode"


ATERUI II


GRAPE System

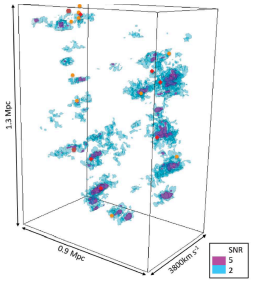

ASTE Telescope


188-cm Reflector Telescope


Radioheliograph

ALMA

Umehata+ 2019, Science, 366, 97

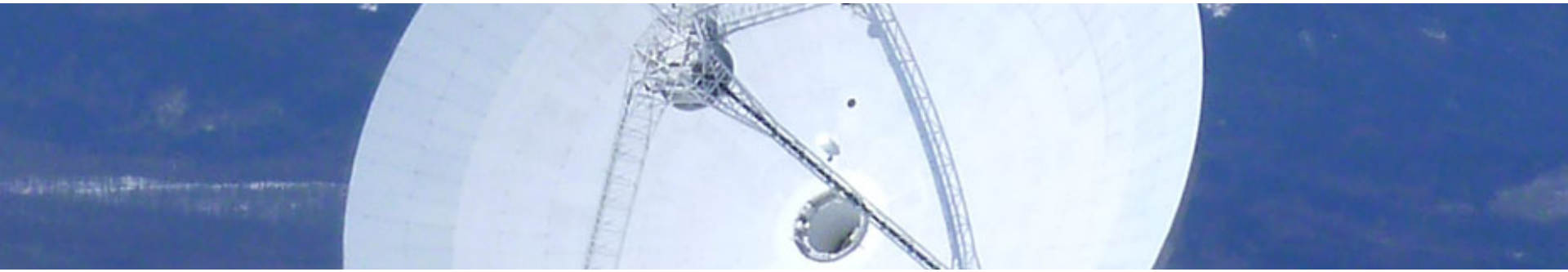


EHT+ 2019

	Chile (CL)	East Asia (EA)	Europe (EU)	North America (NA)	Open Skies	Total
Submitted Proposals						
Number of proposals	90	377	727	504	75	1773
12-m Array time (hours)	1041	3983	8300	5201	623	19148
7-m Array time (hours)	550	2154	3214	2756	176	8850
Total Power Array time (hours)	377	1674	2345	2383	159	6937
Subscription rate						
12-m Array (4300 h offered)	2.4	4.1	5.7	3.6	N/A	4.5
7-m Array time (3000 h offered)	1.8	3.2	3.2	2.7	N/A	3
Total Power Array (3000 h offered)	1.3	2.5	2.3	2.4	N/A	2.3

https://almascience.nao.ac.jp/news/documents-and-tools/cycle7/alma-cycle7-stats

- Strong demands and outstanding science productivity
  - 2nd largest ALMA paper producer (1st is US), but still need to increase the publications from Japanese and EA community
- Overall, the user community is satisfied with the quality of ALMA deliverables, which is achieved by the enormous efforts by JAO and EA ALMA Support Center (EA-ASC).
- Some of the EA-ASC-based services and user support systems are also highly appreciated, including (1) distribution of calibrated MS files, (2) PI support system, and (3) ALMA Joint Scientific Research Program.
- an issue: sustainable proposal review system
  - full-blind review, distributed proposal review vs canonical review, for which proposal category? (regular, large, + “medium” ?)
  - We and NAOJ should carefully watch the outcomes of the cycle 7 supplemental call (& user survey).



https://alma-telescope.jp/assets/uploads/2017/10/IEICE-milestone-telescope-420x420.jpg

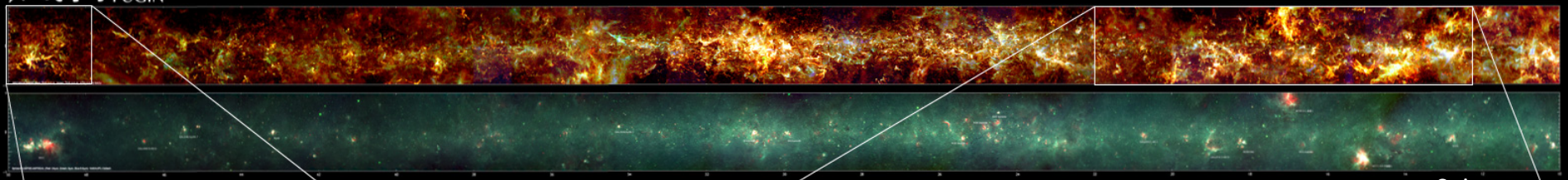
NRO 45-m

NRO 45-m telescope in the ALMA era

- Users in some specific fields left (migrated to ALMA)
  - e.g., proto-planetary disks, high-z galaxies
- But still competitive & productive for some science fields
  - molecular clouds and star-formation ➔ FUGIN, star-formation legacy project, large program on deuterated molecules
  - The Galactic Center ➔ large program on the Central Molecular Zone
  - galaxies in the local universe ➔ COMING
  - Magnetic field (Zeeman effect measurements) ➔ "Z45" receiver
- Good preparation for new ALMA bands (i.e., Band-1, 2)
- "win-win" relation between community (universities) and NRO via joint development + competitive funds, investment for future (new technology development), etc.
  - New observing method using a frequency modulating local oscillator "FMLO" (Taniguchi, A., Tamura, Y., et al., PASJ, in press)
  - "Millimeter Adoptive Optics" by Tamura, Y., (Nagoya U.+) with Grant-in-Aid challenging Exploratory Research
  - 3-mm band continuum camera with MKIDs (U. Tsukuba, Kwansei G.U.+)

Grant-in-Aid A

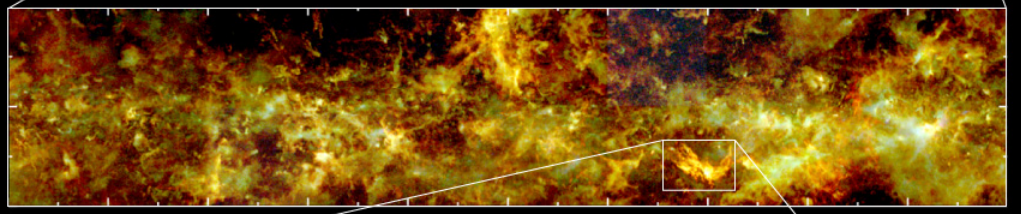
風神 FUGIN FOREST Unbiased Galactic plane Imaging survey with Nobeyama 45-m telescope

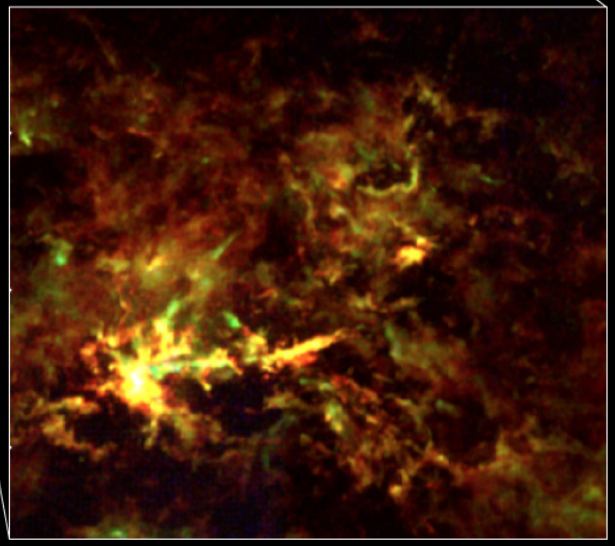


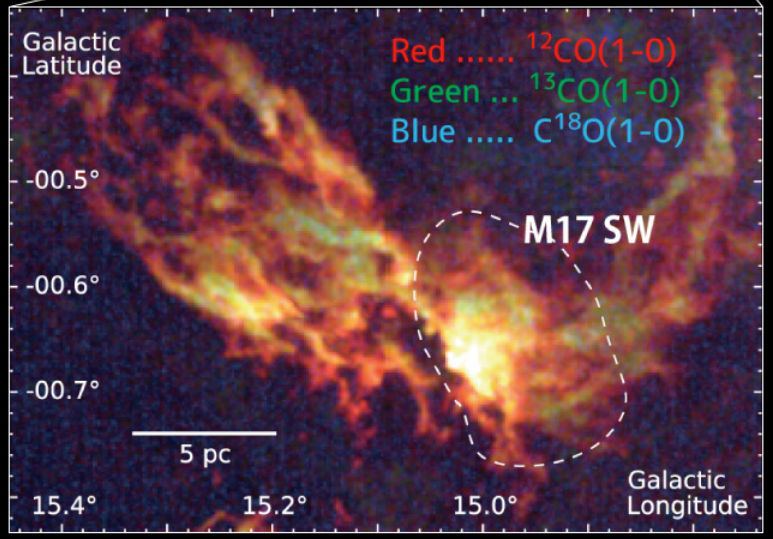
Spitzer

130 deg^2 in total, with 20" resolution

Exploring totally different parameter space from ALMA







NINS NAOJ NOBEYAMA FOREST

Credit: NAOJ/NASA/JPL-Caltech

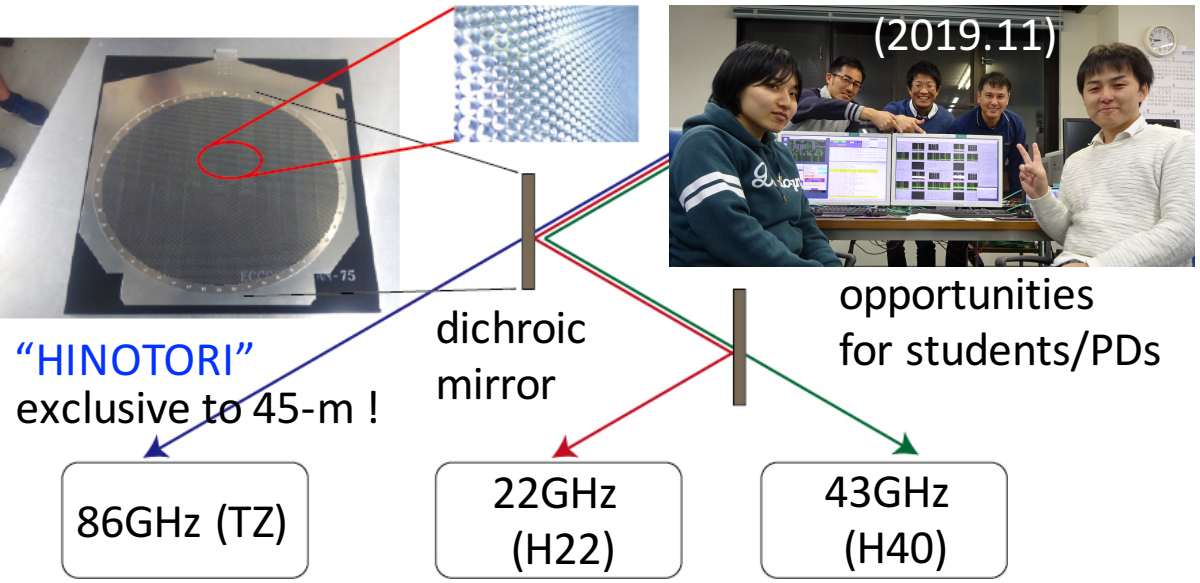
16 papers (refereed) + more papers submitted https://nro-fugin.github.io/

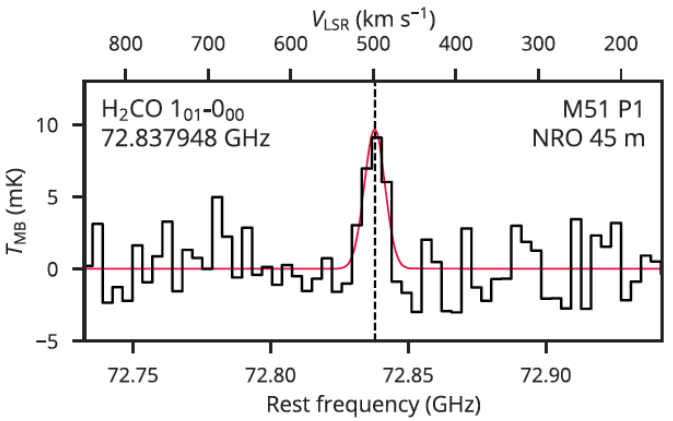
Kagoshima U., Osaka Pref. U., Nagoya U., U. Tsukuba, Joetsu Edu. U., Saitama U., Kwansei Gakuin U., U. Tokyo, Meisei U., RIKEN, ISAS, NAOJ, + Cardiff. U., etc.

University – NRO joint developments with external resources (JSPS grants)

- Twin-beam 2SB receiver "TZ" (2012-2017)
  - U. Tokyo (IoA), Hokkaido Univ., Nagoya U., + NAOJ
- 70 GHz-band 2SB receiver "T70" (2013-now)
  - U. Tokyo (Department of Physics), Osaka Pref. Univ., Tokyo Univ. of Electro-Communications, + NAOJ
- Triple-band simultaneous observing system "HINOTORI" (2016-now)
  - Kagoshima Univ., Osaka Pref. Univ., Yamaguchi Univ., Ibaraki Univ., + NAOJ

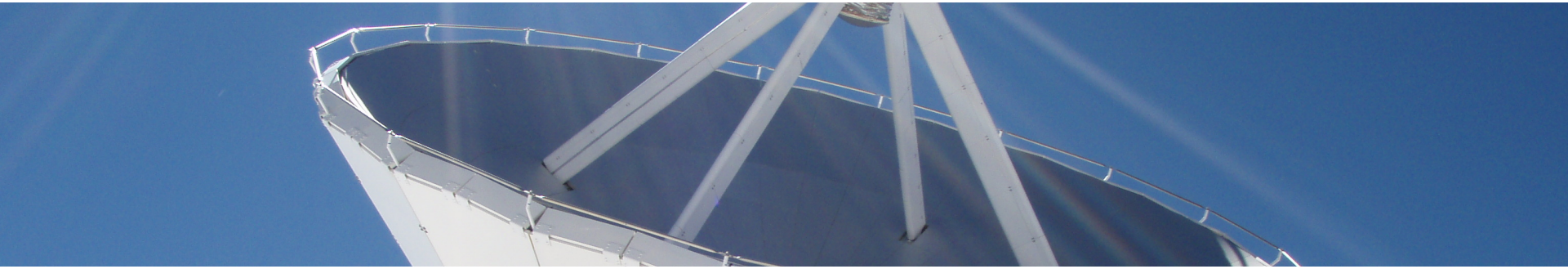
Grant-in-Aid
specially promoted research
scientific research S, A





Extragalactic formaldehyde using T70
➔ preparation for ALMA Band-2

Nishimura, Y., et al. 2019, ApJ, 879, 65



https://www.nro.nao.ac.jp/gallery/images/aste_001.jpg

ASTE 10-m

ASTE 10-m telescope in the ALMA era

- Now recovered from a serious antenna failure (and some troubles), science operation has been resumed
- Current paper production rate is not significant
  - partly because of the recent antenna failure
  - also some of the key instruments (specifically spectrometers) are obsolete

but "cost performance" looks good

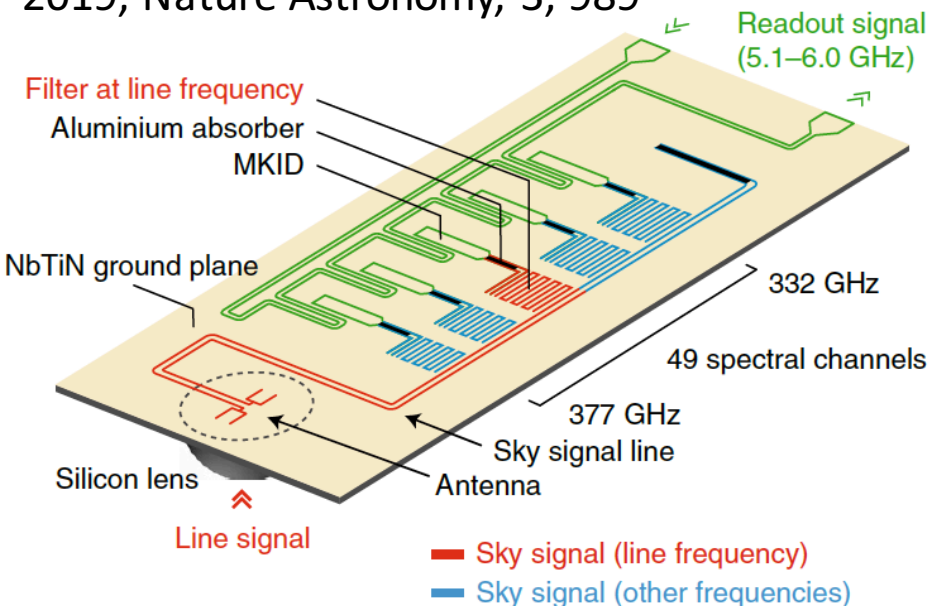
- Nevertheless, given the importance to having an access to submillimeter-wavelengths (= ALMA workhorse bands) and a test bed for new submillimeter-band technology and instrumentation (= realization of ALMA development plan), JSAC encourages both NAOJ and communities to obtain external funds to sustain the operation of ASTE by presenting attractive science goals and technological challenges to achieve the goals.
  - (1) wide-area surveys of the neutral carbon lines (Band 8 & 10) ➔ enhance the ALMA high-frequency science outcomes from Japan/EA

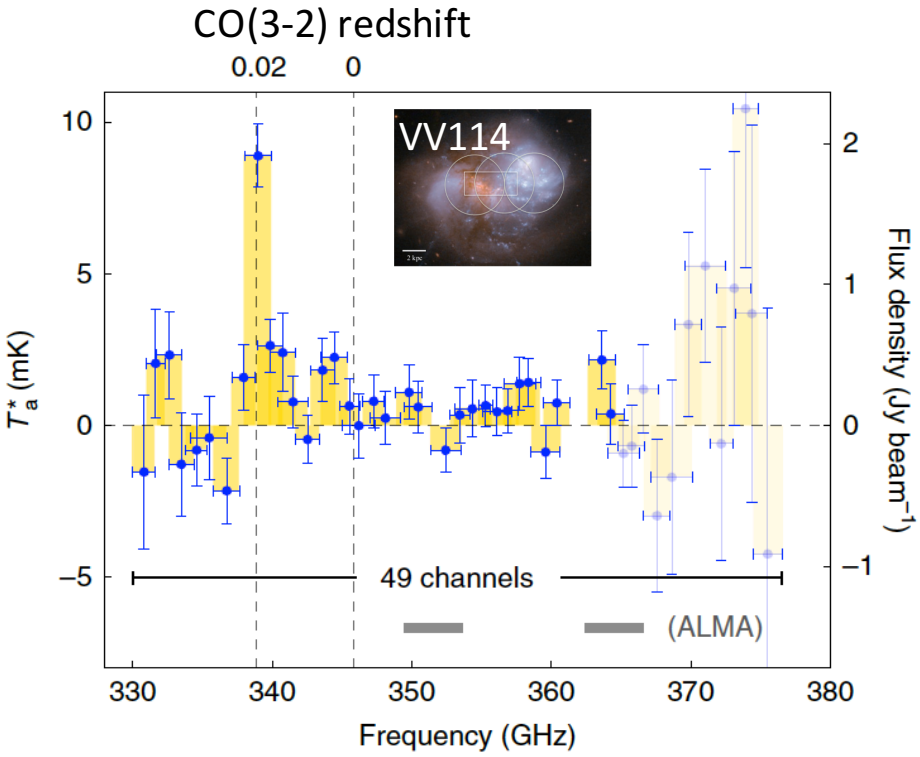
    ← supported by Grant-in-Aid science research A (by NAOJ)
  - (2) ultra-wide-band spectroscopy survey of the redshifted ionized carbon line (rest 158 μm) to study dust-obscured cosmic star-formation history @z>3-7 ➔ more efficient use of unique ALMA capabilities @Band 6 & 7

    ← supported by Grant-in-Aid science research S

First demonstration of the DESHIMA concept

Endo, A., Karatsu, K., Tamura, Y., et al.
2019, Nature Astronomy, 3, 989





nature astronomy
LETTERS
https://doi.org/10.1038/s41550-019-0850-8

First light demonstration of the integrated superconducting spectrometer

Akira Endo[1,2*], Kenichi Karatsu[1,3], Yoichi Tamura[4], Tai Oshima[5,6], Akio Taniguchi[4], Tatsuya Takekoshi[7,8], Shin'ichiro Asayama[5], Tom J. L. C. Bakx[4,5,9], Sjoerd Bosma[1], Juan Bueno[3], Kah Wuy Chin[5,10], Yasunori Fujii[5], Kazuyuki Fujita[11], Robert Huiting[3], Soh Ikarashi[1], Tsuyoshi Ishida[7], Shun Ishii[5,12], Ryohei Kawabe[5,6,10], Teun M. Klapwijk[2,13], Kotaro Kohno[7,14], Akira Kouchi[11], Nuria Llombart[1], Jun Maekawa[5], Vignesh Murugesan[3], Shunichi Nakatsubo[15], Masato Naruse[16], Kazushige Ohtawara[5], Alejandro Pascual Laguna[1,3], Junya Suzuki[17], Koyo Suzuki[4], David J. Thoen[1,2], Takashi Tsukagoshi[5], Tetsutaro Ueda[4], Pieter J. de Visser[3], Paul P. van der Werf[18], Stephen J. C. Yates[19], Yuki Yoshimura[7], Ozan Yurduseven[1] and Jochem J. A. Baselmans[1,3]

Ultra-wideband, three-dimensional (3D) imaging spectrometry in the millimeter–submillimeter (mm–submm) band is an onto their central supermassive black hole[6]. These evolutionary processes occurred in a decadal redshift range of $1+z\sim1$–10.

	DESHIMA 1.0	DESHIMA 2.0
Frequency range	332 – 377 GHz	220 – 440 GHz
[CII] redshift range	4.0 – 4.7	3.3 – 7.6
Spectral resolution R = f/df	380 (dv = 790 km/s)	~500 (±50) (dv ~ 500 km/s)
Number of MKIDs	49	347

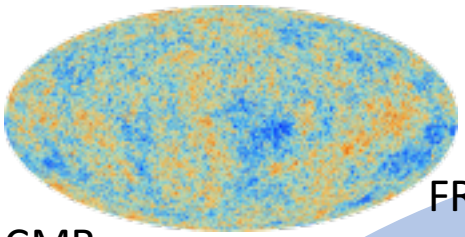
"submm version of X-SHOOTER"

2) Future plans

Scientifically-motivated future radio projects and their relation to others

https://alma-telescope.jp/assets/uploads/2018/05/ALMA-HST_MACS1149-JD_screen_preview.jpeg

https://www.esa.int/var/esa/storage/images/esa_multimedia/images/2013/03/planck_cmb/12583930-4-eng-GB/Planck_CMB_pillars.jpg



CMB inflation

http://litebird.jp/

LiteBIRD

FRBs, magnetic fields

http://ska-jp.org/

SKA1/2

Cosmology & Transients

LSST? WFIRST Euclid

Subaru+HSC/PFS/ULTIMATE

big data, ML

wide-field, 3D surveys

high cadence, transient

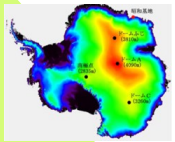
LST/AtLAST

https://www.lstobservatory.org/

http://atlast.pbworks.com/w/page/124067979/AtLAST%20Main%20Page

Antarctic THz

https://www.px.tsukuba.ac.jp/~nakai/astroobs/antarctica.html

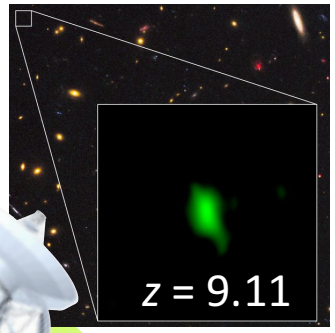


TMT

SPICA

JWST

Epoch of re-ionization



Athena

XRISM

KAGRA

LISA

ALMA

→ ALMA2

Galaxies & SMBHs

THz-wave spectroscopy

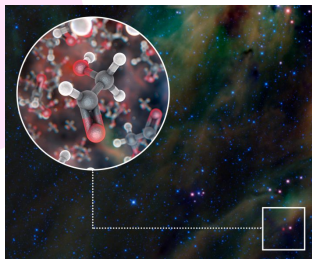
mm to cm-wave

higher resolution

ngVLA

https://ngvla.nrao.edu/

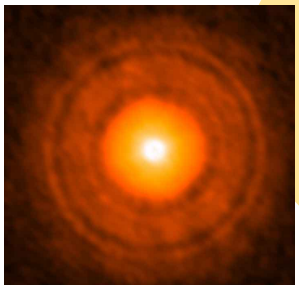
Life & prebiotic molecules in space



Stars & planets

JWST

SPICA TMT



Planet formation

https://alma-telescope.jp/assets/uploads/sites/alma.mtk.nao.ac.jp/j/news/files/editor/20160913_tsukagoshi_fig3_notext.png

https://alma-telescope.jp/assets/uploads/2017/05/eso1234a_pub-1800x1768.jpg

For International Visiting Committee of ALMA (EA regional visit)

Input from the user community Japan Radio Astronomy Forum (宇宙電波懇談会:Udenkon) Since 1970

Nami Sakai (Chief Scientist, RIKEN)

Steering Committee from 2015,

Chair from 2018

Steering Committee:

Takuya Akahori, , Mareki Honma, Nami Sakai(Chair), Shigehisa Takakuwa(Vice Chair), Yoichi Tamura, and Tomoharu Oka

- Survey for future projects (2017)
  (73 responses)

- Mini-survey + Voting (2018)
  (137 responses)

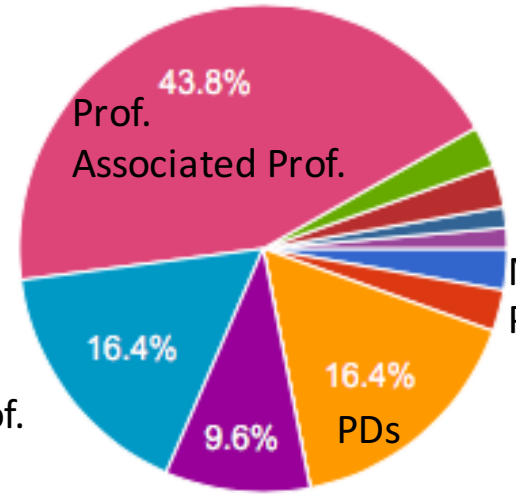
*Total number of members: ~350

Survey in 2017

現在のポジションについておしえてください.

73 responses

Position of the person who answered



Prof.
Associated Prof.

Master Student
PhD. Student

Assistant Prof.
Lecturer
(parmanent)

Assistant Prof.
Lecturer
(Fixed term)

PDs

- 大学院生（修士課程）
- 大学院生（博士課程）
- ポスドク研究員
- 研究管理者 (UR部門など), リサー…
- 任期の定めのある助教, 講師
- 任期の定めのない助教, 講師
- 准教授, 教授, あるいはそれらに相…
- 組織の長

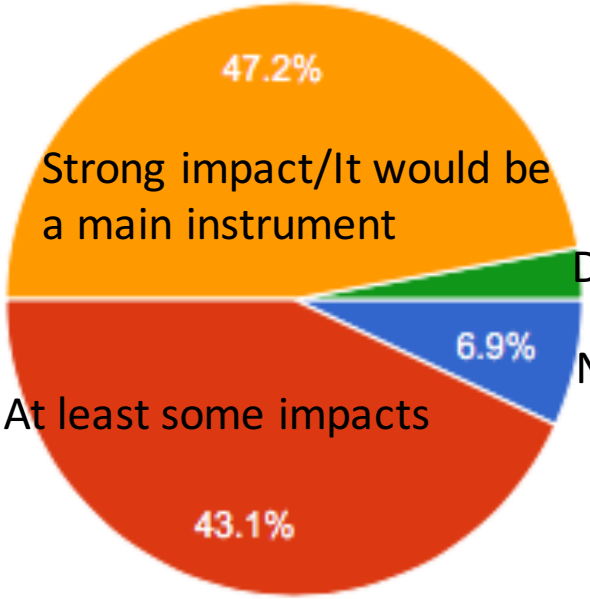
▲ 1/2 ▼

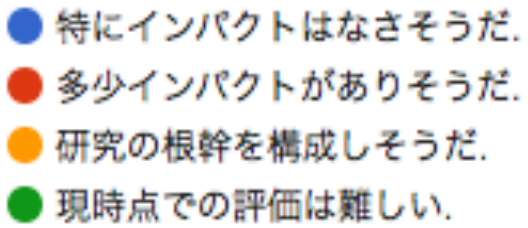
Survey in 2017

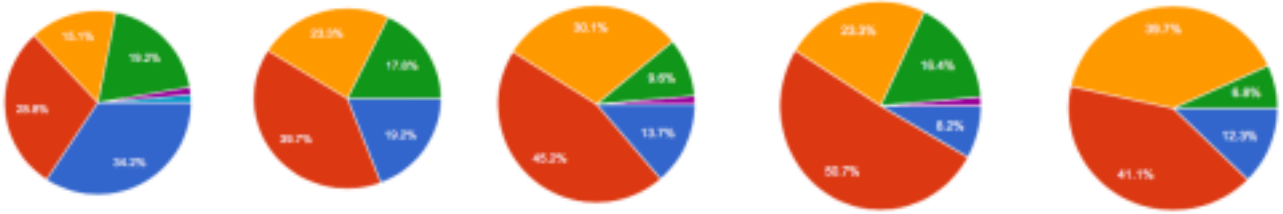
How do you think the each project in relation to your own research?

ALMA 拡張計画 Further developements of ALMA (Upgraded ALMA)

72 responses







ATT/LiteBird/ngVLA/LST/SKA
(Random order)

Mini-survey + Vote in 2018

137 responses

Please chose future plans from ALMA2/ATT/ngVLA/LST/SKA.
Then, put in an order the plans you want to use or you think it is important.
(You can include future plans in other wavelength.)

Order	5	4	3	2	1	Total vote	[%]
ALMA2	88	27	12	3	1	131	96
Radio 1	22	20	23	22	18	105	77
Radio 2	12	9	11	19	27	78	57
Radio 3	4	51	27	17	15	114	83
Radio 4	11	25	36	21	12	105	77
Total	137	132	109	82	73		
Invalid(/137)	0	5	28	55	64		

Summary

- ALMA/ALMA2: top support rate (By far the best)
- Combinations with
  lower-frequency interferometer projects
  (e.g. ngVLA, SKA) and a large single-dish
  telescope-project are also awaited.
- Detailed description on the recommended
  projects for MasterPlan 2020 is given below

https://alma-intweb.mtk.nao.ac.jp/~fukagwms/scj_astphys/recommendation/udenkon.pdf

- Some concerns from education point of view
  (Student education)

3) Expectations for NAOJ

Expectations for NAOJ: near/mid-term

- keep ALMA productive (at least) as same as the current level
  - support programs like ALMA joint science research, which are unique to Japanese ALMA community, are very efficient to enhance the activities in Japanese universities and ALMA science outcomes.
- endorse the proposed NRO 45-m & ASTE operation plan (simplified, project-oriented) to reduce the operation cost
  - the community is expected to play more proactive roles
- exploit the large collecting area @3mm to 4mm of NRO 45-m
  - science preparation for ALMA Band-2 (70 GHz) and 1 (40 GHz)
  - deuterated molecules, magnetic fields, etc. (w/ ASIAA)
  - concern: can NRO accept new receivers/spectrometers? maybe no?
- exploit the submm capabilities of ASTE ← ALMA workhorse !
  - ALMA Band-8 receiver → Band "7+8" receiver (w/ KASI)
  - ALMA Band-10 to promote high-frequency ALMA proposals; can be a unique selling point from EA
  - new technologies: integrated superconducting spectrometers (ISS) as a redshift machine for high-z extreme starbursts (DESHIMA)
- all these capabilities in both 45m and ASTE are in line with the ALMA long-term development activities

Roles of Advanced Technology Center (ATC)

- Access to ATC (open-use, joint development program, etc.): very encouraging to the community/universities who are interested in developing new technologies and instruments for science
  - Universities often have rather limited access to the resources (facilities, human) for developments
- Some good examples
  - ALMA receiver developments of ultra-wide RF/IF mixers (Kojima et al.)
  - ➔ joint study with Osaka Pref. Univ.+ to implement of a wide-RF/IF-band receiver for 1.85-m telescope
  - ➔ joint study with Nagoya Univ., Tokyo Univ. of Electro-communications+ to develop a wide-RF/IF-band receiver for LMT 50-m telescope in Mexico
  - ATC's key technologies can be exploited to gain new science capabilities!
- Keep the availability and accessibility to ATC via open-use, joint development program, etc.
  - although we understand that NAOJ wants to concentrate on NAOJ's project, more flexibility will be very appreciated

Some discussions

- What is the optimal balance between mega-missions (ALMA & TMT, Subaru) and mid/small-scale facilities?
  - including EAO/JCMT? NRO45m, ASTE, VERA, JVN, + future missions SKA1, ngVLA, ..
- We community is keep trying to do our best to obtain external/competitive funds to contribute to have accesses to such mid/small-scale facilities
  - then NAOJ can concentrate on mega-missions more
- How to assess the NAOJ facilities?
  - immediate science merits and productivities are important, of course.
  - long-term science outcomes and growth of the community (including engineering and education) which are playing the central roles to produce science outcomes

Community – NAOJ communications

- We recognize that NAOJ pays strong attentions to the community, because inter-university organizations like NAOJ will not work without support by the community
- JSAC is one of such channels to deliver communities opinions to NAOJ
- It is also important to make NAOJ's decision-making processes transparent to the community
- In this sense, having this symposium can be a good exercise
- We believe that both community and NAOJ are trying to do their best to have good communications, but not sure if the current frameworks are sufficient, given the steady growth of the community (see page 2!)
- Please let us know if you have any opinions, suggestions, etc. for better (➔ audience!)

(photo: K. Kohno)

Summary

Summary 1: assessments of facilities

- ALMA
  - outstanding productivity
  - good communication between the community and NAOJ, effective community support services and programs
- NRO 45-m & ASTE 10-m telescopes
  - still competitive and productive in some fields even in the ALMA era
    - 45m: deuterated molecules @70 GHz (ALMA Band-2), Zeeman effect @40 GHz (ALMA Band-1), Galactic plane (+ Galactic Center) surveys, etc.
    - ASTE: neutral carbon lines @492 GHz (ALMA Band-8) & 809 GHz (ALMA Band-10), ultra-wide-band spectroscopy of high-z IR-luminous galaxies with integrated superconducting spectrometer
    - wide-field surveys, wide instantaneous spectral coverage surveys
  - successful community (universities) – NAOJ joint developments (e.g., receivers like “TZ”, “T70” and “HINOTORI” for 45-m, “DESHIMA” for ASTE)
  - Both will shift to a simplified, project-oriented operation model to reduce the operation cost. Although it is very painful to community, we understand it is inevitable given the current budget conditions of NAOJ.

Summary 2: future plan

- success of ALMA ➔ strong support for "ALMA2" (ALMA development roadmap 2030)
- further demands for more observing capabilities (depending on science fields), reflecting a healthy growth of the community
  - stars and planet formation: more angular resolution and collecting area at longer wavelengths (~3 mm to 7 mm) ➔ ngVLA
  - cosmology & transients: (ultra-) wide-area surveys ➔ LiteBIRD, SKA1/2
  - galaxy & SMBH formation, star-formation: wider, high cadence, 3D surveys (+ wide-field, multi-frequency polarimetry) ➔ LST/AtLAST, Antarctic THz telescope

Summary 3: expectations for NAOJ

- Keep (at least) the current level of ALMA involvement. Very clearly, we put the highest priority on this.
- Explore the optimal balance between mega-missions (ALMA & TMT, Subaru) and mid/small-scale facilities
- Exploit the existing mid/small-scale facilities (i.e., NRO 45-m and ASTE 10-m telescopes)
  - to have "win-win" relations between the community and NAOJ, by developing and proposing focused, competitive science cases using these facilities.
  - These will also enhance the outcomes of ALMA from the community (e.g., more high frequency ALMA proposals, competitive Band-1 proposals on polarization, Band-2 proposals on deuterated molecules, etc.)
  - What is "the minimum resource" to sustain such a business model?