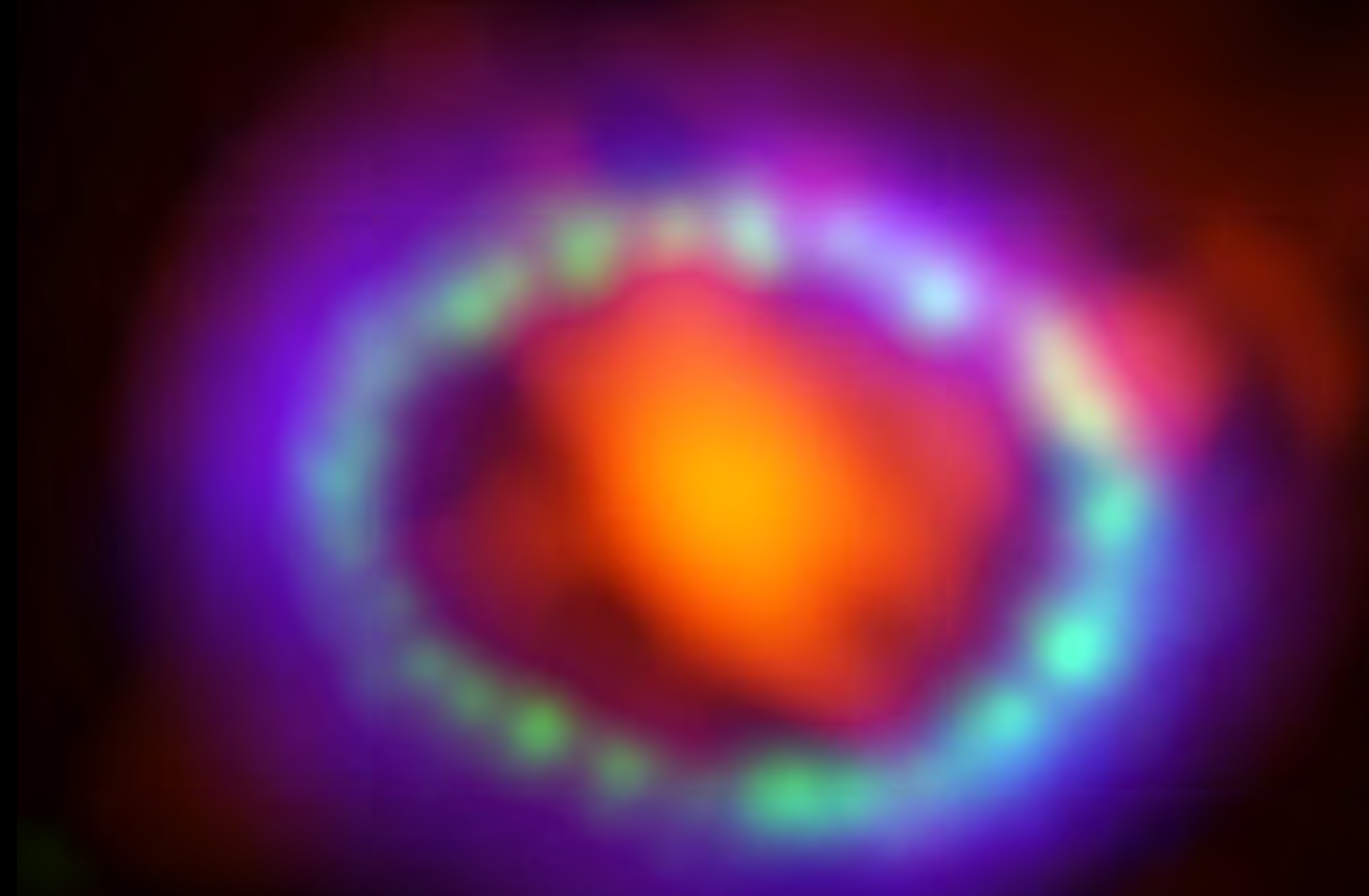


ARCHIVAL SCIENCE OVERVIEW



Anelise Audibert - IAC
Spanish ALMA Days
Tenerife - IACTEC
18-20 February 2025



Funded by the
European Union

ALMA NEWS

ALMA OBSERVATORY

<https://www.almaobservatory.org/en/news/>

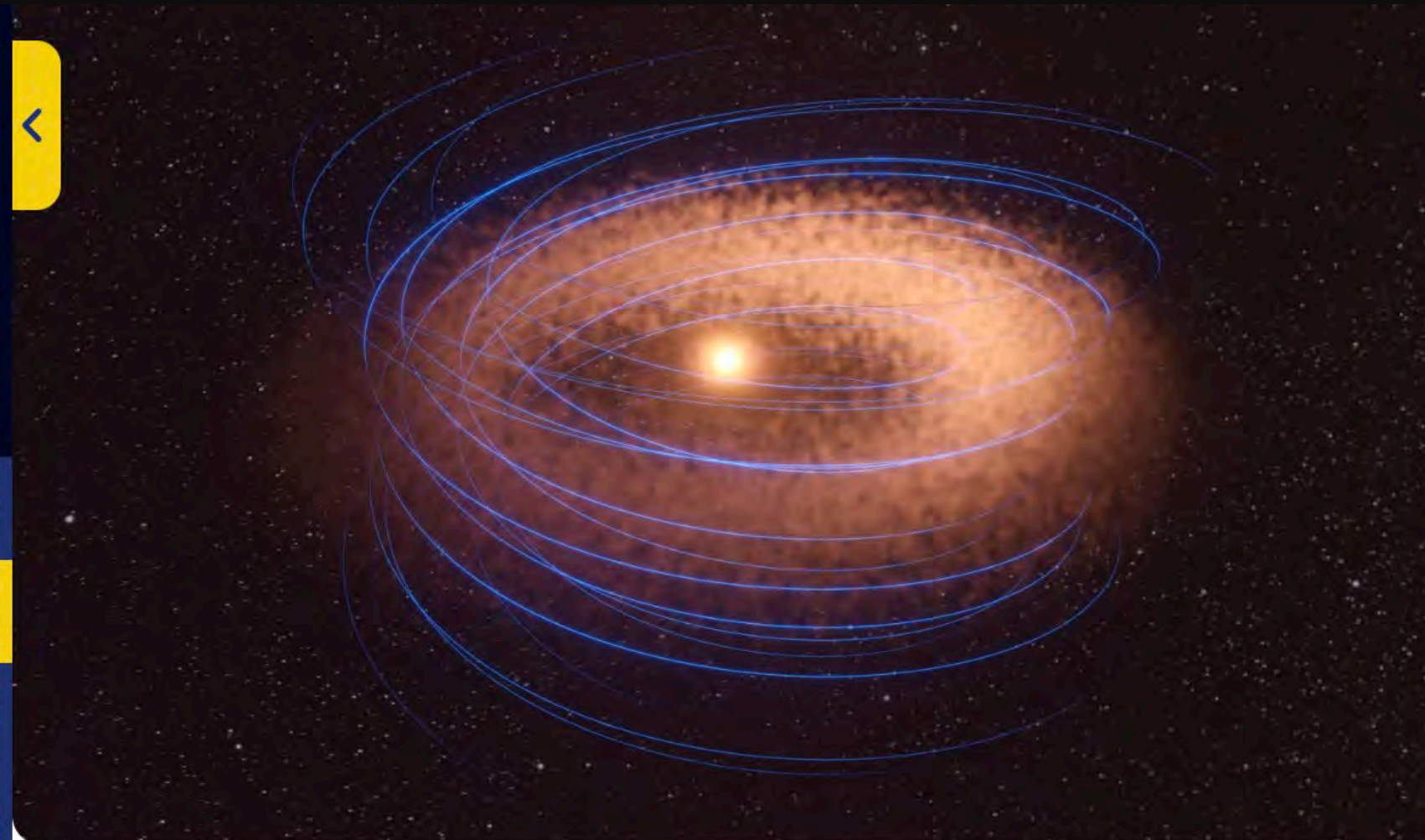
ALMA Atacama Large Millimeter/submillimeter Array

Eng Esp

- About ALMA
- News**
- Outreach
- Multimedia

ALMA for

- Scientists
- Schools
- Media



Press Releases

ALMA observes a magnetic field in a protoplanetary disk for the first time

6 February, 2025

Based on the Atacama Large Millimeter/submillimeter Array (ALMA) multi-band observations of dust polarization, the magnetic field structure in a protoplanetary disk has been measured for the first time. A research team led by Project Assistant Professor Satoshi Ohashi (NAOJ) investigated the dust polarization in the protoplanetary disk around a young star, HD 142527, by analyzing...

News

Press Releases

17 January, 2025

ALMA Uncover Surprising New Methods Planets May Form

Press Releases

16 January, 2025

JWST and ALMA Reveal Young Star Clusters and the Birth of the Universe's First Stars

Archive

Start date

End date



ALMA

ALMA News

[EU ARC Newsletter](#)

[EU ARC Announcements](#)

[About ALMA](#)

[ALMA Observatory](#)

[ALMA Science Portal](#)

[Observing with ALMA](#)

[European Development Studies](#)

[European ALMA Regional Centre](#)

[Employment](#)

[ALMA Advanced Data Products](#)

ALMA News

ALMA News and Announcements

- **European ARC Announcements.** Regularly the European ARC Network publishes information on on-going activities at the ARC Nodes for the ALMA programme.
- **European ARC Newsletter.** The newsletter contains an overview of the recent technical and scientific developments for the ALMA programme. The newsletter aims at the European ALMA user community.

Local ALMA Science News is also available from the [East Asian Local News pages](#) (NAOJ) and the [North American Local News pages](#) (NRAO).

Please also check the [Latest News on the ALMA Science Portal](#) about observing, data releases, software products, etc.

ALMA for the Public

- Press Releases please check the [Observatory Press Releases](#)
- Announcements: Please check the [Observatory Announcements page](#)

Quick Links

- [ALMA Web site](#): The main ALMA Web site maintained by the Joint ALMA Observatory.
- [ALMA Science Portal](#): The primary web interface between ALMA and the science community.
- [ALMA Helpdesk](#): Please use the Helpdesk to contact us for questions of any kind.



EUROPEAN ARC NEWSLETTER

The screenshot shows the top part of the ESO website. On the left is the ESO logo with the text "European Southern Observatory". On the right is the slogan "ESO — Reaching New Heights in Astronomy" above a row of national flags. Below this is a navigation bar with "Public", "Science", and "User Portal" tabs, a "Contact" link, and a search box. A breadcrumb trail reads "Science Users Information > Observing Facilities > ALMA > ALMA News > EU ARC Newsletter" with the date "14 Feb 2025". A sidebar on the left lists various ALMA-related links. The main content area is titled "The European ARC Newsletter" and contains introductory text and a subscription link.

This screenshot shows the content of the European ARC Newsletter. At the top right, it says "European ARC Newsletter" and "31 Jan 2025". The main image is a sunset over a landscape with an ALMA antenna. Below the image is a welcome message and a brief description of the newsletter's content. There are four circular icons representing different sections: "NEWS & ANNOUNCEMENTS", "MEET THE ARC", "POLL OF THE MONTH", and "DID YOU KNOW...?". Below these are two news items: "ALMA Cycle 12 early proposal planning" dated 29 Jan 2025, and "Towards ALMA 2040" dated 01 Jan 2025. A third item, "Release of Science Verification Data for Orion KL in Band 1", is dated 05 Dec 2024. Each item includes a small image and a "Read more" link.

<https://www.eso.org/sci/facilities/alma/news/arc-newsletter.html>

Monthly newsletter

EUROPEAN ARC NEWSLETTER

European Southern Observatory

ESO — Reaching New Heights in Astronomy

Public Science User Portal Contact Search Go!

Science Users Information > Observing Facilities > ALMA > ALMA News > EU ARC Newsletter 14 Feb 2025

The European ARC Newsletter

This Newsletter is a compilation of recent European ALMA Regional Centre Announcement items. Follow the links or visit the [European ARC Announcements](#) to read more. In addition to these Announcements the Newsletter informs you about various developments in the ALMA Programme, as well as about ALMA or ALMA-related meetings.

To start receiving the European ARC Newsletter, please subscribe by sending an email to [this address](#).

EU ARC Newsletter November 2024

EU ARC Newsletter October 2024

EU ARC Newsletter September 2024

EU ARC Newsletter August 2024

EU ARC Newsletter July 2024

EU ARC Newsletter June 2024

EU ARC Newsletter May 2024

EU ARC Newsletter March 2024

European ARC Newsletter
31 Jan 2025

Welcome to the European ALMA Regional Centre Newsletter!

This monthly newsletter is a compilation of recent European ALMA Regional Centre [news and announcements](#), showcasing an exciting [ALMA science result](#) by European colleagues. Every month, you can learn an interesting ALMA fact in "[Did you know](#)" and give your opinion about a particular ALMA matter in the "[Poll of the month](#)".

NEWS & ANNOUNCEMENTS

MEET THE ARC

POLL OF THE MONTH

DID YOU KNOW...?

European ARC News and Announcements


ALMA Cycle 12 early proposal planning
29 Jan 2025:
Key dates have been announced for early proposal planning for Cycle 12.
[Read more](#)

Towards ALMA 2040
01 Jan 2025:
Following the announcement from ESO about the start of the search for its next astronomical ground-based programme for the 2040s (<https://next.eso.org/>), the community is getting organised to prepare the science case for a potential facility in the 2040s ('ALMA 2040'), building upon the successes of the current ALMA Observatory.
[Read more](#)


Release of Science Verification Data for Orion KL in Band 1
05 Dec 2024:
The Science Verification data for Orion KL observed from 2024 April 26 to April 28 are now available on the Science Portal. The data were obtained in the spectral scan mode in Band 1, with the total on-source time of about 129 minutes.
[Read more](#)

<https://www.eso.org/sci/facilities/alma/news/arc-newsletter.html>

Monthly newsletter



European Southern Observatory



ESO Telescope Bibliography

[telbib Statistics](#) | [API](#) | [Help](#) | [Libraries Home](#) | [Archive Home](#) | [ESO Home](#)

REFINE SEARCH

Year

- 2025 (68)
- 2024 (1446)
- 2023 (1305)
- 2022 (1276)
- 2021 (1402)

[more...](#)

Journal

- A&A (10299)
- MNRAS (5337)
- ApJ (4388)
- ApJL (1283)
- AJ (963)

[more...](#)

Instrument

- LIVES (2815)
- ALMA_Band_6 (2452)
- FORS2 (1889)
- ALMA_Band_7 (1678)
- HARPS (1413)

[more...](#)

TELBIB SEARCH

All fields or and

Author 1st auth. +

Title / Abstract / Keywords or and

Journal ▾

Publication year From To

BibCode/Article DOI

ProgramID

Data Collection DOI

Instrument ▾ +

Telescope ▾ +

Site ▾

Only ESO data papers with archive usage

Only ESO data papers (excluding papers that only use non-ESO ALMA / non-ESO APEX data)


The **Telescope Bibliography (telbib)** is maintained by the ESO library. It contains refereed publications that directly use ESO data. ESO's [data citation policy](#) specifies how to acknowledge data in papers. Learn more about the telbib [methodology](#).

Explore telbib metrics:


- Click the [VISUALIZE](#) button on the results page to view **animated charts** of your search results
- Access the [telbib Statistics](#) area to find **interactive graphs** of selected statistics
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- Use the [overview](#) of annual publication statistics to access all telbib papers that pertain to a given year
- Statistics for a given year will not be complete until approx. March of the following year.

Further info:
Contact the ESO librarians at library@eso.org

If you use information, plots, or visualizations obtained with telbib, please kindly acknowledge this by indicating **"Source: ESO Telescope Bibliography (telbib), maintained by the ESO Library."**



European Southern Observatory



ESO Telescope Bibliography

[telbib Statistics](#) | [API](#) | [Help](#) | [Libraries Home](#) | [Archive Home](#) | [ESO Home](#)

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ESO TELBIB

<https://telbib.eso.org/index.php>

European Southern Observatory

ESO Telescope Bibliography

telbib Statistics | API | Help | Libraries Home | Archive Home | ESO Home

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TELbib SEARCH

All fields: All fields or and

Author: Author 1st auth. +

Title / Abstract / Keywords: Title / Abstract / Keywords or and

Journal: Any

Publication year: From: To: 2025

BibCode/Article DOI: BibCode/Article DOI

ProgramID: ProgramID

Data Collection DOI: DataDOI

Instrument: Any +

Telescope: Any +

Site: Any

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SEARCH **RESET**

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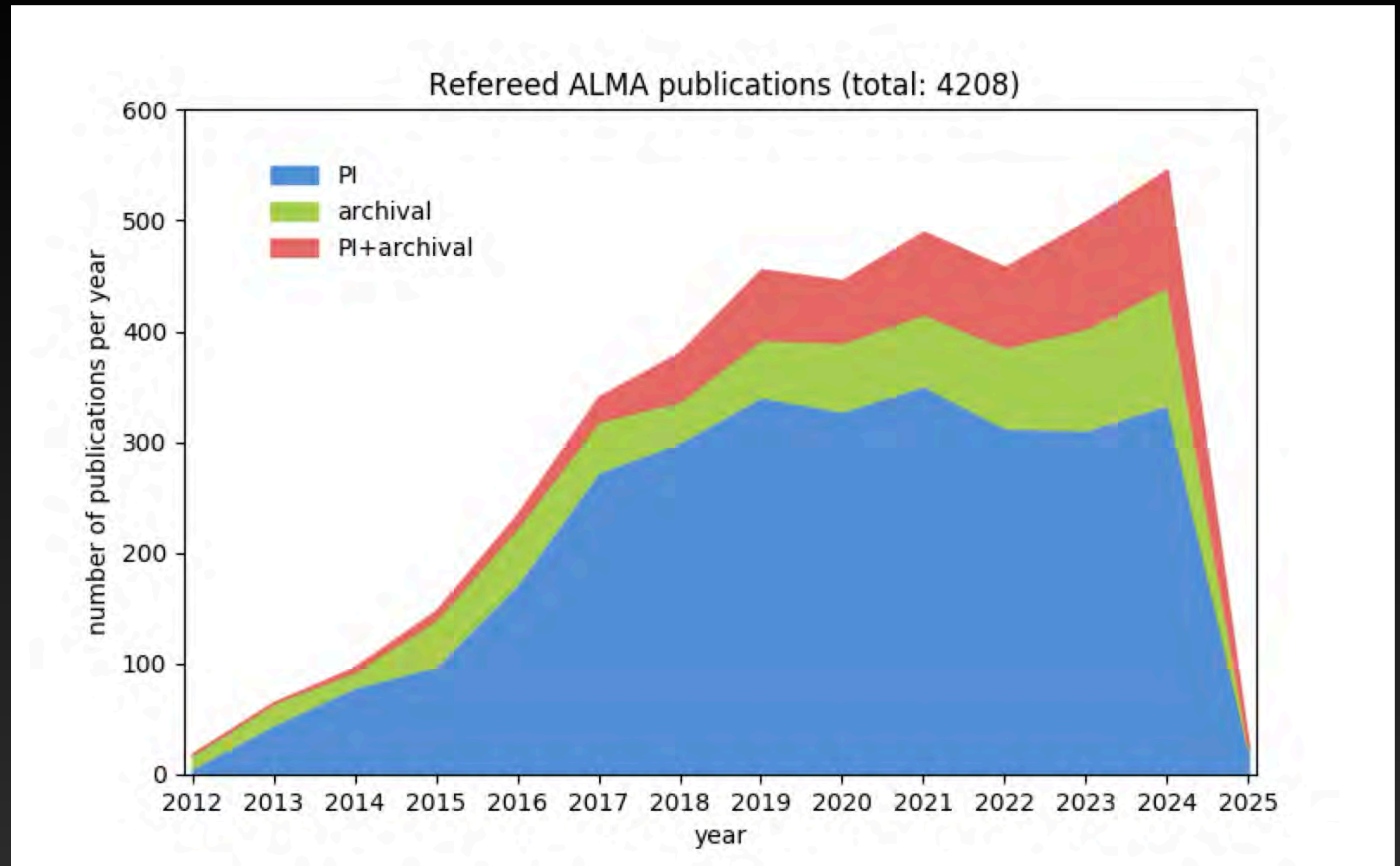
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836 results for
ALMA telescope
+
archive only or
archive and PI

-13% of all publications in Nature involve the use of archival data (9% exclusively on such data)

-publications using of either purely **archival data** or **archival+ PI data** accounted for an impressive fraction of all ALMA publications



Astronomy community has an ever-growing opportunity to leverage ALMA's extensive archive

LOCAL AND HIGH-Z GALAXIES

What's robbing galaxies of their star-forming gas?

The Virgo Environment Traced In CO (VERTICO) survey: physical mechanisms perturbing molecular gas disks and star formation in dense environments

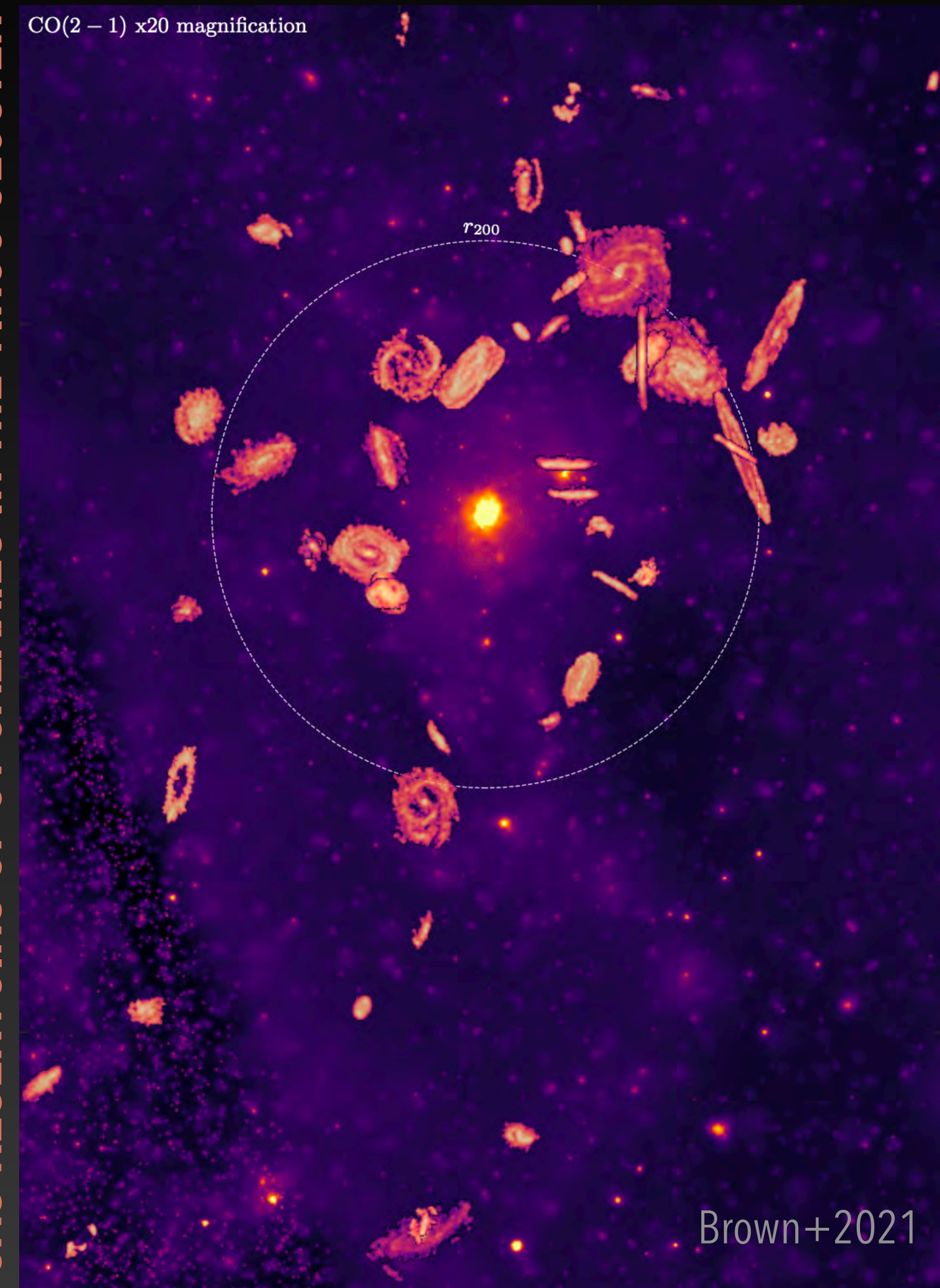
-Virgo Cluster: nearest massive galaxy cluster to the Local Group

-51 galaxies with ACA (7m+TP): 36 targets in CO(2-1) and ALMA Band 6 continuum + 15 from ALMA archive at $\sim 8''$ ($\sim 0.7\text{kpc}$)

-gas morphology and kinematics reveal imprint of stellar structures (**spiral arms, bars, bulges**) and environmental processes (**warps, tails, depletion**)

-ram pressure stripping: violent external mechanisms can quench star formation (Watts+2023, Brown+2023)

GAS RESERVOIRS OF 51 GALAXIES IN THE VIRGO CLUSTER



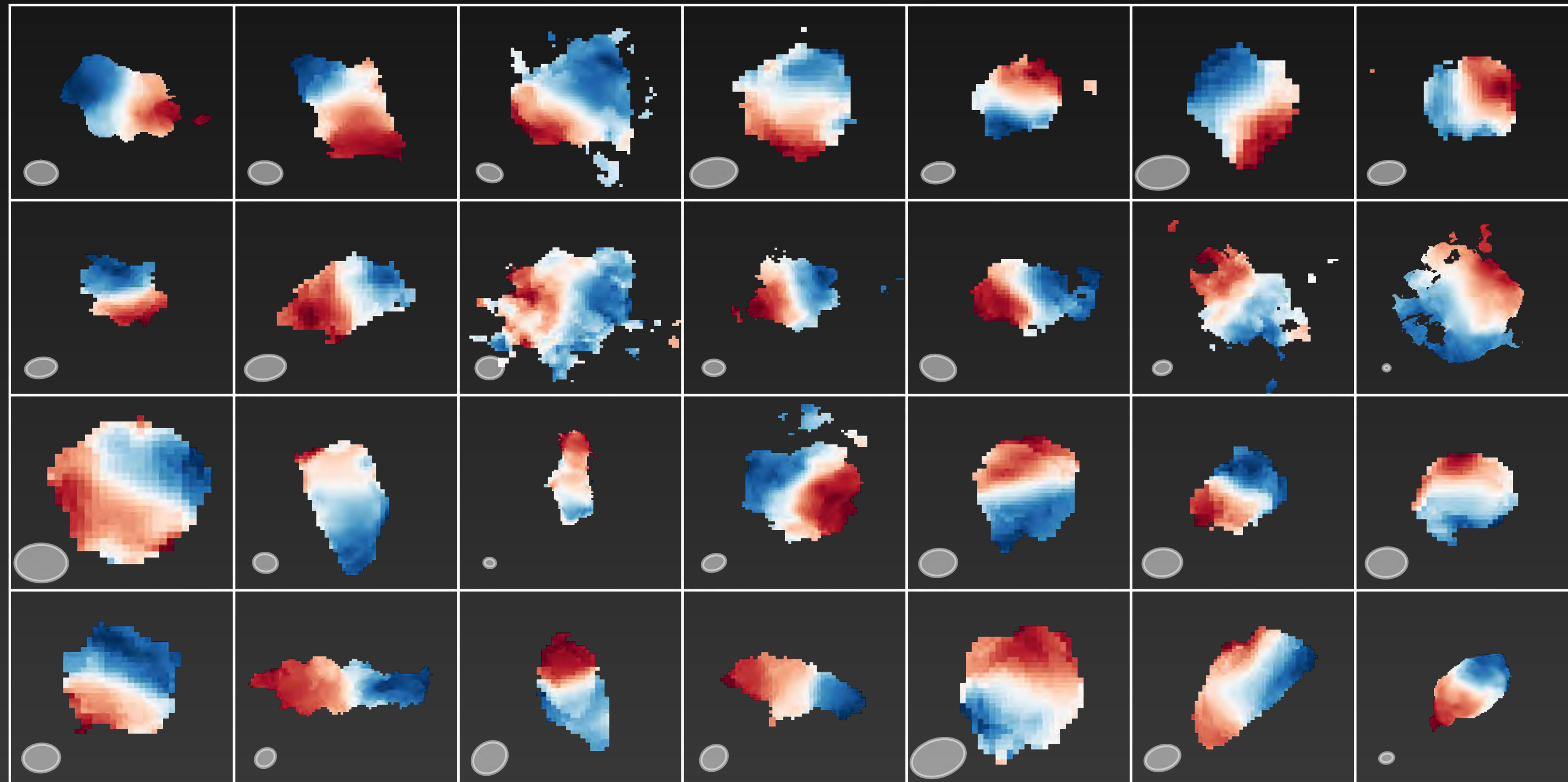
ALPAKA: Archival Large Program to Advance Kinematic Analysis

High-resolution ($\sim 0.25''$) observations of CO and [CII] emission lines of star-forming galaxies at $z=0.5-3.5$

≈ 147 h integration time for 28 star-forming galaxies spanning 7 Gyr cosmic time

-28 ALMA archive: 19 show rotating disks ($v/\sigma \sim 10$)

Rizzo+2023



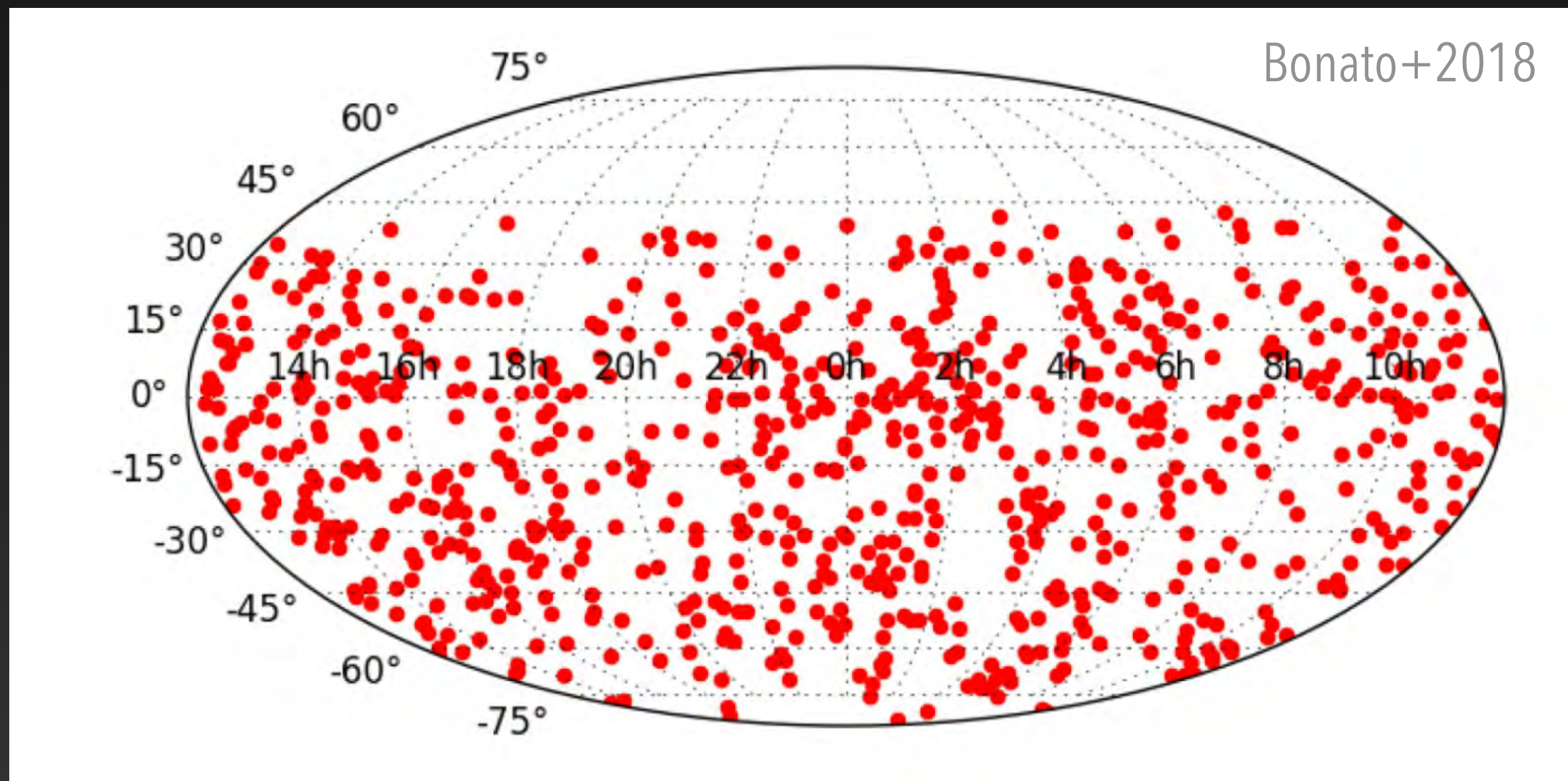
Surveying the universe with ALMA calibrator observations



-Over 800 ALMA calibrators randomly distributed over the sky

-About 600 calibrators have a measured redshift.

Most at $z < 1.5$ with up to $z = 3$



-sky coverage ~ 800 arcmin² (Band 3) to 1 arcmin² (Band 9)

-total ALMACAL observation time to date ~ 2000 h

-ALMACAL dataset grows with each ALMA science observation



Bonato+2018

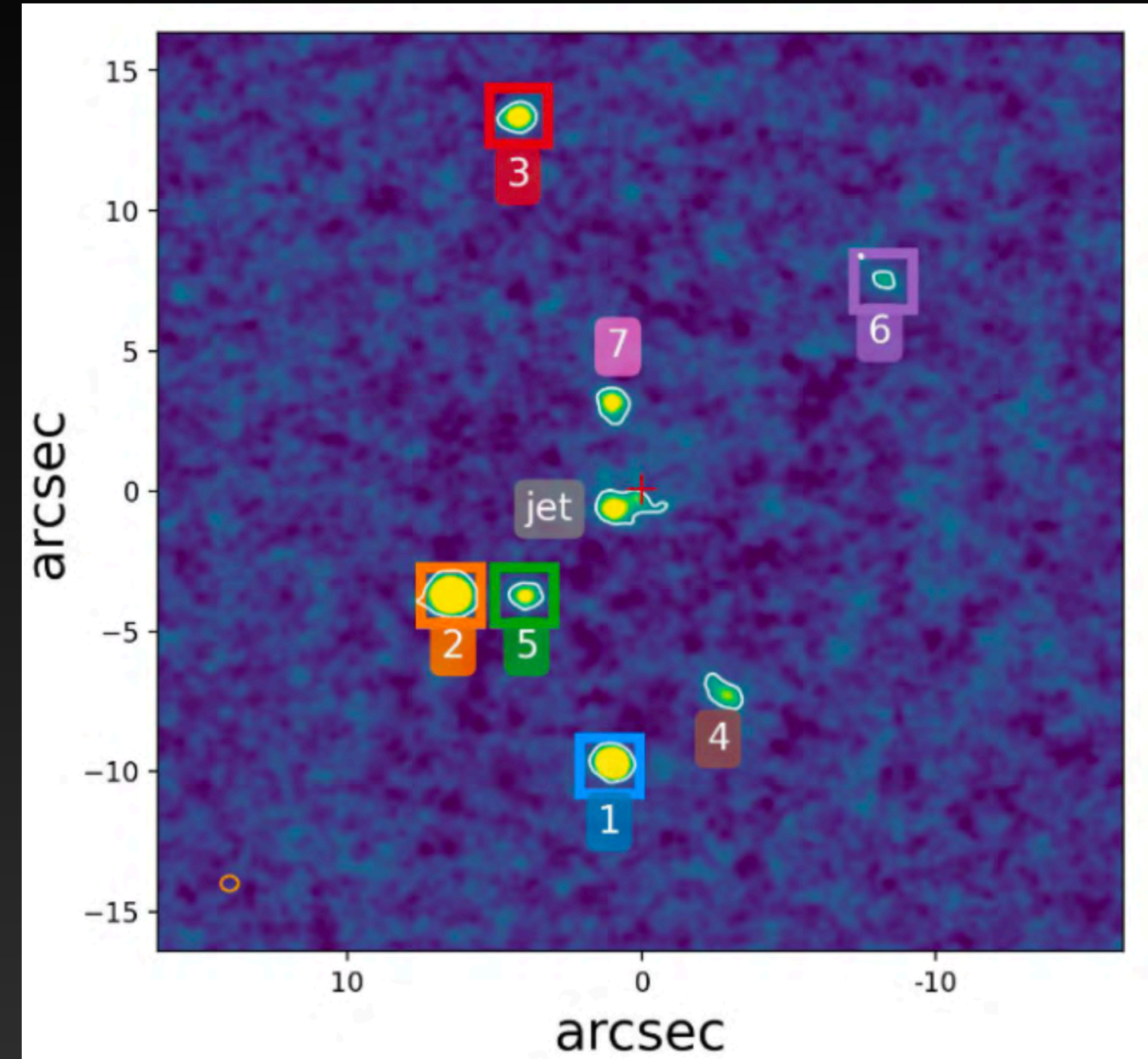
Over-densities as signposts for proto-clusters? a cautionary tale

ALMACAL produced several scientific results (13 papers so far)

-serendipitous discovery of an extremely dense region around blazar J0217–0820 at $z = 0.6$

-8.6h of ALMACAL data accumulated from band 3 to band 7

-over-density, $\delta_{\text{gal}} \approx 8$, is comparable to extreme proto-cluster cores



ALMACAL

Chen+2023

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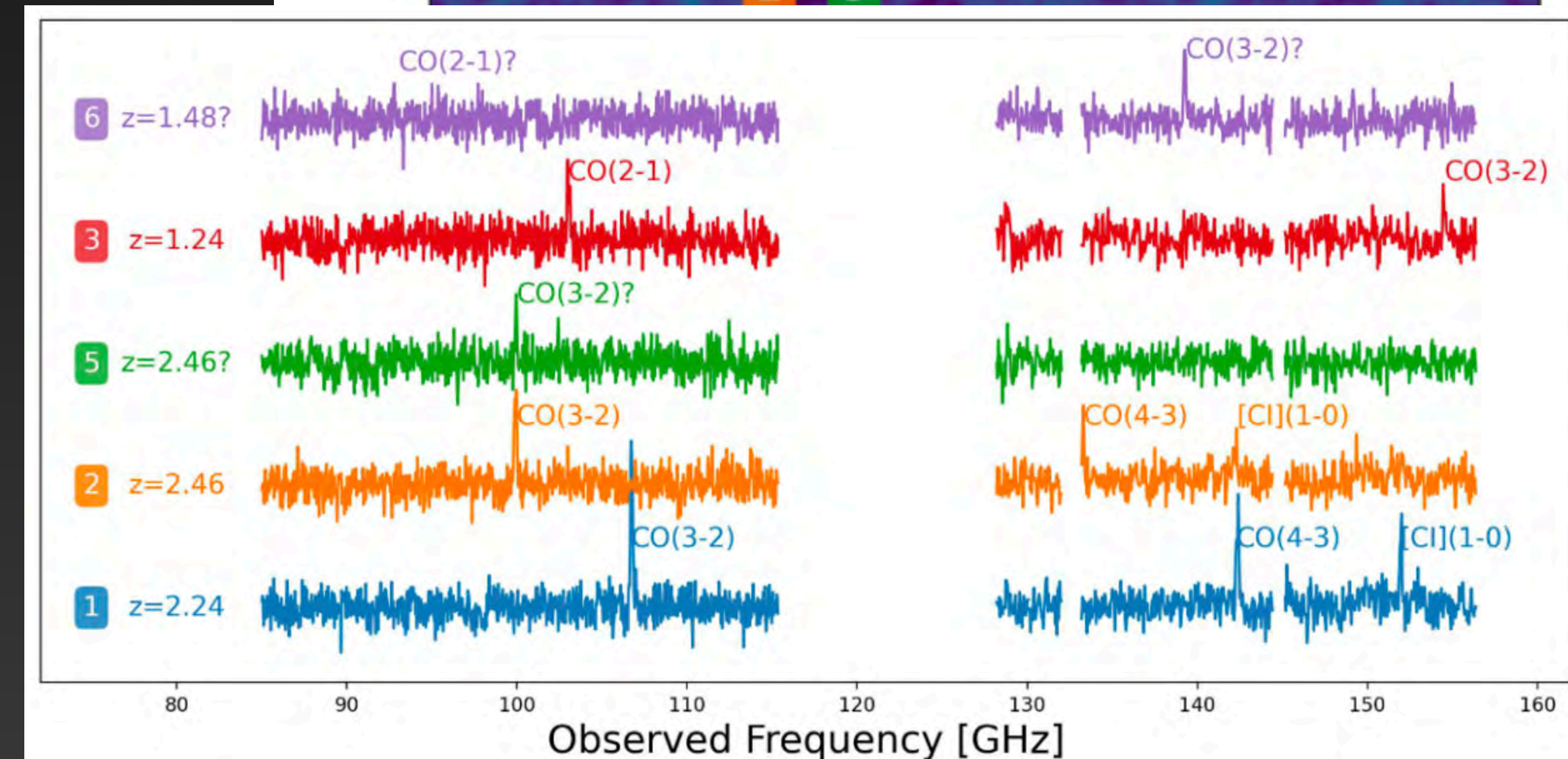
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-central blazar at $z = 0.6$, surrounding dusty starbursts located at 4 different z

-almost entirely due to chance alignments

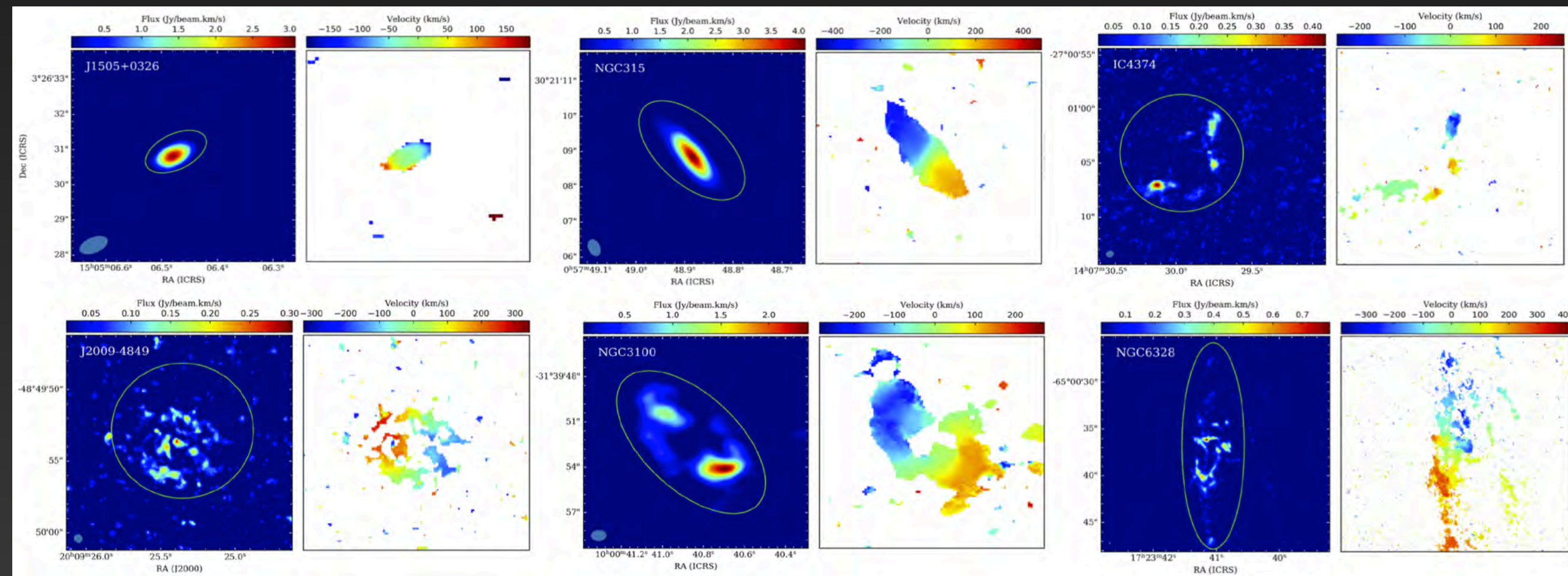
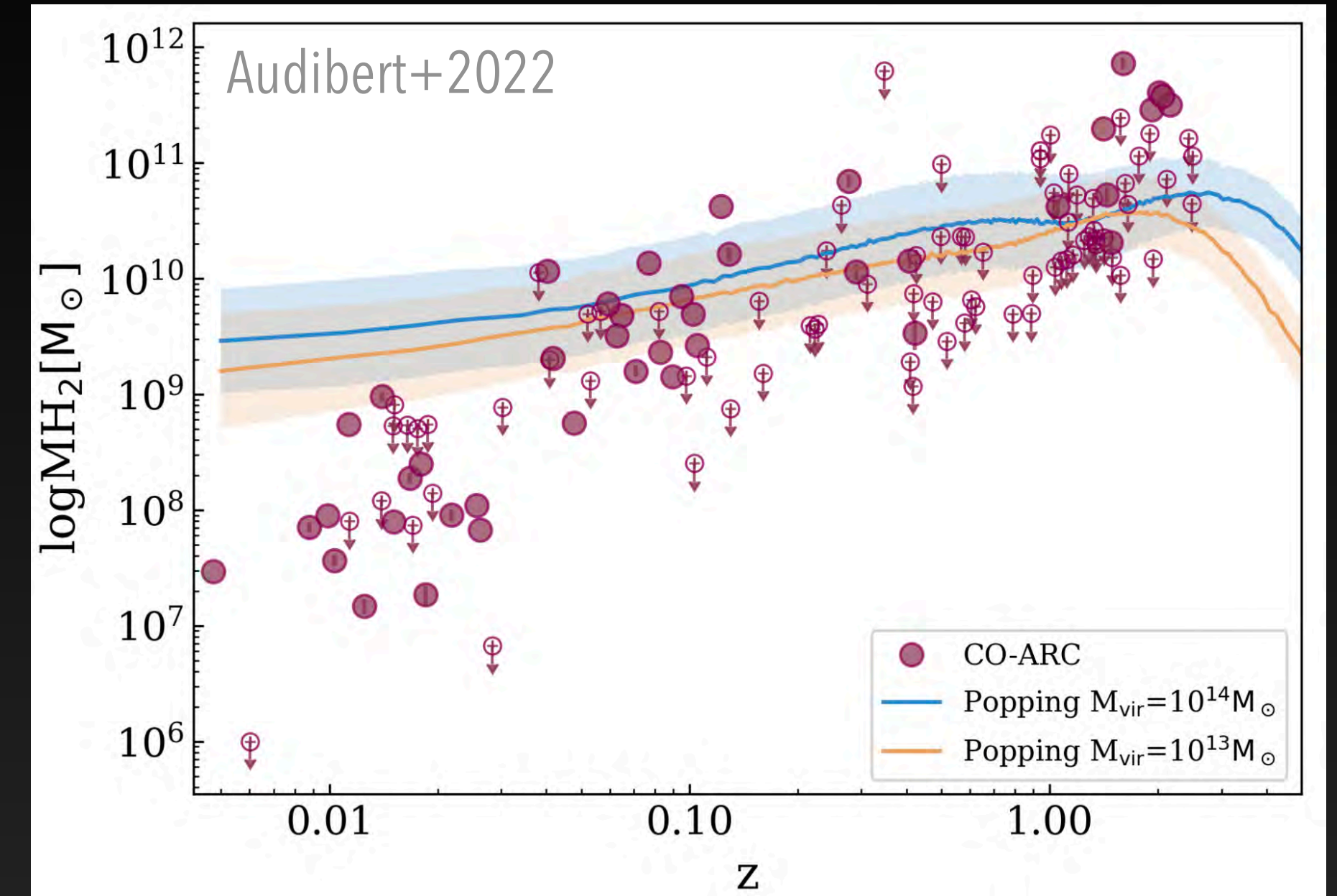


ARC-CO: molecular gas in radio galaxies

Evolution of gas reservoirs in radio galaxies (RGs) with redshift in the ALMA Radio-source Catalogue (ARC)

-ALMA calibrators and targets with CO emission in the spectral coverage (up to J=4) up to $z < 2.5$

-66 RGs observed with ALMA: **ARC-CO** +54 from literature; total sample of **120 RGs**



-variety of morphologies and kinematics: rotating disks, rings, irregular/disturbed kinematics

-The first local CO LF of RGs is 2 to 3 orders of magnitude lower than normal and star-forming galaxies

A variety of quasars morphologies and environments

Catalogue of submillimetre (submm) detections of DR14 Sloan Digital Sky Survey quasars that lie in the aggregate ALMA footprint observed since ALMA Cycle 0

- fluxes are extracted using the ALMA Data Mining Toolkit ($S/N > 3.5$)

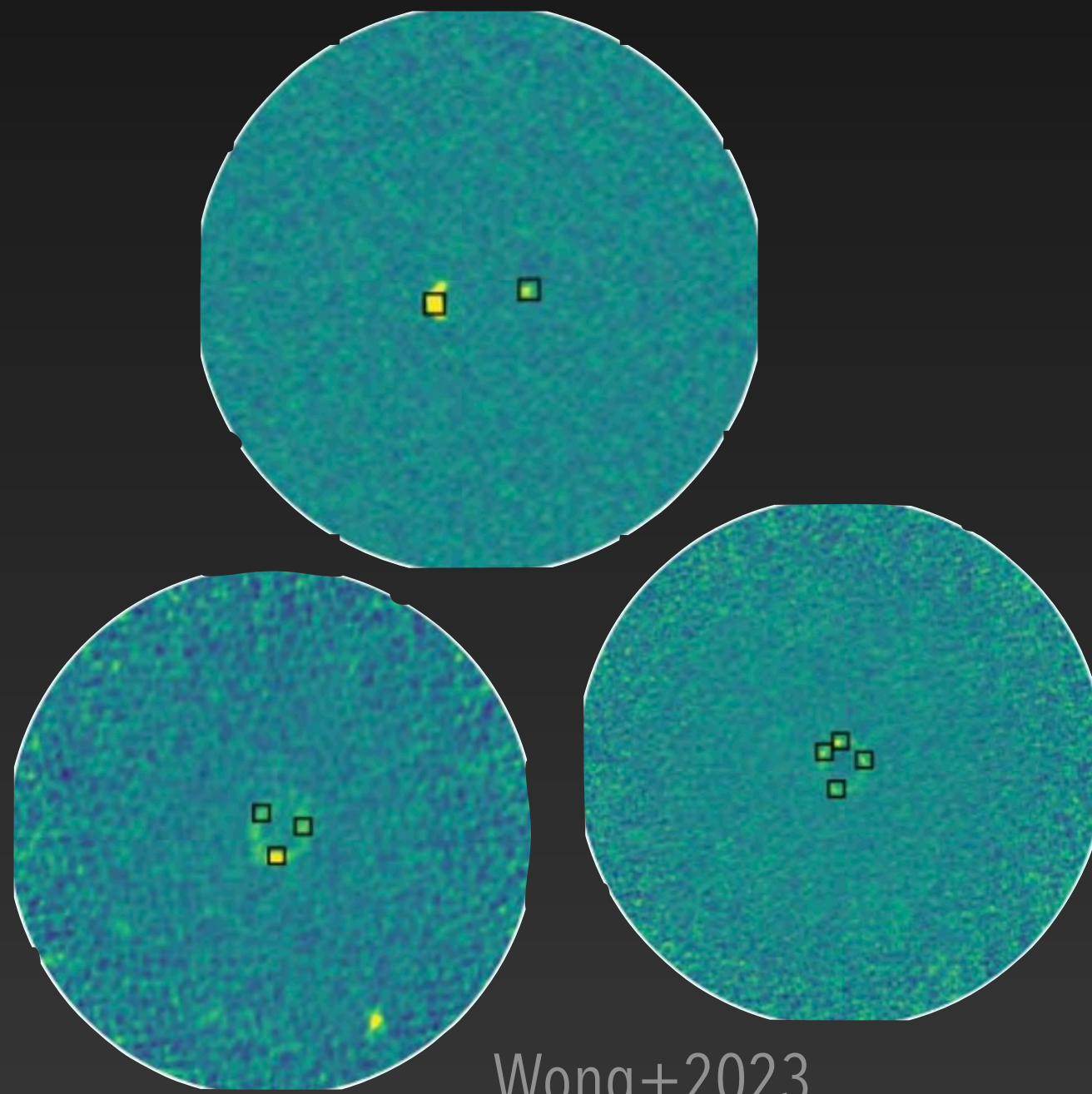
- catalogue of 376 entries, corresponding to 275 unique quasars

- interesting targets found in the process, i.e. **lensed** or **jetted** quasars as well as quasars with nearby **submm counterparts** are highlighted, to facilitate further studies or follow up observations

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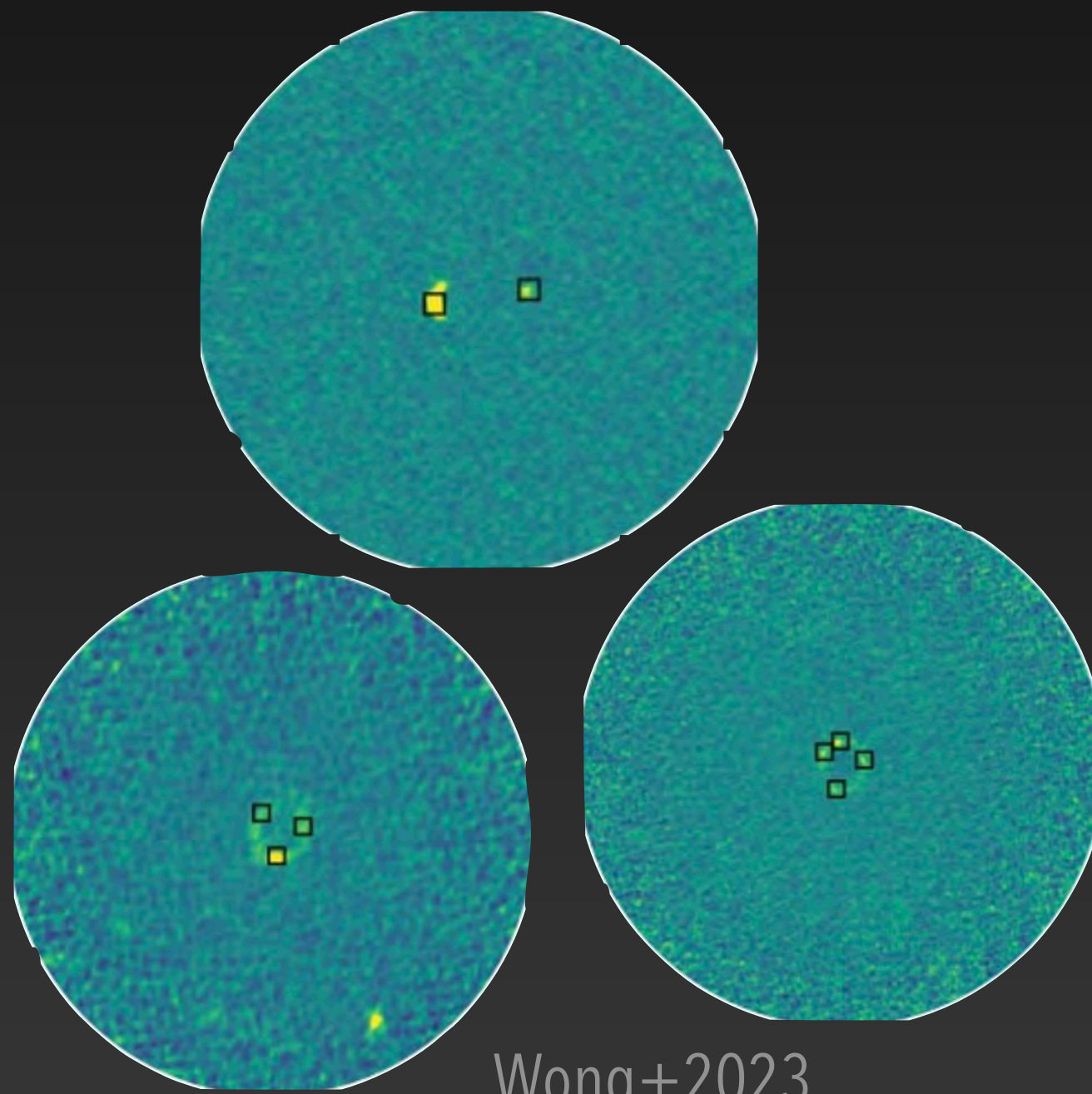
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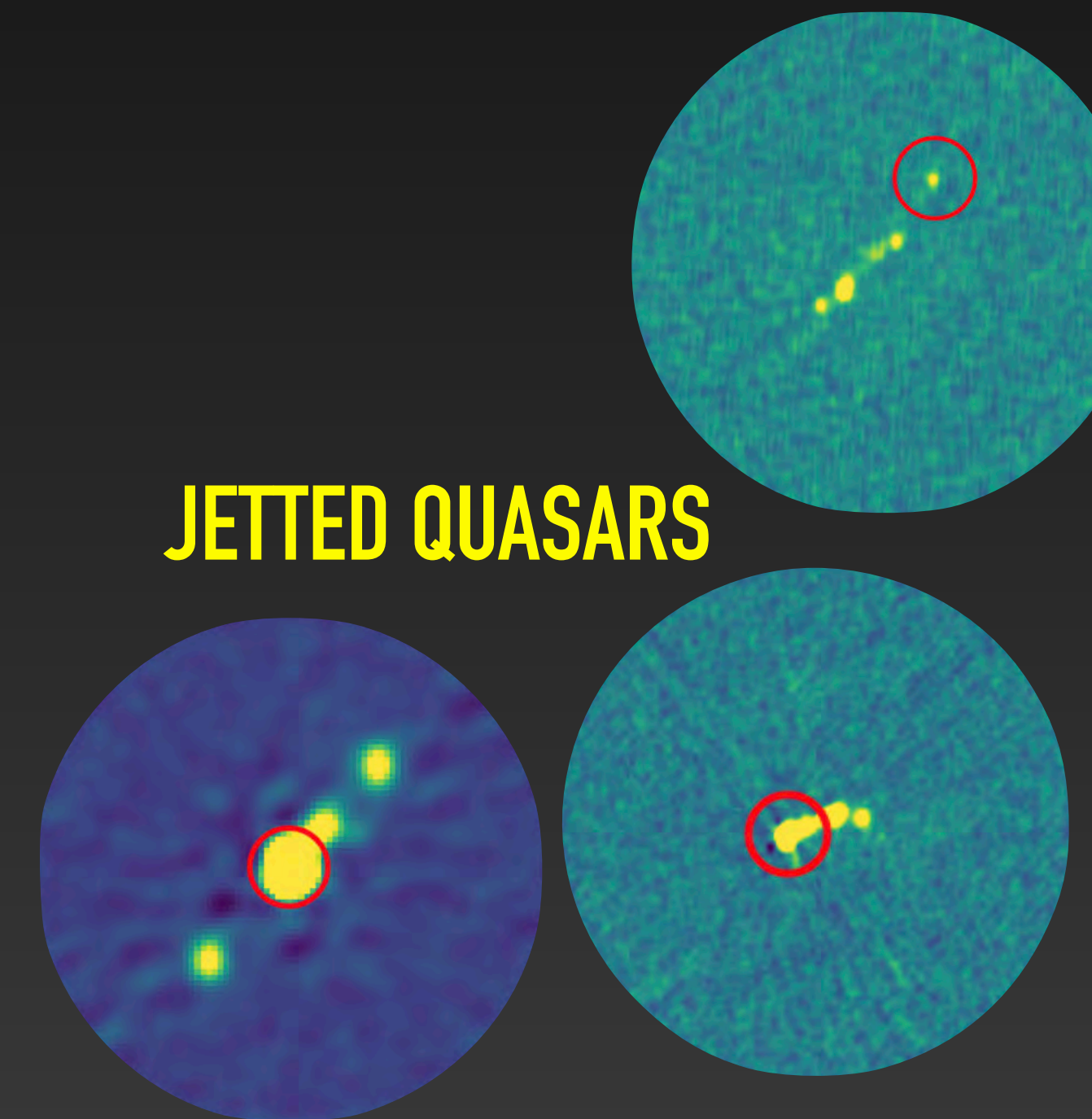
Wong+2023

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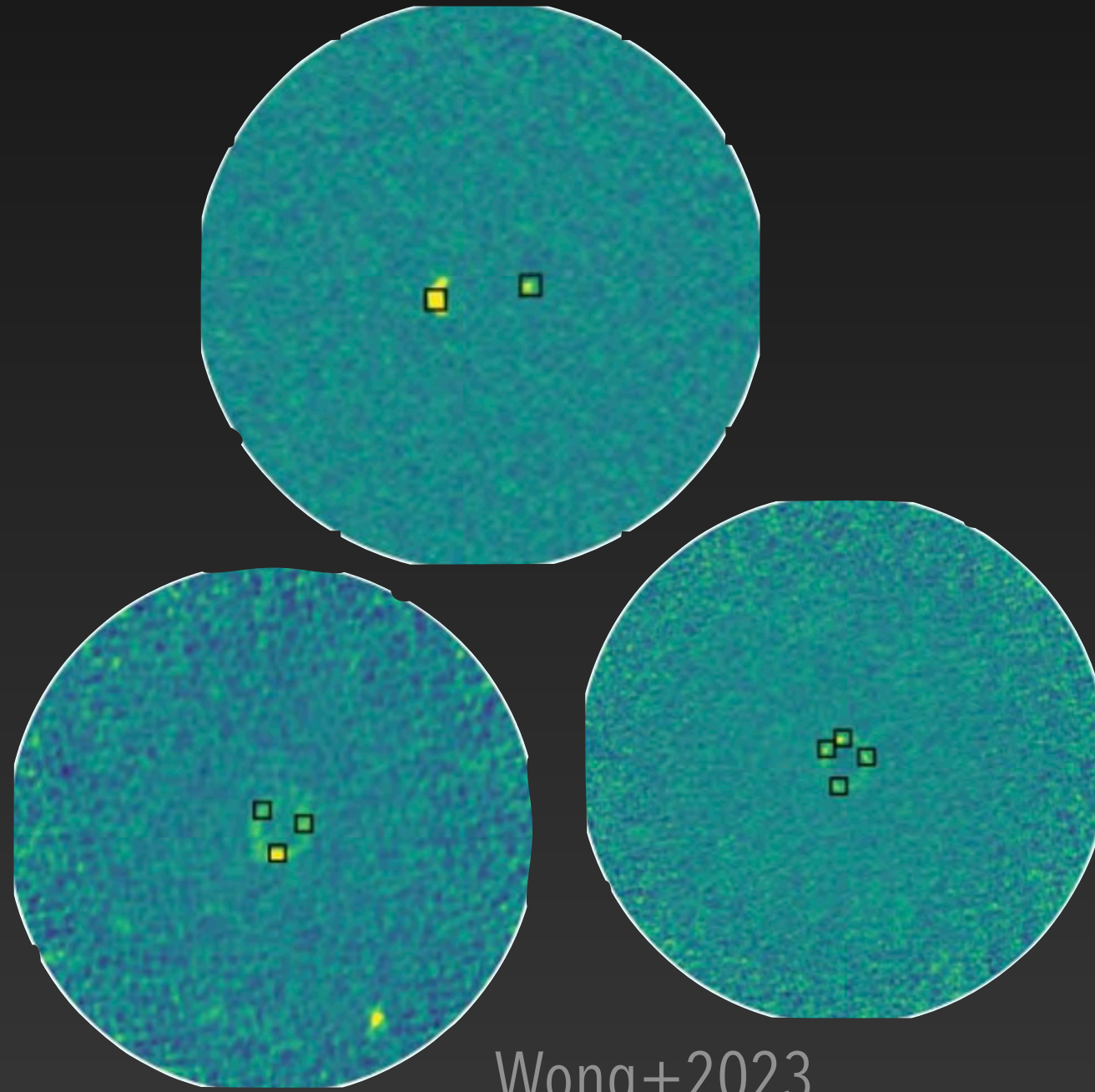
JETTED QUASARS



A variety of quasars morphologies and environments

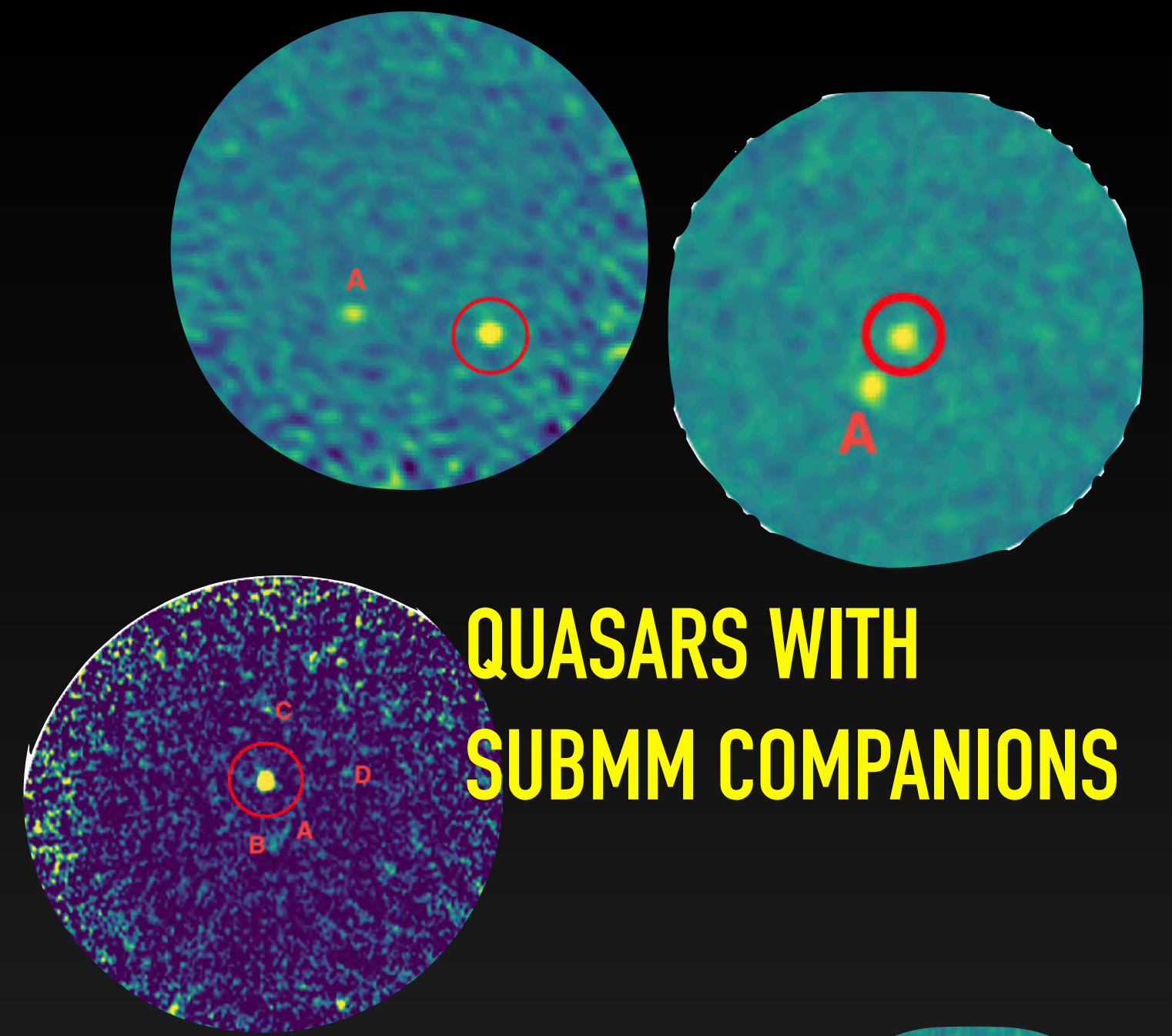
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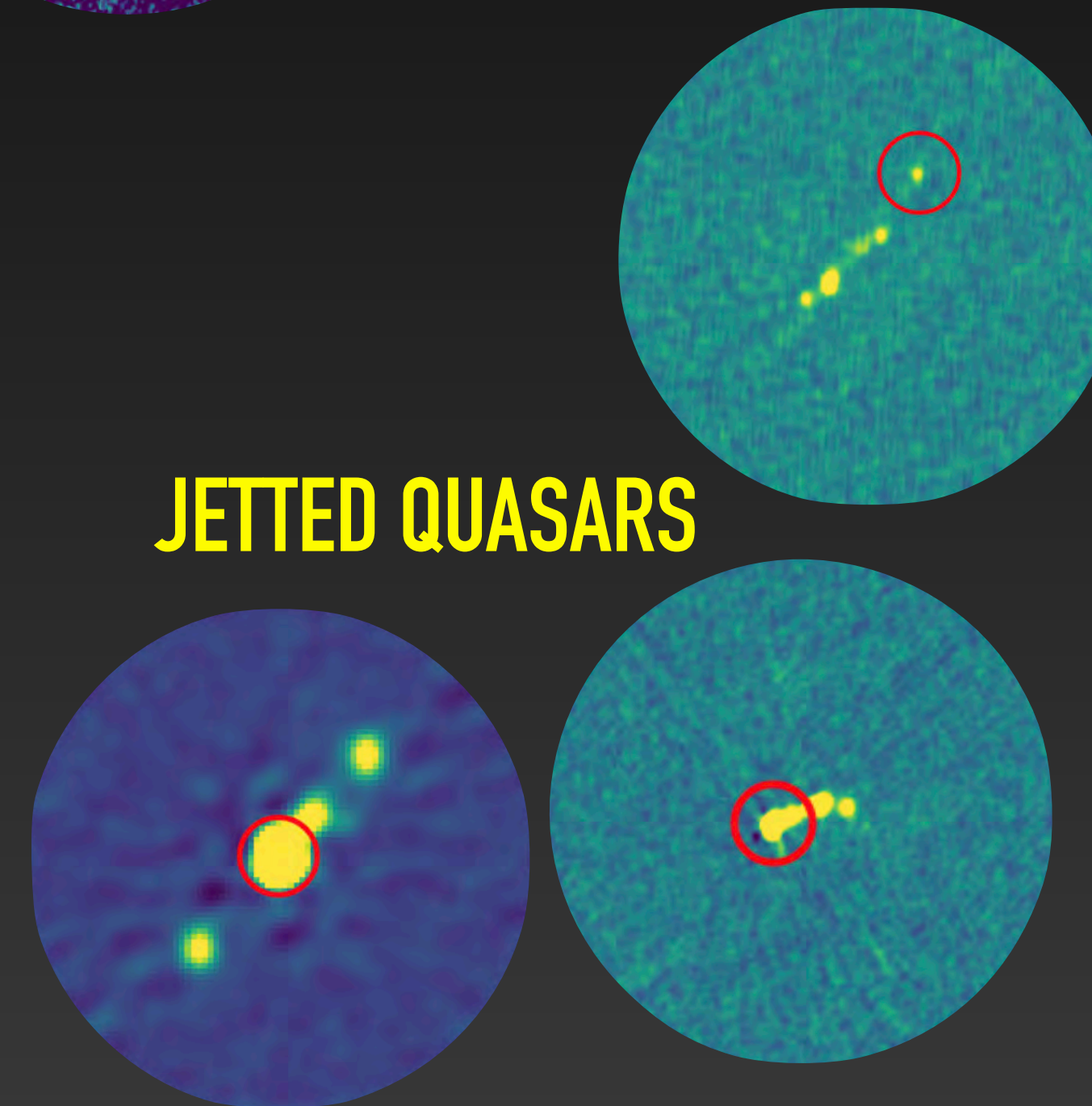


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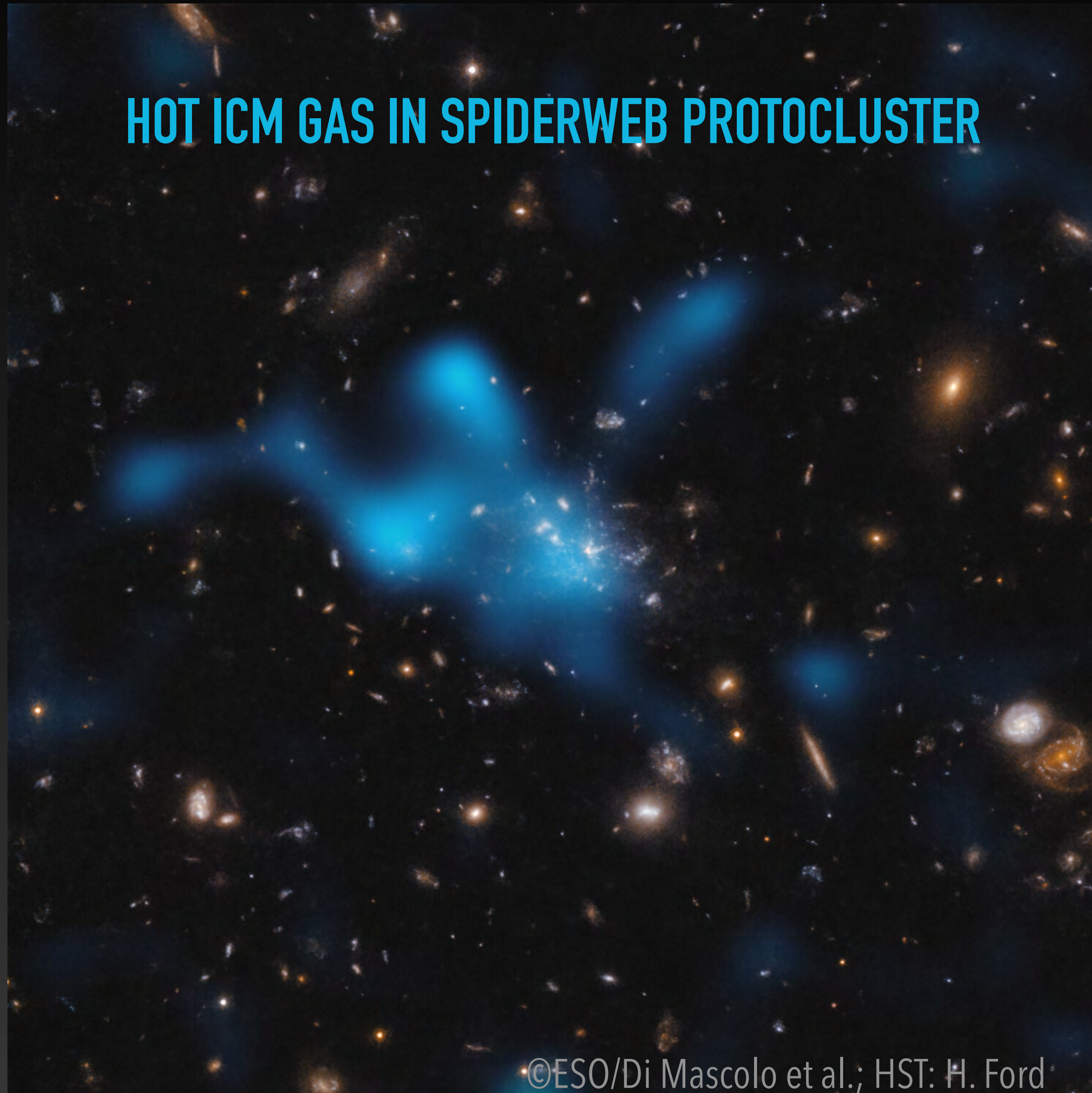
QUASARS WITH SUBMM COMPANIONS



JETTED QUASARS

Birth of a galaxy cluster at redshift ~ 2

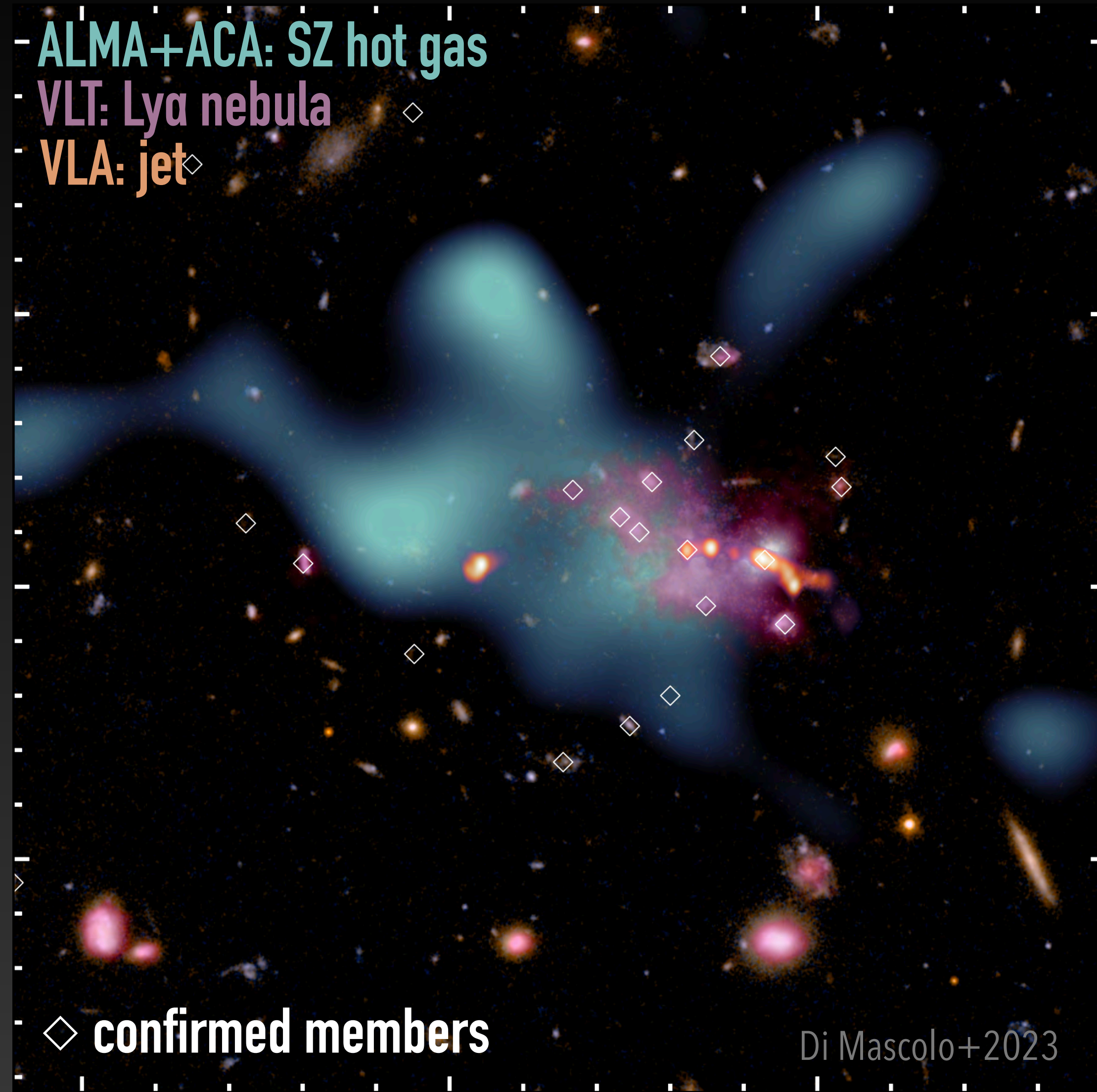
HOT ICM GAS IN SPIDERWEB PROTOCLUSTER



Most distant measurement of the large reservoir of hot gas in the still-forming galaxy cluster around the Spiderweb galaxy

- cosmological simulations have predicted the presence of hot gas in protoclusters
- proprietary Band 3 + archival Band 4 observations
- thermal Sunyaev-Zeldovich (SZ) effect in the direction of a protocluster, reveals the ICM thermal energy
- $M_{\text{hot gas}} = 1000 \times M_{\text{cold gas}}$
- Spiderweb protocluster is expected to turn into a massive galaxy cluster in ~ 10 Gyr

Birth of a galaxy cluster at redshift ~ 2

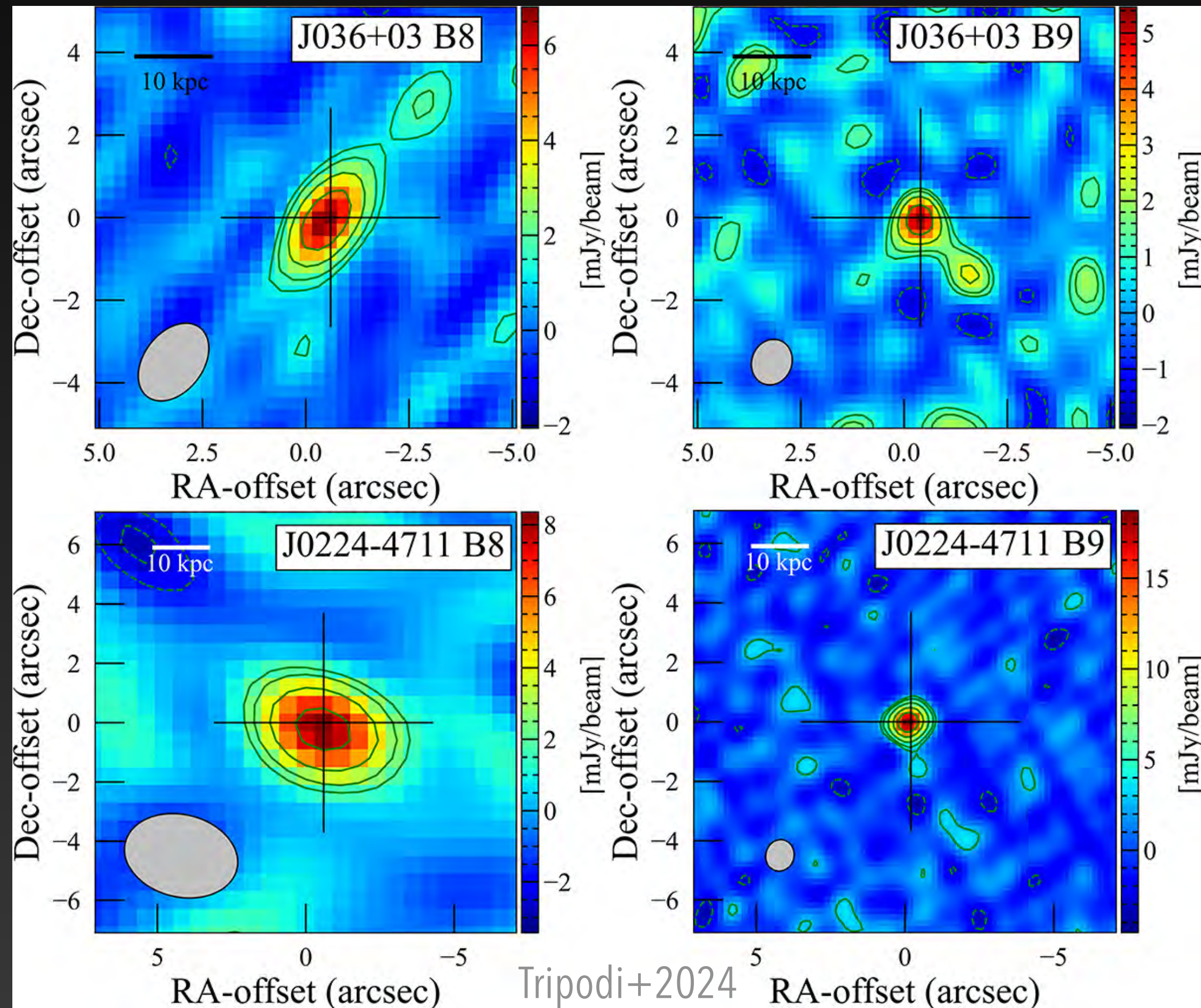


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HYPERION: HYPERluminous QSOs at the Epoch of Reionization

ALMA CONTINUUM OBSERVATIONS



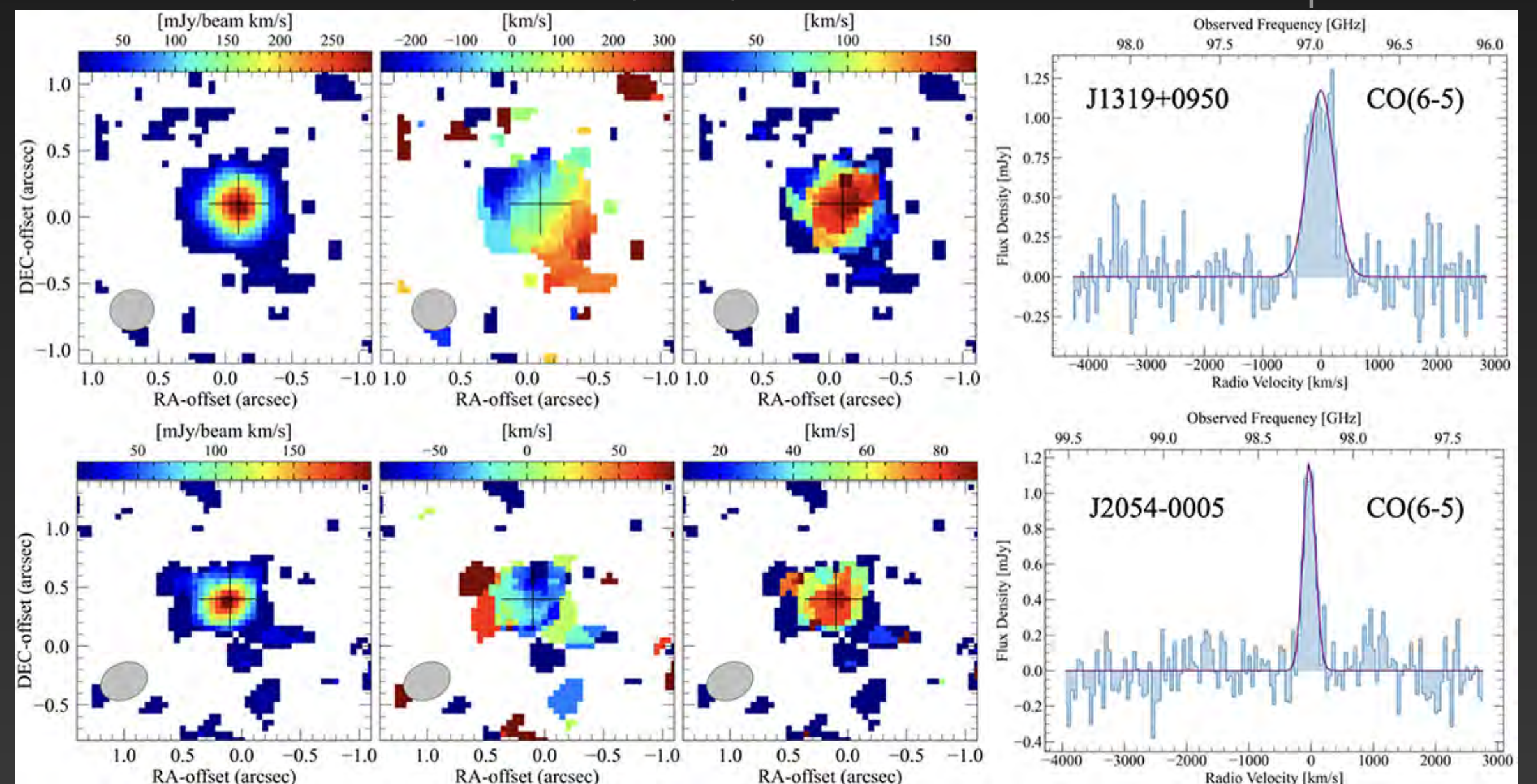
-QSO $z > 6$ sample from Zappacosta+2023

-CO(6-5) and CO(7-6) in 4 QSOs: $M_{\text{mol}} \sim 10^{10} M_{\odot}$

-proprietary+archival ALMA observations in band 8 & 9:
dust properties and SFR of 4 QSOs for the first time

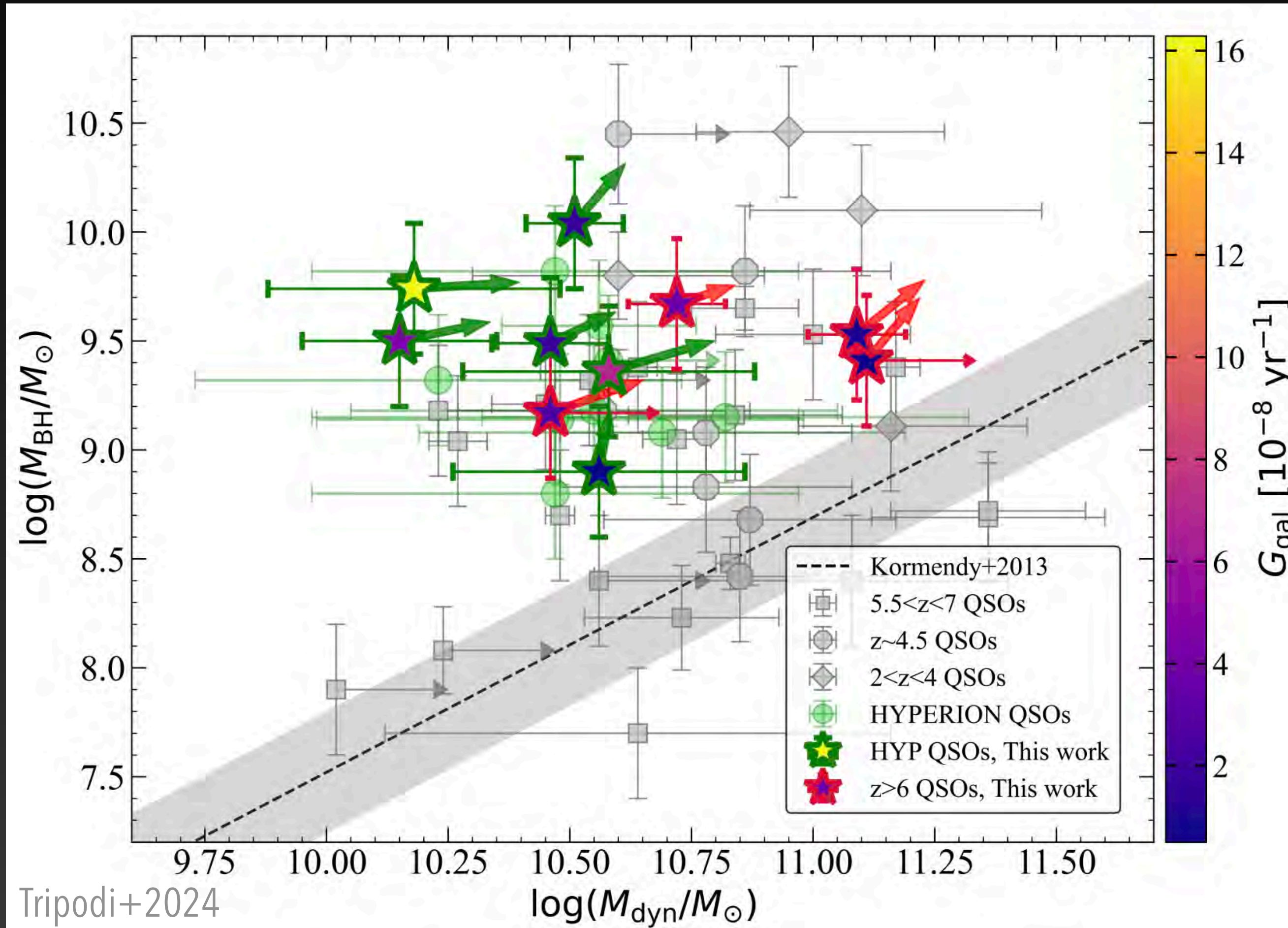
ALMA CO(6-5) OBSERVATIONS

Tripodi+2024



HYPERION: Coevolution of SMBHs and galaxies at $z > 6$

THE CHICKEN OR THE EGG?



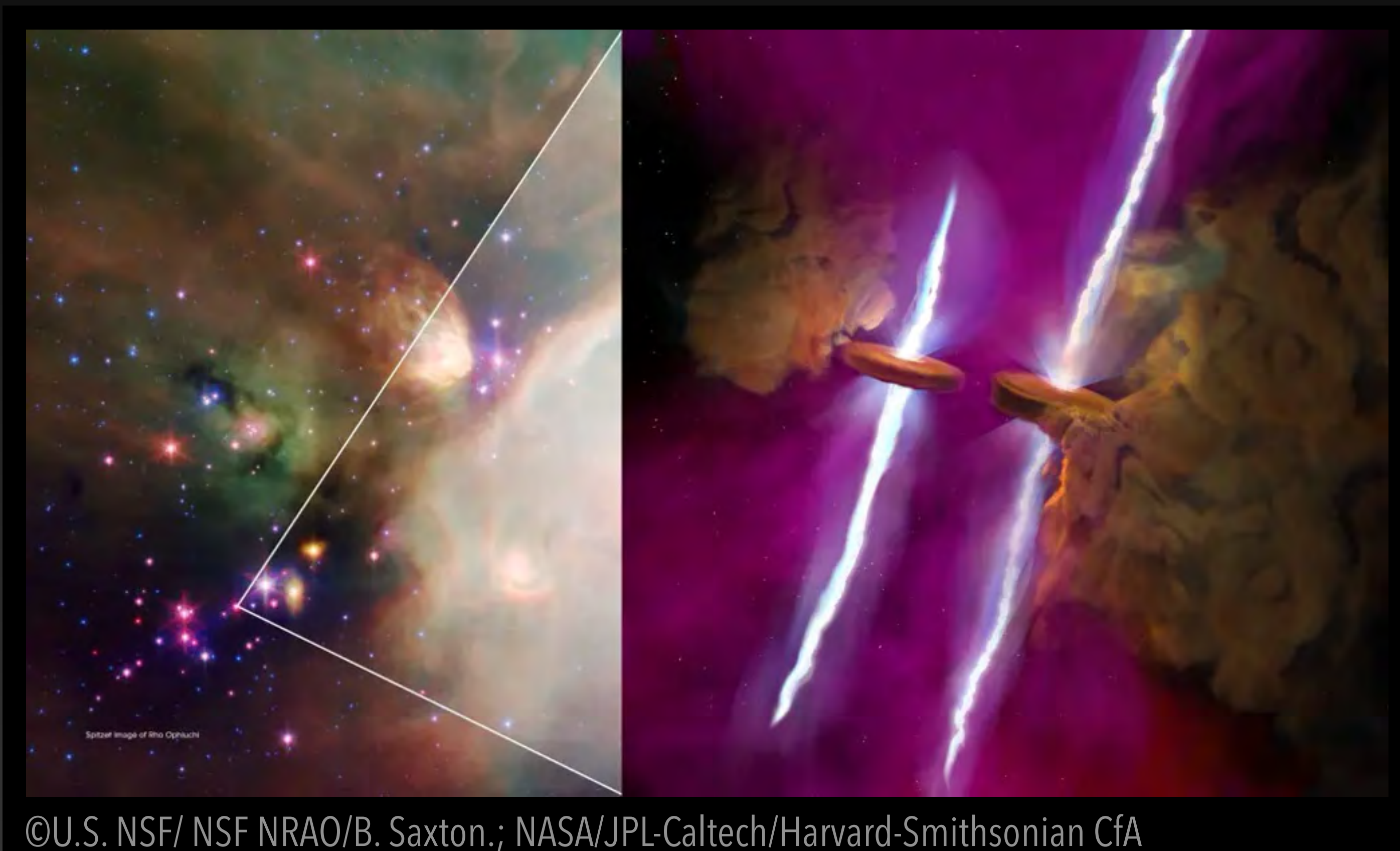
- HYPERION QSOs marked by intense SMBH growth
- above the local $M_{\text{BH}}-M_{\text{dyn}}$ plane: QSOs at $z \gtrsim 6$ undergo rapid galaxy growth - possibly regulated by strong outflows
- pathway: intense black hole growth **followed** by substantial galaxy growth, in contrast with symbiotic growth scenario

A BIT CLOSER:

STARS, PLANETS, EXOCOMETETS

Parallel disks and jets erupting from a pair of young stars

High-resolution (~ 25 au) ALMA Band 4 and Band 6 continuum + CO(2-1) and JWST MIRI-MRS images of multiple system WL20



©U.S. NSF/ NSF NRAO/B. Saxton.; NASA/JPL-Caltech/Harvard-Smithsonian CfA

- star system WL20, in ρ -Ophiuchi molecular cloud complex
- ALMA resolved twin, edge-on disks of ~ 100 AU in WL20S in continuum and CO(2-1)
- MIRI found the parallel jets ([ArII], [FeII], [NiII], [NeII]), and a wide-angled disk wind in H₂ surrounding the ionized jets
- outflow evolutionary scenario: mol. gas dominates in the young; fast, ionized jets dominate in the oldest

Parallel disks and jets erupting from a pair of young stars

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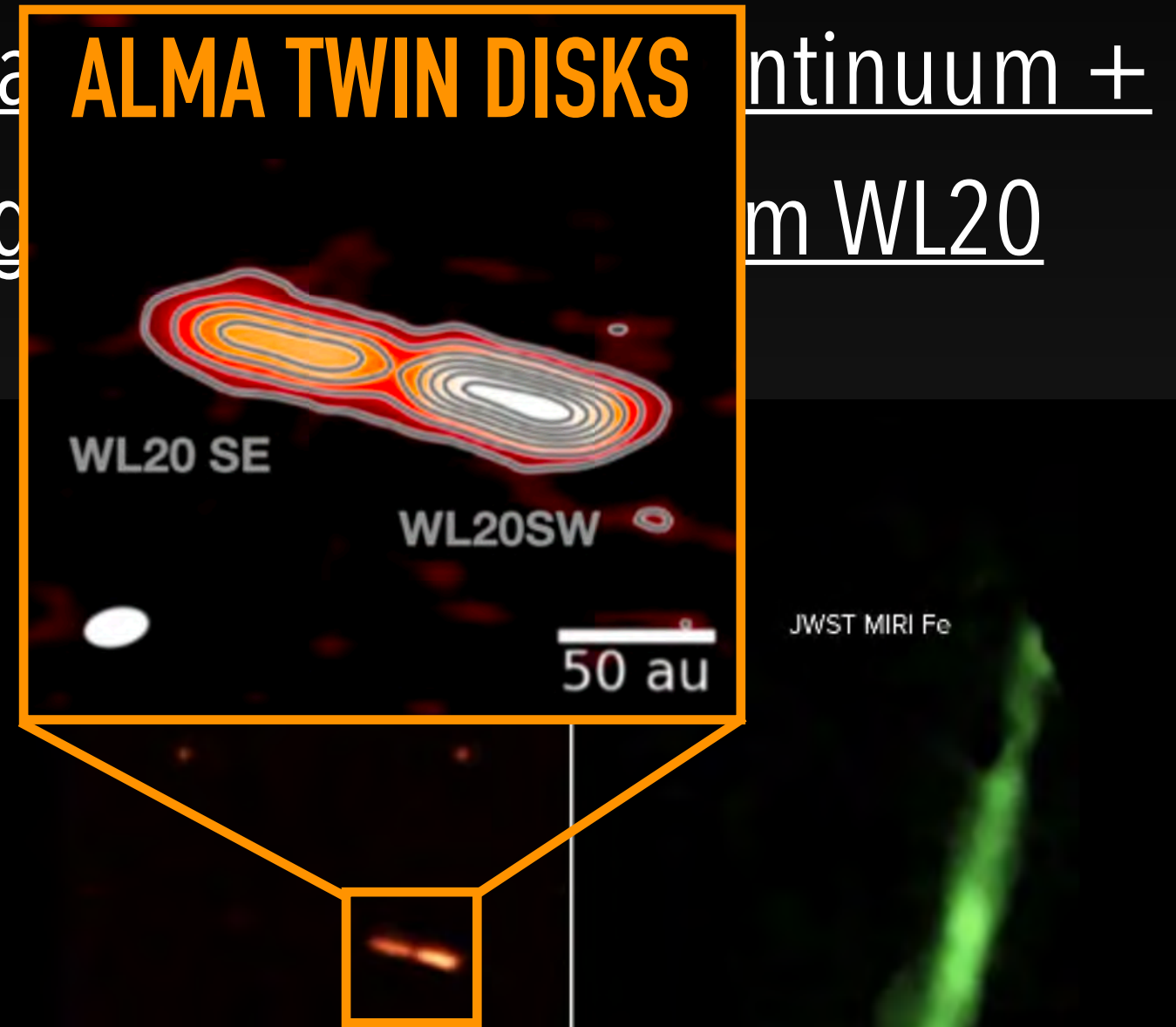
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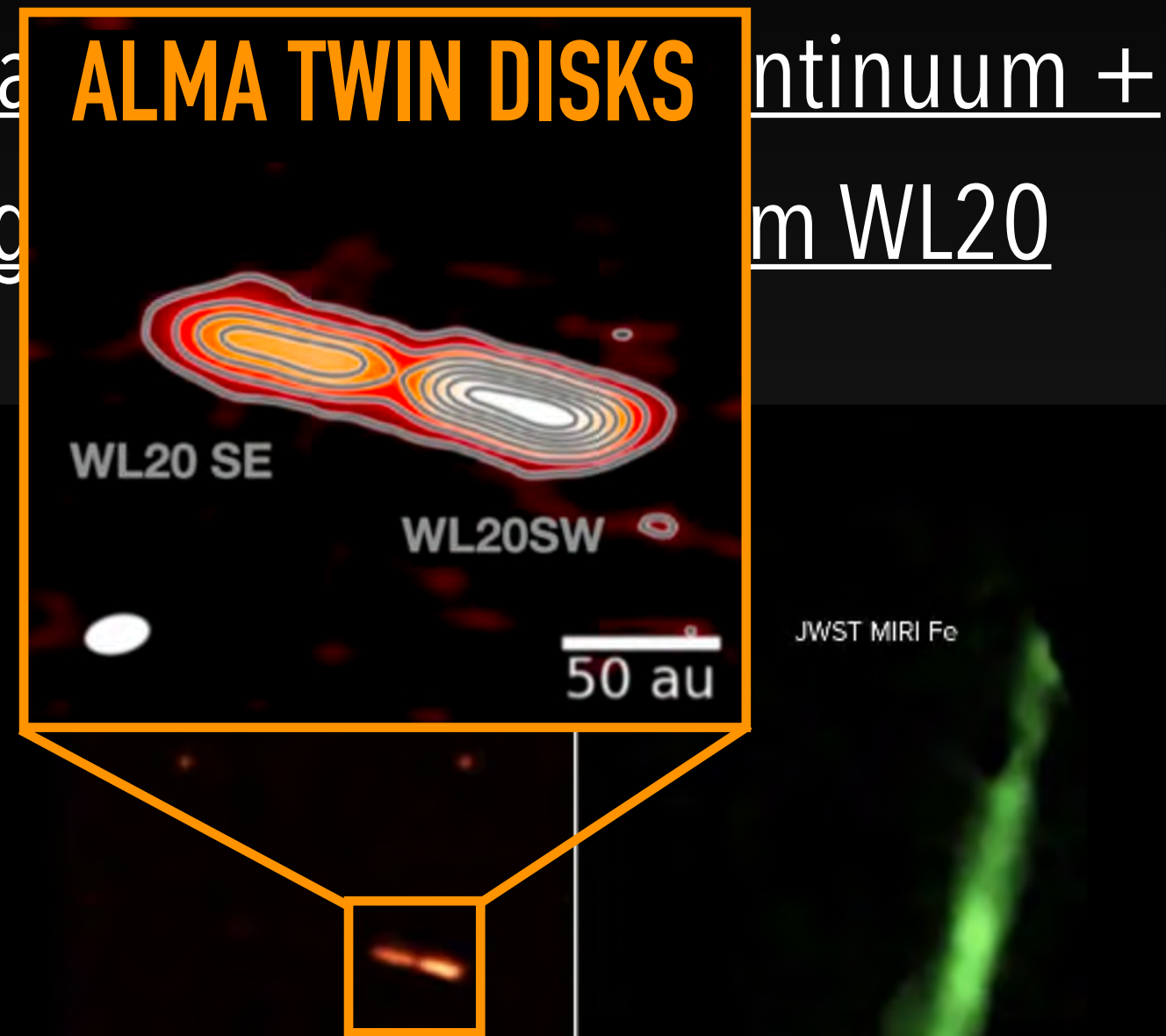
-MIRI found the parallel jets ([ArII], [FeII], [NiII], [NeII]), and a wide-angled disk wind in H₂ surrounding the ionized jets

-outflow evolutionary scenario: mol. gas dominates in the young; fast, ionized jets dominate in the oldest

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Parallel disks and jets erupting from a pair of young stars

High-resolution (~ 25 au) ALMA Band 6 continuum + CO(2-1) and JWST MIRI-MRS images of the young star system WL20



-star system WL20, in ρ -Ophiuchi molecular cloud complex

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Footprints of baby planets in a gaseous disk

New data analysis techniques of ALMA Science Verification observations uncover gaps in the gas disk at ~ 10 au resolution around protostar HL Tau

- performed azimuthal averaging on HCO+ image: locations HCO+ disk gaps match the gaps in the dust found in the ALMA SV high resolution image taken in 2014.
- gaps in the dust are caused by the gravity of (sub-)Jovian mass forming planets
- planets form in short timescales: needs of alternative planet formation scenarios

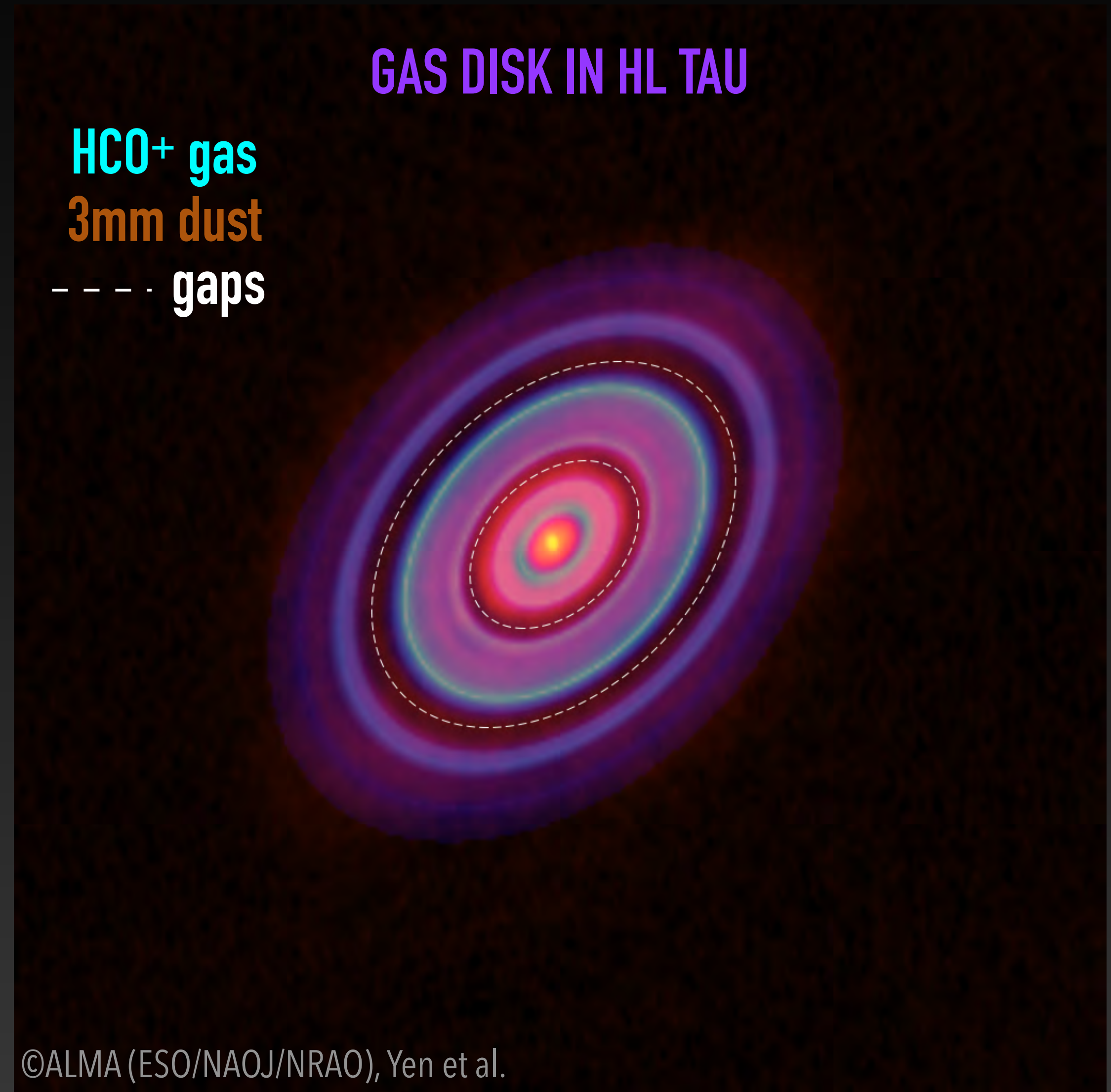
ALMA SV IMAGE OF THE DUST DISK AROUND HL TAURI

©ALMA (ESO/NAOJ/NRAO)

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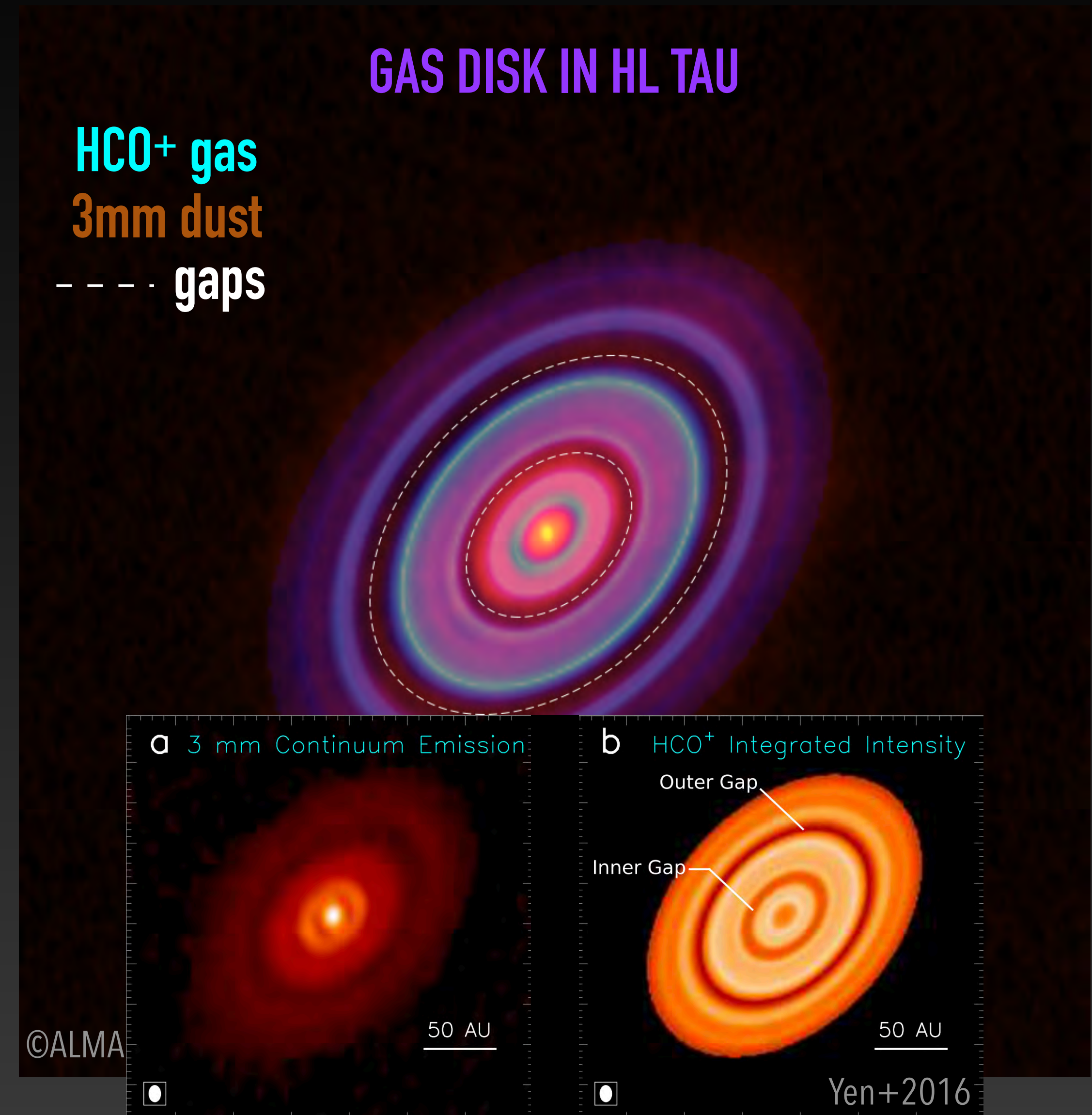
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Article: "Gas Gaps in the Protoplanetary Disk around the Young Protostar HL Tau" Yen et al 2016, *ApJ Letters*

How does planet formation begin?

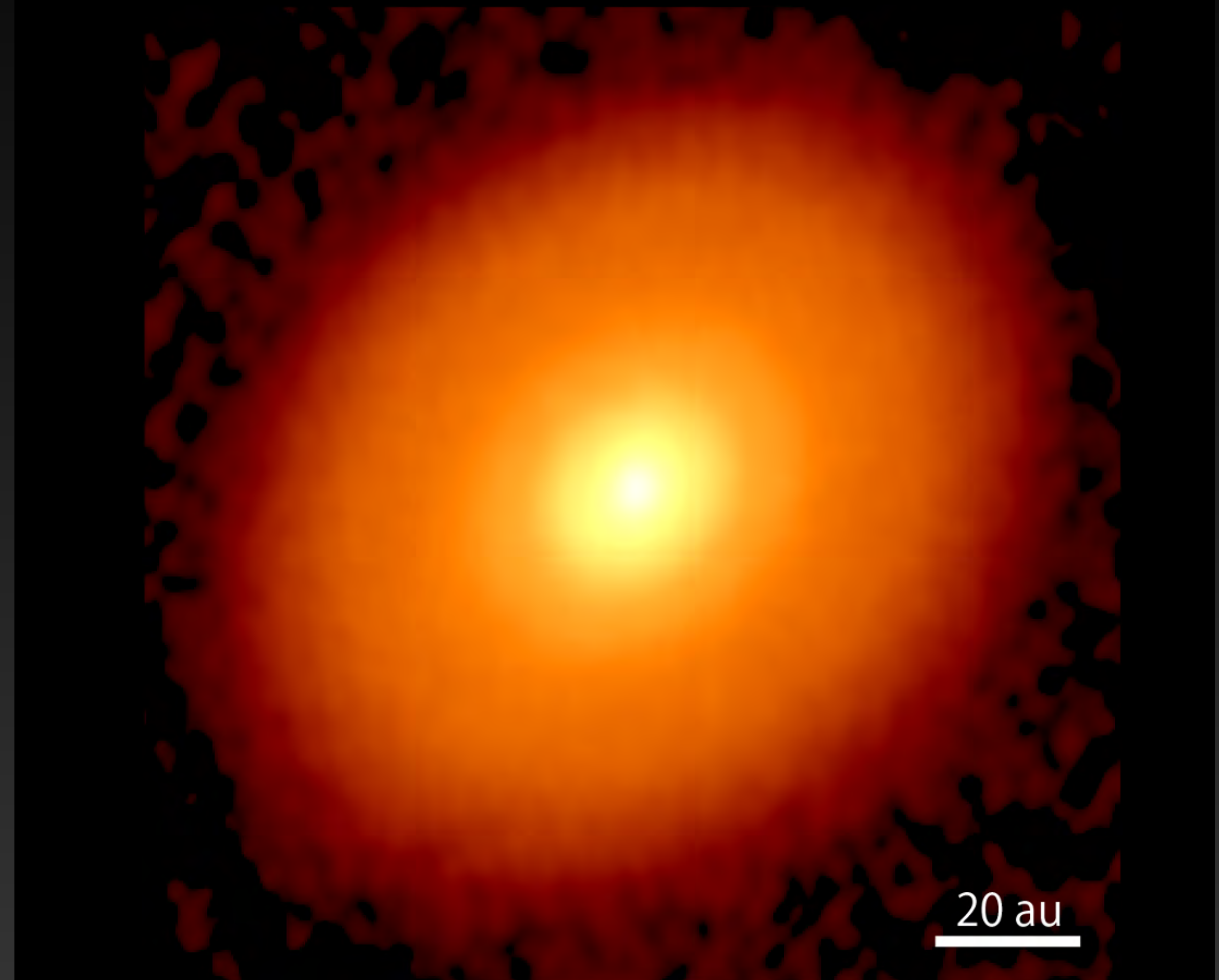
High-resolution (≈ 5 au) 1.3 mm dust continuum observations of young protoplanetary disk around DG Tau reveal thin and smooth disk without substantial substructures

-ALMA archive data @0.87 and 3.1 mm dust analyzed the distributions of dust surface density, temperature, and grain size

-"pristine" disk retains the initial conditions of planet formation

-SED + radiative transfer model: disk's outer regions as the potential starting point for planet formation, challenging current view

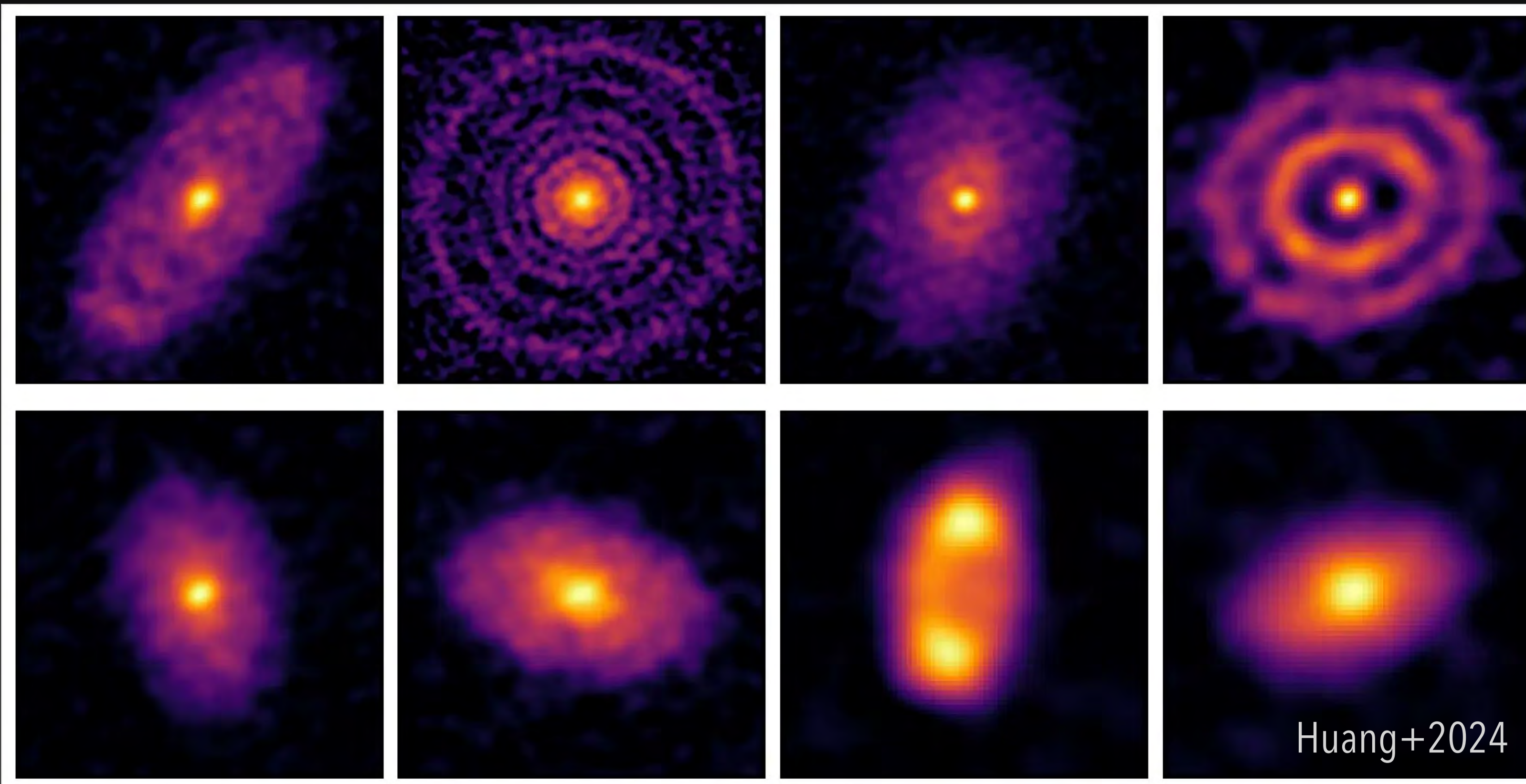
SMOOTH YOUNG PROTOPLANETARY DISK AROUND DG TAU



©ALMA (ESO/NAOJ/NRAO), S. Ohashi, et al.

Planets can form under harsh radiation

High-resolution (~ 8 au) ALMA 1.3 mm continuum images images of 8 protoplanetary disks in the σ -Orionis cluster



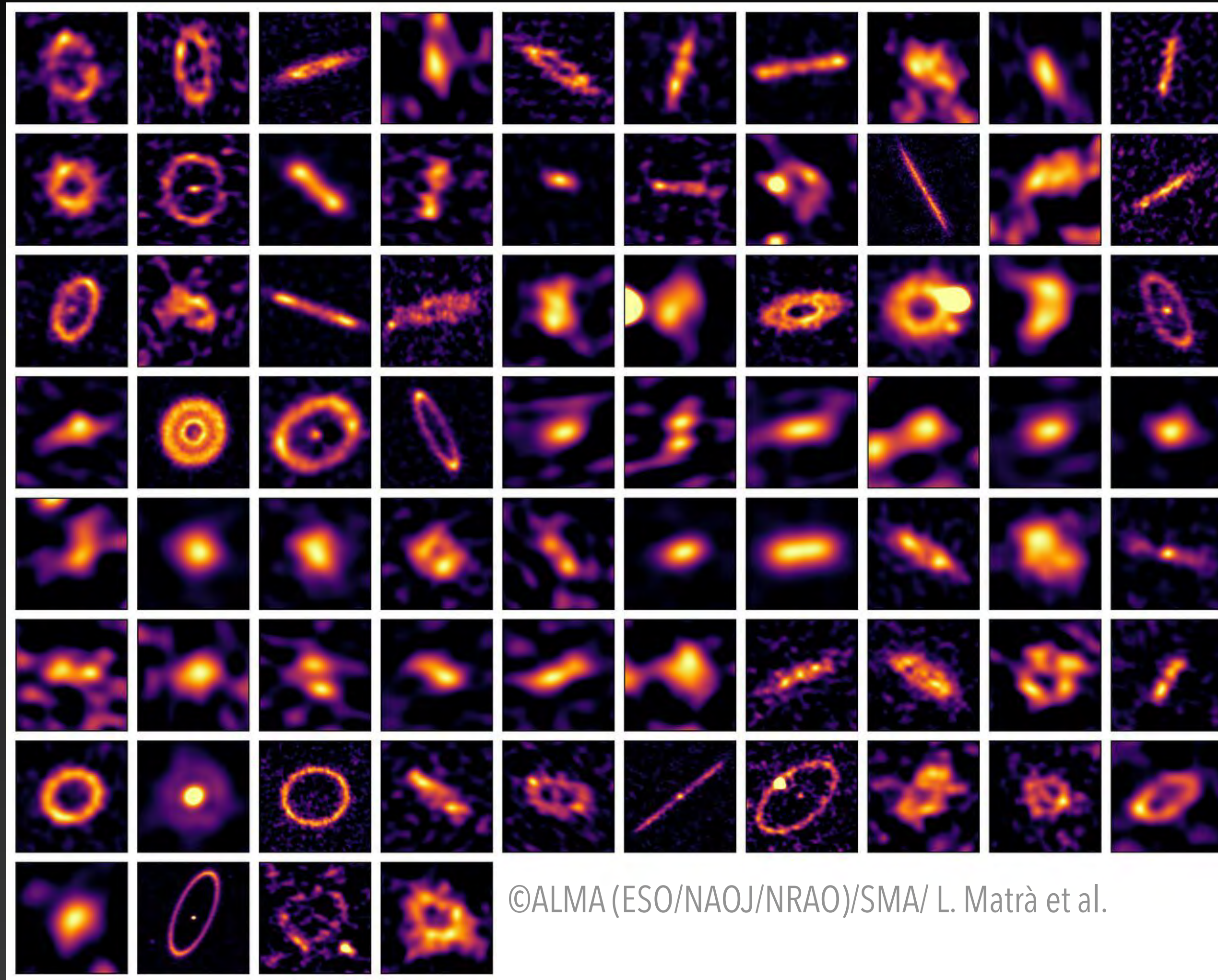
-intense radiation from massive star

-gaps and rings in most of the disks: structures associated with formation of giant planets

-challenge in planet formation: survival of planets in intermediate levels of UV radiation

Exocomet belts in all shapes, sizes and ages

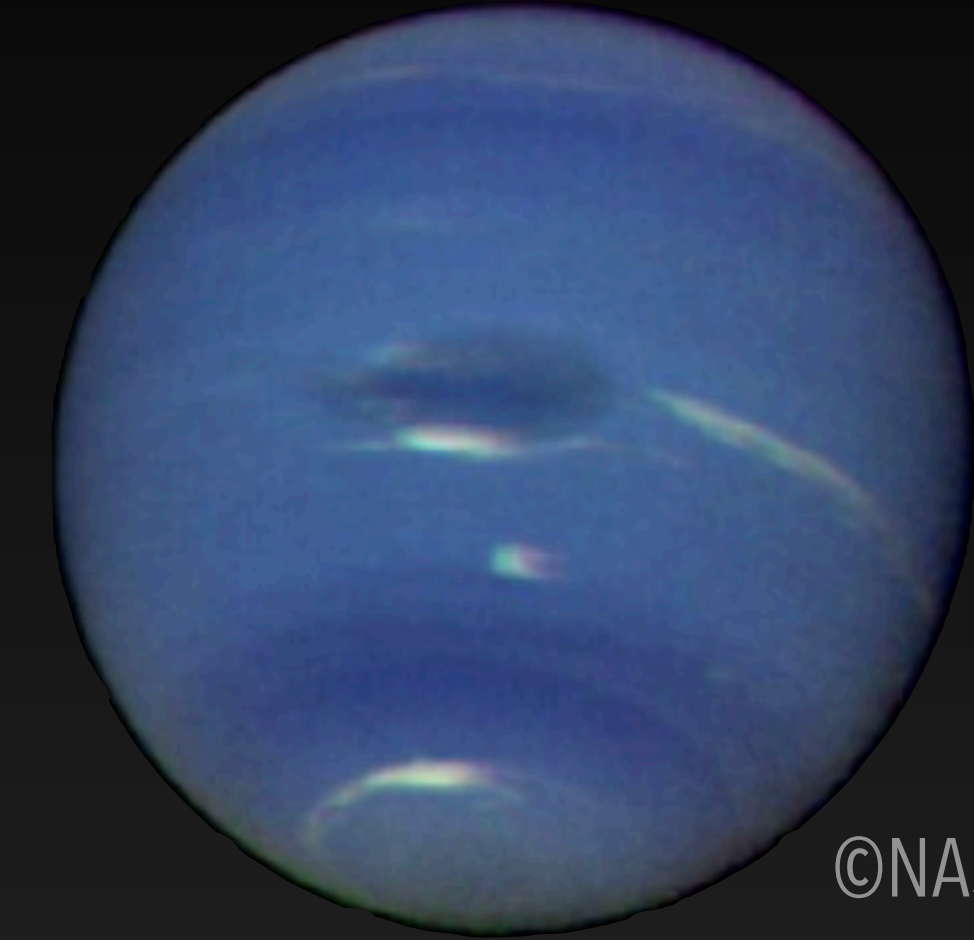
Resolved ALMA and SMA Observations of Nearby Stars (REASONS): largest survey of exocomet belts



- Exocomets: boulders of rock and ice >1 km size, smash together in belts (found $\sim 20\%$ planetary systems)
- resolved dust observations of 74 planetary systems (25 ALMA+SMA survey + 49 archive)
- diversity in structure: narrow rings, or 'belt' like our Kuiper belt, but many are wide, better described as "disks"
- dust depleted faster in smaller belt
- history of our Solar System and Earth

Belt-like distribution of hydrogen cyanide on Neptune's equator

NEPTUNE BY VOYAGER 2 IN 1989



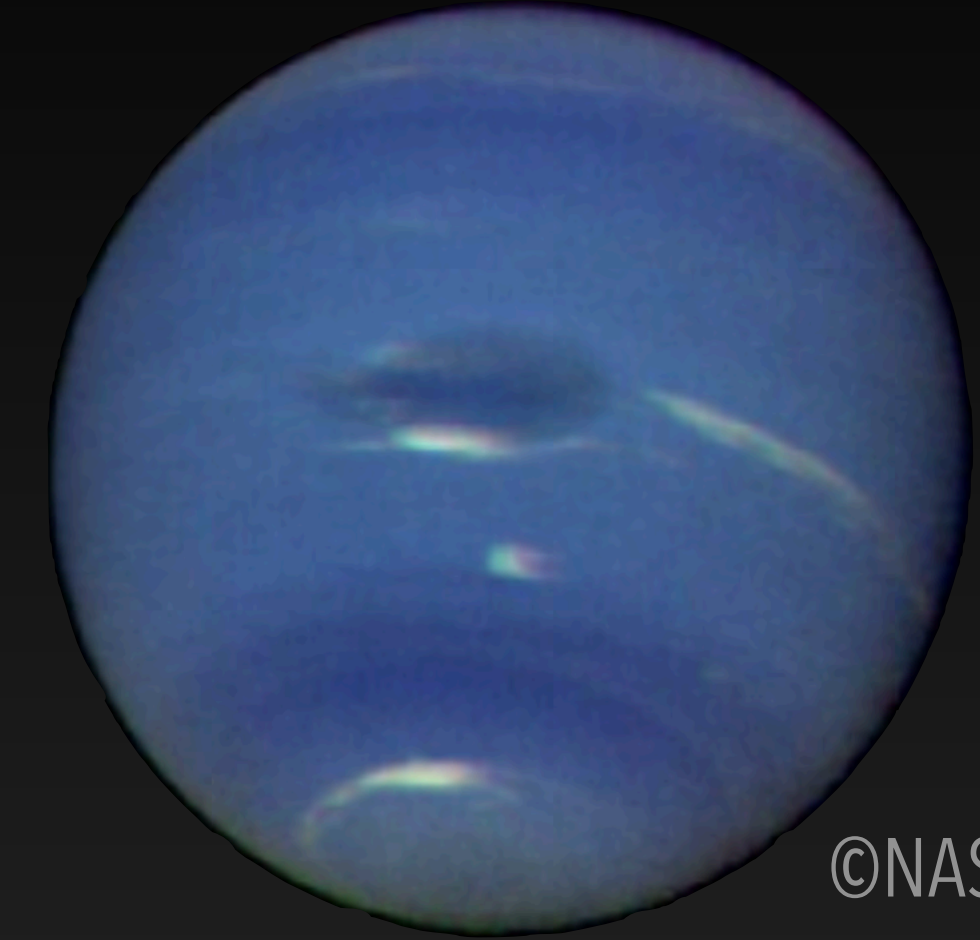
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- HCN(4-3) detected at Neptune's stratosphere (high altitudes)
- 0.4'' beam, enough to resolve Neptune's 2.24'' diameter disk.
- band-like HCN enhancement at the equator: high HCN abundances at the equator, almost depleted at 60° south
- atmospheric dynamics**: large atmospheric flows to HCN rich region, air is transported upward ~60° south and then downward at both the equator and south pole

lino+2020

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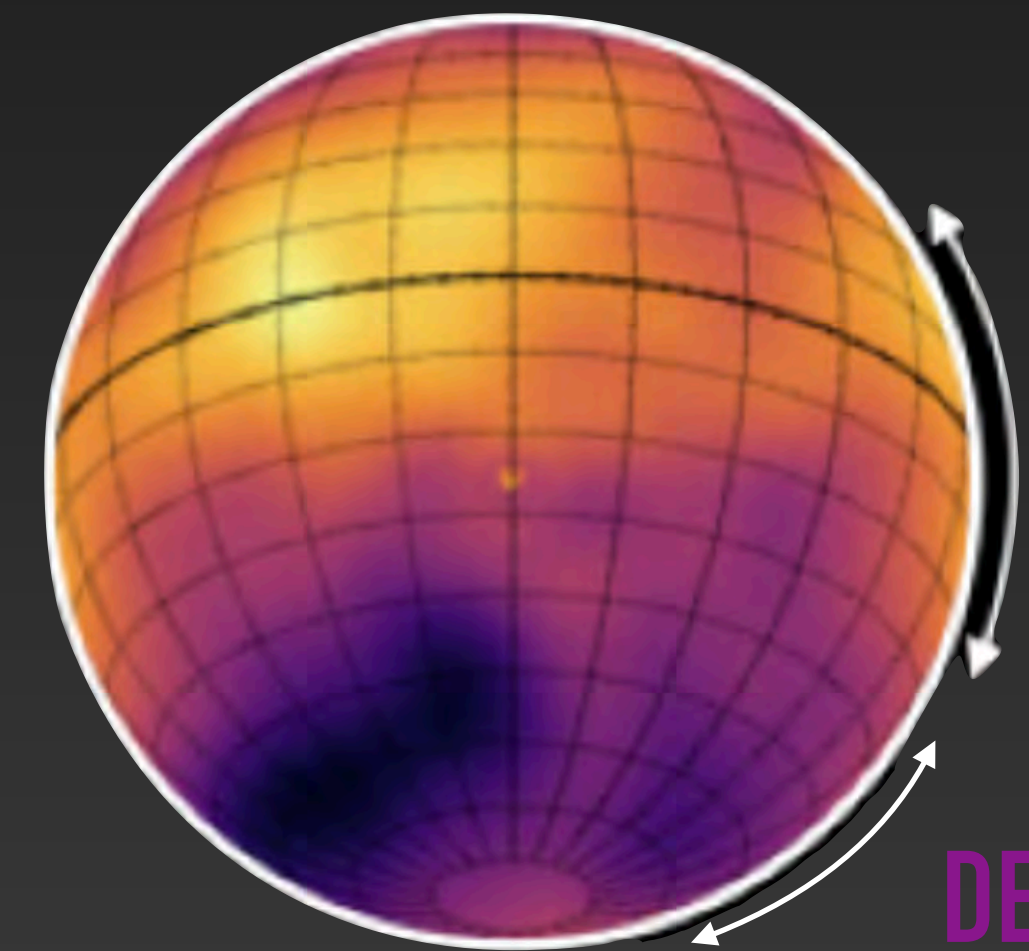
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HCN RATIO BY ALMA IN 2016



ABUNDANT

DEFICIENT

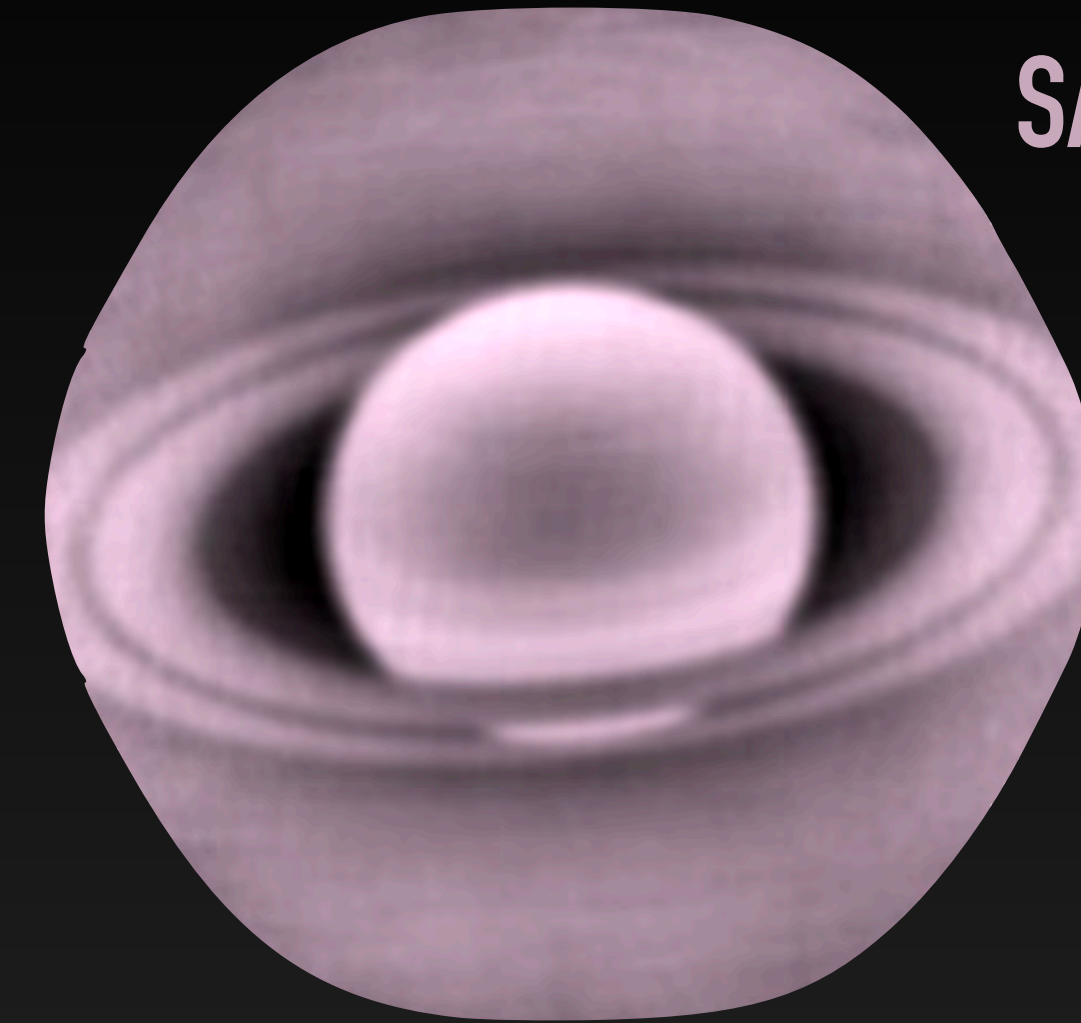
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HCN rings in Saturn's atmosphere

HCN is an important nitrogen molecule: plays key role in formation of several biomolecules via chain reactions

-only archival observations: HCN in eastern and western limbs, up to 475 km in the stratosphere of Saturn

-possible formation mechanism of HCN: photochemical reactions in a mixture of H₂, methane (CH₄) and ammonia (NH₃) under ultraviolet light



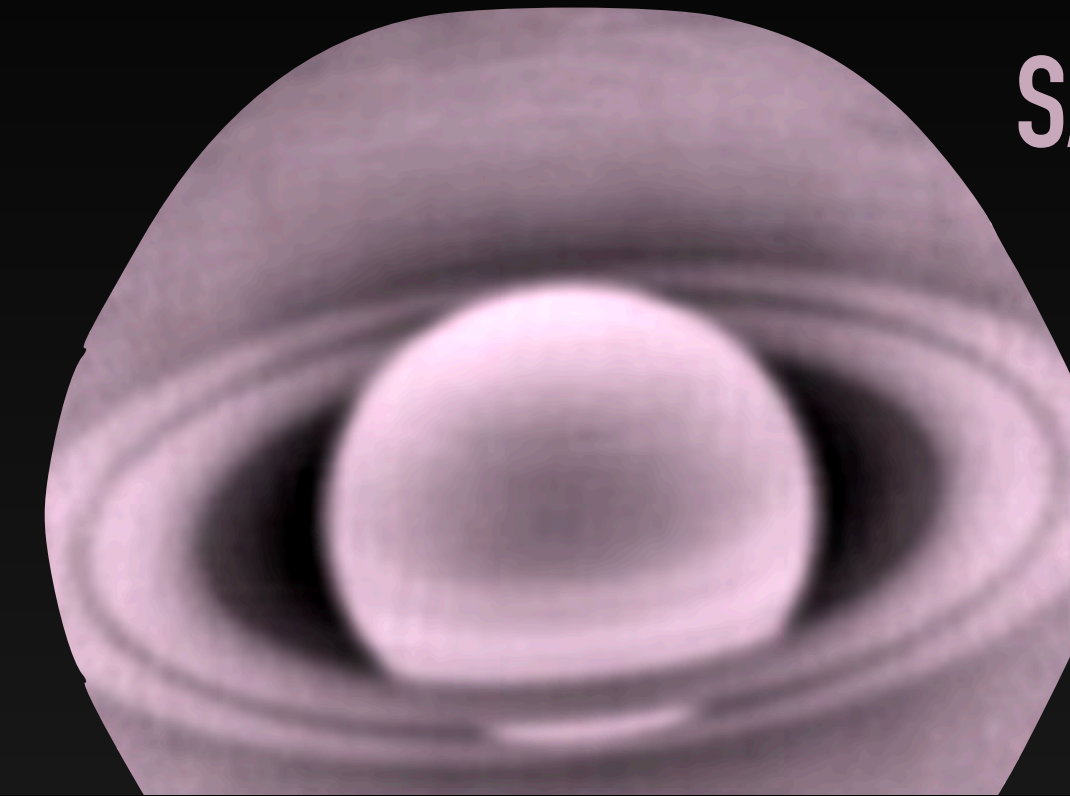
SATURN @350GHZ
CONTINNUM

Manna+2024

HCN rings in Saturn's atmosphere

SATURN @350GHZ
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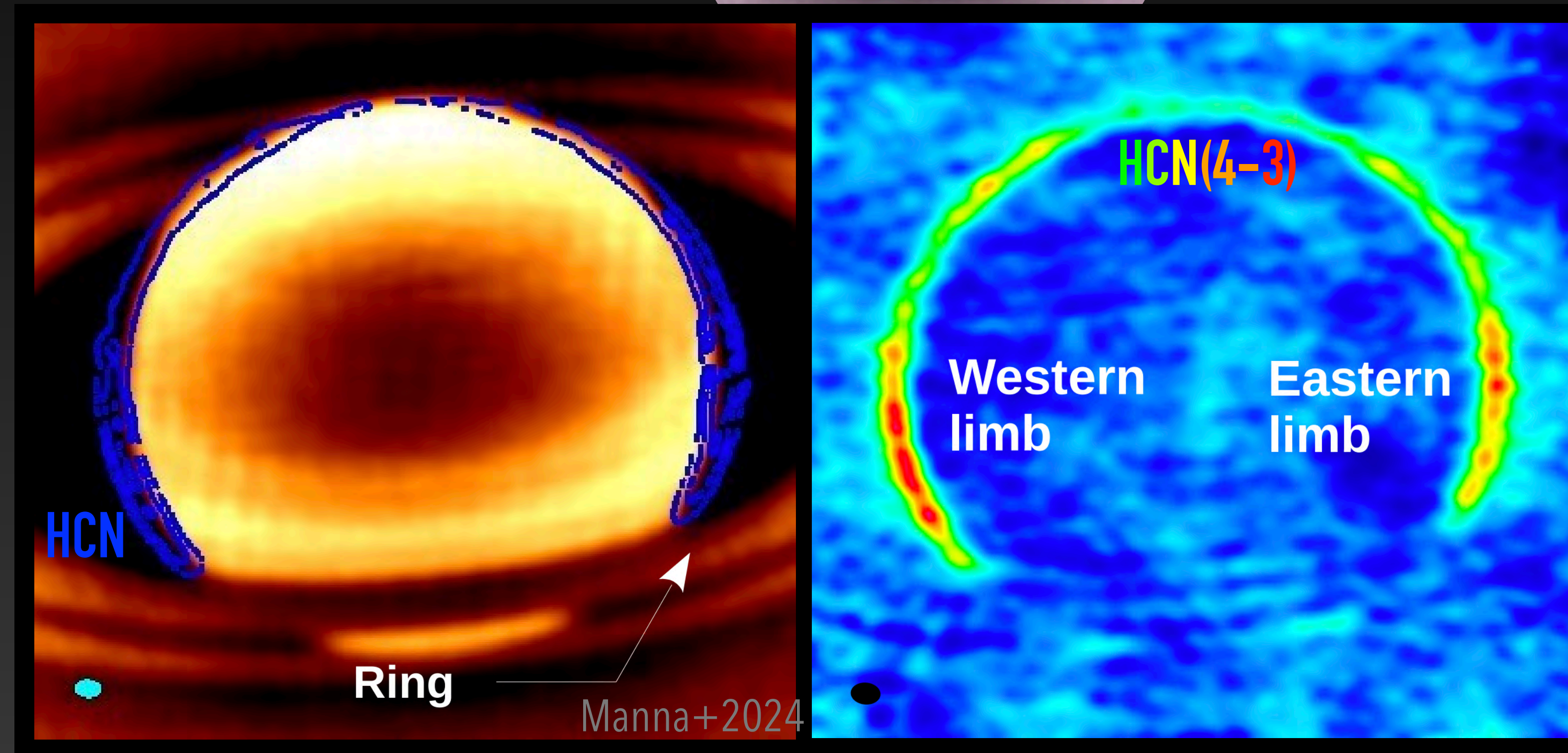
Manna+2024



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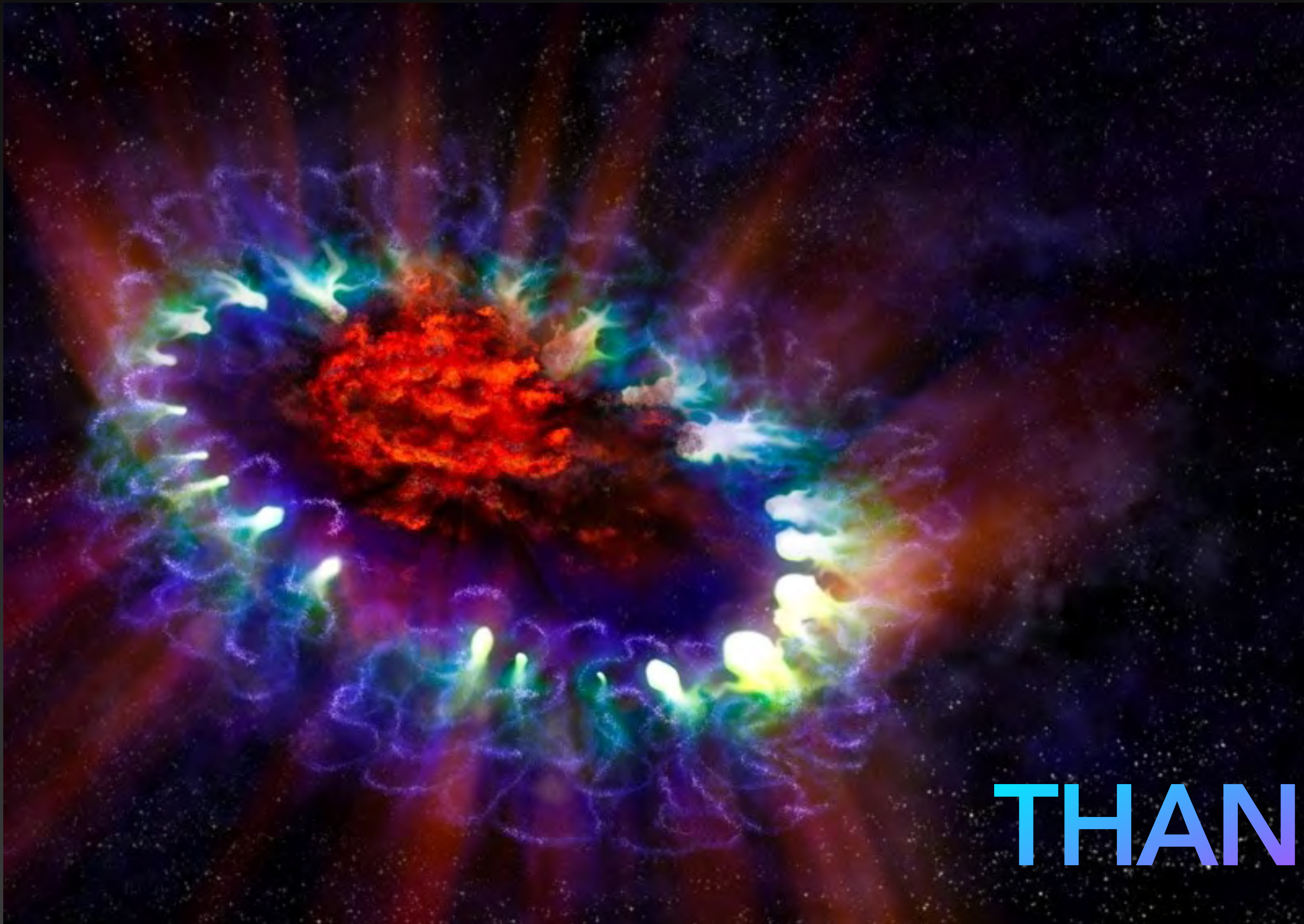
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