

# 2022 CALENDAR



ALMA.Observatory



ALMA.Radiotelescope



ALMAobs



ALMAobservatory



## COVER PAGE



### Silhouette in the Twilight

Bidding farewell to the Sun, a solitary antenna of the 66 that ALMA owns poses in the twilight on the Chajnantor Plateau, revealing its silhouette with perfect parabolic shapes, while the upper layers of the atmosphere are illuminated.

The surface area of these antennas has a margin of error equivalent to only a fraction of the thickness of a human hair, making them one of the most accurate parabolic antennas in the world. Of the 66 antennas, 54 are twelve meters in diameter and 12 are seven meters in diameter. The radio telescope combines the signals from each of them, functioning as an interferometer, as though they were a single giant telescope the size of the entire array.

Unlike fixed telescopes, which are built in one place, these antennas are robust enough to be moved between different bases without damaging their high-precision mechanisms.

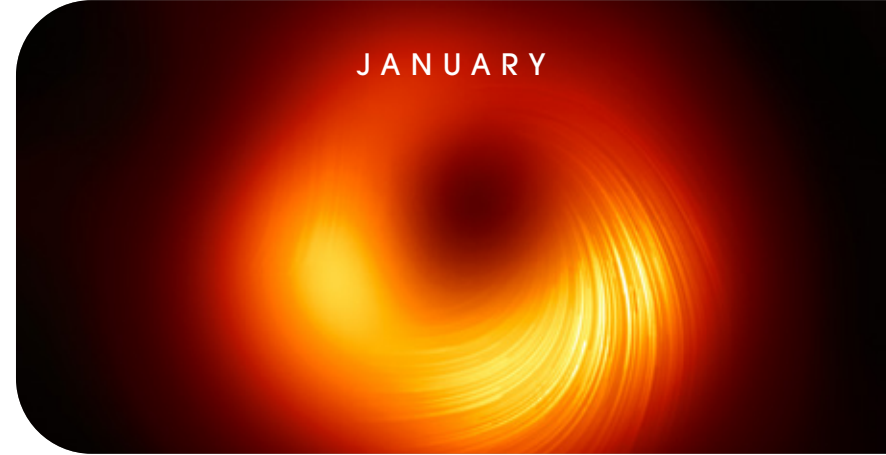
**Credit: Pablo Carrillo – ALMA (ESO/NAOJ/NRAO)**

### Magnetic Fields of a Black Hole

The Event Horizon Telescope (EHT) Collaboration, which linked eight telescopes, including ALMA, to produce the first-ever image of a black hole, has now revealed a new view of the massive object at the center of the Messier 87 (M87) galaxy, how it looks in polarized light. This imprint left by magnetic fields is key to explaining how M87 galaxy can generate powerful jets that extend far beyond. The bright jets of energy and matter that emerge from M87' core and spans out at least 5000 light-years from its center are one of the galaxy's most mysterious and energetic features, as most of the matter near the edge of a black hole eventually rushes into it. But observations suggest that the magnetic fields at black hole's edge are strong enough to push back on the hot gas, causing it to resist gravity's pull.

**Credit: EHT Collaboration**

## JANUARY



## FEBRUARY



### The Rebirth of a Giant

The ALMA antennas are designed to withstand strong winds, temperatures fluctuating between 20 and -20 degrees Celsius, and even snow. What no one could have guessed is that ALMA had to stop its observations in March 2020 due to the health crisis caused by Covid-19. The only instrument that remained active, thanks to a solar power system installed especially for the occasion, was the maser, an atomic clock that allows ALMA to synchronize with the global network of observatories that managed to capture the first image of a black hole.

In October 2020 and thanks to the improved rates achieved in the fight against the pandemic, the decision was made to gradually begin the return to operations to turn the observatory back on and start recovering the antennas. A process that was documented in images and interviews with ALMA workers. On May 29, 2021, "The Rebirth of a Giant" documentary was released.

**Credit: Pablo Bello – ALMA (ESO/NAOJ/NRAO)**

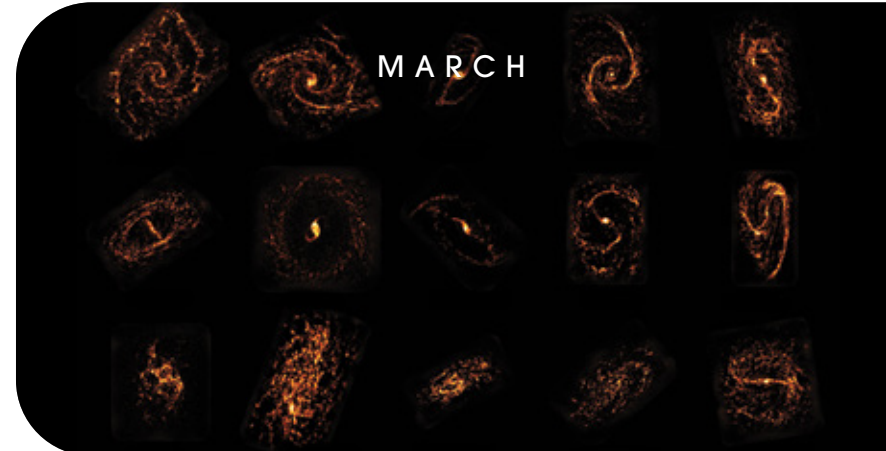
### Cosmic Cartographers Reveal Diversity of Star-Forming Galaxies

A team of astronomers used ALMA has completed the first census of molecular clouds in the nearby Universe, revealing that contrary to previous scientific opinion, these stellar nurseries do not all look and act the same. In fact, they are as diverse as the people and homes, neighborhoods and regions that make up our own world.

Stars form from clouds of dust and gas called molecular clouds. Each stellar nursery in the Universe can form thousands or even tens of thousands of new stars during its lifetime. Between 2013 and 2019, the astronomical team behind the PHANGS (Physics at High Angular Resolution in Nearby Galaxies) project conducted the first systematic survey of 100,000 stellar nurseries across 90 galaxies in the nearby Universe to get a better understanding of how they connect back to their parent galaxies. The observations confirmed that the location, or neighborhood has small but critical role on where and how many stars are born, revealing where the next generation of stars will form.

**Credit: ALMA (ESO/NAOJ/NRAO) / PHANGS, S. Dagnello**

## MARCH



## APRIL



### Side by Side with the Local Community

Community relations are a key part of ALMA's presence in Chile. So much so that ALMA management invited representatives of the Atacameño community to celebrate a ritual for Mother Earth or "Pachamama" on the Chajnantor Plateau prior to the inauguration of the observatory, and also when construction began on the residence that houses the staff. Communication channels with neighboring communities are always open, and they are regularly invited to visit the observatory site.

Since 2004 ALMA has contributed to the development of the Antofagasta region, where the observatory is located, through the ALMA Region II Fund, which promotes productive, social and economic development in the commune of San Pedro de Atacama. This competitive fund has promoted many local initiatives, such as community tourism projects, water channeling, construction of community facilities and equipment, and home water heating through solar panels, among many others.

**Credit: ALMA (ESO/NAOJ/NRAO) / Vectorial Films**

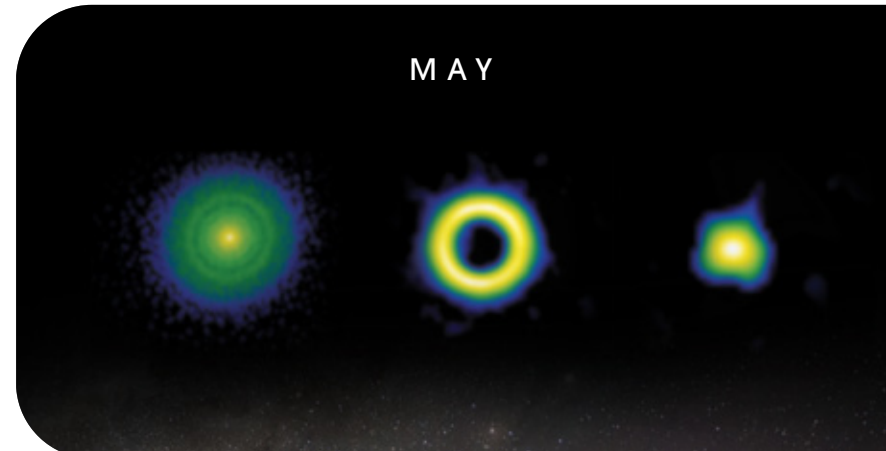
### Science Team Uses Stellar Mass to Link Exoplanets and Planet-Forming Discs

Using data from more than 500 young stars observed with ALMA, a scientific team has uncovered a direct link between protoplanetary discs structures - the planet-forming discs that surrounds stars where new planets form - and planet demographic characteristics of the planets born there. The survey proves that higher mass stars are more likely to be surrounded by discs with "gaps" in them and that these gaps directly correlate to the high occurrence of observed giant exoplanets.

These results provide the scientific community with a view into the past, which allows predicting the appearance of exoplanetary systems at different stages of their formation. Similarly, the link between stellar mass and the number and size of planets could help to better identify stars in the Milky Way that could have rocky planets.

**Credit: ALMA (ESO/NAOJ/NRAO), S. Dagnello**

## MAY



## JUNE



### A True Refuge

Welcoming autumn with storm lightnings near ALMA Residencia, designed to provide a pleasant environment for our collaborators during their shifts and to protect them from the harsh altiplano's climate and its remote location

The construction of the Residencia was the last major piece of ALMA construction. Since its inauguration in April 2017, it has provided accommodation for observatory staff at the ALMA Operations Support Facility (OSF) near San Pedro de Atacama, 28 kilometers from the radio telescope, at 2,900 meters above sea level.

Designed by Finnish architects, it has 120 rooms distributed in six buildings. The common areas have spectacular recreational areas, including a cafeteria, spa with gym, swimming pool, sauna and barbecue area. There is also a kitchen and a large dining room. An architectural design that harmonizes with the topography, surroundings and landscape of the ALMA site.

**Credit: Pablo Carrillo – ALMA (ESO/NAOJ/NRAO)**





### Powerful Stratospheric Winds Measured on Jupiter

Using ALMA, a team of astronomers have directly measured winds in Jupiter's middle atmosphere for the first time. By analyzing the aftermath of a comet collision from 1990s, the researchers have revealed near Jupiter's poles incredibly powerful winds of enormous power were unleashed, with speeds of up to 1450 kilometers per hour. They could represent what they have described as a "unique meteorological beast in our Solar System".

Jupiter is famous for its distinctive red and white bands: swirling clouds of moving gas that astronomers traditionally use to track winds in Jupiter's lower atmosphere. Astronomers have also seen, near Jupiter's poles, the vivid glow known as aurorae, which appear to be associated with strong winds in the planet's upper atmosphere. But researchers had never been able to directly measure the wind patterns between these two atmospheric layers, in the stratosphere. That is, until now.

**Credit: ESO/L. Calçada & NASA/JPL-Caltech/SwRI/MSSS**

### Friends Under the Milky Way

In February 2008, after a long voyage by ship from Belgium, the two huge ALMA antenna transporters (measuring 10 meters wide, 20 meters long and weighing 130 tons each) arrived in Chile. After a week they arrived by land at the ALMA operations base, located 2,900 meters above sea level, near San Pedro de Atacama.

Named Otto and Lore, these giant trucks, tailor made in Germany to comply ALMA's specifications, have 28 wheels each and the equivalent power of two Formula 1 engines. They are capable of picking up and moving a 115-ton antenna and installing it on a concrete base with millimeter precision.

Both play a key role in ALMA's operation. They not only carried each of the 66 antennas to their final destination on the Chajnantor Plateau (5,000 meters altitude), but continue to move them between the multiple pads as needed by the astronomical team.

**Credit: Y. Beletsky (LCO/ESO)**



### ALMA Captures the Death Process of a Distant Colliding Galaxy

Galaxies begin to "die" when they stop forming stars, but until now the astronomical community has never clearly glimpsed the beginning of this process in a far-away galaxy. Using ALMA, a scientific team has seen a galaxy ejecting nearly half of its gas, the building block for star formation. This ejection is happening at a startling rate, equivalent to 10 000 Suns-worth of gas a year — the galaxy is rapidly losing its fuel to make new stars. The team believes that this spectacular event was triggered by a collision with another galaxy, which could lead astronomers to rethink how galaxies stop bringing new stars to life.

ALMA has shed new light on the mechanisms that can halt star formation in distant galaxies. Witnessing such a massive disruption event adds an important piece on the complex puzzle of galaxy evolution.

**Credit: ESO / M. Kornmesser**

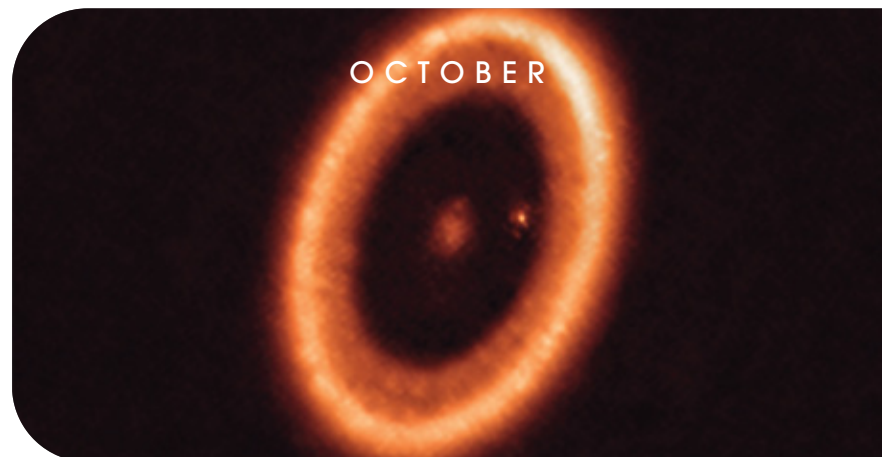
### Moon-Forming Disc around an Exoplanet

Using ALMA, the astronomical community has for the first time detected the presence of a disc around a planet outside our Solar System.

The observations will shed new light on how moons and planets form in young stellar systems. The disc, called circumplanetary disc, surrounds the exoplanet PDS 70c, one of two giant Jupiter-like planets orbiting a star nearly 400 light-years away. There is enough mass in the disc to form up to three satellites the size of the Moon.

Planets form in dusty discs around young stars, carving out cavities as they gobble up the material in this circumstellar disc to grow. At the same time, the gas and dust in the circumplanetary disc can merge into larger and larger bodies through multiple collisions, ultimately leading to the birth of moons.

**Credit: ALMA (ESO/NAOJ/NRAO) / Benisty et al.**



### What do Vicunas Look at?

Despite its similarity to the Martian landscape, the Atacama Desert is home to native flora and fauna that for centuries have developed techniques to adapt to the harsh conditions. Being located in an ecologically fragile area, ALMA has taken expert advice to avoid the impact of the observatory's operations on this marvelous environment.

ALMA workers frequently see vicunas that inhabit this incredible landscape. The vicuna - from the Quechua wik'uña - is for the Atacameño people the property of "Pachamama" (Mother Earth).

Vicunas belong to the family of smaller wild camelids that live only in the Andean altiplano.

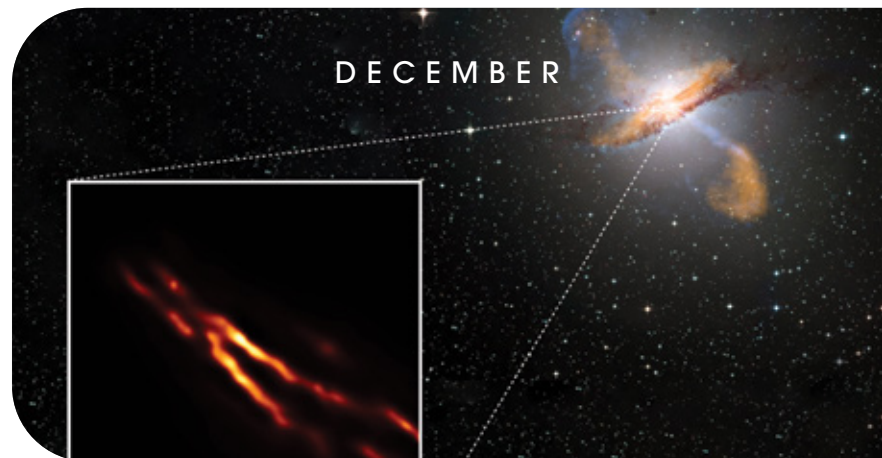
**Credit: Pablo Bello – ALMA (ESO/NAOJ/NRAO)**

### EHT Pinpoints Dark Heart of the Nearest Radio Galaxy

An international team anchored by the Event Horizon Telescope (EHT) Collaboration, which is known for capturing the first image of a black hole in the galaxy Messier 87, has imaged the heart of the nearby radio galaxy Centaurus A in unprecedented detail. The astronomical team pinpointed the location of the central supermassive black hole and revealed how a gigantic jet is being born. Most remarkably, only the outer edges of the jet seemed to emit radiation, which challenges theoretical models of jets.

At radio wavelengths, Centaurus A emerges as one of the largest and brightest objects in the night sky. After being identified as one of the first known extragalactic radio sources in 1949, Centaurus A has been studied extensively across the entire electromagnetic spectrum by a variety of observatories. At the center of Centaurus A lies a black hole with the mass of 55 million suns. The new results show that the EHT provides a treasure trove of data on the rich variety of black holes and there is still more to come.

**Credit: Radboud University; ESO/WFI; MPIfR/ESO/APEX/A. Weiss et al.; NASA/CXC/CfA/R. Kraft et al.; EHT/M. Janssen et al.**



### New Season, New Names

The ALMA antennas under a clear sky. The few clouds make way for the Sun's rays that are gradually thawing the cold Chajnantor Plateau. At 5,000 meters above sea level, it can now begin to say goodbye to the snow.

Only seven of the 66 antennas are visible in this image that could change from next year, since they ceased to be a mere number to finally get their own name. This is thanks to a contest open to the entire community to celebrate the 10-year anniversary of ALMA's first scientific image, released on October 3, 2011, with only twelve antennas working together.

To celebrate this milestone, ALMA invited the public to name each of its 66 antennas using terms from celestial bodies and also words in Kunza, the Atacameño language, since ALMA is located in Likan Antai territory. More than 6,000 people participated in the call by voting for their favorite names.

**Credit: Sergio Otárola – ALMA (ESO/NAOJ/NRAO)**





Credit: EHT Collaboration

JANUARY

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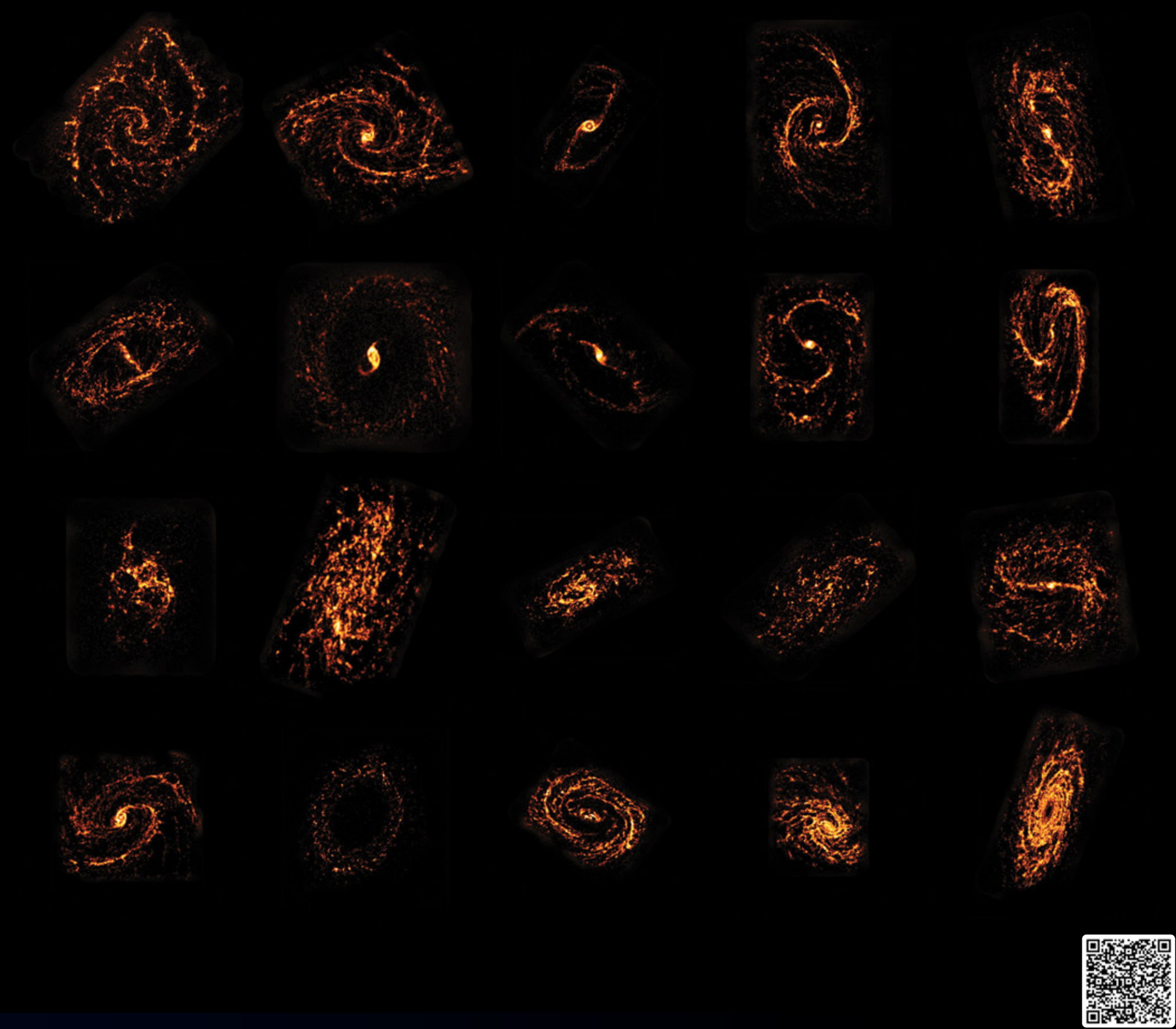


Credit: Pablo Bello – ALMA (ESO/NAOJ/NRAO)

FEBRUARY

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Credit: ALMA (ESO/NAOJ/NRAO) / PHANGS, S. Dagnello

MARCH

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Astronomical image credit: ALMA (ESO/NAOJ/NRAO), S. Dagnello / Antenna image credit: Sergio Otárola – ALMA (ESO/NAOJ/NRAO)

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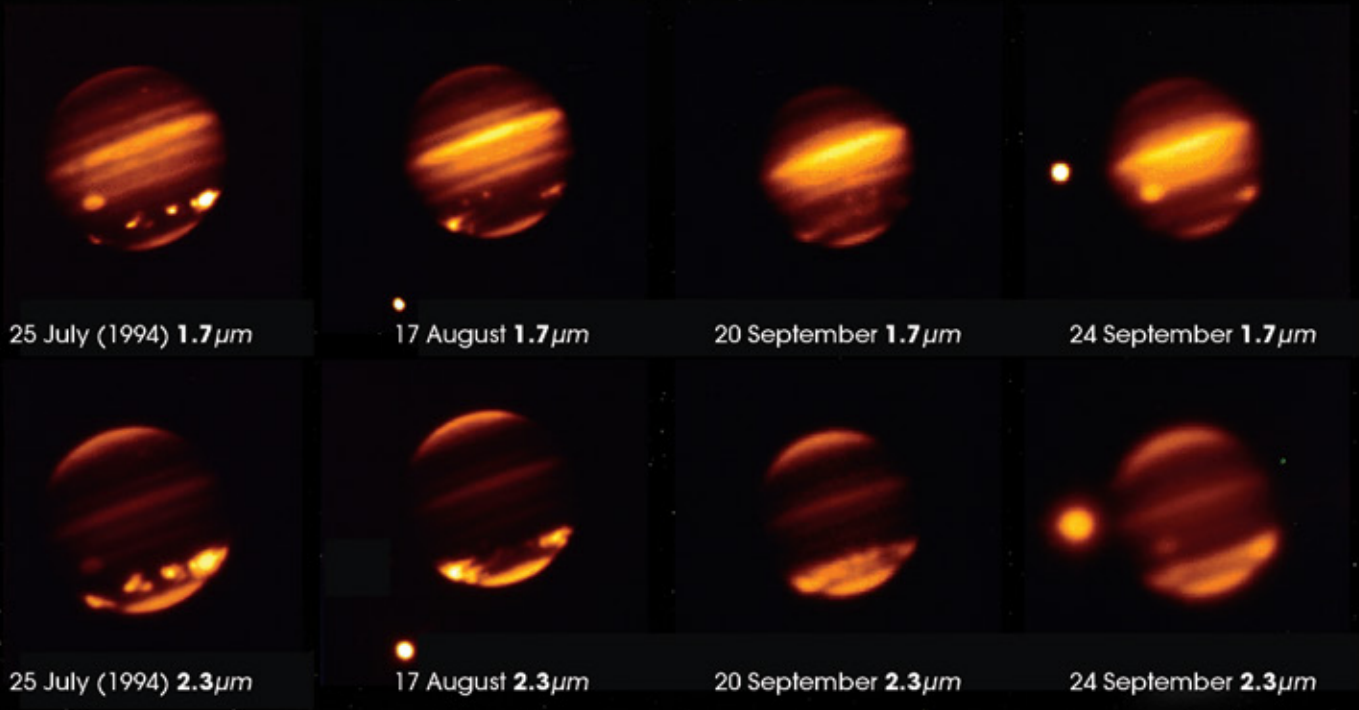
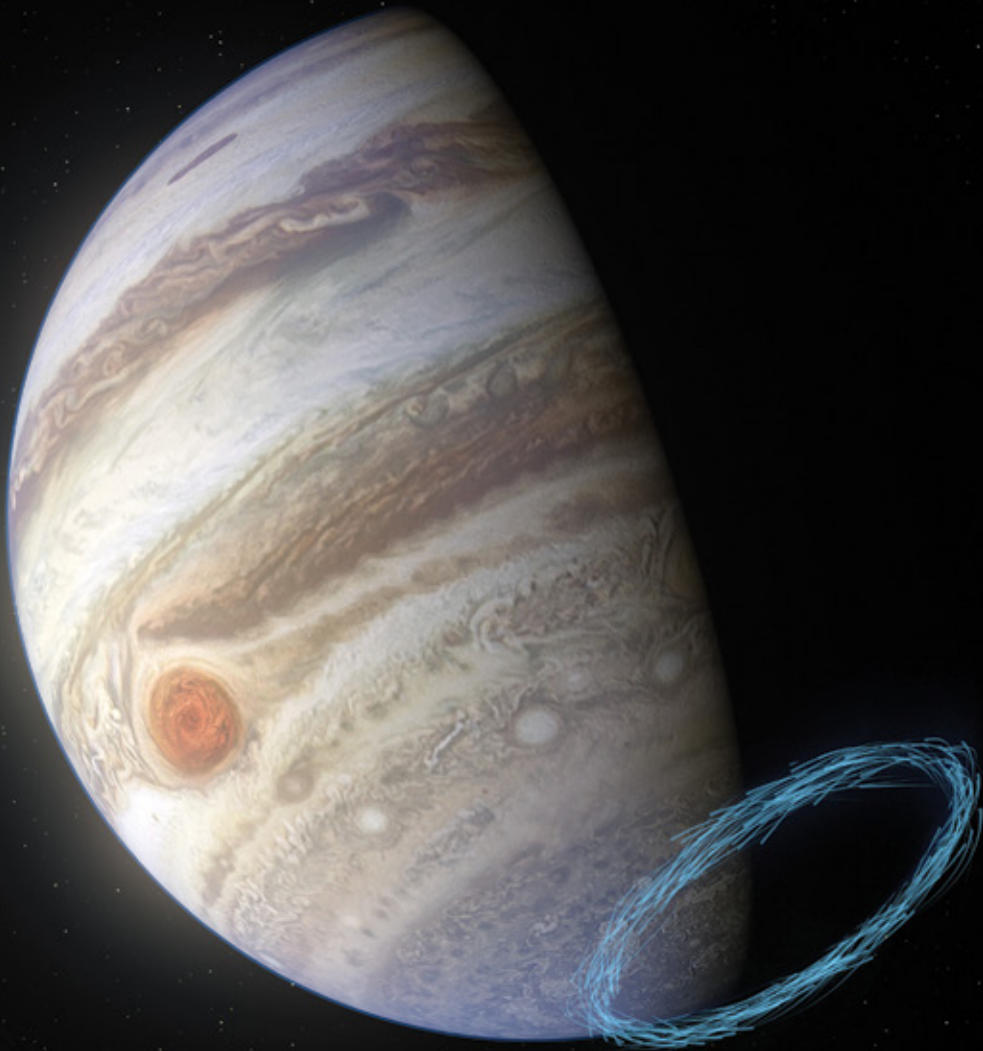


Credit: Pablo Carrillo - ALMA (ESO/NAOJ/NRAO)

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Astronomical image credit: ESO / Artistic representation Image credit: ESO/L. Calçada & NASA/JPL-Caltech/SwRI/MSSS

JULY

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Credit: Y. Beletsky (LCO/ESO)

AUGUST

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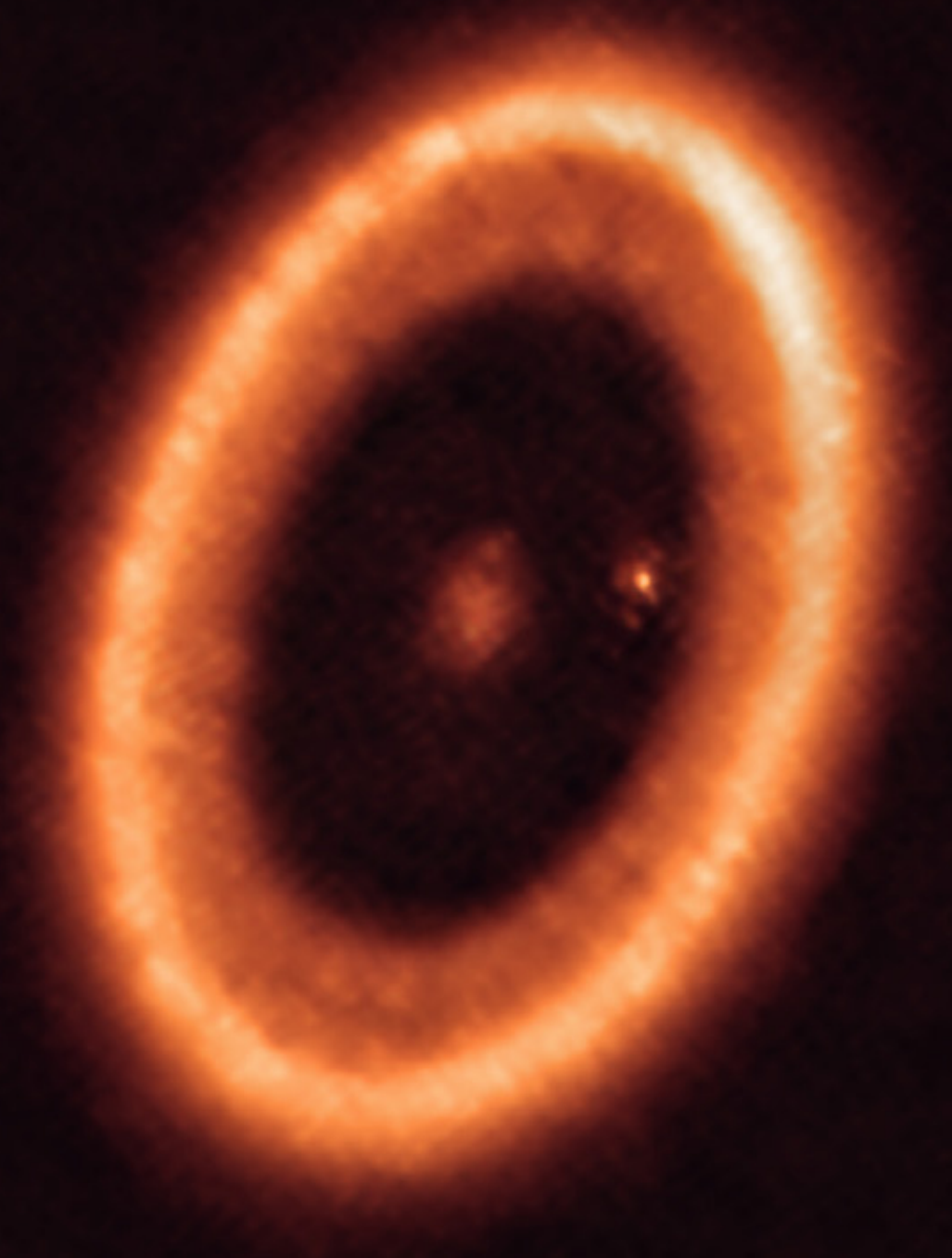


Astronomical image credit: ESO/M. Kornmesser / Antennas image credit: Pablo Carrillo – ALMA (ESO/NAOJ/NRAO)

SEPTEMBER

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Credit: ALMA (ESO/NAOJ/NRAO) / Benisty et al.

OCTOBER

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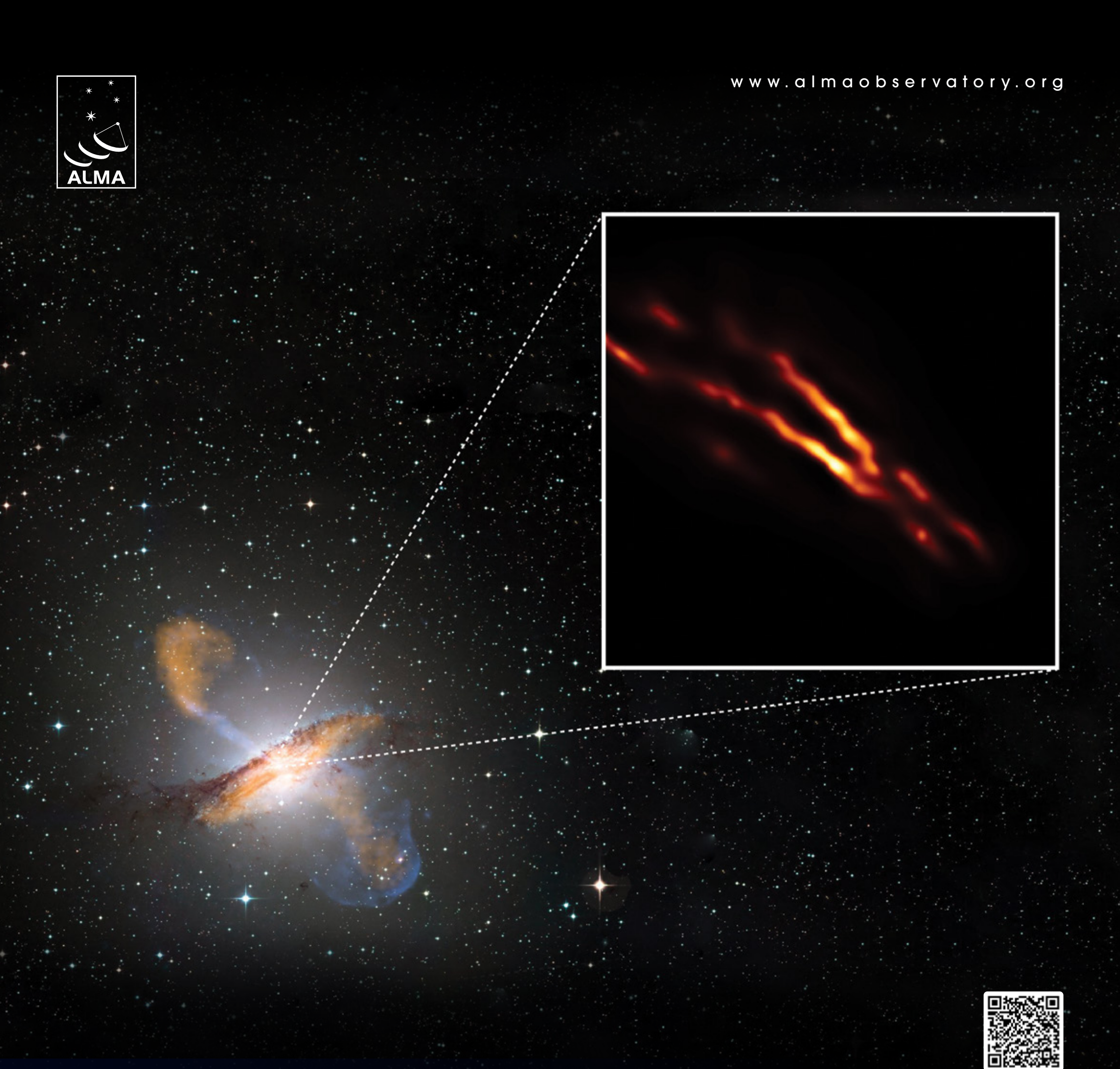


Credit: Pablo Bello – ALMA (ESO/NAOJ/NRAO)

NOVEMBER

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Credit: Radboud University; ESO/WFI; MPIfR/ESO/APEX/A. Weiss et al.; NASA/CXC/CfA/R. Kraft et al.; EHT/M. Janssen et al.

DECEMBER

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Credit: Sergio Otárola - ALMA (ESO/NAOJ/NRAO)

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of the European Organisation for Astronomical Research in the Southern Hemisphere (ESO), the U.S. National Science Foundation (NSF) and the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Republic of Chile. ALMA is funded by ESO on behalf of its Member States, by NSF in cooperation with the National Research Council of Canada (NRC) and the Ministry of Science and Technology (MOST) and by NINS in cooperation with the Academia Sinica (AS) in Taiwan and the Korea Astronomy and Space Science Institute (KASI).

ALMA construction and operations are led by ESO on behalf of its Member States; by the National Radio Astronomy Observatory (NRAO), managed by Associated Universities, Inc. (AUI), on behalf of North America; and by the National Astronomical Observatory of Japan (NAOJ) on behalf of East Asia. The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction, commissioning and operation of ALMA.



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