2021 CALENDAR

www.almaobservatory.org

JANUARY

M	T	W	T	F	S	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

ALMA

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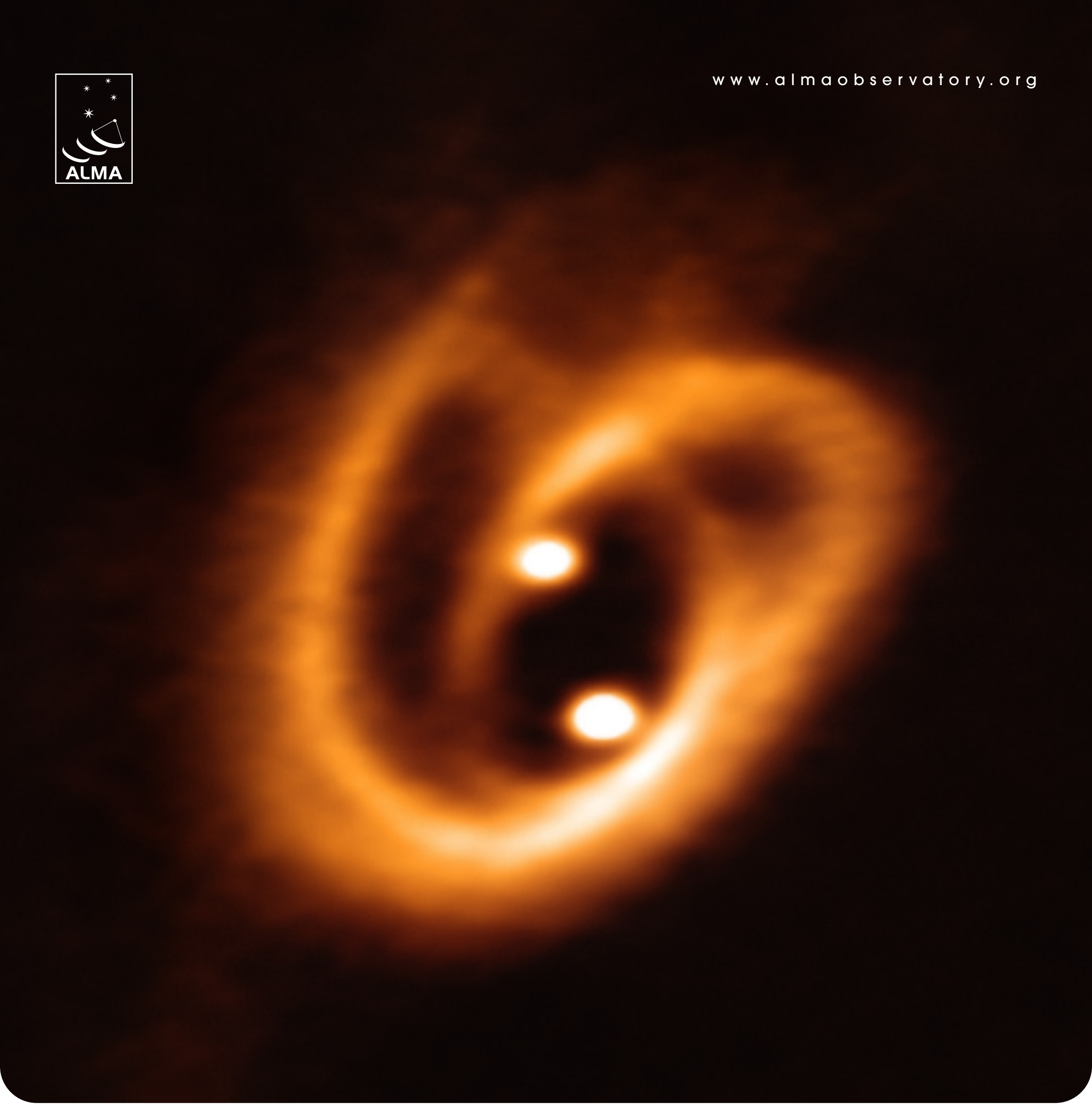

FEBRUARY

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MARCH

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ALMA

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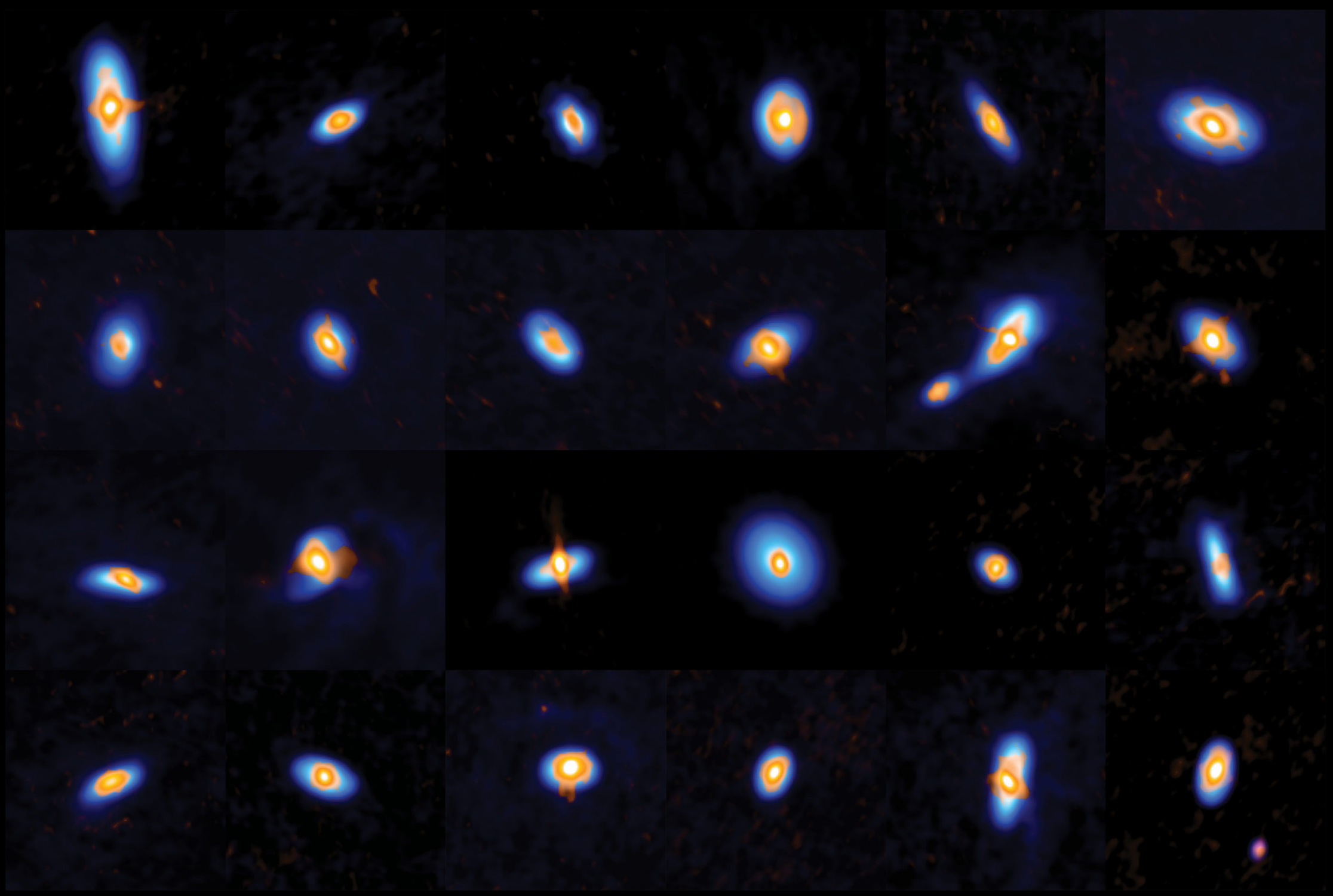

APRIL

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ALMA

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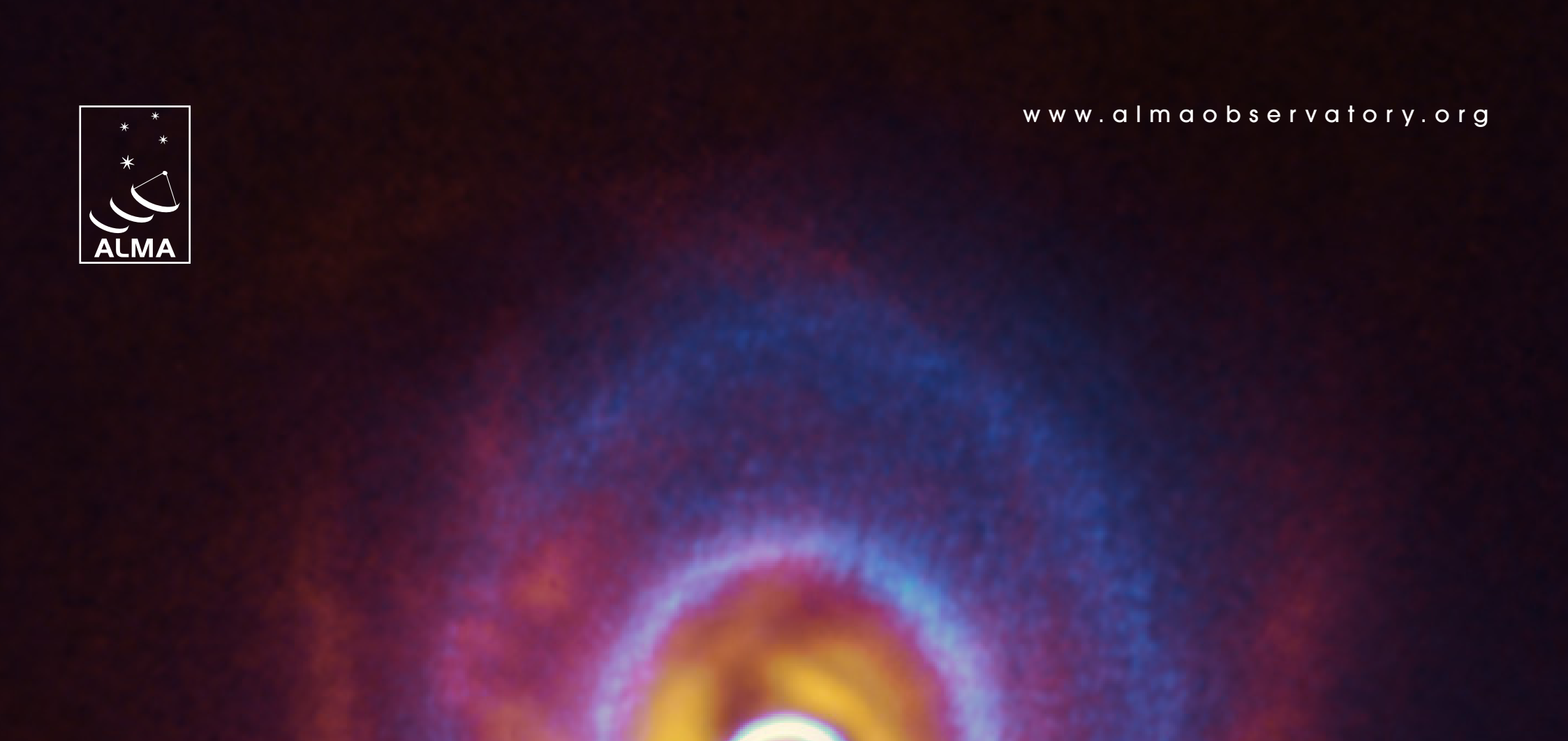

MAY

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ALMA

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JUNE

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ALMA

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JULY

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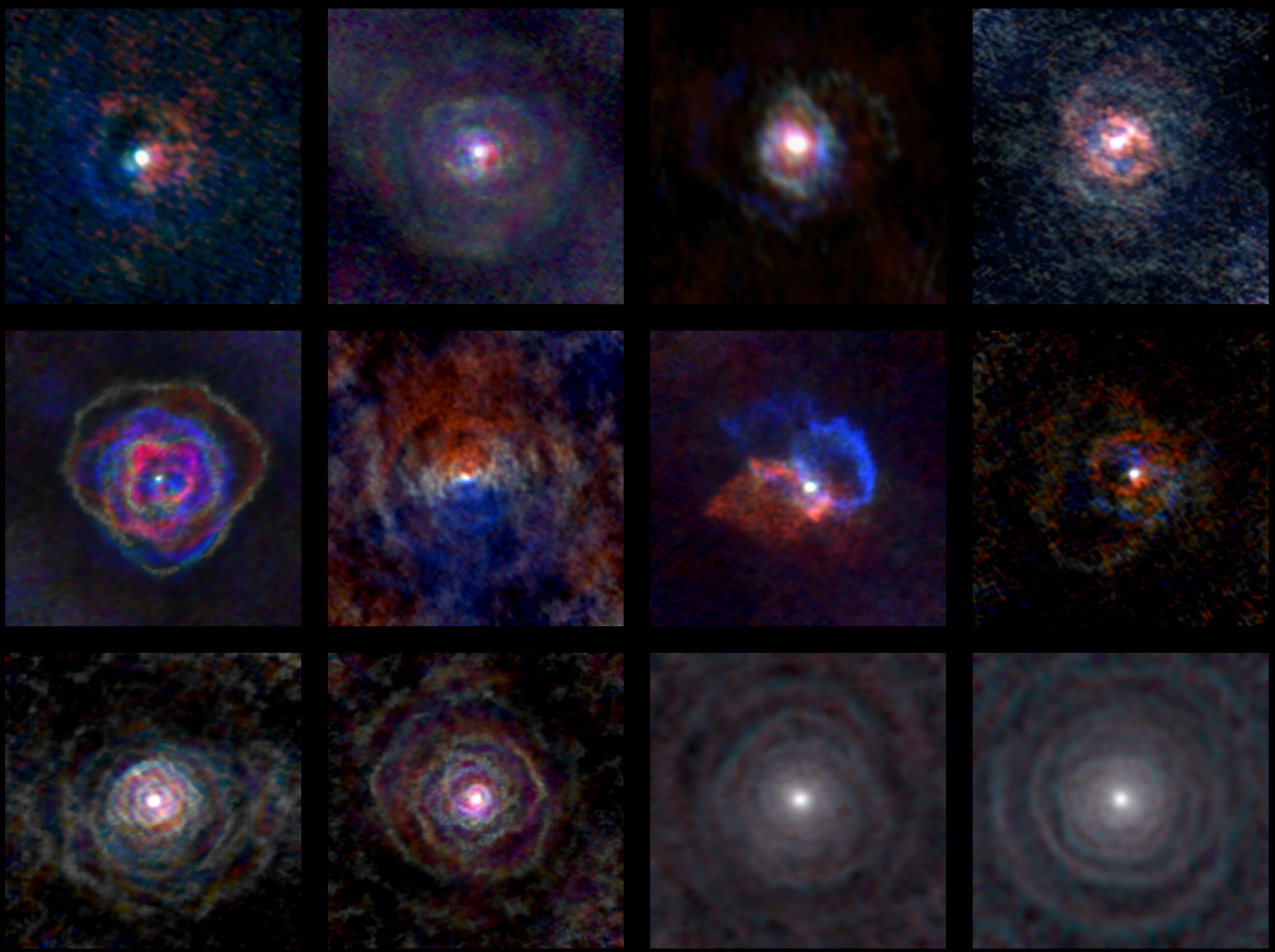

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SEPTEMBER

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ALMA

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OCTOBER

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NOVEMBER

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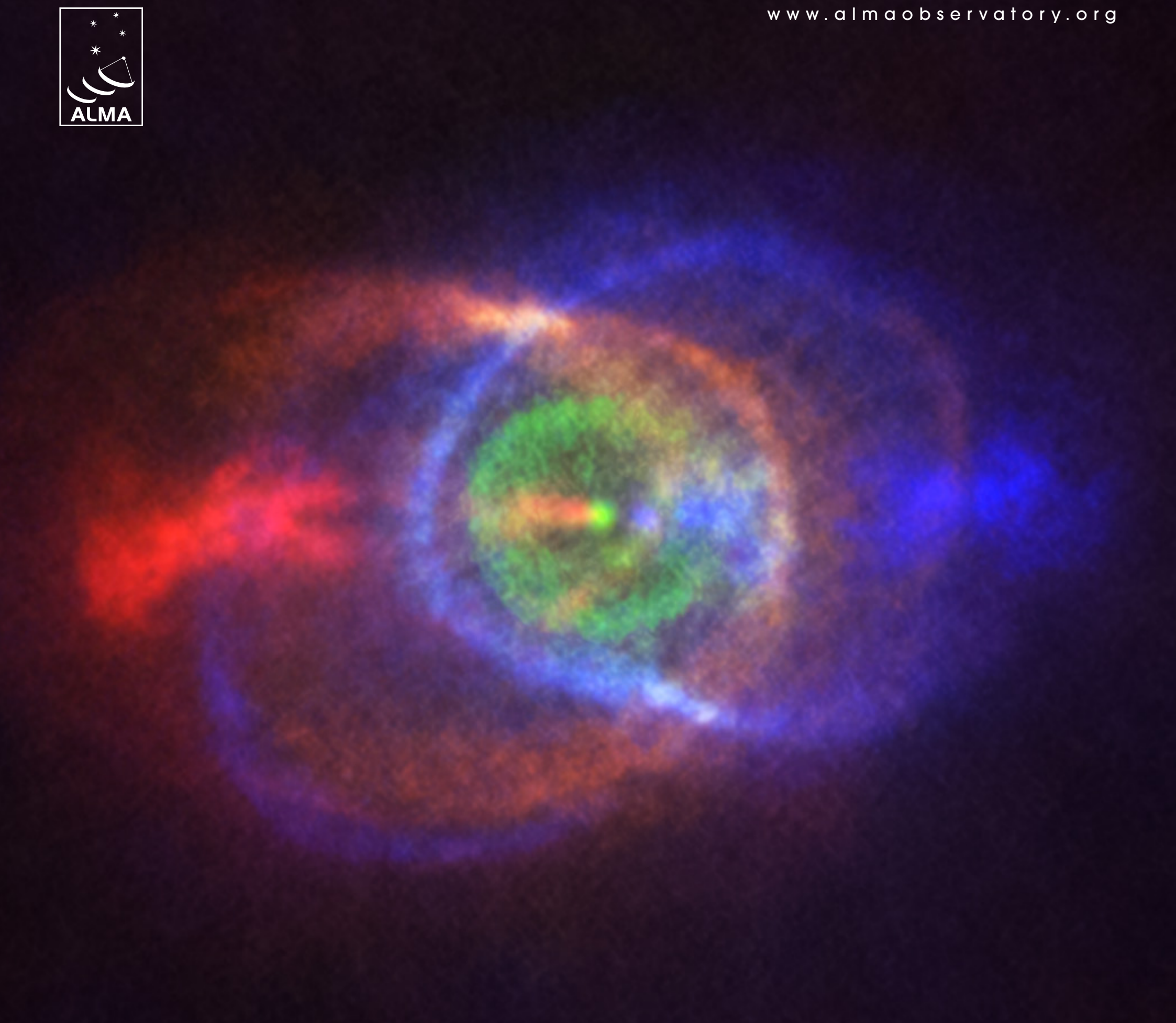

DECEMBER

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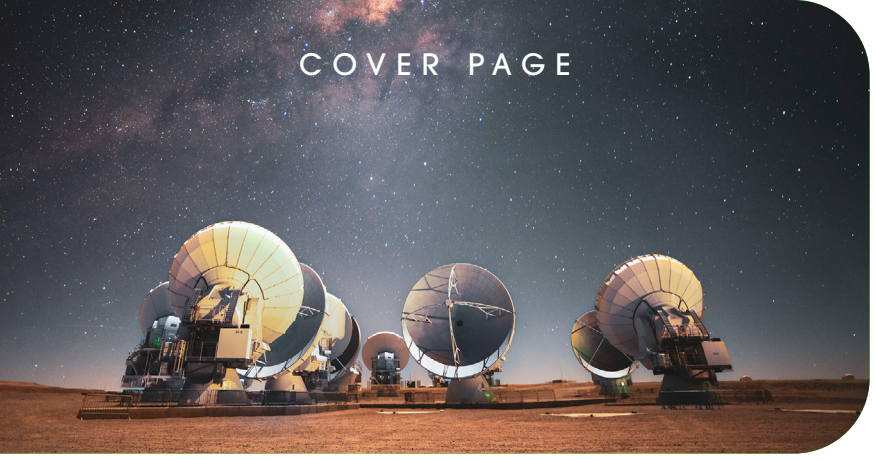


Secret meeting

ALMA antennas under the light of the Moon with the Milky Way over the Chajnantor Plateau in the background at 5,000 meters above sea level, near San Pedro de Atacama.

Although it is inhospitable for humans, the Chajnantor Plateau in northern Chile is the perfect place for astronomy in millimetric and submillimetric waves, which ALMA is sensitive to. This is a special type of light, invisible to us, which can only be captured at these heights. Little atmosphere remains here, and not all millimetric waves of the Universe are absorbed by this. This is why ALMA must be located at such heights. And because of this, the air above the antennas must be very dry; it must have low humidity, because water molecules absorb these waves. Chajnantor is the ideal site!

This long-exposure photography makes it possible to observe by night this apparently secret gathering of ALMA antennas under the bright glow of the Moon and the Milky Way.

Credit: S. Otárola - ALMA (ESO/NAOJ/NRAO)

Cosmic rainbow

A colorful gift that from time to time delights those who are hard at work in the ALMA Operations Support Facility (OSF) in the Chilean Andes.

The rainbows are deeply appreciated for the pleasant touch of color they splash onto an otherwise dark and dismal day, and this was no exception. The rare rainbow appeared above the ALMA camp, located 2900 meters above sea level near San Pedro de Atacama. Professionals in different parts of the world work for ALMA, pushing the frontiers of knowledge. In Chile, around 50 people work in Santiago, and another 200 take turns working in the offices, laboratories and antenna control room, located in the OSF. Most personnel work here, while some climb higher to the Chajnantor Plateau at 5 thousand meters in altitude, to maintain and relocate the antennas, among other activities.

This cosmic rainbow seems to be announcing the arrival of new astronomic discoveries at ALMA.

Credit: A. Silber (ESO/NAOJ/NRAO)

A cosmic pretzel

A team of astronomers used ALMA to obtain an extremely high-resolution image showing two disks in which young stars are growing, fed by a complex pretzel-shaped network of gas and dust filaments. The two baby stars were found in the (BHB2007) 11 system in the Pipe nebula. Observing them sheds new light on the earliest phases of the lives of stars and helps determine the conditions in which binary stars are born.

Previous observations of this binary system were able to determine the outer structure. Now, thanks to the high resolution of ALMA and astronomers from the Max Planck Institute for Extraterrestrial Physics in Germany, we can see their inner structure.

Each of these two stars is surrounded by a gas and dust disk and the complete structure is in turn surrounded by a complex network of dust structures distributed in spiral shapes that give the system the appearance of a pretzel. More studies of young binary systems will lead to a better understanding of how multiple stars form.

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

Ghost town

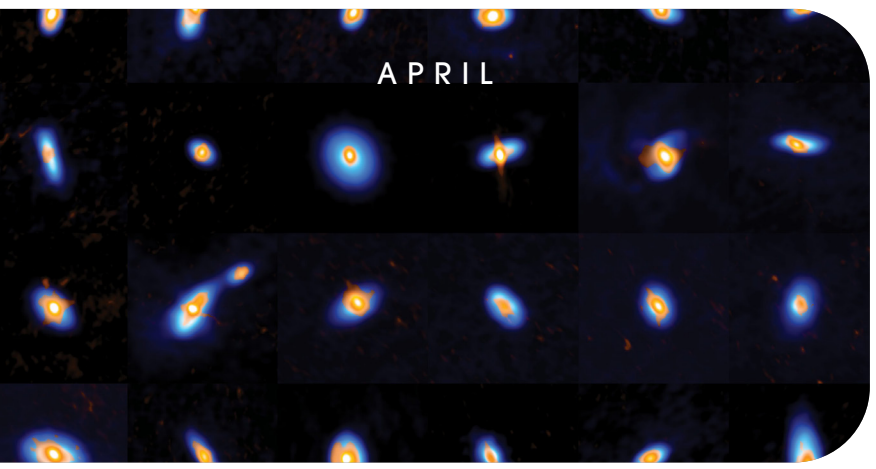
The ALMA facilities were like a ghost town for a good part of 2020 due to the global Covid-19 pandemic, with just the security team on site to protect them.

Seven months after being forced to shut down the observatory, a return to operations has begun, a lengthy task given the magnitude of the challenge of reawakening a true citadel and mostly inactive avant-guard technologies amidst an inhospitable landscape.

The first tasks were to return the power and water supply to the ALMA camp and prepare the residence for the return of staff. After almost 200 days of no electricity, it was switched back on in the Operations Support Facility, and after 223 days, the residence was once again ready to receive occupants.

The first challenges were energizing the antennas and restarting the key activity of the ALMA Correlator (supercomputer), located 5000 meters above sea level. This was followed by scientific tests of observation of the Cosmos, to get back to making science almost a year after the observatory was shut down. It felt more like fiction than reality.

Credit: A. Marinkovic - ALMA (ESO/NOAJ/NRAO)



Stars prepare for the birth of planets

Most of the stars in the Universe are accompanied by planets. These planets are born in rings of gas and dust, called protoplanetary disks, which surround them. One of the current challenges in astronomy is to understand how these disks start to form and what they look like.

Scientists used ALMA and the Karl G. Jansky Very Large Array (VLA), two of the most power radio telescopes in the world, to create more than 300 images of protoplanetary disks around very young stars in the Orion Clouds, revealing new details about the birthplaces of planets and the earliest stages of star formation.

Among hundreds of images obtained, four very young stars, also called protostars, caught the scientists' attention due to their irregular, amorphous shape. Astronomers believe that these are in one of the earliest stages of star formation and some may not even have formed into protostars yet.

Credit: ALMA (ESO/NAOJ/NRAO), J. Tobin; NRAO/AUI/NSF, S. Dagnello

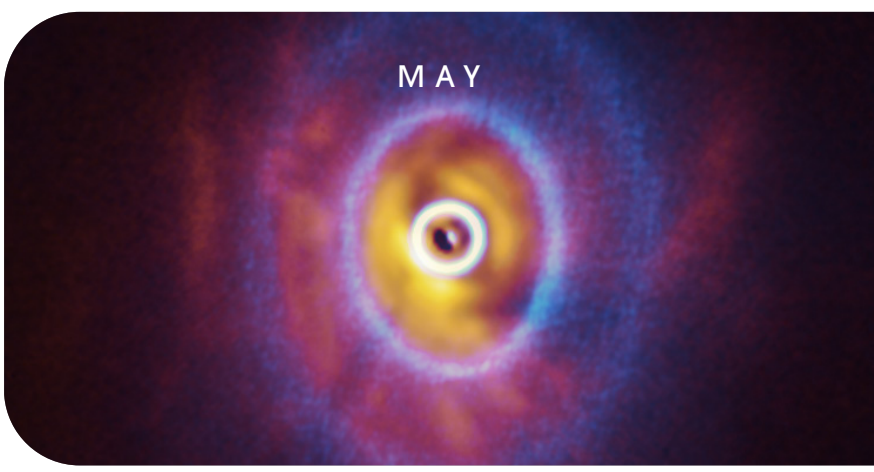
ALMA discovers misaligned rings around triple star system

Unlike planets in our Solar System, which all orbit in the same plane around the Sun, planets around these multi-star systems often have orbits that are not aligned with each other. Their crooked orbits originate in the protoplanetary disks where they are born.

ALMA made it possible to observe for the first time a protoplanetary disk with misaligned rings around a triple star system. GW Orionis is a young star system hosting three stars. Two inner stars orbit each other and are separated by 1 astronomic unit (au), equivalent to the average distance between the Earth and the Sun. A third star orbits the other two at 8 au.

Astronomers propose two possible explanations: either the disk was deformed by the gravitational pull from the stars, or by a recently formed planet. If the existence of a planet is confirmed, it would be the first planet ever discovered to orbit three stars, which would make for a very unusual orbit.

Credit: ALMA (ESO/NAOJ/NRAO), ESO/Exeter/Kraus et al.



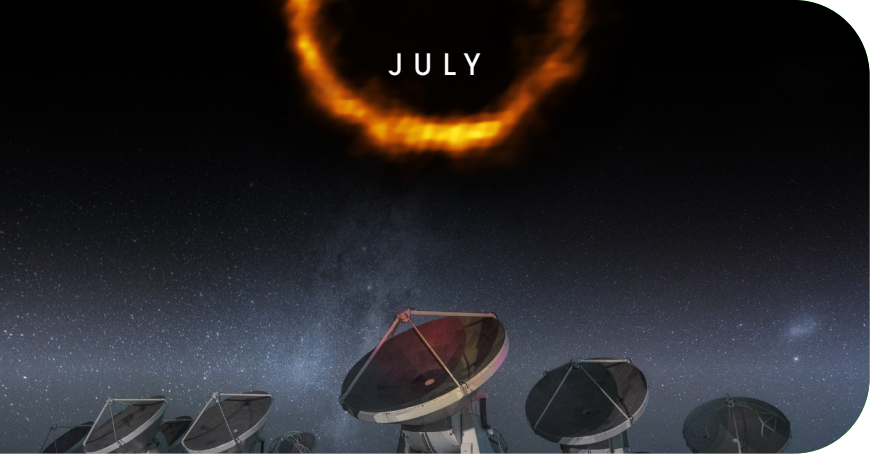
Frequent visitor

Despite its similarity with a Martian landscape, the Atacama Desert is home to endemic flora and fauna, which over centuries have developed techniques to adapt to the rugged living conditions. ALMA workers frequently spot vicuñas, vizcachas, flamingos, foxes, the cardon cactus, rica-rica and llareta, animals and plants that inhabit this incredible landscape.

The Chajnantor Plateau, where the ALMA antennas are located 5,000 meters above sea level, is also visited by the Andean fox (Lycalopex culpaeus), who feeds on rodents, hares, birds and lizards, and to a lesser degree, plants and carrion.

From the outset of the project, the construction of ALMA has maintained a firm commitment to the environment and the local culture, protecting its unique species. Animals such as the llama, the fox and the condor do not only live in the area where the observatory is located, but they are also essential elements to ancestral Andean constellations. They form part of the same sky that is explored by ALMA.

Credit: Peter Pihlmann - ALMA (ESO/NAOJ/NRAO)

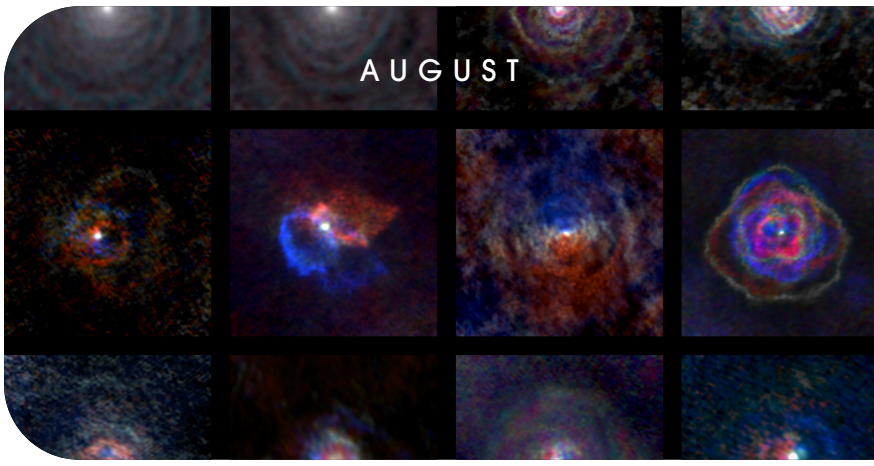


ALMA observes most distant Milky Way look-alike galaxy

Studying distant galaxies is fundamental to our understanding of how galaxies like the Milky Way formed and evolved. Because these galaxies are so far away, detailed observations with even the most powerful telescopes are almost impossible. Astronomers overcome this obstacle by using a nearby galaxy as a powerful magnifying glass, an effect known as gravitational lensing. This is possible because the gravitational pull from the nearby galaxy distorts and bends the light from the distant galaxy, causing it to appear misshapen and magnified. This magnifying effect allowed ALMA to see into the distant past in unprecedented detail.

The image achieved by ALMA revealed the presence of an extremely distant and therefore very young galaxy that to the surprise of the astronomers looks like the Milky Way. This suggests that the early Universe may not be as chaotic as once believed and raises many questions on how a well-ordered galaxy could have formed so soon after the Big Bang.

Astronomical image Credit: ALMA (ESO/NAOJ/NRAO), Rizzo et al. / Antennas Image Credit: D. Kordan (ESO)



Astronomers capture stellar winds in unprecedented detail

Dying stars produce stellar winds, flows of particles that the star expels, which causes them to lose mass and eventually become red giants. As the star evolves further, it heats up again, and the stellar radiation causes the expanding ejected layers of stellar material to glow, forming a planetary nebula.

Astronomers had always assumed that these winds were spherical, like the stars they surround. However, astronomers used ALMA to observe stellar winds around several cold red giant stars to create a catalog of their diverse forms and structures. What astronomers saw surprised them: far from being symmetrical and spherical as expected, they realized that they had multiple shapes and were even quite similar to planetary nebulae. They found stellar winds that had spirals, were disk-shaped or even had cones: a clear indication that the shapes weren't created randomly, but rather that other low-mass stars or even heavy planets in the dying star's vicinity were causing different patterns.

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

Outreach on Radio Astronomy

Bringing the world of radio astronomy closer to the general public is one of the goals of ALMA. To reach this goal, it has designed a system of free guided tours to the Operations Support Facility (OSF) located 2900 meters above sea level in the Atacama Desert. This is where most ALMA employees work, where visitors can tour the antenna control room, laboratories and sometimes see an antenna in maintenance and an antenna transporter.

Every Saturday and Sunday morning, the doors of the observatory open to those who have signed up previously on the ALMA website. For those who want to visit the facilities in northern Chile, the tour starts in San Pedro de Atacama, 50 km away, where they are picked up by the free observatory shuttle.

Guided tours are also held for groups from schools, universities, institutes or scientific organizations to explain how the observatory works and to learn about the work areas. For safety reasons, the Array Operations Site (AOS) on the Chajnantor Plateau, at 5,000 meters above sea level (where the antennas are located) is not open to visitors.

Credit: ALMA (ESO/NAOJ/NRAO)

10 years of cutting-edge science

On October 3, 2011, ALMA opened its eyes, revealing the first scientific image. The most complex earth observatory in the world offered an unprecedented view of the Antenna Galaxies and began a long period of scientific revelations at the forefront of knowledge.

The Antenna Galaxies are a duo of colliding galaxies with extraordinarily distorted shapes. Whereas optic light observations let us see stars in galaxies, ALMA reveals objects that are invisible to the naked eye, such as dense clouds of cold gas where stars are formed.

A decade later, this powerful observatory has participated in multiple top-of-the line scientific discoveries, such as the detailed observation of multiple protoplanetary disks or participation of the first image of a black hole in conjunction with the Event Horizon Telescope.

Credit: ALMA (ESO/NAOJ/NRAO), Telescopio Espacial Hubble de NASA/ESA

Marvelous union between science and landscape

It is easy to lose perspective of scale and dimension amidst the vast Chajnantor Plateau, making even the immense ALMA antennas look tiny.

It is also strange to find these enormous antennas in the middle of the Atacama Desert at 5,000 meters above sea level. It is surprising to see this marvelous union between cutting-edge science and a landscape that has remained intact for thousands of years.

The ALMA antenna operations site is truly inhospitable. Not only because of the intense desert sun, but also because several meters of snow can fall during the "Altiplano winter" in January and February.

ALMA's 66 antennas come from Europe, North America and East Asia. Each manufacturer had to meet identical technical requirements, with only slight design differences.

The 12-meter diameter disks of the ALMA antennas seem to be waving at the clouds as they observe diverse objects in the Universe, including the center of our galaxy and the Magellanic Clouds. This was one of the many reasons why Chile and specifically the Chajnantor Plateau was chosen as the location of ALMA.

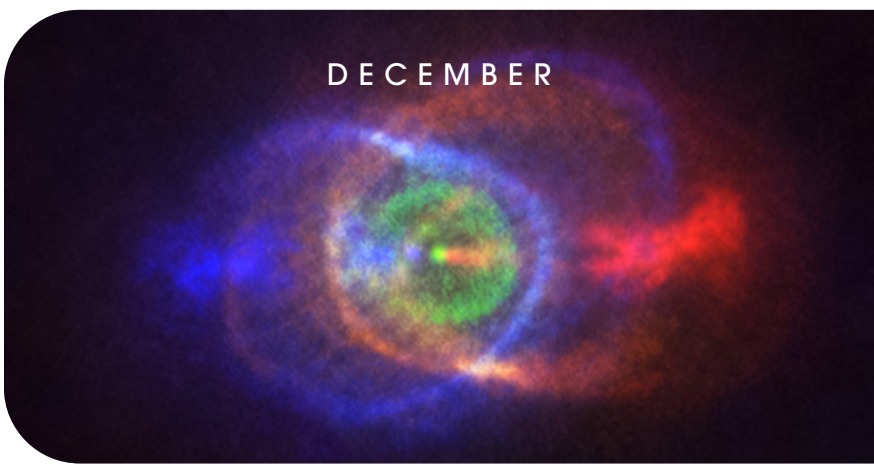
Credit: B. Tafreshi (ESO)

ALMA captures outcome of a stellar fight

Like humans, stars change with age and ultimately die. For the Sun and stars like it, this change will take it through a phase where, having burned all the hydrogen in its core, it swells up into a large and bright red-giant star. Eventually, the dying Sun will lose its outer layers, leaving behind its core: a hot and dense star called a white dwarf.

The double-star system HD101584 is special in the sense that this process was terminated prematurely and dramatically. New ALMA observations complemented by data from APEX enabled the team of astronomers to determine what happened. As the main star puffed up into a red giant, it grew large enough to swallow its lower-mass partner. In response, the smaller star spiraled in towards the giant's core but didn't collide with it. Rather, this maneuver triggered the larger star into an outburst, leaving its gas layers dramatically scattered and its core exposed.

Credit: ALMA (ESO/NAOJ/NRAO), Olofsson et al. Agradecimientos a: Robert Cumming



When the Sun and Moon embrace

Students and teachers from elementary and high schools in San Pedro de Atacama and Toconao received solar glasses from the ALMA observatory to safely observe the solar eclipse on July 2, 2019.

"I really like the glasses because it lets us see how weird eclipses are, when the Sun and Moon actually come together and hug each other," said Sofía Acevedo, 4th grade student at School E-26 in San Pedro de Atacama.

Teachers in the area also became students and learned how to explain eclipses. How can we determine how far the Moon is from Earth? This was one of the questions answered through practical activities that formed part of the workshop "The day when the Sun hides, why do eclipses occur?" in the ALMA Observatory facilities located near San Pedro de Atacama.

ALMA also handed out special devices for visually impaired people to experience the eclipse through sound rather than light.

Credit: 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.

ALMA.Observatory ALMA.Radiotelescope ALMAobs ALMAobservatory