THE FREE MULTIMEDIA MAGAZINE THAT KEEPS YOU UPDATED ON WHAT IS HAPPENING IN SPACE

FREE ASTRONOMY magazine

Bi-monthly magazine of scientific and technical information ✶ March-April 2019

The Genesis Project and planetary protection

Mars rover Opportunity retired

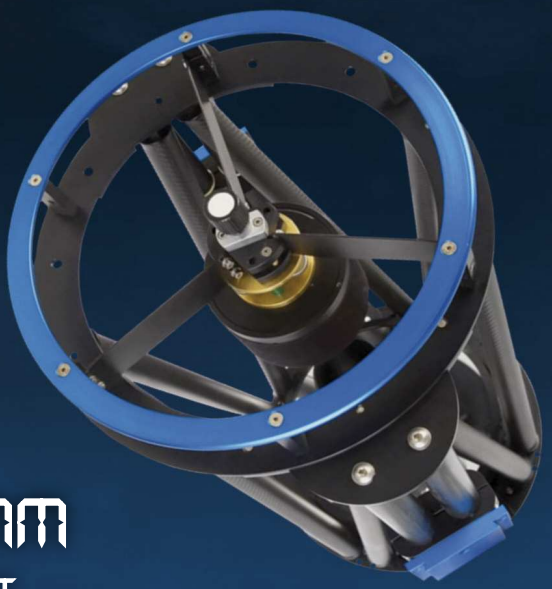
- Hubble sees the brightest quasar in the early Universe
- ESO to host Cherenkov Telescope Array-South at Paranal
- NASA's New Horizons mission reveals entirely new kind of world
- ALMA discovers early protostar with a warped disk
- Hubble finds a fast evaporating exoplanet

Orbital advertising – a concrete risk

www.astropublishing.com ✶ www.facebook.com/astropublishing ✶ info@astropublishing.com

NortheK

Instruments - Composites - Optics



RITCHEY-CHRÉTIEN 250 MM

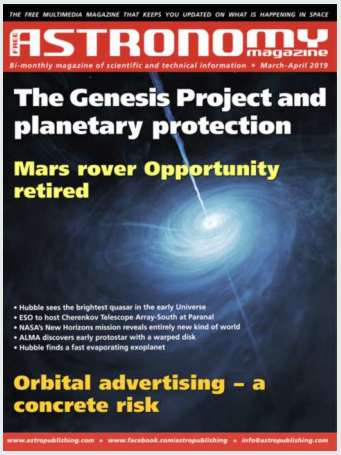
F/8.5 SUPRAX OPTICS FROM SCHOTT
CARBON STRUCTURE
NORTHEK CELL STABILOBLOK 2S
FOCUSER FEATHER TOUCH FTF 2000 2"
WEIGHT 15 KG.

www.northek.it - www.facebook.com/northek.it - info@northek.it - phone +39 01599521

FREE ASTRONOMY magazine

BI-MONTHLY MAGAZINE OF SCIENTIFIC AND TECHNICAL INFORMATION FREELY AVAILABLE THROUGH THE INTERNET

March-April 2019



English edition of the magazine

ASTROFILO

Editor in chief
Michele Ferrara

Scientific advisor
Prof. Enrico Maria Corsini

Publisher
Astro Publishing di Pirlo L.
Via Bonomelli, 106
25049 Iseo - BS - ITALY
email info@astropublishing.com

Internet Service Provider
Aruba S.p.A.
Via San Clemente, 53
24036 Ponte San Pietro - BG - ITALY

Advertising - Administration
Astro Publishing di Pirlo L.
Via Bonomelli, 106
25049 Iseo - BS - ITALY
email admin@astropublishing.com

SUMMARY

The Genesis Pro and planetary p

by Michele Ferrara

revised by Damian G. Allis
NASA Solar System Ambassador

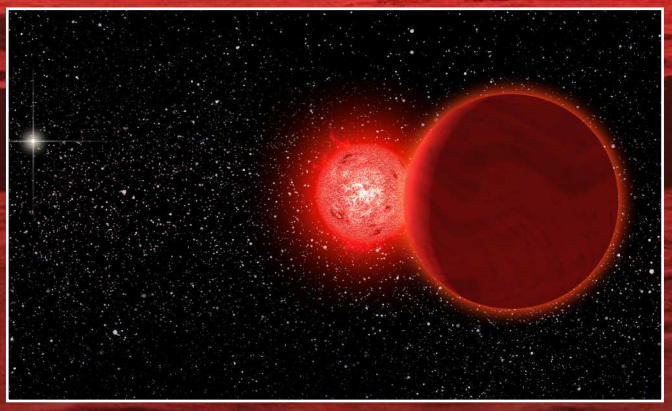
In the relatively near future, we will be able to colonize some exoplanets with elementary life forms. The opportunity to proceed in this direction is linked to a number of factors that are not yet completely understood and that, for some aspects, raise ethical issues. However, the most basic problem remains – that of having an experience that is limited to life only on Earth, a model that is not necessarily universal.

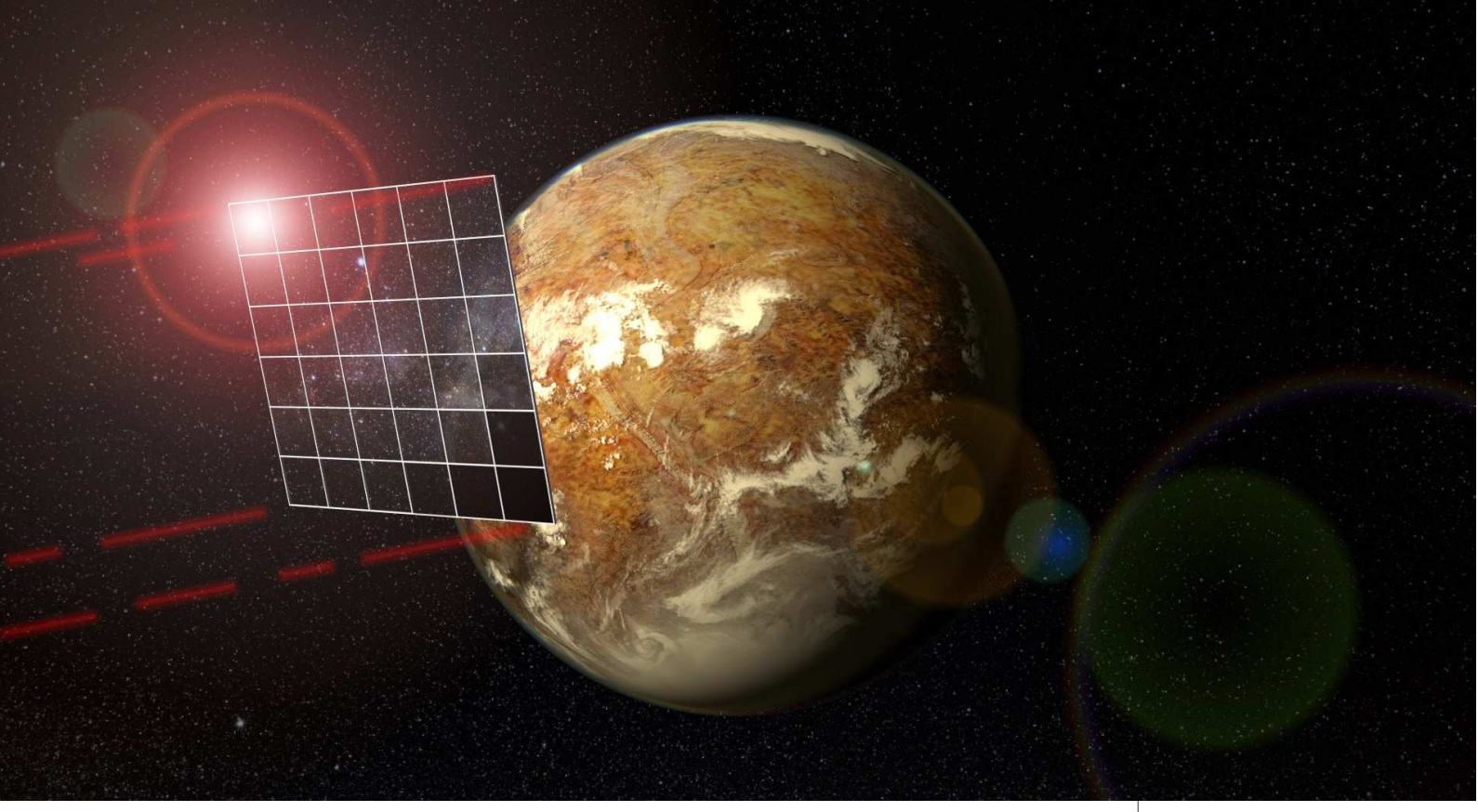
The exploration of other planets, their moons, and smaller bodies must respect a practice known as "planetary protection." Any space agency that decides to land an automatic probe or crew on the surface of a celestial body other than the Earth is required to avoid biological contamination of the visited body, sterilizing all the material that comes into contact with the extraterrestrial envi-

ject rotection

A rendering of the Gliese 667C system as seen from planet "d" (background image) and of Scholz's Star (right). Considered as possible cradles of extraterrestrial life, the red dwarf's planets might not be at all. [ESO/M. Kornmesser, T. Reyes]

ronment. The same procedure is implemented when space missions contemplate the return to Earth of samples taken from other celestial bodies. At first glance, all these precautions may appear excessive, as the existence of extraterrestrial life on the celestial bodies we are now able to reach is very unlikely. However remote the probability of biological contamination is, we cannot





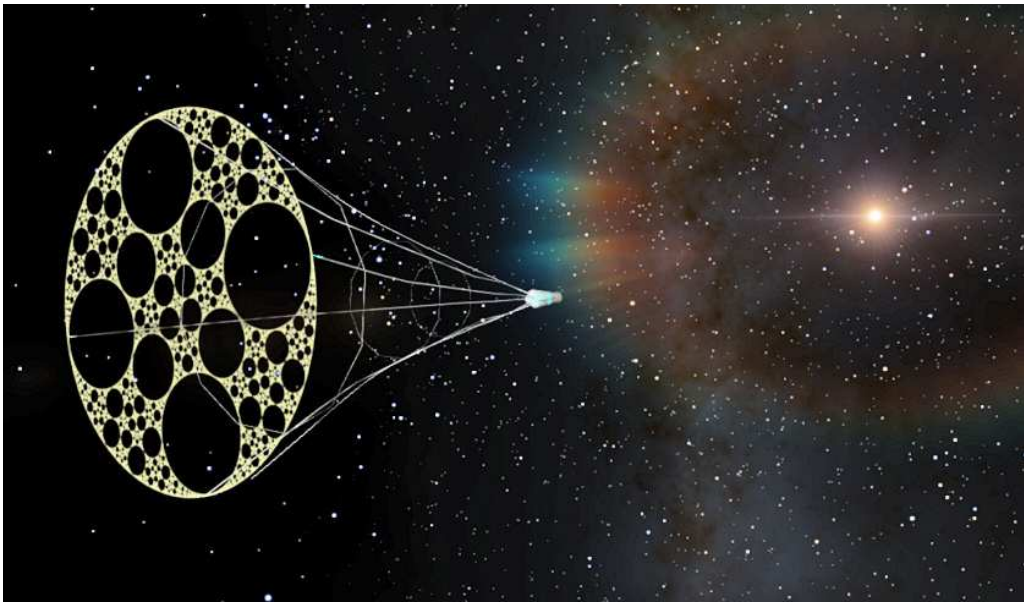
run the risk of bringing life (essentially bacteria) where we intend to go looking for it, thus potentially invalidating the research itself. Nor can we expose our terrestrial biosphere to extraterrestrial contamination, the consequences of which are not at all predictable because we do not know how universal and adaptable the immune systems of the involved organisms might be. Biological defense mechanisms evolve only when the threat becomes real and is recognized on the basis of some typical products of microbial metabolism.

Microbes belonging to an alien biosphere may not be recognized as a threat to terrestrial organisms, and the attacked organisms may have no defense to the alien microbes or their metabolic products.

If the practice of planetary protection is mandatory within our own solar system, the same cannot be said about its application to other planetary systems, even if their exploration comes with similar ethical issues. At first sight, it seems a matter of a distant future – but it is not so, as there are projects that already aim to spread terres-

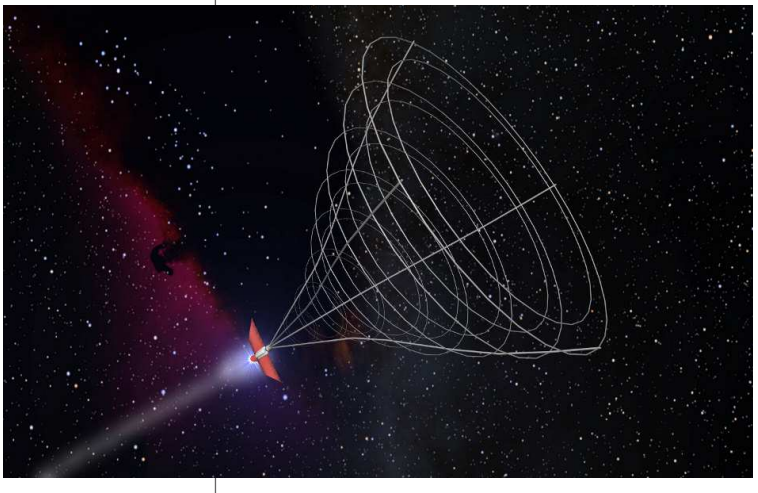
Artist concept of a wafersat approaching the potentially-habitable exoplanet Proxima b. [PHL @ UPR Arecibo] The video below illustrates the Breakthrough Starshot project. [Breakthrough Starshot Initiatives]

On the right and on the bottom, possible designs of the structures needed to brake the Genesis spacecrafts near their destinations. [Steve Bowers]



trial life on potentially habitable extrasolar planets. One of these is the Genesis Project, promoted since 2016 by Claudius Gros of the Institut für Theoretische Physik of the Goethe-Universität in Frankfurt. The idea is based on optimistic assumptions but far from the abstract: it considers three areas of research that have progressed in recent years to the point of allowing a serious assessment of the feasibility of interstellar travel, even with a biological load.

The first area of research is in the great numbers of extrasolar planets and the unveiling of the great variety of existing worlds, a percentage of which may not be able to generate their own biosphere, but may be able to host one introduced from outside.



The second area concerns the possibility of significantly shortening interstellar travel times by accelerating miniaturized, and therefore very light, probes at speeds of tens of thousands of km/s using arrays of powerful laser beams, as foreseen by Starshot Breakthrough Systems.

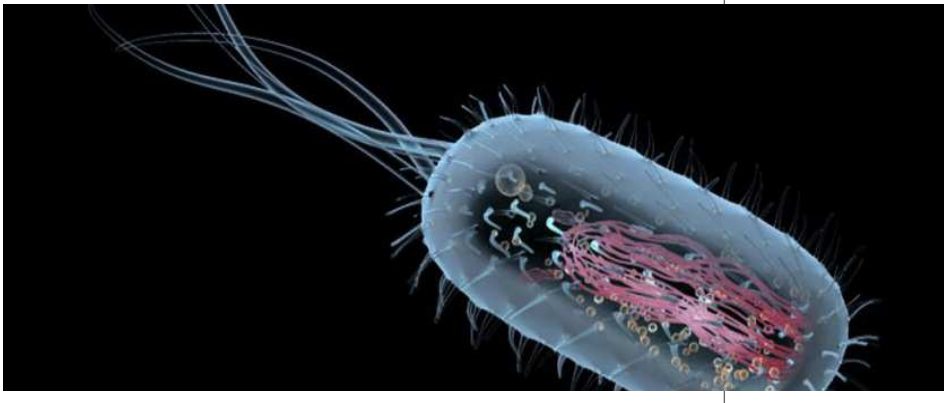
The third area upon which the Genesis Project relies concerns recent progress in the synthesis of microbes that allows us to consider the possibility of using a biological mini-laboratory to synthesize single-cell organisms, starting from their constitutive subcellular elements and tailored to the target planets. In the case of relatively short travels, it could directly send dormant spores, which are then revitalized once the destination is reached.

It is likely that, by the end of this century, a project similar to the one proposed by Gros can be started. It is, therefore, licit to ask ourselves today what ethical and practical issues must be addressed to lead to its realization.

As you can easily imagine, time is the determining factor for defining the purposes of interstellar travel. The form of propulsion known as "directed energy launching sys-

tems," suggested by Breakthrough Initiatives to accelerate so-called wafersats (mini-spacecrafts, weighing a few grams, structured as a wafer and fixed to a sail) using laser light, should be able to reach speeds close to 20% that of light – around 60,000 km/s. At this pace, a wafersat would cover the distance of a light year in as little as five Earth years. In 20-30 years, the Proxima Centauri and Barnard's Star planetary systems could be reached by this method.

Missions moving so fast, achievable thanks to the essentiality of wafersats, pay the price of not being able to carry loads and not being able to do anything more than a very fast flyby of their targets. Therefore, they are not a solution adoptable by the Genesis Project, which has other needs, including the transport of a biological mini-laboratory or, at least, a container with spores. Once close to the destination, the interstellar vehicle will also have to decelerate significantly to allow the release of the vital load into the



The illustrations on these two pages are meant to represent three fundamental episodes in the evolution of life on Earth. Below,

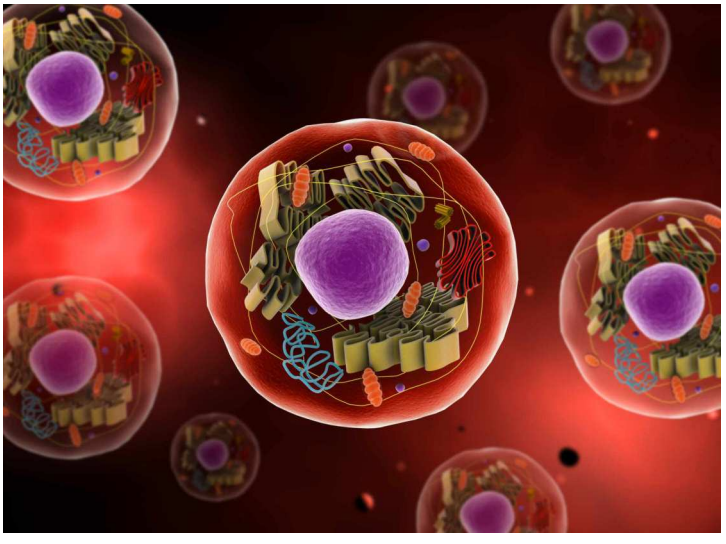
the appearance of prokaryotes, primitive organisms without a structured nucleus. On the right, the appearance of eukaryotes, cells with a well-defined nucleus, from which the evolution of animals and plants occurred. [Getty/Stocktrek Images] Above, the Cambrian explosion, during which there was an extraordinary evolution and diversification of organisms thanks to the abundance of oxygen in the atmosphere. [Quanta Magazine]

atmosphere of the chosen planet. According to Gros, this operation can be accomplished by using a magnetic field created by a superconducting loop with a radius of about 50 km, which, by attracting the free protons encountered towards the end of the travel, would transfer to those protons part of the spacecraft's kinetic energy. Equipping the latter with a device of that kind would increase the mass by about 1.5 tons, resulting in a very strong reduction in the maximum achievable speed.

Gros estimates that the most efficient propulsion systems today realistically imaginable would be able to push a spacecraft of a few tons up to a speed of about 1000 km/s, 50 times faster than that of the Voyager probes. This means that travel to the nearest extrasolar planets would last well over 1200 years, a period that largely exceeds typical human planning horizons. It is unlikely that a "launch-and-forget" mission, which requires enormous funding without bringing any benefit to those who allocate them, could be realized. Moreover, such long navigation times have to survive the lifetime of the technological components, which on average would probably be less than a thousand years.

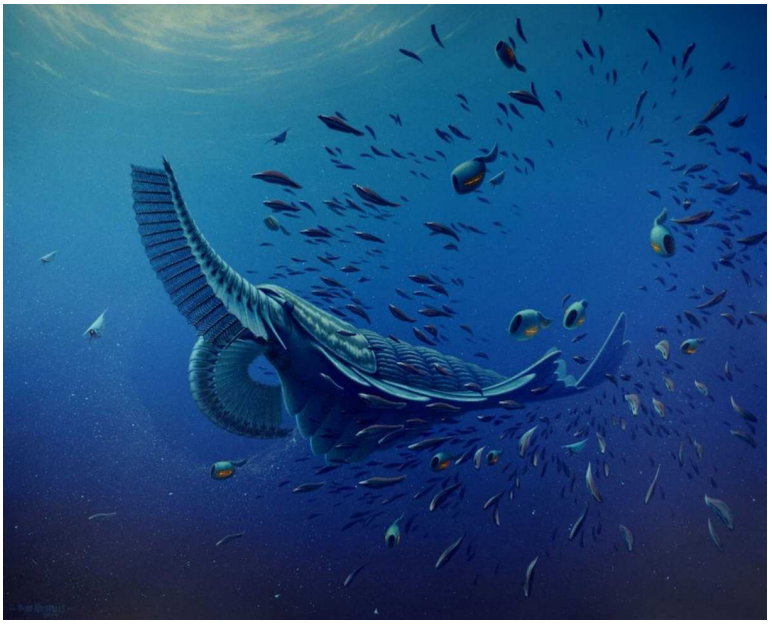
Suppose that we want to be optimistic and hypothesize that the Genesis Project can actually be realized in the near future. In addition to the almost insurmountable technical difficulties, which we leave out, there is left to solve the ethical issue linked with the desire to bring life forms where life might already exist, risking the annihilation of the autochthonous species.

In order to avoid invading a planet that already hosts life, it would be necessary to investigate biomarkers in its atmosphere beforehand, an operation that will be carried out within a few years through the new telescopes that are about to



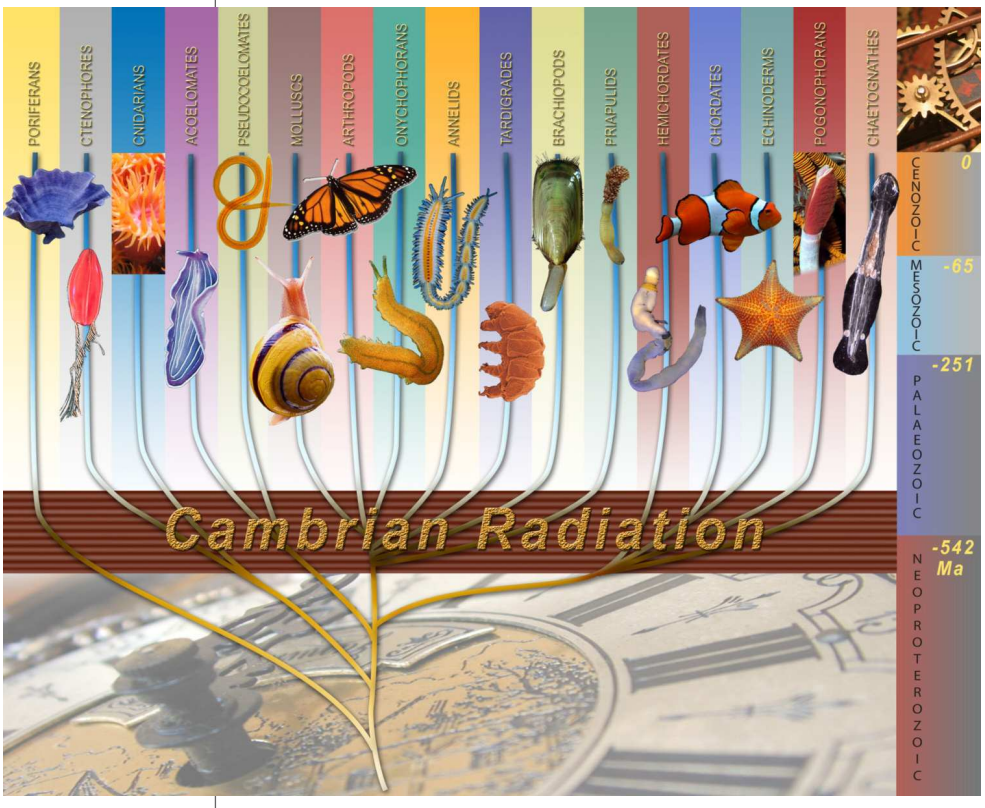
enter the scene. Yet, it will not always be possible to establish with certainty whether a planet is uninhabited.

Gros believes that this problem does not arise if the Genesis missions will target planets habitable for a period shorter than that necessary for the development of single-cell or multicellular organisms. On the basis of the only experience we have – the evolution of life on Earth – we know that, from the formation of our planet to the appearance of prokaryotes (archaea and bacteria, single-cell organisms without a structured nucleus and the first life on Earth), at least 600 million years passed. Then, another couple of billion years had to pass for the evolutionary leap that led to the appearance of eukaryotes, monocellular and multicellular organisms with a well-defined nucleus, which have over time lead to all plants and animals. Here is what Gros said about this: *"It is not a coincidence, that higher life forms are made of eukaryotic and not of prokaryotic cells, but a consequence of the energy barrier that prevents prokaryotic cells to support genomes of eukaryotic size. The massive genomes necessary for the coding of complex eukaryotic morphologies are typically four to six orders of magnitude larger than the genetic information encoding prokaryotic life. The emergence of eukaryotic cells has been on Earth the key bottleneck along the route from unicellular to multi-cellular and morphological complex life."*



In the time-lapse between the appearance of the most elementary prokaryotes and the appearance of the most evolved eukaryotes, the atmosphere of our planet has undergone a decisive transformation: oxygen, almost absent in

This image shows a 2.1 billion-year-old rock containing black-banded ironstone. At that time, oxygen was already abundant in the atmosphere. The rock was found in North America and belongs to the National Museum of Mineralogy and Geology in Dresden, Germany. [André Karwath] On the left, a representation of the rich marine fauna of the Cambrian, where stands out a specimen of Tamiscolaris, an invertebrate that fed itself by filtering the water.



This scheme effectively sums up the great diversification of fauna following the Cambrian explosion (or Cambrian radiation). The taxonomic groups (phyla) literally multiplied in a geologically short period.

the course of the Hadean eon and most of the Archean eon, became more and more abundant at the end of the Archean itself, between 2.8 and 2.5 billion years ago, thanks to the evolution of photosynthetic organisms. These led to the so-called "great oxidation" of the Proterozoic eon, which resulted in what is known as the "Cambrian explosion," a sudden (geologically speaking) appearance of many new animal and plant species, occurring between 540 and 520 million years ago. In this period, the rate of evolution increased by an order of magnitude and the diversity of life forms began that is similar to the diversity we see today.

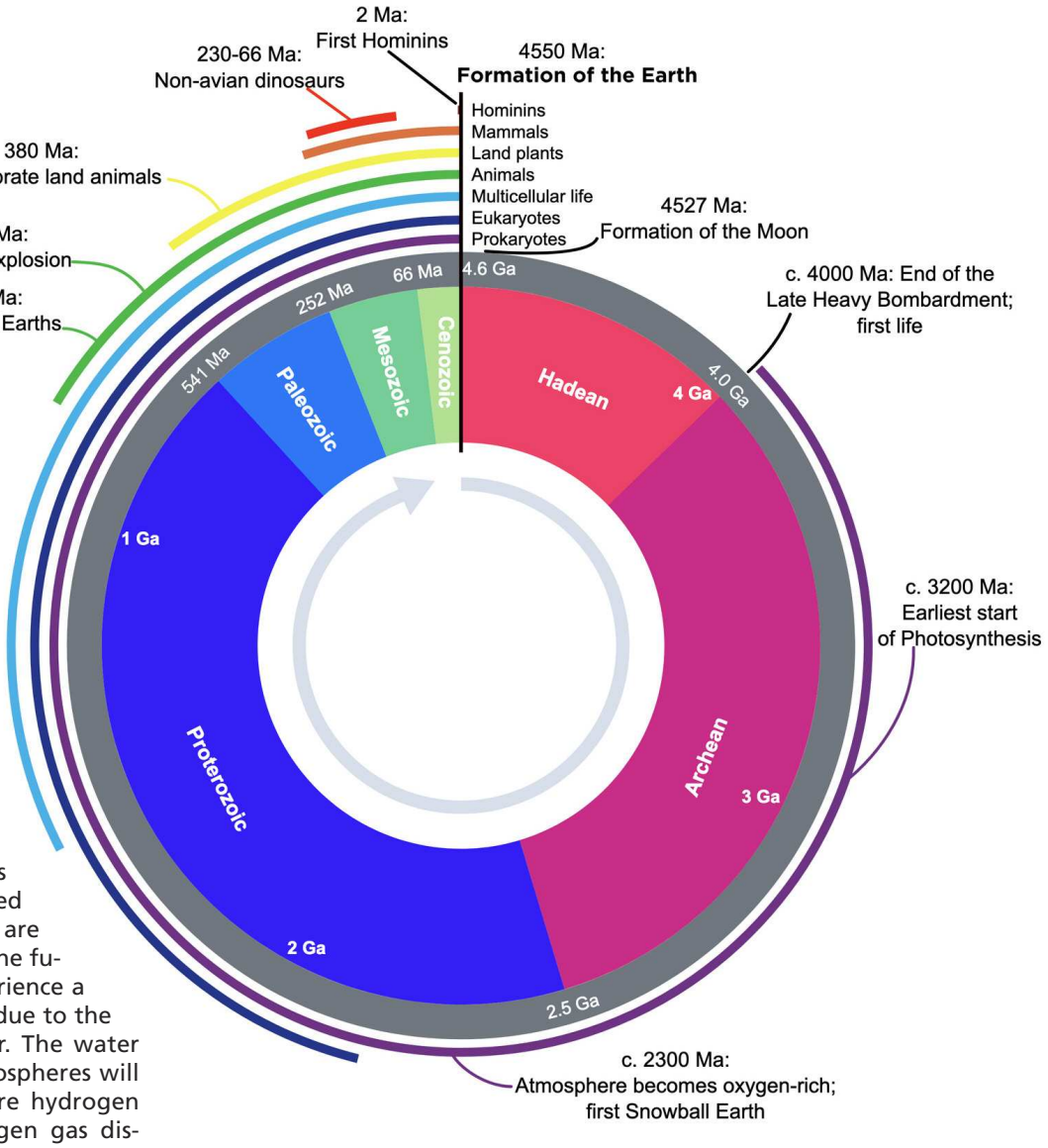
The new scenario effectively canceled the initial conditions favorable to abiogenesis, a process very unlikely in the presence of reactive oxygen molecules. From that time on, new species have arisen through evolution and no new organisms or species have sprung forth from just organic compounds as occurred when life first began on Earth.

In other words, if the Earth's atmosphere had been rich in oxygen from the beginning, life would not have appeared, despite being suitable for hosting eukaryotes and all their descendants.

According to Gros, this circumstance is the decisive element for overcoming the ethical problem in the spread of terrestrial life on extrasolar planets. As targets of the Genesis Project, one could, in fact, select only planets whose original atmosphere was already rich in oxygen; this would guarantee that life could not have appeared on them as we know it.

Although we cannot exclude abiogenesis in the presence of oxygen a priori, a known relation between this gas and cellular energy tells us that the synthesis of the chemical constituents of cells, such as amino acids, bases and lipids, from glucose and ammonium, requires about 13 times more energy per cell in the presence of molecular oxygen (O_2) than in the absence of oxygen. Since Nature preferably adopts solutions that require less energy (this is why the stars are spherical and not cubic), it is reasonable to suppose that a primordial atmosphere rich in oxygen should be generally hostile to the appearance of life. Planets with this type of atmosphere are therefore virtually sterile, but they can adopt terrestrial eukaryotes, allowing them to evolve towards more complex forms. The Genesis Project would hence offer an evolutionary short-cut, skipping the billions of years necessary for basic life forms to evolve and move directly to the point where complex organisms can begin to diversify.

But how can we distinguish between an atmosphere in which oxygen has always been abundant and an atmosphere enriched with



oxygen only subsequently by photosynthetic processes? This point is fundamental for planetary protection purposes. We find the answer in our knowledge of stellar evolution. The time a protostar takes to contract from an interstellar cloud of gas and reach the so-called "main sequence" is inversely proportional to its mass. For Sun-like stars, this period extends to about 10 million years and ends before any planets are fully formed. For smaller mass stars, such as red dwarfs, times can stretch up to several hundred million years. The planets that are orbiting around the latter, in the future habitable zone, will experience a prolonged greenhouse effect due to the larger initial size of their star. The water present in the planetary stratospheres will be photo-dissociated into pure hydrogen and oxygen, with the hydrogen gas dispersed into space due to its lightness, and the oxygen gas left to accumulate in the atmosphere. If this process were the rule (the topic is still under discussion), the number of planets compatible with the Genesis Project would be very high. It is estimated that there can be a habitable planet every five red dwarfs, and that these stars make up 85% of the stellar population of the entire galaxy. Therefore, there may exist tens of millions of "fertilizable" planets, some of which are a few light-years from Earth. All this is positive for Gros, but not for those who trust precisely on a red dwarfs' planetary systems to discover the first traces of extraterrestrial life in the form of biomarkers, among which oxygen seemed to be the most interesting. But for the Genesis Project, there is also some bad news. A study recently conducted by Abraham Loeb and Manasvi Lingam (Harvard University) shows that red dwarfs' planets might not receive enough radiation from their stars to allow photosynthesis: the flow of UV rays would be insufficient to maintain a biosphere similar to Earth's. Perhaps, it is no coincidence that the only inhabited planet we know orbits around a yellow dwarf. ■

This infographic shows with remarkable clarity the fundamental stages of geology and biology on Earth, highlighting events of great importance in the evolution of the biosphere. On the left, Claudius Gros, the promoter of the Genesis project. [Institut für Theoretische Physik, Goethe-Universität]

IMPRESSIVE WIDE-ANGLE VIEWS

Now available in your telescope, too!

omegon®

Omegon Panorama II 100° eyepieces

Astronomy magazine 2018 Star Products

Scan for more info.

Wide angle 100°

With Panorama II eyepieces, a wide field of view allows you to observe more of the cosmos at a glance.

Crisp stars to the periphery

Panorama II eyepieces provide excellent, crisp views, with sharp stars right out to the edge, up to an aperture ratio of f/4.

Waterproof

No need to worry about water or dust getting into the housing! Also easy to clean.

For those who wear glasses

The 21 mm and the 10 mm eyepieces have about 20 mm of eye relief. So using them is always comfortable.

Impressive contrast

High light transmission means more structure can be seen in deep sky objects as compared to standard eyepieces. The lenses are finished with an extremely thin FMC coating.

Lightweight

Weighing only between 320 - 705 g, they are suitable for use with both small and big telescopes.

Rubber armoured and sensible design

The modern design employs black anodized aluminium and the built-in rubber armoring ensures a good grip - even when wearing gloves.

A wide range of focal lengths available

Panorama II eyepieces are available as 5 mm (1,25"), 10 mm (1,25"), 15 mm (2") and 21 mm (2").

BBC Sky at Night MAGAZINE ★★★★★ REVIEWED IN Issue 156 May 2018

Sky at Night says:

"We really enjoyed using these eyepieces and heartily recommend them to intermediate and more experienced observers."

	Article No.	Price in €
1.25" Panorama II eyepiece 5 mm		
H in mm 112, ø in mm 49, weight 320 g	53649	**199**
1.25" Panorama II eyepiece 10 mm		
H in mm 101, ø in mm 56, weight 375 g	53650	**199**
2" Panorama II eyepiece 15 mm		
H in mm 118, ø in mm 66, weight 600 g	53684	**229**
2" Panorama II eyepiece 21 mm		
H in mm 118, ø in mm 71, weight 705 g	53561	**229**

Hubble sees the brightest quasar in the early Universe

by NASA/ESA

Astronomers have discovered the brightest object ever seen at a time when the universe was less than one billion years old, with the help of NASA's Hubble Space Telescope. The brilliant beacon is a quasar, the core of a galaxy with a black hole ravenously eating material surrounding it. Though the quasar is very far away — 12.8 billion light-years — astronomers can detect it because a galaxy closer to Earth acts as a lens and makes the quasar look extra bright. The gravitational field of the closer galaxy warps space itself, bending and amplifying the distant quasar's light. This effect is called gravitational lensing. Though researchers have searched for these very remote quasars for over 20 years, a rare and fortuitous celestial alignment made this one visible to them. *"We don't expect to find many quasars brighter than that in the whole observable universe,"* said lead investigator Xiaohui Fan of the University of Arizona, in Tucson.

The super-bright quasar, cataloged as J043947.08+163415.7, could hold the record of being the brightest in the early universe for some time, making it a unique object for follow-up studies. Shining with light equivalent to 600 trillion Suns, the quasar is fueled by a supermassive black hole at the heart of a young galaxy in the process of forming.

An immense amount of energy is emitted as the black hole consumes material around it. The detection provides a rare opportunity to study a zoomed-in image of how such black holes accompanied star formation in the very early universe and influenced the assembly of galaxies. Besides being bright in visible and infrared wavelengths, the lensed quasar is also bright in submillimeter wavelengths, where it was observed with the James Clerk Maxwell Telescope on Mauna Kea, Hawaii. This is due to hot dust heated by intense star formation in the galaxy hosting the lensed quasar. The formation rate is estimated to be up to 10,000 stars per year (by comparison, our Milky Way galaxy makes one star per year).

"Clearly, this black hole is not only accreting gas, but has a lot of star formation around it," said team member Jinyi Yang at the University of Arizona. *"However, because of the boosting effect of gravitational lensing, the actual rate of star for-*

This artist's impression shows how J043947.08+163415.7, a very distant quasar powered by a supermassive black hole, may look close up. This object is by far the brightest quasar yet discovered in the early Universe. [ESA/Hubble, NASA, M. Kornmesser]

mation could be much lower than the observed brightness suggests," she added. The quasar existed at a transitional period in the universe's evolution, called reionization, where light from young galaxies and quasars reheated the obscuring hydrogen that cooled off not long after the big bang.

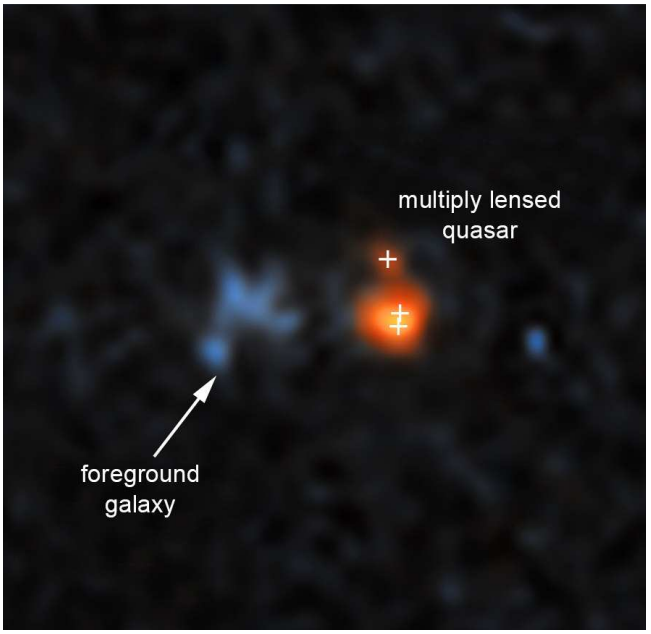
The quasar would have gone undetected if not for the power of gravitational lensing, which boosted its brightness by a factor of 50.

However, because very distant quasars are identified by their red color (due to absorption by diffuse gas in intergalactic space), sometimes their light is "contaminated," and looks bluer because of the starlight of an intervening galaxy.

As a result, they may be overlooked in quasar searches because their

Graphic animation of the quasar J043947.08 + 163415.7, a very distant object powered by a supermassive black hole. [ESA/Hubble, NASA, M. Kornmesser]

color is diluted to resemble that of a normal galaxy. Fan proposes that many other remote quasars have been missed due to this light contamination. His team got lucky with finding J043947.08 +163415.7, because the quasar is so bright it drowns out the starlight from the especially faint foreground lensing galaxy. *"Without this high level of magnification, it would make it impossible for us to see the galaxy,"* said team member Feige Wang of the University of California, Santa Barbara. *"We can even look for gas around the black hole and what the black hole may be influencing in the galaxy."* The object was selected by its color by combining photometric data from the United Kingdom Infrared Telescope Hemisphere Survey, the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS1) at optical wavelengths, and NASA's Wide-field Infrared Survey Explorer archive in the mid-infrared. Follow-up spectroscopic observations were conducted by the University of Arizona's Multi-Mirror Telescope, the Gemini Observatory and the Keck Observatory. These observations revealed the signature of a very faint foreground galaxy directly between the quasar and Earth that is magnifying the quasar image. However, because the source looks fuzzy in the ground-based observations (and so could be mistaken for only a galaxy), the researchers used Hubble's exquisite imaging capabilities to confirm it is a lensed quasar. *"It's a hard system to photograph because it turns out to be so compact, which requires the sharpest view from Hubble,"* Fan said. The quasar is ripe for future scrutiny. Fan's team is analyzing a detailed 20-hour spectrum from the European Southern Observatory's Very Large Telescope, which would show gas absorption features to identify chemical composition and temperatures of intergalactic gas in the early universe. Astronomers also will use the Atacama Large Millimeter/submillimeter Array, and eventually NASA's James Webb Space Telescope, to look within 150 light-years of the black hole to directly detect the influence of the black hole's gravity on gas motion and star formation in its vicinity. ■



This image shows the distant quasar J043947.08+163415.7 as it was observed with the NASA/ESA Hubble Space Telescope. The quasar is one of the brightest objects in the early Universe. However, due to its distance, it only became visible as its image was made brighter and larger by gravitational lensing. The system of the lensed images and the actual lens is so compact that Hubble is the only optical telescope able to resolve it. [NASA, ESA, X. Fan (University of Arizona)]

This animation depicts how the mass of a galaxy is bending the light of a much more distant quasar through gravitational lensing. This way the quasar appear three times larger and 50 times brighter on the night sky. [ESA/Hubble, L. Calçada]

Check our website
WWW.TECNOSKY.IT

APO Refractor
Tecnosky Quadruplet Apo AG70 F5

The AG70 is our recommendation for astrophotographers who are looking for a compact telescope with high speed and a large image circle.
4-element quadruplet design with FPL53 triplet objective for an image without chromatic error.
Stable 2.5" R&P focuser with 1:10 dual transmission - suitable for accessories up to 5 kg.

~~€ 1299~~ € 1.095

APO Refractor
Tecnosky Triplet Apo FPL53 80/480mm V2

A highly corrected, fast apochromat. Its compact dimensions make it a perfect travelling telescope, also ideal for astrophotography.
One of the best 2,5" focusers in its class, plain bearing mounted draw tube, adjustment by rack and pinion, designed for high payload.

€ 890

PROMO

Tecnosky Triplet Apo
FPL53 80/480mm V2
+
Flattner Tecnosky 1X

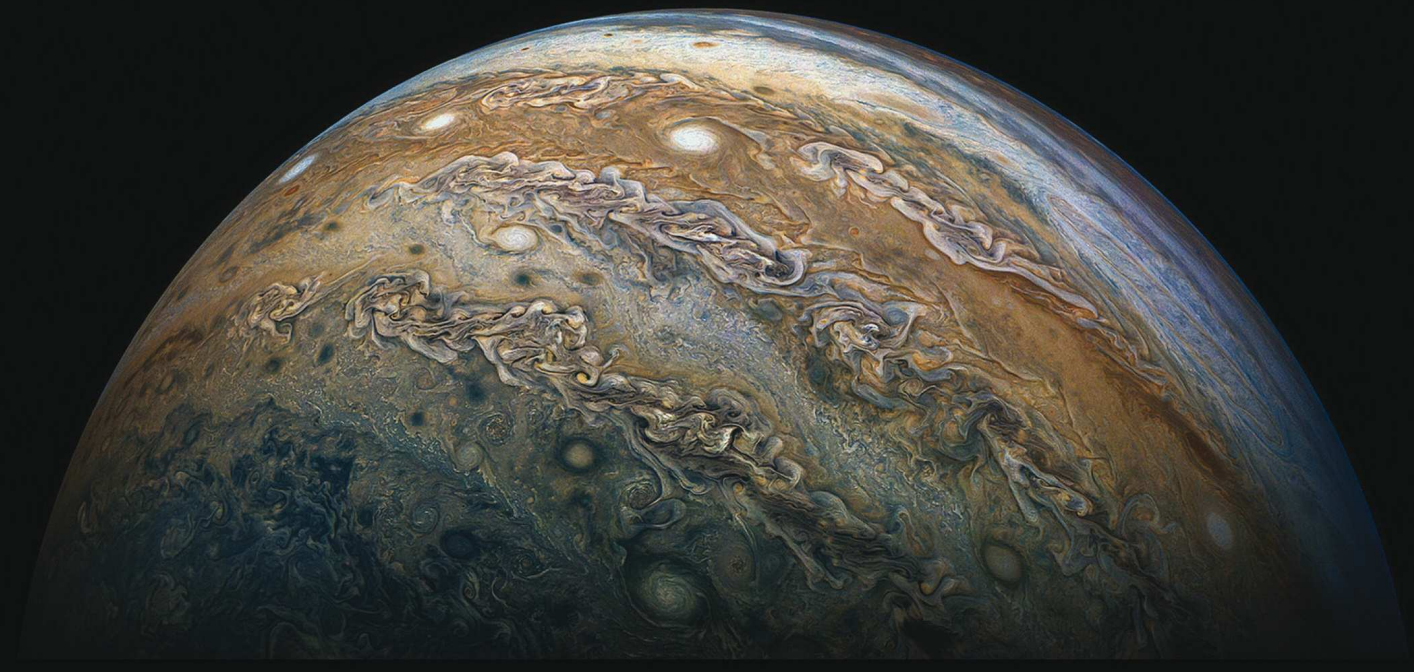
€ 890

Tecnosky Triplet Apo
FPL53 80/480mm V2
+
Flattner/Reducer 0,8X
4 elements

€ 920

Tecnosky Triplet Apo
FPL53 80/480mm V2
+
Flattner FF Tecnosky 2,5"

€ 995



TecnoSky Torino
info.torino@tecnosky.it

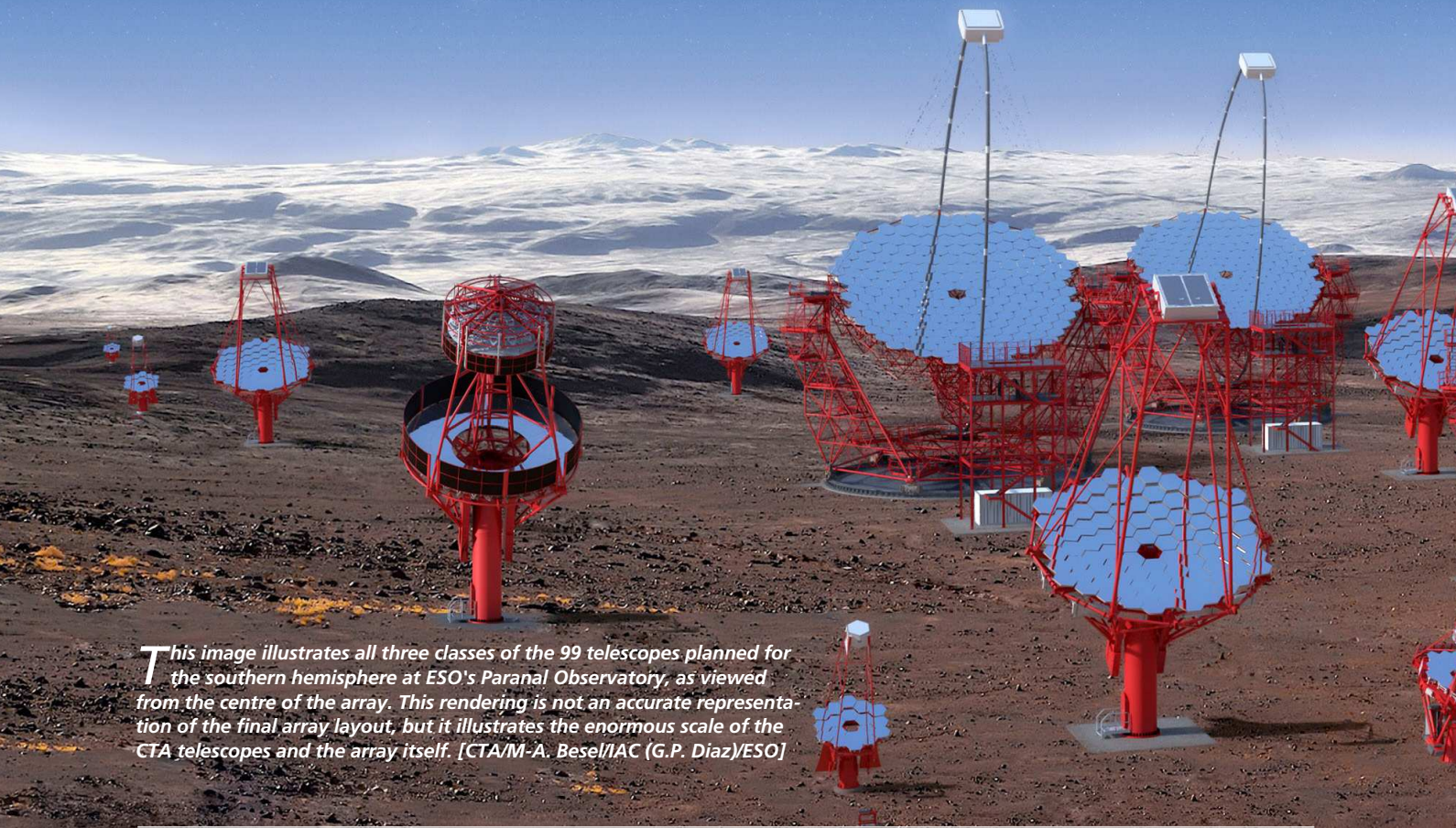
TecnoSky Felizzano
www.tecnosky.it
info@tecnosky.it

Teleskop Service Italia
Signoressa di Trevignano
info@teleskop-express.it

ESO to host Cherenkov Telescope Array-South at Paranal

by ESO

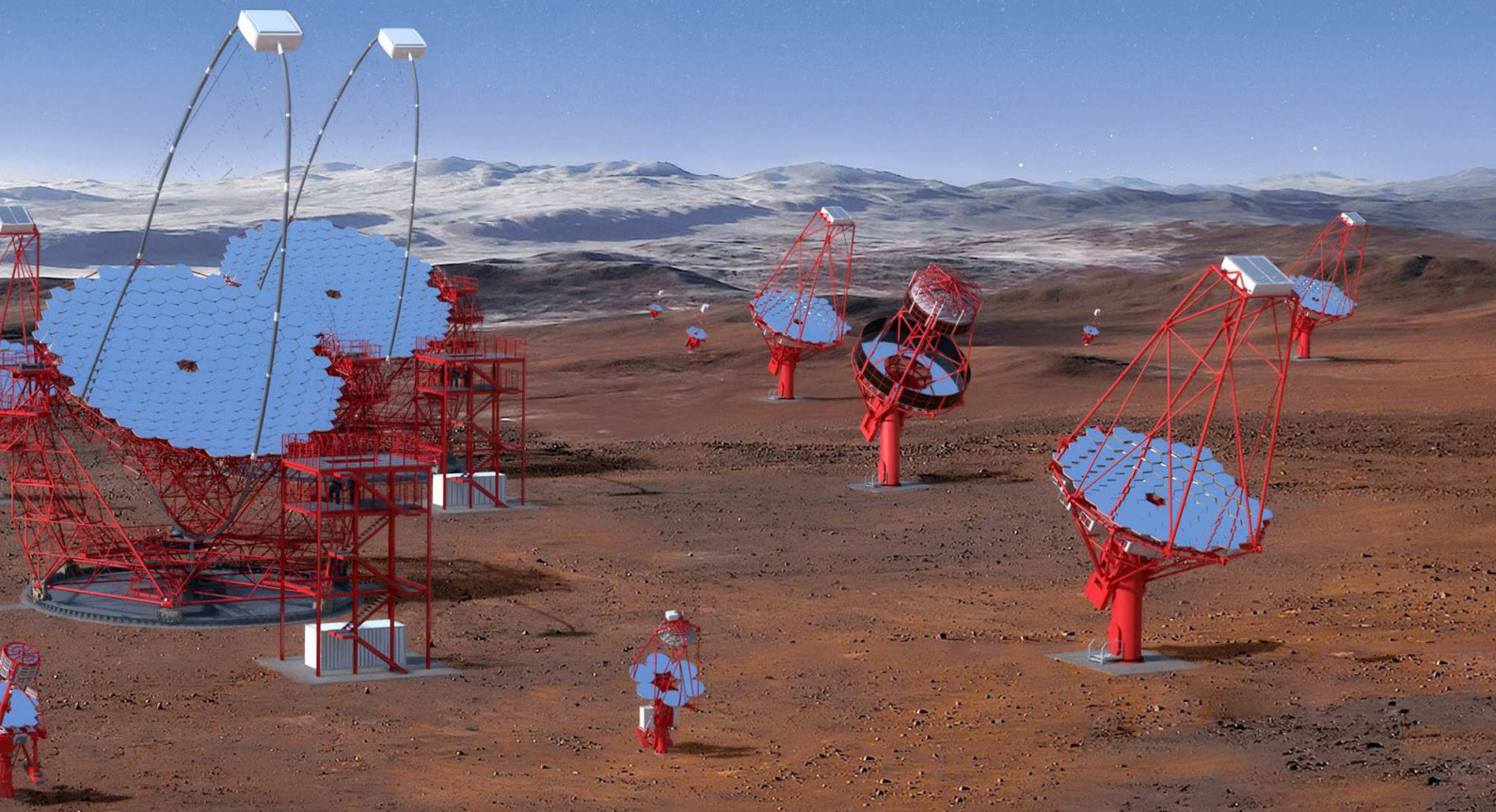
The Cherenkov Telescope Array (CTA) is the next-generation ground-based instrument designed to detect very high energy gamma rays, with sites in both the southern and northern hemispheres. Gamma rays are electromagnetic radiation of very high energy, emitted by the hottest and most extreme objects in the Universe — supermassive black holes, supernovae and maybe even remnants of the Big Bang. On 19 December 2018, Federico Ferrini, Managing Director of the Cherenkov Telescope Array Observatory (CTAO),



This image illustrates all three classes of the 99 telescopes planned for the southern hemisphere at ESO's Paranal Observatory, as viewed from the centre of the array. This rendering is not an accurate representation of the final array layout, but it illustrates the enormous scale of the CTA telescopes and the array itself. [CTA/M-A. Besel/IAC (G.P. Diaz)/ESO]

met with ESO's Director General, Xavier Barcons, at the ESO offices in Santiago, Chile. Together with ESO's Director for Operations, Andreas Kaufer, and other ESO members of personnel, they signed the agreement for the construction and operation of CTA's southern array within ESO's Paranal site in northern Chile. Deputy Minister of Foreign Relations of Chile Carolina Valdivia Torres and ESO's Director General also signed the agreement that enables ESO to host CTA-South at the Paranal Observatory site, as an ESO Programme.

A third agreement was already signed on 17 December 2018 between the Chilean National Commission for Science and Technology (CONICYT) and CTAO. This cooperation agreement aims at fostering astronomical research in Chile, capitalising on the opening of a new observational window as enabled by CTA-South.

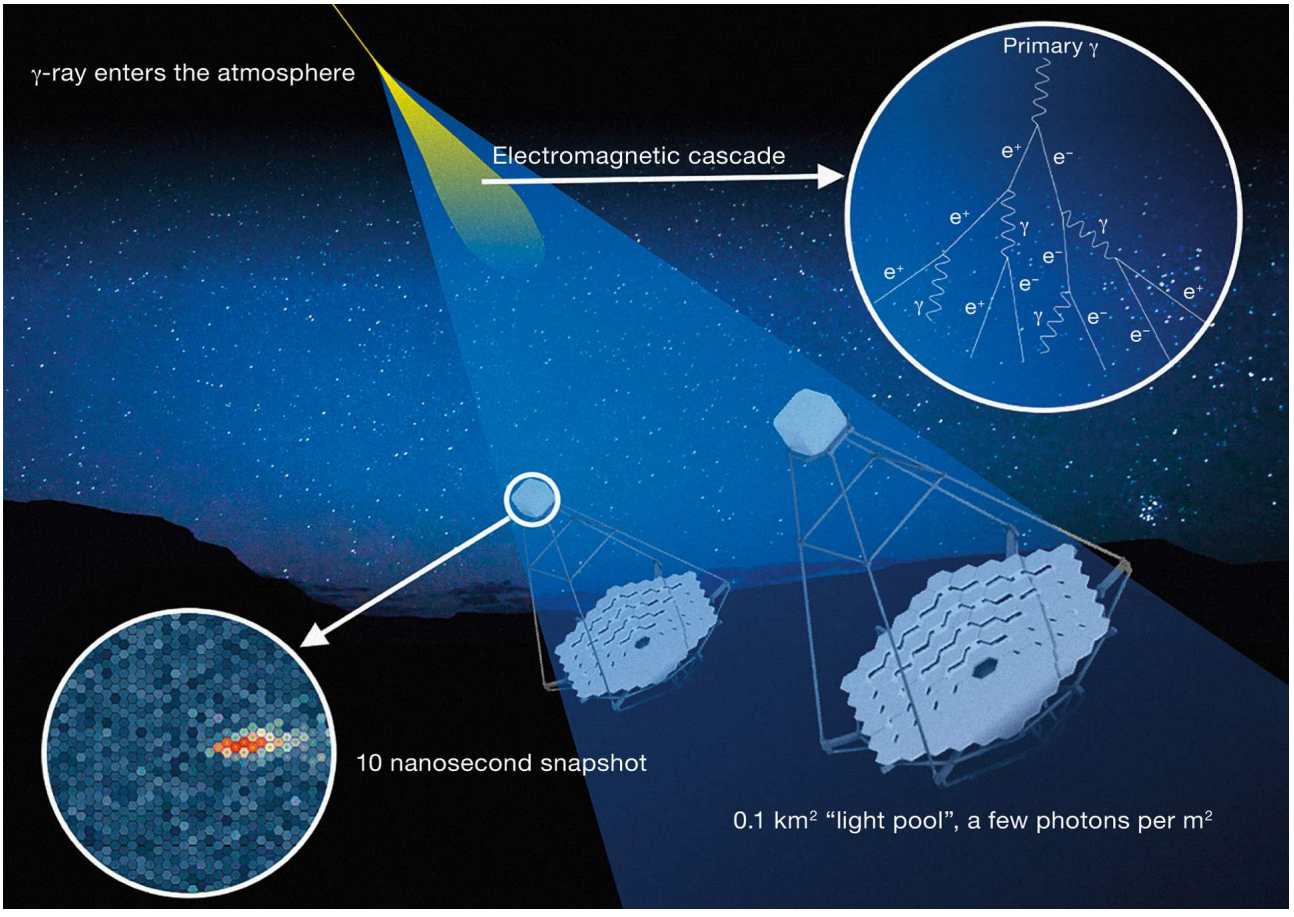


Eso introduces CTA, the world's largest array of gamma-ray telescope. [ESO]

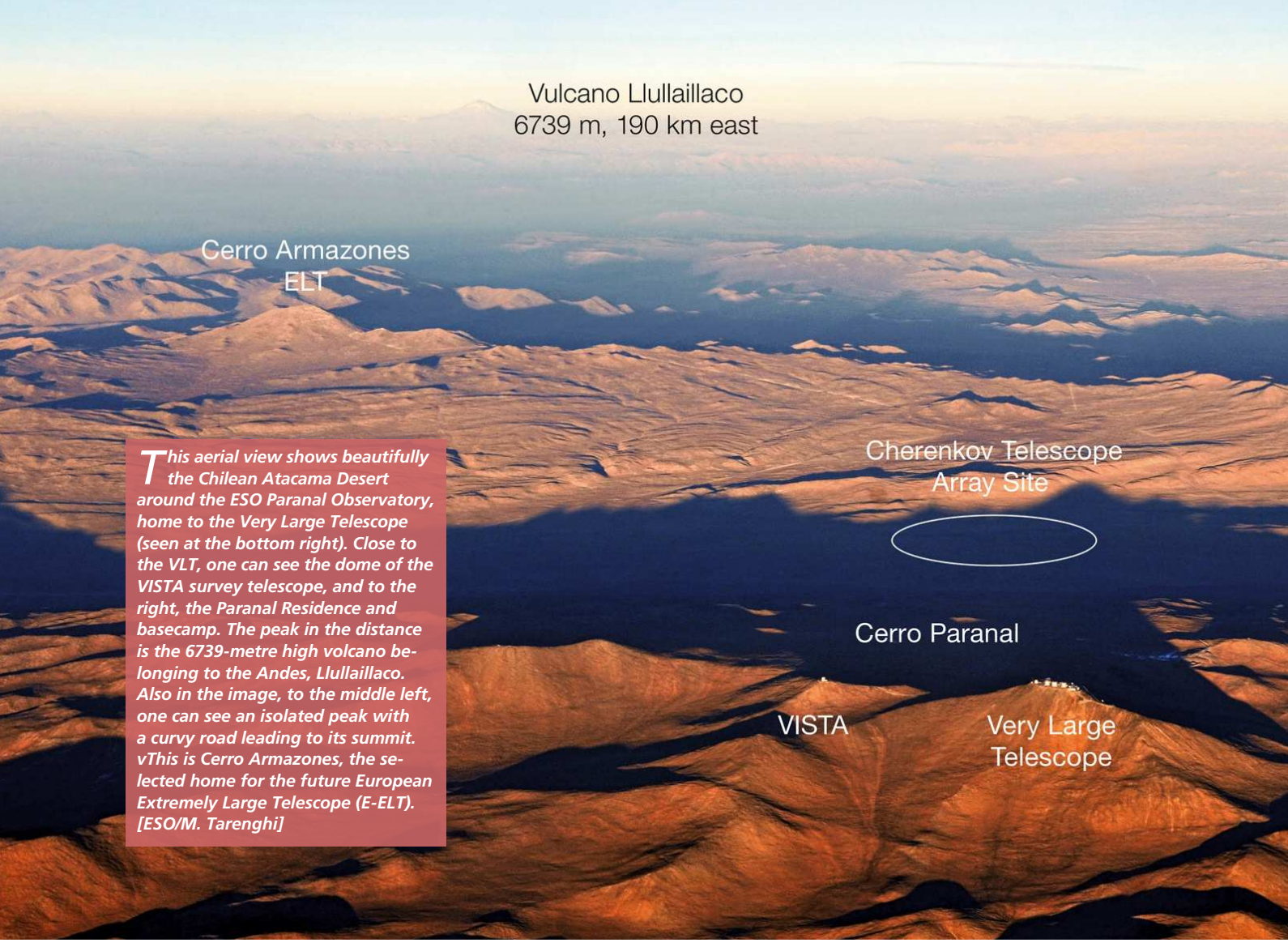
With these three agreements in place, the CTAO will be able to begin construction on the southern site. The Instituto de Astrofisica de Canarias will host CTA's northern hemisphere array at the Observatorio del Roque de los Muchachos on the island of La Palma, Spain. Construction of both the northern and southern arrays is expected to begin in 2020. *"Operating CTA at Paranal will open a new window on the Universe for astronomers in the ESO Member States, Chile, and worldwide,"* commented ESO's Director General, Xavier Barcons. *"ESO's rich experience of maintaining and operating fleets of telescopes in remote areas will be invaluable for the CTA project."*

The southern site of CTA is only 11 kilometres southeast of the location of the Very Large Telescope at ESO's Paranal Observatory in the Atacama Desert, and only 16 kilometres from the construction site of the upcoming Extremely Large Telescope. This is one of the driest and most isolated regions on Earth — an astronomical paradise. In addition to the ideal conditions for year-round observation, installing CTA at the Paranal Observatory provides it with the advantages of ESO's infrastructure. The existing infrastructures and facilities, and ESO's long-lasting experience spearheading international astronomical projects in Chile, will all support the construction and operation of the new telescope array.

"Thanks to the agreements signed today, the CTAO will not only benefit from Chile's spectacular night sky but also from ESO's facilities and deep experience, which will be an invaluable contribution to the realisation of this ambitious system of telescopes," said Federico Ferrini. *"The partnership between ESO and the CTAO will serve as the corner-*



CTA won't be detecting gamma rays directly. It will pick up Cherenkov light, the blue flash of light resulting from gamma rays interacting with the Earth's atmosphere. [CTAO/ESO]



This aerial view shows beautifully the Chilean Atacama Desert around the ESO Paranal Observatory, home to the Very Large Telescope (seen at the bottom right). Close to the VLT, one can see the dome of the VISTA survey telescope, and to the right, the Paranal Residence and basecamp. The peak in the distance is the 6739-metre high volcano belonging to the Andes, Llullaillaco. Also in the image, to the middle left, one can see an isolated peak with a curvy road leading to its summit. vThis is Cerro Armazones, the selected home for the future European Extremely Large Telescope (E-ELT). [ESO/M. Tarenghi]

stone in the fast-growing era of multi-messenger astrophysics, providing an opportunity for further collaboration with other large infrastructures, such as the Atacama Large Millimeter/submillimeter Array (ALMA), the Square Kilometre Array (SKA) and state-of-the-art gravitational-wave interferometers."

Current Cherenkov telescope arrays, sensitive to very high-energy gamma rays, consist of only a handful of individual telescopes, but CTA — with its larger collecting area and excellent angular resolution — will be the largest and most sensitive array of gamma-ray telescopes in the world. It will detect gamma rays with unprecedented accuracy and will be 10 times as sensitive as any of its predecessors.

Although the Earth's atmosphere prevents gamma rays from reaching the surface, CTA's mirrors and high-speed cameras will capture the short-lived flashes of the eerie blue Cherenkov radiation produced when gamma rays interact with Earth's atmosphere. By detecting this Cherenkov light, scientists will be able to trace the gamma ray back to its cosmic source.

The scientific scope of CTA is extremely broad: from understanding the role of relativistic cosmic particles to the search for dark matter. CTA will explore the extreme Universe, probing environments from the immediate neighbourhood of black holes to the cosmic voids on the largest scales. It may even lead to brand new physics as it studies the nature of matter and forces beyond the standard model.

CTA will operate across two sites, one in each hemisphere, allowing it to maximise its coverage of the night sky. When construction is complete, the CTAO will comprise 19 telescopes in the northern hemisphere — located at the Observatorio del Roque de los Muchachos on the island of La Palma in the Canary Islands — and 99 telescopes in the southern hemisphere.

More than 1400 scientists and engineers from countries across five continents are engaged in the scientific and technical development of CTA. The shareholders of the current legal entity — CTAO gGmbH — are the representatives of ministries and funding agencies from Australia, Austria, the Czech Republic, France, Germany, Italy, the Netherlands, Japan, Slovenia, South Africa, Spain, Switzerland and the United Kingdom. They are currently preparing for the establishment of a European Research Infrastructure Consortium — the CTAO ERIC — which will then construct the immense observatory. The ERIC will be composed of CTAO's Member States and associated countries. ■

NASA's New Horizons mission reveals entirely new kind of world

by NASA

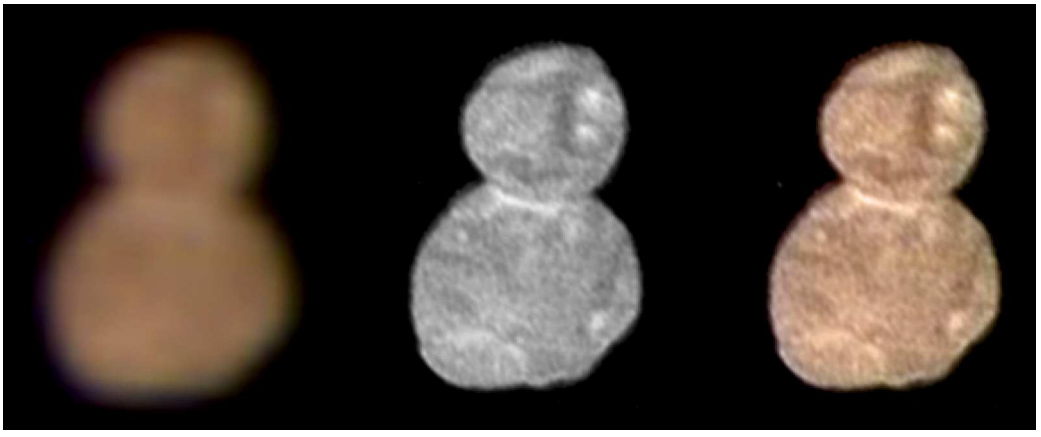
On January 2, 2019, Scientists from NASA's New Horizons mission released the first detailed images of the most distant object ever explored — the Kuiper Belt object nicknamed Ultima Thule. Its remarkable appearance, unlike anything we've seen before, illuminates the processes that built the planets four and a half billion years ago.

"This flyby is a historic achievement," said New Horizons Prin-

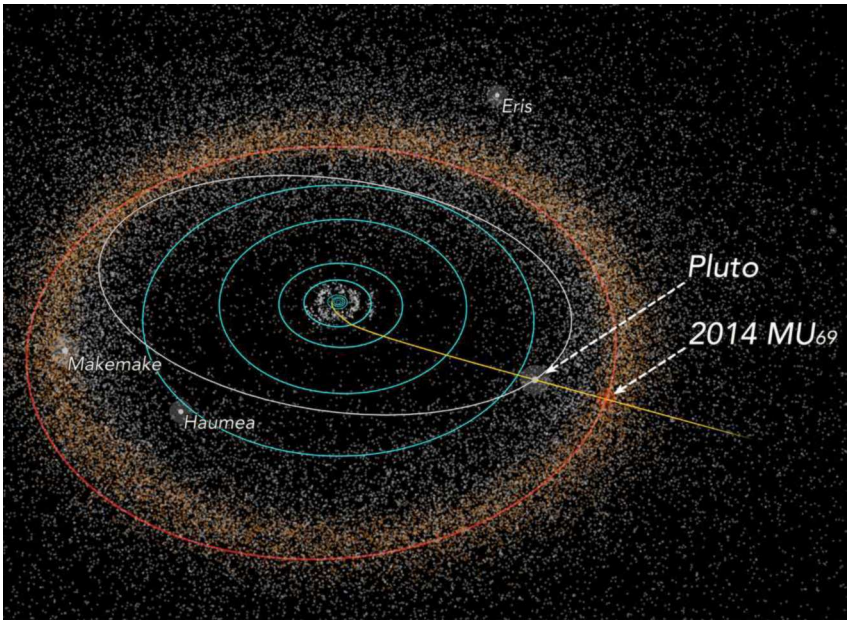
This image taken by the Long-Range Reconnaissance Imager (LORRI) is the most detailed of Ultima Thule returned so far by the New Horizons spacecraft. It was taken at 5:01 Universal Time on January 1, 2019, just 30 minutes before closest approach from a range of 18,000 miles (28,000 kilometers), with an original scale of 730 feet (140 meters) per pixel. [NASA/Johns Hopkins University Applied Physics Laboratory/ Southwest Research Institute]

cipal Investigator Alan Stern of the Southwest Research Institute in Boulder, Colorado. *"Never before has any spacecraft team tracked down such a small body at such high speed so far away in the abyss of space. New Horizons has set a new bar for state-of-the-art spacecraft navigation."*

The new images — taken from as close as 17,000 miles (27,000 kilometers) on approach — revealed Ultima Thule as a "contact binary," consisting of two connected spheres. End to end, the world measures 19 miles (31 kilometers) in length. The team has dubbed the larger sphere "Ultima" (12 miles/19 kilometers across) and the smaller sphere "Thule" (9 miles/14 kilometers across).



The first color image of Ultima Thule, taken at a distance of 85,000 miles (137,000 kilometers) at 4:08 Universal Time on January 1, 2019, highlights its reddish surface. At left is an enhanced color image taken by the Multispectral Visible Imaging Camera (MVIC), produced by combining the near infrared, red and blue channels. The center image taken by the Long-Range Reconnaissance Imager (LORRI) has a higher spatial resolution than MVIC by approximately a factor of five. At right, the color has been overlaid onto the LORRI image to show the color uniformity of the Ultima and Thule lobes. Note the reduced red coloring at the neck of the object. [NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute]



An illustration of New Horizons' flyby of 2014 MU69, also known as Ultima Thule, on New Year's Day in 2019. [NASA/JHUAPL/SwRI/Alex Parker]

The team says that the two spheres likely joined as early as 99 percent of the way back to the formation of the solar system, colliding no faster than two cars in a fender-bender.

"New Horizons is like a time machine, taking us back to the birth of the solar system. We are seeing a physical representation of the beginning of planetary formation, frozen in time," said Jeff Moore, New Horizons Geology and Geophysics team lead. *"Studying Ultima Thule is helping us understand how planets form — both those in our own solar system and those orbiting other stars in our galaxy."*

Data from the New Year's Day flyby will continue to arrive over the next weeks and months, with much higher resolution images yet to come. *"In the coming months, New Horizons will transmit dozens of data sets to Earth, and we'll write new chapters in the story of Ultima Thule — and the solar system,"* said Helene Winters, New Horizons Project Manager. ■

Mars rover Opp

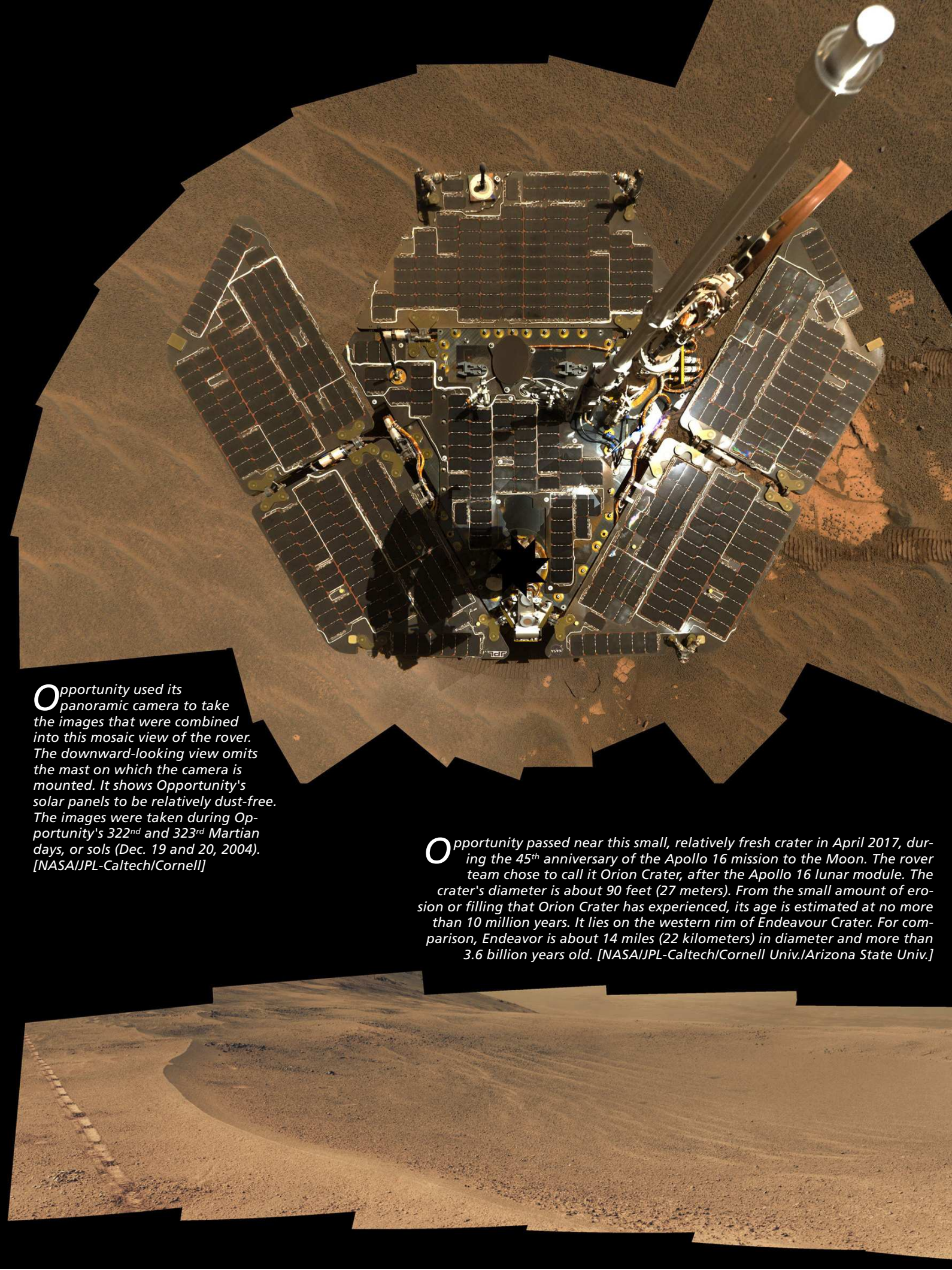
by NASA/JPL-Caltech

revised by Damian G. Allis
NASA Solar System Ambassador

One of the most successful and enduring feats of interplanetary exploration, NASA's Opportunity rover mission ended after almost 15 years exploring the surface of Mars. The Opportunity rover stopped communicating with Earth when a severe Mars-wide dust storm blanketed its location in June 2018. After more than a thousand commands to restore contact, engineers in the Space Flight Operations Facility at NASA's JPL made their last attempt to revive Opportunity last February, but to no avail. This photo-reportage aims to pay tribute to Opportunity and its twin rover Spirit.

ortunity retired

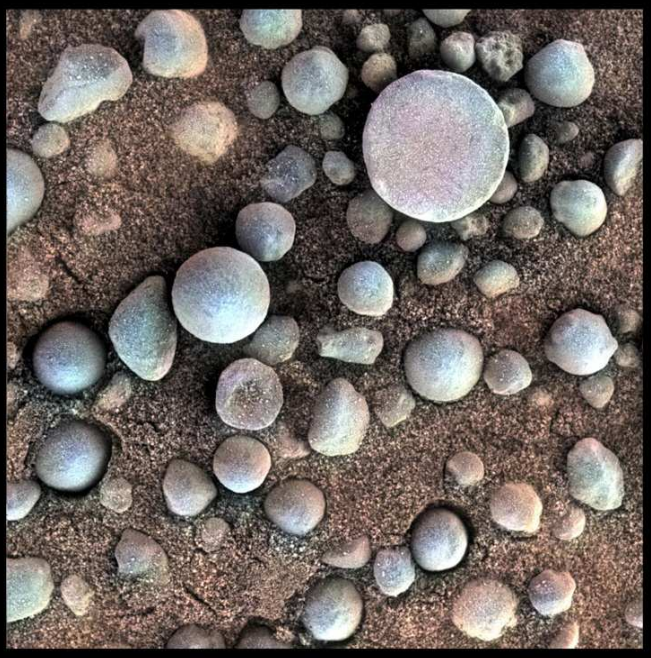
NASA declared its Opportunity Mars rover dead on February 13th, 2019. Eight years before, NASA had declared the same conclusion for its twin rover Spirit. On May 19th, 2005, Spirit captured this stunning, color-corrected view as the Sun sank below the rim of Gusev crater on Mars. Because Mars is farther from the Sun than the Earth is, the Sun appears only about two-thirds the size that it appears in a sunset seen from the Earth. The terrain in the foreground is the rock outcrop Jibsheet, a feature that Spirit investigated for several weeks[NASA/JPL-Caltech/Texas A&M/Cornell]



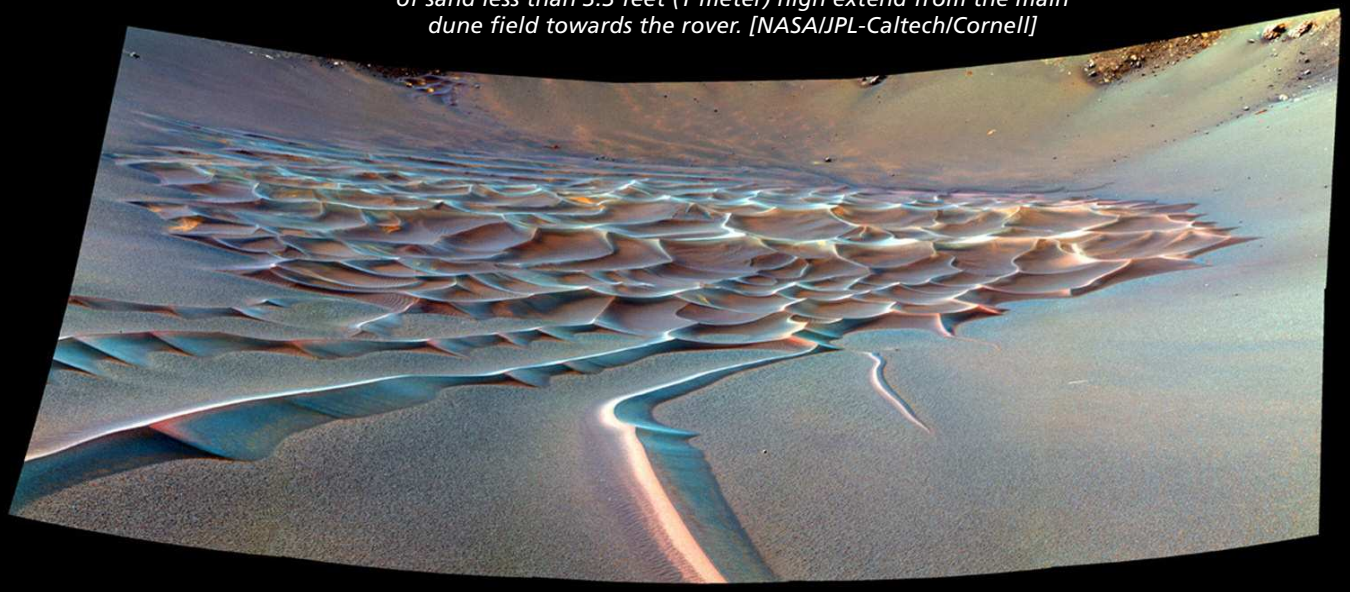
Opportunity used its panoramic camera to take the images that were combined into this mosaic view of the rover. The downward-looking view omits the mast on which the camera is mounted. It shows Opportunity's solar panels to be relatively dust-free. The images were taken during Opportunity's 322nd and 323rd Martian days, or sols (Dec. 19 and 20, 2004). [NASA/JPL-Caltech/Cornell]

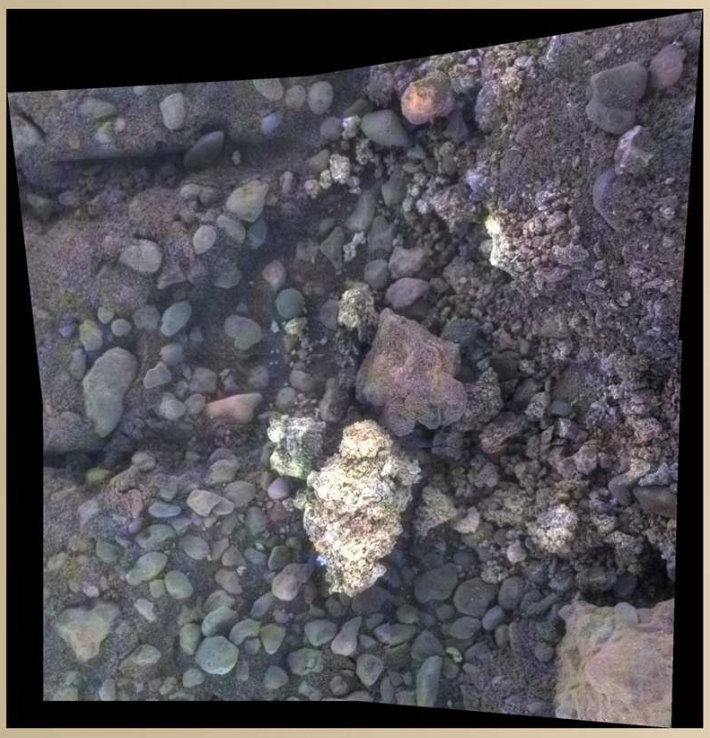
Opportunity passed near this small, relatively fresh crater in April 2017, during the 45th anniversary of the Apollo 16 mission to the Moon. The rover team chose to call it Orion Crater, after the Apollo 16 lunar module. The crater's diameter is about 90 feet (27 meters). From the small amount of erosion or filling that Orion Crater has experienced, its age is estimated at no more than 10 million years. It lies on the western rim of Endeavour Crater. For comparison, Endeavor is about 14 miles (22 kilometers) in diameter and more than 3.6 billion years old. [NASA/JPL-Caltech/Cornell Univ./Arizona State Univ.]

The small spherules on the Martian surface in this close-up image are near Fram Crater, visited by Opportunity during April 2004. The area shown is 1.2 inches (3 centimeters) across. The view comes from the microscopic imager on Opportunity's robotic arm, with color information added from the rover's panoramic camera. These are examples of the mineral concretions nicknamed "blueberries." Opportunity's investigation of the hematite-rich concretions during the rover's three-month prime mission in early 2004 provided evidence of a watery ancient environment. [NASA/JPL-Caltech/Cornell/USGS]



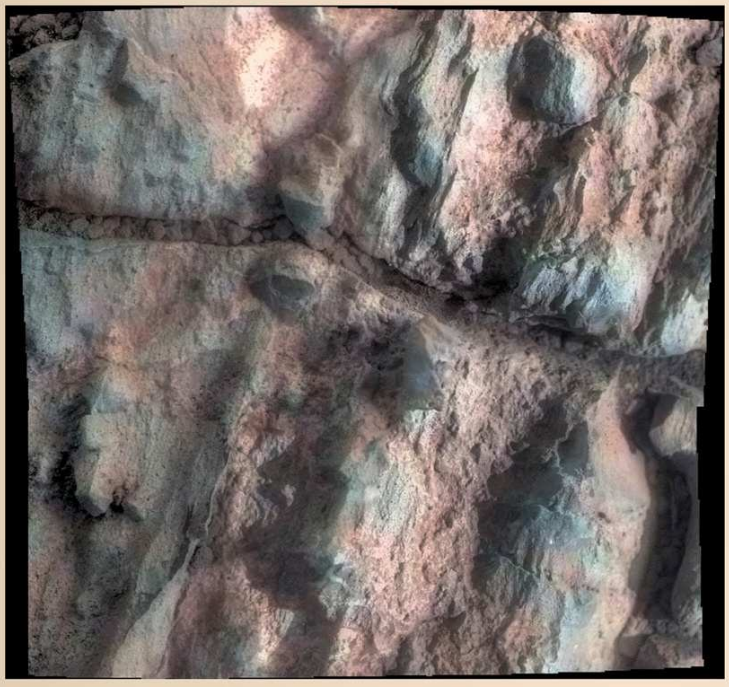
As Opportunity crept farther into Endurance Crater, the dune field on the crater floor appeared even more dramatic, as seen in this false-color image, that highlights the reddish-colored dust present throughout the scene. In this image, sinuous tendrils of sand less than 3.3 feet (1 meter) high extend from the main dune field towards the rover. [NASA/JPL-Caltech/Cornell]

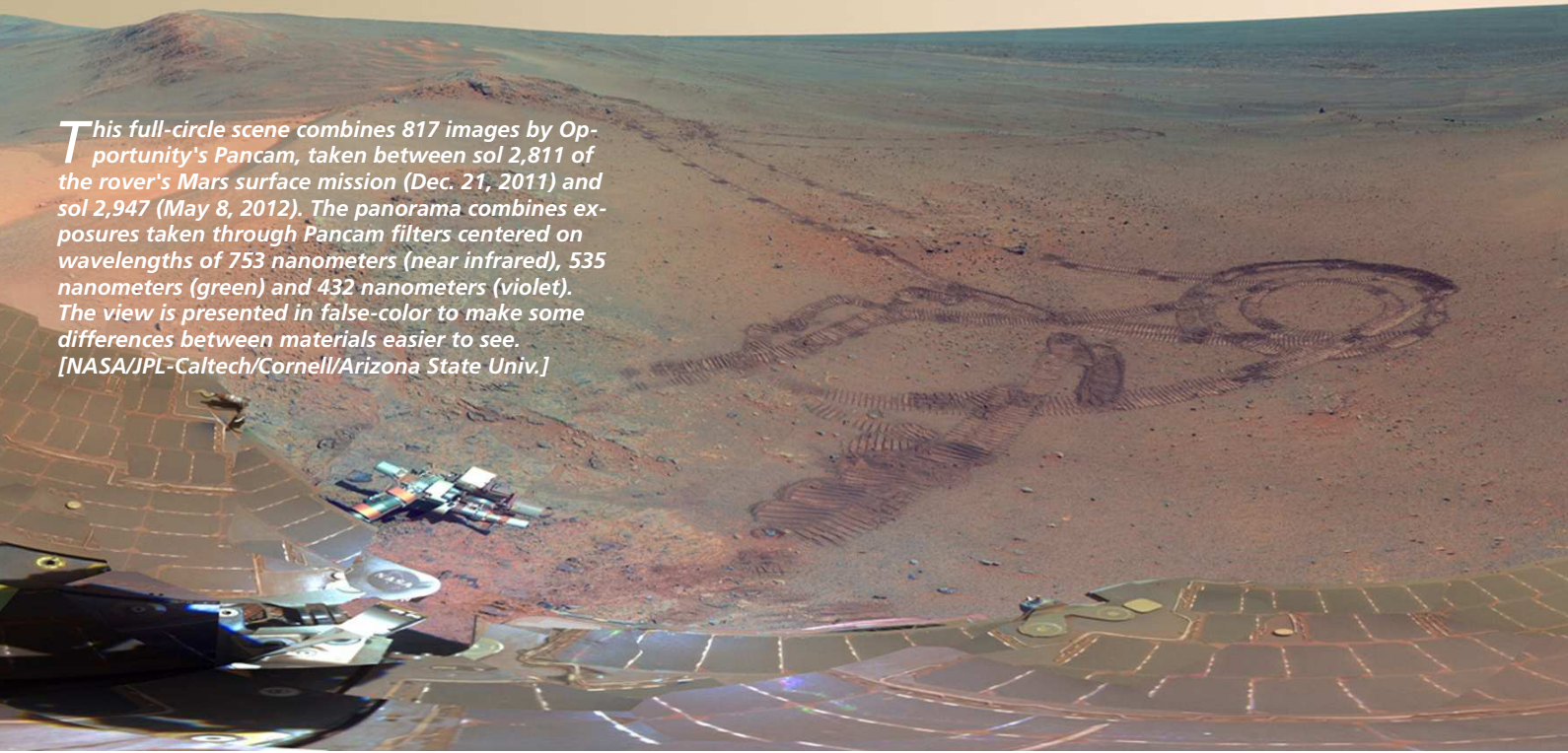




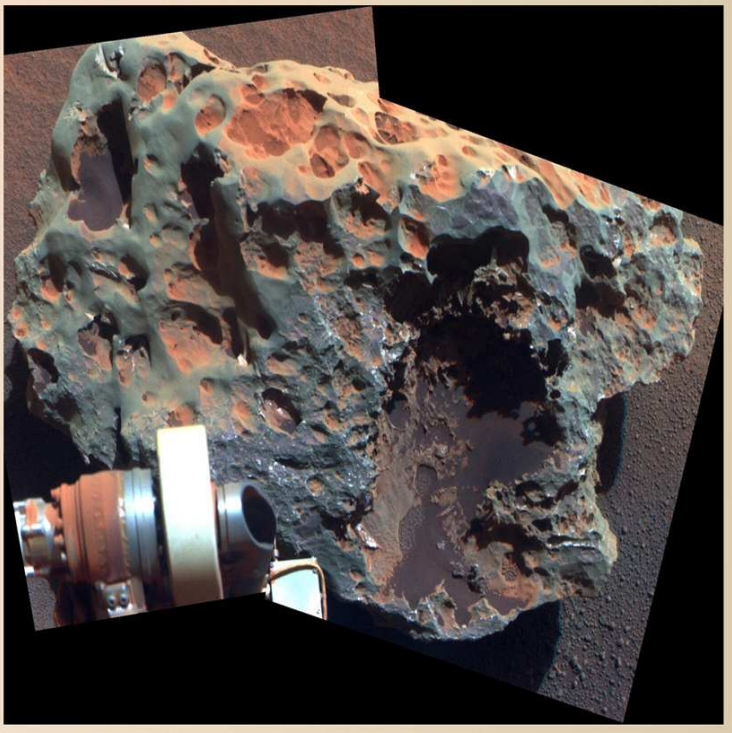
This image of a target called Private Joseph Field combines four images from the microscopic imager on Opportunity's robotic arm, with enhanced color information added from the rover's panoramic camera. This target is within the Marathon Valley area of the western rim of Endeavour Crater. The component images were taken on May 29, 2016. The mosaic shows an area spanning about 2 inches (5 centimeters). [NASA/JPL-Caltech/Cornell/USGS/ASU]

This relatively bright outcropping of rock, dubbed Gasconade, was investigated by Opportunity while the rover was perched on Spirit Mound at the western edge of Endeavour Crater. This mosaic combines four frames taken by the microscopic imager on Opportunity's robotic arm on Oct. 2, 2016. Enhanced color information from Opportunity's panoramic camera has been added to emphasize differences in the materials visible in the target. The view covers an area about 2 inches (5 centimeters) wide. [NASA/JPL-Caltech/Cornell/USGS/ASU]



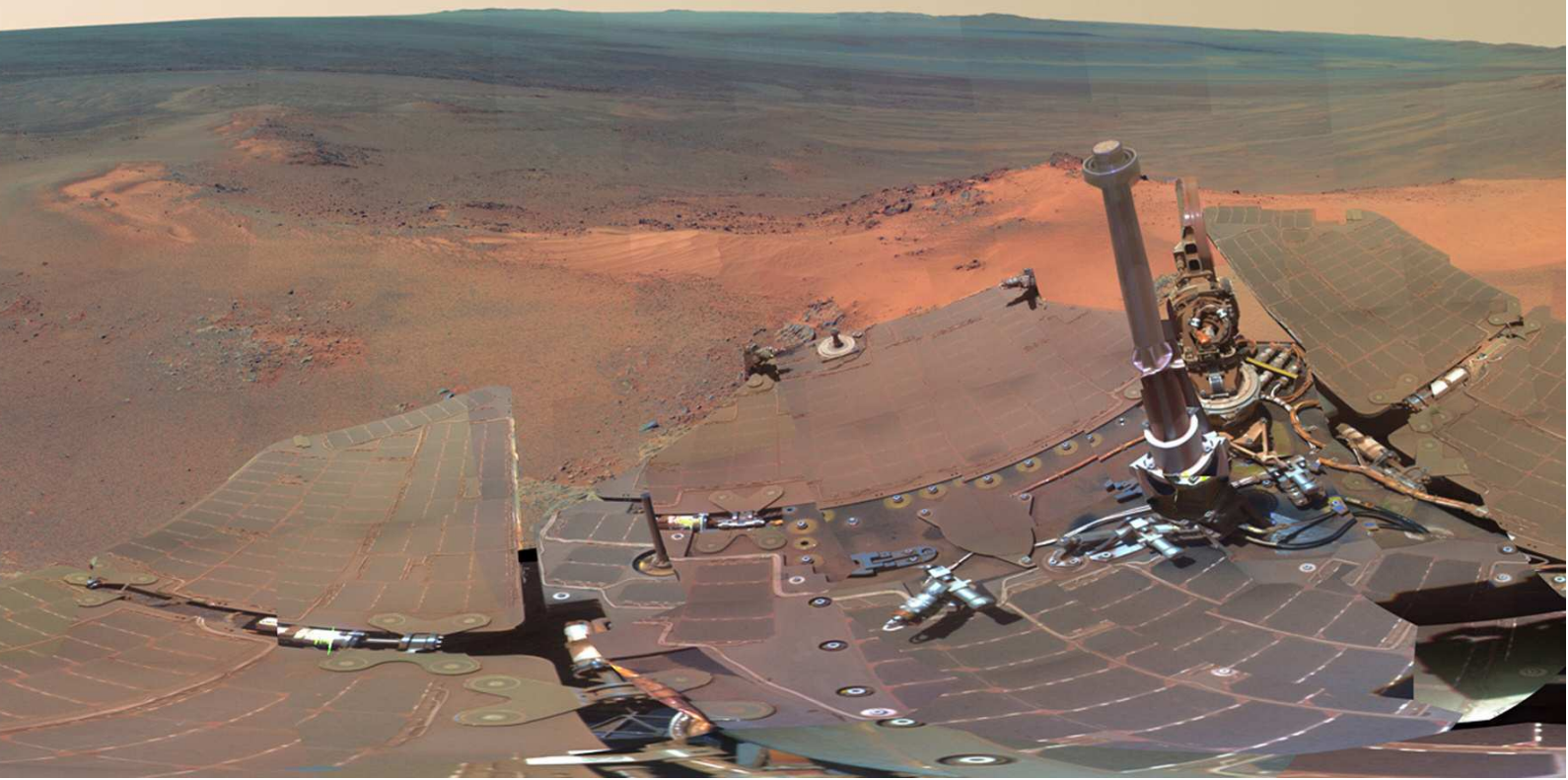


This full-circle scene combines 817 images by Opportunity's Pancam, taken between sol 2,811 of the rover's Mars surface mission (Dec. 21, 2011) and sol 2,947 (May 8, 2012). The panorama combines exposures taken through Pancam filters centered on wavelengths of 753 nanometers (near infrared), 535 nanometers (green) and 432 nanometers (violet). The view is presented in false-color to make some differences between materials easier to see. [NASA/JPL-Caltech/Cornell/Arizona State Univ.]

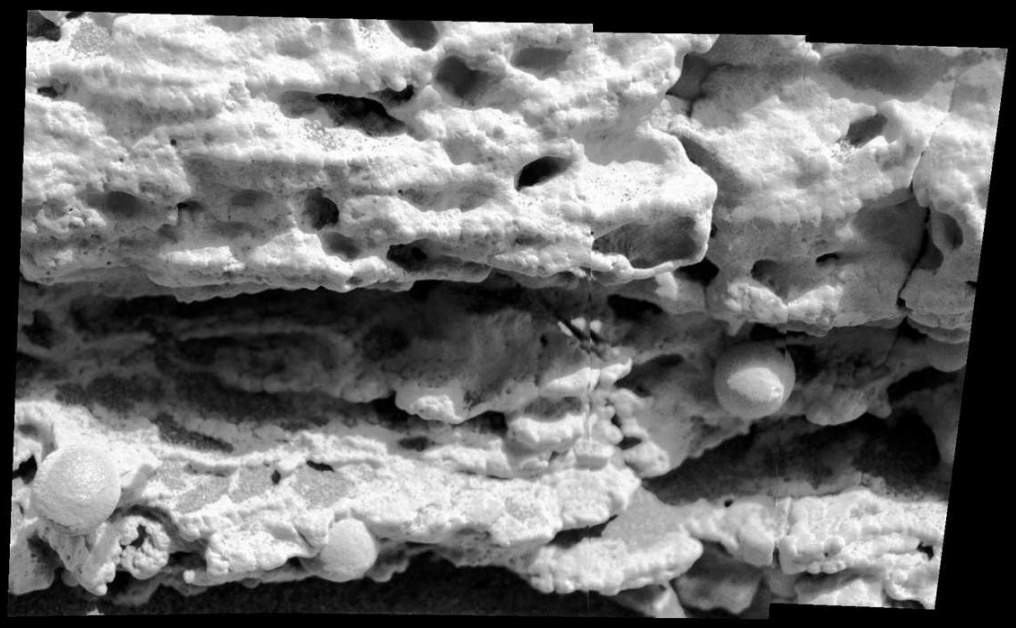


This view of a rock called Block Island, the largest meteorite yet found on Mars, comes from the panoramic camera (Pancam) on Opportunity. Analysis of its composition using the rover's alpha particle X-ray spectrometer confirmed that it is rich in iron and nickel. The rock is about 2 feet (60 centimeters) across. This is a false-color, red-green-blue composite view generated from images taken through the Pancam's filters. The exaggerated color is used for enhancing the visibility of differences among the types of rock and soil materials. [NASA/JPL-Caltech/Cornell]

Spirit took this microscopic imager picture of the drift dubbed "Serpent" on Spirit's 73rd Martian day on Mars after successfully digging into the side of the drift. The image is the first-ever microscopic look inside a drift. It captures only the scuffed interior of the Serpent drift and is dominated by larger, pea-shaped particles. These grains are not natural to the inside of the drift, but are crust particles that have tumbled into the scuffed area as a result of the digging. [NASA/JPL-Caltech/Cornell/USGS]

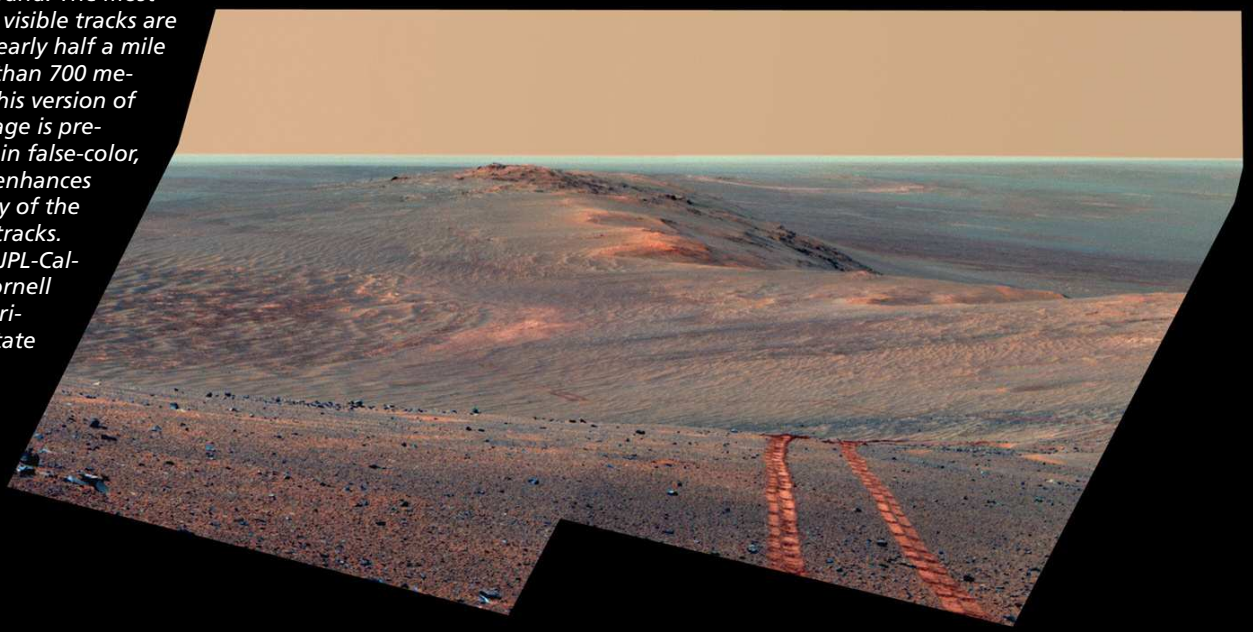


Towards the right side of this enhanced-color scene is a broad notch in the crest of the western rim of Endeavour Crater. Wheel tracks in that area were left by Opportunity as it observed Perseverance Valley from above. Opportunity's Pancam took the component images for this view from a position outside the crater during the span of June 7 to June 19, 2017, sols 4753 to 4765 of the rover's work on Mars. [NASA/JPL-Caltech/Cornell/Arizona State Univ.]

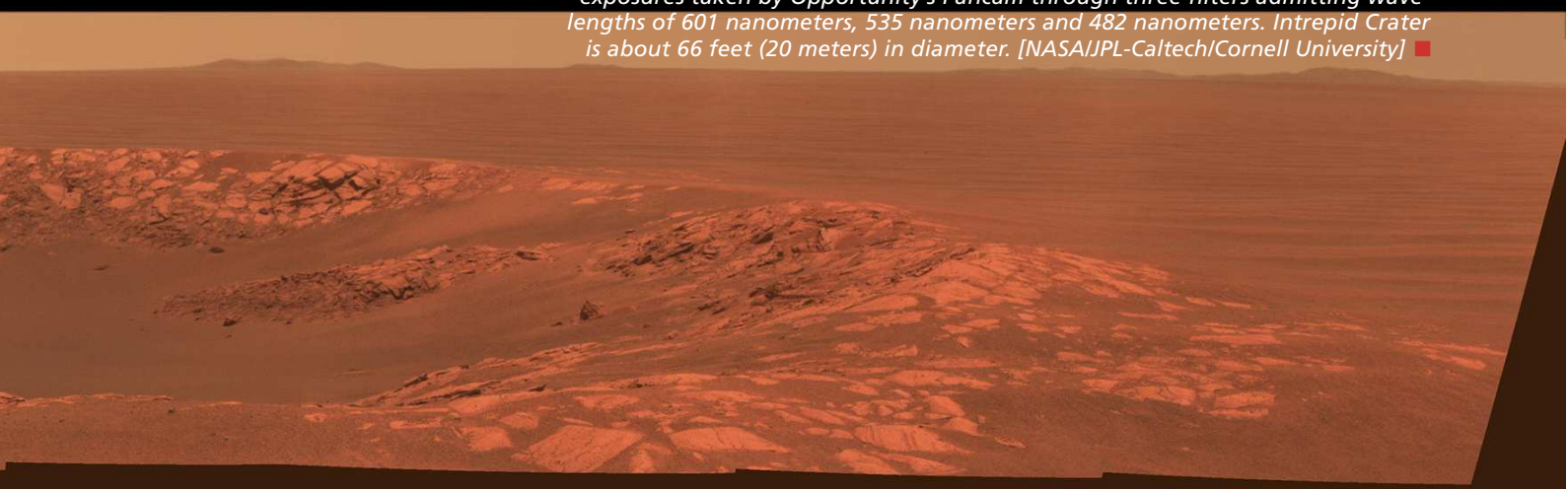


This close-up view of a target rock called Last Chance was acquired by the microscopic imager on Opportunity's arm on March 3, 2004, during its 39th Martian day. The area covered in the view is about 2 inches (5 centimeters) across. The embedded spherules evident in this image reminded researchers of berries in a muffin, so they were nicknamed "blueberries." These mineral concretions and other textures in this rock provided evidence about wet environmental conditions in the ancient past in the Meridiani Planum region. [NASA/JPL-Caltech/Cornell Univ./USGS]

This scene from the Opportunity's Pancam looks back towards part of the west rim of Endeavour Crater. The high point on the rim in the left half of the scene is the southern end of Murray Ridge. Tracks from drives from mid-July 2014 are faintly visible near there, and tracks from subsequent drives advance to the foreground. The most distant visible tracks are from nearly half a mile (more than 700 meters). This version of the image is presented in false-color, which enhances visibility of the wheel tracks. [NASA/JPL-Caltech/Cornell Univ./Arizona State Univ.]



Intrepid Crater on Mars carries the name of the lunar module of NASA's Apollo 12 mission, which landed on the Moon Nov. 19, 1969. Opportunity recorded this view of the crater during the 2,417th sol of the rover's work on Mars (Nov. 11, 2010). This view is presented in approximately true-color, combining exposures taken by Opportunity's Pancam through three filters admitting wavelengths of 601 nanometers, 535 nanometers and 482 nanometers. Intrepid Crater is about 66 feet (20 meters) in diameter. [NASA/JPL-Caltech/Cornell University] ■



ALMA discovers early protostar with a warped disk

by ALMA Observatory

Using the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile, researchers have observed, for the first time, a warped disk around an infant protostar that formed just several tens of thousands of years ago.

This implies that the misalignment of planetary orbits in many planetary systems, including our own, may be caused by distortions in the planet-forming disk early in their existence.

The planets in the Solar System orbit the Sun in planes that are at most about seven degrees offset from the equator of the Sun itself. It has been known for some time that many extrasolar systems have planets that are not lined up in a single plane or with the equator of the star.

One explanation for this is that some planets might have been affected by collisions with other objects in the system or by stars passing by the system, ejecting them from the initial plane.

However, the possibility remained that the formation of planets out of the normal plane was actually caused by a warping of the star-forming cloud out of which the planets were born. Recently, images of protoplanetary disks, rotating disks where planets form around a star, have in fact showed such warping. But it was still unclear how early this happened.

In the latest findings, published in Nature, the group from the RIKEN Cluster for Pioneering Research (CPR) and Chiba University in Japan have discovered that L1527; an infant protostar still embedded within a cloud, has a disk that has two parts, an inner one rotating in one plane, and an outer one in a different plane. The disk is very young and still growing.

L1527, which is about 450 light-years away in the Taurus Molecular Cloud, is a good object for study as it has a disk that is nearly edge-on to our view. According to Nami Sakai, who led the research group, *"this observation shows that it is conceivable that the misalignment of planetary orbits can be caused by a warped structure formed in*

Artist's impression of a warped disk around a protostar. ALMA observed the protostar IRAS04368+2557 in the dark cloud L1527 and discovered that the protostar has a disk with two misaligned parts. [RIKEN]

Whirling southern star trails over ALMA (the Atacama Large Millimeter/submillimeter Array) located in northern Chile. [ESO/Babak Tafreshi]

the earliest stages of planetary formation. We will have to investigate more systems to find out if this is a common phenomenon or not."

The remaining question is what caused the warping of the disk. Sakai suggests two reasonable explanations. *"One possibility,"* she says, *"is that irregularities in the flow of gas and dust in the protostellar cloud are still preserved and manifest themselves as the warped disk. A second possibility is that the magnetic field of the protostar is in a different plane from the rotational plane of the disk, and that the inner disk is being pulled into a different plane from the rest of the disk by the magnetic field."* She says they plan further work to determine which is responsible for the warping of the disk.

Faint glow within galaxy clusters illuminates dark matter

by NASA/ESA

Utilizing Hubble's past observations of six massive galaxy clusters in the Frontier Fields program, astronomers demonstrated that intracluster light — the diffuse glow between galaxies in a cluster — traces the path of dark matter, illuminating its distribution more accurately than existing methods that observe X-ray light.

Intracluster light is the byproduct of interactions between galaxies that disrupt their structures; in the chaos, individual stars are thrown free of their gravitational moorings in their home galaxy to realign themselves with the gravity map of the overall cluster. This is also where the vast majority of dark matter resides. X-ray light indicates where groups of galaxies are colliding, but not the underlying structure of the cluster. This makes it a less precise tracer of dark matter.

"The reason that intracluster light is such an excellent tracer of dark matter in a galaxy cluster is that both the dark matter and these stars forming the intracluster light are free-floating on the gravitational potential of the cluster itself — so they are following exactly the same gravity," said Mireia Montes of the University of New South Wales in Sydney, Australia, who is co-author of the study. *"We have found a new way to see the location where the dark matter should be, because you are tracing exactly the same gravitational potential. We can illuminate, with a very faint glow, the position of dark matter."*

Montes also highlights that not only is the method accurate, but it is more efficient in that it utilizes only deep imaging, rather than the more complex, time-intensive techniques of spectroscopy. This means more clusters and objects in space can be studied in less time — meaning more potential evidence of what dark matter consists of and how it behaves. *"This method puts us in the position to characterize, in a statistical way, the ultimate nature of dark matter,"* Montes said.

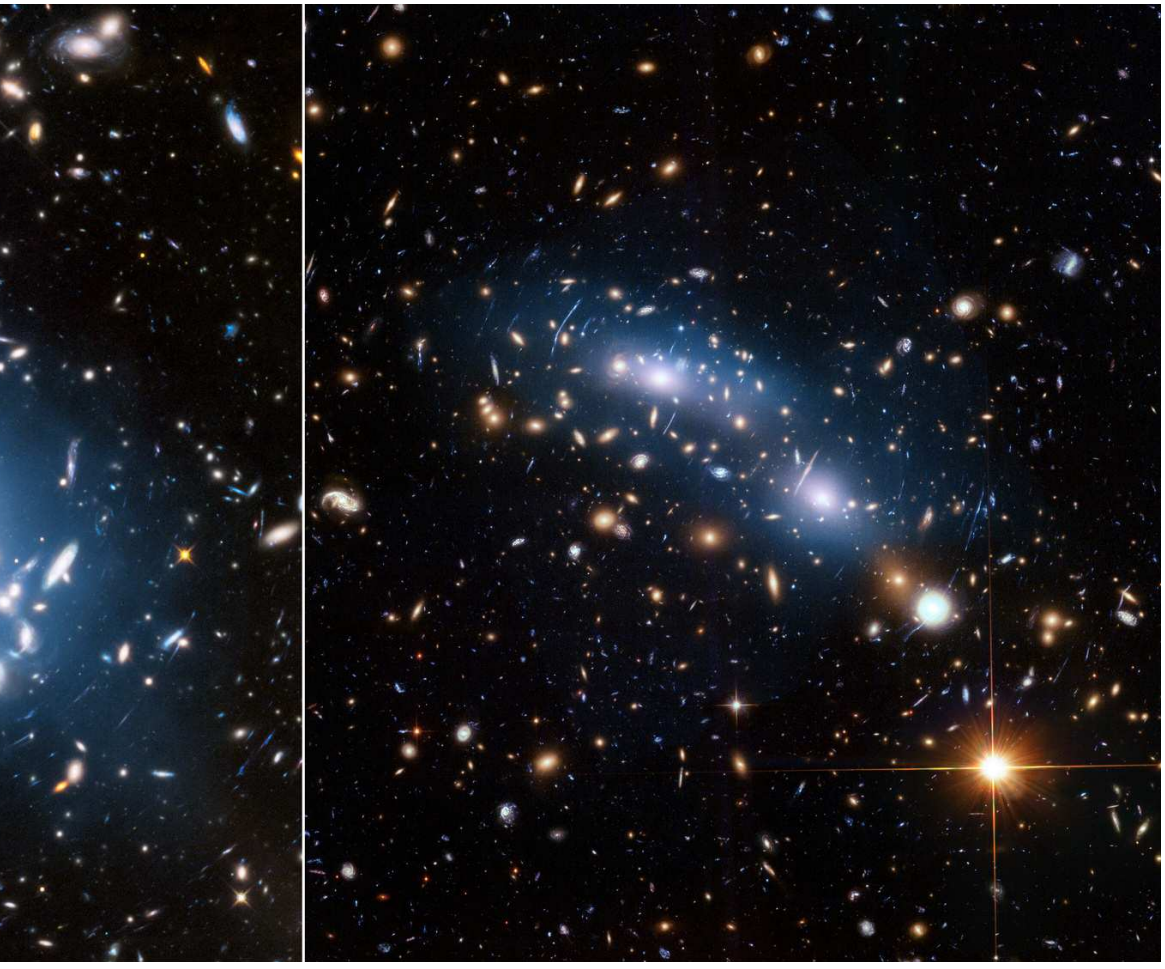
"The idea for the study was sparked while looking at the pristine Hubble Frontier Field images," said study co-author Ignacio Trujillo of the Canary Islands Institute of Astronomy in Tenerife, Spain, who along with Montes had studied intracluster light for years. *"The Hubble Frontier Fields showed intracluster light in unprecedented clarity. The images were in-*

spiring," Trujillo said. *"Still, I did not expect the results to be so precise. The implications for future space-based research are very exciting."*

The astronomers used the Modified Hausdorff Distance (MHD), a metric used in shape matching, to measure the similarities between the contours of the intracluster light and the contours of the different mass maps of the clusters, which are provided as part of the data from the Hubble Frontier Fields project, housed in the Mikulski Archive for Space Telescopes (MAST). The MHD is a measure of how far two subsets are from each other. The smaller the value of MHD, the more similar the two point sets are. This analysis showed that the intracluster light distribution seen in the Hubble Frontier Fields images matched the mass distribution of the six galaxy clusters better than did X-ray emission, as derived from archived observations from Chandra X-ray Observatory's Advanced CCD Imaging Spectrometer (ACIS).

Beyond this initial study, Montes and Trujillo see multiple opportunities to expand their research. To start, they would like to increase the radius of observation in the original six clusters, to see if the degree of tracing accuracy holds up. Another important test of their method will be observation and analysis of additional galaxy clusters by more research teams, to add to the data set and confirm their findings.

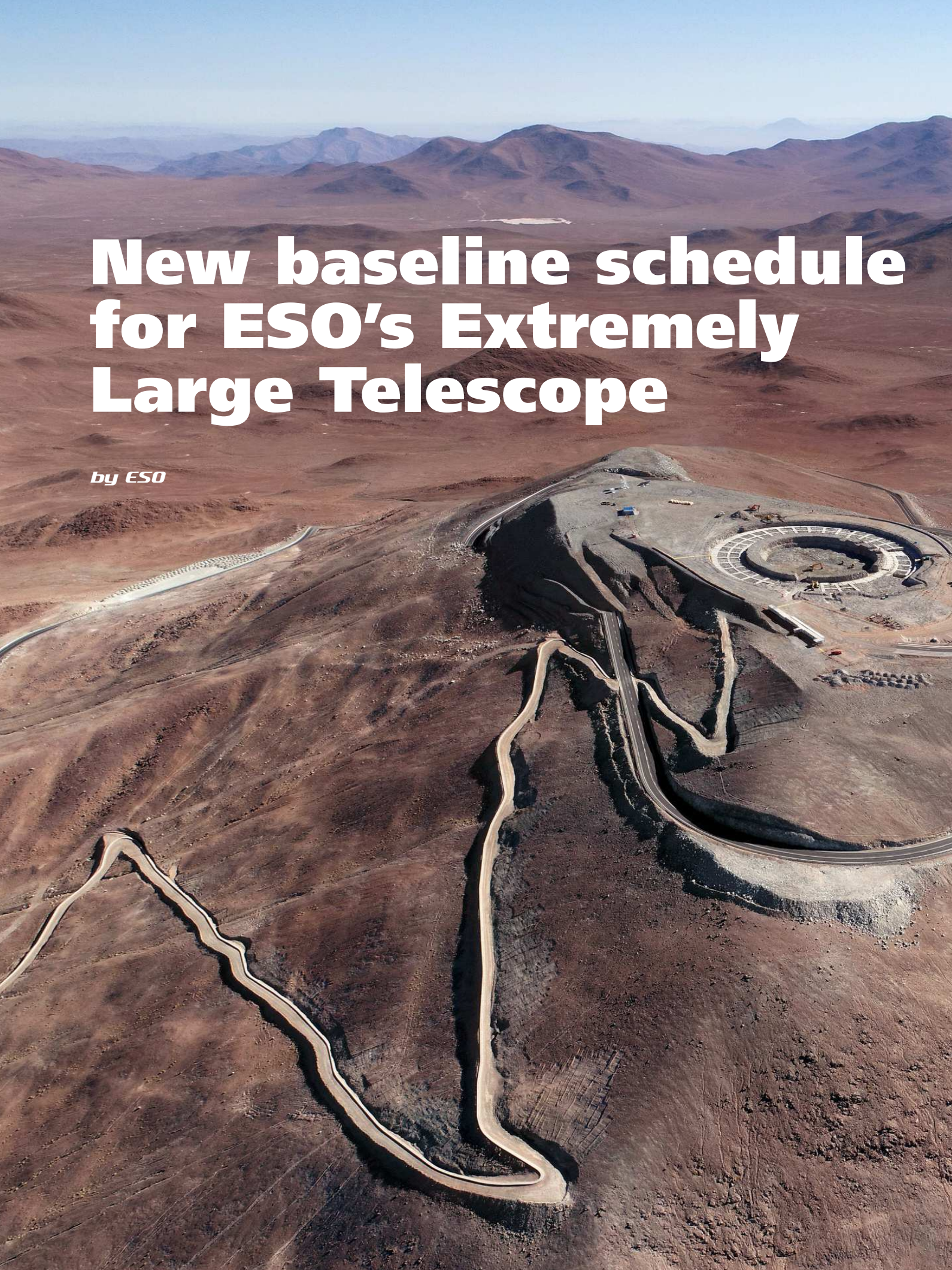
The astronomers also look forward to the application of the same techniques with future powerful space-based telescopes like the James Webb Space Telescope and WFIRST, which will have even more sensitive instruments for resolving faint intracluster light in the distant universe. Trujillo would like to test scaling down the method from massive galaxy clusters to single galaxies. *"It would be fantastic to do this at galactic scales, for example exploring the stellar halos. In principle, the same idea should work; the stars that surround the galaxy as a result of the merging activity should also be following the gravitational potential of the galaxy, illuminating the location and distribution of dark matter."* ■



Two massive galaxy clusters — Abell S1063 (left) and MACS J0416.1-2403 (right) — display a soft blue haze, called intracluster light, embedded among innumerable galaxies. The intracluster light is produced by orphan stars that no longer belong to any single galaxy, having been thrown loose during a violent galaxy interaction, and now drift freely throughout the cluster of galaxies. [NASA, ESA, and M. Montes (University of New South Wales)]

New baseline schedule for ESO's Extremely Large Telescope

by ESO



Construction site of the Extremely Large Telescope on Cerro Armazones in the Chilean Atacama Desert. [G. Hüdepohl (atacamaphoto.com)/ESO]

Since the ESO Council gave their "green light" to start the construction of the Extremely Large Telescope (ELT) in 2014, the programme has been advancing rapidly. To date, almost 90% (by value) of the external contracts have been awarded for the design and manufacture of the telescope, optics, components and instruments.

ESO continuously monitors the performance of ongoing contracts and the schedule of the programme.

With the facts available today, ESO has assessed the current situation of the ongoing work and the tight schedule for the products and activities still to be procured. In light of this, ESO has decided to revise the ELT's baseline schedule. As a result, First Light, previously scheduled for the end of 2024, is currently planned for the end of 2025.

Despite the postponement of the First Light, the schedules committed to in all running contracts and agreements with the ELT industrial contractors and institute partners remain unchanged. ESO will continue to work closely with its contractors and partners to ensure that all existing contractual schedules are met, and that the ELT is delivered as soon as possible.

The scientific strength and uniqueness of the ELT will not be affected by this development. Though the new schedule pushes back the First Light date, the telescope's observational capabilities remain unparalleled. When the world's largest optical telescope begins its operations, it will offer astronomers a unique opportunity to tackle some of the biggest challenges in astrophysics and will vastly advance our scientific knowledge of the Universe. ■

Hubble takes gigantic image of the Triangulum Galaxy

by NASA/ESA

The NASA/ESA Hubble Space Telescope has captured the most detailed image yet of a close neighbour of the Milky Way — the Triangulum Galaxy, a spiral galaxy located at a distance of only three million light-years.

This gigantic image of the Triangulum Galaxy — also known as Messier 33 — is a composite of about 54 different pointings with Hubble's Advanced Camera for Surveys. With a staggering size of 34,372 × 19,345 pixels, it is the second-largest image ever released by Hubble. It is only dwarfed by the image of the Andromeda Galaxy, released in 2015. The mosaic of the Triangulum Galaxy showcases the central region of the galaxy and its inner spiral arms. Millions of stars, hundreds of star clusters and bright nebulae are visible. This image is too large to be easily displayed at full resolution and is best appreciated using the zoom tool. [NASA, ESA, and M. Durbin, J. Dalcanton, and B. F. Williams (University of Washington)]

This panoramic survey of the third-largest galaxy in our Local Group of galaxies provides a mesmerising view of the 40 billion stars that make up one of the most distant objects visible to the naked eye.

This new image of the Triangulum Galaxy — also known as Messier 33 or NGC 598 — has a staggering 665 million pixels and showcases the central region of the galaxy and its inner spiral arms. To stitch together this gigantic mosaic, Hubble's Advanced Camera for Surveys needed to create 54 separate images.

Under excellent dark-sky conditions, the Triangulum Galaxy can be seen with the naked eye as a faint, blurry object in the constellation of Triangulum (the Triangle), where its ethereal glow is an exciting target for amateur astronomers.

The Triangulum Galaxy is a notable member of the Local Group — it is the group's third-largest galaxy, but also the smallest spiral galaxy in the group. It measures only about 60,000 light-years across, compared to the 200,000 light-years of the Andromeda Galaxy; the Milky Way lies between these extremes at about 100,000 light-years in diameter.

The Triangulum Galaxy is not only surpassed in size by the other two spirals, but by the multitude of stars they contain. The Triangulum Galaxy has at least an order of magnitude less stars than the Milky Way and two orders of magnitude less than Andromeda. These numbers are hard to grasp when already in this image 10 to 15 million individual stars are visible.

In contrast to the two larger spirals, the Triangulum Galaxy doesn't have a bright bulge at its centre and it also lacks a bar connecting its spiral arms to the centre. It does, however, contain a huge amount of gas and dust, giving rise to rapid star formation. New stars form at a rate of approximately one solar mass every two years.

The abundance of gas clouds in the Triangulum Galaxy is precisely what drew astronomers to conduct this detailed survey. When stars are born, they use up material in these clouds of gas and dust, leaving less fuel for new stars to emerge.

Hubble's image shows two of the four brightest of these regions in the galaxy: NGC 595 and NGC 604. The latter is the second most luminous region of ionised hydrogen within the Local Group and it is also among the largest known star formation regions in the Local Group.

These detailed observations of the Triangulum Galaxy have tremendous legacy value — combined with those of the Milky Way, the Andromeda Galaxy and the irregular Magellanic Cloud galaxies, they will help astronomers to better understand star formation and stellar evolution. ■

Orbital advertising – a concrete risk

by Michele Ferrara

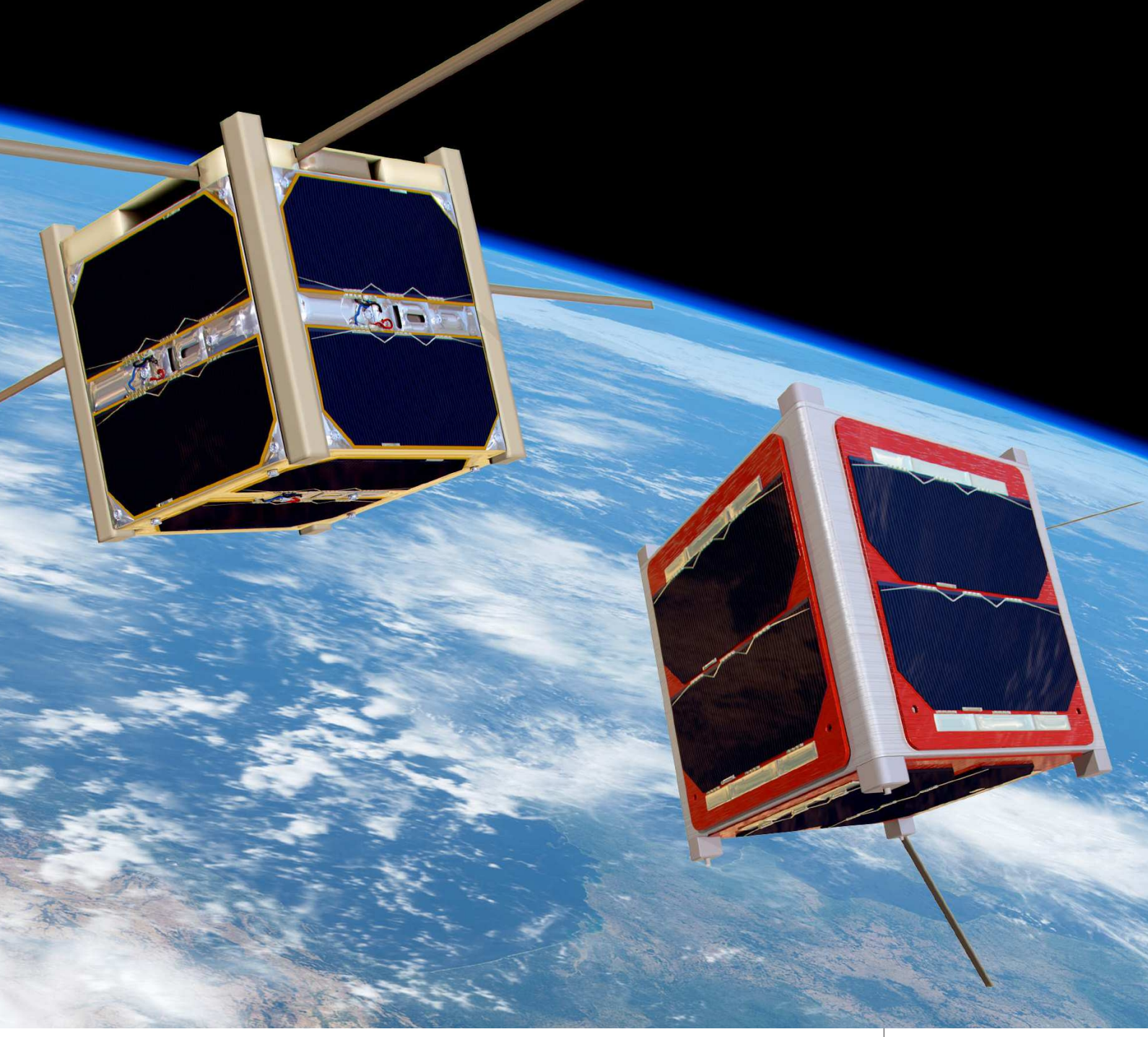
revised by Damian G. Allis
NASA Solar System Ambassador

Watching the night sky with the naked eye might seem to some a boring activity because, with few exceptions, you always see the same things. Some might even think it would be nice if there was at least a bit of space advertising between one observation and another... As incredible as it may seem, someone is really planning to put bright displays in orbit with brands and commercial logos.

Vladilen Sitnikov, CEO of StartRocket, is the one who had the "brilliant" idea of the Orbital Displays, a form of advertising aimed at contaminating the starry sky.

In 2021, a sunset on the Golden Gate Bridge might look like this, with luminous writings appearing among the Moon, stars and planets.

We are continuously bombarded with advertising. It reaches us through TV, radio, phones, internet, print media, signposts, billboards and countless other channels. Sometimes it is tolerable and also useful, especially if it offers something in return and does so with discretion (as happens in the case of this magazine). Other times, it's annoyingly pounding and intrusive (like the subscription campaigns to a leading magazine in the sector). It is not easy to completely avoid advertising messages. One solution is to turn off all communication devices and to spend a night of stargazing far from the pollution of inhabited centers. Apart from a few airplanes and artificial satellites, the relaxing vision we might

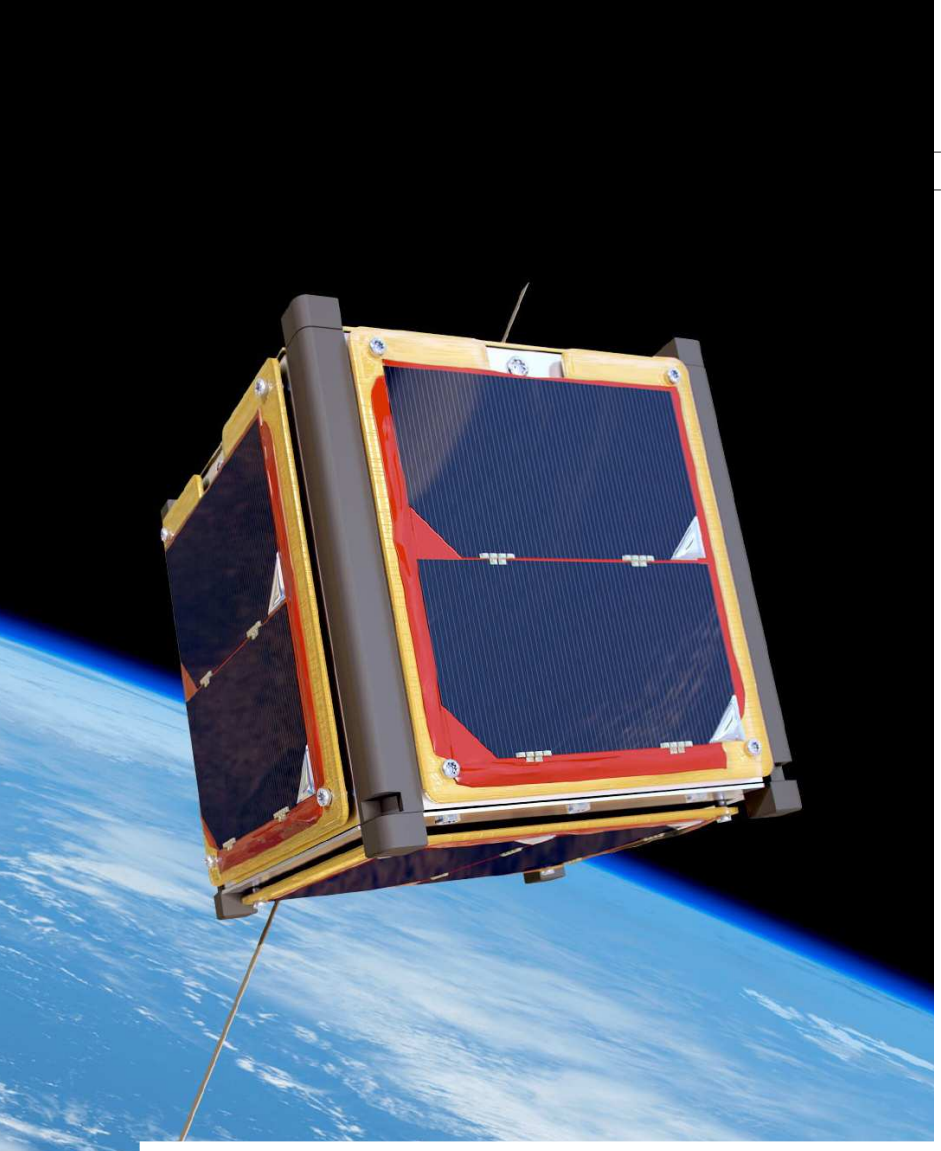


have is substantially the same as our most distant ancestors, and we could certainly appreciate the fact that the biggest "screen" visible to all mankind is completely free of advertising.

However, to someone particularly insensitive, all that space "only" filled with stars might seem like a true waste: you could fill it with advertising and make a lot of money. As absurd as it may seem to us, such contamination of the night sky could happen within a few years. As early as 2021, one might indeed observe the sky at twilight (both in the morning and in the evening), perhaps to admire a planet, a crescent moon, or a comet, and see suddenly emerge from the horizon a very bright artificial "celestial body" having the shape of a brand or a logo of a famous commercial product. After passing through a more-or-less broad arc of sky, the intruder would vanish.

The self-styled Russian aerospace company StartRocket is promoting this worrying initiative, which aims to produce orbital billboards by exploiting the design and control of cubesats. Cubesats are satellites of very small size (as big as shoe boxes), which, due to their light weight, versatility, and affordability, are proving a growing success both in the scientific and commercial fields. Through a single launch, tens of them can be put into orbit and, apart from some spe-

Cubesats, similar to those shown above, will represent the pixels of brands and logos that the Orbital Displays project intends to make appear in our skies. [NASA Johnson/Flickr] On the next page, an example of an imaginary trademark in transit over Mount Fuji. [StartRocket]



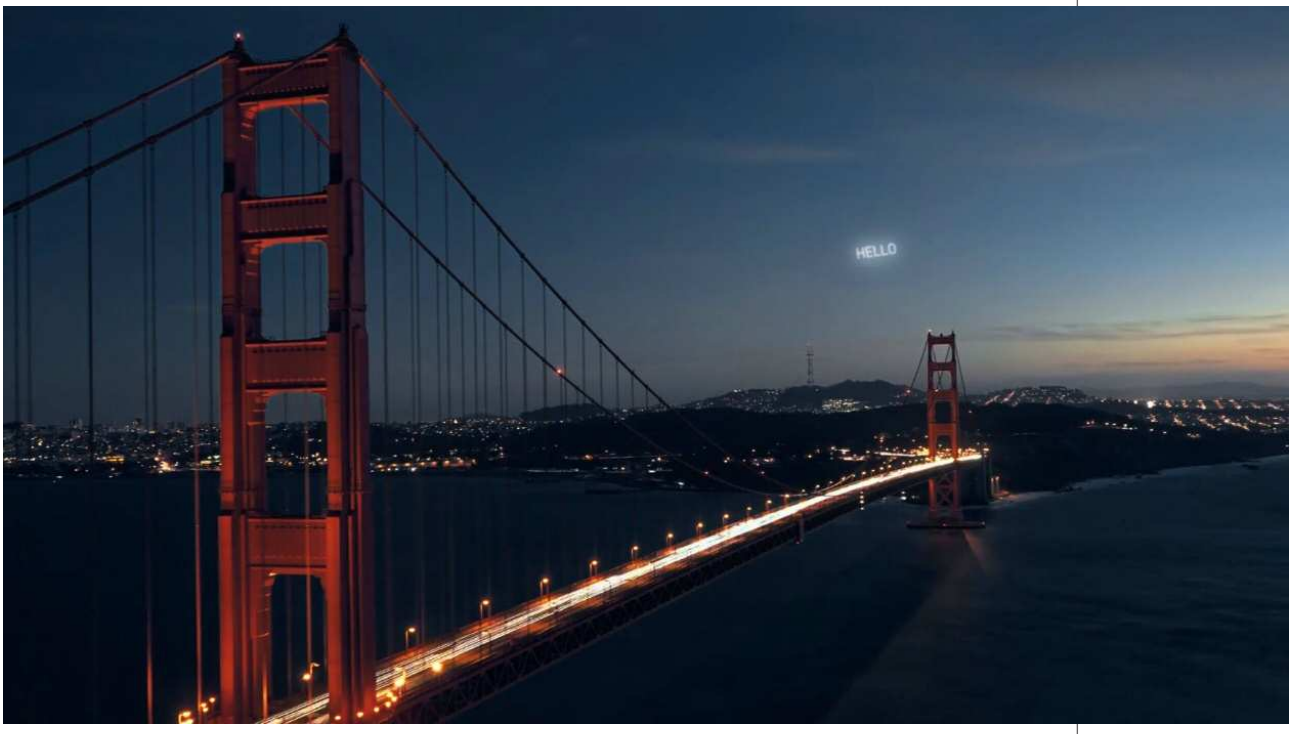
cific applications, they are able to perform tasks that were once possible only with much more cumbersome satellites.

StartRocket plans to launch an entire fleet into low Earth orbit, between 400 and 500 km high, where the International Space Station also operates. Once the goal is reached, the cubesats will be placed in a predetermined formation, about 100 meters apart from one another, and each of them will open a mylar sail with a surface not exceeding 10 square meters, whose task is to reflect sunlight towards the Earth's surface. The sails will cover a total area of about 50 square kilometers and, as if they were moving pixels, can be shifted to compose, from time to time, the names or logos of products and companies that might have the bad taste of being accomplices of the contamination of the last inviolate environment.

StartRocket proudly states that this project, called "Orbital Displays," will open the way for new forms of media. The company also "reassures us" by stating that each display will not be brighter than

This simulation shows the fleet of cubesats already in formation, seen from the outside of their orbit. By opening the sails of one-half of the cubesats, the word "hello" was composed. Below, the result as seen from the ground. [StartRocket]

magnitude -8 (!) and that the orbits will be calculated in order to cause the least possible disturbance to researchers. The company also emphasizes the possibility of using their Orbital Displays to spread messages of public utility in the event of serious continental calamities. About this, here is what the StartRocket's website reports: *"When phones don't work, during zero visibility, power cuts and catastrophical emergencies – government can use the display for urgent notifications for the population."* This statement leaves one a bit perplexed, especially given the fact that, in an emergency situation, it may be difficult to arrange the message that needs to be



spread, and that message has to necessarily be so short as to perhaps be ineffective or useless. It is difficult to think of a different application than the purely commercial one for Orbital Displays.

The bewildering prospect of seeing advertising signs in the twilight sky, as fast as the International Space Station (but up to six times brighter) has already raised much controversy, certainly justified, for other opportunities to implement projects of this kind. A good reason to avoid placing in orbit objects that are substantially useless to the community is that there are already too many. As noted by Patrick Seitzer, professor of astronomy at the University of Michigan in Ann Arbor and expert in space debris, *"Space is getting increasingly crowded. There are over 20,000 objects with orbits in the official public catalog maintained by the U.S. Air Force. Less than 10 percent of those objects are active satellites — the rest are dead satellites, old rocket bodies and parts of spacecraft."*

A sequence of possible twilight and night views contaminated by the presence of the Orbital Displays.

This already serious situation is bound to significantly worsen due to the growing use of cubesats, whose number will increase exponentially in the coming years. Just to give an example, Elon Musk's SpaceX, having inappropriately polluted the Solar System with a car and a puppet, has planned the launch about 7500 cubesats into low Earth orbit. As the astronomer John Barentine (International Dark-Sky Association in Tucson, Arizona, and the American Astronomical Society's Committee on Light Pollution, Radio Interference and Space Debris) points out, advertising displays would not just add trash in orbit and light pollution in the environment, but could also disturb radio signals, creating problems for activities that are much more useful to the space community and society in general. More generally, the whole question is well-summarized by David Kipping, professor of astronomy at Columbia University: *"This is stupid, vandalizes the night sky and corrupts our view of the cosmos."*

Apparently unaware of any reasonable objection, the CEO of StartRocket, Vladilen Sitnikov, minimizes intrusiveness and the risks associated with his initiative, releasing to his interlocutors somewhat uninformed statements, as reported by reliable sources. About advertising, he says: *"It's human nature to advertise everything… Brands* [are] *a beautiful part of humankind."* With reference to the inconvenience its displays would be to astronomers, Sitnikov minimizes: *"It's just six minutes. You can do peeing or making your coffee. So it's a break for you, it's like we* [are] *help*[ing] *them."*

How likely is a future invasion of the twilight sky, then, eventually, the nocturnal sky, by advertising messages? Currently, there are no national and international laws that could prevent such commercial initiatives. The Federal Communications Commission (a US government agency) has recently proposed restrictions on the spread of space junk, but those proposals are not yet law and do not refer to the specific case of orbital advertising. Therefore, from a legal point of view, nobody can prevent anyone from implementing projects such as the one proposed by StartRocket. This does not mean that the Russian startup will succeed in its intent. Sitnikov is not an

engineer with specific aerospace knowledge. In fact, to define the technical details of his project and to develop a prototype of the display, he called on the private Skolkovo Institute of Science and Technology (Skoltech) in Moscow. Moreover, he does not seem to have the necessary funds to go beyond this first phase (over 200 million dollars will be needed).

As a result, the launch of cubesat fleets intended for advertising is subject to the signing of contracts with investors and customers, which are non-existent today. Potential investors and customers may be discouraged by possible boycotts of their products, organized by environmentalists, astronomers, and other categories more-or-less directly annoyed or damaged by the displays. Another factor discouraging the signing of contracts with StartRocket is the fact that a significant part of the planet's population is concentrated in big cities and their suburbs, places where the clear sky is often clouded by atmospheric and light pollution - a circumstance that would frequently prevent the viewing of the displays. Even when they were visible, their presence would take second place compared to the most common and most luminous signs pervasive in many cities.

The StartRocket project could, therefore, run aground before ending the testing phase of the technical studies currently underway. Not having a sufficient engineering and technological background, the company will always be dependent upon external partners, and this will entail high costs against random receipts. Moreover, it is estimated that the operational life of each fleet of cubesats will be about a year, after which, due to the orbital decay and the exhaustion of the propellant necessary for the reconfiguration of the "pixels," substitute cubesats will have to be launched.

Considering all the difficulties that StartRocket will have to overcome to realize and manage its project, it is very probable that it will never succeed. Since Sitnikov and colleagues are also aware of this, it is questionable whether the whole project is not simply a "publicity stunt" to attract public attention and potential investors for more concrete future projects. This is a fairly common strategy in the private aerospace sector. It also happens that the projects then dissolve into nothing, along with the loans granted by imprudent investors.

All in all, those who love the night sky as it is can, for now, feel confident that no one should be able to invade it with bright advertising in the coming years.

But, if in the meantime, no ad hoc laws are passed to defend this last pristine frontier, we can be sure that, sooner or later, the worst will happen. ■

This StartRocket's promotional illustration is accompanied, on the company's website, by a statement that we leave the reader to judge: "Space has to be beautiful. With the best brands our sky will amaze us every night." [StartRocket]

NEW MOON TELESCOPES

The Hybrid

The Classic

Hand Crafted Dobsonians- Made to Order

From 8" to 36"

Featuring The All New SOLID Wood / Aluminum HYBRID!

YouTube

www.newmoontelescopes.com ryan@newmoontelescopes.com

Free open source mater ESO Supernova Planeta & Visitor Centre

by ESO

The exhibition in the ESO Supernova Planetarium & Visitor Centre covers 2200 m2 and aims to answer the most intriguing astronomical questions. Included in the exhibition are 104 app kiosks, 147 panels and 92 huge wall and floor prints. All material produced for the visitor centre is released under Creative Commons and can be reused by other planetariums, science centres and museums all over the world. [ESO/C. Malin]

ials from the rium

The ESO Supernova Planetarium and Visitor Centre is the world's first open-source planetarium, and part of its mission is to develop and share visuals, texts and materials for both the general public and astronomy science communicators. Now that the ESO Supernova is open to the public, the extensive content of its exhibition, a range of its captivating planetarium shows, and many more high-quality outreach materials are available online for reuse under a Creative Commons 4.0 license.

A particular highlight of the ESO Supernova's open-source material is the permanent exhibition in the ESO Supernova — The Living Universe — which covers the topic of life in the Universe in the broadest sense. It connects visitors with astronomical topics by focusing on the human-Universe connection and how we observe the Universe — with an emphasis on ESO facilities. The text and images of the panels, wall images, floor prints and touch-screens making up this 2200 m^2 exhibition are freely available (for information: https://supernova.eso.org/). The panels, designed and laid out by design und mehr, can be enjoyed either on the webpage as HTML-content, as PDF-files, or even as InDesign files, which allow for the panels to be adapted for any required purpose.

They answer different astronomical questions on three different levels: very briefly at an infotainment level, more deeply at an educational level, and in an easy way, dedicated

The ESO Supernova Planetarium & Visitor Centre features a state-of-the-art digital planetarium. All material produced for the visitor centre is released under Creative Commons and can be reused by other planetariums, science centres and museums all over the world. [ESO/P. Horálek]

to kids. Every panel features high-resolution, stunning images and easy to understand graphics.
Aside from the panels, the new online archive also contains more than 100 kiosk applications, which deliver interactive and non-interactive content on different astronomical topics in depth. Like the panels, these

This time-lapse sequence shows the Sun setting behind the ESO Supernova Planetarium & Visitor Centre. The bright celestial object visible after sunset near the centre is Venus. [ESO, P. Horálek]

apps are all bilingual. The apps will be updated regularly, in order to add new content and to reflect the latest astronomical research. The apps work on any Internet-enabled computer running a full-screen Chrome browser, but are optimised to be seen on a screen with a format of 16:9 (e.g. 1920×1080 pixels).
Both those interested in astronomy and professionals working in science centres can also browse the extensive database of high-resolution, high-quality astronomical images and videos which were gathered for the ESO Supernova. These archives feature stunning astronomical images collected by telescopes all over the world, educational video-clips, easy to understand graphics explaining astronomical phenomena, artists' impressions and stunning views of the night sky.
This archive comes in addition to the existing database of images and videos on the ESO main webpage. The videos in ESO's archive also include 360×180 degree immersive experience movies that can be used with virtual reality (VR) glasses, such as Zeiss VR One, Oculus Rift, HTC Vive or Google Cardboard. A third image and video archive is available on the ESA/Hubble webpage, which is also operated by ESO. All of the material can be reused under Creative Commons 4.0 licenses.
In addition to this range of eye-catching material, ESO also shares a music archive containing almost 500 free music tracks composed by ESO Music Ambassadors, including Jennifer Galatis, Johan B. Monell, tonelabs, John Dyson, STAN DART and Steve Buick. Also available are 3D models of everything from ESO telescopes to orbits of stars within the Milky Way.
ESO has already released stunning visual materials for planetariums, and continues to add to the resources available online. Among the freely available material, two full-length shows can be found: Europe to the Stars and The Sun, Our Living Star. As the Supernova continues to captivate audiences, ESO will continue to develop materials and assets for the public communication of astronomy. ■

Hubble finds a fast evaporating exoplanet

by NASA/ESA

Fishermen would be puzzled if they netted only big and little fish, but few medium-sized fish. Astronomers likewise have been perplexed in conducting a census of star-hugging extrasolar planets. They have found hot Jupiter-sized planets and hot super-Earths (planets not less than 1.5 times Earth's diameter). These planets are scorching hot because they orbit very close to their star. But so-called "hot Neptunes," whose atmospheres are heated to more than 1,700 degrees Fahrenheit, have been much harder to find. In fact, only about a handful of hot Neptunes have been found so far.

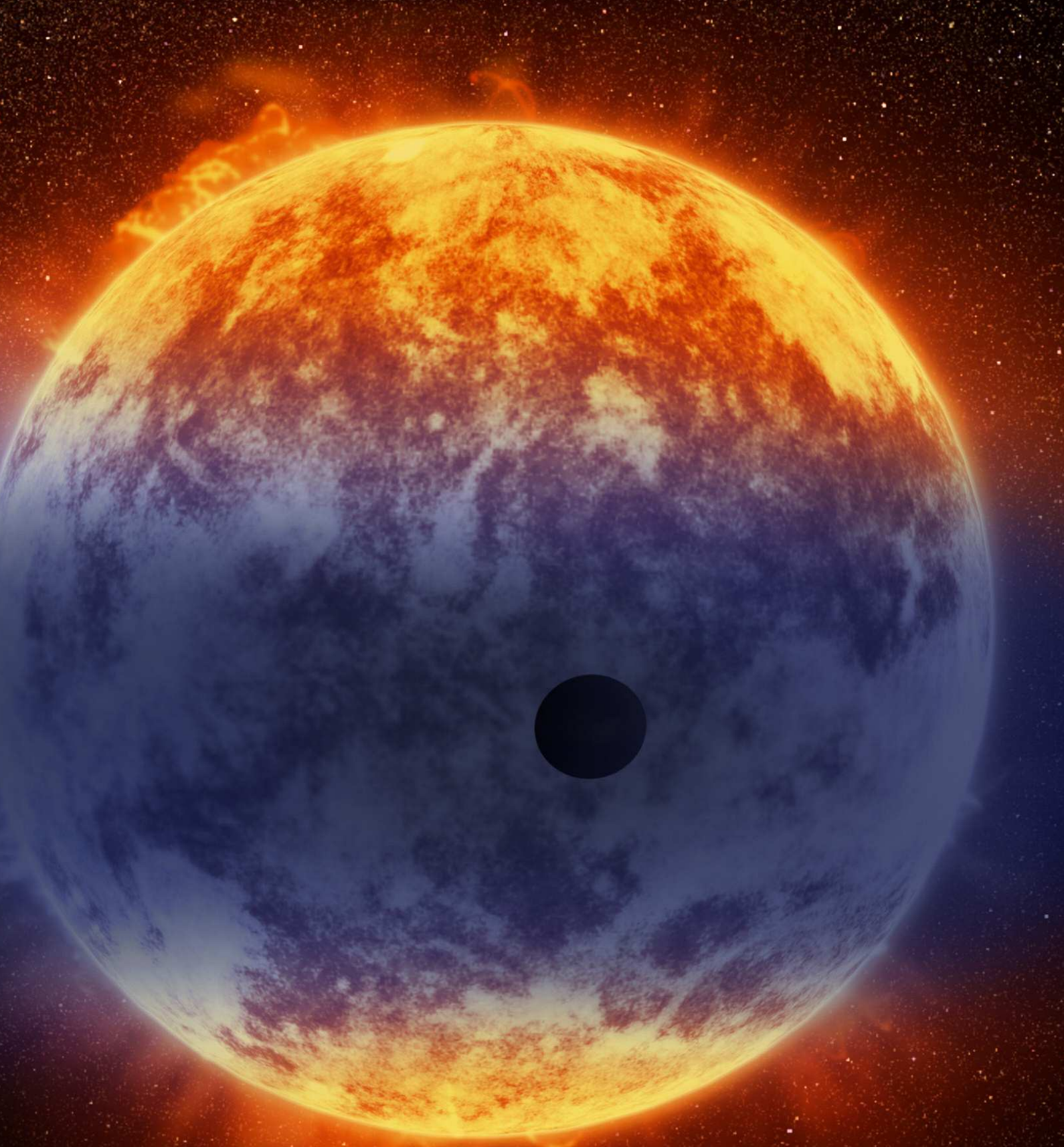
In fact, most of the known Neptune-sized exoplanets are merely "warm," because they orbit farther away from their star than those in the region where astronomers would expect to find hot Neptunes.

The mysterious hot-Neptune deficit suggests that such alien worlds are rare, or, they were plentiful at one time, but have since disappeared. A few years ago astronomers using NASA's Hubble Space Telescope found that one of the warmest known Neptunes (GJ 436b) is losing its atmosphere. The planet isn't expected to evaporate away, but hotter Neptunes might not have been so lucky.

Now, astronomers have used Hubble to nab a second "very warm" Neptune (GJ 3470b) that is losing its atmosphere at a rate 100 times faster than that of GJ 436b. Both planets reside about 3.7 million miles from their star. That's one-tenth the distance between our solar system's innermost planet, Mercury, and the Sun. *"I think this is the first case where this is so dramatic in terms of planetary evolution,"* said lead researcher Vincent Bourrier of the University of Geneva in Sauverny, Switzerland. *"It's one of the most extreme examples of a planet undergoing a major mass-loss over its lifetime. This sizable mass loss has major consequences for its evolution, and it impacts our understanding of the origin and fate of the population of exoplanets close to their stars."*

This artist's illustration shows a giant cloud of hydrogen streaming off a warm, Neptune-sized planet just 97 light-years from Earth. The exoplanet is tiny compared to its star, a red dwarf named GJ 3470. The star's intense radiation is heating the hydrogen in the planet's upper atmosphere to a point where it escapes into space. The alien world is losing hydrogen at a rate 100 times faster than a previously observed warm Neptune whose atmosphere is also evaporating away. [NASA, ESA, and D. Player (STScI)]

As with the previously discovered evaporating planets, the star's intense radiation heats the atmosphere to a point where it escapes the planet's gravitational pull like an untethered hot air balloon. The escaping gas forms a giant cloud around the planet that dissipates into space. One reason why GJ 3470b may be evaporating faster than GJ 436b is that it is not as dense, so it is less able to gravitationally hang on to the heated atmosphere.



What's more, the star hosting GJ 3470b is only 2 billion years old, compared to the 4-billion- to 8-billion-year-old star that planet GJ 436b orbits. The younger star is more energetic, so it bombards the planet with more blistering radiation than GJ 436b receives. Both are red dwarf stars, which are smaller and longer-lived than our Sun.

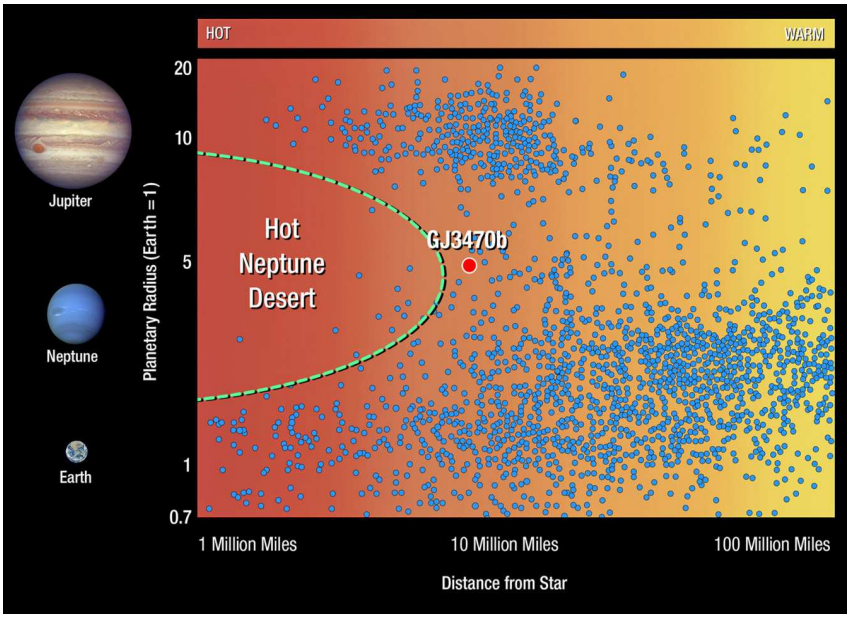
Uncovering two evaporating warm Neptunes reinforces the idea that the hotter version of these distant worlds may be a class of transitory planet whose ultimate fate is to

shrink down to the most common type of known exoplanet, mini-Neptunes — planets with heavy, hydrogen-dominated atmospheres that are larger than Earth but smaller than Neptune.

Eventually, these planets may downsize even further to become super-Earths, more massive, rocky versions of Earth.

"The question has been, where have the hot Neptunes gone?" said Bourrier. *"If we plot planetary size and distance from the star, there's a desert, a hole, in that distribution. That's been a puzzle. We don't really know how much the evaporation of the atmospheres played in forming this desert. But our Hubble observations, which show a large amount of mass loss from a warm Neptune at the edge of the desert, is a direct confirmation that atmospheric escape plays a major role in forming this desert."*

The researchers used Hubble's Space Telescope Imaging Spectrograph to detect the ultraviolet-light signature of hydrogen in a huge cocoon surrounding the planet as it passed in front of its star. The intervening cocoon of hydrogen filters out some of the starlight. These results are interpreted as evidence of the planet's atmosphere bleeding off into space. The team estimates that the planet has lost as much as 35 percent of its material over its lifetime, because it was probably losing mass at a faster rate when its red-dwarf star was younger and emitting even more radiation. If the planet continues to rapidly lose material, it will shrink down to a mini-Neptune in a few billion years. Hydrogen probably isn't the only element evaporating away: it may be a tracer for other material streaming off into space. The researchers plan to use Hubble to hunt for elements heavier than hydrogen and helium that have hitched a ride with the hydrogen gas to escape the planet. *"We think that the hydrogen gas could be dragging heavy elements such as carbon, which reside deeper in the atmosphere, upward and out into space,"* Bourrier said.



This graphic plots exoplanets based on their size and distance from their star. Each dot represents an exoplanet. Planets the size of Jupiter (located at the top of the graphic) and planets the size of Earth and so-called super-Earths (at the bottom) are found both close to and far from their star. But planets the size of Neptune (in the middle of the plot) are scarce close to their star. This so-called desert of hot Neptunes shows that such alien worlds are rare, or, they were plentiful at one time, but have since disappeared. The detection that GJ 3470b, a warm Neptune at the border of the desert, is fast losing its atmosphere suggests that hotter Neptunes may have eroded down to smaller, rocky super-Earths. [NASA, ESA, and A. Feild (STScI)]

The observations are part of the Panchromatic Comparative Exoplanet Treasury (PanCET) survey, a Hubble program to look at 20 exoplanets, mostly hot Jupiters, in the first large-scale ultraviolet, visible, and infrared comparative study of distant worlds.

Observing the evaporation of these two warm Neptunes is encouraging, but team members know they need to study more of them to confirm predictions. Unfortunately, there may be no other planets of this class residing close enough to Earth to observe. The problem is that hydrogen gas cannot be detected in warm Neptunes farther away than 150 light-years from Earth because it is obscured by interstellar gas. GJ 3470b resides 97 light-years away.

However, helium is another tracer for material escaping a warm Neptune's atmosphere. Astronomers could use Hubble and the upcoming NASA James Webb Space Telescope to search in infrared light for helium, because it is not blocked by interstellar material in space.

"Looking for helium could expand our survey range," Bourrier said. "Webb will have incredible sensitivity, so we would be able to detect helium escaping from smaller planets, such as mini-Neptunes." ■

Optical Accessories

- Binoviews
- Diagonals
- Barlows
- Off Axis Guiders
- Guidescopes
- Flattners
- Focal reducers

and much more

Mechanical accessories

- Focusers
- AZ mounts
- Filter wheels
- Guide rings
- Losmandy & Vixen dovetails
- Various mechanical accessories

Cameras & Filters

- QHY ccd cameras
- QHY ccd for guide and planetary imaging
- Full Frame sensors for Deep Sky
- Planetary filters
- Interferenzial filters
- LRGB filter kits

Eyepieces

- Planetary eyepieces
- Wide Field 70° eyepieces
- Ultra Wide Field 100° eyepieces

A complete line of eyepieces for amateur and also for professional users.

Telescopes

Wide range of telescopes from simple achromatic to professional apochromatic refractors.

Tecn Sky
Torino
info.torino@tecnosky.it

Tecn Sky
Felizzano
www.tecnosky.it
info@tecnosky.it

Teleskop Service Italia
Signoressa di Trevignano
info@teleskop-express.it

NortheK

Instruments - Composites - Optics

DALL KIRKHAM 350 MM

F/20 23% OBSTRUCTION

SUPREMAX 33 PRECISION OPTICS FROM SCHOTT

CARBON STRUCTURE - 18-POINT FLOATING CELL

MOTORIZED FOCUSER 2.5" FEATHER TOUCH

VENTILATION AND SUCTION SYSTEM

OF THE BOUNDARY LAYER

WEIGHT 34 KG.

ALSO AVAILABLE IN THE VERSIONS

NEWTON F/4.1 WITH 3" CORRECTOR

RITCHEY CHRÉTIEN WITH F/9

CORRECTOR/REDUCER

CASSEGRAIN CLASSIC F/15