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MAGAZINE  
**PRO ESPACIO**

**WHEN WILL WE  
GET TO**

Mars?

**INTERVIEW**  
**PEDRO DUQUE:**  
EUROPEAN SPACE  
AGENCY (ESA)  
ASTRONAUT

**LATEST NEWS**  
The PAZ satellite  
IS ALREADY IN ORBIT

# WITH CHANGE comes opportunity

Until recently, when someone talked about any type of Space industry, they referred to the Space sector. However, a new concept has emerged –so-called New Space – and I guess we could now define the model known and established more than fifty years ago as traditional (I refuse to call it old).

The term New Space refers to a new global trend with a clearly commercial orientation, one which functions separately from government policies and regulations such as those of the main contractors. To this definition, we could add the adverbs very or highly, together with the adjectives agile, flexible, productive, disruptive and technological.

If New Space is very agile, does that mean the traditional sector is not? If New Space is highly technological or flexible, does it mean traditional industry is not? Not at all. This sector, now called traditional, has been and continues to be innovative although, it's true, now perhaps to a lesser extent. We cannot forget the trips to the Moon, the 135 Space shuttle flights, the International Space Station, Mars exploration, communications, Earth observation and the many other scientific successes. These achievements are opening up the way to new business models. Indeed, some sectors are tending towards stagnation in that they are trying to extend the life of their products and services, to obtain a greater return on their investments. This situation may be equivalent to if not the same as the so-called "digital disruption" that is forcing changes, often traumatic ones, in a significant number of industries in a broad spectrum of sectors.

Just as in any market, following on from a phase of technological growth and stabilization our sector has begun to look for other vectors for entering new markets, attracting new customers, improving existing products and generating new services.

Morgan Stanley has estimated that the Space industry will have an economic impact in 2040 of more than 1.1 quintillion dollars, through products mostly linked to Internet access and connectivity. They have even published a list of the 20 companies that they expect will lead this emerging market. It includes traditional companies in the sector such as Boeing and Lockheed Martin, and others linked to the new economy (perhaps no longer so new!) such as Apple, Facebook, Microsoft, Amazon, Qualcomm, United Technologies and Honeywell.

Given the optimistic estimates and the opportunities emerging around us, it seems obvious that change is irreversible. The question is whether this change will be as drastic and immediate as has been stated. If we talk about immediacy, I think it's no longer necessary to take this into consideration as many of the new proposals are already here as real business models. Regarding the strength and firmness of the change, as always happens this will probably not be in the apocalyptic terms that are sometimes announced. In any case, the industry must keep moving in the direction demanded by market forces. We must be able to adapt our organizations, processes, technologies and models in order to access new opportunities in the market. It is certainly a challenge, but not something new for the Space industry. We have done it before and for sure we can do it again.

I think the most important thing to consider is the quantity and speed of the changes we will face from here on. The global process of digital transformation fuels these increasingly numerous and rapid changes. This is the real challenge that industry in general is facing and, of course, the Space sector will be no exception.

**THE GLOBAL PROCESS OF  
DIGITAL TRANSFORMATION  
FUELS THESE INCREASINGLY  
NUMEROUS AND RAPID  
CHANGES**



Luis Gómez  
CEO  
ALTER TECHNOLOGY  
TUV NORD



## WINTER moon

THIS GORGEOUS COMPOSITE IMAGE SHOWS THIS DECEMBER 2017'S FULL MOON, ALSO KNOWN AS A 'COLD MOON', SEEMING TO HOVER ABOVE A SET OF SATELLITE TRACKING DISHES ON THE CAMPUS OF THE INSTITUTO NACIONAL DE TECNICA AEROSPACIAL (INTA), IN THE SOUTHERN PART OF THE CANARY ISLANDS' GRAN CANARIA, AT MONTAÑA BLANCA.

ONE OF THE ANTENNAS – THE 15 M-DIAMETER DISH SEEN AT LEFT – IS ESA'S MASPALOMAS TRACKING STATION, WHICH CURRENTLY COMMUNICATES WITH ESA'S CLUSTER, LISA PATHFINDER AND XMM-NEWTON MISSIONS.

IT WAS CREATED ON 14 DECEMBER BY AMATEUR PHOTOGRAPHER CLAUS VOGL, FROM FÜRTH, GERMANY, WHO WRITES: "I SPENT MY VACATION LAST WEEK AT GRAN CANARIA. I SPOTTED THE ESA SITE MANY YEARS AGO AND ALWAYS WAS FASCINATED BY THESE BIG ANTENNAS FACING INTO SPACE. THE ENTIRE SHOOTING WINDOW WAS JUST TWO MINUTES. I SHOT FROM ON TOP OF A LITTLE MOUNTAIN 1.6 KILOMETRES WEST OF THE BIG ANTENNA, JUST OUTSIDE A VERY LITTLE VILLAGE CALLED MONTAÑA LA ARENA ON A NARROW DIRT ROAD. THE CAMERA EQUIPMENT WAS A CANON EOS 5D MARK 3 WITH AN EF 70-200/2.8 IS L LENS (EXPOSURE TIME 1.0 SEC/ APERTURE F5.6/ISO 400)."



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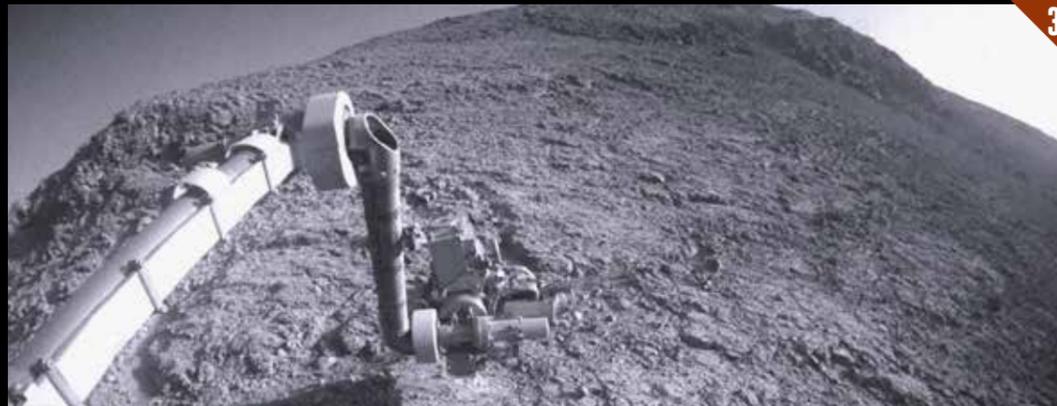
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SUMMARY



# PEDRO DUQUE

EUROPEAN SPACE AGENCY  
(ESA) ASTRONAUT

We went along to the ESAC facilities in Villanueva de la Cañada (about 30 km from Madrid), the center of the European Space Agency (ESA) specializing in Astronomy. It is where the Scientific Operations Centers (SOC) for astronomy and solar system missions are located. It's a magnificent natural setting with evergreen oaks and the ruins of a nearby 15th

century castle (Castillo de Aulencia) providing a spectacular backdrop for ESA's large hi-tech antennas. ESAC also houses the scientific archives of ESA's astronomy and solar system missions, which explains its rapid conversion into a "nerve center" for research and a meeting point for the scientific community.

**Pedro Duque** (March 14, 1963) is an Aeronautical Engineer from the Polytechnic University of Madrid and has been a Member of the Royal Academy of Engineering of Spain since 1999. During his studies at the University he worked as an intern on various projects for the Flight Mechanics Laboratory. In 1986 he joined GMV and the same year was appointed by the company to work in the Precise Orbit Determination Group at the European Space Operations Center (ESOC) of the European Space Agency (ESA), in Darmstadt (Germany).

He stayed there until 1992, working on the development of models and algorithms, as well as in implementing programs for determining spacecraft orbits. In May that year he was selected to join the ESA's Astronaut Corps at the **European Astronaut Center (EAC)**, in Cologne (Germany). From then until July 1993 he completed the Basic Training course at the EAC, as well as another program at the TSPK (the Russian Astronaut Training Center) in Star City (Russia), in preparation for participating in the future cooperation program between ESA and Russia on the MIR Space Station.

In August 1993, Pedro Duque returned to Star City and began training for the **EUROMIR 94** (ESA-Russia) joint mission. In the first phase he qualified as a Scientist-Astronaut for the Soyuz and MIR spacecraft. And in May 1994, he was selected as a member of the Second Crew (Reserve Crew).

A year later Duque was chosen to be a Reserve **Scientist-Astronaut** for the Life and Microgravity Spacelab (LMS) mission, which flew in June-July 1996 with the NASA STS-78 Shuttle. Throughout this 17 day mission, he worked with the coordinating team

that maintained contact between scientists on the ground and the crew aboard the Columbia Shuttle. In August 1996, Duque joined the Class of Mission Specialists at NASA's Johnson Space Center in Houston, qualifying in April 1998 as a 'mission specialist', an indispensable requirement to join a NASA Shuttle mission.

He was also the CEO at Deimos Imaging, S.L., a company focused on making use of the data obtained from Earth observation satellites. In October 2011, Duque returned to ESA and resumed his position as an astronaut, maintaining his qualifications for a potential new space flight. During this period, he led the Flight Operations Office, with responsibility for European activities on the International Space Station and is currently responsible for the control and review of future manned flight projects.

In short, the four space flights in which he has participated makes Pedro Duque a specialist in the adaptation of experiments for carrying them out in spacecraft, as well as organizing tasks and procedures both from ground and from space. So, we started the interview with a question about the ISS (International Space Station).

**DURING HIS STUDIES AT THE UNIVERSITY HE WORKED AS AN INTERN ON VARIOUS PROJECTS FOR THE FLIGHT MECHANICS LABORATORY**

**THE INTERNATIONAL SPACE STATION IS A RESEARCH CENTER LOCATED IN THE EARTH'S ORBIT. ITS MANAGEMENT AND DEVELOPMENT ARE CARRIED OUT THROUGH INTERNATIONAL COOPERATION. THE ISS OPERATION IS GUARANTEED UNTIL 2024.**

**DO ITS RESULTS JUSTIFY THE COSTS INVOLVED IN ITS MAINTENANCE AND FUTURE DEVELOPMENT?**

The project operates as a permanently manned space station in which teams of astronauts and researchers from the five participating space agencies take turns, and is one of the world's greatest engineering achievements. Indeed, its work is guaranteed until 2024 and is revised at each Ministerial conference. We

think we will continue participating with the rest of the partners until at least 2028. The Station's output is very important for science. Its contribution is undeniable.

**WHY HAVEN'T WE RETURNED TO THE MOON? AND HOW LONG WILL IT BE BEFORE WE GET TO MARS?**

From an engineering point of view, we cannot skip any logical trial steps.

**"IN EUROPE, THE OUTLOOK IS VERY DIFFERENT, AND I THINK THEY SHOULD SET HIGHER LONG-TERM GOALS AND GIVE MORE SUPPORT TO THE SPACE SECTOR TO BECOME LEADERS IN SOME LARGE PROJECTS"**

First, we went to the Moon, and we must remember that a great job is done at the ISS which soon could be continued with another station that will go into lunar orbit. In this way we will be able to keep advancing and learning ahead

of going to the Red Planet. Before

then we need to do tests on a much closer celestial body (the Moon) and learn how to solve any emerging problems.

The then US Administration decided that the main objective of beating the Soviet Union in the Space Race had been fulfilled (with the Moon landings) and they substantially reduced their budgets, making it impossible to return. Incidentally, I'd like to mention that three Saturn rockets were left ready to be launched, with the engines prepared for hypothetical launches that never took place.

**IN WHAT AREAS DOES EUROPE NEED TO IMPROVE TO GET CLOSER TO US SUPREMACY IN THE SPACE SECTOR?**

In the USA, there is a highly transversal agreement, even at state level, that they will always provide the necessary means to remain the first

world power in Space exploration. However, in Europe, the outlook is very different, and I think they should set higher long-term goals and give more support to the space sector to become leaders in some large projects. Europe doesn't have programs in some important fields such as space exploration. Plus, our budget is much smaller than the US one.

**WHY DOESN'T EUROPE HAVE A LEADER LIKE ELON MUSK?**

Indeed, Elon Musk is a great entrepreneur. But another key factor is American culture and society. They reward attempts to give it a go, even though it may lead to failure, and are well used to trying something over and over again. For them there is merit in just trying. Failures are seen as mere steps on the ladder to success. Also, there are many people in the US who are willing to invest in new ideas. They know only 1 out of 10 will go ahead, but the one that

succeeds will enable them to recover their full investment. However, in Europe, if you fail people will no longer pay attention to you. There are brave people in all countries, but what we lack is a society that encourages and provides the necessary support, so people know they will have support to try again. For me this phenomenon needs to be analyzed urgently because it is the basis for future technological development.

The European space industry has very few initiatives looking to create products for exports or taking risks. Public-private collaboration is very scarce and should be much greater.

**THIS YEAR, A NEW GENERATION OF TELESCOPES WILL BEGIN TO EXPLORE RECENTLY DISCOVERED 'EXOPLANETS', DO YOU THINK MORE PLANETS LIKE EARTH WILL BE FOUND?**

There are two ESA projects, and others from NASA, and many planets have already been discovered with very uncertain methods. With the new projects, we will find hundreds of thousands of planets although we won't know how to distinguish and analyze them well. They will look like Earth, but we will have to obtain radiation from these planets to analyze them in depth. However, this won't be feasible in the short to medium term. We still know very little about space. People don't realize how vast it is. Even if we were to increase the maximum speed of our spacecraft by a hundredfold it would still take many years to reach those planets. We don't even know how to go to Mars yet, so we must take things step by step.

**"WE SHOULD BE PROVIDING THE RESOURCES TO AVOID A PROBLEM THAT I INTEND TO HIGHLIGHT, THE HUNDREDS OF THOUSANDS OF ASTEROIDS THAT COULD CRASH INTO EARTH"**

These probes are very important. With the latest data to be received indicating that these other planets could support life, we must now explore the satellites of the large planets in the solar system. But once again, we face the lack of adequate funding. Europe could lead that race if the right decisions are taken.

**YOU HAVE REPEATEDLY STATED THE NEED TO INCREASE RESEARCH ON ASTEROIDS. WHY DO YOU CONSIDER IT A PRIORITY? AND WHAT WOULD BE THE IMPLICATIONS OF AN ASTEROID STRIKE?**

We should be providing the resources to avoid a problem that I intend to highlight – the hundreds of thousands of asteroids that could crash into Earth. This requires two types of development. One would be to put a specialized telescope into an orbit closer to the Sun, the other a Don Quixote project to divert an asteroid if necessary. This is a project that could be led by Spanish industry.

NASA has studied the largest meteorites and catalogued them. Almost all of them over 1km in size are being monitored, but there are many thousands of smaller

– and by no means harmless – asteroids close to Earth that are still to be discovered and which can cause trouble. I believe we cannot stay in the dark when we have the means to solve it. If a 1km asteroid falls, it could prove to

be the most important natural catastrophe that humanity has ever suffered. Yet we can predict it and avoid it. What we need to do is get to it and take it seriously. There are projects related to this issue, but they lack the necessary funds because they are not regarded as priorities.



**IS SPACE JUNK A PROBLEM TODAY?**

I think we are in a somewhat dubious legal area, because you don't get fines for abandoning space junk. Especially in geostationary orbit, we are trying to do things well, but technology has its limitations.

We don't know much about how to get rid of Space junk, but we need to make more effort to remove the bigger objects. There are several projects underway and I think this is a potentially interesting business. Meanwhile, we have many ground-based observatories designed to control flying objects, measuring their positions and speeds, and with increasing accuracy. In the future, we could even have satellites observing these objects from space with powerful radars.

**IS THE SPANISH SPACE SECTOR DOING WELL? HOW ARE WE PERCEIVED BY OTHER COUNTRIES?**

From ESA, we can clearly see that there is great deal of competitiveness and that Spain can undertake complicated tasks just like other countries. The problem is that our (financial) contribution is lower, so we cannot lead the projects. I have also seen that our companies are very active in looking for business outside Spain. Our image abroad is really good, even though we went through a major crisis a few years ago with severe budget cuts. That was a bad time for our industry when it was decided that our work was not a priority.

**AT THE END OF FEBRUARY, SPAIN IS GOING TO LAUNCH TWO SATELLITES, ONE RIGHT AFTER THE OTHER; TWO VERY IMPORTANT MILESTONES WITH THE PARTICIPATION OF MANY COMPANIES FROM OUR INDUSTRY.**

It is indeed a great milestone and I wish the best of luck to both Hisdesat and HISPASAT with the launches. PAZ is a radar satellite that reminds me of my time at the Earth observation project, Deimos, a few years ago. As for HISPASAT, it is a project that is already consolidated. We hope that all the companies involved in the two satellites continue to grow as they have done in recent years.

**HOW DO YOU SEE THE FUTURE OF THE SPACE SECTOR?**

The laws of physics are not going to change radically. We must continue working, but progress has been made in some materials, such as solar panels, which need less energy than silicon. There are constant improvements, but even so progress is very slow. That's because Space involves risks, the technological difficulty is huge, and we don't have enough economic resources. Perhaps, if a new president of the European Commission were to be appointed in a few years' time, with greater initiatives and bigger budgets, we could lead some big projects. I would like to put the European flag on any of the planets.

■ TEXT: Iñaki Latasa  
PICTURES: Nacho González

**A recent tribute to Pedro Duque**

On January 29, the Ciudad Lineal district of Madrid paid tribute to one of its most illustrious neighbors with the unveiling of a sculpture representing the Earth on the Avenida de la Institución Libre de Enseñanza, right in front of the Miguel Blasco Vilatela Public School, where Pedro Duque studied.

This piece of interactive nature is based on the winning model in the "Pedro Duque" School Contest, produced by the Infanta Elena Public School of Special Education. 54 students from various state schools in the district took part in the contest in which they had to build a model for the statue, inspired by outer Space or the Solar System.

Ciudad Lineal wanted to pay its own very special tribute to Pedro Duque, by involving schools in the district and in doing so helping to recognize the importance of science.



# WHEN WILL WE GET TO Mars?

*Visionaries say we will set foot on the Red Planet in less than ten years' time, thus becoming the first multi planetary species. However, Government agencies are much more conservative and only NASA has set itself the goal of reaching Mars in the 2030s. How much reality is there in these announcements and how much is down to a search for votes, investment and international influence?*

**AT PRESENT**, the Opportunity and Curiosity rovers are roaming the deserted surface of Mars. Several probes from different countries are orbiting the planet to study its atmosphere and crust. The data and images they send back to Earth are rekindling interest in manned exploration of the most Earth like planet in our solar system.

The first scientist to put forward a technical plan to reach Mars was the German aerospace engineer Wernher von Braun, who became an American citizen after World War II. He did it in his book *The Mars Project*, published in 1952. Since then, more than fifty plans and projects have

followed. All of them predicted mankind would reach the planet in the following 10 to 20 years.

The challenge has been renewed at a time when new countries, such as China or India, have joined the Space Race, to rival the leadership of the US, Russia and Europe. Private initiatives have also appeared, achieving considerable successes in a short time. At the same time, the appeal of the economic exploitation of Space continues to grow, as more investors become interested in injecting capital.

In this scenario, the roadmap proposed by NASA to take

astronauts to the Red Planet consists of three stages. The first is to take advantage of the International Space Station to test technologies and study the effects of microgravity on the human body.

The next step will be to use the Moon as an intermediate platform. This will enable them to test the ability of a group of people to survive autonomously in an environment that -in the case of any problems- is only a few days from Earth, allowing a rescue operation to be mounted.

A key element of NASA's plan is to develop a powerful launcher, the Space Launch System, and a new

spacecraft, the Orion capsule, for the astronauts. By the end of next year both systems should be ready for a first mission. It will be a three-week unmanned test to send the spacecraft thousands of kilometers beyond the Moon and return to Earth without a scratch. This will be followed by a manned mission, one that will mark a milestone in that it will take a group of astronauts the furthest distance humans have ever traveled from Earth.

After these initial flights, assuming everything goes according to plan, by the mid-2030s NASA will be looking to send astronauts to orbit Mars. And, by the end of the decade, to carry out Man's first landing on the planet.

The initial NASA plan included a further preparatory test, which was finally canceled. The agency wanted to capture an asteroid, divert it to a safe orbit around the Earth and then land an astronaut on its surface to collect samples and

bring them back to our planet. Quite a challenge, but for the time being it seems there are not enough funds.

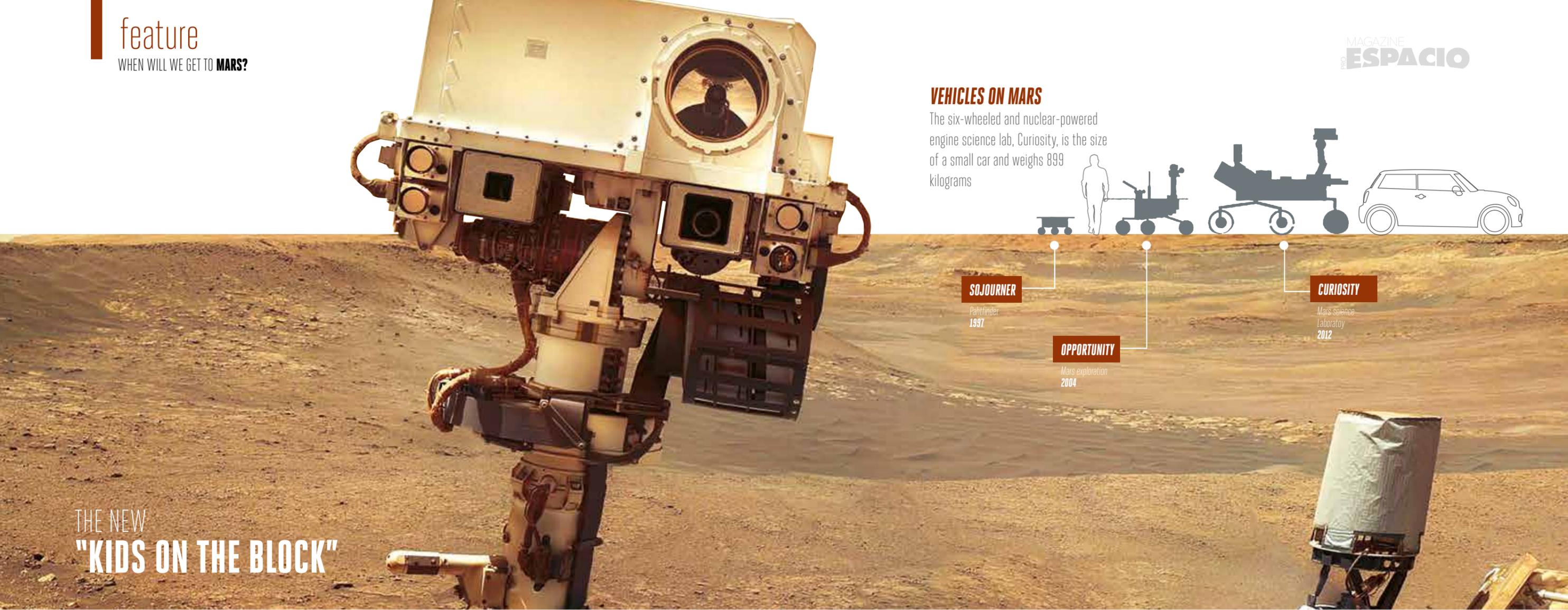
In any case, engineers and scientists are convinced that from a technical point of view they are ready to take on the challenge of conquering Mars. The main hurdle is the enormous budget that will be needed, which takes us on to the political arena.

Each occupant of the White House aspires to leave his personal stamp on the future of the Space Race, just as John F. Kennedy did when he presented the challenge of reaching the Moon in the 1960s. In 2004 George W. Bush established the goal of the US returning to the Moon. It was a decision that Democrat president Barack Obama at first rejected, saying "we've been there before." But then he put Space back into the spotlight when he stated "By the mid-2030s, I believe we can send humans to orbit Mars and return them safely to Earth.

**THE CHALLENGE HAS BEEN RENEWED AT A TIME WHEN NEW COUNTRIES, SUCH AS CHINA OR INDIA, HAVE JOINED THE SPACE RACE, TO RIVAL THE LEADERSHIP OF THE US, RUSSIA AND EUROPE**

And a landing on Mars will follow." Last December, Donald Trump gave an added twist to the tale by resurrecting the Republican goal of returning to the Moon, this time as an intermediate step to "eventually reach Mars and beyond."

Europe has also shown interest in visiting the Moon. ESA Director General Jan Wörner has spoken several times about a project to set up a base there, through a joint initiative open to more partners. He calls it Moon Village, but as yet has not provided any more concrete details. For the Russian agency Roscosmos, getting to the Moon is an essential step to travel on to Mars. It is expected their cosmonauts will land there in 2030, pushing back the challenge of reaching Mars until later decades. China also has its own lunar exploration program, which is expected to take a taikonaut to the Earth's satellite by the middle of the next decade and to establish a base there.



**VEHICLES ON MARS**

The six-wheeled and nuclear-powered engine science lab, Curiosity, is the size of a small car and weighs 899 kilograms



**SOJOURNER**

Pathfinder  
1997

**OPPORTUNITY**

Mars exploration  
2004

**CURIOSITY**

Mars science  
Laboratory  
2012

THE NEW  
**"KIDS ON THE BLOCK"**

**WHILE THESE** large agencies push ahead with their plans, private enterprise initiatives are enjoying certain advantages: they can afford to risk more as they seek to drastically reduce costs and look for ways to do business in Space.

When it comes to the conquest of Mars, one of the most appealing projects is that of SpaceX. The company's renowned President, Elon Musk, has said that in 2022 they will carry out two unmanned trips to Mars. And that just two years later they will be ready to send up several spacecraft with no less than 100 tourists and settlers to build the first ever extraterrestrial city.

His strategy focuses on building a powerful launcher called the Big Falcon Rocket. To reduce costs,

he is committed to recycling the systems used. He wants SpaceX to carry out all its missions with a single rocket, regardless of whether the mission is putting a satellite into orbit, carrying supplies to the International Space Station, or traveling to another planet. He also intends to shake up the passenger transport sector here on Earth, enabling any journey between two points to be made in less than an hour with suborbital flights. "If we do it this way, we would allocate all resources to this new and unique system," he said last September at the International Astronautical Congress in Adelaide (Australia).

Following this approach, in 40 to 100 years Mars could be home to a million people. But for many Musk's idea is more science fiction than reality.

For Robert Zubrin, President and founder of Mars Society, a nonprofit organization that also promotes the colonization of Mars, Musk's project is "too big and fantastic." Although, he explains, "it would be a matter of adjusting magnitudes so that it fits; if you lower the objective of your launcher from transporting 500 tons to 150 tons, the project would fall within the engineering field."

Another surprising proposal from the private sector comes from the Dutch non governmental initiative Mars One. They have devised a project to head to Mars in 2031 with a one-way ticket: those who embark on the adventure will never return to Earth. This formula, they explain, will accelerate the colonization of the planet.

The campaign to recruit volunteers has been a huge success. More than 220,000 people are willing to leave everything behind. The organization has made a first cut in selecting 660 people who meet their requirements, and the first space settlers will be chosen from among them.

According to Mars One, all technical and logistical aspects will be provided by other private companies, such as SpaceX or Lockheed Martin. They will provide the launcher, the spacecraft and other necessary elements to reach our neighboring planet.

To finance the initiative, the organization is proposing to sell the rights to broadcast the lives of the first inhabitants of Mars. The planet would become a set for a reality show to be seen all around

the world. Donations and the sale of intellectual property licenses would be an additional source of income. However, the calculations made by Mars One fail to convince most experts. While they appreciate the innovative component, they just don't see it as viable.

Meanwhile, American giant Lockheed Martin has launched its own idea on how to reduce the costs and risks associated with manned exploration of Mars. Instead of a project, the company talks about a "vision", one that they assure is in line with NASA's plans to reach the planet. The company is proposing to build a Space station for six people to orbit Mars. This would allow several astronauts to land on the planet and explore it, while the others provide support from the station.

As this station would have to be designed to support a scientific mission, it suggests Lockheed Martin believes that the colonization of a planet as hostile as Mars is unlikely, at least for the time being.

**AT PRESENT, THE OPPORTUNITY AND CURIOSITY ROVERS ARE ROAMING THE DESERTED SURFACE OF MARS. SEVERAL PROBES FROM DIFFERENT COUNTRIES ARE ORBITING THE PLANET TO STUDY ITS ATMOSPHERE AND CRUST**

## SHOW ME THE MONEY

**IN AN INTERVIEW** for the money. com portal (part of Time Inc. group) Pascal Lee, Director at Mars Institute (a non-profit research organization partially funded by NASA), shared his thoughts on the approximate costs of a manned mission to Mars, if carried out in the traditional way, i.e. through a government project.

Lee said "it would cost not less than 400,000 million dollars." His estimate is based on that of going to the Moon in the 1960s which required a 10-year program costing the equivalent of 4% of US GDP. "If we consider that traveling to Mars will be much more complex, we will have to multiply this figure by two or three, so we are talking about a trillion dollars investment over 25 years." Taking into account that NASA's entire budget is around 19,000 million dollars, it's clear that to reach Mars the US Congress will have to seriously increase the agency's funds, which seems unlikely to happen at present."

All of this is in terms of government funds for the missions, because the investment capability of private companies remains to be seen. Will they find a new way of coping with the huge cost of space exploration? Will they manage to turn the tide and make Space activity profitable?

As for colonizing the planet, the Director of the Mars Institute considers it a distant possibility. He regards the model followed in the exploration of Antarctica as being more realistic, where a group of researchers lives there for a few years at a base and is then replaced. "Mars' environment is hugely lethal to send people or raise a child there."

It's certain that a trip to this inhospitable planet entails a list of dangers and challenges that are yet to

be solved. The most immediate ones are related to health, since exposure to high-energy solar particles and cosmic rays during the trip would put the lives of astronauts at risk. During the journey – which would take about 200 days – their bodies will also suffer the harmful effects of weightlessness. Living conditions on board could cause psychological pathologies, since the crew will be isolated in a small spacecraft for several months. And once they reach Mars, they will have to live underground or in shelters with little in the way of comforts to protect themselves from the strong radiation.

"MARS' ENVIRONMENT IS HUGEY LETHAL TO SEND PEOPLE OR RAISE A CHILD THERE"

To make things even more difficult, they will lack medical support on the planet. Their stay will necessarily last for several years, given they will have to wait for the orbital distance between Mars and Earth to reduce, something that happens every two years and two months, before they can return home.

Aside from the health issues, there are the technical ones. Engineers are still working on the best way to land on Mars. As the planet has a much higher gravity than the Moon, this will hinder the descent and braking of a spacecraft carrying a large payload, as will be the case with a manned mission.

Mars' atmosphere is too thin to glide in on the descent – that would require far too large wings. And it doesn't provide much confidence for a parachute system either. Jet propulsion could be an option, but the weight of the spacecraft would have to increase to allow for the additional fuel carried.

Another difficulty will be communications with Earth. The distance of 55 to 401 million kilometers that separates

Earth from Mars, depending on their orbital positions, means a message would take between 3 and 22 minutes to reach our planet. And the astronauts would have to wait twice that time to receive an answer. In an emergency, this would be too long to provide support.

After all these problems have been solved, there are the challenges of producing oxygen and fuel from the available resources, and growing enough food and obtaining water to survive.

Another equally important obstacle, especially for colonization and space tourism plans, is the current obligation not to biologically contaminate worlds that could have a life of their own. This is a strict rule that will require the sterilizing of all material that is sent into Space. That is difficult to achieve with humans on board – the carriers of large numbers of microorganisms – and incompatible with tourism.

## TRAVEL TO MARS WITHOUT LEAVING EARTH

There are several current initiatives here on Earth that emulate expeditions to Mars. They enable the main space agencies and organizations interested in exploration to test the ability of humans to adapt to the harsh conditions of the Red Planet. Among them are:

Confinement of astronauts: both NASA and ESA have carried out different missions where astronauts are isolated in terrestrial environments that emulate the conditions on Mars for long periods of time. The objective is to study human reactions in long term confinements, with a crew of a few people living in small spaces, such as the spacecraft during the 200 day journey to Mars. Then, when they reach Mars, of living in bases of about 10 meters in diameter by six meters high, when you can only go outside for a short time and then dressed in a space suit.

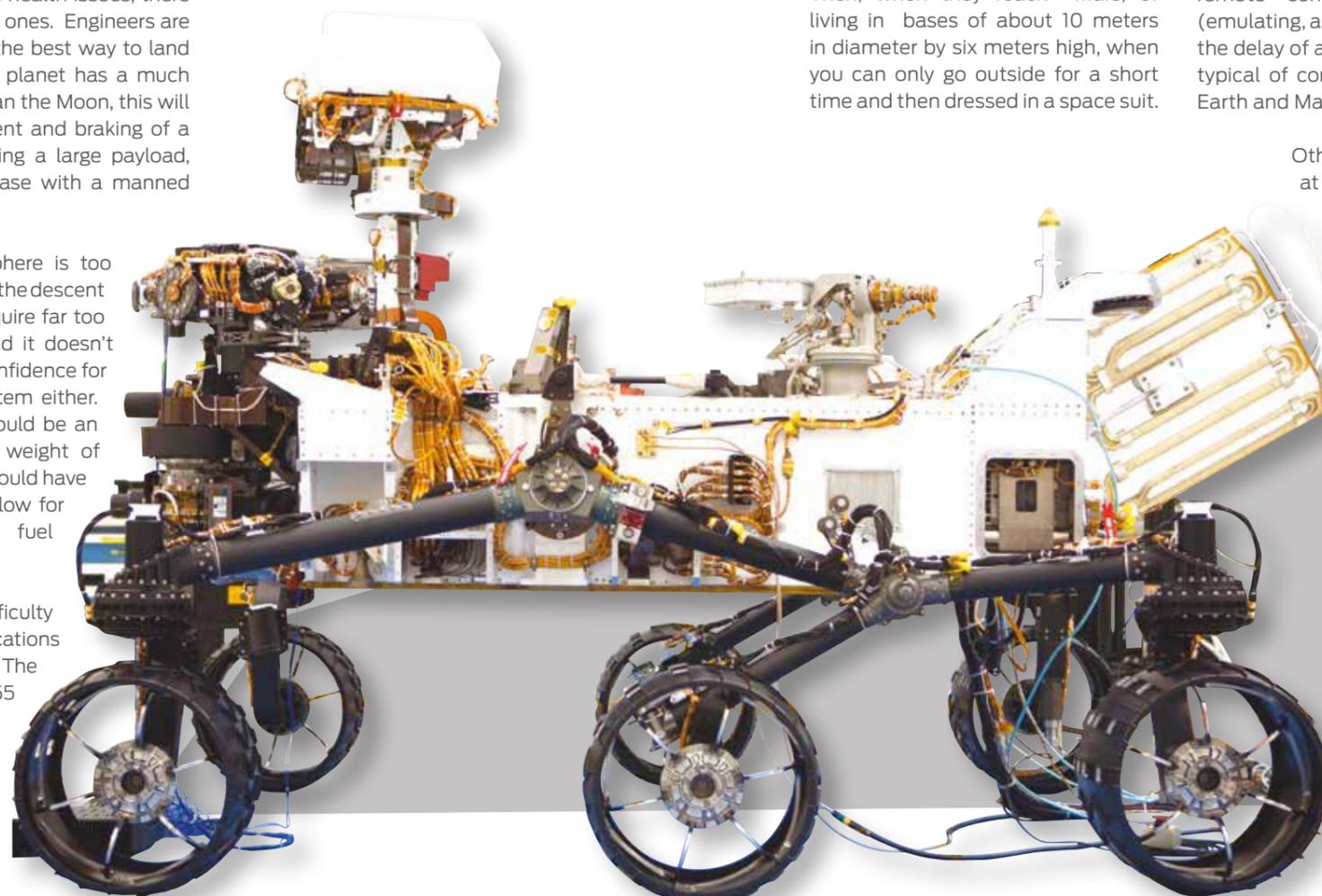
NASA has the **HI-SEAS (Hawaii Space Exploration Analog and Simulation)** facility on the isolated slopes of the Mauna Loa volcano on the island of Hawaii. It even emulates the 20-minute delay in communicating a Mars base with ground control. The first expedition "settled" there in 2013 and the most recent one in 2016. Six scientists – three men and three women – were isolated there for a year.

Meanwhile, in collaboration with the Russian and Chinese agencies, ESA carried out the **Mars500** mission in 2010-2011, with the confinement of six men at the Institute of Biomedical Pathologies (IBMP) of Moscow for 520 days. A 550 m<sup>3</sup> habitat was set up of consisting of four hermetically sealed interconnected modules, and an external module emulating the conditions on the Martian surface. Mars500 has been the longest confinement experiment simulating Martian conditions to date. The experiment has helped achieve progress in telemedicine, psychological support and remote communication protocols (emulating, as in the case of HI-SEAS, the delay of about 20 minutes that is typical of communications between Earth and Mars).

Other missions are aimed at testing rover vehicles or space suits. In Spain, at the Minas

de **Río Tinto (Huelva) mines**, ESA, the Center for Astrobiology (CAB - CSIC/INTA) and the Austrian Forum of Space, launched in 2011 the first European expedition to test the technology needed to travel to Mars. Trials were carried out for a week with the Eurobot rover on the terrain at Río Tinto, which is similar to the surface of Mars. A new space suit was also tested, as well as the medical equipment needed to monitor the astronauts' health.

Special mention must be made here of the experiments carried out by the Mars Society, a non profit association founded in 1998 with the purpose of contributing to the progress of exploration and future human settlements on the Red Planet. They have a network of volunteers around the world and have launched initiatives such as the **Mars Desert** research station in the Utah desert. Since 2001 it has been educating students, researchers and the general public about techniques for human survival on the Red Planet. Another is the **FMARS** research center in the Arctic, where different crews carry out a continuous program for geological, microbiological and climate exploration in a remote, cold and dangerous environment. In doing so they face many restrictions similar to those that will be encountered on Mars. Also, there is the 'Rover Challenge Series' competitions, and other informative programs.



### CURIOSITY

Approximately the size of a small SUV, NASA's **Curiosity** rover is well equipped for a tour of Gale Crater on Mars. This impressive vehicle has six wheel drive and the ability to turn full 360 degrees, as well as the agility to climb steep hills. During a main mission of almost two years after landing on Mars, the explorer will investigate whether Gale Crater has ever offered favorable conditions for microbial life, including chemical ingredients for life.

**NASA's Jet Propulsion Laboratory**, a division of the California Institute of Technology, Pasadena, California, manages the Mars Science Laboratory Project for NASA's Science Mission Directorate, in Washington.

# MARS EXPLORATION FAMILY PORTRAIT



Image credits:  
NASA, Roscosmos, ESA, JAXA,  
Exchange3D.com

Additional research sources:  
Space.com, RussianSpaceWeb.com

Dates indicated are for launch.

Only dedicated Mars missions  
are listed.

Adapted by TEDAE

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## THE HELP OF ROBOTS

**MANY OF THE** hurdles to traveling to Mars are linked to the fragility of us human beings. This has pushed the agencies to make use of robots. But while there have been many successes, the fact is that of 46 attempts to send probes, landers and vehicles to Mars, only 19 missions were completely successful, while six of them achieved partial success and 21 failed.

No matter what happened to them, the information collected on these missions enables us to keep dreaming of pushing manned exploration of Space.

With each passing day, the experience and technical knowledge gained from all these robotic exploration missions is increasing the chances of successfully sending humans to another planet. These probes and vehicles are paving the way for humans to one day achieve their dream of colonizing Mars.

## SPAIN AND MARS

**SPAIN HAS** shown interest in Mars exploration since the beginning of international research. Back in 1956, a news item in NODO, "The Planet Mars", echoed the few data shared by scientists on this planet, which was then believed to harbor

plant and possibly primitive animal life. Spain had a presence in the earliest missions to Mars, firstly through the deep space ground stations that NASA installed at Robledo de Chavela near Madrid. Later Spanish scientists contributed to pioneer Soviet missions such as Phobos I and II and the Russian Mars 96, as part of ESA's participation. Spanish industry, universities and research institutions have helped develop some of the scientific instruments used. From the time of the Rosetta mission, in 2004,

which passed Mars in a gravitational assistance maneuver, Spain's Space industry has been participating in ESA Mars missions and in some NASA and Roscosmos ones: Mars Science Laboratory (NASA) in 2011, Phobos Grunt (Roscosmos) in 2011, and Exomars (ESA-Roscosmos) in 2016. Exomars 2020, which involves a broad section of Spanish industry, will put the spotlight on the first Raman spectrometer to go to Mars, a project being developed in Spain under the leadership of INTA.

# "THE FIRST PERSON TO TRAVEL TO MARS HAS ALREADY BEEN BORN"

INTERVIEW with Hector Guerrero, from the Sub Directorate General of Space Systems at the National Institute of Aerospace Technology (INTA), a leading specialist on the Red Planet. He has led teams in optoelectronic, magnetic and radiation technologies for developing sensors and Space systems. His links with

Mars started in 2007, when he was chosen to lead the Spanish consortium for the development of scientific-technological instruments for the Mars MetNet Precursor mission. He is now an active promoter of Mars exploration

## QUESTION:

### WHY MARS?

ANSWER: Generally speaking, to understand the solar system and the Earth, but there are three main reasons: First, Mars gives us clues about an atmosphere that is fading. Second, to learn about the origins of life on Earth, because they may have derived from rocks that came from Mars; and third, because exploration is the essence of the human spirit – we have to go to Mars because we can.

Mars awakens interest as a portal, to develop technology that will allow us to go further, as well as to check the effects of planetary exploration on the human body. Also, as a field of mineral resources exploitation, in compliance with international space law and regulated by the United Nations. The robotic missions that are being sent to Mars are of a scientific nature, but they are beginning to show a technological bias towards testing new developments, for example in the field of communications. And Mars involves international cooperation.

### Q: WHAT IS THE BIGGEST OBSTACLE TO A MANNED MISSION REACHING MARS?

A: The lack of leadership. We need political will. We will not be able to go to Mars until the United States and Russia come to an agreement. In the past, the Moon landing was the result of competition between these two countries during the Cold War. Right now, we are seeing the emergence of private companies entering the space sector, creating competition that could reactivate the Space race. And there are interesting private initiatives heading for Mars. When China gets to the Moon, it's very likely the great powers will resume their interest in the Space Race. Similarly, other nations like India and the UAE have also set their sights on Mars.

"MARS AWAKENS INTEREST AS A PORTAL, TO DEVELOP TECHNOLOGY THAT WILL ALLOW US TO GO FURTHER, AS WELL AS TO CHECK THE EFFECTS OF PLANETARY EXPLORATION ON THE HUMAN BODY"

### Q: WHAT COULD BE THE NEXT MANNED MISSION TO SPACE?

A: Until the 2020s, the next missions are already agreed and they are all robotic. The next ones will be 'sample return' missions, to bring Mars samples back to Earth, such as those from the NASA 2020 rover, which will leave the samples collected in special containers for a later mission to recover them. Then humans will go beyond lunar orbit, for example to an asteroid, perhaps to fly over it and return, as Frank Borman, James Lovell and William Anders did in the Apollo 8 mission in 1968, when they orbited the Moon. First, we will have to fly past Mars and return. These are prior steps to landing on Mars. I believe the first person who will go to Mars has already been born. Perhaps humans will reach Mars in 2030 or 2040.

### Q: WITH THE EMERGENCE OF NEW SPACE, SHOULD WE TAKE FOR GRANTED THAT PLANETARY EXPLORATION GENERATES ECONOMIC RETURNS FOR THE COMPANIES DRIVING IT? OR SHOULD SPACE EXPLORATION BE ALTRUISTIC?

A: Any attempt by humankind to explore a new territory has always involved making money, and space is no different. Earth orbiting has brought direct benefit in the form of technological development, mainly in communications, Earth observation and positioning systems. Certainly, space exploration responds to a deeper interest, to expand the borders of humankind and, in this sense, it is altruistic exploration. Mars will be the last frontier for many years. But we must go to Mars, because we have the technology to make it happen and exploration is imperative in the human species.



### Q: WHAT WILL BE EUROPE'S PART IN ALL THIS?

A: As of today, Europe doesn't have the capability to lead a manned mission. It will be invited as a guest in any NASA or Roscosmos mission. For the time being, ESA is not planning any manned missions.

### Q: WHAT SHOULD THE FIRST CREW TO TRAVEL TO MARS LOOK LIKE?

A: In my opinion, it should be made up of engineers and scientists, some of them with military training. Perhaps a communications engineer, a mechanical-robotic engineer, a physicist, a geologist, a biologist and a doctor. Both men and women.

■ Oihana Casas and Antonio Tovar

## New TEDAE president

**Jaime de Rábago** became the new President of TEDAE at the beginning of the year. An industrial engineer



who studied at the ICAI School of Engineering in Madrid and the École Centrale de Paris, his career has been closely linked to the technological sectors integrated in TEDAE, as well as to the fields of business, technology and entrepreneurship.

Previously CEO of shipbuilder NAVANTIA, he was responsible for promoting the Observatory for Technological Entrepreneurship

ODICEO-EVERIS and is a partner in venture capital company UNINVEST which specializes in the management of technology transfer funds. He is also Secretary General of the Spanish Confederation of Reciprocal Guarantee Societies (SGR-CESGAR), Vice-Dean of ICAI (having been an associate professor at the School of Engineering for more than 20 years), and Vice-president of the Industrialization Commission at the Spanish Engineering Institute.

TEDAE's Board of Directors thanked outgoing president Adolfo Menendez for the great work he had performed at the Association, helping to consolidate a more operational model in the face of the new challenges that the Defense, Aeronautics, Security and Space industrial sectors are having to address. They also congratulated the new one, convinced that he will lead the Association into this new era with enthusiasm and success.

**"JAIME DE RÁBAGO BECAME THE NEW PRESIDENT OF TEDAE AT THE BEGINNING OF THE YEAR"**

## WORKSHOPS for teachers

**ESA is** organizing its summer and fall Workshops for Teachers, which will take place from July 10 to 13, 2018, and from October 4 to 7, 2018, in Leiden (Netherlands), near the ESA's European Space Research and Technology Center (ESTEC).

Participants will receive training and attend talks on how to include space in their lessons to make science and technology more enjoyable for students. The content will be the same in both sessions and will be organized around three main themes –Space exploration, Earth observation and technology–, with the workshop demonstrating how Space can be applied to the curricula of STEM



(Science, Technology, Engineering and Mathematics) disciplines at school.

The workshops are open to primary and secondary school teachers of STEM-related subjects who reside and work in any ESA Member or Associate State. Priority will be given to teachers

who have not participated in previous workshops organized by ESA.

The deadline for registration is **March 21 at 09:00 CET**

FOR FURTHER INFORMATION: [teachers@esa.int](mailto:teachers@esa.int)

## NEW SCIENCE DIRECTOR AT ESA

ESA has appointed **Günter Hasinger** as Director of Science at the Space Agency, a role he will carry out along with that of Director of the European Space Astronomy Center, (ESAC), which is based in the town of Villanueva de la Cañada in the province of Madrid.

Hasinger replaces astrophysicist Alvaro Gimenez, who had been in charge of ESA's scientific program and the ESAC since 2011.

Like his predecessor, the new Director is an astrophysicist and leading researcher. He was previously head of the University of Hawaii Institute of Astronomy.



Günter Hasinger

DIRECTOR OF SCIENCE AT THE SPACE AGENCY



Launch of Hispasat 30W-6 from Cape Canaveral

**The new HISPASAT communications satellite**, launched on a SpaceX Falcon 9 rocket from Cape Canaveral, is already in space.

The Hispasat 30W-6, which will be located in the 30° West orbital position, will provide a wide range of telecommunications services to Europe, America and North Africa. The beams in Ka band on the Spanish and Moroccan territory will allow providing quality access to the Internet in rural areas, thus favoring access to information technologies in those places where this is not possible with other infrastructures. In addition, the Hispasat 30W-6 will reinforce the distribution of

audiovisual content in Latin America, allowing access to more than 50 million users through its audiovisual distribution platforms, and will offer connectivity in high speed trains and maritime services in the Caribbean and the Mediterranean.

The Hispasat 30W-6 is the fourth satellite of the HISPASAT fleet built by Space Systems Loral, based on its 1300 platform, and has had the participation of Spanish companies for the manufacture of several components and the development of the ground segment: Thales Alenia Space Spain, Airbus D&S Spain, TRYO Aerospace, DAS Photonics, Iberespacio, GMV and Indra.

# The PAZ satellite IS ALREADY IN ORBIT

The **countdown** that preceded the launch of the Paz satellite on February 22 was followed with great expectation both from the Vandenberg Air Force Base, in California, and from INTA's center in Torrejón de Ardoz, Madrid. From the moment the satellite could be seen starting its journey to orbit, all those present, both here and there, burst into prolonged applause celebrating success. And with good reason: Spain had just entered the select group of countries with autonomous Earth observation capability with radar technology.

The Minister of Defense, M<sup>a</sup> Dolores de Cospedal, described the day as "historic for our security and our defense, but also for our space research, our business fabric and, ultimately, for all Spaniards." Little more than an hour later, Hisdesat –owner and operator of the Paz satellite– reported that the satellite was "in perfect health and in the planned orbit."

The joy and happy faces of those attending the launch were more than understandable. After several postponements due to technical and meteorological issues, the launch had been finally carried out successfully. But the joy was basically due to the fact that the Paz satellite undoubtedly is a milestone for Spain, from different perspectives and for different reasons. For the country, because it

will provide the Ministry of Defense with applications for citizen protection and to respond from space to the needs of the Armed Forces regarding border control, intelligence, verification of international treaties or military operations. It will also have multiple civil applications such as environmental control, spill detection, high resolution cartography or urban planning, among others. As part of the National Earth Observation Program (PNOTS) launched in 2007 by the Ministry of Defense, along with the Ministry of Economy, Industry and Competitiveness, the Paz satellite will be completed with a second optical satellite, Ingenio, in the initial two year mission.

For the Spanish space industry, PAZ also means a decisive step, since it was the first time that our companies took on the challenge of building a satellite of that size and complexity. A great example of industry cooperation that has allowed consolidating the Spanish leadership in the space sector as a builder, integrator and operator of satellites of great complexity.

The government satellite services operator Hisdesat, owner of Paz, commissioned Airbus Defence & Space Spain the satellite design and manufacture. The company carried out this work with the collaboration of a team of people from the National Institute of Aerospace Techniques (INTA), the Polytechnic Universities of Catalonia, Madrid and Alcalá de Henares, and more than 15

companies, with Crisa (Airbus Defence and Space), HV Systems, Iberespacio, Indra, NTE (currently integrated in the SENER group) and TRYO Aerospace, among them.

## Several postponements

The launch was initially scheduled for 2015 and the Russian rocket DNPER was chosen by Hisdesat to put it into orbit from the Baikonur Cosmodrome in Kazakhstan. However, the conflict between Ukraine and the Russian Federation first caused to change the launch base of Yasni and subsequently paralyzed the launch program, delaying the project.

Hisdesat decided to contract the launch to SpaceX, a company owned by Elon Musk, whose Falcon 9 rocket fulfilled all the requirements to launch a satellite with the characteristics of Paz. So, finally, on December 28, the Paz satellite departed for California, aboard an adapted Antonov aircraft, along with the Hisdesat and Airbus equipment that would perform the latest checks at the SpaceX facilities until launch.

**FIRST SPANISH  
SATELLITE WITH RADAR  
TECHNOLOGY**

**PAZ PLACES THE  
SPANISH SPACE INDUSTRY  
AT THE TECHNOLOGY  
FOREFRONT**

## The satellite

Paz will be able to provide about 100 images a day with up to 25cm resolution, both day and night, regardless of weather conditions. It will cover an area of over 300,000 kilometers per day and is ready to circle Earth fifteen times a day, at a height of 514 kilometers and a speed of seven kilometers per second.

With a weight of about 1400 kg, 5 meters in height and 2.4m in diameter, Paz integrates an advanced synthetic aperture radar operating in X-band, with 300 MHz bandwidth and maximum capacity for taking images of 420 seconds per orbit. This radar allows the antenna to be electronically pointed and provides an average response time –since the order to take a specific image is sent until it is sent to one of the control centers– of 24 hours.



The Paz satellite departed for Vandenberg Air Force Base (California) aboard an adapted Antonov aircraft from Volga Dnepr Airlines, along with the Hisdesat and Airbus equipment that performed the latest checks at the SpaceX facilities.

CONTINUED ON NEXT PAGE...

... continued from previous page  
The PAZ satellite IS ALREADY IN ORBIT

## Two secondary payloads

The satellite also has a vessel Automatic Identification System (AIS) receiver developed by ExactEarth, a Canadian company in which Hisdesat is the main shareholder, to report on global maritime traffic. This will allow to have the best possible monitoring of this environment, given that, for the first time, AIS and SAR (Synthetic Aperture Radar) data can be combined simultaneously.

THE SATELLITE WILL MEET THE NEEDS FOR DEFENSE AND SECURITY, AS WELL AS OTHER CIVILIAN NEEDS

The other secondary payload on board Paz is a radio occultation and heavy precipitation (ROHP) experiment, led by the Institute of Space Studies of the Higher Council for Scientific Research, IEE-CSIC, and with the cooperation of the Nasa Jet Propulsion Laboratory (JPL) and the National Oceanic and Atmospheric Administration (NOAA). It will allow seeing how GPS signals are hidden when passing through the atmosphere, analyzing the changes that occur due to the different atmospheric elements in the signal received, and detecting and quantifying intense precipitation.

## SAR constellation

Ten minutes after taking off on board a Falcon 9 rocket, the satellite started the journey alone towards its operational orbit at 514 km altitude.

An hour later, Hisdesat confirmed that "telemetry had already been received and telecommands had been sent from INTA's station in Torrejon. Next, the satellite will be placed in its final position in orbit and together with the German satellites TerraSAR X and TanDEM X it will form a constellation of next generation radar satellites."

In fact, the three satellites will work together to form a constellation of very high resolution SAR satellites, considerably reducing the revisit time and increasing

the acquisition capacity, which provides substantial improvements in several applications. Hisdesat and Airbus will jointly market this new configuration.

The Launch and Early Operations (LEOP) carried out by the project team from the GSOC Control Center in Munich were completed on Monday 26. From this moment, the control of the PAZ operation was transferred to INTA's Monitoring Station in Torrejon. This first phase has shown that the satellite is operating perfectly, although critical operations will still be carried out during in orbit validation phase (Commissioning Phase). The mission success will be definitive when the satellite is put into orbit in a few months (IOA).

## The ground segment

The Institute for Aerospace Technology, INTA, is responsible for the satellite ground segment; that is, the monitoring, tracking and collection of data. In its development, they have cooperated with a Spanish industrial group headed by INDRA, including GMV, DEIMOS and the German DLR.

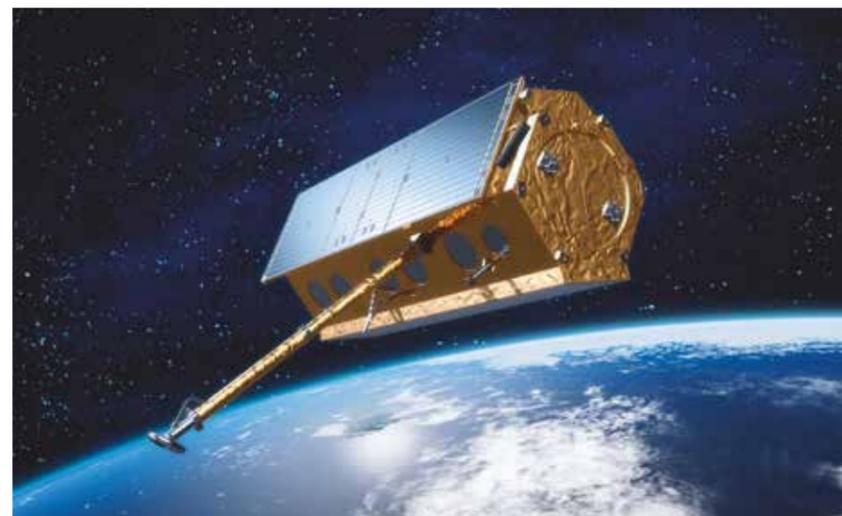
With a significant role as part of the mission, the ground segment consists of three locations: the CEIT (INTA's Space Center in Torrejon), the CESAEROB (a Center for Defense Users) and the Maspalomas Support Station (Canary Islands).



M<sup>a</sup> Dolores de Cospedal described the launch of the Paz satellite as a milestone for security, defense and research in Spain.



The Minister of Defense, the Secretary of State for Defense and the Secretary General for Industry and SMEs applauding after the launch.



F. L., A. S. y B. F.

A tweet from Japanese astronaut Norishige Kanai went far beyond the usual "space circuits" and left the world amazed. Kanai, 41, who had been living on the International Space Station since December, announced on Twitter that he had grown no less than 9 centimeters in height in that time. In his revelation the astronaut –who measured 1.80 meters when he left Earth, well above average for a Japanese man –sounded surprised and worried, wondering "whether I'll fit in the Soyuz (spacecraft) seat when I go back." The next day Kanai rectified the news, visibly relieved, after his captain considered the growth quoted had been too much. With the absence of gravity, it is normal for the spine to stretch in Space, but between two and five centimeters on average. When the measurement was repeated, it turned out Kanai had grown only two centimeters.

"WHETHER I'LL FIT IN THE SOYUZ (SPACECRAFT) SEAT WHEN I GO BACK"

This change in height in Space was explained by Russian doctor Vladimir Joroshev to the press agency RIA Novosti. "The cartilage

## THE "TWEET" ERROR OF NORISHIGE KANAI

tissue modifies in conditions of weightlessness. Our spine consists not only of vertebrae, which are bone tissue, but also intervertebral discs of cartilage tissue. This is very flexible and susceptible to change, unlike bones that remain unaltered in conditions of weightlessness.

"When the load on the spine is reduced tens of times in conditions of weightlessness the cartilaginous tissue of the intervertebral discs lengthens, which leads to an increase in the length of the body."

But once astronauts return to Earth, they all recover their original stature, he added.

B.F.



## GALILEO SECURITY CENTER MOVES TO MADRID

the country as it reinforces the level of contribution and the positioning of our country, our Space community and Space industry in this important satellite navigation program.

The Galileo Security Monitoring Center (GSMC) is a critical part of



Caption: The first inter-ministerial meeting where the road map for the GSMC to be fully operational by March 2019 was studied.



**The forthcoming** Brexit will lead to the relocation of the Galileo Security Monitoring Center headquarters, currently based at Swanwick, south of London, to San Martín de la Vega in Madrid province. Spain was chosen as the new host nation in competition with seven other Member States of the European Union. It is great news for

the system's ground infrastructure, acting as a backup center to the main one which is located on the outskirts of Paris.

The GSMC, which must be fully operational by March 2019, will be relocated on the campus of La Marañosa. Run by INTA, this complex offers highly favorable security

conditions in an area that minimizes the levels of telecommunications interference and electromagnetic fields.

The potential synergies with the Loyola de Palacio GNSS Service Center (GSC), based at the main campus of INTA, in Torrejón de Ardoz, also worked in favor of the GSMC transfer to Madrid. This Center is the sole interface with Galileo's user communities.

The European satellite navigation system already has 22 satellites in orbit – out of a planned total of 26 and a further four for in-orbit backup. A number of Spanish companies have contributed to its design, development and operations.

The Galileo System consists of a satellite constellation that is expected to be fully operational by 2020. Its ground infrastructure will provide positioning information with unprecedented accuracy for many civil applications, including vehicle navigators; mobile phones; sea, air, rail and road transport. It will also offer an extremely precise time synchronization service, aimed at the banking, financial and insurance systems, as well as to the mobile communications sector and power transmission networks.

The Galileo system will benefit a number of economic sectors, with applications designed to protect the environment, to generate tools for precision agriculture and for managing the components of Smart Cities.

Galileo's infrastructure, which has already been providing initial services since December 2016, is expected to make a decisive contribution to the satellite navigation applications and services market, one which according to the European GNSS Agency (GSA) estimates could be worth €135 billion by 2025.

■ T.B. y B.F.



**The CanSat** 2018 European Competition will be held on Santa Maria Island in the Portuguese archipelago of the Azores and organized by the country's Regional Fund for Science and Technology (FRCT).

The campaign will take place from June 28 to July 1, 2018 with eighteen teams participating. They will be the winners of the national **CanSat** competitions in Germany, Belgium, Denmark, Spain, Greece, Ireland, Italy, the Netherlands, the Nordic countries

(Finland, Norway and Sweden hold a joint competition), Portugal, Poland, the United Kingdom, the Czech Republic and Romania, plus a team from Hungary that will be selected directly by ESA.

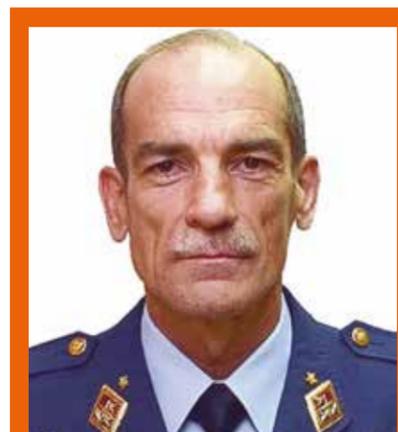
The European **CanSat** Competition is one of many ESA initiatives to help young people improve their skills in the STEM (Science, Technology, Engineering and Mathematics) disciplines and inspire them to pursue careers in these fields. Each team consists of

## CANSAT 2018 IN THE AZORES ISLANDS

up to six high school students, aged between 14 and 19, and a teacher or tutor. As in a real space program, the teams are commissioned to develop their own 'mini-satellite' projects (the **CanSat**) and send progress reports to ESA experts, who will offer advice and evaluate the ability of their **CanSats** for launching. During this phase, they will launch and operate their CanSats, analyzing the data collected and presenting the results to a jury that will be awarding first, second and third prizes. For further information, please contact [cansat@esa.int](mailto:cansat@esa.int)

At the last **CanSat**, 2017, a group of Spanish students from the Burgoneta Secondary Education Institute in Las Rozas (near Madrid) won a prize for creating a satellite the size of a can of soda, which they named "La Burgoneta Espacial."

■ B.F.



Jaime Salom Piqueres

AIR FORCE LIEUTENANT GENERAL

**Air Force Lieutenant** General Jaime Salom Piqueres has taken over from Lieutenant General Ignacio Azqueta as head of the National Institute for Aerospace Technology (INTA), an organization which comes under the jurisdiction of the Ministry of Defense. Speaking at the ceremony to celebrate him taking office, Defense Minister María Dolores de Cospedal stressed there are two words to define the new Director: professionalism and commitment. "His appointment is very exciting, as he will contribute with his knowledge and effort to increase the prestige of this organization in the field of research. I think he is the best professional in the Armed Forces to take over from Lieutenant General Ignacio Azqueta."

## NEW DIRECTOR FOR INTA

Cospedal pointed out that "the Institute sees its competencies, areas of activity and capabilities greatly enlarged, making it today the great technological center for the Ministry of Defense which has been entrusted with the important task of researching and testing Space, aeronautics, land and sea systems."

Lieutenant General Salom, who moved from being Head of Air Combat Command (MACOM), previously worked for INTA as General Sub director of Coordination and Planning for three years.

■ B.F.

# WE ARE IN **MARS**

Since the beginning of this century we have a permanent presence on Mars. The off-road vehicles that are on the surface and the spacecraft that are orbiting the planet allow us knowing the Martian environment in detail by providing essential information to prepare the future of human exploration.

Through its participation in the NASA Mars Science Laboratory missions, the future InSight and Mars 2020 missions, and the Mars Express and ExoMars missions of the European Space Agency, Spain is a major player in developing technologies and obtaining the scientific knowledge necessary for this task.

Text: M. López

ABOUT THE IMAGE:

## ANALYZING THE SURFACE

This image taken by the Opportunity rover in January 2016 shows the tool turret located at the end of its robotic arm. At the time the Opportunity was at the western edge of the Endeavor crater.

Credits: NASA/JPL-Caltech.

moments

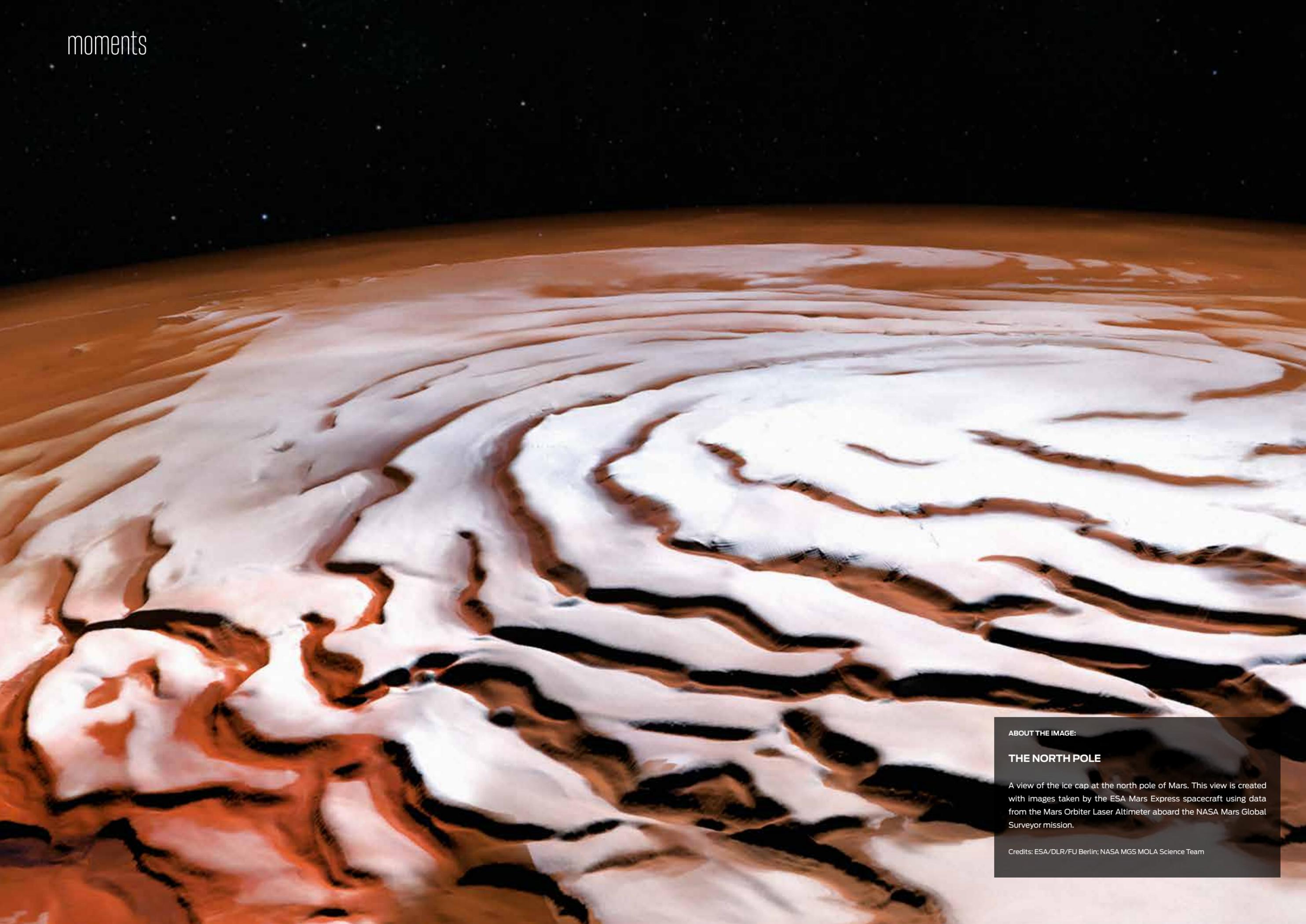
ABOUT THE IMAGE:

### SNOWY DUNES

This image taken by the Mars Reconnaissance Orbiter in May 2017 shows the patterns that appear in spring when the carbonic ice covering the dunes during the winter cracks, letting out gas with sand in suspension.

Credits: NASA/JPL/University of Arizona

moments



ABOUT THE IMAGE:

#### THE NORTH POLE

A view of the ice cap at the north pole of Mars. This view is created with images taken by the ESA Mars Express spacecraft using data from the Mars Orbiter Laser Altimeter aboard the NASA Mars Global Surveyor mission.

Credits: ESA/DLR/FU Berlin; NASA MGS MOLA Science Team



**ABOUT THE IMAGE:**

**SELF-PORTRAIT**

The image shows the Curiosity rover. The Rover Environmental Monitoring Stations (REMS) can be seen on the mast. REMS is one of the Spanish contributions to the Mars Science Laboratory project, which also includes the antenna that allows the Curiosity to communicate with Earth.

# SPACE,

## a Spanish defense sector with growing visibility

*Fernando*  
**ALEJANDRE MARTÍNEZ**

CHIEF OF THE DEFENSE STAFF (JEMAD),  
ARMY GENERAL



**The commitment** of Spain and its Armed Forces to global security can clearly be seen in its so-called Employment of the Armed Forces Concept: one that establishes the operational framework, the way to carry out missions and the general characteristics that military forces need in their operations. It also underpins the defense planning process in fostering an appropriate, practical and acceptable design.

This document identifies the features of present and future operating environments for the Armed Forces, namely: uncertainty and adaptability, diffuse boundaries between war and peace, the widespread and permanent presence of a civilian population, and the importance of technology.

Within this framework, Space systems will be vital for Armed Forces' operations in the most developed countries, thanks to their observation, surveillance and information gathering capabilities. And, because they are critical infrastructure, they will be potential targets in the case of conflict.

Given this scenario, Spain continues to take important steps in Space. A good example is the recent launch of Paz, the first national observation satellite. In addition to being an important surveillance asset for the Ministry of Defense - covering an area of 300,000 km<sup>2</sup> and providing some 200 images per day - it is also an example of public-private collaboration, providing our nation with technological capabilities and professional qualifications that enable us to keep up with our allies.

We also need to highlight the importance of having secure satellite government communications, which are essential for obtaining intelligence, navigation and deployment in operations, and for offering strategic autonomy and freedom of action. The Ministry of Defense is already working on a program to replace our Spainsat and Xtar-Eur satellites, whose useful life will end around 2021, with new generation satellites.

When I took up my post, one of my objectives was to look for innovative solutions in the definition and development of future capabilities, to always be prepared for new challenges and threats. Space fits with these goals and is enjoying preferential attention given its ever growing importance for the defense of Spain and its citizens.



### Deimos Imaging's new partnerships result in a unique virtual portfolio

Deimos Imaging announced partnerships with key stakeholders in the geospatial industry such as E-Geos, Beijing Space View Technology and SI Imaging Services, to broaden its products and services offer. Deimos Imaging's virtual portfolio has now been expanded to 33 Earth Observation satellites, including both optical and radar, with a great variety of different resolutions and for a wide range of valuable monitoring, change detection and precision insights applications.

### Agreement between HISPASAT and Eureka for the reduction of the digital divide in Spain

HISPASAT and the telecommunications company Eureka have reached an agreement to promote satellite broadband in Spain. They offer a high capacity technological solution based on the Ka band of the new Hispasat 30W 6 satellite. The objective is to universalize Internet access, especially in areas where there is no connectivity, or it is of poor quality, giving its inhabitants the opportunities offered by the Information Society.



### Delivery of the New Jupiter2 Control Centre (CDC)

"A tous de DDO: Attention pour le décompte final, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, TOP": these words said by the Launch Range Manager at Guiana Space Centre, culminated three years of work.

For each Ariane, Soyuz or Vega launcher, the CDC is activated to coordinate the final chronology. The status of all range systems, launcher, spacecraft, safety, security and weather forecast has to be "green" in order to enter the final sequence.

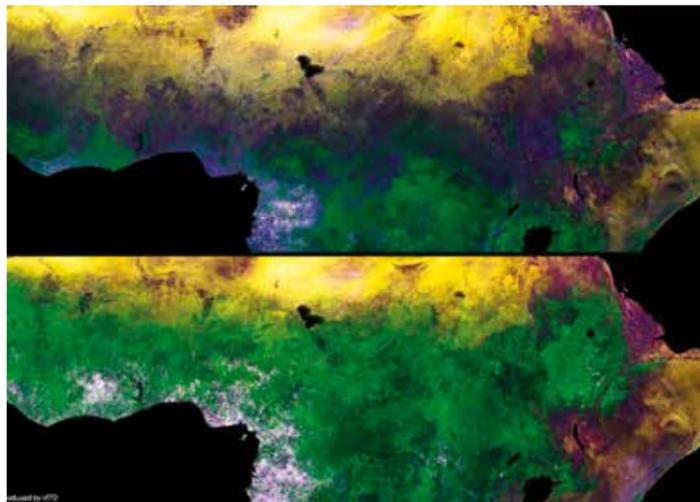


### Airbus returns to Mars once again

Airbus Spain will once again be the prime contractor for the high-gain antenna that will go on board the robotic exploration vehicle that NASA will launch in 2020 to study Mars. This is the second directional antenna built by Airbus, with the support of the CDTI, for a NASA rover. The first antenna was installed in the Curiosity rover, connecting to Earth, sending data and receiving telecommands needed for the vehicle's daily operations.

**GMV applies geospatial science to the benefit of agricultural development in Africa**

GMV coordinates the project H2020 AfriCultuReS (Enhancing Food Security in AFRican AgriCULTUral Systems with the Support of REmote Sensing) which aims to design, implement and operationally validate an integrated system for monitoring, analysis of scenarios and early warning, as a tool for making decisions in the field of the assurance of food production in Africa, where a high percentage of the population suffers severe food shortages.



**MARES training model at NASA's Johnson Space Center**

SENER has installed a training model of the scientific instrument MARES (Muscle Atrophy Research and Exercise System) at the Space Vehicle Mock-Up Facility in the Johnson Space Center, NASA's center for manned space activities, located in Houston, Texas (USA). With this facility, the world's three main space agencies, ESA, Roscosmos and NASA, all have MARES training models for on-land training of astronauts before flying to the ISS, where the definitive system is installed.



**Thales Alenia Space in Spain makes its way into the launchers segment**

Thales Alenia Space in Spain has signed a contract with ArianeGroup to design, develop, qualify and manufacture the telemetry transmitter of the new European launcher Ariane 6. After decades of activity in the space sector, the company expands its comprehensive product portfolio in Spain in the field of space communications with a new generation equipment adapted to very demanding customer requirements.



**INDRA is extending Galileo's ground segment**

Indra will implement four new Up-Link Stations (ULS) that will strengthen Galileo's ground segment and they will prepare it to take control of the 30-satellite constellation, once its deployment is completed in 2020. These stations will be added to the ten Up-Link Stations that Indra has already put into operation and to the other six that the company is developing at this time.



**Photonic Demonstrator on Hispasat 30W-6 at launch base**

SSL and Hispasat worked together to include key developments on Hispasat 30W-6, a satellite which carries a photonics demonstration developed by DAS Photonics. It is aimed at testing and proving the value of using photonics in spacecraft applications. This technology, is, soon expected to reduce the satellite's total mass and enhance payload performance. The photonics receiver replaces traditional microwave components with optical, solid-state components that enable greater flexibility and throughput.



**Telespazio Iberica continues to support the EU's external action**

Telespazio Iberica, as a member of the consortium awarded the SEA contract by SatCen, within the Copernicus Programme, continues to provide operational services to collaborate with the EU's external action. The objective of this project is to support, through the generation of geospatial products, the EU in its mission to promote stable conditions of development, uphold democracy and defend fundamental rights outside its own borders.



**Elecnor Deimos to provide its flight dynamics system fly4EO to Brazil**

Elecnor Deimos flight dynamics system, fly4EO, has been selected by the National Institute of Space Research of Brazil (INPE) for its Satellite Tracking & Control Centre. The system will provide manoeuvre planning, including the launch and early-orbit phase, orbit

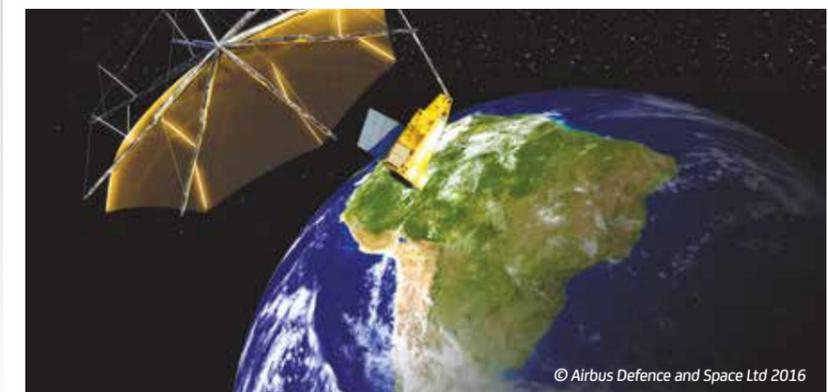
determination and decommissioning capabilities for the first fully Brazilian Earth Observation satellite, Amazonia-1. fly4EO is part of the suite of ground segment products gs4EO, currently employed in Deimos-2 and other ESA and governmental missions.



**TRYO Aerospace, supplier of Biomass' reception subsystem**

TRYO Aerospace has signed a contract with Airbus Defence and Space for the supply of the synthetic aperture radar reception subsystem on board Biomass, ESA's 7th Earth

Explorer. Operating in P band, the mission will study the evolution of the biomass and carbon rates in the forests. TRYO Aerospace equipment with similar capabilities are flying on Galileo satellites, and are in production phase for Meteosat's Third Generation.



**REACT qualified for flight**

The new generation of ARQUIMEA's HDRAS (REACT) actuators is now ready to be used in flight. After validation of the E-SAIL satellite in the structural tests, the first units qualified for flight and assembled in the new clean room of ARQUIMEA will be sent to LUXSPACE in March

for its integration into the satellite flight model. This shipment will be followed in April by the flight units of a complete HDRM for SITAEL μEXSAT satellite.





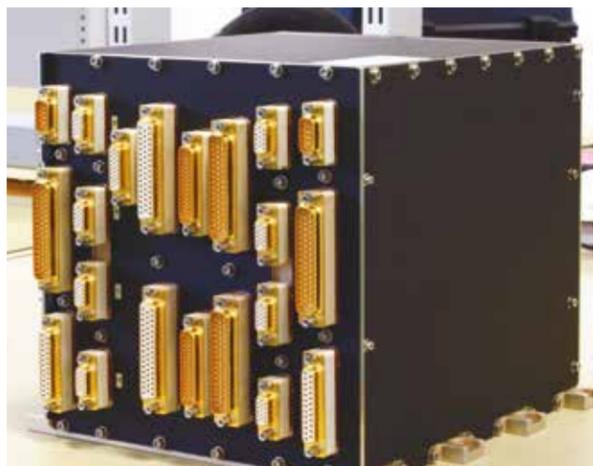
### Eighteen AIS satellites in service

exactEarth, a company partially owned by Hisdesat, announces the availability of exactView RT powered by Harris, the fastest and most complete offer of AIS data services in the maritime market, with 18 satellites in service, reducing latency ratios to one minute.

With the successful launch of the last ten Iridium NEXT satellites, its revolutionary real time service provides a global and constant coverage, opening new application possibilities to have a worldwide vision of the maritime environment.

### Key electronics in PAZ

For the PAZ satellite, CRISA developed the Instrument Control Unit, the 12 control units for radiofrequency transmission and reception modules, and 2 control units for calibration and redundancy. Together these units receive requests from Earth to take images, process them and command the 384 radar modules in real time to take the images required by users, whatever the weather conditions, day and night.



### Small launchers for Europe

TECNALIA participates in the SMILE project whose objective is to increase critical technologies (TRL), developing prototypes of the launcher's components such as engines, structures and avionics. We are talking about an innovative launcher design for small, low cost satellites and the development of facilities for its launch from Norway. Through this initiative, Europe will be provided with technological capacity to launch small satellites without having to rely on large launchers such as Ariane 5 or VEGA.



### PLAnetary Transits and Oscillations of stars (PLATO)

ALTER TECHNOLOGY has been selected as Coordinated Parts Procurement Agent (CPPA) for the payload of the PLATO project of the European Space Agency (ESA).

The CPPA will develop engineering tasks, technical advice for component selection,

procurement and testing, including evaluation and characterization of components not previously used in space.

PLATO will aim to study a large number of extrasolar planets, particularly those with properties similar to Earth.

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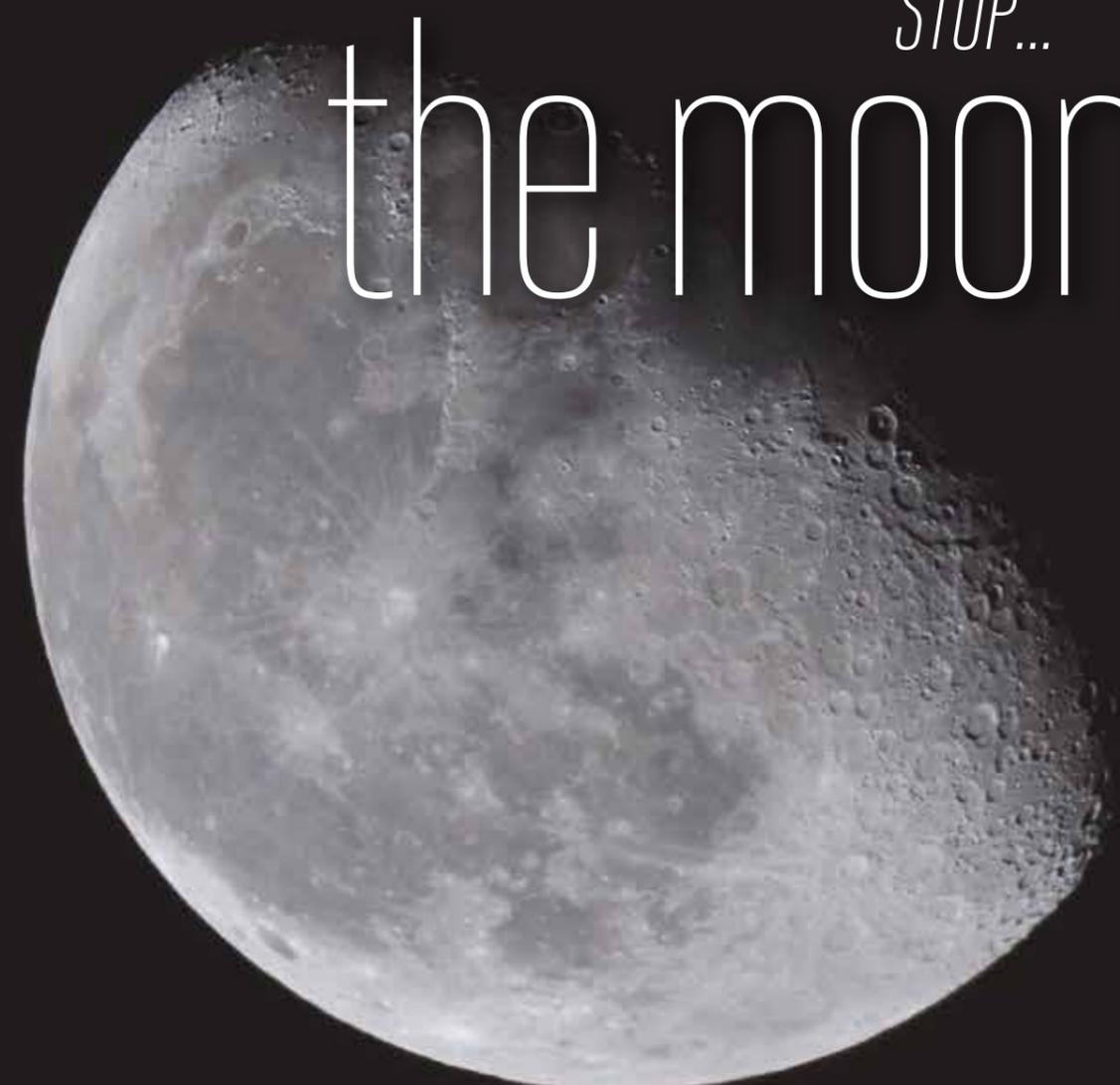
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