

EYE ON SCIENCE

Sci planet

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AND **SPACE**
SCIENCES

Editorial Team

Shahenda Ayman
Hend Fathy
Esraa Ali
Sara Khattab

Dr. Reem Sassy
Lamia Ghoneim
Jailane Salem
Moataz Abdelmegid
Basma Fawzy
Sherine Ramadan
Soha Elborgy
Khaled El-Hussein
Nadia Eldeeb

Design

Asma Haggag

Maha Sherin
Faten Mahmoud

Publishing Department
Language Revision

Contact Us:
PSCeditors@bibalex.org



For additional information
and reservation, please
contact:

psc@bibalex.org
Tel.: +(203) 4839999
Ext.: 2350, 2351
Fax: +(203) 4820464
www.bibalex.org/psc

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Back to Natural Sciences

By: Maissa Azab

Ten years ago, when the Bibliotheca Alexandrina (BA) Planetarium Science Center (PSC) was five years old, a periodic newsletter was launched to further inform the public about the Planetarium Science Center, the first and only one of its kind in Egypt. In its first two years, the PSC Newsletter was purely promotional, featuring brief descriptions and useful information about the Center, its sections, and its activities.

In the PSC Newsletter's third year, it was developed to become a science communication tool in its own right. As of 2009, the PSC Newsletter started featuring articles on scientific topics in relevance to our life; our first issue tackled astronomy, followed by an issue about biodiversity, then climate change.

With the success of the PSC Newsletter in its new approach, it became a quarterly publication; and in 2014, the PSC Newsletter was revamped to become *SCiplanet*, the first Egyptian popular science magazine. It has always been *SCiplanet*'s Editorial Team's objective to engage the public with diverse annual overarching themes, each presented in four subthemes.

In this new year, marking the tenth anniversary since we started in 2007 with the promotional PSC Newsletter, we return to the root of natural sciences. We begin with astronomy, the science of the universe and the science for which planetariums were created to begin with, although in modern-day planetariums, including ours, all sciences and science-related themes are tackled.

It is with great pleasure and pride that we publish our new year's first issue, where we are honored with the valuable input of our cherished contributors: Dr. Mohamed Soliman, Acting Head of the BA Cultural Outreach Sector; Dr. Tarek Elawadi, Director of the BA Antiquities Museum; Dr. Omar Fikry, Head of the BA Planetarium Section; and Dr. Shaymaa Elsherif, In charge of Cultural Programs and Activities at the BA Center for Francophone Activities. *SCiplanet* Editorial Team also extends special thanks to Mr. Mohamed Khamis, Deputy Director of the Art Exhibitions and Collections Departments, for his inspired illustrations.

Dear Reader, we hope you have enjoyed your journey with us throughout the past years, and that, in our new year, we meet your expectations with every new issue hereafter.



By: Dr. Omar Fikry
Head, Planetarium Section,
BA Planetarium Science Center

Theoretical OR Practical Astronomy?

The race between theoretical and practical science is at its peak; this is specifically the case with astronomy and space sciences. Theoretical science or research is formulating hypotheses or conceptions regarding a certain topic or celestial body, and introducing a solution model or a comprehensive image; however, without providing concrete scientific evidence. In astronomy and space science, concrete scientific evidence refers to the actual observation by any adequate equipment.

This race reveals the visions or beliefs of international space agencies, in particular NASA, regarding the projects they embrace and fund with billions of dollars. Any project to launch a spacecraft outside the Earth involves many theoretical questions raised in even more theoretical researches; it is expected from the project to answer these questions, proving them right or wrong. Human lunar landings in the 1960s followed researches and theories about the feasibility of flying around the Earth to begin with, and theoretical studies about sending a human being or a living creature in a spacecraft to a zero-gravity zone. Having realized those dreams, another theoretical leap followed, covering the development of wireless communication technologies. Space agencies tried to answer these researches and develop applications, and so continues the race between the theory and the practice.

A significant example on this race is the "New Horizons" project that NASA launched on 19 January 2006, to the "Pluto System and Kuiper Belt". At the time, scientists and theorists viewed Pluto as the ninth planet, and used the term "Pluto System" to refer to Pluto and its moons. The project was expected to answer the questions raised by the National

Academy of Sciences about the exact position of Pluto from the Kuiper Belt, which extends between Neptune and Pluto. The announced theoretical questions about Pluto and its moons were: Is the terrestrial nature of Pluto similar to that of the inner planets (Mercury, Venus, Earth, and Mars)? What is the nature of Pluto's five moons and their orbits? It is hoped that the "New Horizons" outcomes would give a presentation on the origins of the outer borders of our Solar System.

"New Horizons" achieved its goal, reaching the "Pluto System" on 14 July 2015, paying no attention to the arguments raised in 2008 about the classification of Pluto. The NASA research team responsible for the project presented high-quality photos of Pluto's surface and moons, in addition to other information that was not published on the project's website. The photos and the results encouraged the decision makers in the United States Government to extend the "New Horizons" mission to 2020. The team will continue following up and studying the images sent from its cameras, and the spacecraft will continue its journey beyond Pluto to reach the borders of the Solar System.

NASA's schedules and efforts do not only focus on Pluto, but also on the Juno spacecraft project. Juno was launched on 5 August 2011 to Jupiter, arriving at its destination on 2 July 2016. Although some might think we already have enough information about Jupiter, theoretical questions and researches are still increasing about its atmosphere and the conditions of its magnetic layer that raised suspicions about the formation of the giant planet.

The race continues...

An Overview of the SOLAR SYSTEM

By: Basma Fawzy

The universe is a gigantic place; Earth only makes up a tiny part of it. When we gaze at the stars, a mysterious vastness gazes back at us, waiting to be discovered. Let us not go too far; today, we are only discussing the solar system.

The solar system is made up of the Sun, the planets, and their satellites, in addition to comets and asteroids. A star, radiating heat and energy, the Sun is the largest object in the solar system, making up 99.85% of its mass. It is the center of the solar system, around which eight planets orbit: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Except for Earth, all planets were named according to Roman and Greek mythology.

Mercury travels fast in the sky; that is why it was named after the god of travel and commerce in Roman mythology. Venus shines the brightest in the sky; it was, thus, named after the goddess of love and beauty. Earth is the only planet that takes its name from Old English; Earth simply meaning "the ground". Due to its "fiery" color, Mars carries the name of the god of war. Jupiter is the largest planet in the solar system, so it takes its name from the King of Gods in the Roman mythology. Meanwhile, Saturn is the Roman god of agriculture, Uranus is the name of the earliest god, while Neptune's blue color is the reason it is named after the sea god.

Pluto is intentionally not included in this list simply because it is no longer considered a planet. In 2006, the International Astronomical Union (IAU) added criteria to define a planet, according to which, for an object to be considered a planet, it has to rotate around the Sun, be round or nearly round, and have gravitational dominance. Gravitational dominance means that the planet has to be the largest object in its orbit and has to eject other large objects from its space. Pluto failed to fulfill the last criterion, and therefore, it is now considered a "dwarf planet".

In the solar system, in addition to the planets, there are also satellites of these planets; by definition, a satellite is an object that rotates around another object. As such, Earth is a satellite because it orbits the Sun, the Moon is a satellite because it orbits the Earth, and so on. Most planets in the solar system have satellites except for Venus and Mercury.

The Sun, the planets, and their satellites make up a large part of the solar system, but other objects are not of lesser significance. Comets are icy objects that contain dust, carbon dioxide, ammonia, and ice; they are believed to be leftovers. After the solar system was formed, the remains of the gases and dust made the comets.

Asteroids, on the other hand, are rocky objects that are too small to be considered planets; sometimes, they are called "minor planets". Meanwhile, meteoroids are any small object that orbits the Sun; sometimes, they are the outcome of a comet coming near to the Sun, losing gas and dust, or they could be small asteroids.

When they reach the Earth's atmosphere, the heat and force of the impact create a visible phenomenon known as a meteor, colloquially known as a shooting star, which is basically a meteoroid burning as it enters the atmosphere.

The Sun is 1,391,000 kilometers across; the solar system is part of the Milky Way, a galaxy that contains more than 200 billion stars. As the universe is very large, astronomers do not know for sure the exact number of galaxies in the universe. However, they have come up with an estimate of a hundred billion galaxies by counting the galaxies in a certain region and multiplying the number up to estimate the number for the whole universe.

The whole solar system is a tiny part of the universe, the secrets of which human beings are still just scratching the surface of. Despite all what we know today, there is endless information that we are still unaware of; the universe is a huge place and human beings have only been able to visit the Moon. In 2030, NASA plans to send humans to Mars for the first time; hopefully, bit by bit, science will light up the dark areas of the vastness that gazes at us from the sky.

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WATER in SPACE: An Ongoing Search

Water is a primary reason for the existence of life; the quest for finding life in space is without a doubt linked to the finding of water. While we have yet to actually find living organisms in space, scientists and researchers believe we are ever nearer to that discovery; their belief relies on the existence of water on neighboring planets and moons. The assumption was that water only existed on Earth; however, in the past couple of decades, this has been overhauled. Even the driest of planets, Mars, has been found to have evidence of water on it.

By: Jailane Salem

Ellen Stofan, Chief Scientist of NASA, said: "NASA science activities have provided a wave of amazing findings related to water in recent years that inspire us to continue investigating our origins and the fascinating possibilities for other worlds, and life, in the universe... in our lifetime, we may very well finally answer whether we are alone in the solar system and beyond."

Besides Earth, water can be found in outer space as ice, underground oceans, water vapor, and even as giant molecular clouds between stars; these will hopefully contain the clues and answers to the question of whether there is life beyond our planet or not.

Jupiter's largest moon, Ganymede, is also the biggest one in our solar system. Evidence found underneath its icy surface made researchers believe that a huge salty ocean lays between an outer and inner layer of rock. Researchers based this new information on observational data collected by the Hubble telescope. The amount of water estimated is nothing to scoff at, surpassing that found on Earth; however, this ocean is buried beneath the surface, around 153 kilometers deep.

Another moon in Jupiter's orbit is Europa, which has the smoothest surface in the solar system. Its crust is quite thick and has distinctive reddish marks that run down its surface; under its surface it is believed there is an ocean that covers the entirety of the moon. What makes this body of water special is that it is in liquid form; this is possible because the tidal force Europa is under due to orbiting Jupiter, which is extremely strong as to cause enough friction energy to keep water in its liquid state even though temperatures are beyond freezing.

Titan, Saturn's largest moon, is the only place where liquid lakes can be seen on its surface; whereas they are dissimilar in content to the ones on Earth, they are still quite intriguing. These lakes are filled with methane and ethane instead of water, but water can be found under the surface. This layer of ocean that begins around 50 kilometers below the surface, is believed to be the cause of the changing form of the moon, since it responds to the gravitational pull of Saturn.

Saturn's sixth-largest moon has been found to have an ocean that covers the entire moon. At first, bursts of water vapor, carbon dioxide, and other particles were observed to be erupting from fissures in the moon's surface, alerting researchers to the possibility of the existence of water. It was NASA's Cassini orbiter that provided the visual evidence; over the course of seven years, high resolution images were taken of the moon, and based on those it was concluded that the moon's ice crust floats freely from the core due to the presence of an ocean underneath. The imaging leader of the Cassini mission said: "Some of us regard Enceladus as actually the best place in the solar system to search for extraterrestrial life".

Nevertheless, even with all that water available, how can anything survive in such extreme cold conditions? What gives scientists and researchers hope that there is life in those places? Interestingly enough, the answer lies right here on our planet, in the form of extremophiles. These are organisms that live and thrive in extreme environments, such as places with high pressure and extremely low temperatures.

In Antarctica, Ross Ice Shelf is the largest ice shelf; it is more than 600 kilometers long and 15-50 meters high. Imagine how cold and dark it would be under such a large mass of ice; but, believe it or not, life does indeed exist. Fish were found swimming happily, as well as many other organisms; this gave rise to hope in researchers that perhaps life may exist in other places in the solar system. The investigation, thus, continues; one can only wonder when we will hear about the discovery of life in outer space?

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The BIGGEST Health RISKS in Space

By: Dr. Reem Sassy
Master of Public Health

Since people began travelling in space in 1961, and Yuri Gagarin became the first human to orbit Earth, many people have been dreaming about travelling into orbit, to the Moon or even beyond. However, venturing into the environment of space can have negative effects on the human body. In the words of Star Trek's legendary doctor Leonard "Bones" McCoy, "Space is disease and danger, wrapped in darkness and silence!" He has a point; space travel leaves you weak, tired, sick, and possibly, depressed.

Gravity in space is much weaker than it is on Earth; when people travel in space, they seem to become weightless. Following the advent of space stations that can be inhabited for long periods of time, exposure to weightlessness has been demonstrated to have some deleterious effects on human health.

The most common problem experienced by humans in the initial hours of weightlessness is known as Space Adaptation Syndrome (SAS); commonly referred to as space sickness manifested by nausea and vomiting, vertigo, headaches, lethargy, and overall malaise. The first case of SAS was reported by cosmonaut Gherman Titov in 1961; since then, roughly 45% of all people who have flown in space have suffered from this condition. The duration of space sickness varies, but rarely has it lasted for more than 72 hours, after which the body adjusts to the new environment.

Significant adverse effects of long-term weightlessness include also muscle atrophy and deterioration of the skeleton. Without the effects of gravity, skeletal muscles are no longer required to maintain posture. In a weightless environment, astronauts put almost no weight on the back muscles or leg muscles used for standing up. Those muscles then start to weaken and eventually get smaller and atrophy rapidly. Though these changes are usually temporary, without regular exercise and a special diet, astronauts can lose up to 20% of their muscle mass in just 5–11 days.

One other effect of weightlessness on humans is that some astronauts report a

change in their sense of taste when in space. Some astronauts find that their food is bland, others find that their favorite foods no longer taste as good; some astronauts enjoy eating certain foods that they would not normally eat, and some experience no change whatsoever. Multiple tests have not identified the cause; several theories have been suggested, including food degradation, and psychological changes such as boredom. Astronauts often choose strong-tasting food to combat the loss of taste.

The environment of space is lethal without appropriate protection. The greatest threat in the vacuum of space derives from the lack of oxygen and pressure, although temperature and radiation also pose risks. A certain amount of oxygen is required in the air we breathe; the minimum concentration, or partial pressure, of oxygen that can be tolerated is 0.16 bar. In the vacuum of space, gas exchange in the lungs continues as normal, but results in the removal of all gases, including oxygen, from the bloodstream. After 9–12 seconds, the deoxygenated blood reaches the brain, resulting in the loss of consciousness and possibly leading to hypoxia and death.

On the other hand, unprotected by the Earth's atmosphere and magnetic field, astronauts are at greater risk from the high levels of radiation emitted by the Sun and by distant stars and galaxies. A year in Low-Earth Orbit results in a dose of radiation 10 times that of the annual dose on Earth. High levels of radiation damage lymphocytes—cells heavily involved in maintaining the immune system—which contributes to the lowered immunity experienced by astronauts.

Radiation has also recently been linked to a higher incidence of cataracts in astronauts. Long periods of exposure to radiation can trigger cases of cancer, while even short-duration exposure to extremely high levels, such as that generated by solar flares, can cause potentially fatal radiation poisoning.

Astronauts sleep poorly in space. On some space shuttle missions up to 50% of the crew take sleeping pills, and over all nearly half of all medication used in orbit is intended to help astronauts sleep. Even so, space travelers' average sleep hours each night in space are about 2 hours less than they do on the ground. Fatigue, on Earth or in space, is a serious problem; it affects performance, increases irritability, diminishes concentration, and decreases reaction time, thus increasing the risk of accidents as well. Scientists hope to help crews increase their alertness and reduce performance errors through improvements to spacecraft lighting, sleep schedules, and the scheduling of work shifts.

Those are just some of the effects a trip to space can have on the human body. Scientists and physicians are still working to enhance medical care in space and find solutions to the health challenges of living and working in space for long periods of time. The techniques addressing astronaut health risks on long missions will also benefit patients suffering from similar conditions on Earth; such as bone loss, muscle wasting, shift-related sleep disturbances, and balance disorders.

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THE

Red Shy NEIGHBOR

By: Khaled El-Hussien

Being the closest planet to Earth—only 80 million kilometers away—Mars has always been looked at as the big red apple in space exploration. Yet, the small planet represents quite a challenge with its harsh topography, toxic atmosphere, and extreme climate. Mars was named after the ancient Roman god of war; it is the fourth planet from the Sun with half the size of the Earth, and it has two moons: Phobos and Deimos.

DISCOVER LIFE

The first attempt to send a probe to the surface of Mars was carried out by the Soviet Union during the 1960s; however, the probe nicknamed MARSNIK 1 failed to reach Earth's orbit and the mission was a failure. In 1993, NASA launched the Mars Exploration Program (MEP), seeking to achieve four ambitious goals: to determine if life ever existed on the Red Planet, study and characterize its geology and climate, and eventually prepare for human exploration on its surface.

Massive challenges have faced the program over the years, from entering the planet's orbit, to descending and landing on the surface. One of the toughest challenges was developing technologies that can function properly in the hostile environment of Mars. Countless engineering maneuvers had to be applied to ensure that the rovers, balloons, and sampling systems could withstand and operate properly under the extreme environmental conditions of the Martian desert.

The basic strategy of the MEP was simply to seek signs of life in order to prove if Mars was, is, or can ever be a habitable environment for biological life forms. As water is the key to life, the earlier Mars missions—2001 Mars Odyssey, Mars Exploration Rovers, Mars Reconnaissance orbiter, and Mars Phoenix Lander—focused on discovering any signs of past or present existence

of water. Images from rover expeditions suggested that water did exist on Mars; the sizes, shapes, and distribution of geological forms—such as sand, grit, and small rocks—strongly indicate they were shaped and moved by water in the ancient past.

Until now, the Curiosity rover performed all expeditions. The 899 kg car-sized piece of equipment was launched to Mars on 26 November 2011 from Cape Canaveral Air Force Station; it landed on 6 August 2012 on Aeolis Palus*. The initial goal of Curiosity was to spend 687 on Gale Crater on Mars; yet, it has been persistently comping Martian soil for 1532 days—nearly four years—powered day and night, in all seasons, by its own set of Radioisotope Thermoelectric Generators (RTGs). Excess heat is channeled via internal warming system to keep the rover's sensitive electronic sampling and analyzing equipment in normal operating temperatures protected from Martian frosty ambience.

As Earth's first ambassador to Mars, Curiosity has been doing a great job studying Martian geology and climate, and investigating if the selected research field, Gale crater, has ever hosted any kind of microbial life. Curiosity is now providing information that, one day, will be the keystone for future human exploration on Mars.

However, sending humans to the surface of Mars will be a completely

different challenge with an atmosphere 100 times thinner than that of Earth, and an average temperature of -63°C . Descending and landing a human-carrying ship on the surface safely will be extremely difficult due to the uneven topography of the planet that is basically formed of mountainous terrains filled with rough rocky features as hills, craters and trenches. Landing locations must be selected carefully and landing thrusts must be designed to ensure soft and stable landings to avoid the danger of tipping off the vehicle.

The future of the MEP remains foggy. Due to the huge cost of previous missions and the unusually high failure rate, it became very difficult to rally enough public support to provide funds for any further missions. NASA was even forced to cancel the Mars Science Orbiter mission planned for 2016 to study the climate of the planet.

Nevertheless, scientists still hope that at some point in the near future there will be enough will and means to continue the Mars exploration marathon, and eventually collecting enough knowledge to enable the human race to finally visit its red shy neighbor.

*Aeolis Palus is a plain between the northern wall of Gale Crater and the northern foothills of Aeolis Mons on planet Mars.

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The Puzzling Ringed PLANET

By: Nadia Eldeeb

Saturn is known as the most imposing planet for its magnificent rings, although it is not the only planet that has rings; Jupiter, Uranus, and Neptune have rings too, but not as big and bright. Saturn's spectacular golden arrays, which reflect the sunlight, must have taken Galileo's breath away when he first spotted them through a telescope in 1610, more than 400 years ago!

In 1675, astronomer Jean-Dominique Cassini discovered a "division" between what are now called the A and B rings. It is now known that the gravitational influence of Saturn's moon Mimas is responsible for the Cassini Division, which is 4800 kilometers wide. Astronomers have since been trying to learn more about Saturn's rings; yet, when or how they were formed remains a mystery.

What astronomers agree on is that the rings are made of billions of particles of ice and rocks, ranging in size from the size of a sugar grain to the size of a house. It is believed that the rings might have something to do with Saturn's many moons.

As impressive as it may seem, 59 moons have been identified so far orbiting Saturn, and there are two theories about the planet ring formation. The first states that the rings may have been debris left over from the occasional crash of asteroids and meteoroids into Saturn's moons breaking them into pieces. The other theory states that these rings might have been formed from material left over from Saturn's first formation.

Most of Saturn's moons are relatively small; yet, they include Titan, the second largest moon of the solar system, which happens to be bigger than Mercury, Eris, and Pluto. It looks like a star using small telescopes, while it appears as a disc using larger ones. Titan has a strange cloud, which appears out of nowhere and was formed from a process similar to that of the ozone layer at Earth's Poles. This strange cloud is made of dicyanoacetylene; one of many hydrocarbons that give Titan an atmosphere of orange-brown hue.

The stray of rings is, so far, known to consist of seven large rings named alphabetically in the order they were discovered. For instance, the first ring to be seen was given the name A, having nothing to do with being the closest or the farthest from Saturn. The central one is the very faint D ring, while the farthest from the center, revealed in 2009, could fit a billion Earths. Saturn's F ring, has a curious braided appearance; it is composed of many narrow rings, bends, kinks, and bright clumps on them, which can give the illusion that these strands are braided.

Mysterious spokes have been detected in Saturn's rings, which might form and scatter in few hours; it is presumed that these spokes might have been formed due to Saturn's magnetic field. Though Saturn's magnetic field is not as huge as Jupiter's, it is still 578 times as powerful as Earth's, capturing any small pieces of icy dust with an electric charge, letting them float above the rings in straight marks tracing lines in the magnetic field.

Thanks to Voyagers 1 and 2, and the Cassini-Huygens spacecraft sponsored by NASA in 2005 for four years to study the planet, its moons, rings, and magnetosphere, by descending through Titan's atmosphere and surface orbiting around it 70 times, we would not have known so much about Saturn. Who knows what will be discovered later about this fascinating planet, which keeps intrigued and amazed by how precise this world was created!

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B A C

Forty-four years have passed since the last human landed on the surface of the Moon during the sixth and final mission of the NASA Apollo Program, which successfully took humans to the Moon and safely back to Earth between the years 1963 and 1972. Despite the huge scientific and technological developments in the following years, manned Moon landings were abandoned.

With the end of the Cold War and the fall of the Soviet Union, the space race between Russia and the United States fizzled down, leading to the cut down of NASA funding, and consequently the discontinuation of the Apollo missions. Public interest in lunar exploration died down shortly after; even soft-landing unmanned missions were neglected after the year 1976, with only one unmanned mission to the Moon sent by China in the year 2013: the rover mission "Chang'e 3".

To date, the United States is the only country to have successfully conducted lunar manned missions, the Apollo 17 being not only the final manned Moon landing, but also the last time humans left the Low Earth Orbit. Until recently, NASA's rockets and space shuttles were incapable of surpassing Low Earth Orbit to reach the Moon with the amount of gear required for a manned expedition. The Saturn V⁽¹⁾ capability used during the Apollo era was retired, and the newer space shuttles did not have the needed amount of rocket energy to accelerate the payloads required for a manned mission beyond low-Earth orbit. However, now the technology is back, and better than ever.

BACK to the MOON

By: Lamia Ghoneim

With the successful launch of the Orion⁽²⁾, NASA is finally ready to go further again; NASA is working hard to send humans to an asteroid by the mid-2020s and Mars in the 2030s. However, before any of these giant leaps are taken, the smaller step of returning to the Moon will have to be taken first. In preparation for the Human Mars Mission, NASA is sending humans back to the Moon, or around the Moon to be exact. The powerful new Space Launch System Rocket and the Orion Spacecraft are how we will get there.

The new Orion spacecraft is built to take humans farther into space than they have ever gone before. It is meticulously designed to carry the crew to space, provide emergency abort capability, sustain the crew, and provide a safe return to Earth. On 5 December 2014, it successfully completed its first flight test, launched atop a Delta IV Heavy⁽³⁾ rocket from Cape Canaveral Air Force Station's Space Launch Complex 37. Loaded with almost 1,200 sensors, Orion completed a two-orbit, 4.5-hour flight to test many of the systems most critical to safety before it carries astronauts.

NASA's plan for Orion's first mission will send the spacecraft beyond the Moon and back. This first Exploration Mission, or EM-1, will not carry a crew, but will instead be controlled from the ground. The spacecraft will perform a flyby of the Moon, using lunar gravity to gain speed and propel itself 70,000 km beyond the Moon, almost half-a-million km from Earth—further than any human has ever travelled. On its return journey, Orion will do another flyby of the Moon before heading back to Earth. The second Exploration Mission, or EM-2, will have a similar flight plan but with four astronauts on board.

Engineers at NASA's Michoud Assembly Facility in New Orleans—one of the largest manufacturing plants in the world—have been busy welding together Orion's crucial underlying structure. The recent completion of these welds formed Orion's pressure

vessel, which equips the crew module with a tightly-sealed environment that ensures life-support for the vehicle's crew.

The EM-1, scheduled for 2018, will see an un-crewed Orion fly beyond Low-Earth Orbit on the most powerful rocket ever developed, NASA's Space Launch System (SLS). "EM-1 will take Orion and the Space Launch system into a high lunar orbit and that is actually the orbit that NASA has identified to do the asteroid retrieval mission that will bring a large boulder into that orbit," explained Lockheed Martin's Orion Program Manager, Mike Hawes.

The EM-2, scheduled to launch between the years 2021–2023, will follow the same journey, with a crew to perform the practice flyby of a captured asteroid in lunar orbit. It is to be a 10-day to 14-day mission with a crew of four astronauts, who are expected to spend four days in the lunar orbit, paving the way for the human mission to Mars by testing longer duration flights.

The design of the Orion crew module closely resembles the Apollo module, but will need to accompany the extra materials or consumables needed for the long journey to Mars, as well as living space for the astronauts. "For Mars, we know that we will need more consumables so we anticipate a habitat module and additional propulsion systems that will be needed for that," Hawes explained, "all those things factor into the ultimate design."

Returning to the Moon is exciting; it allows for conducting more research on its surface and maybe learning how to use its raw materials. It also offers the opportunity to test new technologies needed for future space exploration, including habitation modules, lunar prospecting, and landing and ascent vehicles. We might even be able to build a permanent lunar base, in preparation for building a colony on a new habitable planet; the application possibilities are endless.

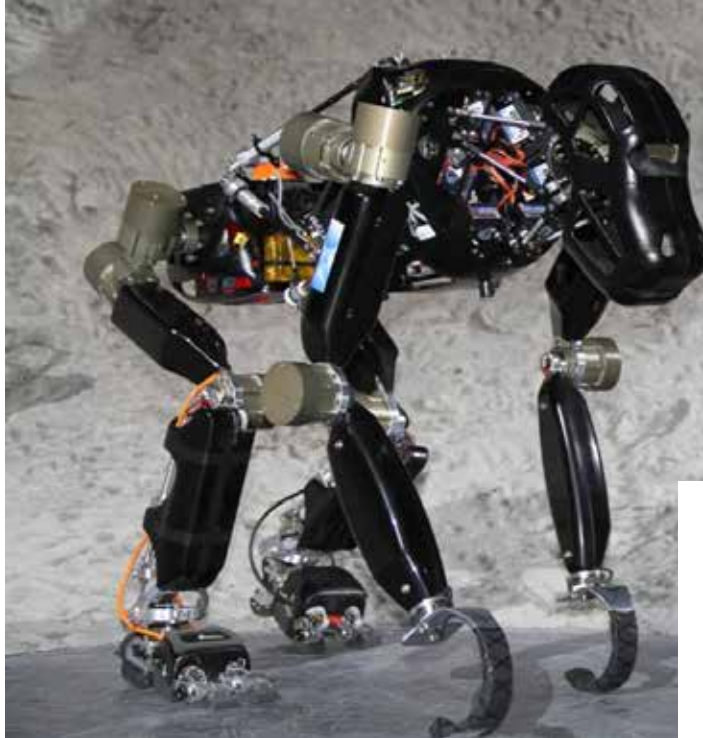


Glossary

- (1) **Saturn V:** An American human-rated expendable rocket used by NASA between 1966 and 1973.
- (2) **Orion Spacecraft:** An American spacecraft intended to carry a crew of four astronauts to destinations at or beyond low Earth orbit.
- (3) **Delta IV Heavy:** An expendable heavy lift launch vehicle, and the world's highest capacity rocket currently in operation.

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Next Monkey in Space is a Robot!

By: Lamia Ghoneim

Many forgotten heroes have paved the way for humans to venture into space; some of them are actually humans' closest living primate relatives: monkeys.

Before manned missions to space, monkeys were sent, by both American and Russian space institutions, to investigate the biological effects of space travel. Overall, thirty-two monkeys flew in the space program, most of which have not made it back to Earth safely. Despite losses, monkeys taught scientists a tremendous deal, and saved human lives that could have been lost if it were not for the service those monkeys performed for their countries and for humanity.

In honor of those heroes, we present to you the next monkey planning a trip to space: "Charlie", the Robo-Ape. Officially named the "iStruct Demonstrator", Charlie is a German space exploration robot based on the model of a Chimpanzee. Designed by the German Research Center for Artificial Intelligence (DFKI) in Bremen, the robotic chimpanzee has mechanical arms, legs, and a spine that mimic the way primates behave, and is made to replace the wheeled robot models currently used in lunar missions.

DFKI hopes its design will capitalize on the inherent stability of the ape's quadrupedal stance without losing the chimp's flexibility in climbing, grasping, and moving over all types of grounds. Weighing in at 18 kg and with dimensions of 66 x 43 x 75 cm, the robo-ape is remarkably similar in both size and stature to real apes, which are well-known for their flexibility in many environments. Another benefit of the

design is that the robot could stand on its back legs, while its hands are used for other purposes, such as collecting and studying samples from the surrounding environment.

The researchers plan to send the mechanical chimp to the Moon to explore the lunar landscape to benefit from its maneuverability. While a rover may struggle with the slope of a crater or rocks strewn across the ground, a robo-ape could clamber up a slope on all fours or carefully pick its way over rocks. DFKI employed several other smart innovations that will help the robo-ape traverse the Moon's hills and craters.

Inside this robotic ape, there are 43 sensors that can detect the force pressed upon them when it walks, enabling it to remain stable. Six sensors on exposed sections of the ape are used for collision detection, distance sensors tell the ape how far away the ground is while it walks, and a three-axis accelerometer orientates the feet so that steps are taken according to the slope of the ground below.

Two temperature sensors also help to compensate for temperature changes in the electronics, and digital magnetic angular encoders monitor every moving axes of the foot and ankle structure. It also has 26 degrees of freedom thanks to various electric motors.

DFKI have also incorporated something called a multi-locomotion system, which replaces an otherwise solid and inflexible connection between either ends of the iStruct Demonstrator's body, with an actuated spinal column. From this flexible core, a six-axis force/torque sensor makes sure the ape does not topple over while

walking or performing more complicated actions, when moving around on all four limbs. The robot can also right itself if, in rare cases, it falls over.

All of this makes for an incredibly agile and maneuverable robot. Gone would be the slow progress made by a rover as the ground ahead is analyzed before it trundles on. Instead, robo-apes could adeptly pick their way across treacherous terrain to perform key science in alien locales.

"We chose the ape because it allows us to study several locomotion modes" DFKI researcher, Daniel Kuhn, told CNN. "For example, they have quite good quadrupedal walking abilities but they can also perform stand-up motion and walk on two legs, their ability to do this is greater than other animals. This change in posture and walking form interested us" he said.

Four-legged locomotion, Kuhn explained, might be stable, but for speed and agility on flat ground, bipedal walking has the edge. The chimp's greatest asset is that it can choose which form of movement best fits the situation. "They can choose; if the environment will not let you move in a stable fashion on two legs, they can choose four. When the environment improves, two legs allow you to get a better view over the field."

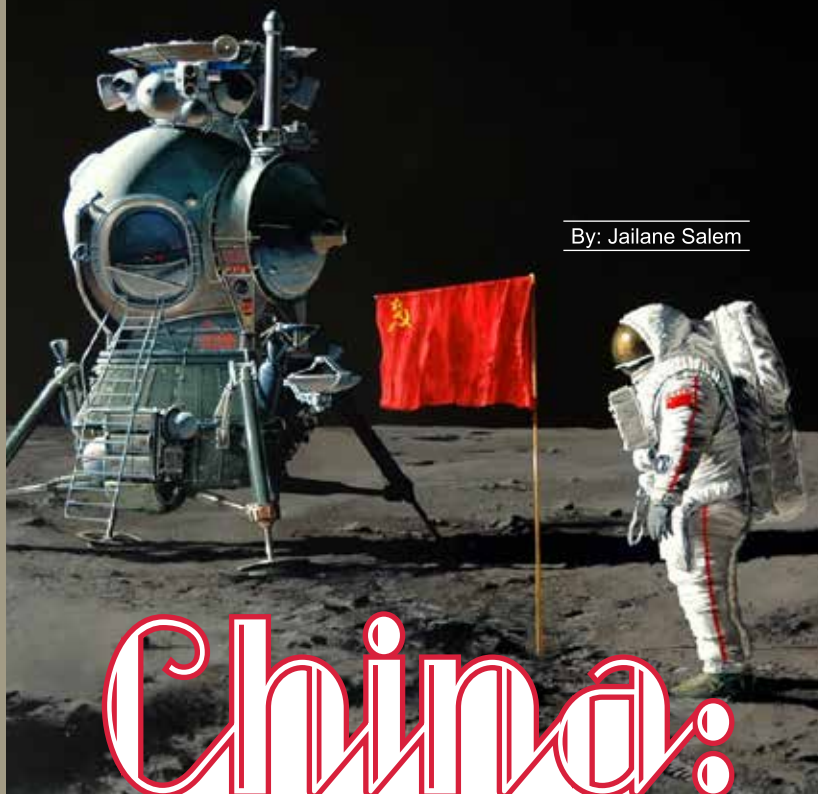
The project team has built lunar craters in the lab and is currently testing the robo-ape in a mock lunar landscape, in preparation for its actual lunar exploration trip.

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Even if some of us were not yet born when the whole Space Race was taking place, we did hear about it. This famous race took place during the Cold War, where the USA and the Soviet Union (USSR)—sworn rivals at the time—were absolutely determined on one-upping each other in space exploration, research, and achievement, each vying to become the space superpower. The Space Race started in 1955 and was over by 1991, producing many great achievements for both USA and Russia, who until now have great presence in space explorations. One variant, however, is that they are no longer the only parties in the race, having long been joined by China, Europe, India and Japan.



By: Jailane Salem

China:

A RISING STAR IN SPACE

China was late to the game, where its space program was established in the 1950s and their first satellite was launched in the 1970s. However, it was not until 2003 that they were able to send a manned space mission, which made them the third country to successfully do so. Whilst they had a slow start, in 2011 they overtook the USA in regard to numbers of launches per year; they also have the second best figure for successful launches, coming second to Europe. “They are just taking a very different approach than the USA did. We launched a lot; they only launch every three years or so, but take a very big step forward with each launch”, said Joan Johnson-Freese, Professor at the US Naval War College.

The China National Space Administration has many long-term goals. One of the goals is to improve their standing in the world of space science, which they have been following by recently welcoming international collaborations, and working together with other space agencies such as the European Space Agency (ESA). Another goal down the line that China wants to achieve is to

send a robotic mission to the dark side of the Moon, before sending a manned mission to the Moon by 2030.

They also plan to establish a crewed space station. There are three working space stations in orbit; the International Space Station (ISS), and two Chinese space stations: Tiangong-1 and Tiangong-2 (launched in 2016). These stations are assembled and built over time as each manned mission arrives and adds to it. They are there for astronauts to study the effect of long-term space habitation on the human body, how they can plant food in space, study space phenomenon and carry out experiments that can only be carried out in space.

While the Chinese space stations are not always manned, unlike the ISS, it is an eventual goal for the Chinese. China has also signed an agreement with the UN Office for Outer Space Affairs to allow the station to be used by astronauts from UN Member States. This will allow astronauts to carry out research, especially those who come from developing countries that find space exploration too expensive to carry out on their own.

One of the reasons China is so intent on making its mark in the space exploration field is, as Wang Chi of the National Space Science Center said: “With the development of the Chinese space program, we are trying to make contributions to human knowledge about the universe”. While this is admirable, the fact that making your mark in space is also a matter of prestige and signals that you are a country of immense power, which was actually one of the driving forces behind the earlier Space Race, cannot be overlooked.

It is no surprise, thus, that China spends around USD six billion per year on its space program; it is incomparable with the USA, which spends USD forty billion yearly. However, if we were to compare a different set of numbers, perhaps we will see why spending large amounts of money is not always the best of strategy; the USA made only 19 successful space launches in 2013, compared with China’s 14 and Russia’s 31. This shows that the Chinese work with great efficiency; compared to what they have achieved so far, their trajectory for the future looks as bright as the stars they are reaching for.



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Unexplained Object Beyond

NEPTUNE

By: Soha Elborgy

Niku is 160,000 times fainter than Neptune and the astronomers estimate it is around 11 times smaller than the dwarf planet Pluto; this makes it a minor planet—smaller than a planet but not quite a comet. “I hope everyone has buckled their seatbelts because the outer solar system just got a lot weirder,” said Bannister.

Evidence of a minor planet is based on six icy objects in the debris field beyond Neptune, rotating on orbits that are aligned to one another. Those orbits are all pointing in the same direction, suggesting the existence of a hidden planet forcing them to align. If there were not a planet along this orbit, the gravitational force from the known planets should have twisted the orbits by now.

Referring to this minor planet, Dr. Bannister said “There it was on the screen—this dot of light moving so slowly that it had to be at least twice as far as Neptune from the Sun”. The exact size of the new object and its surface properties are still under study; Dr. Bannister says that the planet could be small and shiny, or big and dull. The majority of minor planets were destroyed as the giant planets moved to their current positions; Niku is one of the few survivors to the present day.

The solar system is very flat; the orbits of all the planets are within a few degrees of the same plane. This means that any object that does not orbit in the plane of the solar system, or circles in an opposite direction, must have been knocked off course. What is knocking the object off course is not quite known yet. Scientists have tested to see if this wrong orbit is caused by the gravitational pull of a large object’s gravity causing it to orbit at an angle to everything else and backward.

It turns out that the outer solar system has only showed us a fraction of its mysteries. Michele Bannister, an astronomer at Queens University in Belfast, has spoken about the discovery of a Trans-Neptunian Object (TNO) faintly hiding behind Neptune’s orbit in the outer solar system. The object was first sighted by Dr. J.J. Kavelaars, an astronomer with the National Research Council of Canada; astronomers have nicknamed the TNO “Niku”.

Several theories such as a hidden super-Earth known as “Planet Nine”, an unseen dwarf star called “Nemesis”, or an unknown dwarf planet in the Kuiper Belt, are all problematic; at least according to our current understanding of the universe. Proposing the possibility of “Planet Nine”, came from a group of other objects that orbit at a highly tilted angle.

Eventually, several astronomers concluded that the “mechanism causing and maintaining this common plane is still unknown”. One possibility is that a collision could have knocked it off its course, or that the TNO was captured from another part of the galaxy when it passed too close to the Sun. There is no evidence, however, that either of these theories could be the real reason to the object’s goofy orbit.

Dr. Matthew Holman, an astronomer at the Harvard–Smithsonian Centre for Astrophysics, who was part of the team that discovered Niku, said “It suggests that there is more going on in the outer solar system than we are fully aware of”. The team’s study has yet to be peer-reviewed, but it is available on arXiv.org—a repository of e-prints in physics, mathematics, computer science, quantitative biology, quantitative finance and statistics—while the researchers take feedback prior to publication.

This discovery, however confusing it might currently be, is very exciting for all the scientists and astronomers. If this turned out to be a new planet, it could very much reshape the outer space as we know it today.

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Baby Star to Reveal How Massive Stars Are Formed

By: Soha Elborgy

A newly published article in the *Astrophysical Journal* shows that what was once thought to be an old star is actually a protostar⁽¹⁾ 12,000 light years away from Earth. The lead author of the study, Martin Cordiner of NASA's Goddard Space Flight Center and Catholic University of America, said that it was first studied as an aging, expanding, red massive star, also known as an Asymptotic Giant Branch (AGB) star, which is his area of expertise. However, as the study went further, he discovered that it was not an old star, but rather a newly-born one.

"Astronomers recognized this object as noteworthy around the year 2000 and have been trying ever since to decide how far along its development is," said Cordiner. The object was found to be peculiar when it was studied at specific radio frequencies. Several teams of astronomers studied it using ground-based telescopes and concluded that it was an oxygen-rich star roughly ten times bigger than the Sun. However, the question was: What kind of star was it?

Some researchers favored the idea that the star was evolved; that is, it has passed the peak of its life cycle and is on the decline. For most of their lives, stars obtain energy by fusing hydrogen in their cores, as the Sun does now. Having consumed most of their

hydrogen, older stars rely on heavier fuels that do not last as long, leading to their rapid deterioration. Scientists initially proposed that it was an old star surrounded by a cloud typical of that which accompanies young stars. Another idea, however, was that the observations might be capturing two objects: a very old star and an embryonic cloud of star-making material in the same field.

The team studying the object used Herschel Space Observatory and analyzed data gathered earlier with NASA's advanced Spitzer Space Telescope to look through the infrared spectrum at the star's dust emission, which detected water and ice in the cloud around the star. So far, all the evidence supports the baby star scenario; based on the star's Doppler signatures⁽²⁾, it is jetting gas out of its poles at a high speed of 90 kilometers per second. "Those are really characteristic features of very young protostars, which are still feeding on their parent gas cloud they spray out these jets at the poles," says Cordiner. Alternatively, old stars shoot jets at roughly 10–30 kilometers per second.

The team found out that the baby star is brighter than it was thought to be, emitting about 20,000 times the energy of the Sun. The team also found large quantities of ice made from water and carbon dioxide located on dust grains in the cloud surrounding it, which blocked out the starlight and made it look dimmer. Moreover, the dense cloud ring around the object appears to be coalescing, which characterizes young stars, whereas it expands in cases of old stars.

To better study the protostar's shape and structure, the team plans to take infrared images of it using NASA's telescope SOFIA. They will also explore the star's chemistry to see if it has hot core forming

complex organic molecules; if it does, it would definitely be a baby star.

Although 12,000 light years from Earth, much farther than the well-known protostar Source I in Orion KL, which is "one of the star formation experts' favorite sources to look at to find out the earliest stages of massive star formation," said Cordiner, this new protostar is still in our Milky Way galaxy and close enough to study. It even has one major advantage over the Orion protostar, being farther from other objects that would interfere with measurements.

"That could make it quite an important object for ongoing detailed studies of the star formation process," explained Cordiner. "How do massive stars form? How do they pull in gas from their surroundings? How do they feed back radiation and energy to the surrounding environment? If you have a nice isolated object like this you can study it more easily". Cordiner described the object as a definitely exciting one, which can teach astrophysicists a lot about how massive stars form; "it is just one of those objects that keeps on giving".

This baby star discovery is our gate to a better insight into the world of star formation and a fresh seed to further discoveries in the field.

Glossary

A protostar is a very young star that is still gathering mass from its parent molecular cloud.

Doppler signature is the characteristic mark of the star frequency of gas emissions.

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"Astronomers recognized this object as noteworthy around the year 2000 and have been trying ever since to decide how far along its development is"



Rare Astronomical Phenomena

By: Sara Khattab

The skies never stop amazing us with numerous, fascinating, and often rare astronomical phenomena. In certain conditions, some of these astronomical events can be observed by the naked eye without the use of binoculars or telescopes. The predicted date and time of different celestial phenomena, such as meteor showers, eclipses, and other interesting events, are listed in an astronomy calendar to be tracked by sky watchers and astronomy amateurs.



Planetary Transits

A planetary transit occurs when a planet travels across the Sun; it may be considered a special kind of eclipse. Only inner planets—Mercury and Venus—transit across the Sun and can be seen from Earth because they are the only planets that lie between the Earth and Sun. During the transit, the planets can be seen from Earth as a small black disk moving in front of the Sun.

Venus transits occur rarely because the planet's orbit is tilted just over three degrees from the plane of the solar system, which means that most of the time Venus passes above or below the Sun's disk. The transit takes place when Venus reaches a point in its orbit where it is directly between the Earth and the Sun. Venus transits occur in patterns, four times every 243 years; each pair of transits occurs 8 years apart separated from the next pair by a long gap of 105.5 years or 121.5 years.

Since the invention of the telescopes 400 years ago, only seven transits have been observed. The first recorded transit of Venus was in 1639 by Jeremiah Horrocks; the first to predict Venus transit was Johannes Kepler in 1627. The last pair of transits occurred on 8 June 2004, and 5 and 6 June 2012, marking the last Venus transit of the 21st century. The next transits

will take place on 10 and 11 December 2117, and on 8 December 2125. The 2012 transit lasted for about 6 hours and 40 minutes, and was visible across North America, Europe, Asia, and eastern Africa; while the rest of the world witnessed it the next day.

Despite the rare occurrence of Venus transits, they were used to collect information about the solar system, to calculate the estimate size of the Sun, and to study Venus' atmosphere. The latest transit provided astronomers with some research opportunities to refine the techniques used in the search of exoplanets.

On the other hand, Mercury's orbit is inclined about 7 degrees compared to that of Earth; so Mercury, Earth, and the Sun also line up rarely. The transit of Mercury happens more frequently than Venus transits though—about thirteen times a century—because Mercury is closer to the Sun, and thus, orbits more rapidly.

Mercury transits usually occur in May and November; the last transit occurred on 8 May 2016, while the next one will occur on 11 November 2019. Mercury's transit across the Sun in around seven-and-a-half hours; this rare transit is usually visible in most of the countries except for those who happen to be at night when the transit occurs.

Rare Lunar Events

"Once in a blue moon" is an expression usually used to say that something does not happen very often. What is a blue moon?

There are two definitions of this infrequent phenomenon. The first is that it is the third full moon in an astronomical season with four full moons; the second states that it is the second full moon in a calendar month. This event is monitored closely by astronomers and researchers because it is

an odd occurrence in the standard lunar calendar. The Farmer's Almanac* called this extra full moon a "Blue Moon", but the term is confusing as it does not necessarily mean that the moon will turn blue.

However, it is possible to see the moon blue in color when the atmosphere is full of particles that may give it color. In 1883, a volcano in Indonesia exploded; the whole atmosphere filled with dense ash, and the full moon turned blue. The last Blue Moon was witnessed on 21 May 2016, and the next Blue Moon is expected to occur on 31 January 2018.



Another lunar event is the supermoon, which is a full moon that coincides with perigee—the Moon's closest point to Earth in its monthly orbit. During this period, the super full moon looks about 7% bigger and 16% brighter than an average full moon. On 14 November 2016, a supermoon occurred, and it was the closest to Earth since 26 January 1948; the moon was only 356,509 km far from Earth. The Moon will not come this close to Earth again until November 2034.

*The Farmer's Almanac is a reference book that contains weather forecasts, tide tables, planting charts, and astronomical data.

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THE TUNGUSKA EVENT

By: Moataz Abdelmegid

On the morning of 30 June 1908, an explosion ripped through the air above a remote forest in Siberia, Russia, near the Podkamennaya Tunguska River. The fireball is believed to have been 50–100 m wide; it depleted 2000 square kilometers of the Taiga forest in the area, flattening about 80 million trees. The explosion caused the earth to tremble, while all windows smashed in the nearest town over 60 kilometers away; luckily, the explosion caused no known human casualties. Nearby residents, however, felt the explosion heat from blast, while they eye-witnessed the largest impact event on Earth in recorded history.

The explosion is generally attributed to the mid-air disruption of a superbolide*. It is classified as an impact event, even though no impact crater has been found; the object is thought to have disintegrated at an altitude of 5–10 kilometers rather than hit the surface of the Earth. Scientists estimate that the impact produced about 185 times more energy than the Hiroshima atomic bomb; eyewitnesses reported incredible stories of the event. Some reported seeing the sky split in two; high above the forest the whole northern part of the sky appeared covered with fire. Others reported that there was a bang in the sky and a mighty crash; the crash was followed by a noise like stones falling from the sky or guns firing.

The Tunguska region of Siberia is a remote place, with a dramatic climate. It has a long hostile winter and a very short summer, when the ground changes into a muddy uninhabitable swamp. This makes the area extremely hard to get to; when the explosion happened, nobody ventured to the site to investigate. This was partly because the Russian authorities had more pressing concerns than satisfying scientific curiosity. Political strife in the country was growing with World War I and the Russian Revolution just a few years

away; the details of the event were, thus, not available to the world until twenty years later.

In 1927, Russian scientist Leonid Kulik finally convinced the Russian authorities to allow him to lead a team of qualified scientists to visit the impact area on a scientific mission. Upon arrival, the damage was still immediately apparent, almost twenty years after the blast. He found a large area of flattened trees, spreading out about 50 kilometers wide in a strange butterfly shape.

Kulik proposed that an extraterrestrial meteor had exploded in the atmosphere; it puzzled him though that there was no impact crater, or in fact, any meteoric remnants at all. To explain this, he suggested that the swampy ground was too soft to preserve whatever hit it, and that any debris from the collision had been buried. Kulik wrote in his 1938 conclusions: "We should expect to encounter, at a depth of hardly less than 25 meters, crushed masses of this nickeliferous iron, individual pieces of which may have a weight of one or two hundred metric tons".

In 2013, one team led by Victor Kvasnytsya of the National Academy of Sciences of Ukraine put an end to much of the speculation of the earlier decades. The researchers analyzed microscopic samples of rocks collected from the explosion site in 1978; the rocks had a meteoric origin. The analyzed fragments were recovered from a layer of compost dating back to 1908; the remnants had traces of a carbon mineral known as lonsdaleite, which has a crystal structure almost like diamond. This particular mineral is known to form when a graphite-containing structure, such as a meteor, crashes into Earth.

NASA's Meteoroid Environment Office performed computer simulation to explain the stages of the Tunguska explosion. The cosmic body entered our atmosphere at 15–30 km; fortunately, our atmosphere is good

at protecting us. The atmosphere will generally break rocks smaller than a football field up a few kilometers above the Earth's surface, producing an occasional shower of smaller rocks that will be cold by the time they hit the ground. In the case of Tunguska, the incoming meteor must have been extremely fragile, or the explosion so intense, it obliterated all its remnants 8–10 km above Earth.

In the second stage, the atmosphere vaporized the object into tiny pieces, while at the same time intense kinetic energy also transformed them into heat; the process is similar to a chemical explosion. In conventional explosions, chemical or nuclear energy is transformed into heat; in other words, any remnants from whatever entered Earth's atmosphere were turned into cosmic dust in the process.

Scientists believe that the probability of this event happening again in the same way is extremely small. In a far unlikely event, given the huge surface area of the Earth that is covered in water, if a Tunguska-type event happens again, the overwhelming probability is that it will happen nowhere near human population.

***A Superbolide:** A large meteor with a high apparent magnitude which explodes in the atmosphere.

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OUT OF ORBIT



By: Esraa Ali

Man traveling to space was once a one-shot endeavor, and dangerous at all levels. The history of spacefaring includes failures that remind us of the dangers of venturing to space, which have been depicted in several science fiction movies in an exaggerated fashion. The space setting itself is used as a manifestation of human nightmares.

Several movies depicted characters exposed to the vacuum of space; space was displayed as a cold and dark place with aliens; it is also displayed as an exploration of the characters' inner psychology through the isolation of space travel. Moreover, space is displayed as an exploration of humanity's past, present, and future.

In the early 20th century, theoretical works of interplanetary travel emerged; inspired from science fiction works, such as Jules Verne's *From the Earth to the Moon*. In 1903, the first realistic proposal of spaceflight was published by Konstantin Tsiolkovsky, *The Exploration of Cosmic Space by Means of Reaction Devices*, which was then followed by a burst of scientific investigations that gave sufficient power for space exploration to become possible.

In 1957, in a competition, dubbed the Space Race, which brought an engaging touch of science fiction to the Cold War between the Soviet Union and the United States, both countries developed the first orbital spaceflight. Henceforth, humanity ventured out of our homeland Earth, and touched the possibility of worlds beyond. Nevertheless, since the 1970s, spaceflights have not ventured further than the original pioneers did, as many astronauts have

reported worrying negative effects on their bodies.

If we think of space as a plan B to keep us alive and finding new resources, we have to think twice. Ever since the invention of rocket-powered flights, accidents and disasters have occurred, in both manned and unmanned flights, where the first remain the ones with the deepest impact on the public. These accidents include the tragic flight of Soyuz 11, which occurred in 1971; the Challenger explosion, which occurred in 1986, when the NASA Space Shuttle orbiter Challenger broke apart 73 seconds into its flight; and the Columbia disaster, which occurred in 2003, when Columbia disintegrated as it re-entered Earth's atmosphere.

There are common causes of space accidents, which are linked to defects in the design and technology failures, which lead to tragic loss of lives. Those involved in the operation of space travel have the obligation to investigate the causes of these accidents and know how to prevent their occurrences. Analyzing space risks can bring more awareness to prevent next tragic space disaster.

Once astronauts reach space, they are not out of danger. They become more exposed to a new set of risks and extreme conditions in space, such as radiations that the Earth's atmosphere shields us from. While there are astronauts responsible for commanding the missions and flying shuttles, there are others responsible for maintaining the spacecraft and performing any necessary Extravehicular Activity (EVA), who are mission specialist

astronauts. This happens when these astronauts enter the vacuum, meaning that there is a near or total lack of gas molecules.

Inside the spacecraft, the atmosphere can be controlled, unlike outside of it. There is no oxygen in space; thus, astronauts cannot breathe without assistance. Moreover, the temperature is so low they would freeze without proper protection. That is why astronauts have to take their environment with them when they leave Earth, as well as when they need to work outside the spacecraft by wearing specially-designed spacesuits that also protects them from the harshness of space.

The harshness of spaceflight was exemplified by President John Kennedy in his 1962 famous speech, stating that: "We choose to go to the Moon, not because it is easy, but because it is hard". Today, spaceflight has become more viable and routinely with the advances in technology; the risk of losing human life during space travel is now similar to the risk of climbing Mount Everest.

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INVASION EARTH

By: Hend Fathy

When I come across Sci-Fi movies involving aliens, I would switch the TV to National Geographic, and watch its science communication shows that bring me back to the real world. Nevertheless, I was recently following a show entitled Invasion Earth, which made me question if those Sci-Fi movies were really fictional. Invasion Earth investigates the world's most intriguing Unidentified Flying Objects (UFO) sightings, aiming to answer the old question: Are we alone in this universe?

Westall Mass UFO Sighting Melbourne, Australia, 6 April 1966

As students and teachers at Westall High School were having their break in the schoolyard, they witnessed a breathtaking scene. Eye-witnesses all over the town said they saw a grey saucer-shaped craft hovering over the School. The craft was there for around twenty minutes; it landed in a grove of pine trees beside the School known as "The Grange", then rose again and disappeared.

Graham Simonds, the school captain, said that science teacher Barbara Robins photographed the UFO, but the camera was soon confiscated by the authorities. In the afternoon, a full school assembly was held. The Headmaster, accompanied by officials, said that "nothing had happened; there are no such things as flying saucers". Simonds said that students and staff were told to keep their mouths shut.

Local resident, Kevin Hurley said the object left behind a round area with flattened grass where it landed. He added that he tried to revisit the area, but was stopped by soldiers who advised him to go away. Yet, he saw behind them experts examining the area and collecting soil samples.

Cognitive psychologist Susan Clancy tried to reach a scientific explanation. She proposed that it could be a case of mass hysteria, a phenomenon that transmits collective allusions of threats through a population in society as a result of rumors and fear. Until today, the truth of what happened is not clear.

The Mysterious Disappearance of Fredrich Valentich Australia, 21 October 1978

The story began shortly after sunset when Frederick Valentich was piloting over the Ocean towards King Island. Valentich radioed to Melbourne Air Flight Service reporting a large aircraft with four bright lights hovering over his plane, followed by rapid lights that headed towards him. He said it was not an aircraft and did not behave as one. After a short conversation with controller Steve Robey, who confirmed that there was no traffic in the area, silence prevailed for 17 seconds with audible unidentified staccato noise. Valentich disappeared along with his aircraft.

The case was bewildering to investigators. All the efforts exerted to find the plane wreck went in vain. The aircraft's technical safety report issued before the flight confirmed it was in great condition. Valentich was a promising

young pilot in great health condition, and the weather was perfect for flying. To make things more mysterious, a photograph taken by a tourist captures a strange dark object in the sky at the same time of the accident; yet, even this clue did not tell much about the truth of what happened.

According to Mike Hodges, the aircraft mechanic, one possible explanation is that Valentich was unconsciously flying upside down, which could happen to pilots with humble experience in night flights over the seas. In that scenario, the lights he saw were reflections of his own plane on the Ocean surface, and he was so taken by his observations that he did not observe that in his navigation system until he finally crashed into the Ocean.

However, the official investigation report, issued four years later, stated that "the reason for the disappearance of the aircraft has not been determined", and hence the mystery remains unsolved.

Western Whitehouse Under Attack Texas, USA, 8 January 2008

At around 6:00 pm, Steve Allen and his friends witnessed a huge flying object with lights at all of its angles. The object moved rapidly from east to west, and returned after a while

with two F-16 Fighting Falcons chasing it. The object headed to President George W. Bush's Western Whitehouse, which was very close, and around which aviation was prohibited.

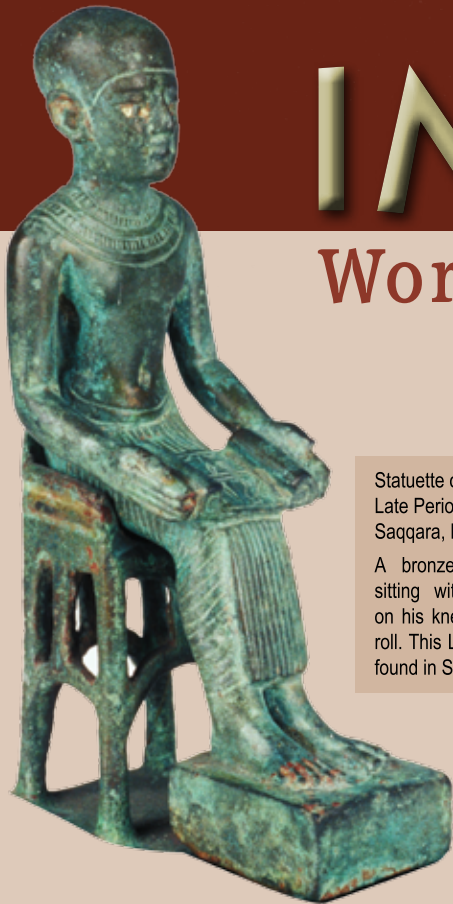
The US Air Force initially said it must have been reflections from commercial planes, a scenario rejected by eye-witnesses. After two weeks, they said they realized a "reporting error", and that ten F-16 Fighting Falcons had been on a night-time training mission in the area. The final official report stated that it was merely military maneuvers.

The UFO investigative organization MUFON issued a report where it analyzed the radar records from the Federal Aviation Administration and the National Weather Service. They compared the radar data to the witnesses' accounts, and their testimonies were confirmed. Until today, the eye-witnesses still believe the government is hiding the truth.

Are we alone in this world? Do governments know more than they reveal to us? These questions still seem taboo, and although scientifically trained experts insist that every UFO sighting has a rational explanation, some continue to defy understanding.

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Late Period (664-332 BCE)
Saqqara, Bronze, 14.5 cm

A bronze statue of Imhotep sitting with his hands resting on his knees holding a papyrus roll. This Late Period statue was found in Saqqara.

IMHOTEP

World's First Astronomer

By: Tarek El Awady, PhD
Director, Bibliotheca Alexandrina Antiquities Museum

On a limestone base, which represents all that is left from a life-size statue of King Djoser, a unique inscription was found. It records, for the first and the last time in Ancient Egyptian history, the name and the titles of a non-royal person on a royal statue. The name of that person was Imhotep, the royal architect to whom the achievement of the construction of Egypt's first pyramid is attributed.

Many scholars agreed that Imhotep deserved to be honored by King Djoser by depicting his name and titles on the King's statue, because Imhotep's architectural achievements did not only satisfy the King's wishes of building a remarkable tomb to guarantee eternity for his name, but also Imhotep's architectural evolution opened a new era for the Egyptian civilization. It well represented the shift between two main historical eras; namely, the

shift between the Early Dynastic Period (3050–2686 BCE) and the Old Kingdom (2686–2181 BCE). Without Imhotep's architectural revolution, the Egyptians would not have been able to build the Great Pyramid of Giza eighty years after the construction of the Step Pyramid at Saqqara.

Imhotep's first contribution to science was obviously the use of stone, on a large scale, as the primary building material; it consequently represented the shift from mudbrick architecture to stone architecture. However, Imhotep was not only an architect but also a "Wer-Maaw: The Great Stargazer", or an astronomer. The title "Wer-Maaw" is depicted among Imhotep's titles on the Djoser's base, which is now on display at the Imhotep Museum in Saqqara. The title was studied by many scholars who agreed that Imhotep was also a priest at the sun-temple of Re at the ancient city "Iun, now Ain Shams in Cairo".

In fact, Architecture and Astronomy were very much intertwined in Ancient Egyptian times. The alignment of every architectural component of the pyramid complex had to be according to the position of the stars and four directions of the world. It is true that all pyramid complexes in the Old Kingdom are different in shape and size, but they all follow the same system of directions and alignments. The entrance to the pyramid is in the middle of the northern façade of the pyramid, and the existence of the mortuary temple is on the east side of the pyramid, starting from the Fourth Dynasty onward.

Astronomy existed in many fields in the life of ancient Egyptians, in addition to the architecture of their tombs and houses. Thanks to the well-preserved late temples, which have survived from the Greco-Roman time, such as Dendera, Esna, and Edfu temples, we know that each temple contained one or two staircases leading to the roof of the temple, where a place was reserved for a particular category of priests/astronomers to observe the stars. Early excavation carried out in the Old Kingdom pyramid complexes revealed that mortuary temples also contained staircases leading to their roofs for the same purpose; observing the stars to set up the exact days of celebrating holy feasts of different gods and goddess, and most importantly, fixing the schedule of the funerary rituals of the deceased king.

Imhotep is a leader and pioneer in the fields of architecture, astronomy, and management, which helped mold the Ancient Egyptian civilization. It is not a surprise that intellectuals in Ancient Egypt took him as their perfect role model; ancient scribes and writers would spill water while pronouncing Imhotep's name before they started a project. In later times, Imhotep joined the gods of the Pantheon and was worshipped among the gods and goddesses of knowledge and healing.

With all the information we have on Imhotep from all different periods of history, we still do not know any information about his family or his origin. His tomb is an unsolved mystery. In Ancient Egyptian literature, Imhotep's father was referred to as a commoner farmer. Undoubtedly, Imhotep will remain in the hearts of the Egyptians as the actual founder of Egypt's dazzling beauty.

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ERATOSTHENEΣ

OF CYRENE

By: Dr. Shaymaa Elsherif
In charge of Cultural Programs and Activities
BA Center for Francophone Activities

Eratosthenes of Cyrene was the third librarian of the Ancient Library of Alexandria, and one of the greatest scientists humanity has ever known. Eratosthenes, son of Aglaos, was born in Cyrene, in Libya, 276 BCE; he passed away around 195 BCE. Throughout his childhood and until his young adulthood, he studied in Cyrene, which was at the time a center of Hellenistic culture.

ΒΕΤΑ TEACHER

experiment that the Earth is round. Indeed, he was the first to successfully measure the Earth's circumference; his result deviates by less than 1% from modern day calculation. He was one of few astronomers in the Ancient Library; moreover, he was a mathematician, and founded the "Sieve of Eratosthenes" used for finding prime numbers. Last but not least, he wrote about literature and language.

There have been many accounts about the esteemed scientist; unfortunately, none of his written works survived. We only know him through those who followed; everybody endorsed his role, even those who disagreed with him. Everybody acknowledged that he really was the "Beta teacher". We never knew what exactly happened to his written works; however, it remains amazing that his great legacy survived.

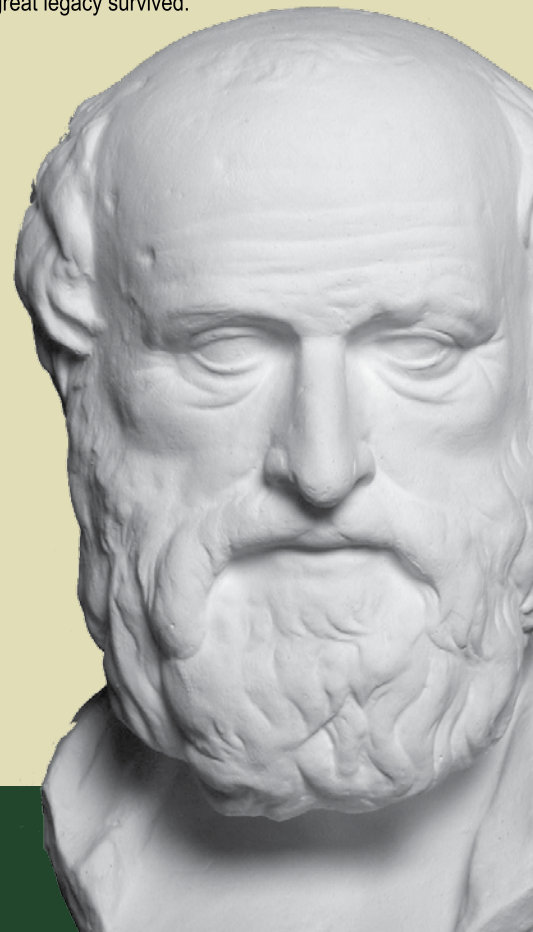
Eratosthenes then moved to Athena, a significant educational and cultural place, where he studied philosophy, as well as mathematics and sciences, at its major educational centers: Plato's Academy and Aristotle's Lyceum. His philosophical beliefs inspired his literary and philosophical publications, which caught the attention. As a result, King Ptolemy III Euergetes summoned him to Egypt to tutor his son. Hence, he gained a scholarship and accommodation at the Mouseion, the home of sciences and arts, and the most famous scientific institute in the Ancient World.

Despite of Eratosthenes' distinguished status and high rank, he did not stop at that; his scientific contributions were what immortalized him. He founded Geography—the name of which he derived from the word *Geographicus*, meaning "drawing Earth"—and Cartography, the study and practice of drawing maps. He also founded Chronology, and was the first to document Greek history by date, excluding all myths.

Eratosthenes was also the first to draw the Earth map on a sphere, and was the first to prove through a flawless scientific

Eratosthenes' companions gave him two nicknames that asserted his prolific knowledge as an encyclopedic scientist. The first was "Pentathlos", meaning "multidisciplinary person with multiple gifts", which was used at the time to refer to skilled athletes. The second and more famous nick name was "Beta Teacher"; Beta being the second letter in the Greek alphabet, implying that he was second to Plato in all sciences.

Eratosthenes directed the Library of Alexandria for around forty years. During this period, a "daughter library" was built at the Serapeum—currently Kom el Shoqafa, Alexandria—to house the huge number of papyrus scrolls that did not fit in the Main Library building at the Royal Quarter by the Sea. Eratosthenes was keen for knowledge until the end, spending days and nights learning and researching. Unfortunately, he lost his sight at the age of eighty, and hence gave up his position as librarian. It seems his sight meant the world to him, for he then decided to end his life, thus, starving himself to death.





Celestial Arts

By: Maissa Azab

Science and art go naturally hand in hand. Both are means of investigation; artists, like scientists, study—materials, people, culture, history, religion, mythology, etc.—and learn to transform information into something else. In Ancient Greece, the word for art was *techne*, from which technique and technology are derived—terms that are aptly applied to both scientific and artistic practices.

For thousands of years artists and scientists have created stories or images about the sky and its constellations to explain our vast universe. Large monuments were constructed by ancient cultures to interpret the cosmos, while smaller objects, such as celestial spheres, astrolabes, and armillary spheres, were developed to navigate the unknown.

Astronomical motifs embellish humanity's most ancient artifacts; yet, until 1609, nobody depicted the lights in the sky as places we might visit. However, when Galileo turned his telescope towards the Moon and observed its craters, valleys, plains, and mountains, and sketched them, he became the first astronomical artist, making the huge conceptual leap of depicting the Moon as another world.

Once the planets were recognized as material bodies similar to Earth, people assumed they must be inhabited. Johannes Kepler had already written the first science fiction novel in 1608; entitled *Somnium* (Dream), it recounts a visit to the Moon brought about by supernatural means. Kepler tried to imagine living conditions on that smaller, slowly-rotating world. Due to the lower gravity "everything is monstrously

large in size; growth is very rapid". To avoid the two-week-long lunar night, the Moon's inhabitants "have no safe and secure established dwelling, but instead wander about their world in troops". Point by point, Kepler deduced a plausible scenario from the available facts.

The *Astronomer* (1668) by Dutch painter Johannes Vermeer is another example of the profound connection between science and art. Vermeer's painting celebrates an astronomer; yet, it equally celebrates the work of artists and the materials of this world. The painting hanging on the back wall was created by a local artist; the Middle Eastern carpet on the table was crafted by a foreign artist; Vermeer's own paints—ground mineral pigments mixed with linseed oil—and brushes were produced by local artisans. The globe at which the astronomer gazes evidences the link between science and art most pointedly, for it demonstrates this astronomer's, and his culture's, combined interest in finely crafted objects and scientific systems, such as cartography and astronomy.

Although artists created fanciful drawings of alien beings in the intervening centuries, realistic renderings of the landscapes of

other worlds came surprisingly late in the 19th century. The illustrations of James Nasmyth, a Scottish engineer and inventor, in his 1885 book about the Moon are remarkable. He created some of the first special effects shots by using a pinhole camera to photograph tabletop plaster models of lunar features. He retouched the photos to create a proper lunar environment; his dramatic alien peaks established a visual meme that persists even today in science fiction art.

French astronomer–artist Lucien Rudaux (1874–1947) took astronomical illustration to the next level. His depictions of lunar landscapes were indeed the most accurate until space probes and astronauts photographed the Moon. Rudaux was also one of the first to venture beyond the Moon, depicting Jupiter and Saturn as they might appear from their satellites. His depiction of Jupiter from Io's surface shows the bowing of Jupiter's cloud bands toward the pole as would be observed from near the planet; in a telescope, the bands appear parallel.

Science fiction magazines and picture essay magazines were once a major outlet for space art, often featuring planets, spaceships, and dramatic alien landscapes. Born in 1888, architect-turned-artist Chesley Bonestell is the grand master of astronomical art. His paintings have a near-photographic realism that elevated the idea of space travel from fantasy to possibility. The strength of Bonestell's work was the portrayal of exotic worlds with their own alien beauty, often giving a sense of destination, as much as of the technological means of getting there. His artwork in the 1947 book, *The Conquest of Space*, inspired scientists and engineers who made space travel a reality.

Astronomical or space art is largely an outgrowth of the artistic standards of



ARCHEOLOGY FROM SPACE

By: Sherine Ramadan

Bonestell. It is an aspect of art, the primary emphasis of which is to give viewers visual impressions of alien and exotic places in the cosmos; the source of visual inspiration that our growing abilities to gather and propagate have spread through mass culture. The first photographs of the entire Earth by satellites and manned Apollo missions brought a new sense of our world as an island in empty space, promoting ideas of the essential unity of humanity.

Today, many astronomical artists have traded paintbrushes for computer styluses; 3D modeling software enables us to create images of breathtaking realism, but the challenge of interpreting data from telescopes and space probes remains the same. Astronomical artists play a role similar to that of medical illustrators, in that they attempt to depict aspects of nature beyond ordinary experience. Even as space probes complete a preliminary exploration of the worlds of the solar system, our imaginations can range farther, to the realm of exoplanets and black holes, to the frontier of the observable universe, and to the dawn of time itself.

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When talking about archeologists and treasure hunters, most of us picture Indiana Jones; a university professor and archaeologist famously played in movies by Harrison Ford. Many people love the high level of excitement, not to mention the chance to travel to exotic countries, searching for treasures in ancient temples, rescuing people in distress, fighting bad guys and saving the world.

In the real world, however, things are not that easy; discovering lost ancient cities may take years. Primarily, archaeologists depend on shovels, paper maps to reveal the location of ancient ruins. Thankfully "Satellite Archaeology" now facilitates searching for mysterious, buried, and missing clues for thousands of years.

Satellite Archaeology is a new method for mapping and monitoring potential archaeological sites facing urbanization, looting, and groundwater pollution that could pose threats to such sites. It uses high resolution satellites with thermal and infrared capabilities to pinpoint potential sites of interest in the earth around a meter or so in depth.

In fact, this technique has become an increasingly important tool in archaeological research; it allows archaeologists to uncover unique data that is unobtainable using traditional techniques. Satellites make a 3D image of the area to show if there are any man-made structures beneath soil and vegetation that cannot be seen by the naked eye. Once those potential sites are identified, they are then verified by humans on the ground.

Sarah Helen Parcak, an archaeologist, Egyptologist, and remote sensing expert, has used NASA topography data to identify potential archaeological sites in Egypt, Rome, and elsewhere in the former Roman

Empire. She leads survey and excavation projects in Fayoum, Sinai, and Egypt's East Delta. Thanks to satellite-facilitated infrared imaging techniques by remote-sensing satellites, Parcak and her team were able to discover thousands of ancient sites in Egypt, tracing structures buried deep in the sand; such as the ancient network of streets and houses of Tanis that was once a capital of ancient Egypt, which are now completely invisible beneath the visible ground.

More than 1000 tombs and 3000 ancient settlements were also revealed by looking at infrared images, which show underground buildings due to the differing densities between the rather dense mud-bricks used in ancient Egypt in building construction and the typically less dense surrounding sands or soils under which mud-brick building foundations may often now lay buried. The cameras on the satellites are so powerful they can spot objects of less than a meter in diameter.

There is no doubt that the latest techniques of remote-sensing methods will enable archeologists to find hundreds of thousands of undiscovered ancient sites across the globe. They may stop excavating entirely and send tiny robots to explore underground, leaving the world's cultural heritage treasures undisturbed for the benefit of future generations. Meanwhile, archaeologists are hoping for better resolutions to be improved to the point where they are capable of zooming in on a single pottery shard buried beneath the Earth's surface.

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Al-Tūsī Couple:

The Evidence

By: Dr. Mohamed Soliman
Acting Head of the BA Cultural Outreach Sector

We all know that geocentrism was the prevailing conception of celestial bodies' motion since the beginning of human observations of planets and stars—for the sake of guidance—until Copernicus' solar system model emerged. Geocentrism, also known as the Aristotelian conception, proposed that the Earth was the center of the universe, orbited by the other planets and celestial bodies.

Ptolemy later added to Aristotle's work with the Epicycle Theory in his book *Almagest*; the theory proposes that the planets move epicyclically and not circularly as Aristotle claimed. Ptolemy's theory managed to explain the contradictions in Aristotle's theory regarding the Earth's motion in relation with the Moon and the planets. Aristotle's claim of circular motion was not compatible with the visible motion of the Moon and stars; visible planetary motion is very complicated due to vacillation, which is not accounted for in Aristotle's theory.

Copernicus proved those theories wrong in the sixteenth century, advocating heliocentrism, which entails that the Sun is the center of the universe, and that planets—including Earth—orbit it, in addition to other details. French astronomer Kléber—supported by the studies and observations of Danish astronomer Tycho Brahe's—later managed to put more accurate laws and said orbits were elliptic. Galileo validated Kléber's work and proved it right by observation; yet, what was there two-hundred years before correcting the Ptolemaic model of the Solar System?

Let us read the following quote for the science historian Toby Huff, from his book *The Rise of Early Modern Science*, talking about the achievements of Muslim Arab astronomers: "Their achievement in natural sciences is best represented in developing astronomical models that mathematically equal Copernicus', which followed two hundred years later". He also mentioned the Maragheh Observatory—one of the most prominent Islamic Schools of Astronomy—and its scientists, such as *Ibn Al-Šātīr*, Nasīrul-Dīn Al-Tūsī, and Qutbul-Dīn Al-Šīrāzī, who perceived the universe in a different way than Ptolemy. Their models of the universe were mentioned in Copernicus' writings; actually, the models—modified by Ibn Al-Šātīr—developed at Maragheh Observatory are very similar to Copernicus' that one can say he was a follower of the Observatory that existed 200 years before.

Two-hundred years before Copernicus, Muslim scientists knew the Ptolemaic model had many inaccuracies and did not match actual observations. However, they did not have the appropriate explanations to decipher planetary motion until Ibn Al-Šātīr stated that: "Celestial bodies do not follow the Ptolemaic model". Ibn Al-Šātīr proved Ptolemy's theory wrong through observation and experimenting, and modified it. He then proposed a theory of planetary motion; he also managed to define the orbits of Mercury and the Moon, and developed models for their motion that were used at the Observatory.

Copernicus also used "Nasīrul- Dīn Al-Tūsī Couple", which is a model Al-Tūsī mentioned in his book *Al-Tazkira*, aiming to represent the motion of celestial bodies. The Couple knocked down Aristotle's and Ptolemy's conception of motion confined

to linear or circular schemes. Al-Tūsī proved that linear motion can result from two circular motions, which enabled him to explain planetary motion except for Mercury. Later, Ibn Al-Šātīr used Al-Tūsī Couple to explain Mercury's motion, although it was erroneous; scientists found the same inaccuracies in Copernicus' model of Mercury's motion.

American orientalist Swerdlow said Copernicus' wrong model of Mercury's motion is the same as Ibn Al-Šātīr's, which indicated that he copied from other sources without fully understanding the science. It also proves that Ibn Al-Šātīr, at least, greatly influenced Copernicus.

My goal here is not to list the achievements of Muslim astronomers during the Golden Age of Islam, for I believe they are quite evident. Yet, we need to ask whether Copernicus read their literature? In other words, did he copy their conception of heliocentrism and the motion of celestial bodies? Did he copy Ibn Al-Šātīr and Nasīrul-Dīn Al-Tūsī in particular? Was he trapped by Mercury's motion, Al-Tūsī Couple, and Ibn Al-Šātīr's calculations? Indeed, it is such a big case that cannot be singled in one short article. Researchers wrote hundreds of papers defending or accusing him, or trying to explain how the Maragheh Observatory manuscripts—particularly Al-Tūsī's and Ibn Al-Šātīr's—to him?

Here is the answer: Having extensively studied the conceptions of Copernicus and Ibn Al-Šātīr of celestial bodies' motion and their equations in 1970, in 1973, astronomy scholar David King found rare Arabic manuscripts, including Ibn Al-Šātīr equations, in Kraków University where Copernicus studied in Poland!

NEW EARTH-LIKE PLANET

By: Sherine Ramadan



For generations, mankind has dreamt of exploring new worlds and finding life elsewhere. While the Apollo 11 mission was epic for being the first where a human being had set foot on another planetary body, some of us may live to see yet another new first in space exploration; the possible discovery of life on another planet.

In August 2016, the world of science was excited about the discovery of an Earth-like planet, "Proxima b", discovered by the European Southern Observatory's scientists. What makes this recent discovery particularly interesting is not only because this newly-discovered planet is very similar to Earth in mass and is 4.2 light-years from it, but it also orbits within the habitable zone of its host star Proxima Centauri, completing an orbit once every 11.2 days.

Based on their observations, scientists believe that conditions may be ripe to support life. It has a temperature that is suitable for liquid water to exist on the surface without evaporating, because its star is much cooler than our Sun. However, some scientists caution that we might be jumping to conclusions about its ability to support life; more information about the planet's physical characteristics is needed for a proper evaluation.

We do not have sufficient information to know if there is any chance of it having an atmosphere. If it does not, it would be similar to Mars with little protection from the radiation emitted by its Sun. Furthermore, with the current technology, it would take around 70,000 years to reach this planet, although emerging technology could halve that.

Regardless of whether or not "Proxima b" turns out to be inhabitable, its discovery is sure to further the study and exploration of exoplanets, which could then lead us to finding even more places where extraterrestrial life may exist in the universe.

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VISITORS INFO

Planetarium

Available Shows

Enlightened Mind
19 min. Full-dome Show

The Mission
24 min. Full-dome Show

Stars Show
45 min. Live Show by the
PSC Resident Astronomer

Oasis in Space
25 min. Full-dome Show

Stars of the Pharaohs
35 min. Full-dome Show

Seven Wonders
30 min. Full-dome Show

The Life of Trees
33 min. Full-dome Show

Kaluoka'hina
35 min. Full-dome Show

To Space and Back
25 min. IMAX Show

**Alexandria, The Cradle of
Astronomy**
22 min. Full-dome Show

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For the Planetarium daily schedule and fees, please consult the Center's official website:

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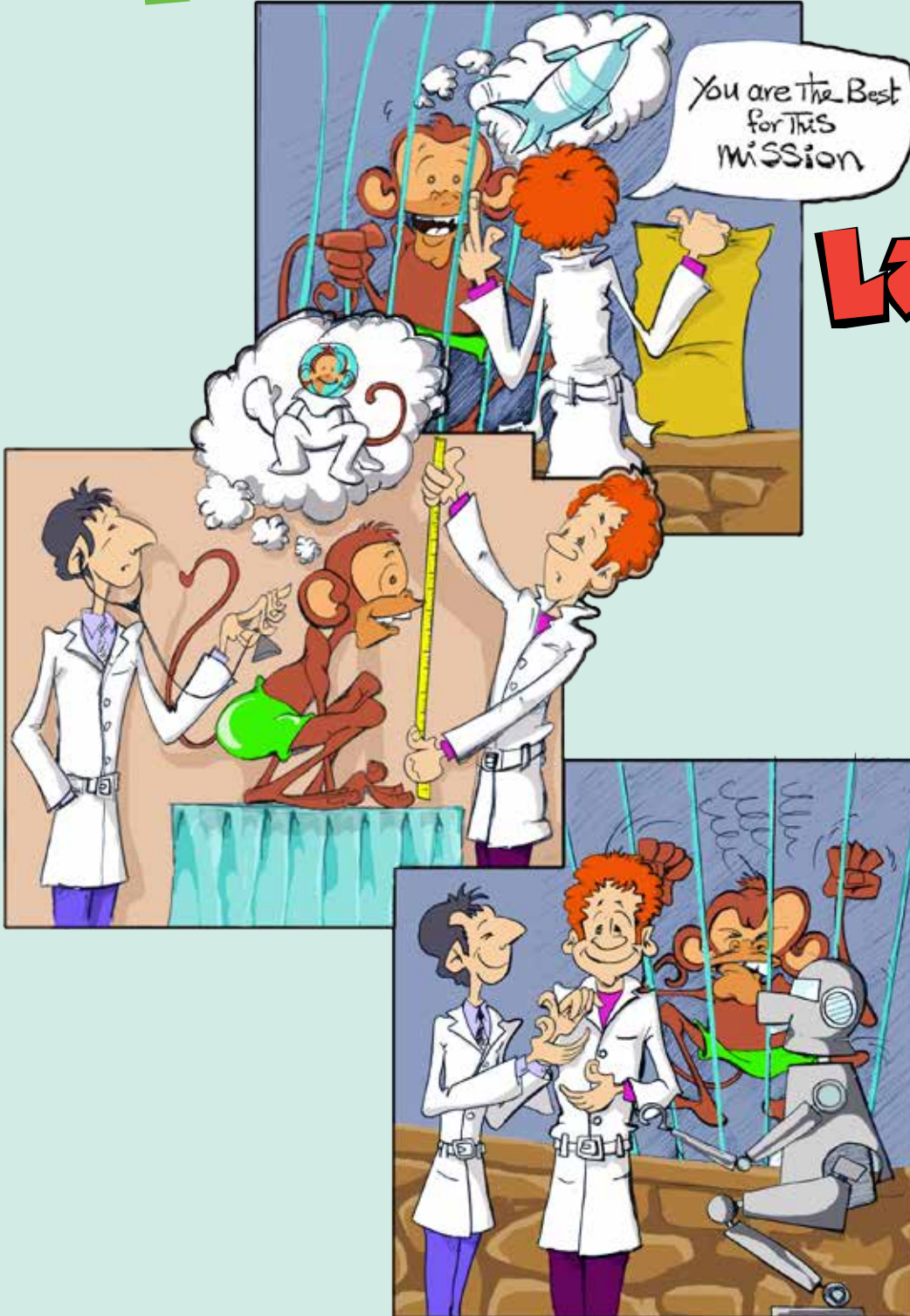
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Check out the "Next Monkey in Space is a Robot" article, page 10.
Illustrated by: Mohamed Khamis