South Downs Mercury

The monthly circular of South Downs Astronomical Society
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- Next meeting Friday 6th October Lecture room of the South Downs Planetarium, Chichester, at 7.30pm. Please support a raffle we are organizing this month

- Main Talk Bob Mizon Pole Stars of Other Planets

- Astronomers find a new way to catch the 'tails' of quasars in massive galaxies. Radio jets beamed from gigantic black holes are still a mystery

By Katyanna Quach 13 Sep 2017 at 00:07

Physicists have managed to analyse the hidden "tails" swirling around quasars in supermassive black holes by using a combination of radio telescopes and the Gaia space observatory. A quasar is an active black hole, identified by plumes of matter shooting out from its centre, and a shroud of gas and dust known as an accretion disk. When matter from the accretion disk is swallowed by the quasar, it heats up and releases energy across the range of the electromagnetic spectrum, shooting out hot jets of matter. Observing a quasar at various wavelengths of light allows scientists to piece together its different properties. Two Russian physicists compared data from the European Space Agency's Gaia telescope and radio telescopes, only to find several discrepancies. A paper published in the Monthly Notices of the Royal Astronomical Society shows how the inconsistencies actually provide researchers with a unique window to discover the accretion disk and the jets of material that look like "tails" around quasars. Leonid Petrov, co-author of the paper and a researcher at the Russian Academy of Sciences said: "There are things you can't see in the radio [wavelengths]. Thus, for instance, an accretion disk around a supermassive black hole emits mostly visible and ultraviolet light. So we decided to combine the data from two sources." Gaia measures the total power emitted from the long jets of material emitted from quasars, and the radio telescopes look at the angular resolution. Both give information about the position of the quasar's location, but for six per cent of the objects, the coordinates from both instruments were not in agreement. The researchers found that the quasars veered off in the same direction as the jets. "By comparing the data from radio interferometers and optical telescopes, we can obtain information about hot jets and the accretion disks surrounding black holes at the centre of galaxies in the visible part of the spectrum. We have now gained a better understanding of what their structure is and what processes occur inside them," said Yuri Kovalev, first author of the paper and a researcher at the Moscow Institute of Physics and Technology. The shift in data has given scientists a new way to recreate and study the structure of faraway quasars at high precision. "This precision is superior to what is possible with ordinary optical telescopes and even with Hubble," said Kovalev. The researchers hope that this will help reveal the exact mechanisms powering the radio jets, so that the true nature of active supermassive black holes can be understood.

Astronomers map 845 galaxies in glorious 3D, maybe dark matter too. It's all gone potato-shaped for some galaxies already

By Richard Chirgwin 12 Sep 2017 at 07:02

Contact us - by email at: roger@burgess.gotadsl.co.uk Society - by email via: www.southdownsas.org.uk
Web Page http://www.southdownsas.org.uk/ https://twitter.com/SouthDownsAstro
Or by telephone: 01243 785325 Fax 01243 785092


The Australian Astronomical Observatory's SAMI instrument

A team led by Sydney University's Dr Caroline Foster has created three-dimensional images of 845 galaxies, claiming it is the biggest collection of 3D galactic representations ever gathered. Created since 2013, when the Sydney Australian Astronomical Observatory Multi-object Integral Field Spectrograph (SAMI) saw first light, the survey may also help us to figure out where all the dark matter is hiding.

Dr Forster, a research fellow at the Australian Astronomical Observatory (AAO) at the start of the project, told the Australian Broadcasting Corporation's *The World Today* program "There's a lot of literature, mostly on the theoretical side, that discusses how the true shape, the 3D shape of galaxies changes as a function of what happened to them over the course of their life." “These [theoretical papers] typically include dark matter in them. Dark matter is one of the mysteries of modern astronomy … if we could pinpoint the true three-dimensional shape of the dark matter behind those galaxies that would give us a clue about what dark matter might be.”

In the meantime, the SAMI results help confirm what we know about the universe, such as the association between rotation and shape. Faster-spinning galaxies tend towards flatter shapes than those rotating more slowly. Speedily-spinning spiral galaxies have more circular disks. When two galaxies combine, the result is generally more spherical, as Dr Foster writes at The Conversation here; on the other hand, in falling gas makes a galaxy flatter (by making it spin faster). Such ideas have been put forward over the 90 years since astronomers first began studying galaxies – but the SAMI survey has let the group measure the relationship between shape and rotation. And there have been surprises, such as galaxies that aren't symmetrical on two axes, instead being shaped more like potatoes.

As the AAO explains here, the SAMI instrument studies 13 galaxies at a time through a bundle of optical fibres (one bundle per galaxy, 61 fibres per bundle).

In Dr Foster's survey, SAMI gathered detailed information about the movement both of gas and stars inside its target galaxies.

The study has been published in the Monthly Notices of the Royal Astronomical Society, and Sydney University's media announcement is here.

- Pains of giving birth to stars gives heft to elliptical galaxies

So, does my stellar nursery look big in this?

By Katyanna Quach 11 Sep 2017 at 23:01


NGC 1316, a gigantic elliptical galaxy that is believed to contain a spiral galaxy (Image credit: P Goudfrooij, Hubble Heritage Team

The rate of star formation might play a bigger role in affecting a galaxy's shape than previously thought, according to a recent study. Galaxies, a smattering of dust, gas and stars glued together by gravitational attraction, come in all sorts of shapes and sizes. Edwin Hubble's classic "tuning fork" diagram describes four different types: elliptical, disk-like lenticulars, spirals and irregular galaxies. The lack of a defined structure and a large bulge where old stars and gas are concentrated have led scientists to believe that ellipticals are formed when two smaller galaxies merge together. But a paper published in The Astrophysical Journal shows that a burst of star formation will cause a galaxy's centre to puff up in size. The concentrated material dominates the galaxy's evolution, and over time it mellows out to become an elliptical or lenticular galaxy.

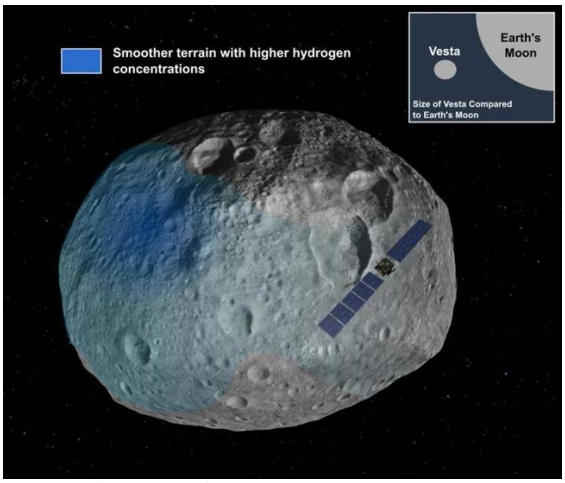
Ken-ichi Tadaki, lead author of the paper and a postdoctoral researcher at the National Astronomical Observatory of Japan, said: "Massive elliptical galaxies are believed to be

formed from collisions of disk galaxies. But it is uncertain whether all the elliptical galaxies have experienced galaxy collision. There may be an alternative path." By inspecting the light from different galaxies from 11 billion years ago, the researchers can see what the galaxies looked like in the past, three billion years after the Big Bang. It's a time when star formation was most active. The Hubble Space Telescope captures the ancient light, allowing scientists to see the shape of the galaxies. The Atacama Large Millimetre/submillimetre Array, a series of radio telescopes in Chile, examines the amount of molecular dust and clouds in the cores of galaxies – an indicator of star formation activity. The massive clusters of gas and dust in the galaxies concentrate star formation at the centre of the galaxy. By using the European Southern Observatory's Very Large Telescope, the researchers confirmed that none of the galaxies' stellar bulges were a result of merger events. "Here, we obtained firm evidence that dense galactic cores can be formed without galaxy collisions. They can also be formed by intense star formation in the heart of the galaxy," noted Tadaki.

- Signs of ground ice found on ancient protoplanet asteroid Vesta. Scientists reignite the idea of water-bearing asteroids bringing oceans to Earth

By Katyanna Quach 13 Sep 2017 at 21:44

Scientists have found evidence that there may be ground ice on Vesta, the brightest asteroid visible from Earth. It's not the first time that ice has been detected on space rocks, and it adds credibility to the idea that asteroids may have brought water to Earth's oceans. As asteroids crashed into Earth, the impact would have melted the icy deposits, leaving large pools of water. A paper published in Nature Communications describes how radar data from NASA's Dawn spacecraft reveals that a variation in signal reflectivity shows Vesta's surface is rough and pock-marked. But unlike the Moon, the patterns cannot be fully explained by craters and are instead signs of ice. Dawn uses a technique known as "bistatic radar." Beams of radio waves are sent down to Vesta, and the signals are reflected back and decoded by scientists working at NASA's Jet Propulsion Laboratory. A team of scientists found that large areas with high radio reflectivity and surface smoothness, over hundreds of square kilometres, also contained strong hydrogen concentrations, measured by Dawn's gamma ray and neutron detector instrument.



A model of Vesta's surface. The bluer regions highlight smoother areas with higher concentrations of hydrogen (Image credit: Elizabeth Palmer and Essam Heggy)

Essam Heggy, co-author of the paper and a researcher at the University of Southern California, described the radar signal as "seeing a flame from a lighter in the middle of day from the opposite side of the United States." It "suggests that potential ground-ice presence may have contributed to the formation of Vesta's current surface texture," according to the paper. Vesta is the second-largest asteroid floating in the Solar System's asteroid belt, between Mars and Jupiter. It has a mean diameter of 525 kilometres (326 miles). Together with Ceres – a dwarf planet with a diameter of 945 kilometres (587 miles) – both rocks are ideal targets to study the Solar System's origins, because they are leftover remnants that did not get swept up by the rocky planets billions of years ago. It is believed that the sheer size of Vesta means it could have a core and mantle, just like Earth. The team hopes to perform similar measurements on Ceres to "compare the surface roughness properties of the two asteroids and how they correlate with subsurface hydrogen concentration." "We hope to understand ice enrichment on asteroids and how that ice shaped the surface of this unique body. Also, how many other asteroids could potentially bear ice, to what

extent, and, if so, what role did asteroids play in water transport across the solar system?"

- Weird white dwarf pulsar baffles Astronomers as its pulsating pattern changes over decades. AR Scorpii was the first white dwarf pulsar to be found

By Katyanna Quach 13 Sep 2017 at 19:04

Image credit: M Garlick/University of Warwick, ESA/Hubble

Scientists trying to crack the mystery behind the fastest-pulsating white dwarf have found that its brightness levels change over a timescale of decades. AR Scorpii is a distant, peculiar binary star system located 380 light years away. It's made of a collapsed white dwarf star circling its larger red dwarf companion. It was first discovered by a group of amateur astronomers, who spotted a strange object flashing quickly. AR Sco was believed to be a single variable star, but further observations revealed it was a completely new type of system often described as a white-dwarf pulsar. Every two minutes, the magnetized star emits a stream of particles and radiation that appears like flash beams of light, directed onto its neighbouring red dwarf. It completes an orbit about every 3.5 hours, and is roughly the size of Earth but has a mass 300,000 times higher. It is estimated that if you scoop a teaspoon of AR Sco's matter, it would weigh 15 tons. Scientists are at a loss trying to explain how the strange star musters up the energy to pulse so frequently, and how it interacts with its companion star. A group of researchers has attempted to study the binary system by analysing data gathered by the Kepler Space Telescope's K2 mission and a sky survey covering the star over a decade from 2005 to 2016. Their results have been published in The Astrophysical Journal Letters. Peter Garnavich, co-author of the paper and a physics professor at the University of Notre Dame in South Bend, Indiana, said: "One model of this system predicts long-term variations in the way the two stars interact. It was not known what the time scale of these changes might be – whether 20 to 200 years. By looking at the K2 and archival data, we were able to show that in addition to hourly changes in the system, there are variations occurring over decades." The light curve of the white dwarf shows a spike every two minutes, and a puzzling variation in brightness over the orbital period. Colin Littlefield, co-author of the paper and a researcher also at the University of Notre Dame, said they found that "12 years ago, AR Scorpii's peak brightness came a bit later in its orbit than it does now. "This does not solve the mystery, but it is another piece to the puzzle that is AR Scorpii."

- 15 'could it be aliens?' fast radio bursts observed in one night. Who or what had 10 million trillion trillion joules to play with, 3 billion light years away?

By Richard Chirgwin 4 Sep 2017 at 04:58

Fast Radio Burst-hunters have suffered London Bus syndrome again: fifteen have shown up at once. A bout of sky-watching at Green Bank in West Virginia, under the auspices of the Breakthrough Initiative's Listen project, has turned up 15 pulses from repeater source FRB 121102. Scientists already knew FRB 121102 was enticing: back in January, researchers said it could push out 10 million trillion trillion joules in mere milliseconds, and it was the first FRB to be pinned down to a host galaxy (a dwarf around 3 billion light years away). The new observations were made by University of California Berkeley postdoc Dr Vishal Gajjar, who used the Breakthrough Listen instrument at Green Bank on August 26 to accumulate 00 terabytes of observations of FRB 121102's location. The data was collected in just five hours – the reason there's so much is that the instrument covered all frequencies from 4 GHz to 8 GHz. Dr Gajjar took those observations, looking for short pulses showing the characteristic dispersion (delay as a function of frequency) that indicates gas between Earth and the source. "The distinctive shape that the dispersion imposes on the initial pulse is an indicator of the amount of material between us and the source, and hence an indicator of the distance to the host galaxy," the Breakthrough Initiative's announcement explains. The 15 new pulses happened in just those five hours, showing the source is in a "newly active state". The

several gigahertz of captured bandwidth "should shed additional light on the processes giving rise to FRB emission". Breakthrough's announcement has also given rise to the inevitable "is it aliens?" speculation, because that's the question Stephen Hawking and Yuri Milner wanted to answer when they established the Breakthrough Initiative. "Whether or not FRBs eventually turn out to be signatures of extra-terrestrial technology, Breakthrough Listen is helping to push the frontiers of a new and rapidly growing area of our understanding of the Universe around us", the announcement says. The group promises a deeper analysis in a future journal article, and has put its observations on The Astronomer's Telegram for all to see.

- Hubble catches a glimpse WASP-12b, an almost pitch-black exoplanet

Black planet, black world

By Katyanna Quach 14 Sep 2017 at 21:51

Artist's impression of WASP-12b with its parent star WASP-12a (Image credit: NASA, ESA, and G Bacon (STScI)

Scientists studying WASP-12b, an exoplanet 871 light years from Earth, have determined that it reflects almost no light, making it one of the darkest planets in space. The team has published their results in a paper in The Astrophysical Journal on Thursday. The Space Telescope Imaging Spectrograph on board the Hubble Space Telescope was used to measure the light reflected from the planet, a property known as "albedo." Light enters the spectrograph through a camera lens, and it's split into a frequency spectrum. Taylor Bell, lead author of the paper and a Master's student in astronomy at McGill University in Montreal, Quebec, Canada, said the results were surprising. "The measured albedo of WASP-12b is 0.064 at most. This is an extremely low value, making the planet darker than fresh asphalt!" Albedo is measured on a scale from zero – a pristine black body that absorbs all light – to one – a perfect white body that reflects all light. WASP-12b is about two times less reflective than the Moon, which has an albedo of 0.12. Since its discovery in 2008, WASP-12b has become one of the most studied exoplanets and has a range of strange properties. It orbits its parent star WASP-12a – a dwarf star with a similar mass and size as our Sun – very closely, at a distance of 3,403,762 kilometres (2,115,000 miles). It is approximately 44 times closer to its star than the Earth is to the Sun. The close proximity means the strong tidal forces exerted on the planet stretch it out to an egg shape and heat its surface up to 2,600°C (4,712°F). It also has one of the lowest densities, and size and mass similar to a gas giant, making it a "hot Jupiter." Scientists aren't completely sure why WASP-12b reflects so little light, but its high temperature is the most likely explanation. "There are other hot Jupiter's that have been found to be remarkably black, but they are much cooler than WASP-12b. For those planets, it is suggested that things like clouds and alkali metals are the reason for the absorption of light, but those don't work for WASP-12b because it is so incredibly hot," said Bell. The side that receives the most light reaches temperatures that are too hot for clouds and alkali metals to form. Molecules absorb the energy and are ionized; hydrogen molecules split up into atomic hydrogen in its atmosphere, leading to a low albedo. WASP-12b doesn't look completely pitch black, but its hot temperature means that it glows slightly red like hot metal. It's also not the darkest known exoplanet – that award goes to TrES-2b, another hot Jupiter, which has an albedo of 0.0136. Hot Jupiter's are rare, and not all of them have low albedos. The researchers compared the results for WASP-12b to exoplanet HD 189733b, and found that it reflects an azure blue colour like Earth.

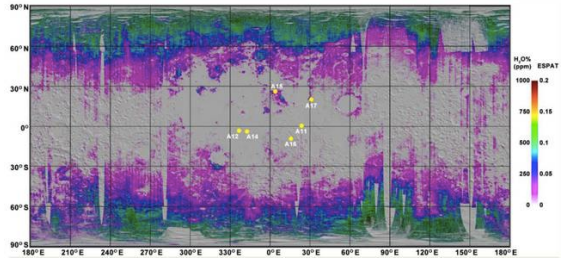
"The fact that the first two exoplanets with measured spectral albedo exhibit significant differences demonstrates the importance of these types of spectral observations, and highlights the great diversity among hot Jupiter's," said Bell.

- Scientists produce a map marking water hotspots on the Moon

Just landed on the Moon and fancy a drink? Step on up

By Katyanna Quach 14 Sep 2017 at 06:29

Scientists have created the first map that traces the water content on the surface of the Moon, in the hopes that it may come in handy for astronauts searching for drinking water or fuel. A paper published in Science Advances on Thursday shows how scientists used data taken from NASA's Moon Mineralogy Mapper (M^3) – an imaging spectrometer on board the Chandrayaan-1 probe – to sniff out water molecules. In 2009, M^3 discovered hydroxyl molecules containing one oxygen and one hydrogen atom and water in the soil. By plotting the abundance of hydroxyl concentrations across the Moon's latitude, researchers from Brown University in Providence, Rhode Island, can provide a map of the water levels on the satellite. The Moon is incredibly arid compared to Earth. Nearer the poles, the maximum average of water is only around 500 to 750 parts per million – less than the amount found in Earth's driest deserts. Shuai Li, lead author of the paper who is now a postdoctoral researcher at the University of Hawaii (but was a PhD student at Brown University at the time of the study), said: "The signature of water is present nearly everywhere on the lunar surface, not limited to the polar regions as previously reported. The amount of water increases toward the poles and does not show significant difference among distinct compositional terrains." Although the map shows a small concentration of water, the scientists still think it can be useful for astronauts thinking about drawing the liquid up from the soil.



A map showing water content on the Moon. It is wetter toward the poles and drier toward the equator. The dots mark the Apollo landing sites Ralph Milliken, co-author of the paper and an associate professor at Brown, said: "This is a roadmap to where water exists on the surface of the Moon. Now that we have these quantitative maps showing where the water is and in what amounts, we can start thinking about whether or not it could be worthwhile to extract, either as drinking water for astronauts or to produce fuel." "It remains to be seen whether extraction could be feasible. But these results show us what the range of water availability across the surface is, so we can start thinking about where we might want to go to get it and whether it makes economic sense to do so," he added. The map also helps scientists work out the source of the water. The distribution is mostly uniform, with levels decreasing from the poles to the equator. It's a sign that most of the hydroxyl and water molecules are formed from the particles scattered by the solar wind billowing from the Sun. There are also pockets of water concentrations near the equator, which scientists believe come from within the Moon's mantle and that rose to the surface as magma. The amount of water also changes throughout the day. In the mornings and evenings, lunar soil is much wetter, but gets drier during the afternoons. Its proof that the Moon is a dynamic system, but Milliken said the mechanism for this fluctuation remains unknown. "But it tells us that the process of water formation in the lunar soil is active and happening today. This raises the possibility that water may re-accumulate after extraction, but we need to better understand the physics of why and how this happens to understand the timescale over which water may be renewed." It's not clear exactly how much water exists on the Moon. There are regions that are hidden from the Sun's rays, and the M^3 cannot measure those areas because it relies on measuring the amount of light reflected off the Moon's surface to detect minerals. The darkened areas may hold large beds of ice. "Those ice deposits may indeed be there," Milliken said, "but because they are in shadowed areas it's not something we can easily confirm using these data." "We're only sensing the upper millimetre or so of soil, and we can't say for sure what the water content is like underneath that. The distribution of water with depth could make a big difference in terms of how much water is actually there," he added.

- Hubble Space Telescope spies possibility of liquid water in TRAPPIST-1. First time astronomers have detected water in the planetary system

By Katyanna Quach 1 Sep 2017 at 20:10

Artist's impression of an exoplanet system

The Hubble Space Telescope has spotted possible signs of water on the outer planets of TRAPPIST-1, the system with the most exoplanets in a star's habitable zone.

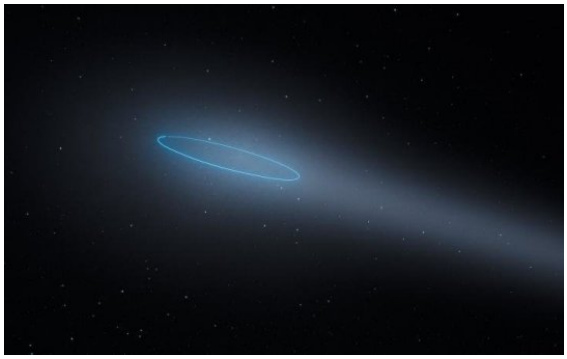
The TRAPPIST-1 system – named after the TRAnsiting Planets and PlanetesImals Small Telescope in Chile – was discovered last year. It has been described as a mini solar-system, complete with seven Earth-sized planets orbiting a dwarf star over 40 light years away. Three out of the seven planets are in the habitable zone, the magical region where liquid water can theoretically exist. Now, an international team of scientists believes those planets may harbour a considerable amount of water. A paper published Thursday in The Astrophysical Journal describes the results gathered from the Space Telescope Imaging Spectrograph on the Hubble Space Telescope. The researchers probed the ultraviolet radiation received by each planet. Vincent Bourrier, lead author of the paper and a researcher from the Observatoire de l'Université de Genève, Switzerland, said: "Ultraviolet radiation is an important factor in the atmospheric evolution of planets." "Ultraviolet sunlight breaks molecules apart, ultraviolet starlight can break water vapour in the atmospheres of exoplanets into hydrogen and oxygen." The level of ultraviolet energy projected onto each planet is important. At low energies, UV light destroys the bonds in water molecules – a process known as photo dissociation. But at higher doses, extreme UV and X-rays heating the upper atmosphere of a planet pass on enough energy for the hydrogen and oxygen, which have been broken up by photo dissociation, to escape. The hydrogen and oxygen gas molecules leaving the planet's atmosphere can be detected as a water vapour. The results show that the planets could have lost a considerable amount of water over time. The two planets – TRAPPIST-1b and TRAPPIST-1c – closest to their parent star receive the most UV radiation and have probably lost the most water – a volume of up to 20 Earth-oceans worth of water in the last eight billion years. The rate of water loss for the three planets in the habitable zone – e, f and g – is much lower, which may mean there could still be some liquid left on their surfaces. It shows that "atmospheric escape may play an important role in the evolution of these planets," said Julien de Wit, co-author of the study and a researcher from the Massachusetts Institute of Technology. No conclusive results can be drawn from the Hubble Space Telescope, and more observations need to be made with the James Webb Space Telescope, which is expected to be launched next year. "While our results suggest that the outer planets are the best candidates to search for water with the upcoming James Webb Space Telescope, they also highlight the need for theoretical studies and complementary observations at all wavelengths to determine the nature of the TRAPPIST-1 planets and their potential habitability," said Bourrier.

- Unique type of object discovered in our solar system

Date: September 20, 2017
Source: ESA/Hubble Information Centre

Summary:

Astronomers have observed the intriguing characteristics of an unusual type of object in the asteroid belt between Mars and Jupiter: two asteroids orbiting each other and exhibiting comet-like features, including a bright coma and a long tail. This is the first known binary asteroid also classified as a comet.

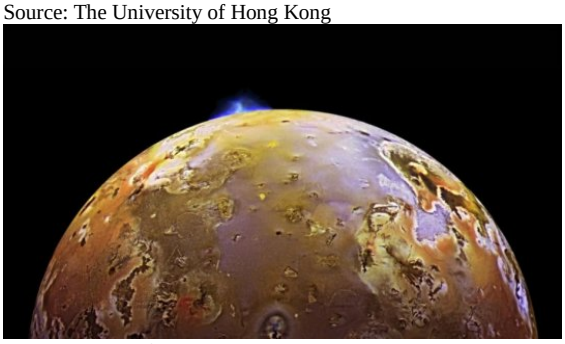


This artist's impression shows the binary asteroid 288P, located in the main asteroid belt between the planets Mars and Jupiter. The object is unique as it is a binary asteroid which also behaves like a comet. The comet-like properties are the result of water sublimation, caused by the heat of the Sun. The orbit of the asteroids is marked by a blue ellipse.
Credit: ESA/Hubble, L. Calçada

With the help of the NASA/ESA Hubble Space Telescope, a German-led group of astronomers have observed the intriguing characteristics of an unusual type of object in the asteroid belt between Mars and Jupiter: two asteroids orbiting each other and exhibiting comet-like features, including a bright coma and a long tail. This is the first known binary asteroid also classified as a comet. The research is presented in a paper published in the journal *Nature* today. In September 2016, just before the asteroid 288P made its closest approach to the Sun, it was close enough to Earth to allow astronomers a detailed look at it using the NASA/ESA Hubble Space Telescope. The images of 288P, which is located in the asteroid belt between Mars and Jupiter, revealed that it was actually not a single object, but two asteroids of almost the same mass and size, orbiting each other at a distance of about 100 kilometres. That discovery was in itself an important find; because they orbit each other, the masses of the objects in such systems can be measured. But the observations also revealed ongoing activity in the binary system. "We detected strong indications of the sublimation of water ice due to the increased solar heating -- similar to how the tail of a comet is created," explains Jessica Agarwal (Max Planck Institute for Solar System Research, Germany), the team leader and main author of the research paper. This makes 288P the first known binary asteroid that is also classified as a main-belt comet. Understanding the origin and evolution of main-belt comets -- comets that orbit amongst the numerous asteroids between Mars and Jupiter -- is a crucial element in our understanding of the formation and evolution of the whole Solar System. Among the questions main-belt comets can help to answer is how water came to Earth [2]. Since only a few objects of this type are known, 288P presents itself as an extremely important system for future studies. The various features of 288P -- wide separation of the two components, near-equal component size, high eccentricity and comet-like activity -- also make it unique among the few known wide asteroid binaries in the Solar System. The observed activity of 288P also reveals information about its past, notes Agarwal: "Surface ice cannot survive in the asteroid belt for the age of the Solar System but can be protected for billions of years by a refractory dust mantle, only a few metres thick." From this, the team concluded that 288P has existed as a binary system for only about 5000 years. Agarwal elaborates on the formation scenario: "The most probable formation scenario of 288P is a breakup due to fast rotation. After that, the two fragments may have been moved further apart by sublimation torques." The fact that 288P is so different from all other known binary asteroids raises some questions about whether it is not just a coincidence that it presents such unique properties. As finding 288P included a lot of luck, it is likely to remain the only example of its kind for a long time. "We need more theoretical and observational work, as well as more objects similar to 288P, to find an answer to this question," concludes Agarwal.

- ❖ New concept of terrestrial planet formation

Date: September 20, 2017
Source: The University of Hong Kong



This is a photo of Io with a volcanic plume at the top.
Credit: The University of Hong Kong

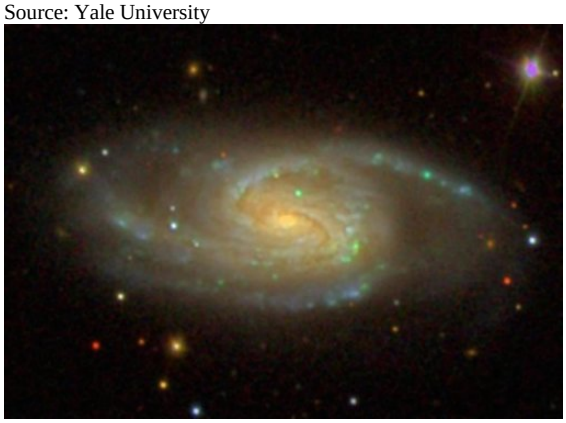
Scientists have long been intrigued by the surfaces of terrestrial bodies other than Earth which reveal deep similarities beneath their superficially differing volcanic and tectonic

histories. A team of scientists from NASA, Hampton University and the University of Hong Kong propose a new way of understanding the cooling and transfer of heat from terrestrial planetary interiors and how that affects the generation of the volcanic terrains that dominate the rocky planets. Based on the present dynamics of Jupiter's tidally heated moon, Io, the scientists hypothesize that the geological histories of the solar system's terrestrial bodies, specifically Mercury, Venus, Moon and Mars, are consistent with a mode of early planetary evolution involving heat-pipes. They further propose that heat-pipe cooling is a universal process that may explain the common features seen on the surfaces of terrestrial planets. The team's findings are discussed in a paper recently published in *Earth and Planetary Science Letters*. "We believe that the concept of a heat-pipe mode of planet formation is important and will help explain the evolution of all rocky planets," said Dr. Justin Simon, NASA Planetary Scientist, Centre for Isotope Cosmo chemistry and Geochronology in the Astromaterials Research and Exploration Science Division at NASA's Johnson Space Centre in Houston, Texas and one of the co-authors of the paper. "If shown to be correct, it will be discussed along with the theories of plate tectonics, planetary 'magma oceans' and the 'giant impact theory for the origin of the moon.'" The scientists hypothesize heat-pipe cooling was involved in the evolution of all terrestrial planets including early Earth and represents the transition from the magma ocean to the rigid-lid or plate tectonic modes of planetary evolution. Heat-pipes transport heat from the interior to the surface via mantle melting and magma ascent. The resulting eruptions lead to global volcanic resurfacing by which older volcanic layers are progressively buried and pushed downward to form thick, cold and strong mechanical lithospheres. The authors review the observations relevant to the formation of the surfaces of each of the terrestrial planets and current models that have been proposed to explain them. They then discuss the major outstanding problems and show how the heat-pipe hypothesis can resolve these in a consistent way across all planets. "The terrestrial bodies in our solar system look different enough that the classical view is that they all formed differently, at least in terms of making their outer shells. If our analysis holds merit, it points in the direction of a universal model for the early development of terrestrial planets, across our solar system and beyond," said Dr. Alexander Webb, Associate Professor, The University of Hong Kong. The authors note that Mercury was globally resurfaced early in its evolution by volcanic eruptions emplacing smooth plains with few identifiable eruption centres. The authors conclude that the geological observations of the planet point to an episode of heat-pipes operating for somewhat less than the first billion years of Mercury's evolution. The surface of Venus is also dominated by lavas with broad plains made up of numerous flows spanning hundreds of kilometres at low slope with few identifiable source structures. Venus does not display sufficient volcanic flux to currently experience active heat-pipe cooling, but the authors conclude that the thick, stagnant lithospheric lid is a relic of heat-pipe operation that ceased rapidly several hundred million years ago. Among the most important surface features on Mars are its large volcanos, ancient cratered terrains and the crustal dichotomy between the elevated southern hemisphere and the depressed northern hemisphere. It remains unclear which processes were responsible for the formation of the dichotomy, but the authors conclude that a strong ancient lithosphere created by heat-pipe volcanism would have aided in the preservation of this ancient feature. Similarly, the Moon stands out as having a shape that is dramatically out of hydrostatic equilibrium, but preserving a disequilibrium shape requires a strong, early-formed lithosphere. The authors argue that a strong lithosphere is precisely the expected behaviour of a body experiencing heat-pipe cooling. The team brought together geological, geochemical and geochronological evidence from the terrestrial bodies in our solar system to show that heat-pipes may have provided the primary mechanism of crustal formation and resurfacing. The heat-pipe hypothesis provides a uniform explanation for common features of the known terrestrial planets that have not undergone plate tectonics and should be considered an important aspect of their evolution. "The development of this theory is a great example of how exploration of our planetary neighbours, in this case [Jupiter's moon] Io, has led to a deeper understanding of Earth as well as rocky planets across the galaxy," said

Dr. William Moore, professor of atmospheric and planetary sciences, Hampton University, USA. Heat-pipes should also occur on rocky exoplanets orbiting other stars. A planet twice the mass of Earth should take more than twice as long to cool, because the surface area does not grow as fast as the mass. For large exoplanets, the lifetime of the heat-pipe mode may exceed the lifetime of Sun-like parent stars and thus any subsequent plate-tectonic phase may never be observed. This study forces us to rethink our expectations of what types of surfaces and atmospheres to expect as we expand our exploration of other solar systems.

- ❖ Is the Milky Way an 'outlier' galaxy? Studying its 'siblings' for clues

Date: September 20, 2017
Source: Yale University



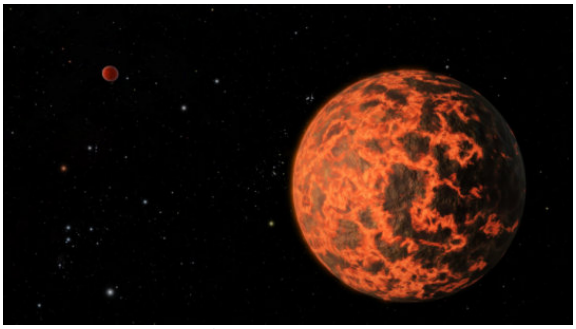
This is a three-color optical image of a Milky Way sibling.
Credit: Sloan Digital Sky Survey

The most-studied galaxy in the universe -- the Milky Way -- might not be as "typical" as previously thought, according to a new study. The Milky Way, which is home to Earth and its solar system, is host to several dozen smaller galaxy satellites. These smaller galaxies orbit around the Milky Way and are useful in understanding the Milky Way itself. Early results from the Satellites Around Galactic Analogs (SAGA) Survey indicate that the Milky Way's satellites are much more tranquil than other systems of comparable luminosity and environment. Many satellites of those "sibling" galaxies are actively pumping out new stars, but the Milky Way's satellites are mostly inert, the researchers found. This is significant, according to the researchers, because many models for what we know about the universe rely on galaxies behaving in a fashion similar to the Milky Way. "We use the Milky Way and its surroundings to study absolutely everything," said Yale astrophysicist Marla Geha, lead author of the paper, which appears in the *Astrophysical Journal*. "Hundreds of studies come out every year about dark matter, cosmology, star formation, and galaxy formation, using the Milky Way as a guide. But it's possible that the Milky Way is an outlier." The SAGA Survey began five years ago with a goal of studying the satellite galaxies around 100 Milky Way siblings. Thus far it has studied eight other Milky Way sibling systems, which the researchers say is too small of a sample to come to any definitive conclusions. SAGA expects to have studied 25 Milky Way siblings in the next two years. Yet the survey already has people talking. At a recent conference where Geha presented some of SAGA's initial findings, another researcher told her, "You've just thrown a monkey wrench into what we know about how small galaxies form." "Our work puts the Milky Way into a broader context," said SAGA researcher Risa Wechsler, an astrophysicist at the Kavli Institute at Stanford University. "The SAGA Survey will provide a critical new understanding of galaxy formation and of the nature of dark matter." Wechsler, Geha, and their team said they will continue to improve the efficiency of finding satellites around Milky Way siblings. "I really want to know the answer to whether the Milky Way is unique, or totally normal," Geha said. "By studying our siblings, we learn more about ourselves."

- ❖ The return of the comet-like exoplanet

Astronomers have discovered a comet-like exoplanet that trails a huge, Rapunzel-like hair made of gas behind it

Date: September 14, 2017
Source: Université de Genève



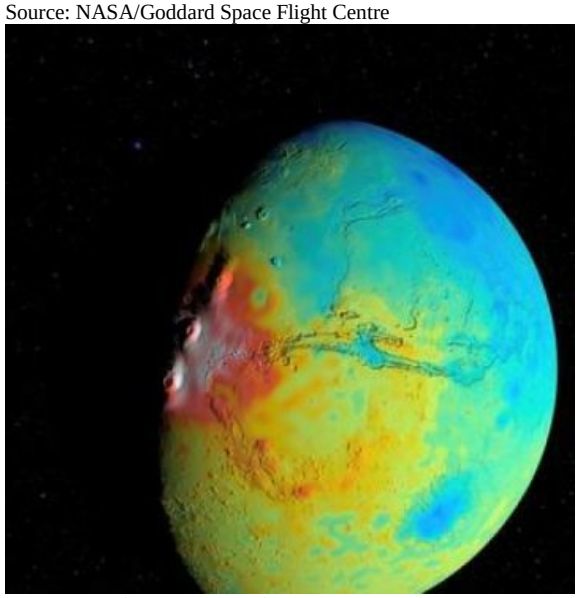
An artist’s impression of GJ 436b can be seen in the background in this image.
Credit: NASA/JPL-Caltech

Astronomers from the University of Geneva (UNIGE), Switzerland, also members of the Planets National Centre of Competence in

Research, have been working on a joint project with the universities of Berne, Warwick, Grenoble Alpes and the Paris Institute of Astrophysics. The research team focused the Hubble Space Telescope on an exoplanet that had already been seen losing its atmosphere, which forms an enormous cloud of hydrogen, giving the planet the appearance of a giant comet. During earlier observations in 2015, it was not possible to cover the whole cloud, whose shape was predicted by numerical simulations. Thanks to these new observations, however, the scientists have finally been able to confirm the initial predictions. The results are unveiled in the journal *Astronomy & Astrophysics*. Exoplanet GJ 436b is similar in size to Neptune (i.e. about four times larger than Earth). Seen through ultraviolet (UV) glasses, it reveals a huge, Rapunzel-like hair made of gas. This phenomenon, detected in 2015 by astronomers from UNIGE's Faculty of Sciences Observatory, could be due to the planet proximity to its host star: it takes the planet no more than three days to circle around it. The planet loses a part of its hydrogen-rich atmosphere because of the intense stellar irradiation. The lost atmosphere remains for some time around the planet in the form of a huge cloud of gas, which absorbs UV radiation from the star. This is why the cloud can only be seen with Hubble's UV eye. "We were flabbergasted by the mere size of the cloud, which our initial observations could not cover in its entirety as it passes in front of the star," explains David Ehrenreich, associate professor at UNIGE and principal investigator of the European Research Council-funded project Four Aces, who obtained the observations. The team extrapolated the initial data with a numerical model, to predict what could be the cloud exact shape. The simulation resulted in a comet-like cloud with a trailing tail stretching over tens of millions of kilometres. The team headed by Baptiste Lavie, a Planets PhD student at UNIGE, directed Hubble at GJ 436b afresh. The findings backed up the researchers' predictions in every respect: "I was getting grey hair from analysing the new observations," says Lavie. "So it was hugely satisfying to see that the panache of hydrogen escaping from the planet was really there, in line with the predictions, because now we understand how it is formed." The data injected into the numerical model explained the observations accurately: "We even took into account the pressure that the light from the star exerts on the hydrogen atoms that escape from the planet!" says Vincent Bourrier, the UNIGE astronomer who developed the digital model. Solving the mystery of this rare phenomenon means the researchers are now in a position to understand how it affects other exoplanets, some receiving even more irradiation than GJ 436b. "We're expecting some more surprises," says Lavie with a smile.

- ❖ New gravity map suggests Mars has a porous crust

Date: September 13, 2017
Source: NASA/Goddard Space Flight Centre



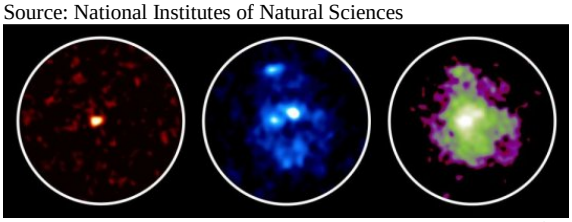
A new map of the thickness of Mars' crust shows less variation between thicker regions (red) and thinner regions (blue), compared to earlier mapping. This view is centred on Valles Marineris, with the Tharsis Montes near the terminator to its west. The map is based on modelling of the Red Planet's gravity field by scientists at NASA's Goddard Space Flight Centre in Greenbelt, Maryland. The team found that globally Mars' crust is less dense, on average, than previously thought, which implies smaller variations in crustal thickness.
Credit: NASA/Goddard/UMBC/MIT/E. Mazarico

NASA scientists have found evidence that Mars' crust is not as dense as previously thought, a clue that could help researchers better understand the Red Planet's interior structure and evolution. A lower density likely means that at least part of Mars' crust is relatively porous. At this point, however, the team cannot rule out the possibility of a different mineral composition or perhaps a thinner crust. "The crust is the end-result of everything that happened during a planet's history, so a lower density could have important implications about Mars' formation and evolution," said Sander Goossens of NASA's Goddard Space Flight Centre in Greenbelt, Maryland. Goossens is the lead

author of a *Geophysical Research Letters* paper describing the work. The researchers mapped the density of the Martian crust, estimating the average density is 2,582 kilograms per meter cubed (about 161 pounds per cubic foot). That's comparable to the average density of the lunar crust. Typically, Mars' crust has been considered at least as dense as Earth's oceanic crust, which is about 2,900 kilograms per meter cubed (about 181 pounds per cubic foot). The new value is derived from Mars' gravity field, a global model that can be extracted from satellite tracking data using sophisticated mathematical tools. The gravity field for Earth is extremely detailed, because the data sets have very high resolution. Recent studies of the Moon by NASA's Gravity Recovery and Interior Laboratory, or GRAIL, mission also yielded a precise gravity map. The data sets for Mars don't have as much resolution, so it's more difficult to pin down the density of the crust from current gravity maps. As a result, previous estimates relied more heavily on studies of the composition of Mars' soil and rocks. "As this story comes together, we're coming to the conclusion that it's not enough just to know the composition of the rocks," said Goddard planetary geologist Greg Neumann, a co-author on the paper. "We also need to know how the rocks have been reworked over time." Goossens and colleagues started with the same data used for an existing gravity model but put a new twist on it by coming up with a different constraint and applying it to obtain the new solution. A constraint compensates for the fact that even the best data sets can't capture every last detail. Instead of taking the standard approach, known to those in the field as the Kaula constraint, the team created a constraint that considers the accurate measurements of Mars' elevation changes, or topography. "With this approach, we were able to squeeze out more information about the gravity field from the existing data sets," said Goddard geophysicist Terence Sabaka, the second author on the paper. Before taking on Mars, the researchers tested their approach by applying it to the gravity field that was in use before the GRAIL mission. The resulting estimate for the density of the moon's crust essentially matched the GRAIL result of 2,550 kilograms per meter cubed (about 159 pounds per cubic foot). From the new model, the team generated global maps of the crust's density and thickness. These maps show the kinds of variations the researchers expect, such as denser crust beneath Mars' giant volcanoes. The researchers note that NASA's InSight mission -- short for Interior Exploration using Seismic Investigations, Geodesy and Heat Transport -- is expected to provide the kinds of measurements that could confirm their finding. This Discovery Program mission, scheduled for launch in 2018, will place a geophysical lander on Mars to study its deep interior.

- Explosive birth of stars swells galactic cores. ALMA spots transforming disk galaxies

Date: September 10, 2017
Source: National Institutes of Natural Sciences



Submillimetre waves detected with ALMA are shown in the left, indicating the location of dense dust and gas where stars are being formed. Optical and infrared light seen with the Hubble Space Telescope are shown in the middle and right, respectively. A large galactic disk is seen in infrared, while three young star clusters are seen in optical light.
Credit: ALMA (ESO/NAOJ/NRAO), NASA/ESA Hubble Space Telescope, Tadaki et al.

Astronomers found that active star formation up swells galaxies, like yeast helps bread rise. Using three powerful telescopes on the ground and in orbit, they observed galaxies from 11 billion years ago and found explosive formation of stars in the cores of galaxies. This suggests that galaxies can change their own shape without interaction with other galaxies. "Massive elliptical galaxies are believed to be formed from collisions of disk galaxies," said Ken-ichi Tadaki, the lead author of two research papers and a postdoctoral researcher at the National Astronomical Observatory of Japan (NAOJ). "But, it is uncertain whether all the elliptical galaxies have experienced galaxy collision. There may be an alternative path." Aiming to understand galactic metamorphosis, the international team explored distant galaxies 11 billion light-years away. Because it takes time for the light from distant objects to reach us, by observing galaxies 11 billion light-years away, the team can see what the Universe looked like 11 billion years ago, 3 billion years after the Big Bang. This corresponds the peak epoch of galaxy formation; the foundations of most galaxies

were formed in this epoch. Receiving faint light which has travelled 11 billion years is tough work. The team harnessed the power of three telescopes to anatomize the ancient galaxies. First, they used NAOJ's 8.2-m Subaru Telescope in Hawai`i and picked out 25 galaxies in this epoch. Then they targeted the galaxies for observations with NASA/ESA's Hubble Space Telescope (HST) and the Atacama Large Millimetre/submillimetre Array (ALMA). The astronomers used HST to capture the light from stars which tells us the "current" (as of when the light was emitted, 11 billion years ago) shape of the galaxies, while ALMA observed submillimetre waves from cold clouds of gas and dust, where new stars are being formed. By combining the two, we know the shapes of the galaxies 11 billion years ago and how they are evolving. Thanks to their high resolution, HST and ALMA could illustrate the metamorphosis of the galaxies. With HST images the team found that a disk component dominates the galaxies. Meanwhile, the ALMA images show that there is a massive reservoir of gas and dust, the material of stars, so that stars are forming very actively. The star formation activity is so high that huge numbers of stars will be formed at the centres of the galaxies. This leads the astronomers to think that ultimately the galaxies will be dominated by the stellar bulge and become elliptical or lenticular galaxies. "Here, we obtained firm evidence that dense galactic cores can be formed without galaxy collisions. They can also be formed by intense star formation in the heart of the galaxy." said Tadaki. The team used the European Southern Observatory's Very Large Telescope to observe the target galaxies and confirmed that there are no indications of massive galaxy collisions. Almost 100 years ago, American astronomer Edwin Hubble invented the morphological classification scheme for galaxies. Since then, many astronomers have devoted considerable effort to understanding the origin of the variety in galaxy shapes. Utilizing the most advanced telescopes, modern astronomers have come one step closer to solving the mysteries of galaxies.

- ❖ Are we being watched? Tens of other worlds could spot the Earth

Date: September 8, 2017
Source: Royal Astronomical Society

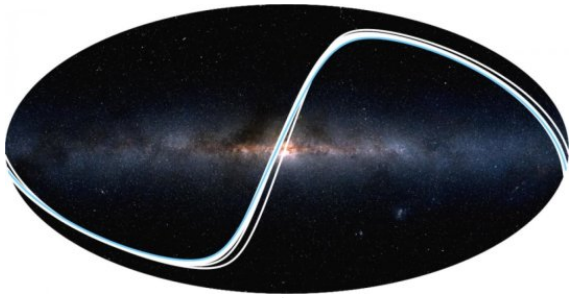


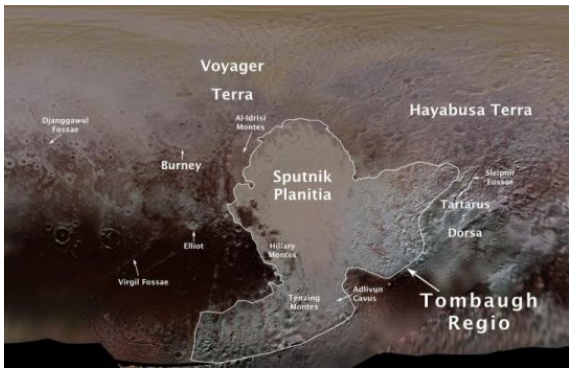
Image showing where transits of our solar system planets can be observed. Each line represents where one of the planets could be seen to transit, with the blue line representing Earth; an observer located here could detect us.
Credit: 2MASS / A. Mellinger / R. Wells

A group of scientists from Queen's University Belfast and the Max Planck Institute for Solar System Research in Germany have turned exoplanet-hunting on its head, in a study that instead looks at how an alien observer might be able to detect Earth using our own methods. They find that at least nine exoplanets are ideally placed to observe transits of Earth, in a new work published in the journal *Monthly Notices of the Royal Astronomical Society*. Thanks to facilities and missions such as SuperWASP and Kepler, we have now discovered thousands of planets orbiting stars other than our Sun, worlds known as 'exoplanets'. The vast majority of these are found when the planets cross in front of their host stars in what are known as 'transits', which allow astronomers to see light from the host star dim slightly at regular intervals every time the planet passes between us and the distant star. In the new study, the authors reverse this concept and ask, "How would an alien observer see the Solar System?" They identified parts of the distant sky from where various planets in our Solar System could be seen to pass in front of the Sun -- so-called 'transit zones' -- concluding that the terrestrial planets (Mercury, Venus, Earth, and Mars) are actually much more likely to be spotted than the more distant 'Jovian' planets (Jupiter, Saturn, Uranus, and Neptune), despite their much larger size. "Larger planets would naturally block out more light as they pass in front of their star," commented lead author Robert Wells, a PhD student at Queen's University Belfast. "However the more important factor is actually how close the planet is to its parent star -- since the terrestrial planets are much closer to the Sun than the gas giants, they'll be more likely to be seen in transit." To look for worlds where civilisations would have the best chance of spotting our Solar System, the astronomers looked for parts of the sky from

which more than one planet could be seen crossing the face of the Sun. They found that three planets at most could be observed from anywhere outside of the Solar System, and that not all combinations of three planets are possible. Katja Poppenhaeger, a co-author of the study, adds, "We estimate that a randomly positioned observer would have roughly a 1 in 40 chance of observing at least one planet. The probability of detecting at least two planets would be about ten times lower, and to detect three would be a further ten times smaller than this." Of the thousands of known exoplanets, the team identified sixty-eight worlds where observers would see one or more of the planets in our Solar System transit the Sun. Nine of these planets are ideally placed to observe transits of Earth, although none of the worlds are deemed to be habitable. In addition, the team estimate that there should be approximately ten (currently undiscovered) worlds which are favourably located to detect the Earth and are capable of sustaining life as we know it. To date however, no habitable planets have been discovered from which a civilisation could detect the Earth with our current level of technology. The ongoing K2 mission of NASA's Kepler spacecraft is to continue to hunt for exoplanets in different regions of the sky for a few months at a time. These regions are centred close to the plane of Earth's orbit, which means that there are many target stars located in the transit zones of the Solar System planets. The team's plans for future work include targeting these transit zones to search for exoplanets, hopefully finding some which could be habitable.

- ❖ Pluto features given first official names

Date: September 7, 2017
Source: International Astronomical Union



Pluto's first official surface-feature names are marked on this map, compiled from images and data gathered by NASA's New Horizons spacecraft during its flight through the Pluto system in 2015.
Credit: NASA/JHUAPL/SwRI/Ross Beyer

The IAU has assigned names to fourteen geological features on the surface of Pluto. The names pay homage to the underworld mythology, pioneering space missions, historic pioneers who crossed new horizons in exploration, and scientists and engineers associated with Pluto and the Kuiper Belt. This is the first set of official names of surface features on Pluto to be approved by the IAU, the internationally recognised authority for naming celestial bodies and their surface features. NASA's New Horizons team proposed the names to the IAU following the first reconnaissance of Pluto and its moons by the New Horizons spacecraft. Some of the names were suggested by members of the public during the Our Pluto campaign, which was launched as a partnership between the IAU, the New Horizons project and the SETI Institute. Other names had been used informally by the New Horizons science team to describe the many regions, mountain ranges, plains, valleys and craters discovered during the first close-up look at the surfaces of Pluto and its largest moon, Charon. "We're very excited to approve names recognising people of significance to Pluto and the pursuit of exploration as well as the mythology of the underworld. These names highlight the importance of pushing to the frontiers of discovery," said Rita Schulz, chair of the IAU Working Group for Planetary System Nomenclature. "We appreciate the contribution of the general public in the form of their their naming suggestions and the New Horizons team for proposing these names to us." More names are expected to be proposed to the IAU, both for Pluto and for its moons. "The approved designations honour many people and space missions who paved the way for the historic exploration of Pluto and the Kuiper Belt, the most distant worlds ever explored," said Alan Stern, New Horizons Principal Investigator from the Southwest Research Institute (SwRI) in Boulder, Colorado. The approved Pluto surface feature names are listed below.

Tombaugh Regio honours Clyde Tombaugh (1906-1997), the U.S. astronomer who discovered Pluto in 1930 from Lowell Observatory in Arizona.

Burney crater honours Venetia Burney (1918-2009), who as an 11-year-old schoolgirl suggested the name "Pluto" for Clyde

Tombaugh's newly discovered planet. Later in life she taught mathematics and economics.

Sputnik Planitia is a large plain named after Sputnik 1, the first space satellite, launched by the Soviet Union in 1957.

Tenzing Montes and Hillary Montes are mountain ranges honouring Tenzing Norgay (1914-1986) and Sir Edmund Hillary (1919-2008), the Indian/Nepali Sherpa and New Zealand mountaineer who were the first to reach the summit of Mount Everest and return safely.

Al-Idrisi Montes honours Ash-Sharif al-Idrisi (1100-1165/66), a noted Arab mapmaker and geographer whose landmark work of medieval geography is sometimes translated as "The Pleasure of Him Who Longs to Cross the Horizons."

Djanggawul Fossae defines a network of long, narrow depressions named for the Djanggawuls, three ancestral beings in indigenous Australian mythology who travelled between the island of the dead and Australia, creating the landscape and filling it with vegetation.

Sleipnir Fossa is named for the powerful, eight-legged horse of Norse mythology that carried the god Odin into the underworld.

Virgil Fossae honours Virgil, one of the greatest Roman poets and Dante's fictional guide through hell and purgatory in the Divine Comedy.

Adlivun Cavus is a deep depression named for Adlivun, the underworld in Inuit mythology.

Hayabusa Terra is a large land mass saluting the Japanese spacecraft and mission (2003-2010) that returned the first asteroid sample.

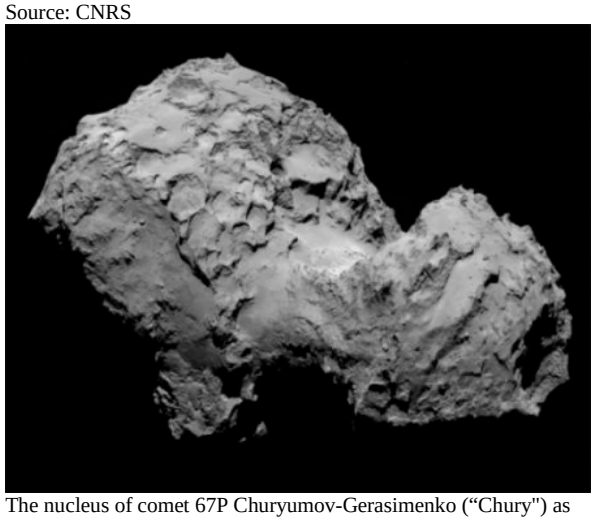
Voyager Terra honours the pair of NASA spacecraft, launched in 1977, that performed the first "grand tour" of all four giant planets. The Voyager spacecraft are now probing the boundary between the Sun and interstellar space.

Tartarus Dorsa is a ridge named for Tartarus, the deepest, darkest pit of the underworld in Greek mythology.

Elliot crater recognises James Elliot (1943-2011), an MIT researcher who pioneered the use of stellar occultation’s to study the Solar System -- leading to discoveries such as the rings of Uranus and the first detection of Pluto's thin atmosphere.

- ❖ Does the organic material of comets predate our solar system?

Date: September 6, 2017
Source: CNRS



The nucleus of comet 67P Churyumov-Gerasimenko (“Chury") as seen by the European Rosetta space probe.
Credit: © ESA / Rosetta / MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA

The ESA's Rosetta mission, which ended in September 2016, found that organic matter made up 40% (by mass) of the nucleus of comet 67P Churyumov-Gerasimenko, a.k.a. Chury. Organic compounds, combining carbon, hydrogen, nitrogen, and oxygen, are building blocks of life on Earth. Yet, according to Jean-Loup Bertaux and Rosine Lallement -- from the Laboratoire Atmosphères, Milieux, Observations Spatiales (CNRS / UPMC / Université de Versailles Saint-Quentin-en-Yvelines) and the Galaxies, Étoiles, Physique et Instrumentation department of the Paris Observatory (Observatoire de Paris / CNRS / Université Paris Diderot), respectively -- these organic molecules were produced in interstellar space, well before the formation of the Solar System. Bertaux and Lallement further assert that astronomers are already familiar with much of this matter. For 70 years, scientists have known that analysis of stellar spectra indicates unknown absorptions, throughout interstellar space, at specific wavelengths called the diffuse interstellar bands (DIBs). DIBs are attributed to complex organic molecules that US astrophysicist Theodore Snow believes may constitute the largest known reservoir of organic matter in the Universe. This

interstellar organic material is usually found in the same proportions. However, very dense clouds of matter like presolar nebulae are exceptions. In the middle of these nebulae, where matter is even denser, DIB absorptions plateau or even drop. This is because the organic molecules responsible for DIBs clump together there. The clumped matter absorbs less radiation than when it floated freely in space. Such primitive nebulae end up contracting to form a solar system like our own, with planets . . . and comets. The Rosetta mission taught us that comet nuclei form by gentle accretion of grains progressively greater in size. First, small particles stick together into larger grains. These in turn combine into larger chunks, and so on, until they form a comet nucleus a few kilometres wide. Thus, the organic molecules that formerly populated the primitive nebulae -- and that are responsible for DIBs -- were probably not destroyed, but instead incorporated into the grains making up cometary nuclei. And there they have remained for 4.6 billion years. A sample-return mission would allow laboratory analysis of cometary organic material and finally reveal the identity of the mysterious interstellar matter underlying observed absorption lines in stellar spectra. If cometary organic molecules were indeed produced in interstellar space -- and if they played a role in the emergence of life on our planet, as scientists believe today -- might they not also have seeded life on many other planets of our galaxy?

- Accretion-powered pulsar reveals unique timing glitch

Date: September 6, 2017
Source: Royal Astronomical Society

Composite image of the X-ray pulsar SXP 1062 surrounded by the supernova remnant. The false-colour image combines X-ray (blue) and optical data (oxygen: green, hydrogen: red).
Credit: ESA / XMM-Newton / L. Oskinova, University of Potsdam, Germany / M. Guerrero, Instituto de Astrofisica de Andalucia, Spain (X-ray); Cerro Tololo Inter-American Observatory / R. Gruendl & Y. H. Chu, University of Illinois at Urbana-Champaign, USA (optical)

The discovery of the largest timing irregularity yet observed in a pulsar is the first confirmation that pulsars in binary systems exhibit the strange phenomenon known as a 'glitch'. The study is published in the journal *Monthly Notices of the Royal Astronomical Society*. Pulsars are one possible result of the final stages of evolution of massive stars. Such stars end their lives in huge supernova explosions, ejecting their stellar materials outwards into space and leaving behind an extremely dense and compact object; this could either be a white dwarf, a neutron star or a black hole. If a neutron star is left, it may have a very strong magnetic field and rotate extremely quickly, emitting a beam of light that can be observed when the beam points towards Earth, in much the same way as a lighthouse beam sweeping past an observer. To the observer on Earth, it looks as though the star is emitting pulses of light, hence the name 'pulsar'. Now a group of scientists from the Middle East Technical University and Baskent University in Turkey have discovered a sudden change in the rotation speed of the peculiar pulsar SXP 1062. These jumps in frequency, known as 'glitches', are commonly seen in isolated pulsars, but have so far never been observed in binary pulsars (pulsars orbiting with a companion white dwarf or neutron star) such as SXP 1062. SXP 1062 is located in the Small Magellanic Cloud, a satellite galaxy of our own Milky Way galaxy, and one of our nearest intergalactic neighbours at 200,000 light years away. Lead author of the study, Mr M. Mirac Serim, a senior PhD student working under the

supervision of Prof Altan Baykal, said, "This pulsar is particularly interesting, since as well as orbiting its partner star as part of a binary pair, it is also still surrounded by the remnants of the supernova explosion which created it." The pulsar is thought to pull in the leftover material from the supernova explosion, feeding on it in a process known as accretion. The team believe that the size of the glitch is due to the gravitational influence of its companion star and this accretion of the surrounding remnant material, which together exert large forces on the crust of the neutron star. When these forces are no longer sustainable, a rapid change in internal structure transfers momentum to the crust, changing the rotation of the pulsar very suddenly and producing a glitch. "The fractional frequency jump observed during this glitch is the largest, and is unique to this particular pulsar," commented Dr Seyda Sahiner, a co-author of the study. "The size of the glitch indicates that the interiors of neutron stars in binary systems may be quite different to the interiors of isolated neutron stars."

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