Space News Update

— February 14, 2020 —

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1. New Horizons Team Uncovers a Critical Piece of the Planetary Formation Puzzle

Data from NASA's New Horizons mission are providing new insights into how planets and planetesimals – the building blocks of the planets – were formed.

The New Horizons spacecraft flew past the ancient Kuiper Belt object Arrokoth (2014 MU69) on Jan. 1, 2019, providing humankind's first close-up look at one of the icy remnants of solar system formation in the vast region beyond the orbit of Neptune. Using detailed data on the object's shape, geology, color and composition – gathered during a record-setting flyby that occurred more than four billion miles from Earth – researchers have apparently answered a longstanding question about planetesimal origins, and therefore made a major advance in understanding how the planets themselves formed.

The team reports those findings in a set of three papers in the journal Science, and at a media briefing Feb. 13 at the annual American Association for the Advancement of Science meeting in Seattle.

"Arrokoth is the most distant, most primitive and most pristine object ever explored by spacecraft, so we knew it would have a unique story to tell," said New Horizons Principal Investigator Alan Stern, of the Southwest Research Institute in Boulder, Colorado. "It's teaching us how planetesimals formed, and we believe the result marks a significant advance in understanding overall planetesimal and planet formation."

The first post-flyby images transmitted from New Horizons last year showed that Arrokoth had two connected lobes, a smooth surface and a uniform composition, indicating it was likely pristine and would provide decisive information on how bodies like it formed. These first results were published in Science last May.

"This is truly an exciting find for what is already a very successful and history-making mission" said Lori Glaze, director of NASA's Planetary Science Division. "The continued discoveries of NASA's New Horizons spacecraft astound as it reshapes our knowledge and understanding of how planetary bodies form in solar systems across the universe."

Over the following months, working with more and higher-resolution data as well as sophisticated computer simulations, the mission team assembled a picture of how Arrokoth must have formed. Their analysis indicates that the lobes of this "contact binary" object were once separate bodies that formed close together and at low velocity, orbited each other, and then gently merged to create the 22-mile long object New Horizons observed.

This indicates Arrokoth formed during the gravity-driven collapse of a cloud of solid particles in the primordial solar nebula, rather than by the competing theory of planetesimal formation called hierarchical accretion. Unlike the high-speed collisions between planetesimals in hierarchical accretion, in particle-cloud collapse, particles merge gently, slowly growing larger.

"Just as fossils tell us how species evolved on Earth, planetesimals tell us how planets formed in space," said William McKinnon, a New Horizons co-investigator from Washington University in St. Louis, and lead author of an Arrokoth formation paper in Science this week. "Arrokoth looks the way it does not because it formed through violent collisions, but in more of an intricate dance, in which its component objects slowly orbited each other before coming together."

Two other important pieces of evidence support this conclusion. The uniform color and composition of Arrokoth's surface shows the KBO formed from nearby material, as local cloud collapse models predict, rather than a mishmash of matter from more separated parts of the nebula, as hierarchical models might predict.

The flattened shapes of each of Arrokoth's lobes, as well as the remarkably close alignment of their poles and equators, also point to a more orderly merger from a collapse cloud. Further still, Arrokoth's smooth, lightly cratered surface indicates its face has remained well preserved since the end of the planet formation era.

"Arrokoth has the physical features of a body that came together slowly, with 'local' materials in the solar nebula," said Will Grundy, New Horizons composition theme team lead from Lowell Observatory in Flagstaff, Arizona, and the lead author of a second Science paper. "An object like Arrokoth wouldn't have formed, or look the way it does, in a more chaotic accretion environment."

The latest Arrokoth reports significantly expand on the May 2019 Science paper, led by Stern. The three new papers are based on 10 times as much data as the first report, and together provide a far more complete picture of Arrokoth's origin.

"All of the evidence we've found points to particle-cloud collapse models, and all but rule out hierarchical accretion for the formation mode of Arrokoth, and by inference, other planetesimals," Stern said.

New Horizons continues to carry out new observations of additional Kuiper Belt objects it passes in the distance. New Horizons also continues to map the charged-particle radiation and dust environment in the Kuiper Belt. The new KBOs being observed now are too far away to reveal discoveries like those on Arrokoth, but the team can measure aspects such as each object's surface properties and shape. This summer the mission team will begin using large groundbased telescopes to search for new KBOs to study in this way, and even for another flyby target if fuel allows.

The New Horizons spacecraft is now 4.4 billion miles (7.1 billion kilometers) from Earth, operating normally and speeding deeper into the Kuiper Belt at nearly 31,300 miles (50,400 kilometers) per hour.

The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, designed, built and operates the New Horizons spacecraft, and manages the mission for NASA's Science Mission Directorate. The Marshall Space Flight Center Planetary Management Office provides the NASA oversight for the New Horizons. Southwest Research Institute, based in San Antonio, directs the mission via Principal Investigator Stern, and leads the science team, payload operations and encounter science planning. New Horizons is part of the New Frontiers Program managed by NASA's Marshall Space Flight Center in Huntsville, Alabama.

Source: NASA Return to Contents

2. Citizen Scientists Discover Rare Cosmic Pairing

Citizen scientists have uncovered a bizarre pairing of two brown dwarfs, objects much smaller than the Sun that lack enough mass for nuclear fusion. The discovery, reported in *The Astrophysical Journal* and confirmed by a scientific team led by astrophysicist Jackie Faherty at the American Museum of Natural History, shows that brown dwarf systems—the formation of which are still poorly understood—can be very low mass and extremely far apart yet inexorably linked.

"Astronomers would conclude that brown dwarfs separated by billions of miles would dissolve as they moved through the galaxy over time," said Faherty, a senior scientist in the Museum's Department of Astrophysics and a co-founder of the citizen science project Backyard Worlds: Planet 9, which led to the new discovery. "But we've found one that is still very much together."

The Backyard Worlds project lets anyone with a computer and an internet connection flip through images taken by NASA's Wide Field Infrared Survey Explorer (WISE) spacecraft and help astronomers identify new worlds beyond our solar system. If an object is close enough to Earth, it will appear to "jump" when multiple images taken of the same spot in the sky a few years apart are compared. The goal for Backyard Worlds volunteers—of which there are more than 50,000—is to flag the moving objects they see in these digital flipbooks for further investigation by the science team. So far, volunteers have reviewed more than 4 million flipbooks.

In June 2018, citizen scientists flipping through the Backyard Worlds images noticed an unusual pairing: one object that appeared faint but moved fast—the telltale sign of a new brown dwarf—and another brighter object moving nearby and at the same rate. The Backyard Worlds science team was alerted and became immediately excited about this rare cosmic sighting.

Brown dwarfs, sometimes called "failed stars," are spread throughout the Milky Way. They lack enough mass to sustain stable nuclear fusion but they are hot enough to glow brightest in the infrared range of the light spectrum. While stars and brown dwarfs can be found in pairs or larger groupings, finding a pair with low total mass and at a very large separation from each other is not common.

In December 2018, members of the Backyard Worlds science team used the Baade Magellan telescope in Chile outfitted with the FIRE spectrograph to confirm that the fainter source is indeed a member of one of the coldest classes of brown dwarfs: a T8. The brighter object was also confirmed as a low-temperature object: an L1. In addition, they learned that the L1 was previously observed with the European Space Agency's Gaia telescope and found to be just 78 light years from the Sun.

The researchers used the distance calculated by Gaia to precisely measure the brightness of each source and extract mass estimates. They found that the T8 object has about 34 times the mass of Jupiter, and the L1 has about 72 times the mass of Jupiter. They are separated by 341 astronomical units (1 astronomical unit is roughly the distance between the Sun and the Earth, about 93 million miles). The system is estimated to be a few billion years old.

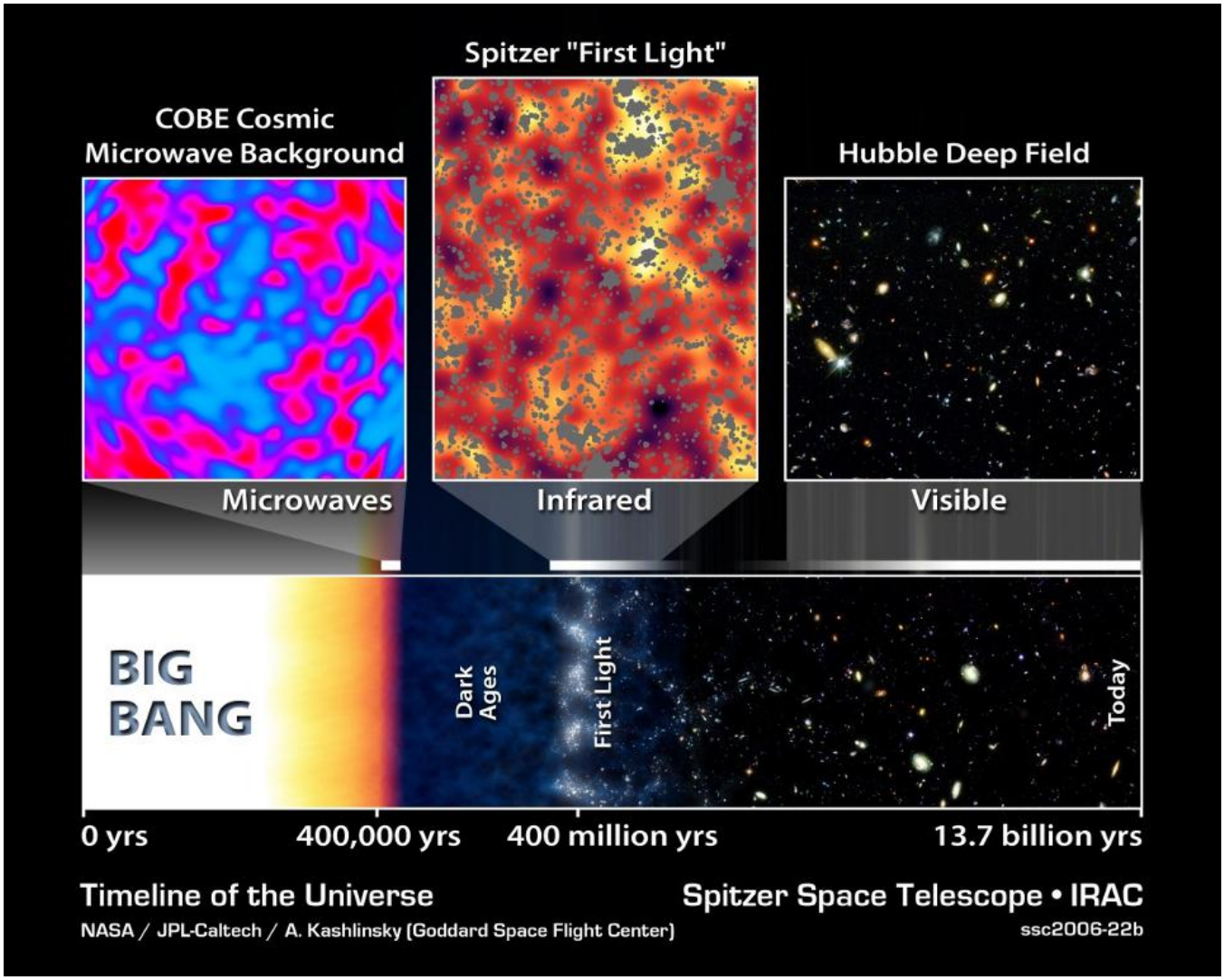
"While there are a handful of young pairings that rival this mass and separation, there is no known older system that rivals it, which raises the question: how and why did this cosmic pair survive?" said Marc Kuchner, an astrophysicist and citizen science officer for NASA's Science Mission Directorate.

"This is an excellent example of citizen scientists on the case," Faherty said. "We are still searching for clues as to how brown dwarfs form and this system is a provocative instance of what is possible at the extremes of survivability in the Milky Way."

Explore further: Citizen scientists uncover a cold new world near sun

Source: Phys.org Return to Contents

3. Astronomers Simulated How the Universe Would Look Without Dark Matter



Since the 1960s, there has been a general consensus among astronomers and cosmologists that the majority of the Universe is made up of an invisible, mysterious mass (known as Dark Matter). While scientists still haven't identified the candidate particle that makes up this mass, indirect tests and simulations have shown that Dark Matter must exist in order for the Universe to be the way it is.

In a fascinating twist, a team of European researchers conducted a simulation that looked at a Universe without Dark Matter. Using an alternative theory known as MOdified Newtonian Dynamics (MOND), the team created a computer simulation in which the galaxies were actually very similar to what we see in the Universe today. These findings could help to resolve one of the most enduring mysteries of modern cosmology.

The study that describes their findings (recently published in the *Astrophysical Journal*) was conducted by the Stellar Populations and Dynamics Research Group (SPODYR) – led by Prof. Pavel Kroupa of the Helmholtz Institue for Radiation and Nuclear Physics at the University of Bonn. He was joined by Nils Wittenburg, a doctoral member of SPODYR, and Benoit Famaey – the Research Director at the University of Strasbourg.

This theory that gravity behaves differently than previously thought (depending on the scale) was first proposed by Israeli physicist Prof. Dr. Mordehai Milgrom – hence the alternative name "Milgromian gravity." According to this theory, the attraction between two masses obeys Newton's Laws of Motion (aka. Universal Gravitation) only up to a certain point.

At lower accelerations, as is the case with galaxies, the influence of gravity becomes considerably stronger. In short, the attraction of a body depends not only on its own mass but also on whether other objects are in its vicinity. This theory is a possible explanation for why galaxies do not break apart as a result of their rotational speed.

MOND is also attractive because it makes the existence of Dark Matter (which remains unconfirmed) entirely superfluous. Nevertheless, MOND remains a largely unproven and untested theory, which is what Wittenberg and his colleagues sought to address. With the help of Famaey, the team employed computational software that conducts gravitational computations (which they designed) to simulate a cosmos where MOND exists.

This consisted of simulating the birth of the first stars and galaxies – which are believed to have formed between 100,000 and 300,000 years after the Big Bang – and how they have evolved since. What they found, interestingly enough, was that the distribution and velocity of the stars in the computer-generated galaxies followed the same pattern as those that are visible in the Universe today.

As Wittenburg, who was the lead author on the study, explained:

"In many aspects, our results are remarkably close to what we actually observe with telescopes. Furthermore, our simulation resulted mostly in the formation of rotating disk galaxies like the Milky Way and almost all other large galaxies we know. Dark matter simulations, on the other hand, predominantly create galaxies without distinct matter disks – a discrepancy to the observations that is difficult to explain."

In addition, the MOND simulation was virtually immune to changes in parameters, like the frequency of supernovae and their effect on the distribution of matter in galaxies. In the case of simulations where the existence of Dark Matter is assumed, however, changes in these parameters have a considerable effect. This is not to say that the MOND simulations were correct on all points.

For example, the simulations relied on some rather simple assumptions about the distribution of matter and the conditions present during the early Universe. "Our simulation is only a first step," Prof. Kroupa emphasized. "We now have to repeat the calculations and include more complex influencing factors. Then we will see if the MOND theory actually explains reality."

Invariably, when it comes to the dynamics and behavior of the Universe on the grandest of scales and longest of time periods, the jury is still out. While the existence of Dark Matter remains unproven, it is the only cosmological theory that is consistent with General Relativity – an endlessly proven theory and the only working hypothesis for how gravity behaves on cosmological scales.

And while MOND provides some resolution to theoretical problems presented by Dark Matter, it presents problems of its own. In the near future, a number of next-generation observatories that could help resolve this mystery will be going into space – including the *James Webb Space Telescope* (JWST) and the ESA's *Euclid* mission.

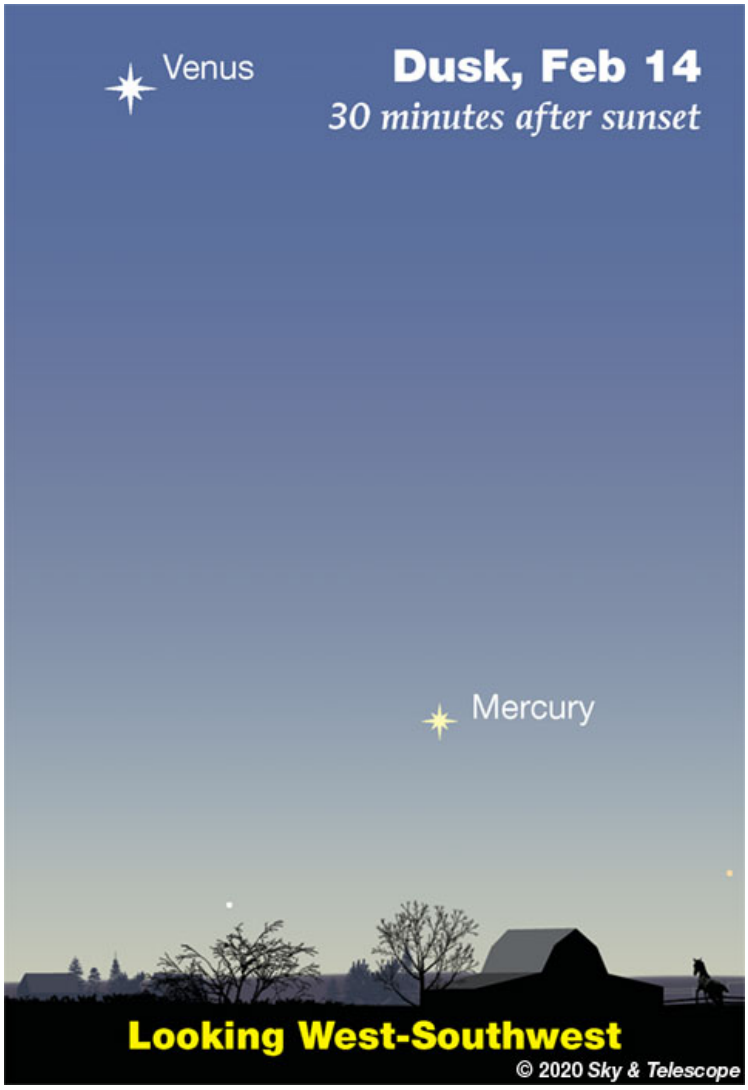
These and other missions will offer a better picture of the geometry of the Universe and improved measurements of the cosmic expansion. From this, scientists hope to gain a better understanding of how Dark Matter could have affected cosmic evolution – not to mention Dark Energy, another cosmological mystery that is also the subject of debate!

Further Reading: University of Bonn, arXiv

Source: Universe Today Return to Contents

The Night Sky

Friday, Feb. 14



• By 8 or 9 p.m. now, the Big Dipper stands vertically on its handle in the northeast. In the northwest, Cassiopeia also stands on end at about the same height. Between them is Polaris. Winter's end is in sight.

Saturday, Feb. 15

• Last-quarter Moon (exact at 5:17 p.m. EST.) The Moon rises around 1 or 2 a.m. tonight with the head of Scorpius following up just below it. By the beginning of dawn Sunday they're nice and high in the south-southeast. At that time Antares is the brightest star under the Moon, and the last to fade out in the oncoming light of day.

Sunday, Feb. 16

• High in the northern sky these evenings, in the seemingly empty wastes between Capella overhead and Polaris due north, sprawls big, very dim Camelopardalis, the Giraffe — perhaps the biggest often-visible constellation you don't know. Unless you have a really dark sky, you'll need binoculars to work out its nondescript pattern using the constellation chart in the center of *Sky & Telescope* — a challenge project that will build your skills for correctly relating what you see in binoculars to what you see, *much* smaller, on a sky map.

If you're new at this, start with brighter, easier constellations and save the shy Giraffe until you get good at it.

Monday, Feb. 17

• Occultation of Mars. Early Tuesday morning, the bright limb of the thick waning crescent Moon occults Mars (just 5.2 arcseconds in diameter) for much of North and Central America. Near the East Coast the event happens in daylight with the Moon nicely high in the south. Farther west it happens in morning twilight or pre-dawn darkness. Mars emerges from behind the Moon's dark limb up to an hour or more later. Map, and local timetables for the disappearance and (starting about halfway down) the reappearance.

Source: Sky & Telescope

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ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Tue Feb 18, 6:24 AM	2 min	18°	11° above S	18° above SSE

Sighting information for other cities can be found at NASA's Satellite Sighting Information

NASA-TV Highlights

(all times Eastern Standard Time)

February 14, Friday
11 a.m. – SpaceCast Weekly (All Channels)
3:15 p.m. - Coverage of the launch of the Northrop Grumman Cygnus CRS-13 cargo craft to the International Space Station; launch scheduled at 3:43 p.m. EST - Johnson Space Center via Wallops Flight Facility, Va. (All Channels)

February 16, Sunday
2:30 a.m. - Coverage of the Rendezvous and Capture of the Northrop Grumman Cygnus CRS-13 Cargo Craft at the International Space Station (Capture scheduled at 4 a.m. EST) - Johnson Space Center (All Channels)
6 a.m. - Coverage of the Installation of the Northrop Grumman Cygnus CRS-13 Cargo Craft to the International Space Station - Johnson Space Center (All Channels)

February 19, Wednesday
12:40 p.m.– International Space Station Expedition 62 educational in-flight event with the East Middle School in Grand Blanc, Michigan, to discuss the Zero-G Oven with NASA astronaut Jessica Meir (All Channels)

Watch NASA TV on the Net by going to the NASA website.

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Space Calendar

- Feb 14 -  [Feb 14] Cygnus CRS-13 (NG-13)/ CAPSat Antares 230 Launch (International Space Station)
- Feb 14 - Comet 219P/LINEAR At Opposition (3.905 AU)
- Feb 14 - Comet P/2019 V2 (Groeller) Closest Approach To Earth (4.169 AU)
- Feb 14 - Asteroid 4031 Mueller Closest Approach To Earth (0.920 AU)
- Feb 14 - Asteroid 35734 Dilithium Closest Approach To Earth (1.483 AU)
- Feb 14 - Asteroid 10044 Squyres Closest Approach To Earth (2.319 AU)
- Feb 14 - 20th Anniversary (2000), NEAR, Asteroid Eros Orbit Insertion
- Feb 14 - 30th Anniversary (1990), Voyager 1, Family Portrait Images
- Feb 14 - 40th Anniversary (1980), Solar Maximum Mission Launch
- Feb 14-15 - Southwest Strings Meeting 2020 (SWSM 20), Logan, Utah
- Feb 15 -  [Feb 08] Galileo Day
- Feb 15 -  [Feb 09] Starlink 5 (60)/ SmallSat Rideshare Mission 2/ SkySat 16-18 Falcon 9 Launch
- Feb 15 - Comet 374P/Larson At Opposition (2.781 AU)
- Feb 15 - Comet 159P/LONEOS At Opposition (3.980 AU)
- Feb 15 - Apollo Asteroid 63373 (2002 PZ39) Near-Earth Flyby (0.039 AU)
- Feb 15 - Asteroid 2531 Cambridge Closest Approach To Earth (1.867 AU)
- Feb 15 - Asteroid 9012 Benner Closest Approach To Earth (2.337 AU)
- Feb 15 - Asteroid 296907 Alexander Closest Approach To Earth (2.414 AU)
- Feb 15 - Roger Chaffee's 85th Birthday (1935)
- Feb 15 - Mildred Shapley Matthews' 105th Birthday (1915)
- Feb 16 - Comet 163P/NEAT Closest Approach To Earth (1.623 AU)
- Feb 16 - Apollo Asteroid 2020 BL14 Near-Earth Flyby (0.046 AU)
- Feb 16 - Asteroid 1791 Patsayev Closest Approach To Earth (1.987 AU)
- Feb 16 - Asteroid 31319 Vespucci Closest Approach To Earth (2.111 AU)
- Feb 16 - Asteroid 51824 Mikeanderson Closest Approach To Earth (2.352 AU)
- Feb 16 -  [Feb 09] Kuiper Belt Object 2014 AN55 At Opposition (45.092 AU)
- Feb 16 - 55th Anniversary (1965), Pegasus 1 Launch
- Feb 17 - Comet 138P/Shoemaker-Levy At Opposition (1.982 AU)
- Feb 17 - Comet 152P/Helin-Lawrence At Opposition (3.507 AU)
- Feb 17 - Aten Asteroid 2018 CW2 Near-Earth Flyby (0.015 AU)
- Feb 17 - Apollo Asteroid 2020 CK1 Near-Earth Flyby (0.022 AU)
- Feb 17 - Aten Asteroid 326290 Akhenaten Closest Approach To Earth (0.446 AU)
- Feb 17 - Amor Asteroid 7088 Ishtar Closest Approach To Earth (0.559 AU)
- Feb 17 - Asteroid 8275 Inca Closest Approach To Earth (0.985 AU)
- Feb 17 - Asteroid 2244 Tesla Closest Approach To Earth (1.906 AU)
- Feb 17 - 55th Anniversary (1965), Ranger 8 Launch (Moon Impact Mission)

Source: JPL Space Calendar

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Food for Thought

NASA Selects Four Possible Missions to Study the Secrets of the Solar System

NASA has selected four Discovery Program investigations to develop concept studies for new missions. Although they're not official missions yet and some ultimately may not be chosen to move forward, the selections focus on compelling targets and science that are not covered by NASA's active missions or recent selections. Final selections will be made next year.

NASA's Discovery Program invites scientists and engineers to assemble a team to design exciting planetary science missions that deepen what we know about the solar system and our place in it. These missions will provide frequent flight opportunities for focused planetary science investigations. The goal of the program is to address pressing questions in planetary science and increase our understanding of our solar system.

"These selected missions have the potential to transform our understanding of some of the solar system's most active and complex worlds," said Thomas Zurbuchen, associate administrator of NASA's Science Mission Directorate. "Exploring any one of these celestial bodies will help unlock the secrets of how it, and others like it, came to be in the cosmos."

Each of the four nine-month studies will receive $3 million to develop and mature concepts and will conclude with a Concept Study Report. After evaluating the concept studies, NASA will continue development of up to two missions towards flight.

The proposals were chosen based on their potential science value and feasibility of development plans following a competitive peer-review process.

The selected proposals are:

DAVINCI+ (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging Plus)

DAVINCI+ will analyze Venus' atmosphere to understand how it formed, evolved and determine whether Venus ever had an ocean. DAVINCI+ plunges through Venus' inhospitable atmosphere to precisely measure its composition down to the surface. The instruments are encapsulated within a purpose-built descent sphere to protect them from the intense environment of Venus. The "+" in DAVINCI+ refers to the imaging component

of the mission, which includes cameras on the descent sphere and orbiter designed to map surface rock-type. The last U.S.-led, in-situ mission to Venus was in 1978. The results from DAVINCI+ have the potential to reshape our understanding of terrestrial planet formation in our solar system and beyond. James Garvin of NASA's Goddard Space Flight Center in Greenbelt, Maryland, is the principal investigator. Goddard would provide project management.

Io Volcano Observer (IVO)

IVO would explore Jupiter's moon, Io, to learn how tidal forces shape planetary bodies. Io is heated by the constant crush of Jupiter's gravity and is the most volcanically active body in the solar system. Little is known about Io's specific characteristics, such as whether a magma ocean exists in its interior. Using close-in flybys, IVO would assess how magma is generated and erupted on Io. The mission's results could revolutionize our understanding of the formation and evolution of rocky, terrestrial bodies, as well as icy ocean worlds in our solar system, and extrasolar planets across the universe. Alfred McEwen of the University of Arizona in Tucson is the principal investigator. The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland would provide project management.

TRIDENT

Trident would explore Triton, a unique and highly active icy moon of Neptune, to understand pathways to habitable worlds at tremendous distances from the Sun. NASA's Voyager 2 mission showed that Triton has active resurfacing—generating the second youngest surface in the solar system—with the potential for erupting plumes and an atmosphere. Coupled with an ionosphere that can create organic snow and the potential for an interior ocean, Triton is an exciting exploration target to understand how habitable worlds may develop in our solar system and others. Using a single fly-by, Trident would map Triton, characterize active processes, and determine whether the predicted subsurface ocean exists. Louise Prockter of the Lunar and Planetary Institute/Universities Space Research Association in Houston is the principal investigator. NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, would provide project management

VERITAS (Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy)

VERITAS would map Venus' surface to determine the planet's geologic history and understand why Venus developed so differently than the Earth. Orbiting Venus with a synthetic aperture radar, VERITAS charts surface elevations over nearly the entire planet to create three-dimensional reconstructions of topography and confirm whether processes, such as plate tectonics and volcanism, are still active on Venus. VERITAS would also map infrared emissions from the surface to map Venus' geology, which is largely unknown. Suzanne Smrekar of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, is the principal investigator. JPL would provide project management.

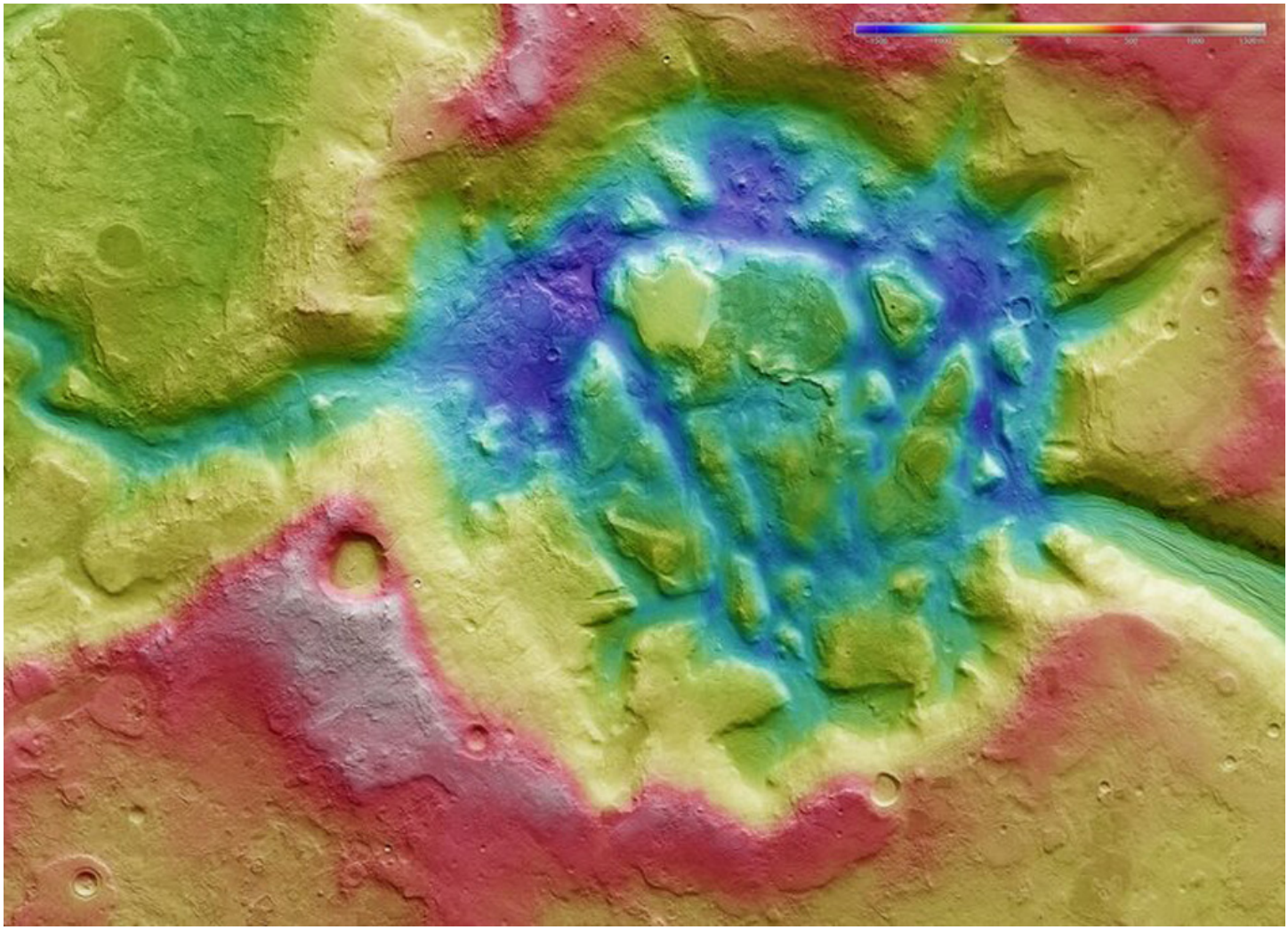
The concepts were chosen from proposals submitted in 2019 under NASA Announcement of Opportunity (AO) NNH19ZDA010O, Discovery Program. The selected investigations will be managed by the Planetary Missions Program Office at NASA's Marshall Space Flight Center in Huntsville, Alabama, as part of the Discovery Program. The Discovery Program conducts space science investigations in the Planetary Science Division of NASA's Science Mission Directorate, guided by NASA's agency priorities and the Decadal Survey process of the National Academy of Sciences.

Established in 1992, NASA's Discovery Program has supported the development and implementation of over 20 missions and instruments. These selections are part of the ninth Discovery Program competition.

For more information about NASA's planetary science, visit https://www.nasa.gov/solarsystem

Source: NASA Return to Contents

Space Image of the Week



The Topography of Nilosyrtis Mensae

Explanation This colour-coded topographic image shows a region of Mars' surface named Nilosyrtis Mensae, based on data gathered by the Mars Express High Resolution Stereo Camera on 29 September 2019 during orbit 19908.

This view is based on a digital terrain model (DTM) of the region, from which the topography of the landscape can be derived; lower parts of the surface are shown in blues and purples, while higher altitude regions show up in whites, yellows and reds, as indicated on the scale to the bottom left. North is to the right.

More information and larger image

Image Credit: ESA/DLR/FU Berlin

Source: Spaceref.com

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