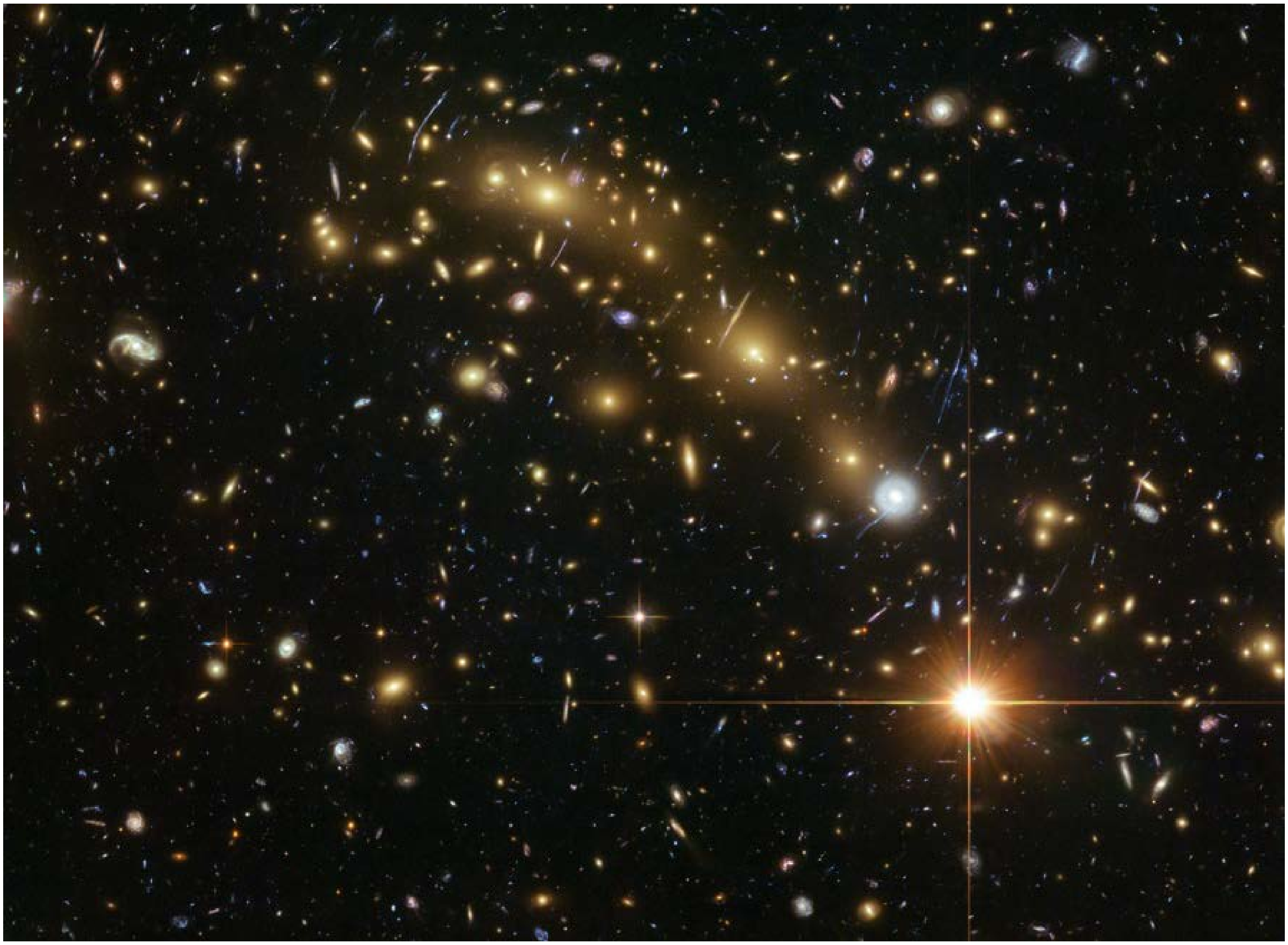
Space News Update

— June 13, 2017 —

Contents

1. Galaxy Alignment Traced Back 10 Billion Years



A new study led by Michael West of Lowell Observatory and Roberto De Propris of the University of Turku, Finland, reveals that the most massive galaxies in the universe have been aligned with their surroundings for at least ten billion years. This discovery shows that galaxies, like people, are influenced by their environment from a young age.

Astronomers have long known that galaxies cluster together into enormous systems - the urban centers of the cosmos - and that the largest galaxies tend to 'point' towards their neighbors. But how and when these alignments occur remains a mystery.

Using the Hubble Space Telescope, the international team of collaborators peered across cosmic time to observe 65 distant galaxy clusters whose light has taken billions of years to reach Earth. They showed for the first time that the largest galaxies in these systems were already aligned with their surroundings when the universe was only 1/3 of its current age.

- Our results show that galaxy alignments were established very early in the universe's history. It's an important new piece to the puzzle because it says that whatever caused the alignments, it acted quickly, says De Propris.

Although clusters have hundreds or thousands of member galaxies, most are randomly oriented in space. Only the biggest galaxies are aligned with their surroundings, which suggests that they are especially sensitive to their environment.

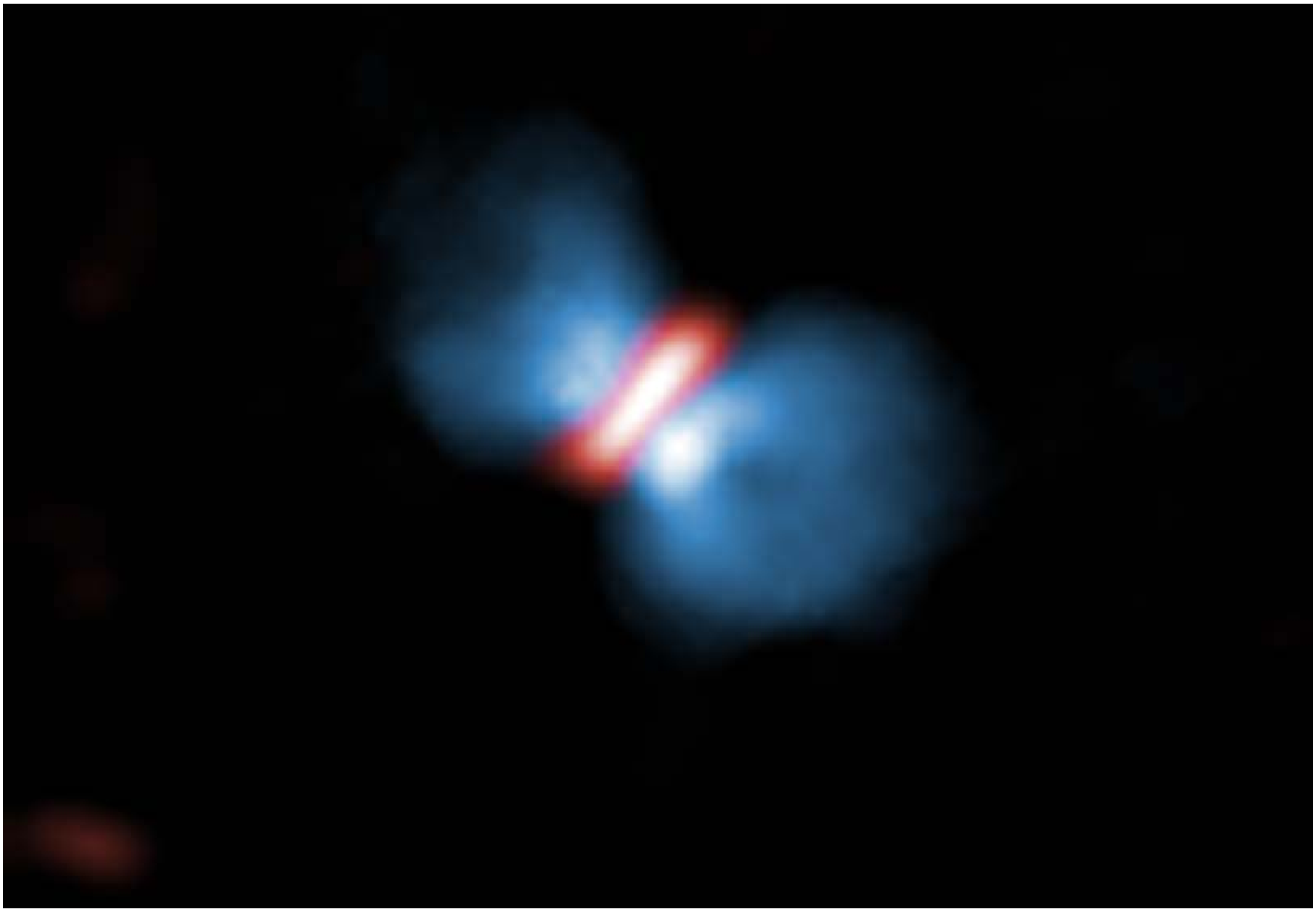
The team is eager to look further back in time by observing more remote clusters. But studying galaxies at the dawn of the time is not easy, even with Hubble.

- We're trying to measure the shapes and orientations of galaxies that appear very faint and very small because of their great distances, which is challenging, notes De Propris.

In addition to West and De Propris, the team includes Malcolm Bremer and Steven Phillipps, both at the University of Bristol.

Source: EurekAlert Return to Contents

2. ALMA Hears Birth Cry of a Massive Baby Star



Stars form from gas and dust floating in interstellar space. But, astronomers do not yet fully understand how it is possible to form the massive stars seen in space. One key issue is gas rotation. The parent cloud rotates slowly in the initial stage and the rotation becomes faster as the cloud shrinks due to self-gravity. Stars formed in such a process should have very rapid rotation, but this is not the case. The stars observed in the Universe rotate more slowly.

How is the rotational momentum dissipated? One possible scenario involves that the gas emanating from baby stars. If the gas outflow rotates, it can carry rotational momentum away from the system. Astronomers have tried to detect the rotation of the outflow to test this scenario and understand its launching mechanism. In a few cases signatures of rotation have been found, but it has been difficult to resolve clearly, especially around massive baby stars.

The team of astronomers led by Tomoya Hirota, an assistant professor at the National Astronomical Observatory of Japan (NAOJ) and SOKENDAI (the Graduate University for Advanced Studies) observed a massive baby star called Orion KL Source I in the famous Orion Nebula, located 1,400 light-years away from the Earth. The Orion Nebula is the closest massive-star forming region to Earth. Thanks to its close vicinity and

ALMA's advanced capabilities, the team was able to reveal the nature of the outflow from Source I. "We have clearly imaged the rotation of the outflow," said Hirota, the lead author of the research paper published in the journal *Nature Astronomy*. "In addition, the result gives us important insight into the launching mechanism of the outflow."

The new ALMA observations beautifully illustrate the rotation of the outflow. The outflow rotates in the same direction as the gas disk surrounding the star. This strongly supports the idea that the outflow plays an important role in dissipating the rotational energy.

Furthermore, ALMA clearly shows that the outflow is launched not from the vicinity of the baby star itself, but rather from the outer edge of the disk. This morphology agrees well with the "magnetocentrifugal disk wind model." In this model, gas in the rotating disk moves outward due to the centrifugal force and then moves upward along the magnetic field lines to form outflows. Although previous observations with ALMA have found supporting evidence around a low-mass protostar, there was little compelling evidence around massive protostars because most of the massive-star forming regions are rather distant and difficult to investigate in detail.

"In addition to high sensitivity and fidelity, high resolution submillimeter-wave observation is essential to our study, which ALMA made possible for the first time. Submillimeter waves are a unique diagnostic tool for the dense innermost region of the outflow, and at that exact place we detected the rotation," explained Hirota.

"ALMA's resolution will become even higher in the future. We would like to observe other objects to improve our understanding of the launching mechanism of outflows and the formation scenario of massive stars with the assistance of theoretical research."

ALMA also imaged rotation of a gas jet from a low-mass protostar. Please read the press release "Baby Star Spits a "Spinning Jet" As It Munches -Down on a "Space Hamburger"" from the Academia Sinica Institute of Astronomy and Astrophysics, Taiwan.

Source: Phys.org Return to Contents

3. Cloudy with a Chance of Radiation: NASA Studies Simulated Radiation

In each life a little rain must fall, but in space, one of the biggest risks to astronauts' health is radiation "rain". NASA's Human Research Program (HRP) is simulating space radiation on Earth following upgrades to the NASA Space Radiation Laboratory (NSRL) at the U.S. Department of Energy's Brookhaven National Laboratory. These upgrades help researchers on Earth learn more about the effects of ionizing space radiation, to help keep astronauts safe on a journey to Mars.

Radiation is one of the most dangerous risks to humans in space, and one of the most challenging to simulate here on Earth. The risk to human health significantly increases when astronauts travel beyond Lower Earth Orbit (LEO) outside the magnetosphere. The magnetosphere shields Earth from solar particle events (SPEs) and radiation caused by the sun and galactic cosmic rays (GCR) produced by supernova fragments. Radiation particles like ions can be dangerous to humans because they can pass through skin, depositing energy and damaging cells or DNA along the way. This damage can increase the risk for diseases later in life or cause radiation sickness during the mission.

Radiation may cause damage to the central nervous system, cardiovascular system, and circulatory system of astronauts. There is evidence that humans exposed to large doses of radiation from radiotherapy experience cognitive and behavioral changes, and recent studies suggest these risks may occur at lower doses for GCR creating a possible risk for operating a space vehicle. Space environment variables (Ex. microgravity, CO_2, lack of sleep, etc.) which produce stress could interact with radiation in a synergistic fashion exacerbating the impacts.

With the recent upgrades to the NSRL, NASA is improving its ability to understand the effects of radiation on the body. The most notable upgrades were made to the GCR simulator, which was recently highlighted in *ScienceDirect*.

“There is ample research on acute effects of radiation exposure but very little on latent effects, and the latter more closely resembles the health effects expected from long duration space flight,” Lisa Carnell, Ph.D., Medical Countermeasure Lead for NASA Space Radiation said. “Imagine ion trajectories to be similar to rain; sometimes there is a downpour (solar particle event) and sometimes there a light drizzle or heavy, sparse droplets (similar to galactic cosmic radiation). With the upgrades we can simulate different types of ion rain with multiple types of ions sequentially versus only one type of ion at a time.”

The GCR upgrades enable researchers to rapidly switch ion types and energy intensities. To support these improvements, software controls were added to permit smooth movement from target to target. The cooling system in one of the Electron Beam Ion Source, or EBIS magnets was upgraded to handle higher energy currents. In addition, new probes were installed in two of the beamline’s magnets to speed up setting changes.

Before these upgrades, switching radiation beams was not an easy or efficient process in the NSRL. The lab was originally designed to harness ions from Brookhaven’s Booster accelerator, which produces all species of ions within a range of energies. Now switching ion species and energies can be done in minutes. More realistic studies and radiation countermeasure tests are conducted because investigators can better simulate the space environment.

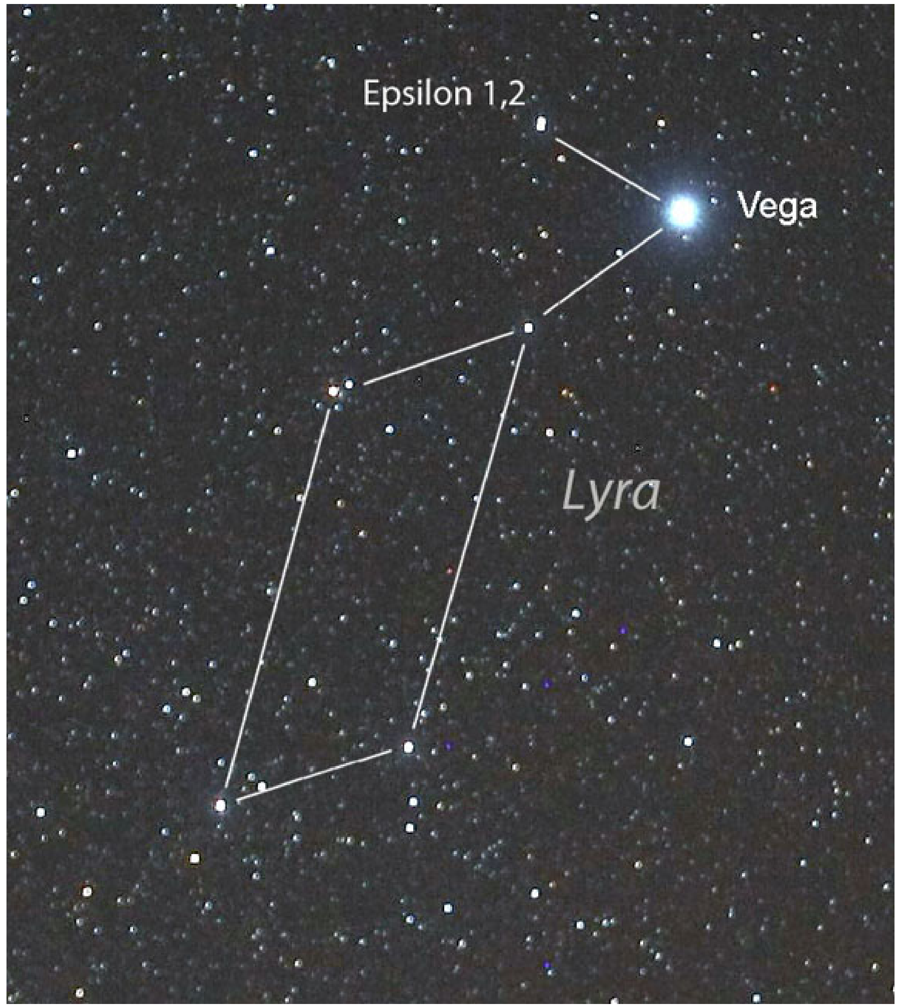
The improvements in beam energy enable coverage of a greater part of the GCR spectrum. The larger beam makes it possible to radiate numerous samples at once and increase throughput and efficiency. Precision control also increases the accuracy for dose delivery. Uniformity of the radiation field intensity also reduces uncertainties in dose deliveries.

This results in a more accurate testing environment for NASA researchers who are developing various types of shielding materials to protect astronauts from radiation. HRP investigators can use the technology to test tissue samples leading to health countermeasures to protect against molecular damage. Cancer researchers also can explore various heavy ion therapies to eradicate tumors. The NSRL is one of the few labs in the United States capable of contributing to heavy ion radiotherapy research. Users from NASA, national laboratories, and more than 50 institutions and universities in the U.S., Europe, and Japan test medical, biological, and physical samples using the NSRL ion beam line.

Source: NASA Return to Contents

The Night Sky

Tuesday, June 13



• After dark, Vega is the brightest star very high in the east. Just lower left of it (or upper left in this photo) is 4th-magnitude Epsilon Lyrae, the Double-Double. Epsilon forms one corner of a roughly equilateral triangle with Vega and Zeta Lyrae. The triangle is less than 2° on a side, hardly the width of your thumb at arm's length.

Binoculars easily resolve Epsilon. And a 4-inch telescope at 100× or more should resolve each of Epsilon's wide components into a tight pair.

Zeta Lyrae is also a double star for binoculars; much tougher, but plainly resolved in a telescope.

Delta Lyrae, below Zeta, is a much wider and easier pair.

• On Wednesday morning, the Sun rises its earliest of the year if you're near 40° north latitude. The summer solstice comes seven days later.

Wednesday, June 14

• Saturn is at opposition tonight. For just a few days around opposition, Saturn's rings turn a little brighter than usual with respect to Saturn's globe, a phenomenon called the Seeliger effect. It's caused by ring particles backscattering sunlight toward the Sun (and, right now, Earth).

Thursday, June 15

• With June halfway through, the Big Dipper has swung around to hang down by its handle high in the northwest during evening. The middle star of its handle is Mizar, with tiny Alcor right next to it. On which side of Mizar should you look for Alcor? As always, on the side toward Vega! Which now is shining high in the eastern sky.

Friday, June 16

• By the time it's fully dark this week, Altair is shining well up in the east. A finger-width above it or to its upper left is its little sidekick Tarazed (Gamma Aquilae), actually an orange giant that's far in the background. Altair is 17 light-years from us; Tarazed is about 460.

Source: [Sky & Telescope] [Return to Contents]

ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Wed Jun 14, 9:06 PM	4 min	16°	11° above W	11° above SSW

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

NASA-TV Highlights

(all times Eastern Daylight Time)

5 a.m., Wednesday, June 14 - ISS Progress 67 Launch Coverage (Launch scheduled at 5:20 a.m. ET) (all channels)

7 a.m., Friday, June 16 - ISS Progress 67 Docking Coverage (Docking scheduled at 7:42 a.m. ET) (all channels)

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

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Space Calendar

- Jun 13 - Comet 73P-AI/Schwassmann-Wachmann Perihelion (0.964 AU)
- Jun 13 - Comet P/2017 G2 (PANSTARRS) Perihelion (2.846 AU)
- Jun 13 - Comet P/1999 XN120 (Catalina) Perihelion (3.297 AU)
- Jun 13 - Comet C/2015 O1 (PANSTARRS) At Opposition (3.552 AU)
- Jun 13 - Comet 64P/Swift-Gehrels At Opposition (3.589 AU)
- Jun 13 - Apollo Asteroid 2017 FR2 Near-Earth Flyby (0.078 AU)
- Jun 13 - Asteroid 3355 Onizuka Closest Approach To Earth (1.320 AU)
- Jun 13 - Asteroid 51823 Rickhusband Closest Approach To Earth (2.645 AU)
- Jun 13 - Asteroid 1268 Libya Closest Approach To Earth (3.313 AU)
- Jun 14 - HOT [Jun 07] 50th Anniversary (1967), Mariner 5 Launch (Venus Flyby Mission)
- Jun 14 - HOT [Jun 12] Progress MS-6 Soyuz-2.1a Launch (International Space Station 67P)
- Jun 14 - Asteroid 5066 Garradd Closest Approach To Earth (0.622 AU)
- Jun 14 - Asteroid 3834 Zappafrank Closest Approach To Earth (1.156 AU)
- Jun 14 - Asteroid 11334 Rio de Janeiro Closest Approach To Earth (1.359 AU)
- Jun 14 - Asteroid 6546 Kaye Closest Approach To Earth (2.105 AU)
- Jun 15 - Saturn At Opposition
- Jun 15 - Comet P/2001 R6 (LINEAR-Skiff) At Opposition (2.890 AU)
- Jun 15 - Comet P/1996 R2 (Lagerkvist) Closest Approach To Earth (2.961 AU)
- Jun 15 - Asteroid 22903 Georgeclooney Closest Approach To Earth (1.349 AU)
- Jun 15 - Asteroid 2952 Lilliputia Closest Approach To Earth (1.581 AU)
- Jun 15 - Asteroid 1691 Oort Closest Approach To Earth (2.574 AU)
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- Jun 15 - 265th Anniversary (1752), Ben Franklin's Kite-Flying Lightning Experiment
- Jun 16 - UPDATED [Jun 12] Hard X-Ray Modulation Telescope (HXMT)/ Zhuhai-1 CZ-4B Launch
- Jun 16 - Moon Occults Neptune
- Jun 16 - Comet 150P/LONEOS At Opposition (2.204 AU)
- Jun 16 - Comet P/2016 J3 At Opposition (3.464 AU)
- Jun 16 - Apollo Asteroid 2010 VB1 Near-Earth Flyby (0.026 AU)
- Jun 16 - Asteroid 1322 Coppernicus Closest Approach To Earth (0.863 AU)
- Jun 16 - Asteroid 3949 Mach Closest Approach To Earth (1.168 AU)
- Jun 16 - Asteroid 3651 Friedman Closest Approach To Earth (1.218 AU)
- Jun 16 - Amor Asteroid 9950 ESA Closest Approach To Earth (1.413 AU)
- Jun 16 - Asteroid 16761 Hertz Closest Approach To Earth (1.735 AU)
- Jun 16 - Asteroid 12757 Yangtze Closest Approach To Earth (1.807 AU)
- Jun 16 - Plutino 28978 Ixion At Opposition (38.699 AU)

Source: JPL Space Calendar

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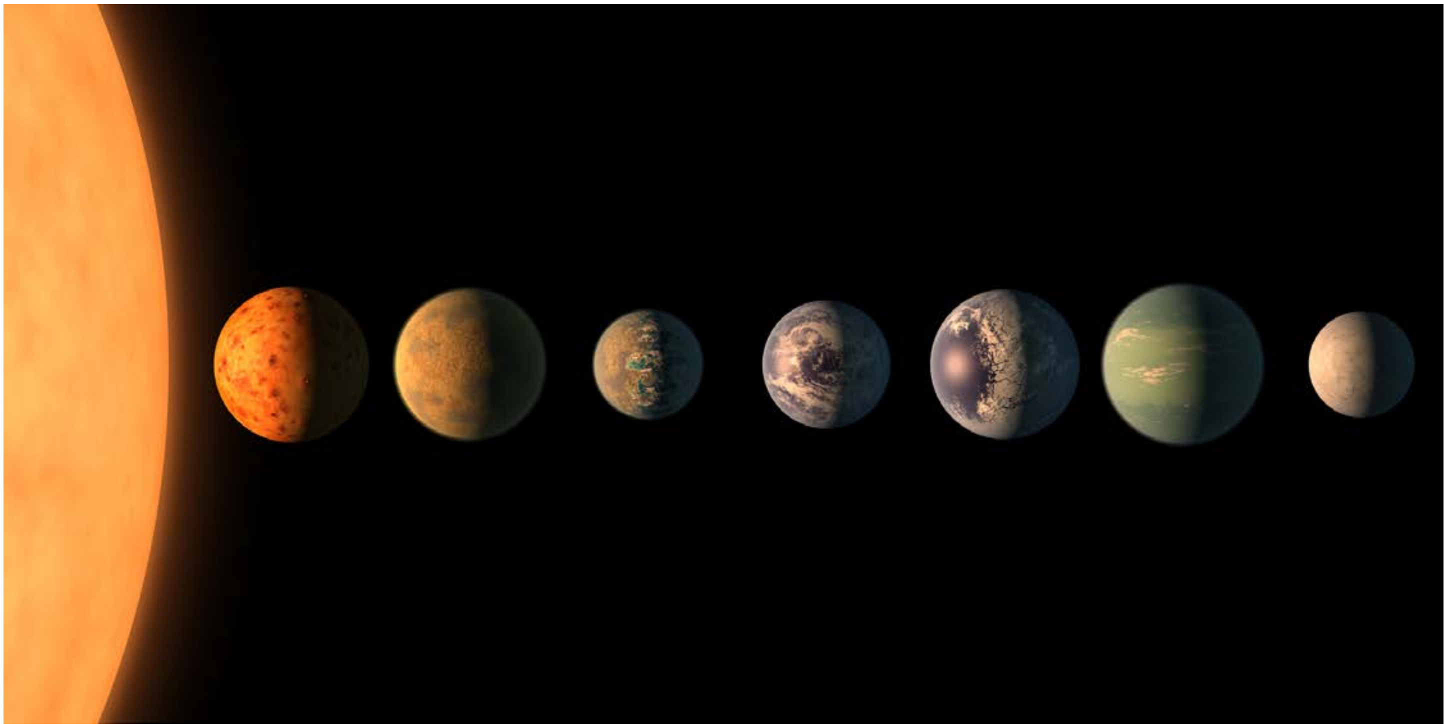
Food for Thought

The Art of Exoplanets



The moon hanging in the night sky sent Robert Hurt's mind into deep space -- to a region some 40 light years away, in fact, where seven Earth-sized planets crowded close to a dim, red sun.

Hurt, a visualization scientist at Caltech's IPAC center, was walking outside his home in Mar Vista, California, shortly after he learned of the discovery of these rocky worlds around a star called TRAPPIST-1 and got the assignment to visualize them. The planets had been revealed by NASA's Spitzer Space Telescope and ground-based observatories.

"I just stopped dead in my tracks, and I just stared at it," Hurt said in an interview. "I was imagining that could be, not our moon, but the next planet over - what it would be like to be in a system where you could look up and see continental features on the next planet."

So began a kind of inspirational avalanche. Hurt and his colleague, multimedia producer Tim Pyle, developed a series of arresting, photorealistic images of what the new system's tightly packed planets might look like -- so tightly packed that they would loom large in each other's skies. Their visions of the TRAPPIST-1 system would appear in leading news outlets around the world.

Artists like Hurt and Pyle, who render vibrant visualizations based on data from Spitzer and other missions, are hybrids of sorts, blending expertise in both science and art. From squiggles on charts and columns of numbers, they conjure red, blue and green worlds, with half-frozen oceans or bubbling lava. Or they transport us to the surface of a world with a red-orange sun fixed in place, and a sky full of planetary companions.

"For the public, the value of this is not just giving them a picture of something somebody made up," said Douglas Hudgins, a program scientist for the Exoplanet Exploration Program at NASA Headquarters in Washington. "These are real, educated guesses of how something might look to human beings. An image is worth a thousand words."

Hurt says he and Pyle are building on the work of artistic pioneers.

"There's actually a long history and tradition for space art and science-based illustration," he said. "If you trace its roots back to the artist Chesley Bonestell (famous in the 1950s and '60s), he really was the artist who got this idea: Let's go and imagine what the planets in our solar system might actually look like if you were, say, on Jupiter's moon, Io. How big would Jupiter appear in the sky, and what angle would we be viewing it from?"

To begin work on their visualizations, Hurt divided up the seven TRAPPIST-1 planets with Pyle, who shares an office with him at Caltech's IPAC center in Pasadena, California.

Hurt holds a Ph.D. in astrophysics, and has worked at the center since he was a post-doctoral researcher in 1996 - when astronomical art was just his hobby.

"They created a job for me," he said.

Pyle, whose background is in Hollywood special effects, joined Hurt in 2004.

Hurt turns to Pyle for artistic inspiration, while Pyle relies on Hurt to check his science.

"Robert and I have our desks right next to each other, so we're constantly giving each other feedback," Pyle said. "We're each upping each other's game, I think."

The TRAPPIST-1 worlds offered both of them a unique challenge. The two already had a reputation for illustrating many exoplanets - planets around stars beyond our own -- but never seven Earth-sized worlds in a single system. The planets cluster so close to their star that a "year" on each of them -- the time they take to complete a single orbit -- can be numbered in Earth days.

And like the overwhelming majority of the thousands of exoplanets found so far, they were detected using indirect means. No telescope exists today that is powerful enough to photograph them.

Real science informed their artistic vision. Using data from the telescopes that reveal each planet's diameter as well as its "weight," or mass, and known stellar physics to determine the amount of light each planet would receive, the artists went to work.

Both consulted closely with the planets' discovery team as they planned for a NASA announcement to coincide with a report in the journal Nature.

"When we're doing these artist's concepts, we're never saying, 'This is what these planets actually look like,'" Pyle said. "We're doing plausible illustrations of what they could look like, based on what we know so far. Having this wide range of seven planets actually let us illustrate almost the whole breadth of what would be plausible. This was going to be this incredible interstellar laboratory for what could happen on an Earth-sized planet."

For TRAPPIST-1b, Pyle took Jupiter's volcanic moon, Io, as an inspiration, based on suggestions from the science team. For the outermost world, TRAPPIST-1h, he chose two other Jovian moons, the ice-encased Ganymede and Europa.

After talking to the scientists, Hurt portrayed TRAPPIST-1c as dry and rocky. But because all seven planets are probably tidally locked, forever presenting one face to their star and the other to the cosmos, he placed an ice cap on the dark side.

TRAPPIST-1d was one of three that fall inside the "habitable zone" of the star, or the right distance away from it to allow possible liquid water on the surface.

"The researchers told us they would like to see it portrayed as something they called an 'eyeball world,'" Hurt said. "You have a dry, hot side that's facing the star and an ice cap on the back side. But somewhere in between, you have (a zone) where the ice could melt and be sustained as liquid water."

At this point, Hurt said, art intervened. The scientists rejected his first version of the planet, which showed liquid water intruding far into the "dayside" of TRAPPIST-1d. They argued that the water would most likely be found well within the planet's dark half.

"Then I kind of pushed back, and said, 'If it's on the dark side, no one can look at it and understand we're saying there's water there,'" Hurt said. They struck a compromise: more water toward the dayside than the science team might expect, but a better visual representation of the science.

The same push and pull between science and art extends to other forms of astronomical visualization, whether it's a Valentine's Day cartoon of a star pulsing like a heart in time with its planet, or materials for the blockbuster announcement of the first detection of gravitational waves by the Laser Interferometer Gravitational-Wave Observatory in February 2016. They've also illustrated asteroids, neutron stars, pulsars and brown dwarfs.

Visualizations based on data can also inform science, leading to genuine scientific insights. The scientists' conclusions about TRAPPIST-1 at first seemed to suggest the planets would be bathed in red light, potentially obscuring features like blue-hued bodies of water.

"It makes it hard to really differentiate what is going on," Hurt said.

Hurt decided to investigate. A colleague provided him with a spectrum of a red dwarf star similar to TRAPPIST-1. He overlaid that with the "responsivity curves" of the human eye, and found that most of the scientists' "red" came from infrared light, invisible to human eyes. Subtract that, and what is left is a more reddish-orange hue that we might see standing on the surface of a TRAPPIST-1 world -- "kind of the same color you would expect to get from a low-wattage light bulb," Hurt said. "And the scientists looked at that and said, 'Oh, ok, great, it's orange.' When the math tells you the answer, there really isn't a lot to argue about."

For Hurt, the real goal of scientific illustration is to excite the public, engage them in the science, and provide a snapshot of scientific knowledge.

"If you look at the whole history of space art, reaching back many, many decades, you will find you have a visual record," he said. "The art is a historical record of our changing understanding of the universe. It becomes a part of the story, and a part of the research, I think."

For more information on exoplanets, visit: https://exoplanets.nasa.gov

Source: JPL

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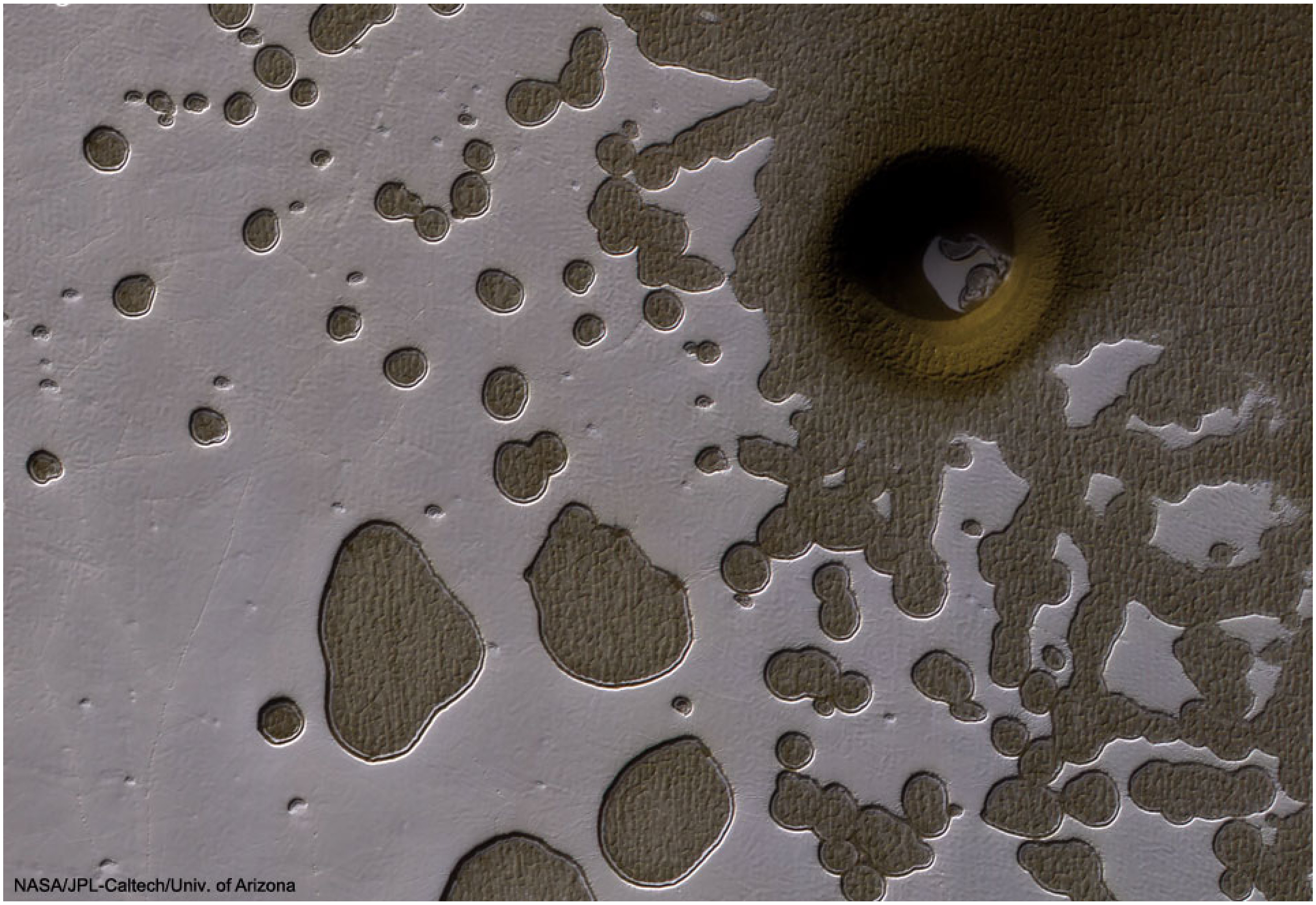
Space Image of the Week



An Unusual Hole in Mars
Image Credit: NASA, MRO, HiRISE, JPL, U. Arizona

Explanation: What created this unusual hole in Mars? Actually, there are numerous holes pictured in this Swiss cheese-like landscape, with all-but-one of them showing a dusty, dark, Martian terrain beneath evaporating, light, carbon-dioxide ice. The most unusual hole is on the upper right, spans about 100-meters, and seems to punch through to a lower level. Why this hole exists and why it is surrounded by a circular crater remains a topic of speculation, although a leading hypothesis is that it was created by a meteor impact. Holes such as this are of particular interest because they might be portals to lower levels that extend into expansive underground caves. If so, these naturally-occurring tunnels are relatively protected from the harsh surface of Mars, making them relatively good candidates to contain Martian life. These pits are therefore prime targets for possible future spacecraft, robots, and even human interplanetary explorers.

Source: APOD Return to Contents