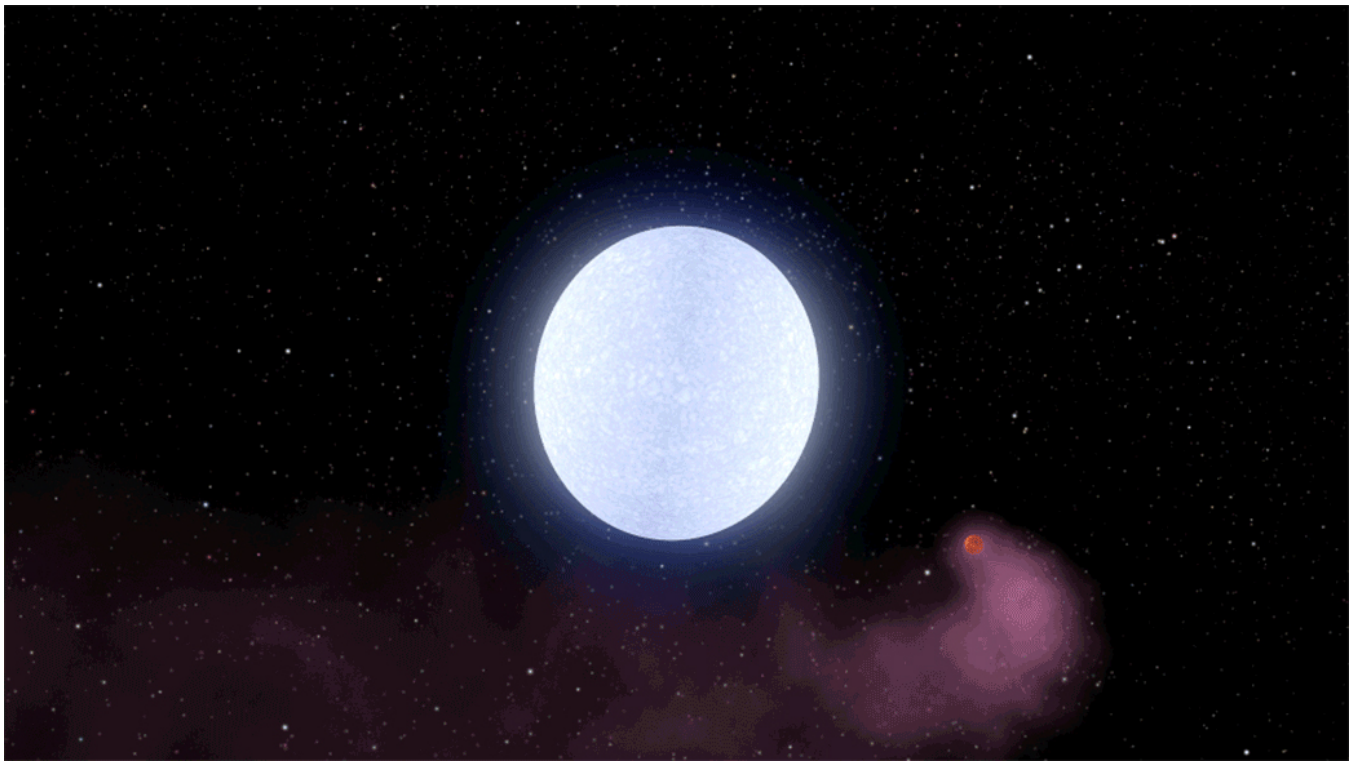
Space News Update

— June 6, 2017 —

Contents

1. A Planet Hotter Than Most Stars



A newly discovered Jupiter-like world is so hot that it's stretching the definition of the word "planet." With a day-side temperature of 4,600 Kelvin (more than 7,800 degrees Fahrenheit), planet KELT-9b is hotter than most stars, and only 1,200 Kelvin (about 2,000 degrees Fahrenheit) cooler than our own sun.

In this week's issue of the journal *Nature* and at a presentation at the American Astronomical Society spring meeting, an international research team led by astronomers at The Ohio State University and Vanderbilt University describes a planet with some very unusual features.

For instance, it's a gas giant 2.8 times more massive than Jupiter but only half as dense, because the extreme radiation from its host star has caused its atmosphere to puff up like a balloon. And because it is tidally locked to its star--as the Moon is to Earth--the day side of the planet is perpetually bombarded by stellar radiation, and as a result is so hot that molecules such as water, carbon dioxide, and methane can't form there. The properties of the night side are still mysterious--molecules may be able to form there, but probably only temporarily.

"It's a planet by any of the typical definitions based on mass, but its atmosphere is almost certainly unlike any other planet we've ever seen just because of the temperature of its day side," said Scott Gaudi, professor of astronomy at The Ohio State University and a leader of the study.

KELT-9b orbits a star, dubbed KELT-9, which is more than twice as large and nearly twice as hot as our sun. Keivan Stassun, a professor of physics and astronomy at Vanderbilt who directed the study with Gaudi said, "KELT-9 radiates so much ultraviolet radiation that it may completely evaporate the planet. Or, if gas giant planets like KELT-9b possess solid rocky cores as some theories suggest, the planet may be boiled down to a barren rock, like Mercury."

That is, if the star doesn't grow to engulf it first. "KELT-9 will swell to become a red giant star in about a billion years," said Stassun. "The long-term prospects for life, or real estate for that matter, on KELT-9b are not looking good."

Given that its atmosphere is constantly blasted with high levels of ultraviolet radiation, the planet may even be shedding a tail of evaporated planetary material like a comet, Gaudi added. While Gaudi and Stassun spend a lot of time developing missions designed to find habitable planets in other solar systems, the scientists said there's a good reason to study worlds that are unlivable in the extreme.

"As has been highlighted by the recent discoveries from the MEarth collaboration, the planet around Proxima Centauri, and the astonishing system discovered around TRAPPIST-1, the astronomical community is clearly focused on finding Earthlike planets around small, cooler stars like our sun. They are easy targets and there's a lot that can be learned about potentially habitable planets orbiting very low-mass stars in general. On the other hand, because KELT-9b's host star is bigger and hotter than the sun, it complements those efforts and provides a kind of touchstone for understanding how planetary systems form around hot, massive stars," Gaudi said.

Stassun added, "As we seek to develop a complete picture of the variety of other worlds out there, it's important to know not only how planets form and evolve, but also when and under what conditions they are destroyed."

How was this new planet found?

In 2014, astronomers using the KELT-North telescope at Winer Observatory in Arizona noticed a tiny drop in the star's brightness--only about half of one percent-- that indicated that a planet may have passed in front of the star. The brightness dipped once every 1.5 days, which means the planet completes a "yearly" circuit around its star every 1.5 days.

Subsequent observations confirmed the signal to be due to a planet, and revealed it to be what astronomers call a "hot Jupiter"--the ideal kind of planet for the KELT telescopes to spot.

KELT is short for "Kilodegree Extremely Little Telescope." Astronomers at Ohio State, Vanderbilt University, and Lehigh University jointly operate two KELTs (one each in the Northern and Southern Hemispheres) in order to fill a large gap in the available technologies for finding extrasolar planets.

Other telescopes are designed to look at very faint stars in much small sections of the sky, and at very high resolution. The KELTs, in contrast, look at millions of very bright stars at once, over broad sections of sky, and at low resolution.

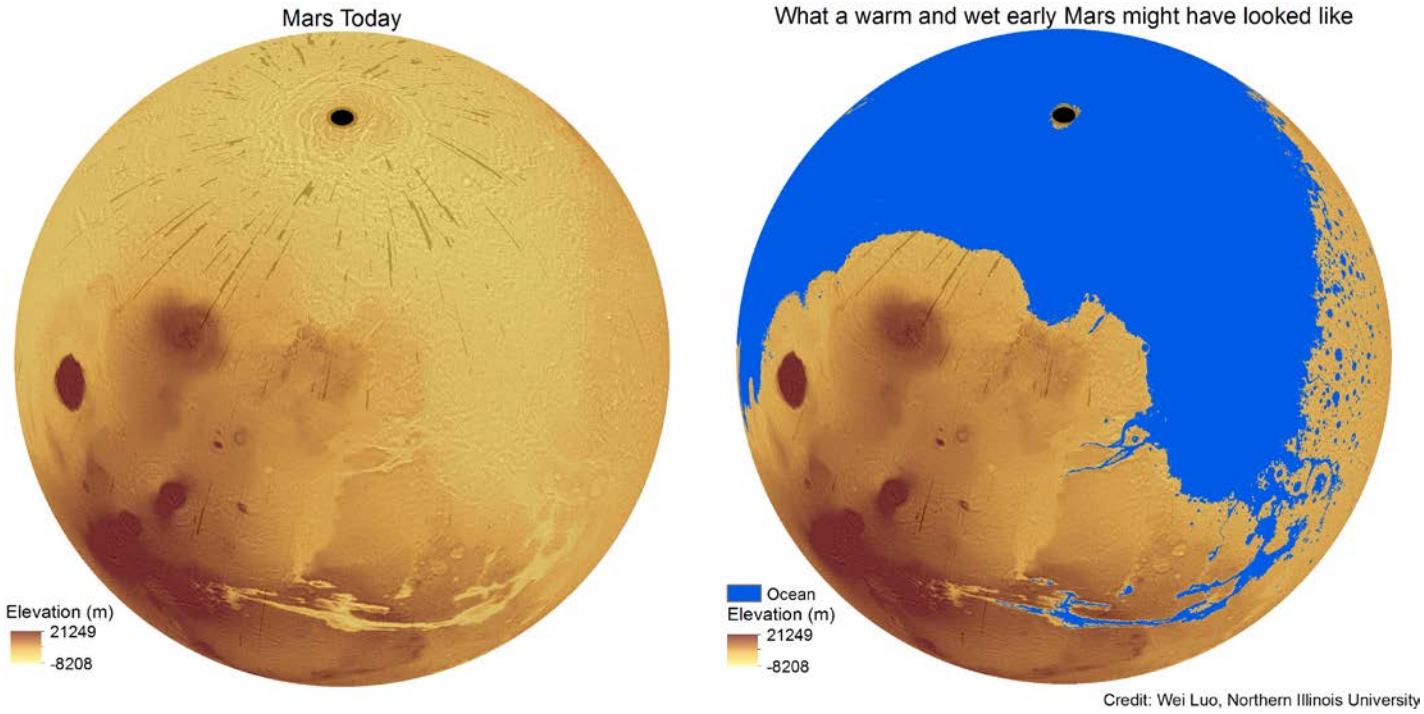
It's a low-cost means of planet hunting, using mostly off-the-shelf technology: whereas a traditional astronomical telescope costs millions of dollars to build, the hardware for a KELT telescope runs less than $75,000.

"This discovery is a testament to the discovery power of small telescopes, and the ability of citizen scientists to directly contribute to cutting-edge scientific research," said Joshua Pepper, astronomer and assistant professor of physics at Lehigh University, who built the two KELT telescopes.

The astronomers hope to take a closer look at KELT-9b with other telescopes--including Spitzer, the Hubble Space Telescope (HST), and eventually the James Webb Space Telescope. Observations with HST would enable them to see if the planet really does have a cometary tail, and allow them to determine how much longer that planet will survive its current hellish condition.

Source: EurekAlert Return to Contents

2. How Much Water Was Needed to Carve Valleys on Mars?



A new study led by Northern Illinois University geography professor Wei Luo calculates the amount of water needed to carve the ancient network of valleys on Mars and concludes the Red Planet's surface was once much more watery than previously thought.

The study bolsters the idea that Mars once had a warmer climate and active hydrologic cycle, with water evaporating from an ancient ocean, returning to the surface as rainfall and eroding the planet's extensive network of valleys.

Satellites orbiting Mars and rovers on its surface have provided scientists with convincing evidence that water helped shape the planet's landscape billions of years ago. But questions have lingered over how much water actually flowed on the planet, and the ocean hypothesis has been hotly debated.

In the new study, published June 5, in the online journal Nature Communications, Luo and colleagues used an innovative algorithm to more precisely calculate the volume of cavity space within Mars valleys and the amount of water that would have been needed to create those cavities through erosion over time. The majority of the valley networks are more than 3 billion years old.

"Our most conservative estimates of the global volume of the Martian valley networks and the cumulative amount of water needed to carve those valleys are at least 10 times greater than most previous estimates," Luo said.

Additionally, the new estimate of the amount of water needed to sculpt the valleys is at least one order of magnitude larger than the volume of a hypothesized ocean and 4,000 times the volume of the valley cavities, Luo said.

"That means water must have recycled through the valley systems on Mars many times, and a large open body of water or ocean is needed to facilitate such active cycling," Luo said. "I would imagine early Mars as being similar to what we have on Earth--with an ocean, lakes, running rivers and rainfall."

But a large piece of the puzzle is missing, he added, because climate models have not been able to reproduce an early Mars climate sufficiently warm enough to promote an active hydrologic cycle.

"Mars is much farther way from the sun than Earth, and when the sun was younger, it was not as bright as it is today," Luo said. "So there's still a lot to work out in trying to reconcile the evidence for more water."

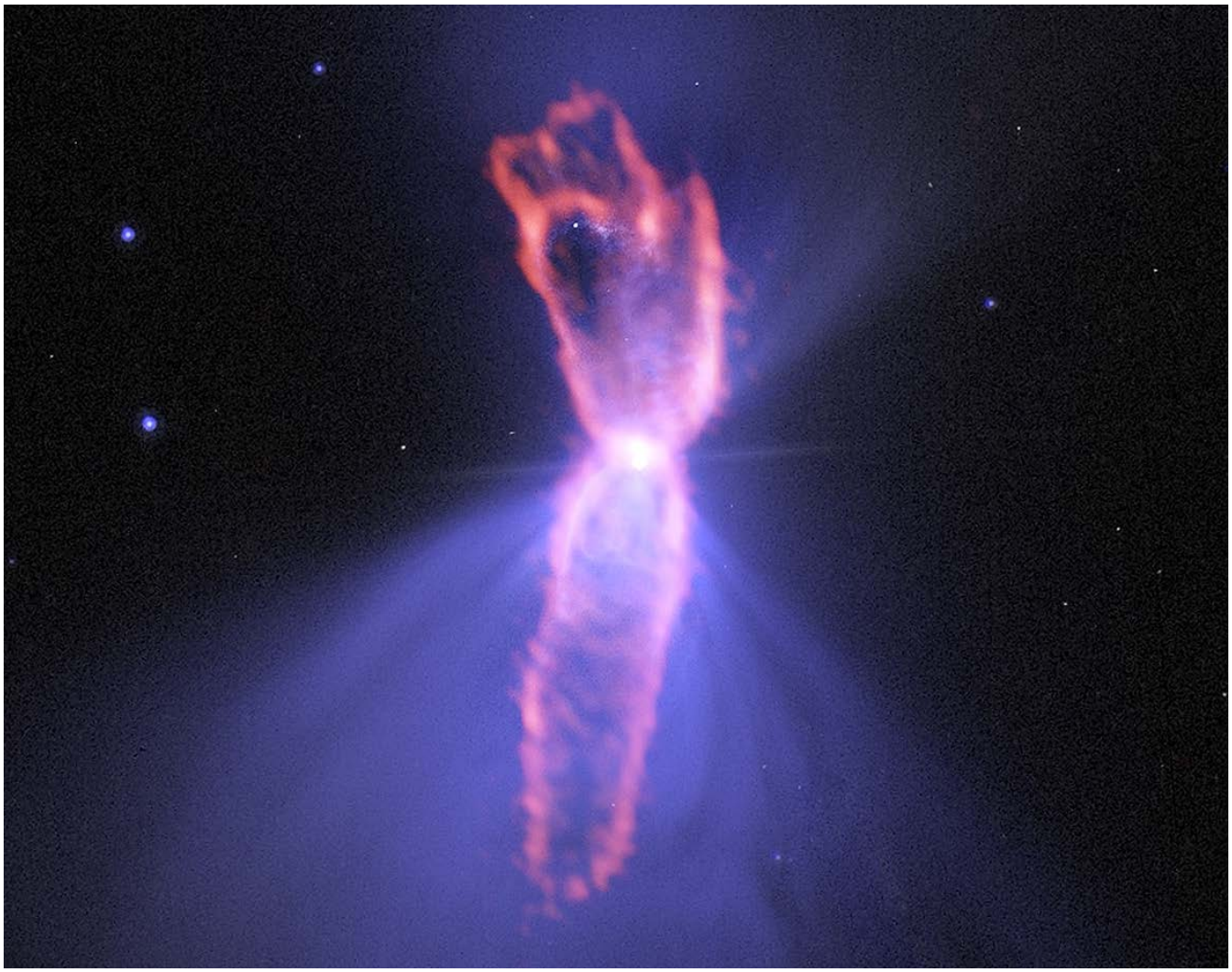
NASA's Mars Data Analysis Program provided funding to conduct the investigation. Professor Alan Howard of the University of Virginia and NIU Ph.D. student Xuezhi Cang collaborated on the research and co-authored the Nature Communications article.

To determine the volume of Mars' valley networks globally, the scientists developed computer algorithms, based on those used in terrestrial laser-generated data analyses with very high resolution. They applied the algorithms to the digital elevation model data, estimating the depth of all the Mars' valleys at pixel level.

"The increase in the estimated volume of valley erosion in this study primarily results from taking into account the incision of the many small tributaries draining into the main valleys," co-author Howard said.

Source: SpaceRef.com Return to Contents

3. ALMA Returns to Boomerang Nebula



An ancient, red giant star in the throes of a frigid death has produced the coldest known object in the cosmos—the Boomerang Nebula. How this star was able to create an environment strikingly colder than the natural background temperature of deep space has been a compelling mystery for more than two decades.

The answer, according to astronomers using the Atacama Large Millimeter/submillimeter Array (ALMA), may be that a small companion star has plunged into the heart of the red giant, ejecting most the matter of the larger star as an ultra-cold outflow of gas and dust.

This outflow is expanding so rapidly—about 10 times faster than a single star could produce on its own—that its temperature has fallen to less than half a degree Kelvin (minus 458.5 degrees Fahrenheit). Zero degrees Kelvin is known as absolute zero, the point at which all thermodynamic motion stops.

The ALMA observations enabled the researchers to unravel this mystery by providing the first precise calculations of the nebula's extent, age, mass, and kinetic energy.

"These new data show us that most of the stellar envelope from the massive red giant star has been blasted out into space at speeds far beyond the capabilities of a single, red giant star, " said Raghvendra Sahai, an astronomer at NASA's Jet Propulsion Laboratory in Pasadena, California, and lead author on a paper appearing in the *Astrophysical Journal*. "The only way to eject so much mass and at such extreme speeds is from the gravitational energy of two interacting stars, which would explain the puzzling properties of the ultra-cold

outflow." Such close companions may be responsible for the early and violent demise of most stars in the universe, Sahai noted.

"The extreme properties of the Boomerang challenge the conventional ideas about such interactions and provide us with one of the best opportunities to test the physics of binary systems that contain a giant star," adds Wouter Vlemmings, an astronomer at Chalmers University of Technology in Sweden and co-author on the study.

The Boomerang Nebula is located about 5,000 light-years from Earth in the constellation Centaurus. The red giant star at its center is expected to shrink and get hotter, ultimately ionizing the gas around it to produce a planetary nebula. Planetary nebulae are dazzling objects created when stars like our sun (or a few times bigger) shed their outer layers as an expanding shell near the end of their nuclear-fusion-powered life. The Boomerang Nebula represents the very early stages of this process, a so-called pre-planetary nebula.

When the Boomerang Nebula was first observed in 1995, astronomers noted that it was absorbing the light of the Cosmic Microwave Background, which is the leftover radiation from the Big Bang. This radiation provides the natural background temperature of space—only 2.725 degrees above absolute zero. For the Boomerang Nebula to absorb that radiation, it had to be even colder than this lingering, dim energy that has been continually cooling for more than 13 billion years.

The new ALMA observations also produced an evocative image of this pre-planetary nebula, showing an hourglass-shaped outflow inside a roughly round ultra-cold outflow. The hourglass outflow stretches more than three trillion kilometers from end to end (about 21,000 times the distance from the Sun to the Earth), and is the result of a jet that is being fired by the central star, sweeping up the inner regions of the ultra-cold outflow like a snowplow.

The ultra-cold outflow is more than 10 times bigger. Traveling more than 150 kilometers per second, it took material at its outer edges approximately 3,500 years to reach these extreme distances after it was first ejected from the dying star.

These conditions, however, will not last long. Even now, the Boomerang Nebula is slowly warming.

"We see this remarkable object at a very special, very short-lived period of its life," noted Lars-Åke Nyman, an astronomer at the Joint ALMA Observatory in Santiago, Chile, and co-author on the paper. "It's possible these super cosmic freezers are quite common in the universe, but they can only maintain such extreme temperatures for a relatively short time."

Source: Phys.org Return to Contents

The Night Sky

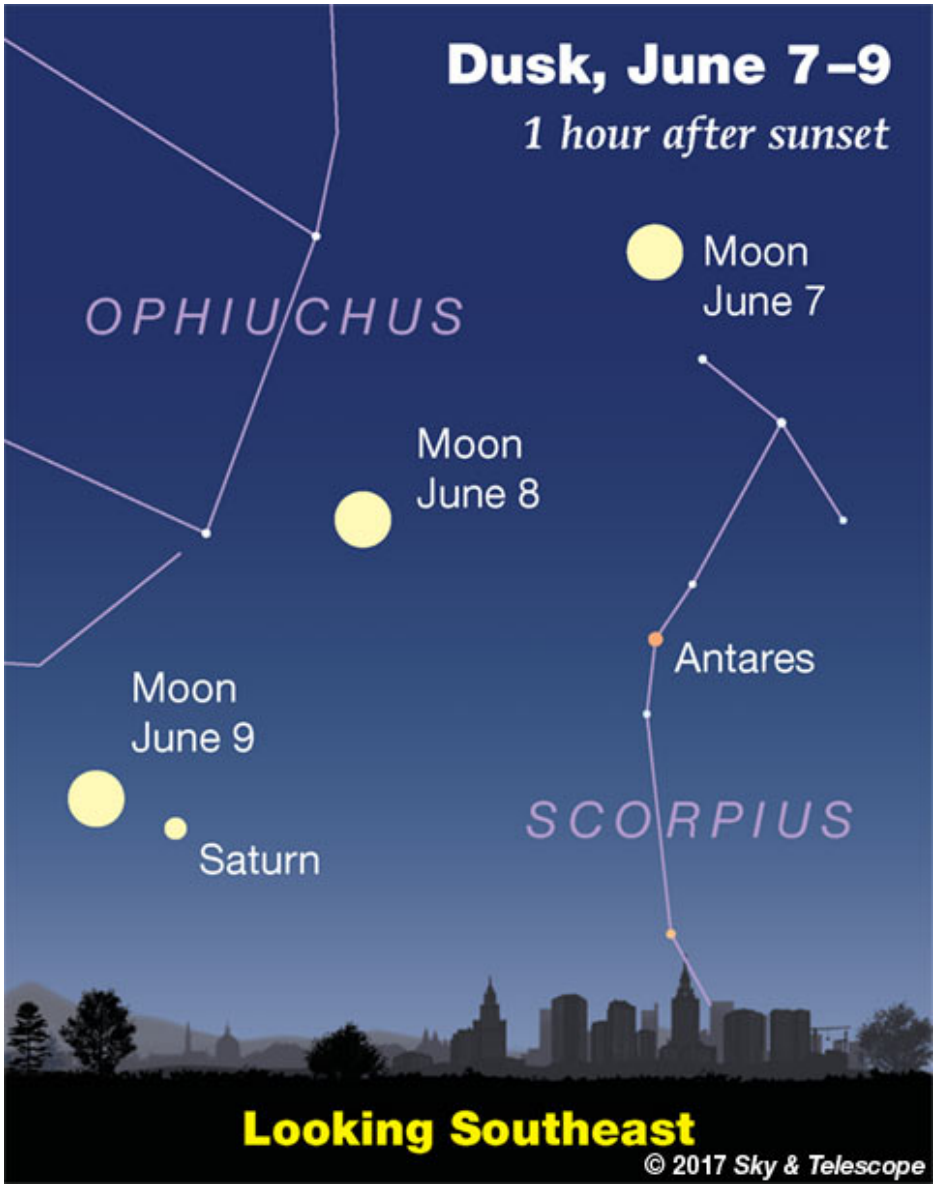
Tuesday, June 6

• After dark, Vega is the brightest star very high in the east. Just a little lower left of it 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 any telescope.

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



Wednesday, June 7

• With June well under way, 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 little Alcor right next to it. On which side of Mizar should you look for Alcor? As always, on the side toward Vega! Which is now shining in the east-northeast.

Thursday, June 8

• The Moon after dark forms a neat triangle with Antares to its lower right and Saturn to its lower left. Watch the triangle rotate clockwise as it crosses the sky through the night.

Friday, June 9

• As twilight deepens, look for Saturn just a few degrees to the right of the just-past-full Moon. Watch the Moon pull a little farther from Saturn as the hours pass.

Source: Sky & Telescope

Return to Contents

ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Tue Jun 6, 9:38 PM	4 min	19°	15° above N	10° above ENE
Tue Jun 6, 11:13 PM	2 min	34°	12° above WNW	34° above WNW
Wed Jun 7, 10:22 PM	2 min	59°	27° above NW	51° above ENE
Thu Jun 8, 9:30 PM	4 min	33°	23° above NNW	12° above E
Thu Jun 8, 11:05 PM	1 min	20°	11° above WNW	20° above W
Fri Jun 9, 10:14 PM	2 min	52°	22° above WNW	46° above S

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

NASA-TV Highlights

(all times Eastern Daylight Time)

2 p.m., Wednesday, June 7 - 2017 Astronaut Candidate Class Introduction with Vice President Mike Pence (all channels)

3 p.m., Wednesday, June 7 - Visit of Vice President Mike Pence to Mission Control, Houston (all channels)

4:30 p.m., Wednesday, June 7 - 2017 Astronaut Candidate Class News Conference from the Johnson Space Center, Houston (all channels)

6 p.m., Wednesday, June 7 - Replay of the 2017 Astronaut Candidate Class Introduction (all channels)

9:30 a.m., Friday, June 9 - ISS Expedition 52 In-Flight Educational Event with the Leeds Elementary School in Elkton, Maryland and Flight Engineer Jack Fischer of NASA (starts at 9:35 a.m.) (all channels)

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

Space Calendar

- Jun 06 - Comet C/2016 A8 (LINEAR) At Opposition (2.718 AU)
- Jun 06 - Comet P/1996 R2 (Lagerkvist) At Opposition (2.973 AU)
- Jun 06 - Apollo Asteroid 2017 KQ27 Near-Earth Flyby (0.003 AU)
- Jun 06 - Apollo Asteroid 2017 KR27 Near-Earth Flyby (0.018 AU)
- Jun 06 - Apollo Asteroid 2012 HN13 Near-Earth Flyby (0.073 AU)
- Jun 06 - Asteroid 13070 Seanconnery Closest Approach To Earth (1.254 AU)
- Jun 06 - Asteroid 1886 Lowell Closest Approach To Earth (1.315 AU)
- Jun 06 - Asteroid 1756 Giacobini Closest Approach To Earth (1.938 AU)
- Jun 06 - Asteroid 2046 Leningrad Closest Approach To Earth (2.217 AU)
- Jun 06 - David Scott's 85th Birthday (1932)
- Jun 06 - Ralph Baldwin's 105th Birthday (1912)
- Jun 07 - Comet 75D/Kohoutek At Opposition (4.222 AU)
- Jun 07 - NEW [Jun 04] Amor Asteroid 2017 LE Near-Earth Flyby (0.013 AU)
- Jun 07 - Asteroid 7032 Hitchcock Closest Approach To Earth (1.476 AU)
- Jun 07 - Asteroid 7291 Hyakutake Closest Approach To Earth (2.531 AU)
- Jun 07 - Kuiper Belt Object 2010 KZ39 At Opposition (45.083 AU)
- Jun 07 - George de Bothezat's 135th Birthday (1882)
- Jun 07 - Charles Barkla's 140th Birthday (1877)
- Jun 08 - HOT [Jun 02] World Oceans Day
- Jun 08 - Comet 73P-BS/Schwassmann-Wachmann Near-Earth Flyby (0.056 AU)
- Jun 08 - Comet 121P/Shoemaker-Holt At Opposition (4.267 AU)
- Jun 08 - Apollo Asteroid 2011 PU1 Near-Earth Flyby (0.061 AU)
- Jun 08 - Apollo Asteroid 2063 Bacchus Closest Approach To Earth (1.417 AU)
- Jun 08 - Asteroid 82332 Las Vegas Closest Approach To Earth (1.735 AU)
- Jun 08 - Asteroid 9012 Benner Closest Approach To Earth (2.205 AU)
- Jun 08 - 10th Anniversary (2007), STS-117 Launch (Space Shuttle Atlantis, International Space Station)
- Jun 08 - Bruce McCandless' 80th Birthday (1937)
- Jun 08 - Alfred Rordame's 155th Birthday (1862)
- Jun 09 - Comet 138P/Shoemaker-Levy At Opposition (3.698 AU)
- Jun 09 - NEW [Jun 03] Amor Asteroid 2017 KS34 Near-Earth Flyby (0.074 AU)
- Jun 09 - Asteroid 5203 Pavarotti Closest Approach To Earth (0.935 AU)
- Jun 09 - Asteroid 4766 Malin Closest Approach To Earth (1.916 AU)
- Jun 09 - Neptune Trojan 2013 KY18 At Opposition (29.186 AU)
- Jun 09 - 65th Anniversary (1952), Abee Meteorite Fall in Canada
- Jun 09 - Johann Gottfied Galle's 205th Birthday (1812)
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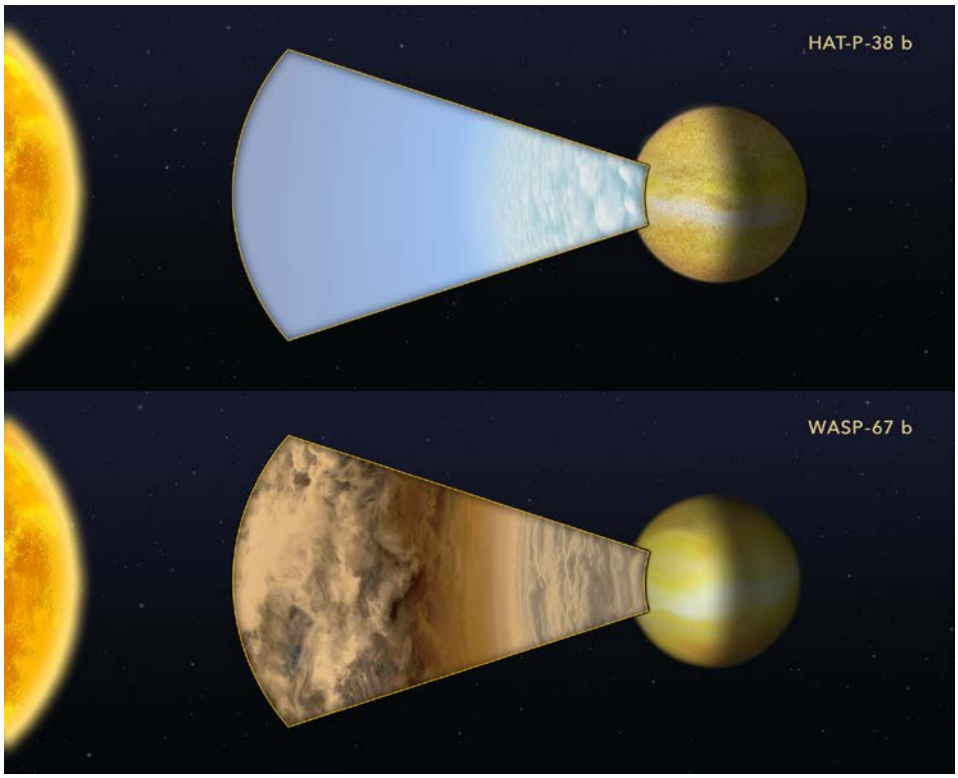
Source: JPL Space Calendar

Return to Contents

Food for Thought

Hubble's Tale of Two Exoplanets: Nature vs. Nurture



Is it a case of nature versus nurture when it comes to two "cousin" exoplanets? In a unique experiment, scientists used NASA's Hubble Space Telescope to study two "hot Jupiter" exoplanets. Because these planets are virtually the same size and temperature, and orbit around nearly identical stars at the same distance, the team hypothesized that their atmospheres should be alike. What they found surprised them.

Lead researcher Giovanni Bruno of the Space Telescope Science Institute in Baltimore, Maryland, explained, "What we're seeing in looking at the two atmospheres is that they're not the same. One planet—WASP-67 b—is cloudier than the other—HAT-P-38 b. We don't see what we're expecting, and we need to understand why we find this difference."

The team used Hubble's Wide Field Camera 3 to look at the planets' spectral fingerprints, which measure chemical composition. "The effect that clouds have on the spectral signature of water allows us to measure the amount of clouds in the atmosphere," Bruno said. "More clouds mean that the water feature is reduced." The teams found that for WASP-67 b there are more clouds at the altitudes probed by these measurements.

"This tells us that there had to be something in their past that is changing the way these planets look," said Bruno.

Today the planets whirl around their yellow dwarf stars once every 4.5 Earth days, tightly orbiting their stars closer than Mercury orbits our sun. But in the past, the planets probably migrated inward toward the star from the locations where they formed.

Perhaps one planet formed differently than the other, under a different set of circumstances. "You can say it's nature versus nurture," explains co-investigator Kevin Stevenson. "Right now, they appear to have the same physical properties. So, if their measured composition is defined by their current state, then it should be the

same for both planets. But that's not the case. Instead, it looks like their formation histories could be playing an important role."

The clouds on these hot, Jupiter-like gas giants are nothing like those on Earth. Instead, they are probably alkali clouds, composed of molecules such as sodium sulfide and potassium chloride. The average temperature on each planet is more than 1,300 degrees Fahrenheit.

The exoplanets are tidally locked, with the same side always facing the parent star. This means they have a very hot day-side and a cooler night-side. Instead of sporting multiple cloud bands like Jupiter does, each probably has just one broad equatorial band that slowly moves the heat around from the day-side to the night-side.

The team is just beginning to learn what factors are important in making some exoplanets cloudy and some clear. To better understand what the planets' pasts may have been, scientists will need future observations with Hubble and the soon-to-be-launched James Webb Space Telescope.

The team's results were presented on June 5 at the 230th meeting of the American Astronomical Society in Austin, Texas.

Source: NASA Return to Contents

Space Image of the Week

Orion: Belt, Flame, and Horsehead
Image Credit & Copyright: Rogelio Bernal Andreo (Deep Sky Colors)

Explanation: What surrounds the famous belt stars of Orion? A deep exposure shows everything from dark nebula to star clusters, all embedded in an extended patch of gaseous wisps in the greater Orion Molecular Cloud Complex. The brightest three stars, appearing diagonally on the left of the featured image are indeed the famous three stars that make up the belt of Orion. Just below Alnitak, the lowest of the three belt stars, is the Flame Nebula, glowing with excited hydrogen gas and immersed in filaments of dark brown dust. Just to the right of Alnitak lies the Horsehead Nebula, a dark indentation of dense dust that has perhaps the most recognized nebular shapes on the sky. The dark molecular cloud, roughly 1,500 light years distant, is cataloged as Barnard 33 and is seen primarily because it is backlit by the nearby massive star Sigma Orionis. The Horsehead Nebula will slowly shift its apparent shape over the next few million years and will eventually be destroyed by the high-energy starlight.

Source: APOD

Return to Contents