On Sep 6, Commander Jeff Williams returned to Earth from the ISS after setting an all-time NASA record of 534 total days in space. This was the experienced astronaut's fourth mission since 2000.

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A Successful Launch of the First Asteroid Sample-return Mission

OUT OF THIS WORLD

By Abhay Shah

On September 8, NASA embarked on a ground-breaking mission that will literally break ground on one of the oldest objects in our Solar System, an asteroid. The Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx) will map 101955 Bennu, a nearby asteroid, and retrieve a sample of its surface to bring back to Earth for study – the first mission of its kind.

In the early Solar System, asteroids were significant to the creation of planetismals, rocky objects that coalesced into protoplanetary disks of gas and dust from which the planets ultimately formed. Additionally, our young Earth may have received much of its earliest water from the bombardment of asteroids. Asteroids have driven large-scale cosmic impacts in our Solar System, and OSIRIS-REx will help us to understand more about these important objects' origins and composition. With a better understanding of asteroids, scientists can uncover more about the early formation of our Solar System and the beginnings of life.

But studying these vital celestial bodies isn't easy. Most asteroids are relatively small and distant and lie in the Asteroid Belt between Mars and Jupiter, making them difficult to reach or even examine with ground telescopes. Bennu was chosen for a visit by OSIRIS-REx because it is a NEO (Near-Earth Object). To be accessible for a sample-return mission, an asteroid must be located within 1.6 astronomical units (AU) and 0.8 AU from the Sun (the Earth is 1 AU). Bennu lies at approximately 1.3 AU. In addition, it has an orbit with low eccentricity and inclination, making it easier for a spacecraft encounter.

Artist's illustration of OSIRIS-REx with its robotic arm extended to take a sample at the asteroid 101955 Bennu.

Meanwhile, Bennu's 492-m diameter also makes it large enough for a spacecraft to

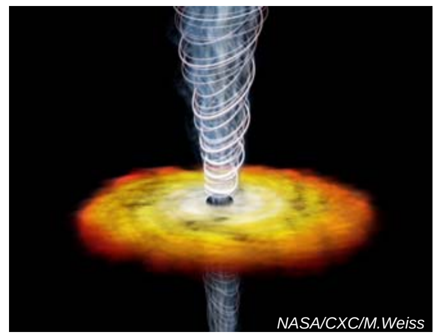
OSIRIS-REx On its Way (cont'd on Page 6)

Contemplating Quasars: Cosmic Beacons in the Universe

UNDERSTANDING OUR UNIVERSE

By Alan Rude

Quasar. The word is short for quasi-stellar radio source, a name that means "*star-like emitters of radio waves.*" The name was given to these unusual objects when they were first detected in the 1960s. Astronomers now know that most quasars are only faint radio wave emitters, compared with the amounts of other electromagnetic radiation they emit, but this charming name remains today.



Powerful high-energy jets accompany accretion around a supermassive black hole, producing a quasar.

In 1963, Maarten Schmidt, a Caltech astronomer working at Mt. Palomar Observatory, first discovered a quasar, a mysterious phenonomena unlike anything seen before. The most distant object detected to date, it also had the greatest intrinsic luminosity ever observed. In fact, it was so bright that it was initially mistaken for a star. But measurements of the redshift in its light spectra (a shift toward longer wavelengths) indicated that it was billions of light years away – too distant to be a star. Its luminosity and distance proved it was something entirely new; neither a faraway galaxy, because it appeared only as a point of light, nor any other type of cosmic object. Yet most of these mere points of light are larger than our Solar System.

Quasars lie between 10 and 13 billion light-years away from Earth; there are none any closer. Since their light coming to us has been travelling for at least 10 billion years, quasars may have been prevalent in the early universe. However, they stopped forming long ago. Although more than 200,000 quasars have been observed so far, they are relatively rare. This number may seem large, but it is miniscule compared with the number of known galaxies in our universe.

The advent of the Hubble Space Telescope and its observations over the past 26 years have allowed astronomers to

Contemplating Quasars (cont'd on Page 6)

THIS MONTH: ***Winter Astronomy Class Begins Nov 9, Night Sky Photography Workshop Begins Nov 10***

WHAT'S UP IN THE SKY

AAA Observers' Guide

By Tony Faddoul

November's Evening Planets: Mars will be between Sagittarius the Archer and Capricornus the Sea Goat until 9 PM this month. Saturn will be in Ophiuchus the Serpent Bearer for about one hour after sunset during the first half of November. Bright Venus will be in Sagittarius for about one hour after sunset. Mercury will be in Ophiuchus for about one hour after sunset in the second half of the month. Uranus will be in Pisces the Fish and Neptune in Aquarius the Water Bearer.

November's Evening Stars: Spot the Summer Triangle of Vega in Lyra the Harp, Deneb in Cygnus the Swan, and Altair in Aquila the Eagle until midnight, setting earlier every night. The Winter Triangle of Sirius (the brightest star viewed from Earth) in Canis Major the Great Dog, Betelgeuse in Orion the Hunter, and Procyon in Canis Minor the Small Dog will be beginning at 11 PM. Bright Capella in Auriga the Charioteer will be up all night. See the stars of constellations Andromeda, Cassiopeia, Perseus, Cepheus, Draco, Pegasus, Aries, Taurus, Pisces, and Ursa Major and Ursa Minor (the Big and Little Dippers).

November's Morning Planets: Uranus will be in Pisces until 4 AM, setting earlier each night until 2 AM by the end of the month. Jupiter will be in Virgo the Maiden around 4 AM, rising earlier each night until 2 AM by the end of November.

November's Morning Stars: Sirius will be up until the start of the morning in Canis Major. Spot Capella in Auriga, Aldebaran in Taurus the Bull, Betelgeuse and Rigel in Orion, and the stars of Aries, Gemini, Orion, Pisces, Andromeda, Cassiopeia, Draco, Cepheus, Perseus, Leo, and the two Dippers.

November "Skylights"

Nov 7	First Quarter Moon 2:50 AM
Nov 14	Full Moon 8:50 AM
	Supermoon at perigee (221,500 miles away)
Nov 18	Leonid Meteor Shower peaks - predawn
Nov 21	Last Quarter Moon 3:30 PM
Nov 27	Moon 2° north of Jupiter - dawn
Nov 27	Moon at apogee (252,600 miles away)
Nov 29	New Moon 7:18 AM

Times given in EST (Daylight Savings ends Nov 6).

Largest Supermoon in 7 Decades

On November 14, Earth's Moon will be full, bright, and the center of attention around the globe – appearing at its largest in our sky in 68 years.

What is a Supermoon?

The Moon on Sep 27, 2015 at perigee (left) and on March 5, 2015 at apogee (right).

The Moon circles the Earth in an elliptical orbit, which means that its distance from us varies. A Supermoon occurs when the Moon is full and at its closest to Earth. At these times, it appears larger in our sky. While "Supermoon" is not an astronomical term, it has been used widely over the past few decades. The technical term for this alignment of the Earth-Moon-Sun system is perigee-syzygy.

How Big will the Moon Be?

On the 14th, the Full Moon will be at its closest to Earth, or perigee, at 221,524 miles away. That's about 30,000 miles closer than when the Moon is at its furthest distance this year, or apogee. Distance is measured from the Moon's center to Earth's center, but if we measured from where we stand to the surface of the Moon, the distance will be just 216,480 miles. The Moon will appear 7% larger than it appears on average, a difference that is not very distinguishable for the human eye.

Is this a Coincidence?

It is normal for the Moon to be at its closest to Earth around the full phase. However, it is much more rare for the Earth and the Moon to be in the exact points in their orbits to bring them this close. Not since January 1948 has the Moon been this close to Earth – and it won't happen again until November 2034.

When is the Best Time to See the Supermoon?

The best view of the Supermoon is at nightfall on Monday, November 14, when the Moon also rises. It will seem bigger when it is closer to the horizon and to landscape objects. A good view can also be had on the Sunday and Tuesday evenings before and after the Supermoon phase, when the Moon will appear almost full and with only 2% less illumination.

What are the Effects of a Supermoon?

The Supermoon can be found in the constellation Aries on Nov 14 and in Taurus on Nov 15 – so what does that mean? Not a thing. However, the proximity of the Supermoon to Earth will produce higher tides than usual, with the highest tide on Nov 15. Otherwise, the Supermoon's only influence on Earthlings is a treat to a beautiful sight in the night sky.

Sources: timeanddate.com; Astronomy Magazine.

Follow veteran sky watcher Tony Faddoul each month, as he points our minds and our scopes toward the night sky.

Putting the Awe in Utah: The Night Sky at Arches NP

FOCUS ON THE UNIVERSE

By Stan Honda

Normally, I plan night sky photography trips when there will be a New Moon, to take advantage of darker skies. But in mid-September, I found myself in Arches National Park with a bright Full Moon threatening to drown out the photographic possibilities of this beautifully dark location. Located in southeastern Utah near the town of Moab, the Park boasts a spectacular landscape of natural arches and fantastic-looking rock formations. I was determined to capture its nighttime wonder, with or without the Moon's cooperation.

I traveled to Arches with my friend Rush, who hails from Albuquerque. We had a week to go before conducting our night sky photography workshops in Flagstaff, AZ and the Chaco Culture National Historic Park in New Mexico, so we decided to squeeze in an astrophotography adventure.

In Utah, we stayed at the Devils Garden campground, located at the end of a paved road that runs deep into the Park. This was truly the best place to experience Arches. After an afternoon scouting trip, we decided to set up our equipment near Balanced Rock, an eerie rock formation that looks like a huge round boulder atop a pedestal. With a clear view to the east, my plan was to photograph the iconic site with the Milky Way, just as the rising moon would light up the rock.

Sunset was at 7:23 PM that evening, and moonrise at 8:54 PM. Astronomical twilight was at 8:52 PM, so the sky was going to be at its very darkest for the night just when the moon would rise – and what a dark sky it was! We set up around 8 PM, and a brilliant Milky Way was in full glory, standing almost straight up in the south and arching high overhead to the north. That night, I used a Sony a7S camera with a Nikon 14-24mm f2.8 lens, attached via a Novoflex lens adapter. All were mounted on a Manfrotto Befree, a great, compact travel tripod.

I took some very nice photos with the rock silhouetted against the stars of the Milky Way, but there was a drawback to shooting Balanced Rock at night – it lies just off the main road through Arches, and headlights danced across the rock every time a car drove by. I was worried that the glare of the lights would interfere with my shot, just when I was trying to capture the site at moonrise. But fortunately, traffic dropped off around then, and I was able to shoot between the occasional interruptions.

Looking to the east, we soon spied a glow on the horizon. Just before 9 PM, a light almost as bright as a car headlight shined right at us: there was the Moon, just two days past its full phase. Initially, the moonlight only grazed the very top of Balanced Rock, so I had enough time to take a few test shots to determine that an exposure of ISO 6400, 8 seconds, f2.8 would capture the light on the rock and the stars in the background.

At first, I worried that a huge sandstone rock formation just to the left of Balanced Rock would light up from the Moon and distract from the main subject of my photo. But in a few minutes, I discovered that the second rock would remain in shadow, while the Moon lit the full 128 feet of Balanced Rock's height. The ground was also illuminated, and the Milky Way was clearly visible between the two formations. With the Moon low on the horizon, it cast a warm glow on the scene, its light passing through the haze and dust of the atmosphere. That effect lasted only a few minutes, and the giant Moon rose higher in the sky, washing out the stars.

Moonrise: The Milky Way above the iconic Balanced Rock at Arches National Park in Utah.

Because the light was fairly balanced in my best photo, processing the image wasn't difficult. I really liked the light on the rock itself, so I brightened it slightly while keeping its deep orange color. Selecting just the sky in Photoshop, I added contrast, neutralized the color, and brightened the stars slightly, so they wouldn't blend into the background. Side lighting on Balanced Rock added dimension to the image, with the rock formation's right side partly in shadow.

So if you find yourself under a Full Moon during a night sky shoot, plan for the moonrise. You'll have a small window as the Moon lights your foreground features below a fairly dark sky – it pays (and pays off!) to get the timing right.

Explore more night sky photography at **www.stanhonda.com.**

Submit your photography questions to **stanhonda@gmail.com.**

Stan Honda is a professional photographer. Formerly with Agence France-Presse, Stan covered the Space Shuttle program. In his "Focus on the Universe" column, he shares his night sky images and explores his passions for astronomy and photography.

Finding the Signal in the Noise: Using Stats to Discover New Worlds

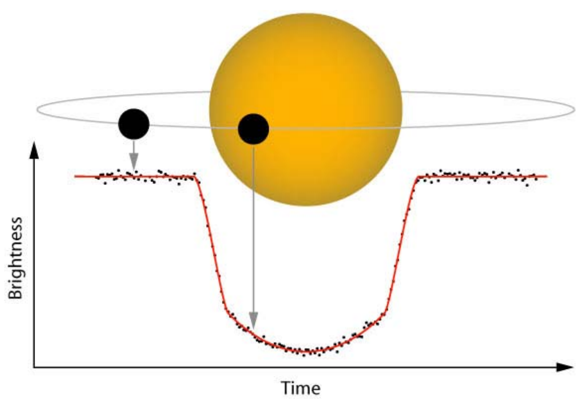
ASTRO TALKS

By Harriet Brettle

It's hard to avoid exoplanets these days, and why would you want to, with so many exciting discoveries being announced this year? In May, NASA introduced us to over 1,000 new exoplanets, and only a few weeks ago, a research team led by Queen Mary University of London confirmed the discovery of an Earth-sized planet around Proxima Centauri – our nearest stellar neighbor! Science fiction enthusiasts dream about what it is like on other worlds, but today the study of planets beyond our Solar System has made those dreams a reality.

In July, I spent a week at Caltech for the annual Sagan Summer Exoplanet Workshop to learn about the latest research in this field. The Workshops are hosted by the NASA Exoplanet Science Institute. This year, the Workshop highlighted how statistics are used to enhance the research of exoplanet hunters. There are a number of methods used to detect and characterize exoplanets, and each has its own advantages and challenges. As Carl Sagan himself once said, "*Extraordinary claims require extraordinary evidence,*" and with the extraordinary amount of data now being collected, exoplanet researchers must use data analysis techniques that rely on a statistical approach.

The discoveries announced in May were the result of statistical analysis of data from the Kepler space telescope, which uses the *transit method* to detect exoplanets. When a planet passes in front of its host star as it orbits, it blocks some of the light. This dip in brightness can be observed from Earth and shows up with a telltale transiting light curve.



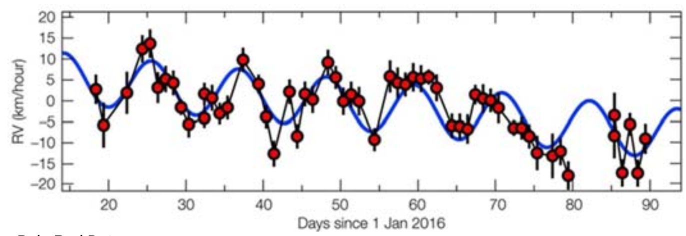
Univ. Hawaii Institute for Astronomy

When the planet WASP-10b crosses the disk of its star, WASP-10, the brightness of the star decreases, allowing scientists to measure the precise size of the planet.

Transits are hard enough to observe, given the dimness of stars, but there are other challenges with this method. Astronomical noise makes it difficult to know for certain that there is a planet orbiting a given star. Phenomena like binary stars, sunspots, and stellar magnetic cycles can also produce dips in a light curve that may resemble a transiting planet.

Tim Morton, an Associate Research Scholar at Princeton, was the brains behind the May NASA announcement, and he presented his approach to extracting unwanted noise from Kepler data during the Workshop. To determine which observed stars really had an orbiting planet, Morton wrote a special computer code that runs through the entire Kepler database – that's thousands of light curves!

Morton's code compares the probability that a light curve is a result of a transiting planet against the probability that it's a false positive. Alternative astrophysical explanations produce light curves with different characteristics. For example, sunspots on the surface of a star will have the same period as the star's own rotation, while the magnetic cycles of stars occur over different time periods. These differences can help to isolate transiting planet characteristics from the data. The code also only considers high signal noise to ensure that astrophysical false positives were picked out, rather than instrumentation blips or gaps in the data. From this, Morton was able to determine, with a high level of statistical confidence, that 1,000 light curves were due to a transiting planet.



Pale Red Dot

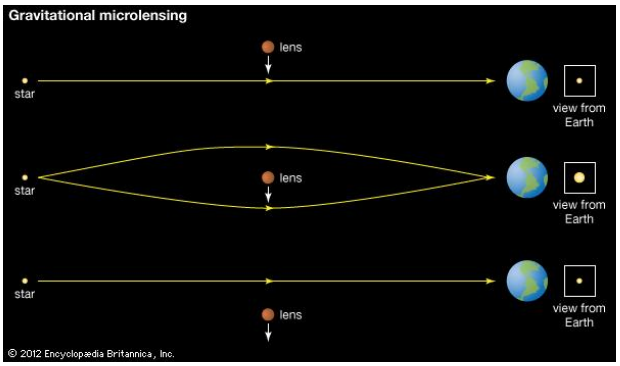
The Doppler Effect for Proxima Centauri shows how the star moves towards and away from Earth over time. The wobble is caused by an orbiting planet.

The recent discovery of an Earth-sized planet around Proxima Centauri was made thanks to another observation technique: *radial velocity* (RV). If a star has an orbiting planet, the center of mass of the star-planet system will not be at the center of the star, but rather it will be slightly off-center, causing the star to wobble about this combined center of mass. We can observe this wobble by the Doppler Effect – when the star is moving towards us, its light spectra is blueshifted toward shorter wavelengths, and when it moving away from us, the spectra is redshifted to longer wavelengths.

In its wobble, Proxima Centauri approaches Earth at about 5 km per hour, which is normal human walking pace, and it recedes at the same speed. This regular pattern of changing radial velocities repeats with a period of 11.2 days. Careful analysis of the resulting tiny Doppler shifts indicated the presence of a planet with a mass of at least 1.3 times that of the Earth, orbiting at about 7 million km from its host star.

As with transits, a challenge of the RV method is removing unwanted noise from the data. Stellar effects like sunspots and magnetic activity can have an even greater impact on a star's radial velocity than an orbiting planet. Xavier Dumusque of Harvard University explained how his work applies the detailed information we already have about our Sun to the observed activity of RV target stars. With our solar data, he is able to separate out astrophysical alternatives for Doppler shifts from the stars that wobble from orbiting planets.

In addition to these techniques, *microlensing* is another method used by astronomers to observe star-planet systems thousands of light-years away. When a distant star passes behind another star in our field of view, the foreground star acts as a gravitational lens, bending the light of the hidden star so that they appear next to each other. When the two stars become perfectly aligned from Earth's perspective, the light of the hidden star emerges on every side of the lens star, creating an "Einstein ring." Telescopes cannot distinguish the two stars, so they appear at that moment as one source of light, brighter than the lens star alone. And when the background star has a planet, the planet's gravity bends its light too, creating another image of the star and a spike in brightness during the microlensing event. This change in luminosity will reveal the distant exoplanet and provide information about its mass, orbit, and period with a high degree of accuracy.



Gravitational microlensing occurs as one star moves in front of a distant star. When the lens star is directly between Earth and the distant star, it appears to increase in brightness.

A drawback to this technique is that microlensings are one-off events that can't be revisited. The method requires continuous, wide field imaging of the sky that targets tens of thousands of potential planets at a time. That's a lot of data. And more is on the way: NASA's Wide Field Infrared Survey Telescope (WFIRST) is due to launch in the mid 2020s, and this exciting new mission will surely discover many more distant exoplanets through microlensing.

Another option for exoplanet hunters is *direct imaging,* which does exactly what it's name suggests. By blotting out a star's light, which can drown out everything around it, the reflection off of orbiting planets can be seen in greater detail. NASA's 2018 James Webb Space Telescope will be primed for direct imaging, as will WFIRST. Both will be able to discover new exoplanets, focusing their efforts on star-planet systems already identified by radial velocity observations.

Recent improvements in technology have led to leaps in our understanding of exoplanets. Research is shifting from discovery to analysis and is seeking not just *to find* but *to find out about* these new worlds. Do they have an atmosphere? Can their surfaces support liquid water? Could they sustain life? By using existing data and the power of statistics, we can enhance our understanding of other planets.

One revelation from the Sagan Summer Workshop was that astronomers still struggle to find planets that resemble those in our own Solar System. There isn't much overlap between the thousands of new exoplanets discovered and our more familiar neighbors. We are only now beginning to understand the diversity of planets out there in our galaxy.

Exoplanet researchers' aims are ambitious; learning about planets beyond the Solar System will help answer the ultimate question about life, the universe, and everything. Hopefully, they will discover something more illuminating than *The Hitchhikers Guide to the Galaxy's* answer, *"42!"* e

Mad for Mars

Lessons to Learn When You Don't Stick the Landing

On October 19, the European Space Agency's Schiaparelli spacecraft failed to make its intended "soft landing" on Mars. The lander was part of ESA's ExoMars 2016 mission, which did successfully place the Trace Gas Orbiter (TGO) into orbit around the Red Planet. Radio signals picked up by the TGO and the Giant Metrewave Radio Telescope in India indicate that Schiaparelli stopped transmitting just before the lander was supposed to touch down and after completing most of its preparatory steps. During its six-minute descent, the lander decelerated through the Martian atmosphere, ejected its back heat shield, and unfurled its parachute. But after that, the signals stopped. Schiaparelli's thrusters may have shut down too soon.

One day later, NASA's Mars Reconnaissance Orbiter (MRO) photographed the intended landing area of Schiaparelli and discovered two new objects on the planet's surface half a mile apart – likely the robot lander and the parachute. The U.S. space agency believes that with the thrusters powered down, the lander must have experienced freefall from about 1.2 to 2.5 miles above the surface, hitting the ground at over 186 mph. Its onboard propellant would have exploded the spacecraft upon impact.

A board of inquiry will examine the signals and images further, but ESA is taking the lander loss on the chin. "*Schiaparelli's primary role was to test European landing technologies. Recording the data during the descent was part of that*," said ESA Director General Johann-Dietrich Wörner.

Had Schiaparelli landed safely, it was only expected to survive for a short time, perhaps just 2 to 8 sols, with limited battery power and few scientific tools. The sensors it did possess were intended to measure wind speed and direction, humidity, atmospheric pressure near the surface, atmospheric transparency, and atmospheric electrification. Schiaparelli would have taken the very first measurements of electric fields on the Martian surface. Its scientific goal was to learn more about the role of electric forces on dust lifting, the process that initiates dust storms.

ESA's ExoMars 2016 mission's Schiaparelli lander undergoing thermal tests in June.

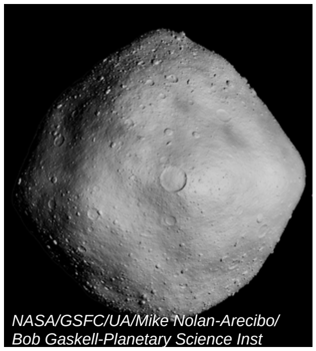
Schiaparelli is Europe's second lander to crash on Mars; last year, MRO finally found the remains of the 2003 Beagle 2 lander. The loss of Schiaparelli is not expected to impact ESA's ExoMars 2020 mission, which aims to land a rover on the planet using a different landing system, designed by Russia.

Meanwhile, the TGO is in fine working order. It is designed to search for and analyze gases like methane that may indicate biological processes on Mars. "*We have an impressive orbiter around Mars ready for science and for relay support for the ExoMars rover mission in 2020*," said Wörner. e AMW ***Sources: exploration.esa.int; nasa.gov; nytimes.com.***

OSIRIS-REx On its Way (cont'd from Page 1)

come into contact with it. An asteroid smaller than 200 meters would spin so fast that debris and material would fly off its surface and potentially damage the spacecraft.

But most importantly, Bennu was selected because of its carbon-rich composition. This primitive asteroid hasn't really changed in the past 4 million years, and it contains organic molecules and amino acids that may have been the precursors to life on Earth.



A radar image of the asteroid Bennu, formerly known as 1999 RQ36, with simulated cratering and topography.

NASA has calculated that OSIRIS-REx will arrive at Bennu on August 17, 2018. But before it can collect any samples, NASA scientists have to figure out the best place for the spacecraft to make contact. Upon arrival at Bennu, OSIRIS-REx is scheduled to take surface images of the rotating asteroid, calculate its mass, and build a shape model that highlights Bennu's features. To do this, OSIRIS-REx must fly in formation with the asteroid, using thrusting and braking maneuvers to match Bennu's velocity, which averages 63,000 mph. The spacecraft will have picked up speed with a gravity assist from a flyby of Earth in 2017.

Data collection during the global mapping phase is the focal point of the mission. Several possible contact sites must be vetted by the spacecraft for optimal touchdown and optimal surface material (regolith) procurement. OSIRIS-REx will only have one opportunity to make contact with Bennu, so it must build the most accurate model of its surface features, and all of its scientific equipment must be absolutely precise. The biggest threat during this phase is solar radiation pressure. Outgassing from the spacecraft and thermal emission from the asteroid could propel the spacecraft toward a different trajectory.

OSIRIS-REx will spend several years mapping Bennu before making contact. Then, on July 4, 2020, the spacecraft will extend its Touch-And-Go Sample Acquisition Mechanism (TAGSAM), a robotic arm with a sampler head, to collect surface material. It will touch Bennu for just five seconds, releasing a burst of nitrogen gas to stir up the soil and force up to 4 pounds of dust into a collector. The dust is then put into a Sample Return Capsule that will be brought back to Earth.

Unfortunately, the spacecraft won't be able to begin that journey back home for another year – a window for departure won't open until March 2021. Once OSIRIS-REx finally arrives back at Earth, it will jettison the capsule and deflect itself into solar orbit. The capsule, with its precious dust cargo, will land in the Utah desert on September 24, 2023.

With this historic endeavor, NASA aims to bring the largest sample of extraterrestrial material to Earth since the Apollo era. And while we learned a great deal about Earth from Moon dust, a Bennu soil sample may hold the answers to our very existence. We are only just at the beginning of our journey to understanding our Solar System, and ourselves.

Sources: nasa.gov.

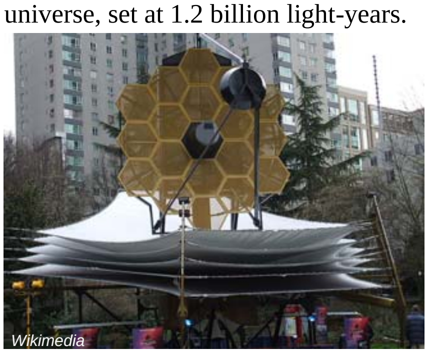
Contemplating Quasars (cont'd from Page 1)

construct a theory about quasars. Hubble data indicate that quasars almost always reside at the center of active galaxies. Active galaxies are those where the total energy emitted far exceeds the radiation of all the stars in that galaxy. So, what is producing that extra energy? Infall of matter into a supermassive black hole – billions of times the mass of the Sun – at these galactic centers can result in very hot regions of the accretion disk, where huge amounts of energy are released. This energy produces the light of other electromagnetic radiation spectra that we observe at the black hole, and it can also power a quasar. Supermassive black holes are the engines of quasars.

For reasons not yet fully understood, the emissions of quasars, occurring almost at the speed of light, are twin jets positioned one hundred eighty degrees apart. When one of the jets is pointed directly at the Earth, we can detect its brilliant light and the super-energetic radiation of the quasar.

To sum up: quasars are extraordinarily bright, incredibly far, and extremely old. They are also exceptionally small for the huge amount of energy they emit.

Now, in addition to all these superlatives, a team of astronomers has discovered that the largest structure in the universe is one that is made up of quasars. This structure, which stretches 9 billion light-years across, has been named the Large Quasar Group (LQG), and it appears to conflict with a widely accepted cosmological principle: the universe should look uniform when observed at the largest scales. It also breaks the current upper size limit for cosmic structures in the universe, set at 1.2 billion light-years.



The new James Webb Space Telescope is set to launch in 2018. Its unprecedented resolution and sensitivity may help us to better understand ancient quasars.

"*This discovery was very much a surprise, since it breaks the cosmological record as the largest structure in the known universe*," says Roger Clowes, an astronomer at England's University of Central Lancashire, "*This represents a challenge to our current understanding and now creates a mystery – rather than solves one. It could mean that our mathematical description of the Universe has been oversimplified – and that would represent a serious difficulty and a serious increase in complexity*."

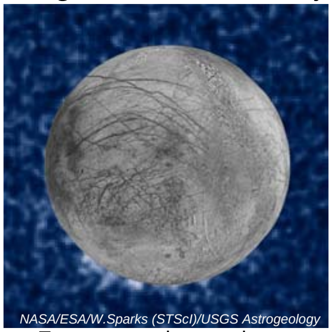
When we observe quasars, we are looking back in time to a period not long after the Big Bang, when light was just piercing the particle fog. Studying quasars and quasar clusters can provide a more detailed picture of what was going on in that era, both for themselves and their hosts, the active galaxies. Some believe that quasar radiation, approximately 11 billion years ago, prevented the coalescence of gas and dust clouds, and slowed the formation of stars. But to verify this theory, and to understand these remarkable objects, we need to take a closer look – and observatories like the new James Webb Space Telescope should give us the eyes we need.

Sources: sdss.org; sci-news.com; universetoday.com.

Hubble Hubbub

Water Plumes on Europa

In September, astronomers announced that Jupiter's moon Europa may have plumes of water vapor erupting from its surface. Estimated to rise about 125 miles high, the plumes contain materials that emanated from below a thick layer of ice on the moon. And deep below the ice of Europa is a global ocean. Lured by the possibilities of this ocean, NASA has been planning a mission to visit the Jovian moon. But while we know that Europa's ocean contains twice as much water as all the oceans on Earth, we don't know how far beneath the ice it begins. Drilling to reach the liquid water would be futile without knowing the thickness of the ice. But with plumes spewing into space, a vessel could simply fly by, reach out a robotic hand, and test the waters. The vapor may contain organics from the deepest depths of the ocean. *"Europa's ocean is considered to be one of the most promising places that could potentially harbor life in the solar system,"* said NASA's Geoff Yoder. Led by William Sparks of the Space Telescope Science Institute (STScI) in Baltimore, the astronomers observed the plumes in silhouette, while looking for signs of a possible thin atmosphere around Europa as it passed in front of bright Jupiter. The image supports another Hubble observation in 2012 that indicated plumes at Europa's south pole. If confirmed, Europa would be the second body in the Solar System known to have water vapor plumes, after Saturn's moon Enceladus. *AMW* **Source: nasa.gov.**



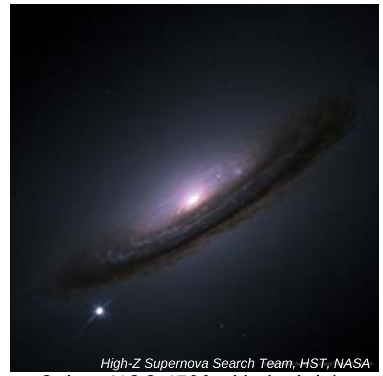
NASA/ESA/W.Sparks (STScI)/USGS Astrogeology

Europa superimposed on a composite image taken by Hubble's spectrograph, which shows the silhouette of water vapor plumes (bottom left) erupting.

Celestial Selection of the Month

Supernova 1994D

50 million light-years away, and 50 million years ago, a star exploded in the constellation Virgo, but its brilliant light was only seen on Earth 22 years ago. The supernova was discovered independently in 1994 by researchers from UC Berkeley and Princeton. SN 1994D lies in the outskirts of spiral galaxy NGC 4526, which was also home to SN 1969E. One of the brightest supernovae seen in recent history, SN 1994D shined at its maximum brightness with magnitude 11.8; its host galaxy is also very luminous with a magnitude of 9.6. SN 1994D is a Type 1a supernova. This is not a rare type, but it is special. It was classified as Type 1a, because all such supernovae have the same intrinsic brightness, and they all dim at the same rate. For this reason, Type 1a supernovae are used as standard candles for measuring distance in the universe. In fact, the measurement of these special star explosions led to the discovery that the universe is expanding at an accelerated rate – the light spectra of distant Type 1a supernovae was redshifted toward longer wavelengths, further away than they should be. A Type 1a supernova occurs in binary systems where at least one of the two stars orbiting each other is a white dwarf. White dwarfs are limited to a certain mass, so if they accrete too much from a companion, nuclear fusion can initiate, and a runaway reaction will release enough energy for an explosion. *AMW* **Sources: rochesterastronomy.org; spacetelescope.org; nasa.gov.**



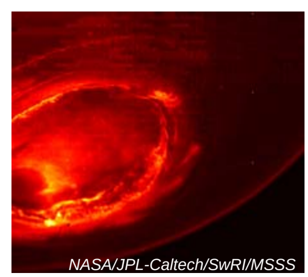
High-Z Supernova Search Team, HST, NASA

Galaxy NGC 4526 with the bright explosion of SN 1994D (lower left), a Type 1a supernova.

Probing the Solar System

Jupiter's North Pole Like Nothing Else

In August, NASA's Juno spacecraft imaged storms at Jupiter's north pole unlike anything observed on other gas giants in the Solar System. *"First glimpse of Jupiter's north pole, and it looks like nothing we have seen or imagined before,"* said Scott Bolton, principal investigator of Juno. *"It's bluer in color up there than other parts of the planet, and there are a lot of storms."* Juno took the image during the first of 36 planned orbital flybys of the planet, in a transit that took six hours. However, it took a day and a half for the data collected to download, and it will take much longer for the analysis to be complete. The image was taken from 2,500 miles above Jupiter's clouds. *"There is no sign of the latitudinal bands or zone and belts that we are used to – this image is hardly recognizable as Jupiter,"* said Bolton, *"We're seeing signs that the clouds have shadows, possibly indicating that the clouds are at a higher altitude than other features."* Meanwhile, other instruments aboard Juno are also collecting data. The Jovian Infrared Auroral Mapper (JIRAM) is observing the planet's poles and has detected hot spots never seen before. It has also taken the first images of Jupiter's southern aurora. *"JIRAM is getting under Jupiter's skin,"* said co-investigator Alberto Adriani. *"No other instruments, both from Earth or space, have been able to see the southern aurora. Now, with JIRAM, we see that it appears to be very bright and well-structured."* But Juno isn't just looking at Jupiter, it's listening to it too. The WAVES instrument has recorded ghostly sounds from above the planet. Known about since the 1950s, these radio emissions, the strongest in the Solar System, are caused by the energetic particles that create the huge auroras. *"Jupiter is talking to us in a way only gas-giant worlds can,"* said co-investigator Bill Kurth. *AMW* **Source: nasa.gov.**



NASA/JPL-Caltech/SwRI/MSSS

Juno's JIRAM infrared view of Jupiter's southern aurora is not visible from Earth.

NASA/JPL-Caltech/SwRI/MSSS

Jupiter's north pole imaged by NASA's Juno spacecraft on Aug 27 shows unusual storms and weather.

AAA Events on the Horizon

NOVEMBER 2016

WED, Nov 2

AAA Social Event at Reichenbach Hall – Manhattan, *M*

@ 6:30 pm – 8:30 pm

Meet new AAA Members and reconnect with old friends. Cash bar with a few snacks provided.

FRI, Nov 4 *Next Dec 2*

2016-2017 Lecture Series at AMNH – Manhattan, *MP*

@ 6:15 pm – 8:00 pm

"*In the Shadow of the Moon: The Lure of the Solar Eclipses*" with AAA's Stan Honda and Tony Hoffman. In the Kaufmann Theater (*Enter at 77th St*). Details at www.aaa.org/lectures/.

Observing at Floyd Bennett Field – Brooklyn, *PTC*

@ 8 pm – 10 pm *Next Dec 9*

SAT, Nov 5

Observing at Great Kills – Staten Island, *PTC*

@ 8:30 pm – 11 pm

Observing at Brooklyn Museum Plaza – Brooklyn, *PTC*

@ 9 pm – 11 pm

WED, Nov 9, 16, & 30 *Next Dec 7, 14, 21*

Winter Astronomy Class at Cicatelli Center – Manhattan, *M*

@ 6:30 pm – 8:30 pm

"*Clocks, Calendars, and Coordinates, and Orbits*" with David Kiefer. $60 for AAA Members only. Register at www.aaa.org/education/classes/.

Nov 10, 15, 19 or 22, & 29 *Next Dec 3 & 6*

Intro Night Sky Photography at Cicatelli Center – Manhattan, *M*

@ 6:30 pm – 8:30 pm

Join AAA's Stan Honda for an introductory in-depth workshop about wide-field night sky photography with digital SLR or mirrorless cameras. Learn how to shoot starscapes, landscapes, eclipses, the Sun, the Moon, and astronomical phenomena. Includes a fieldtrip to Central Park. $60 for AAA Members only. Register at www.aaa.org/education/classes/.

SUN, Nov 13

Solar Observing at Flushing Meadows Park – Queens, *PTC*

@ 11 am – 1 pm

***M*: Members only; *P*: Public event; *T*: Bring telescopes, binoculars; *C*: Cancelled if cloudy.**

For location & cancellation information visit www.aaa.org.

Other Astronomy Events in and around NYC

FRI, Nov 4

@ 7 pm **Columbia Stargazing/Lectures at Pupin Hall – Manhattan, *F***

"*Origins: The Chemicals of Life*" with Daniel Wolf Savin. Observing follows, weather permitting. (*outreach.astro.columbia.edu*)

SAT, Nov 5

@ 7 pm **Night Sky at Inwood Hill Park (Pats Lawn) – Manhattan, *F***

"*Taurid Meteor Shower.*" See 5 to 10 meteors an hour! (*nycgovparks.org*)

SUN, Nov 6

@ 6 pm **Astronomy at Pelham Bay Nature Center – Bronx, *F***

NYC Urban Park Rangers guide observing. (*nycgovparks.org*)

SAT, Nov 12

@ 6 pm **Astronomy at Lemon Creek Park – Staten Island, *F***

NYC Urban Park Rangers guide observing. (*nycgovparks.org*)

TUES, Nov 15

@ 7 pm **Dark Nights Bright Lights at Tony Dapolito Rec Ctr – Manhattan, *F***

Chat with a NASA expert and learn about the search for the nearest inhabitable planet during an observing session. (*nycgovparks.org*)

WED, Nov16

@ 8 pm **Astronomy on Tap at The Way Station – Brooklyn, *F***

NYC Astro. Join scientists from around the five boroughs to learn about their latest research (*683 Washington Ave*). (*astronomyontap.org*)

SAT, Nov 19

@ 6 pm **Night Sky at Rockaway Beach (Boardwalk/116 St) – Queens, *F***

NYC Urban Park Rangers guide naked-eye observing. (*nycgovparks.org*)

@ 7 pm **AMNH Special Event (Hayden Planetarium) – Manhattan, *X***

"*SeismoDome: Sights and Sounds of Earthquakes and Global Seismology*." Join for an immersive experience of these planetary events. (*amnh.org*)

SUN, Nov 20

@ 2 pm **Kids Astronomy at Greenbelt Nature Center – Staten Island, *F***

"*Mysteries of the Universe*." Learn about the origins of the universe and life on Earth, and discover what came before and what's next. (*nycgovparks.org*)

MON, Nov 21

@ 7:30 pm **AMNH Frontiers Lecture (Hayden Planetarium) – Manhattan, *X***

"*Spaceman: An Evening with Mike Massimino.*" Hear about the astronaut's compelling life story from blue-collar Long Island to space. (*amnh.org*)

FRI, Nov 18

@ 7 pm **Columbia Stargazing/Lectures at Pupin Hall – Manhattan, *F***

"*How to Stage the Moon Landings*" with Zephyr Penoyre Observing follows, weather permitting. (*outreach.astro.columbia.edu*)

TUES, Nov 29

@ 7:30 pm **AMNH Astronomy Live (Hayden Planetarium) – Manhattan, *X***

"*Next Generation Astronomy*" with Jackie Faherty and Jana Grcevich. What we can expect from the new James Webb Space Telescope and the Gaia mission? What will they tell us about our cosmic origins? (*amnh.org*)

***F*: Free; *X*: Tickets required** (contact vendor for information); ***T*: Bring telescopes, binoculars**.

A Message from the AAA President

Dear AAA Members:

Sadly, we were rained out for the annual AAA Urban Starfest on Oct 1. Although the rain ended by the afternoon, the Sheep Meadow in Central Park was soaked, and the clouds were thick. Thanks to all the volunteers and coordinators who worked so hard for this event. Here's hoping for better luck next year!

The 2016-2017 Friday night Lecture Series at the American Museum of Natural History continues this month on Nov 4 as AAA's Stan Honda and Tony Hoffman share their adventures photographing eclipses with "*In the Shadow of the Moon: The Lure of Solar Eclipses*." Find the full series schedule at www.aaa.org/lectures/.

AAA's Winter Astronomy Class begins this month with David Kiefer's "*Clocks, Calendars, Coordinates, Orbits*," while Stan Honda leads an AAA Intro to Night Sky Photography Workshop. Registration is open for both, so sign up now at www.aaa.org/education/classes/.

For information about other events and observing sessions visit **www.aaa.org/calendar**.

Marcelo Cabrera

Marcelo Cabrera, *AAA President*

The Amateur Astronomers' Association of New York

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