Southwest Florida Astronomical Society
SWFAS

The Eyepiece
October 2014

Contents:

A MESSAGE FROM THE PRESIDENT

As we enter Fall, there is a lot going on both event wise and astronomically.

October brings us 2 eclipses, meteor showers and hopefully some cooler and drier weather. Last month our major event was International Observe the Moon Night. The weather did not cooperate well for us, Gary and I only had a family of 4 and just barely got the moon through clouds. At the planetarium, Bruce and the crew there had around 90. The star party for the 27th was also rained out.

I would like to introduce Heather Preston, she is the new planetarium director at the Calusa Nature Center Planetarium. She will be at the meeting so you all can meet her.

This month the weekend of the 17-19th is a very busy weekend. We have the Cub Scouts at Camp Miles Fri night and Solar observing there Saturday as well as Ding Darling Days on Sanibel on Sunday. Sunday I can use help with handouts as well as solar scopes at Ding Darling.

Brian

In the Sky this Month

Moon: October – 1st Quarter 1st; Full 8th; Last Quarter 15th; New 23rd; 1st Quarter 30th.

Total Lunar Eclipse: October 8th from 4:45 am to 7:24 am.
Partial Solar Eclipse: October 23rd with maximum eclipse (~25%) seen at sunset EST.
For safe solar viewing see http://www.skyandtelescope.com/observing/celestial-objects-to-watch/eclipses/
Eclipse info: http://www.skyandtelescope.com/astronomy-news/observing-news/total-lunar-eclipse-09262014/

The Planets:
Saturn is barely visible in evening at beginning of month.
Mars begins the month near Antares at magnitude 0.8 and moves east through the month towards top of Sagittarius' teapot.
Uranus is visible in Pisces all month. It has a close conjunction with the moon during the total lunar eclipse so the blue-green of Uranus should be especially impressive when viewed near the reddish disc of the eclipsed Moon.
Neptune is visible in Aquarius all month.
Finder charts are located at **skypub.com/urnep**.
Jupiter - rise occurs around 2:30 am at start of month. The -2.1 magnitude planet moves from Cancer into Leo during mid-month and ends the month in the vicinity of Regulus.
Mercury returns in the early dawn towards the end of the month.
Venus begins the month rising only ½ hr before the sun, and then later each morning. It passes through superior conjunction on October 25.

Messier Objects – Compare four Globular Clusters: M30 in Capricorn; M2 & M72 in Aquarius; and M15 in Pegasus. The Dumbbell Nebula (M27) may be found between Alberio (in Cygnus) and Delphinus.

Double Stars of the Month
Binocular – Epsilon Pegasi; Magnitudes 2.5, 8.7; Separation 144".

Telescope – Sagittarius 54 (SW of Barnard's Galaxy); Magnitudes 5.4, 7.7; Separation 45".
Telescope, Challenging – Zeta Aquarii; Magnitudes 4.3, 4.5; Separation 1.8".

The International Space Station: Several good views this month.
Oct 3rd at 8:35 pm from SSW to S; max alt 45°; for 2 minutes at -2.7 mag.
Oct 4th at 7:47 pm from S to ENE; max alt 27°; for 5 minutes at -2.2 mag.
Oct 5th at 8:34 pm from WSW to N; max alt 32°; for 5 minutes at -1.6 mag.
Oct 6th at 7:44 pm from SW to NE; max alt 78°; for 7 minutes at -3.0 mag.
Oct 8th at 7:43 pm from W to N; max alt 28°; for 5 minutes at -0.8 mag.
Oct 27th at 8:16 pm from NW to SW; max alt 75°; for 3 minutes at -3.2 mag.
Oct 28th at 7:26 pm from NNW to ESE; max alt 46°; for 6 minutes at -3.0 mag.
Oct 29th at 8:14 pm from W to S; max alt 19°; for 5 minutes at -0.5 mag.
Oct 30th at 7:23 pm from WNW to SSE; max alt 41°; for 6 minutes at -1.9 mag.

Hubble Space Telescope: Several good viewing opportunities late in the month.
Oct 24th at 8:56 pm from WSW to WSW; max alt 32°; for 2 minutes at 2.4 mag.
Oct 25th at 8:49 pm from W to W; max alt 41°; for 3 minutes at 2.0 mag.
Oct 26th at 8:42 pm from W to W; max alt 51°; for 3 minutes at 1.6 mag.
Oct 27th at 8:35 pm from W to WNW; max alt 59°; for 4 minutes at 1.2 mag.
Oct 28th at 8:28 pm from W to NNW; max alt 65°; for 4 minutes at 1.0 mag.
Oct 29th at 8:21 pm from W to N; max alt 67°; for 4 minutes at 0.8 mag.
Oct 30th at 8:13 pm from W to NE; max alt 69°; for 5 minutes at 0.7 mag.
Oct 31st at 8:06 pm from W to ENE; max alt 75°; for 5 minutes at 0.7 mag.
Extracted from http://www.heavens-above.com/

Future Events

Upcoming Meetings

Our Next monthly meeting will be October 2nd. Speaker/topic for the evening will be Brian discussing current events for the fall/winter. Focus will be on 2 eclipses and meteor showers to plan for.
Our November 6th meeting is a special night. We have a talk by Brian McGaffney of Nutwood Observatory and dark sky preserve. It is also our Telescope Renaissance night, so people can bring in scopes that they need help with. It is also a public nature center night as the Sierra Club, Herp Society and we will all be open to visitors that night. There will not be a formal business meeting that night. We will be starting at 7pm that night.

Star Party and Event Schedule

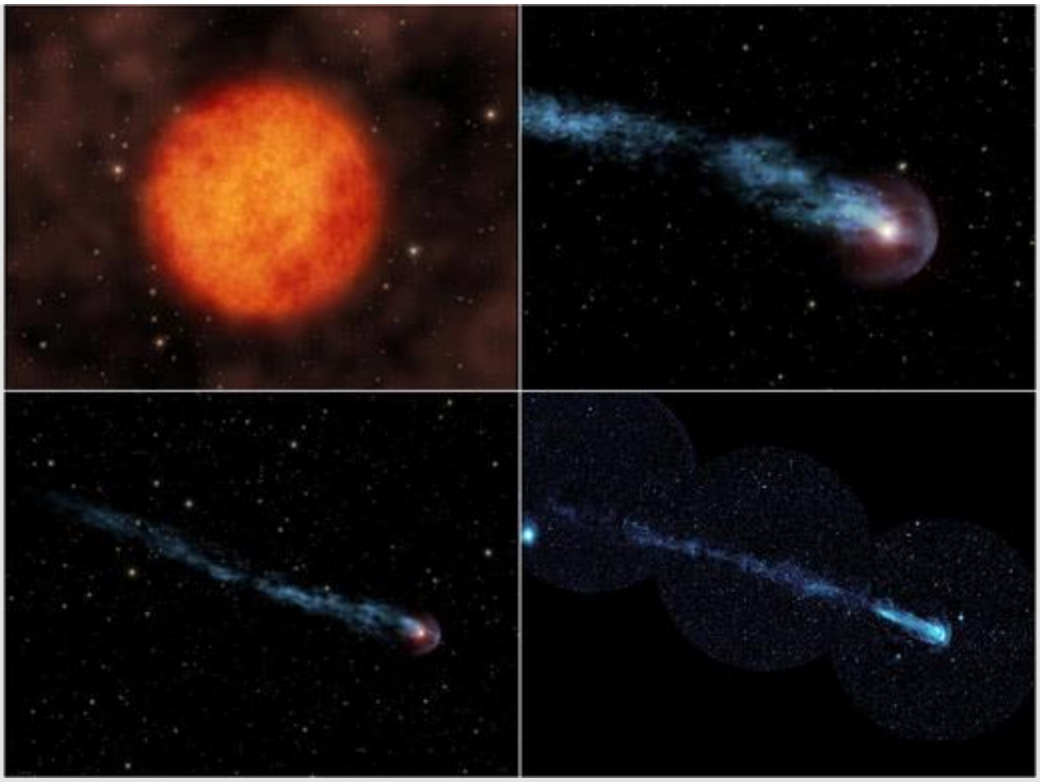
Date	Event	Location	Time	Info/Contact
Thursday, October 2nd	Monthly Meeting	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
Wed Oct 15th	Oasis Middle AeroSpace Program Presentation	Oasis Middle-Cape Coral	Daytime	Carol Stewart/ Johnnie Royal
Fri/Sat Oct 17/18	Cub Scout Extravaganze	Camp Miles	Dusk/Day	Brian Risley
Sun Oct 19th	Ding Darling Days	Ding Darling – Sanibel	9:00am-4:00 pm	Brian Risley
Fri October 24th	Astronomy for Amateurs	Hickey’s Creek Park	7:30 pm	Kelly Flaherty
Sat Oct 25th	Star Party	CRP	Dusk	Bruce Dissette
Thursday, November 6th	Monthly Meeting - Brian McGaffney Talk and Telescope Renaissance	Calusa Nature Center & Planetarium	7:00 pm	Brian Risley

November 22nd	Star Party	CRP	Dusk	Bruce Dissette
November 22nd	Homeschool Event	Koreshan Park - Estero	Dusk	Brian Risley
Thursday, December 4th	Monthly Meeting – Officer Elections	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
Saturday December 6th	Nature Center Event	Calusa Nature Center & Planetarium	7:30 pm	Heather Preston
Sat Dec 20th	Star Party	CRP	Dusk	Bruce Dissette
Thurs Jan 1, 2015	No Meeting		Holiday	
Saturday January 3rd 2015	Nature Center Event	Calusa Nature Center & Planetarium	7:30 pm	Heather Preston
Fri January 16th 2015	Astronomy for Amateurs	Hickey's Creek Park	6:30 pm	Kelly Flaherty
Sat Jan 17th	Star Party	CRP	Dusk	Bruce Dissette
Thurs Jan 22nd 2015	School Event	Country Oaks Elementary – Labelle	Dusk	Brian Risley
Thursday, February 5th	Monthly Meeting – Program TBD	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
Sat Feb 7th 2015	Shell Point Star Party	Shell Point Village	Dusk	Doug Heatherly
Fri Feb 20th	Astronomy for Amateurs	Hickey's Creek Park	7:00 pm	Kelly Flaherty
Sat Feb 21st	Star Party	CRP	Dusk	Bruce Dissette
Thursday, March 5th	Monthly Meeting – Program TBD	Calusa Nature Center & Planetarium	7:30 pm	Brian Risley
Sat March 20th	Star Party	CRP	Dusk	Bruce Dissette
Thursday, April 2nd	Monthly Meeting – Jack Berninger Program	Calusa Nature Center & Planetarium	7:30 pm (Program 1st then bus meeting)	Brian Risley

Minutes of SWFAS Meeting – September 4th, 2014

The minutes will appear in a later publication

A Real Shooting Star



+ Play animation - Lower resolution (Quicktime - 6.5Mb)
+ Play animation - Higher resolution (Quicktime - 27Mb)

This artist's animation illustrates a star flying through our galaxy at supersonic speeds, leaving a 13-light-year-long trail of glowing material in its wake. The star, named Mira (pronounced my-rah) after the Latin word for "wonderful," sheds material that will be recycled into new stars, planets and possibly even life. NASA's Galaxy Evolution Explorer discovered the long trail of material behind Mira during its survey of the entire sky in ultraviolet light.

The animation begins by showing a close-up of Mira - a red-giant star near the end of its life. Red giants are red in color and extremely bloated; for example, if a red giant were to replace our sun, it would engulf everything out to the orbit of Mars. They constantly blow off gas and dust in the form of stellar winds, supplying the galaxy with molecules, such as oxygen and carbon, that will make their way into new solar systems. Our sun will mature into a red giant in about 5 billion years.

As the animation pulls out, we can see the enormous trail of material deposited behind Mira as it hurls along between the stars. Like a boat traveling through water, a bow shock, or build up of gas, forms ahead of the star in the direction of its motion. Gas in the bow shock is heated and then mixes with the cool hydrogen gas in the wind that is blowing off Mira. This heated hydrogen gas then flows around behind the star, forming a turbulent wake.

Why does the trailing hydrogen gas glow in ultraviolet light? When it is heated, it transitions into a higher-energy state, which then loses energy by emitting ultraviolet light - a process known as fluorescence.

Finally, the artist's rendering gives way to the actual ultraviolet image taken by the Galaxy Evolution Explorer

Mira is located 350 light-years from Earth in the constellation Cetus, otherwise known as the whale. Coincidentally, Mira and its "whale of a tail" can be found in the tail of the whale constellation.

Image credit: NASA/JPL-Caltech

9,096 Stars in the Sky — Is That All?

By: Bob King

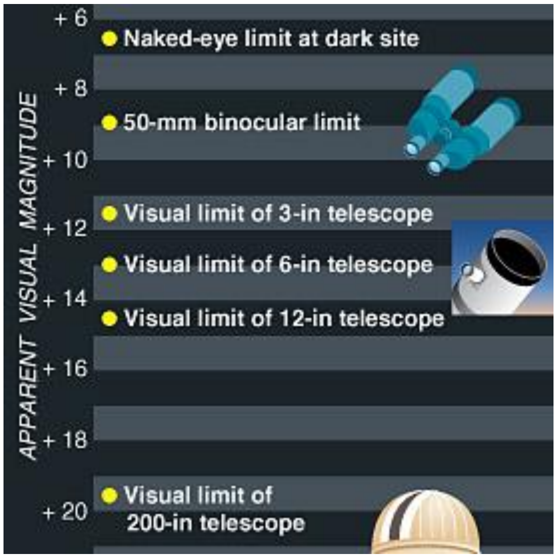
Ten thousand stars bedazzle the eye on a dark night. Wait, how many?

How many stars can you see in the sky? -- *Bob King*

Go out on a dark night and you'd swear there are thousands of stars in the sky. Too many to count. 10,000 at least. But why guess when someone has already done the counting for you? Astronomer **Dorrit Hoffleit** of Yale University, well known for her work with variable stars, compiled the **Yale Bright Star Catalog** decades ago. It tabulates every star visible from Earth to magnitude 6.5, the naked eye limit for most of humanity.

You might be in for a surprise when you read it, though. The total comes to 9,096 stars visible across the entire sky. Both hemispheres. Since we can only see half the celestial sphere at any moment, we necessarily divide that number by two to arrive at 4,548 stars (give or take depending on the season). And that's from the darkest sky you can imagine. I don't know about you, but that number seems paltry to one's impression of an inky night in the backcountry.

At the poles, where the north and south polestars are pinned to the zenith and no stars rise or set, the same ~4,500 stars are visible every single clear night of the year. At northern mid-latitudes, the pole star is halfway up in the northern sky, allowing us to peer deeper into the southern realms of the celestial sphere. During the course of a year from latitude 45° north, we see roughly half again as many stars as we do at a particular time on a given evening. That tallies up to approximately 6,800 stars. Still pretty lean, but apparently enough to convey the impression of an intensely starry sky.



Why stop at the naked eye? 50-mm binoculars increase the number of stars to about 100,000 while observers using a 3-inch telescope can spy about 5 million.
Sky and Telescope

Astronomers use the **magnitude scale** to measure star and planet brightness. Each magnitude is 2.5 times brighter than the one below it. Altair, in Aquila the Eagle, shines at about magnitude +1 which is 2.5 times brighter than a 2nd magnitude star, which is 2.5 times brighter than a 3rd magnitude star, and so on.

A first magnitude star is 2.5 x 2.5 x 2.5 x 2.5 x 2.5 (about 100) times brighter than a 6th magnitude star.

The bigger the magnitude number, the fainter the star. If an object is *really* bright, it's assigned a negative magnitude. Sirius, the brightest star sparkles at magnitude –1.4, Jupiter at –2.5, and Venus tops the planets at –4.4. The Full Moon reaches a magnificent –12.7, bested only by the Sun at –26.7.

The sky facing south at nightfall in late September from a dark, light-pollution-free site with stars visible to magnitude 6.5, the naked eye limit. Click to enlarge.
Source: Stellarium

While the total number of naked eye stars may seem unimpressive, consider what happens to the sky in and around cities, where most of us live. From the suburbs, the magnitude limit is around +4 for a worldwide total of about 900 stars or *half* that for your location. If we set the city limit at magnitude +2 (stars similar to the Big Dipper in brightness) we're left with just 70 stars worldwide, or 35 stars visible from say, downtown Chicago or Boston.

The same sky as above but seen from the downtown of a larger city. The reddish glow is simulated light pollution from high-pressure sodium vapor lights. *Source: Stellarium*

No wonder city dwellers are stunned by the night sky when they take their first trip to the country. Stars barely exist for those trapped beneath an ever-present dome of light pollution.

Numbers increase exponentially if we go in the opposite direction as there are far more faint stars than bright. The standard limit for a pair of 50-mm binoculars is 9th magnitude, opening up a vista of some 217,000 stars across the heavens. Impressed? A 3-inch telescope pulls in a treasure-worthy 5.3 million, enough for several lifetimes of viewing pleasure. Dare I go further?

If we had eyes that could gather as much light as do a pair of 50-mm binoculars, we'd be dumbstruck with its richness. Many of the fainter stars can barely be seen in this much reduced simulation. Click to enlarge.
Source: Stellarium

On the very best nights, I can reach 16th magnitude with my 15-inch telescope, or 380 million stars. Well, only half that really, but who's counting?

Building Big Elliptical Galaxies' Cores

By: Camille M. Carlisle | August 29, 2014

Astronomers are tracking down the seeds that likely grew to become today's most massive elliptical galaxies.

This image of the elliptical galaxy NGC 4472 is from the Sloan Digital Sky Survey. NGC 4472 (also known as Messier 49) is a massive galaxy in the Virgo Cluster.

Astronomers like galactic runts. It's not that they're cute — although the Large Magellanic Cloud is vaguely reminiscent of a fuzzy caterpillar. It's that runts were likely the building blocks of the big galaxies we see today.

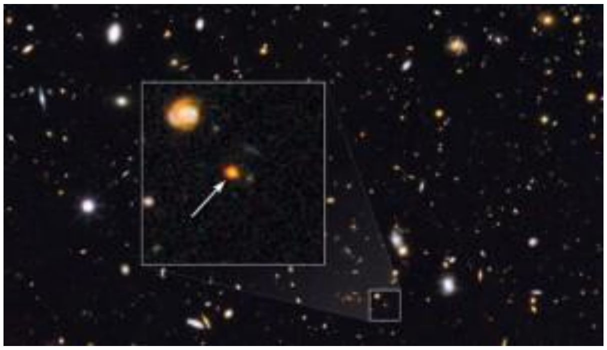
The largest, most massive galaxies in the local universe are ellipticals, big golden clouds of stars that have burned through their star-forming gas reservoirs and now sit "quiescent," enjoying old age. But about a decade ago, astronomers looking into the early universe discovered that quiescent galaxies 10 or 11 billion years ago were actually the *smallest* galaxies around, roughly one-tenth the size of today's ellipticals and one-third (or less) that of the other star-forming galaxies at that epoch.

Even so, the compact galaxies were massive: in stars they can outweigh the Milky Way, even though they're on the order of one-tenth the size.

These compact quiescents likely grew into the red-and-dead behemoths of today. Three lines of evidence point to that interpretation, explains Guillermo Barro (University of California, Santa Cruz). One, there are very few compact quiescent galaxies today, so they must have disappeared somewhere. Two, the density of stars in these ancient, compact galaxies is similar to that in the cores of local, big ellipticals. And three, if the compact galaxies grew by merging with less massive companions (probable), the mergers would have preferentially built up the galaxies' outer edges, leaving the core more or less unchanged (explaining #2).

. . . But where did the *cores* come from?

Astronomers potentially found an answer to that question in the last year or so when they discovered compact, star-forming galaxies that existed around 11 billion years ago (a.k.a. at a redshift of about 2). These star-forming galaxies had sizes and masses similar to the compact, quiescent galaxies.



Of the vast number of galaxies in this image from the Hubble Space Telescope GOODS North survey, one, dubbed GOODS-N-774 (inset), sticks out as a compact yet massive galaxy that's producing stars at a rate roughly 90 times that of the Milky Way. The galaxy is one of 14 found recently that appear to be the cores of today's massive elliptical galaxies. *NASA / ESA / E. Nelson (Yale University)*

Now, two teams have confirmed that the velocity of gas moving around inside several of these small star-forming galaxies matches the velocities of stars in the small quiescent ones. It's this gas that forms stars, so if the dynamics of the gas match the dynamics of the stars, that's a pretty good indicator that we're looking at the same type of beast at different ages.

Both Barro and his colleagues and an independent team comprising Erica Nelson (Yale) and her colleagues came to this conclusion using multiwavelength data for compact galaxies found in the GOODS and COSMOS surveys. These objects all have redshifts between 1.97 and 2.49, meaning they existed right at the time the transition seems to have happened. They also have stellar masses ranging from 40 billion to 200 billion Suns. (The Milky Way has a total stellar mass at the lower end of this range.)

Assuming the gas motions calculated are for gas that's settled into these compact galaxies and isn't infalling or outflowing (and the teams are pretty sure that's true), and assuming no more gas will dump down onto these cores, star formation will burn through the available gas in a few hundred million years. Feedback from gas-guzzling, jet-spewing supermassive black holes might exacerbate the quick death by removing gas, too. Barro's team found X-ray evidence for an active galactic nucleus (AGN) in 7 of the 13 galaxies it studied, while Nelson's team saw no sign of an AGN in the galaxy it analyzed.

This timeline puts the compact, star-forming galaxies right on track to become the small, quiescent galaxies observed. They'll probably all be "dead" in 1 to 2 billion years, or at a redshift of 1.5 or so. Afterwards, they will (we think) build up their outer edges to become today's massive ellipticals.

This all works very nicely. But it does raise a big-picture question. Last year Nelson and other members of her team observed the growth of less massive, disk galaxies (similar to the Milky Way) between 7.5 and 11 billion years ago. The observations showed that such galaxies built up both their core bulges and their disks at the same time. But the new results confirm that more massive, elliptical galaxies likely grew from the inside out. Why the difference? Perhaps because ellipticals tend to grow in denser parts of the universe (true); perhaps because the universe itself was denser billions of years ago (also true). Or perhaps there's something else going on.

References:

G. Barro et al. "Keck-I MOSFIRE Spectroscopy of Compact Star-forming Galaxies at z>2: High Velocity Dispersions in Progenitors of Compact Quiescent Galaxies." arXiv.org. Posted May 27, 2014.

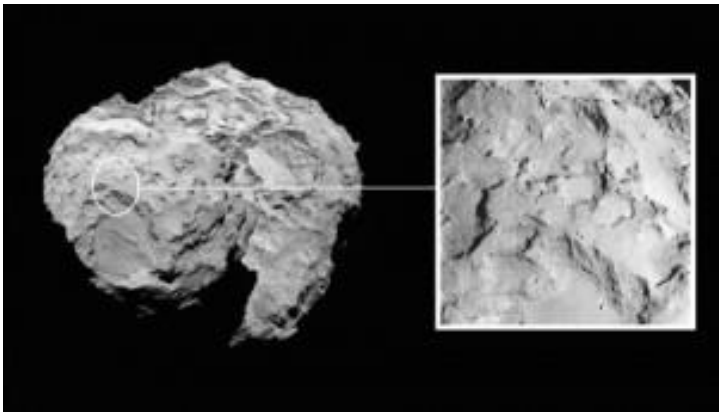
E. Nelson et al. "A Massive Galaxy in its Core Formation Phase Three Billion Years after the Big Bang." *Nature*. August 27, 2014.

Where Will Philae Land on Comet 67P?

By: Kelly Beatty

On November 11th, the European Space Agency's Rosetta spacecraft will dispatch the heavily instrumented Philae lander to an area called "Site J" on one end of Comet 67P/Churyumov–Gerasimenko.

The European Space Agency's Rosetta spacecraft finally arrived at Comet 67P/Churyumov–Gerasimenko a month ago, after a 10-year cruise through interplanetary space. In an ideal world, Comet C-G would have been a nice smooth ball of dust and ice with a big X marking the safest and most scientifically interesting landing site for the craft's Philae lander. Had that been the case, says Rosetta mission manager Fred Janssen, his team would have put the odds of a successful landing at 70% or 75%.

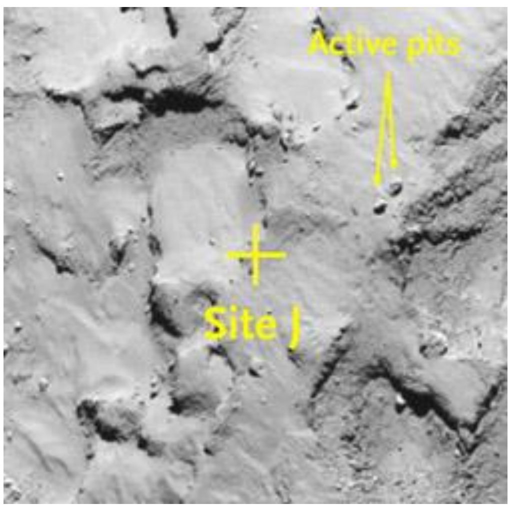


Rosetta images of the irregular nucleus of Comet 67P/Churyumov–Gerasimenko and a close-up of Site J, the location where the mission's Philae lander will touch down.
ESA / Rosetta / MPS for OSIRIS Team

But nature has thrown the project a few curves. Not only is the comet's nucleus complicated — an irregular, double-lobed structure 2½ miles (4 km) long — but it's also much rougher and craggier than expected. Add to that the comet's ahead-of-schedule activity (it's already giving off jets of gas despite being 3.4 astronomical units from the Sun), and all bets are off. At an ESA press briefing earlier today, Janssen declined to offer a revised risk assessment. "No site meets all the engineering criteria," he allowed.

That said, Philae has to set down *someplace,* and the team has winnowed down an initial set of 10 candidate sites to primary and backup locations. The best location, designated Site J, is on the comet's smaller lobe (think of it as the "head"); the backup, Site C, is on the larger "body." Engineers opted to stay clear of the smooth-textured "neck" between them, because from there it would be difficult for Philae to remain in constant radio contact with the main spacecraft as it orbits the nucleus.

"This was not an easy task," noted Stephan Ulamec, lander manager for the German space agency DLR. "Site J is a mix of flat areas and rough terrain. It's not a perfectly flat area. There is still risk with high-slope areas."



A close-up of Site J, the Philae landing site on November 11th. The area is not flat, but it has modest slopes and is relatively free of boulders. It also offers a direct view of two small pits that are outgassing sources. The view is about 1,000 feet (300 m) across.
ESA / Rosetta / MPS for OSIRIS Team

The smaller-lobe site won out in part because cameras have already identified two small pits near it that are sources of outgassing. "Site J meets all the criteria to fulfill all the science criteria," explains Jean-Pierre Bibring, the lander's lead scientist. Each of Philae's 10 instruments will be able to operate "at least once to its full capability."

These sites will get another two months of scrutiny from the battery of remote-sensing instruments aboard Rosetta, which will soon move in closer from its current distance of 20 miles (30 km), first to an altitude of 12 miles (20 km) and then to just 6 miles (10 km).

Assuming no "gotchas" emerge, the spacecraft will release Philae on November 11th for its 7-hour-long "fall" the the comet's surface. Once it makes contact at roughly 2 miles per hour (1 meter per second), the washing-machine-size, 220-pound (100-kg) lander will anchor itself using a mechanical harpoon, then quickly take a 360° panorama and measure the pressure of cometary gas surrounding it.

The comet's nucleus is not a solid ball of frozen water and dirt; instead, the terrain looks very dark, due to carbon-rich organic molecules, and it appears surprisingly rocky and angular — perhaps a consequence of shock compression during impacts. Early estimates suggest the mean density is only 0.4 gram per cubic centimeter, and the surface gravity is only about $^{1}/_{100,000}$ that on Earth.

Artist's impression of Philae on the surface of Comet 67P/Churyumov-Gerasimenko.
ESA / ATG medialab

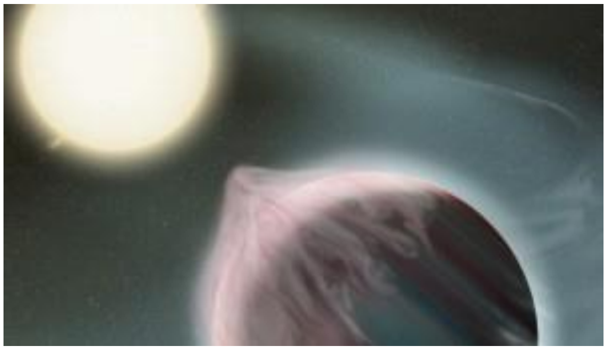
Philae's scientific payload includes a drill that will extract samples of the nucleus from depths of at least 9 inches (230 mm), likely deep enough to ensure that the excavated material is pristine and unaltered by the comet's passes near the Sun. (It comes as close as 1.24 a.u., or 115 million miles, every 6.45 years.) Samples will then be fed to three instruments to determine the molecular, elemental, and isotopic composition, augmented by elemental assays by another spectrometer on the surface. An onboard radar and acoustic sounder will probe the the interior structure to depths of several tens of meters. Other instruments will measure the nucleus's magnetic and electrical properties. And there'll be plenty of panoramic images from an onboard camera.

With luck, Philae will last several months, powered initially by onboard batteries and later by small solar-cell panels. Meanwhile, Rosetta will accompany Comet Churyumov–Gerasimenko as it swings through perihelion (August 13, 2015) and beyond. The hope is to get at least 13 months of observations. Perhaps, Bibring muses, the long run of observations will allow mission scientists to determine if Comet C-G got its two-faced personality from two cometary masses that merged or because a single body has eroding into the wild shape seen today.

Do Exoplanets Transform Between Classes?

By: Shannon Hall | September 2, 2014

A new analysis suggests that hot super-Earths might be the skeletal remnants of hot Jupiters stripped of their atmospheres.



An artist's depiction of an early stage in the destruction of a hot Jupiter by its star. NASA / GSFC / Frank Reddy

Most alien planets are unlike any planet in our solar system. Hot Jupiters, for example, are broiling gas giants circling closer to their stars than Mercury orbits the Sun. Astronomers suspect that the star-planet tidal interaction will ultimately drag a hot Jupiter inward toward its doom.

More recently, astronomers have discovered a second class of star-hugging planets in the wealth of data from NASA's crippled Kepler space telescope. These so-called hot super-Earths are rocky or icy planets that can be up to 10 times Earth's mass and also orbit extremely close to their host stars.

Astronomers have speculated that the two classes may be related. But Francesca Valsecchi (Northwestern University) and her colleagues now take this a step further, suggesting that these odd planets are stripped hot Jupiters. Instead of forming as super-Earths, they are the skeletal remnants of gas giants peeled of their atmospheres.

The underlying theory is relatively simple. As the exoplanet spirals in toward its host star, the system will eventually reach the point where the two Roche lobes touch.

“The Roche limit or Roche lobe is the region around a planet or star (or moon or lump of bread dough) where that object's gravity dominates — it's a ‘sphere of influence’ so to speak,” explains coauthor Jason Steffen (also at Northwestern University).

When a fluffy star in a binary system overflows its Roche lobe, it can pour material down onto its smaller, denser companion star. In a similar way, when a hot Jupiter reaches the point where its Roche lobe and its star's Roche lobe meet, the interaction opens a gravitational path along which mass can transfer from the exoplanet to the star. So the hot Jupiter inevitably starts shedding its gaseous envelope.

Valsecchi and colleagues modeled this transformation for several different cases. But they started early in the planet's history, placing the hot Jupiter not under the glare of its bright star, but in the chilly outer reaches of the planetary system where astronomers think gas giants first form. Due to the star-planet tidal interaction, the planet migrates inward toward the star. But once the planet's Roche lobe reaches the star's Roche lobe, something interesting happens. The planet's orbit reacts to the mass transfer by moving slightly outwards.

But this slight movement doesn't stop it from shedding its entire atmosphere. Once the rocky or icy core is exposed, tidal forces take over again, causing the orbit to shrink once more and bring the planet close enough for the star to swallow it, explains Valsecchi.

"Broadly the idea makes sense," says expert David Trilling (Northern Arizona University). "The only evidence will be indirect, so the question is really whether this theory explains the observational evidence better than all other competing theories."

Trilling and colleagues first mentioned this idea briefly in a paper published in 1998. But at the time, only a few hot Jupiters had been detected and no hot super-Earths. We're now in a much better position to understand how planets might transition between classes.

The research team did compare their results to observations, finding that most known hot super-Earths have similar orbital periods and masses to those modeled.

If the results hold, hot Jupiters might be about three times as common as what astronomers have inferred directly from observations, because the number of single super-Earths observed is nearly twice the number of hot Jupiters.

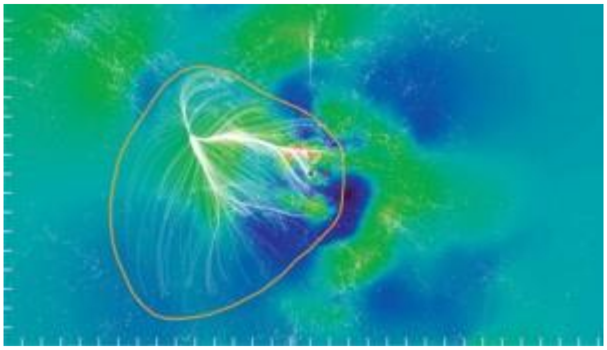
Reference:

Francesca Valsecchi et al. "From Hot Jupiters to Super-Earths via Roche Lobe Overflow" *Astrophysical Journal Letters*, Accepted

Laniakea: Our Home Supercluster

By: Camille M. Carlisle

Measurements of thousands of galaxies' motions toward and away from us reveal that the Milky Way sits on the edge of a gigantic supercluster of galaxies.



A slice of the Laniakea Supercluster in the supergalactic equatorial plane. (The supergalactic plane is a reference plane in a cosmological coordinate system and passes through the Sun, the Milky Way's center, and the center of the Virgo Cluster of galaxies. It's almost perpendicular to the galactic plane of the Milky Way.) The Milky Way is at the little blue dot toward the right-hand edge of the circled region (just below the reddish area, which is the Virgo Cluster).
Credit: SDvision interactive visualization software by DP at CEA/Saclay, France

Astronomers have mapped the cosmic watershed in which our Milky Way Galaxy is a droplet. The massive structure, which the research team dubs the Laniakea Supercluster, extends more than 500 million light-years and contains 100,000 large galaxies.

The work, published in the September 4th *Nature*, is the first to trace our local supercluster on such a large scale. It also provides a physical way to define what a supercluster actually is.

Researchers have been working out the gravitational structure in our local universe for decades. Based on work by Gerard de Vaucouleurs in the 1950s, astronomers have thought of our galaxy as being on the edge of the so-called Local Supercluster, a structure about 100 million light-years wide that's centered on the Virgo Cluster of galaxies.

But astronomers have also seen much larger structures in the universe, on the scale of several hundred million light-years, thanks to the Sloan Digital Sky Survey and other work. These maps have generally depended on calculating galaxies' 3-D locations based on the galaxies' cosmological redshifts, the shift in a galaxy's spectral lines due to the galaxy's apparent motion as the universe itself expands.

Brent Tully (University of Hawaii, Honolulu) and colleagues have taken a different approach. They used galaxies' *peculiar velocities*, which are the galaxies' motions due to the local gravitational landscape. Galaxies fall toward or away from one another in this landscape; the Milky Way and many others seem to be moving toward what's called the Great Attractor, a dense region in the vicinity of the Centaurus, Norma, and Hydra clusters about 160 million light-years away.

Peculiar velocities are on the order of a few hundred kilometers per second, whereas the cosmic expansion velocities rise to 10,000 km/s roughly 130 million light-years away. (Due to the nature of cosmic expansion, a galaxy recedes faster the farther away it is.) There's about 10-20% uncertainty in the peculiar velocity measurement for an individual galaxy, says Tully. So only for nearby galaxies is an individual system's peculiar velocity high enough compared with its expansion velocity for astronomers to peg it confidently. Farther out, the data are sparser.

But the team found a way around this problem by using an analysis technique called Wiener filtering. This algorithm allowed the team to essentially take a step back and look at the big picture, revealing the large-scale flow patterns created by galaxies' motions. With this wide-field view, the individual uncertainties don't matter so much.

Last year, the team used this technique to map the local universe's web of filaments, clusters, and voids, creating a fascinating video simulation of the flow patterns in the gravitational watershed. Now, they've taken a closer look using their Cosmicflows-2 catalog, which contains more than 8,100 galaxies. The new catalog reveals where the flows merge and diverge, unveiling a gargantuan structure on whose periphery the Milky Way sits. The Great Attractor is a central valley in this newly demarcated watershed.

The team calls this huge supercluster Laniakea, from the Hawaiian *lani* (heaven) + *akea* (spacious, immeasurable).

The analysis also reveals other structures, including a separate supercluster called Perseus-Pisces and a distant concentration named Shapley, which lies about 650 million light-years away and toward which Laniakea is moving.

The team put together an intro video, which I'm embedded below:

Cosmologist Elmo Tempel (Tartu Observatory, Estonia) says that, due to the nature of the analysis, he's confident that the Laniakea structure exists. "However, the exact boundaries of Laniakea are not so well established, and they may change if more measurements are carried out," he cautions.

Because stringent distance measurements (on which the peculiar velocity calculations depend) are much rarer beyond about 300 million light-years, it's hard to make out what's going on out there. Given that Laniakea is moving toward Shapley, our supercluster might indeed be only the trunk of the elephant, Tully says. For now, all he and his colleagues can say is that they've isolated a "local basin of gravitational attraction." Finding out whether it's an appendage of something larger will require accurate distance measurements that reach three times farther than the current catalog.

Nature has also created an in-depth video on the discovery, which I recommend watching.

References:

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