Southwest Florida Astronomical Society
SWFAS

The Eyepiece
July 2014

Contents:

A MESSAGE FROM THE PRESIDENT

I hope everyone has a fun and safe 4th!

Because of the long weekend, there is not a meeting this month!

At the last meeting, we agreed to get a Celestron GT mount for use with the PST instead of having to put it on the larger C-8 scopes. I did sell the Super Polaris Mount Head, so we have funds from equipment sales that were meant for the PST anyway, so no real extra expense. There are a few surprises with this as well, which will be covered at the August meeting.
Gary McFall helped with making out the dovetail mount and light shield for the PST as well as an adapter for tripod mounting. I have supplied a tripod, so now everything is set. Needless to say, it works like a champ! I even tested it with imaging the other day and tracking is great. Simple to use, aim it at the sun, put in the date/time and a few quick looks in the eyepiece to make sure the sun is there and it's tracking!

At this time, I don't have a program locked in for August, so if you have any ideas or want to do one, please let me know.

The June star party on the 28th was impacted heavily by the weather. I went up there at 9pm, with clouds covering a good portion of the sky. Gary McFall was already there. New Member Elvis Rodriguez arrived shortly after. Then Tony Heiner arrived. Skies started to break a little. By about 11:30, things were really opening up. We all wrapped it up by about 1am, the skies fairly clear. Mosquitos were definitely in attendance! Let's go ahead and make the July Star Party again at SeaHawk Park.

On the 19th, we will be at the Cape Coral Yacht Club for their Annual Parks and Rec day from 10am – 1pm. We do need people to do handouts, most likely indoors again. We will set up the telescopes out in the field by the boat ramp again.

Brian

In the Sky this Month

Moon: July – 1st Quarter 5th; Full 12th; Last Quarter 18th; New 26th.
Explore the north shore of Mare Imbrium marked by lunar Alps, crater Plato, and Sinus Iridum. This strip is thought to be a coalesced pair of crustal islands that were torn from their original locations some 100 miles to the NE during the refilling of the Imbrium crater by magma flowing underneath the moon's crust.

The Planets
Jupiter will exit the western sky early in the month with a reduced, but still impressive, -1.8 magnitude.
Mars fades in magnitude from 0.0 to +0.4 in July, but still impressive. It has conjunction with Spica on July 13th, coming to within 1.3° of the1.0 magnitude star. It displays a slight gibbous phase this month.
Saturn is now center stage with magnitude of 0.4-0.5 this month. It remains in the vicinity of double star, α Librae (Zubenelgenubi).
Venus still shines at magnitude -3.8 at dawn, its dimmest of the year, so far.
Mercury appears in the morning to the lower left of Venus later in the month.
Uranus and Neptune are both visible before dawn. Finder charts can be found at **skypub.com/urnep**.

Messier Objects – Compare the Fab 5 Globular Clusters; M3 in Canes Venatici; M4 in Scorpius; M5 in Serpens; M13 in Hercules; M22 in Sagittarius.

Double Stars of the Month
Binocular – Alpha Librae; Magnitude 2.8, 5.2; Separation 231"

Telescope – Alpha Canum Venaticorum; Magnitude 2.9, 5.5; Separation 19"

Telescope, Challenging – 44 Boötis; Magnitudes 5.3 & 5.8-6.4; Separation 1.06" July 1, closing to 1.03" by Sept 15. Can your scope split a double star with 1 arc second separation? *S&T, July, 2014, p52.*

The International Space Station: Not visible in evenings this month.

Hubble Space Telescope: Viewing opportunities entire 2nd half of the month.
July 16th at 9:58 pm from SW to S; max alt 31°; for 3 minutes at 1.8 mag.
July 17th at 9:51 pm from SW to SE; max alt 46°; for 4 minutes at 1.0 mag.
July 18th at 9:44 pm from WSW to ESE; max alt 59°; for 6 minutes at 0.8 mag.
June 19th at 9:37 pm from WSW to E; max alt 74°; for 6 minutes at 0.7 mag.
July 20th at 9:30 pm from WSW to E; max alt 88°; for 7 minutes at 0.7 mag.
July 21st at 9:23 pm from W to ENE; max alt 81°; for 7 minutes at 0.8 mag.
July 22nd at 9:17 pm from W to ENE; max alt 73°; for 8 minutes at 1.0 mag.
July 23rd at 9:10 pm from W to E; max alt 69°; for 8 minutes at 1.0 mag.
July 24th at 9:03 pm from W to E; max alt 67°; for 8 minutes at 1.1 mag.
July 25th at 8:56 pm from W to E; max alt 68°; for 8 minutes at 1.1 mag.
July 26th at 8:50 pm from W to E; max alt 72°; for 8 minutes at 1.0 mag.
July 27th at 8:43 pm from W to E; max alt 79°; for 8 minutes at 0.9 mag.
July 28th at 8:36 pm from W to ESE; max alt 89°; for 8 minutes at 0.8 mag.
July 29th at 10:11 pm from W to SW; max alt 24°; for 3 minutes at 2.4 mag.
Extracted from http://www.heavens-above.com/

Future Events

Upcoming Meetings

Our July meeting will be cancelled because of the holiday. The next monthly meeting will be August 7th.

Star Party and Event Schedule

Date	Event	Location	Time	Info/Contact
July 19th	Cape Coral Parks & Rec event	Yacht Club	10 am – 1 pm	Solar viewing/ Brian Risley
July 26th	Star Party	Seahawk Park, 1030 NW 28 St, Cape Coral	Dusk	Bruce Dissette
August 23rd	Star Party	CRP	Dusk	Bruce Dissette
Sept. 27th	Star Party	CRP	Dusk	Bruce Dissette
October 25th	Star Party	CRP	Dusk	Bruce Dissette
November 22nd	Star Party	CRP	Dusk	Bruce Dissette
December 20th	Star Party	CRP	Dusk	Bruce Dissette

Minutes of SWFAS Meeting – June 5, 2014

The June 5th 2014 SWFAS meeting was called to order in the planetarium at 7:30 by Brian Risley. Brian asked if there were any visitors or new prospective members present.

Brian Risley and Carol Stewart thanked members for assisting at the Skyline Elem. event on Friday, May 9th. Johnnie Royal, Tony Heiner, Brian Risley, Carol Stewart, Gary McFall, and Doug Heatherly helped to make the evening very successful. There was a great turnout, the skies were clear and everyone had a good time.

Carol Stewart also thanked Gary Mcfall, Bruce Dissette, Tony Heiner, and Doug Heatherly for assisting with Astronomy Day at the planetarium which also was a great success on Saturday, May 10th.

Carol Stewart also thanked Scott Flaig for coming out for the May evening astronomy program to present a program on his book as he had done previously for a SWFAS meeting. There were about five total visitors for the program.

Brian Risley asked if the members would like to go to the RC Seahawk Park in Cape Coral for the star party on June 28th instead of CRP. Carol Stewart moved to accept and Tony Heiner seconded the motion. Motion passed.

Brian Risley reminded members about the Cape Coral Parks & Recreation Day on Saturday, July 19th at the Cape Coral Yacht Club, and to let Brian know if anyone can help out with solar observing.

It was decided to leave it open, for now, where the members would go for the July 26th star party.

Brian Risley talked about the Coconut Point Hyatt telescope program. They purchased a CPC1100 and Brian will help them learn how to set up the scope and make a manual for them to follow as well. Carol Stewart will provide handouts to advertise CNCP and the planetarium and quarterly observing targets for the staff to use with their guests.

Brian Risley thanked Jordan Blessing, SWFAS member, for the bolt cases donation that we received at the Skyline Elem. event. There were 2 cases of these items…all for free from Jordan. Thank you Jordan! SWFAS will be selling these for $1.50 each and proceeds will help fund a PST mount project for the club. Gary McFall made the motion to proceed in the sale of these items and Brian Shultis seconded the motion. Motion passed.

Brian Shultis made a motion to cancel the July 3rd, 2014 SWFAS meeting. Motion passed.

Carol Stewart told members about the upcoming June evening program on Hurricane Preparedness presented by the Lee County Emergency Operations Center staff on Wednesday, June 25th. She also told members that Scott Flaig is a new board of trustee for the CNCP and will be specifically working on the planetarium committee to help move the facility forward.

Reports:

The VP, Bruce Dissette, was not present. There was nothing new to report on the newsletter. Don Palmer was not present, and Tony gave the treasurer report.

Brian Shultis moved to accept the treasurer's report and Stephen Berni seconded the motion. Motion carried.

Chuck Pavlick talked about the Fakahatchee observing nights. Brian and others mentioned that hardly any meteors were seen from the possible new Camelopardalids meteor shower.

Maria Berni had nothing to report on the library. Danny Secary, historian, was not present. Brian Risley gave a brief equipment report and told members SWFAS has lots of telescopes to loan out.

Bill Francis was not present to report on the web site and Brian Risley told members we still need a program coordinator.

Brian Risley told members that the Astronomical League membership fees are due at the end of June and that he is in the process of contacting members who have not renewed their dues for this year to get our membership list in order. The dues invoice will be paid by Tony Heiner once Brian has everything in order.

Brian Shultis moved to accept payment of the AL dues and Tony Heiner seconded the motion. Motion carried.

Mary Vilbig suggested that Brian should talk a little about the AL and what all it has to offer members for those that may not know. Brian discussed that receiving the Reflector magazine was one benefit and how the AL observing programs can help members through structured observing projects.

Brian Risley talked briefly about the Night Sky Network web site being revamped recently.

Meeting adjourned.

Brian Risley presented a thorough program about solar observing that included different methods to observe the sun, features easily seen with white light and HA scopes, and specific names and types of features seen on the sun.

Meeting notes submitted by Carol Stewart

A Glorious Gravitational Lens

By Dr. Ethan Siegel

As we look at the universe on larger and larger scales, from stars to galaxies to groups to the largest galaxy clusters, we become able to perceive objects that are significantly farther away. But as we consider these larger classes of objects, they don't merely emit increased amounts of light, but they *also* contain increased amounts of **mass**. Under the best of circumstances, these gravitational clumps can open up a window to the distant universe well beyond what any astronomer could hope to see otherwise.

The oldest style of telescope is the refractor, where light from an arbitrarily distant source is passed through a converging lens. The incoming light rays—initially spread over a large area—are brought together at a point on the opposite side of the lens, with light rays from significantly closer sources bent in characteristic ways as well. While the universe doesn't consist of large optical lenses, **mass itself** is capable of bending light in accord with Einstein's theory of General Relativity, and acts as a *gravitational* lens!

The first prediction that real-life galaxy clusters would behave as such lenses came from Fritz Zwicky in 1937. These foreground masses would lead to multiple images and distorted arcs of the same lensed background object, all of which would be magnified as well. It wasn't until 1979, however, that this process was confirmed with the observation of the Twin Quasar: QSO 0957+561. Gravitational lensing requires a serendipitous alignment of a massive foreground galaxy cluster with a background galaxy (or cluster) in the right location to be seen by an observer at our location, but the universe is kind enough to provide us with many such examples of this good fortune, including one accessible to astrophotographers with 11" scopes and larger: Abell 2218.

Located in the Constellation of Draco at position (J2000): R.A. 16h 35m 54s, Dec. +66° 13' 00" (about 2° North of the star 18 Draconis), Abell 2218 is an extremely massive cluster of about 10,000 galaxies located 2 billion light years away, but it's *also* located quite close to the zenith for northern hemisphere observers, making it a great target for deep-sky astrophotography. Multiple images and sweeping arcs abound between magnitudes 17 and 20, and include galaxies at a variety of redshifts ranging from z=0.7 all the way up to z=2.5, with farther ones at even fainter magnitudes unveiled by Hubble. For those looking for an astronomical challenge this summer, take a shot at Abell 2218, a cluster responsible for perhaps the most glorious gravitational lens visible from Earth!

Learn about current efforts to study gravitational lensing using NASA facilities: *http://www.nasa.gov/press/2014/january/nasas-fermi-makes-first-gamma-ray-study-of-a-gravitational-lens/*

Kids can learn about gravity at NASA's Space Place: http://spaceplace.nasa.gov/what-is-gravity/

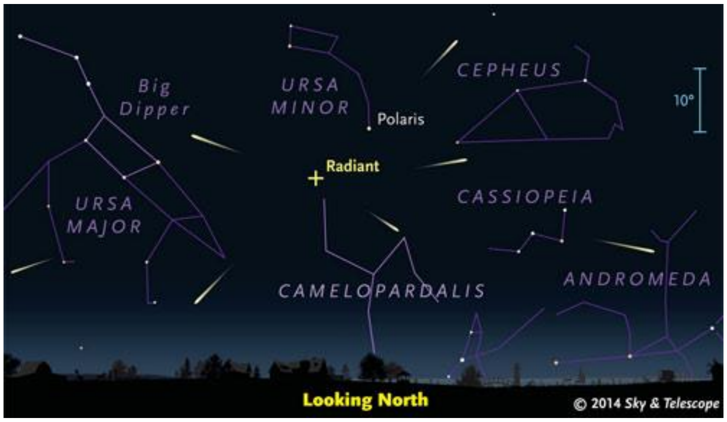
Abel 2218. Image credit: NASA, ESA, and Johan Richard (Caltech).

Acknowledgement: Davide de Martin & James Long (ESA/Hubble).

First Reports: Camelopardalids Disappoint

By: Kelly Beatty | May 24, 2014

Dynamicists had predicted that Comet 209P/LINEAR would create an active meteor display in the early morning of May 24th. But reports from observers across the U.S. and Canada suggest that the Camelopardalid meteor shower was weak at best.



Meteors in the May 24th early-morning display will appear anywhere in the sky, but all will fly in the direction away from a point near Polaris in the northern sky.
Sky & Telescope illustration

Meteor dynamicists had been unanimous in their prediction that skygazers would witness a new meteor shower — the Camelopardalids — last night. The sharp, brief peak was supposed to last just a few hours, centered at roughly 7:00 Universal Time (3 a.m. Eastern Daylight Time). This timing made the U.S. and southern Canada the prime real estate for meteor watching last night.

However, the predictions of *how many* meteors we'd see varied widely, ranging from a very weak, inconsequential display to a possible "storm" (1,000 meteors per hour under ideal conditions). The consensus view was that we'd see perhaps one or two meteors per minute, something akin to the best traditional showers like the Perseids and Geminids.

Now the dynamicists will have to recheck their calculations, because early reports from observers suggest that the Camelopardalids were weak at best. Typical is this report from *S&T* contributing editor Joe Rao, who made a long-distance trek with his wife from soggy New York in order to find clear skies:

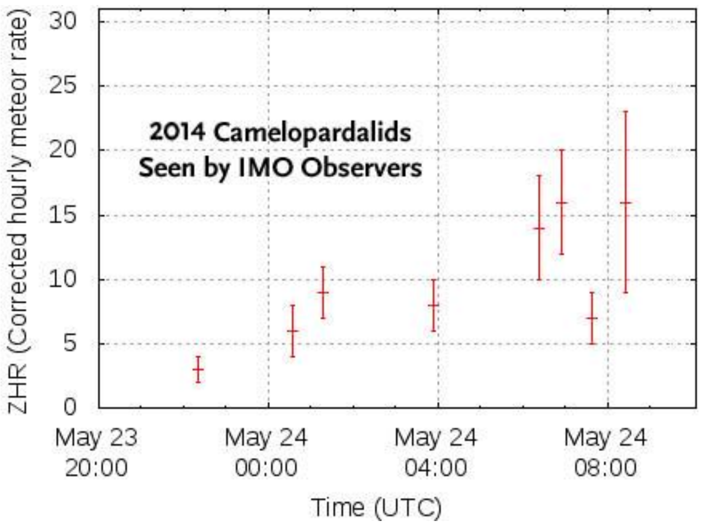
"The 'Cams' were pretty much a bust as seen from here in Dunmore, West Virginia. Indeed, these meteors certainly could have done more. Renate and I watched from the comfort of two lounge chairs under a beautiful sky that conservatively was no worse than magnitude 6, with a spectacular Milky Way stretching from Cassiopeia to Scorpius. We were out from 1:45 to 3:30 a.m. EDT and saw 8 possible Camelopardalids. The best one by far was a slow moving dazzler of at least –5 magnitude at 3:20 a.m., which appeared below Arcturus. That was pretty much the highlight."

Astrophotographer Jerry Lodriguss, based in suburban Philadelphia, offered a more blunt assessment, tagging this as the "biggest disappointment of the millennium so far — much worse than Comet ISON." He used two cameras to shoot 455 frames that covered nearly 7,000 square degrees of sky between 6:07 and 8:12 UT. "I think I may have recorded one piddling little meteor . . . We had eight observers and we saw, maybe, 2-3 meteors per hour. And they were extremely unimpressive. No fireballs at all."

Star-trail specialist Gavin Heffernan staked out a location in California's Joshua Tree National Park and lucked out. This bright Campelopardalid lit up the sky, taking aim at the Milky Way's center in Sagittarius, at 11:35 p.m. local time on May 23rd. Heffernan has also posted a [YouTube video of the event](#).
Sunchaser Pictures

NASA's Marshall Space Flight Center, home to the agency's Meteoroid Environment Office, hosted a live event that garnered 2,000+ comments from participants. Among them was Gerald Loosehelm, observing near Madison, Wisconsin, who reports, "Went out with my wife for over an hour and we saw about 6 each." Robert Beyer Jr. adds, "I went to an observation point outside Augustus, Missouri. I did see 23 total meteors. About 8 of them were really nice with long tails."

But they were among the more fortunate observers. Others commented "Nothing here in Florida," "I have been waiting for 3 hours now and saw nothing," and "Nothing happening here in Rosemead, CA." Results compiled by the International Meteor Organization suggest that the 2014 Camelopardalids had a *zenithal hourly rate* of no more than 15. (ZHR is what you'd see under ideal sky conditions with the shower's radiant directly overhead. Your results may vary.)



Visual sightings of the Camelpardalid meteor shower fell well below expectations, as shown in this plot of sightings by observers worldwide. *ZHR,* the *zenithal hourly rate,* is how many meteors you'd see in a very dark sky under ideal conditions.
International Meteor Organization.

All told, it appears that the shower *does* exist, but its performance last night was weak at best. This matches the prediction of Peter Jenniskens (SETI Institute), who, with help from Finnish specialist Esko Lyytinen, first noted the possibility of a Camelopardalid shower based on Jupiter's perturbation of the orbit of Comet 209P/LINEAR in February 2012. Jenniskens was very conservative in his estimate — more so than his counterparts (including Lyytinen) — because this year's shower involved particles shed by the comet long ago. "We do not know what rate to expect," he told me earlier this week, "because the comet was not observed in the 18th, 19th and early 20th centuries. The present comet activity may not be representative."

Three New Findings About the Moon

By: Kelly Beatty | June 13, 2014

Researchers have announced interesting news concerning the Moon, especially about how and when it formed, and why the "Man in the Moon" constantly stares at us whenever the lunar disk is fully lit.

When the Moon is full, its most dominant features are the dark *maria* (lava seas) that cover much of the hemisphere facing Earth.
Gary Seronik

Last Friday, the 13th, a full Moon came and went at 12:11 a.m. Eastern Daylight Time. Though not a cause for worry, this coincidence of ominous date and lunar phase was rather unusual — as reckoned in Universal Time, it won't occur again until for another 35 years!

The occasion coincided with a week that featured a trio of interesting research findings about the Moon.

When Did the Moon Form?

Cosmic thinkers have wondered where the Moon came from for a very long time. A century ago, in the absence of any real proof one way or the other, researchers had proposed three possibilities: the Moon formed alongside Earth as a pair (an idea termed *"co-accretion"*), it became trapped by Earth while passing close by (the *"capture scenario"*), or it was spit out when Earth spun so rapidly that it became unstable and split in two ("fission").

Artist's depiction of a collision between two planetary bodies. Such an impact between the Earth and "Theia," a Mars-sized object, likely formed the Moon.
NASA / JPL

All are interesting, but once geochemists got their hands on actual lunar samples, they quickly concluded that none of these are likely correct. Instead, computer simulations in the 1970s showed that the Moon most likely formed when a Mars-size object struck the young Earth. This ejected a huge jet of debris that formed a ring around our young planet and rapidly coalesced into the Moon. (The putative impactor is often called Theia, named for the Titan in Greek mythology who gave birth to Selene, the goddess of the Moon.)

This "giant-impact hypothesis" neatly explains many unique aspects of lunar composition. For example, Moon rocks contain isotopes of oxygen, tungsten, and other elements in ratios that are very close matches to Earth's (more on this point in a moment). Yet lunar rocks contain very little iron and (virtually) no water or other volatile elements. Also, the angular momentum of the Earth-Moon system is very high.

So when did this big splat occur? It's hard to pin down exactly, because geochemists have to rely on difficult measurements of trace radioactive isotopes and their daughter products in lunar rocks. Until recently, the best answer was "about 100 million years after the solar system's formation," which would put the age at about 4.47 billion years.

However, new results, presented this week at the Goldschmidt Geochemistry Conference, suggest it happened some 60 million years earlier. Guillaume Avice and Bernard Marty (University of Lorraine, France) analyzed xenon gas trapped inside quartz-bearing rocks from South Africa and Australia. Their model takes into account how much xenon was present when the solar-system formed (as determined from meteorites); how much was created by the fission of radioactive iodine, plutonium, and uranium; and how much has lost to outer space (during, say, a major impact).

"The xenon gas signals allow us to calculate when the atmosphere was being formed," Avice notes in a press release, "which was probably at the time the Earth collided with a planet-sized body, leading to the formation of the Moon. Our results mean that both the Earth and the Moon are older than we had thought."

So, based on this result, we should all reset our Earth-Moon clocks to 4.53 billion years and counting.

How Did the Moon Form?

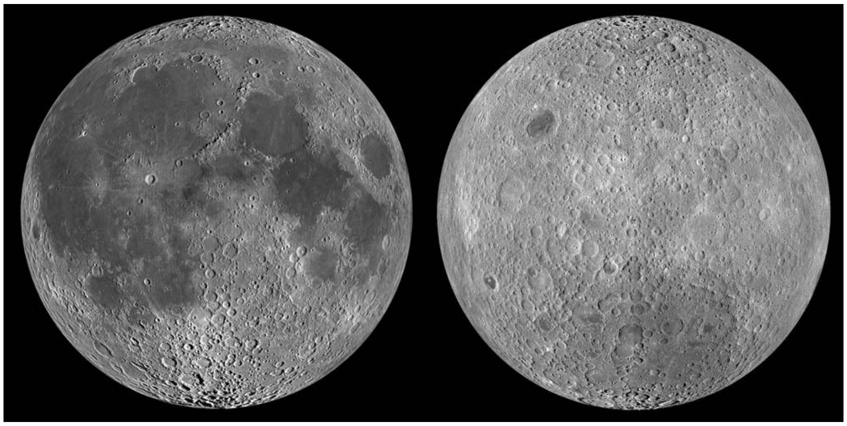
The giant-impact hypothesis fits the observational data well but still has some holes in it (no pun intended).

For example, the Moon should be a compositional *mélange* that's part proto-Earth and part Theia. Computer simulations have consistently suggested that a glancing blow would have been required in order to squirt enough material into orbit. Yet previous analyses have shown that the ratios of oxygen's three isotopes match *exactly* in terrestrial and lunar rocks. This could only occur if Theia and Earth started out with identical blends of oxygen isotopes (virtually impossible) or if somehow Earth and its newly formed Moon swapped white-hot vapor with each other (far-fetched at best) so that the isotopes could "equilibrate". (Or, conceivably, no giant impact occurred at all.)

The good news is that the oxygen ratios aren't exact after all. In *Science* for June 6th, a team led by Daniel Herwartz (George August University, Göttingen, Germany) used improved techniques to derive the isotopic ratios of oxygen-16, -17, and -18. First, they tried analyzing lunar meteorites that have fallen onto Earth, but their technique was sensitive enough to detect terrestrial contamination. So instead they tested lunar samples returned by the Apollo 11, 12, and 16 missions.

Using these, the researchers found a difference of 12 ± 3 parts per million in the ^{17}O:^{16}O ratios of terrestrial and lunar rocks. "The differences are small and difficult to detect, but they are there," says Herwartz. The upshot is that the giant collision really happened. It also puts some strict limits on Theia's composition, though one lingering problem is that we don't know how massive it was. Some recent modeling suggests that, if Earth were already spinning rapidly when it got smacked, then a relatively small impactor could have triggered the Moon's formation. In that case, less than about 10% of the eventual lunar mass must have come from Theia.

Why is the Moon Two-Faced?



We see only half of the Moon (left), the hemisphere that displays many dark, circular maria (lava plains). By contrast, the farside (right), visible thanks to spacecraft, contains very few mare deposits.
NASA / Arizona State Univ.

This week's third lunar result takes a stab at resolving a 55-year-old mystery. Since the Moon's rotation is locked in such a way that we see only one hemisphere, we didn't know what the unseen half looked like. Then, in 1959, the Soviet spacecraft Luna 3 radioed the historic first-ever views of the lunar farside that showed it to be *very* different: the familiar dark maria so common on the nearside are almost completely absent.

Various researchers have tried to explain this dichotomy in the decades since, but with no real consensus emerging. Now Penn State researchers Arpita Roy, Jason Wright, and Steinn Sigurdsson think they have the answer.

Writing in the June 9th issue of *Astrophysical Journal Letters,* they explain that when the Moon first formed it was much closer, just 5% to 10% of its present distance, and that its rotation quickly became tidally locked. Both bodies were still hot from the collision, with Earth's surface a red-hot 4,500°F (2500°C). This meant the lunar nearside was continually seared by the looming, glowing Earth that dominated its sky, too hot for any minerals to condense into solid.

But the farside, out of sight from Earth, cooled much quicker. The first solids to form were rich in aluminum and calcium, minerals that have relatively low densities. These early minerals became the building blocks for the lunar crust, which accumulated faster and grew substantially thicker on the generally cooler farside.

Later on, titanic collisions battered all of the young Moon's surface. The nearside's relatively thin crust, fractured deeply by the largest impacts, provided an easy conduit for dense, metal-enriched magmas to rise from the deep interior to the surface. These formed the pattern of dark maria — the familiar "Man in the Moon" — seen today. But similar eruptions were almost nonexistent on the farside, due to its thicker crust.

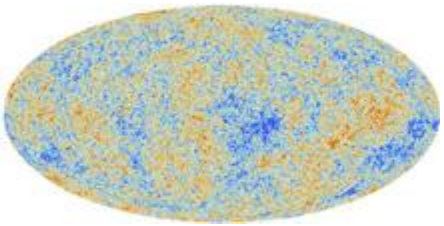
And *that*, claim Roy and her colleagues, is how the Moon got its two-faced appearance.

- See more at: http://www.skyandtelescope.com/astronomy-news/three-new-findings-moon/#sthash.keYSL5MZ.dpuf

Big Bang Inflation Evidence Inconclusive

By: Camille M. Carlisle | June 2, 2014

New analyses suggest that observations heralded as evidence for the universe's brief growth spurt don't conclusively show what researchers thought they did.



The oldest light in our universe, seen today as the cosmic microwave background, suffuses the cosmos. This all-sky map, created from all nine frequency bands of the Planck spacecraft, shows the CMB's details at a precision never before acquired.

Hubbub is a-bubbling in cosmology right now. In March, the BICEP2 team announced that they'd detected swirling polarization patterns called B-modes in the cosmic microwave background (CMB), the leftover radiation from the universe's birth. These patterns should exist in the CMB if the universe underwent a moment of exponential expansion called inflation that lasted roughly a nano-nano-nano-nanosecond.

The announcement set off fireworks-level excitement and speculations about a Nobel prize for the theorists who first proposed inflation, if the result was confirmed.

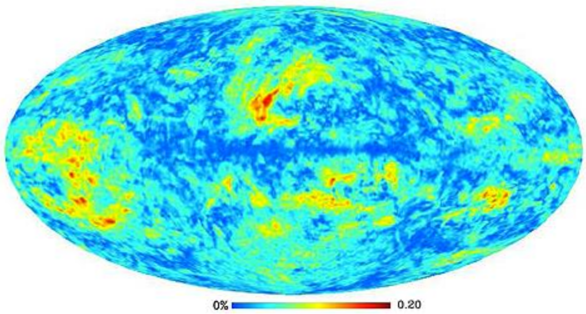
But now, two other teams have combined the BICEP2 data with the latest release from the Planck mission and are painting a different picture. Both these teams say they can't distinguish whether the B-modes the BICEP2 team detected are in the CMB or in the emission from dust filling our own galaxy.

This blog is long because the issue is complicated and deserves careful treatment. But if you take one thing away from this article, let it be this: we don't know what the correct answer is yet. But we soon might. The back-and-forth we're experiencing now is simply how science works.

Confusing Signals

The problem is twofold. One, we're stuck in a galaxy. Looking at the cosmos from inside the Milky Way is like looking at a road through a fogged, bug-spattered windshield. Observers have to peel away all this "foreground" stuff so that they can see the CMB.

At the frequency BICEP2 observed, the three main signals we care about are the CMB (which is polarized at a level we're trying to figure out), dust (also polarized), and the cosmic infrared background (CIB, unpolarized). The CIB is the sum of infrared light from billions of unresolved, dusty galaxies, and it suffuses the cosmos in much the same way that the CMB does.



A preliminary map of polarized emission from the Planck satellite included the cosmic infrared background, which damped the polarized signal from dust in the Milky Way. The color coding is for zero to 20% polarized.

To tease out the CMB's signal, cosmologists must identify how much of the signal they observe from a given part of the sky comes from each source. To do this, the BICEP2 team used a preliminary all-sky map of polarized dust emission, taken from a conference presentation given by a Planck team member in April 2013.

But this map included the CIB. Because the CIB is just integrated light from dust in a whole bunch of galaxies, it looks like the dust in the Milky Way — except it's not polarized. If you look at the whole dusty signal together, it looks like about 5% of the emission is polarized. But if half the signal in there is unpolarized and you remove that part, the "fractional polarization" of what's left goes up, maybe to 10% (I'm using rough numbers here).

The Planck team knew the CIB was a problem and spent a year weeding it out. They released a preliminary CIB-less dust map several weeks ago.

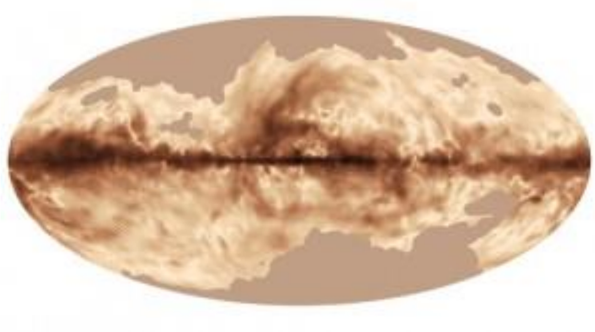
It's this second map that the two new papers are using. With the revised polarized dust map, a team from University of California, Berkeley, and another team from Princeton and New York University say the BICEP2 team might have lowballed the amount of polarization that comes from the Milky Way's dust. In other words, we can't conclude anything about where the B-modes BICEP2 sees come from.

Frequency Matters in Cosmology

There's a big BUT here, the #2 of the twofold problem: all the teams are extrapolating.

The Planck polarization map is at 353 GHz, where the dust emission is strong. But BICEP2 observed at 150 GHz. So cosmologists have to take a three-step approach, explains Planck scientist Charles Lawrence (JPL).

First, they need to know how much of the galactic dust emission at 353 GHz is polarized. Second, the strength of the galactic dust signal is different at different frequencies, so they need to correctly deduce what the signal looks like at 150 GHz, where the dust emission is weaker. Third, they need to correctly split that polarization signal into its two types, E-modes and B-modes.



The magnetic field of our Milky Way Galaxy as seen by ESA's Planck satellite. This image was compiled from the first all-sky observations of polarized light emitted by interstellar dust in the Milky Way.

The BICEP2 team extrapolated to 150 GHz using a 353-GHz, CIB-tainted map of the section of sky that they observed. The two other teams extrapolated using a 353-GHz map that's clean of the CIB *but doesn't include* the BICEP2 field of view. The Planck team hasn't released the data for regions near the north and south galactic poles because the observations of those sectors are ridiculously hard to analyze. And BICEP2 looked at the Southern Hole.

The Planck team is taking so long because the scientists are working on a cosmic scale. The Planck satellite observed the CMB to high precision in order to measure the numbers that characterize the universe, things related to its expansion speed and density and so forth. The team has to correlate all these observations and calculations with one another before they're finished.

"It's not like you can have a result over here on one side that is inconsistent with another on the other side, and then say, 'Oh whoops, we didn't notice that,'" Lawrence says, laughing. It all has to fit together. "This is just hard work and it has to be done right. So it takes as long as it takes."

The Planck data are important in part because they'll obviate the need to extrapolate. Planck measured polarization at 30, 44, 70, 100, 143, 217, and 353 GHz. In the units that the cosmologists use to make their maps, the CMB signal doesn't change as you look in different frequencies. But the dust signal does. So if researchers can look at how the signal changes as they move between frequencies, they can effectively wipe the dust off their cosmic windshield.

Several sources have reported that Planck's results will be out in October. The real deadline is the first week of December, because that's when the next Planck conference is scheduled. They might be out earlier, in part or in total, but the conference deadline is drop-dead, Lawrence says. These results will include the temperature and polarization data from the full mission; the previous release in 2013 included only the first half of the temperature data. It's too soon to say whether the upcoming release will include Planck's version of direct B-mode measurements.

The fact that the BICEP2 result hinges on Planck's data has upped the stakes. "There's one thing that everybody agrees on, and that is we *have* to be right," Lawrence stresses. "*We cannot afford to be wrong about this*. And if it takes a little bit longer, and we say 'Well, what about—? Or have we checked this?' or so on, then that's going to happen. Until that's done, it's not done."

That's life in the messy universe.

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Three Exoplanet Molds: Metals Matter

By: Shannon Hall | June 3, 2014

The latest data from the crippled Kepler space telescope point to three distinct molds of exoplanets — rocky planets, gas dwarfs, and ice or gas giants — distinguishable based on the level of heavy elements in their host star's atmosphere.

This artist's conception shows a terrestrial exoplanet, a gas giant and a mid-sized gas dwarf. *J. Jauch.*

Astronomers using archival data from NASA's crippled Kepler space telescope have found that the presence of three types of exoplanets — rocky planets, gas dwarfs, and ice or gas giants — around a star depends highly on the host star's metallicity.

Lars Buchhave (Harvard-Smithsonian Center for Astrophysics and University of Copenhagen, Denmark) and colleagues published their findings in the May 29th Nature and announced the results June 2nd at the summer meeting of the American Astronomical Society in Boston.

When exoplanet discoveries first started trickling in, the majority of known worlds were hot Jupiters, sizzling gas giants circling close to their host stars. Once the exoplanet count passed a few dozen in the late 1990s a new relationship became clear: hot Jupiters more often circled stars with high levels of metals — the astronomer's slang term for elements heavier than hydrogen and helium.

This wasn't a huge surprise. The chemical fingerprints of those stars point back to the chemical makeup of the ancient disk of dust and gas that formed both the star and its orbiting hot Jupiter. In this disk, grains glom together until they ultimately form planets. Metals within the disk should quicken this process, allowing planets to build up cores and large gaseous envelopes before the disk dissipates.

And so the question arises: do small planets follow the same trend?

Until now the answer was no: small planets circle stars spanning a wide range of metallicities. But with very little data, the absence of a trend for small planets wasn't set in stone.

So Buchhave and colleagues looked at a much larger dataset, by taking follow-up spectra of 405 stars orbited by 600 small exoplanet candidates. "We wanted to see if these host stars differed significantly from each other when we looked at [small] planets of different sizes," says Buchhave.

Without any analysis there's still a wide range of metallicities. "It's not possible to pick out one system and from its metallicity predict what type of planets are orbiting its star," says Bucchave.

But when Bucchave and colleagues took a statistical look, they were surprised to see two clear dividing lines, one at a radius 1.7 times Earth's and the other at a radius 3.9 times Earth's. The divisions separate the host stars into three metallicity groups, suggesting that three different populations of exoplanets exist, each roughly tied to different metallicities.

"When you examine metallicity on a large statistically significant sample, it is possible to see features in the metallicities of the host stars," says Bucchave. "This indicates that although metallicity is only one of the many factors affecting planet formation, it does seem to play an important role in the outcome of planet formation."

Despite the scatter, Bucchave and colleagues find the three metallicity regions are distinct from one another by 4.5σ. The rule of thumb in physics is that 1σ could be due to random chance or scatter, while 3σ counts as a true observation. In order to verify the Higgs Boson, particle physicists had to make a 5σ detection — so 4.5σ is pretty good.

The two clear transitions hint at changes in composition between these three planet populations.

In our own solar system we only have two distinct populations: terrestrial planets and gas or ice giants. But Kepler has discovered an abundance of exoplanets in the middle, including the so-called superEarths. "So we really want to know about these planets," says Bucchave. "Are they rocky planets with a thin compact atmosphere like the Earth? Or are they rocky cores with some sort of extended hydrogen-helium envelope where there's really no surface?"

For planets smaller than 1.7 times the size of Earth, the host star's metallicity tends to be roughly solar. These planets are the terrestrial sort we're familiar with: solid bodies made of rocky material, perhaps with an iron core and with only a compact atmosphere, says coauthor David Latham (Harvard-Smithsonian Center for Astrophysics).

At a slightly higher metallicity, stars are more likely to have planets between 1.7 and 3.9 times the size of Earth — dubbed gas dwarfs by the team — that have rocky cores and thick atmospheres of hydrogen and helium, of which there are no solar system equivalents.

Above 3.9 times the size of Earth are familiar gas and ice giants, which are more common around stars with an even higher metallicity (about 1.5 times solar), in agreement with previous studies.

The results suggest that there's a metallicity sweet spot for terrestrial planets to form, roughly the same as the Sun's. That bodes well for forming Earth-like planets around Sun-like stars.

Although Buchhave and colleagues successfully show three distinct exoplanet populations based purely on metallicity, they emphasize that multiple factors affect planet formation.

"Clearly the data are telling us that metallicity matters, but how exactly is still not entirely clear," says exoplanet expert Jarrett Johnson (Los Alamos National Laboratory). "It's now a challenge to piece together a complete, coherent picture of planet formation that explains the results of this work, among others."

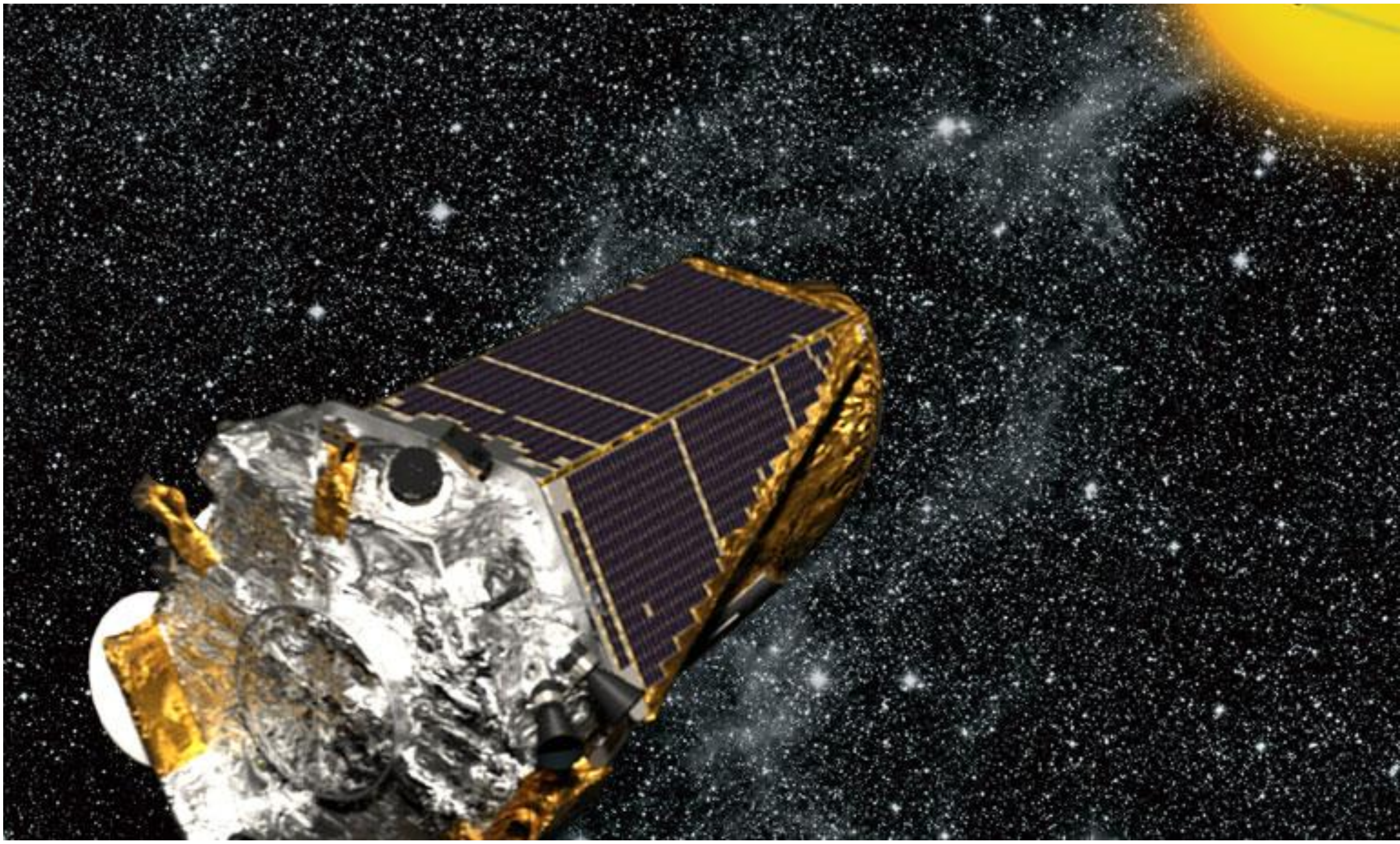
The next step will be to use the upcoming Transiting Exoplanet Survey Satellite (TESS) to probe nearer and brighter transiting planets, allowing follow-up measurements and confirmation of these metallicity-versus-size results, says Latham.

L. Buchhave et al. "Three Regimes of Extrasolar Planet Radius Inferred from Host Star Metallicites," *Nature,* May 28, 2014

- See more at: http://www.skyandtelescope.com/astronomy-news/three-exoplanet-molds-metals-matter/#sthash.o6y0cSFc.dpuf

Sun shines new life on Kepler space telescope

NASA's prolific planet hunter brought back to life by balancing on sunlight
BY **CHRISTOPHER CROCKETT**



NOT QUITE DEAD The Kepler spacecraft, seen in an artist's illustration, is getting back to work after an early forced retirement. To compensate for the loss of two reaction wheels, the planet hunter will use sunlight to steady its gaze.

WENDY STENZEL/KEPLER MISSION/NASA

Reports of Kepler's death have been greatly exaggerated.

NASA's flagship planet hunter, which netted nearly 1,000 confirmed exoplanets during its four-year mission, is getting a second chance at life with a little help from the sun. The space agency has given the new mission, dubbed K2, the go-ahead to start observations at the end of May.

Kepler was knocked out of commission last spring when the second of its four reaction wheels stopped working (*SN Online: 5/15/13*). The reaction wheels keep the telescope pointed in the right direction; any spacecraft needs at least three. Once Kepler was down to two wheels, it could no longer sufficiently steady itself to search for other solar systems.

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