The Astronomical Society of the Pacific (ASP), speaking from the perspective of 124 years of advancing science and science education, expresses its profound concern over the Obama Administration’s fiscal year 2014 Science, Technology, Engineering, and Mathematics (STEM) education restructuring proposal. This proposal will drastically reduce NASA’s education and public outreach (EPO) effort, including the abrupt termination of all mission-based EPO efforts in NASA’s Science Mission Directorate (SMD). We believe that this action will significantly damage STEM education efforts — just the opposite of what the Administration intends.

As stated in its policy guide, NASA “can make especially important contributions (in) education and raising the general level of public understanding and appreciation of science and technology.” The agency has also, in our estimation, recognized the fundamental principal that science and science education work best when they go hand-in-hand. For nearly two decades, NASA’s science directorate has embedded educators working with scientists directly into its science missions and programs. This pioneering approach has produced authentic science education experiences, using metrics to document significant impacts for millions of students, teachers, and the engaged taxpaying public in support of strategic and national STEM goals.

NASA’s SMD EPO has amplified its reach by partnering with a national network of schools, colleges, museums, non-profit organizations, and others, leveraging resources to achieve maximum impact for the benefit of the nation and its youth. The agency and its partners also understand that effective education does not occur solely in the classroom; NASA has effectively championed out-of-school experiences that complement formal learning in synergistic ways.

NASA SMD anticipated the Administration in recognizing the value of coordinated efforts: as early as 1997, it established the concept of coordinating forums to enhance its programmatic efforts. Four years ago, it established Science Education and Public Outreach Forums (SEPOFs) for each of its science divisions. The SEPOFs work together, using a common set of goals, metrics, and robust evaluation approaches to coordinate the work of mission and program EPO in a collaborative, communication-rich environment. This approach increases STEM education impact as scientists and educators — working together — inspire, engage, educate, and train with real, cutting-edge, scientific discoveries and techniques.

In the ASP’s view, these efforts already directly support the President’s national STEM goals. Most use capabilities unique to NASA that cannot be duplicated or disseminated by other agencies. Virtually all will be lost — overnight — under the current plan.

This is the time to truly take a step forward in advancing national STEM goals. We strongly urge the Administration to listen to the collective voices expressing concern over this proposal — experts who successfully deliver science education programs and training every day to the educators and learners who shape our future.

We call upon the Administration to reconsider its plan, and work together with its science agencies to craft a STEM education strategy that will build upon, leverage, and strengthen existing and effective programs rather than dismantle them. In this way, we can collaboratively advance strategic STEM initiatives for the national good. We will provide current and future generations with the very best foundation to ensure their STEM literacy, and we will create an education legacy worthy of our shared goals.
Better Conference Talks
EMILY LAKDAWALLA
I’ve been to a lot of conferences and attended a lot of talks, and the best advice I can give for presenting a better talk is: Respect your audience.

Divine Animals: Plato, Aristotle, and the Stars
STEPHEN CASE
The ideas of Plato and Aristotle on the nature of the stars, though they seem odd to us today, gave rise to distinct traditions in the history of astronomy.

The ASP at its Heart
JAMES G. MANNING
The Astronomical Society of the Pacific (ASP) is 124 years old this year, and while our vision has evolved, we are still working together to advance science literacy through astronomy.

Astronomy in the News
A Moon mystery solved, a new kind of variable star discovered, and the Big Bang theory strengthened — these are a few of the discoveries that recently made news in the astronomical community.

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on the cover
Front: UGC 12158 is an excellent example of a barred spiral galaxy. Barred spirals feature spectacular swirling arms of stars that emanate from a bar-shaped center. Such bar structures are found in about two-thirds of spiral galaxies. One estimate places the diameter of this galaxy at 140,000 light-years, and it’s thought to be a larger version of the Milky Way. Courtesy ESA/Hubble/NASA.
Back: On Oct. 5, 2008, NASA’s Cassini spacecraft captured this stunning mosaic of Saturn’s moon Enceladus. Craters and cratered terrains are rare in this enhanced-color view of the moon’s southern hemisphere. Instead, the surface is replete with fractures, folds, and ridges — all hallmarks of remarkable tectonic activity for a relatively small world. Courtesy NASA/JPL/Space Science Institute.
Where is the Long View?

If you read nothing else in this issue, please read the ASP’s statement regarding the proposed cuts to NASA’s education and public outreach (EPO) programs on page 2, and our Executive Director’s comments on page 6. If the idea of these potential cuts leave you feeling angry, upset, unhappy, or just plain annoyed, then please write the Congress Critters sitting on two critical committees and tell them to cut the cuts: the US House Committee on Science, Space, and Technology (http://science.house.gov/about) and the US Senate Committee on Commerce, Science, and Transportation (http://tinyurl.com/k7j8h2n).

Full disclosure. I’m Canadian, and I work for the ASP from Canada. Some might say, therefore, that I don’t have a horse in this race. And I will admit that I have plenty of problems with my own government when it comes to their attitude toward science.

But NASA’s EPO programs have an influence that extends far beyond America’s borders. Or, to modify a phrase often used by James Manning, the ASP’s Executive Director: NASA’s EPO program leaves a footprint bigger than the size of its shoe.

Thanks to NASA’s past generosity (and, by definition, the generosity of the US), the world has an interest in this EPO fight. The educational materials that NASA has created and disseminated have benefited students worldwide. Children who were turned on to science via the American space program, which they knew about largely thanks to NASA’s EPO programs (in their various forms during decades past) are now creating innovations for the benefit of all.

Yes, the US has a budget crunch. The debit and deficit are frighteningly large. Maybe NASA can no longer afford to give things away. But to cut a program that generates an interest in science, that inspires the next generation to think of science as anything but dull, that will ultimately provide a payback far beyond its cost…that, to me, is just typical short-sighted chopping by those with no long view. And if you don’t have a long view, you don’t have a future.

Paul Deans
Editor, Mercury
Like salt and pepper for our viands, life tastes better when it’s spiced by a little serendipity.

Early this spring, when it was still rainy along the Pacific coast, I was emerging from the grocery store after the workday. It had been drizzly the whole day long, but here at sunset, even as it sprinkled, the Sun managed to peek out from the cloud deck in the remote west. Just minutes from setting into the sea, the Sun kindled the underbellies of the clouds with golden fire, and gilded the wet hills to the east in a warm glow. Glancing over my shoulder as I surveyed the scene (for I am one of those people who, when I step out of doors, always looks up) I found myself suddenly confronted by an enormous rainbow — the best I’ve seen in a long, long time.

It was magnificent. With the Sun barely above the horizon, the bow was semicircular — a gigantic arch of brilliant color stretching over the grocery store, and over me. A ghostly secondary rainbow arched above the primary, the colors reversed. The pot of gold, clearly just off in the golden hills where the prismatic curve of the double rainbow met the earth, seemed almost within reach.

All around me in the parking lot, shoppers stopped and gaped, and in unison pulled out their cell phones to record the moment with their portable camera functions. But no view screen could contain it all. It was a moment to be absorbed directly through the senses.

For precious minutes, the rainbow persisted as sunlight refracted and reflected through the invisible raindrops of the day’s ending sprinkles. And then the Sun dipped into the distant sea, the bow faded, and the sky began to deepen into dusk. And all we lucky observers went back to our business.
But for those few minutes, the day had been made glorious, and life was good.

Lord knows, life can be difficult. But it also has the capability of delivering little gifts, if we’re open to them — unexpected moments of beauty, of wonder, of revelation and insight. When poets speak about “moments of illumination,” I’d like to think they are talking about moments like this.

And the sky in particular seems especially good at them, if you ask me. Those of us attuned to be attentive to the sky end up frequently delighted — by the sudden sighting of the sliver crescent Moon hanging like porcelain in a blue sky at dusk; by the flash of a bright meteor, burning green or gold across the stars; by a ruddy full Moon rising through drifting clouds; by the glittering arc of the Milky Way that appears when we leave civilization behind; and even by the three-minute passage of the International Space Station, when we realize what it is — as bright as Arcturus and the same color. And occasionally, by an unexpected rainbow arching across the sky.

Such little, serendipitous gifts are not to be missed if at all possible, for they sweeten daily life and lift us out of ourselves into the larger world. And as we at the ASP work to make more people sky-attentive, through our programs and trainings and products and publications like the one you’re reading now, we hope that more people will experience these little gifts, grow in understanding and appreciation of the amazing universe in which we live, and find their day lightened by the thought.

It is a good thing to strive for, as we advance the cause of science literacy using the sky we all love. We thank you for your support of this mission, and for your participation in it. And that said, I can think of no better wish than to wish you a little serendipity in your lives!

P.S. Of course, to get a rainbow you need a little rain. And right now the ASP (and the publicly funded science education and public outreach community) has a little rain falling on its windshield as we drive forward into the future. On page 2 you will find our statement about the proposed 2014 budget cuts to NASA’s education and public outreach (EPO) programs. We think such cuts will significantly damage STEM education efforts — efforts that the ASP strongly supports through its various programs.

We have called upon the Administration and policy makers to reconsider this plan, and work together with science agencies to craft a STEM education strategy that will build upon, leverage, and strengthen existing and effective programs rather than dismantle them. In this way, we can collaboratively advance strategic STEM initiatives for the national good, provide current and future generations with the very best foundation to ensure their STEM literacy, and create an education legacy worthy of our shared goals.

I ask that you take a moment to read page 2, and, if you feel as we do, we encourage you to make your voices heard. Contact your elected officials and let them know that NASA EPO funding is making an impact in STEM learning and literacy. And please write to the Congressional representatives sitting on these two committees, and ask them to reverse the proposed cuts:

The US House Committee on Science, Space, and Technology (http://science.house.gov/about) and

The US Senate Committee on Commerce, Science, and Transportation (http://tinyurl.com/k7j8h2n).

On a positive note, at our upcoming annual conference we are providing an opportunity to showcase and document the impacts, measurable metrics, lessons learned, and emerging best practices from nearly two decades of NASA-funded education, public outreach, and educational research and assessment. We hope you’ll join us for this important discussion.

— J.G.M.

JAMES G. MANNING is the Executive Director of the Astronomical Society of the Pacific.
The concept of a “thought experiment” was employed as far back as the ancient Greeks. It was a handy mental device centuries ago when laboratories were not yet developed and real experiments to answer the exotic questions of physics and astronomy were just pipe dreams. The concept came to more general attention thanks to Einstein’s thought experiments regarding relativity.

The idea of creating a water telescope was born of a genuine observational result — the discovery of stellar aberration by James Bradley, England’s Astronomer Royal. Stellar aberration is the variation of a star’s position against more distant stars due to the annual motion of Earth around the Sun. At most, it results in a change in position of 40 arcseconds. (On average, the Moon is 2,000 arcseconds in diameter.) Through careful observation Bradley discovered this effect, and by 1728 he had developed a theory to explain it.

Aberration and the speed of light intrigued Roger Boscovich, the Director of Brera Observatory in Milan. Croation by birth, he spent most of his life in Rome and Milan. The principle of the water-telescope was first explained by Boscovich in a letter to Giambattista Beccaria in 1766, and then in 1785 fully developed in the second volume of his optical and astronomical papers.

In his thought experiment, Boscovich imagined the passage of starlight through water, instead of air, as it reached a telescope. At that time no one knew if the velocity of light increased or decreased when it passed through water. If the speed increased, then aberration would decrease. Boscovich reasoned this fundamental problem could be solved with a water telescope, and that the experiment could better be conducted using a terrestrial object rather than a star.

Boscovich and his theories of the physical universe had a great influence on scientific thinkers of the 18th century. One of his greatest supporters was John Robison, Professor of Natural Philosophy at Edinburgh University from 1774 to 1805. But despite his support, it was Robison who demolished Boscovich’s idea of using a water telescope to measure a change in stellar aberration. This is how Robison stated the idea put forth by Boscovich.

“If a telescope be constructed, having its tube filled with water, and be directed to a terrestrial object, it will be found to deviate from that object by a certain determined quantity every day. It will follow from this, that a person shut up in a mine or dungeon may, without seeing the sun or heavens, discover the motion of the earth round the centre of the solar system, and also whether this centre be in motion, and the velocity and direction of this motion.”

Clearly, this was a very important result, if it were true. Robison said, in a paper published in Edinburgh in 1788, that the experiment would work if only the velocity of light changed. But this is not the case, he said, because the ray that goes down the axis of the telescope is not perpendicular to it, but comes in at an angle depending
on the aberration. Since both the velocity and angle change, the effect sought by Boscovich cannot be seen.

Most ideas have a long and eventful life, and this was certainly true of the outlandish notion of a water telescope. Nearly a century later such a telescope was actually made! In one of the most remarkable experiments ever conducted at Greenwich Observatory just east of London, George Airy, the Astronomer Royal, set up a water telescope to observe the star gamma Draconis. Data was collected in the spring and autumn of 1871 and 1872. When the data was analyzed, it showed the position of [the] star exactly as it was observed in an ordinary telescope. Since no aberration correction could be measured, corroborating Robison’s belief, the telescope was dismantled.

What actually prompted Airy to conduct the experiment was not to prove Robison right and Boscovich wrong. Other people were investigating the speed of light in a medium that is itself moving, not realizing the speed of light is a constant. It was all very confusing to researchers in the 19th century, who believed in the existence of an ether — an immovable substance that permeated all of space.

This returns us to Einstein and the theory of relativity. As we know from relativity, Airy’s experiment with the water telescope was a trivial one since the observer is at rest relative to the telescope, so a null result accords with relativity. Once the notion of the ether was disproved, and Einstein’s concept of relative motion was understood with the speed of light a universal constant, it all became clear, but it took the greatest physicists many decades to unravel these issues.

CLIFFORD J. CUNNINGHAM was recently seen chatting with the star Tom Sizemore, whose action movies include Saving Private Ryan and Black Hawk Down.

The Amazing Red Spider Nebulae

Can molecular abundances reflect the age of a nebula?

Low- to intermediate-mass stars (0.5 to 8 times the Sun’s mass) are known to evolve into Asymptotic Giant Branch (AGB) stars. The outermost regions of AGB stars are cool enough for chemical bonds to occur. AGB stars exhibit both organic and inorganic molecules: in fact, more than 70 chemically distinct molecules have been identified in AGB stars.

Ultimately, AGB stars evolve into planetary nebulae (PNe). But for a brief period of time they become proto-planetary nebulae (PPNe). The central stars of PPNe are still too cool to ionize the circumstellar envelope. We expect the molecular chemistry of PPNe to be fairly rich and observations confirm this. Once the central white dwarf is exposed, intense UV radiation should destroy most, if not all, molecules. (After all, UV photons from the Sun destroy molecular bonds in the terrestrial atmosphere and the Sun is much cooler than a white dwarf!) Actually, chemical models predict that certain molecules might survive the late stages of PN evolution if these
molecules are protected inside dusty knots or clumps.

There have been survey studies examining the carbon monoxide (CO) content of PNe and some of these are also found to contain hydrogen cyanide (HCN) and its tautomer hydrogen isocyanide (HNC), cyanide (CN), and the formyl ion (HCO⁺). Only a few PNe have been the subject of detailed molecular studies — these include the young planetary nebulae NGC 7027 (roughly 700 years old) and the Helix nebula (the oldest known at 12,000 years of age). Both contain CO, CN, HCN, the ethynyl radical (CCH), and HCO⁺; however, a number of species found in the Helix are absent from NGC 7027 including carbon monosulfide (CS) and HNC, and possibly cyclopropenylidene (C₃H₂). Likewise, several molecular species found in the younger nebula are absent from the older nebula. Are these differences a reflection of nebular age as some studies suggest?

Recently, J. L. Edwards and L. M. Ziurys examined the molecular content of the Red Spider Nebula (NGC 6537). It is some 1,600 years old and lies 3,000 light-years from Earth. The Red Spider was known to contain molecular hydrogen (H₂) and CO, but Edwards and Ziurys detected an array of molecular species — amazing and unexpected given that this nebula contains one of the hottest observed white dwarf stars.

Like NGC 7027 and the Helix, the Red Spider Nebula contains CN, HCN, CCH, and HCO⁺. Like the Helix it also contains HNC. However, the Red Spider also contains formaldehyde (H₂CO), CS, and sulfur oxide (SO).

Edwards and Ziurys compared the molecular content of the three nebulae. All contain CO, HCN, and HCO⁺ with abundances that differ only by a factor of two or three. Each contains CN and CCH, but compared to NGC 7027, it is approximately two times more abundant in the Red Spider and at least 10 times more abundant in the Helix. Both H₂CO and HNC were undetected in NGC 7027; however, while both the Helix and the Red Spider contain these molecules, these are about 10 times more prevalent in the Helix.

The absence of H₂CO is easily explained: the Helix and Red Spider nebulae are oxygen-rich while NGC 7027 is carbon-rich (though the latter makes the absence of HNC in NGC 7027 a bit surprising). The absence of SO in carbon-rich NGC 7027 is not unexpected, and SO has never been searched for in the Helix — its detection in the Red Spider is further evidence of its oxygen-rich environment.

It has been suggested that CS is destroyed in the process of nebular evolution from PPNe to PNe, but its abundance in the Red Spider and older PNe is inconsistent with this hypothesis. The ratio of HCN/HNC is predicted to decreases with age due to increased photoionization; however, HNC is absent in NGC 7027 and HCN/HNC is approximately two for both the Red Spider and the Helix, despite their age difference.

Consequently, Edwards and Ziurys suggest that molecular abundances reflect the physical properties of nebulae and the chemical content of the progenitor star, rather than nebular age.

JENNIFER BIRRIEL is an Associate Professor of Physics in the Department of Mathematics, Computer Science & Physics at Morehead State University in KY. She's ashamed to admit it, but every now and then she sneaks a peek at the list (http://tinyurl.com/kxf66h) of interstellar and circumstellar molecules available on Wikipedia.
Curiosity Update
A brief review of Curiosity’s first year on Mars.

After surviving the most complicated landing in NASA’s history, the Mars Science Laboratory (MSL) — better known as Curiosity — began its exploration of Gale Crater on August 6 of last year. Gale Crater, an ancient impact located near the Martian equator, was selected because observations from orbit showed evidence of clays and sulfates, two minerals that form in the presence of water. The rover’s eventual destination, Aeolis Mons (informally known as Mount Sharp) rises 18,000 feet from the center of the crater. The mountain has many layers of exposed rock, recording nearly four billion years of Martian history. The rover carries a payload of 10 instruments, allowing its team on Earth to study Mars in greater detail than ever before.

In addition to three cameras, two radiation detectors, and a complete weather station, there are four analysis tools on board. The Alpha Particle X-Ray Spectrometer (APXS) bombards samples with radiation to help determine their chemical composition. Curiosity can also scoop Martian soil into the Chemistry and Mineralogy (ChemMin) system, containing the first x-ray diffraction spectrometer on another planet, to break down its components. Sample Analysis at Mars (SAM) is essentially a self-contained geology lab, with several instruments to examine rock and soil. Finally, the Chemistry and Camera experiment (ChemCam) uses a laser to vaporize rock and then analyzes the resulting plasma.

The first several weeks on the surface were spent double-checking and calibrating the instruments and updating software. All the equipment checked out, and investigations began in earnest. The first laser tests of ChemCam instrument took place on August 19. ChemMin performed its first analysis in October, determining that the soil near the landing site was similar to the volcanic soils of Hawaii. The rover has drilled into two rocks to collect interior samples, which were analyzed with ChemMin and SAM.

All went smoothly until the last week in February 2013, when a computer glitch necessitated a swap to the “B-side” redundant system. Science operations were suspended for three weeks while engineers worked to develop a patch for the corrupted “A-side” memory. Two weeks after returning to normal status, April brought a welcome break for the team — Mars’
orbit took it behind the Sun for a month-long conjunction that cut off communication with the Red Planet. Curiosity spent its “Spring Break” parked in an area dubbed Yellowknife Bay, autonomously collecting weather and radiation data but otherwise idle. Its team, however, was far from idle, working on analyzing the huge amounts of data the rover had sent back in the proceeding months.

The most exciting discovery so far was made using the rover’s mast camera and ChemCam. Curiosity has found smooth pebbles — known as clasts — that would look very familiar to anyone who has ever played in a stream. These clasts provide strong evidence that there was once flowing liquid water on Mars — an excellent step in the search for life on the Red Planet. The lead scientist on the discovery, Dr. Rebecca Williams of the Planetary Science Institute, says: “The rounded pebble shape requires significant fluvial abrasion and indicates long-distance water transport of the pebbles, over at least several kilometers.” By comparing the Martian observations to streams here on Earth, Williams’ team was able to figure out that: “The stream was flowing at a minimum speed equivalent to a walking pace — a meter per second — and it was ankle deep to hip deep.” (For more details, go to http://tinyurl.com/m8mteej.)

In the months since landing, Curiosity has traveled about 750 meters from its landing site. The MSL team expects the trip to Mount Sharp to take about a year while they investigate the rocks and terrain along the way. Curiosity’s initial two-year mission has been extended indefinitely, and promises many more discoveries on its journey.

EMILY JOSEPH is a Research Assistant, with an emphasis on Mars studies, at the Planetary Science Institute in Tucson, Arizona.

Here Comes the Anti-Glitch

Astronomers detect a glitch in their theory of pulsar glitches.

Who says you can’t teach an old pulsar astronomer new tricks? Astronomers have been shaken from their comfortable understanding of pulsars with the discovery of a glitch, or a sudden change in a pulsar spin rate, that made one particular pulsar suddenly slow down.

The glitch altered the pulsar’s spin by a mere 2.2 millionths of a second, but still…pulsars aren’t supposed to behave this way. Glitches always increase the spin rate. So scientists say this new glitch, dubbed the anti-glitch, must be pointing to unexplained physics inside the pulsar, in which dwells some of the weirdest matter in the universe. The finding was presented at the annual meeting of the Canadian Astronomical Society on May 30, 2013, and also appears in the May 30 issue of Nature.

The anti-glitch happened not on some ordinary pulsar but rather on a more exotic one — a so-called magnetar known as 1E 2259+586, located some 10,000 light-years away in the constellation Cassiopeia.
Now, to understand pulsars and magnetars is to temporarily lose grip of reality. Pulsars are neutron stars, the core remains of massive stars that had gone supernova. They still contain the mass of about two suns but that mass is compacted into a sphere only about 20 kilometers across.

Even the densest among us still can appreciate how dense a neutron star must be. A teaspoon of its matter would weigh more than all the automobiles in the United States and Canada. Its surface is likely a kilometer-thick sheath of iron atoms arranged in a smooth crystal lattice. Below is a superdense liquid, likely a superfluid of neutrons. The pressure could be high enough to liberate quarks from the neutrons, creating a theoretical quark fluid not known to exist anywhere.

Pulsars pulse with steady beams of energy as the neutron star spins, like a rapidly spinning lighthouse. A magnetar is all of this and, oh yeah, fantastic magnetic fields to boot. Whereas a pulsar has a magnetic field (channeling those pulses) of $10^8$ telsa, a mere trillion times that of Earth’s, a magnetar’s field is up to $10^{11}$ telsa, powerful enough to strip your credit card clean at a distance from Earth to the Moon.

Scientists have found several hundred pulsars that exhibit glitches in their remarkably steady spin-down rates, where the pulsar’s spin suddenly quickens. Theorists say that such glitches are an indication of interior superfluid. The superfluid can spin at a different, faster rate than the outer crust, and every once in a while, a surface event such as a starquake can release that pent-up energy below. The superfluid thus acts like a flywheel, suddenly increasing the outer crust’s spin.

And all of that made sense until Robert Archibald, a McGill University graduate student, discovered the anti-glitch, a sudden and dramatic decrease in the spin rate. He made this discovery during routine observations of 1E 2259+586 with Swift, NASA’s orbiting telescope with gamma-ray, x-ray, and ultraviolet detectors.

There’s no solid explanation, yet, why the spin rate would drop so suddenly. If the pulsar were like a blender — and the RPMs are similar, at more than 40,000 revolutions per minute — this would be almost like changing speeds downward. The paper’s authors, which include Vicky Kaspi of McGill, Archibald’s advisor, suggest that maybe the superfluid in the core, in parts, can spin more slowly than the crust and act like breaks instead of a flywheel.

Robert Duncan of the University of Texas at Austin, who along with Christopher Thompson at the Canadian Institute for Theoretical Physics predicted the existence of magnetars in 1992, agrees that this scenario is possible and already has been working on the math. Duncan said the superfluid could have numerous rotating regions and is likely far more complicated than astronomers have thought.

Conveniently enough, NASA is planning the Neutron star Interior Composition Explorer (NICER) mission to do just what the name states. The x-ray mission was selected to proceed to formulation phase in April 2013, and it could launch as early as 2016.

CHRISTOPHER WANJEK, author of the comical novel Hey, Einstein!, hopes for a glitch, not an anti-glitch, in the NASA glitch mission, astronomically speaking.
Last winter, the New York Times reported the 2012 “Trend in International Mathematics and Science Study” results, indicating that US 8th graders ranked 9th in math and 10th in science. Although there were small gains at this level in science scores, the ranking remains problematic for many educational leaders. But I am less worried about standardized test scores than I am in decreasing interest among our young people in science, technology, engineering, and math (STEM) careers, and in the fact that, though we have made some progress during the past 40 years, we still attract few women to STEM.

We need women in STEM. As Sue Rosser, the Provost at San Francisco State University, argues in her Chronicle of Higher Education article, gender diversity leads to better science because of the different problem choices and the methods employed to solve them.

American Institute of Physics statistics indicate that we have nearly tripled the number of women receiving bachelor degrees in astronomy from 1976 to 2005 — women now receive 40% of the degrees (though women receive only 20% of physics degrees). But the pipeline is leaky, meaning that even though more women are getting degrees at all levels, few find full-time jobs. Women hold just 11% of the full professorships and 24% of associate professorships in astronomy. Worldwide, only 16% of the International Astronomical Union membership is women.

In a revealing study, Corinne Moss-Racusin et al of Yale University sent out a one-page resume to more than 100 professors, asking them to rate the likelihood of a promising but not stellar student in obtaining a lab manager position. The only difference in the resume was that half carried the name “Jennifer” and half named the student “John.” John received a rating of 4 out of 7 while Jennifer received a 3.3. Jennifer was also told her likely salary would be $3,800 less than John’s. Interestingly, this employment bias extended across academic rank, discipline, and gender of the rating professors.

It is past time that the myth of women’s ability in math and science is put to rest. An American Association of University Women study indicates that women in high school have better grade-point-averages in math and science than men, and that standardized test score differences are decreasing as gender bias is removed. Any perceived lack of female role models is due to gender bias in the media, not a lack of capable women scientists, but can you name ten contemporary women astronomers?

The lack of women in STEM is due also to social reasons. Studies show mothers encourage sons more than daughters to engage in hands-on activities in science museums, and teachers unwittingly reinforce this in the classroom. Hands-on activity, though, is often stated by girls as one of the reasons they like science; in fact, 74% of girls report liking STEM. Unfortunately, only 20% of female first-year...
college students indicate an interest in STEM careers versus 50% of males. Brian Nosek et al of the University of Virginia notes that women who find it easier to associate men with science (i.e., gender-science stereotype) show less interest in pursuing science in the future.

The AAUW study mentioned earlier has some additional insights as to why young women opt out. Girls exhibit a lack of confidence when doing math and science, which is often reinforced by teachers stating that boys do better than girls in these areas. But when explicitly told that girls do as well as boys, girls perform as well as boys. In addition to watching for unconscious messages of gender expectations, we need to insist that young women have equal chances to work with hands-on activities, including using computers, meters, and machines. Girls prefer to focus on applications and not methods, so math and science learning should be project- and not methods-oriented. Girls list encouragement by their high school teachers as important in their choice to pursue STEM degrees, but they also list “advice” from high school counselors as greatly dissuading.

Experience with science programs for girls suggests that the gender of mentors is less important than having an opportunity for girls to engage science with their peers. We should mention female scientists by name as often as we recount discoveries by male scientists. And check out the Girl Scouts of America STEM report (http://tinyurl.com/89x8wqf) to see what else you can do to encourage our young women to engage in STEM.

DAVID BRUNING teaches astronomy at a Midwestern state university. He apologizes to Carl Frost for the rearrangement of his poem in the title but hopes that we will all help young women develop positive, confident attitudes toward science.

Why Do I Engage in EPO?

I personally believe that it is incredibly shortsighted to halt all NASA-directed education and public outreach in exchange for infinitesimal cost savings. Much has been poignantly written elsewhere about these proposed cuts, and so I won’t bother rehashing those arguments here. But all the collective soul-searching related to these cuts has made me reflective about my own personal experiences: Why do I engage in EPO?

The “E” part of EPO is easy to explain. I enjoy teaching, and believe it is incredibly important for college students to graduate with at least basic science literacy. I could speak for hours about my personal
believe in the power of education. And even if that didn’t convince you as to why I engage in education, then there is always the obvious prosaic answer: as an assistant professor, teaching is a significant portion of my job — it’s what I’m paid to do!

Public outreach is much harder to explain. Many astronomers who engage in public outreach do so without any obvious form of compensation. A few lucky astronomers have an NSF or other grant that requires outreach — and actually take that requirement seriously. But many other receive nothing — not even an acknowledgement or a pat on the back from their home institution.

Why then, we feel bad when we can’t do more outreach because of our other obligations? Why do we persist despite being told, either directly or indirectly by others somewhere along the way, that outreach is a waste of time and energy? How do we endure when even our government — despite all their concerns about STEM education — seems to label outreach as worthless?

First, I believe we owe it to our community. The vast majority of astronomy funding comes from taxpayers. But astronomy is such “pure science” that its impact on humanity is often much more subtle than biology or chemistry. We have a duty to help translate our findings and their importance into everyday language. Astronomy provides clues that help us understand our place in the universe, and point us toward the answers to enduring human questions about how we got here, are we alone, and what is our future? Astronomers have the luxury of pursuing these questions because of our community, so we should share what we find!

Next, I see astronomy as a fantastic “gateway drug” to science in general. Beautiful images of the cosmos can draw in people and get them asking questions. I’d be perfectly happy if not a single person that I’ve ever interacted with during public outreach became a professional scientist — I just want these people to take away an appreciation of science. I want science to become alive and real for them, and to decrease their fear of science as something unknowable. I want to give them the insight that scientists are human beings and not the caricatures they see on TV — to know that science is, in a sense, a living, breathing entity that changes and evolves over time.

Finally, there is another reason we might do outreach that we don’t always admit: outreach can be a self-affirming pursuit. I enjoy rambling on about astronomy, and public outreach gives me a captive audience. And who doesn’t like feeling as though they are the most knowledgeable person in the room about something? That’s a real ego-boost!

The outreach I have always engaged in is grassroots, such as building one-on-one relationships with local classrooms. While this kind of outreach can seem relatively low-impact compared to what is carried out by NASA, at least I can feel lucky that my funding can never be slashed, since I have no funding in the first place! But seriously, I hope that astronomy can weather this storm. I hope that our profession uses this moment of crisis to engage in meaningful discussion and to emerge with a renewed commitment to EPO.

BETHANY COBB is an Assistant Professor of Honors and Physics at The George Washington University, where she studies gamma-ray bursts and teaches physics/astronomy to non-science majors.
Did you know that the Astronomical Society of the Pacific (ASP) is a leading publisher of conference proceedings on recent developments in astronomy and astrophysics? Or that ever since 1889, the technical journal of the ASP has published refereed papers on astronomical research covering all wavelengths and distance scales, as well as papers on the latest innovations in astronomical instrumentation and software?

**Who Makes a Scientific Journal Hum?**
by Jeff Mangum

In April 2013, several news outlets reported the discovery of an extrasolar planetary system possessing five planets, two of which are “super-Earth” type planets orbiting in the habitable zone of their parent star (Kepler-62). How certain is the scientific community that this result is correct? Was this just an announcement made independently by a group of scientists without being scrutinized by the wider scientific community?

The answer in this case, and for the vast majority of scientific results reported by the news media, is that the research behind the Kepler-62 news report was published in a scientific journal whose articles are evaluated by independent scientists not associated with this particular research result. This is an example of a process called “peer review,” whereby a research article is assessed by one or more people whose qualifications allow them to independently evaluate the veracity of a scientific research result. Peer review has been a staple of the scientific review process for nearly 350 years, having first been used in 1665 by the editor of the Philosophical Transactions of the Royal Society. All credible scientific research is published in peer-reviewed journals, representing the foundation upon which the scientific community controls the quality of its science. As the vast majority of scientific research is publicly funded, trust in scientific results is the foundation upon which the relationship between the scientific community and the general public is built.

A number of peer-reviewed research publications serve the astronomical community. The Publications of the Astronomical Society of the Pacific (PASP) is one of those journals. PASP publishes refereed papers on astronomical research covering all wavelengths and distance scales as well as papers on the latest innovations in astronomical instrumentation and software.

Published continuously since 1889, PASP operates with the same process used by most astronomical research publications. Editors receive manuscripts from authors, find qualified reviewers for those articles, and negotiate the interaction between author and reviewer. At the culmination of the review process, the PASP editor makes a decision as to whether a manuscript is acceptable for publication.
In essence, the editors are the individuals “turning the crank” of a scientific journal’s machinery.

This process operates continuously and without interruption, and relies on a significant commitment by scientists who serve as reviewers and editors of these publications. PASP has historically been fortunate to have a small group of dedicated and talented scientists who have served as editors. Recently, two of PASP’s long-time editors, Paula Szkody and Toby Smith, stepped down after each serving the astronomical community for more than a decade.

Paula Szkody is a Professor in the Astronomy Department at the University of Washington. Paula served as a Scientific Editor for the Astrophysical Journal from 2002 until she became Editor of PASP in 2005, a position she held until January 1, 2013. Toby Smith is a Lecturer in the Astronomy Department at the University of Washington. Toby began his editorial career as an Assistant Editor for the Astronomical Journal in September 1996, working with then-Editor Paul Hodge. Toby continued in this role until 2005, when the editorial office for the Astronomical Journal moved to the University of Wisconsin. At that point, Toby took on the role of Associate Editor for PASP, serving in that position until April 2013. Finally, PASP continues to benefit from having Daniel Fabricant’s expertise as Associate Editor for Instrumentation since May 2003, a tenure now spanning three editors!

Paula’s 11 years, Toby’s 15 years, and Dan’s 10 years (and counting) of service as editors puts them in a very select group of scientists who have devoted a large amount of their time to this valuable and necessary service to the astronomical community. Furthermore, editorial duties are in most cases tasks which are added to an astronomer’s normal research and teaching responsibilities.

On behalf of the entire astronomical community, I would like to thank Paula and Toby for their 26 years of service, and Dan for his continuing commitment to the PASP editorial process. Without their dedication to the production of science results, public announcements such as the discovery of the remarkable Kepler-62 planetary system would not have passed the credibility standard set by the scientific community.

**Conference Series Celebrates 25th Anniversary**

by James G. Manning

In 1988, Harold McNamara, professor of astronomy at Brigham Young University (BYU) and editor of the Publications of the Astronomical Society of the Pacific (PASP) for 20 years, shepherded a new ASP enterprise to its first product: a volume of the proceedings of a scientific conference titled Progress and Opportunities in Southern Hemisphere Optical Astronomy: The CTIO 25th Anniversary Symposium.

Back then, the CTIO (Cerro Tololo Inter-American Observatory in Chile) was celebrating its 25th anniversary. This year, we are delighted to be celebrating the 25th anniversary of the birth of
the ASP Conference Series (ASPCS), which provides a low-cost and expeditiously published avenue for documenting and distributing the proceedings of scientific and related conferences, symposia, colloquia, and meetings.

Harold McNamara served as editor of the ASPCS for 16 years, and was succeeded by fellow BYU astronomer J. Ward Moody as editor in 2004. Moody, in turn, was succeeded in 2009 by Joseph Jensen, an astronomer at nearby Utah Valley University.

Through 25 years of continuous publication, the Conference Series has produced more than 470 volumes to date. The volumes are distributed to conference attendees; through subscriptions to colleges, universities, research institutions, and other organizations; and via individual sales. The series provides electronic versions as well as the still-popular print volumes in the well-known ASP blue and white cover design, and reports on conferences the world over as a very significant part of the Society’s global reach. In addition to the regular conference proceedings volumes, the ASPCS has also published six Monographs containing reference material of lasting value, and a number of IAU Symposia.

Current editor Jensen and his able staff (including Jonathan Barnes, Cindy Moody, Pepita Ridgeway and Blaine Haws) continue to advance the Society’s goals, and to build upon the legacies of editors McNamara and Moody and their staff members, by further refining and expanding the services provided through the ASPCS, focusing on the goals of timely publishing, streamlining the process for authors and editors, and maintaining the high quality of its products.

Their good work shows. In addition to publishing about 20 volumes annually, last year alone the Conference Series website was visited 100,000 times by more than 60,000 unique visitors from a total of 156 different countries.

So a very happy anniversary to the ASP Conference Series! We thank the editors and staff — past and present — for their excellent work and dedication. And may the enterprise begun in 1988 continue to serve the Society’s professional constituencies and advance the mission of the Society for many more years to come. ☀

JEFF MANGUM is a scientist at the National Radio Astronomy Observatory who studies star formation at radio through submillimeter wavelengths. He is also the new editor of the Publications of the Astronomical Society of the Pacific. JAMES G. MANNING is the Executive Director of the ASP.
Better Conference Talks

The best advice for presenting a better talk? Respect your audience.

By Emily Lakdawalla

Here I am talking up robotic exploration at the USA Science and Engineering Festival in April 2012. This article, and the blog entry on which it is based, came about because of my frustration at how bad presentations can get in the way of really exciting science. [Courtesy The Planetary Society.]
I’ve been to a lot of conferences and seen a lot of talks, and it’s amazing to me how a bad presentation can get in the way of really exciting science. This article is a response to my frustration about bad conference presentations. I do feel a little hesitant to set myself up as an expert on this, because I know I have a lot of work to do to improve my talks. Still, I think I have useful advice to offer.

I can summarize that advice in three words: **Respect Your Audience.** All those people in the room in front of you — they are not you. But their time is as valuable as yours. Work to deliver them a presentation that is designed for them, to inform and interest them in your work, to leave them pleased that they spent that five or 10 or 50 minutes of their valuable time listening to you. Here are five key questions to consider as you prepare your talk.

**Whom Are You Speaking To?**

Most scientists at conferences appear to be speaking to themselves, or, perhaps, to the people who will eventually be reviewing their paper. Perhaps that’s all you care about, in which case you can stop reading this article right now. But if you actually want people in the room to learn anything from you, you need to think about who they are and what they will come in to the room knowing and not knowing.

The wider an audience you are addressing, the more contextual information you will need to provide to them. Deleting necessary context from your talk, in order to present more of what you did, cuts out large swaths of audience. It is an act of disrespect to your audience.

If you do not provide the people in your audience with information that they require in order to understand you, it is the same as telling them that you do not care if they understand you or not!

Please note that I am not speaking of intelligence here. I am speaking of background knowledge. Still, context trumps data, every time. You can spend a whole conference presentation talking about TLAs to an audience of incredibly intelligent people, but if
they don’t know what a TLA is, it’s likely you won’t have communicated a danged thing. (And what, you ask, is a TLA? A Three-Letter Acronym, of course.)

Really good speakers are ones who manage to communicate something to everybody in the room, no matter who they are or how much they already know. To the relatively ignorant, you should at least convey the driving questions behind your work. At the same time, to the well informed, you should convey how your work has added to or broadened or contradicted what has come before it.

If this is overwhelming, pick somebody in the middle of the ignorance/specialty spectrum to pitch your talk to. At a conference, I imagine a graduate-educated person whose specialty is not the same as mine. And then I ask the next question.

**What Do You Want Your Audience to Learn?**

It amazes me that people prepare talks without ever asking this question, but they appear to. A lot of people spend a lot of time describing their research methods: what you did is, after all, what you spent most of your time doing. But the whole point of your work was to learn something that you could then communicate to others. Don’t force the audience to go through the same process you had to, in order to get to the result. You can save your audience all that work by telling them what it was you learned.

Here’s an exercise that I highly recommend. Compose a Tweet summarizing your talk. You get 140 characters. You don’t get to use text-speak or Esperanto. It needn’t have perfect grammar, but it needs to be sensible, comprehensible English. In that limited space, you are not likely to say a whole lot about your methods! If you do, you are boring. “I mapped clay minerals on Mars.” Who cares? “Large areas of Mars experienced rainfall over tens of thousands of years.” Cool.

Make that Tweet your conclusion slide. Make sure that your talk delivers that conclusion. How are you going to do that? Well….
What Is Your Story?
It is impossible to overemphasize the importance of narrative in a talk. You, standing up in front of an audience, are telling a story in which you are the principal character. What's your motivation? What are the big questions that drive your professional curiosity? Did you answer your questions, or was your search fruitless?

There are several fairly standard kinds of stories that work great for scientific talks. The easiest ones for space science? You are solving a mystery, or you are an intrepid explorer who has gone to a place no one has gone before. Maybe you have fought a pitched battle with a legendary monster of a data set.

Stories are fun. If you tell a good story, you hook your audience, and then they will willingly follow you even into dark corners of your subspecialty.

Stories are also functional, especially for people in the audience who may be struggling to follow you on that journey. If, for example, you tell your audience that this is a crime story, pretty much everybody in the room should be able to understand what the crime was at the beginning of your talk. Then, if you lose them while you're talking about evidence gathering, you still have a chance of picking them up again when you tell them: that was the evidence, and this piece of evidence led me to the perp. Even if an audience doesn't get spectroscopy or understand what a general circulation model is, they probably get how crime stories work.

Narrative is not just helpful to your audience; it's helpful to you, too. It provides a structure for your talk and helps you determine what is crucial to conveying your message — and what is not. Which is very important when you consider the following question....

How Long Do You Have to Speak?
You cannot say all the same things in a 15-minute talk slot as in a one-hour colloquium. You just can't. Don't even try.

However, you can tell the same story, which is why I put story before talk length in this article. Do you have a favorite novel that's been made into both a miniseries and a movie, and maybe even a one-hour show? Think about the differences in story among these. As you go from longer to shorter versions, you see reductions in characters, in settings, in subplots, and finally in the main plot line itself. Yet the story (usually) remains recognizable. Exactly the same process is necessary to go from a scientific paper to a colloquium to a long conference talk to a short presentation.

It is especially important for very short talks to practice your talk and then, if it is too long, cut out information that is not needed to tell your story. You cannot solve the problem of a too-long talk by talking faster. You must simplify the story that you are trying to tell. It is only now, once you have identified your audience, your take-home message, and your story, that you should begin to think about making a PowerPoint presentation.

What Visuals Will Amplify Your Story?
I've observed that a lot of people use the phrase “prepare a talk” as though it is synonymous with “compose a PowerPoint presentation.” Don't do that.

I don't hate PowerPoint. PowerPoint doesn't kill scientific conferences. People kill scientific conferences with bad PowerPoint presentations. PowerPoint — or any other means of projecting visual content in front of a large audience — is a tool, and like any tool, it can be used for good or for evil.

When PowerPoint is used for good, it serves to emphasize or amplify points that you, the speaker, are making with your voice and your body language. No matter what, your slides should serve to enhance your presentation, not to distract from it.
What is the number one error that almost everyone makes with PowerPoint presentations? There are too many words on their slides.

We use the same parts of our brains to process spoken language and written language. If you show me a slide containing more than a few words, I must choose between reading your slide and listening to you speak. I am physically incapable of doing both at the same time. If I try, I am liable to jump between reading some text and listening to some speech and then I miss things and I get lost.

Try this. Put words on your title slide — your title, name, coauthors, and acknowledgments. Put words on your conclusion slide — that Tweet I suggested earlier, and your name and contact information. On all the slides in between: no words, just pictures…and pictures only when necessary. If a picture would not help me understand your point, put in a blank slide. Yes, I’m quite serious.

There is a great deal of power in a completely blank slide. Put one up and watch the entire audience suddenly make eye contact with you. I like to put blank slides in places where I am making transitions in talks. It is a reminder to me to remind the audience where we came from, and inform them where we are going. I can look them in the eye and check in with them to see if they are still with me.

Now that I’ve gotten my lecture on talk organization out of the way, here are bits of advice gleaned from personal experience, from the advice of friends, and from a wide variety of sources on the Internet.

Speak Differently Than You Write

Do not use acronyms in your speech, unless you are confident that everyone present understands them. Look suspiciously at any abbreviation that you are tempted to use. Ask about each one: Will everyone in my audience know what I mean when I say this? If not, then I’m sorry but you can’t use it. You don’t have to say “Mars Reconnaissance Orbiter” instead of “MRO” every time. You can just say “the spacecraft” or “the ship” or “the orbiter.” More people will understand what you mean by that than will understand “MRO.”
I hate talks where people define a new acronym in the beginning of the talk and then carry on using it throughout the rest of their talk. If you are writing a paper that is all about something called recurring slope lineae, it’s okay to define “RSL” early and then use the acronym to refer to the features in the rest of your paper. However, it is bad, bad, bad to do this in a talk. If someone misses your definition, they will spend your entire talk wondering what the heck an “RSL” is, and they will learn nothing from you.

The same goes for any piece of technical jargon. Just like an acronym, jargon acts as shorthand, making communication among people who know the jargon more efficient. But jargon is an impenetrable barrier to people who can’t translate it. And if the piece of jargon that you are using is the subject of your talk, and you insist upon using it, you’ve just walled off a big chunk of your audience. Don’t disrespect your audience by using jargon they won’t know…and it’s not good enough to define it once in the beginning of your talk.

Related to this, here’s a cool trick: Don’t use polysyllabic Latinate words when you can use Anglo-Saxon ones. Speak these two sentences: “The compressive stress resulted in a crustal length reduction of thirty-one percent.” And: “The crust got squished to just two-thirds as wide.” Use the first one in your paper. Speak, and gesticulate, the second one.

Whatever you do, don’t call this “dumbing down” your language. You are not dumbing it down; you are oomphing it up. Language is a tool for the communication of information. Use the words that will produce the strongest signal in your audience’s receiving brains.

Simplify your sentence structure. In a technical paper, a single sentence can span a whole paragraph. Modifying clause piles on top of modifying clause. But excessive dependent clauses are deadly in speech. If I lose track of which noun your lengthy list of clauses is modifying, I lose the whole sentence.

If a point is important, repeat it. You can’t bold it or underline it when you’re talking. But you can repeat it; repetition is verbal underlining. It also functions like putting up a blank slide. Repeat something and you’ll start making eye contact with your audience again.
Say something three times and they’ll all be looking at you.

**Don’t go over your time.** *Do not go over your time.* Speaking so long that there is no time for questions informs your audience that you do not care what they think of your work or whether they understood your presentation. Speaking so long that you run into the next speaker’s time informs your audience that you think you are more important than the next speaker and more important than anything else the audience had been planning to do at that time.

Both are insulting and disrespectful. If, when you talk, you seem to vary widely in your talk length, bring your smart phone to the podium, run a countdown clock app, and make sure the screen will stay on through the length of your talk. If you seem to be running long, do not talk faster. That will reduce, not increase, what audiences take away from your talk. Skip ahead and finish on time.

### Slides With Too Many Words and Other Problems

If you must put words on your slides, use very few, and do not use complete sentences. A title for a slide is okay. If you are talking about something that may be unfamiliar to some (say, recurring slope lineae), please show a photo of that thing and label it as being that thing. This will aid understanding. But don’t put a several-sentence definition of the thing on your slide.

**No text below 20 points.** If most of the audience can’t read it, why bother putting it on the slide?

**Graphs can be a big problem.** There is a tremendous amount of information in a graph. Think very carefully before you include one in your talk, and then be prepared to spend time explaining it. And take out every line or label that is not strictly necessary.

**Equations are even worse than graphs.** Seriously, don’t put equations on your slides.

**Data tables: Bad.** No. Don’t.

**Approximately one in ten of the men in your audience are color-blind.** What this means is: Never, ever, use a ROYGBV spectrum to represent a continuously varying property. [Vischeck](http://www.vischeck.com) is a super website to use to ascertain whether your graphics will be...
incomprehensible to the color-blind.

**One thing per slide.** You can only say one thing at a time. What is on the screen should be emphasizing what you are saying right now. If it is illustrating something else, it confuses rather than aids people in understanding what you are saying. It works very well to start with a relatively empty slide to which things get added as you speak — for instance, starting with a photo and then adding circles around interesting features as you point them out.

**Without words, your slides will almost certainly not be able to serve as a stand-alone record of your presentation.** If your slides could stand alone, then your presence wouldn’t be necessary. Obviously this means that you can’t make a presentation by reading from your slides. People who read their slides to the audience are usually facing away from the audience. It is disrespectful to your audience, and moreover, it looks stupid. You’re going to have to have separate notes. I mostly don’t use notes when I speak, but I still have notes from when I was planning my talk, and I keep digital copies of those notes in a folder with my PowerPoint presentations.

**Put your name (maybe even your abstract number) on your slides.** I can’t tell you how much of my time in the audience at conferences I spend shuffling around the program trying to figure out the name of the person currently giving the talk so that I can find and read the abstract later. Put your name and maybe your abstract number in the corner and you make my life so much easier. You also make it more likely that you’ll be contacted after your talk is over by someone who was interested by it. If nothing else, make sure to put your name and contact information on your conclusion slide.

**Your last slide is the one place where you ought to have a sentence.** I like one Tweetable sentence that summarizes your talk. Don’t make your final slide say only “Thank You” (though there’s no harm in also putting that on the slide), and especially don’t make it say only “Questions?”

Humor is useful, but it should be topic appropriate. At the 2012 SpaceUp Unconference in San Diego, my statement relating to this slide was: “Some of the moons of the solar system are larger than Pluto.” [Planetary Society]
Some Final Thoughts

A word on the number of slides. It’s a commonly cited rule of thumb that you should have about one slide per minute. I think, though, that this assumes that people will be reading your slides. This one-per-minute rule doesn’t work as well if your slides aren’t word-heavy. And it makes the PowerPoint presentation drive your talk organization, rather than the other way around. So I don’t find that rule of thumb particularly useful. Focus, first, on what you want to say. Have slides at appropriate places to emphasize what you are saying. If you can’t say what you need to say in your allotted time, you need to say less. Eliminate slides or slide content that are no longer needed to support what you are no longer saying.

A word on animations. If your presentation contains an animation (and they can be awesome visuals), make sure you have tested that your animation works. I like animated GIFs in PowerPoint presentations because they always seem to work. If you know you will have control of the clicker, an even easier way to do a not-very-many-frame animation is just to put one frame per slide and advance them manually. That will work even if (horrors!) your PowerPoint is turned into a PDF.

A word on anxiety about forgetting your talk. I think a lot of presenters write their entire talk on their slides because they’re afraid they’ll stand up in front of all of those people and forget what they want to say. I have a lousy memory and find it impossible to memorize the specific words I want to use; getting away from using text on slides as a crutch was a serious challenge for me. Practice helps a great deal. Here’s a method I use, especially for short talks. I try to memorize the first sentence I intend to say about each slide or sequence of slides. Then I speak more off-the-cuff for a few sentences about that part of the story. While I am doing that, I visually check in with my audience to make sure they are with me. When I advance the slide, I glance at it, and that triggers the sentence I intended to say when I advanced that slide. If I have words on slides, they are usually just titles; those titles also serve as my cues to help me get my intended first sentence out.

You Respect Me, I’ll Respect You

Many scientists find presentations terrifying. The certainty that the audience is judging you can make you nervous, stiff, and defensive instead of natural, open, and engaging. But most people in the audience really just want to learn from you. Respect them, and they’ll give you the benefit of their doubt.

Pretend that there is only one person out there, and that you’re sitting at a bar or on a park bench with them, relating your work to them. Don’t be afraid to show your passion for your work, your excitement about a cool result, your confusion about something that didn’t work, or any other emotion.

Just talk to me. Tell me your story, and show that you are doing your best to help me understand you and learn from you. You respect me, and I’ll respect you!

Emily Lakdawalla is Senior Editor at the Planetary Society and is a passionate advocate for the exploration of all of the worlds of our solar system. Through blogs, photos, videos, podcasts, print articles, Twitter, and any other medium she can put her hand to, Emily shares the adventure of space exploration with the world. The longer, unedited blog version of this is at http://tinyurl.com/cjj6xuy.

More Good Presentation Ideas

Scientists Are Humans Too (http://tinyurl.com/cmatmqm)
Giving an Academic Talk (http://tinyurl.com/z7qzo)
Spectacular Scientific Talks (http://tinyurl.com/bl88tx2)
Advice on Giving a Scientific Talk (http://tinyurl.com/c4ecaaha)

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Divine Animals: Plato, Aristotle, and the Stars

The ideas of Plato and Aristotle on the nature of the stars gave rise to distinct traditions in the history of astronomy.

By Stephen Case

Through the history of stargazing, the stars have often been perceived as simply a static, unchanging background against which constellations were outlined or planetary motion measured. [Johann Bode, Uranographia sive Astrorum Descriptio.] Unless otherwise noted, all images are courtesy the Adler Planetarium & Astronomy Museum.
Speculation on the nature of the stars has, for most of history, operated at or beyond the edge of evidence. For the early natural philosophers, naked-eye observations of the night sky were the only way to reach conclusions about the heavens.

In the centuries before the telescope, the stars provided an unchanging vista for everyone of sufficient visual acuity. Yet from this seemingly uniform set of empirical data, astronomers and philosophers reached widely varying conclusions. On the question of the stars, the writings of the two founders of Western philosophy and science, Plato (427-347 BC) and Aristotle (384-322 BC), defined opposing schools that remained influential for a millennium. While the Aristotelian view of the stars as aethereal, unearthly bodies gained dominance in the medieval period, the rediscovery of Platonic writings in the late Renaissance contributed to early modern conceptions of the stars as rotating, fiery objects. The views of Plato and his commentators, who viewed the stars as living beings — the “divine animals” of the heavens — though largely forgotten today, represent an important chapter in the history of astronomy.

**Plato’s View**

The story of the Platonic stars begins with a cautionary tale from *Timaeus*, the work in which Plato provides an account of the creation of the physical world and which remained Europe’s primary scientific text until the 12th century. In the text, Plato talks about the origin of certain animals, all of which came into being through the reincarnation of men who were philosophically lacking. In particular, birds, says Plato, “came from harmless but light-witted men, who studied the heavens but imagined in their simplicity that the surest evidence in these matters come through the eye.” For Plato, the evidence of the senses is clearly not enough to reach conclusions regarding the nature of the heavens. Trusting our eyes alone will not yield true knowledge, unless we want to run the risk of growing feathers in the next life!

To have a true knowledge of the stars, Plato argues, we must add reason to what our sight shows. Our eyes show us the luminosity and motion of the stars. Plato claims that the stars are made “for the most part of fire, that [they] might be the most bright and fair to see...” He also believes that they are spherical in shape. They are fiery because luminosity is a property of fire, and they participate in the motion of the universe as a whole — rising in the east and setting in the west — because we see them performing this motion night after night. But this for Plato is hardly the complete picture. According to Plato, these spherical, fiery objects have two motions.
In addition to their nightly revolution, they also have an axial rotation, a motion “uniform in the same place, as each always thinks the same thoughts about the same things…. The stars are “living beings divine and everlasting, which abide forever revolving uniformly upon themselves.”

To modern ears, this vision of the stars sounds at once familiar and jarring. Today we know that the stars are “fiery” objects that are both spherical and have axial rotation, but the idea of the stars as living beings certainly seems strange. For Plato, though, the idea of the stars as divine animals was intimately linked to the way they moved: circular rotation was a characteristic of rational thought. Living, rational beings — both the stars on their axes and the universe in its daily revolution from east to west — experienced rotational motion. Though the fiery nature of the stars could be argued by their luminosity, their axial rotation, for which there was no observational evidence, arose from a metaphysical claim: as living beings, the stars imitated the rational, rotational motion of the universe as a whole.

The goal of Plato’s Timaeus was to discern evidence of rationality in the universe, and for Plato the motion of the heavens and the stars was central to this. Indeed, it was the reason that astronomy was of such use to humanity. “The motions akin to the divine part in us are the thoughts and revolutions of the universe; these, therefore, every man should follow…. [B]y learning to know the harmonies and revolutions of the world, he should bring the intelligent part…into the likeness of that which intelligence discerns…."

For Plato, studying the celestial motions of astronomy brought the human mind into harmony with the rationality of the cosmos.

Debates over the physical nature of the stars had important implications for early natural philosophy. [Alain Mallet, “Planisphere,” Description de l’Univers: De La Sphera.] Both Plato and Aristotle conceived of the stars as surrounding an Earth-centered cosmos, but they differed in important ways regarding what those stars were like. [Vincenzo Coronelli, Epitome Cosmografica.]
Aristotle’s View

Though Aristotle was originally a student of Plato (and the tutor of Alexander the Great), how much his philosophy differs from that of Plato is illustrated by the first passage of Aristotle's *Metaphysics*. “All men by nature desire to know. An indication of this is the delight we take in our senses; for even apart from their usefulness they are loved for themselves; and above all others the sense of sight…. [W]e prefer sight to almost everything else. The reason is that this, most of all the senses, makes us know and brings to light many differences between things.”

Of course Aristotle, like Plato, didn’t rely on sight alone when it came to reaching conclusions regarding the heavens, but he clearly puts more emphasis on the potential of the senses to achieve real knowledge about the physical world.

Aristotle sets out his views on the stars in book II of *On the Heavens*, the work in which he explores the nature of the celestial regions. Whereas Plato posits a fiery nature for the stars based on their luminosity, Aristotle reasons the other way. He starts with the motion of the heavens as a whole to reach conclusions regarding their nature, and from that he deduces the character of the stars.

Because sight shows the motion of the sky is circular, not the natural motion of any of the terrestrial elements (not straight-line motion toward, or away from, the center of the universe), Aristotle proposes the existence of a fifth element, the aether, the natural motion of which is to move in a circle. Once the existence of this element has been established, Aristotle goes on to explain the nature of the stars. “The most logical and consistent hypothesis,” he says, “is to make each star consist of the body in which it moves, since we have maintained that there is a body whose nature it is to move in a circle.” For Aristotle the stars were composed of aether, not fire.

What of the axial rotations of the Platonic stars? In Aristotle’s universe this motion is not possible. The stars, Aristotle says, are logically either moving through the heavens or carried along with the heavens. Against the first option, he reasons from lack of evidence. They are not moving through the heavens, he says, because we do not hear them moving nor do we see the physical effects of the thunderous sound such bodies would generate. “[I]f the bodies of the stars,” he writes, “moved in a quantity either of air or of fire…the noise which they created would inevitably be tremendous, and this being so, it would reach and shatter things here on earth.”

Just as thrown stones whistle through the air, if the planets and stars move through the heavens, such large, swift bodies would generate intense noise. This does not happen, argues Aristotle, because the motion of the stars is not through the heavens but along with the heavens, like boats in a stream. Because the stars do not move freely but are carried with the heavens, they cannot also rotate as Plato...
claimed. In addition, Aristotle points out that there was no evidence they moved in such a manner. Finally, he reasons by analogy. The Moon always shows the same face to Earth, proving that it does not rotate. Likewise the other celestial objects, including the stars, would not rotate either.

**Changing Views**

Though Plato and Aristotle viewed the same stars, they reached widely different conclusions as to their natures — conclusions that resulted in distinct traditions regarding the properties of the heavens. Aristotle’s conception of the aether led him to claim a distinct divide between the eternal, changeless heavens and the ever-changing regions below the Moon. In this he had a final and powerful piece of evidence: the lack of any appreciable change among the fixed stars. This evidence was strong enough that followers of Plato went to great lengths to reconcile Plato’s claim for the fiery nature of the stars with the changeless heavens. How could the heavens be composed of elements like things on the Earth and yet be eternal?

Later Platonists such as Plotinus (204-270 AD) and Proclus (412-485 AD) explained this by differentiating between a celestial fire composing the stars and a terrestrial fire like that on Earth. Even John Philoponus (490-570 AD), the Alexandrian Christian who pushed hardest against Aristotle’s divide between celestial and terrestrial realms, admitted that while the heavens could in principle be created and destroyed, they in actuality did not decay. While Philoponus argued against the Aristotelian concept of a fifth...
element (citing, among other things, the evidence of varied star colors and brightness), their changelessness was unquestioned.

Fast-forward one thousand years. The Platonic conception of living, fiery, rotating stars had faded out in late antiquity, while the Aristotelian view prevailed. But Platonic thought reemerged in the late Renaissance through the translations and commentaries of humanists like Marsilio Ficino (1433-1499). Ficino, for example, reaffirmed Plato’s ideas of rotating stars. “Every star,” he wrote in his commentary on the Timaeus, “through its rotation about its own center, imitates the action of its soul around its own mind…."

Nicolaus Copernicus (1473-1543) read Ficino’s De Sole, in which Ficino refers to the Sun as the “greatest of stars” and the spiritual center of the universe, while Johannes Kepler (1571-1630) followed the Platonists in making the Sun the true source of life and force in the cosmos, specifically the center of force for the motion of the planets.

Within a century or so, the Platonic conception of the stars had won out. Fiery, rotating objects such as the Sun had replaced Aristotle’s aethereal stars. The divine animals, first conceptualized by Plato and his followers, had become the stars of early modern astronomy.

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The Astronomical Society of the Pacific (ASP) is 124 years old this year, and while our vision has evolved, we are still working together to advance science literacy through astronomy.

By James G. Manning
The Astronomical Society of the Pacific (ASP) is 124 years old this year, and it all happened because of a January 1, 1889, total eclipse of the Sun. Astronomers from the newly opened Lick Observatory had encouraged the local amateur photographers club to go north and photograph, meeting afterwards to share their pictures and their experiences. At that meeting, the participants decided that: “The cordial cooperation of many amateur and professional astronomers in the very successful observations of the Solar Eclipse of January 1, 1889, has again brought forward the desirability of organizing an Astronomical Society of the Pacific, in order that this pleasant and close association may not be lost, either as a scientific or as a social force.”

As a result, on February 7, 1889, the Society was born with 40 founding members and a mission: to advance the science of astronomy and diffusing information concerning it. The passing years have tweaked the mission a bit, evolving into one of increasing the public understanding and appreciation of astronomy, and most recently: to advance science literacy through astronomy. We may be getting less loquacious as the decades pass, but the Society remains true to the astronomical focus at its heart, even as it responds and adapts to the challenges of an ever-changing world.

In 2003, the ASP confirmed a trend that had been developing for several decades: an increased focus on education. In fact, the vision statement developed as part of the 2003 Strategic Plan stated that the ASP wanted: to be, and to be generally recognized among its target audiences and communities as, the nation’s leading non-governmental organization whose primary purpose is the advancement and improvement of astronomy and space science education. Its professional publications, its membership program, its annual meeting, and its products would all continue, but increasingly, the Society would aim to make a dent in the science education landscape.

Strategic Impacts
As a result of the 2003 Strategic Plan, a great deal of educational impact (read “dent”) has in fact occurred during the last decade. And the accumulated impact is becoming impressive, we think, as the following several examples illustrate.

Project ASTRO is a national program that improves the teaching of astronomy and physical science by linking professional and amateur astronomers with local educators. Some 3,000 teacher/astronomer teams have been trained to provide hands-on astronomy lessons to an estimated 350,000 school children at sites around the country since the program’s inception in the 1990s.

Night Sky Network (NSN) is a community of hundreds of astronomy clubs across the US that share their time and telescopes to provide the public with unique astronomy experiences. We provide this NASA-branded network of 425 astronomy clubs with training and materials to enhance their public astronomy outreach events, and
they have responded in kind by impressively logging (to date) more than 23,000 events reaching 2.4 million people.

**Astronomy From the Ground Up (AFGU)** provides informal science educators and interpreters with new and innovative ways to communicate astronomy. Currently, some 975 informal educators at 700 museums, nature centers, and national parks have gone through the program — increasing the astronomy education capacity of these informal educators within those 700 museums, nature centers, and national parks that have a combined estimated annual attendance of 117 million.

Our publications also have a significant impact. The *Publications of the Astronomical Society of the Pacific (PASP)* has appeared continuously since 1889 and has released 910 issues during those 124 years. The *ASP Conference Series (ASPCS)* has published more than 470 volumes to date; in 2012 the ASPCS website was visited 100,000 times by more than 60,000 unique visitors from 156 countries.

**We Never Stop**

But do we rest on these laurels? Hardly.

Just as some sharks need to keep moving to keep water flowing over their gills so they receive the oxygen necessary to survive, the ASP also always keeps moving, looking for the next opportunity to advance its mission and do good in the world. A not-for-profit organization such as ours can never stand still, and we have continued to move forward. Not long ago we established a new Strategic Plan whose vision statement is: *The Astronomical Society of the Pacific will be an internationally recognized leader in bringing together a community of scientists, educators, communicators, amateur astronomers, and the public to advance science and science literacy. We continue to move and evolve with the tide of change in our environment.*

Within our Strategic Plan are four main goals for the Society, each anchored to a key word for easier recall.

- **Goal One: Continuity.** The Society will continue to serve its primary constituencies with existing and proven programs, networks, and services, and will develop new initiatives to serve these groups.
- **Goal Two: Connectivity.** The Society will use its unique position to build bridges and create stronger opportunities for connections between the constituencies we serve in goal one.
- **Goal Three: Visibility.** The Society will become more visible and to wider audiences in performing this work.
- **Goal Four: Sustainability.** The Society will develop and/or acquire the means to sustain the efforts described in goals one, two, and three.

**New Initiatives**

A couple of examples may serve to illustrate how the four strategic goals vibrate through our programs and efforts.

We have recently received a major National Science Foundation grant for a new informal education initiative called **My Sky Tonight.** This is a full-scale development project designed to create a core competence in informal science education (ISE) around astronomy learning for young children three to five years old.

![Peggy Henderson](image1.png)
years of age. The project will develop and fully implement early childhood astronomy activities in the first field-wide effort to increase the capacity of ISE institutions to effectively engage our youngest visitors in the domain.

With this project, we are building on our experience, our track record, and our past programs to take new directions and serve new audiences — young children and their families. The effort creates Continuity by providing a new avenue for a current target constituency — informal science educators — to benefit from the work we are doing and offer effective programming for young children.

My Sky Tonight will Connect informal science educators with the public, specifically families with young children. This project also has the potential to find its way into various networks, such as the 700 museums we serve through the AGFU network, to be widely dispersed and appropriately branded to create Visibility for the work of the ASP.

Finally, the NSF grant offers Sustainability for the project through its conclusion, with the possibility of the development of commercial products available for families with young children to help fund further efforts, and accomplishments, upon which further initiatives may be developed.

A second example is the newly announced NASA Discovery Mission to Mars called InSight, which will place a seismometer and heat flow instrument on Mars to study its deep core and help scientists understand the processes that formed the rocky planets of the inner solar system. The ASP is a partner in the mission and will develop a hands-on education toolkit on seismology, vulcanology, and other related subjects for the Night Sky Network (presuming the EPO effort survives the current extreme action proposed in the President’s GFY14 budget proposal — see page 2).

With this project, we are providing Continuity through a new product/program for amateur astronomers in the NSN. This also represents an opportunity to Connect amateur astronomers with InSight and planetary scientists. And it’s hard not to get Visibility when you’re part of a NASA mission going to Mars! The funding and the toolkit that will be produced as part of this program as a permanent product will help the Sustainability of the Society as well.

Opportunities
While these two new initiatives are good for us and very much in line with our Strategic Plan, we’re still not resting on our laurels. Like that shark I alluded to earlier, we have to keep moving. In thinking about the future, I see three significant opportunities for us to develop as we continue to apply our Strategic Plan to the good work that we do.

• The Society has supported many of its mission-advancing programs with funding secured via competitive grants at the federal level. As this landscape continues to shift, we are making strides to diversify our portfolio of public and private funding
sources, and increase private sector partnerships in support of advancing STEM learning and literacy through the appealing avenue of astronomy. Corporations, foundations, and individuals all have a stake in a science-literate future; we look forward to showcasing existing programs and offering exciting new initiatives to advance our shared strategic objectives.

- While we serve a number of professional constituencies and leverage our efforts with them by providing training — for example, to enhance their work with their own audiences — we’re also looking at developing more direct public outreach initiatives. By increasing our visibility among more diverse communities, and offering new connections to the ASP and our work with the public, we aim to increase our footprint and our impact in advancing our mission.

- The world runs online these days, and we are excited by opportunities to take advantage in ways far beyond Facebook and Twitter. Our new dynamic website, our online Member/Donor portal making member and supporter interactions and donations easy and secure, and our Annual Meeting app that will enable individual event management, networking, and connectivity in San Jose, are a few examples of where we are going and what we can do by employing social media tools and technologies in support of our mission, our members, and the constituencies we serve.

Our Ultimate Goal
As these examples suggest, the ASP is very busy and active, and is always looking for — and coming up with — new ways to innovate and build on where we’ve been to secure our path forward to enable us to touch lives in all the ways that we do, though all the programs and resources that we offer; help people find their way in the big, wide universe; and encourage people to look up and understand what they’re seeing up there. And to build on the past — the astronomical past and the ASP’s past — to engage the future.

Engaging the future can mean many things. What it means to me, in the context of the ASP, is to turn today’s children into tomorrow’s scientists, science teachers, and science-literate and engaged adults, for the benefit of society, our species, and our planet. It doesn’t get much bigger than that! With our funding partners, our members, our staff, and our Board working together to move the organization forward, we truly can achieve our ultimate goal: to leave a footprint bigger than the size of our shoe. And always — advancing science literacy through astronomy.

JAMES G. MANNING is the Executive Director of the Astronomical Society of the Pacific.
NASA’s GRAIL Mission Solves Moon Mystery
Goddard Space Flight Center

MORE INFORMATION: http://tinyurl.com/kp5n6rm

NASA’s Gravity Recovery and Interior Laboratory (GRAIL) mission has uncovered the origin of massive invisible regions that make the Moon’s gravity uneven, a phenomenon that affects the operations of lunar-orbiting spacecraft.

GRAIL’s twin spacecraft studied the internal structure and composition of the Moon in unprecedented detail for nine months. They pinpointed the locations of large, dense regions called mass concentrations, or mascons, which are characterized by strong gravitational pull. Mascons lurk beneath the lunar surface and cannot be seen by normal optical cameras.

GRAIL scientists found the mascons by combining the gravity data from GRAIL with sophisticated computer models of large asteroid impacts and known detail about the geologic evolution of the impact craters.

“GRAIL data confirm that lunar mascons were generated when large asteroids or comets impacted the ancient Moon, when its interior was much hotter than it is now,” said Jay Melosh, a GRAIL co-investigator at Purdue University in West Lafayette, Ind. “We believe the data from GRAIL show how the Moon’s light crust and dense mantle combined with the shock of a large impact to create the distinctive pattern of density anomalies that we recognize as mascons.”

The origin of lunar mascons has been a mystery in planetary science since their discovery in 1968 by a team at NASA’s Jet Propulsion Laboratory. Researchers generally agree mascons resulted from ancient impacts billions of years ago. It was not clear until now how much of the unseen excess mass resulted from lava filling the crater or iron-rich mantle upwelling to the crust.
Saturn is Like an Antiques Shop, Cassini Suggests

NASA/Jet Propulsion Laboratory

MORE INFORMATION: http://tinyurl.com/k4ogs22

A new analysis of data from NASA’s Cassini spacecraft suggests that Saturn’s moons and rings are gently worn vintage goods from around the time of our solar system’s birth. Though they are tinted on the surface from recent “pollution,” these bodies date back more than four billion years. They are from around the time that the planetary bodies in our neighborhood began to form out of the proto-planetary nebula, the cloud of material still orbiting the Sun after its ignition as a star.

“Studying the Saturnian system helps us understand the chemical and physical evolution of our entire solar system,” said Gianrico Filacchione, a Cassini participating scientist at Italy’s National Institute for Astrophysics, Rome. “We know now that understanding this evolution requires not just studying a single moon or ring, but piecing together the relationships intertwining these bodies.”

Data from Cassini’s visual and infrared mapping spectrometer (VIMS) have revealed how water ice and also colors — which are the signs of non-water and organic materials — are distributed throughout the Saturnian system. The spectrometer’s data in the visible part of the light spectrum show that coloring on the rings and moons generally is only skin-deep.

Using its infrared range, VIMS also detected abundant water ice — too much to have been deposited by comets or other recent means. So the authors deduce that the water ices must have formed around the time of the birth of the solar system, because Saturn orbits the Sun beyond the so-called “snow line.” Out beyond the snow line, in the outer solar system where Saturn resides, the environment is conducive to preserving water ice, like a deep freezer.
Stars Don’t Obliterate Their Planets (Very Often)
NASA/Jet Propulsion Laboratory

MORE INFORMATION: http://tinyurl.com/kvwq7qz

Stars have an alluring pull on planets, especially those in a class called hot Jupiters, which are gas giants that form farther from their stars before migrating inward and heating up. Now, a new study using data from NASA’s Kepler Space Telescope shows that hot Jupiters, despite their close-in orbits, are not regularly consumed by their stars. Instead, the planets remain in fairly stable orbits for billions of years, until the day comes when they may ultimately get eaten.

“Eventually, all hot Jupiters get closer and closer to their stars, but in this study we are showing that this process stops before the stars get too close,” said Peter Plavchan of NASA’s Exoplanet Science Institute at the California Institute of Technology, Pasadena, Calif. “The planets mostly stabilize once their orbits become circular, whipping around their stars every few days.”

The study is the first to demonstrate how the hot Jupiter planets halt their inward march on stars. Gravitational, or tidal, forces of a star circularize and stabilize a planet’s orbit; when its orbit finally become circular, the migration ceases.

“When only a few hot Jupiters were known, several models could explain the observations;” said Jack Lissauer, a Kepler scientist at NASA’s Ames Research Center, Moffet Field, Calif., not affiliated with the study. “But finding trends in populations of these planets shows that tides, in combination with gravitational forces by often unseen planetary and stellar companions, can bring these giant planets close to their host stars.”

The new study answers questions about the end of the hot Jupiters’ travels, revealing what put the brakes on their migration. Previously, there were a handful of theories explaining how this might occur.
ALMA Discovers Comet Factory

European Southern Observatory

MORE INFORMATION: http://tinyurl.com/ktnf8je

Astronomers using the new Atacama Large Millimeter/submillimeter Array (ALMA) have imaged a region around a young star where dust particles can grow by clumping together. This is the first time that such a dust trap has been clearly observed and modeled. It solves a long-standing mystery about how dust particles in discs grow to larger sizes so that they can eventually form comets, planets and other rocky bodies.

Nienke van der Marel, a PhD student at Leiden Observatory in the Netherlands, was using ALMA along with her co-workers, to study the disc in a system called Oph-IRS 48. They found that the star was circled by a ring of gas with a central hole that was probably created by an unseen planet or companion star. Earlier observations using ESO’s Very Large Telescope had already shown that the small dust particles also formed a similar ring structure. But the new ALMA view of where the larger millimeter-sized dust particles were found was very different.

“At first the shape of the dust in the image came as a complete surprise to us,” says van der Marel. “Instead of the ring we had expected to see, we found a very clear cashew-nut shape. We had to convince ourselves that this feature was real, but the strong signal and sharpness of the ALMA observations left no doubt about the structure. Then we realized what we had found.”

What had been discovered was a region where bigger dust grains were trapped and could grow much larger by colliding and sticking together. This was a dust trap — just what the theorists were looking for. The dust trap forms as bigger dust particles move in the direction of regions of higher pressure.
New Kind of Variable Star Discovered
European Southern Observatory

MORE INFORMATION: http://tinyurl.com/npcr6hz

Astronomers using the Swiss 1.2-metre Euler telescope at ESO’s La Silla Observatory in Chile have found a new type of variable star. The discovery was based on the detection of very tiny changes in brightness of stars in a cluster. The observations revealed previously unknown properties of these stars that defy current theories and raise questions about the origin of the variations.

The new results are based on regular measurements of the brightness of more than three thousand stars in the open star cluster NGC 3766 over a period of seven years. They reveal how 36 of the cluster’s stars followed an unexpected pattern — they had tiny regular variations in their brightness at the level of 0.1% of the stars’ normal brightness. These variations had periods between about two and 20 hours. The stars are somewhat hotter and brighter than the Sun, but otherwise apparently unremarkable. The new class of variable stars is yet to be given a name.

This level of precision in the measurements is twice as good as that achieved by comparable studies from other telescopes — and sufficient to reveal these tiny variations for the first time.

Although the cause of the variability remains unknown, there is a tantalizing clue: some of the stars seem to be fast rotators. They spin at speeds that are more than half of their critical velocity, which is the threshold where stars become unstable and throw off material into space.
International Team Strengthens Big Bang Theory

*W.M. Keck Observatory*

MORE INFORMATION: [http://tinyurl.com/lq2orfd](http://tinyurl.com/lq2orfd)

An international team of scientists using the most powerful telescope on Earth has discovered the moments just after the Big Bang happened more like the theory predicts, eliminating a significant discrepancy that troubled physicists for two decades.

One of the most important problems in physics and astronomy was the inconsistency between the lithium isotopes previously observed in the oldest stars in our galaxy, which suggested levels about two hundred times more Li-6 and about three to five times less Li-7 than Big Bang nucleosynthesis predicts. This serious problem in our understanding of the early universe has invoked exotic physics and fruitless searches for pre-galactic production sources to reconcile the differences.

The team, led by Karin Lind of the University of Cambridge, has proven the decades-old inventory relied on lower quality observational data with analysis using several simplifications that resulted in spurious detections of lithium isotopes.

Using observations of ancient stars with W. M. Keck Observatory’s 10-meter telescope and state-of-the-art models of their atmospheres has shown that there is no conflict between their lithium-6 and lithium-7 content and predictions of the standard theory of Big Bang nucleosynthesis, thus restoring the order in our theory of the early universe.

Taking accurate measurements of lithium-6 and lithium-7 in old stars is extremely challenging, both from a theoretical and observational perspective, in particular for lithium-6, because being the less abundant isotope of lithium, its signature is very weak.

Even with the mighty Keck I telescope, a single star must be observed for several hours to gather enough photons for a detailed observation. The modeling of such data is also very demanding.
Earth’s Milky Way Neighborhood Gets More Respect

National Radio Astronomy Observatory

MORE INFORMATION: http://tinyurl.com/l4c3ufb

Our solar system’s Milky Way neighborhood just went upscale. We reside between two major spiral arms of our home galaxy, in a structure called the Local Arm. New research using the ultra-sharp radio vision of the National Science Foundation’s Very Long Baseline Array (VLBA) indicates that the Local Arm, previously thought to be only a small spur, instead is much more like the adjacent major arms, and is likely a significant branch of one of them.

“Our new evidence suggests that the Local Arm should appear as a prominent feature of the Milky Way,” said Alberto Sanna, of the Max-Planck Institute for Radio Astronomy. Sanna and his colleagues presented their findings to the American Astronomical Society’s June 2013 meeting in Indianapolis, Indiana.

Determining the structure of our own galaxy has been a long-standing problem for astronomers because we are inside it.

To help resolve this problem, researchers turned to the VLBA and its ability to make the most accurate measurements of positions in the sky available to astronomers. A striking result was an upgrade to the status of the Local Arm within which our solar system resides. We are between two major spiral arms of the galaxy, the Sagittarius Arm and the Perseus Arm. The Sagittarius Arm is closer to the galactic center and the Perseus Arm is farther out in the galaxy. The Local Arm previously was thought to be a minor structure, a “spur” between the two longer arms.

“Based on both the distances and the space motions we measured, our Local Arm is not a spur. It is a major structure, maybe a branch of the Perseus Arm, or possibly an independent arm segment,” Sanna said.

The scientists also presented new details about the distribution of star formation in the Perseus Arm, and about the more-distant Outer Arm, which encompasses a warp in our galaxy.
A Video Map of Motions in the Nearby Universe

*Institute for Astronomy, University of Hawaii*

MORE INFORMATION: http://tinyurl.com/k55yi57

An international team of researchers, including University of Hawaii at Manoa astronomer Brent Tully, has mapped the motions of structures of the nearby universe in greater detail than ever before. The maps are presented as a video, which provides a dynamic three-dimensional representation of the universe through the use of rotation, panning, and zooming. The Cosmic Flows project has mapped visible and dark matter densities around our Milky Way galaxy up to a distance of 300 million light-years.

The large-scale structure of the universe is a complex web of clusters, filaments, and voids. Large voids — relatively empty spaces — are bounded by filaments that form superclusters of galaxies, the largest structures in the universe. Our Milky Way galaxy lies in a supercluster of 100,000 galaxies.

Just as the movement of tectonic plates reveals the properties of Earth’s interior, the movements of the galaxies reveal information about the main constituents of the universe: dark energy and dark matter. Dark matter is unseen matter whose presence can be deduced only by its effect on the motions of galaxies and stars because it does not give off or reflect light. Dark energy is the mysterious force that is causing the expansion of the universe to accelerate.

Map showing all galaxies in the local universe color-coded by their distance to us: blue galaxies are the closest, and red are farther, up to 300 million light-years away. (Institute for Astronomy)
Catherine Wolfe Bruce Gold Medal

Established by Catherine Wolfe Bruce, and first awarded in 1898, for a lifetime of outstanding research in astronomy.

Dr. James Edward Gunn, Princeton University.

Dr. Gunn is the Eugene Higgins Professor Emeritus of Astronomy at Princeton University. He is considered the Leonardo da Vinci of his time, having made significant contributions to all three main branches of any science: theory, observation, and instrumentation development.

Dr. Gunn earned his bachelor’s degree at Rice University in Houston, Texas, in 1961, and his PhD from the California Institute of Technology (Caltech) in 1966. Two years later, he joined the faculty of Princeton University. Subsequently, he worked at the University of California at Berkeley and Caltech before returning to Princeton.

Dr. Gunn’s early theoretical work in astronomy helped establish the current understanding of how galaxies form and the properties of the space between galaxies. He also suggested important observational tests to confirm the presence of dark matter in galaxies, and predicted the existence of a Gunn–Peterson trough in the spectra of distant quasars. In the mid-1960s, Gunn and fellow graduate student, Bruce Peterson, realized that quasars could be used as distant background sources to detect tenuous neutral hydrogen in intergalactic space between Earth and the quasar. Hydrogen uniformly distributed in intergalactic space produces overlapping absorption lines that appear like a trough in the spectrum of quasars. Confirming his prediction, a Gunn-Peterson trough was observed in 2001 in the spectrum of an extremely distant quasar (with redshift \( z = 6.28 \)) that was found by the Sloan Digital Sky Survey.

Much of Dr. Gunn’s later work has involved leadership in major observational projects. He developed plans for one of the first uses of digital camera technology for space observation, a project that led to the Sloan Digital Sky Survey, the most extensive three-dimensional mapping of the universe to date. He was a pioneer in adapting the Charged Coupled Device (CCD) for routine use in astronomy and also played a major role in designing the Wide Field and Planetary Camera on the Hubble Space Telescope.

Three of his many distinguished awards include the Gold Medal of the Royal Astronomical Society (1994), the Crafoord Prize, awarded in subjects not eligible for the Nobel Prize (2005), and the Henry Norris Russell Lectureship, the highest honor of the American Astronomical Society (2005). Dr. Gunn is a Member of the National Academy of Sciences.
Las Cumbres Amateur Outreach Award for outstanding outreach by an amateur astronomer to children and the public.

Chuck Bueter, South Bend, Indiana (Informal Education Professional)

As an amateur astronomer dedicated to science education through astronomy public outreach, Chuck Bueter has demonstrated exceptional skill, enthusiasm, creativity, and personal dedication in his many programs and activities for all ages. Through his websites, regular blogs, tweets, creative educational concepts, and above all his accessibility, Chuck has connected with the public both nationally and globally for several decades. Just a selective list of his outstanding achievements includes his innovative Paper Plate educational activities; his mentorship and various instructional contributions to the Kids Astro Camp; his papers, workshops, and contributions to the Great Lakes Planetarium Association; his long association with the outreach activities of the Michiana Astronomical Society; his widely acclaimed Transit of Venus programs in 2004 and 2012; and his longstanding advocacy for dark skies through his association with the Dark Skies Working Group and other initiatives including his Let There Be Night planetarium show. Fellow educators, amateur and professional astronomers, and innumerable K-12 students and members of the public who have been enlightened by Chuck Bueter, universally agree that he is an inspiration in what an entrepreneurial individual citizen can do to promote science education.

Robert J. Trumpler Award for a recent PhD thesis considered unusually important to astronomy.

Gurtina Besla, Columbia University, New York

This award recognizes the PhD work that Gurtina Besla carried out at Harvard University, under the supervision of Lars Henquist. Her thesis was titled “Modeling the Magellanic System: Insights into Galactic Accretion and Evolution.”

In her thesis, she proposed an entirely new theory for the evolutionary history of the Magellanic Clouds, according to which they have only recently entered the halo of the Milky Way. This paper has had a significant impact on efforts to understand the assembly history of our galaxy and has already been cited more than 150 times. In addition, it has spawned a number of follow-up studies led by Gurtina, demonstrating that this new picture can explain in a novel manner the origin of the Magellanic Stream; the present proximity of the Large and Small Magellanic Clouds; the unexpectedly high frequency of microlensing events observed towards the LMC; the internal stellar populations and kinematics of both the LMC and SMC; the off-center bar in the LMC; and the discovery of a stellar population in the LMC with anomalous colors and kinematic properties. Her work is highly original and marked by deep physical insight. She effectively combines theoretical work, simulations, and data analysis in a way that’s remarkable for someone just beginning a career in astrophysics.
Klumpke-Roberts Award for outstanding contributions to the public understanding and appreciation of astronomy.

Dr. Mary Kay Hemenway, University of Texas at Austin

Mary Kay began her career at the University of Texas (UT) Austin in 1977, where she has instructed thousands of undergraduates, graduates, and teachers. For 30 years, she served as Director, Educational Services Office of the Astronomy Department, which supports all teaching aspects for a department that enrolls more than 3,000 students per year in astronomy courses. She been a senior lecturer in the Department of Astronomy and a research associate at McDonald Observatory, leading education programs for K-12 teachers and students with more than 20 summer teacher professional development workshops, developing exhibits at the observatory, writing curriculum for K-12 and undergraduate education, and working directly with schools and science teacher organizations.

Mary Kay is a national and international leader in astronomy education. She was the Education Officer for the American Astronomical Society for eight years, and also served as the President of IAU’s Division C on Education, Outreach and Heritage. In 2009, the AAS awarded Mary Kay its Education Prize in recognition of her outstanding contributions to the education of the public, students and the next generation of professional astronomers. And from 1999 to 2012, Mary Kay served as the secretary to the Board of Directors of the ASP.

The Thomas J. Brennan Award for exceptional achievement related to the teaching of astronomy at the high school level.

Gregg Williams, Merrillville, Indiana, School District (Planetarium Director)

Gregg teaches the Merrillville High astronomy class, which he developed for both a one- and two-semester course. He prepares and presents programs for a wide variety of classes, including not only for high school, but also for grades K-8.

Gregg has taught classes for teachers in Northwestern Indiana on the use of Starlab Planetariums and planetarium astronomy, and he has helped greatly regional teachers who are new to the planetarium education profession. Gregg has been active in the Great Lakes Planetarium Association, serving on the Executive Committee and hosting the GLPA conferences twice at Merrillville. He offers public programs in the Merrillville planetarium and evening sky viewing with telescopes. During the 30-plus years that Gregg has been in his position, he has seen and positively affected more than a half million students and adults in the Merrillville community.

Gregg has been an outstanding mentor to hundreds of students in grades 7-12, each year accepting 40 students from these grades into a Planetarium Astronomy Club. A former student, now a teacher, writes, “Mr. Williams has had a significant impact on my teaching techniques and style. I have been able to use many of his
motivational techniques in my own classroom with great success.” Gregg Williams is a master teacher.

**Richard H. Emmons Award** for excellence in college astronomy teaching.

**Charles Tolbert, Professor Emeritus, Astronomy Department, University of Virginia**

Charlie Tolbert has been at the University of Virginia since 1967, where his introductory astronomy sequence has been one of the most popular courses for more than 40 years. In that time, he has delivered nearly 5,000 lectures to more than 31,000 students, inspiring a legion of people with his love of astronomy. He has offered hundreds of astronomy programs and tours of McCormick Observatory. Charlie is well known for his enthusiastic and engaging lecture style and is one of the most popular professors at the University of Virginia.

Charlie also has a national reputation as a leader in astronomy education. He was the Education Officer for the American Astronomical Society from 1985-91, during which he managed the Harlow Shapely Visiting Lectureship program and published the brochure “Understanding the Universe: A Career in Astronomy.” He has been a member of the International Astronomical Union’s Commission on Astronomy Education and Commission on the Exchange of Astronomers, and a member of the American Institute of Physics Programs Policy Committee. Charlie’s legacy will not only be the thousands of students that he instructed directly, but the dozens of faculty and graduate students that he inspired through his example as an enthusiastic and dedicated astronomy educator.

**Priscilla and Bart Bok Award**

The Priscilla and Bart Bok Awards are given jointly by the ASP and the American Astronomical Society at the annual Intel International Science and Engineering Fair (the world’s largest international pre-college science competition). The main criterion for selecting the two annual Bok Award winners is scientific merit.

The Bok prize is named for Bart and Priscilla Bok. Bart Bok was an accomplished research astronomer who made important contributions to scientific understanding of the Milky Way and star formation. Throughout his life, and especially as an ASP Board member, Bok was a strong advocate for education and outreach in astronomy as was his wife, Priscilla, also a distinguished astronomer. This year the three judges for this award were Katy Garmany (lead judge), NOAO; Dr. John Glaspey, NOAO (retired); and Dr. Chris Groppi, School of Earth and Space Exploration, Arizona State University.

The Bok first award of $1,000 went to Arjun Raghavan for his project “Photometric Evidence of Changes in Pulsation Characteristics of Hot Subdwarf B Stars.” He attends Chapel Hill High School, Chapel Hill NC, and is a rising senior.

The Bok second award of $500 went to Michaela Brchnelova for her project “X-Ray Measurements of Tycho Supernova Remnant’s...”
Dynamics.” She is also a rising senior at Gymnazium Hubeneho 23 in Slovakia.

Incidentally, one of the top prizes at the entire fair (the Intel Foundation Young Scientist Award of $50,000) went to Henry Lin, 17, of Shreveport, La. — our second place Bok winner from last year.

Contributed by Katy Garmany

NEW MEMBERS — The ASP welcomes new members who joined between April 1 and June 15, 2013.

General Membership
David Begay, Friday Harbor, WA
Michaela Brchnelova, Bratislava, Slovakia
James M. Carlisle, San Antonio, TX
Geneviève E. de Messières, Silver Spring, MD
David E. Dunn, Rocklin, CA
Romeo Durscher, Stanford, CA
Helene Flohic, Santiago, Chile
Joseph L. Fragola, San Jose, CA
Jim Goodridge, Grasswood SK, Canada
Filip Jagodzinski, Ellensburg, WA
Jeyhan Kartaltepe, Tucson, AZ
Nancy C. Maryboy, Friday Harbor, WA
Jeremy D. Murphy, Princeton, NJ

Cassandra Paul, San Jose, CA
Christina Pease, New York, NY
Carolyn Peruta, Rohnert Park, CA
Arjun Raghavan, Chapel Hill, NC
Neil Reynolds, Johannesburg, CA
Elise J. Ricard, San Francisco, CA
Michael J. Roberts, San Francisco, CA
Aaron Romanowsky, Scotts Valley, CA
Samantha M. Thompson, Flagstaff, AZ
David A. Ventimiglia, San Francisco, CA

Technical Membership
John B. Brown, Tucson, AZ
William H. Nelson, Birmingham, AL

Astronomy compels the soul to look upwards and leads us from this world to another.
— Plato

Leave a universal legacy...

Astronomy shows us that we are part of something much greater than ourselves, and that our actions on Earth have a lasting impact. A legacy gift to the ASP as part of your estate plan reflects this understanding, and will support future generations as they reach for the stars.

astrosociety.org/donate or (415) 337-1100 x106
The Skies of August

Save the date: the night of August 11/12. This is when the **Perseid meteor shower** peaks. There’s no Moon to interfere with your enjoyment of this annual shower, so plan to be somewhere dark that evening to see if you can spot the 60-plus meteors per hour that often grace the summer sky. The best block of time to observe is from 11pm on the 11th until dawn on the 12th (that’s Sunday night to Monday morning). The night of August 10/11 is reasonably good, too, if you can’t stay up late on the 11th/12th.

Why is the shower called the Perseids? If you track the paths of the meteors backwards, you’ll notice that they appear to come from a particular spot in the sky. That spot is called the **radiant**, and the constellation in which a shower’s radiant lies lends its name to the meteor shower. As you can see on the sky chart (right), the radiant for the Perseids lies in northern Perseus, below the eastern portion of the W-shape of stars that forms Cassiopeia.

As for where to look? Don’t stare at the radiant; look off to one side. Some observers think it’s best to watch the area between the radiant and the zenith (the point directly overhead). Regardless, gaze toward the darkest part of your sky, and try to avoid lights that will spoil the darkness and your ability to spot the fainter Perseids.

If you miss this year’s shower or are clouded out, note that in 2014 the Moon is just past full on Perseid night (that’s bad) but the Moon is almost new on Perseid night in 2015 (that’s good).

As the month opens, **Venus** continues to hang low in the west after sunset. On the 9th, this brilliant planet is to the upper right of the 3-day-old crescent Moon, though you may find Venus in the twilight before you spot the Moon. On the 10th the Moon is almost due east of Venus. Two days later, the now 6-day-old Moon is below **Saturn**. The ringed world will soon be lost in the solar glare, so now is the time to take out your telescope and explore Saturn, its rings,
and as many moons as you can find.

Mars, Jupiter, and Mercury are all in the dawn sky. Jupiter rises first — 2.5 hours before the Sun at the start of August and 4.5 hours prior to sunrise at month’s end. It is easy to spot as it’s the brightest object in the morning sky. But if you need confirmation, the crescent Moon is to Jupiter’s upper right on the 3rd and to its immediate right on the 31st.

On the 4th, use the lunar crescent as a guide to the other two planets. About two hours before sunrise, dim red Mars is roughly 6° to the upper left of the Moon, while brighter Mercury is some 8° to the Moon’s lower left. But while Mars continues to rise, Mercury plunges back into the solar glare during the second week of the month.

**The Skies of September**

Venus continues to stay ahead of the Sun, setting about 90 minutes after sunset during the entire month. While it remains low in the west and southwest as dusk falls, its visibility improves simply because it’s now getting darker faster after sunset. On the 8th, Venus and the crescent Moon make a lovely pair as twilight deepens — a fine target for astrophotographers who like Earth and sky scenics.

The next night the Moon sits to the far left of Saturn. The ringed planet is rapidly falling sunward, but first it slides by Venus. From the 16th to the 19th inclusive, Saturn is some 4° to the upper right of much-brighter Venus.

In the morning sky, Mars rises more than three hours before the Sun and is high in the east before sunrise. On the 2nd, the faint red planet is roughly 8° to the upper left of the thin crescent Moon. Rising 90 minutes before Mars is giant Jupiter, not at all hard to spot in the predawn sky. On the 1st Jupiter sits far above the crescent Moon, while during the morning hours of the 28th the giant planet rests to the Moon’s upper left. Mercury is hard to spot until month-end.

The Autumnal Equinox occurs on the 22nd at 4:44 pm Eastern time; 1:44 pm Pacific time.

**The Skies of October**

Here’s a real challenge for those with a clear and low western sky. On October 6, about 30 minutes after sunset, use a pair of binoculars to scan the west-southwest. Can you spot the 2-day-old crescent Moon a mere 5° above the horizon? If so, look beneath the Moon; if you see a very faint dot of light, that’s Mercury. Then tilt your binoculars up very slightly; if you spot an even fainter dot above the crescent, that’s Saturn. Both planets will hang around, extremely low in the west, for the rest of the month, but early October is, realistically, your only chance to “easily” spot them this month.

On the 7th and 8th the crescent Moon passes Venus; there’s no missing this brilliant planet. By month’s end the planet doesn’t set until more than two hours after the Sun. Have a peek at this veiled world through a small telescope; does it look like a cloudy first-quarter Moon? If you follow Venus for the rest of the year, you’ll see that ‘half-moon’ phase change to a thin crescent, even as the planet slowly grows larger in your scope’s field of view.

Meanwhile, Jupiter rises in the east before midnight; the Moon
visits on the 25th and 26th. And Mars continues to sit higher into the east during the early morning hours. It’s still pretty dim — it’s 18 months until it is at its brightest once again — so look for a faint reddish star to the upper left of the crescent Moon on the morning of the 1st, and to the far left of the lunar crescent on the 29th.

October 12 is International Observe the Moon night. Visit observe-the-moonnight.org to learn more. Also on the 12th is the autumn version of Astronomy Day, so get out and share the sky with your friends.

Coming Soon…
As November approaches, the astronomical community (and the world in general) will be abuzz about Comet ISON. Already dubbed the “Comet of the Century” by some, this comet will swing by the Sun on November 28th and may put on a nice show in the dawn skies of early December. But less then six months prior to perihelion (closest approach to the Sun), its brightness was less than what had been initially predicted. Regardless, Comet ISON will be in the dawn sky in early December, and it should be a pretty sight (even if it’s not comet-of-the-century material). For reliable information, check Sky & Telescope’s Comet ISON update page [http://tinyurl.com/lx5um3f].

S&T Sky Charts
Thanks to Sky & Telescope magazine, Mercury readers have direct access to S&T’s online Interactive Sky Chart, which is a Java applet that simulates a naked-eye view of the sky from any location on Earth at any time of night. Charted stars and planets are the ones typically visible without optical aid under clear suburban skies. Some deep-sky objects that can be seen in binoculars are plotted too. If you have trouble getting the Sky Chart to open on your computer, please review S&T’s detailed system requirements and their Help page. Note that Java must be enabled on your browser.

Links to Sky & Telescope’s Interactive Star Chart: August • September • October
These links will take you to a chart set for 40° north latitude and 100° west longitude (useful throughout the continental US) at 10:00 pm local time at mid-month in August, and 9:00 pm in September and October. The chart can be used one hour later at the start of each month and one hour earlier at month-end.

You can alter the chart’s date, time, and location; detailed instructions and hints for using the chart can be found on the Help page. To really become familiar with this program, see the article: Fun with S&T’s Interactive Sky Chart.

For iPad Users
S&T’s Interactive Sky Chart does not work on the iPad; try the SkySafari 3 app (through iTunes). Here is a review. If ASP iPad users have another favorite, please tell me about it.
The Americas by Day and Night

These stunning views of North, Central, and much of South America are not individual images. Rather, they are composite photos, created by stitching together a number of swaths of the Earth’s surface, as imaged by the Suomi NPP spacecraft (Suomi National Polar-orbiting Partnership) during several orbits of the robotic satellite, and digitally projected onto a globe. A multitude of features are visible on the high-resolution versions; go here (http://tinyurl.com/mny4pz3) to download your own hi-res copies. [NASA Earth Observatory images by Robert Simmon, using Suomi NPP VIIRS data from Chris Elvidge (NOAA National Geophysical Data Center). Suomi NPP is the result of a partnership between NASA, NOAA, and the Department of Defense.]